B&K PRECISION®

Models: 894, 895

500 kHz/1 MHz LCR Meter

USER MANUAL

Safety Summary

The following safety precautions apply to both operating and maintenance personnel and must be followed during all phases of operation, service, and repair of this instrument.

⚠WARNING

Before applying power to this instrument:
Read and understand the safety and operational information in this manual.
Apply all the listed safety precautions.
Verify that the voltage selector at the line power cord input is set to the correct line voltage. Operating the instrument at an incorrect line voltage will void the warranty.
Make all connections to the instrument before applying power.
Do not operate the instrument in ways not specified by this manual or by B&K Precision.

Failure to comply with these precautions or with warnings elsewhere in this manual violates the safety standards of design, manufacture, and intended use of the instrument. B&K Precision assumes no liability for a customer's failure to comply with these requirements.

Category rating
The IEC 61010 standard defines safety category ratings that specify the amount of electrical energy available and the voltage impulses that may occur on electrical conductors associated with these category ratings. The category rating is a Roman numeral of I, II, III, or IV. This rating is also accompanied by a maximum voltage of the circuit to be tested, which defines the voltage impulses expected and required insulation clearances. These categories are:

Category I (CAT I): Measurement instruments whose measurement inputs are not intended to be connected to the mains supply. The voltages in the environment are typically derived from a limited-energy transformer or a battery.

Category II (CAT II): Measurement instruments whose measurement inputs are meant to be connected to the mains supply at a standard wall outlet or similar sources. Example measurement environments are portable tools and household appliances.

Category III (CAT III): Measurement instruments whose measurement inputs are meant to be connected to the mains installation of a building. Examples are measurements inside a building's circuit breaker panel or the wiring of permanently-installed motors.

Category IV (CAT IV): Measurement instruments whose measurement inputs are meant to be connected to the primary power entering a building or other outdoor wiring.

⚠WARNING

Do not use this instrument in an electrical environment with a higher category rating than what is specified in this manual for this instrument.

⚠WARNING

You must ensure that each accessory you use with this instrument has a category rating equal to or higher than the instrument's category rating to maintain the instrument's category rating. Failure to do so will lower the category rating of the measuring system.

Electrical Power

This instrument is intended to be powered from a CATEGORY II mains power environment. The mains power should be 115 V RMS or 230 V RMS. Use only the power cord supplied with the instrument and ensure it is appropriate for your country of use.

Ground the Instrument

⚠WARNING

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical safety ground. This instrument is grounded through the ground conductor of the supplied, three-conductor *AC* line power cable. The power cable must be plugged into an approved three-conductor electrical outlet. The power jack and mating plug of the power cable meet IEC safety standards.

⚠WARNING

Do not alter or defeat the ground connection. Without the safety ground connection, all accessible conductive parts (including control knobs) may provide an electric shock. Failure to use a properly-grounded approved outlet and the recommended three-conductor *AC* line power cable may result in injury or death.

⚠WARNING

Unless otherwise stated, a ground connection on the instrument's front or rear panel is for a reference of potential only and is not to be used as a safety ground.

Do not operate in an explosive or flammable atmosphere

⚠WARNING

Do not operate the instrument in the presence of flammable gases or vapors, fumes, or finely-divided particulates.

⚠WARNING

The instrument is designed to be used in office-type indoor environments. Do not operate the instrument

In the presence of noxious, corrosive, or flammable fumes, gases, vapors, chemicals, or finely-divided particulates.
In relative humidity conditions outside the instrument's specifications.
In environments where there is a danger of any liquid being spilled on the instrument or where any liquid can condense on the instrument.
In air temperatures exceeding the specified operating temperatures.
In atmospheric pressures outside the specified altitude limits or where the surrounding gas is not air.
In environments with restricted cooling air flow, even if the air temperatures are within specifications.
In direct sunlight.

⚠CAUTION

This instrument is intended to be used in an indoor pollution degree 2 environment. The operating temperature range is 0 °C to 40 °C and 20% to 80% relative humidity, with no condensation allowed.
Measurements made by this instrument may be outside specifications if the instrument is used in non-office-type environments. Such environments may include rapid temperature or humidity changes, sunlight, vibration and/or mechanical shocks, acoustic noise, electrical noise, strong electric fields, or strong magnetic fields.

Do not operate instrument if damaged

⚠WARNING

If the instrument is damaged, appears to be damaged, or if any liquid, chemical, or other material gets on or inside the instrument, remove the instrument's power cord, remove the instrument from service, label it as not to be operated, and return the instrument to B&K Precision for repair. Notify B&K Precision of the nature of any contamination of the instrument.

Clean the instrument only as instructed

⚠WARNING

Do not clean the instrument, its switches, or its terminals with contact cleaners, abrasives, lubricants, solvents, acids/bases, or other such chemicals. Clean the instrument only with a clean dry lint-free cloth or as instructed in this manual.

Not for critical applications

⚠WARNING

This instrument is not authorized for use in contact with the human body or for use as a component in a life-support device or system.

Do not touch live circuits

⚠WARNING

Instrument covers must not be removed by operating personnel. Component replacement and internal adjustments must be made by qualified service-trained maintenance personnel who are aware of the hazards involved when the instrument's covers and shields are removed. Under certain conditions, even with the power cord removed, dangerous voltages may exist when the covers are removed. To avoid injuries, always disconnect the power cord from the instrument, disconnect all other connections (for example, test leads, computer interface cables, etc.), discharge all circuits, and verify there are no hazardous voltages present on any conductors by measurements with a properly-operating voltage-sensing device before touching any internal parts. Verify the voltage-sensing device is working properly before and after making the measurements by testing with known-operating voltage sources and test for both DC and AC voltages. Do not attempt any service or adjustment unless another person capable of rendering first aid and resuscitation is present.
Do not insert any object into an instrument's ventilation openings or other openings.

⚠WARNING

Hazardous voltages may be present in unexpected locations in circuitry being tested when a fault condition in the circuit exists.

Fuse replacement

⚠WARNING

Fuse replacement must be done by qualified service-trained maintenance personnel who are aware of the instrument's fuse requirements and safe replacement procedures. Disconnect the instrument from the power line before replacing fuses. Replace fuses only with new fuses of the fuse types, voltage ratings, and current ratings specified in this manual or on the back of the instrument. Failure to do so may damage the instrument, lead to a safety hazard, or cause a fire. Failure to use the specified fuses will void the warranty.

Servicing

⚠CAUTION

Do not substitute parts that are not approved by B&K Precision or modify this instrument. Return the instrument to B&K Precision for service and repair to ensure that safety and performance features are maintained.

Cooling fans

⚠CAUTION

This instrument contains one or more cooling fans. For continued safe operation of the instrument, the air inlet and exhaust openings for these fans must not be blocked nor must accumulated dust or other debris be allowed to reduce air flow. Maintain at least 25 mm clearance around the sides of the instrument that contain air inlet and exhaust ports. If mounted in a rack, position power devices in the rack above the instrument to minimize instrument heating while rack mounted. Do not continue to operate the instrument if you cannot verify the fan is operating (note some fans may have intermittent duty cycles). Do not insert any object into the fan's inlet or outlet.

For continued safe use of the instrument

Do not place heavy objects on the instrument.
Do not obstruct cooling air flow to the instrument.
Do not place a hot soldering iron on the instrument.
Do not pull the instrument with the power cord, connected probe, or connected test lead.
Do not move the instrument when a probe is connected to a circuit being tested.

Compliance Statements

Disposal of Old Electrical & Electronic Equipment (Applicable in the European Union and other European countries with separate collection systems)
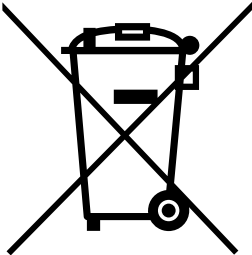
This product is subject to Directive 2002/96/EC of the European Parliament and the Council of the European Union on waste electrical and electronic equipment (WEEE), and in jurisdictions adopting that Directive, is marked as being put on the market after August 13, 2005, and should not be disposed of as unsorted municipal waste. Please utilize your local WEEE collection facilities in the disposition of this product and otherwise observe all applicable requirements.

CE Declaration of Conformity

This instrument meets the requirements of 2006/95/EC Low Voltage Directive and 2004/108/EC Electromagnetic Compatibility Directive with the following standards.

Low Voltage Directive 2006/95/EC
EN 61010:2010
EN 61010-2-030:2010

EMC Directive 2004/108/EC
EN 61326-1:2013
EN 6100-3-2:2006+A1:2009+A2:2009
EN 61000-3-3:2008
(CISPR 11:2009+A1:2010
IEC 61000-4-2:2008
IEC 61000-4-3-:2006+A1:2007+A2:2010
IEC 61000-4-4:2012
IEC 61000-4-5:2005
IEC 61000-4-6:2008
IEC 61000-4-11:2004)

Safety Symbols

⚠	Refer to the user manual for warning information to avoid hazard or personal injury and prevent damage to instrument.
⚡	Electric Shock hazard
∿	Alternating current (AC)
⏚	Chassis (earth ground) symbol.
⏚	Ground terminal
▭	On (Power). This is the In position of the power switch when instrument is ON.
▭	Off (Power). This is the Out position of the power switch when instrument is OFF.
⚠CAUTION	CAUTION indicates a hazardous situation which, if not avoided, will result in minor or moderate injury
⚠WARNING	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury
⚠DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
NOTICE	NOTICE is used to address practices not related to physical injury.

Contents

1. General Information

1.1 Product Overview

The B&K Precision models 894 and 895 are precision bench LCR meters. They are capable of measuring the capacitance, inductance and resistance of components with basic accuracy of 0.05%. These meters have an adjustable test frequency, from 20 Hz to 500 kHz (894) and 20 Hz to 1 MHz (895). With the vivid 4.3-inch TFT LCD, users can operate and read the measurements easily. This LCR meter is designed to fit standard 19in racks with a 2U form factor.

The sweep function provides a quick look at the characteristics of the components, allowing the customer to systematically test the primary and secondary parameters of those components using up to 201 frequencies. The BIN comparator function helps quickly sort components up to 10 bins. With built-in USB, RS-232, LAN and GPIB (895 only), these LCR meters can be remotely controlled to perform daily operations in production, quality control and laboratory environments.

Features:
• Basic accuracy 0.05%
• Test frequency from 20 Hz to 500 KHz (894) and 1 MHz (895)
• Frequency sweep function
• Bin sorting comparator
• Adjustable measurement speed for fast readout or better accuracy
• Standard USB, Ethernet, RS-232C and GPIB interface (895 only)
• Save and recall up to 40 internal measurement setups
• 4.3" color TFT LCD display

1.2 Package Contents

Please inspect the instrument mechanically and electrically upon receiving it. Unpack all items from the shipping carton, and check for any obvious signs of physical damage that may have occurred during transportation. Report any damage to the shipping agent immediately. Save the original packing carton for possible future reshipment. Every instrument is shipped with the following contents:

1 x Model 894/895 bench LCR meter
1 x AC power cord
1 x 4-wire Kelvin clip test lead
1 x 4-terminal test fixture
1 x Certificate of Calibration
1 x Test Report
1 x Shorting Bar

Verify that all items above are included in the shipping container. If anything is missing, please contact **B&K Precision.**
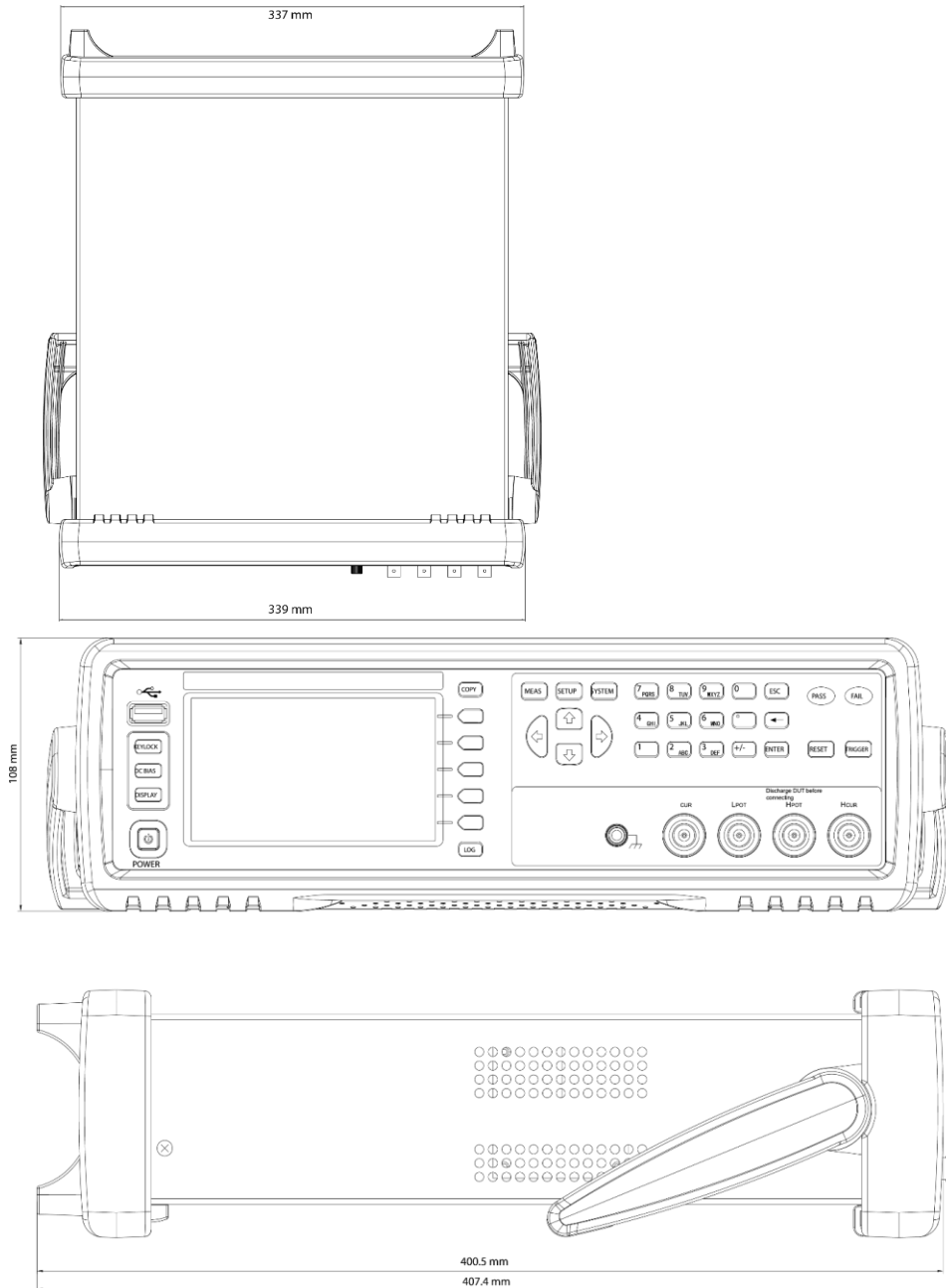
1.3 Dimensions

Figure 1 - Dimensions

1.4 Front Panel Overview
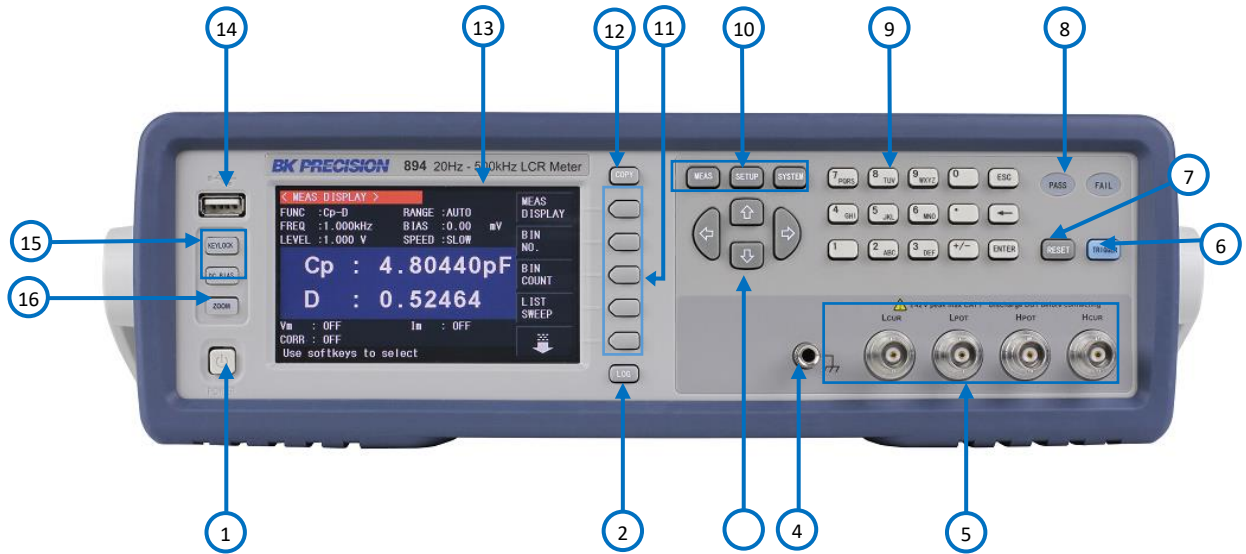
Figure 2 - Front Panel Overview

Front Panel Description

1	Power On/Off Switch
2	Log Key
3	Cursor
4	Ground Terminal
5	Measurement Terminals
6	Trigger Key
7	Reset Key
8	Pass/Fail LED indicators
9	Numerical Keypad
10	Menu Keys: MEAS, SETUP and SYSTEM
11	Softkeys
12	Copy Key
13	4.3" TFT Color LCD Display Window
14	USB Host Port
15	Auxiliary Keys
16	Zoom Button

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1.5 Rear Panel Overview

Figure 3 - Rear Panel Overview

Rear Panel Description

①	**AC Power Input Receptacle**
②	**Fuse Box**
③	**Chassis Ground Terminal**
④	**GPIB Interface (895 only)**
⑤	**Handler Interface**
⑥	**RS-232 Interface**
⑦	**USB Interface**
⑧	**LAN Interface**

1.6 Display Overview
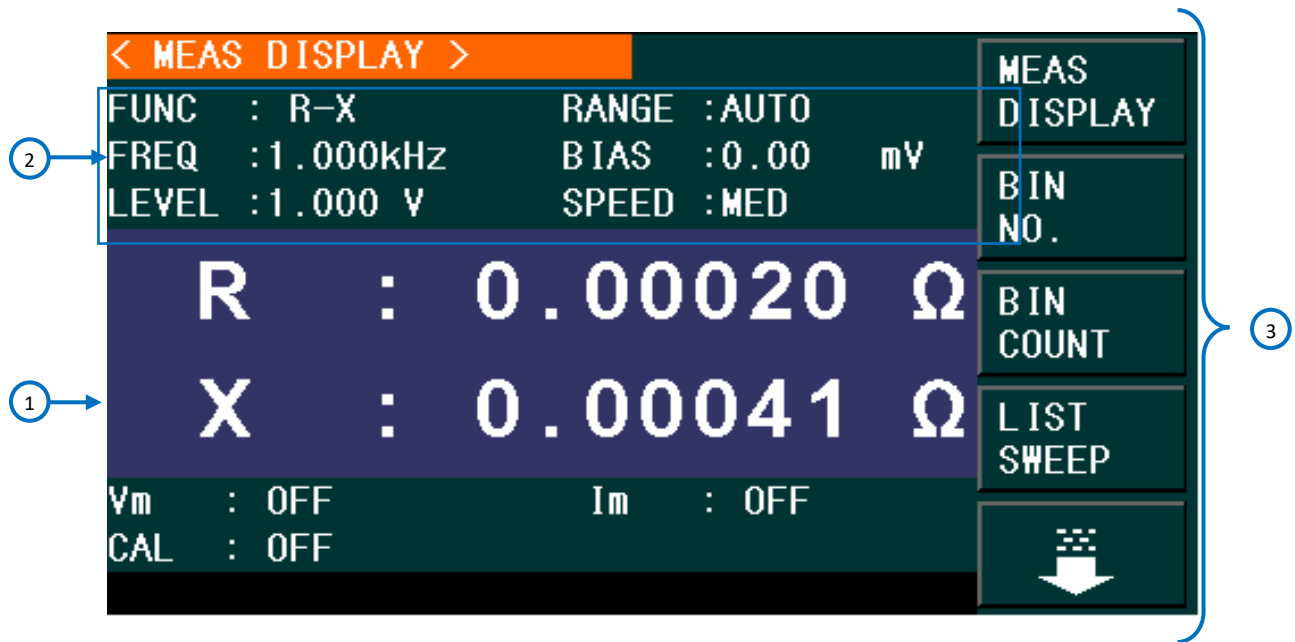
Figure 4 - Display Overview

Display Description

①	**Main Display Field** *Displays measurement parameters and results*
②	**Menu Functions** *Displays measurement settings*
③	**Menu Options** *Displays menu options*

2 Getting Started

Before connecting and powering up the instrument, please review and go through the instructions in this chapter.

2.1 Input Power Requirements

Input Power

The instrument has a selectable AC input that accepts line voltage and frequency input within:

AC Input: **100-120 VAC or 198-242 VAC**
Frequency: **47 – 63 Hz**

Before connecting to an AC outlet or external power source, be sure that the fuse is the appropriate for the mains (refer to Fuse Requirements). Also, verify that the AC power cord, including the extension line, is compatible with the rated voltage/current and that there is sufficient circuit capacity for the power supply. Once verified, connect the cable firmly.

⚠WARNING   **The included AC power cord is safety certified for this instrument operating in rated range. To change a cable or add an extension cable, be sure that it can meet the required power ratings for this instrument. Any misuse with wrong or unsafe cables will void the warranty.**

Fuse Requirements

An AC input fuse is necessary when powering the instrument. The fuse is located at the back of the instrument. In the event the fuse needs to be replaced, make sure the AC input power cord is disconnected from the instrument before replacing. Refer to the table below for the fuse requirements with either 115 VAC or 230 VAC.

⚠WARNING   **Before replacing fuse, disconnect AC input power cord first to prevent electric shock.**

⚠   **Only use a fuse of the same rating as required. Using a different rated fuse will damage the instrument.**

Model	Fuse Specification (110 V)	Fuse Specification (220 V)
894	T 4AL, 250 V	T2AL, 250 V
895	T 4AL, 250 V	T2AL, 250 V

Table 1 - Fuse Requirements

Fuse Replacement

- Locate the fuse box next to the AC input connector in the rear panel
- With a small flat blade screwdriver, insert into the fuse box slit to pull and slide out the fuse box as indicated below.
- Check and replace fuse if necessary.
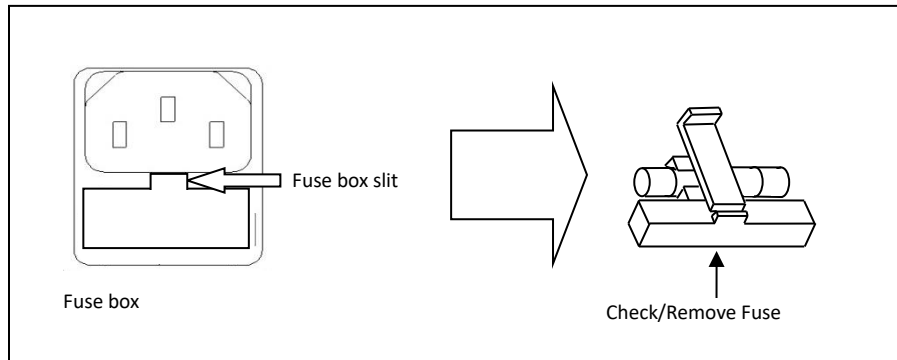
Figure 5 - Fuse replacement

Leakage current

The leakage current should not be larger than 3.5 mA (AC effective value).

2.2 Preliminary Check

Complete the following steps to verify that the instrument is ready for use.

Verify AC Input Voltage
Verify and check to make sure proper AC voltages are available to power the instrument. The AC voltage range must meet the acceptable specification as explained in previous section.

Connect Power
Connect AC power cord to the AC receptacle in the rear panel and press the power switch to the ON position to turn ON the instrument. The instrument will have a boot screen while loading, after which the main screen will be displayed.

2.3 Safety Requirements

The 894/895 are   **CAT I** safety rated.
Normal working conditions: (0^oC~40^oC, relative humidity ≤75%).

3 Making Measurements

The meter has a 4.3-inch TFT display. The Measurement Display screen is divided into the following zones:
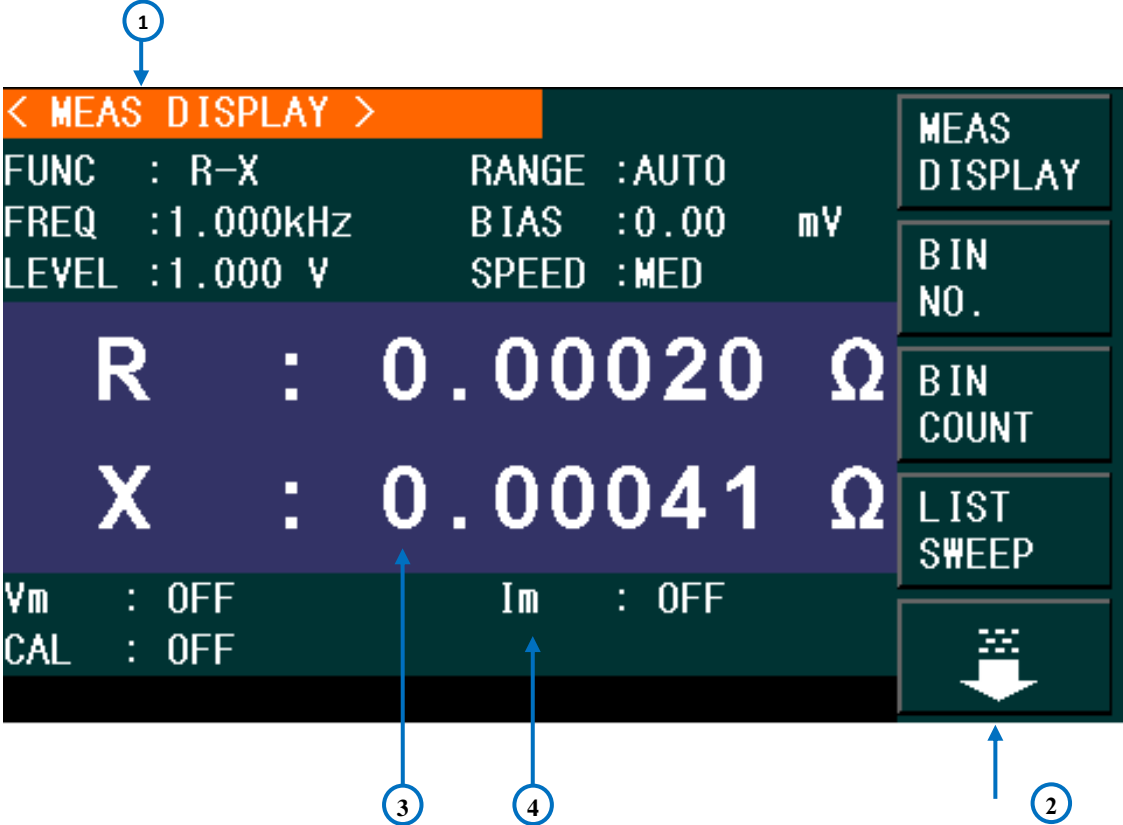
Figure 6 - Measurement Display Fields

Measurement Display Fields Description

1. ***Display page name***
   Indicate the name of the currently displayed page.
2. ***Soft menu keys***
   Displays on-screen soft keys for navigating soft menu items.
3. ***Measurement display field***
   Displays measurement results.
4. ***Information***
   Displays information about signal source and correction.

3.1 Measurement Display Menu

⚠WARNING **If the component under test is a capacitor, make sure the capacitor has been fully discharged before connecting it to the instrument. Failing to discharge the capacitor may damage the instrument and may void the warranty.**

⚠

To measure a component, connect it to the test leads or insert it into the test fixture (*i.e. the 4-wire Kelvin clip test lead or the 1 x 4-terminal text fixture)*. Press [MEAS], the **<MEAS DISPLAY>** page will be displayed on the main screen:

Figure 7 - Measurement Display Menu

The measurement parameters that can be set in this page are:
- Test function (FUNC)
- Test frequency (FREQ)
- Test level (LEVEL)
- Test range (RANGE)
- DC Bias (BIAS)
- Test speed (SPEED)

The Measurement Display field shows the primary and secondary measurements results. In addition, the "Information" field displays the value of the output voltage and current if the voltage and current monitors are enabled. Otherwise, the unit will display "OFF". The CORR (Correction) field will display the type of correction that is enabled: Open, Short and/or Load.

3.2 Measurement Parameters

The Measurement Parameters field lets the user select different settings for the measurement to be taken.

Figure 8 - Measurement Function Display

Test results of the primary and secondary parameters are displayed in two lines. The primary parameter is displayed in the upper line while the secondary parameter is displayed in the lower line.

Primary Parameters

Parameter	Description
Cp	Capacitance measured using a parallel equivalent circuit model
Cs	Capacitance measured using a series equivalent circuit model
Lp	Inductance measured using a parallel equivalent circuit model
Ls	Inductance measured using a series equivalent circuit model
Z	Impedance
Y	Admittance
R	Resistance using a specified AC frequency and level
G	Conductance
DCR	Resistance using a DC bias.
L2-A*	Primary Inductance

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L2-B*	Secondary Inductance

Table 2 - Primary Parameters

*Used with transformer test fixture TL89T1.

Secondary Parameters

Parameter	Description
Q	Quality factor
D	Dissipation factor
R_s	Equivalent Series Resistance (ESR)
R_p	Equivalent Parallel Resistance
X	Reactance
B	Admittance
Θ	Phase Angle
N, 1/N*	Turn Ratio and Polarity
M*	Mutual Inductance
R2	DC Resistance

Table 3 - Secondary Parameters

*Used with transformer test fixture TL89T1.

Parameter Combinations

The combinations of primary and secondary parameters, including the series and parallel combinations are listed below:

Primary Parameter	Series Mode Combinations	Parallel Mode Combinations
C	Cs-Q Cs-D Cs-Rs	Cp-Q Cp-D Cp-Rp Cp-G
L	Ls-Q Ls-D Ls-R	Lp-Q Lp-D Lp-Rp Lp-G

Table 4 – Primary Parameter Combinations: Series and Parallel

Primary Parameter	Combinations
Z	d r
Y	d r

	X
R	Rp-X
	Rp-Q
G-B	N/A
DCR	N/A
	N
	1/N
L2A*	M
	R2
	N
	1/N
L2B*	M
	R2

Table 5 – Additional Primary Parameter Combinations

*Used with transformer test fixture TL89T1.

Selecting Primary and Secondary Parameters

1) Move the cursor to select **FUNC** field , and the following soft keys will be displayed on the screen.
   - **Cp—...→**
   - **Cs—...→**
   - **Lp—...→**
   - **Ls—...→**
   - **↓**

2) Press the soft key corresponding to **Cp—...→** to select **Cp** as the primary parameter, and the following parameters will be displayed:
   - **Cp-D**
   - **Cp-Q**
   - **Cp-G**
   - **Cp-Rp**
   - **←**

   Press the soft key to select the secondary parameter. Then press ← to return to the previous menu.

3) Press **Cs—...→** to select **Cs** as the primary parameter, and the following parameters will be displayed:

- **Cs-D**
- **Cs-Q**
- **Cs-Rs**
- ←

Press the soft key to select the secondary parameter. Then press ← **t**o return to the previous menu.

4) Press **Lp**—...→ to select **Lp** as the primary parameter, and the following parameters will be displayed:
   - **Lp-D**
   - **Lp-Q**
   - **Lp-G**
   - **Lp-Rp**
   - ←

Press the soft key to select the secondary parameter. Then press ← to return to the previous menu.

5) Press **Ls**—...→ to select **Ls** as the primary parameter, and the following parameters will be displayed:
   - **Ls-D**
   - **Ls-Q**
   - **Ls-Rs**
   - ←

Press the soft key to select the secondary parameter. Then press ← to return to the previous menu.

6) Press ↓ to see more parameter options, and the following will be displayed.
   - **Z**—...→
   - **Y**—...→
   - **R**—...→
   - ↑
   - ↓

7) Press **Z**—...→ to select **Z** as the primary parameter, and the following parameters will be displayed:
   - **Z-d**
   - **Z-r**
   - ←

Press the soft key to select the secondary parameter. Then press ← to return to the

previous menu.

8) Press **Y——...→** to select **Y** as the primary parameter, and the following parameters will be displayed.
- **Y-d**
- **Y-r**
- **←**

Press the soft key to select the secondary parameter. Then press ← to return to the previous menu.

9) Press **R——...→** to select **R** as the primary parameter, the following parameters will be displayed.
- **R-X**
- **Rp-Q**
- **Rs-Q**
- **←**

Press the soft key to select the secondary parameter. Then press ← to return to the previous menu.

10) Press **↓**, the following parameters will be shown.
- **G-B**
- **DCR**
- **L2A—...→**
- **L2B —...→**
- **↑**

11) Press **G-B** to select **G** as the primary parameter and **B** as the secondary parameter.

12) Press **DCR** to select DC resistance as the measurement parameter.

13) Press **L2A-...→**, the following parameters will be displayed:
- **L2A-N**
- **L2A-1/N**
- **L2A-M**
- **L2A-R2**
- **←**

Press the soft key corresponding to the required parameter. Then press ← to return to the previous menu.

14) Press **L2B-…→**. The following parameters will be displayed:

- **L2B-N**
- **L2A-1/N**
- **L2B-M**
- **L2B-R2**
- **←**

Press the soft key to select the secondary parameter. Then press ← to return to the previous menu.

Note: L2A and L2B should be used with transformer test fixture TL89T1.

Test range

The measurement range should be selected in accordance with the impedance value of the tested LCR component.
The 894/895 have 11 AC measurement ranges: 10Ω, 30Ω, 100Ω, 300Ω, 1kΩ, 3kΩ, 10kΩ, 30kΩ, 100kΩ, 300kΩ, and 1MΩ (895 only).
The 894/895 have 14 DCR measurement ranges: 30mΩ, 100mΩ, 300mΩ, 1Ω, 10Ω, 100Ω, 300Ω, 1kΩ, 3kΩ, 10kΩ, 30kΩ, 100kΩ, 300kΩ, and 1MΩ (895 only).

Setting the test range:
1) Move the cursor to the range field, the following soft keys will be displayed:
- **AUTO** The soft key is used to set the range mode to **AUTO**.
- **HOLD** The soft key is used to switch the **AUTO** mode to the **HOLD** mode. In this mode, the range will be locked in the current measurement range, which is displayed in the range field.
- **↑(+)** The soft key is used to increase the range under **HOLD** mode.
- **↓(-)** The soft key is used to decrease the range under **HOLD** mode.
2) Use the soft keys to set measurement range.

Test frequency

Frequency range of the 894 meter ranges from 20Hz to 500 KHz, and up to 1 MHz for 895.

Note: When the test function is set to DCR, the FREQ field will display "---".

Frequency range (F)	Test frequency point	Resolution
20 Hz ≤ F ≤ 99.99 Hz	20.00 Hz, 20.01Hz ……99.99 Hz	0.01 Hz
100 Hz ≤ F ≤ 999.9 Hz	100.0 Hz, 100.1Hz ……999.9 Hz	0.1 Hz
1 kHz ≤ F ≤ 9.999 kHz	1.000 kHz, 1.001 kHz ……9.999 kHz	1 Hz
10 kHz ≤ F ≤ 99.99 kHz	10.00 kHz, 10.01 kHz……99.99 kHz	10 Hz
100 kHz ≤ F ≤ 1 MHz	100.0 kHz, 100.1 kHz……1 MHz	100 Hz

Table 6 - Frequency Range, Test Frequency Points and Resolution

Setting the test frequency:

    There are two ways to set measurement frequency: soft keys, numeric keys.

1) Move the cursor to the FREQ field, and the following soft keys will be displayed:

- ↑**(++)** This is a coarse adjustment soft key used to increase the frequency. Press this key to change the frequency in the following sequence: 20Hz, 100Hz, 1 kHz, 10 kHz, 100 kHz, 500 KHz (894) and 1 MHz (895).

- ↑**(+)** This is a fine adjustment soft key used to increase the frequency. Press this key, to change the frequency between the following values:

Hz	Hz	kHz	kHz	kHz	MHz
20	100	1.0	10	100	1*
25	120	1.2	12	120	
30	150	1.5	15	150	*895 only
40	200	2.0	20	200	
50	250	2.5	25	250	
60	300	3.0	30	300	
80	400	4.0	40	400	
	500	5.0	50	500	
	600	6.0	60	600*	
	800	8.0	80	800*	

Table 7 - Test Frequencies

- ↓**(-)** This is a fine adjustment soft key used to decrease the frequency. The selectable frequencies are the same as that of ↑ **(+)** in the above.

- ↓**(--)** This is a coarse adjustment soft key used to decrease the frequency. The selectable frequencies are the same as that of ↑ **(++)** in the above.

2) Use soft keys or numeric keys to select the frequency. When using numeric keys, the soft key displays the available frequency units (Hz, kHz and MHz). You can use them to input the unit after entering the numeric value. If [ENTER] is pressed to input frequency, the unit defaults to Hz.

Test Signal Level

The test signal level (current or voltage) can be configured using this function. The test signal values available are the RMS equivalent of the sine wave signal. The corresponding current level mode value has a linear relationship with the internal resistance.

    The test signal level voltage has a valid range from 5 mVrms to 2 Vrms. The resolution will change according to each range as follows:

Voltage Level	Resolution
5 mVrms – 100 mVrms	100 µVrms
100 mVrms – 1 Vrms	1m Vrms
1 Vrms – 2 Vrms	10 mVrms

Table 8 - Voltage Level Resolution

The test signal level current range is as follows:

Impedance	Current Range
30 Ω	166.7 µA to 66.7 mA
50 Ω	100.0 µA to 40.0 mA
100 Ω	50.0 µA to 20.0 mA

Table 9 - Current Range vs. Impedance

Note: When the test function is set to DCR, the LEVEL field will display "---".

The Auto Level Control function (ALC) can measure constant voltage or current. It can be enabled from the <**MEAS**> page. When it is ON, " ***** " will be displayed following the current level value.

Setting the test level:

There are two ways to set the level of the test signal source: soft keys, numeric keys.
1) Move the cursor to **LEVEL**, and the following soft keys will be displayed.

- ↑**(+)** This soft key is used to increase the level of the test signal source.

- ↓**(-)** This soft key is used to decrease the level of the test signal source.

2) Use soft keys or numeric keys to set the test level. When using numeric keys, the soft key displays the available units (mV, V, µA, mA and A). You can use them to input the unit after entering the numeric value. If [ENTER] is pressed to input the level, the unit defaults to V or A.

DC BIAS

The meter has an internal DC bias voltage from -5 V to +5 V and a current from -25 mA to 25mA.

Note: When the test function is set to DCR, the BIAS field will display "---".

Setting DC bias:

There are two ways to set the DC bias: Use soft keys and numeric keys. Move the cursor to DC BIAS, and the following soft keys will be displayed.

- **↑(+)** - This soft key is used to increase the output level of DC bias.

- **↓(-)** - This soft key is used to decrease the output level of DC bias.

1) Use soft keys or numeric keys to set the DC bias source. When using numeric keys, the soft key displays the available units (mV, V, µA, mA and A). You can use them to input the unit after entering the numeric value. If the [ENTER] button is pressed to input bias value, the unit defaults to V or A.

Press the [DC BIAS] key on the front panel to enable DC bias output. The [DC BIAS] key will be lid.

Test speed

The test speed is determined by the following factors:

- Integration time (A/D conversion)
- Average test times (average test times per test)
- Measurement delay (from startup to the start of measurement)
- Display time of test results

You can select FAST, MED or SLOW. Generally, test results are more stable and accurate when set to SLOW.

- Fast: Approx. 75 times/s (13 ms/reading）
- Medium: Approx. 11 times/s (90 ms/time）
- Slow: Approx. 2.7 times/s (370 ms/time）

Note: The fast and middle speed will be slow down when frequency <10 kHz.

Setting the test speed:

Move the cursor to SPEED, and the following soft keys will be displayed:

- **FAST**
- **MED**
- **SLOW**

Use the soft keys to select the test speed.

Digits Resolution

The measurement results of the meter can display up to 6 floating-point digits. The 894 and 895 can be manually configured to display a fixed number of digits or automatically select

the number of digits based on range.

Setting Decimal Resolution

1) Move the cursor to MEASUREMENT DISPLAY FIELD (**Figure 6**) to either the primary measurement or secondary measurement and the following soft keys will be displayed:
   - Decimal Point Auto (**D.P. Auto**)
   - Decimal Point Hold (**D.P. Fix**)
   - Decimal Point Position Increment (**D.P. POS INCR +**)
   - Decimal Point Position Decrement (**D.P. POS DECL -**)

2) Press **DECIMAL AUTO** to reset the decimal position of the primary or the secondary parameter test result to its default setting.
3) Press **DECIMAL HOLD** to lock the decimal location of the primary or the secondary parameter test result.
4) Press **DECIMAL LOCATION +** to increase the displayed digit by ten times.
5) Press **DECIMAL LOCATION -** to decrease the displayed digit by ten times.

NOTE: Under the following circumstances, the decimal lock function will be disabled automatically and return to auto:
   - **Changing the test function.**
   - **Changing the deviation test mode (ΔABS, Δ%, OFF) in deviation test mode.**

Zoom

The 894/895 LCR meters let the user enlarge the display size of the measurement results.

- Press once the **Zoom** button to enlarge the measurement results display and press it once more to return normal view. Refer to Figure 2 for more information.

Figure 9 - Zoom

3.3 Correction

The user can perform OPEN, SHORT, and LOAD correction used to eliminate stray admittance, residual impedances and other measurement errors. There are two correction methods.

Sweep correction: Performs an OPEN/SHORT correction at all pre-set frequency points.
Point frequency correction: Performs an OPEN/SHORT/LOAD correction at user-selected frequencies.

The following parameters can be set on the **<CORRECTION>** page:

- Open Correction (**OPEN**)
- Short Correction (**SHORT**)
- Load Correction (**LOAD**)
- Cable length selection (**CABLE**)
- Single/Multiple Correction mode selection (**MODE**)
- Load Correction test function (**FUNC**)
- Spot Number (**SPOT No.)**
- Frequency points of **OPEN**, **SHOR** and **LOAD** (**FREQ**)
- Reference values for frequency points (**REF A**, **REF B**)
- Open values for frequency points (**OPEN A**, **OPEN B**)
- Short values for frequency points (**SHORT A**, **SHORT B**)
- Load values for frequency points (**LOAD A**, **LOAD B**)

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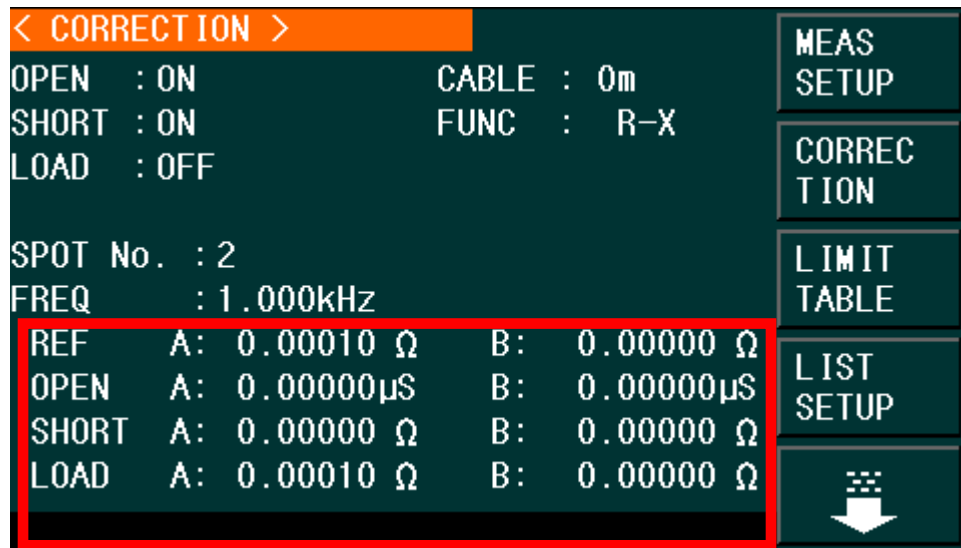
Correction Monitoring Zones.

Figure 10 – Correction/Correction Menu

The Correction Monitoring zones display the results of the load correction function (**REF A and B**, **OPEN A and B, SHORT A and B, LOAD A and B**). These are the values that will be used to compensate a measurement after an open, short and load calibration is performed.

The correction operation has three modes:

1. **Sweep Correction:**
    When the FREQ option is set to OFF and the OPEN/SHORT options are set to ON, there will be an OPEN/SHORT correction over 48 pre-set frequencies. Any frequency measurement not part of the 48 pre-set frequencies will use an interpolation algorithm to calculate the correction factor for that specific frequency.
2. **Point-Frequency Correction:**
    When the FREQ option is set to ON and OPEN/SHORT/LOAD are also set to ON, there will be an OPEN/SHORT/LOAD correction applied to all frequency points that are identical to those specified by the user only. Up to 201 frequencies points are applied.
3. **No Correction applied to measurements:** OPEN/SHORT/LOAD corrections can be turned ON/OFF individually.

Note: There will be an indicator (>>>>>>>=========) at the bottom of the screen showing the progress of the correction operation.

Sweep Correction

Open Correction

The open correction function can eliminate the errors caused by the stray admittance (G, B) that may exist within the test fixture or leads. Refer to Figure 11.
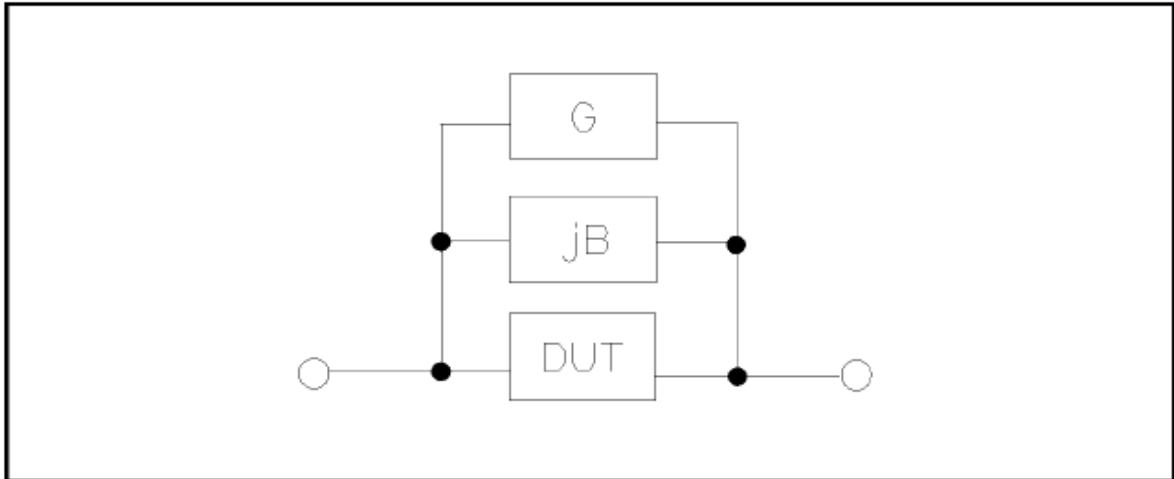
Figure 11 - Stray Admittance

Open Correction Procedure

1) Connect the test fixture to the test terminal. Make sure the test fixture is not connected to any DUT and it is "open".
2) Press the SETUP button and enter the MEASURE SETUP menu.
3) Press the softkey, **CORRECTION** (displayed to the right of the screen in the soft key zone), to enter the **Correction** menu. Press the down key and select the **OPEN** option. The following soft keys will be displayed on the soft keys to the right of the screen:

  ON: OPEN Correction adjustment to the current measurement.
           Press **ON** to turn the function of open-circuit Correction on.

  OFF: Turns off the OPEN Correction.
           Press **OFF** to turn the OPEN correction off. There will be no **OPEN** Correction performed in measurements.

  MEAS OPEN: Measures the open conditions.
           Press the MEAS OPEN softkey and the meter will test the open admittance (capacitance and inductance) over 48 frequencies.
           Note: This progress takes approximately 75 seconds to complete.
           The following soft key will be displayed on the top right corner of the screen:
             • **ABORT:** This soft key cancels the current open correction operation.

DCR OPEN: Tests the Open resistance for DCR.

      The following soft key will be displayed on the top right corner of the display:

- **ABORT:** This soft key cancels the current open correction operation.

4) Keep the test fixture open (no connection), then press the softkey **MEAS OPEN** to execute open calibration. The meter will beep when the correction is completed.

Short Correction

The short correction feature compensates for any residual impedance that may exist within the test fixture or leads, as shown in Figure 12. Short Correction uses 48 fixed frequencies to adjust and compensate the input.
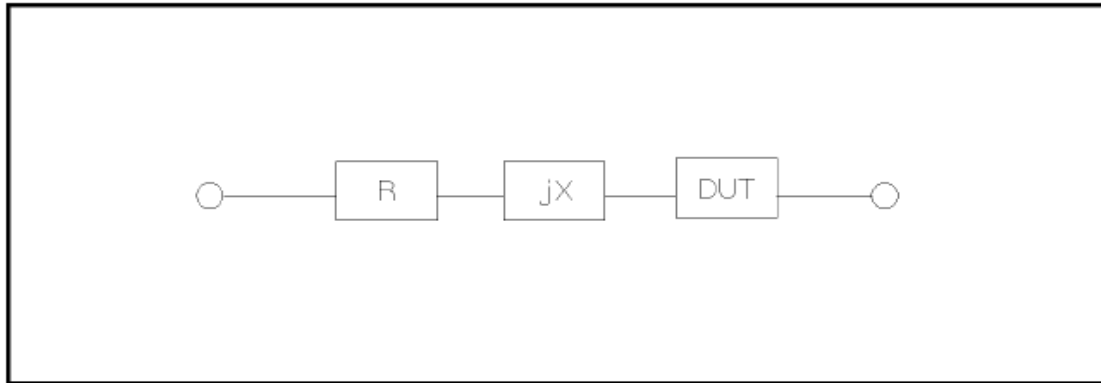
Figure 12 – Residual Inductance

Short Correction Procedure
1) Connect the test fixture to the test terminal, or insert a shorting bar into the test fixture.
2) Press the SETUP button and enter the MEASURE SETUP menu.
3) Press the softkey, CORRECTION, to enter the Correction menu. Press the Down Key and select the **SHORT** option. The following soft keys will be displayed on the soft keys to the right of the screen:

ON: Applies a **SHORT** correction adjustment to the current measurement.
      Press **ON** to perform a short-circuit correction.

OFF: Turns off the **SHORT** correction.
      Press **OFF** to turn the SHORT correction function off. There will be no **Short Correction** performed in measurements.

MEAS SHORT: Tests the residual impedance (resistance and reactance) over the 48 pre-set frequencies when shorted.

Press the **MEASURE SHORT** soft key. Full frequency correction takes approximately 75 seconds. The following soft key will be displayed on the top right corner of the display:

- **ABORT:** This soft key cancels the current short correction operation.

DCR SHORT: Short resistance test for DCR.

The following soft key will be displayed on the top right corner of the display:

- **ABORT:** This soft key cancels the current short correction operation.

4) Insert the short plate to the test fixture.
5) Move the cursor to the **SHORT** zone. **ON**, **OFF** and **MEAS SHORT** will be displayed in the soft key zone.
6) Press **MEAS SHORT** to execute the short calibration. The meter will beep when the correction is completed
7) Press **ON** to turn the short calibration function.
8) Move the cursor to the **LOAD** zone. **ON**, **OFF** will be displayed in the soft key zone.
9) Press **OFF** to turn off the load calibration function.
10) Move the cursor to the **FREQ** zone, **ON**, **OFF**, **MEAS OPEN**, **MEAS SHORT** and **MEAS LOAD** will be displayed in the soft key zone.
11) Press **OFF** to turn off the point-frequency calibration function of **FREQ**.

Load Correction (Point-Frequency Correction)

The **Load Correction** performs a correction at frequency points defined by the user (up to 201 frequencies). The preset frequencies can be set in the **FREQ** field of the display. The standard reference values can be set in the setup zones of **REF A** and **REF B**.

The reference values of the component must be entered prior to performing a **Load Correction**.
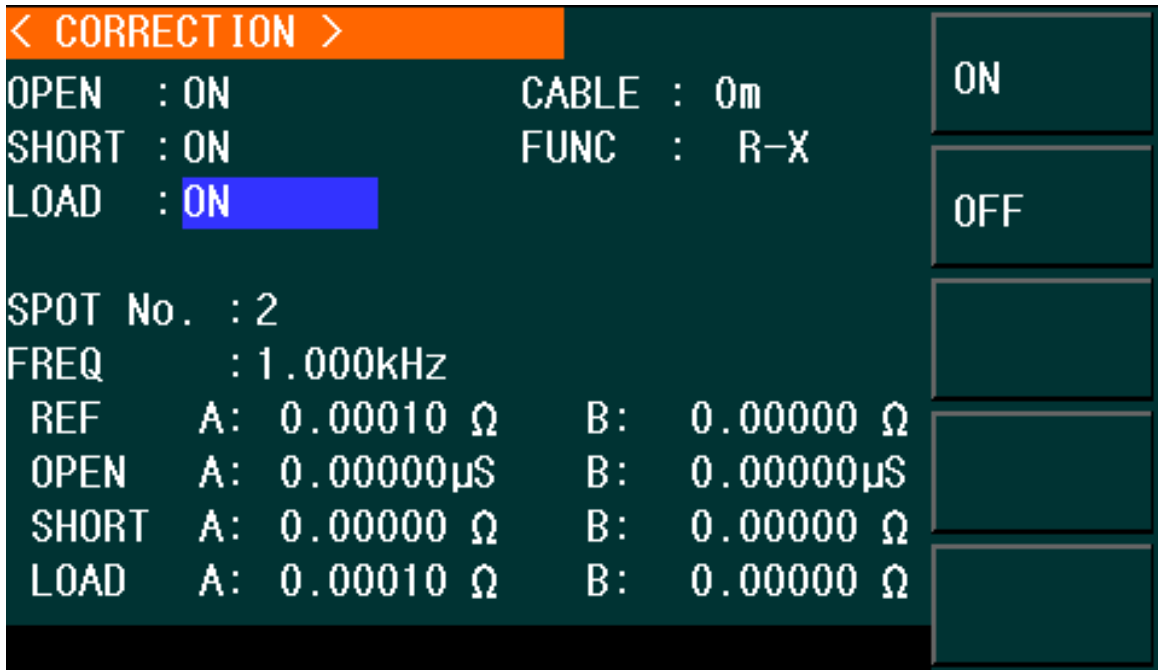
Figure 13 - Procedure for Correction at User-Specified Frequencies.

1. Connect the test fixture to the test terminal of the meter. Make sure the test fixture is not connected to any device.
2. Press the **SETUP** button and enter the **MEASURE SETUP** menu.
3. Press the softkey, **CORRECTION**, to enter the Correction menu.
4. Press the **ON** softkey to enable **LOAD** correction. When Load Correction is enabled, Short and Open Calibration will also be enabled for Point-Frequency Correction and they can be enabled by turning them on.
5. Using the cursor keys and softkeys, set the standard test function in the **FUNC** field (any settings entered will depend on this function).
6. Using the cursor keys, move the cursor to **SPOT No**. and select one spot (range from 1 to 201).
   a. Enter a value using the numerical key pad or
   b. Use the soft key: **INCR++**, **INCR+**, **DECR-**, and **DECR--**. The keys increment or decrement the selected number by one (+,-) or by ten (++,--).
7. Press the Down Key and select the **FREQ** option.
8. Use numeric keys to input the correction frequency. After entering a numeric value, the available unit softkeys (Hz, kHz and MHz) will be displayed. When the **ENTER** key is used to input correction frequency, the unit defaults to Hz. The original preset *open/short/load* Correction frequency data is displayed on the frequency setting display field.

The following softkeys will be displayed:

ON: Press this soft key to enable the open/short/load Correction data.
OFF: Press the soft key to disable the open/short/load Correction data.
MEAS OPEN: Press this soft key to execute open correction at the frequency entered in step number 8**.**
MEAS SHORT: Press this soft key to execute short correction at the specified frequency.
MEAS LOAD: Press this soft key to execute the load correction at **FREQ** selected in step number 8.

9. Connect the test fixture to the test terminal.

OPEN CORRECTION
   a. Disconnect any device under test from the test leads or test fixture and make sure the test terminals are open (nothing connected).
   b. Press **MEAS OPEN** to perform open correction at the current set frequency. The test result (G, B) of the open correction test will be displayed at the bottom of the screen.
   c. Move the cursor to **OPEN**.
   d. Press **ON** to perform an open correction calculation at the selected frequency in later measurements.

SHORT CORRECTION
   a. Disconnect any device under test from the test leads or test fixture and make sure the test terminals are open (nothing connected).
   b. Press **MEAS SHORT** to perform short correction at the current set frequency. The test result (G, B) of the open correction test will be displayed at the bottom of the screen.
   c. Move the cursor to **SHORT**.
   d. Press ON to perform a short correction calculation at the selected frequency in later measurements.

LOAD CORRECTION
   a. Using the cursors, navigate to **REF A** field.
   b. Enter a known value or reference value (for the component to be used as a standard) for the primary parameter set in the **FUNC** field.
   c. Using the cursors, navigate to **REF B** field.
      Enter a known value or reference value for the secondary parameter set in the **FUNC** field (for the component to be used as a standard).

10. Move the cursor to the **FREQ** display field.
11. Connect the component to be used as a standard to the test fixture.
12. Press **MEAS LOAD**, and the instrument will execute a load correction. The real test

results of the standard component will be displayed in **LOAD A and LOAD B**.

13. Press **ON** to perform load correction calculation at preset frequencies in later measurements.

3.4 Cable Length Selection

The available cable length is 0m (when using the included 4-terminal test fixture), or 1m. To select the desired length, please follow the steps below:

1) Press the **SETUP** button.
2) Press the soft key **Correction**.
3) In the **Correction** menu, use the cursor keys to navigate to the **Cable** option.
4) Use the soft keys to select the desired length.

3.5 Impedance Parameters

Components such as inductors (L), capacitors (C), and resistors (R) can respond to test signals with varying frequencies and levels in different ways. Large capacitors tested at high frequencies can respond differently than when tested at lower frequencies. Large inductors tested at low frequencies can respond differently than when tested at higher frequencies. In contrast, resistors will respond relatively the same at high or low frequencies. Due to these characteristics, it is very important to understand the complex impedance parameters of the electronic components. The meter allows users to vary these test signals' measurement frequency, measurement level, and equivalent circuit choice to characterize the component under test.

When analyzing the impedance using the impedance measurement plane (), it can be visualized by the real element (Resistance) on the X-axis and the imaginary element (Reactance) on the Y-axis. This impedance measurement plane can also be seen as polar coordinates. |Z| is the magnitude and θ is the phase of the impedance.
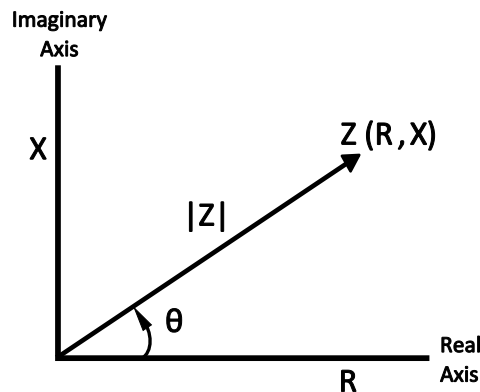
Figure 14 - Complex Impedance Plane

$$Z = R + jX = |Z|\angle\theta \ \left(\Omega\right)$$

$$R = |Z| \cos\theta \qquad\qquad X = |Z| \sin\theta$$

$$|Z| = \sqrt{R^2 + X^2} \quad \theta = \tan^{-1}\left(\frac{X}{R}\right)$$

$$Z = Impedance$$
$$R = Resistance$$
$$X = Reactance$$

$$\Omega = Ohm$$

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

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

$$L = Inductance \ (H)$$
$$C = Capacitance \ (F)$$
$$f = Frequency \ (Hz)$$
$$\omega = Frequency \ \left(\frac{rad}{s}\right)$$

For components, the quality factor (Q) serves as a measurement 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 associated with inductors and D (dissipation factor) for capacitors. Below shows the relationships between these parameters:

$$Q = \frac{1}{D} = \frac{|X|}{R}$$
$$= \frac{\omega L}{R} = \frac{1}{\omega C R}$$
$$= \frac{2\pi f L}{R} = \frac{1}{2\pi f C R}$$

$$Q = Quality \ Factor$$
$$D = Dissipation \ Factor$$
$$C = Capacitance$$
$$L = Inductance$$

Series and Parallel Models

Components are modeled with one of the two following equivalent circuits:
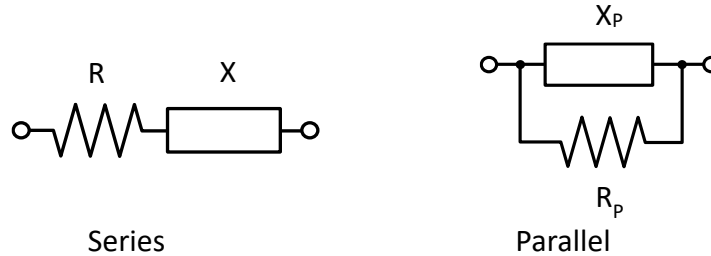
Series   Parallel

Figure 15 - Series and Parallel Models

The impedance for the series model is:
$$Z = R_S + jX_S$$

The impedance for the parallel model is:
$$\frac{1}{Z} = \frac{1}{R_P} + \frac{1}{jX_P}$$

These circuit models are mathematically equivalent. The LCR meter measures an impedance, which gives two independent numbers, the magnitude ($|Z|$) and phase (θ) of the impedance. These are changed into rectangular components R and X, giving the real and imaginary part of the impedance. These rectangular components can then be transformed into either a series or parallel circuit of a pure resistance and pure reactance. These transformed circuits have exactly the same impedance as the measured value, only at the measured frequency.

Choosing a Test Frequency

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

Capacitance

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

frequency would be optimal. For example, if the capacitance of the component is to be in the mF range, then selecting in the range of 20 Hz to 200 Hz for test frequency would give much better results. The results will also be obvious because if the same component was tested with 1 kHz or above, the measured readings may look erroneous on the display.

In all cases, it is best to check with the manufacturer's data sheet in order to determine the best test frequency to use for measurement.

Inductance

Typically, a 1 kHz test frequency is used to measure inductors that are used in audio and RF circuits. This is because these components operate at higher frequencies and require that they be measured at higher frequencies above 1 kHz. However, a 120 Hz test signal is used to measure inductors that are used for applications such as filter chokes in power supplies, which are typically operated at 60 Hz AC (in U.S.) with 120 Hz filter frequencies.

In general, inductors below 2 mH should be measured at 1 kHz frequency while inductors above 200 H should be measured at 120 Hz.

In all cases, it is best to check with the manufacturer's data sheet in order to determine the best test frequency to use for measurement.

Choosing a Measurement Circuit Model

There are two measurement circuit models to choose from, **series** or **parallel**, when characterizing components under test. The LCR meter will make measurements regardless of which model is chosen, but components will display more accurate results if the correct measurement model is selected. To determine the better model to choose depends on the impedance of the component at the specified frequency.

Capacitance

The impedance in a capacitor is negatively proportional. Therefore, the larger capacitance means the lower impedance, the smaller capacitance reverts to higher impedance. Figure 16 shows the equivalent circuit of capacitor. If the capacitance is small, the parallel resistance (R_P) becomes large and more relevant than the series resistance (R_S). If the capacitance is large, the series resistance becomes dominant and the parallel resistance becomes insignificant. Hence, it is proper to use the parallel model for low capacitance measurement and series model for high capacitance measurement.
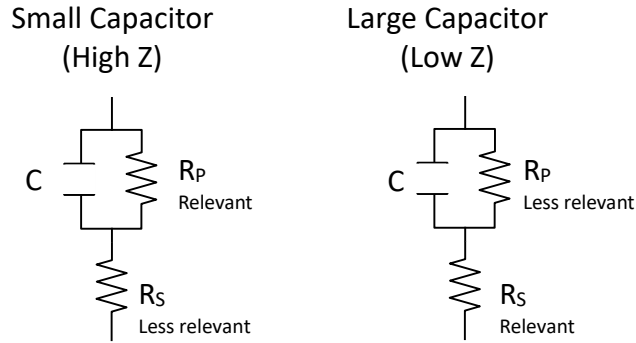
Figure 16 - Equivalent Capacitor Circuit

Inductance

The impedance of an inductor is positively proportional. Therefore, the larger inductances equals to higher impedance and vice versa. Figure 17 shows the equivalent circuit of an inductor. When the inductance is small, the series resistance (R_S) becomes more important than the parallel resistance (R_P). When the inductance is large, the parallel resistance should be taken into consideration. Therefore, it is recommended to use the series model to measure an inductor with low inductance and parallel model to measure an inductor with high inductance.
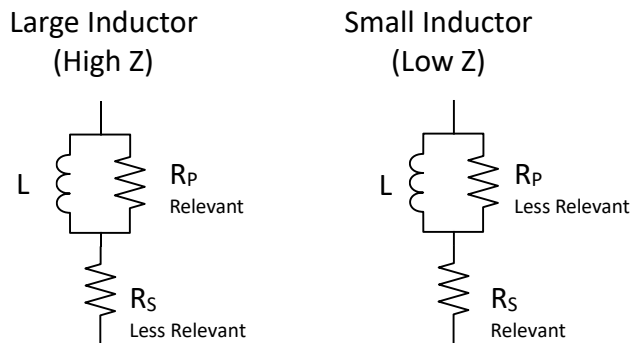
Figure 17 - Equivalent Inductor Circuit

Generally, if the impedance is greater than 100 Ω* use the parallel circuit model. Use the series circuit model when the impedance is less than 100 Ω*.

*Note: This is only a typical value. In all cases, it is best to check with the manufacturer's data sheet in order to determine the best model to use for measurement.

The following table translates this approximate impedance rule into inductance and capacitance values:

Frequency (kHz)	Capacitors		Inductors	
	Use series model when	Use parallel model when	Use series model when	Use parallel model when
0.1	> 16 μF	< 16 μF	< 160 mH	> 160 mH
1	> 1.6 μF	< 1.6 μF	< 16 mH	> 16 mH
10	> 160 nF	< 160 nF	< 1.6 mH	> 1.6 mH
100	> 16 nF	< 16 nF	> 160 μH	> 160 μH

Table 10 - Series/Parallel Model Guideline

3.6 Measure Setup Menu

The Measure Setup page allows the user modify a series of parameters used while performing a measurement. To access the Measure Setup menu, press the **SETUP** up button. The screen display will look like Figure 18.
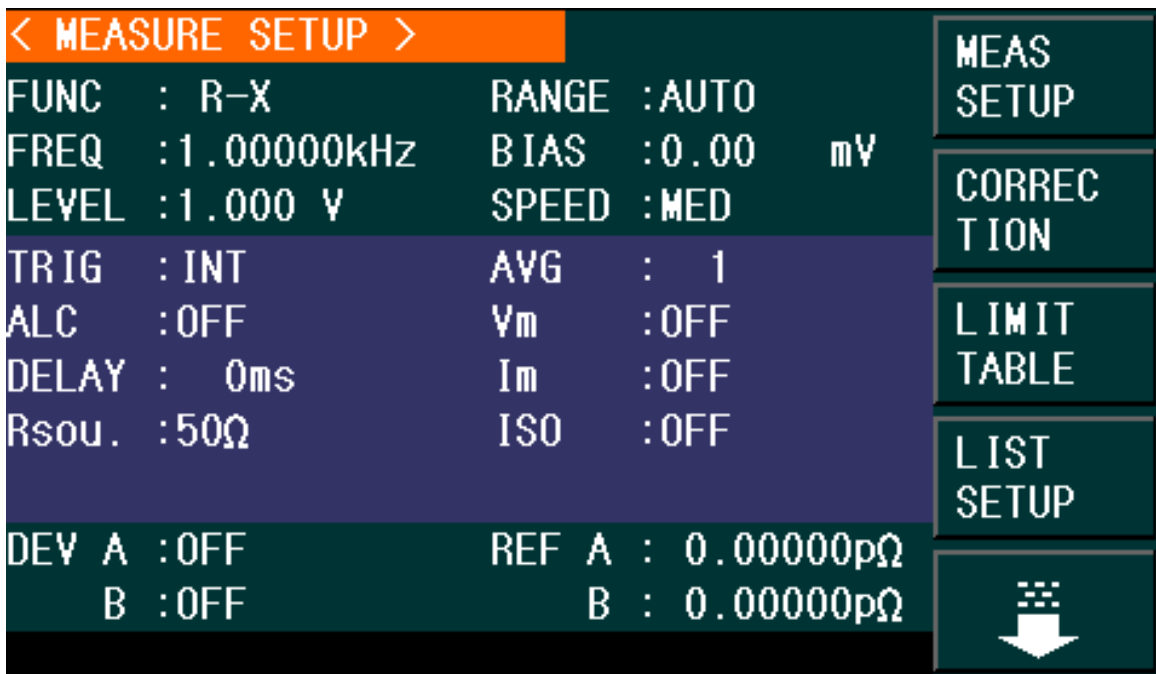
Figure 18 - Measure Setup Menu

- In this page, the following control parameters can be set: Trigger Mode (**TRIG**)
- Auto Level Control (**ALC**)
- Delay Time (**DELAY**)
- Output Impedance (**Rsou.**)
- Average times (**AVG**)
- Voltage Level Monitor ON/ OFF (**Vm**)

- Current Level Monitor ON/ OFF (**Im**)
- Bias Current Isolation ON/ OFF (**ISO**)
- Deviation Test Mode A (**DEV A**)
- Deviation Test Mode B (**DEV B**)
- Deviation Test Reference Value A (**REF A**)
- Deviation Test Reference Value B (**REF B**)

In addition, the following parameters can also be set (see section 3.2 for detailed description):
- Test function (**FUNC**)
- Test frequency (**FREQ**)
- Test Signal Level (**LEVEL**)
- Test range **(RANGE)**
- Test speed (**SPEED**)
- DC Bias (**DC BIAS**)

Trigger Mode (TRIG)

There are 4 trigger modes: **INT**, **MAN**, **EXT** and **BUS**.

When the trigger mode is set as **INT**, the meter will make sequential and repeated tests.
When the trigger mode is set as **MAN**, press [**TRIGGER**] once, the meter will make one test.
When the trigger mode is set as **EXT**, once the HANDLER interface receives a positive impulse, the meter will execute one measurement.
When the trigger mode is set as **BUS**, once the **GPIB** interface receives a TRIGGER command, the meter will execute a test. Note: **BUS** mode cannot be set on the front panel.

NOTE: In the process of testing the trigger signal should be sent after the test is completed, otherwise the trigger signal will be ignored. When optional HANDLER interface triggers the meter, the trigger mode is set to EXT.

Setting Trigger Selection
Three out of the four modes of the trigger operation can be set in the front panel.

1) In the **<MEASURE SETUP>** page, move the cursor to the **TRIGGER** field, and the following soft keys will be displayed:
   - **INT**
   - **MAN**
   - **EXT**
2) Use above soft keys to set the trigger mode.
3) **BUS** trigger mode has to be set using remote communication by sending the command: **TRIGger:SOURce BUS**.

Auto Level Control (ALC)

Auto level control function can adjust the actual test level (voltage across or current through DUT) to the test level value. This function helps ensure a constant test voltage or current.

When using this function, the test level can be set within the range below:
Constant voltage: 10 mV$_{rms}$ to 1 V$_{rms}$
Constant current: 100 μA$_{rms}$ to 10 mA$_{rms}$

NOTE: If the level exceeds above ranges, this function will be automatically disabled.

Setting Auto Level Control

1) In the **<MEASURE SETUP>** page, using the cursor keys, move the cursor to the **ALC** field, and the following softkeys will be displayed:

2) Move the cursor to **ALC**, and the following softkeys are displayed:
   - **ON:** Press to turn on the auto level control function.
   - **OFF:** Press to turn off the auto level control function.

To ensure the best accuracy possible for the type of device being measured:
   - Turn ALC ON
   - Select the right frequency for the application of the device
   - Select the right amplitude

Bias Current Isolation

Bias current isolation function can prevent DC current from affecting the test input circuit. When the bias current isolation function is set as ON, the bias current flowing through DUT can reach 100mA. When the bias current isolation function is set as OFF, the bias current value allowed to flow through DUT is shown as Table 11.

DC Resistance of DUT	10 Ω	30 Ω	100 Ω	300 Ω	1 kΩ	3 kΩ	10 kΩ	30 Ω	100 kΩ
Max. current	2 mA	2 mA	2 mA	2 mA	1 mA	300 μA	100 μA	30 μA	10 μA

Table 11 – Max. DC Bias Current

Note: After bias current isolation function is turned on, the test accuracy will be influenced, so under the condition of low frequency and bias current, the bias current isolation function should be set as OFF.

Setting the Bias Current Isolation Function

Follow these steps and set the bias current isolation function ON or OFF.
1. In the **<MEASURE SETUP>** page, using the cursor keys, move the cursor to the <u>ISO</u> zone, the following soft keys will be displayed:
2. Move the cursor to **ISO** zone, the following soft keys will be displayed:
   - **ON:** Press this soft button to turn on the bias current isolation function.
   - **OFF:** Press this soft button to turn off the bias current isolation function.

Average (AVG)

The Average sets the number of samples to use for averaging before a measurement is made. This can be set from 1 to 255. The higher the number of samples used for averaging, the higher the accuracy of the measurement. The lesser the number of samples used for averaging, the lesser the accuracy of the measurement; but measurement speed will increase.

Setting Test Average
1) In the **<MEASURE SETUP>** page, using the cursor keys, move the cursor to <u>AVG</u>, and the following softkeys will be displayed:

   - **INCR +**   This key is used to increase the number of measurements used to average the final value displayed.
   - **DECR -**   This key is used to increase the number of measurements used to average the final value displayed.
2) Use **INCR +** or **DECR –** softkeys or the numeric keypad, following by Enter, to set the average amount.

Level Monitor (Vm/Im)

The level monitor function can monitor the actual voltage or current across the DUT.

The monitored value is displayed on the <**MEASURE DISP**> page as:
   - **Vm:** Monitored voltage
   - **Im**: Monitored current

Setting the Level Monitor Function

1) In the **<MEASURE SETUP>** page, using the cursor keys, move the cursor to **Vm** or **Im**, and the following soft keys will be displayed:
   - ON
   - OFF
2) Press ON to set the voltage or current monitor function ON.
3) Press OFF to set the voltage or current monitor function OFF.

NOTE: **The selected function can affect the level monitor function. When the correction data changes, the level monitor value will also change. When correction is switched between OPEN, SHORT or LOAD, the level monitor value will be affected as well.**

Delay Time (DELAY)

This function delays the start of the measurement after a trigger is received. This delay will also be applied in the SWEEP mode at each test point. The range of the trigger delay time can be set from 0 s to 60 s with 1 ms resolution. When the instrument is triggered by the HANDLER interface, the trigger delay time can ensure DUT and test terminal have a reliable contact.

Setting Delay Time Function
Execute the following steps to set the measurement delay time.
1) In the **<MEASURE SETUP>** page, using the cursor keys, move the cursor to **DELAY**.
2) Use numeric keys to input delay time. After pressing a numeric key, the following unit keys will be displayed. These softkeys can replace **[ENTER]** to input delay time.
   - **msec**
   - **sec**

Output Impedance

The meter provides three output impedances: 100 Ω, 50 Ω, 30 Ω. When testing inductance, it is necessary to input the same output impedance so as to make data comparison with other instruments.

Note: **When an optional bias board is selected, only 100Ω is available.**

Setting Output Impedance
Execute the following operations to set output impedance
1) In the **<MEASURE SETUP>** page, using the cursor keys and mover to the **Rsou**, and the following soft keys will be displayed:
   - **100 Ω**
   - **50 Ω**
   - **30 Ω**

2) Press any of the softkey to change the output impedance..

Deviation Test Function (DEV A/DEV B)

The deviation value is equivalent to the real test value subtracted from the pre-set reference value. This function is useful when observing variations of component parameters.

- **Δy (Absolute Deviation mode)**
  Displays the difference between the test value of the DUT and the preset reference value. The formula for calculating ΔABS is shown below:

  ΔABS=X-Y
  Where X is the test value of DUT
  Y is the preset reference value

- **Δ% (Percentage deviation mode)**
  Displays the percent difference between the test value of DUT and the preset reference value divided by the reference value. It is calculated by the below formula:

  Δ%=(X-Y)/Y*100[%]
  Where X is the test value of DUT
      Y is the preset reference value

Setting Deviation Test Function

1. In the **<MEASURE SETUP>** page, move the cursor to **DEV A/DEV B**. The following softkeys will be displayed:
   - **ABS**: Absolute Deviation Mode
   - **%:** Percentage Deviation Mode
   - **OFF**
2. Press the above softkeys to select the type of Deviation or to disable the function.
3. Move the cursor to the primary parameter **REF A** or the secondary parameter **REF B** to input the reference values.
   - To measure the reference parameter, place a component in the test terminal and press the **Measure** key that will be displayed on the top right corner of the screen.
   - To enter the reference parameter, use the numerical keys; the following units will be available in the softkey field: **p, n, u, m, press the -> to see the options k, M, and *1**. Press either of them to select the unit.

4 Limit Table Setup

The Limit Table Setup allows the user to set the parameters for the Bin Sorting Function. This page allows the user to set the parameters for the built-in comparator. These LCR meters can set nine bin limits of the primary parameters and one of the secondary parameters. The tested result can be divided into up to ten bins (BIN 1 to BIN 9 and BIN OUT). If the primary parameter of the DUT (device under test) is within the limit range from BIN1 to BIN9, but the secondary parameter is out of the limit range, the DUT can be sorted into aux bin.

Press **SETUP** and then **LIMIT TABLE** to enter into the **<LIMIT TABLE SETUP>** page as the following figure shown.
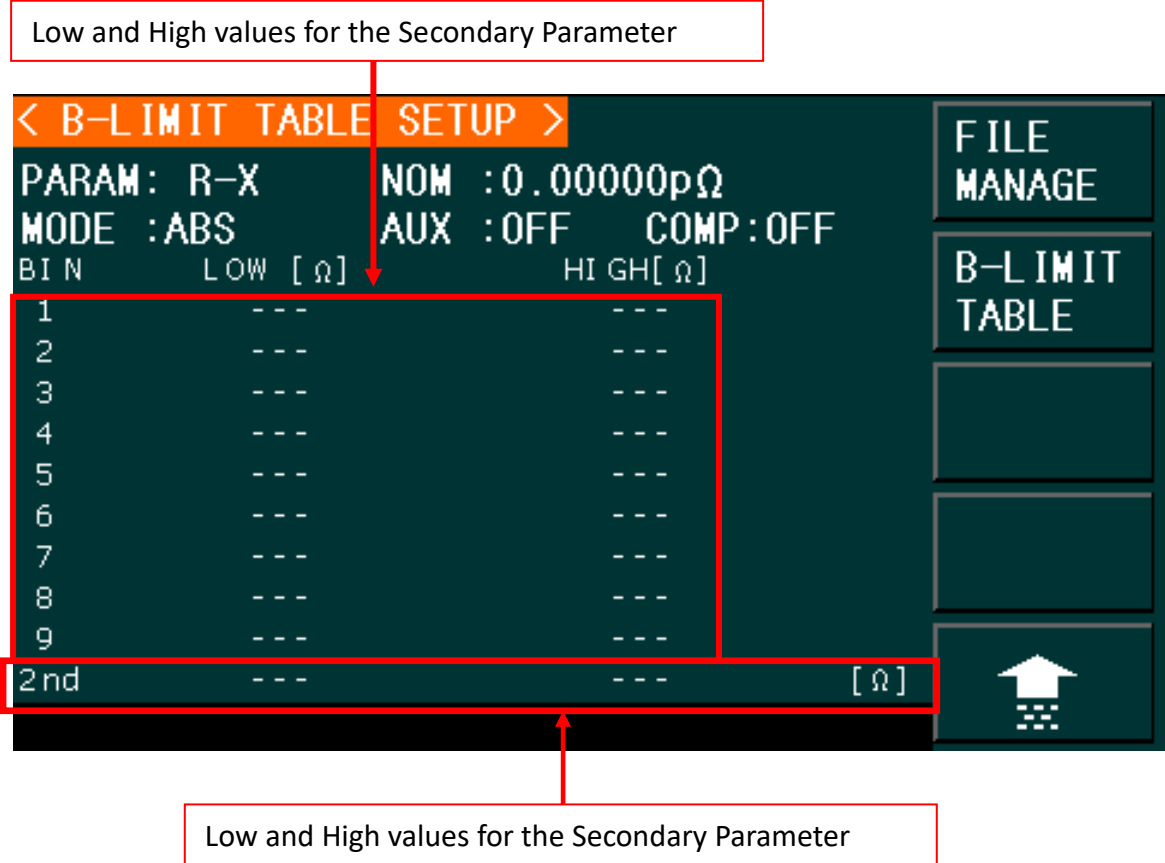
Figure 19 - Limit Table Setup

The following limit parameters of the Compare Function can only be set on **<LIMIT TABLE SETUP>** page.

    Measurement parameters (**PARAM**)
    Compare function modes (**MODE**)

Nominal value (**NOM**)
Auxiliary bin ON/OFF (**AUX**)
Comparator Function ON/OFF (**COM**)
High/Low limit of each bin (**HIGH/LOW**)

4.1 Measurement Parameters (PARAM)

For more details on how to set up Test Parameters and the available options go to section 3.2 Measurement Parameters.

Swap Parameters

This function will swap the primary and the secondary parameter in **PARAM**. For example, when the measurement parameter is **Cp-D**, the swap parameter function can change the measurement parameter to D-Cp.

Swapping Parameters

Follow the steps below to swap the primary and the secondary parameters.

1) Press **SETUP**.
2) Press **LIMIT TABLE** to enter into the **<LIMIT TABLE SETUP>** page
3) Move the cursor to **PARAM**, and the following soft key will be displayed.
   - **SWAP PARAM**
4) Press **SWAP PARAM** to swap the primary and the secondary parameters.

4.2 Compare Function Modes (MODE)

The compare function has two limit setup modes for the primary parameter as shown below in Figure 20.
- **Tolerance mode**
  Under tolerance mode, set the deviation of the nominal value (**NOM**) as the compare limit value. There are two deviation settings: percentage deviation, absolute deviation.
- **Sequential mode**
  Under sequential mode, the range of the test value is the compare limit value. The compare limit value should be set in the order from smallest to largest.
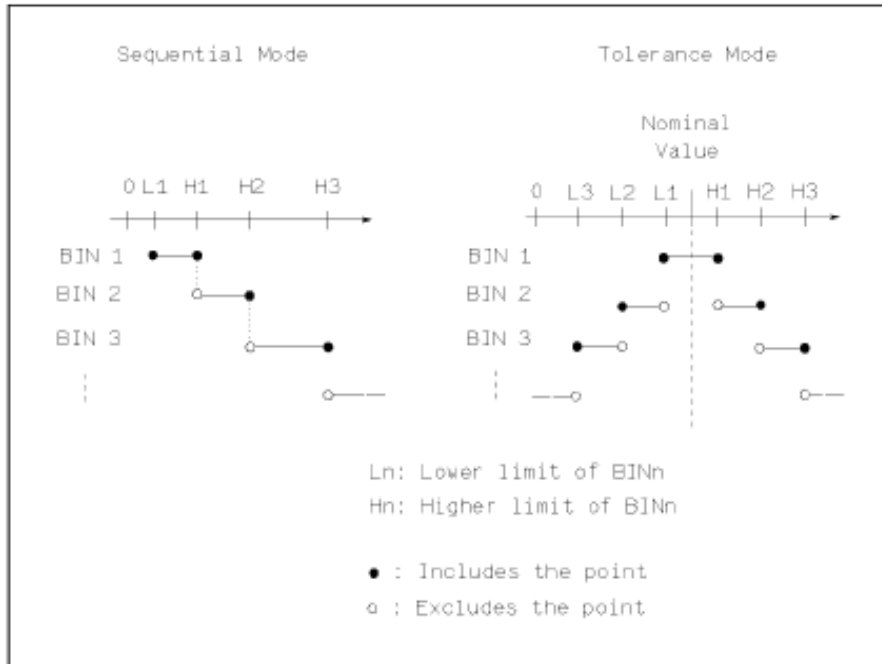
Figure 20 - Tolerance Mode and Sequential Mode

Note: When setting limit values of the tolerance mode, the error range should be set in the order from small to large. If the error range of BIN1 is the largest one, then all DUT will sort into BIN 1.

Under tolerance mode, the low limit does not need to be smaller than the nominal value and the high limit does not need to be larger than the nominal value. The limit range of each bin can be overlapped.

Setting Limit Modes

1) Press **SETUP**.
2) Press **LIMIT TABLE** to enter into the **<LIMIT TABLE SETUP>** page.
3) Move the cursor to **MODE**, and the following soft keys will be displayed:
   o **%TOL :** Set percentage deviation tolerance (% TOL) as the limit mode.
   o **ABS TOL:** Set absolute deviation tolerance (ABS TOL) as the limit mode.
   o **SEQ MODE:** Sequential mode as the limit mode (SEQ)
4) Press the softkey to select the required the limit mode.

Tolerance Mode

When the tolerance mode is selected as the limit mode of the primary parameter, it is necessary to set the nominal value. The nominal value can be any value within the display range.

When the sequential mode is selected as the limit mode the primary parameter, the nominal

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value can be set, but it is optional.

Setting the Nominal Value
1) Press **SETUP**.
2) Press **LIMIT TABLE** to enter into the **<LIMIT TABLE SETUP>** page.
3) Move the cursor to **NOM**.
4) Use numeric keys to input nominal value.
   - The following softkeys for the units of the nominal value will become available:
     p, n, μ, and **m**
   - Press the → key to access additional units softkeys:
     k, M, *1
   Alternatively, enter a value directly using the numeric keypad, then press **ENTER**.

4.3 Auxiliary Bin (AUX)

Three conditions may occur during the secondary parameter sorting that will determine if the Auxiliary Bin would be enabled:
- On **<LIMIT TABLE SETUP>** page, no low/high limits of the secondary parameters have been set.
- On **<LIMIT TABLE SETUP>** page, the low/high limits of the secondary parameters have been set but **Aux** function is set as OFF.
  In this case, only those components that have a secondary parameter that is within the specified limits will be sorted. If the secondary parameters are outside the limits set and the corresponding primary parameters are within limit ranges, the components will be sorted into BIN OUT.
- On <**LIMIT TABLE SETUP**> page, the low/high limits of the secondary parameters have been set and the **Aux** function is set as ON.
  In this case, if the primary parameter is out of the limit range, it is sorted into BIN OUT. If the primary parameter of DUT is within the limit range but its secondary parameter is out of the limit range, the DUT will be sorted into the **Aux** bin.

Note: **When the secondary parameter has the Low Limit set only, with the auxiliary bin set to ON, if the primary parameter of the DUT is within the limit range and the secondary parameter is smaller than or equal to its low limit, the DUT will be sorted into the auxiliary bin. When the secondary parameter has the high limit set only, with the auxiliary bin set to ON, if the primary parameter of DUT is within the limit range and the secondary parameter is larger than or equal to its high limit, the DUT will be sorted into the auxiliary bin.**

Setting the Auxiliary Bin

1) Press the SETUP key. (Located between the MEAS and SYSTEM keys).

2) Press the LIMIT TABLE softkey.
3) Using the arrow keys, move the cursor to **AUX**, the following soft keys will be displayed.
   ON
   OFF
4) Press the ON softkey to enable the Aux Bin or, press OFF to turn the Aux Bin off.

4.4 Comparator Function (COMP)

Nine bin limits of the primary parameters and one bin limit of the secondary parameters can be set. The tested results can be sorted into ten bins (BIN 1 to BIN 9 and BIN OUT). This function is especially useful if the handler interface is used.

Enabling Compare Function

1) Press **SETUP**.
2) Press **LIMIT TABLE** to enter into the **<LIMIT TABLE SETUP>** page.
3) Move the cursor to **COMP**, the following soft keys will be displayed.
   - **ON**
   - **OFF**
4) Use above soft keys to enable (ON) or disable (OFF) the compare function.

4.5 High/Low Limits

The meter can set bin limits of nine primary parameters and one secondary parameter. The test results can be sorted into ten bins at most (BIN 1 to BIN 9 and BIN OUT). The high/low limits of primary parameters can be set in high limit and low limit of bins from BIN 1 to BIN 9. The limit of the secondary parameter can be set in the **HIGH** and **LOW** fields at the bottom of the screen in the field labeled "**2nd**" (2nd for Secondary Parameter) at the bottom of the Limit Table SETUP screen, as detailed in Figure 19.

Operation steps for setting high/low limit

Follow this steps to set sorting limits:
1) Press **SETUP**.
2) Press **LIMIT TABLE** to enter into the **<LIMIT TABLE SETUP>** page
3) The primary parameter must be set in the <MEAS DISPLAY> page. Access this page by pressing the MEAS key and follow the instructions detailed in the section: **Selecting**

Primary and Secondary Parameters.
4) Use the cursor to set the nominal value in the **NOM** field.
5) Set the limit **MODE** of the primary parameter (as described in section 4.2 Compare).

Repeat steps 6 to 9 if the Tolerance Mode was selected until the limits of BIN 9 are input. The cursor will automatically move <u>LOW </u>of 2nd or repeat steps 10 to 14 if the Sequential Mode was selected in Step 5.

6) User numeric keys to input low limit value in Low limit. After inputting the data, you can select the units softkeys (**p, n, μ, m, k, M, *1**). After inputting limit value in **<u>LOW</u>** of BIN 1, the low limit of BIN 1 will be automatically set to – (absolute limit) and the high limit will be set to + (absolute limit).
7) The cursor will automatically move to **<u>LOW</u>** of BIN 2.
8) After inputting the low limit of the secondary parameter, the cursor will automatically move to **<u>HIGH</u>** of 2nd.
9) Input the high limit of the secondary parameter.
10) In Low limit of BIN 1, use numeric keys to input the low limit, then select the units softkeys (**p, n, μ, m, k, M, *1**).
11) After inputting the low limit of BIN 1, the cursor will automatically move to **<u>HIGH</u>** of BIN 1. Input the high limit of BIN 1.
12) The cursor will automatically move **<u>HIGH</u>** of BIN 2. In sequential mode, the low limit of BIN 2 will be the high limit of BIN 1. Input the high limit of BIN 2.
13) Repeat step 9 until the high limit of BIN 9 is input. Then the cursor will automatically move to **<u>LOW</u>** of 2nd. Input the low limit of the secondary parameter.
14) The cursor will automatically move to **<u>HIGH </u>**of 2nd. Input the high limit of the secondary parameter.

5 Bin Sorting Function

The following test conditions are displayed in the **<BIN No. Disp>** page. The following cannot be set on this page but can be set in **<MEAS SETUP>** page.
- Test function (FUNCA)
- Test frequency (FREQ)
- Test level (LEVEL)
- Test range (RANG)
- Test speed (SPEED)
- DC BIAS
- ON/OFF set state of OPEN, SHORT, LOAD (CORR)

To set these test conditions, refer to section 3.6 Measure Setup Menu.
Press the **MEAS key** and then the **BIN NO.** softkey to enter into **<BIN NO. DISP>** display page.

Figure 21 - Bin Sorting Function

5.1 Bin Count Display

The Bin Count Display page shows the count of the comparator function. It also provides the information in the monitor fields for the Binning Function: **PARAM, NOM, Bin Number, Bin Sorting Limits (LOW/HIGH) and COUNT**. This page displays only results (except for the COUNT option).
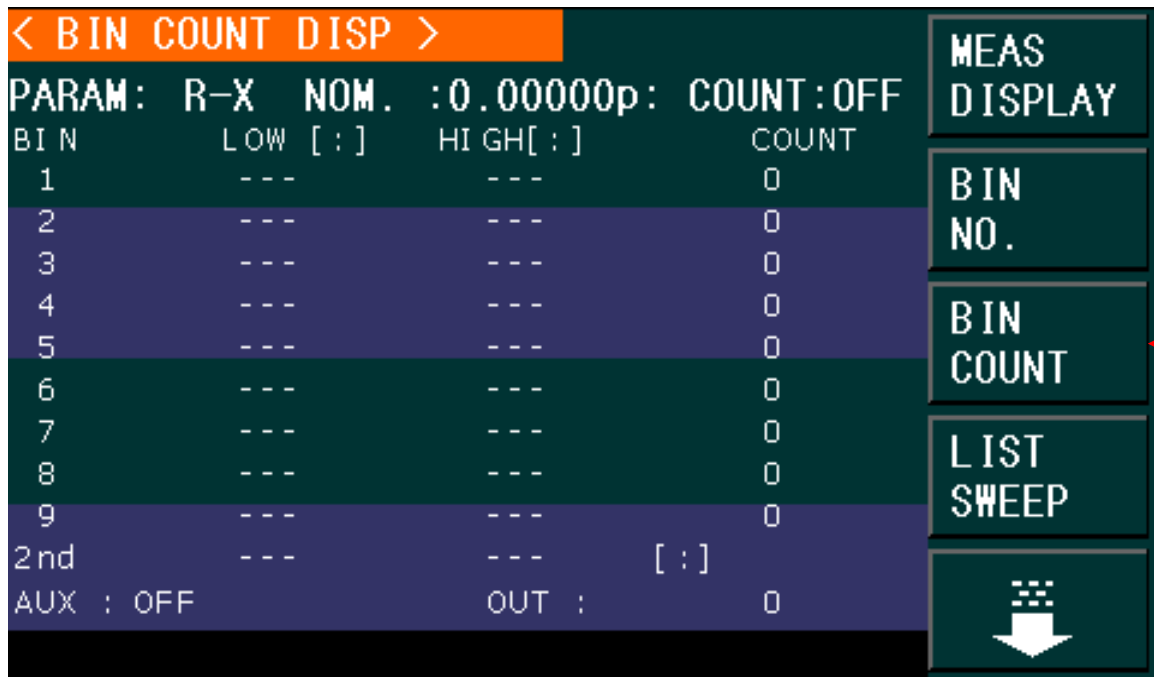
Figure 22 - Bin Count Display

Go to the <**BIN COUNT DISP**> page to see the count of each bin:
   a)   Press <**MEAS DISP>**
   b)   Pres the soft key **BIN COUNT**

The <**BIN COUNT DISP**> page allows the user to turn the **Count** function **ON** or **OFF**.
To enable the **Count** option:
   a)   While in the <**BIN COUNT DISP**> menu, press the down arrow in the cursors keys.
        The softkeys **ON** or **OFF** will become available on the top right of the page.
   b)   Press **ON** to turn on the bin count.

PARAM

Parameter zone shows the "Function" parameter.

NOM.

Nominal parameter is the nominal value for bin compare function.

COUNT

This parameter shows the count value of the current bin.

Setting the Bin Count Function

Execute the following operations to set the bin count function ON/OFF on <**BIN COUNT DISP**> page.

1) On <**BIN COUNT DISP**> page, move the cursor to **COUNT**, the following soft keys will be displayed.
   - **ON**
   - **OFF**
   - **RESET**
2) Press the soft key **ON** to turn on the count function.
3) Press the soft key **OFF** to turn off the count function.
4) Press the soft key **RESET**, and the following soft keys will be displayed.
   - **YES**
   - **NO**
5) Press the soft key **YES** to reset all bin counts to 0.
6) Press the soft key **NO** to cancel the reset operation.

BIN

This shows the bin number of the limit list. "2nd" means the secondary parameter limit.

HIGH/LOW

This shows the high and the low limits of the limit list.

AUX

This shows the count value of the auxiliary bin.

OUT

This shows the count value of the out bin.

6 List Sweep Setup

The List Sweep Setup page allows the user to configure the List Sweep for up to 201 frequencies, test signal levels, DC bias voltage or DC current source.

On **<LIST SWEEP SETUP>** page, the following list sweep parameters can be set.
- Mode (**SEQ** or **STEP**)
- Sweep Parameters (frequency **[Hz]**, level **[V]**, level **[A]**, bias **[V]**, bias **[A]**)
- Sweep Test Points (**Hz, V, A**)
- Limit Parameter (**LMT**)
- High/Low Limit (**HIGH**, **LOW**)
- Delay in Seconds (**DELY**)Clear Table (**No.**)

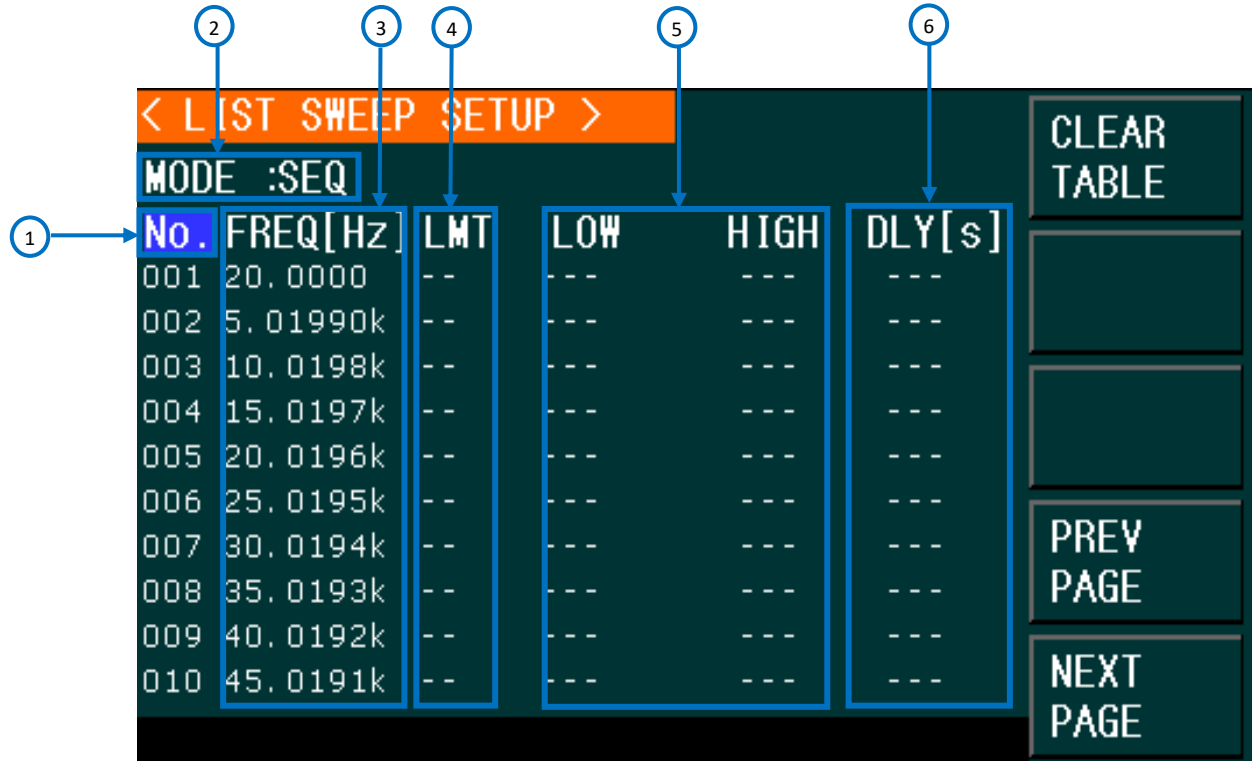**Figure 23 - List Sweep Setup**

①**No.**

When the cursor is set in this area, the soft keys will display "PREV PAGE" and "NEXT PAGE". By pressing any of these two soft keys the user will be able to navigate through the List Sweep Display.

Clear Table
This option clears the table completely.

② *Mode*

The meter can automatically sweep up to 201 frequencies, test levels or DC bias. Two sweep modes are available: **SEQ** and **STEP**. In **SEQ** mode, each press of the **TRIGGER** button will initiate a test of all list sweep test points. In **STEP** mode, each press of the **TRIGGER** button test one point at a time of the list sweep.

NOTE: When the trigger mode is set to INT, sweep test modes of SEQ and STEP will not be controlled by [TRIGGER]. When the trigger mode is set to MAN, [TRIGGER] can be used to trigger the list sweep test.

Setting the List Sweep Mode:
1) On the <**LIST SWEEP DISP**> page, move the cursor to **MODE**, and the following soft keys will be displayed:
   - **SEQ**
   - **STEP**
2) Press **SEQ** to set the sweep mode as sequential sweep test mode.
3) Press **STEP** to set the sweep mode as single step sweep test mode.

③ *Sweep Parameter*

The sweep parameters can be: frequency **[Hz]**, level **[V]**, level **[I]**, bias **[V]**, and bias **[I]**.

Setting the Measurement parameter
1) Press **[SETUP]** and then **LIST SWEEP** to enter into the <**LIST SWEEP SETUP**> menu.
2) Move the cursor the line following **MODE**. The following soft keys will be displayed:
   - **FREQ [Hz]** = Frequency as the sweep parameter.
   - **LEVEL [V]** = Voltage as the sweep parameter.
   - **LEVEL [A]** = Current as the sweep parameter.
   - **BIAS [V]** = DC bias voltage as the sweep parameter.
   - **BIAS [A]** = DC bias current as the sweep parameter.
3) Press one of above soft keys to select the list sweep parameter.

Sweep Test Points

Setting the Sweep Test Points
1) Press **[SETUP]** and then **LIST SETUP** to enter into the <**LIST SWEEP SETUP**> menu.
2) Using the cursor keys, move the cursors to a sweep point. The following options will become available:

- **Delete Line:** Clears all the parameters of the line selected
- **Fill Linear:** Fills the table linearly between the high value and low value.
- **Fill Log:** Fills the table linearly between the high value and low value.
- **Prev Page:** Returns to previous page.
- **Next Page:** Moves onto the next page.

The user can enter the sweep test point values manually if **Fill Linear** or **Fill Log** is not selected. The meter will perform the sweep only with the values entered in the field below the Sweep Parameter (i.e. frequency **[Hz]**, level **[V]**, level **[A]**, bias **[V]**, bias **[A]**).

3) Enter a value in the Sweep Test Point (the field below the Sweep Parameter) using the numeric keypad.
4) Using the softkeys, select the units available (Hz, kHz, and MHz).

Filling the Sweep Test Points Table Automatically:
There are two ways to fill the frequencies of the Sweep Table automatically:
1. **Fill Linear**
2. **Fill Log**
The user can set the first and last values where the sweep will take place. Then select the option Fill Linear and the unit will automatically populate the 2nd to 9th frequency steps.

For example, the user sets the 1 step to be 100 Hz. Second step to be 1000 Hz. Then the option selected is **Fill Linear**.

The frequency values will populate as follows:
100 Hz, 200 Hz, 300 Hz, 400 Hz, 500 Hz, 600 Hz, 700 Hz, 800 Hz, 900 Hz and 1,000 Hz. The spaces between points for the frequency sweep are even because the linear option is selected.

Also, if the user does not set the low and high values, these LCR meters will automatically fill the entire table, from the lowest frequency (20 Hz) to the highest value (1 MHz) linearly or logarithmically, depending on the user selection.

④ *Limit Parameters*

The limit parameters are used to select which parameter, primary or secondary, is used to compare with the high and low limits of the table. To select the primary parameters or secondary parameters, select **LMT A**, or **LMT B** respectively. If this function is off, then the measured values will not be compared against the low and high limits.

⑤ *High/Low Limits*

This zone shows the high and the low limits of the limit list.

⑥ *Delay*

DLY parameter indicates the delay time from the last measurement of each sweep step to the next sweep measurement.

7 List Sweep Display

Press the menu key **[MEAS DISPLAY]** and then the soft key **LIST SWEEP** to enter into the **<LIST SWEEP DISP>** page, shown below:

Figure 24 - List Sweep Setup

NOTE: When the trigger mode is set to INT, sweep test modes SEQ and STEP will not be controlled by the TRIGGER key. When the trigger mode is set to MAN, [TRIGGER] can be used to trigger the list sweep test and Reset to Stop the sweep and once stopped, it can also reset the sweep.

The test points will be automatically tested in scanning mode. Meanwhile, comparison will be made between test results and limit values. In the process of list sweep test, "►" denotes the current sweep test point.

Only the following control parameter can be set in <**LIST SWEEP DISP**>:
- Sweep mode (**MODE**)

Select **MODE** on this page to set between SEQ (sequence) or STEP.
- In SEQ mode, each press of **TRIGGER** key will trigger the meter to automatically test all list sweep test points.
- In STEP mode, each press of the **TRIGGER** key will trigger the meter to test one sweep point.

List Sweep Display Fields

No.
    When the cursor is set in this area, the soft keys will display "PREV PAGE" and "NEXT PAGE". By pressing any of these two soft keys the user will be able to navigate through the List Sweep Display.

FREQ (Hz)
This shows the swept frequencies.

R[:] X[:]
This displays the primary and secondary parameter measurements.

CMP (Compare)
This indicates the compare results of the swept points. L means the result is lower than the limit and H is higher than the limit. A blank space indicates that it is within the limit.

Operation steps for setting the list sweep mode:

To set the sweep mode on the <**LIST SWEEP DISP**> page as **SEQ** or **STEP**:
1. On the < **LIST SWEEP DISP** > page, move the cursor to **MODE**, and the following softkeys will be displayed:
    SEQ
    STEP
2. Press **SEQ** to set the sweep mode as sequential sweep test mode
    Or
    Press **STEP** to set the sweep mode as single step sweep test mode.

Running a List Sweep Example

Manual trigger can be used to control when to start and stop sweep when trigger source is set to manual (MAN). If the trigger source is set to internal trigger (INT), list sweep will run indefinitely as soon as LIST SWEEP is pressed in the <MEAS DISP> page.

1. Press the setup button. The following screen will be displayed: <Measure Setup> and navigate to the TRIG field. Press the softkey **MAN** to select Manual trigger.
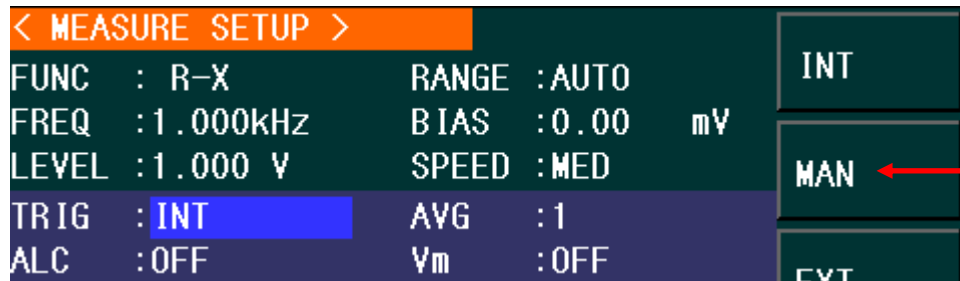
2. Trigger has been set to manual. Press the SETUP button to exit to the previous menu:
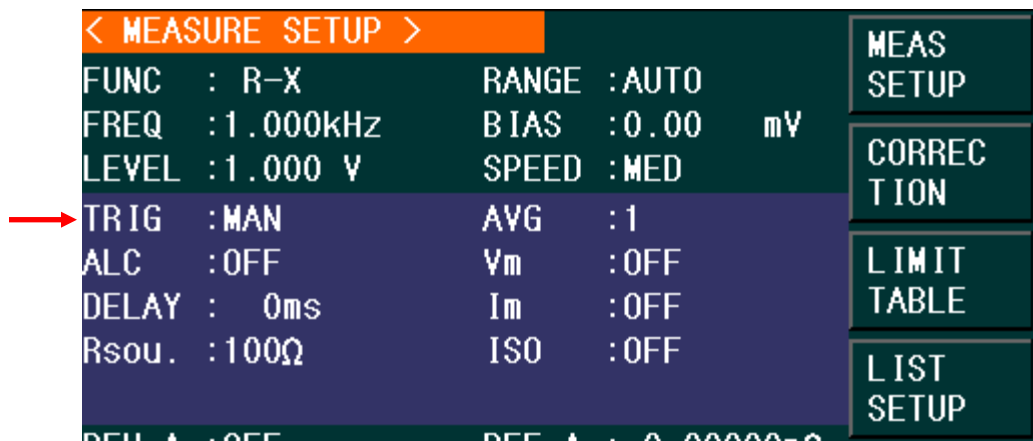
3. Press the LIST SETUP softkey to the right of the screen. The following menu will be displayed:
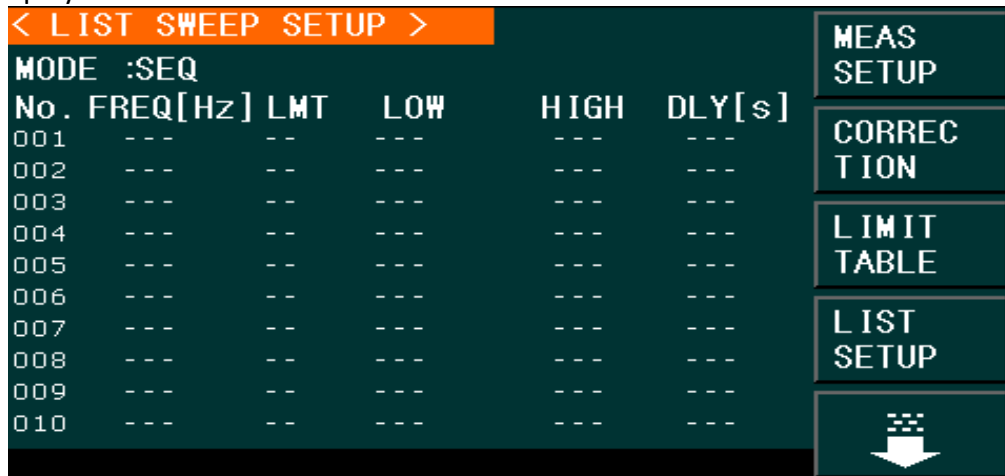
4. Using the cursors navigate to the **MODE** and select **SEQ**.

5. Using the cursors navigate to the parameter to be swept, select the **FREQ [Hz]** by pressing the softkey.
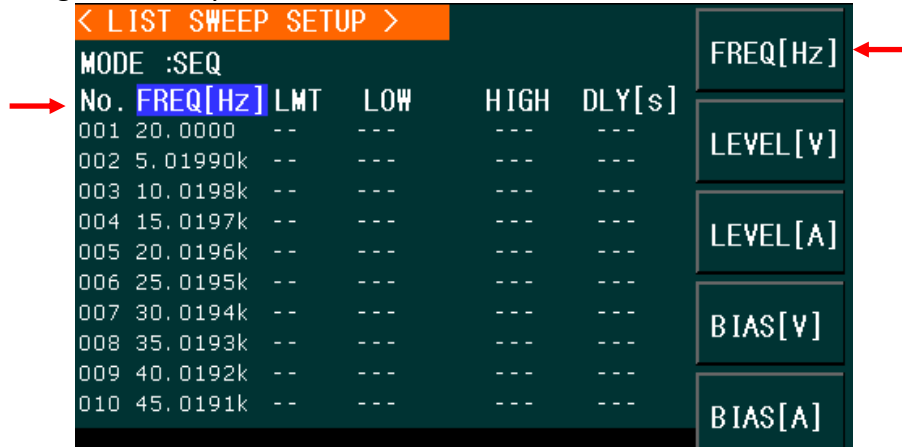
6. Using the arrow keys, navigate to the frequency fields, then press **Fill Linear**.

```
< LIST SWEEP SETUP >                    DELETE
MODE :SEQ                               LINE
No. FREQ[Hz] LMT   LOW      HIGH  DLY[s]
001   - - -   - -  - - -    - - -  - - -  FILL
002   - - -   - -  - - -    - - -  - - -  LINEAR
003   - - -   - -  - - -    - - -  - - -
004   - - -   - -  - - -    - - -  - - -  FILL
005   - - -   - -  - - -    - - -  - - -  LOG
```

```
< LIST SWEEP SETUP >                    DELETE
MODE :SEQ                               LINE
No. FREQ[Hz] LMT   LOW      HIGH  DLY[s]
001  20.0000  - -  - - -    - - -  - - -  FILL
002  5.01990k - -  - - -    - - -  - - -  LINEAR
003  10.0198k - -  - - -    - - -  - - -
004  15.0197k - -  - - -    - - -  - - -  FILL
005  20.0196k - -  - - -    - - -  - - -  LOG
006  25.0195k - -  - - -    - - -  - - -
007  30.0194k - -  - - -    - - -  - - -  PREV
008  35.0193k - -  - - -    - - -  - - -  PAGE
009  40.0192k - -  - - -    - - -  - - -
010  45.0191k - -  - - -    - - -  - - -  NEXT
                                          PAGE
```
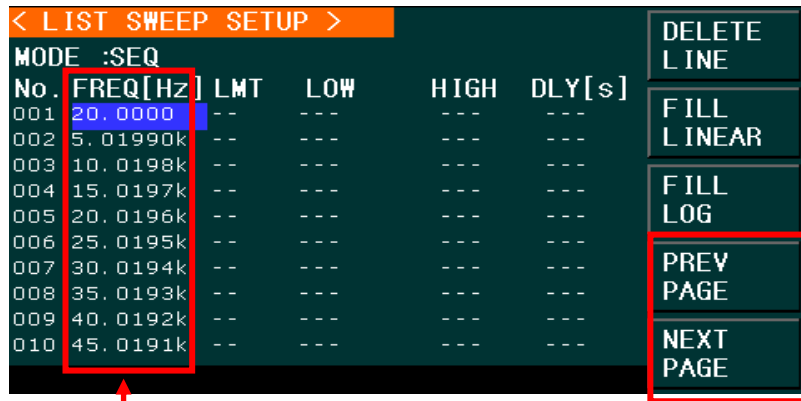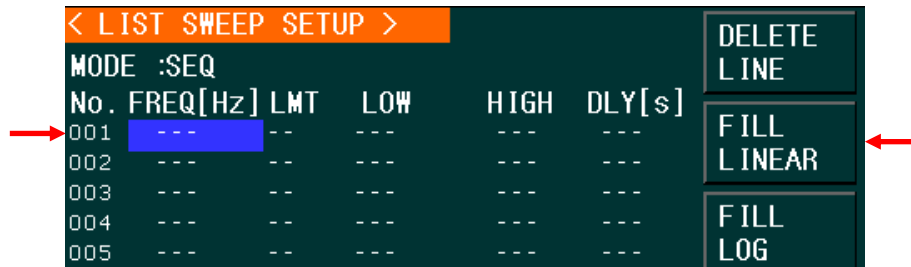
Frequencies filled linearly by pressing the Fill Linear softkey.

Use these softkeys to navigate through all the values.

7. Go to the main page by pressing the **MEAS** button and press the **LIST SWEEP** softkey.

```
< MEAS DISPLAY >                              MEAS
FUNC   : R-X          RANGE  :AUTO           DISPLAY
FREQ   :1.000kHz      BIAS   :0.00    mV     
LEVEL  :1.000 V       SPEED  :MED            BIN
                                             NO.

    R    :                             Ω     BIN
                                             COUNT
    X    :                             Ω     LIST
                                             SWEEP
Vm    : OFF           Im    : OFF
CORR  : OFF
```
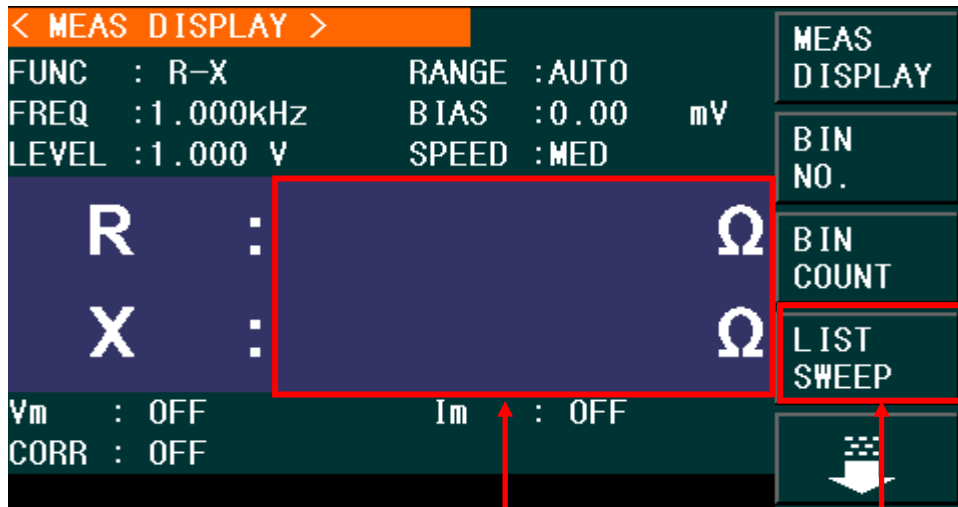
No readings since the trigger was set to manual.

Press to enter to the List Sweep Display

8. Press the [Trigger] button and the sweep will start. To stop, press the [Reset] button once. To restart the sweep, press the [Reset] button twice.

The results of a frequency linear sweep of the primary and secondary parameters R and X are shown below:

```
< LIST SWEEP DISP >

MODE  :SEQ
 No.  FREQ[Hz]    R [Ω]       X [Ω]    CMP
 001  20.0000     1.50266M    634.500    P
 002  5.01990k    1.50025M   -45.4533k   P
 003  10.0198k    1.49550M   -90.5897k   P
 004  15.0197k    1.48809M   -133.992k   P
 005  20.0196k    1.47801M   -176.581k   P
 006  25.0195k    1.46501M   -217.590k   P
 007  30.0194k    1.45076M   -257.637k   P
 008  35.0193k    1.43858M   -298.054k   P
 009  40.0192k    1.41586M   -332.740k   P
 010  45.0191k    1.39875M   -370.812k   P
```

PREV
PAGE

NEXT
PAGE

Figure 25 - Frequency Linear Sweep Results

8 System and File Management

8.1 System Setup

Press the **System** key to enter into the **<SYSTEM SETUP>** page shown below and modify any of the options shown:

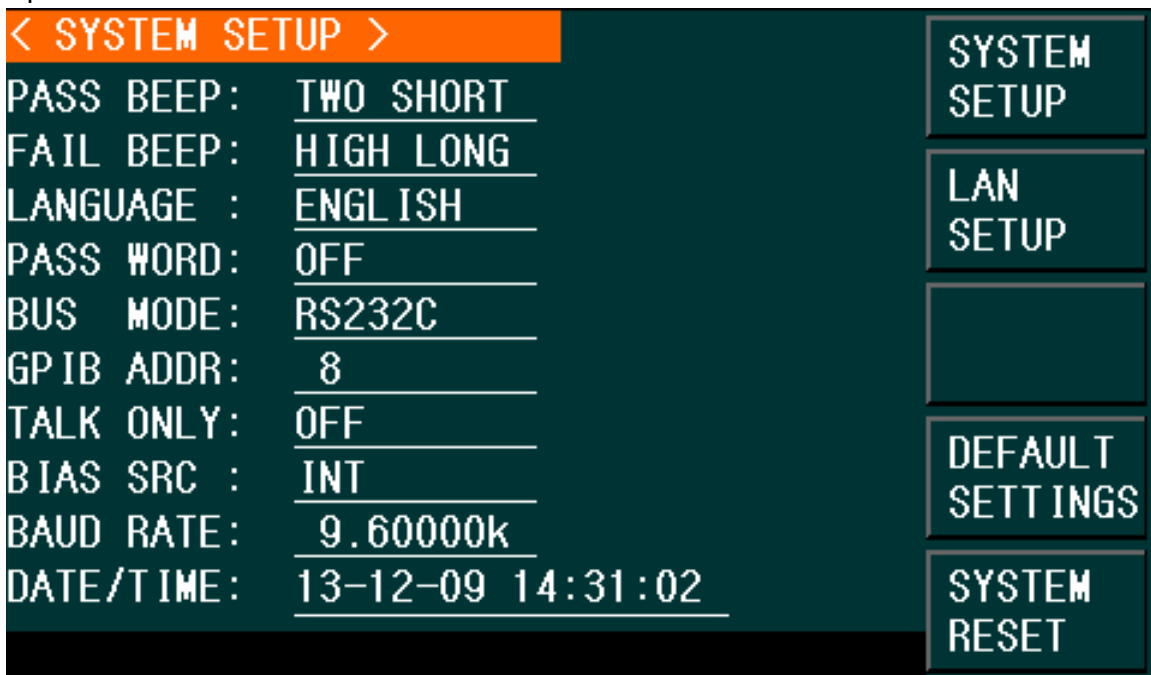**Figure 26 - System Setup**

On this page, the following options can be setup: **PASS beep, FAIL beep, language, PASS word, bus mode, GPIB address, TALK only, Bias SRC, baud rate, date/time**.

NOTE: Press LOG key to save the setup when finished to save the settings of this page.

Pass Beep

Pass beep configures the beep when the measurement results pass the specified test conditions.

Operation steps for setting PASS BEEP

1) Move the cursor to **PASS BEEP**, and the following softkeys will be displayed.
- HIGH LONG
  This soft key selects a long, high tone beep.
- HIGH SHORT
  This soft key selects a short, high tone beep.
- LOW LONG
  This soft key selects a long, low tone beep.
- TWO SHORT
  This soft key selects two short, low tone beeps.
- OFF
  This soft key disables the pass beep function.

Fail Beep

Fail beep configures the beep when the measurement results do not pass the specified test conditions.

1) Move the cursor to **FAIL BEEP**, and the following softkeys will be displayed.
- HIGH LONG
- This soft key selects a long, high tone beep.
- HIGH SHORT
- This soft key selects a short, high tone beep.
- LOW LONG
- This soft key selects a long, low tone beep.
- TWO SHORT
- This soft key selects two short, low tone beeps.
- OFF
- This soft key disables the pass beep function.

Language

This sets the display language of the instrument.

1) Move the cursor to **LANGUAGE**, and the following softkeys will be displayed.
- **ENGLISH**
  This softkey selects English as the display language.
- **CHINESE**
  This softkey selects Chinese as the display language.

Password

This configures the password–protection mode.

1) Move the cursor to **PASSWORD**, and the following soft keys will be displayed.
   - **OFF**

   This soft key disables the password protection mode.
   - **Hold SYSTEM**

   This soft key enables the password protection mode including file protection and boot up password.
   - **Hold FILE**

   This soft key sets protection to user's file.
   - **MODIFY**

   This soft key is used to change the password. The operation steps are as follows:

   Press **MODIFY** to input a new password (password must be 4 digits). A message prompt will ask for the new password. Input the new password again to confirm changes.

Note: The instrument has a default password 0895.

Bus Mode

This mode is used to select RS-232, GPIB, LAN, USBTMC or USBCDC(virtual COM) remote interface.

1) Move the cursor to **BUS**, and the following soft keys will be displayed.
   - RS-232C
   - GPIB
   - LAN
   - USBTMC
   - USBCDC
2) Use the above soft keys to select an interface for remote communication.

GPIB ADDR (895 only)

This configures the address of the instrument for remote communication via GPIB interface.

1) Move the cursor to **GPIB ADDR**, and the following soft keys will be displayed.
   - **↑ (+)**
   a) This soft key is used to increase the GPIB address number.
   - **↓ (-)**
   b) This soft key is used to decrease the GPIB address number.

Talk Only

The Talk only function configures the instrument to send each measurement result to bus through the remote interfaces. When it is ON, the instrument cannot be controlled by a remote PC.

1) Move the cursor to **<u>TALK ONLY</u>**, the following soft keys will be displayed.
   - **ON**
   - **OFF**
2) Press **ON** to turn on the talk only function or **OFF** to turn off this function.

Bias SRC

Bias source is used to select the DC bias power. The instrument provides the bias source as shown below:
   - INT mode
   The standard DC bias voltage source is from -5 V to +5 V and the DC bias current source is from -50 mA to +50mA.

Baud Rate

Baud rate is used select the baud rate for the RS-232 or USBCDC (virtual COM) interface.

Move the cursor to **<u>BAUD RATE</u>**, and the following soft keys will be displayed.
   - ↑ (+)
   This soft key is used to increase the baud rate.
   - ↓ (-)
   This soft key is used to decrease the baud rate.

The available baud rates are: 9600, 19200, 28800, 38400, 48000, 57600, and 115200.

Date/Time

The date format is: Year, Month, and Day.
The time format is 24 hrs. For example: 16:00:00 hrs. would be used instead of 4:00:00 pm.

8.2 LAN Setup

Follow the instructions below to select the Ethernet interface and configure it for remote operation.

1. Press the **SYSTEM** button and you will see the following options:
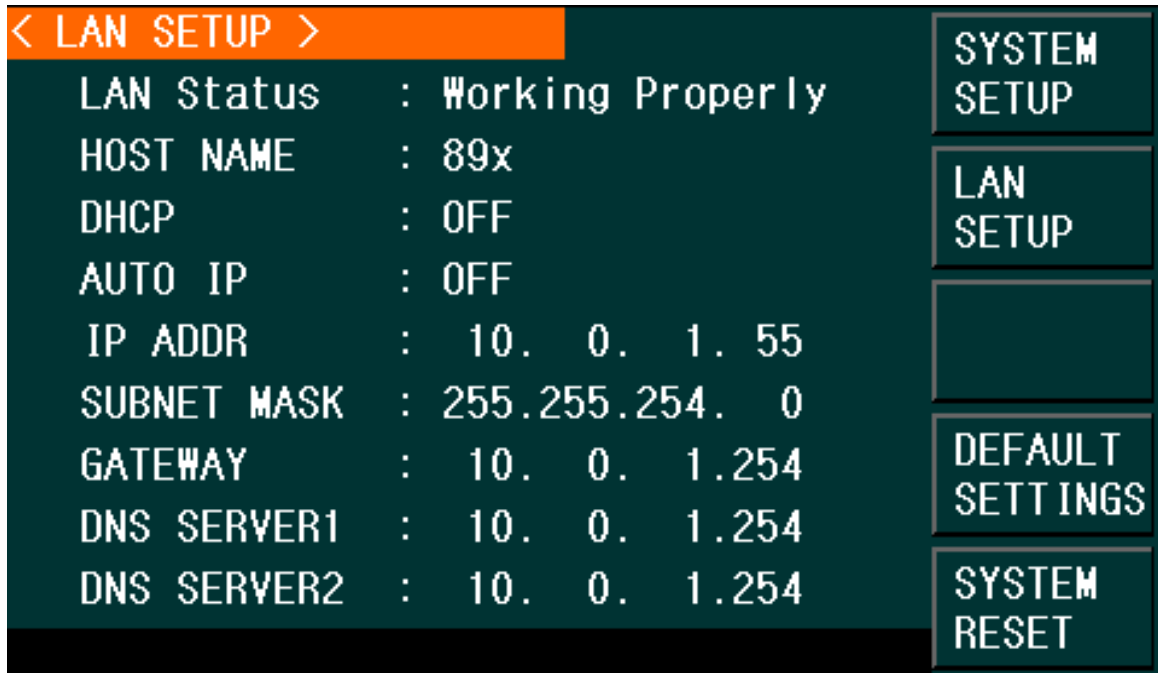
Figure 27 - LAN Setup

2. Press the **LAN SETUP** button.
3. To turn on the **AUTO IP (or off)** and the DCHP options, using the arrows, move the cursor to the **AUTO IP** (or DCHP) field and using the soft menu keys press the **ON** option. AUTO IP field will display whether that option is turned on or off.
4. Using the keypad and arrow keys to set the values required to establish communication via Ethernet for IP Addr, Subnet Mask, Gateway, DNS Server1 and DNS server2.

NOTE: **The unit must already be connected via Ethernet connection and the connected network/router must be compatible to assign the correct parameters to the instrument.**

---

5. Press any of the softkey buttons or any of the Menu Keys to exit the LAN SETUP page.

8.3 Default Settings and System Reset

In the <System Setup> menu, the softkeys to the right of the screen allow the customer to set the unit to **Default Settings** or perform a **System Reset**.

- Press the **Default Settings** soft button to set all the settings of the System Setup menu to their factory default values.
- Press the **System Reset** soft button to reset the instrument.

8.4 File Management

The LCR meters have built-in non-volatile memory for storing and recalling instrument settings. Most measurement menus, (i.e. Meas Display, List Sweep, etc.) have the **File Manage** option at the bottom of the soft keys menu. To go to the page that has the **File Manage** option, press the white down arrow ⇩ soft key. Press **FILE MANAGE** soft key to enter into the **LCR FILES LIST** (Internal memory) as shown below:

Figure 28 - File Management

Setup file (.STA)*

40 user setup files (*.STA file) can be saved and recalled to and from the instrument. In addition, users can use an external USB Flash drive (U-disk) to save/recall up to 500 setup files.

The settings stored in each Setup File are listed below:
- Settings on <MEASURE SETUP> page
  - ☐ FUNCA
  - ☐ FREQ
  - ☐ LEVEL
  - ☐ RANGE
  - ☐ SPEED
  - ☐ DC BIAS
  - ☐ BIAS SRC
  - ☐ TRIGG
  - ☐ ALC
  - ☐ DELAY
  - ☐ Rsou
  - ☐ AVG
  - ☐ Vm
  - ☐ Cm
  - ☐ ISO
  - ☐ DEV A
  - ☐ DEV B
  - ☐ REF A
  - ☐ REF B
- Settings on <BIN COUNT DISP> page
  - ☐ BIN COUNT (ON/OFF)
- Settings on <LIMIT TAABLE SETUP> page
  - ☐ PARAM (swap parameter)
  - ☐ NOM (reference value)
  - ☐ MODE (%-TOL/ABS-TOL/SEQ-MODE)
  - ☐ AUX (ON/OFF)
  - ☐ COM (ON/OFF)
  - ☐ High and low limits of each bin
- Settings on <List Sweep Setup> page
  - ☐ List Sweep Mode (SEQ/STEP)
  - ☐ List Sweep Parameter (Frequency/Level/Bias)
  - ☐ Test points of all sweep parameters
  - ☐ High and low limits of all test points, including limit parameters (LIMIT-DATA A/LIMIT-DATA B)
- Page format currently displayed

Saving Settings to File

1. Configure the settings to be saved (see above list of settings saved for each page).
2. Move the cursor to **FILE MANAGE** from any of the pages with that menu available (i.e. Meas Display, Measure Setup, etc.), and the following soft keys will be displayed.
- **LOAD**
- **SAVE**
- **DEL**
- **FIND**
- ⇩
- **COPY TO E:**
- ⇧
3. In the file list (under the **LCR ID** label) move the cursor to the file-saved position or input the file number directly.

Figure 29 - LCR Files List

4. Press **STORE**, the following soft keys will be displayed.
- **Yes**
- **No**

    The following message will be displayed at the bottom of the screen:
    "Are you sure you want to save to XXX" (file No.)

5. Press **No** to cancel the current save operation and return to step 2.

6. Press Yes, and "**File name: "** will be displayed at the bottom of the screen.

7. Use numeric keys to input the current file name and press the ENTER key. The control and setting parameters will then be saved into the file with this name.

Load setting following these steps

1. Press **FILE MANAGE**, the **LCR File List** and the following soft keys will be displayed.
- **LOAD**
- **SAVE**
- **DEL**
- **FIND**
- ⇩
- **COPY TO E**:
- ⇧
2. In the file list (under the **LCR ID** label, see **Figure 29**), move the cursor to the file-saved position or input the file number directly.
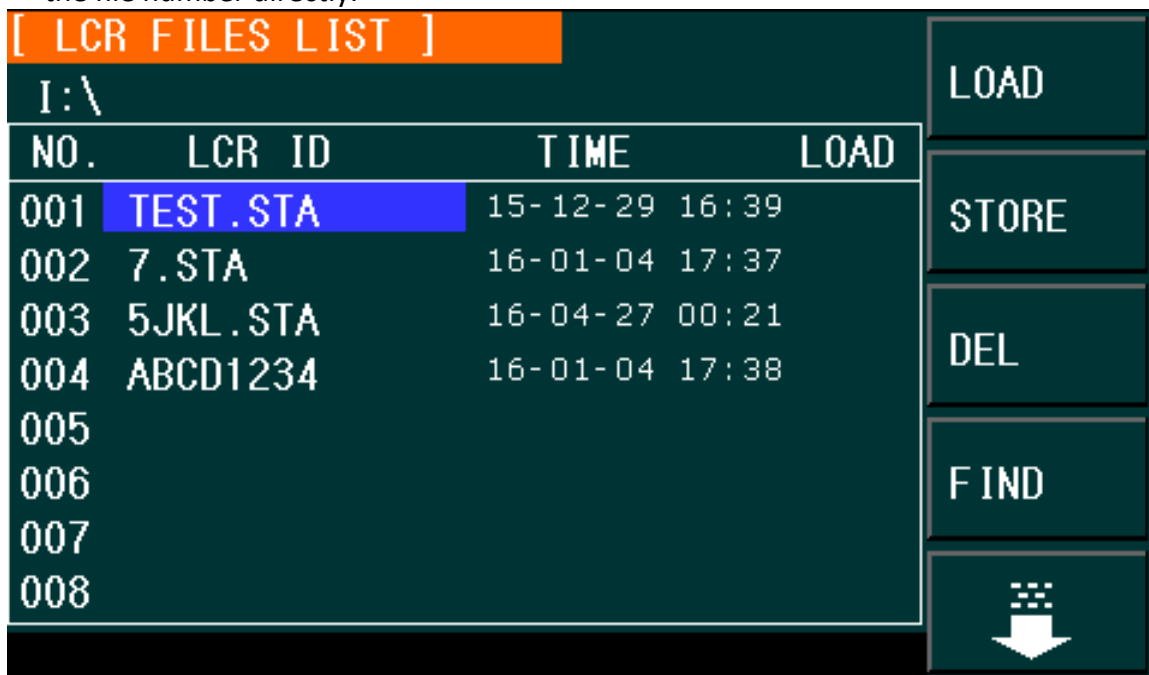3. Press **LOAD**, and the following soft keys will be displayed.
- **Yes**
- **No**
4. Press **No** to cancel the current load operation and return to step 1.
5. Press **Yes** to load the currently selected file. The LCR meter will return to the **MEAS DISPLAY** page.

Copying a file to an U disk
1. Press **FILE MANAGE**, the file list and the following soft keys will be displayed.
- **LOAD**
- **SAVE**
- **DEL**
- **FIND**
- ⇩
- **COPY to E:**
- ⇧
2. Move the cursor to the file to be copied and press [ENTER] to confirm.
3. Press **COPY to E:** to copy the file to the instrument.
4. While copying the file, the progress bar will appear to show the copy progress. When completed, the progress bar will disappear.

Searching for an existing file

1. It is possible to access the LCR LIST FILE menu in these screens: **MEAS DISPLAY** or **MEASURE SETUP.**
2. Press the down arrow to access the next page.
3. Press the **FILE MENU** to enter the **<LCR FILES LIST>** screen. This list displays the files saved internally.
4. Use the [←] and [→] to view one by one page.
5. Press the soft key **FIND.** The screen will display the message: "Enter value or select"

6. Input the name and then press the [ENTER] to search the target file or input the page number and press the [ENTER] to search the file.

Save Screenshot

To take a screenshot of the LCD screen, follow these instructions:

1. Insert a USB drive into the front USB host port.
2. Press the [Copy] button.
3. The unit will automatically create a folder on the USB drive with the name PIC.
4. The screenshot will be saved to the folder mentioned above. The name assigned to the screenshot will start at zero, but if there are other screenshots from this units in that folder, it will assign the lowest value possible.

Save Measurements File

1. Configure the unit to measure a device (Func, Freq, Level, etc.)
2. Insert a USB drive into the USB host port of the unit.
3. Press the [Log] button to start saving measurements.
   The 894/895 will create a folder labeled CSV inside the USB drive. Inside of it, it will also create a .csv file and will start saving measurements to it. The name of the .csv file will include the date and the file number saved in that date. (i.e. 0104_001, for the second file save on January 4th).
4. Press the [Log] button to stop saving measurements.

USB Flash Driver Requirements

The meter features a USB host interface for connecting an external USB flash drive (U-Disk). Below lists the requirements of the USB flash drive as supported by the instrument:
- Meets the USB 1.0/1.1 standard
- Capacity: 32MB/256MB/2GB/4GB
- File format: FAT16, FAT32 (Format the USB memory from a Windows® operating system)

9 Specifications

Note: All specifications apply to the unit after:
Temperature Stabilization time: 30 mins
Operating Temperature: 23 °C ± 5 °C
Specifications are subject to change without notice.

Test Signal Frequency			
Model	**Range**	**Minimum resolution**	**Accuracy**
894	20 Hz - 500 kHz	0.01 Hz	0.01 %
895	20 Hz - 1 MHz		

Test Signal Levels	
AC source (ALC* OFF)	
Voltage Accuracy	10% x set voltage ± 2mV
Voltage Level	**Resolution**
5 mVrms - 100 mVrms	100 µVrms
100 mVrms - 1 Vrms	1 mVrms
1 Vrms - 2 Vrms	10 mVrms
Current Accuracy	10 % x set current ± 10 µA
Current Range	**Impedance**
166.7 µArms - 66.7 mArms	30 Ω
100.0 µArms - 40.0 mArms	50 Ω
50.0 µArms - 20.0 mArms	100 Ω

AC source (ALC* ON)[1]		
Voltage	Range	10 mVrms – 1 Vrms
	Accuracy	6 % x set voltage ± 2 mV
Current	Range	100 µArms - 10 mArms
	Accuracy	6 % x set current ± 10 µA
DC bias source		
Voltage	Range	-5 V to +5 V
	Accuracy	1 % x set voltage ± 5 mV
	Resolution	0.01 mV
Current	Range	-50 mA to +50 mA
	Accuracy	1 % x set current ± 50 µA

	Resolution	0. 1 μA

*Auto Level Control

1: Resolution and impedance see AC source (ALC OFF) specification

Measurements		
Measurement parameters	L, C, R, G, X, Z, Y, B, θ, Q, D, DCR	
Transformer measurement parameters[2]	L2A, L2B, N, 1/N, M	
Basic accuracy	0.05 %	
AC source Output impedance (± 2%)	30 Ω, 50 Ω, 100 Ω	
Typical measurement time (≥10 kHz) (excluding display refresh time)	Fast	13 ms / measurement
	Medium	67 ms / measurement
	Slow	187 ms / measurement
Equivalent circuit	Series, Parallel	
Range mode	Auto, Hold	
Averaging	1-255 measurements	
Correction function	Open, Short and Load correction	
Cable length compensation	0 & 1 meter	
Math operations	Direct reading, ΔABS, Δ%	
Trigger mode	Internal, Manual, External, Bus	
Delay time setup	Time from trigger to start: 0 to 60 seconds	
	Resolution: 1 ms	
Comparator (Bin sorting)	10-bin sorting, primary bins BIN1-BIN9 and OUT, secondary bin AUX	
	Bin counter: 0 to 999,999	
	PASS/FAIL indication via front panel LED or handler interface signal	
List sweep	201 sweep points	Sweep test frequency, test signal AC voltage, test signal AC current, test signal DC bias voltage and test signal DC bias current
	Measurement parameters	Primary and secondary
	Sweep modes	Linear or Logarithmic
	Trigger mode	Sequential and Step
	Comparator	One pair of lower and upper limits for primary or secondary parameter (user selectable)
Internal non-volatile memory	Save / recall 40 setups	

2: Requires optional fixture TL89T1

General		
External USB memory		Save / recall setups, screenshots, measurements and sweep data logs
Remote interface		USB (USBTMC or virtual COM), RS232, LAN, GPIB (895 only)
Handler interface		36-pin connector
AC input	Voltage	110/220 VAC ±10%
	Frequency	47 – 63 Hz
Power consumption		Max. 80 VA
Operating temperature		0 °C to 40 °C
Storage temperature		-10 °C to 70 °C
Relative humidity		Up to 80%
Display		4.3" TFT color display
Dimensions (WxHxD)		Without bezel: 280 mm × 88 mm × 370 mm (11.02" x 3.46" x 14.56") With bezel: 369 mm × 108 mm × 408 mm (14.52" x 4.25" x 16.06")
Weight		5 kg (11 lbs)
Safety		EN61010-1:2001, EU Low Voltage Directive 2006/95/EC
Electromagnetic Compatibility		Meets EMC Directive 2004/108/EC, EN61326-1:2006
Three-Year Warranty		
Standard accessories		AC power cord, 4-wire Kelvin clip test lead, 4-terminal test fixture, shorting bar, certificate of calibration, test report
Optional accessories		Transformer test fixture TL89T1

9.1 Basic Accuracy A

Note: The accuracies apply to the unit after:

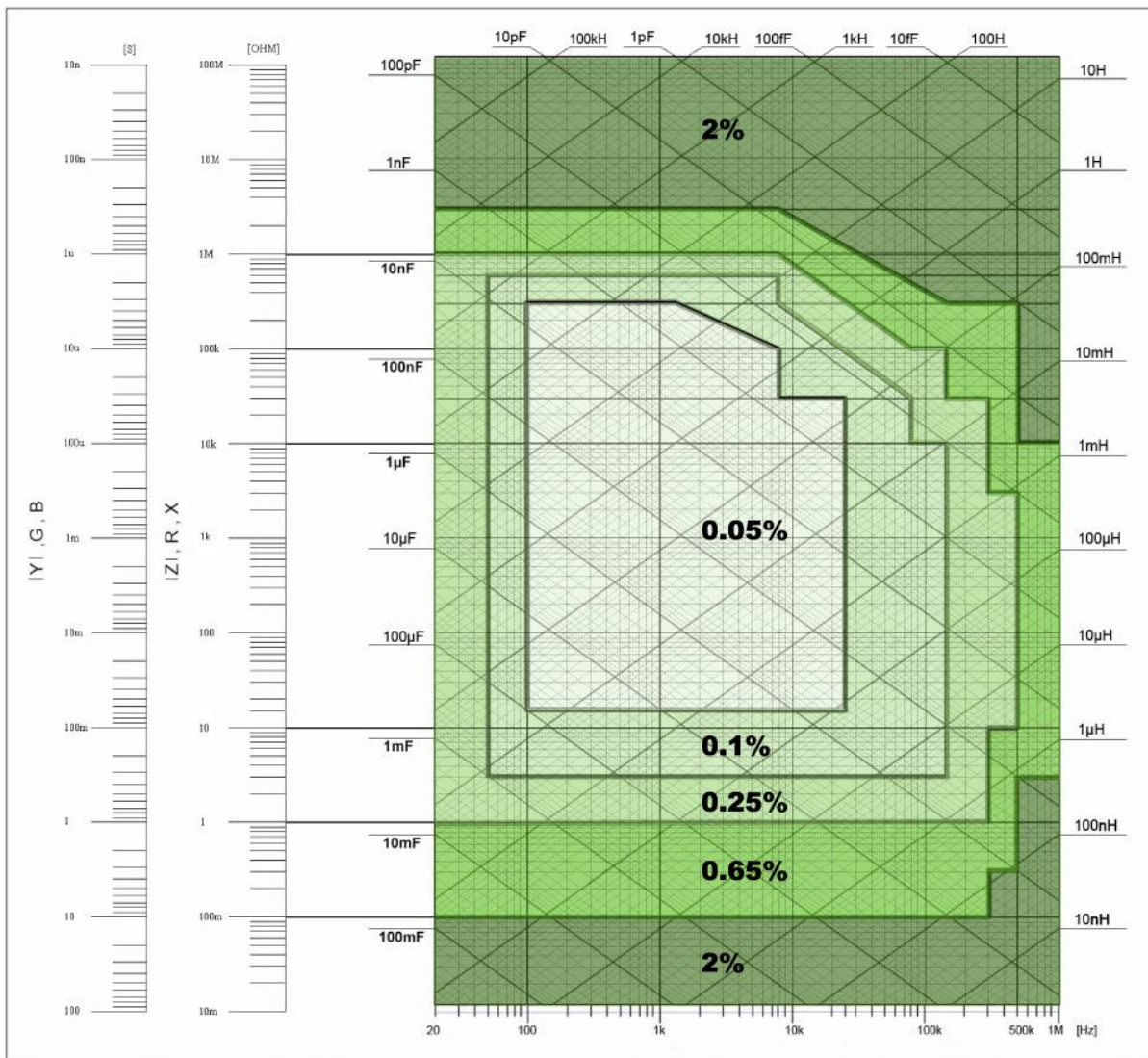|	
Correction after warming up:	OPEN and SHORT
Test Cable Length:	0 m
Speed:	Slow/Medium
DC Bias:	Off
Range:	Auto
AC Test Signal Level =	0.5 to 1 Volt

Figure 30 - Basic Accuracy "A"

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Figure 30 depicts the basic accuracy using low or medium measurement speed. Whenever a values falls on a range line use the larger accuracy value. Measurements tend to be less accurate when high speed measurements are performed. When selecting fast measurements speed, multiply by 2 the accuracy shown above.

9.2 Measurement Accuracy Ae

The Measurement Accuracy **Ae** includes the following: test voltage level, impedance of the DUT, frequency used (directly calibrated or indirectly calibrated), cable length, temperature factor and scan fixture modification error, in addition to the accuracy of the unit.

The accuracy Ae of Z, Y, L, C, R, X, G and B is expressed as:

$$A_e = \pm [A_L \times A + (K_a + K_b + K_c) \times 100 + K_d + K_f] \times K_e \quad [\%]$$

A：Measurement Accuracy (From Figure 30)

A$_L$: Level correction factor (Table 12)

K$_a$：Impedance rate factor (Table 13)

K$_b$：Impedance rate factor (Table 13)

K$_c$：Calibrated interpolating factor (Table 16)

K$_d$：Cable length factor (see *Cable Length Factor: Kd*)

K$_e$：Temperature factor (Table 18)

~~**K$_f$**：Scan fixture modification factor (no adding：K$_f$ = 0, adding：K$_f$ = 0.2)~~

Parameter	Condition	Measurement Accuracy Ae
L, C, X, B	$D_x \leq 0.1$	**Ae**=Ae
R, G	$Q_x \leq 0.1$	**Ae**=Ae
L, C, X, B	$D_x \geq 0.1$	**Ae**=Ae($\sqrt{1 + D_x^2}$)
R, G	$Q_x \geq 0.1$	**Ae**=Ae($\sqrt{1 + Q_x^2}$)

Accuracy of G is only available in G-B combination.

Measurement Correction Factors

The basic accuracy A applies when the voltage test level range is between 500 mVrms to 1.0 Vrms. When the voltage test level is outside this range, select the value of **A$_L$** according to Table

12 - Level Correction Factor (A_L).

Level Correction Factor A_L

Vs = Test signal voltage (Vrms)	Level Correction Factor (AL)
[5 m, 50 m]	2.5 × 50 mVrms / Vs
(50 m, 200 m)	2.5
(200 m, 500 m)	500 mVrms / Vs
(500 m, 1)	1
(1, 2]	2

Table 12 - Level Correction Factor (A_L)

The figure below shows the correction level factor (A_L) graphically.
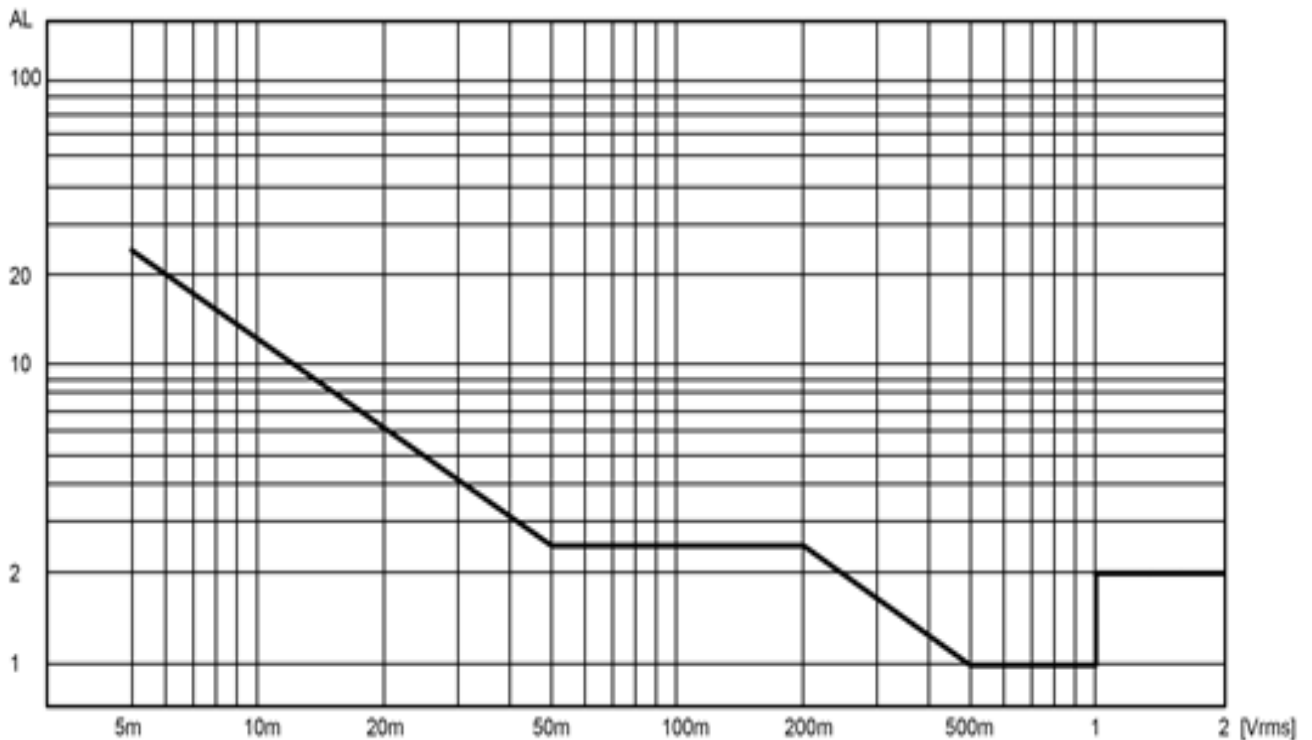
Figure 31 – Correction Level Factor – A_L

Impedance Rate Factors: Ka and Kb

Ka or Kb will be used depending on the impedance of the device under test. Only one of these two factors will be used at a time. Each one has a compensation table that is used to adjust the result of the calculation based on the length of the cable. The compensation for Ka should be added to Ka and the compensation for Kb should be multiplied by Kb.

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Speed	Frequency	Ka	Kb
Medium Slow	Fm ≤ 1.2 kHz	$(\frac{1\times10^{-3}}{|Z_m|})(1+\frac{200}{V_s})\sqrt{\frac{100}{f_m}}$	$|Z_m|(0.3\times10^{-9})(1+\frac{70}{V_s})\sqrt{\frac{100}{f_m}}$
	1.2 kHz < fm ≤ 8 kHz	$(\frac{1\times10^{-3}}{|Z_m|})(1+\frac{200}{V_s})$	$|Z_m|(1\times10^{-9})(1+\frac{70}{V_s})$
	8 kHz < fm ≤ 150 kHz		$|Z_m|(3\times10^{-9})(1+\frac{70}{V_s})$
	150 kHz < fm ≤ 1 MHz	$(\frac{1\times10^{-3}}{|Z_m|})(3+\frac{200}{V_s})$	$|Z_m|(10\times10^{-9})(1+\frac{70}{V_s})$
Fast	Fm ≤ 1.2 kHz	$(\frac{2.5\times10^{-3}}{|Z_m|})(1+\frac{400}{V_s})\sqrt{\frac{100}{f_m}}$	$|Z_m|(0.6\times10^{-9})(1+\frac{100}{V_s})\sqrt{\frac{100}{f_m}}$
	1.2 kHz < fm ≤ 8 kHz	$(\frac{2.5\times10^{-3}}{|Z_m|})(1+\frac{400}{V_s})$	$|Z_m|(2\times10^{-9})(1+\frac{100}{V_s})$
	8 kHz < fm ≤ 150 kHz		$|Z_m|(6\times10^{-9})(1+\frac{100}{V_s})$
	150 kHz < fm ≤ 1 MHz	$(\frac{2.5\times10^{-3}}{|Z_m|})(2+\frac{400}{V_s})$	$|Z_m|(20\times10^{-9})(1+\frac{100}{V_s})$

Table 13 - Impedance Rate Factors - Ka and Kb

Where, f_m is the test frequency and the unit is [Hz].
Zm= Measured Impedance of DUT
The unit of the tested impedance is [Ω].
The unit of the test signal voltage is [mV$_{rms}$].

When the impedance is smaller than 500 Ω, Ka applies and Kb is not specified.
When the impedance is bigger than 500 Ω, Kb applies and Ka is not specified.

If the cable length of the text fixture is extended, apply the following compensation to Ka and Kb:

Ka Compensation

Determine the K_a compensation and add it to the K_a value obtained from the table above, the result will be the new K_a and it is this value what should be used in the accuracy calculation:

Cable length L [m]	0	1	2
Ka	0	0.0005	0.0010

Table 14 - Extended Cable Length – K$_a$ Compensation (Impendace Z$_m$ < 500 ohms)

Kb Compensation

Determine the K_b compensation and multiply it by the K_b value obtained from the table above, the result will be the new K_b and it is this value what should be used in the accuracy calculation:

Cable length L [m]	0	1	2
Fm ≤ 100 kHz	1	1+5×fm	1+10×fm
100 kHz < fm ≤ 300 kHz	1	1+2×fm	1+4×fm
300 kHz < fm ≤ 1 MHz	1	1+0.5×fm	1+1×fm

Table 15 - Cable Length Extended - K_b Compensation (Impendace Z_m >500 ohms)

Where, f_m is the test frequency and the unit is [MHz].

Calibrated Interpolating Factor: K_c

If the frequency used is any of the frequency stated in , Kc will be a "direct calibrated frequency" and if it is any other frequency (not listed on the table), Kc will be considered "other frequency" and the value of each type of frequency should be obtained from the table below ():

Test frequency	K_c
Direct calibrated frequency	0
Other frequency	0.0003

Table 16 - Calibrated Interpolating Factor Kc

			20	25	30	40	50	60	80	[Hz]
100	120	150	200	250	300	400	500	600	800	[Hz]
1	1.2	1.5	2	2.5	3	4	5	6	8	[kHz]
10	12	15	20	25	30	40	50	60	80	[kHz]
100	120	150	200	250	300	400	500	600	800	[kHz]
1										[MHz]

Table 17 - Direct Calibrated Frequencies

Cable Length Factor: Kd

$0.15\% \times (f_m / 1MHz)^2 \times L^2$

f_m: test frequency [MHz]

L: test cable length [m], respectively 0m, 1m

When using scan, take the correction factor K_d as the cable length.

Temperature Factor: Ke

Temperature (℃)	0 - 18	18 - 28	28 - 40
Ke	4	1	4

Table 18 - Temperature Factor Ke

Accuracy of D

When D_x (tested value of D) $\leq$ 0.1, the accuracy of D_e is given by the formula below:

$$\mathbf{D_e} = \pm\frac{A_e}{100}$$

When D_x > 0.1, D_e should be multiplied by $(1+D_x)$.

Accuracy of Q

The accuracy of Q is given by the formula below:

$$\mathbf{Q_e} = \pm\frac{Q_x \times D_e}{1 \mp Q_x \times D_e}$$

Where, Q_x is the value of the tested Q.
D_e is the accuracy of D.
Above formula should be used when $Q_x \times D_e$ < 1.

Accuracy of ϑ

The accuracy of θ is given by the formula below:

$$\mathbf{\theta e} = \frac{180}{\pi} \times \frac{A_e}{100} \ [deg]$$

Accuracy of G

When D_x (tested value of D) $\leq$ 0.1, the accuracy of G is given by the formula below:

$$\mathbf{G_e} = B_x \times D_e \ [S]$$
$$B_x = 2\pi f C_x \text{ for capacitance}$$
$$B_x = \frac{1}{2\pi f L_x} \text{ for inductance}$$

Where, B_x is the value of tested B with the unit [S].
C_x is the value of tested C with the unit [F].
L_x is the value of tested L with the unit [H].
D_e is the accuracy of D.

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F is test frequency.

Note: The accuracy of G is only available in C_p-G and L_p-G combination

Accuracy of Rp

When D_x (value of tested D) ≤ 0.1 the accuracy of R_p is given by the formula below:

$$\mathbf{R_p} = \pm\frac{R_{px} \times D_e}{D_x \mp D_e} \qquad [\Omega]$$

Where, R_{px} is the value of tested R_p with the unit [S].
D_x is the value of test D with the unit [F].
D_e is the accuracy of D.

Accuracy of Rs

When D_x (value of tested D) ≤0.1
The accuracy of R_s is given by the formula below:

$$\mathbf{R_{se}} = X_x \times D_e \qquad [\Omega]$$
$$X_x = 2\pi f L_x, \text{ for inductance.}$$
$$X_x = \frac{1}{2\pi f C_x}, \text{ for capacitance.}$$

Where, X_x is the value of test X with the unit [S].
C_x is the value of test C with the unit [F].
L_x is the value of test L with the unit [H].
D_e is the accuracy of D
F is test frequency

Accuracy of DCR

A $(1+R_x/5M\Omega+16m\Omega/R_x)$[%] ± 0.2 mΩ
When the instrument is in Middle and slow speed, A=0.25
In Fast speed, A=0.5
Where, R_x is the tested resistance.

Accuracy of leakage inductance Lk

Inductance L's accuracy +0.2

9.3 Accuracy Calculation Examples

Example 1

Standard Capacitor Value: 10.004 nF @ 1 KHz
Measured value: 10.0046 nF @1 KHz
Dissipation Factor "D": 0.00044
Test Signal Level: 1 V
Speed: Slow
Cable Length= 0 (no compensation needed)
D<0.1 then: Ae is NOT multiplied by $\sqrt{1 + D_x{}^2}$

Ae = Capacitance Accuracy = ± [(A$_L$× A) + (K$_a$+K$_b$+K$_c$)× 100 + K$_d$ + K$_f$] × K$_e$ [%]

Factor	Reason
A$_L$=1	Test voltage level was 1 Volt, according to the table 13 of manual the correction factor for this voltage level is 1.
A = 0.05%	Using Figure 27 of the manual, the Test Measurement Accuracy (A) of a 10.004 nF @ 1 KHz is 0.05% (intersection of 10 nF and 1 KHz on the chart).
Ka= N/A	Zm= Impedance of the DUT = 15.90913 KOhms Impedance of the device under test is bigger than 500 ohms. Ka=0.
Kb=	Use formula from Table 14 to find the value of Kb. Kb = $\left\lvert Z_m \right\rvert (0.3 \times 10^{-9})(1+\frac{70}{V_s})\sqrt{\frac{100}{f_m}}$ Kb is used because the impedance of DUT is bigger than 500 ohms. Zm= Impedance of the DUT = 15.90913 KOhms fm= 1 KHz (test frequency) Vs= 1000 (voltage test signal in millivolts) Kb= $\lvert 15{,}905.7 \rvert (0.3 x 10^{-9}) \left(1 + \frac{70}{1000}\right) (\sqrt{100/1{,}000})$ Kb=0.0000016147798 Cable Length =0. No Kb compensation (see Table 16)
Kc= 0	Test frequency 1 KHz = Direct Calibrated Frequency= 0 See Table 17.

Kd= 0	L=0, therefore, Kd=0.
Ke= 1	Room temperature during test= 20°. Temperature Factor =1. See Table 19.
Kf = 0	Fixture no available for this unit.

$A_e = \pm [A_L \times A + (K_a + K_b + K_c) \times 100 + K_d] \times K_e$ [%]

$$A_e = {}^+_- [(1x0.05) + (0 + 0.0000016147798 + 0)x100 + 0]x1 = {}^+_- 0.050162\%$$

Finding the valid range: +/- 0.050162%x10.004nF= +/- 5.018206x10^-12

10.004nF + 5.018106x10^-12= 10.00902 nf

10.004nF - 5.018106x10^-12= 9.9989818 nf

Valid range of measurements= **[10.00902 nF,** 9.99898 **nF]**

The 895 measured 10.0046 nF nF which falls under the accepted range.

Example 2

Standard Capacitor Value: 9.995 nF D=0.0002 @ 100 KHz
Measured value: C=10.0061nF @ 100 KHz
Dissipation Factor "D": 0.00045
Test Signal Level: 1 V
Speed: Slow
Cable Length = 1 meter
D<0.1 then: Ae is NOT multiplied by $\sqrt{1 + D_x{}^2}$

Ae = Capacitance Accuracy = ± [(A_L× A) + (K_a+K_b+K_c) × 100 + K_d] × K_e [%]

Factor	Reason
A_L=1	Test voltage level was 1 Volt, according to the table 13 of manual the correction factor for this voltage level is 1.
A = 0.1%	Using Figure 27 of the manual, the Test Measurement Accuracy (A) of a 10.00651 nF @ 1 KHz is 0.05% (intersection of 10 nF and 100 KHz on the chart).
Ka= 0.00053995862	$Ka = (\dfrac{1\times10^{-3}}{\|Z_m\|})(1+\dfrac{200}{V_s})$ Ka is chosen because impedance is less than 500 Ohms. Zm= Impedance of the DUT = 159.069 Ohms fm= 100 KHz (test frequency)

	Vs= 1 (voltage test signal) Ka = $(\frac{1x10^{-3}}{159.235})$ (1+(200/1000)) Ka = 0.000007536, but since we are using a 1 meter long testing fixture, Ka needs to be compensated. (table 15) Ka (new)= 0.0000075303+0.0005=0.0005075303
Kb= N/A	
Kc= 0	Test frequency 100 KHz = Direct Calibrated Frequency= 0 See Table 17.
Kd= 0	L=1 meter, test cable lenght Kd= 0.15%×(f$_m$ / 1MHz)^2 × L^2 f$_m$: test frequency [MHz] Kd= 0.0015x(0.1 MHz/1 MHz) ^{2}x(1)^2 Kd= 1.5E-5
Ke= 1	Room temperature during test= 20°. Temperature Factor =1. See Table 19.
K$_f$ = 0	Fixture no available for this unit.

A$_e$ = ± [A$_L$× A+ （K$_a$+K$_b$+K$_c$）×100+ K$_d$ + K$_f$]×K$_e$ [%]

$A_e = \pm[(1x0.1) + (\ 0.0005075303 + 0 + 0)x100 + 1.5x10^{-5} + 0]x1 = \pm 0.15077\%$

Finding the valid range: $\pm$ 0.15077% x 9.995 nF = 1.506946E-11

9.995 nF + 1.506946E-11= 10.001006nF

9.995 nF - 1.506946E-11= 9.997993 nF

Valid range of measurements= [10.0212 nF, 9.9910 nF]

The 895 with measured **10.0054** nF which falls under the accepted range.

Note how the first example is more accurate and the reason is because the test fixture does not use a cable (cable length =0) and it is done using a frequency with a better accuracy for that capacitor size.

10 Remote Interface

The instrument has RS232, USB (virtual COM), LAN, and GPIB (895 only) interfaces for remote control. This chapter will describe how users can remotely operate the instrument and use SCPI (Standard Commands for Programmable Instruments) commands via these interfaces.

10.1Interface Configuration

For more information on how to set up this interface, refer to 8.1 , Bus Mode.

RS-232

For RS-232 connectivity, refer to the diagram below for the pinout information. The RS-232 is labeled in the rear panel and it is a female DB-9 interface. Use a null modem or crossover cable where pins 2 and 3 are reversed.
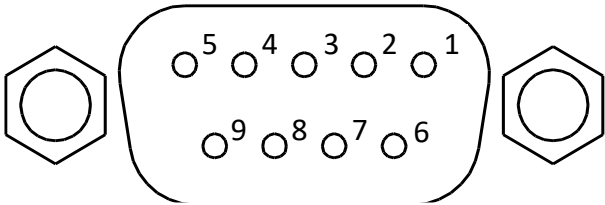
PIN	Description
1	-
2	Transmit Data
3	Receive Data
4	-
5	GND
6	-
7	CTS
8	RTS
9	-

Parameter	Description
Baud rate	9600, 19200, 28800, 38400, 48000, 57600, and 115200.

Parity and data bit	None/8 bits, Even/8 bits, Odd/8 bits
Stop bit	1, 2
Flow control	None

Table 19 - RS-232C Settings

NOTICE	The RS-232 interface does not support hardware flow control (only transmit, receive, and ground pins are used). The programmer should be aware of this limitation and notice the command process time of the LCR meter. If the remote commands are sent too fast to the LCR meter, the internal buffer may overrun and cause a communication error. Therefore, adding a delay between commands may be necessary to allow time for the meter to process.

USB (USBCDC - Virtual COM)

The standard USB port is a virtual COM port that can be used for remote communication. There are no settings in the menu system for USB configuration. The settings are the same as the settings for RS-232.

NOTICE	The USB interface does not support hardware flow control (only transmit, receive, and ground pins are used). The programmer should be aware of this limitation and notice the command process time of the LCR meter. If the remote commands are sent too fast to the LCR meter, the internal buffer may overrun and cause a communication error. Therefore, adding a delay between commands may be necessary to allow time for the meter to process.

USBTMC

USB The standard USB port is a USBTMC-compliant port that can be used for remote communication. There are no additional settings in the menu system for USB configuration. The only requirement is that the USBTMC driver be installed. It is included when a VISA software is installed on the computer. (We recommend using NI-VISA, which can be downloaded at http://www.ni.com/visa/).

LAN (Ethernet)

The 894/895 can also be controlled via LAN interface. Refer to 8.1, LAN Setup for more information.

GPIB (895 Only)

The GPIB address of the LCR meter can be configured from 1-31. To communicate via GPIB, connect a GPIB cable to the GPIB port at the back of the LCR meter. Refer 8.1, GPIB ADDR (895 only), for more information.

10.2 Remote Commands

The instrument supports some SCPI commands and some instrument specific commands. These commands enable a computer to remotely communicate and control the instrument over any of the supported remote interfaces: USBTMC, RS-232, LAN, and GPIB (895 only).

Refer to the programming manual for details, which can be downloaded from
www.bkprecision.com

11 Handler Interface

The 894 and 895 are equipped with a Handler Interface. This interface allows users to fully automate component sorting, inspection and quality control to increase the efficiency of sorting process. The Handler Interface can output a signal to indicate the completion of a task and allows an external trigger to trigger the instrument.

11.1 Technical description

The following table shows the description for 894/895 HANDLER.

Type of Signal	Characteristics
Output	- Low effective optoelectronic isolation, open collector output - BIN comparator: Good/Not Good - List sweep comparator: IN/OUT for every sweep point and Pass/Fail for all the devices compared - INDEX: AD Conversion ended - EOC: end of one test and comparison - Alarm: alarm for circuit interruption
Input	- Optoelectronic isolation - External Trigger: Pulse width ≥ 1μS - Use of Handler will lock the keys on the front panel.

Table 20 - Technical Description

Note: The 894/895 uses a 36-pin connector.

11.2 Handler Operation

The definition for the signal line

The Handler interface has 3 signal lines: comparison output, control output and control input. The output signals for the BIN comparison or list sweep comparison functions are detailed below:

Comparison Signal Lines
- **Comparison output signal**
  BIN1-BIN9
  AUX
  OUT
  PHI (the main parameter is bigger than the high limit)
  PLO (the main parameter is low)
  SREJ (The test result is outside the valid range)
- **Control output signal**
  INDEX (Analog test finished signal)
  EOM (Test ended and the compared data effective)
  ALARM (Circuit interruption)
- **Control input signal**
  EXT.TRIG (External trigger signal)
  Keylock (Key lock).

The Comparison signal distribution for the pins is described in Table 2:

Pin	Signal name	Description
1	/BIN1	
2	/BIN2	
3	/BIN3	
4	/BIN4	BIN sorted result
5	/BIN5	/BIN (BIN number) output are all open collector
6	/BIN6	outputs.
7	/BIN7	
8	/BIN8	
9	/BIN9	
10	/OUT	
11	/AUX	
12 13	/EXT.TRIG	**External trigger**: when the trigger mode is EXT.TRIG, the 894/895 will be triggered by the positive-edge pulse signal in this pin.
14 15	EXT.DCV2	**External DC voltage 2**: The DC provider pin for the optoelectronic coupling signal (/EXT_TRIG, /Key Lock, /ALARM, /INDEX, /EOM)

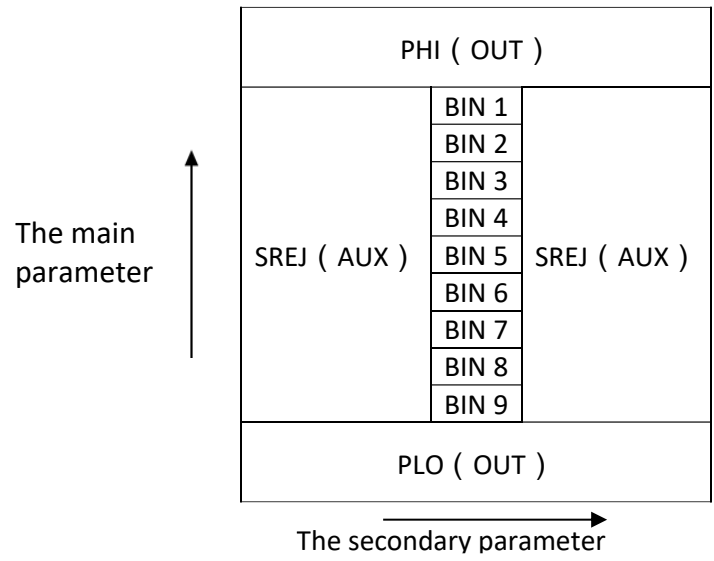|		
16 17 18	+5V	**Internal +5V:** It is not recommended to use the internal +5 V. If this voltage output is used, the current should be lower than 0.3 A, and that the signal line is far from a disturbance source.
19	/PHI	Indicates that the test result is greater than the high limit set on BIN1 to BIN9.
20	/PLO	The main parameter is lower than the lower limit in BIN1 to BIN9.
21	/SREJ	The test result is outside the valid range.
22-24	NC	Not connection.
25	/KEY LOCK	When this line is asserted, the keys in the front panel are locked.
27 28	/EXT.DCV1	**The external DC voltage 1:** this is a pull-up DC Voltage pin for optoelectronic coupling signal (/BIN-/BIN9, /AUX, /OUT, /PHI, /PLO,/SREJ).
29	/ALARM	When circuit is interrupted, this signal is asserted.
30	/INDEX	When the analog test is finished and the UNKNOWN terminal can be connected to another DUT, /INDEX is asserted. However, the comparison signal is asserted until /EOM is asserted.
31	/EOM	**End Of Measurement:** when the test data and the compared results are asserted, this signal is also asserted.
32 33	COM2	The reference ground for external power EXTV2.
34-36	COM1	The reference ground for external power EXTV1.

Table 21 - Comparison Output Pinout

Figure 32 - Signal Distribution for BIN Comparison

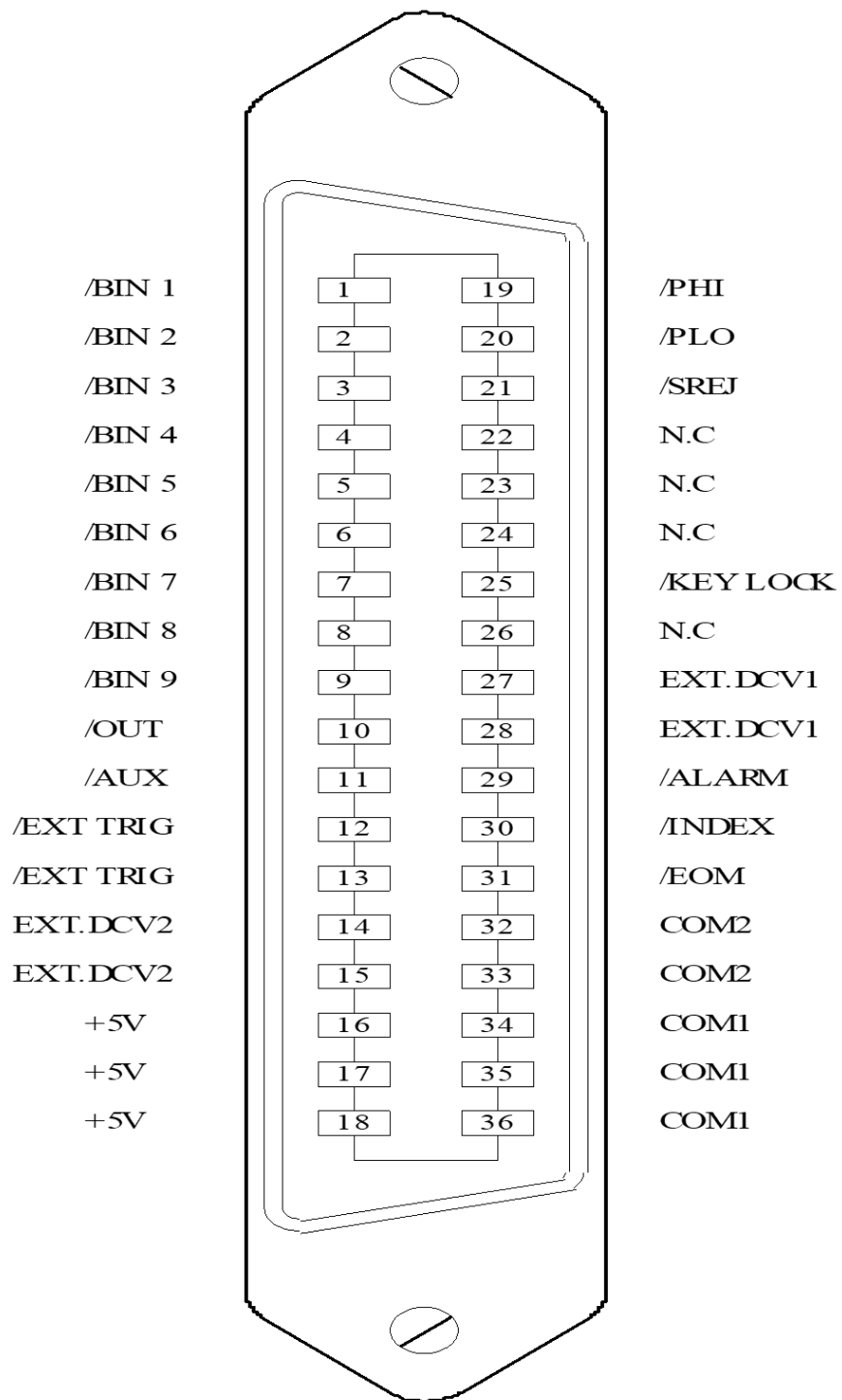|				
/BIN 1	1		19	/PHI
/BIN 2	2		20	/PLO
/BIN 3	3		21	/SREJ
/BIN 4	4		22	N.C
/BIN 5	5		23	N.C
/BIN 6	6		24	N.C
/BIN 7	7		25	/KEY LOCK
/BIN 8	8		26	N.C
/BIN 9	9		27	EXT.DCV1
/OUT	10		28	EXT.DCV1
/AUX	11		29	/ALARM
/EXT TRIG	12		30	/INDEX
/EXT TRIG	13		31	/EOM
EXT.DCV2	14		32	COM2
EXT.DCV2	15		33	COM2
+5V	16		34	COM1
+5V	17		35	COM1
+5V	18		36	COM1

Figure 33 - Handler's Pinout

Note: In the List Sweep Comparator the signals for /BIN1 - /BIN9, /OUT, /AUX, /PHI, /PLO and /SREJ are different from those of the BIN Comparison function.
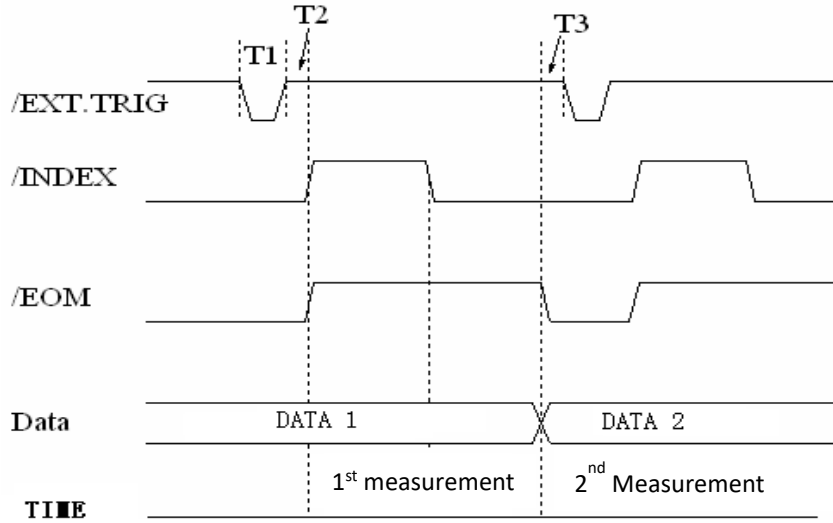
Time	Minimum	Maximum
T1: trigger pulse-width	1us	---
T2:delay time	200us	Display time^3 + 200us
T3:the trigger waiting time after /EOM output	0us	---

Display Page	Time (ms)
MEAS DISPLAY	8
BIN NO.DISPLAY	5
BIN COUNT DISPLAY	0.5

Figure 34 -Handler Interface Timing

Notes: Measurement time: Refer to the

Typical comparison time is approximately 1 ms.

Display time for every display page is:

MEAS DISPLAY: 8ms;

BIN NO.DISPLAY: 5ms;

BIN COUNT DISPLAY: 0.5ms

List Sweep Comparison Signals

The List Sweep Comparison signal output is different from other modes, including Bin Comparison:

- **List Sweep Comparison Output Signal**
  /BIN1-/BIN9 and */OUT* show the **IN** *(good) or* */OUT* (over the standard) result.
  /AUX shows **PASS/FAIL** result.
  When a sweep test is finished, these signals will be at the output signal.
- **Control Output Signal**
  /INDEX (Analog test finished)
  /EOM (End of measurement).

- **SEQ sweep mode**
  /INDEX is defined as the effective signal when the last sweep point of the analog test is finished.
  /EOM is defined as the effective signal when all the test results are effective after every list sweep task is finished.

- **STEP sweep mode**
  /INDEX is defined as the effective signal when the analog test of every sweep point is finished.
  /EOM is defined as the effective signal when the test and the comparison of every step are finished.

The pin distribution for list sweep is shown in the table below and in Figure 33. The timing chart is shown in **Figure 36**.

The table below shows the list sweep comparison pin assignment and functionality:

Pin	Signal	Description
1	/BIN1	Out of the limit of sweep point1
2	/BIN2	Out of the limit of sweep point2
3	/BIN3	Out of the limit of sweep point3
4	/BIN4	Out of the limit of sweep point4
5	/BIN5	Out of the limit of sweep point5
6	/BIN6	Out of the limit of sweep point6
7	/BIN7	Out of the limit of sweep point7
8	/BIN8	Out of the limit of sweep point8
9	/BIN9	Out of the limit of sweep point9
10	/OUT	Out of the limit of sweep point10
11	/AUX	/AUX is asserted when at least one device under test is not good in the list.

30	/INDEX	**SEQ:** When the analog test of the last sweep point is finished and the UNKNOWN terminal can be connected to another DUT, /INDEX is asserted. However, the comparison signal is asserted until /EOM is also asserted. **STEP:** When the analog test at each sweep point is finished, /INDEX is asserted, but the comparison signal is asserted until the line /EOM is also asserted.
31	/EOM	The End of Measurement signal has different functions on SEQ and STEP modes: **SEQ:** When the test is finished and the compared results are available, /EOM is asserted. **STEP:** When the test of every sweep point is completed, /EOM is asserted. The comparison result signal is effective until /EOM is asserted.
Rest of pins		The pin assignment of the rest of the pins is the same as the pin assignment of the Comparison Function.

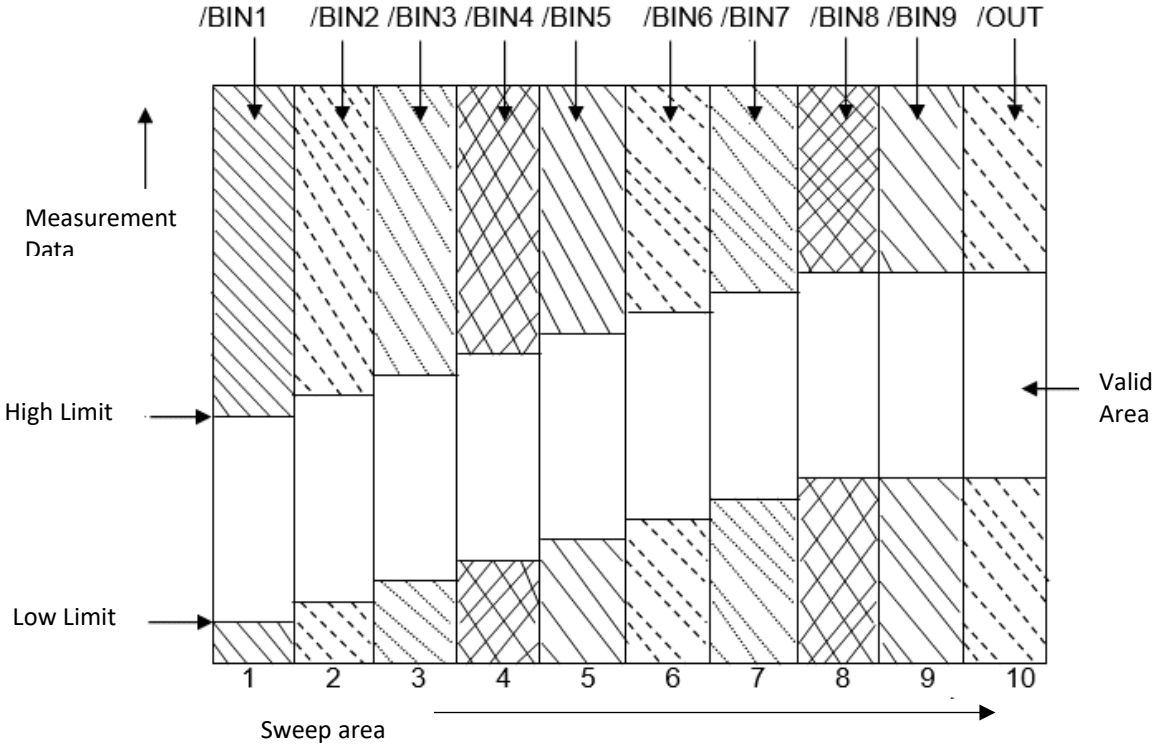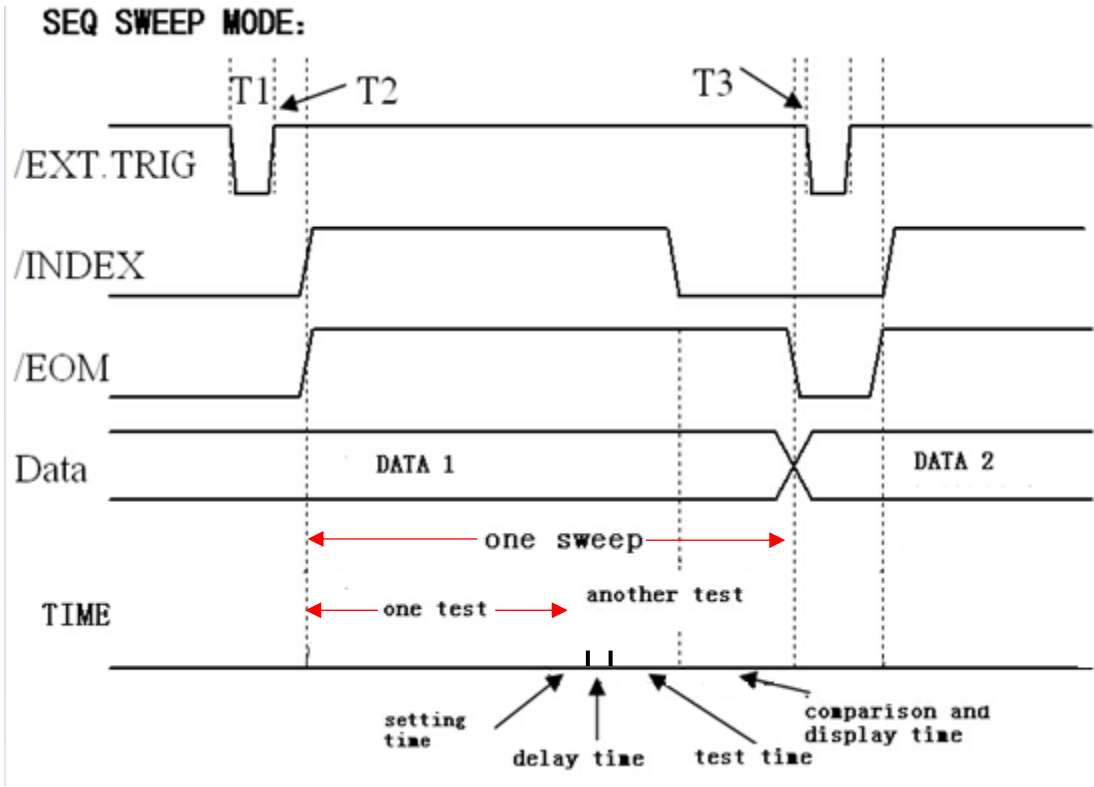**Table 22 - List Sweep Comparison Pinout**

Figure 35 - List Sweep Comparison Signal Areas

*Notes: 1. Setting time, delay time, test time and comparison and display time are not to scale.
2. The setting time includes the correction ON/OFF time.
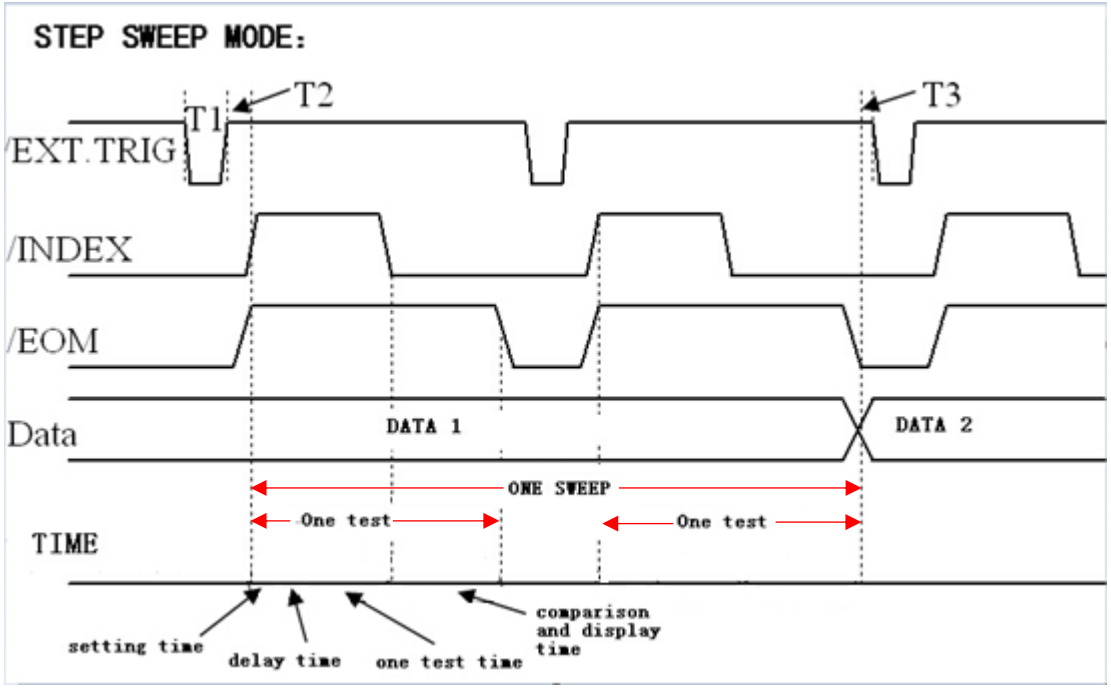3. The comparison and display time is 4.5ms approximately.

Figure 36 - List Sweep Timing Diagram

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11.3 Electrical features

As shown in the previous section, the signal assignment and functions of most pins are different for the comparison and the list sweep comparison. However, the electrical features are the same. Therefore, the following description can be applied to BIN comparison and List Sweep comparison.

There is DC isolation on the output on pins 1 to pin 16 generated by a collector-open optoelectronic coupler. The output voltage on every line is set by the pull-up resistance on the HANDLER interface board. The pull-up resistance is connected to the internal voltage (+5V), or the external voltage (EXTV: +5V).

The electrical features of the DC isolation output can be divided into 2 types shown in the table below:

Table 23 - Electrical Features of DC Isolation Output

Output Signal	Output Rated Voltage		Max Current	Reference Ground in the Circuit
	LOW	*HIGH*		
Compared Signal /BIN1 - /BIN9 /AUX /OUT /PHI /PLO	≤0.5V	+5V to +24V	6mA	Internal pull-up voltage: 894/895 GND EXTV1: COM1COM1
Control Signal /INDEX /EOM /ALARM	≤0.5V	+5V to 24V	5mA	Internal pull-up voltage : 894/895 GND EXTV2: COM2COM2

HANDLER Interface Board Circuit

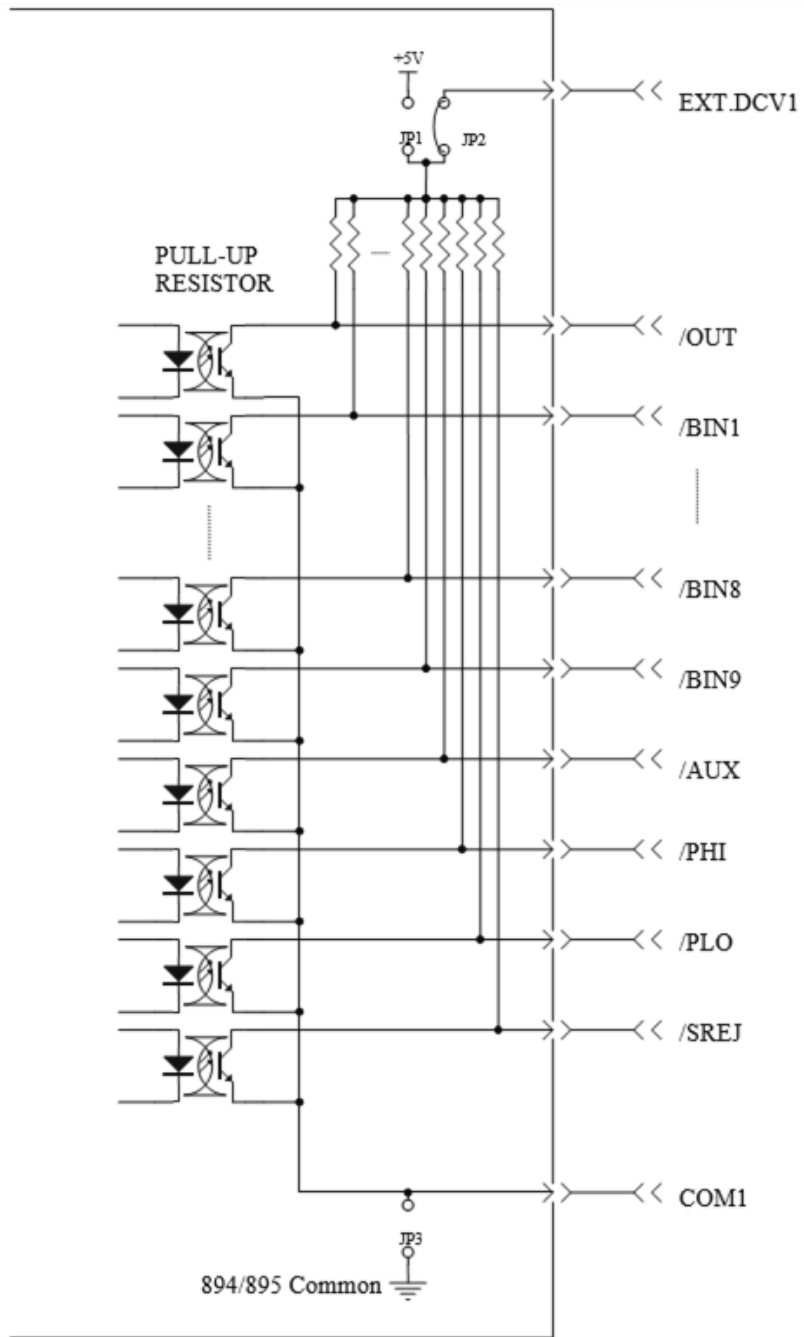The output circuit for the Comparison result output is shown in the figure below:

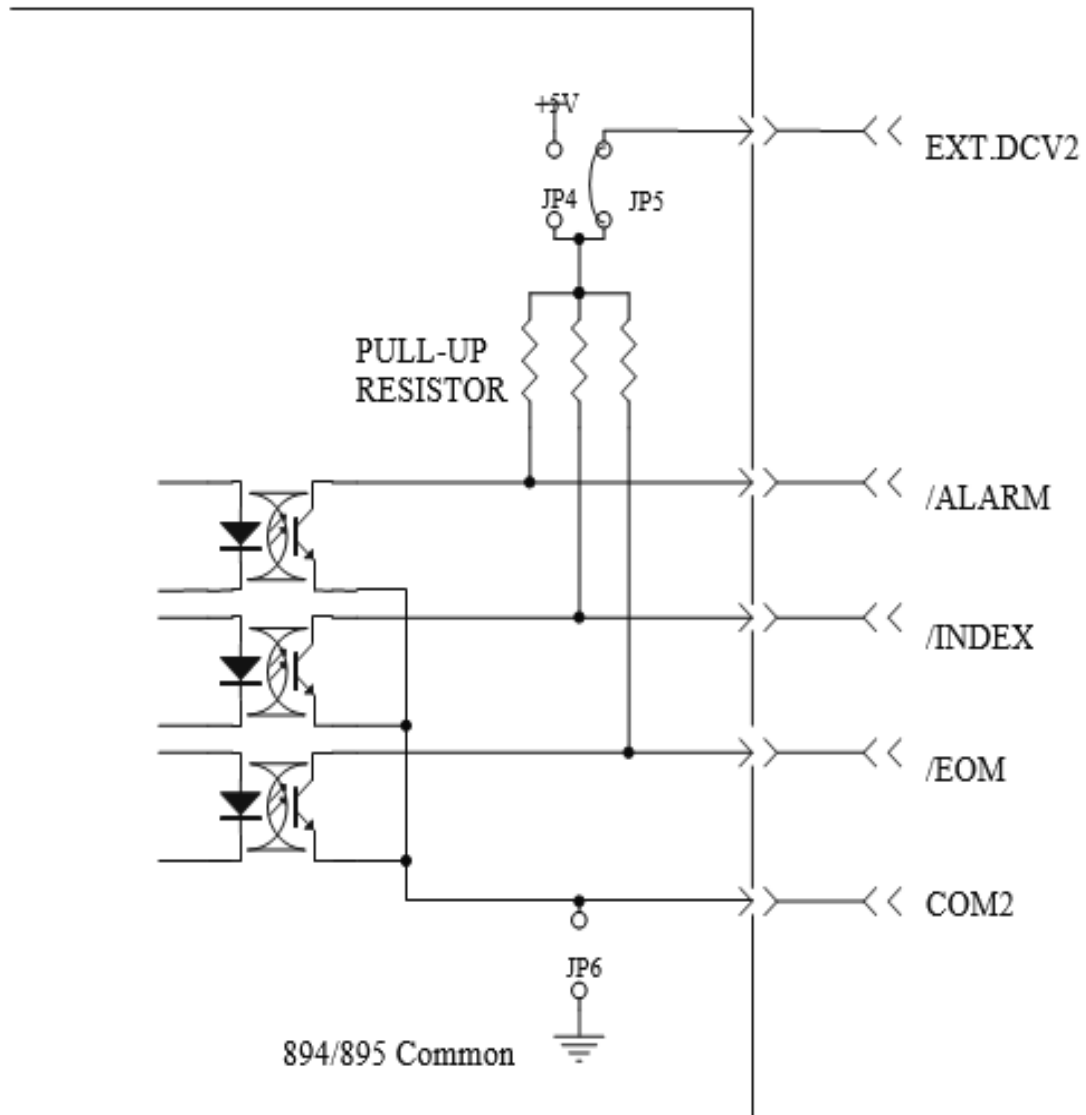**Figure 37 - Output Circuit for the Comparison Results**

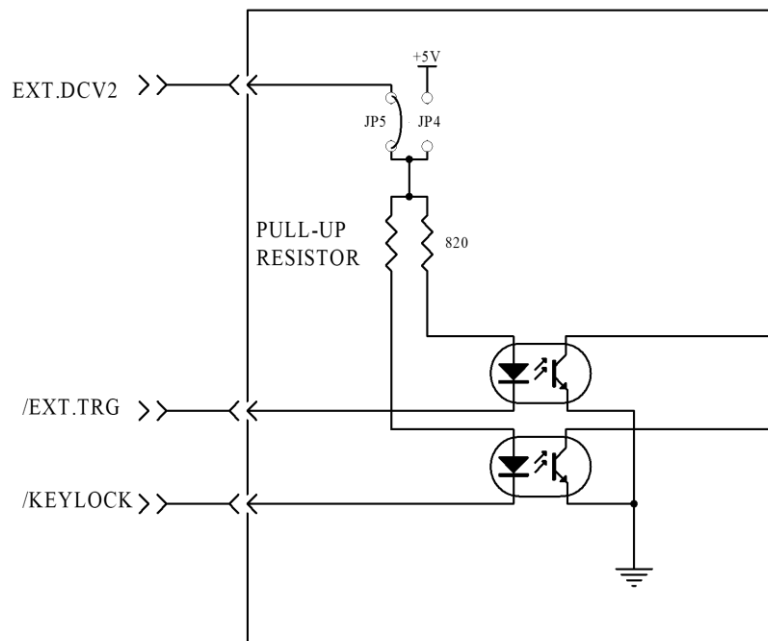**Figure 38 - Output Circuit for Control Signal**

Figure 39 - Input Circuit for Control Signal

11.4 Handler Operation

The following procedure will show how to use the Handler Interface Comparison and the List Sweep Comparison.

The procedure to set the Handler Interface Comparison is detailed below:
1. Press the softkey [**LIMIT TABLE**]. The **LIMIT TABLE SETUP** page will be displayed.
2. Set the standard value and the high limit and the low limit in **LIMIT TABLE SETUP**.
3. Move the cursor to **COMP** field. The softkey area will display :
   - **ON**
   - **OFF**
4. Press the softkey **ON** to enable the comparison function.
5. Press the sotfkey **BIN NO**. or **BIN COUNT**, and the DUT will be tested; at the same time, you can set the counter for the DUT and the Auxiliary BIN.

   Note: COMP ON/OFF can be set in BIN COUNT page.

The procedure to set the List Sweep Comparison is shown below:

1. Press **LIST SETUP**. The **LIST SWEEP SETUP** page will be displayed.
2. Set the parameters for the sweep mode: sweep frequency point, reference value, the high limits and the low limits.
3. Press [**MEAS**].
4. Press the softkey **LIST SWEEP**, **LIST SWEEP DISP** page will be displayed.

The following method can be used to improve the speed:
1. Set the range to the maximum that the capacitance may be, and lock this range.
2. Set **Vm**: OFF and **Im**: OFF in the **MEAS SETUP** page.
3. Test the DUT in the **BIN COUNT** page.

12 Troubleshooting Guide

Below are some frequently asked questions and answers. Please check if any apply to your instrument before contacting B&K Precision.

Q: I cannot power up the instrument
- Check that the power cord is securely connected to the AC input and there is live power from your electrical AC outlet.
- Check and confirm that the correct fuse is inserted and not blown.
- Verify that the AC power coming from the mains is the correct voltage. The LCR meters can accept a specific range of AC input voltages. Refer to section "***2.1 Input Power Requirements***".

Q: The front panel keys are not responding to key presses
- When the unit goes into Remote Mode, the "Keylock" button will turn on (red) indicating that the front panel is locked. To unlock press the "Keylock" button once, you will hear a loud beep and the unit will unlock.

SERVICE INFORMATION

Warranty Service: Please go to the support and service section on our website at bkprecision.com to obtain a RMA #. Return the product in the original packaging with proof of purchase to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device.

Non-Warranty Service: Please go to the support and service section on our website at bkprecision.com to obtain a RMA #. Return the product in the original packaging to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device. Customers not on an open account must include payment in the form of a money order or credit card. For the most current repair charges please refer to the service and support section on our website.

Return all merchandise to B&K Precision Corp. with prepaid shipping. The flat-rate repair charge for Non-Warranty Service does not include return shipping. Return shipping to locations in North America is included for Warranty Service. For overnight shipments and non-North American shipping fees please contact B&K Precision Corp.

B&K Precision Corp.
22820 Savi Ranch Parkway
Yorba Linda, CA 92887
bkprecision.com
714-921-9095

Include with the returned instrument your complete return shipping address, contact name, phone number and description of problem.

LIMITED THREE-YEAR WARRANTY

B&K Precision Corp. warrants to the original purchaser that its products and the component parts thereof, will be free from defects in workmanship and materials for a period of **three years** from date of purchase.

B&K Precision Corp. will, without charge, repair or replace, at its option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form of a sales receipt.

To help us better serve you, please complete the warranty registration for your new instrument via our website bkprecision.com

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. The warranty is void if the serial number is altered, defaced or removed.

B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitations of incidental or consequential damages. So the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

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B&K Precision Corp.
22820 Savi Ranch Parkway
Yorba Linda, CA 92887
bkprecision.com
714-921-9095

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