

FNIRSI

LCR-ST2

MASTER CLASS

A Complete Guide to Precision Measurements with LCR-ST2

"Where the numbers meet the truth."



LZ3AI
Sofia, 2026

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ABOUT THIS BOOK: MUCH MORE THAN AN INSTRUCTION

This book is not just a translation of the official manual. It is the result of hundreds of hours of measurements on real amateur radio structures. The goal is one: to turn the FNIRSI LCR-ST2 from „smart tweezers“ into a powerful diagnostic center in your workplace. Here you will find not only "which buttons to press", but also "why the values look like this" and "how the circuit lies to you" when measuring directly on the printed circuit board.

INTRODUCTION

With the advent of SMD components, standard multimeters have become inconvenient and sometimes dangerous for fine tracks. The LCR-ST2 solves this problem by combining 4-wire measurement (Kelvin method) into a compact package.

Conventions

In the text you will find the following signs:

- <POWER hold> – on/off button and action;
 - <SELECT click> – three-position button for selection and action;
 - <MENU click> – menu and action button;
 - <SETTING> – an option from the function menu.
-

Important note about firmware

All descriptions, procedures and illustrations in this manual are based on a specific software version (more precisely, firmware) of **FNIRSI LCR-ST2 v1.5.1**, current at the time of writing (the current one is visible in the picture).



The manufacturer periodically releases updates to add new features or optimize current ones. You may notice some differences in menu names or the behavior of some buttons on newer firmware versions. Recent new versions have brought significant improvements in measurement stability at high frequencies (**100 kHz**), adjusted the algorithm for automatic small inductance detection, better temperature compensation and optimization of the scan mode. If your instrument is firmware **V1.5.1**, you now have much more stable readings at low capacities compared to the first batches.

Note: The menus and functions described are current for firmware version as of **April 2026**. With future updates, **FNIRSI** may change the names or location of some settings.

If you find a discrepancy, first look at the version section in the function menu to check the relevance of your firmware:

<**POWER** hold> <**SELECT** right> <**SETTINGS**> < **SELECT** click> < **SELECT** right>
<**ABOUT**>< **SELECT** click> <**LCR-ST2 V.1.5.1**> (or newer)

This "Master Class" is a living organism and reflects the real experience with the available equipment, but always keep in mind the dynamic nature of FNIRSI's software development.

LZ3AI advises: to change the firmware

Do not start using the appliance if you have not recently checked the latest firmware. If necessary, update it.

Important! All changes and settings to the transceiver are made at your own risk, regardless of whether you have read this disclaimer or not (disclaimer). The author is not responsible for damages caused by improper actions and recommends that you always consult the official management of FNIRSI before making system changes. The author is not responsible for actions related to the texts in this book. Any claims for covering costs and/or damages arising during such actions are null and void.

Practice – checking and installing new firmware

1. Enter the function menu: <**MENU** hold> <**SELECT** left/right> <**SETTINGS**>< **SELECT** click>< **SELECT** right><**ABOUT**>< **SELECT** click>
 2. If the version is under **V1.5.1** (or the current version), connect the appliance to a computer in USB Update mode: <**SELECT** hold> together with **the** <**POWER** hold> <USB cable to a computer> a window with a new device (folder) opens.
 3. Copy .bin file to the device that appears. The appliance will restart on its own.
-


CHAPTER 1: Introduction and Preferred Configuration

1.1. Introduction to the governing bodies

The FNIRSI LCR-ST2 is designed for one-handed priority operation and a minimum amount of controls, which requires getting used to the combined functions of the buttons.

1.1.1. Buttons and ports

The buttons and ports have several functions:

- **<POWER> Power Button:**
 - **<POWER hold>** Long press - on/off (ON/OFF).
 - **<POWER click>** Short press – alternately remember (Hold) or release the last measurement.
- **<SELECT> Three-position navigation and selection button (joystick):**
 - **<SELECT left>** Allows quick left switching between menu options and/or between the main modes (Auto, R, C, L, D) without entering the menu;
 - **<SELECT right>** Allows quick right switching between menu options and/or between main modes (Auto, R, C, L, D) without entering the menu;
 - **<SELECT click>** Select;
 - **<SELECT left hold>** Toggle the secondary parameters to the bottom left;
 - **<SELECT right hold>** Toggle the secondary parameters at the bottom right;
 - **<SELECT hold>** prepares to switch to data transfer mode.
- **<MENU> Menu Button **
 - **<MENU click>** Switches a different screen format – basic or advanced.
 - **<MENU hold>** Switch to the function menu.
- **Type-C port:**
 - **< USB charger or port>**Charging;
 - **<SELECT hold>** followed by **<POWER hold>** **<USB cable to computer>**Data transfer and system software update

1.2. Reading the display

1.2.1. Basic and extended screen

The display depicts the main measured parameter and secondary parameters.

It can be switched to a basic screen and an extended screen (or the so-called dual equivalent mode).

- The base screen shows the main measured parameter in large numbers, above it in small numbers there is a row for the status (measurement conditions), and below it there is a row with two readings – on the bottom left are measured R (active resistance), C (capacitance), L (inductance) and Z (impedance), on the right θ (phase shift), X (reactance), D (losses) and Q (quality factor).



- The extended screen (dual equivalent mode) shows in the same way the above status row and below the secondary parameters, but in place of the main parameter (large digits), two lower-digit rows are visible: one row indicates equivalent serial coupling, the other – equivalent parallel coupling – the left digits are active resistance (R_s , R_p), and the right digits are capacitance (C_s , C_p) or inductance (L_s , L_p).



The screen is small, but informatively saturated. The device has a gyroscope. If you are working at an unusual angle in a densely populated circuit board, the display will rotate on its own to see it correctly. It is important to recognize:

- **Main parameter:** large numbers (e.g. the capacity in microfarads).
- **Secondary parameter:** the small digits (e.g. D - the losses or θ - the phase angle).
- **Test conditions:** Frequency and Level – they should always be in front of your eyes, because they determine the correctness of the measurement.
- **Battery indicator and screen freeze:** icon for battery charge and screen freezing (remembering).

1.2.2. Main parameters

These are **the large numbers** in the center of the screen. They show the physical quantity that you have selected or that **AUTO** mode has identified.

- **Example:** If you are measuring a capacitor, the main parameter will be its capacitance (e.g. **100.0 μ F**).
- **What is it for:** It gives us the nominal value of the element – what is usually written on some of its body.

1.2.3. Secondary parameters

These are **the small numbers** located below or next to the main parameter. They are the "secret power" of the instrument. They measure the parasitic or qualitative characteristics of the component. In the lower left part, **R** (active resistance), **C** (capacitance), **L** (inductance) and **Z** (impedance) are measured, on the right are measured **θ** (phase shift), **X** (reactance), **D** (losses) and **Q** (quality factor).

One of the most powerful but hidden features of the three-position button <SELECT> is the ability to manually select secondary parameters in real time:

- <SELECT Left Hold>: Changes the left secondary parameter. You can switch between **R**, **C**, **L**, and **Z** regardless of the main mode.
- <SELECT Right Hold>: Changes the right secondary parameter. You can choose between **θ**, **X**, **D**, and **Q**.

This means that if you measure the coil (**L**), you can manually call **up Q** (Quality Factor) directly on the main screen.

Secondary parameters give the complete characteristic of the element. For example, **θ** is the phase shift (phase angle) between voltage and current.

- With a **clean resistor**, it is close to **0°**.
- With an **ideal capacitor**, it is **-90°**.
- With an **ideal inductor**, it is **+90°**. If you measure the coil and see an angle of **45°**, this immediately tells you that it has high losses (high active resistance) or a defective core.

1.2.4. Why is it important to look at the primary and secondary parameters at the same time?

Experience has shown that the basic parameter tells what quantity the "thing" being measured is, and the secondary tells how strong it is. A capacitor may indicate an ideal capacitance (say, **100μF**), but if the secondary parameter **θ** is around **0** and **D** is high, that capacitor is damaged and will cause noise or restart in the circuit.

1.2.5. Status line reading (measurement conditions)

At the top of the "screenshot" you always see the settings at which the measurement is performed, the default when initially turned on is <AUTO | 1K | 0.6V> – which means:

- **Measurement mode: AUTO** - automatic
- **Frequency: 1K**. If you don't keep track of it, the result can be misleading (especially with coils).
- **Level: 0.6V**. This is the voltage that is used for the measurement. It is important to know that you are measuring in "safe" mode for the board.

1.2.6. How do I enter the modification mode?

In case it is not the first time the switching on, the appliance remembers the last measurement conditions.

Here is an example of changes in conditions when measuring <LCR>:

- <POWER hold> turns on the appliance;
- <SELECT click> includes measurement <LCR>;
- <MENU click> includes a detailed screen;
- <SELECT click> selects a parameter to change in the status;
- <SELECT selection> changes the parameter to the desired value;
- <SELECT click> confirms the selection and proceeds to the next one;
- <MENU click> returns the main screen.



1.3. Set a preferred configuration

System settings: Adjust them according to your preferences and for ease of use. They are set up once and rarely change, but everyone determines what they should be. These are only initial suggestions.

- **Auto-Power Off: Auto Power Off** - set it to 10 or 15 minutes to save battery during long repairs. Adjustable by <MENU hold> <SETTINGS> <AUTO-POWER OFF>
- **Brightness:** brightness – high brightness is important when working under high lighting on the workbench. Adjusted by <MENU hold> <SETTINGS> <BRIGHTNESS> through **10%**. Set it to **70%**.
- **Sound:** sound. Adjusted by <MENU hold> <SETTINGS><VOLUME> through **10%**. Set it to **70%**. In the current firmware, **v1.5.1** sounds the following features:
 - **Press confirmation:** A beep when operating the buttons.
 - **When sorting:** the appliance makes a sound when the component is **PASS** (in the norms) or **NG** (defective). This is the only mode in which the sound is used for diagnostics without looking at the screen.
 - **No audible indication for a circuit:** since the device is a specialized LCR meter, it measures the impedance constantly. If you want to use it for short searches, you need to keep an eye **on the R (resistance) values** on the display. It will not "squeak" at **0 Ω**, as a multimeter does.

1.4. Firmware

This book is based on **firmware V1.5.1**. With older or newer versions, it is possible that the menu specification may be different, and some functions may have improved accuracy or a different interface.

Always check your current version in the menu <MENU hold> <SELECT left/right> <SETTINGS>< SELECT click>< SELECT right><ABOUT>.

1.5. Changing the tips

- **Gold tweezers:** For SMD and other details and print tracks.
- **Kelvin cables:** When the component is bulky or you want to measure outside the board with maximum precision.

1.6. LZ3AI advises: for display operation

- In firmware **V1.5.1**, the rendering of secondary parameters has been improved. At first, it is "intimidating", but over time it will be more convenient and useful for you to see the extended display. If your screen shows only one large number, use the <MENU click> enable the display of secondary parameters. In amateur radio practice, they are often the ones who solve the problems, for example, for capacitors **Q** and **ESR/Rs** are more important than microfarads.
- In **AUTO** mode, if the unit oscillates between **R** and **L** for a coil with a very thin wire, look exactly **at θ** . If the angle is above **+10-15°**, the component definitely has an inductive character, even if its active resistance is high.
- Each time the nozzles are changed, be sure to calibrate the tool again if you need accurate readings.
- Always check that the tips are clean. Oxides on the metal can add hundreds of milliohms of error in low-impedance resistors.
- To save battery, you can set the brightness and volume to **70%** or less if they are enough for the specific illumination.
- **HOLD** is a handy feature, for example when measuring in hard-to-reach places and you cannot view the screen at the same time as the tips of the device.
- If you are annoyed by the gyroscope's change of screen direction, turn this feature off <SETTINGS>.

1.7. Practice: to set preferred parameters

1. Switch on the appliance and enter <SETTING>.
2. Explore all the setup options.
3. Set the automatic shutdown to 15 minutes.
4. Rotate the device in your hand and see how the gyroscope reacts – get used to it so you don't get disoriented when measuring vertically mounted boards.

CHAPTER 2: Accuracy Basics and Instrument Calibration

2.1. 4-wire Kelvin circuit

Why is **LCR-ST2** more accurate than a standard cable multimeter? In ordinary measurements, the resistance of the cables themselves and the contact resistance of the probes are added to the result. The **LCR-ST2** uses a **4-wire circuit**, with two independent wires going to each tip of the tweezers:

- **Drive (Force):** One wire supplies the measuring signal (current).
- **Sense:** through the other wire, the voltage drop directly on the terminals of the component is measured. In this way, the device mathematically ignores the resistance of the arms and contacts, ensuring the precision typical of laboratory stationary instruments.

2.2. Calibration and operation of the reference board

The V1.5.1 firmware makes the **LCR-ST2** a precision instrument by "training" (calibration) on 9 reference points. The use of the original calibration board with the nine resistors (0 Ω to 10 M Ω) is critical for the linearization of the instrument and more accurate approximation when measuring.

2.2.1. Calibration Interface:

- **Center Part:** Displays the target face value.
- **Bottom left:** Current measured number (you see in real time how the device is approaching the truth).
- **Bottom right (Status):** Your command and status dashboard.
- **Navigation:** With <**SELECT** left/right> select the resistor, and with <**SELECT** click> start the process.

2.2.2. The step-by-step calibration procedure:

- **Preparation: Clean** the tips of the tweezers without scrubbing with sandpaper, file or other abrasives – the tips are gold-plated. Select the resistor from the menu and insert the tips into the corresponding holes on the board.
- **Initialization:** Status indicates **State: Be ready**. Make sure the contact is stable and do not move.
- **Process:** After < **SELECT** click>, the status becomes **State: Start XX%**. The process takes about a minute for each point and does not proceed linearly – it is possible for the percentages to "slow down" at certain moments while the DSP processor processes the data, and at others to "speed up".

1. **Completion:** When you see **State: Success**, you move on to the next value.
2. **Flexibility:** The device allows for "shuffled" calibration. If you suspect a bad contact at any value, you can go back and repeat it.

2.2.3. Special calibration modes:

- **OC (Open Circuit):** It is performed with tweezers fully open, without contact.
- **SC (Short Circuit):** It is performed with the $0\ \Omega$ resistor of the calibration board with reference values, although it can also be done with a direct "short" with the tips of the device.
- **Voltage Calibration (10V):** If you have a laboratory voltage source calibrated to exactly **10.000V**, you can calibrate the voltmeter of the appliance for maximum accuracy when measuring batteries and power supplies.

2.3. LZ3AI advises: for calibration

- **Never neglect the calibration:** it removes the parasitic parameters of the tweezers itself.
- **Keep the circuit board clean:** finger grease on the $1\ \Omega$ and $10\ \text{M}\ \Omega$ resistors can change their value due to the parallel resistance of the skin. Hold the circuit board by the edges.
- **Compressive force:** when calibrating at point $0\ \Omega$ (Short), press the tips with the same force with which you measure the components. Different pressures change the contact resistance. If possible, fix the tweezers or board on the table. Even a slight shake of the hand will change the conditions and resistance. Poor calibration of $0\ \text{ohms}$ will introduce a system error in all your subsequent measurements.
- **Temperature:** the reference resistors on the board have their own temperature coefficient. Calibrate in the room where you will work after the appliance and the board have been there for at least 15 minutes.
- **Patience is punctuality:** one minute of resistor seems like a lot, but this is the time when the device "clears" all parasitic noises. Do not interrupt the process!

2.4. Practice: for calibration

1. Perform the full calibration cycle. You may skip voltage calibration if you do not have a precise **10 V** source available. Follow the prompts on the screen at the bottom right. Use the three-position button to change values and select, and to start the specific calibration.
2. Start with **the SC ($0\ \Omega$)** and continue with the other 8 resistors on the calibration board.
3. Skip **10 V** if you don't have a precise voltage source.
4. Lastly, do an open contact (**OC**) calibration.
5. After the end of the procedure, measure one of the resistors on the board itself (e.g. **100 k Ω** in normal measurement mode. If the instrument shows a deviation of less than **0.5%**, the calibration is successful.

CHAPTER 3: Techniques for Measuring Directly on the Board (In-Circuit)

Anyone who has been involved in the repair of electronic devices knows how much time saves the ability to measure the board itself, without soldering. This is the most difficult scenario, since the rest of the components in the circuit affect the readings. When there is a "dead" device in front of you, **the FNIRSI LCR-ST2** can cut the diagnostic time in half if you know how to use it as a "scanner" for circuits.

3.1. Extremely low voltage

- **The magic of 0.1 V:** How to measure resistors and capacitors without activating adjacent semiconductors (diodes/transistors). Set the test voltage to **0.1V**. This is below the opening threshold of most PN junctions (diodes and transistors), which allows you to measure resistors and capacitors without them being "shunted" by semiconductors nearby.

3.2. Short circuit localization (mΩ resolution)

Although the **LCR-ST2** does not have a classic sonic "ringing", its strength is in the milliohm resolution.

- **"Drop" method:** If you have a short supply line circuit (VCC to GND), the multimeter will squeak anywhere on the track. With **the LCR-ST2** in R mode, move along the track: if the unit shows **150 mΩ** at one end and **20 mΩ** at the other, you are physically approaching the faulty component. The lowest value in milliohms indicates the exact location of the breakdown.

3.3. Test frequency selection

Frequency determines how the appliance "sees" the component through the "noise" of the other elements:

- **100Hz / 120Hz:** Use for filtering electrolytes. Low frequency is necessary for proper calculation of large capacities.
- **1kHz:** Universal frequency for passive component inspection.
- **10kHz - 100kHz:** Critical for SMD ceramics and ESR. High frequency allows you to ignore high-value parallel resistances as the capacitor's reactive resistance becomes very low.
- **Sweep Mode:** If the impedance "graph" is not smooth but has "peaks", this is a sure sign of parasitic influence from a coil or other reactive component in the vicinity.

3.4. When does AUTO mode fail? (Manual Control)

The **AUTO mode** is smart, but on the board, it is easily fooled and can make mistakes.

- **Example:** If you measure a small capacitor with a low-value resistor in parallel (e.g. in a load circuit), the automation will go wrong and show only **R**.
- **Solution:** Switch manually to **mode C**. By selecting a high frequency (**100 kHz**) and manually setting mode **C**, you force the unit to filter the active ingredient (resistor) and try to extract the capacitance.

3.5. LZ3AI advises: to measure directly on the board

- **Dilute the capacitors! This** is the golden rule. The **LCR-ST2** is a sensitive instrument. A residual charge above a few volts can damage the input protections, although they are improved in **V1.5.1**.
- **The "lower value" rule:** On the board, always expect to measure a **lower** resistance than the rating (due to parallel paths). If you measure a **higher** resistance, **the resistor** is certainly faulty (broken or "escaped" upwards). The circuit cannot increase the value of the resistor; it can only decrease it.
- **Diode polarity:** In **D mode**, if you're measuring on a circuit board, always swap probes. If you see very low impedance in both directions, it's probably not the diode that's faulty, but you have a parallel low-impedance resistor or coil.

3.6. Practice: to measure directly on the board

1. Find an old circuit board with a diode and a resistor parallel to it (often found at the base of transistors).
2. Measure the resistor at **Level 0.6 V** – see how the value is wrong because the diode opens.
3. Change to **Level 0.1 V** – watch as the value of the resistor stabilizes to its actual value.
4. Change the frequency from **1 kHz** to **100 kHz** on some small capacitor and see how the secondary **ESR/Rs parameter** becomes much more accurate.

CHAPTER 4: Inductance and Component Quality (Q-Factor)

4.1. Coil Measurement (L) and Phase Angle

Inductance is highly dependent on the operating frequency. Unlike a resistor, a coil changes its inductive resistance according to the formula $\mathbf{XL = 2\pi fL}$.

4.1.1. Frequency rule:

- **For large inductances with ferrite cores (mH):** Use **100 Hz** or **1 kHz**.
- **For small air coils (μH):** Be sure to switch to **100 kHz**. At low frequency, their resistance is so small that the appliance may think of them as a simple wire (short circuit).

4.1.2. Quick Assessment

With **the FNIRSI LCR-ST2**, the main method for quickly evaluating the coil is through the main screen.

- **Secondary parameters:** In L mode, the appliance displays **C** (parasitic capacitance) and θ (phase angle).
- **θ (Theta) – Your Quick Test:** Since the ideal coil has a phase shift of $+90^\circ$, the closer the reading is to this value, the cleaner the inductance. If the angle falls below $+45^\circ$, the component has huge losses (active resistance) or defect.

4.2. How to monitor the quality factor (Q)

The quality factor (**Q**) is the ratio between the inductive and active resistance of the coil. It is the best indicator of the "health" of the component:

- **High Q:** Means "pure" low-loss inductance.
- **Low Q:** Signals a problem (interwinding short, bad core, or frequency-inappropriate core).

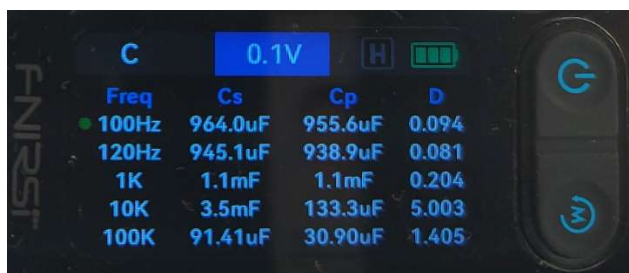
4.2.1. Invoking Q on the main screen (quick method)

In **V1.5.1**, you no longer need to enter special modes to see Q.

- While measuring in **L mode**, simply **hold <SELECT to the right>**.
- The value in the bottom right corner of the screen will change from phase angle θ to **Q**. So you have constant control over the quality in real time.

4.2.2. SCAN mode: full frequency picture

While Q is now on the main screen, SCAN mode remains the "lab" of tweezers for deep analysis.



C	0.1V	H	
Freq	Cs	Cp	D
100Hz	964.0uF	955.6uF	0.094
120Hz	945.1uF	938.9uF	0.081
1K	1.1mF	1.1mF	0.204
10K	3.5mF	133.3uF	5.003
100K	91.41uF	30.90uF	1.405

1. Enter **SCAN mode**.
2. Here, the device takes a series of measurements at different frequencies (**100 Hz to 100 kHz**).
3. **The result table:** In the third column (after Freq and Ls/Lp), you will find the value of **Q** for each frequency point.

- **Why is it useful?** Inductance is a dynamic quantity. SCAN mode allows you to see exactly at what frequency your coil reaches its maximum efficiency (highest Q) and where it begins to lose its properties.

4.3. Reading the "Engineering" Display (Dual Equivalent Mode)

When you press <MENU click> during a standard measurement, the screen with the mathematical models appears – dual equivalent mode or, simply, extended display:

- **The [+] symbol (Series):** indicates the sequential substitution scheme ($R_s + L_s$, $R_s + C_s$). Keep an eye on low-impedance coils (power chokes) and electrolytic capacitors.
- **The [||] symbol (Parallel):** indicates the parallel circuit ($R_p + L_p$, $R_p + C_p$). Keep an eye on high-frequency coils with many coils where parasitic capacitance is a factor.

4.4. LZ3AI advises: to track the "health" of components

- **The "health" indicator:** If you are in a hurry, do not enter **SCAN**. Just look at θ on the main screen. If you are measuring the coil and θ is a negative number (e.g. -70°), it means that the coil has entered into its own resonance and behaves like a capacitor at this frequency.
- **Q-factor in SCAN:** Use **SCAN mode when selecting coils for oscillating circles. Look for the frequency at which Q is highest** – this is the optimal operating point of your component.
- **Don't ignore the Q-factor. Keep** an eye on this parameter. A low Q at a coil often means "baked" coils or micro-short.
- If you are measuring inductance and it is constantly recognized as a resistor in **AUTO** mode, switch to **manual mode L** and raise the frequency to **10 kHz or 100 kHz**. Smaller inductances are measured more accurately at high frequencies.

4.5. Practice: for the quality of components

1. Connect a small choke and enter **SCAN** mode.
2. Look at the third column in the table. Observe how **Q** changes at **100 Hz**, **1 kHz**, and **100 kHz**.
3. Go back to the main screen and see how **θ corresponds** to these changes. You will notice that the highest **Q** in the **SCAN** corresponds to the largest angle **θ** (closest to **90°**).

CHAPTER 5: Measurement and Diagnostics of Voltage, Batteries, Capacitors and Diodes

This chapter discusses practical methods for inspecting the components that are most often the cause of equipment failure.

5.1. Capacitors and the Golden Rule of ESR

Electrolytic capacitors are the "weak point" of electronics. They often lose their properties (dry out) without this being visible externally.

- **The ESR test (Rs):** This is the equivalent consistent resistance. For the health of a capacitor, **ESR/Rs** is a much more important parameter than capacitance.
- In the **LCR-ST2** menu, the **ESR parameter** is indicated as **Rs (Resistance Series)**. **When you encounter a "low ESR" requirement in the service descriptions, look at the Rs reading of your appliance at a frequency of 100 kHz.**
- **In-circuit measurement:** The **LCR-ST2** allows measurement at **0.1 V**, which ensures that you will not activate the semiconductors in the circuit.
- **Parallel paths:** If you are measuring a filter capacitor in a power line, the instrument will display the total capacitance of all capacitors in that assembly. **However, ESR/Rs** will guide you on the general status of the filter.

5.2. Working as an "Intelligent Multimeter"

One of the greatest strengths of the **LCR-ST2** is that it can measure voltage and diodes without changing the appliance.

- **Voltage (VDC):** The device measures up to $\pm 30\text{V}$. It automatically detects polarity. Extremely useful for checking power rails and batteries.



- **Diode test:** The appliance shows the voltage drop at the PN-junction (**Vf**):
 - **Silicon diode:** **0.5 V – 0.7 V.**
 - **Shots diodes:** **0.1 V – 0.4 V.**
 - **LED (LED):** **1.8 V – 3.0 V.** (The appliance may not be able to power some powerful white or blue LEDs due to voltage limit).

5.3. Sorting

This mode is ideal for selecting components with the same parameters (e.g. pairs of transistors or precision resistors).



- You set a nominal value and tolerance (e.g. **1 %**).
- The appliance signals visually and audibly: it lights up green (PASS) and emits a single sound if the component is normal, and red (NG) and makes a double sound if it is outside it.



5.4. LZ3AI advises: to measure components

- **Discharge:** Always discharge capacitors before measuring! Despite the protections, a residual high charge can damage the input circuits or give you an unpleasant feeling.
- **Defect Criterion:** If the **ESR/RS** is above **2 Ω** for a capacitor above **100 μF**, it is a "passenger" (defective).
- **Safety:** Never use **L**, **C** or **R** mode to measure internal battery resistance! Although the **LCR-ST2** has protections, measuring voltage in "Capacity" mode is risky for the input ADC (analog-to-digital converter). This will damage your **LCR-ST2**. The instrument can only safely measure **the DC** voltage of batteries. For proper measurement of internal resistance, please read the specialized articles on professional battery test instruments here: <https://www.galanto.com/en/internal-resistance-of-the-car-battery/> and here: <https://www.galanto.com/en/whether-the-battery-is-excellent-good-or-damaged/>.

5.5. Practice: for measuring components

1. Find a circuit board from an old switching power supply. Measure the filter capacitors at **100 kHz**. Compare the measured **Rs (ESR)** with the table in Appendix 1.
2. Switch to **Voltage** mode and check the voltage of a single **1.5 V** battery.
3. Enter **Diode** mode and test a single LED. Observe the value of the straight direction drop (**Vf**).

CHAPTER 6: Expert Fault Diagnosis

In this chapter, we'll explore how to turn **LCR-ST2** into a powerful tool for detecting hard-to-diagnose defects using its high sensitivity.

6.1. Short Circuit Locating – Milliohm Technique

When you have a punctured component (capacitor or transistor) on a power bus, the standard multimeter "rings" along the entire length of the track. **However, the LCR-ST2** allows you to see the differences in milliohms ($m\Omega$).

- **The technique:** Move the tweezers along the track. Even 2-3 centimeters of copper track have their own resistance.
- **Principle:** The closer you are to the physical location of the "short", the lower the value of the screen will be.
 - Point A: **0.08 Ω**
 - Point B: **0.02 Ω** -> **The defect is here!**
- **Why is it accurate? Thanks** to the **4-wire circuit (Kelvin)**, the device ignores the resistance of its own arms and measures only what is between the tips.
- **Short Circuit Locating:** A milliohm technique for detecting a punctured component along a power line - move the tweezers along the track. The point with the lowest resistance is the location of the defective component.
- Even if the board "rings" short anywhere on a bus, the resistance is not the same. Use the high resolution of the **LCR-ST2**.
 - Measurements at different points along the track. Where the value is **lowest** (e.g. **0.02 Ω** vs. **0.08 Ω** at the other end) is the physical location of the defective component.
 - Here, the 4-wire measurement of the tweezers is invaluable because it ignores the resistance of the probes themselves.

6.2. Fault detection and benchmarking (Signature Analysis)

This is the fastest repair method when you have two identical boards (strong and defective). You don't need to know how the circuit works – you just need to find out the differences.

- **Z mode (Impedance):** Switch the unit to **Z mode** and select a frequency of **10 kHz**. Impedance gives the full picture (combination of resistance, capacitance, and inductance) at a given point.
- **The method:** Touch the same nodes on both boards in sequence relative to the "table" (GND).
 - If you see $Z = 150 \Omega$ on a rugged **board**, and $Z = 1.2 \text{ k}\Omega$ on a **faulty** board, then you have found the "sore spot".

6.3. Inspection of various electronic components directly on the board

This is the art of "isolating" a component software without soldering it:

- **Resistors in parallel with diodes:** Always use **Level 0.1V**. This ensures that the diode does not "open" and does not distort the value of the resistor.
- **Capacitors in power buses:** The measurements at **100 kHz**. At this frequency, the reactance of the capacitor is minimal and the unit manages to see its **ESR (Rs)**, ignoring the surrounding loads.
- **Transformers and Inductances:** Check them in **L + Rs** mode. If you find an inductance whose resistance (**Rs**) is abnormally high for the thickness of the winding, you probably have corrosion or partial interruption.

6.4. Frequency scanning (Sweep Mode) for hidden defects

The **SCAN** (or Sweep) mode is not just about measuring **the Q-factor**. It is invaluable for detecting defects that only occur at a certain frequency.

- If a filter or coil looks good at **1 kHz**, run a scan up to **100 kHz**. If the graph has abrupt, illogical jumps ("noise"), this often means a defect in the structure of the component or a "cold" solder that reacts to high frequency.

6.5. LZ3AI advises: for measurement with frequency scanning

- **Power supply first: 90%** of short circuits are in ceramic capacitors on power rails. Use the milliohm technique there first.
- **Z is better than R:** When comparing two boards, always use the **Impedance mode (Z)** at a frequency above **1 kHz**. Regular DC impedance (**R**) often does not indicate deviations that AC immediately "catches".
- **Be careful with polarity:** Although you measure with alternating current, on some active circuits on the board, the touch polarity may change the impedance slightly due to the parasitic diodes in the chips. Compare the boards by holding the tweezers in the same direction.

6.6. Practice: for frequency scanning measurement

1. Take a sturdy board and find a few control points. Record their **Z** impedance at **10 kHz**.
2. Simulate "failure" by tapping the dot with a damp finger or adding a parallel resistor, and see how **the Z** changes dramatically.
3. Use the **SCAN** mode on a small transformer and observe how the inductive resistance changes as the frequency increases.

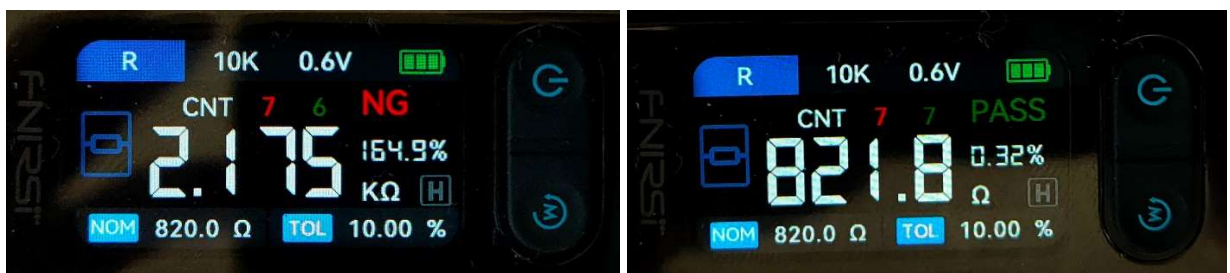
CHAPTER 7: Mass Testing and Automation

This chapter focuses on efficiency – how to use **the LCR-ST2** to work quickly with a large number of components.

7.1. Sorting Mode

Sorting mode turns tweezers into intelligent quality control.

- **Setting:** Set the "reference" (e.g. resistor **10 k Ω** and tolerance (e.g. **1 %** or **5 %**).
- **Visual indication:** The appliance lights up **green (PASS)** and emits a **single sound** if the component is normal, and **red (NG)** and makes a **double sound** if it is outside it.



- **Application:** Ideal when assembling kits or selecting matched components for audio amplifiers or RF filters.

7.2. Blind work in tight spaces

The LCR-ST2 is designed to work in densely populated circuit boards of modern smartphones and laptops.

- **Audible Signaling:** Use the audible signal when sorting to keep your eyes off the microscopic **SMD** components.
- **Hold function:** If you are measuring a point that is difficult to reach and you cannot see the screen, the appliance can hold the last stable value to look at after pulling the tweezers.

7.3. Maintenance and care of the appliance

To maintain accuracy, you must protect the mechanical integrity of the appliance and provide it with basic maintenance.

- **Care of the tips:** Never use the tweezers to mechanically scrape off varnish, oxides or solder residues! The tips are gold-plated and precisely calibrated. Any distortion or filing changes their parasitic parameters and will compromise the measurements at **100 kHz**.
- **Cleaning:** Use only isopropyl alcohol and a soft cloth. The cleanliness of the tips is directly related to the accuracy of milliohms (**m Ω**) measurements.

7.4. LZ3AI advises: for sorting and maintenance of the appliance

- **Tweezers are not a screwdriver:** A common mistake is to try to "lift" a smoked component with the tips of the tweezers. This will deform them irreparably. Use regular tweezers for mechanical work and LCR-ST2 for measurement only.
- **Battery protection:** If you are not going to use the appliance for a long time, charge it to about **50-60%**. Lithium polymer batteries do not like to sit completely discharged.

7.5. Practice: for the sorting and maintenance of the appliance

1. Take a strip with 20 identical **SMD** resistors. Set **the Sorting Mode** to **1%** and go through them. See how quickly the device classifies them.
 2. Check the peaks in strong light – if you see layers, clean them up and recalibrate the **Short (SC)** calibration. You will notice how the values become more stable.
-

CONCLUSION

Electronics repair and design are as much a science as it is an art. The **FNIRSI LCR-ST2** is the tool that turns invisible processes into clear numbers and graphs, giving us confidence in every solder. I hope this guide will help you get the most out of your "smart tweezers" and make hours spent on boards even more enjoyable.

Remember that the best tool remains your curiosity and attention to detail. Technology changes, but the principles of good diagnosis are eternal.

Technical documentation is like a nautical chart – it shows you the way, but you hold the rudder. Always trust logic first and then the instrument. Your **LCR-ST2** is a tool, but your knowledge is the power that makes it useful.

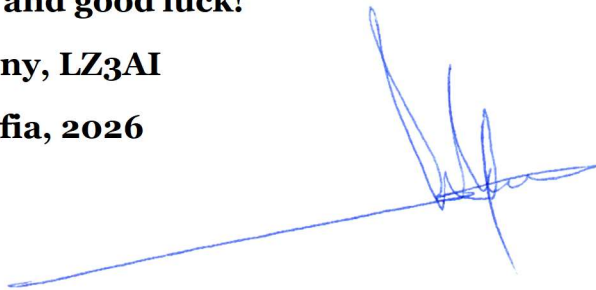
Thank you for your shared passion! See you on the air!

73 and success! Tony, LZ3AI

73 and good luck!

Tony, LZ3AI

Sofia, 2026

A handwritten signature in blue ink, appearing to be 'Tony LZ3AI', with a long horizontal line extending to the left.

<https://www.qrz.com/db/LZ3AI>

<https://www.linkedin.com/in/lz3ai>

<https://www.galanto.com>

Frequently Asked Questions (FAQs)

This section contains the answers to the questions that arise in real operation with the appliance when theory meets practice.

Q01: Why does the appliance show "C" (capacity) when measuring a coil?

- **A: This** is the parasitic capacitance of the coils. If this capacitance is abnormally high, the coil may be defective, or you may have chosen too high a frequency at which it no longer works as an inductance.

Q02: How do I know if a capacitor has "dried up" if its capacitance seems normal?

- **A:** Look at the **Rs (ESR) parameter**. Often the capacitance stays within the norms, but the internal resistance jumps dramatically. If **the Rs** is above the values in **Appendix 1**, the capacitor is for replacement.

Q03: Why does the readings "jump" and not stable?

- **A: This** is usually due to poor contact or unoxidized peaks. Clean the peaks with alcohol. Another reason may be residual charge in the capacitor – always dilute before measuring!

Q04: Do I need to calibrate the appliance every time I turn it on?

- **A:** Not necessarily, but it is recommended if you are going to measure very small values (below **1 Ω** or below **10 pF**) or if you have changed the measurement frequency.
-

Applications

Annex 1: Table of Acceptable ESR (Rs) of Electrolytic Capacitors

The values are in **ohms (Ω)** at a test frequency of **100 kHz**. These are the limit values for robust components.

Capacity	10V	16V	25V	35V	63V	160V+
1 μF	5.0	4.0	3.0	2.5	2.0	10.0
10 μF	2.5	2.0	1.5	1.2	1.0	4.0
47 μF	1.0	0.8	0.6	0.5	0.4	1.5
100 μF	0.6	0.5	0.3	0.2	0.2	0.8
470 μF	0.2	0.15	0.1	0.08	0.06	0.3
1000 μF	0.1	0.08	0.06	0.05	0.04	0.15

Appendix 2: Operational checklists

Checklist 1: Before Work (Preparation)

- Are the tips of tweezers cleaned with isopropyl alcohol?
- Has Open Calibration been done?
- Has Short Calibration (**SC**) been done?
- Is the appliance battery above **20%**?

Checklist 2: In-Circuit Measurement

- Is the device completely disconnected from the power supply?
 - Are capacitors discharged? (**Critical!**)
 - Is the test level set to **0.1 V** so that it is not affected by semiconductors?
 - Is **100 kHz** for **ESR/RS** or **100 Hz** for capacity selected?
-

Appendix 3: Function menu.

<POWER hold> switches on/off the appliance

<MENU >

<MENU click> includes a detailed screen if it is in a given measurement mode

<MENU hold> displays the function menu

<SELECT left> decreases

<SELECT left hold> changes the left secondary parameter (R/C/L/Z)

<SELECT right> increases

<SELECT right hold> changes the right secondary parameter (θ /X/D/Q)

<SELECT click> confirms

<LCR> L, C or R measurement mode

<SELECT click> measurement <LCR> is included;

<MENU click> a detailed screen is turned on;

<SELECT click> is selected in the parameter status;

<AUTO/R/C/L/D> measurement mode;

<100Hz/120Hz/1K/10K/100K> measurement frequency;

<0.1V/0.3V/0.6V/1V/> measurement voltage;

<SELECT selection> the parameter is changed;

<SELECT click> the selection is confirmed and the next one;

<MENU click> returns to the main screen;

<MENU hold> displays the function menu;

<SCAN> all-frequency scanning measurement

<SELECT click> a parameter for change is selected;

<R/C/L> **measurement mode;**

<0.1V/0.3V/0.6V/1V/> measurement voltage;

<MENU hold> displays the function menu

<SORT>

<SELECT click> a parameter for change is selected;

<R/C/L> **measurement mode;**

<**SELECT** left/right> changes the parameter

<**100Hz/120Hz/1K/10K/100K**> **measurement frequency;**

<**SELECT** left/right> changes the parameter

<**0.1V/0.3V/0.6V/1V/**> measurement voltage;

<**SELECT** left/right> changes the parameter

<**SELECT** left hold> resets sorting

<**MENU hold**> **displays the function menu**

<**VOLTAGE**> voltage measurement

<**SETTING**> appliance configuration

<**Language**> language

<**CH**> Chinese

<**EN**> English

<**MENU** click> confirms and returns

<**Speed**> Speed

<Slow> slow (more accurate measurements)

<Fast> fast (faster measurements – sorting)

<MENU click> confirms and returns

<**Start page**> home (main, start) page

<**Main Page**> function menu

<**LCR**> L, C, R measurement

<**Sweep**> frequency scanning

<**Filter**> sort

<**Voltage**> confirms and returns

<MENU click> confirms and returns

<**Orientation**> Orientation on the display

<**Auto**> Auto Orientation

<**Right**> right-hand oriented display

<**Left**> Left-Oriented Display

<MENU click> confirms and returns

<**Brightness**> яркость

<**0-100%**> brightness through 10%

<**MENU** click> confirms and returns

<**Volume**>

<**0-100%**> volume through 10%

<**MENU** click> confirms and returns

<**Auto Power Off**> **Auto Power Off**

<**OFF**> off

<**5min**> after 5 minutes

<**15min**> after 15 minutes

<**30min**> after 30 minutes

<**MENU** click> confirms and returns

<**Calibration**>

<**SC**> Closed Circuit – Short Circuit

<**1Ω**> 1 ohm

<**10Ω**> 10 ohms

<**100Ω**> 100 ohms

<**1kΩ**> 1 kilo

<**10kΩ**> 10 килоома

<**100kΩ**> 100 килоома

<**1MΩ**> 1 megaohm

<**10MΩ**> 10 megawatts

<**OC**> Open Circuit

<**10V**> 10 волта

<**MENU** click> confirms and returns

<**About**> About – shows the firmware version

<**Factory Settings**> Factory Settings

<**CANC**> отказ

<**OK**> ok

<**MENU** click> confirms and returns

<**MENU** hold> displays the function menu

<**SELECT**> select button

<**SELECT** left> decreases

<**SELECT** right> increases

<**SELECT** click> confirms

Glossary of terms and abbreviations used

To speak a language, here are the basic concepts used in this guide:

- **ESR (Equivalent Series Resistance / Rs):** Equivalent consistent resistance. The most important indicator of the "health" of a capacitor.
 - **Q-Factor (Quality Factor):** Quality factor of the coil. Indicates the ratio between inductive and active resistance (how "clean" the coil is).
 - **Θ (Theta/Theta):** Phase angle, phase offset. Indicates the delay between current and voltage. $+90^\circ$ is an ideal coil, -90° is an ideal capacitor.
 - **Z (Impedance):** Total resistance of the component under alternating current.
 - **D (Dissipation Factor):** Loss factor (the reciprocal of **the** Q-factor). Important when testing capacitors.
 - **4-wire measurement (Kelvin Connection):** A method in which the instrument uses two wires to supply current and two to measure voltage. This allows for precise measurement of milliohms, ignoring the resistance of the probes themselves.
 - **In-Circuit:** A measurement method without soldering the circuit component.
 - **Vf (Forward Voltage):** Voltage drop on a diode in a straight direction.
 - **SMD (Surface Mount Device):** Surface mount components (the small elements that the tweezers grip).
-

Sources and literature used

Official technical specifications and practical experience from leading specialists in the field of measuring technology have been used in the compilation of this manual:

1. **FNIRSI Technology Co., Ltd.** – *LCR-ST2 Intelligent Tweezers User Manual (V1.2)*. Official Operating and Calibration Manual.
2. **FNIRSI Firmware Documentation (v1.5.1)** – Specifications of software updates and algorithms for automatic recognition of components.
3. **H. W. Ott** – *Noise Reduction Techniques in Electronic Systems*. Fundamentals of Impedance Measurements and Noise Filtering.
4. **Specialized video reviews and analyses:**
 - "FNIRSI ST2 Smart Tweezers: Full Review and Laboratory Tests" (Technical Accuracy Analysis).
 - "Practical use of LCR tweezers in the repair of motherboards" (Methods for In-Circuit Diagnostics).
5. **Galanto Electronic Library** – Materials for internal resistance of batteries and diagnostics of electrolytic capacitors.
6. **LZ3AI Personal Archive and Practice** – Results of Real Measurements and Calibration in a Radio Amateur Environment.

