LucchiMeter PRO

User Manual

LucchiCremona

Cremona — Italy

www.lucchimeter.com

ver. 2.1

Table of Contents

1. Introduction

Figure 1.1 — LucchiMeter PRO with probes connected and reference bar on artisan workbench

1.1 What is the LucchiMeter

The **LucchiMeter** is an ultrasonic measuring instrument that determines the **speed of sound propagation through wood** and other materials.

The measurement is performed using two probes — a **transmitter (TX)** and a **receiver (RX)** — that generate and detect an acoustic pulse. The time the pulse takes to travel through the material, combined with the length of the sample, gives the value of the sound speed, expressed in meters per second (m/sec).

From a physical standpoint, the speed of sound propagation in a material is denoted by the quantity **C**. In the world of violin making, this same value is informally referred to as the **"Lucchi value"** — a designation born in the daily practice of craftsmen in the field, which has progressively spread internationally and is now a recognized reference for assessing the elastic

and vibrational quality of wood intended for the construction of musical instruments.

1.2 History and Tradition

Cremona is the city of Stradivari and of the violin, whose distinctive sound is born from the vibrations of the **resonance spruce** with which the instrument is built.

The LucchiMeter was conceived in **1983** through the insight of **Giovanni Lucchi**, a master bow maker in Cremona, after years of research and experimentation. The need was for a reliable measurement method to select the wood most suited to crafting violin bows of the highest level.

From the first prototype intended for in-house use in the workshop, the instrument evolved through successive versions, eventually becoming a product distributed worldwide. More than forty years on, the LucchiMeter is now an established reality in the violin making world.

The **Lucchi family** is proud to have linked its name to a designation that, while remaining informal, is today adopted across the international violin making community as a quality reference — the fruit of the artisanal tradition of Cremona.

1.3 The Lucchi Value

The “Lucchi value” is, in fact, the speed of sound propagation **C** measured in the material, expressed in m/sec. The higher this value, the greater the wood’s capacity to transmit vibrations efficiently — a fundamental characteristic for the acoustic performance of a musical instrument.

Being a **non-invasive and non-destructive** measurement, it can be performed on precious materials without altering their integrity in any way. For this reason, the LucchiMeter is also used as a research tool for the study of antique instruments.

The Lucchi value is now adopted as an **objective quality criterion** in the price lists of wood merchants, replacing or complementing subjective assessments based on appearance or personal experience.

1.4 Intended Users

The LucchiMeter PRO is an instrument intended for anyone working with wood for musical instruments and needing an objective parameter for its evaluation:

- **Bow makers**, to select wood for crafting bows
- **Violin makers and makers of bowed string instruments**, to choose high-quality spruce and maple
- **Guitar makers**, to evaluate the wood of soundboards and backs
- **Universities and violin making schools**, which use it as a teaching and research tool
- **Museums and foundations**, which employ it for the study and cataloguing of historic instruments
- **Wood merchants**, who use it as an objective reference in their price lists

---

Thanks to the LucchiMeter, violin makers can work the material with greater awareness, and musicians can find the best instruments on the market.

2. Package Contents

Inside the **LucchiMeter PRO** package you will find the following items:

Figure 2.1 — LucchiMeter PRO package contents with components numbered 1–8

1. **LucchiMeter PRO instrument**
2. **TX Flat Probe** — transmitter with flat contact surface
3. **RX Exponential Probe** — receiver with conical profile
4. **BNC cables** — set of 3 identical, interchangeable cables for probe connection (2 are required for use; the third is supplied as a spare)

5. **Transparent plexiglass verification bar** — used to check the correct operation of the instrument after the SET ZERO procedure (see *Chapter 11 — Verification Bar*)
6. **Universal 100–240 V power adapter** (automatic), with EU plug, two USB-C/USB-A outputs and a US plug adapter
7. **USB-C cable** for connecting the power adapter to the instrument
8. **Soft carrying case with compartments** for transporting and storing the instrument and accessories
9. **Printed user manual** in Italian and English *(not shown in photo)*
10. **Formulas Sheet and MIN/MAX Values Table**, listing the main physical quantities involved in material measurement and the reference values for the most common wood species used in violin making *(not shown in photo)*

2.1 Important Notes

- The instrument can be powered in two ways: via **USB-C cable** (connected to the supplied power adapter) or with **4 AA batteries**, alkaline or rechargeable (**NOT INCLUDED**). See *Chapter 4 — Power Supply*.
- On first use, it is recommended to verify that all the items listed above are present. In case of missing or damaged components, contact support at the addresses listed in *Chapter 15 — Contact and Support*.

3. Device Overview

This chapter introduces all the parts that make up the **LucchiMeter PRO**, so that the user can become familiar with the instrument before moving on to its practical use.

Figure 3.1 — LucchiMeter PRO — front view of the device

3.1 Front Panel

The device has a vertical rectangular shape, with reinforced corners and a sturdy plastic body. On the front face, from top to bottom, are located:

- The **LCD display**, which shows all measurement information and settings
- The **circular keypad** in blue, with the five operating keys
- The **two BNC connectors** for probe connection: **TX** (*transmitter*) and **RX** (*receiver*)

3.2 Display

The instrument is equipped with a monochrome **backlit LCD** display.

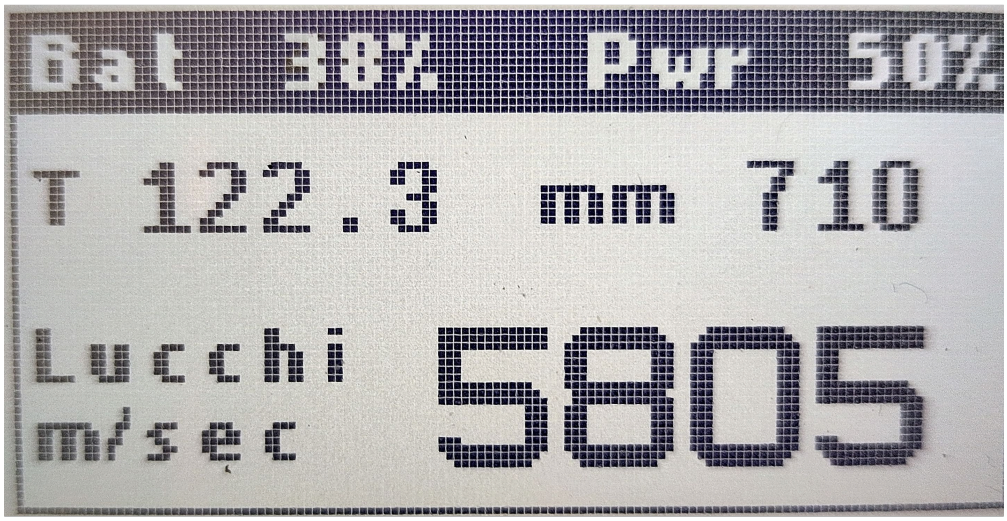

Figure 3.2 — LucchiMeter PRO LCD display during a measurement, showing Bat, Pwr, mm and Lucchi value in m/sec

During a measurement, the display shows the following information simultaneously:

- **Bat** — battery charge percentage. When the instrument is powered through the USB-C port, this indication is not meaningful and should be ignored.
- **Pwr** — power level of the signal emitted by the **TX** probe (transmitter), set by the user (see *Chapter 8 — Advanced Settings*)
- **T** — pulse propagation time, expressed in microseconds
- **mm** — sample length in millimeters, set by the user and used to calculate the Lucchi value (m/sec) (see *Chapter 7 — Taking a Measurement*)
- **Lucchi m/sec** — calculated Lucchi value, i.e. the speed of sound propagation in the measured material

If the unit label on the display changes from **m/sec** to **m/sec***, this means that the displayed Lucchi value is altered by the active SET CORRECTION factor (see *Chapter 8 — Advanced Settings*).

If the calculated speed falls outside the instrument's readable range, the indication **OVER** is shown in place of the numeric value.

3.3 The Five Keys

The circular keypad below the display comprises **five keys** arranged around a central button:

- **ZERO / ON-OFF** *(central button, symbol ⏻)* — When the instrument is off, a short press turns it on. To turn it off, press and hold until it powers down completely. When the instrument is on, a short press starts the **SET ZERO** procedure instead (see *Chapter 6 — SET ZERO Procedure*).
- **UP** *(upper key, arrow ▲)* — opens the **POWER** setting (the power of the pulse emitted by the TX probe) and, with each subsequent press, increases its value (see *Chapter 8 — Advanced Settings*)
- **DOWN** *(lower key, arrow ▼)* — opens the **POWER** setting (the power of the pulse emitted by the TX probe) and, with each subsequent press, decreases its value (see *Chapter 8 — Advanced Settings*)
- **LENGTH** *(right key)* — opens the setting for the sample length in millimeters (see *Chapter 7 — Taking a Measurement*)
- **CORR.** *(left key)* — opens the correction factor setting (see *Chapter 8 — Advanced Settings*)

Within each setting menu (**POWER**, **LENGTH**, **CORR.**) the current value is modified with the **UP** ▲ and **DOWN** ▼ keys: each single press changes the value by one unit, while holding the key down switches to continuous change. Pressing the **LENGTH** key together with UP or DOWN, the change occurs at an accelerated speed — particularly useful for **LENGTH** settings.

In all setting menus (**POWER**, **LENGTH**, **CORR.**), after 3 seconds without any key press the display automatically returns to the measurement screen.

3.4 Probe Connectors

In the lower portion of the front panel are the **two BNC connectors** for probe connection:

- **TX** *(on the left)* — output to the transmitter probe
- **RX** *(on the right)* — input from the receiver probe

The two connectors are identified by the **TX** and **RX** labels silkscreened above each of them. The instrument operates correctly even if the two probes are swapped, but for the best measurement result it is preferable to connect the **flat and wide** probe to the **TX** port — which generates a broader transmission beam — and the **pointed** probe to the **RX** port — which offers a more precise

and localized reception point. For details on the supplied cables and probes, see *Chapter 5 — Connecting the Probes*.

3.5 USB-C Port

On the upper side of the instrument there is a **USB-C port** intended exclusively for powering the device, via the supplied power adapter or any other USB-C adapter providing **5 Volts** and at least **1000 mA**.

> **Note:** the USB-C port **does not charge** any AA batteries inserted in the battery compartment. The two power modes (USB-C and AA batteries) use separate circuits. For further details, see *Chapter 4 — Power Supply*.

4. Power Supply

This chapter describes the two ways of powering the **LucchiMeter PRO** — through the **USB-C** port or through **4 AA batteries** — and the procedures for turning the instrument on and off. The two power modes use completely separate circuits: the USB-C adapter does not charge the AA batteries.

4.1 USB-C Power Supply

On the upper side of the instrument there is a **USB-C** port dedicated to external power. It is sufficient to connect the supplied adapter to this port and plug the adapter into a wall socket: the instrument is immediately ready for use.

In the absence of the original adapter, any other USB-C adapter providing **5 Volts** and a current of **at least 1000 mA** can be used.

When the instrument is powered through USB-C, the **Bat** indication on the display is not meaningful and should be ignored (see *Chapter 3.2 — Display*).

4.2 AA Battery Power Supply

As an alternative to the USB-C adapter, the instrument can be powered by **4 AA batteries (1.5 V)** inserted in the dedicated battery compartment. The batteries can be of the **alkaline** (disposable) type or **rechargeable** (NiMH); in the latter case, charging must be performed with an external charger, since the instrument does not charge the inserted batteries (see *Section 4.3*).

When the instrument is battery-powered, the **Bat** indication followed by the remaining charge percentage is visible in the upper-left area of the display (see *Chapter 3.2 — Display*). It is recommended to replace or recharge the batteries when this value drops below **20%**, to avoid inaccurate readings due to insufficient voltage.

4.3 Separate Circuits: No Charging via USB-C

The two power modes of the LucchiMeter PRO — USB-C and AA batteries — are managed by **completely separate electronic circuits**. The USB-C port therefore does not charge any AA batteries inserted in the battery compartment: rechargeable NiMH batteries must be removed and recharged with an external charger.

The main advantage of this design choice is the total absence of interaction between the two power sources: connecting the USB-C adapter while batteries — of any type, alkaline or rechargeable — are already inserted in the instrument causes no problem and no risk of damage.

4.4 Turning On and Off

Once the power mode (USB-C or AA batteries) has been chosen, to **turn on** the instrument briefly press the central **ZERO / ON-OFF** key of the circular keypad (see *Chapter 3.3 — The Five Keys*).

To **turn off** the instrument, press and hold the same **ZERO / ON-OFF** key until the display switches off completely.

The instrument is equipped with an **auto power-off** function that preserves battery life when the instrument is not actually in use. If for **1 consecutive minute** the probes do not detect any pulse — a condition in which the display shows the **OVER** indication (see *Chapter 3.2 — Display*) — the LucchiMeter switches off automatically. As long as the probes remain correctly placed on the sample and receive the pulse, the instrument stays on indefinitely.

5. Connecting the Probes

The LucchiMeter PRO is supplied with two probes — one with a **flat and wide contact surface** and one with a **pointed contact** — connected to the instrument through a coaxial cable with **BNC** connector (see *Chapter 3.4 — Probe Connectors*). This chapter describes how to identify the two probes, how to connect them correctly to the instrument, and which types of probes are available.

5.1 Identifying TX and RX

The two BNC connectors on the front panel of the instrument are identified by the **TX** (transmitter probe, on the left) and **RX** (receiver probe, on the right) silkscreens. The probes supplied as standard carry no marking, since they can be connected indifferently to either connector.

To obtain the best compromise between width of the transmission beam and precision of the reception point, the standard configuration is **TX = flat and wide probe / RX = pointed probe** (see *Chapter 3.4 — Probe Connectors*). It is however possible to use two probes of the same type — two flat or two pointed — should the specific measurement require it; the instrument operates correctly in all combinations.

5.2 Connection Procedure

Probes may be connected and disconnected with the instrument either on or off. To connect each probe:

1. Align the BNC plug of the probe cable with the corresponding connector on the instrument, matching the two side slots of the plug with the two pins of the connector.
2. Push the plug gently against the connector.
3. Rotate the outer sleeve of the plug by approximately a quarter turn clockwise, until you feel the locking click of the bayonet mechanism.

To disconnect the probe, rotate the outer sleeve of the plug by a quarter turn counterclockwise and pull the plug out of the connector.

> **Important:** during connection and disconnection, always act **exclusively on the metal sleeve** of the BNC plug. **Under no circumstances pull on the coaxial cable of the probe**: doing so can cause the internal conductors to detach from the connector and — due to the short circuits that may result — damage the internal electronic components of the LucchiMeter.

5.3 Available Probe Types

LucchiCremona supplies two probes of different types as standard with the LucchiMeter PRO, chosen to offer the user the greatest flexibility for the most common measurements:

- **Flat and wide contact probe** — rests on the sample with an extended surface, generating a broad transmission beam. It is the type usually connected to the **TX** connector, where the wide-spectrum coverage helps to irradiate the sample with ultrasonic pulses.
- **Pointed probe** — concentrates contact at a single point, ensuring precise and localized reception. It is the type usually connected to the **RX** connector, where the selectivity of the reading point allows the pulse arrival time to be measured accurately.

Both probes are physically interchangeable and can be connected to either connector (TX or RX); for particular needs it is also possible to work with two probes of the same type (two flat or two pointed) — the choice depends on the geometry of the sample and on the type of measurement intended.

6. SET ZERO Procedure

Before accurate measurements can be performed with the LucchiMeter PRO, it is necessary to carry out the **SET ZERO** procedure, which zeroes the instrument taking into account the pair of probes connected. This chapter explains when to perform the SET ZERO, how to carry it out step by step, and which quick checks should be done at the beginning of each measurement session.

6.1 Purpose of the SET ZERO

The **SET ZERO** procedure is intended to compensate for the propagation delays of the ultrasonic pulse introduced by the probe cables. Without this initial compensation, every measurement would be affected by a systematic offset — constant for the pair of probes in use — that would distort the calculation of the Lucchi value.

The SET ZERO must be performed:

- **on first use** of the instrument;
- **every time the probes are replaced** (or even just one of the two).

The zeroing is **stored in the instrument** even after power-off, so it does not need to be repeated at every turn-on. However, it is good practice, before starting a measurement session, to perform two quick checks:

1. **Zero verification**: bring the two probes together as for the SET ZERO procedure; if the display shows **0 microseconds** (or a value very close to zero), the stored zero is still correct.
2. **Verification with the plexiglass verification bar**: rest the probes against the supplied reference bar and verify the two time values marked on the bar itself — **5 microseconds** measuring the width and **40 microseconds** measuring the length (see *Chapter 11 — Verification Bar*).

If both checks are positive, the instrument is ready for accurate measurements. Otherwise, perform a new SET ZERO procedure (see *Section 6.2*).

6.2 Carrying Out the Procedure

With the instrument on and the two probes connected (see *Chapter 5 — Connecting the Probes*), to perform the SET ZERO proceed as follows:

1. Bring the two probes **against each other**, placing the **flat rubber** part of one probe in contact with the **pointed rubber** tip of the other.
2. Apply a **light, firm and steady pressure**, keeping the two probes aligned. This pressure must be the same as will then be applied to the probes during every measurement on a sample (see the note on pressure below).
3. Briefly press the central **ZERO / ON-OFF** key on the circular keypad.
4. The display shows the **SET ZERO Wait** indication (see *fig. 6.1*): keep the probes in the same position and with the same pressure until this screen remains visible.
5. At the end of the procedure the display shows **ZERO OK!** (see *fig. 6.2*): the pair of probes is now correctly zeroed and the instrument is ready for measurement.

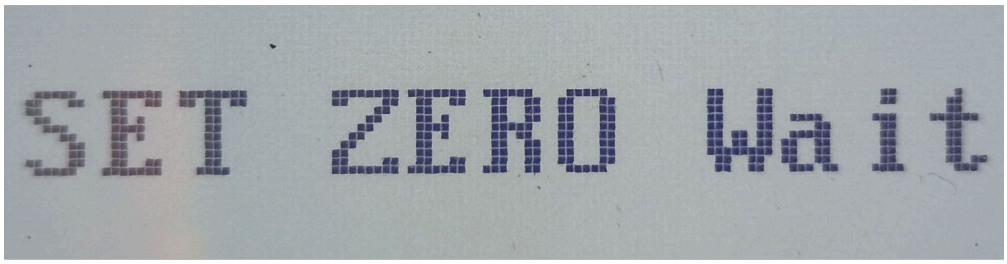

Figure 6.1 — SET ZERO Wait — procedure in progress, keep the probes still and under pressure

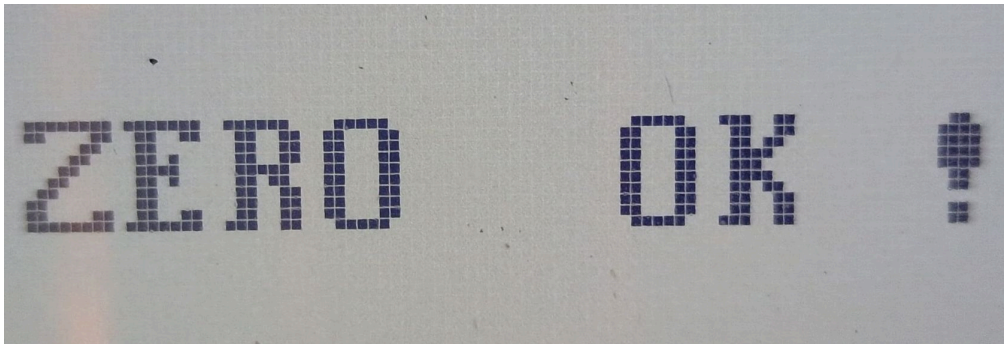

Figure 6.2 — ZERO OK! — zeroing completed successfully

> **Note on probe pressure:** the pressure applied to the probes directly affects the measured propagation time. The coupling rubber, by deforming, reduces the thickness interposed between probe and material, shortening the path of the pulse and therefore decreasing

the microseconds read. For this reason it is essential to apply **always the same pressure** both during the SET ZERO and during subsequent measurements: only in this way will the zeroing be consistent with the real measurement conditions.

6.3 Errors During the Procedure

If during the SET ZERO procedure the instrument detects an **instability in the reading** — typically caused by an involuntary movement of the probes, by an inconsistent pressure, or by an irregular contact between the rubber surfaces — the procedure is not completed and the display shows the **ERROR! REPEAT** message (see *fig. 6.3*).

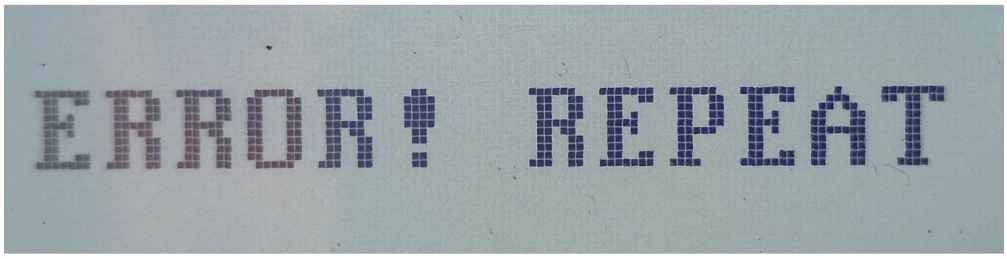

Figure 6.3 — ERROR! REPEAT — instability detected during the SET ZERO procedure

In this case it is sufficient to repeat the procedure described in *Section 6.2*, paying particular attention to:

- keeping the two probes **perfectly still** throughout the **SET ZERO Wait** screen;
- applying a **constant pressure** that does not vary, even minimally, during the entire procedure;
- verifying that the **rubber** surfaces of the probes are clean and in full contact with one another, with no dust, wood residue, or other foreign matter in between.

The zeroing previously stored by the instrument is **not lost** in case of error: if the new procedure does not succeed, the LucchiMeter continues to use the last valid SET ZERO previously performed.

7. Taking a Measurement

Once the SET ZERO has been performed (see *Chapter 6*) and the probes are correctly connected, the instrument is ready for measurements. A correct measurement requires two successive operations: setting the **length of the sample** being measured — expressed in millimeters — and positioning the probes at the two ends of the sample. The Lucchi value is computed in real time and updated on the display.

7.1 Setting the Length (LENGTH)

Before each measurement it is necessary to indicate to the LucchiMeter PRO the **length of the sample** in millimeters, that is, the distance between the two points where the probes will be placed. To set it:

1. Press the **LENGTH** key on the right side of the circular keypad. The setting menu opens and the display shows the current value in mm.
2. Use the **UP** ▲ and **DOWN** ▼ keys to increase or decrease the value until the desired length is reached.
3. Wait for the automatic return to the measurement screen: after **3 seconds** without any key press, the display returns to the main view and the new length is stored (see *Chapter 3.3 — The Five Keys*).

The set value is **also stored after the instrument is powered off**: at the next turn-on the LucchiMeter will display the last length used, and it will only need to be changed if the next sample has a different size.

Optional setting. Setting the LENGTH is not mandatory but it is a practical aid when measuring several samples of equal or similar size: once set, the instrument automatically calculates and displays the corresponding Lucchi value. When the samples have widely varying sizes, however, it may be faster to perform the measurement **without modifying** the length, read only the **time T in microseconds** on the display, and manually derive the m/sec value with the formula:

> **Lucchi (m/sec) = (mm / microsec) × 1000**

In this case, the Lucchi value shown by the instrument is not meaningful, because it is calculated using the last stored length, which does not match the sample being measured. This mode avoids having to modify the LENGTH at every sample change.

7.2 Performing the Measurement

With the length set (where applicable), to perform the measurement on a wood sample:

1. Rest the **two probes** at the two ends of the sample, at the points between which you want to measure sound propagation.
2. Apply a **constant pressure** to the probes, equal to that applied during the SET ZERO procedure (see *Chapter 6.2 — Note on probe pressure*). A different pressure would alter the measured times and make the reading not comparable with the zeroing.
3. Keep the probes **still** on the sample: the instrument updates the reading once per second. The steadier the hand, the more consistent the values read.
4. Read the **Lucchi m/sec** value directly on the display.

During the measurement it is normal to need to **manually fine-tune the position of the probes** on the sample surface, looking for the right tilt, until the **optimal contact point** is found. This point corresponds to the **minimum value of T (microseconds)** detected: at a given length, a shorter propagation time indicates a cleaner acoustic path and therefore a more accurate measurement.

Wide samples. When a sample has a significant width compared to the probe contact point, multiple measurements can be performed by moving the entire pair of probes across the width — typically at the center and near the two ends. During these shifts it is essential that the two probes always remain **aligned on the same straight line**, that is, on the shortest line connecting the two opposite contact points, so that the measured distance coincides with the set length. Since wood is a naturally non-homogeneous material, it is entirely normal that the various longitudinal measurements on the same sample return different Lucchi values: this variability reflects the internal structure of the wood and is not an imprecision of the instrument.

The instrument does not store the reading: **as soon as the probes are removed from the sample, the reading is lost**. To record the result, it must be noted manually before disconnecting the probes.

7.3 Interpreting the Display During Measurement

During the measurement the display shows all the parameters described in *Chapter 3.2 — Display* simultaneously: battery charge (**Bat**), pulse power level (**Pwr**), propagation time in microseconds (**T**), set length (**mm**) and calculated Lucchi value (**Lucchi m/sec**).

The **Lucchi value** is the final result of the measurement: it is the speed of sound propagation in the material, expressed in meters per second, and constitutes the "Lucchi value" of the measured sample. It is the number that — in violin making, commercial or research practice — is compared with the reference values to evaluate the acoustic quality of the wood.

If the unit label on the display changes from **m/sec** to **m/sec***, this means that the Lucchi value is altered by the currently set SET CORRECTION factor (see *Chapter 3.2 — Display* and *Chapter 8 — Advanced Settings*).

The OVER Indication

In place of the numeric Lucchi value, the **OVER** indication may appear in two distinct situations:

1. **Invalid propagation time** — when the probes are not in contact with the sample, when the contact is insufficient for the instrument to detect a stable ultrasonic pulse, or when the measured **T** value equals zero (a condition that would make the calculation of the m/sec speed impossible).
2. **Out-of-scale result** — when the time reading is correct, but the Lucchi value calculated from it and from the set length exceeds the **9999.9 m/sec** limit displayable by the instrument. This situation typically occurs when the **LENGTH** value has been set too small relative to the actual sample being measured.

In both cases it is sufficient — respectively — to reposition the probes correctly on the sample, or to correct the LENGTH value so as to bring the measurement back within the instrument scale.

8. Advanced Settings

Beyond the sample length, the LucchiMeter PRO allows the user to act on two **optional parameters** that adapt the instrument to particular measurement conditions: the **power of the ultrasonic pulse** (SET POWER) and a possible **percentage correction factor** applied to the calculated Lucchi value (SET CORRECTION). Both settings are **stored even after the instrument is powered off** and remain active until a new modification.

8.1 SET POWER — Pulse Power

The **POWER** parameter regulates the power of the ultrasonic pulse generated by the **TX** (transmitter) probe, expressed as a percentage. To modify it, from the main measurement screen press the **UP** ▲ or **DOWN** ▼ keys on the circular keypad: the **POWER** setting menu opens and with each subsequent press the value increases (UP) or decreases (DOWN). After **3 seconds** without any key press, the display automatically returns to the measurement screen and the new value is stored (see *Chapter 3.3 — The Five Keys*).

The POWER value can be adjusted in the range **20% – 100%**. The default value — and in most cases the most balanced one — is **50%**: this setting is suitable for the majority of wood samples commonly measured.

When to adjust the power

- **Small samples** (indicatively around 10 cm in length): it is preferable to **lower** the power. Too intense a pulse on a small sample can in fact trigger **false readings** due to saturation or disturbance of the received signal.
- **Large samples** (long trunks): if the pulse emitted at 50% does not reach the RX probe in a sufficiently stable way — a condition typically signaled by the **OVER** indication on the display (see *Chapter 7.3*) — it is advisable to progressively **increase** the power, up to a maximum of **100%** if needed.

The currently active POWER level is always visible in the measurement screen next to the **Pwr** indication (see *Chapter 3.2 — Display*).

8.2 SET CORRECTION — Correction Factor

The **SET CORRECTION** parameter allows the user to apply a **percentage** correction factor to the Lucchi value calculated by the instrument, which is

added proportionally to the value itself. The formula by which the correction is applied is:

> **Lucchi displayed = Lucchi calculated × (1 + SET CORR. / 100)**

For example, with a correction factor of **5.0%** applied to a calculated Lucchi value of **5000 m/sec**, the display will show **5250 m/sec** — that is, 5000 plus 5% of 5000.

The time value **T** in microseconds shown on the first line of the display is **never affected** by the SET CORRECTION, since it is the direct physical measurement made by the instrument: the percentage correction acts exclusively on the Lucchi value calculated from T and from the length.

The SET CORRECTION value can be set **exclusively positive**. The default value — and for most measurements the one to keep — is **0.0%**: in these conditions the number shown on the display coincides exactly with the Lucchi value calculated by the instrument and is not altered in any way.

To modify the correction factor:

1. Press the **CORR.** key on the left side of the circular keypad. The setting menu opens and the display shows the current value of the factor.
2. Use the **UP** ▲ and **DOWN** ▼ keys to bring the value to the desired percentage.
3. After **3 seconds** without any key press, the display returns to the measurement screen and the new correction factor is stored.

When the correction factor is **different from 0.0%**, on the display the unit label changes from **m/sec** to **m/sec***, with a final asterisk that immediately and visibly signals to the user that the displayed Lucchi value is not the "raw" value calculated by the instrument, but a value corrected according to the active setting (see *Chapter 3.2 — Display*).

8.3 Practical Use Cases of SET CORRECTION

In general, every **cut or hole** made on a wood sample tends to **lower** the Lucchi value read, with a reduction all the more marked the larger the holes or notches are with respect to the volume of the piece. In the same way, the **moisture** level of the wood also affects the measurement: freshly cut green wood gives lower readings than the same wood once seasoned.

It is important to stress that these variations **do not correspond to a modification of the intrinsic acoustic characteristics** of the material: the

wood remains the same. Only the conditions in which the measurement is performed and the ultrasonic path between the probes change.

The SET CORRECTION factor was conceived precisely to allow the experienced operator to **numerically compensate for these known variations**, bringing the reading back to a value more representative of the actual acoustic quality of the wood — be it the "expected" value after seasoning, or the "original" value before machining. The following sections illustrate three typical use cases where this function is useful.

8.3.1 Moisture Compensation in Wood

The Lucchi value of the same wood sample **progressively grows** as the material loses moisture during seasoning. A freshly cut piece, with high moisture content (typically around 40%), returns significantly lower readings than the same piece once seasoned to equilibrium moisture (on average between **8% and 12%**, the value considered "complete seasoning"). Once this moisture level is reached, both the moisture content and the Lucchi value stabilize: both can be considered **final**.

The magnitude of the variation depends on the wood species. As an example, from direct experience on **spruce** an approximately linear correlation has emerged: **for every percentage point of moisture lost, approximately one percentage point of Lucchi value is gained**. This is an empirical figure, to be verified each time on one's own raw material, but useful as an order of magnitude for the most common species in violin making.

Starting from this relationship it is possible to estimate the **final** Lucchi value of a still-fresh piece. Example:

- A piece of spruce measured fresh at **40%** moisture returns a Lucchi value equal to **X**.
- Seasoning will lower its moisture from 40% to about 10% — a difference of **30 percentage points**.
- Applying the "1% moisture less = 1% Lucchi more" relationship, the expected final Lucchi value will be approximately **X + 30%**.

The same reasoning can be applied directly during measurement by setting **SET CORRECTION = 30%**: the display will show in real time a **prediction** of the Lucchi value that the same piece will have at the end of seasoning, marked by the **m/sec*** indication on the second line.

> **Note:** the "−1% moisture = +1% Lucchi" relationship is the result of empirical data collected on spruce; it is to be considered a general indication, to be refined with personal trials on one's own wood batches and for each species used.

8.3.2 Compensation for Cuts and Holes in Finished Bows

During the crafting of the bow, **two holes** are made in the stick: the one for the **button** and the **mortise**, a hole of rectangular section intended to host the frog joint. By measuring the same piece of wood with the LucchiMeter PRO **before** and **after** these operations, the Lucchi value turns out to be **systematically lower** than that detected on the intact wood, even though the wood is physically the same. The cause is purely geometric: the interruption of the fibers at the holes alters the ultrasonic path between the probes, lowering the reading.

To **trace back to the original Lucchi value** of the wood knowing only the measurement of the finished bow, it is sufficient to apply an appropriate **SET CORRECTION**. The average values observed in the production of standard bows are the following:

Type of bow	SET CORRECTION
Violin bow	**2.2%**
Viola bow	**2.3%**
Cello bow	**2.6%**
Double bass bow	**3.6%**

Practical example: a finished violin bow that returns a Lucchi value of **5380 m/sec** on the display, measured with SET CORRECTION = **2.2%**, will again show **5500 m/sec** (approximately) — that is, the value the same wood would have had **before** the mortise and the button hole were made.

These values derive from observation on a large number of bows and prove valid for the great majority of cases, including antique bows. Those who build bows can however **refine their own table** by measuring the wood before and after machining and deriving the correction factor specific to the dimensions of mortise and hole made on their own pieces.

8.3.3 F-holes Compensation in Finished Violins

The same principle illustrated for bows also applies to the **soundboard of violins**. When the soundboard is completed, the two **F-holes** are cut on its surface. These cuts interrupt part of the wood fibers and, consequently, **lower**

the Lucchi value measured on the finished soundboard compared with that detected on the intact wood, before the F-holes were cut.

To **trace back to the original Lucchi value** of the wood of an already-machined soundboard, a correction factor of typically higher value compared to bows can be applied, since the F-holes interrupt a greater amount of fibers. Experience indicates that a **SET CORRECTION ≈ 8%** returns, on finished violins, a value close to that of the original wood before the F-holes were cut.

Since this is a less consolidated figure than that for bows — and one that depends on the actual shape and size of the F-holes cut by the individual maker — it is recommended, for those who build violins, to **verify their own correction factor** by measuring the soundboard **before** and **after** cutting the F-holes and deriving from these two readings the SET CORRECTION value most suited to their own work.

9. Understanding the Lucchi Value

Once it is understood how to perform a measurement and how to manage the instrument settings, it remains to grasp the meaning of the number that the LucchiMeter PRO returns on the display: the **Lucchi value**, expressed in meters per second. This chapter describes what this quantity physically represents, how to read it in a qualitative key, and what reference ranges have been observed in the main wood species used in violin making.

9.1 Physical Meaning of the Lucchi Value

The **Lucchi value** is the **speed of sound propagation** within the measured wood, expressed in meters per second (**m/sec**). It is a purely physical quantity, calculated as the ratio between the distance traveled by the ultrasonic pulse (the length of the sample, in millimeters) and the time taken to travel it (the time **T**, in microseconds), as illustrated in *Chapter 7.1*.

This speed is directly correlated to the **elastic and vibrational properties** of the material: the more elastic the wood is relative to its density, the more rapidly the mechanical wave propagates within it. This is the physical principle by which the Lucchi value is today recognized internationally as an **objective indicator of the acoustic quality of wood** intended for the construction of musical instruments.

The LucchiMeter PRO always returns the speed measured **along the alignment direction of the probes** on the sample: depending on how these are positioned, the same instrument can provide either the **longitudinal** speed — with probes aligned parallel to the direction of the fibers — or the **transverse** speed — with probes aligned perpendicularly. For two-dimensional samples such as violin soundboards, complete characterization of the wood requires both measurements: the longitudinal and transverse values can differ greatly, and in the violin making world the quality of a soundboard is evaluated on the combination of the two speeds (see *Section 9.3*).

9.2 How to Read the Lucchi Value

In general terms, a **high** Lucchi value indicates wood in which the mechanical wave propagates rapidly: a material with a good ratio between stiffness and elasticity on one side and lightness on the other. These are the typical characteristics of woods considered "musically prized": better sound transmission, greater promptness of response, richer harmonic presence.

A **low** Lucchi value, conversely, signals wood with reduced ability to transmit vibrations efficiently. The causes can be multiple: high density not balanced by corresponding elasticity, irregular grain, presence of internal defects (knots, fractures, rots), high residual moisture, or simply the intrinsic characteristics of a wood species not particularly suited to musical use.

It must however be stressed that the Lucchi value is a **purely instrumental measurement**: it does not replace the craftsman's experience. The final acoustic quality also depends on factors that the instrument does not measure — direction of the fibers, distribution of the annual rings, presence of knots, direction of the cut, seasoning method, and so on. The Lucchi value is therefore an **objective reference data point**, to be combined with — and not opposed to — the sensory assessment and the practical experience of those who work the wood.

Furthermore, as recalled in *Chapter 7.2*, wood is a **naturally non-homogeneous material**: measurements performed at different points of the same piece can return different values. This variability is not an imprecision of the instrument, but rather additional information on the internal structure of the material.

9.3 Typical Reference Values

The values reported below derive from **direct measurements performed on real samples** of the main wood species employed in violin making. They are not "absolute" or exhaustive ranges: they represent the interval within which the great majority of pieces measured in our experience falls, and constitute an orientation reference for those starting to use the instrument. For a more extensive table, including other wood species, refer to the **MIN-MAX Values Sheet** supplied with the LucchiMeter PRO.

All the values in the table refer to the **longitudinal speed** (probes aligned with the direction of the fibers), with the only explicitly indicated exception.

Species	Longitudinal speed	Notes
Spruce *(soundboards)*	4350 – 6300 m/sec	Transverse speed: 700 – 2100 m/sec
Maple *(backs, ribs, necks)*	3300 – 5200 m/sec	
Pernambuco *(bows)*	4350 – 6130 m/sec	See quality thresholds below
Ebony *(fingerboards, accessories)*	3100 – 4000 m/sec	

Practical Thresholds for Pernambuco Bow Wood

Pernambuco, due to its specific intended use in bow making, is the species on which LucchiCremona has accumulated the most extensive experience. The following Lucchi value thresholds describe the quality levels typically associated with the sticks of finished bows:

- **Below 5000 m/sec** — not usable for producing bows of acceptable quality.
- **5000 – 5200 m/sec** — soft bows, lacking strength and elasticity, with a dull sound. Typically used for entry-level student bows.
- **5200 – 5500 m/sec** — medium-quality bows, with decent responsiveness and a more present though still dark sound. Typically used for good-level student bows.
- **Above 5500 m/sec** — Pernambuco becomes a sought-after material with increasing price. Bows produced from this wood offer a bright, harmonic-rich, snappy sound: ideal characteristics for virtuosity and rapid bow strokes. These are the bows intended for professional concert use or for the highest-level student instruments.
- **Towards 6000 m/sec** — rare values to find, in which all the acoustic and mechanical characteristics reach their peak.

A Note on the Evaluation of Soundboards

For the woods intended for violin soundboards — spruce first and foremost — the longitudinal speed alone is **not sufficient** to express a quality judgment. There are pieces with longitudinal speed close to the top of the scale but with particularly low transverse speed, and vice versa. In the violin world, and in general for any wood intended to vibrate thanks to a two-dimensional plate, the overall evaluation must be made on the **combination of the two measurements**, and requires specific experience that the LucchiMeter PRO supports by providing the instrumental data but does not replace.

10. Applications

The LucchiMeter PRO finds use in many areas of the musical wood supply chain, from raw material selection to machining process control, all the way to the evaluation of finished — including historic — instruments. This chapter presents an essential overview of the most common use contexts, without claiming to be exhaustive: each user can develop further applications according to their own professional needs.

10.1 Wood Selection and Trading

The most direct use of the LucchiMeter PRO is the **qualitative selection** of wood intended for the construction of musical instruments. By measuring a number of samples of the same species, the violin maker or bow maker can compare the Lucchi values and objectively identify the pieces with the best acoustic characteristics, integrating the instrumental data with their own sensory assessment.

In the **wood trade**, the Lucchi value has by now entered sales price lists as an **objective criterion for price differentiation**. The most evident example is the market of Pernambuco for bows: a stick at 5000 m/sec costs on the order of 10 dollars, while a stick at 5900 m/sec — with the associated acoustic and mechanical characteristics (see *Chapter 9.3*) — can reach quotations on the order of 1000 dollars. The price difference directly reflects the difference in acoustic quality ascertained by the instrument, independently of subjective assessments.

10.2 Verifying the Effects of Machining and Treatments

The LucchiMeter PRO allows the **impact** that the various stages of machining or treatment of the wood have on its acoustic characteristics to be **objectively evaluated**. The typical procedure consists in measuring the same sample **before and after** each operation, recording any variation of the Lucchi value.

The situations in which this “before/after” approach is particularly useful include:

- **Thermal treatments** — verification of possible variations of the Lucchi value induced by forced drying cycles or thermo-treatment.
- **Varnishing and impregnation** — control of the effect of surface finishes on the acoustic response of the wood.
- **Gluing** — measurement of the behavior of the wood once joined to other elements or veneers.
- **Machining** — evaluation of any degradation introduced by tools that subject the wood to intense vibrations (circular saw, milling machine, industrial sander).

The data collected with this method have no absolute value in themselves, but allow the individual operator to build over time a **documented empirical knowledge** of their own processes: an objective basis on which to calibrate one's production choices.

10.3 Evaluation of Finished Instruments

The LucchiMeter PRO also allows **finished instruments** to be measured — bows, violins and in general bowed string instruments on which the probes can be rested on a portion of wood of the stick or the soundboard. Measurements performed on a finished instrument return lower values than those of the intact wood, due to the holes and cuts made during construction (mortise and button hole for bows; F-holes for violin soundboards).

Using the **SET CORRECTION** function with the factors indicated for the various types of instrument, it is possible to trace back from the measured value to the **original Lucchi value** of the wood used — information of great use in the purchase phase, in commercial evaluation, or in comparing different instruments. For the details of the correction factors and of the procedure, see *Chapter 8.3.2 — Compensation for Cuts and Holes in Finished Bows* and *Chapter 8.3.3 — F-holes Compensation in Finished Violins.*

10.4 Cataloguing and Research on Antique Instruments

The **non-destructive** nature of the measurement makes the LucchiMeter PRO particularly suited to the study and cataloguing of **historic and valuable instruments**, where any form of invasive intervention is obviously excluded. The probes alone, resting on the surface of the wood, allow an objective datum on the acoustic characteristics of the instrument to be acquired without altering its integrity in any way.

Several **foundations and museum institutions** dedicated to the conservation of antique violins, violas, cellos and bows today include the Lucchi value among the parameters recorded in their cataloguing files, alongside the traditional historical, constructive and dimensional information. The inclusion of the Lucchi value in archive files constitutes a valuable reference both for comparative studies on the woods used in different eras and by different makers, and for monitoring over time any evolution of the acoustic characteristics of the preserved instruments.

11. Verification Bar

To verify at any time that the LucchiMeter PRO is returning consistent readings, the instrument is supplied with a small **plexiglass verification bar** that carries two reference propagation time values. It is worth restating that this is a **verification — not calibration — bar**: the only true "calibration" procedure of the instrument is the **SET ZERO** described in *Chapter 6*, which acts as a **tare** of the connected probe pair. The bar serves instead to confirm a posteriori that the stored zero is still valid and that the readings fall within the expected range.

11.1 Characteristics of the Bar

The bar is made of **plexiglass** — a material chosen for the stability of its properties over time and with temperature — and carries silkscreened directly on its surface the two time values that the instrument must return when the probes are rested against one of its two working sides:

- **5 microseconds** measuring the **width** of the bar
- **40 microseconds** measuring the **length** of the bar

No dimensions are indicated: the reference values are directly the **two time measurements**, so that the instrument check can be carried out without need for further parameters.

11.2 Verifying the Instrument with the Bar

The check must be performed **after carrying out the SET ZERO procedure** (see *Chapter 6.2*) and should be repeated, as good practice, at the beginning of each measurement session or whenever there is doubt about the consistency of the readings. The complete procedure includes **three successive checks**:

1. **Zero verification** — bring the two probes against each other exactly as for performing a new SET ZERO (flat rubber against pointed rubber, light and steady pressure). The display must indicate **T = 0 microseconds** or a value very close to zero.
2. **Width measurement of the bar** — rest the probes against the two opposite faces of the bar on its short side. The display must indicate **T ≈ 5 microseconds**.

3. **Length measurement of the bar** — rest the probes against the two ends of the bar on its long side. The display must indicate **T ≈ 40 microseconds**.

In all three checks the probes must be positioned and pressed **in the same way** as for normal measurements — light, firm and steady pressure (see *Chapter 6.2 — Note on probe pressure*).

Allowed tolerance. For all three readings a deviation of approximately **± 0.5 microseconds** from the reference value is acceptable. Variability within this tolerance is mainly due to small differences in pressure applied to the probes and is normal.

11.3 What to Do if the Verification Fails

If one or more readings deviate significantly from the reference values (beyond the ±0.5 microsecond tolerance), proceed in this order:

1. **Repeat the SET ZERO** following step by step the procedure of *Chapter 6.2*. In most cases a new zeroing — with clean probes and uniform pressure — realigns the readings within the tolerance.
2. **Repeat the three checks** on the bar. If all of them fall within the tolerance, the instrument is once again ready for reliable measurements.
3. **If the discrepancy persists** even after a new SET ZERO, the instrument or the probes may require service. In this case, contact LucchiCremona support at the addresses listed in *Chapter 15 — Contact and Support*.

11.4 Tip: Personal Verification Stick for Long Measurements

The plexiglass bar supplied as standard allows the consistency of the instrument to be verified only within the typical time range of short measurements. When measurements are routinely performed on samples of greater length — indicatively **above 50 cm** — it can be useful to create one's own **personal verification stick** of suitable length, to be used as an additional reference.

The procedure is simple:

1. Obtain a **stick** of any material (wood, plexiglass, rigid plastic) sufficiently long compared to one's typical uses.
2. Once the LucchiMeter PRO has **passed the three standard checks** described in *Section 11.2*, perform a measurement of the time **T** in microseconds on the personal stick.

3. **Write the read T value** directly on the stick itself, with a permanent marker or a permanent label.

In every subsequent measurement session, in addition to the three standard checks on the plexiglass bar, a fourth check can now be performed by comparing the time read on one's stick with the originally noted value: if the reading falls within **±0.5 microseconds** of the reference value, the instrument is to be considered reliable also for measurements of similar length.

12. Maintenance and Storage

The LucchiMeter PRO is a precision electronic instrument that does not require any particular periodic maintenance. A few simple cleaning and storage precautions are enough to ensure its full reliability over time.

12.1 Cleaning the Instrument and the Probes

For ordinary cleaning of the LucchiMeter PRO body and of the probes, a **soft dry cloth** is sufficient, optionally **lightly dampened with water**. The cloth serves to remove dust, wood residue or fingerprints accumulated during use.

> **Important:** never use **solvents, alcohol, thinners, aggressive detergents or sprays** on the instrument or on the probes. These substances can damage the silkscreening on the front panel, the coupling rubber of the probes and — should solvents penetrate through the openings — the internal electronic components.

12.2 Carrying Case

The LucchiMeter PRO is supplied with a **soft carrying case** equipped with **dedicated compartments** for the safe transport of all the instrument's components: the central unit, the two probes with their cables, the USB-C power adapter, the plexiglass verification bar, and any optional accessories.

It is recommended to **always use the supplied case** for moving the instrument, placing each component in the intended compartment. This precaution especially protects the BNC connectors of the probes and the coaxial cables, which remain sheltered from accidental impacts and from excessive twists or bends that, over time, could compromise the electrical continuity of the conductors (see *Chapter 5.2 — Connection Procedure*).

12.3 Long-term Storage

In case of **prolonged non-use** of the instrument — indicatively beyond one month — it is appropriate to follow two simple precautions:

- **Remove the AA batteries** from the battery compartment. Even good-quality alkaline batteries can, over time, leak electrolyte that irreversibly damages electrical contacts and adjacent circuits.
- **Store the instrument in a dry environment**, away from sources of moisture. Like any electronic device, the LucchiMeter PRO does not tolerate prolonged exposure to high humidity, which can cause oxidation of the internal contacts.

No other particular precautions are required: normal ambient temperature, absence of strong mechanical vibrations and protection from dust — all easily guaranteed by the use of the supplied carrying case (see *Section 12.2*) — are conditions sufficient to preserve the instrument for long periods.

13. Technical Specifications

The following tables summarize the essential technical specifications of the LucchiMeter PRO. For the functional details of each parameter, please refer to the relevant chapters of the manual.

13.1 Physical Characteristics

Parameter	Value
Dimensions (width × height × depth)	173 × 98 × 48 mm
Depth without protruding BNC connectors	33 mm
Weight	325 g

13.2 Display

Parameter	Value
Type	Monochrome backlit LCD

13.3 Probes and Connections

Parameter	Value
Probes supplied	2 (1 flat and 1 pointed)
Probe connectors	2 × BNC (TX transmitter, RX receiver)
Power port	USB-C

13.4 Power Supply

Parameter	Value
Via USB-C port	5 V, minimum current 1000 mA
Via batteries	4 × AA 1.5 V (alkaline or NiMH)
Auto power-off	after 1 minute in OVER condition

13.5 Measurement

Parameter	Value
Time T resolution	0.1 microseconds
Maximum displayed Lucchi value	9999.9 m/sec
SET POWER range	20% – 100% (default 50%)
SET CORRECTION	exclusively positive (default 0.0%)

14. Troubleshooting

The table below collects the most common problems that may occur while using the LucchiMeter PRO, with the related probable causes and the corrective actions to take.

Power, supply and SET ZERO

Problem	Probable cause	What to do
The instrument does not turn on	Batteries discharged or not inserted	Replace the batteries or connect the USB-C adapter
	USB-C adapter not working	Verify the wall socket and the adapter specifications (5 V, ≥ 1000 mA)
The instrument switches off by itself after about 1 minute	Automatic power-off in OVER condition	Normal behavior (see *Chapter 4.4*)
	Batteries nearly discharged	Replace the batteries or use the USB-C adapter
“Bat” indication very low	Batteries nearly discharged	Replace the batteries
During SET ZERO “ERROR! REPEAT” appears	Probes moved during the procedure	Repeat keeping the probes still
	Inconsistent pressure	Apply a light and steady pressure
	Probe rubbers dirty	Clean the rubber surfaces and repeat

Measurement, probes and readings

Problem	Probable cause	What to do
"OVER" appears on the display	Probes not in contact with the sample	Reposition the probes
	LENGTH too small → Lucchi above 9999.9 m/sec	Correct the LENGTH value
	Measured time T equal to zero	Reposition the probes on the sample
Inconsistent or out-of-tolerance readings	Need to redo the SET ZERO	Repeat the SET ZERO (*Chapter 6.2*)
	Verification with the bar failed	See *Chapter 11.3*
A probe does not respond	BNC plug not locked correctly	Verify the bayonet lock (*Chapter 5.2*)
	Coaxial cable damaged	Replace with the spare cable supplied. If the problem persists, contact support
Lucchi value accompanied by asterisk (m/sec*)	SET CORRECTION active and not 0%	Verify the SET CORRECTION value (*Chapter 8.2*)

For any anomaly not resolved by this table, contact LucchiCremona support at the addresses listed in *Chapter 15 — Contact and Support.*

15. Contact and Support

For any technical assistance request, commercial information or report regarding the LucchiMeter PRO, you can contact LucchiCremona at the following addresses.

LucchiCremona
Via Stazione, 25
26100 Cremona — Italy

Landline phone — +39 0372 491193
Mobile phone *(also WhatsApp and Telegram)* — +39 338 820 53 55
Email — info@lucchimeter.com
Website — www.lucchimeter.com

LucchiMeter PRO

LUCCHI CREMONA

Via Stazione 25 — 26100 Cremona — Italy

Phone +39 0372 491193 · Mobile/WhatsApp +39 338 820 53 55

info@lucchimeter.com · www.lucchimeter.com