LucchiMeter BASIC

User Manual

LucchiCremona

Cremona — Italy

www.lucchimeter.com

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1. Introduction

Figure 1.1 — LucchiMeter BASIC 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 **LucchiMeter BASIC** measures the **propagation time** of the ultrasonic pulse through the material, expressed in microseconds. Knowing the length of the sample, the speed of sound in meters per second (m/sec) — the so-called **Lucchi value** — can then be calculated (see Chapter 7).

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 BASIC 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

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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

The **LucchiMeter BASIC** package contains the following items:

Figure 2.1 — Contents of the LucchiMeter BASIC package with components numbered 1-8

1. **LucchiMeter BASIC instrument**
2. **TX Flat Probe** — flat-surface transmitter
3. **RX Exponential Probe** — receiver with conical profile
4. **BNC Cables** — set of 3 identical and interchangeable cables for connecting the probes (2 are needed for use, the third is provided as a spare)

5. **Transparent plexiglass verification bar** — used to verify the correct operation of the instrument after the SET ZERO procedure (see *Chapter 11 — Verification Bar*)
6. **Universal 100-240V power supply** (auto-switching), with EU plug, two USB-C/USB-A outputs and a US plug adapter
7. **USB-C cable** for connecting the power supply 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 and MIN/MAX Values Sheet**, which lists the main physical quantities involved in the measurement of materials and the reference values for the most common types of wood 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*.
- Upon first use, it is recommended to verify the presence of all the items listed above. In case of missing or damaged components, contact technical 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 BASIC**, so that the user can become familiar with the instrument before moving on to its practical use.

Figure 3.1 — LucchiMeter BASIC — 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 **keypad** with the three operating keys
- The **two BNC connectors** for connecting the probes: **TX** (*transmitter probe*) and **RX** (*receiver probe*)

3.2 Display

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

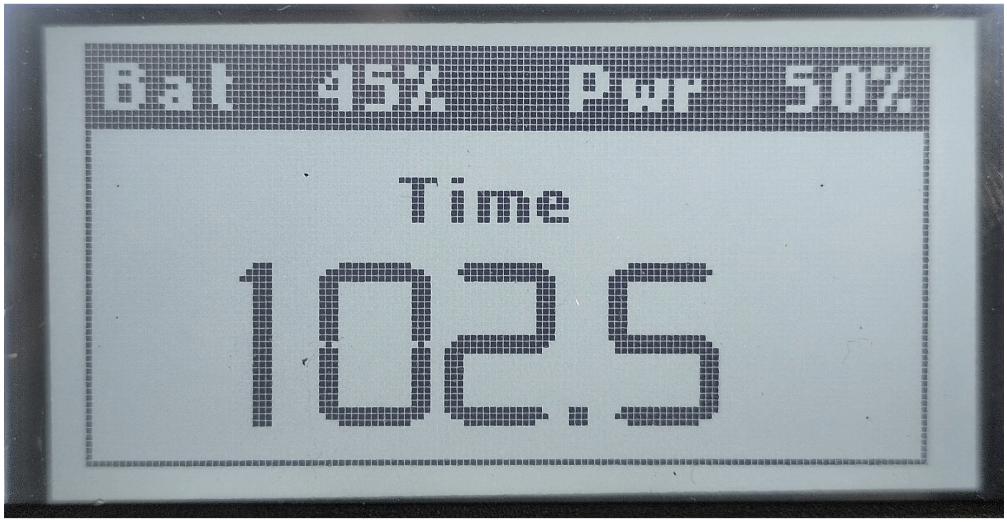

Figure 3.2 — LCD display of the LucchiMeter BASIC during a measurement, showing Bat, Pwr and Time in microseconds

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

- **Bat** — percentage of remaining battery charge. When the instrument is powered via the USB-C port, this indication is not significant and should be ignored.
- **Pwr** — power level of the signal emitted by the **TX** (transmitter) probe, user-adjustable (see *Chapter 8 — Advanced Settings*)
- **Time** — propagation time of the pulse, expressed in microseconds

When the signal is not detected by the RX probe (probes not in contact with the sample or signal too weak), the indication **OVER** is shown in place of the numeric value.

3.3 The Three Keys

The keypad located below the display includes **three keys**: a central button and two keys arranged one above and one below:

- **ZERO / ON-OFF** *(central button, symbol ⏻)* — When the instrument is off, a short press turns it on. To switch it off, press and hold until it shuts down completely. With the instrument on, a short press starts the **SET ZERO** procedure (see *Chapter 6 — SET ZERO Procedure*).
- **UP** *(top key, arrow ▲)* — pressing it **increases** the value of **POWER** (power of the pulse emitted by the TX probe). The current value is visible in the

Pwr bar at the top of the display and updates in real time (see *Chapter 8 — Advanced Settings*).

- **DOWN** *(bottom key, arrow ▾)* — pressing it **decreases** the value of **POWER**, with the same behavior as the UP key in the opposite direction.

With each single press of **UP** or **DOWN**, the POWER value changes by one unit, while keeping the key pressed makes the variation continuous.

3.4 Probe Connectors

In the lower part of the front panel are the **two BNC connectors** for connecting the probes:

- **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 silk-screened above each one. The instrument operates correctly even when the two probes are swapped, but for the best measurement result it is preferable to connect to the **TX** port the **flat and wide** probe, which generates a wider transmission beam, and to the **RX** port the **pointed** probe, which offers a more precise and localized reception point. For details about the supplied cables and probes, see *Chapter 5 — Connecting the Probes*.

3.5 USB-C Port

On the top side of the instrument there is a **USB-C port** dedicated exclusively to powering the device via the supplied power adapter or any other USB-C power adapter providing 5 Volts and a minimum of 1000 mA.

> **Note:** the USB-C port **does not charge** any AA batteries inserted in the battery compartment. The two power supply 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 power supply modes of the **LucchiMeter BASIC** — via **USB-C** port or via **4 AA batteries** — and the instrument's power-on and power-off procedures. The two power supply modes use completely separate circuits: the USB-C power adapter does not charge the AA batteries.

4.1 USB-C Power Supply

On the top side of the instrument there is a **USB-C** port dedicated to external power supply. Simply connect the supplied power adapter to this port and plug the adapter into a power outlet: the instrument is immediately ready for use.

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

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

4.2 AA Battery Power Supply

As an alternative to the USB-C power adapter, the instrument can be powered by **4 AA 1.5 V batteries** inserted in the dedicated battery compartment. The batteries can be of the **alkaline** type (disposable) 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 top-left of the display shows the **Bat** indication followed by the percentage of remaining charge (see *Chapter 3.2 — Display*). It is recommended to replace or recharge the batteries when the value drops below **20%**, to avoid imprecise readings due to insufficient voltage.

4.3 Separate Circuits: No Charging via USB-C

The two power supply modes of the LucchiMeter BASIC — 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 charged 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 power adapter while the instrument already has batteries inserted — of any type, alkaline or rechargeable — does not cause any problem or risk of damage.

4.4 Turning On and Off

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

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

The instrument has an **auto power-off** function that preserves its autonomy when not actively used. If for **1 consecutive minute** the probes do not detect any pulse — a condition in which the display shows the indication **OVER** (see *Chapter 3.2 — Display*) — the LucchiMeter turns off automatically. As long as the probes remain correctly positioned on the sample and receive the pulse, the instrument stays on with no time limit.

5. Connecting the Probes

The LucchiMeter BASIC is supplied with two probes — one with a **flat and wide contact** and one with a **pointed tip** — connected to the instrument via 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 are available.

5.1 Identifying TX and RX

The two BNC connectors on the front panel of the instrument are identified by the silk-screened markings **TX** (transmitter probe, on the left) and **RX** (receiver probe, on the right). The supplied probes do not bear any marking, as they can be connected interchangeably to either connector.

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

5.2 Connection Procedure

The connection and disconnection of the probes can be carried out interchangeably with the instrument on or off. To connect each probe:

1. Align the BNC plug of the probe cable with the corresponding connector on the instrument, making the two side grooves of the plug coincide with the two pins of the connector.
2. Gently push the plug against the connector.
3. Rotate the outer sleeve of the plug about 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 a quarter turn counter-clockwise and pull the plug out of the connector.

> **Important:** during connection and disconnection, **always operate only on the metallic sleeve** of the BNC plug. **Never pull the coaxial cable of the probe under any circumstances**: this operation can cause the internal detachment of the conductors 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 with the LucchiMeter BASIC two probes of different types, chosen to offer the user maximum flexibility in the most common measurements:

- **Flat and wide contact probe** — rests on the sample with an extended surface, generating a wide transmission beam. It is the type usually connected to the **TX** connector, where broad-spectrum coverage helps to irradiate the sample with ultrasonic pulses.
- **Pointed probe** — concentrates the 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 for accurate evaluation of the pulse arrival time.

Both probes are physically interchangeable and can be connected to either connector (TX or RX); in case of 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 the type of measurement intended.

6. SET ZERO Procedure

Before being able to perform accurate measurements with the LucchiMeter BASIC, the **SET ZERO** procedure must be carried out, 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 to do at the beginning of each measurement session.

6.1 Purpose of the SET ZERO

The **SET ZERO** procedure has the purpose of compensating for the ultrasonic pulse propagation delays 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;
- **whenever the probes are replaced** (or even just one of them).

The zero setting is **stored in the instrument** even after switching off, so it is not necessary to repeat it at every power-on. However, before starting a measurement session, it is good practice to perform two quick checks:

1. **Zero check**: bring the two probes together as for the SET ZERO procedure; if the display reads **0 microsec** (or a value very close to zero), it means the stored zero is still correct.
2. **Plexiglass verification bar check**: rest the probes on the supplied reference bar and verify the two time measurements reported on the bar itself — **5 microsec** measuring the width and **40 microsec** measuring the length (see *Chapter 11 — Verification Bar*).

If both checks are positive, the instrument is ready to perform 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 **one against the other**, placing the **flat rubber surface** of one probe in contact with the **rubber tip** of the other.
2. Apply a **light, firm and stable pressure**, keeping the two probes aligned. This pressure must be the same that will then be applied to the probes during each measurement on the sample (see note on pressure below).
3. Briefly press the central **ZERO / ON-OFF** key on the keypad.
4. The display shows the indication **SET ZERO Wait** (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.

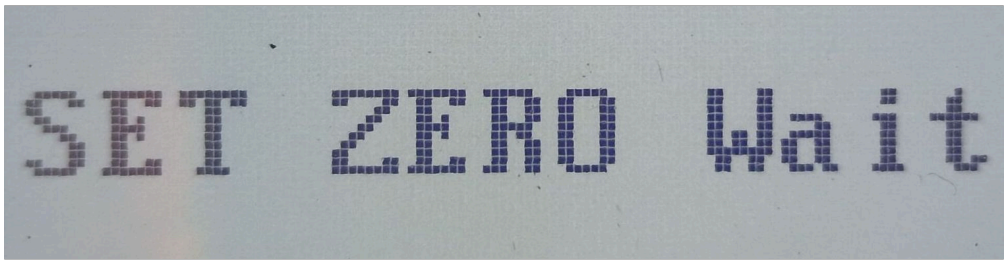

Figure 6.1 — SET ZERO Wait — procedure in progress, keep probes still and under pressure

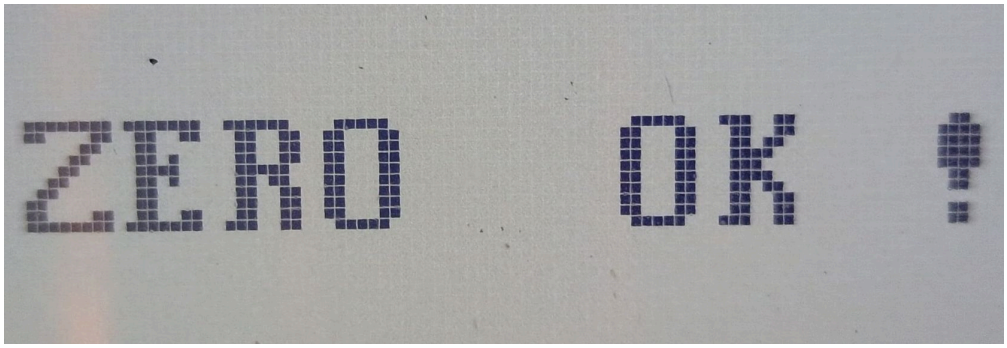

Figure 6.2 — ZERO OK! — zeroing completed successfully

> **Note on probe pressure:** the pressure applied to the probes directly influences the propagation time measured. The coupling rubber, deforming, reduces the thickness interposed between probe and material, shortening the pulse path 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 is the zeroing consistent with the actual measurement conditions.

6.3 Errors During the Procedure

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

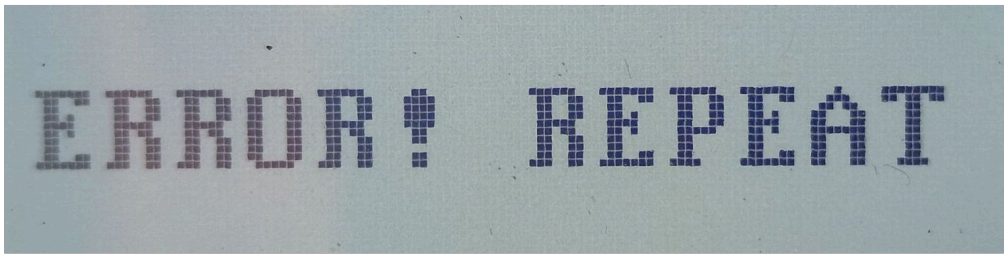

Figure 6.3 — ERROR! REPEAT — instability detected during the SET ZERO procedure

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

- keeping the two probes **perfectly still** for the entire duration of the **SET ZERO Wait** screen;
- applying a **constant pressure**, not variable even minimally, throughout the entire procedure;
- verifying that the **rubber** surfaces of the probes are clean and in full contact with each other, without any interposition of dust, wood residue or other foreign bodies.

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

7. Taking a Measurement

Once the SET ZERO has been performed (see *Chapter 6*) and the probes correctly connected, the instrument is ready for measurements. The LucchiMeter BASIC measures the **time T** that the ultrasonic pulse takes to travel through the sample (in microseconds). Knowing the **length of the sample** (in millimeters), the **Lucchi value** in meters per second can then be manually calculated.

7.1 Measuring the Length of the Sample

Before each measurement it is necessary to know the **length of the sample** in millimeters, that is, the distance between the two points where the probes will be placed. Use a ruler, a tape measure or a caliper to measure this distance and note the value: it will be needed in the final step of calculating the Lucchi value (see *Section 7.4*).

7.2 Positioning the Probes

To perform the measurement on a wood sample:

1. Rest the **two probes** on the two ends of the sample, at the points between which the propagation of sound is to be measured.
2. Apply a **constant pressure** on the probes, equal to the one applied during the SET ZERO procedure (see *Chapter 6.2 — Note on probe pressure*). A different pressure would alter the measured times and would 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 read values will be with each other.
4. Read the **Time** value (in microseconds) directly on the display.

During the measurement it is normal to **manually refine the position of the probes** on the surface of the sample, looking for the right inclination, until identifying the **optimal contact point**. This point corresponds to the **minimum Time (microseconds)** reading: at equal length, a shorter propagation time indicates a “cleaner” acoustic path and therefore a more accurate measurement.

Wide samples. When the sample has a significant width compared to the contact point of the probes, it is possible to take multiple measurements by moving the entire pair of probes along the width — typically at the center and near the two edges. During these movements it is essential that the two probes always remain **aligned on the same straight line**, that is, on the shortest line joining the two opposite contact points, so that the measured distance coincides with the sample length. Being a naturally inhomogeneous material, it is completely normal that different longitudinal measurements on the same sample return different Time values: this variability reflects the internal structure of the wood and does not constitute an inaccuracy of the instrument.

The instrument does not store the read value: **moving the probes away from the sample makes the reading lost immediately**. To record the result, it is necessary to note it manually before detaching the probes.

7.3 Interpreting the Display During Measurement

During the measurement the display shows simultaneously the parameters described in *Chapter 3.2 — Display*: the battery charge state (**Bat**), the pulse power level (**Pwr**) and the propagation time in microseconds (**Time**).

The **Time value** represents the data directly provided by the instrument. In practice it is then used to derive the **Lucchi value** of the sample by applying the formula described in the next section.

The OVER Indication

The indication **OVER** can appear in place of the numeric Time value when the signal is not detected by the RX probe: typically because the probes are not in contact with the sample, or because the contact is insufficient for the instrument to detect a stable ultrasonic pulse.

In these cases it is sufficient to reposition the probes correctly on the sample until a stable numeric reading is restored.

7.4 Calculating the Lucchi Value

Once the **Time** value (microseconds) read on the display and the **sample length** (millimeters) measured in *Section 7.1* have been noted, the Lucchi value is obtained with the formula:

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

Example. On a sample 600 mm long, the instrument reads a Time of 120 microsec. The Lucchi value is:

> 600 / 120 × 1000 = **5000 m/sec**

The number obtained is the Lucchi value of the sample: the speed of sound propagation in the wood, expressed in meters per second. In violin making, commercial or research practice this number is then compared with reference values to evaluate the acoustic quality of the material (see *Chapter 9 — Understanding the Lucchi Value*).

8. Advanced Settings

The LucchiMeter BASIC allows the user to adjust an optional parameter that adapts the instrument to particular measurement conditions: the ultrasonic pulse power (**SET POWER**). This chapter also describes three practical situations in which the calculated Lucchi value can be refined by manually applying a percentage correction factor, to obtain a value more representative of the actual acoustic quality of the wood.

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, press the **UP** ▲ or **DOWN** ▼ keys directly from the measurement screen: with each press the POWER value increases (UP) or decreases (DOWN) by one unit, while keeping the key pressed makes the variation continuous. The current value is always visible in the **Pwr** bar at the top of the display and updates in real time (see *Chapter 3.2 — Display*). The setting is **stored even after the instrument is switched off** and remains active until a subsequent modification.

The POWER value is adjustable in the **20% – 100%** range. 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 modify the power

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

8.2 Manual Corrections to the Calculation of the Lucchi Value

In general, every operation of **cutting or drilling** carried out on a wood sample tends to **decrease** the Lucchi value read, with a reduction that is more marked the larger the holes or notches are with respect to the volume of the piece. In the same way, the level of **moisture** of the wood also affects the measurement: freshly cut wood provides lower readings than the same wood once seasoned.

It is important to underline 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 change, along with the ultrasonic path between the probes.

It is possible to compensate for these known variations by manually applying a **percentage correction factor** to the calculated Lucchi value (see *Chapter 7.4*). The formula becomes:

> **Corrected Lucchi (m/sec) = (mm / microsec) × 1000 × (1 + corr. / 100)**

The following sections illustrate three typical use cases in which this correction proves useful.

8.2.1 Compensating for Wood Moisture

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

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

Starting from this relationship, the **final** Lucchi value of a still-fresh piece can be estimated. 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 relationship "1% moisture less = 1% Lucchi more", the predicted final Lucchi value will be approximately **X + 30%**.

The same reasoning can be applied directly at the measurement stage by applying a manual correction of **+30%** to the calculated Lucchi value. If the fresh piece measured returns for example a calculated Lucchi value of 4200 m/sec, the estimated value after seasoning will be:

> 4200 × (1 + 30 / 100) = 4200 × 1.30 ≈ **5460 m/sec**

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

8.2.2 Compensating for Cuts and Holes in Finished Bows

During the manufacturing of the bow, **two holes** are made in the stick: the one for the **button** and the **mortise**, a rectangular-section hole intended to house the frog joint. By measuring the same piece of wood with the LucchiMeter BASIC **before** and **after** these operations, the Lucchi value turns out **systematically lower** than the one recorded on the intact wood, even though the wood is physically the same. The cause is purely geometric: the interruption of the fibers in correspondence with the holes modifies 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 a correction factor of appropriate magnitude to the calculated Lucchi value. The average values observed in standard bow production are the following:

Bow type	Correction
Violin bow	**2.2%**
Viola bow	**2.3%**
Cello bow	**2.6%**
Double bass bow	**3.6%**

Practical example: if measuring a finished violin bow one calculates a Lucchi value of **5380 m/sec**, applying a correction of **2.2%** gives the estimated value of the original wood before processing:

> $5380 \times (1 + 2.2 / 100) = 5380 \times 1.022 \approx$ **5500 m/sec**

These values derive from the observation of a large number of bows and are valid for the vast majority of cases, including antique bows. Bow makers can however **refine their own table** by measuring the wood before and after processing and deriving the specific correction factor for the dimensions of mortise and hole made on their own pieces.

8.2.3 Compensating for F-holes 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 to the one recorded on the intact wood, before the cutting of the F-holes.

To **trace back to the original Lucchi value** of the wood of an already worked soundboard, it is possible to apply to the calculated Lucchi value a correction factor of typically higher magnitude than that of the bows, since the F-holes interrupt a greater quantity of fibers. Experience indicates that applying to the calculated Lucchi value a correction of about **+8%** returns a value close to the original one of the wood before the cutting of the F-holes.

Being a less consolidated figure compared to that of the bows — and depending on the shape and size of the F-holes actually made by the individual violin maker — it is advised, 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 correction value most suited to their own work.

9. Understanding the Lucchi Value

Once it is clear how to perform a measurement and how to manage the instrument settings, what remains is to understand the meaning of the **Lucchi value** obtained (see *Chapter 7*), expressed in meters per second. This chapter describes what this quantity physically represents, how to read it qualitatively and what reference ranges have been observed for 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 it takes to cover 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 in relation to its density, the more rapidly the mechanical wave propagates through it. This is the physical principle by which the Lucchi value is now internationally recognized as an **objective indicator of the acoustic quality of wood** intended for the construction of musical instruments.

The measurement with the LucchiMeter BASIC always provides the speed **along the direction of alignment of the probes** on the sample: depending on how these are positioned, the same instrument can provide both the **longitudinal speed** — with probes aligned parallel to the direction of the fibers — and the **transverse speed** — with probes aligned perpendicularly. For two-dimensional shape samples such as violin soundboards, the complete characterization of the wood requires both measurements: longitudinal and transverse values can differ greatly, and in the world of violin making 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 a wood in which the mechanical wave propagates quickly: that is, a material with a good ratio between rigidity and elasticity on one side and lightness on the other. These are the typical characteristics of woods considered "musically prized": better sound transmission, greater responsiveness, richer harmonic presence.

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

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

Moreover, as recalled in *Chapter 7.2*, wood is a **naturally inhomogeneous material**: measurements taken at different points of the same piece can return different values. This variability does not constitute an inaccuracy of the instrument, but rather additional information about the internal structure of the material.

9.3 Typical Reference Values

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

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

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, for its specific use destination in the construction of bows, is the species on which LucchiCremona has matured the deepest experience. The following Lucchi value thresholds describe the quality levels typically associated with bow sticks:

- **Below 5000 m/sec** — not usable to produce bows of acceptable quality.
- **5000 – 5200 m/sec** — soft bows, lacking strength and elasticity, with dull sound. Typically used for first-level study bows.
- **5200 – 5500 m/sec** — medium-good bows, with decent responsiveness and more present sound, although still muted. Typically used for good-level study bows.
- **Above 5500 m/sec** — pernambuco becomes a sought-after material with increasing price. The bows produced with this wood present a brilliant sound, rich in harmonics, snappy: optimal characteristics for virtuosity and rapid bow strokes. These are the bows intended for professional concert use or for top-level study instruments.
- **Towards 6000 m/sec** — values rarely found, in which all the acoustic and mechanical characteristics reach their maximum.

A Note on Soundboard Evaluation

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

10. Applications

The LucchiMeter BASIC is used in many areas of the musical wood supply chain, from the selection of raw material to the control of manufacturing processes, up to the evaluation of finished instruments — including historical ones. This chapter presents an essential overview of the most common use contexts, without claim of exhaustiveness: 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 BASIC is the **qualitative selection** of wood intended for the construction of musical instruments. By measuring a certain number of samples of the same species, the violin maker or the bow maker can compare the Lucchi values and objectively identify the pieces with the best acoustic characteristics, integrating the instrumental figure with their own sensory evaluation.

In **wood trading**, the Lucchi value has by now entered sales price lists as an **objective criterion for price differentiation**. The most evident example is the Pernambuco bow wood market: a stick at 5000 m/sec costs in 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 in the order of 1000 dollars. The price difference directly reflects the acoustic quality difference ascertained by the instrument, regardless of subjective evaluations.

10.2 Verifying the Effects of Machining and Treatments

The LucchiMeter BASIC allows to **objectively evaluate the impact** that the various phases of processing or treatment of the wood produce on its acoustic characteristics. The typical procedure consists in measuring the same sample **before and after** each operation, recording any variation in the Lucchi value.

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

- **Thermal treatments** — verification of any Lucchi value changes induced by forced drying or thermo-treatment cycles.

- **Varnishing and impregnation** — control of the effect of surface finishes on the acoustic response of the wood.
- **Gluing** — measurement of wood behavior once coupled with 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 each operator to build over time a **documented empirical knowledge** of their own processes: an objective basis on which to calibrate their own production choices.

10.3 Evaluation of Finished Instruments

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

By manually applying to the calculated Lucchi value the **correction factors** indicated for the different types of instrument, it is possible to trace back to the **original Lucchi value** of the wood used — information of great usefulness in the purchase phase, in commercial evaluation or in comparison between different instruments. For the details of the correction factors and the procedure, see *Chapter 8.2.2 — Compensating for Cuts and Holes in Finished Bows* and *Chapter 8.2.3 — Compensating for F-holes in Finished Violins*.

10.4 Cataloguing and Research on Antique Instruments

The **non-destructive** characteristic of the measurement makes the LucchiMeter BASIC particularly suited to the study and cataloguing of **historical and valuable instruments**, where any form of invasive intervention is obviously excluded. The probes simply resting on the surface of the wood allow to acquire an objective figure on the acoustic characteristics of the instrument 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 own cataloguing forms, alongside traditional historical, constructional and dimensional information. The inclusion of the Lucchi value in archive records constitutes a precious reference both for comparative studies on the woods used in the various eras and by the various violin makers, and for monitoring over time the possible evolution of the acoustic characteristics of preserved instruments.

11. Verification Bar

To verify at any moment that the LucchiMeter BASIC is returning consistent readings, the instrument is supplied with a small **plexiglass verification bar** that reports two reference propagation time values. It is worth reiterating that this is a **verification bar, not a 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 pair of probes connected. The bar instead serves to confirm afterwards that the stored zero is still valid and that the readings fall within the expected neighborhood.

11.1 Characteristics of the Bar

The bar is made of **plexiglass** — material chosen for the stability of its properties over time and in relation to temperature — and reports silk-screened directly on its surface the two time values that the instrument must return when the probes are rested on one of its two working sides:

- **5 microsec** measuring the **width** of the bar
- **40 microsec** 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 performed without need for further parameters.

11.2 Verifying the Instrument with the Bar

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

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

3. **Bar length measurement** — rest the probes on the two ends of the bar on its long side. The display must indicate **T ≈ 40 microsec**.

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

Allowed tolerance. For all three readings, a deviation of about **± 0.5 microsec** 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 microsec tolerance), proceed in order:

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

11.4 Tip: Personal Verification Stick for Long Measurements

The plexiglass bar supplied with the instrument allows to verify the consistency of the instrument only in the time interval typical of short measurements. When measurements are routinely carried out on samples of greater length — indicatively **over 50 cm** — it can be useful to create one's own **personal verification stick** of adequate length, to be used as an additional reference.

The procedure is simple:

1. Procure a **stick** of any material (wood, plexiglass, rigid plastic) sufficiently long with respect to one's typical uses.

2. Once the LucchiMeter BASIC 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. **Note the T value read** 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 the personal stick with the initially noted value: if the reading falls within a **neighborhood of ±0.5 microsec** of the reference value, the instrument is to be considered reliable also for measurements of similar length.

12. Maintenance and Storage

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

12.1 Cleaning the Instrument and the Probes

For ordinary cleaning of the body of the LucchiMeter BASIC and of the probes, a **soft dry cloth** is sufficient, possibly **slightly dampened with water**. The cloth serves to remove dust, wood residues 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 silk-screened markings on the front panel, the coupling rubbers of the probes and — in case of solvents penetrating through the openings — the internal electronic components.

12.2 Carrying Case

The LucchiMeter BASIC is supplied with a **soft carrying case** equipped with **dedicated compartments** for the safe transport of all the instrument components: the main 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** when moving the instrument, placing each component in the provided compartment. This precaution protects in particular the BNC connectors of the probes and the coaxial cables, which remain sheltered from accidental impacts and from excessive twisting or bending 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 disuse** of the instrument — indicatively over 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, present electrolyte liquid leaks that irreversibly damage the electrical contacts and adjacent circuits.
- **Store the instrument in a dry environment**, away from sources of moisture. Like all electronic equipment, the LucchiMeter BASIC does not tolerate well 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 — easily guaranteed by the use of the supplied carrying case (see *Section 12.2*) — are sufficient conditions to preserve the instrument for long periods.

13. Technical Specifications

The tables that follow summarize the essential technical specifications of the LucchiMeter BASIC. For the functional details of each parameter, refer to the 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	Backlit monochrome 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 microsec
SET POWER range	20% – 100% (default 50%)

14. Troubleshooting

The following table collects the most common problems that may occur during the use of the LucchiMeter BASIC, with their probable causes and the corrective actions to be taken.

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 power adapter
	Faulty USB-C power adapter	Verify the power outlet and the specifications of the adapter (5 V, ≥ 1000 mA)
The instrument turns off by itself after about 1 minute	Automatic power-off in OVER condition	Normal behavior (see *Chapter 4.4*)
	Batteries almost discharged	Replace the batteries or use the USB-C power adapter
“Bat” indication very low	Batteries almost discharged	Replace the batteries
During SET ZERO “ERROR! REPEAT” appears	Probes moved during the procedure	Repeat keeping the probes still
	Pressure not constant	Apply a light and stable pressure
	Probe rubbers dirty	Clean the rubber surfaces and repeat

Measurement, probes and readings

Problem	Probable cause	What to do
The display shows “OVER”	Probes not in contact with the sample	Reposition the probes
	Time T measured equal to zero	Reposition the probes on the sample
Inconsistent readings or out of tolerance	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 correctly locked	Check the bayonet click (*Chapter 5.2*)
	Coaxial cable damaged	Replace with the spare cable supplied. If the problem persists, contact support

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

15. Contact and Support

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

LucchiCremona
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26100 Cremona — Italy

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