USER MANUAL

RastreCurve 2Plus

Fault tracer based on Analog Signature Analysis (Curve Tracer)



Figure 1 – RastreCurve 2Plus and the accessories supplied with the equipment

RastreCurve 2Plus software – reference version 1.9902

RastreCurve Indústria de Equipamentos Eletrônicos Ltda • www.rastrecurve.com
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1. Introduction

The **RastreCurve 2Plus** is a fault locator and tracer for electronic boards and modules, also known as an **analog signature analyzer** (ASA – Analog Signature Analysis) or **Curve Tracer**. It combines the functions of a signal generator and an XY oscilloscope in a single USB module, making it possible to diagnose boards **without powering them** and, in most cases, **without a schematic or boardview**.

In short: the equipment injects a low-energy alternating signal into a point of the **powered-off** board, measures the resulting voltage and current and draws the **VI curve** – the "signature" of that point. By comparing the signature of a faulty board with that of a good board (physical or stored), the fault shows up as a difference in the drawing. The complete theory is in **chapter 2**.

1.1 What the 2Plus offers

- Real-time comparison with **2 channels** (good board × faulty board) and **2 Channels FULL** mode (two technicians working at the same time).
- **Comparison with memory**: projects ("virtual boards") with a photo of the board, visual marking of components and curves stored pin by pin.
- **4 power profiles** for testing and for storing: Low, Normal, Automatic and Maximum.
- Special tests: **Impedance**, **Saturation**, **3D (4 profiles)**, **Switching** (3 points) and **Pulse** (yellow channel).
- Adjustable comparison tolerance, bad-pin report and file protection against editing.
- Free access to the **Curve Cloud** (more than 1,100 projects shared by the community) and opening of curves from the 10 Vpp and 20 Vpp models.
- Lifetime software license for Windows; comparison mode also on Linux, macOS and Android (via USB/OTG). Languages: Portuguese, Spanish, English, Italian, French and Slovak.

1.2 2Plus and Lite: what is different

In the principle of **curve comparison** the two models are identical: compare one circuit with another – if the curves match, the circuit is OK; if they do not, there is a fault. It is painstaking, step-by-step work, but very rewarding. The **2Plus** stands out for its extra tests, which make it possible to test active components directly on the board.

Function	2Plus	Lite
Power profiles for testing	4	4
Power profiles when storing	4	1
Test channels / pulse channel	2 / 1	2 / none
VI curves, 2-channel comparison, projects with photo, visual marking	Yes	Yes
Curve cloud, support and updates free of charge	Yes	Yes
Impedance test	Yes	Yes
Saturation, 3D (4 profiles), switching and pulse tests	Yes	No
Store saturation, 3D, impedance, switching and pulse tests	Yes	No
Curve protection with password and backup	Yes	No
Open and test curves from the 10 Vpp and 20 Vpp models	Yes	No

1.3 Where it can be used

On practically any electronic board: automotive (ECU, ABS, instrument clusters), industrial (inverters, PLC, CNC, soft-starters), home appliances and white goods, air conditioning and inverter units, TV and audio, computing (motherboards, notebooks, printers), telecommunications, medical and hospital equipment, agricultural, marine, aviation, scales, welding machines, among others.

2. How it works: the theory of signature analysis

This chapter explains **why** the RastreCurve finds faults without a schematic and without powering the board. Understanding the theory helps you choose the right profile, interpret the curves and avoid confusing a normal characteristic of the circuit with a fault.

2.1 The central idea: comparing signatures

Every point of a circuit has its own electrical behavior: it lets more or less current through, stores energy (capacitors and inductors) or only conducts above a certain voltage (diodes, transistor junctions, IC pins). When we apply a known signal and record **how that point responds**, we obtain a drawing that works like a **fingerprint** – the **analog signature** of the point.

- Two **identical, good** boards have the **same signature** at the same point.
- If a component in the net changes (burns, shorts, opens, loses capacitance, becomes leaky), **the drawing changes**.
- That is why you do not need to know how the circuit works: just compare point by point. It is painstaking, step-by-step work, but very rewarding – and once the good board has been stored, it never has to be done again.

2.2 The measuring circuit

Inside the RastreCurve there is a **sine-wave signal generator** connected to the test point through a **fixed 10 kΩ impedance**. The channel probe goes on the board point and the green lead on GND. The equipment measures **the voltage at the point (X axis)** and **the current (Y axis)**, which is calculated from the voltage drop across the 10 kΩ.

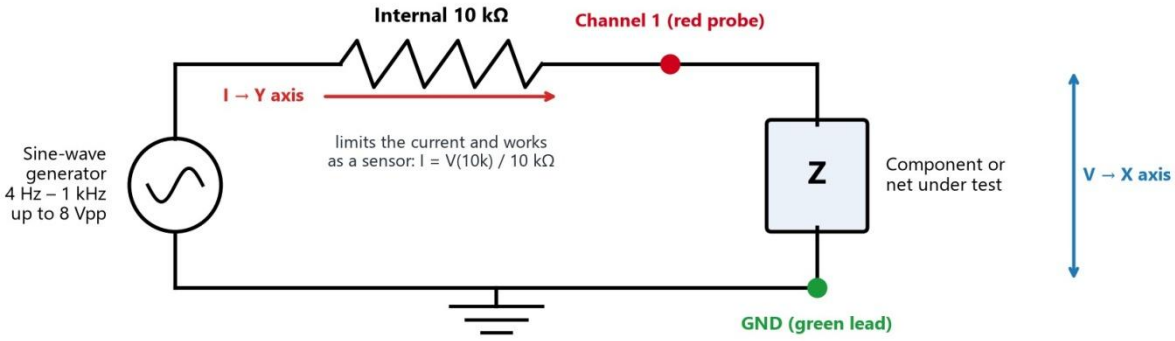


Figure 2 – Measuring circuit: generator, internal 10 kΩ and the component (Z) form a voltage divider

The 10 kΩ and the component form a **voltage divider**:

> **NOTE**
>
> **V(point) = Vgenerator × Z / (Z + 10 kΩ)**
>
> **I = Vgenerator / (Z + 10 kΩ)**
>
> The shape of the curve therefore depends on the relationship between the impedance of the point (Z) and the fixed 10 kΩ. The 10 kΩ also limits the current, protecting the circuit under test.

Impedance of the point (Z)	What happens in the divider	Resulting curve

Impedance of the point (Z)	What happens in the divider	Resulting curve
Z ≈ 0 (short)	Almost all the voltage drops across the 10 kΩ; the current is maximum and the voltage at the point is almost zero	**Vertical line**
Z = 10 kΩ	The voltage is split in half	Line tilted at ~45°
Very high Z (open)	Almost all the voltage stays at the point; current almost zero	**Horizontal line**
Reactive Z (C or L)	Voltage and current are shifted in time	Ellipse / spiral
Non-linear Z (diode, IC)	The impedance changes with the applied voltage	Curve with “knees”

2.3 From the sine wave to the drawing on the screen

In each cycle of the signal, the equipment records **more than 900 pairs of values (voltage, current)**. Each pair becomes a point on the XY graph – as on an oscilloscope in XY mode (Lissajous figure). The sequence of these points forms the curve. In the figure below, the colored dots show the same instant on the time graphs and on the VI curve: since in a capacitor the current **leads** the voltage, the drawing becomes an ellipse (here, a circle, because the reactance equals the 10 kΩ).

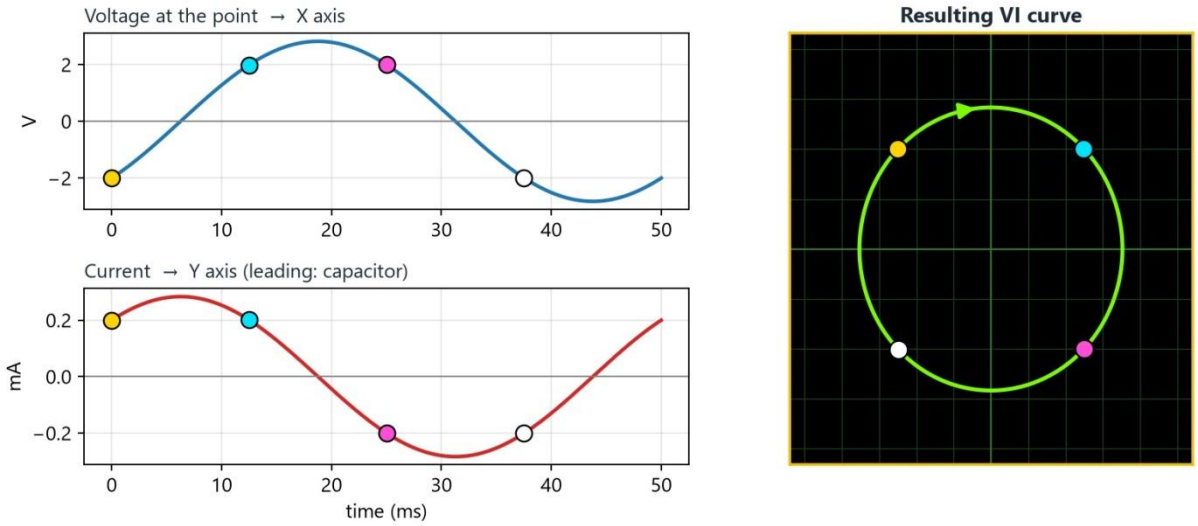


Figure 3 – The voltage (X axis) and the current (Y axis) over time form the VI curve

2.4 Resistance: the slope of the line

In a resistor, voltage and current are proportional and **in phase** (Ohm’s Law, V = R × I), so the curve is a **straight line**. The slope indicates the value: the **lower** the resistance, the more **vertical** (closer to a short); the **higher**, the more **horizontal** (closer to an open). With the internal 10 kΩ impedance, a 10 kΩ resistor sits at about 45°. Very low resistors look like a short and very high ones look open.

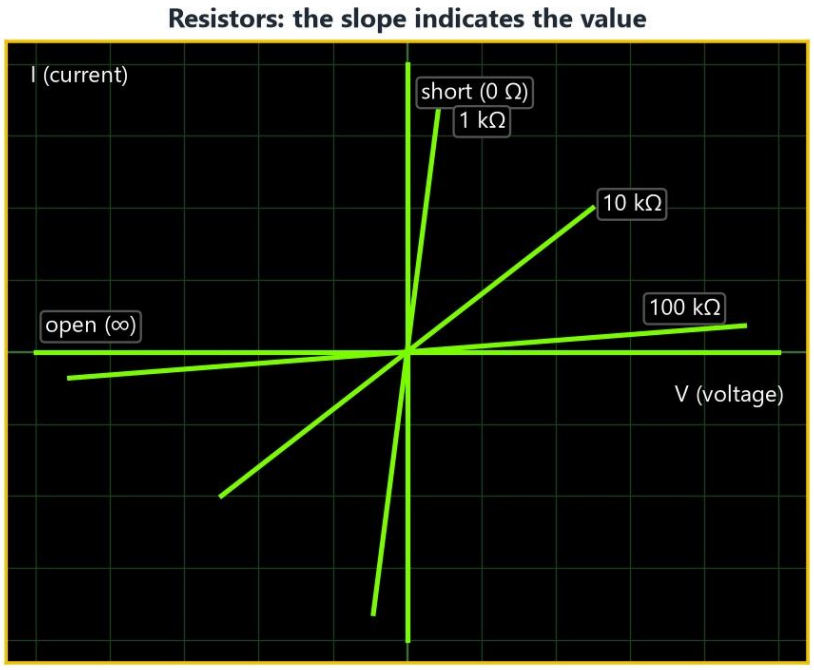


Figure 4 – Family of resistors: from short (vertical) to open (horizontal)

2.5 Reactance: capacitors, inductors and frequency

Capacitors and inductors **store energy**, so current and voltage are **out of phase** – the line opens into an **ellipse**. The "resistance" they offer is the **reactance**, which depends on frequency:

> **NOTE**
> Capacitor: **Xc = 1 / (2 × π × f × C)** – decreases as the frequency increases.
> Inductor: **XL = 2 × π × f × L** – increases as the frequency increases.

That is why **the same capacitor changes its drawing depending on the power profile**: at 4 Hz its reactance is high and it hardly interferes; at higher frequencies the reactance drops, the ellipse becomes vertical and the capacitor starts to "look like a short", dominating the curve of the point:

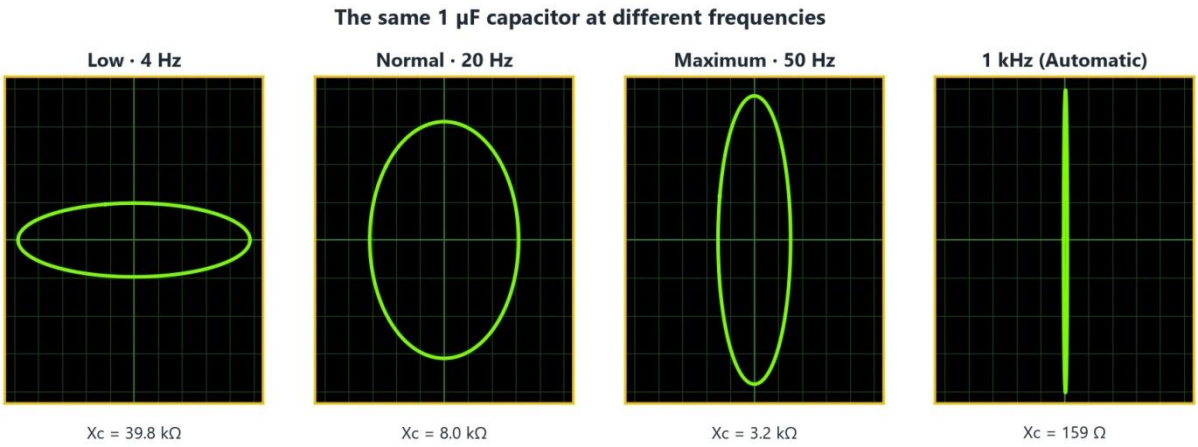


Figure 5 – A 1 µF capacitor seen at different frequencies

Capacitor	Low (4 Hz)	Normal (20 Hz)	Maximum (50 Hz)	1 kHz
100 nF	398 kΩ	80 kΩ	32 kΩ	1.6 kΩ
1 µF	39.8 kΩ	8.0 kΩ	3.2 kΩ	159 Ω

Capacitor	Low (4 Hz)	Normal (20 Hz)	Maximum (50 Hz)	1 kHz
10 µF	4.0 kΩ	796 Ω	318 Ω	16 Ω
100 µF	398 Ω	80 Ω	32 Ω	1,6 Ω

Rule of thumb: when the reactance becomes **much lower than 10 kΩ**, the capacitor dominates the point and hides the other components. That is why boards with large capacitors call for **Low Power** (chapter 8).

The direction of the spiral

Because the RastreCurve excitation is **pulsed** (section 2.7), the curve of a reactive component starts at the center and does not close perfectly: it forms a **spiral**. The direction of rotation identifies the component: **capacitor clockwise** (the current leads the voltage) and **inductor counterclockwise** (the current lags). The width of the spiral depends on the value of the component.

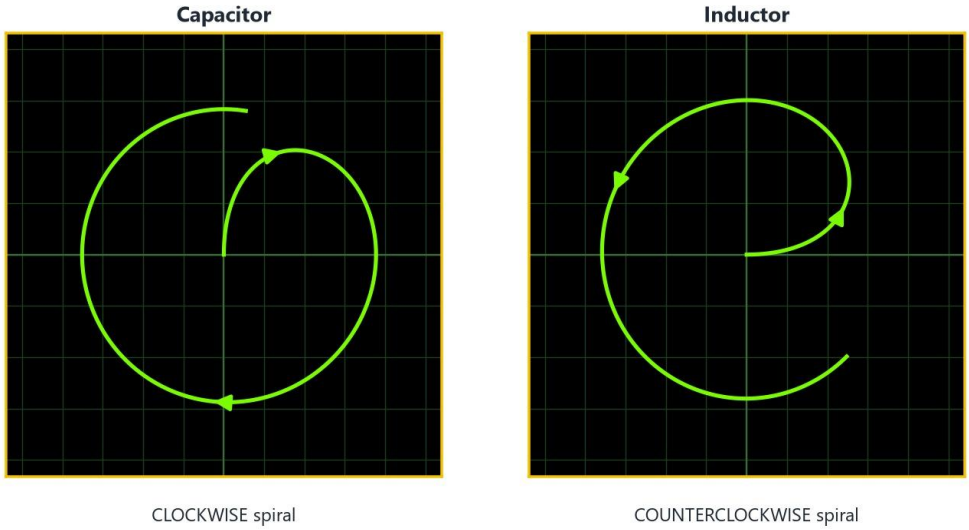


Figure 6 – Direction of rotation of the spiral: capacitor (clockwise) and inductor (counterclockwise)

2.6 Semiconductors: diodes, transistors and ICs

A **PN junction** (diode, base-emitter or base-collector of a transistor) practically does not conduct when reverse biased and starts conducting strongly above about **0.6 to 0.7 V** (silicon) when forward biased. The result is a curve with a **"knee"**: horizontal on one side (open) and vertical on the other (conducting). A **Zener** diode shows a second knee at the Zener voltage. **Integrated circuit pins** usually combine internal protection diodes with resistances, producing characteristic mixed shapes.

In the sheet below we have gathered the most common signatures – it is worth keeping it at hand on the bench:

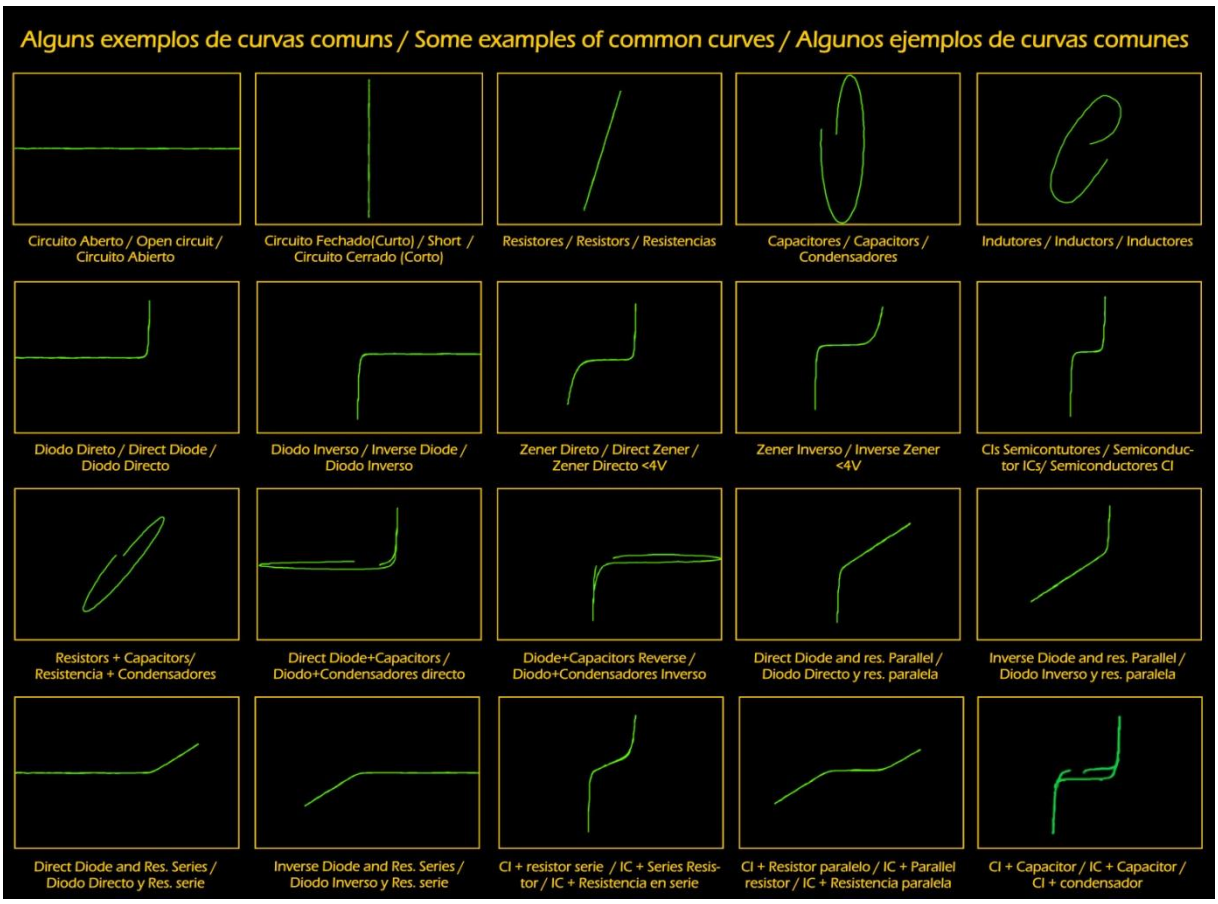


Figure 7 – Examples of common curves (RastreCurve reference sheet)

2.7 Pulsed excitation × continuous excitation

There are two excitation philosophies in signature analyzers:

- **Continuous** (used by instruments such as ABI and Huntron): the signal is applied non-stop; the circuit reaches steady state and the equipment captures an already stabilized cycle (about 100 samples per cycle). Capacitors and inductors appear as **closed ellipses**.
- **Pulsed** (RastreCurve): the signal is applied in **1.5 ms** pulses and each capture starts at the **beginning of the sine wave**. The acquisition includes the **transient response** – charging and discharging of capacitors, reaction of inductors. Capacitors and inductors appear as **spirals** whose direction identifies the component.



Figure 8 – Continuous signal (left) × pulsed signal, one cycle with a pause (right)

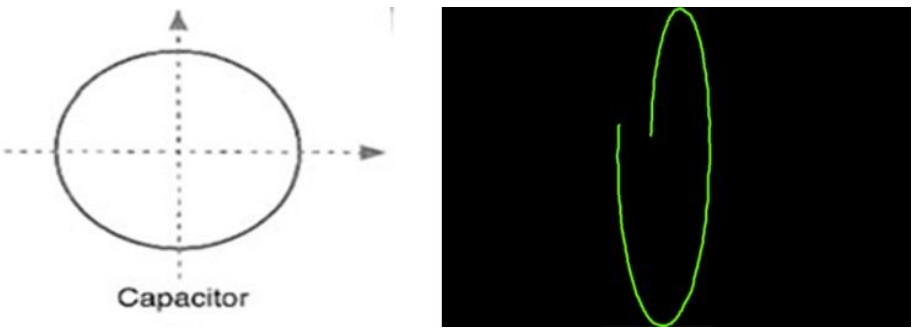


Figure 9 – Capacitor: ellipse with continuous excitation (left) and spiral with the RastreCurve pulsed excitation (right)

Characteristic	Continuous	Pulsed (RastreCurve)
Type of excitation	Continuous	Pulsed / restarted at each capture
Use of the transient	No (discarded)	Yes – it is a source of information
Typical shape of C and L	Ellipse	Spiral (direction indicates C or L)
Main information	Steady-state impedance	Transient response + impedance
Energy applied to the circuit	Continuous	Only for 1.5 ms – safe for CMOS, microcontrollers and sensors

The two methods are complementary. The pulsed method better reveals the **dynamic and reactive** behavior of components – useful for capacitors, inductors and dynamic faults – and applies less energy to the circuit.

2.8 The curve belongs to the net, not to the component

With the components soldered in place, the instrument measures **everything connected to the point**. The curve is the sum of the behaviors: a diode alone shows the typical knee; with a resistor in parallel, the "open" part tilts; with a capacitor in parallel, a spiral appears that may hide the diode.

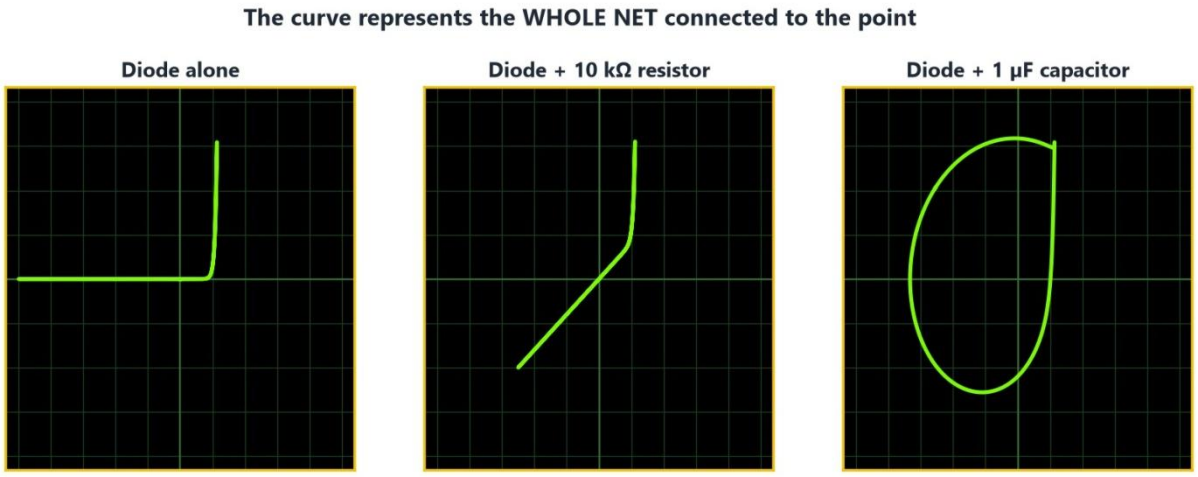


Figure 10 – The same diode with different components connected in parallel

- That is why the **same component in different circuits** has different curves – always compare the **same point** on identical boards.
- A shorted capacitor makes **all points on the same line** show a short. To find the culprit, **isolate sections** (remove a series diode or the suspect IC) and measure again.

2.9 Why there are power profiles

Each profile changes the **frequency** and the **amplitude** of the signal. The frequency controls how much capacitors and inductors interfere (section 2.5); the amplitude controls how much of the semiconductor junctions is "explored" (8 Vpp bias the junctions well beyond the knee; 4 Vpp protect low-voltage circuits). See how a diode with a 4.7 µF capacitor in parallel appears in each profile – only at Low Power is the diode still recognizable:

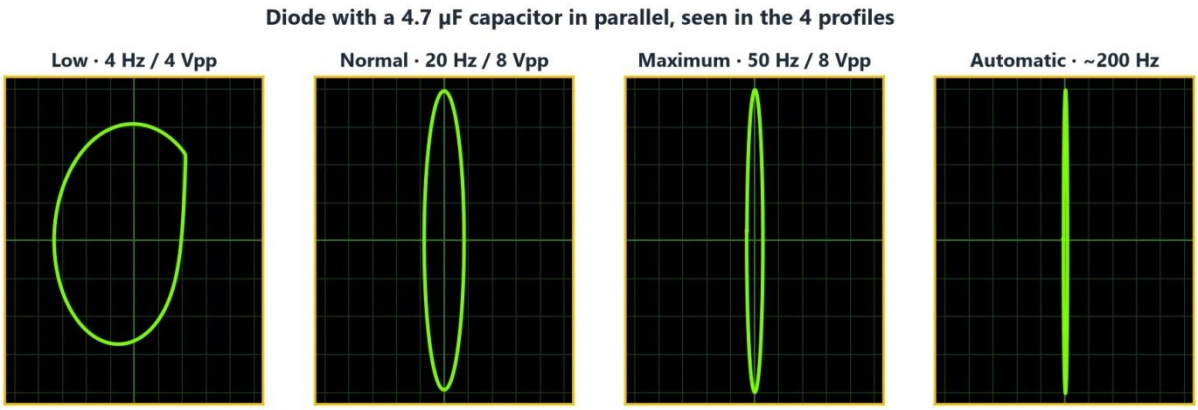


Figure 11 – The same point seen in the 4 power profiles

Detailed selection rules are in **chapter 8**.

2.10 How the software compares and calculates the difference

In a comparison, the reference curve (memory or good board) and the measured curve are drawn together. The software compares the more than 900 samples of the two curves and calculates a **percentage difference index** from the area between them. If the value exceeds the **tolerance** (2% to 20%, default 5%), the result turns red with a thumbs-down.

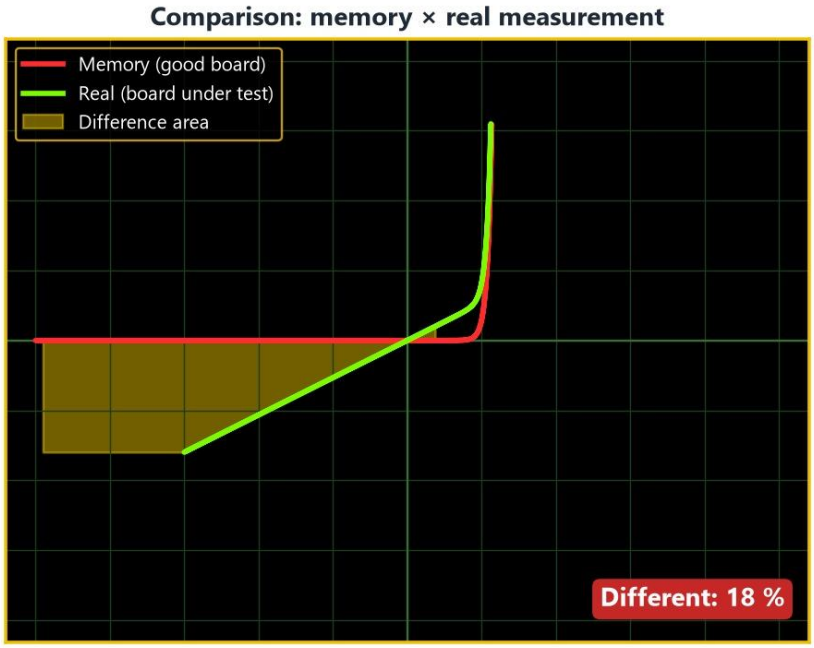


Figure 12 – Memory curve (red), real curve (green) and the difference area

> **TIP**
>
> **The shape of the curve is the most important information**; the number is supporting information. Small error values do not necessarily indicate a fault, and small differences **in the central part** of the curve deserve attention. Differences only in the left part (reverse bias) are usually tolerable.

Real example: a small difference that was the fault

A power supply with a **TNY** IC did not work. In the comparison, only the **BYPASS** pin showed a small difference (about 2%). This pin has the 100 nF bypass capacitor, which sets the IC current limit; on the

faulty board it measured **less than 20 nF**, and the IC shut down. After replacing the capacitor, the power supply worked again.

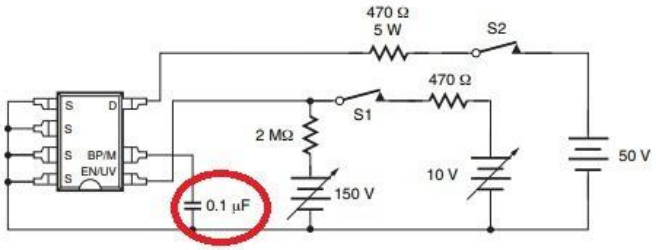


Figure 13 – TNY circuit: the 0.1 µF bypass capacitor (circled)



Figure 14 – Comparison of the BYPASS pin: a small but real difference

2.11 Earth, GND and chassis ground

The three terms are often used as synonyms, but they have nuances:

- **Earth** (PE): physical connection to the ground, used for safety and to reduce interference.
- **Chassis / signal ground**: the local reference of the circuit (the board ground plane, the negative).
- **GND**: generic term for "common reference". On the RastreCurve, the **GND** terminal (green) is the reference point of the instrument, which you connect to the negative, to the board ground or, if you wish, to a physical earth.

A physical earth connection is not required to use the RastreCurve, but it can help in very noisy environments. What matters is that **the equipment GND is on the same reference as the measured point** – and, if the board has separate grounds, to bridge them or measure in stages (chapter 9).

2.12 Limitations of the method

- The test is performed **with the board powered off**; it does not replace functional verification with the circuit powered.
- Components **in parallel** add up their curves – sometimes you need to isolate sections to find the culprit.
- Programmable components (microcontrollers, FPGAs, DSPs) and ICs with a **charge pump** may show variable or unstable curves.
- Internal logic faults (corrupted memory, firmware) do not show up in the curve; if nothing is found, carefully examine memories, processors and ICs that run hot.
- Components from **different manufacturers** may have slightly different curves; be suspicious when the difference repeats on several pins.

3. Safety and precautions

WARNING

All tests must be performed with the board or module **completely disconnected** from the mains and **without batteries**.

Discharge all capacitors before starting – especially power-supply filter electrolytics, which can hold tens or hundreds of volts. Confirm the discharge with a multimeter.

Never connect the RastreCurve to a powered circuit. The software itself shows this warning blinking on the main screen.

- Use an antistatic wrist strap, gloves or mat when handling sensitive boards and components.
- Do not touch the board or the probe tips with your fingers during measurement – this adds noise and changes the curve.
- Avoid non-original notebook power supplies on the computer used with the equipment: they can inject noise and mains voltage that disturb the acquisition.
- Do not inject external signals into the board during the test.
- Isolate and ground the chassis of the equipment under test whenever possible.
- If you bridge (“jumper”) separate grounds to make testing easier, **remove all jumpers** before powering the board again.
- The RastreCurve 2Plus is manufactured in compliance with the RoHS directive.

4. Getting to know the equipment

4.1 Package contents

- 1 RastreCurve 2Plus acquisition module;
- 1 pair of needle-type test probes (red and black);
- 2 green ground (GND) leads;
- 1 yellow lead with clip (pulse channel);
- 1 USB cable;
- DVD with software, drivers, manuals, videos and the **serial number** printed on the envelope.

> **TIP**
> Keep the DVD envelope: the serial number is required to register the software and to download updated versions from the website.

4.2 Front panel and connections

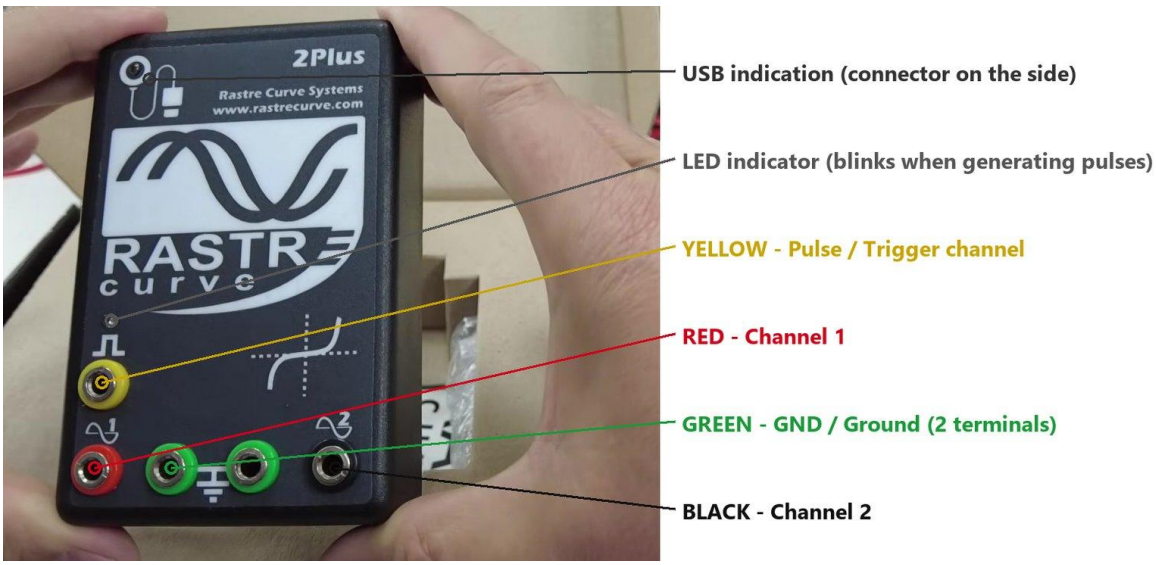


Figure 15 – Front panel of the RastreCurve 2Plus

Terminal	Color	Function
Channel 1	Red	Main test probe. Used in all modes (it is the only channel used when creating projects and in the impedance test).
Channel 2	Black	Second test probe: second board in the 2-channel comparison, or control terminal (base/gate) in the switching test.
GND (2 terminals)	Green	Measurement reference (ground). One terminal for each channel; connect it to the board ground point.
Pulse / Trigger	Yellow	Generates pulses synchronized with the sine wave to trigger the gate/base of transistors, MOSFETs, TRIACs, SCRs and optocouplers (Pulse Test). In the Saturation Test it supplies 5 V through a 10 kΩ series resistor.
LED	—	Blinks while pulse generation is active.
USB	—	Connector on the side of the module. Communication with the PC and power supply of the equipment (there is no external power supply).

5. Technical specifications

Characteristic	Value
Channels	3 – two for testing/comparison/storing (Channel 1 and Channel 2) and one for pulse triggering (yellow)
Output impedance (series)	10 kΩ, fixed in all profiles
Maximum test current	10 mA
Signal application time	1.5 ms per measurement (pulsed excitation)
Power profiles	4 – Low, Normal, Automatic and Maximum (table below)
Frequency range	4 Hz to 1 kHz
Samples per curve	More than 900 (V, I) pairs per cycle
Power supply	Via the USB 2.0 port only
Operating system	Windows (XP SP3 to Windows 10/11, 32 or 64 bits); comparison mode also on Linux, macOS and Android via USB/OTG
Comparison tolerance	Adjustable from 2% to 20% (default 5%)

Power profile parameters

Profile	Frequency	Peak voltage	Peak-to-peak voltage
Low Power	4 Hz	2 Vp	4 Vpp
Normal Power (default)	20 Hz	4 Vp	8 Vpp
Automatic Power	20 Hz to 1 kHz (variable)	4 Vp	8 Vpp
Maximum Power	50 Hz	4 Vp	8 Vpp

> **NOTE**
> Low Power is also called “minimum”. Profile selection is detailed in chapter 8.

6. Software installation

6.1 Where to get the installer

The software can be installed from the DVD supplied with the equipment, but we recommend downloading the latest version from **rastrecurve.com** (software download area): enter the serial number printed on the DVD envelope and click **Download Setup** or **Download All**.

The DVD contains the folders **Driver**, **Manual**, **Software acesso Remoto** (remote access software, so technical support can access your computer if necessary), **Suporte**, **Vídeo** (repair and procedure videos) and the installer **Setup_RastreCurve_2Plus**.

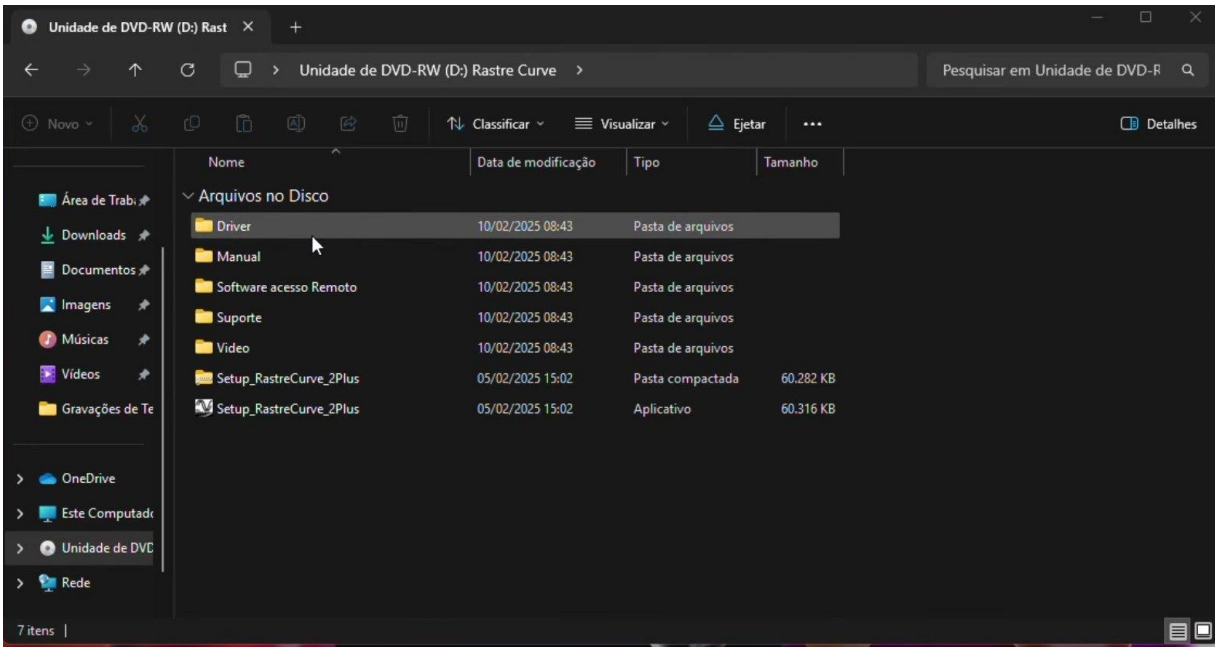


Figure 16 – Contents of the installation DVD

6.2 Step by step

1. Run **Setup_RastreCurve_2Plus**. If it does not open with a double-click, right-click it and choose **Run as administrator**.
2. Select the installation language and click **OK**.
3. Accept the terms of the agreement and click **Next**.
4. Keep the suggested destination folder (on C:) and click **Next**. Also keep the Start menu folder name.
5. Check **Create a desktop icon**, click **Next** and then **Install**.
6. The equipment driver is installed; wait for the message “The operation completed successfully” and click **OK**.
7. The **NI LabVIEW Run-Time Engine** installer then opens (required by the software). Click **Next** keeping the default directory, accept the terms (**Accept**) and continue with **Next** to the end. The complete installation takes 4 to 5 minutes.
8. In the “Installation Complete” window, click **Next** and **restart the computer**.

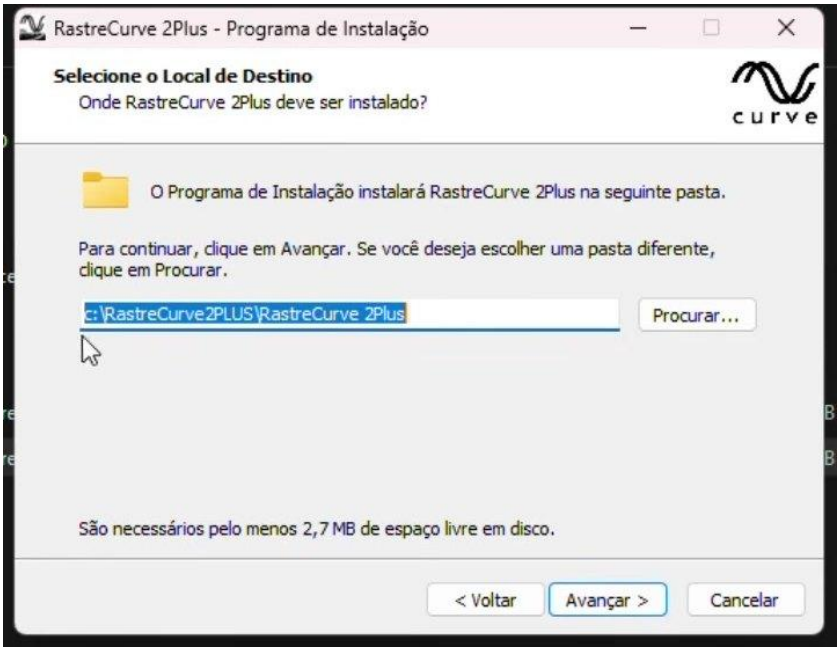


Figure 17 – Selecting the destination folder



Figure 18 – Installing the NI LabVIEW Run-Time Engine

6.3 First use and registration

When opening the program for the first time, choose the language and fill in the registration screen with **your name** and the equipment **serial number** (4 fields). Click **OK** and wait for the drivers to load.

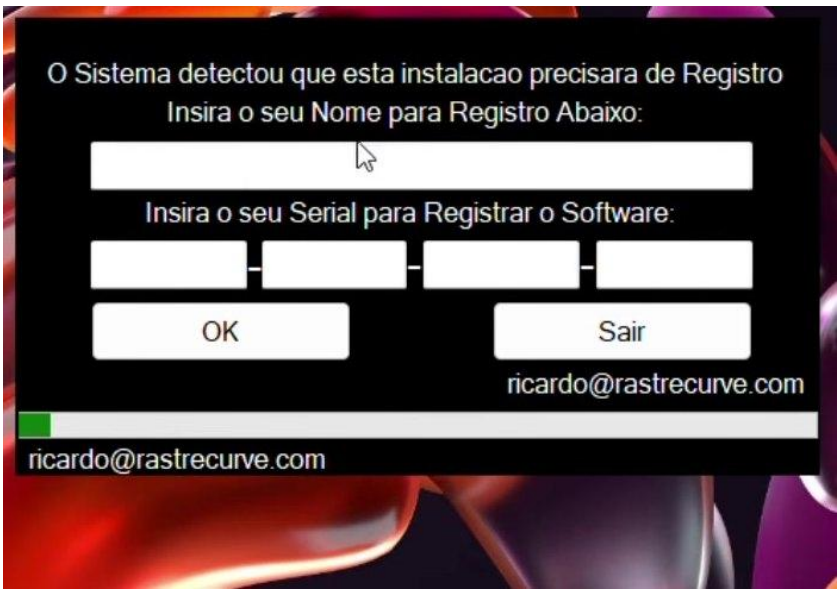


Figure 19 – Software registration screen

6.4 Connecting the equipment

Connect the RastreCurve 2Plus to a USB port **before** opening the software (or connect it with the software open – it searches for the device automatically). If the equipment is not found, the software shows a warning in red; once connected, the **Connected** indicator turns green on the test screens.



Figure 20 – Device not found warning

6.5 If Windows rejects the driver

On some computers Windows blocks the driver because it lacks a certificate. In that case:

1. Open the **Driver** folder on the DVD, right-click **myDrivers.cer** and choose **Install Certificate**.
2. Select **Current User** and click **Next**.
3. Choose **Place all certificates in the following store**, select **Trusted Root Certification Authorities** and click **OK**.
4. Click **Next** and **Finish**.
5. Reinstall the driver – it will now be accepted by Windows.

TIP

If the problem persists, use the program in the **Software acesso Remoto** folder and contact support (chapter 21).

7. Software main screen

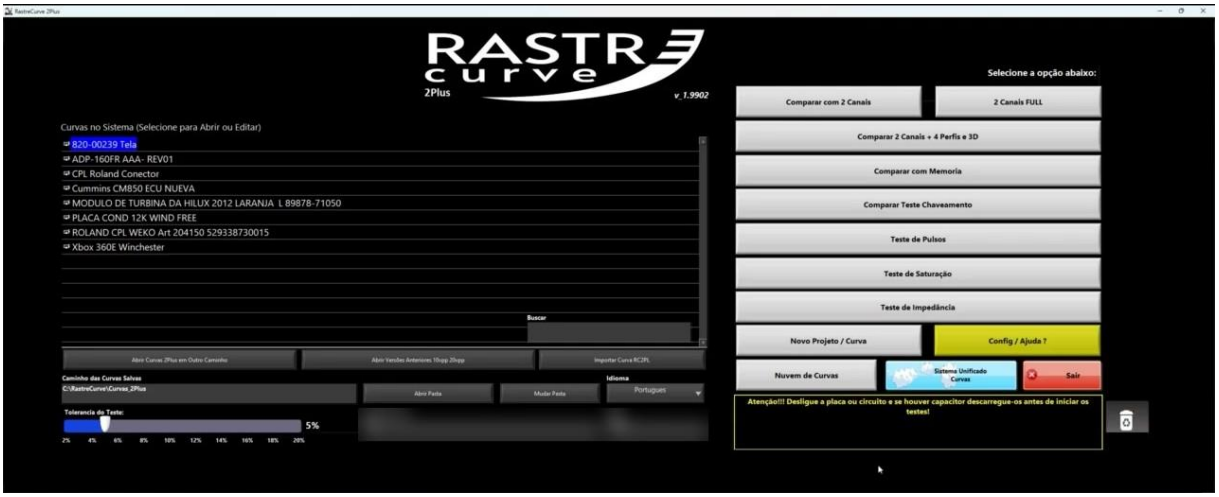


Figure 21 – Main menu of the RastreCurve 2Plus software (v1.9902)

7.1 Function buttons

Button	What it does
Compare with 2 Channels	Compares two physical boards in real time: good board on one channel, faulty board on the other (chapter 9).
2 Channels FULL	Uses the two channels independently, allowing two technicians to work at the same time.
Compare 2 Channels + 4 Profiles and 3D	Compares the point in the 4 power profiles simultaneously and shows the 3D graph (chapter 13).
Compare with Memory	Compares the faulty board with stored curves/projects (virtual board).
Compare Switching Test	Conduction test of transistors, MOSFETs, JFETs and TRIACs with 3 points (chapter 14).
Pulse Test	Applies pulses on the yellow channel with adjustable angle and duration (chapter 15).
Saturation Test	Biases the point through the yellow terminal (5 V / 10 kΩ) and detects leakage, impaired saturation and consumption variations (chapter 16).
Impedance Test	Distinguishes low-impedance sections from real short circuits (chapter 12).
New Project / Curve	Creates a new project (virtual board) with a photo and stored curves (chapter 10).
Curve Cloud	Downloads community projects and uploads yours (chapter 18).
Unified Curve System	**New in v1.9902.** Opens the unified curve portal (2Plus and Lite), with community, rewards and gift shop (chapter 18).
Config / Help ?	Company data and logo, help links, manuals and updates (section 7.3).
Exit	Closes the program (in previous versions: “Close System”).

7.2 Curve area and settings

- **Curves in the System**: lists the projects saved in the curve folder. Click a project to open the options **Test Memory Curve**, **Edit Curve**, **Rename Curve**, **Delete Curve**, **Backup/Share RC2PL** and **Back to Menu**. The **Search** field filters the list.
- **Open 2Plus Curves from Another Path**: opens projects stored in another folder.

- **Open Previous Versions 10vpp 20vpp: opens curves created on the 10 Vpp and 20 Vpp models.**
- **Import RC2PL Curve**: imports a shared project file (.rc2pl).
- **Saved Curves Path**: default folder (c:\RastreCurve\Curvas_2Plus), with the **Open Folder** and **Change Folder** buttons.
- **Language**: changes the interface language.
- **Test Tolerance**: sets, from 2% to 20% (default 5%), the maximum deviation accepted between the reference curve and the measured curve. Above it the result appears in red with a “thumbs-down”; within it, in green with a “thumbs-up”.

> **TIP**
>
> The tolerance is a reference, not the final rule. If all points of a board are around 1% and only one net shows 2%, that net deserves attention, even below 5%. **The shape of the curve is the most important information**; the number is supporting information.

7.3 Config / Help and your company data

The **Config / Help ?** button replaces the function buttons with shortcuts: **Your Data / Logo**, **Web Site / Forum**, **YouTube Videos**, **Site Videos**, **Manuals**, **Software / Updates**, **SMD Marks** (SMD marking codes), **Equivalents** (component equivalents) and **Back to Menu**.



Figure 22 – Config / Help screen with the company logo displayed

1. Click **Your Data / Logo**.
2. Fill in **Company Name** and **Company Data** (address, city, phone…).
3. In **Logo**, click the folder icon and select the logo image.
4. Click **Save Data**. The logo will appear on the main screen and in the **test reports** (section 11.4).

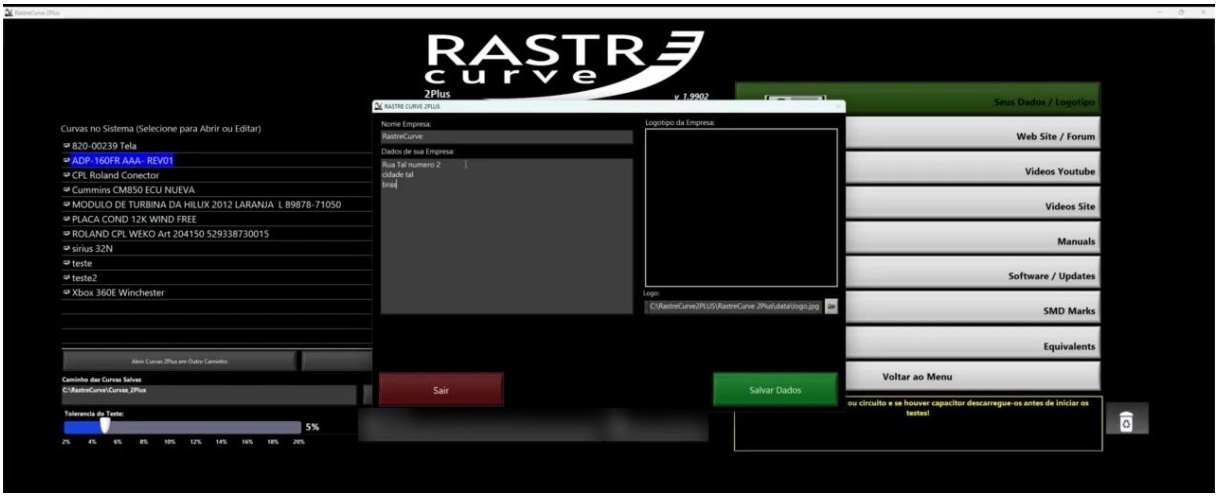


Figure 23 – Entering the company data and logo

8. Power profiles: which one to use?

Each profile changes the **frequency** and the **amplitude** of the test signal. The 10 kΩ impedance is always the same; what changes is how the signal interacts with the components, especially with capacitors. The profile can be changed at any time during testing and storing – but **always compare in the same profile in which the reference was stored**.

Profile	Use when…	Avoid when…
Low (4 Hz / 4 Vpp)	There are large capacitors (≥ 47 µF) at the point; power supplies and filters; transformers and inductors; most curves appear vertical (capacitor dominating); low-voltage circuits (≤ 3.3 V), sensors, displays, BGAs; ICs with a charge pump (after removing the external capacitors).	Power semiconductors (4 Vpp barely biases the junction); telling apart high-value resistors.
Normal (20 Hz / 8 Vpp) – default	Starting point for any board; digital logic (TTL, CMOS, microcontrollers, memories); signal diodes, resistors, optocouplers; good × bad board comparison; ECUs, motor drivers, medical boards.	Capacitors above 100 µF at the point; power transistors and amplifiers.
Automatic (20 Hz–1 kHz / 8 Vpp)	Completely unknown board with few capacitors; initial exploration; when adaptive current limiting is desired.	Boards with active oscillators (unstable curves); when the board type is already known (Normal is more repeatable).
Maximum (50 Hz / 8 Vpp)	NPN/PNP transistors, MOSFETs, IGBTs, SCRs, TRIACs; power amplifiers (TDA, LM, STK); rectifier diodes and Zeners > 2 V; shunt resistors; detection of leakage and junction degradation.	Capacitor ≥ 47 µF in parallel; very sensitive components (photodiodes, MEMS); low-voltage circuits where 8 Vpp may force conduction.

8.1 The capacitor rule

The instrument does not measure the isolated component: it measures **everything connected to the point**. A large capacitor in parallel diverts the test current and starts to “dominate” the curve. The larger the capacitance, the **lower** the power (frequency) should be:

Capacitor at the point	Recommendation
Below 10 µF	Normally does not interfere at Normal (20 Hz) or Maximum (50 Hz).
10 µF to 200 µF	May interfere at 20–50 Hz: use Low Power (4 Hz) or Automatic.
Above 200 µF	Always use Low Power; consider removing the capacitor before the test.
Above 2,000 µF	Removal strongly recommended in any profile.
100 nF decoupling	Rarely interfere – can be ignored.

8.2 Quick guide

Situation	Profile
First inspection of any board	Normal
Large filter capacitors (≥ 47 µF) at the point	Low
Signal or power transistors, MOSFET, SCR, TRIAC	Normal or Maximum
Audio / power amplifiers	Maximum

Situation	Profile
Almost all curves vertical	Low
Unknown board, without large capacitors	Automatic → then adjust
Digital logic (microcontrollers, CMOS, TTL)	Normal
IC with charge pump (MAX232, ICL7660…)	Low + remove external capacitors if they interfere
Transformers and inductors at the point	Low
Saturation test / leakage detection	Maximum
Shunt / sense resistors (very low value)	Maximum

TIP

Use the 4-profile comparison (chapter 13) to separate faults: a difference that **grows with frequency** indicates an altered capacitor or a frequency-dependent fault; a difference that is **the same in all profiles** indicates a resistive fault; a difference **only at low frequency** suggests a DC bias problem.

9. First tests: comparing with 2 channels

9.1 The reference point (GND)

Every measurement is taken between the channel probe and the **reference ground** (green lead). Before measuring, identify a GND point on the board:

- On boards with a **single ground net** (desktop and notebook motherboards, for example), any ground point works for the whole board: screws in plated holes, USB/audio/RJ-45/VGA connector shells, grounded heatsinks.
- Use the multimeter on the continuity range: with one probe on a known ground, go over the board – every point that “beeps” belongs to the same ground net.
- On boards with **separate grounds** (switching power supplies: primary × secondary, printer power supplies), move the green lead according to the section being tested **or** temporarily bridge the grounds with alligator clips/wires, forming a single net. Note this in the project description and **remove the jumpers** when finished.

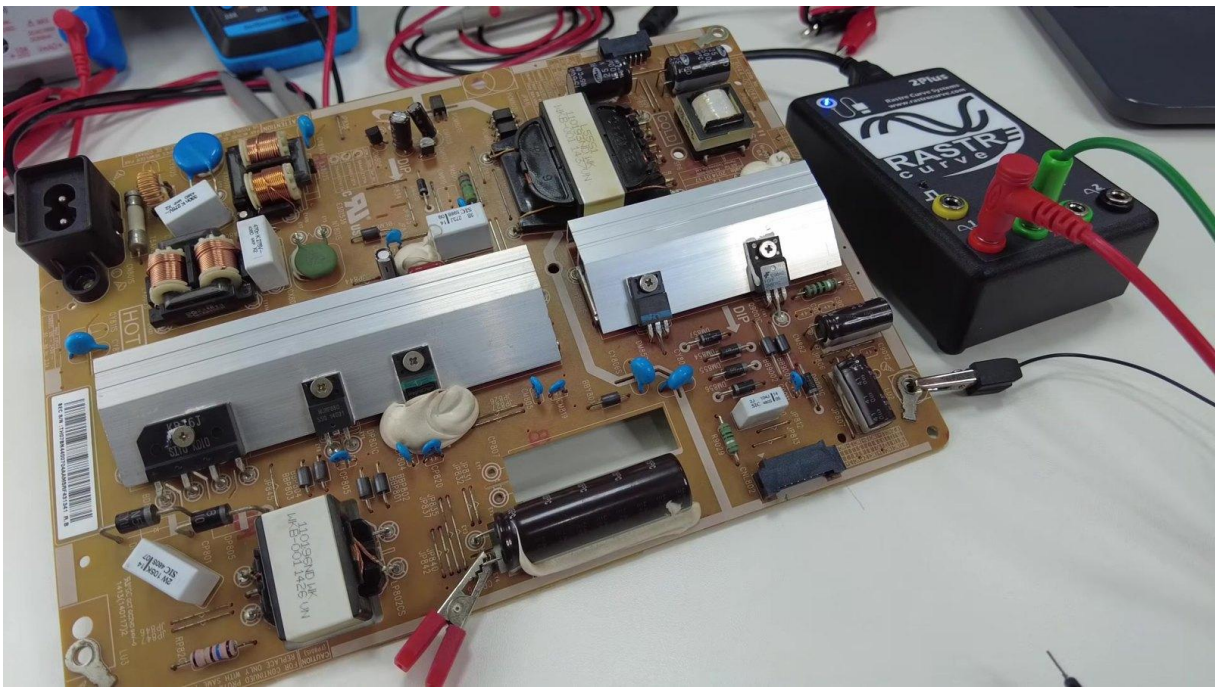


Figure 24 – Primary and secondary grounds bridged with alligator clips to test the whole board

9.2 The analysis is done “by net”

The curve of a point represents **all the components connected to it**. If a capacitor on the line is shorted, all points on that line may show a short. So, when you find a difference, investigate the components of the net; if possible, **isolate sections** (removing, for example, a series diode or the main IC) and repeat the measurement to find out where the fault is. The same component, soldered in different circuits, also produces different curves.

9.3 Comparing two physical boards

Use two **identical** boards (same brand, model and version): one good and one faulty. Ideal for workshops that always work on the same boards.

1. In the main menu click **Compare with 2 Channels**.

2. Connect the two pairs of probes respecting the colors: green leads on the green terminals, red on Channel 1, black on Channel 2.
3. Clip each green lead to the GND of one board (the same point on both).
4. Touch the Channel 1 probe on a point of the good board and the Channel 2 probe on **exactly the same point** of the faulty board. It does not matter which board is on which channel, as long as each board uses one channel.
5. Watch the curves (by default Channel 1 in green and Channel 2 in red) and the percentage deviation: green with thumbs-up = within tolerance; red with thumbs-down = difference.
6. Follow the fault line component by component, pin by pin. To speed things up, first compare groups of components (for example, starting from the power connector) and then focus on the group that differed.

On the comparison screen you can also **save** the measured curve, change the **colors** of each channel and return to the menu with **OK / Exit [ESC]**.

> **TIP**
>
> Test the whole board before replacing components and start with the most serious faults: **shorts and open circuits**. Then investigate the subtle differences – especially in the **central part** of the curve, which usually indicates a real fault. Differences only in the left part (reverse bias) can be tolerated, since manufacturers do not guarantee that characteristic.

10. Creating a project (virtual board)

The project is the RastreCurve "gold mine": you store the curves of a **good** board once, with the photo and position of each component, and then you can diagnose any identical faulty board without needing the good board on the bench. Over time, the workshop builds its own **curve database**.

> **NOTE**
> **Only Channel 1** is used when creating projects (red probe + green GND lead).

10.1 Prepare the photos

Photograph the good board **from straight above**, with good lighting and sharp focus. If there are components on both sides (SMD on the bottom side), take one photo of the **front** and another of the **back**. Save the photos on the computer before starting.

10.2 Create the project

1. In the main menu click **New Project / Curve**.
2. In **Curve Name**, type an easy-to-identify name (manufacturer, model and version of the board – e.g. "SAMSUNG TV POWER SUPPLY BOARD").
3. In **Project details**, record everything that may help in the future: equipment, model, serial number, bridged grounds, notes.
4. Click **Select Photo or Image** and choose the photo of the board.



Figure 25 – New project: name and details

10.3 Image pre-editing (new in v1.9902)

After choosing the photo, the new **pre-editing** screen opens, where you freely assemble the project "board sheet": several images can be placed side by side, one above the other or in any arrangement (connector, front and back of the board, module label, datasheet, pinout…).

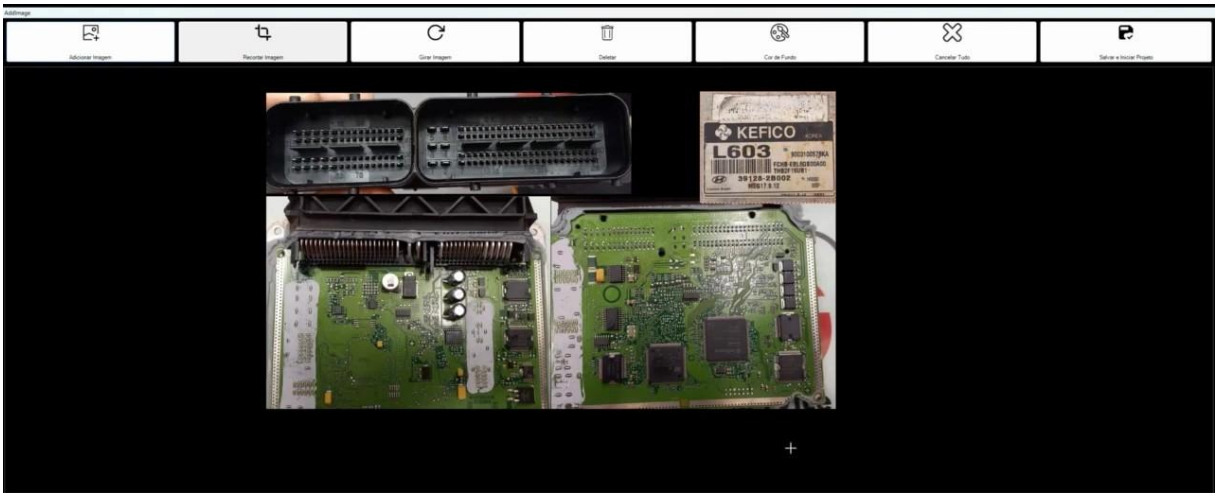


Figure 26 – Pre-editing: connector, front, back and module label assembled on a single sheet

Button	Function
Add Image	Inserts another image on the sheet.
Crop Image	Crops the selected image (remove borders, background and unnecessary parts).
Rotate Image	Rotates the selected image.
Delete	Removes the selected image.
Background Color	Changes the background color of the sheet.
Cancel All	Discards the editing.
Save and Start Project	Finishes the assembly and opens the Edit Project window.

Click an image and **drag** it to position it; use the handles to **resize** and align the images with each other. For a simple project, just select a single photo, rotate it if necessary and click **Save and Start Project**.

TIP

Assembled the image one way and want to change it later? In the menu, select the project, click **Edit Curve** and use **Change photo**. Markings already made can be repositioned with **Move mark** (section 10.9).

NOTE

In previous versions (up to 1.96) editing was done in the **Edit Image** window, with blue crop bars, **Rotate Image** and **Add Image Below / Right**.

10.4 The Edit Project window



Figure 27 – Edit Project window (v1.9902) with the sheet assembled in pre-editing

Button / key	Function
Zoom [F2]	Enlarges the image; each click on the desired point zooms in further (or hold CTRL and mark the area).
Resize [F3]	Returns the image to its original size.
Move [F4]	Drags the image to position it.
Select / Edit [F5]	Selects an already marked component to edit it or store curves.
Ground (GND) [F6]	Marks on the photo the ground point used in the measurement.
Mark [F7]	Marks a component on the photo (click and drag a rectangle).
Text and Arrows [F8]	Inserts notes and arrows on the photo.
Insert + Curve [F9]	Click a marked component to store a new curve on it.
View Component curves [F12]	Shows the curves already stored for a component.
Ok & Save [ESC]	Saves the project and returns.
Change photo / Add New Image or Project	Replaces the photo or adds images.
Attach Files / Attached Files	Attaches datasheets, schematics or other files to the project.
Check Board / Find Component	Checks the board and finds an already registered component.
Video links	Stores links to videos related to the repair.
Protect File Against Editing	Locks changes (the “Changes Locked” indicator lights up). It is not a password; it can be undone.
Delete All / Redo	Clears the project markings.

The **Marked Components** and **Items on Board** counters show the mapping progress.

10.5 Mark the ground point

1. Locate on the real board a GND point close to the area to be stored and clip the green lead to it.
2. In the software, click **Ground (GND) [F6]**, draw a rectangle over the same point on the photo and, on the enlarged image, click exactly on the point (a grounded screw, for example).
3. Repeat to mark other ground points, if any. Hold the mouse still over the marking to see its information.

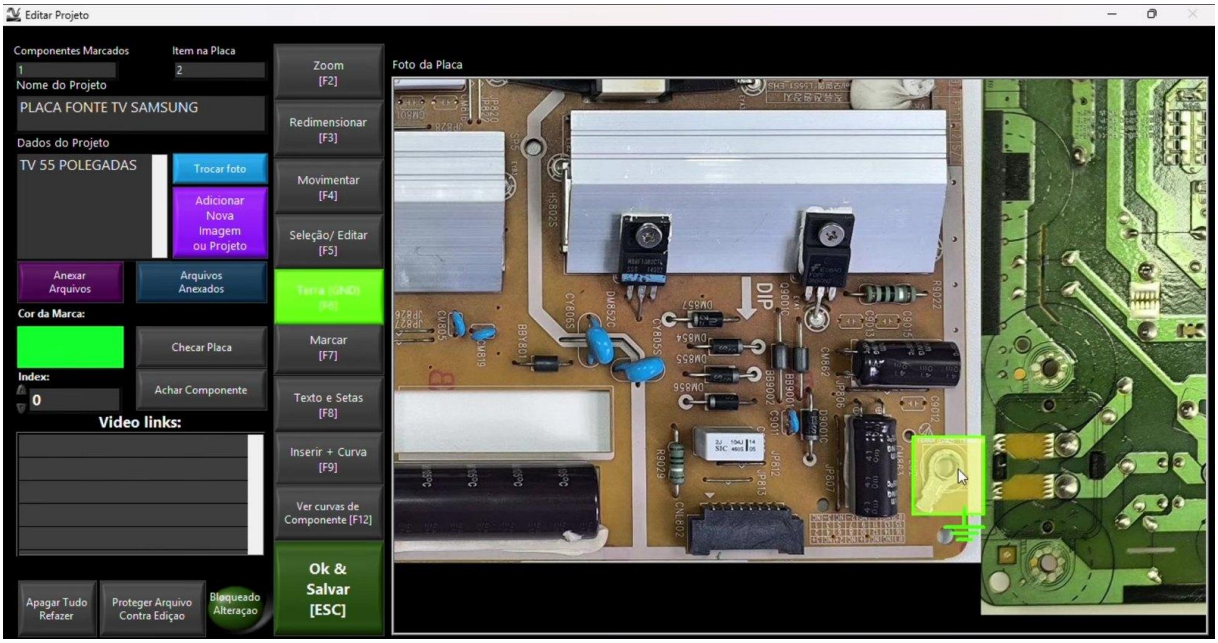


Figure 28 – Ground point marked on the board photo

10.6 Mark a component

1. Use **Zoom** to see the component clearly.
2. Click **Mark [F7]** and draw a rectangle around the component.
3. On the enlarged image, click **pin 1** (on two-terminal components, click the terminal connected to ground). On ICs, pin 1 is next to the “dot” or the notch; counting continues counterclockwise. If in doubt, check the datasheet.

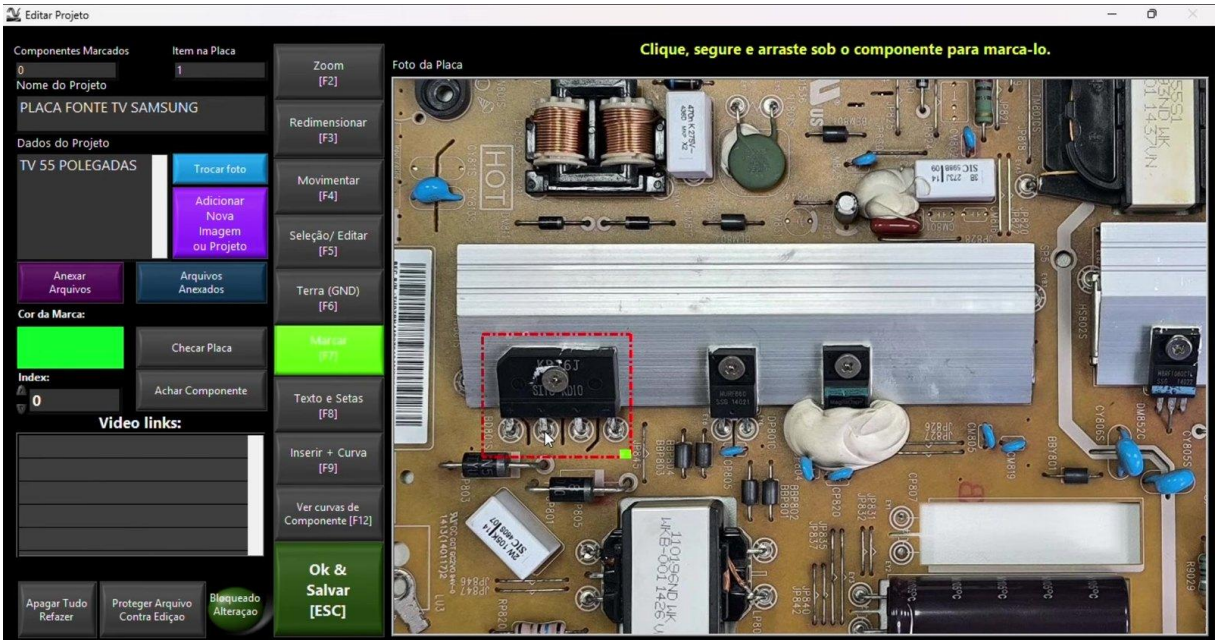


Figure 29 – Marking a component with a rectangle

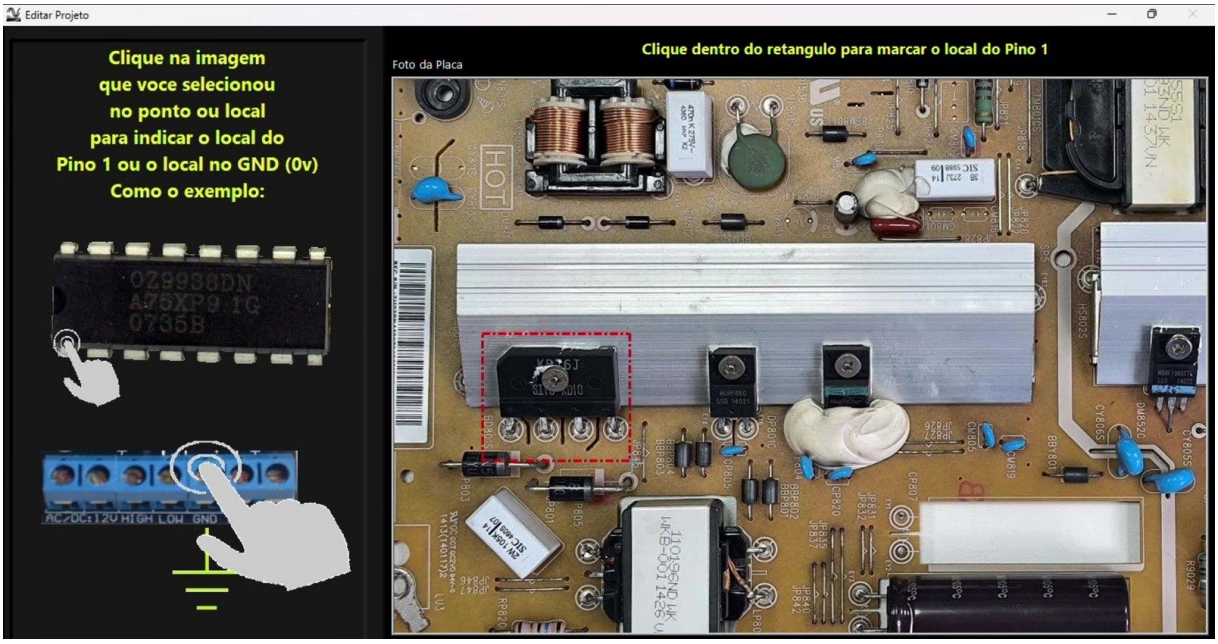


Figure 30 – Indicating pin 1 of the component

Marking the position of all pins (v1.9902)

When editing pins (and also while storing) the software shows all pins already marked on the enlarged photo. You can mark the pins **one by one while storing** or **all at once** before storing: click the yellow marking icon, then click on the photo over pin 1, 2, 3… in the indicated order (“Click now on point N”).

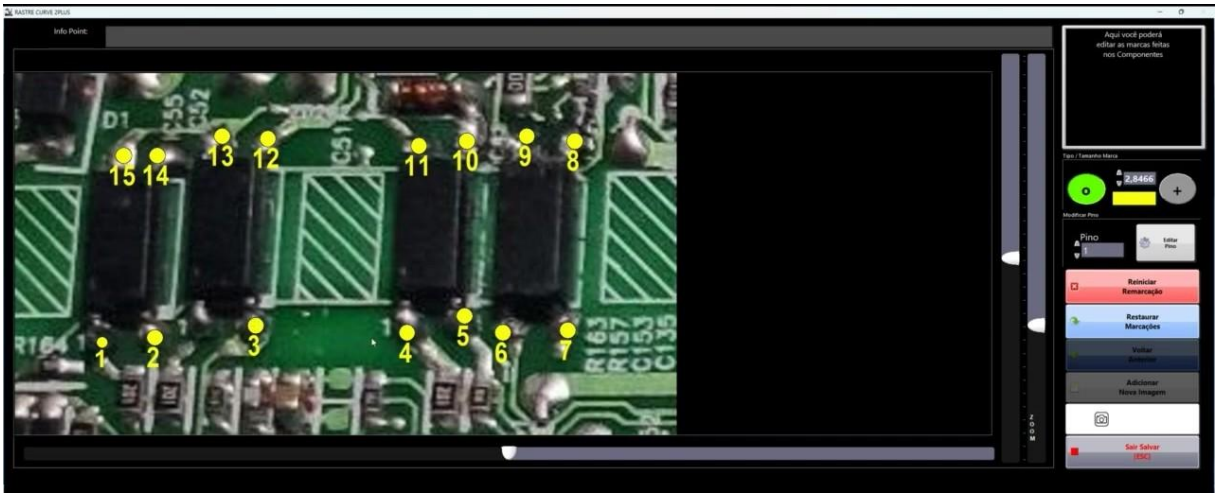


Figure 31 – All pins of an IC marked at once

Button	Function
Restart Re-marking	Erases the positions and restarts marking from the chosen pin.
Restore Markings	Undoes the changes and returns to the previous positions.
Go Back	Goes back one pin at each click – you can now go back as many pins as you want.
Edit Pin	Select the pin number and click on the photo to reposition only that pin.
Add New Image	Adds an image to the component.
Mark size	Adjusts the size of the pin marker on the photo.
Exit Save [ESC]	Stores the positions and closes.

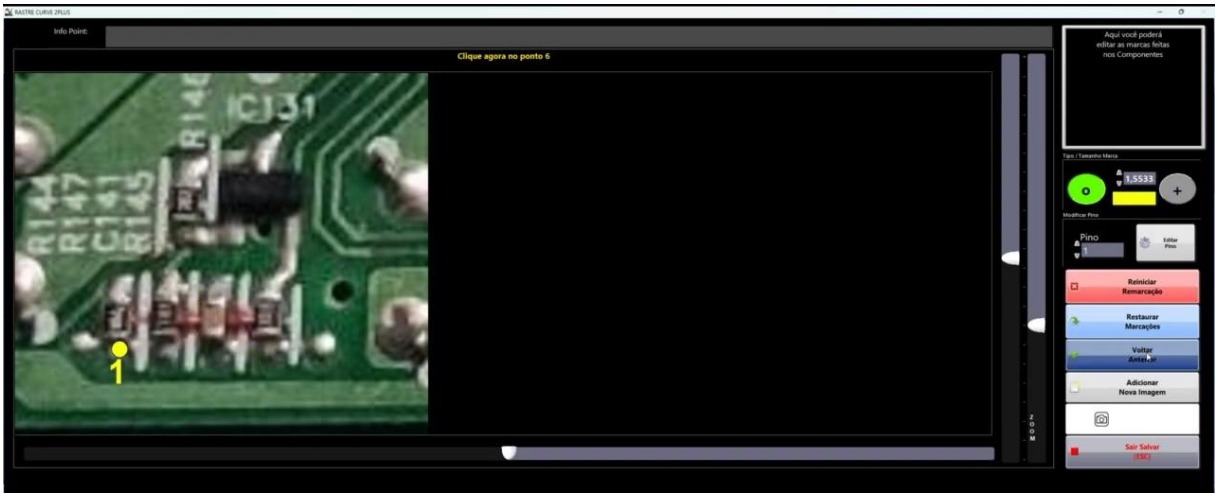


Figure 32 – Pin marking screen: "Click now on point 6"

10.7 Enter the data and choose the capture type

1. Click **Insert + Curve [F9]** and click the marked component (red rectangle, "Component without memory").
2. Fill in **Component Code** (what is written on the body, e.g. HT93LC46), **Component Id on the Board** (silkscreen: U1, C12, Q3…) and **Notes**.
3. Enter the **Number of Pins**.
4. Choose the capture type (table below). For the common VI curve use **Capture Curves Normal Mode**.

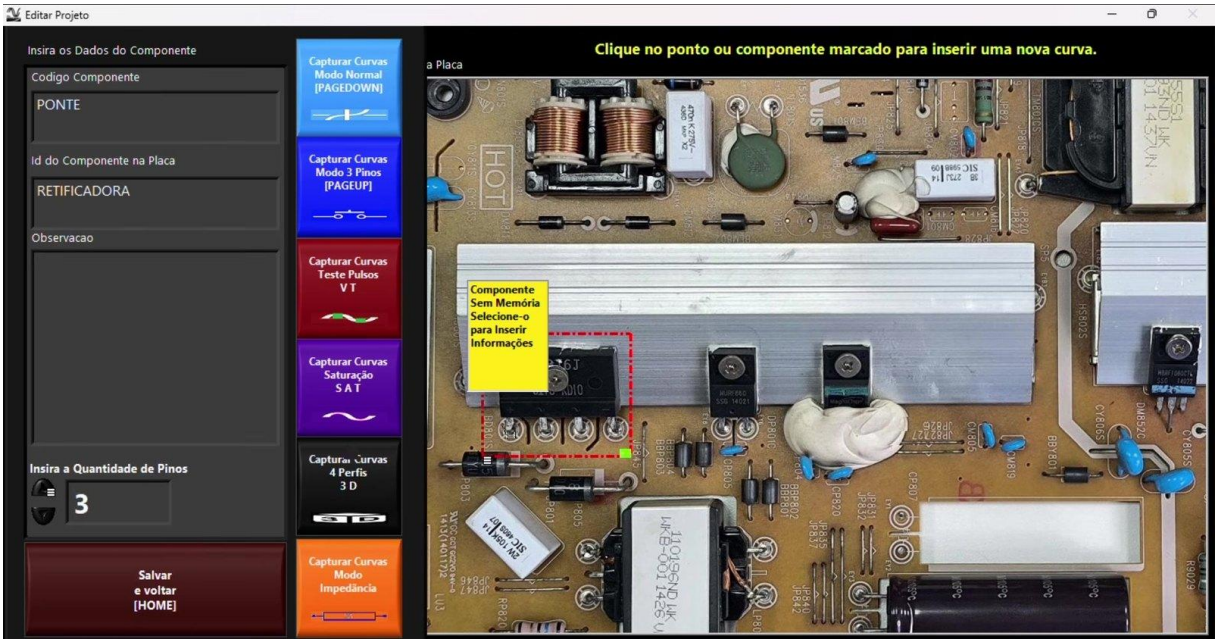


Figure 33 – Component data and capture types

Capture type	Use
Normal Mode	Standard VI curve, pin by pin (the most used).
3-Pin Mode	Switching curves of 3-terminal components.
VT Pulse Test	Stores the response to the pulse test.
SAT Saturation	Stores the saturation test.
4 Profiles 3D	Stores the point in the 4 power profiles.
Impedance Mode	Stores the impedance percentage of each pin (chapter 12).

The same component can receive **several types of curve** (e.g. Normal and Impedance). To add another curve to an already stored component, use **Insert + Curve** again: the **New Curve** window opens, where you enter a description, confirm the number of pins and choose the test type (shortcuts F7 to F12), confirming with **OK [HOME]**.

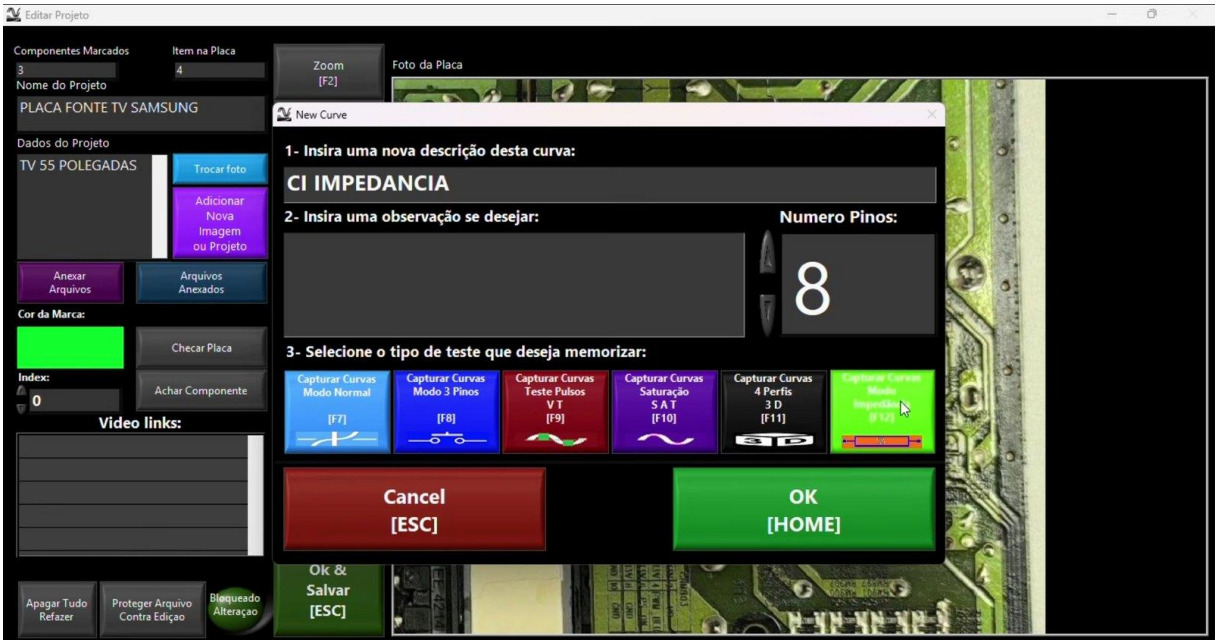


Figure 34 – New Curve window: adding another type of curve to the component

10.8 Store the curves pin by pin (Recording Mode)

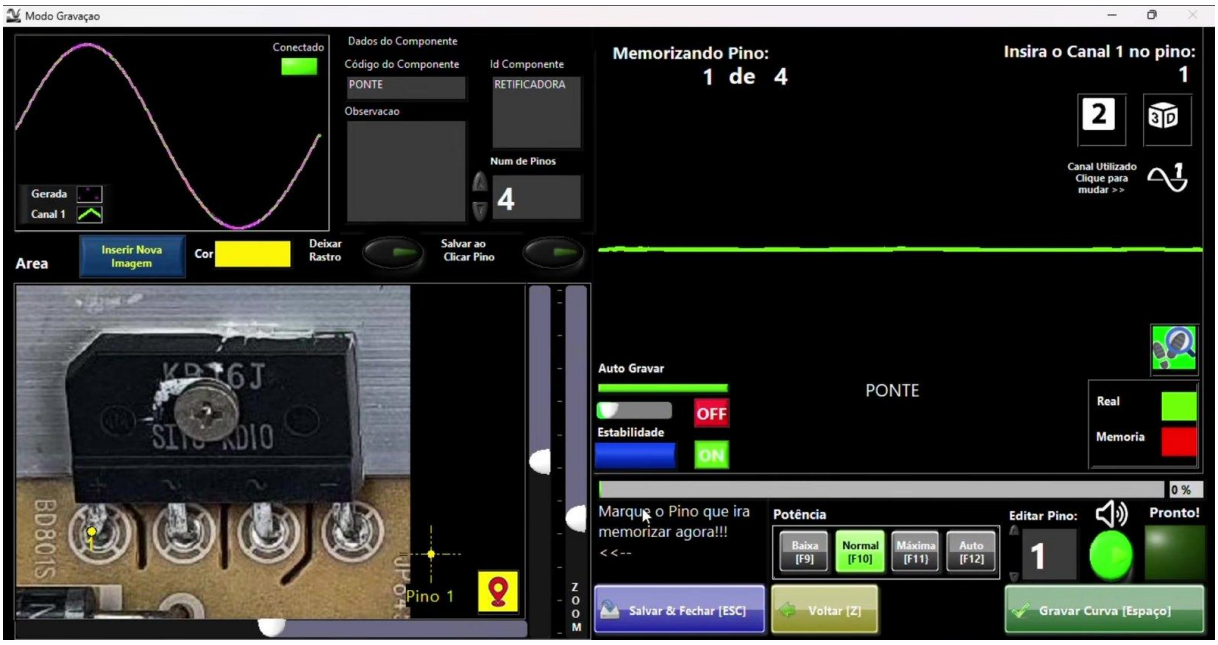


Figure 35 – Recording Mode – ready to store pin 1 of 4

The screen shows the generated signal, the component data, the enlarged photo, "**Storing Pin: X of N**" and "**Insert Channel 1 on pin**". At the bottom are the **Stability** bar, the **Auto Record** option, the **Power** selection (Low F9, Normal F10, Maximum F11, Auto F12), the **beep** and the buttons **Save & Close [ESC]**, **Back [Z]** and **Record Curve [Space]**.

1. With the green lead on GND, mark on the image the pin that will be stored.

2. Touch the red probe (Channel 1) to the pin. The curve appears on the right.
3. Wait for the **Stability** bar to settle – points with capacitors on the line take a few seconds to stabilize (it is normal for the curve to "move" while the capacitor charges).
4. Press **Space** (or **Record Curve**). A beep confirms it and the software moves to the next pin.
5. Repeat up to the last pin and click **Save & Close [ESC]**. The component rectangle turns **green** (component with memory).

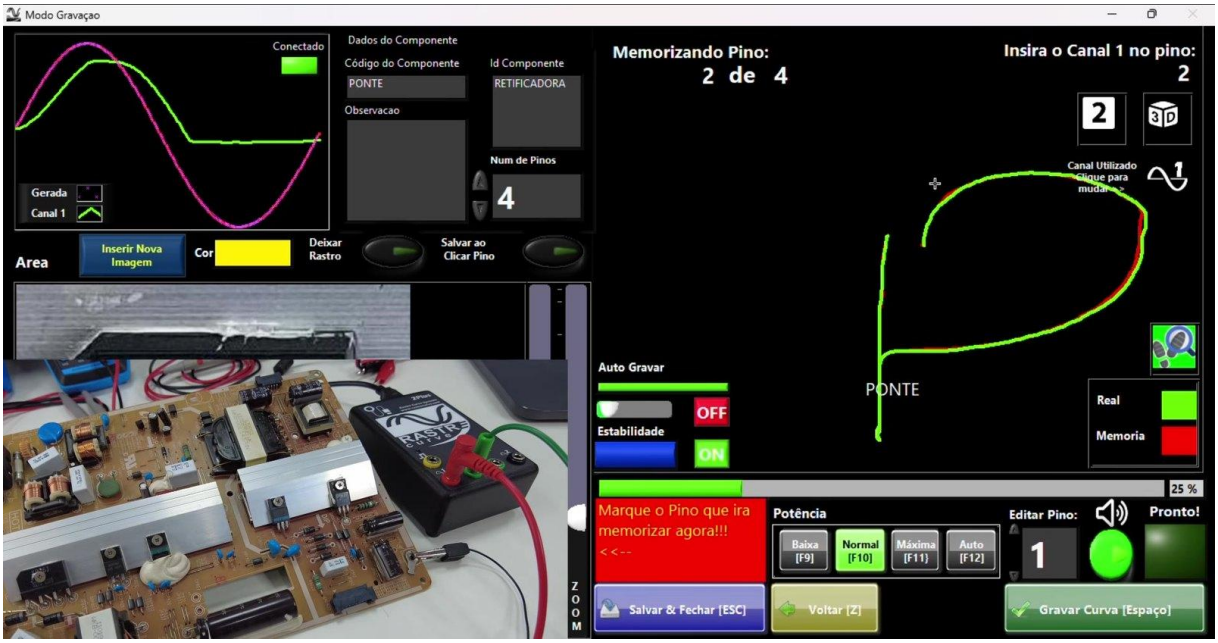


Figure 36 – Curve of pin 2 of the bridge rectifier being stored

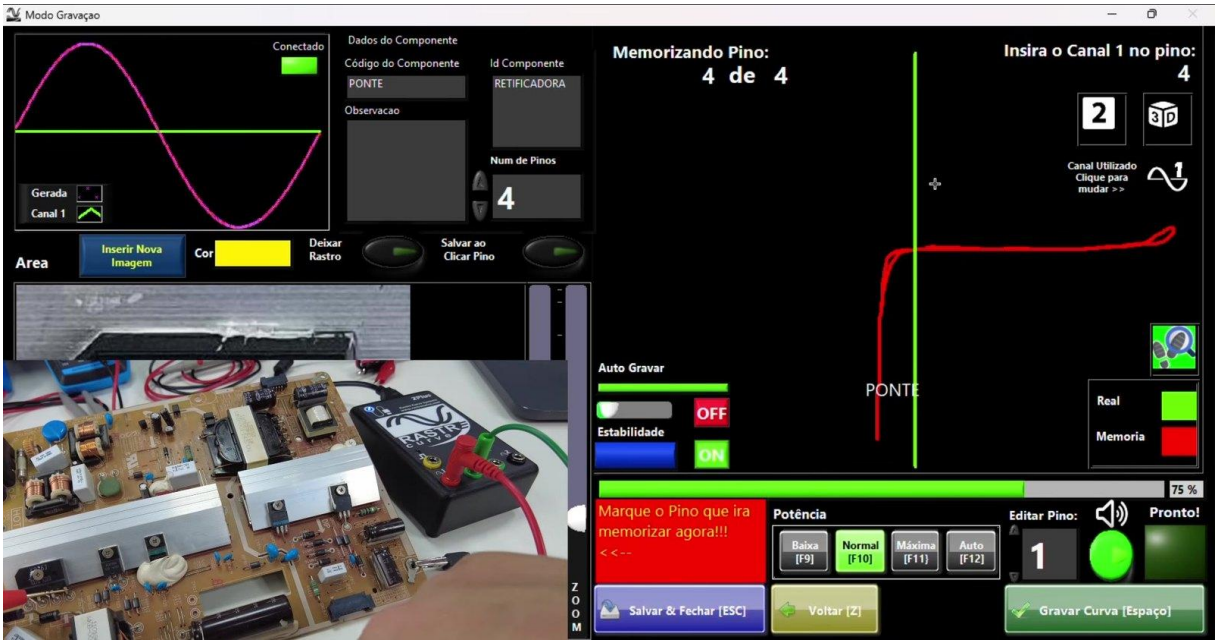


Figure 37 – Pin connected to GND itself: vertical line (equivalent to a short) – normal situation

TIP

There is no need to follow a schematic order: store the components in the order that is most practical visually. Within each component, however, store the pins **in order**, from 1 to the last.

Use **Auto Record** to store automatically as soon as the curve stabilizes and speed up large boards.

Repeat the process for all components. The project can be done over several sessions: select it in the menu and use Edit Curve to continue. To view the curves of a component, click View Component curves [F12] and then the component.

10.9 Move marks and clone curves (v1.9902)

In **Edit Project**, **right-click** a marking (component or GND). The **"What do you want?"** window offers:

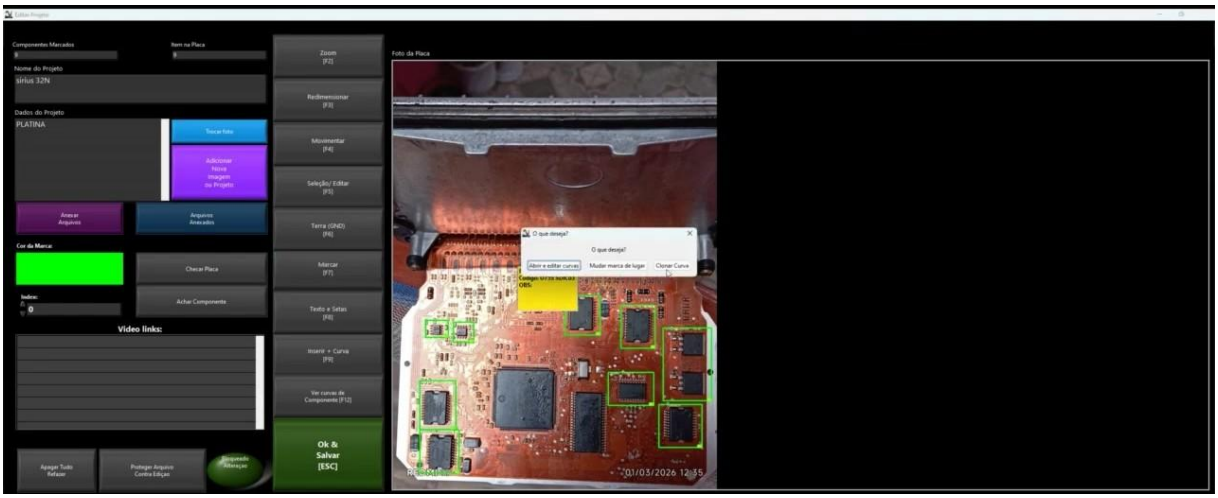


Figure 38 – Right-click on a marking: Move mark or Clone Curve

Move mark

Moves the marking – **with all the stored memory** – to another point of the photo. Useful when you stored the curves on the right component of the physical board but marked the wrong component on the photo, or when you changed the project photo.

1. Right-click the marking and choose **Move mark**.
2. Draw the rectangle at the new location ("Mark the new point or component to which the memory will be transferred") and click pin 1 / the GND point.
3. To undo, right-click the marking and choose **Back to original place**.



Figure 39 – Transferring the ground (GND) marking to another point

If the point does **not** have anything stored yet, you can also simply delete it and mark it again.

Clone Curve

On boards with **blocks of identical components** (several identical ICs, MOSFETs or drivers in identical circuits), there is no need to store all of them: store one and **clone** the memory to the others.

1. Right-click the already stored component and choose **Clone Curve**.
2. Mark the new component on the photo (rectangle and pin 1). All curves are copied; the Id receives a suffix, for example “C03 (1)”.
3. Repeat for each identical component. Check with **View Component curves [F12]**.

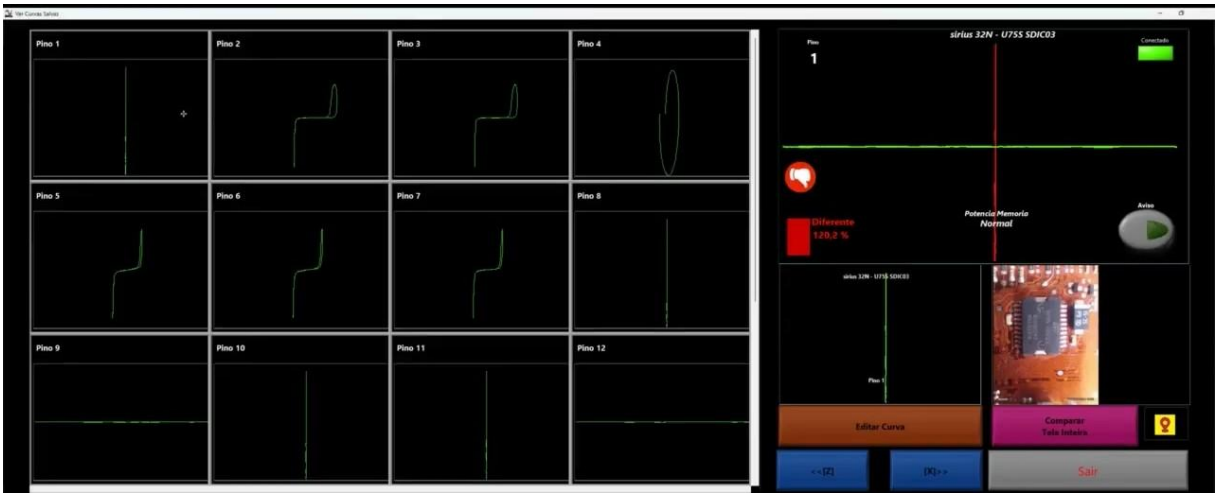


Figure 40 – Curves of a cloned IC, identical to those of the original component

> **WARNING**
> Only clone components that are in **identical circuits**. Since the analysis is done by net, the same component in another circuit may have different curves – when in doubt, store it.

10.10 Edit stored curves

Select the component (right-click or **Select/Edit [F5]**) → **Edit Point** → **Edit current curves**. The **Edit Curves** screen shows thumbnails of all pins:

- Click a pin (or use **Go to Pin**) and record the curve again with **Capture Curve [SPACE]**.
- **Right-click** a pin and choose **delete this pin** to remove a pin that did not need to be stored; the following pins are renumbered automatically.
- **Save and Exit [ESC]** stores the changes; **Cancel and Exit [DEL]** discards everything and the project returns to how it was.

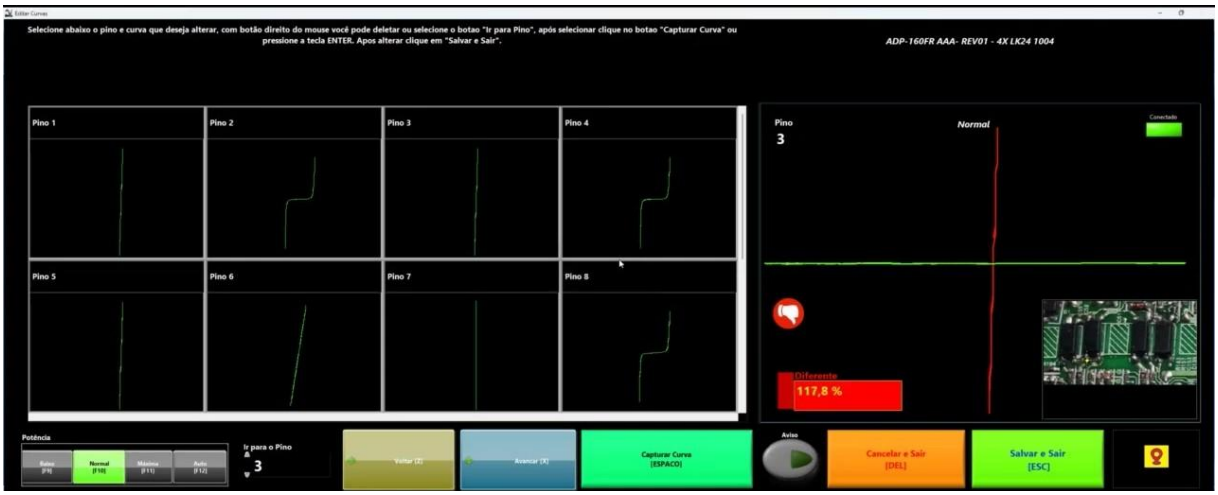


Figure 41 – Edit Curves: pin thumbnails and the curve of the selected pin

10.11 Long descriptions

When you rest the mouse over a component, the yellow information window now has a **scroll bar** when the description is long: use the mouse wheel to read everything without the text going off the image.



Figure 42 – Long description shown with a scroll bar

11. Testing a board with the memory

With the project of the good board ready, the faulty board is tested on **Channel 1**, comparing each pin with the stored curve.

1. In the main menu, click the project in the **Curves in the System** list.
2. Click **Test Memory Curve**.



Figure 43 – Selected project and its options

11.1 Board Test Mode

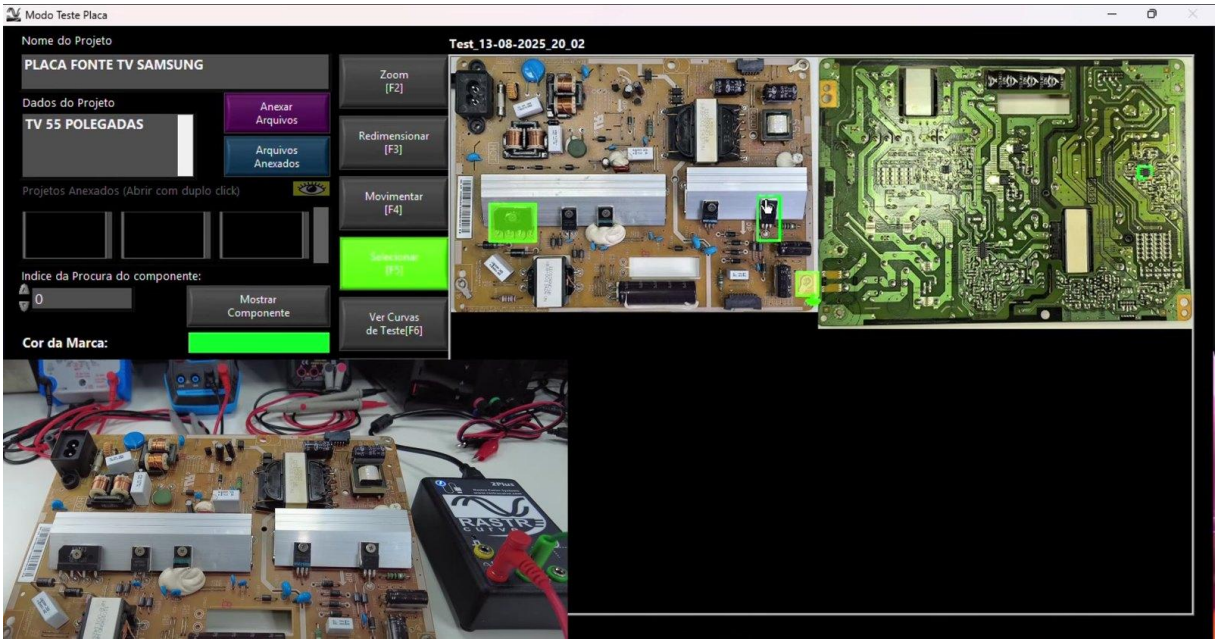


Figure 44 – Board Test Mode: tested components appear marked

The window shows the project photo, its name and data, the buttons Zoom [F2], Resize [F3], Move [F4], Select [F5] and View Test Curves [F6], as well as Attach Files / Attached Files and the component search. Each test session receives a name with date and time and can be renamed, loaded, deleted or started from scratch (New Test). Pins marked as bad are listed and can be saved.

Ways to start testing a component:

- Click **Select [F5]**, click the component on the photo and then **Open and test**; or
- Choose the component in the **Component Search Index**, click **Show Component** and **Measure Component**; or
- Use **View Test Curves** and click the component to see all its curves and test by clicking the curve of each pin.

11.2 Test Mode (pin by pin)

The stored curve (**Memory**, red) appears for the pin shown in **Measure Pin**. Touch the Channel 1 probe to the same pin of the board under test: the **Real** curve (green) appears overlaid and the software shows the percentage difference.

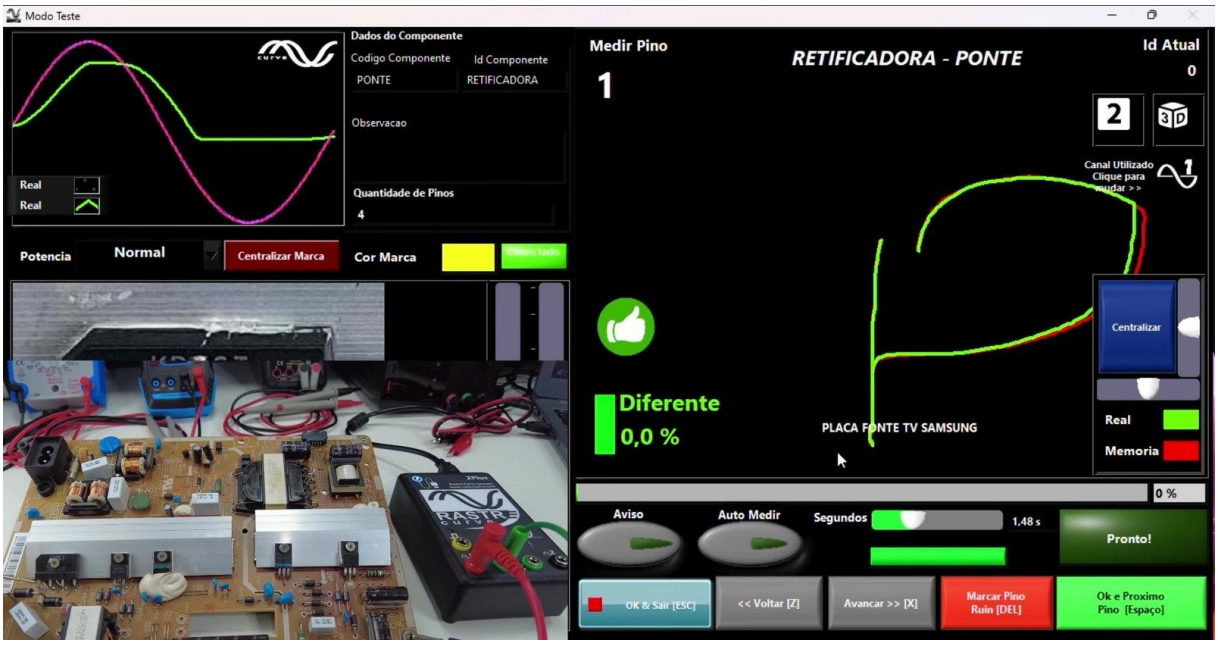


Figure 45 – Pin 1 within tolerance: 0.0% difference and thumbs-up

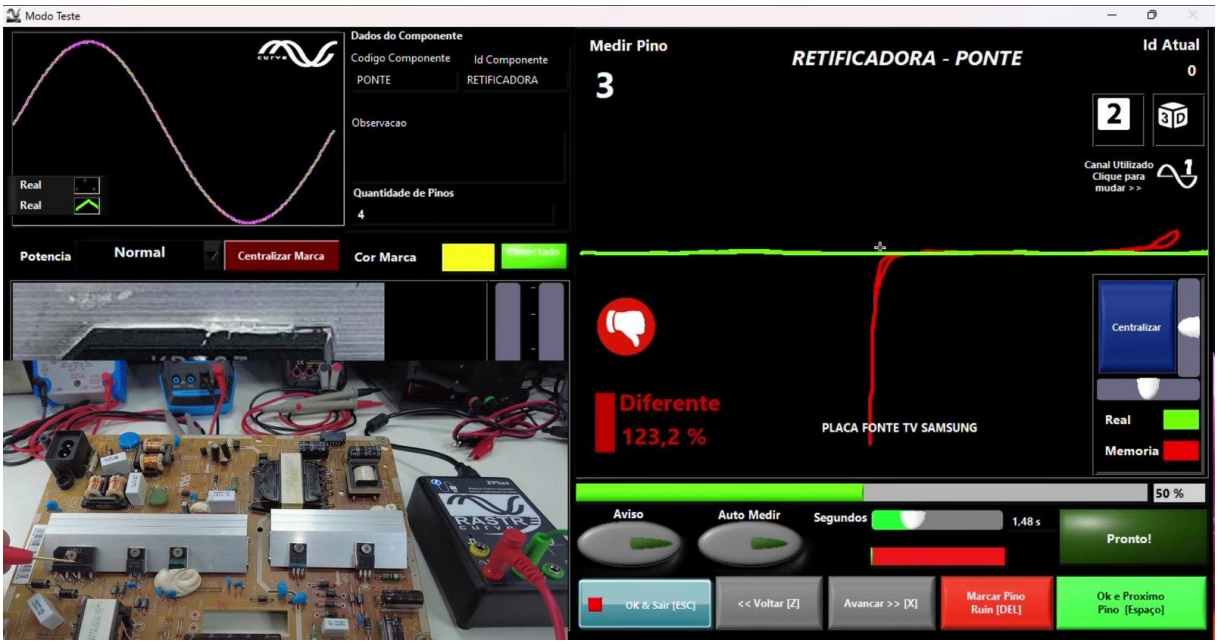


Figure 46 – Probe on the wrong pin: different curve (123.2%) and thumbs-down

Button / key	Function

Button / key	Function
Ok and Next Pin [Space]	Accepts the pin as good and moves to the next one.
Mark Bad Pin [DEL]	Records the pin as faulty.
<< Back [Z] / Forward >> [X]	Navigates between pins.
OK & Exit [ESC]	Ends the test of the component.
Power	Profile used in the measurement – keep the same one used when storing.
Auto Measure / Seconds	Moves on automatically after the set time with a stable curve.
Alert	Turns the pass/fail beep on/off.
Center / Center Mark	Re-centers the curve and the marking on the photo.

When a component is finished, it is marked **green** on the photo if all pins are good, or **red** if any pin was marked as bad.

> **WARNING**
> A bad pin indicates a fault **in the component or in something connected to that pin**. To confirm, desolder the suspect component and repeat the measurement on the points of the line: if the difference disappears, the fault was in the removed component; if it remains, the fault is in another component of the same net.

11.4 Test report (v1.9902)

In **Board Test Mode**, select a test in **Tests Done**, click **Load Test** and then **Report**. The report lists the total number of components, tested, not tested, passed and failed, and shows the **failed pins** with the curves (memory × real) and the error percentage.

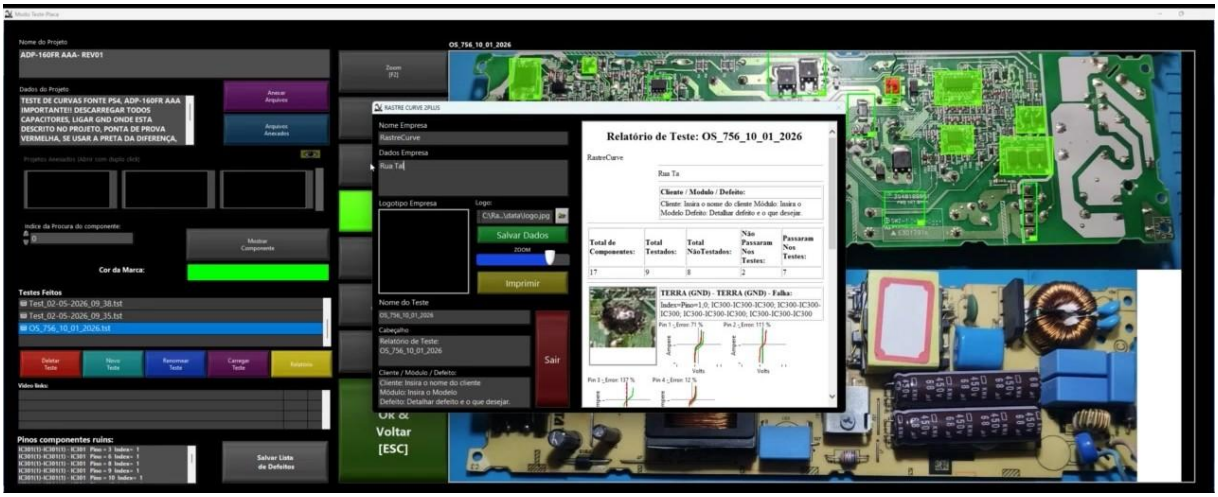


Figure 47 – Generating the test report

- The fields on the left are edited **dynamically** (the report updates as you type): **Company Name**, **Company Data**, **Company Logo**, **Test Name**, **Header** and **Customer / Module / Fault**.
- **Save Data** keeps the company data for the next reports (the same as in Config / Help → Your Data / Logo).
- **Print** sends it to the printer; to create a file, choose the **Microsoft Print to PDF** printer and save the PDF – ideal to attach to the customer's service order.

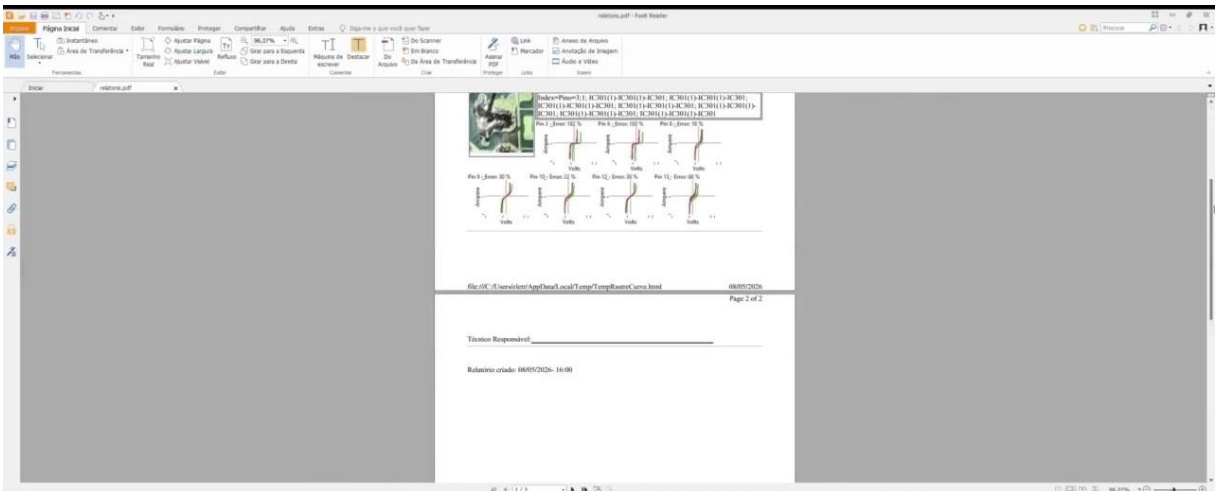


Figure 48 – Report saved as PDF

12. Impedance Test

The multimeter often “beeps” or shows a very low resistance (0.1 Ω, 0.2 Ω…) on nets that **are not shorted** – they just have low impedance, such as power rails, capacitor banks and filter coils. The 2Plus impedance test applies a sine-wave signal, processes about 9,000 samples and expresses the impedance of the point **as a percentage relative to a calibrated short**, making it possible to distinguish low impedance from a real short. The equipment distinguishes sections from approximately 10 Ω.

> **NOTE**
> The impedance test is not a “short locator” by heat or voltage; it indicates **how close to a short** each point is, so you can compare points and follow the net.

12.1 Calibrate the short-circuit point

1. Open **Impedance Test** from the menu (or, inside a project, capture curves in **Impedance Mode**). Only Channel 1 is used.
2. Click **Calibrate the Short-Circuit Point [HOME]**.
3. Touch the Channel 1 probe to the GND lead (tip to tip) and click **HOLD OFF**. Wait for it to finish.
4. The short reference (pink/lilac line, “Memory”) is stored as **0.00%**.

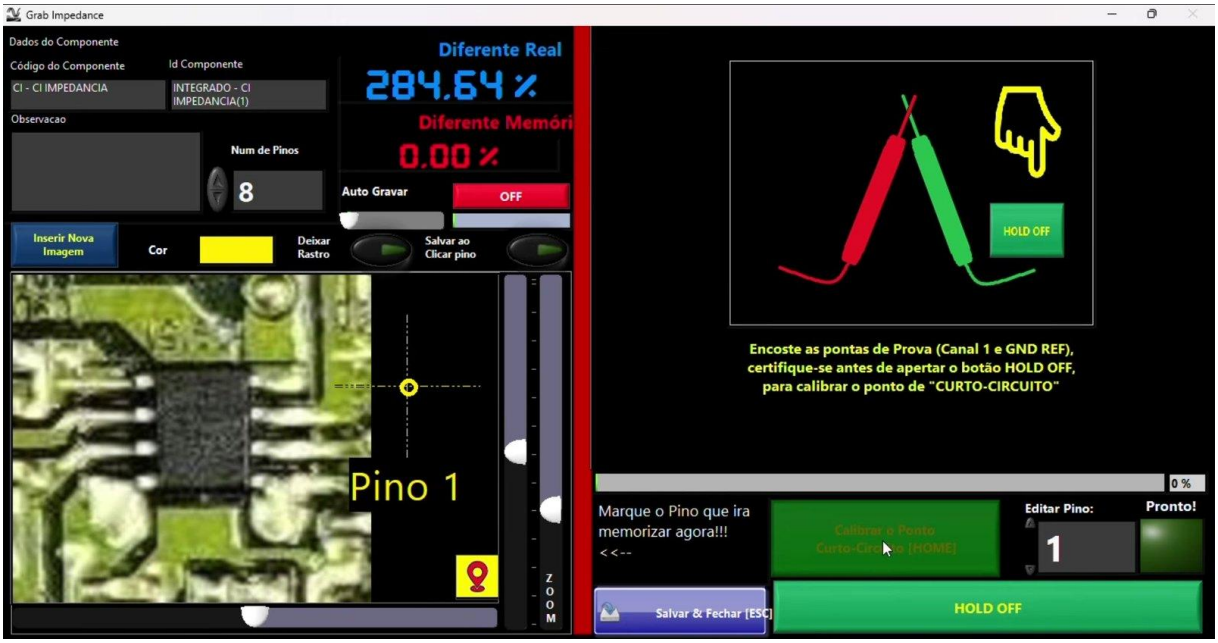


Figure 49 – Calibration of the short-circuit point

12.2 Measuring

Clip the green lead to the GND closest to the net and touch the Channel 1 probe on the desired points. The **Real Difference** value shows the percentage relative to the short: **the lower the percentage, the lower the impedance**.

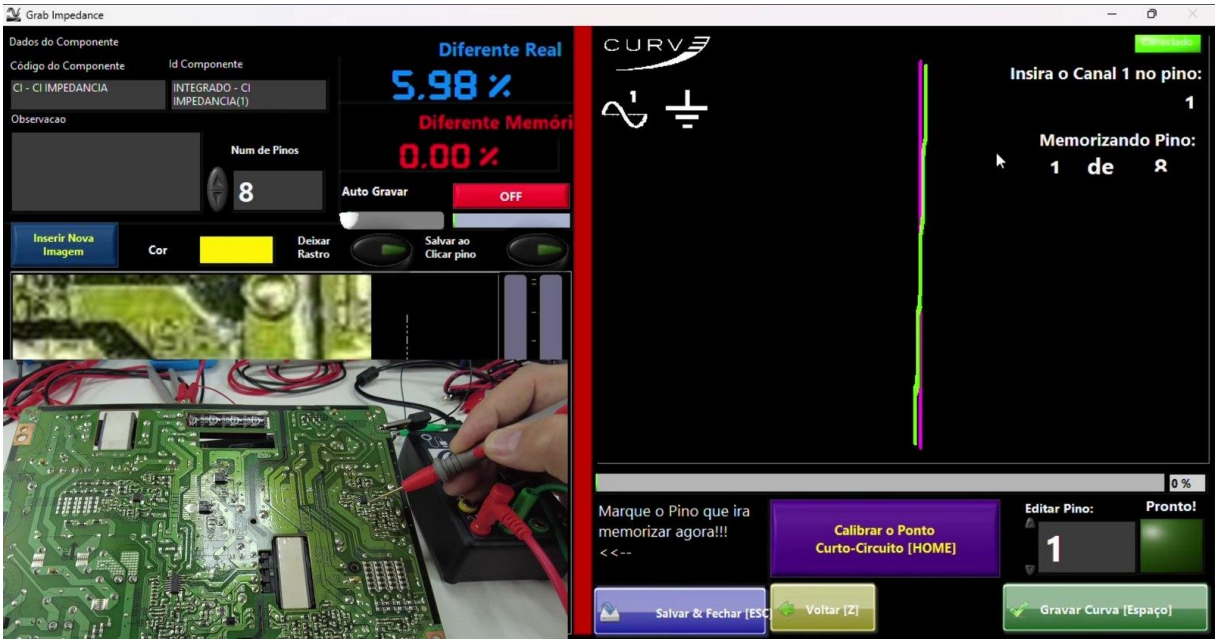


Figure 50 – Pin 1 of an IC at 5.98%: low impedance, but not a short

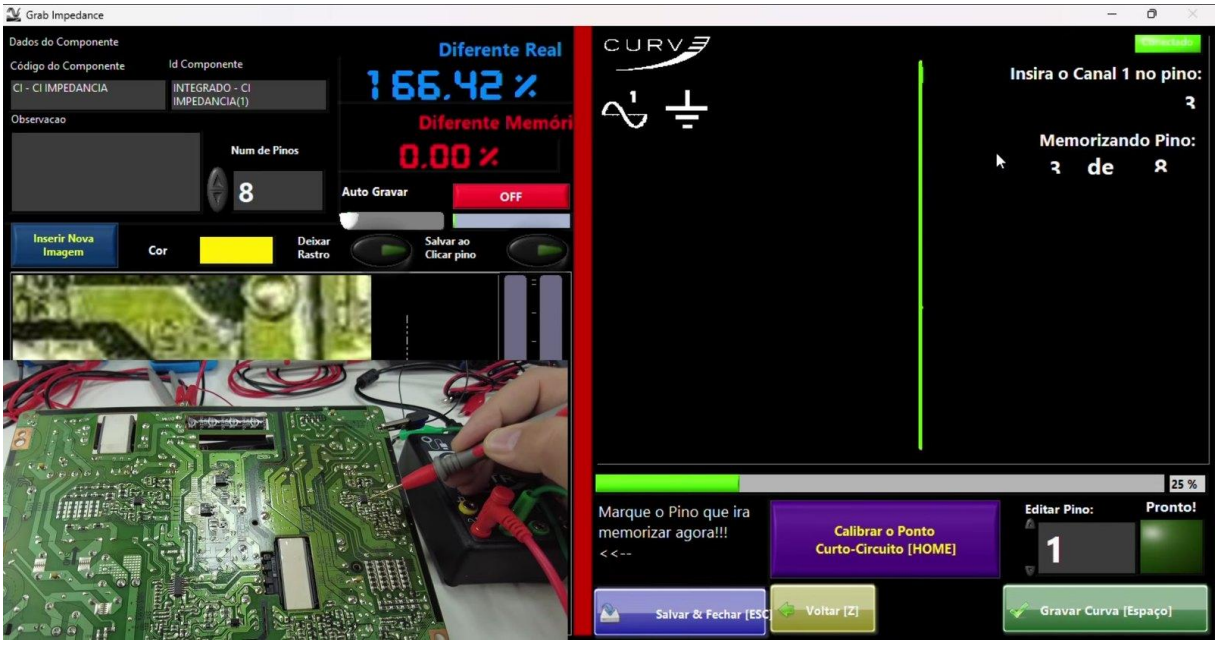


Figure 51 – Pin connected to the IC's own GND: 0% (expected for the ground pin)

TIP

Real example (PlayStation 4 board, 24-pin PWM IC): several pins show a **vertical line** – in the common VI test this could be mistaken for a short. In the impedance test, however, they read **0.15%**, **0.21%** and **0.23%**: they are **low-impedance** lines, not shorts. Only the pin really connected to GND reads **0.00%**.

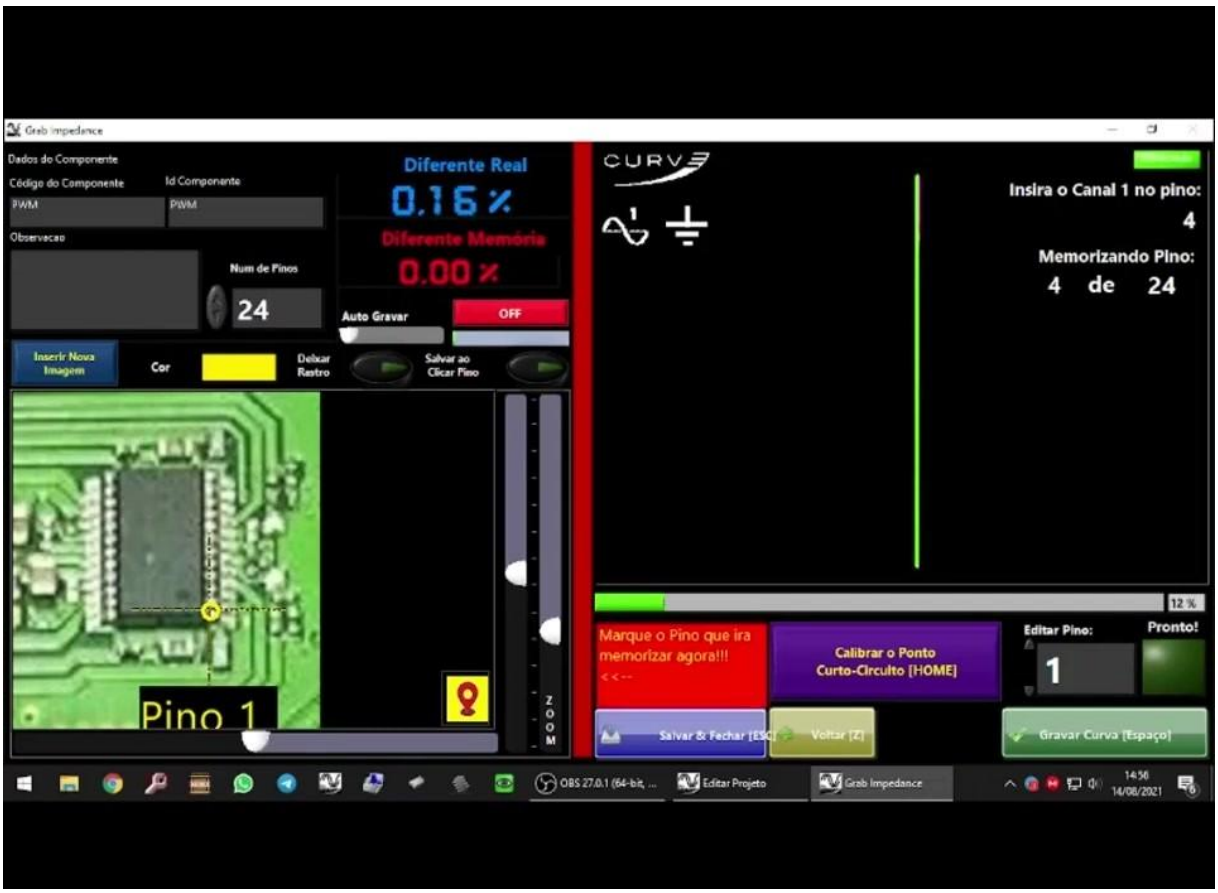


Figure 52 – Vertical line at 0.16%: low impedance, not a short

Result	Interpretation
0,00%	True short circuit (or the point is GND itself).
0.20% to 5%	Significant low impedance: partially shorted component, main power rail or large capacitors. Analyze the context.
5% to 50%	Low to moderate impedance: active components, decoupling, signal traces. Usually normal.
Above 50%	Moderate to high impedance: normal for most points.

TIP

0% is different from 0.20%. Only consider it a short when the value is zero – and check in the datasheet that the pin is not the component's own GND.

What matters most is the **discrepancy**: if similar points are between 40% and 80% and one of them shows 0.5%, that is the one to investigate.

Use **Record Ranking [Space]** to save, with a clear name (silkscreen, component), the points **closest to a short**; they appear in "Ranking closest to short circuit". There is no need to record points reading 100%.

Divide the board into sections (power, processing, outputs), find the section with the lowest impedance and keep subdividing until you isolate the component.

13. Compare 2 channels + 4 profiles and 3D

This function measures the same point in the **four power profiles** (Low, Normal, Automatic and Maximum), shows the percentage difference of each one, the **Overall Average** and a **3D** graph (voltage × current × frequency). With more variables, faults that only appear at a certain frequency – capacitor with high ESR, degraded junction, trace with a micro-crack – become evident.

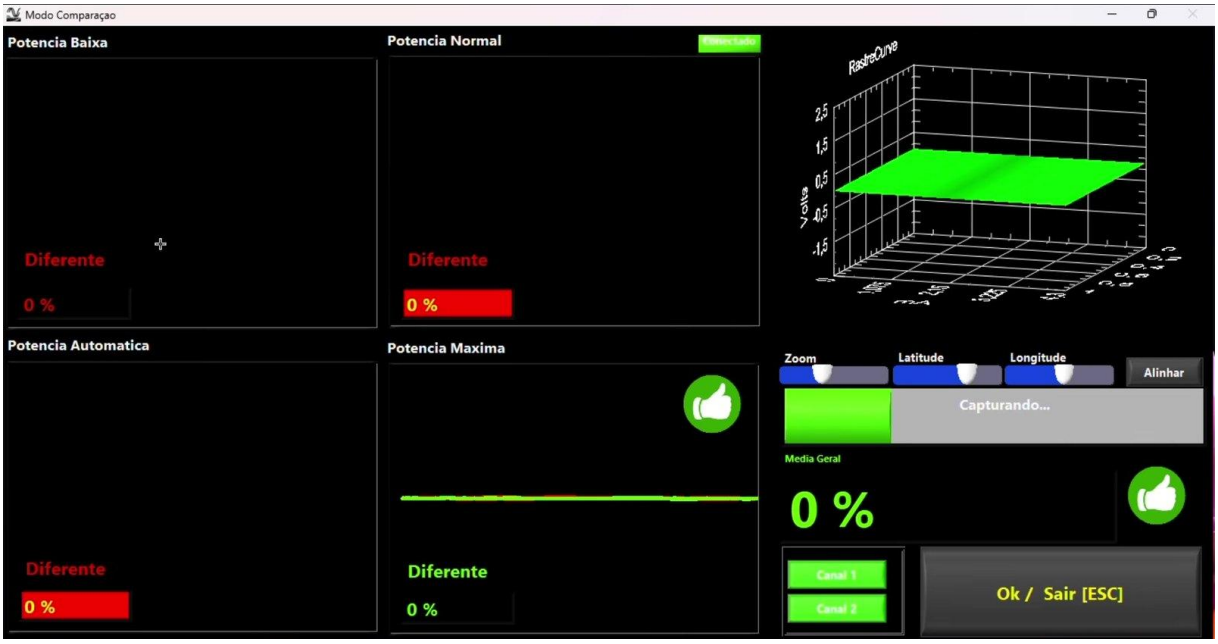


Figure 53 – Comparison in the 4 profiles with 3D graph



Figure 54 – Comparison in the 4 profiles: memory curves (red), real curves (green) and 3D graph

- The **Channel 1** and **Channel 2** buttons select the compared channels.
- **Zoom**, **Latitude**, **Longitude** and **Align** rotate and adjust the 3D view.
- In projects, use the **4 Profiles 3D** capture to store the reference in the four profiles.

Interpret the progression of the differences according to the tip in chapter 8: for example, 0% → 0% → 7% → 15% (Low → Maximum) is the classic signature of an increasing capacitive effect.

14. Switching Test

Checks whether transistors and thyristors **conduct and block** correctly, using 3 connection points: Channel 2 drives the control terminal while Channel 1 observes the power terminal.

1. In the menu click **Compare Switching Test**.
2. In **Usage Mode**, choose the type: NPN Transistor, PNP Transistor, N/P-channel JFET, N/P-channel MOSFET, TRIAC etc. The diagram shows how to connect the probes.
3. Identify the terminals in the component datasheet and connect according to the table.
4. Watch the curve and the percentage. To use a reference, capture a good component with **Capture Channel 1 [Z key]** and compare the others.

Component	Channel 1 (red)	Channel 2 (black)	GND (green)
NPN transistor	Collector	Base	Emitter
N-channel MOSFET	Drain	Gate	Source
IGBT	Collector	Gate	Emitter
TRIAC	MT2	Gate	MT1

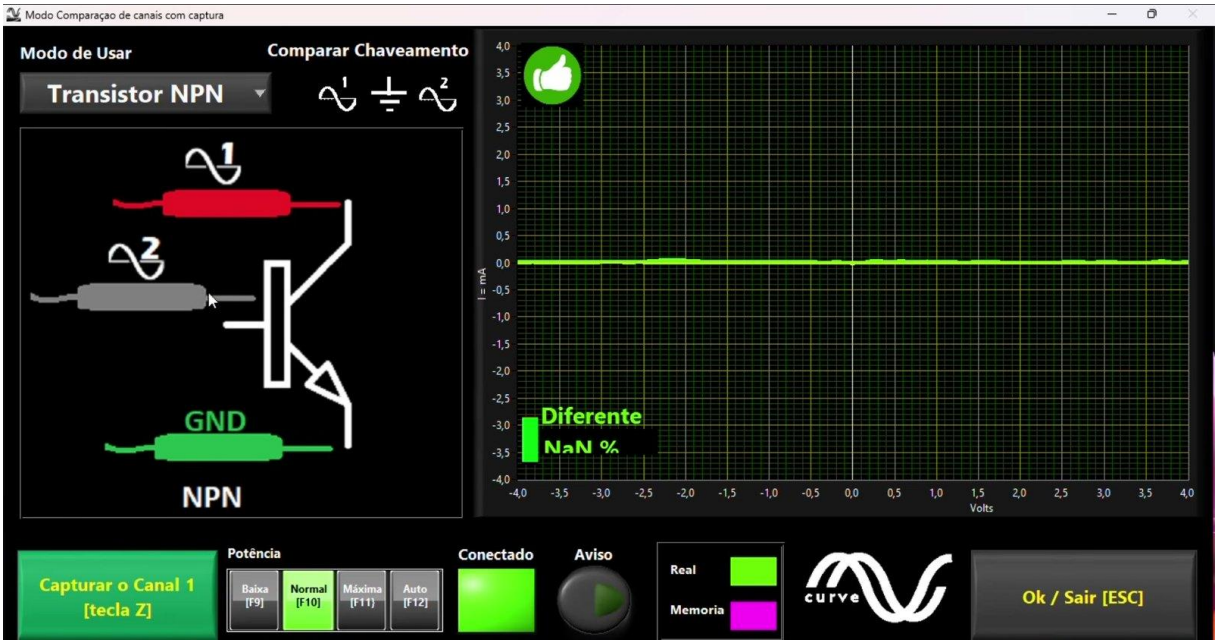


Figure 55 – Selecting the type (NPN Transistor) and connection diagram

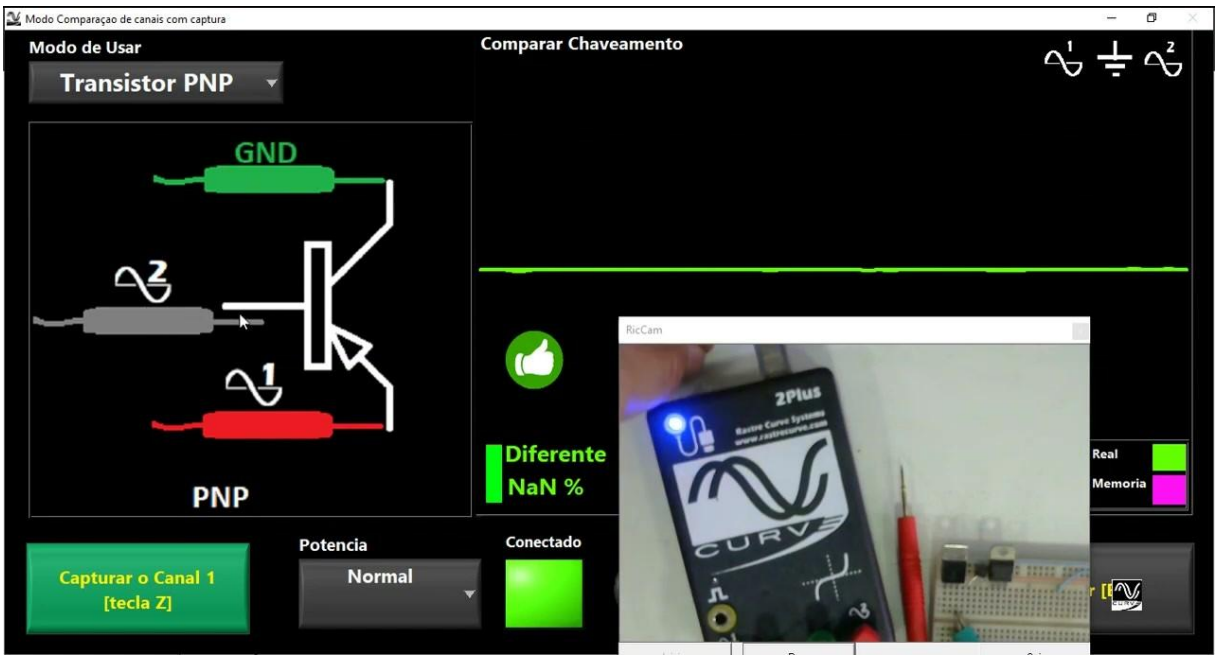


Figure 56 – PNP Transistor mode: connection diagram (Channel 1, Channel 2 and GND)

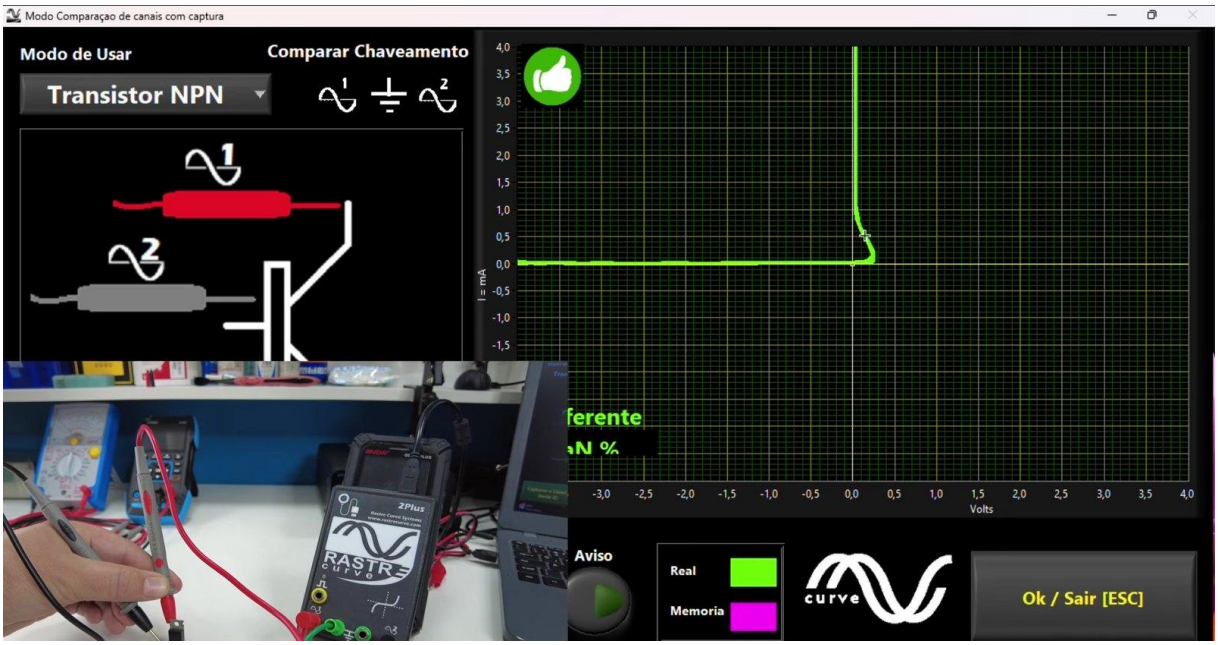


Figure 57 – TIP41C (NPN) conducting normally from ~0.3 V

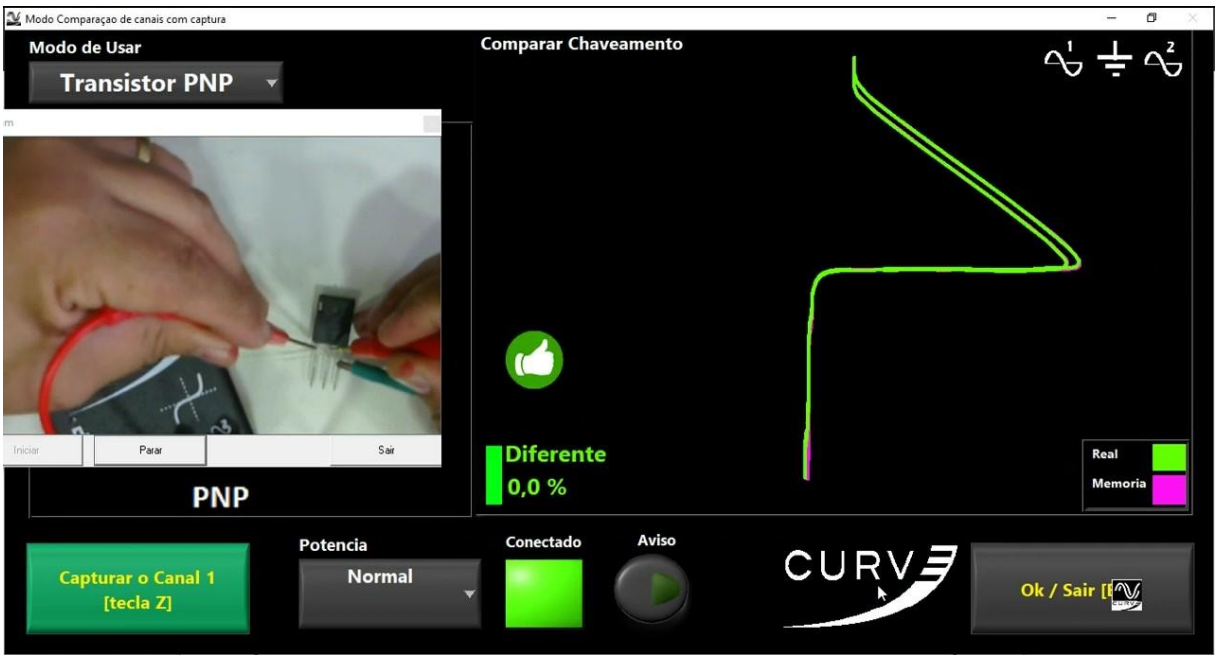


Figure 58 – Good transistor: curve equal to the memory (0.0%) and thumbs-up

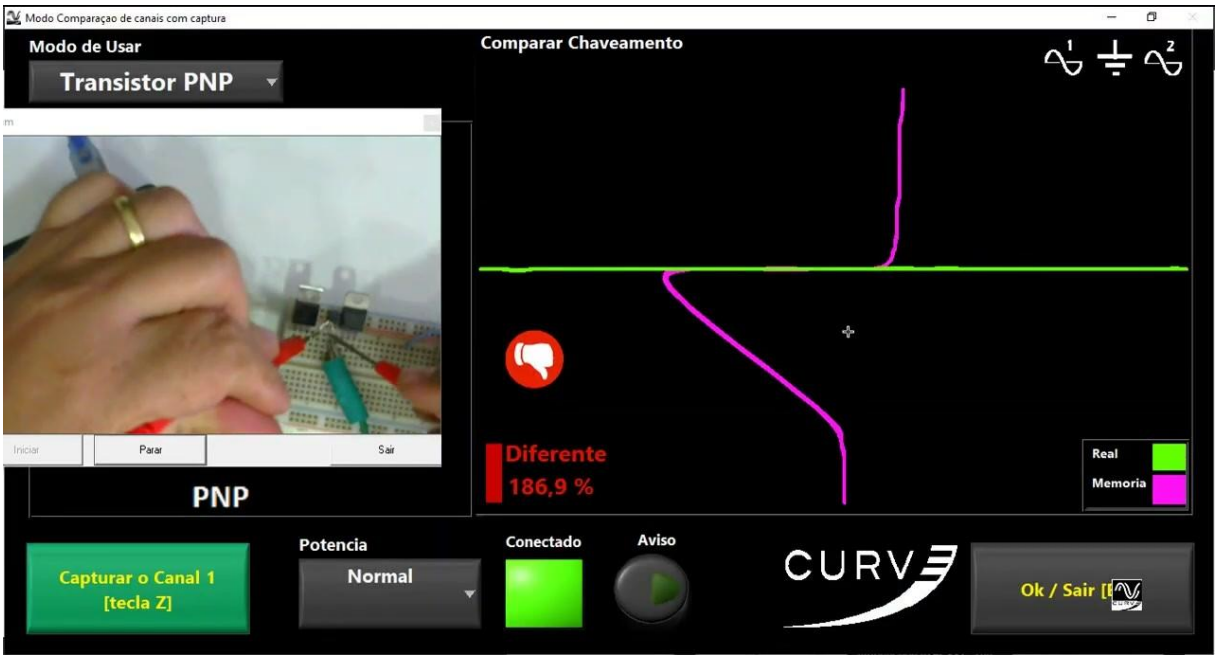


Figure 59 – Faulty transistor: curve different from the memory (186.9%)

Result	Meaning
95–100%	Identical component or perfect equivalent.
85–95%	Functional, with small acceptable variations.
70–85%	Suspicious – analyze the shape of the curve.
Below 70%	Probably faulty.

- **Shorted**: permanent conduction, no response to the base/gate drive.
- **Open**: no conduction during the whole cycle.
- **Leaky**: residual conduction in the cut-off region (raised baseline).
- **Damaged gate/base**: no switching transitions, only capacitive variations (common in MOSFETs after electrostatic discharge).

NOTE

The switching test can be performed with the component **on or off the board**. The same principle of 2 independent channels can also be applied on the Lite model, through the Compare with 2 Channels mode.

15. Pulse Test

Generates **two pulses** synchronized with the test sine wave through the **yellow** terminal: Pulse 1 in the positive half-cycle (0° to 180°) and Pulse 2 in the negative half-cycle (180° to 360°). This makes it possible to trigger the gate/base and observe the real switching of transistors, MOSFETs, TRIACs, SCRs and optocouplers.

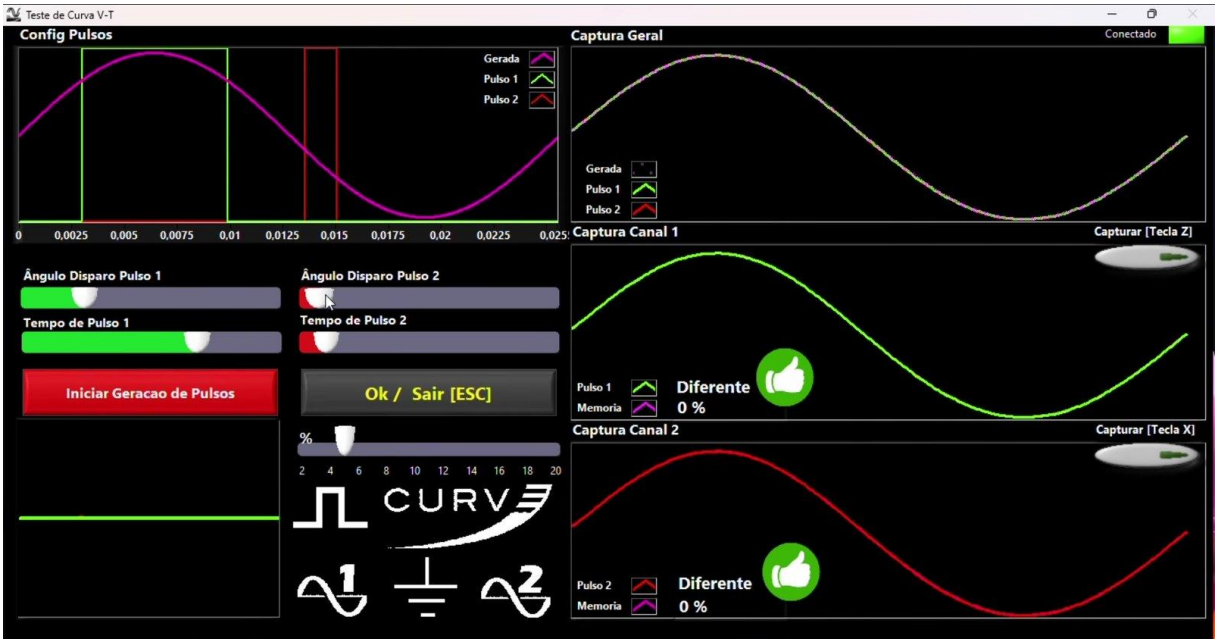


Figure 60 – Pulse Test screen (V-T Curve Test)

15.1 Controls

- **Pulse 1 / Pulse 2 Firing Angle**: point of the sine wave where each pulse starts. Avoid 0° (zero crossing); values of 30° to 45° are a good start. For TRIACs use symmetrical angles (e.g. 45° and 225°).
- **Pulse 1 / Pulse 2 Time**: duration of each pulse.
- **Start / Stop Pulse Generation**: turns the pulses on and off (the equipment LED blinks while generating).
- **General Capture**, **Channel 1 Capture** and **Channel 2 Capture**: show the generated sine wave, the pulses and the responses. **Capture [Z Key]** and **[X Key]** store the responses of channels 1 and 2 for comparison ("Different" percentage and thumbs-up/down).
- The **%** slider (2 to 20) adjusts the comparison tolerance.

15.2 Connections

Component	Yellow (pulse)	Channel 1 (red)	GND (green)	Suggested pulse
NPN transistor	Base	Collector	Emitter	1–3 ms
N-channel MOSFET	Gate	Drain	Source	0.5–2 ms, near the peak of the sine wave
TRIAC	Gate	MT2	MT1	2–5 ms, in both half-cycles
SCR	Gate	Anode	Cathode	2–4 ms in the positive half-cycle
Optocoupler	LED anode	Phototransistor collector	LED cathode / emitter	1–3 ms

15.3 Example: N-channel MOSFET (2SK3680)

Before the pulse, Channel 1 shows only the conduction of the body diode. When you click **Start Pulse Generation**, the MOSFET starts switching and the curve changes; when stopped, it returns to the previous state – a sign that the component is in good condition. A good SCR must **keep conducting** after the pulse until the zero crossing; a good TRIAC must trigger **symmetrically** in both half-cycles.

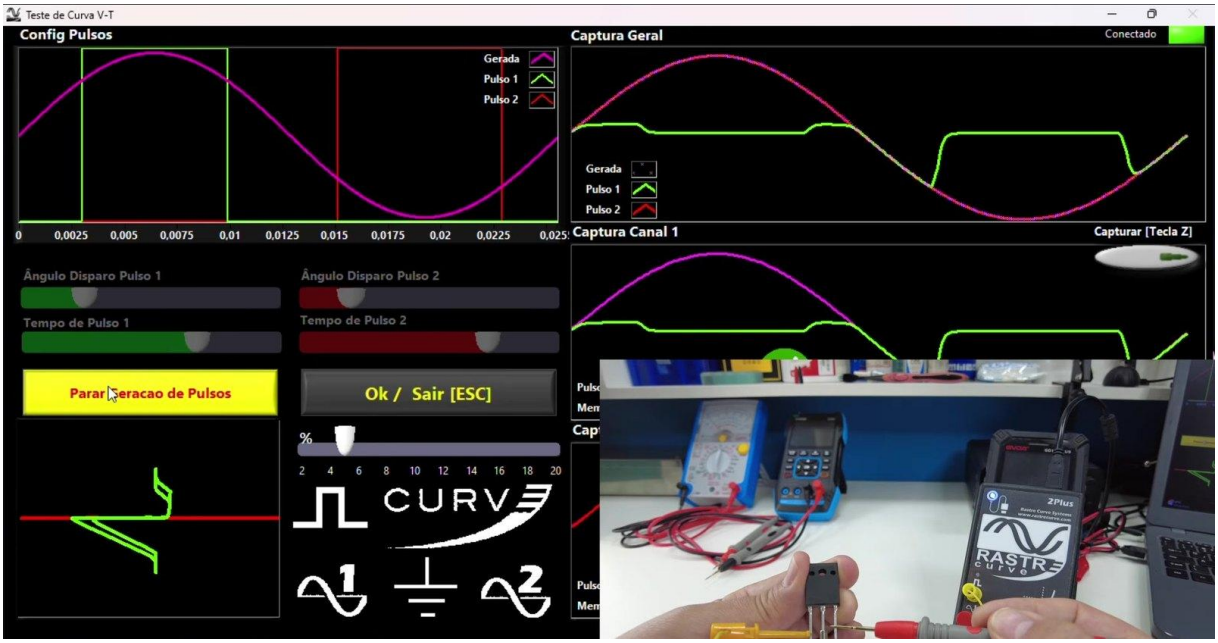


Figure 61 – MOSFET switching with the pulses active

15.4 Example: SCR and TRIAC

SCR: yellow (pulse) on the **gate**, Channel 1 on the **anode** and GND on the **cathode**. Set Pulse 1 in the positive half-cycle and click **Start Pulse Generation**. Without a pulse there is no response (high impedance); with a pulse, the SCR **conducts only in the positive half-cycle**, from the firing point to the zero crossing.

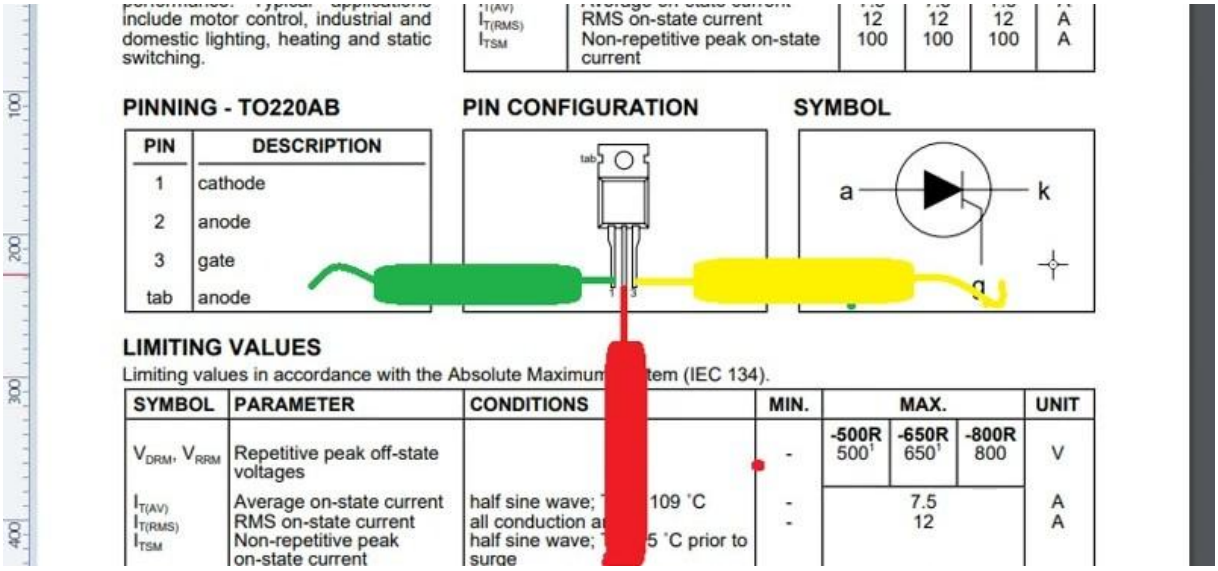


Figure 62 – SCR connection: GND (green) on the cathode, Channel 1 (red) on the anode, pulse (yellow) on the gate

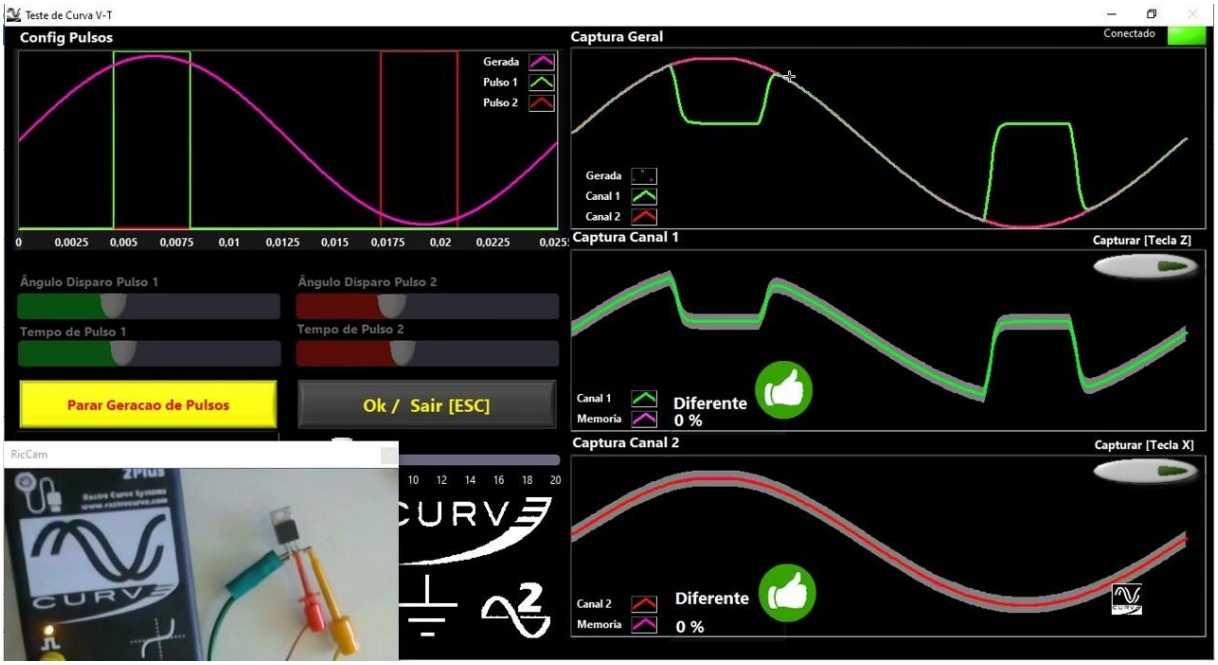


Figure 63 – SCR firing in the positive half-cycle, equal to the memory (0%)

TRIAC (e.g. TIC216): GND on **MT1**, Channel 1 on **MT2** and yellow on the **gate**. A good TRIAC conducts **in both half-cycles** (Pulse 1 and Pulse 2). Capture the response of a good component with **Capture [Z Key]** and compare: a different response (e.g. 28.81%) indicates irregular triggering.

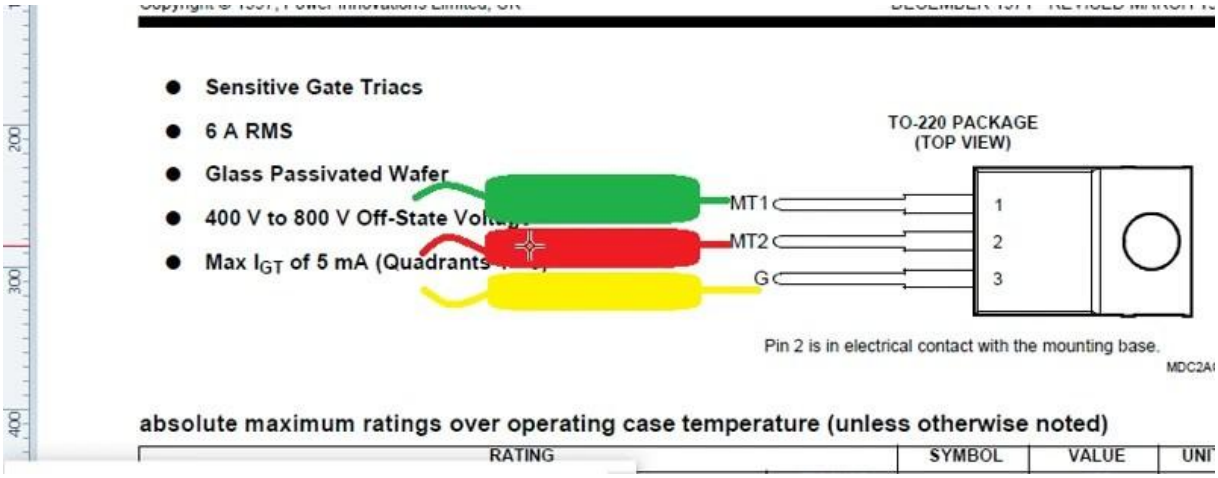


Figure 64 – TRIAC connection: GND on MT1, Channel 1 on MT2 and pulse on the gate

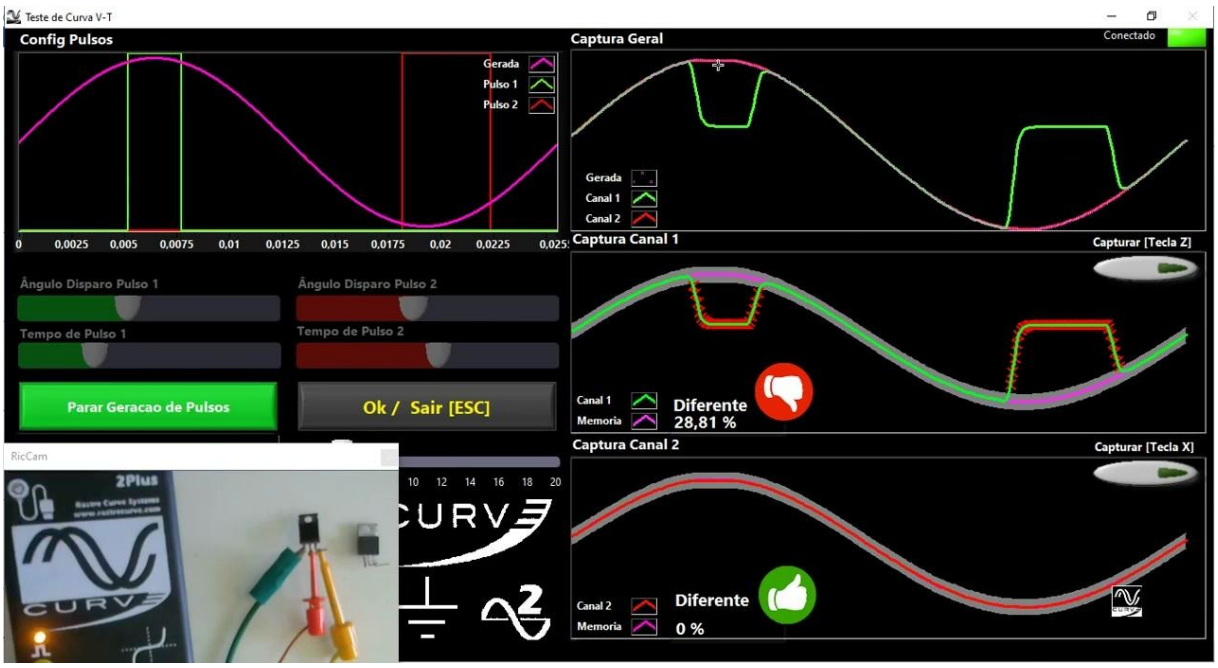


Figure 65 – TRIAC compared with the memory: 28.81% difference

15.5 Example: optocoupler with the pulse test

PC817 optocoupler: **pulse (yellow) on pin 1** (LED anode), **GND on pin 2**, **Channel 1 on pin 4** (collector) and the other **GND on pin 3** (emitter). Without pulse generation there is no response; when you click **Start Pulse Generation**, the LED is biased and the phototransistor conducts exactly during the pulses (Response 1 and Response 2).

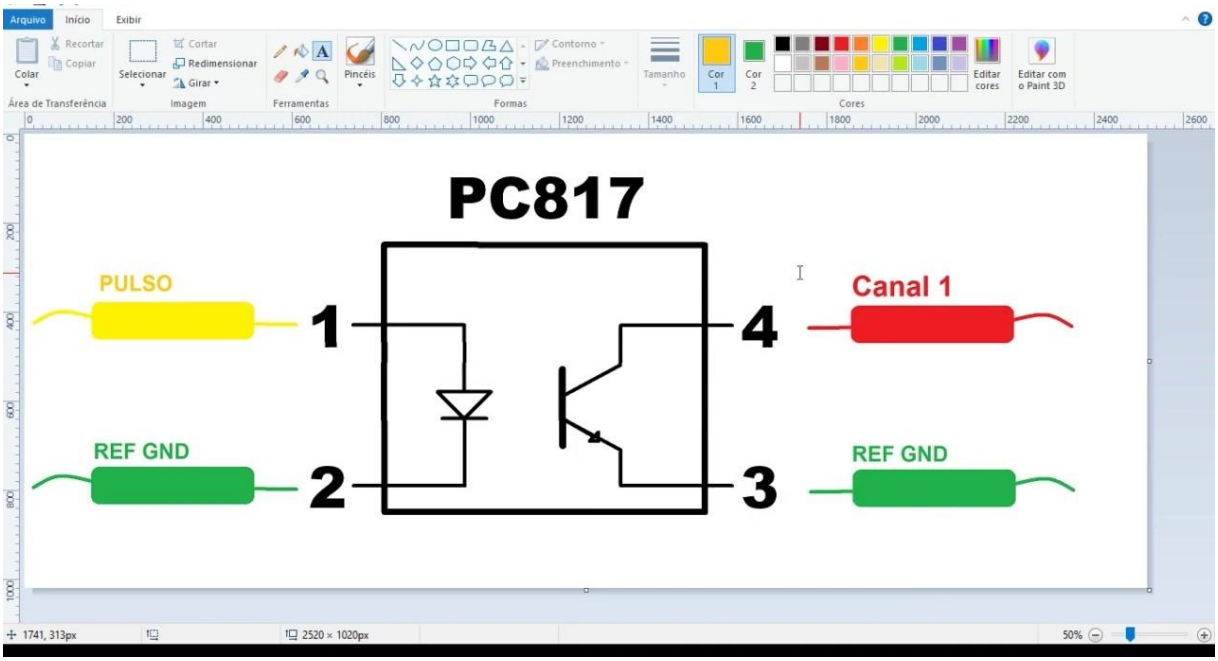


Figure 66 – PC817 connection for the pulse test

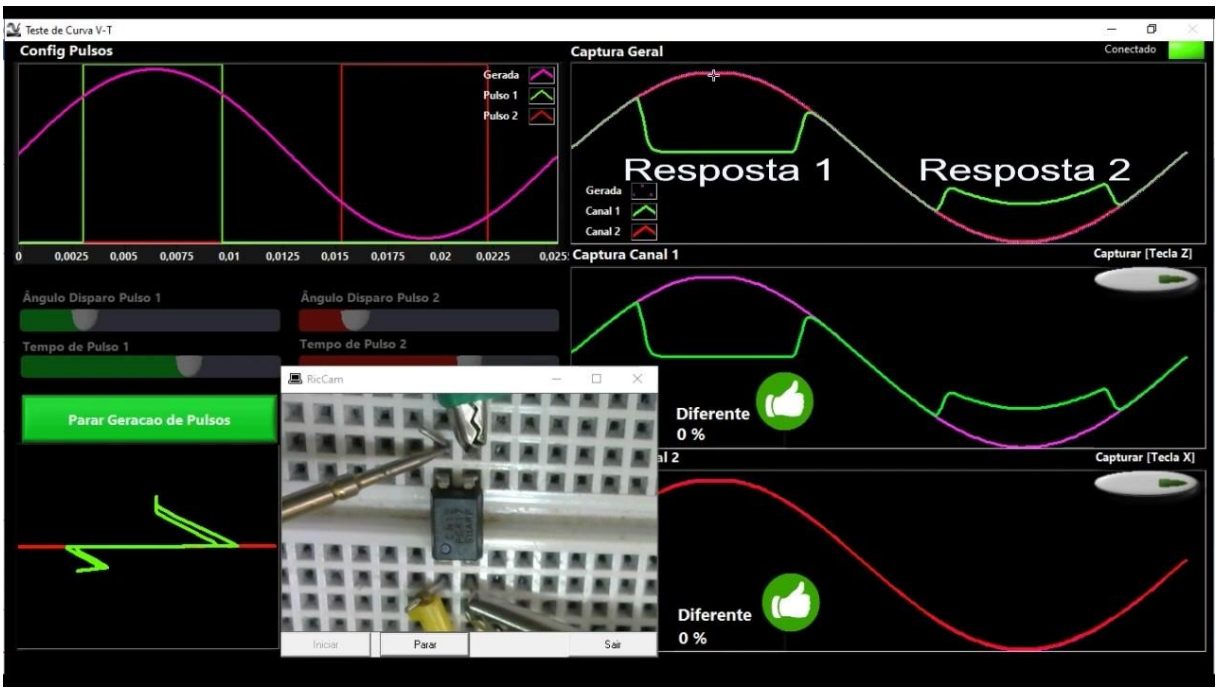


Figure 67 – Phototransistor response to the two pulses

16. Saturation Test

The saturation test helps find components that are **leaky, saturated or "worn out"** and **consumption variations** in a circuit – faults that often **do not show up** in the common VI curve. A voltage is generated and applied to the circuit and, during this supply, **three 1.5 ms modulated signals** are injected at intervals; the equipment monitors the **reaction time and the response** of the component or point under test.

The supply comes from the RastreCurve itself: the **yellow** terminal provides **5 V through a 10 kΩ series resistor** (an impedance that limits the current). This makes it possible to detect impaired saturation, leakage, resistance changes in the net and changes in consumption.

16.1 With Voltage or Without Voltage

When you open **Saturation Test**, the "Attention before Proceeding!!!" screen asks you to choose the mode. **Position the probes before choosing** and keep them in place until the end of the test:

- **With Voltage**: the 5 V voltage is generated on the yellow (pulse) terminal. Connect the **yellow to the positive (VCC)** of the circuit/IC and the **green to the negative (GND)**; Channel 1 goes on the point to be monitored.
- **Without Voltage**: the yellow terminal does not generate voltage; use only GND and Channel 1 on the point to be monitored.

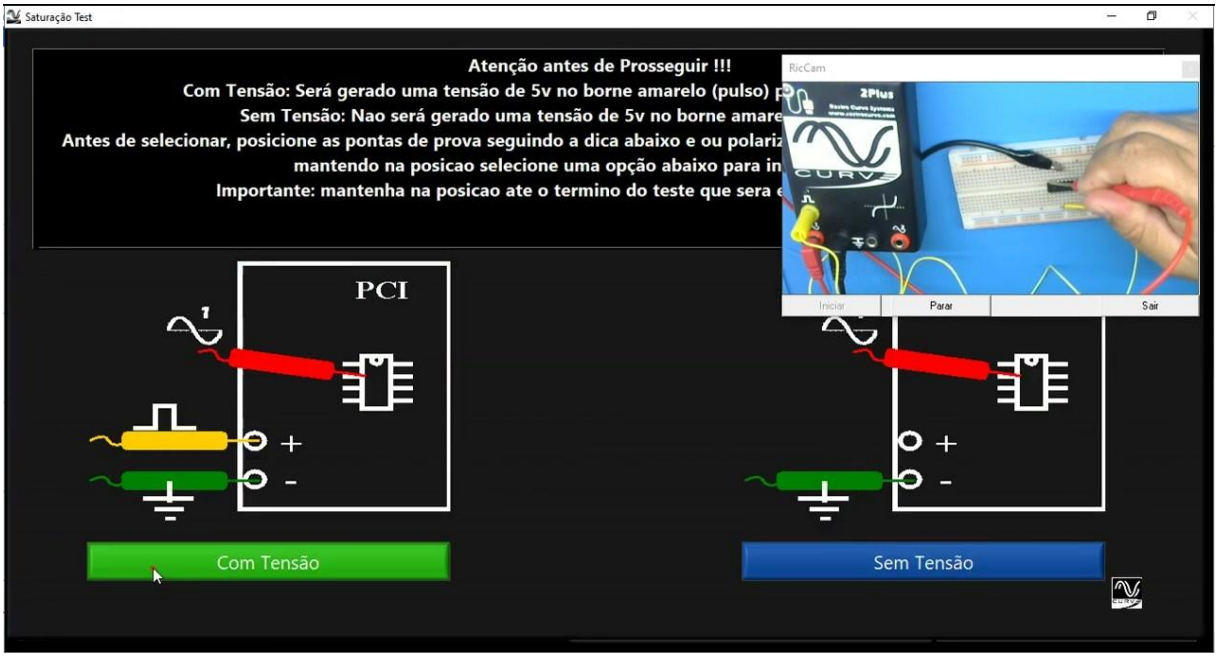


Figure 68 – Choosing the mode: With Voltage (yellow on +, green on –) or Without Voltage

16.2 The test screen

- **Voltage Saturation Range** and **Current Saturation Range**: Min, Normal and Max curves of the current measurement and of the memory (Min/Normal/Max Mem).
- **Voltage Response** and **Current Response**: response of the point over time (up to 1.5 ms).
- **Generated Modulated Signal**: the injected signal.
- **Memorize** stores the reference response (good component/board); **Start Capture** measures; **Different %** shows the deviation relative to the memory; **Ok / Exit [ESC]** closes.

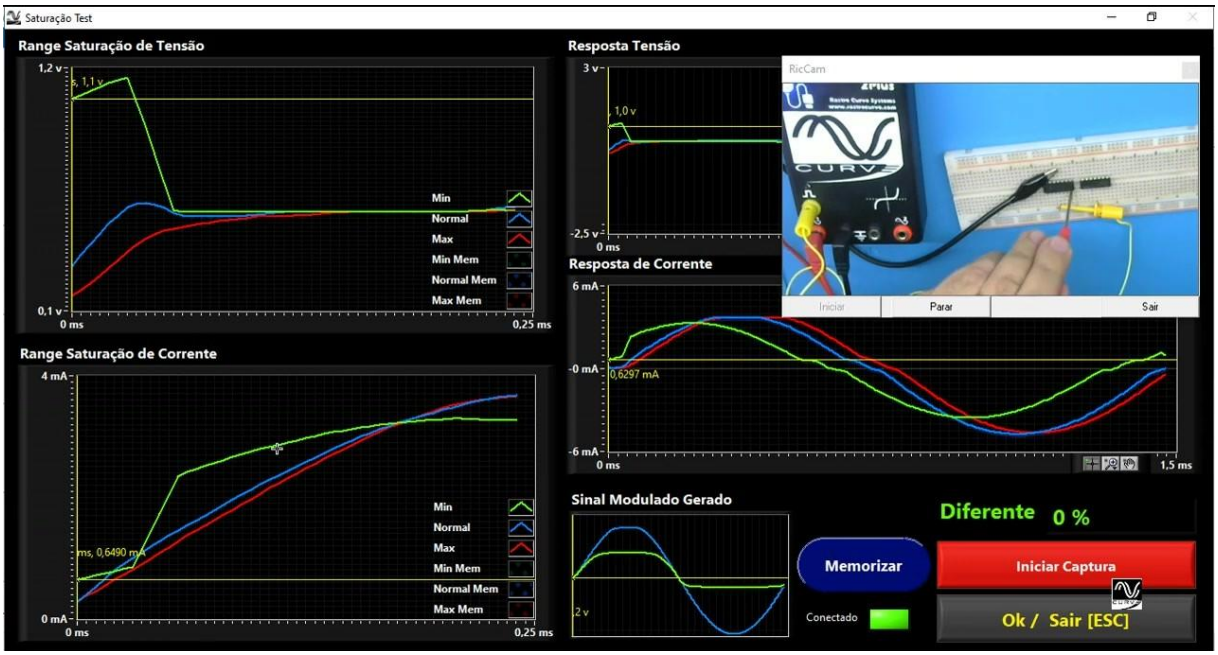


Figure 69 – Output of a good IC compared with the memory: 0% difference

16.3 Example: quad operational amplifier

An IC with four operational amplifiers had a fault on the **fourth output (pin 14)**. In the common VI curve test, inputs and outputs were **identical** to those of the other amplifiers – the fault did not show up. In the saturation test **With Voltage** (yellow on **pin 4**, VCC; GND on **pin 11**), output 1 was stored and the others were compared: outputs 2 and 3 stayed between 0% and 1.65%, and **output 4 read 177%**, revealing the faulty amplifier.



Figure 70 – Faulty output: 177% difference in the saturation test

WARNING

The board must be **disconnected from the mains and batteries**, with the capacitors discharged. The only supply applied is the 5 V / 10 kΩ provided by the RastreCurve itself – no external power supply must be connected.

In projects, use the SAT Saturation capture to store the reference together with the other curves of the component.

16.4 Recommended diagnostic sequence

1. VI curve (Normal) – screening and comparison with the reference.
2. Saturation – dynamic behavior and leakage.
3. 4 Profiles / 3D – if a frequency-dependent fault is suspected.
4. Switching / Pulses – for switching components.

17. Interpreting the curves

17.1 Characteristic curves

Even without a reference board, the shape of the curve already says a lot about the point:

Curve shape	Indicates	Remarks
Horizontal line	Open circuit (no current)	Broken trace, loose pin, open component. Very high-value resistors also look like this.
Vertical line	Short circuit / point connected to GND	Confirm with Low Power. Very low resistors and very large capacitors also tend to be vertical.
Tilted line	Resistor	The slope depends on the value (10 kΩ ≈ 45°).
Clockwise spiral / ellipse	Capacitor (or RC)	Width proportional to capacitance and frequency.
Counterclockwise spiral / ellipse	Inductor / transformer	At 4 Hz, large inductors look almost like a short.
Asymmetric exponential (knee ~0.6 V)	Diode / PN junction	B-E and B-C junctions of transistors, IC protection diodes.
Exponential + reverse step	Zener diode	The step indicates the Zener voltage.
Mixed shape (diode + resistor)	IC pin	Typical shape of TTL/CMOS IC pins.
Tilted ellipse	Resistor + capacitor	Combination of the two curves.

17.2 Example: optocoupler with 2 channels

In **Compare with 2 Channels**: Channel 1 on pin 1 (LED anode), one GND on pin 2 (cathode), the other GND on pin 3 (emitter) and Channel 2 on pin 4 (collector). Channel 1 shows the LED curve and, at the same time, Channel 2 shows the phototransistor tilting (conducting). Without the signal on the LED, Channel 2 stays flat (no conduction).

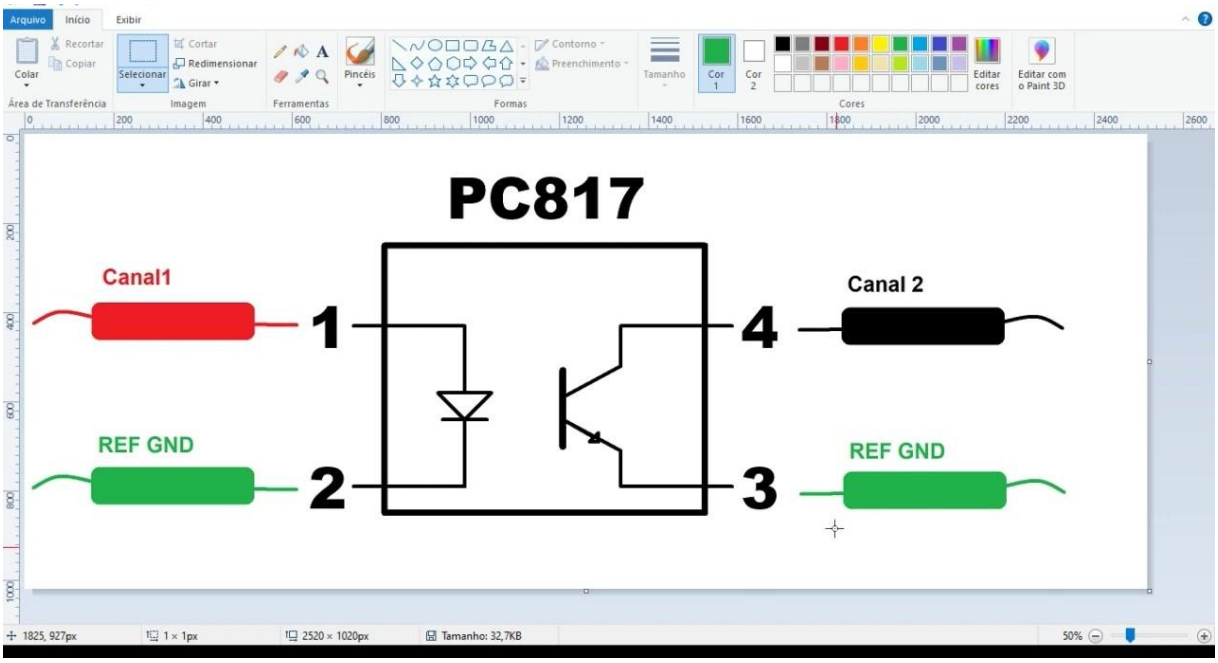


Figure 71 – PC817 connection in Compare with 2 Channels

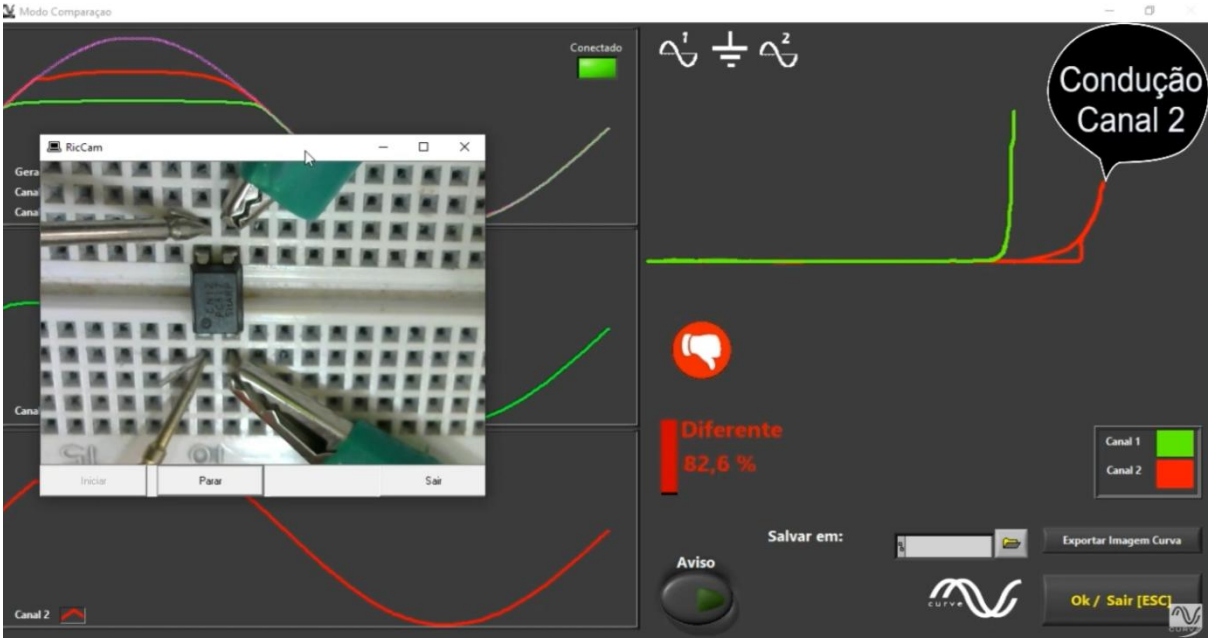


Figure 72 – Optocoupler: LED on Channel 1 and phototransistor conducting on Channel 2

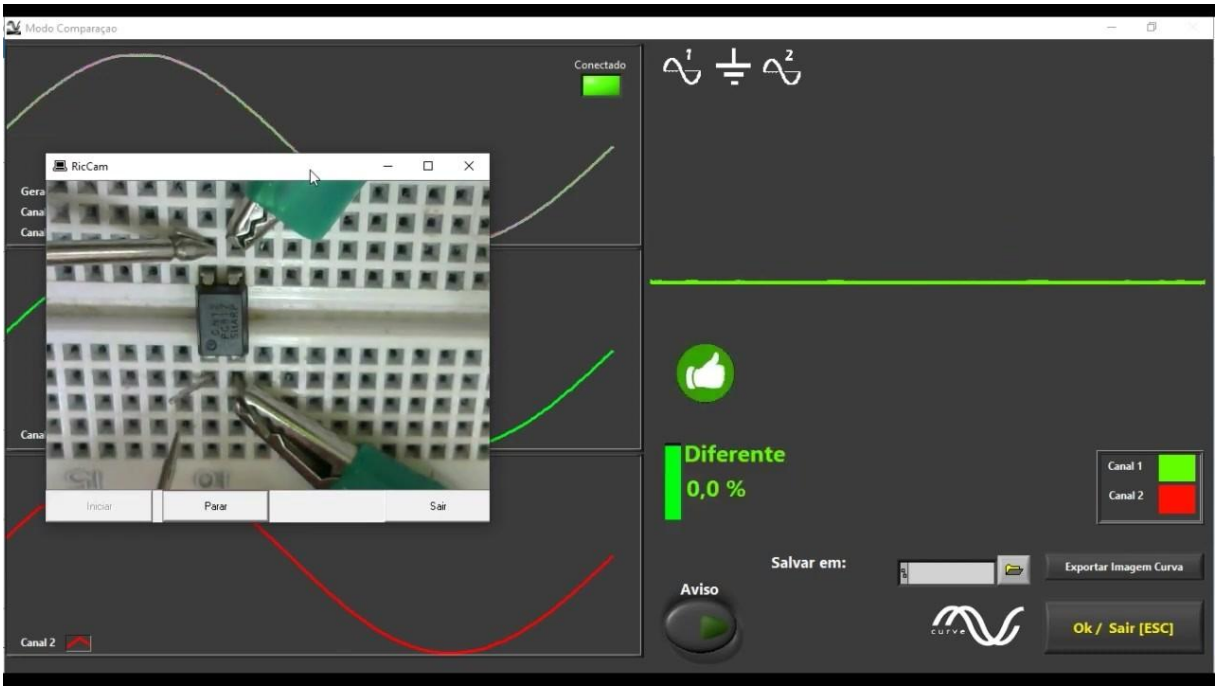


Figure 73 – Channel 2 conducting when the LED is biased by Channel 1

The same test works on the **Lite** model. On the 2Plus, the optocoupler can also be tested with the **Pulse Test** (section 15.5).

18. Curve Cloud and Unified Curve System

18.1 Curve Cloud (in the software)

The **Curve Cloud** gathers more than 1,100 free projects created by the community (automotive, air conditioning, agricultural, fitness equipment, amplifiers, industry…). You do not need to have every good board to build your database.

1. In the menu click **Curve Cloud** and select the **2Plus** version; the software checks the connection and loads the list.
2. Use **Search** to filter and click a curve to see the information on the server.
3. Click **Download to your PC**. The project will then appear in **Curves in the System**.

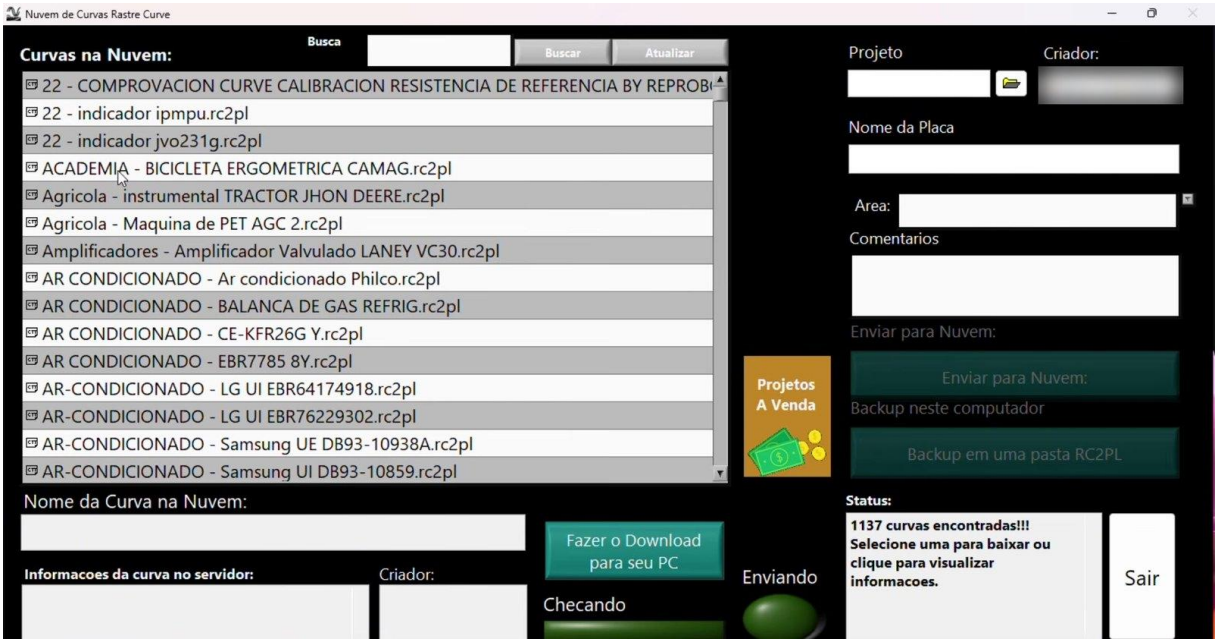


Figure 74 – Curve Cloud: 1,137 curves available at the time of recording

To **contribute**, select your project, fill in **Board Name**, **Area** and **Comments** and click **Send to Cloud**. The **Backup to an RC2PL folder** button creates a local copy; in the menu, **Backup/Share RC2PL** exports the project and **Import RC2PL Curve** imports received files. Projects can be protected with a password and serial number.

On the **rastrecurve.com** website there is also the curve database, the discussion forum by area, the software download and explanatory videos. There are also WhatsApp user communities by specialty.

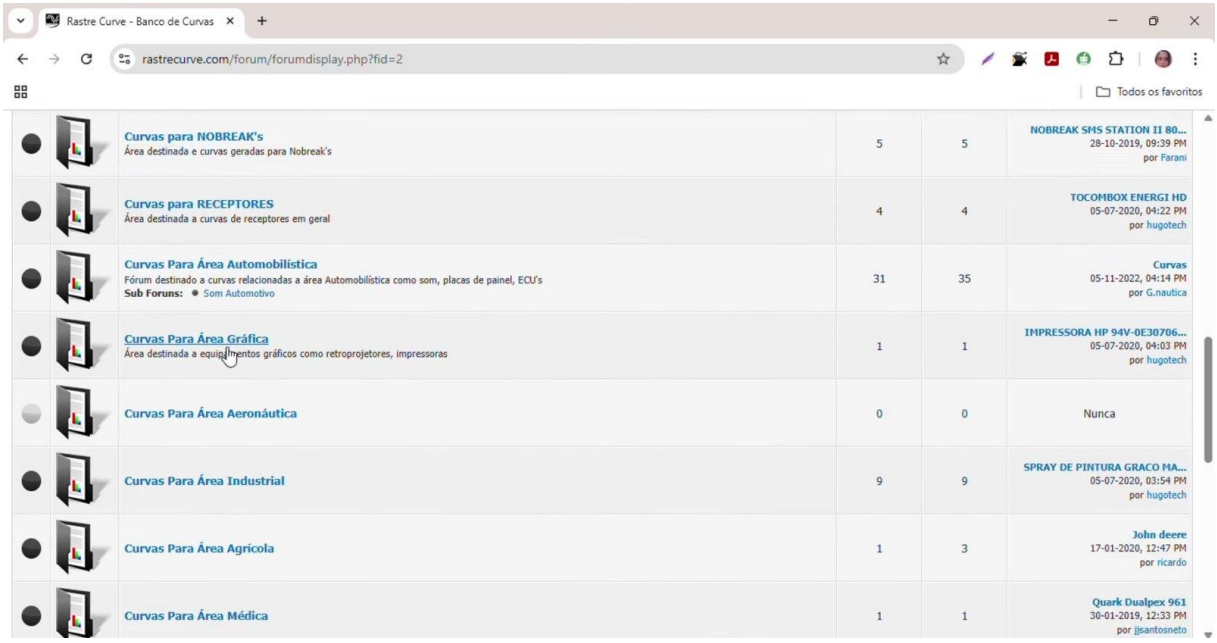


Figure 75 – Forum and curve database on the rastrecurve.com website

18.2 Unified Curve System (v1.9902)

The **Unified Curve System** is the new RastreCurve community portal. It gathers in one place the curves of the **2Plus and Lite** (and also those of the Mini, 10 Vpp and 20 Vpp models, in tabs), as well as videos, rewards, ranking and gift shop. Access it with the blue **Unified Curve System** button on the main menu.

Registration and login

1. On the first access click **Register**: enter a **user name**, the **equipment serial number** and a **password**, and click **Validate Registration**.
2. On subsequent accesses, go to **Login** with your user name and password. Check **remember user/password** so you do not have to type them again.

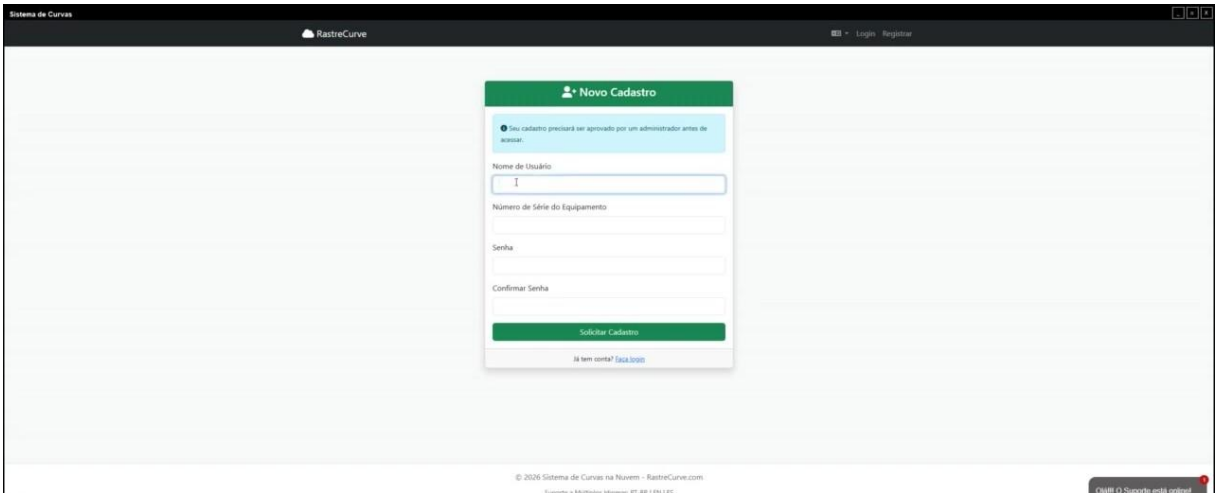


Figure 76 – Registration in the Unified Curve System

Dashboard

The home page shows the **Latest Curves**, the **Featured Rewards**, the **Latest Videos Posted**, the **Quick Chat** with whoever is online and the new members of the **Community**. The top menu gives access to **Home, Curves, Videos, Rewards, Ranking, Gift Shop and Portals**; on the right are the **notifications**, the **language** (Portuguese, English and Spanish) and your **profile**.

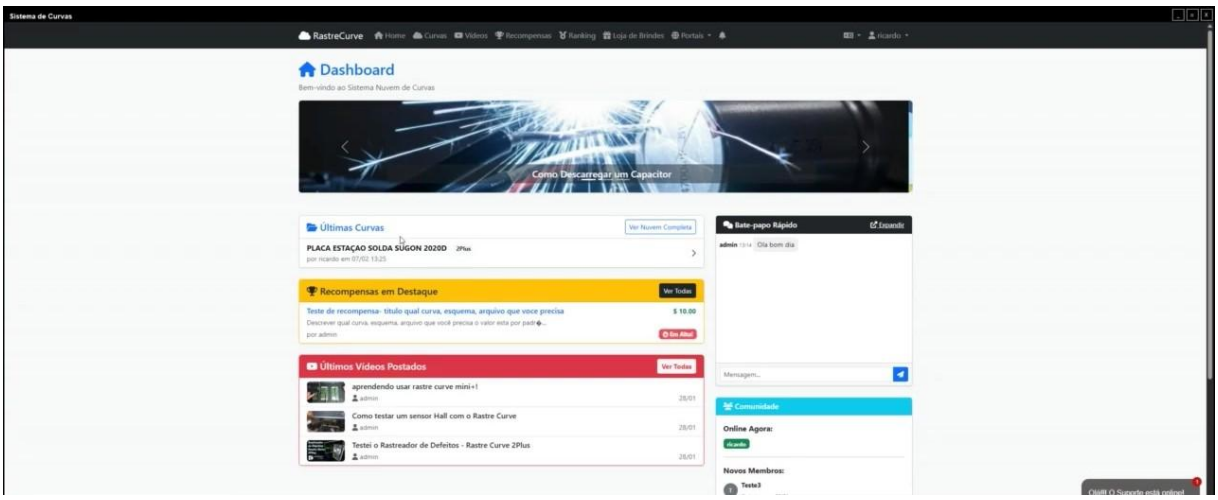


Figure 77 – Unified Curve System dashboard

Curves: search, view and download

- Browse the **2Plus/Lite**, **MINI**, **10vpp** and **20vpp** tabs or search by **name, description, user** or **category** (automotive, industrial, computing…).
- **Peek** opens the preview; right-click the photo and use **Enlarge image** to see details of the board.
- **Download**: if the 2Plus (or Lite) software is installed, the file is **unzipped automatically** and sent to your curve database; otherwise, save it and import it later (**Import RC2PL Curve**).

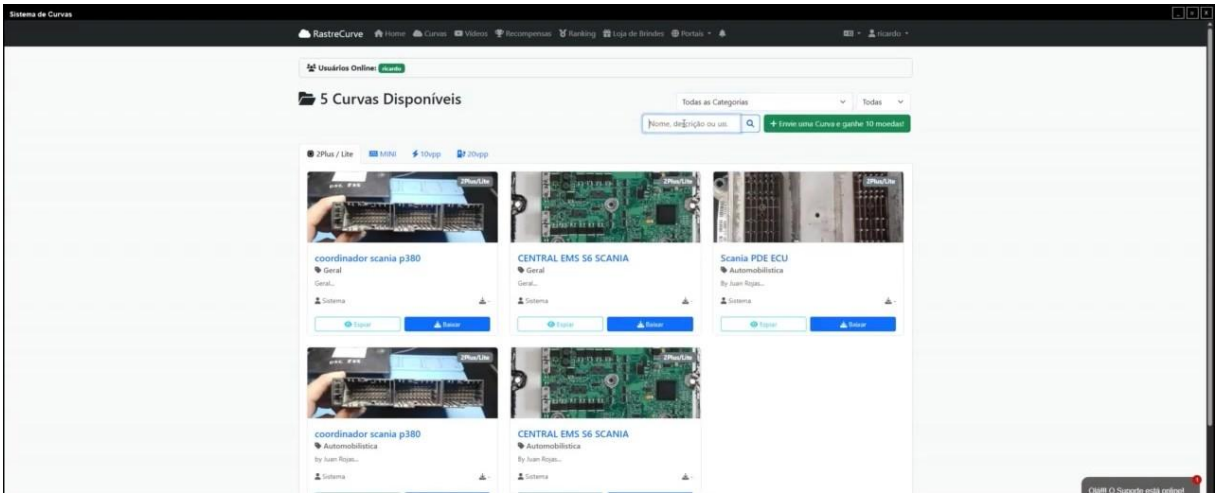


Figure 78 – Curves available on the portal

On the page of each curve there is the **Version History** (the author can publish corrections and you can download any version), the **Questions about the File** field to talk to the author and the **Ratings and Comments** (1 to 5 stars).

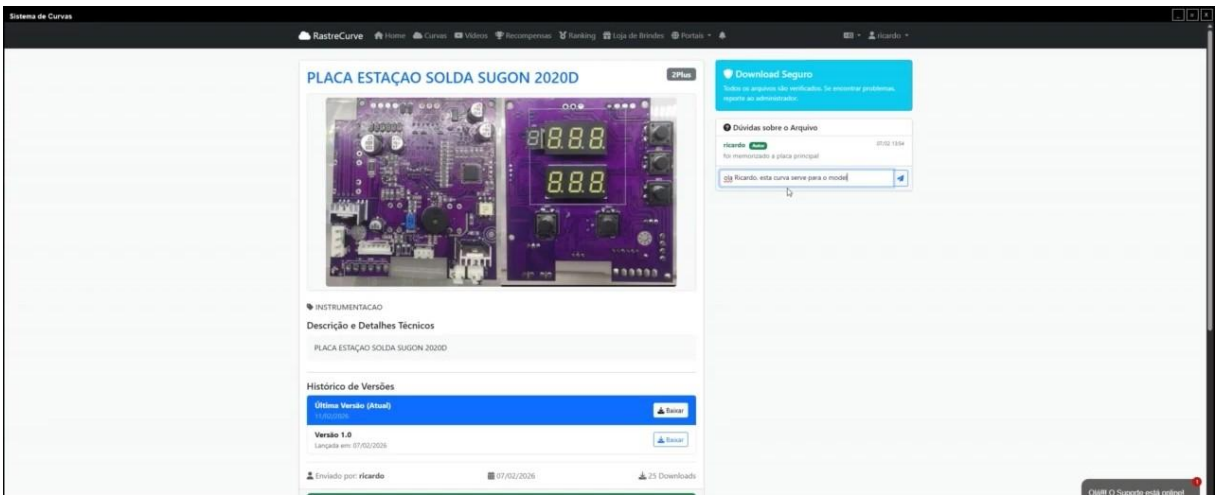


Figure 79 – Curve page: versions, download and questions to the author

Uploading a curve

Click **Upload a Curve and earn 10 coins!** and fill in **Curve Name**, **Category**, **Equipment Model**, **Notes and Details**, the **photo** (preview) and the **curve file**. Check **Is this a curve FOR SALE (Ad)?** if you want to sell it: enter the price, WhatsApp, e-mail and a **password**, which you release only to whoever pays. Without the sale option, the curve is free for everyone.

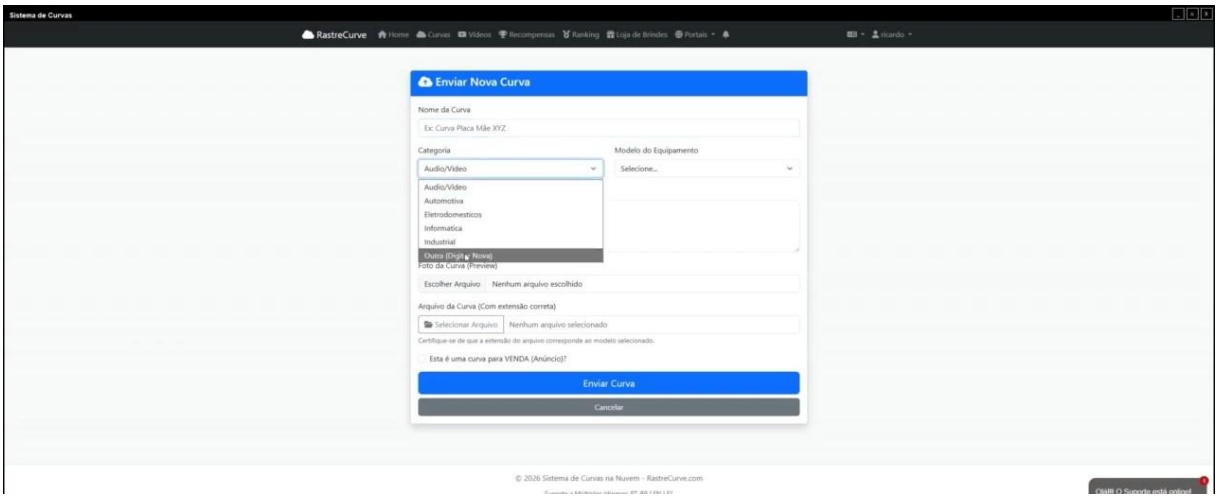


Figure 80 – Upload New Curve form

Coins, ranking and gift shop

Coins are **virtual points** of the system – **they are not money**. They accumulate as you use the portal and publish content. Each **curve** or **video** posted is worth **10 coins**, and the author also earns coins from **positive ratings**. Coins count toward the **Ranking** and can be exchanged in the **Gift Shop** (at the time of the video: key ring 50, needle test probe 120, mug 160 and T-shirt 200 coins). When redeeming, enter your name, tax ID and address; progress and tracking appear in **Track My Redemptions**. The coin **statement** is in your profile.

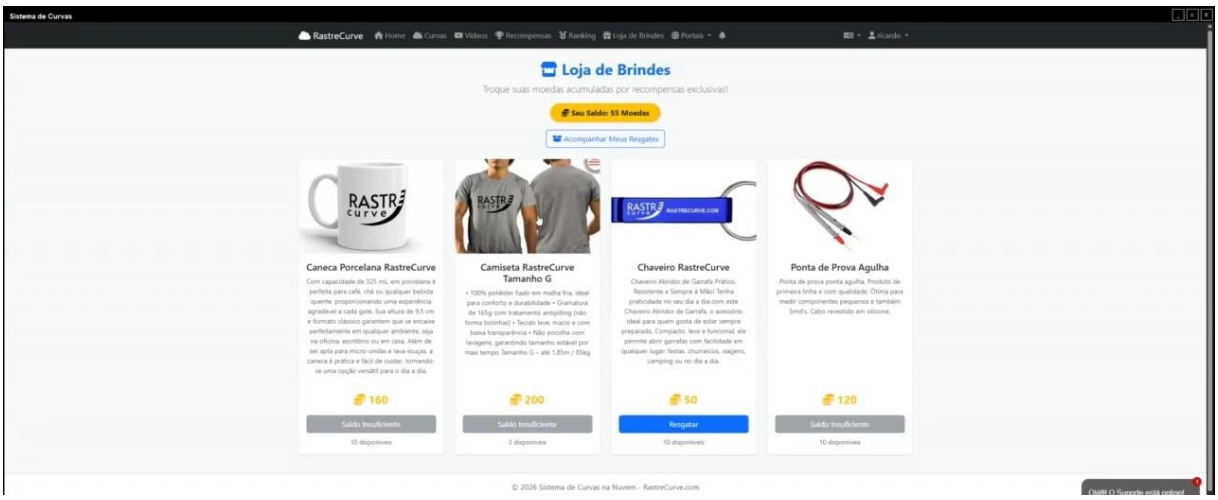


Figure 81 – Gift Shop

Rewards

Need a curve (or schematic, file) that nobody has published? Create a **reward** (unlike coins, here the amount offered is actually paid between users): click **Create a reward**, describe what you need, set the **share value** and, if you wish, attach a reference photo. Other interested users can **join** with the same share, increasing the total amount.

- Whoever **fulfills** the reward uploads the file, which is **held in escrow on the server**, and controls its release: they release the download to those who paid and block those who did not.
- Payment is arranged **directly between the users** (for example, by bank transfer); RastreCurve **charges no commission** and is not responsible for transactions made outside the system. In case of a problem, there is a feedback channel with the administrator.

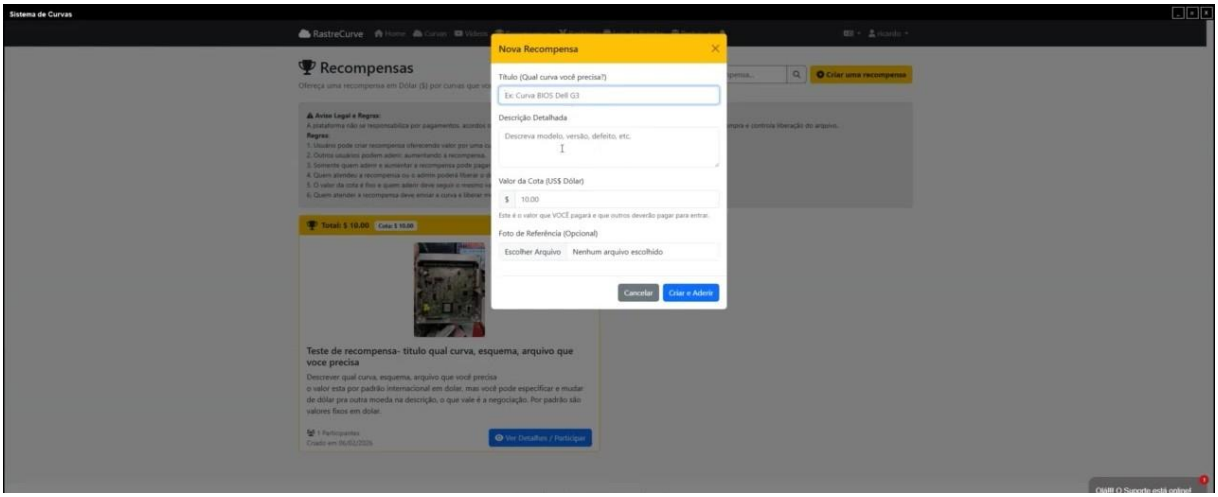


Figure 82 – Creating a new reward

Portals

The **Portals** menu gathers support, forum, feed, help center, training course, repair tips, YouTube channels, the RastreCurve book and the software download.

19. Tips and troubleshooting

Symptom	Probable cause	Solution
Curve oscillates / does not repeat	Active oscillator on the board (crystal, multivibrator); hand on the board	Disable the oscillators; place a 10 kΩ resistor between VCC and GND (or between the channel and GND); change the GND reference (for example, to the positive); do not touch the board.
Almost all curves vertical	Large capacitors at many points	Use Low Power (4 Hz). If necessary, remove the large capacitors.
Irregular curve on IC with charge pump (MAX232, ICL7660)	Internal charge pump voltage conflicts with the signal	Low Power + remove the external charge pump capacitors, or place a resistor between the channel and GND.
Identical ICs with different curves	Different manufacturers (typical on reset, set, preset, clear)	Normal on 1–2 pins; suspect a fault if it occurs on several pins.
No fault found, board does not work	Internal fault in memory, processor or IC that runs hot	Test these ICs carefully (Maximum Power / Saturation); test them off the board if possible.
Small difference only in the center of the graph	Altered internal parameter (e.g. out-of-value bypass capacitor)	High attention – it may be the real fault. Mark the pin as bad and investigate the net.
Board with more than one ground	Separate GND nets	Bridge the grounds during the test or store in stages, noting it in the description.
“Device not found”	USB cable, port or driver	Change the port/cable; reinstall the driver (section 6.5); check the Connected indicator.
Inconsistent results	Poor contact, oxidized probe tips, temperature	Clean the probe tips with isopropyl alcohol; wait for thermal stabilization; check the leads.

TIP

Real example: a power supply with the TNY IC did not work. The only difference was on the BYPASS pin: the 100 nF ceramic capacitor was measuring less than 20 nF, causing the IC to shut down. **A small difference can be the fault.**

20. Quick key reference

Screen	Keys
Edit Project	F2 Zoom • F3 Resize • F4 Move • F5 Select/Edit • F6 Ground (GND) • F7 Mark • F8 Text and Arrows • F9 Insert + Curve • F12 View curves • ESC Ok & Save
Component data	PAGEDOWN Capture Normal Mode • PAGEUP 3-Pin Mode • HOME Save and return
New Curve	F7 Normal • F8 3 Pins • F9 VT Pulses • F10 Saturation • F11 4 Profiles 3D • F12 Impedance • HOME OK • ESC Cancel
Recording Mode	Space Record Curve • Z Back • ESC Save & Close • F9 Low • F10 Normal • F11 Maximum • F12 Auto
Test Mode	Space Ok and Next Pin • DEL Mark Bad Pin • Z Back • X Forward • ESC OK & Exit
Board Test Mode	F2 Zoom • F3 Resize • F4 Move • F5 Select • F6 View Test Curves
Impedance Test	HOME Calibrate short circuit • Space Record • Z Back • ESC Save & Close
Switching / Pulses	Z Capture Channel 1 • X Capture Channel 2 • ESC Ok / Exit
Edit Curves (v1.9902)	Space Capture Curve • Z Back • X Forward • DEL Cancel and Exit • ESC Save and Exit • right-click on the pin: delete pin
Pin marking (v1.9902)	ESC Exit and Save

21. Warranty and support

RastreCurve products have a **3-month** warranty against manufacturing defects, counted from the invoice date, in accordance with the consumer protection legislation that applies to the sale. Even after the warranty period, RastreCurve does not charge labor for repairs – only shipping and components at cost price. Returns are accepted only by prior agreement and within **7 days** of receipt.

Access to technical support, software updates and the Curve Cloud is free of charge.

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Sales	comercial@rastrecurve.com • +55 17 99118-0770
Support / WhatsApp	+55 17 99118-0770 • ricardo@rastrecurve.com
YouTube	youtube.com/@Rastrecurve
Company	RastreCurve Indústria de Equipamentos Eletrônicos Ltda – CNPJ (Brazilian company ID) 48.044.677/0001-58 – Rua Silvio Caldas, 2049, Nato Vetorasso – ZIP 15042-103 – São José do Rio Preto, SP – Brazil



Thank you for being part of this family!!!