X WORKSPOT

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Automation of tests on substation equipment through a multifunctional tool capable of performing tests at primary and secondary levels

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Abstract

- Increasingly **competitive** market
- ↑ Electricity Availability = ↑ **Invoicing**
- **Periodic monitoring** of assets is necessary, ensuring perfect functioning of these
- This work presents a portable tool capable of performing tests at **primary and secondary levels**
- Practical tests will be carried out, aiming to demonstrate its potential to **automate** maintenance and commissioning processes

Why take commissions?

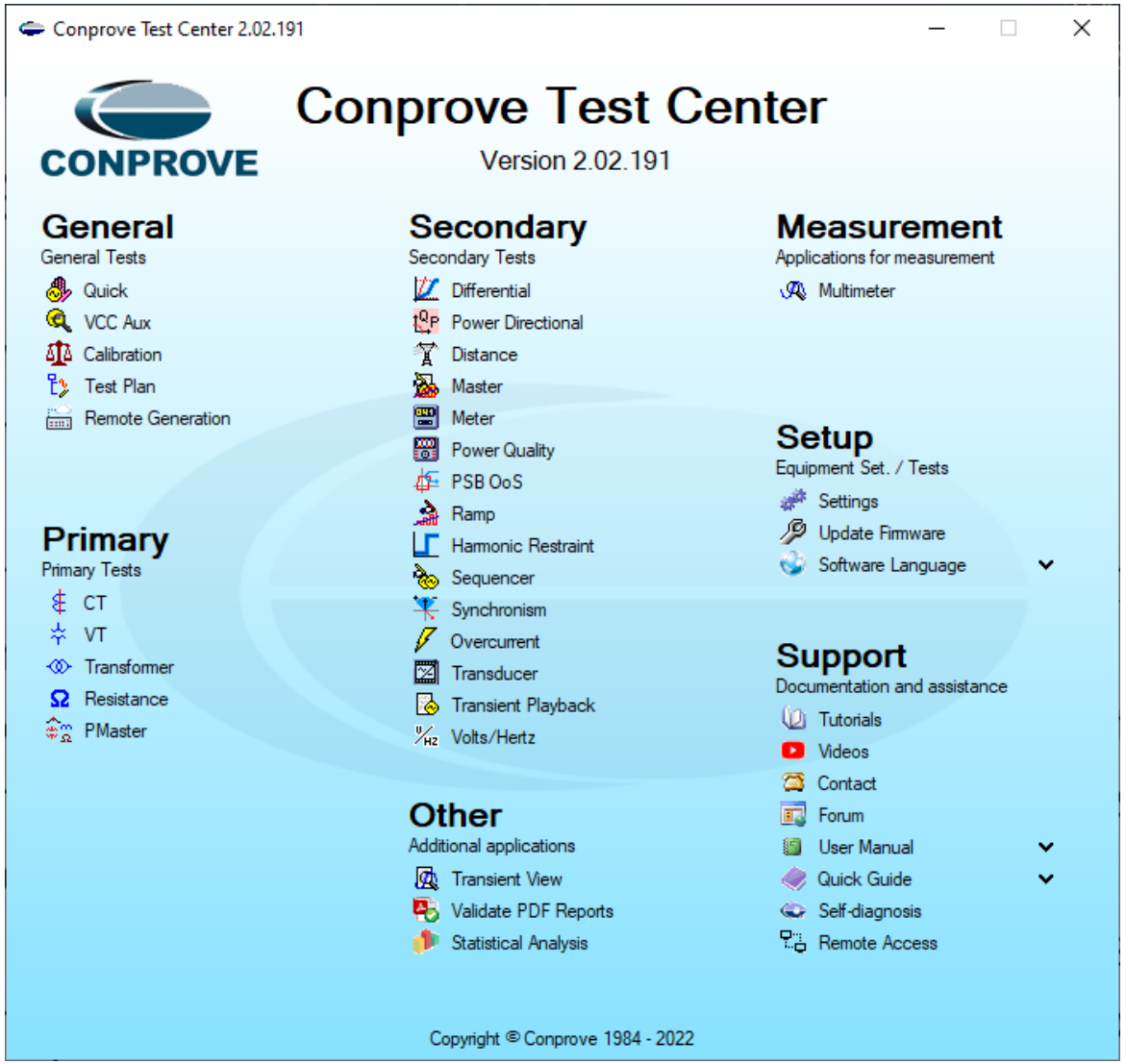
- **Main system components**: generators, transmission lines, transformers, buses, circuit breakers, etc.
- Once they come into operation, they are subjected to: **mechanical stresses**, **environmental action**, **electrical stresses**, **aging**, etc.
- High cost of system **unavailability**
- It is important to evaluate the conditions of these equipments throughout their **useful life**.

Features of the developed tool

- Tests served by the new tool:
  - Dielectric **withstand**;
  - Transformation ratio measurement (single or three-phase **TTR**);
  - Measurement of low electrical resistances (**Microhmmeter**);
  - Ohmic resistance measurement (**Milliohmmeter**);
  - Survey of the CT excitation curve (knee voltage; **excitation curve**);
  - Measuring the opening/closing time of circuit breakers (**Breaker Oscillograph**);
  - **Wiring** check;
  - **Burden measurement** on the secondary of CTs and VTs;
  - Measurement of pick-up values and operating times of protection functions (**relay test set**);
  - And others.

Test Platform Main Screen

- Manages over **30 device applications**
- All software available in languages: **Portuguese, English and Spanish**
- Software for testing at **primary and secondary level**
- **Group** tests into a single Test Plan
  - Further **automating** testing and **reducing overall time**
  - Allows inserting images with the **connection diagram**, **checklist**, **pauses** for connection change.



Test - Dielectric Withstand

- Objective:
  - Check **equipment insulation**. In this way, corrective actions can be taken before the total loss of insulation

- Methodology:
  - Definition of **maximum leakage current**
  - Voltage injection is **gradual** and **interrupted** if leakage current exceeds the permissible value, **protecting** equipment under test
  - **Automatic scale adjustment**
  - Current value is displayed on the software screen and **compared** to a **range of allowed values** to pass or fail the test

Test - Transformer Turns Ratio (TTR)

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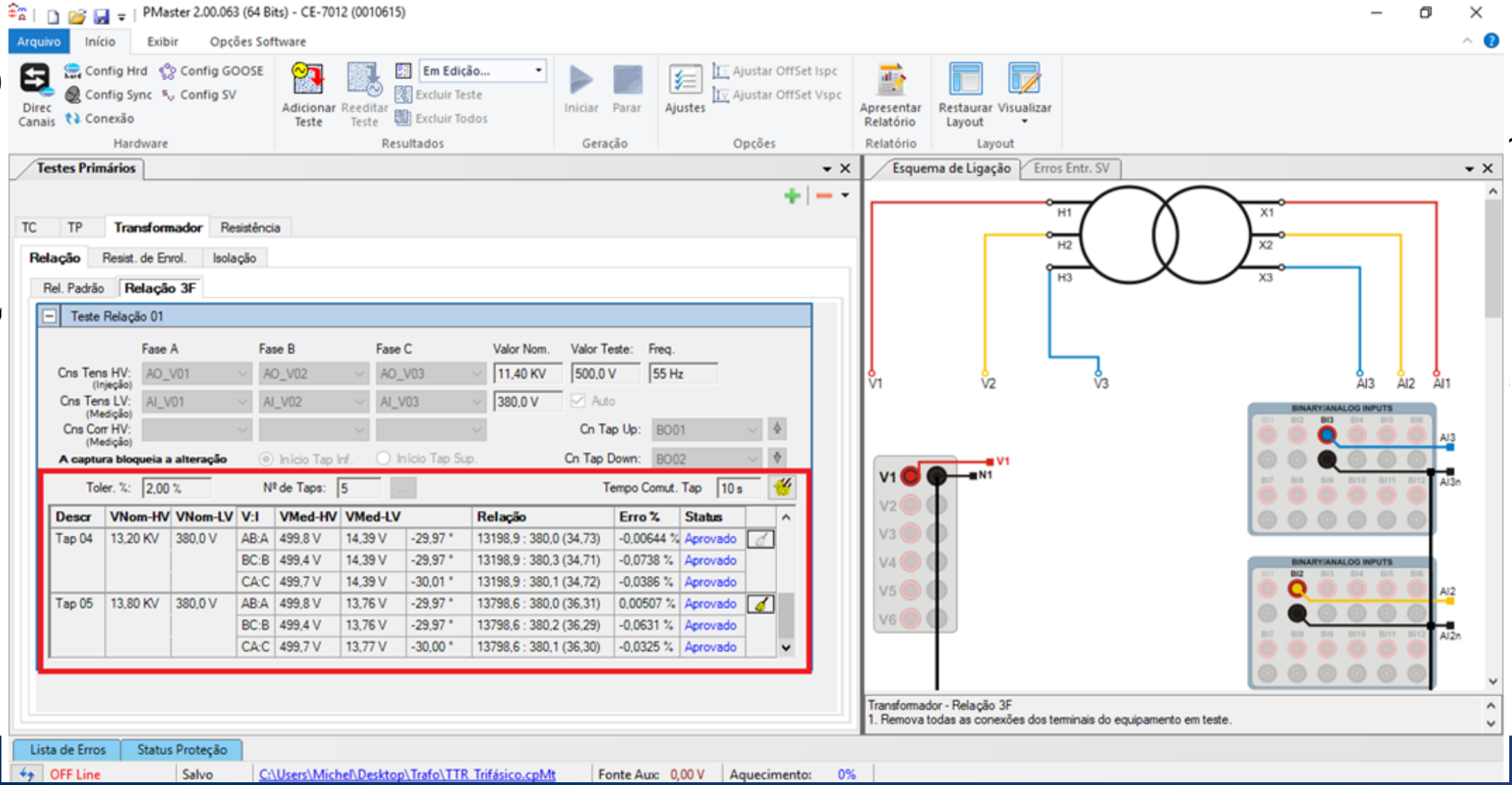

Test - Measurement of low electrical resistances

- Objective:
  - Measurement of ohmic resistance between **contacts** (**circuit breakers, disconnecting switches**), allowing determination of the state of the **fixed and mobile contacts**

- Methodology:
  - Injection of **current** values and measurement of **voltage** values
  - Measuring range from **125 nΩ** to **100 MΩ**
  - **4-wire measurement** (**Kelvin method**) to prevent the wiring or contact resistance of the test leads from **interfering** with the result

Test - Ohmic resistance measurement

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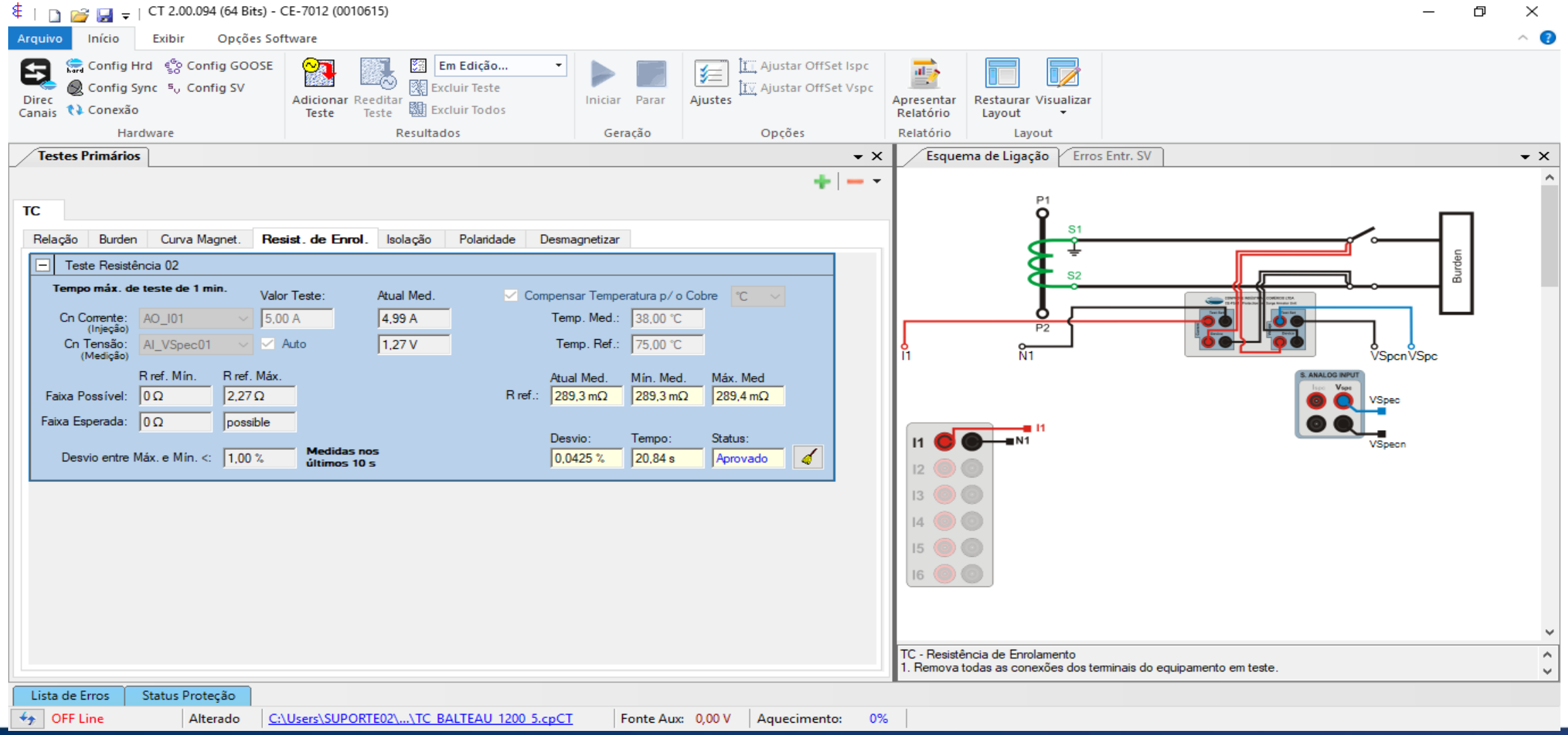

Test - Excitation Curve of CTs

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- Metho
  - **Volta** ll increase in vo
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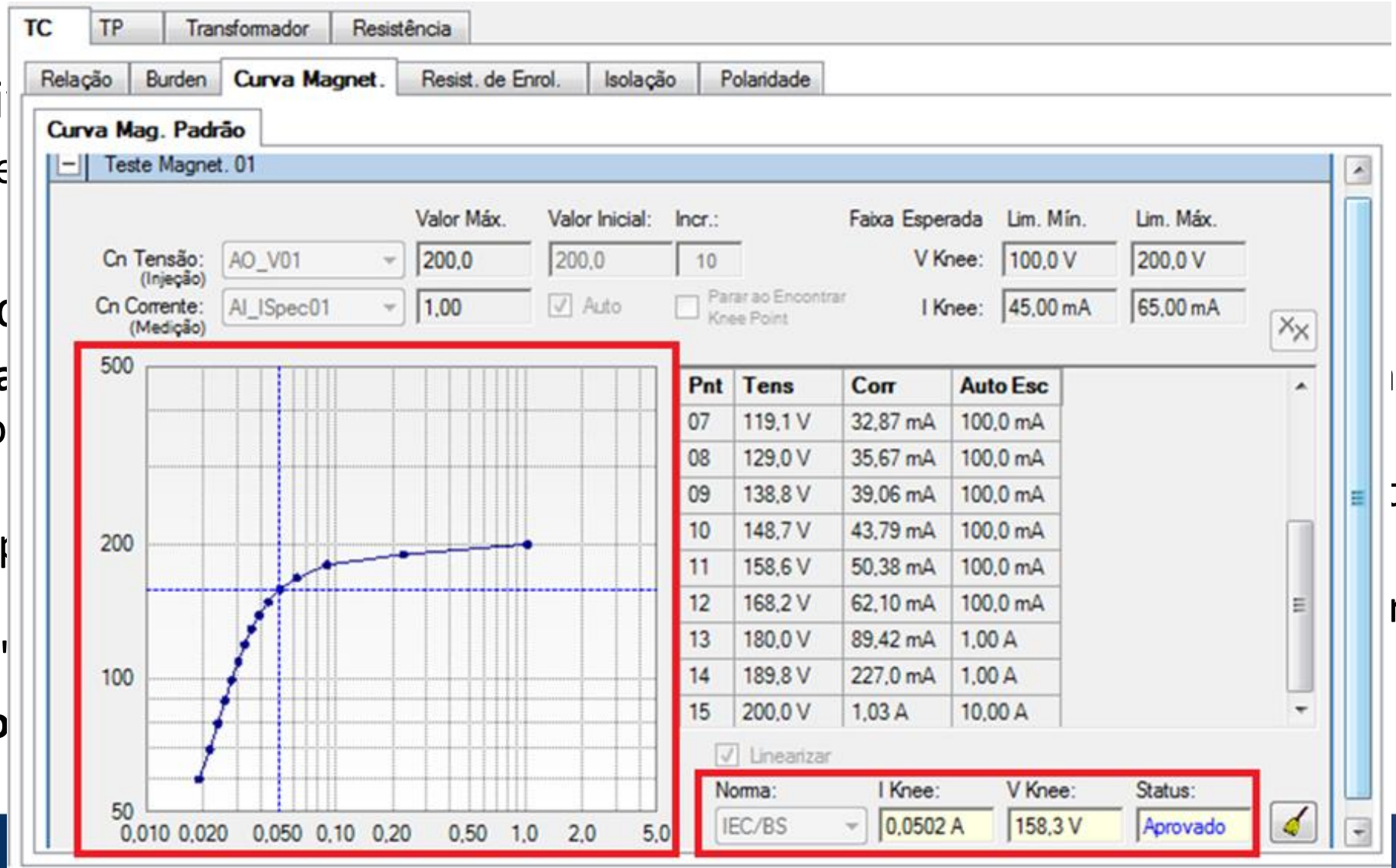
  - Tool rd used by user'
  - **Auto**



Test - Circuit breaker opening and closing times

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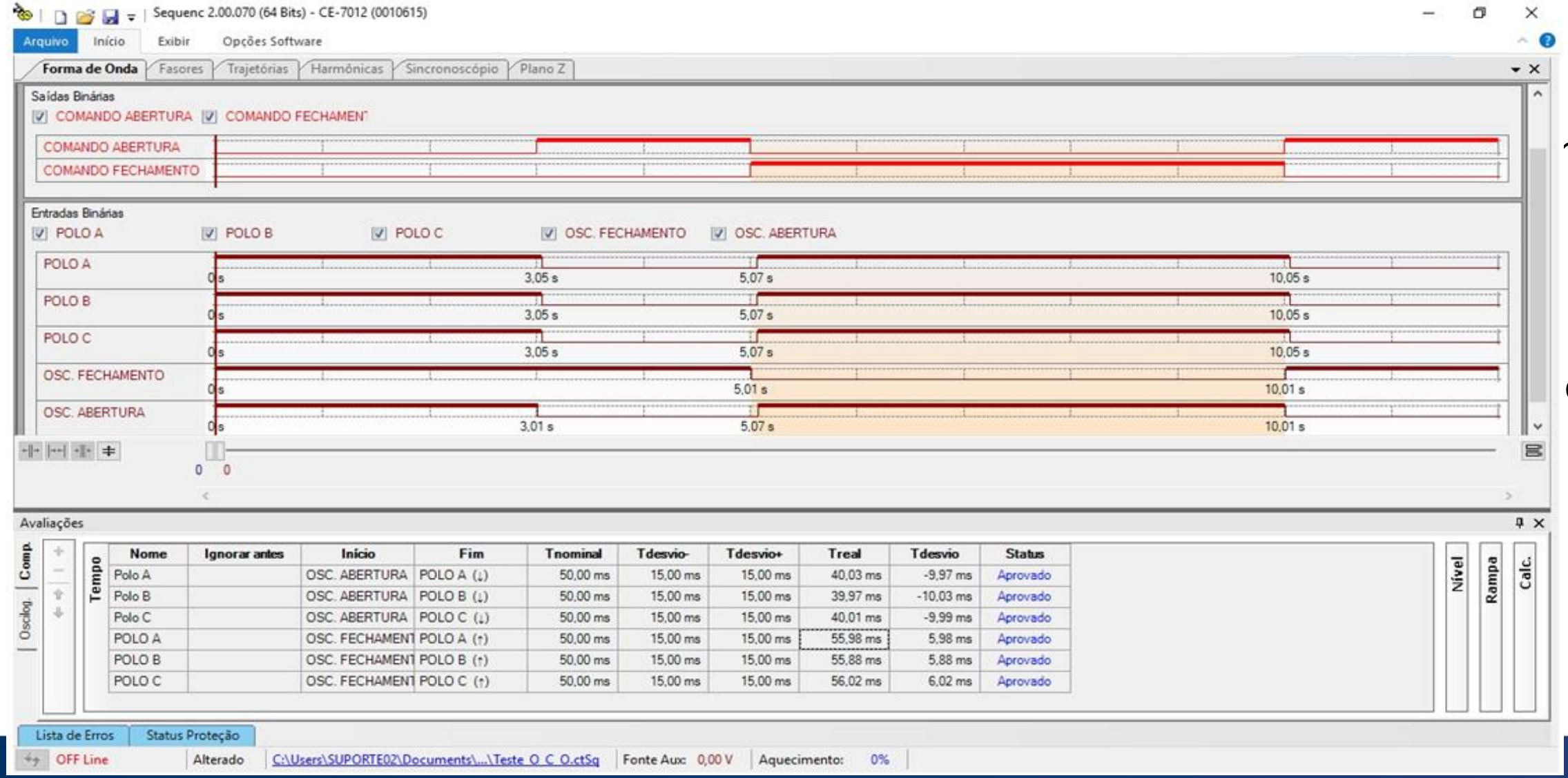

Test - Wiring check

- Objective:
  - **Verification of cables** that carry information to protection, measurement and control systems, identifying **occurrences of wrong connections**

- Methodology:
  - **High power** current and voltage injection
  - Possibility of testing in **three-phase mode**, detecting problems faster than single-phase equipment
  - Possibility to work in **different network conditions**, avoiding problems related to **frequency and amplitude variations**

Test - Burden measurement of CTs and VTs

- Objective:
  - Verification of the **load on the secondary** of instrument transformers, since high burden values can cause **CT saturation** or **VT thermal overload**

- Methodology:
  - **Currents/voltages** with **sufficient power** to inject the CT/VT **secondary value** and associated voltage/current measurement in addition to the **phase shift**
  - The entire process of injection, measurement and impedance calculation is **carried out automatically**, directly and quickly by the tool.

Test - Measurement of pick-up and operating times

- Objective:
  - Verification of correct performance of **protection functions** by determining their **pick-up values** and **operating times**

- Methodology:
  - Allows **automatic testing of various protection functions**: 50/51, 67,27, 59, 81, 87, Rest. Harm., 21, 25, among others
  - Full compatibility with the **IEC 61850** standard allowing tests involving **GOOSE and Sampled Values** messages
  - Time synchronization via **GPS**, **IEEE1588** and **IRIG-B**

Test - CE-70XX Family and Traditional Equipment

Equipment	Weight (Kg)	Volume (liters)	Equipment	Weight (Kg)	Volume (litros)
CE-7012	19.50	30.24	Current Injection Test Set	33.0	63.00
			Hipot	3.50	5.852
			TTR	8.70	8.769
			Microhmmeter	11.0	25.712
			CT Excitation Curve	50.0	252.0
			Circuit Breaker Oscillograph	6.50	16.500
			Relay test set	17.0	25.448
			Power Quality	5.70	7.500
			Polarimeter	0.55	0.717
			Phase Meter	0.20	0.120
Total Weight / Volume	**19.5**	**30.24**	**Total Weight / Volume**	**136.15**	**405.618**

Conclusions

- Introduced **multifunctional** tool that raises standards of commissioning in substations (**primary and secondary**)
- Automation of the main **test/report routines**
- Tool equivalent to at least **10 test equipment** available on the market (14% of the total weight and 7% of the volume)
- Due to pre-test and post-test features, user can perform tests on average **3 to 5 times faster** than using traditional equipment.

Thanks!!!

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