Introduction to Relay Tripping Curves-PRO2©

User Guide
Version 2.2.4
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Table of Contents

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1. Introduction

Relay Tripping Curves-PRO2 is a specialized software designed to calculate and plot characteristic overcurrent protection curves for phase (ANSI 50/51) and ground (ANSI 50N/51N), using mathematical equations and standards from leading relay manufacturers. The program offers an intuitive interface to visualize these curves on a Log-Log scale, making it ideal for engineers, technicians, and electrical engineering students.

With this software, you can:

- Plot and analyze up to 20 adjustment curves for ANSI 50/51 and 50N/51N functions from different manufacturers.

- Perform numerical calculations and print the results.
- Plot trip points and compare them with the adjusted inverse curve.
- Activate a cursor to display amps vs. time values along the curve.
- Generate comprehensive reports including settings data, verification tables, plots, and images.
- Calculate and optimize selectivity between two inverse curves and generate the corresponding report.
- Switch between primary and secondary values.
- Adjust the Log-Log plane scale as needed.
- Plot curves at different voltage levels.
- Change the language (Spanish/English).
- Customize the report logo (optional).

Below, you will find a detailed description of all functions and features to help users become fully familiar with the software.

Download the software at: www.protelectsa.net

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2. Target Audience

Relay Tripping Curves-PRO2 is intended for:

Students

- Learn concepts about the construction of inverse curves used in protection relays.
- Understand and work with the mathematical equations for curve construction.
- Analyze selectivity between two protection relays.
- Work with primary and secondary values in power systems.
- Acquire basic knowledge for protection coordination studies.

Electrical Engineers and Technicians

- Easily visualize and consult relay settings in plants and substations.

- Quickly evaluate selectivity between devices and make adjustment decisions.
- Conduct protection coordination studies between upstream and downstream equipment.
- Analyze the behavior of the curve during trips and tests, including fault current and trip time.
- Generate reports with relay settings and plots of their inverse curves.

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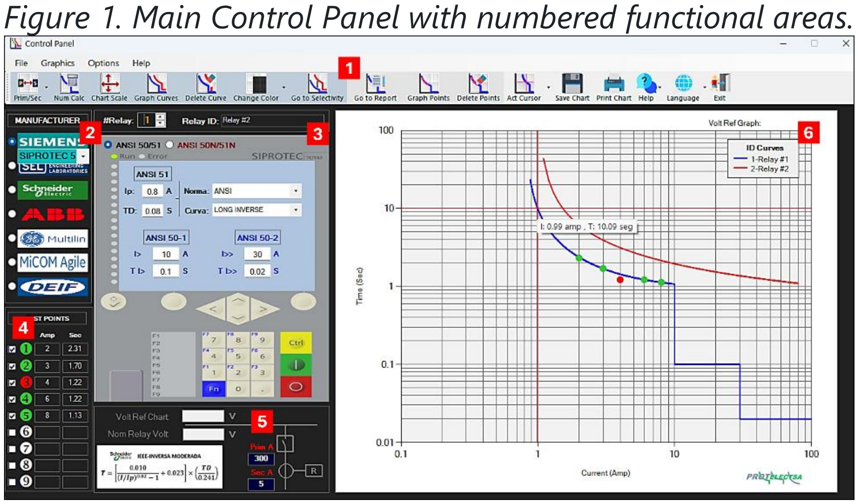
3. Control Panel and User Menus

The main window (Control Panel) contains all necessary modules and buttons. Depending on the operation, pop-up windows may appear.

The following image shows the main Control Panel of Relay Tripping Curves-PRO2, with numbered functional areas:

1. Toolbar
2. Manufacturer selector
3. Relay configuration area
4. Test points module
5. Voltage parameters and curve equation
6. Log-Log graph

Figure 1. Main Control Panel with numbered functional areas.

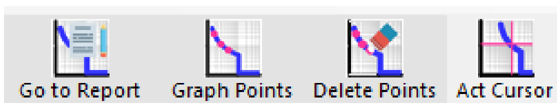


Toolbar

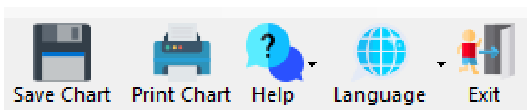
Divided into three main groups:

- **Graph Menu:** Plot curves, switch between secondary/primary values, modify the scale or background color, perform numerical calculations, and access selectivity analysis.

- **Test Menu:** Plot/erase test points, activate the cursor, and access the report window.



- **General Menu:** Save curves, print, change language, access help, and exit.



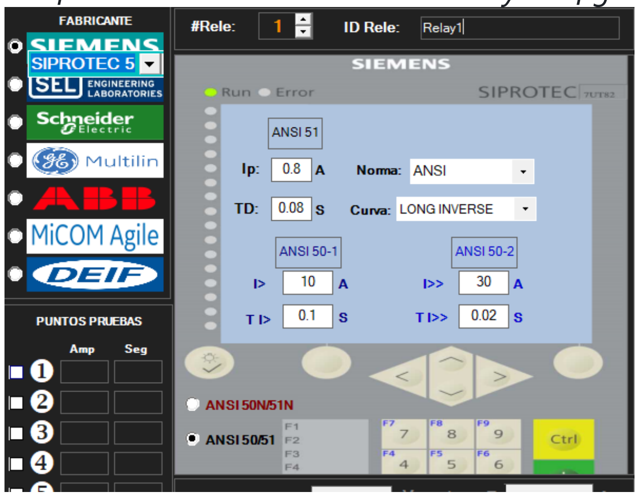
Drop-Down Menu

Includes the same options as the toolbar, presented in a drop-down format.

Manufacturer Selection and Relay Configuration

- To configure relay settings, first select the manufacturer and model. This will display a simulated panel to facilitate data entry.
- The following image shows the manufacturer selection menu and the configuration area for entering relay parameters.

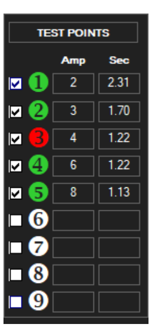
Figure 2. Manufacturer selection menu and relay configuration area.



Configurable Parameters:

- **ANSI 51 or 51N:**
  - Ip: Pickup current (primary or secondary amperes)
  - Td: Time dial
  - Standard: ANSI, IEC, US Curves, or IEEE
  - Curve: Curve type according to the standard
- **ANSI 50 or 50N:**
  - I>: Instantaneous pickup current
  - TI>: Time delay for ANSI 50

Include the relay number and identification. Data entry is easy via the simulated panel.



Test Points

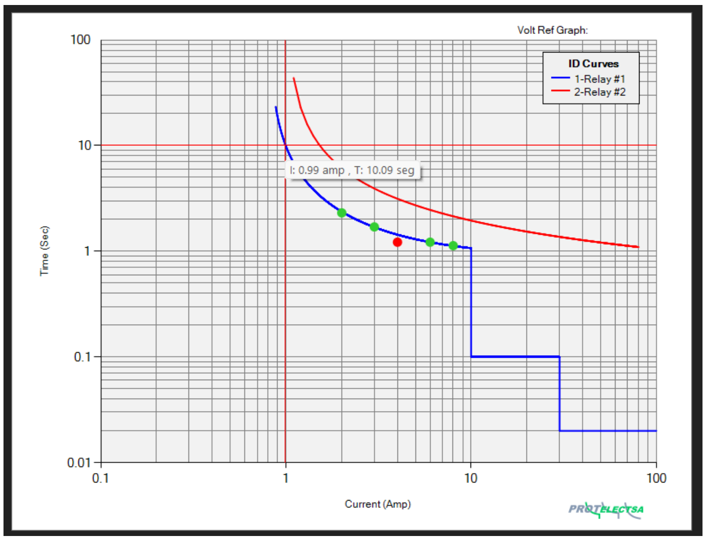
In the test points module, enter the current and time values obtained from injection tests or event records. These points are automatically plotted and compared with the selected curve.

Vn and Tc Data Box

- Enter the current transformer ratio (for secondary values).
- Enter operating and reference voltages (for primary values).
- The curve equation is displayed according to the selected standard.

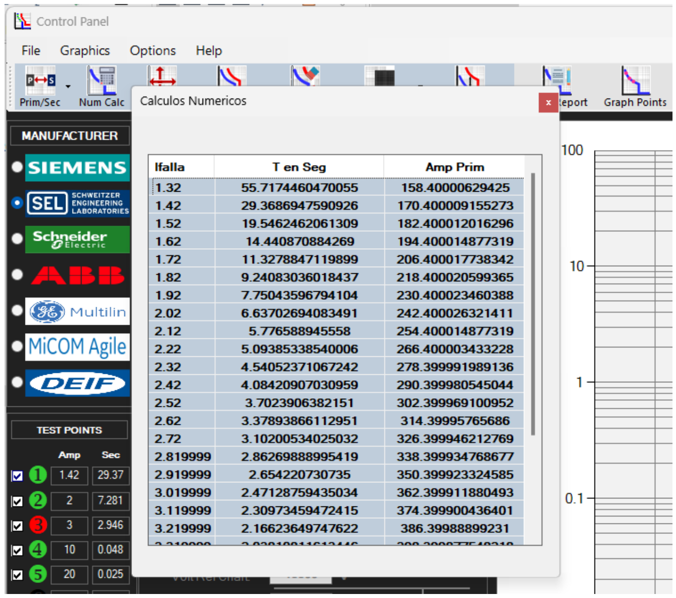
Log-Log Plot

Allows you to visualize the inverse curves and test points. The cursor can be activated to inspect amps and time values.



4. Numerical Calculations

The mathematical results of the plotted curves can be viewed and generated in a PDF report by pressing the "Cal Num" button.



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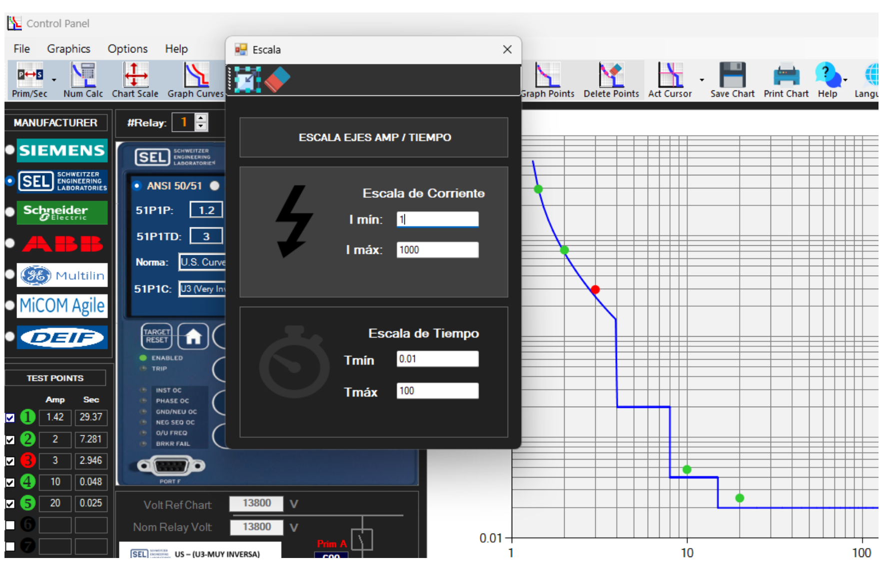
5. Log-Log Plane Customization

- **Scale:** Default is Imin: 0.1 / Imax: 100 and Tmin: 0.01 / Tmax: 100. This can be modified as needed.
- **Background Color:** White, black, blue, or gray.
- **Cursor:** Allows you to see current and time values at any point along the curve.



6. How to Plot Curves

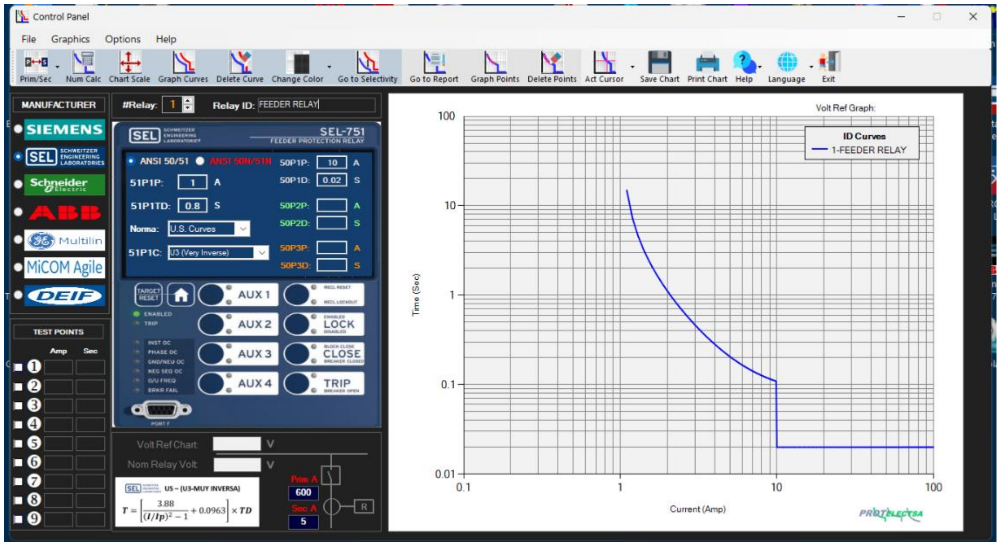
Relay Tripping Curves-PRO2 allows you to plot inverse curves for ANSI 50/51 functions of any relay, using ANSI, IEC, or IEEE standards. You can work with primary or secondary values and at different voltage levels.

Plotting with Secondary Values

- Default mode.
- Maximum current scale: 100 A (modifiable).
- Enter the CT ratio for calculations.
- Operating/reference voltages are disabled.

Example 1: Plotting ANSI 50/51 for SEL-751A

- Select manufacturer: SEL
- Enter relay settings:
    - 51P1P (Pickup ANSI 51): 1 Amp
    - 51P1TD (Time Dial): 0.8 Sec
    - Standard: U.S. Curves
    - 51P1C (Curve type): U3 (Very Inverse)
    - 50P1P (Pickup ANSI 50): 10 Amp
    - 50P1TD (Delay): 0.02 Sec
- Enter CT ratio:
    - A Prim: 600
    - A Sec: 5
- Press "Plot Curves".



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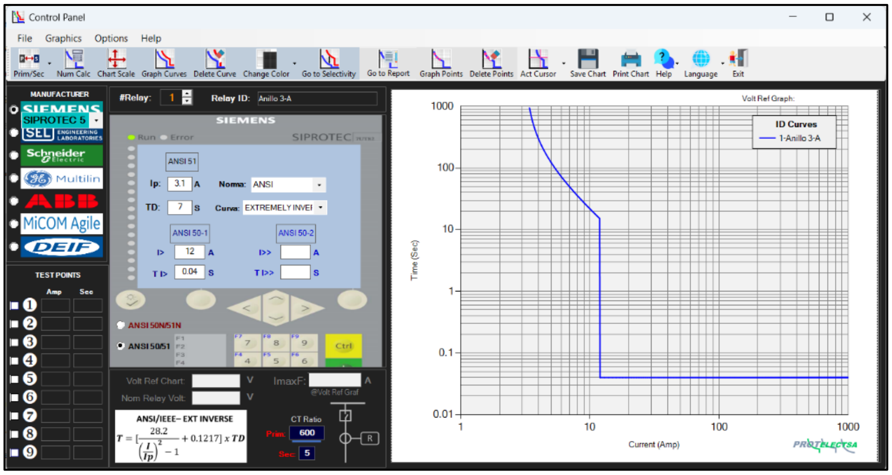
7. Plotting Test Points

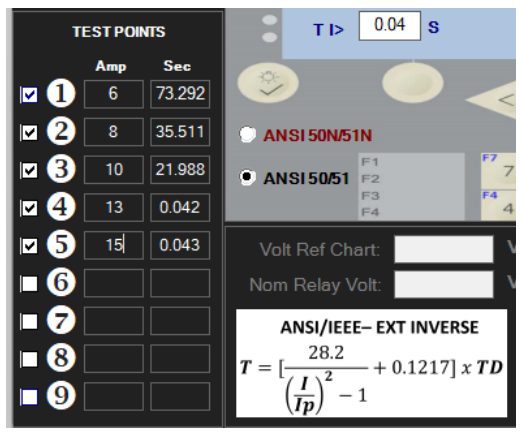
You can plot test points (current and time) to verify relay operation. Points within ±10% of the curve appear green, others red. The software generates comprehensive reports with comparison tables and plots.

Example 2: Secondary current injection tests for SIEMENS SIPROTEC 5 relay

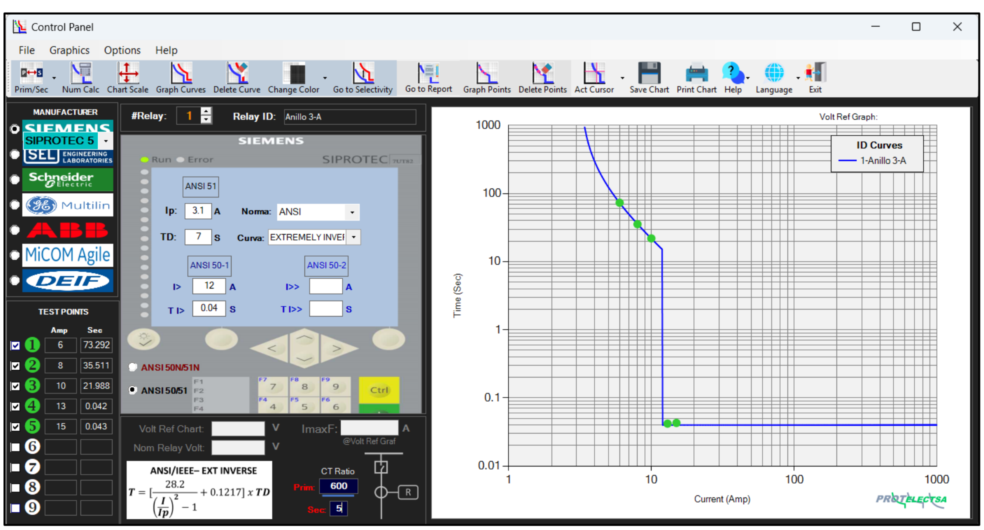
- Select manufacturer: SIEMENS SIPROTEC 5
- Enter relay settings:
  - Ip (Pickup ANSI 51): 3.1 Amp
  - TD (Time Dial): 7 Sec
  - Standard: ANSI
  - Curve: EXTREMELY INVERSE
  - I> (Pickup ANSI 50): 12 Amp
  - TI> (Delay): 0.04 Sec
- Enter CT ratio:
  - A Prim: 600
  - A Sec: 5
- Press "Plot Curves".



- In the "TEST POINTS" panel, enter current vs. time data from the test set.



- Press "Plot Points" to display them on the curve. Points within ±10% (ANSI 51) and ±30% (ANSI 50) appear green; out-of-range points are shown in red.



8. Generating Reports

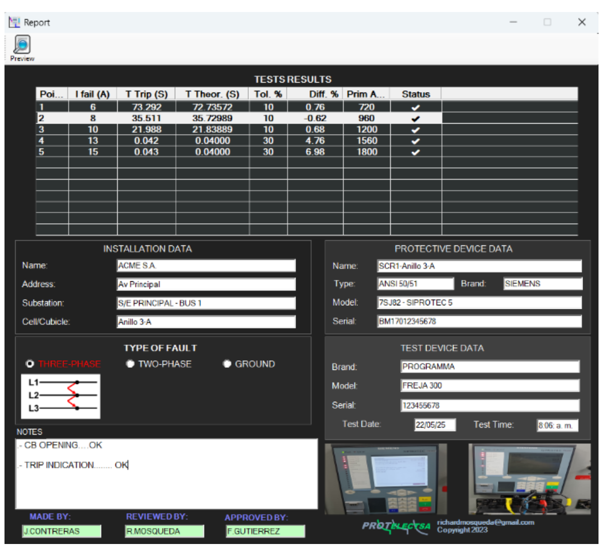
Reports include:

- Test results and comparison tables.
- Relay, installation, and test equipment data.
- Fault type (three-phase, two-phase, ground).
- Relevant notes and photos.
- Curve plot, CT ratio, and date/time.

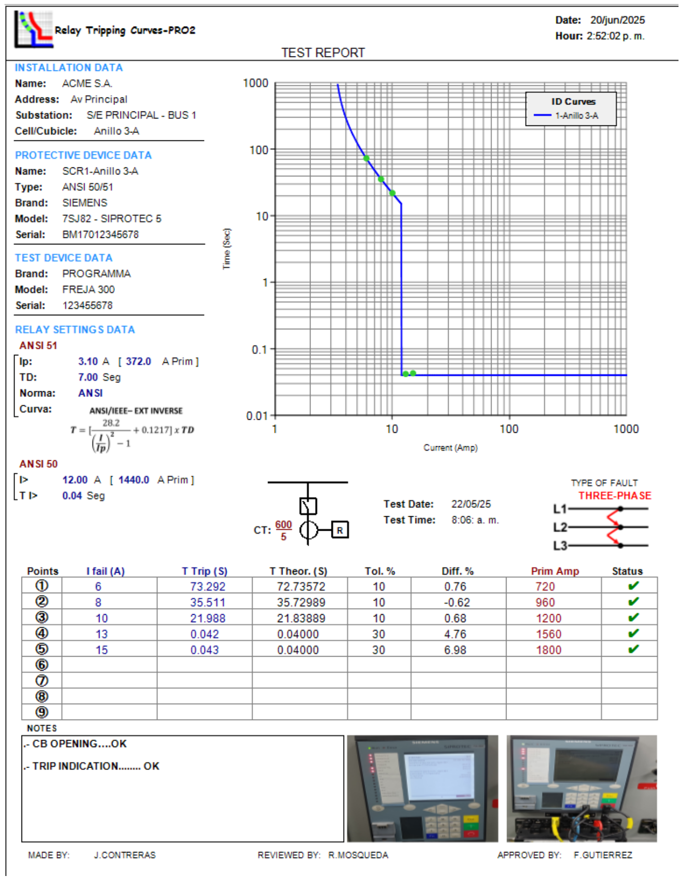
Reports can be previewed and exported as PDF.

Example 3: Generate a test report

- Press "Generate Report" and fill in the required fields in the pop-up window:
    - Installation data
    - Protection equipment data
    - Test equipment data
    - Test fault type
    - Include images
    - Notes and involved personnel



You can generate the report by pressing “Preview” and then “Print” to save it as a PDF.



Relay Tripping Curves-PRO2

Date: 20/jun/2025
Hour: 2:52:02 p. m.

TEST REPORT

INSTALLATION DATA
Name: ACME S.A.
Address: Av Principal
Substation: S/E PRINCIPAL - BUS 1
Cell/Cubicle: Anillo 3-A

PROTECTIVE DEVICE DATA
Name: SCR1-Anillo 3-A
Type: ANSI 50/51
Brand: SIEMENS
Model: 7SJ82 - SIPROTEC 5
Serial: BM17012345678

TEST DEVICE DATA
Brand: PROGRAMMA
Model: FREJA 300
Serial: 123456678

RELAY SETTINGS DATA
ANSI 51
Ip: 3.10 A [372.0 A Prim]
TD: 7.00 Seg
Norma: ANSI
Curva: ANSI/IEEE- EXT INVERSE

$$T = \left[\frac{28.2}{\left(\frac{I}{Ip}\right)^2 - 1} + 0.1217\right] x\, TD$$

ANSI 50
I>: 12.00 A [1440.0 A Prim]
T I>: 0.04 Seg

Points	I fail (A)	T Trip (S)	T Theor. (S)	Tol. %	Diff. %	Prim Amp	Status
①	6	73.292	72.73572	10	0.76	720	✔
②	8	35.511	35.72989	10	-0.62	960	✔
③	10	21.988	21.83889	10	0.68	1200	✔
④	13	0.042	0.04000	30	4.76	1560	✔
⑤	15	0.043	0.04000	30	6.98	1800	✔
⑥							
⑦							
⑧							
⑨							

NOTES
.- CB OPENING....OK
.- TRIP INDICATION........ OK

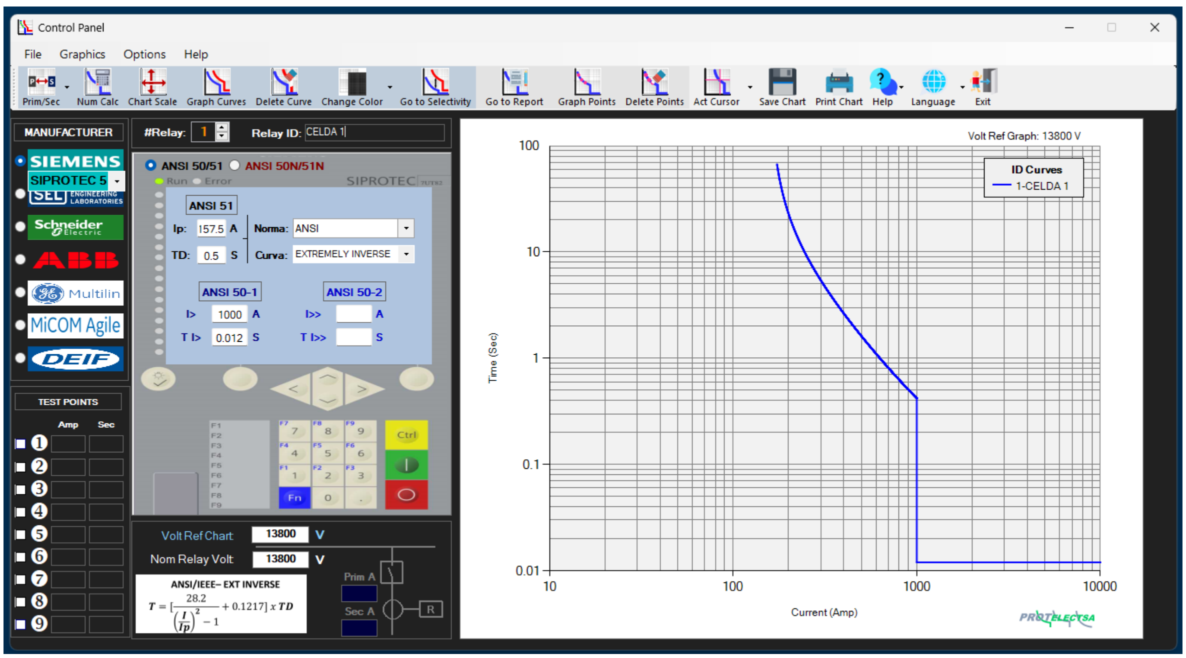
MADE BY: J.CONTRERAS   REVIEWED BY: R.MOSQUEDA   APPROVED BY: F.GUTIERREZ

Plotting with Primary Values

Example 4: Plotting at the same voltage level

- Switch to primary values using the “Prim/Sec” button. If there is a secondary curve, delete it with “Delete Curve”.
- Maximum current scale: 1000 A (modifiable).
- Enter voltages:
  - Relay Nominal Voltage: 13800 V
  - Reference Voltage for Plot: 13800 V
- CT ratio input is disabled.
- Select manufacturer: SIEMENS, SIPROTEC 5

- Enter relay settings:
    - Ip (Pickup ANSI 51): 157.5 Amp
    - TD (Time Dial): 0.5 Seg
    - Standard: ANSI
    - Curve: EXTREMELY INVERSE
    - I> (Pickup ANSI 50): 1000 Amp
    - TI> (Delay): 0.012 Seg
- Press "Plot Curves".



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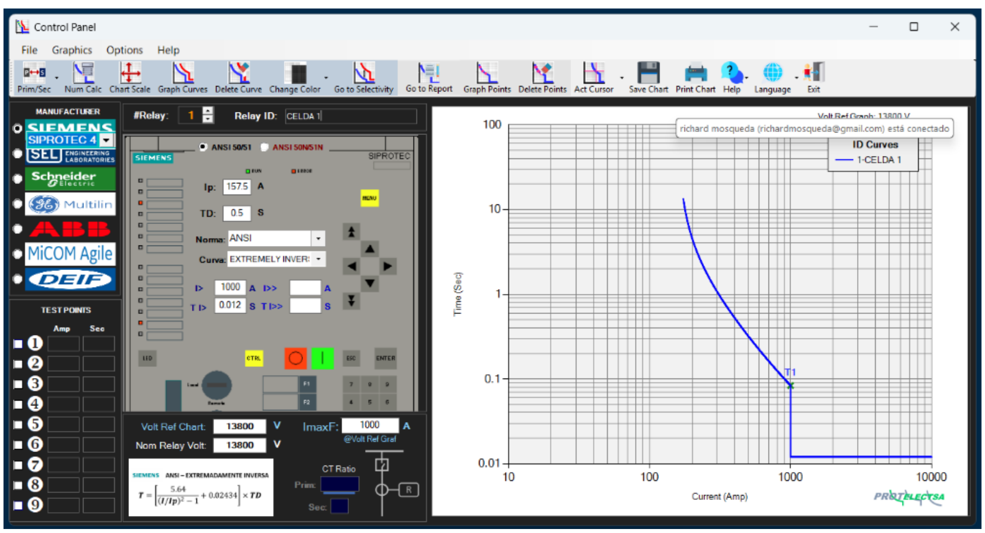
9. Selectivity Analysis Between Two Curves

Relay Tripping Curves-PRO2 allows you to evaluate and optimize time selectivity between two curves.

Example 5: Selectivity at the same voltage level

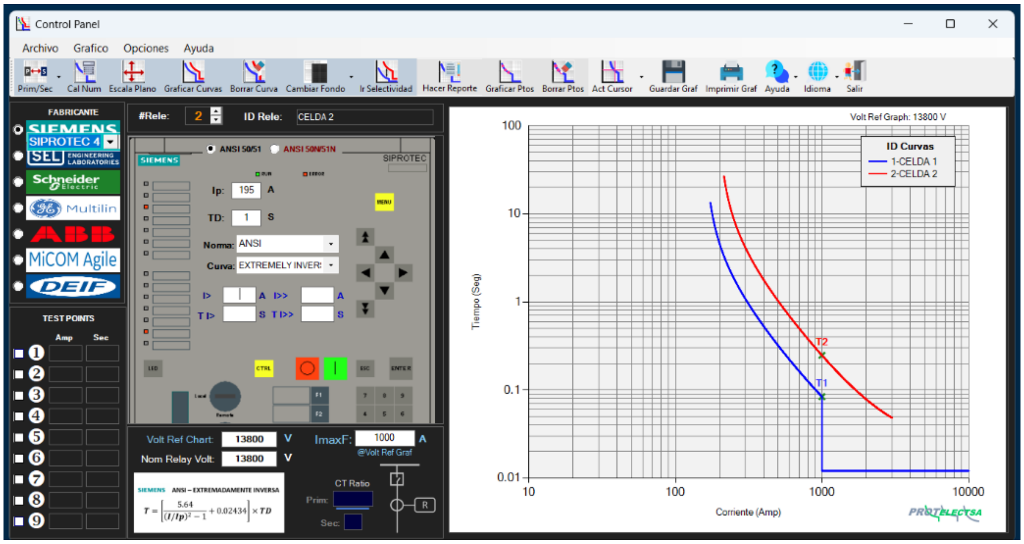
1. Switch to primary values.
2. Select and plot the "Downstream Relay" (#1) curve.
3. Enter reference and nominal voltages.
    1. Nom Relay Volt (Voltage level where the relay operates): 13800 V

    2. Volt Ref Chart (Log-Log Chart reference voltage): 13800 V
4. Enter the maximum fault current (ImaxF): 1000 A
5. Select manufacturer: SIEMENS, SIPROTEC 4
6. Enter relay settings:
    1. Ip (Pickup ANSI 51): 157.5 Amp
    2. TD (Time Dial): 0.5 Seg
    3. Standard: ANSI
    4. Curve: EXTREMELY INVERSE
    5. I> (Pickup ANSI 50): 1000 Amp
    6. TI> (Delay): 0.012 Seg
7. Press "Plot Curves" The curve of the "Downstream Relay" (#1) is graphed, indicating T1 (tripping time of relay #1 at the maximum fault current (ImaxF)).

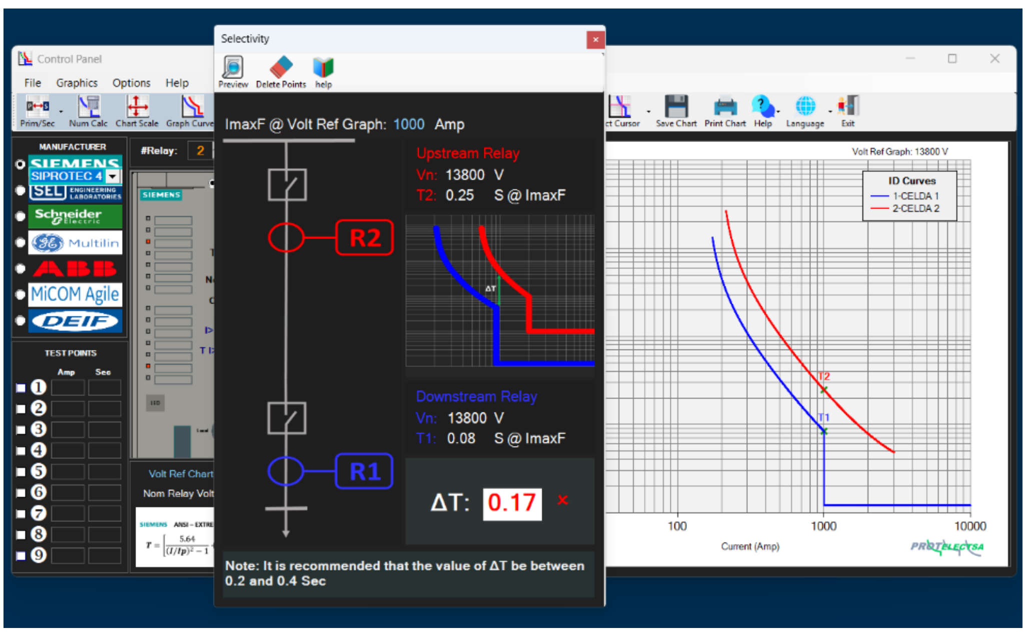


8. Select the "Upstream Relay" (#2) and plot its curve.
9. Select manufacturer: SIEMENS, SIPROTEC 4
10. Enter relay settings:
    1. Ip (Pickup ANSI 51): 195 Amp
    2. TD (Time Dial): 1 Seg
    3. Standard: ANSI
    4. Curve: EXTREMELY INVERSE
    5. I> (Pickup ANSI 50):
    6. TI> (Delay):

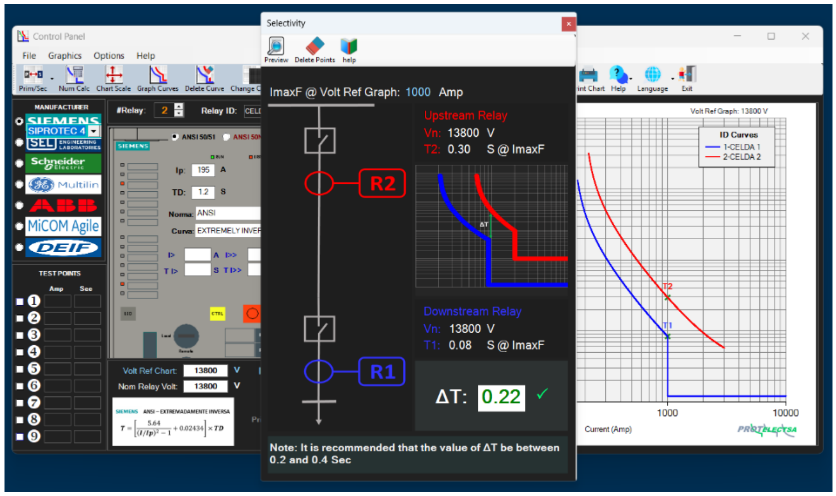
11. Enter relay parameters and press "Plot Curves" The curve of the "Upstream Relay" (#2) is graphed, indicating T2 (trip time of relay #2) at the maximum fault current (ImaxF).



12. Open the Selectivity window to view ΔT.



13. Adjust the Time Dial (TD) to optimize ΔT.

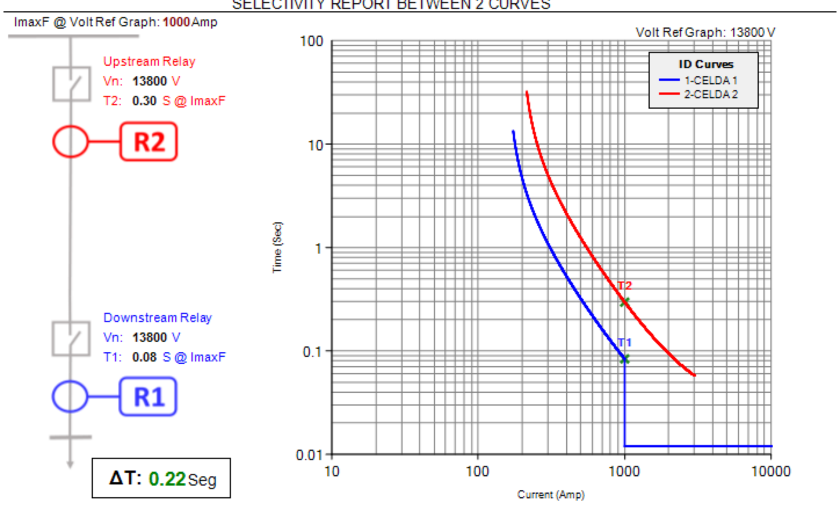


You can generate the corresponding report.

Relay Tripping Curves-PRO2

Date: 20/jun/2025
Hour: 12:13:56 p. m.

SELECTIVITY REPORT BETWEEN 2 CURVES



DOWNSTREAM EQUIPMENT SETTINGS

Relay Name: CELDA 1
Brand: SIPROTEC 4
ANSI 51:
Pickup (Ip): 157.5
Time Dial (TD): 0.5
Standard: ANSI
Curve: EXTREMELY INVERSE

SIEMENS ANSI - EXTREMADAMENTE INVERSA

$$T = \left[\frac{5.64}{(I/Ip)^2 - 1} + 0.02434\right] \times TD$$

ANSI 50:
Pickup (I>): 1000
Time Delay (TI>): 0.012

UPSTREAM EQUIPMENT SETTINGS

Relay Name: CELDA 2
Brand: SIPROTEC 4
ANSI 51:
Pickup (Ip): 195
Time Dial (TD): 1.2
Standard: ANSI
Curve: EXTREMELY INVERSE

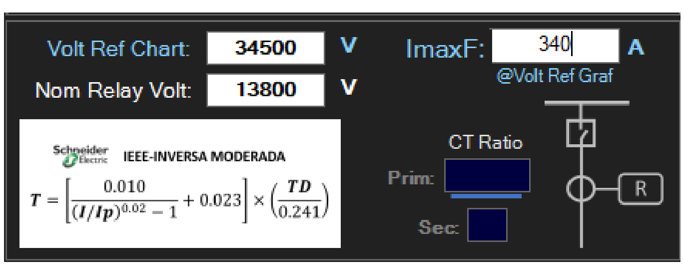
SIEMENS ANSI - EXTREMADAMENTE INVERSA

$$T = \left[\frac{5.64}{(I/Ip)^2 - 1} + 0.02434\right] \times TD$$

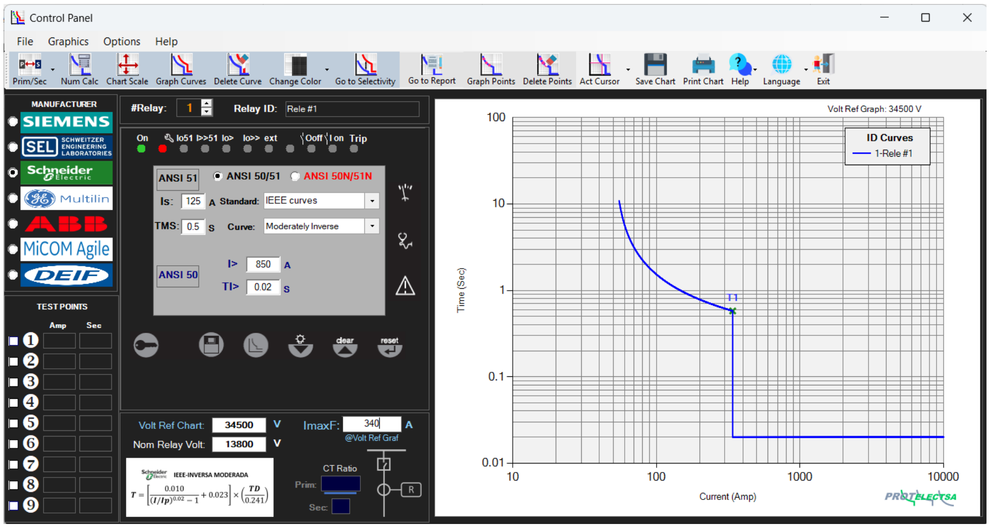
ANSI 50:
Pickup (I>):
Time Delay (TI>):

Example 6: Selectivity at different voltage levels

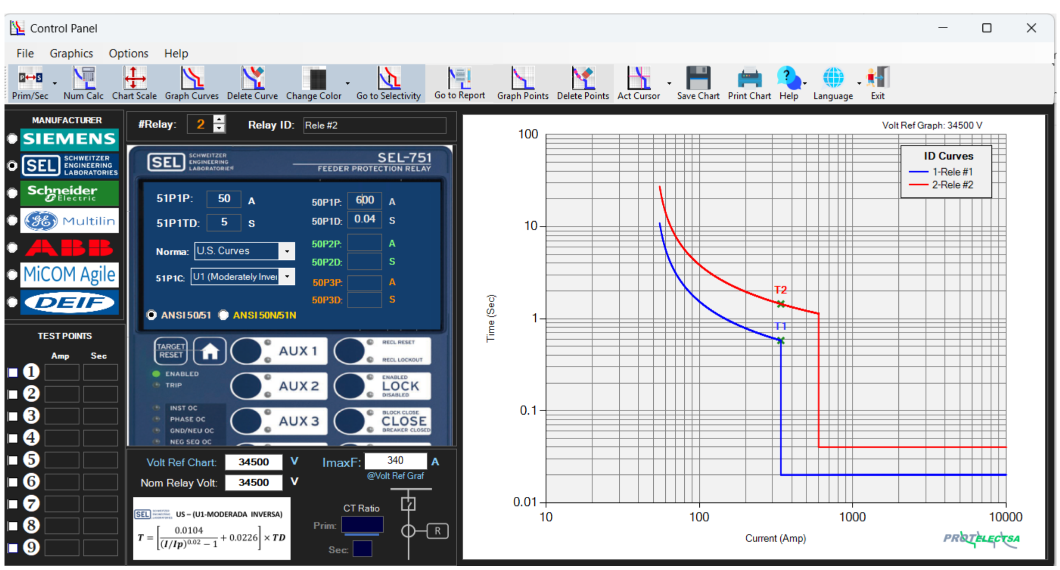
1. Switch to primary values.
2. Select and plot the "Downstream Relay" (#1) curve.
3. Select manufacturer: SCHNEIDER
4. Enter relay settings:
    1. Ip (Pickup ANSI 51): 125 Amp
    2. TD (Time Dial): 0.5 Seg
    3. Standard: IEEE
    4. Curve: MODERATELY INVERSE
    5. I> (Pickup ANSI 50): 850 Amp
    6. TI> (Delay): 0.02 Seg
    7. Enter reference and nominal voltages of "Downstream Relay #1":
        1. Nom Relay Volt (Volt level where the relay operates): 34500 V
        2. Volt Ref Chart (Log-Log Chart reference voltage): 13800 V
5. Enter the maximum fault current (ImaxF): for the "Downstream Relay #1" (NOTE: as the curve is going to be graphed referenced to a voltage of 34500 V and the "Downstream Relay #1" operates at a level of 13800, the "ImaxF" must be referred to the voltage level of the graph, in this example the ImaxF will be equal to 850 Amp @ 13800 V, but referred to 34500 V, that is: 850 x (13.8/34.5) = 340 Amp @ 34500 V)



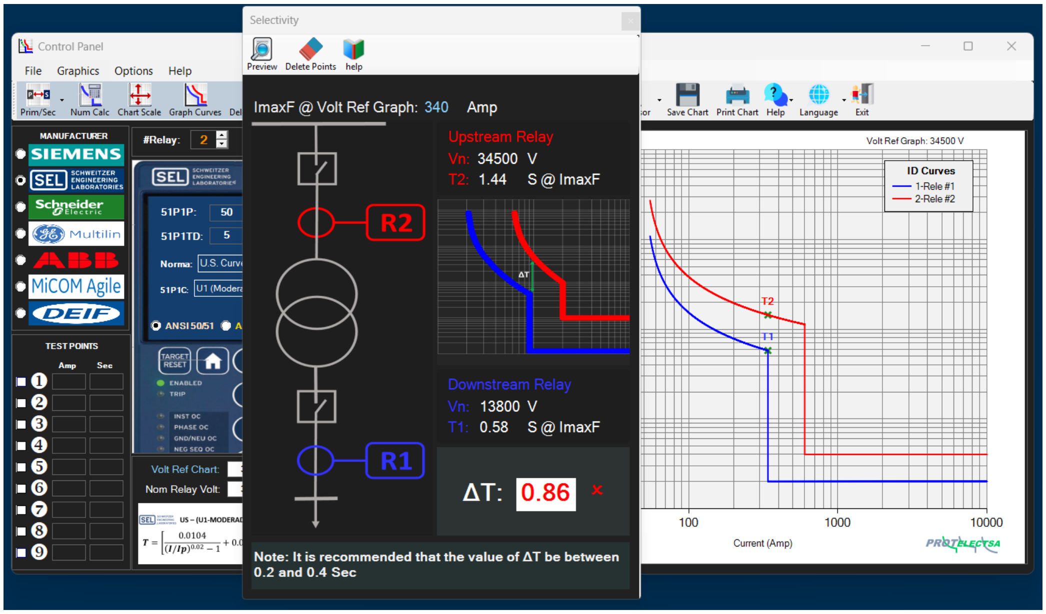
6. Press "Plot Curves" The curve of the "Downstream Relay" (#1) is graphed, indicating T1 (tripping time of relay #1 at the maximum fault current (ImaxF)).



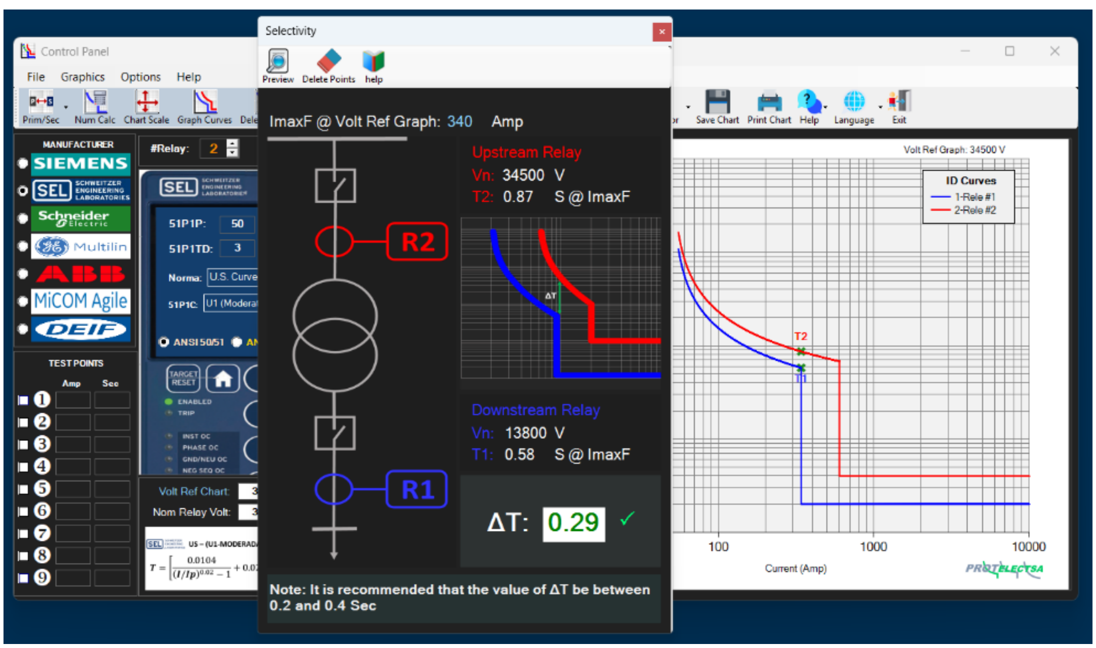
7. Select the "Upstream Relay" (#2) and plot its curve.
8. Select manufacturer: SEL
9. Enter relay settings:
    1. 51P1P (Pickup ANSI 51): 50 Amp
    2. 51P1TD (Time Dial): 5 Sec
    3. Standard: U.S. Curves
    4. 51P1C (Curve): U1(Moderately Inverse)
    5. 50P1P (Pickup ANSI 50): 600 Amp
    6. 50P1TD (Delay): 0.04 Sec
10. Enter relay parameters and press "Plot Curves" The curve of the "Upstream Relay" (#2) is graphed, indicating T2 (trip time of relay #2) at the maximum fault current (ImaxF).



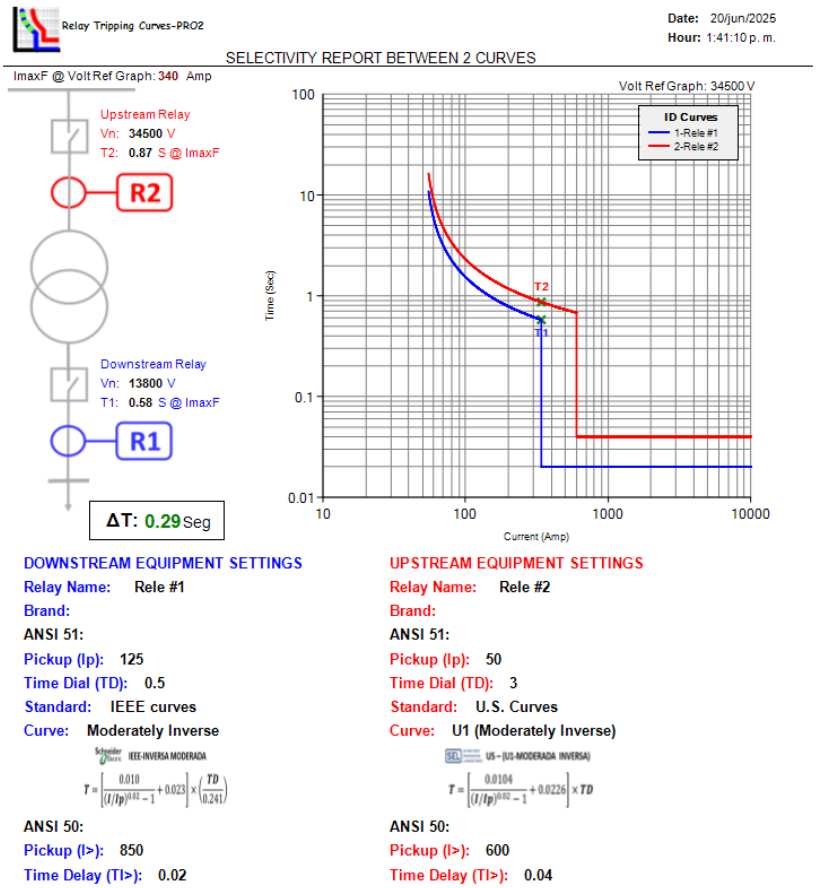
11. Open the Selectivity window to view ΔT.



12. Adjust the Time Dial (TD) to optimize ΔT.



You can generate the corresponding report.



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10. Other Features

- **Save Plot:** Export curves as .jpg or .png.
- **Print Plot:** Print curves directly from the Control Panel.
- **Multi-language support:** Spanish and English.
- **Report customization:** Option to add a customized logo (on request).

Download the software at: www.protelectsa.net