

Protection: R-X graph plotter



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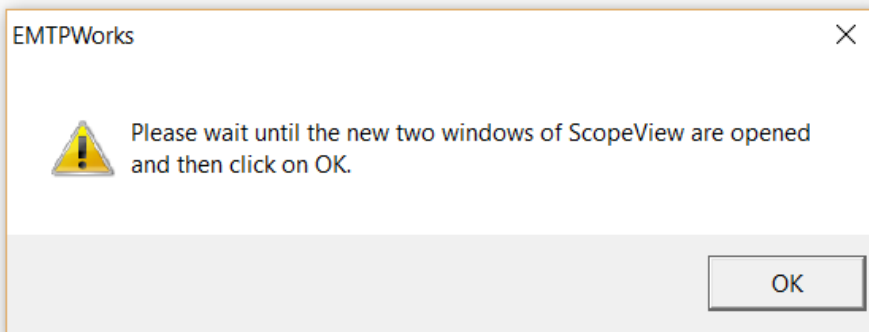
1 Impedance Locus and Distance protection zones tab

This device provides the visualization of load impedance locus and protection zones for a given relay in R-X graphs using a ScopeView template. To display the zones of several relays in the same template, use the manual procedure (see Section 3). It is applicable to phase-to-phase and phase-to-ground distance, power-swing/out-of-step and loss-of field elements. If some of these elements or their scopes are disabled, the corresponding graphs will be removed after clicking on the start button of ScopeView and then OK on the warning window.

The locus scope selections are made in the “Function Scopes” tab of each relay and must be checked before running the simulations.

2 Automatic procedure

When the checkbox “Check to open a new ScopeView application and load R-X graphs for relay” is checked, the following alert window appears.



The user must wait till the new ScopeView application instance fully opens before pressing on the OK button of the above message. The application may also appear as blinking in the Windows taskbar.

In the Signals window of ScopeView, some automatically selected signals may have a non-existing signal warning (yellow icon, see Figure 2-1). This means that the corresponding scope is either not enabled or the scopes in the “Function Scopes” tab of the relay are not selected.

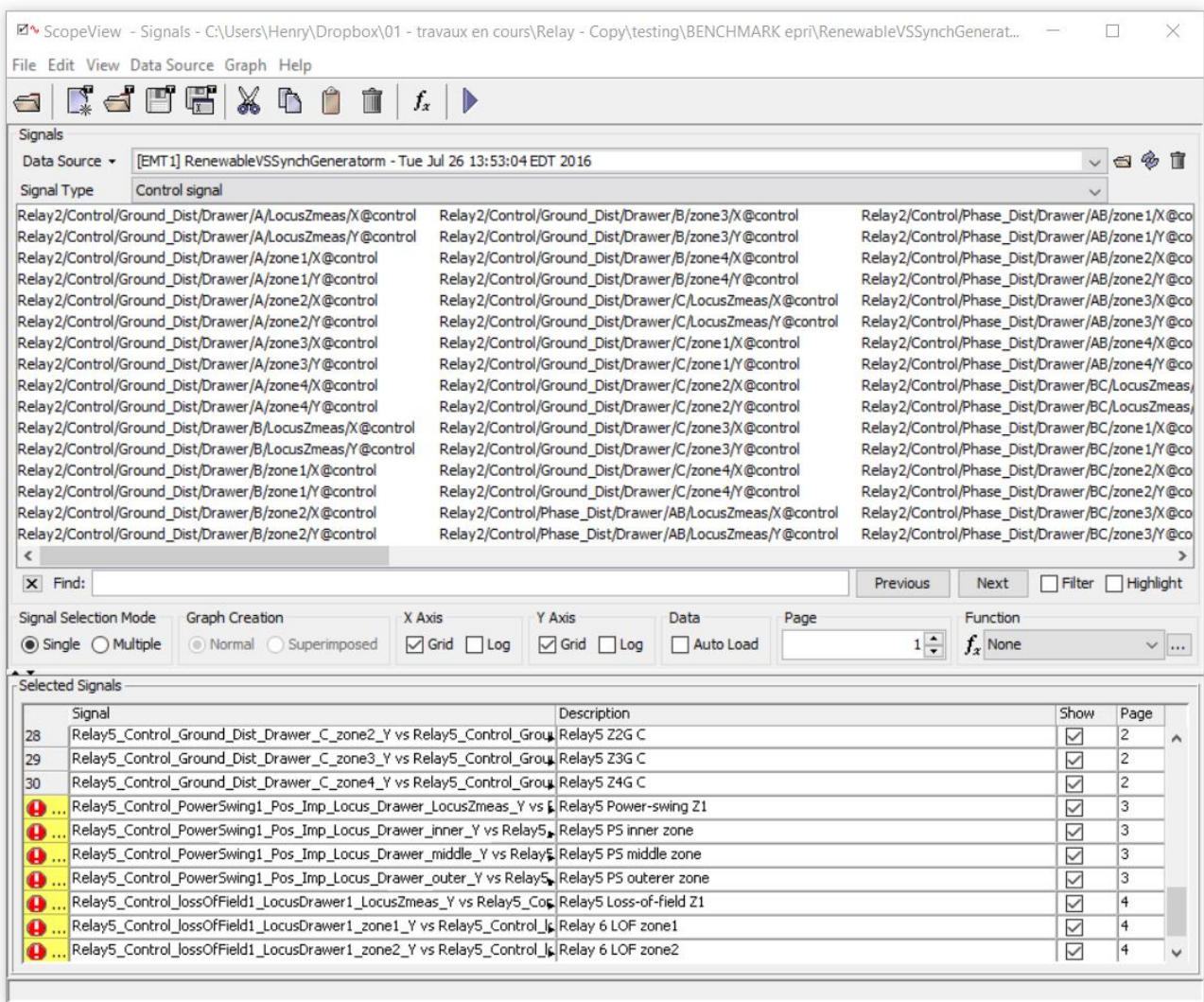



Figure 2-1 Signal selections window of ScopeView.

The user must press the start button  at the top of the ScopeView window in Figure 2-1, in order to display the R-X graphs. If some signals are non-existing (see Figure 2-1, yellow icons), a warning message will appear (see Figure 2-2) and the user can select the Yes button to remove the non-existent signals.

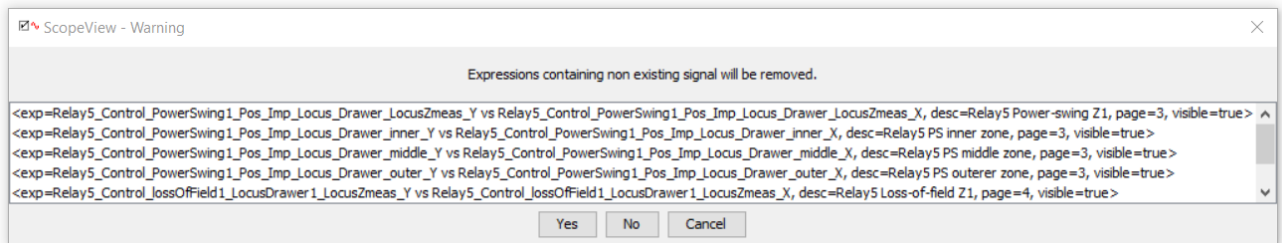


Figure 2-2 Warning message asking confirmation before removing non-existing signals.

The valid graphs are displayed on different pages in this order: phase-to-phase Distance, phase-to-ground Distance, Power Swing and finally Loss-Of-Field.

The page tabs used to navigate between are available at the bottom left corner of the ScopeView window (see Figure 2-3, Page tab).

The graphs descriptions or pages can be modified from the Signals window of ScopeView. By default:

- ZiG is the zone i of the ground distance
- ZiP is the zone i of the phase distance
- PS stands for Power-Swing
- LOF stands for Lost-Of-Field

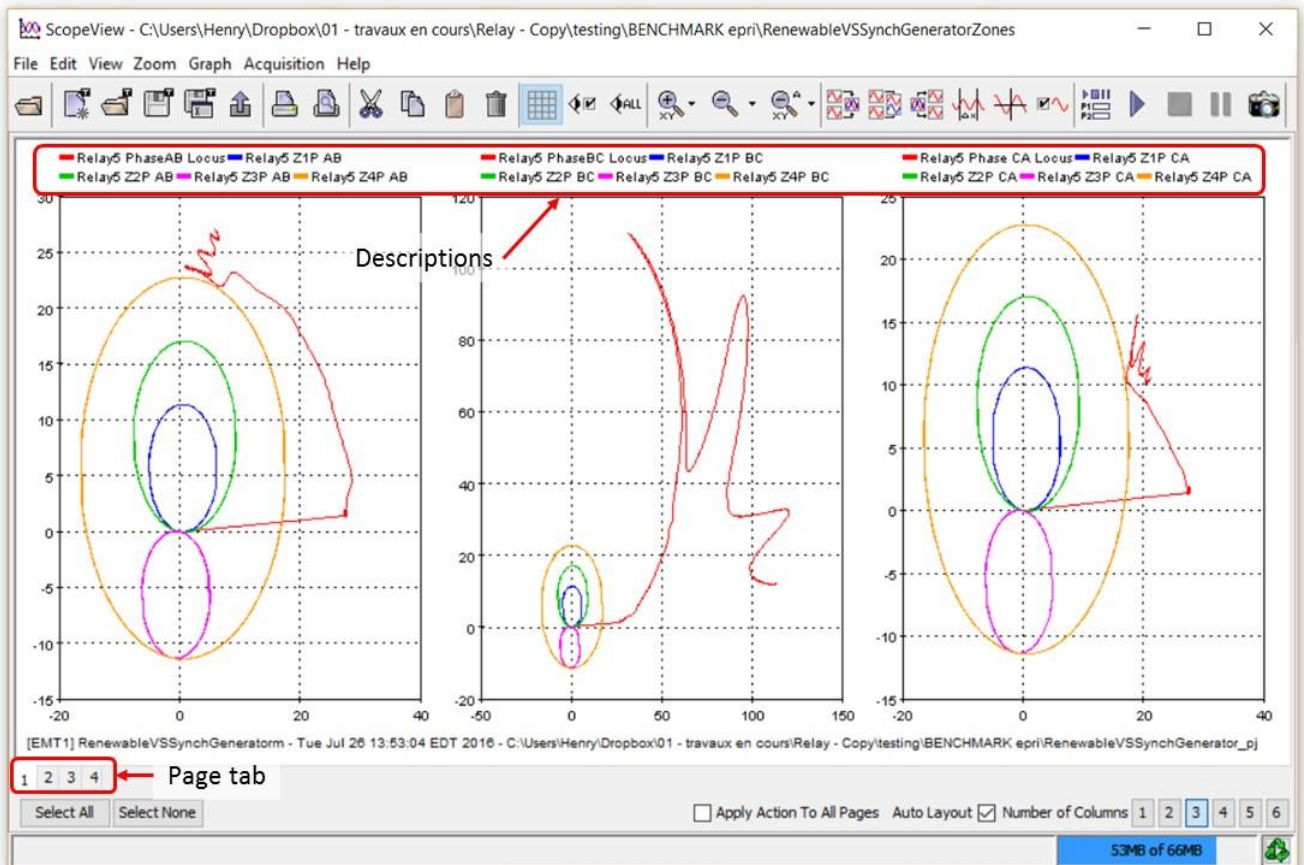


Figure 2-3: Graphs displayed in ScopeView.

3 Manual procedure

The following steps can be followed for the manual procedure (see Figure 3-1):

1. Open ScopeView and the “Advanced Function Editor”
2. In the category “All”, select “Versus”
3. In the “Selected Signals” section, select the X and Y points
4. Click on “Add Function”
5. Modify (option) the signal descriptions

The play button can be pushed to visualize the selections.

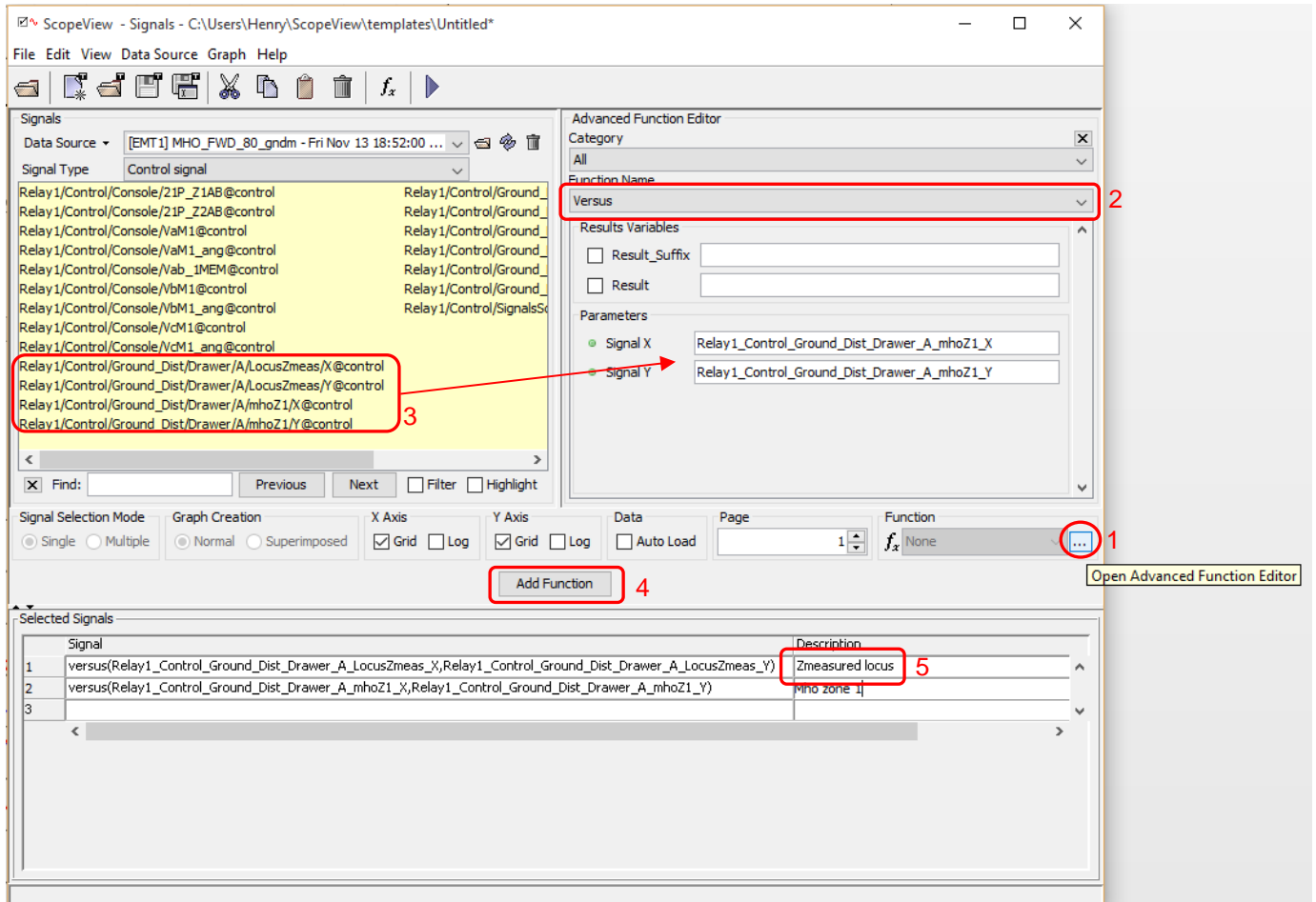


Figure 3-1 ScopeView window

4 Plotting features

4.1 Smoother

In order to avoid fast variations due to the effect of fast transients on the Discrete Fourier algorithm, the resistance and admittance values of the locus are averaged on a period of 20 ms before being plotted.

4.2 Steady-state point

When an impedance locus goes into a stable position, which means its impedance does not vary, a dot is drawn (see Figure 4-1). The dot size expands and reaches a maximum value after staying at the same position for a time defined by the input **Expansion time** in the “Function Scopes” tab of the considered relay.

The radius of the dot when the maximum size is reached is:

- For Distance elements: 2% of the line positive-sequence impedance magnitude in Ω at the secondary of the measurement transformers. This value is derived for the input Positive-sequence magnitude in the Line characteristics tab.
- For Power Swing elements: 2% of Outer zone forward reach impedance in Ω at the secondary of the measurement transformers. This value is derived from the inputs in the “Power swing” tab.
- For Loss-Of-Field: 2% of twice the Zone 1 diameter impedance in Ω at the secondary of the measurement transformers. This input is in the Loss-of-field tab.

The criteria to detect a stable position:

$$\left| \frac{dR}{dt} \right| < 0.001|R|$$

$$\left| \frac{dX}{dt} \right| < 0.001|X|$$
(0.1)

Where R is the locus resistance and X the admittance. Both values are averaged twice over 20ms periods.

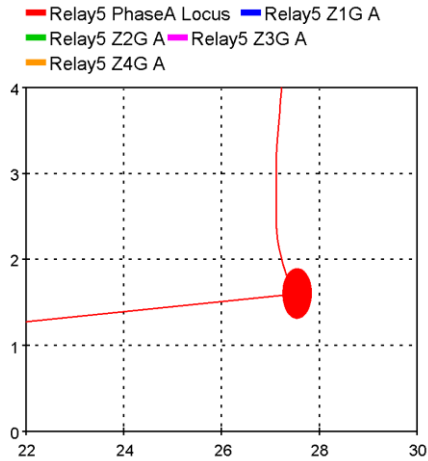


Figure 4-1 Dot shown when locus is in steady-state condition.

4.3 Timestamps

When a locus is not on a steady-state point, at every cycle a small dropout is drawn on its trajectory (see Figure 4-2). It helps having a rough idea on the time the locus spends between each zones. The further away the dropouts are from each other, the faster the swing is.

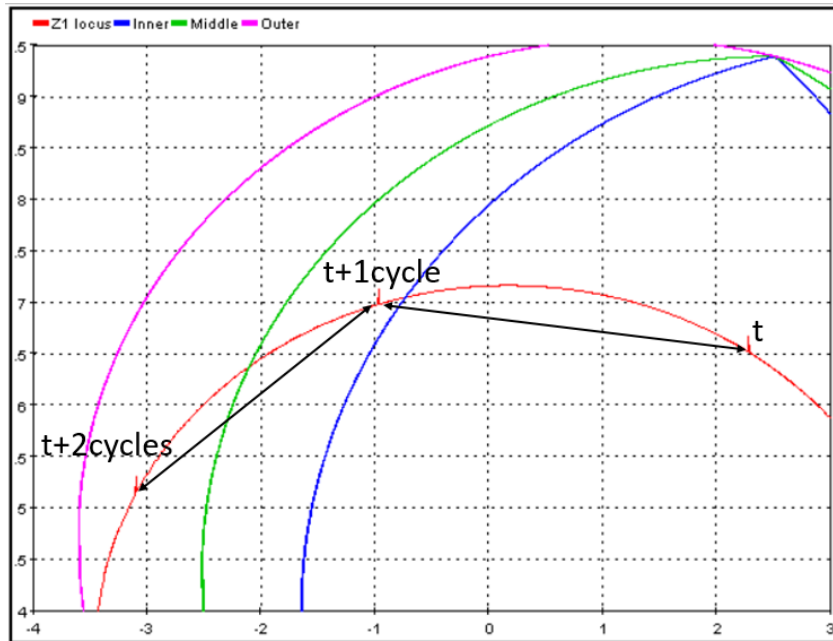


Figure 4-2 Dropout draw on the locus trajectories for every cycle.