



# SYNCHROWAVE Event Software Instruction Manual

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## Introduction

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The SEL-5601-2 SYNCHROWAVE<sup>®</sup> Event Software provides the following components and capabilities:

Basic and advanced:

- Analog and digital charts
- Harmonic and spectral analysis
- Phasor value derivation and display in phasor diagram and complex chart
- Automatic calculation of symmetrical components
- Reconfigurable display
- ACB or ABC phase rotation support
- Searchable signal lists and relay settings
- View COMTRADE and SEL ASCII format event reports

Advanced version only:

- Custom calculations on analog, digital, and complex quantities
- Impedance plane analysis of distance element (mho) operation, alpha plane analysis of differential element (87L) operation, Bewley Lattice analysis of traveling-wave data
- Simultaneous analysis of multiple events with optional time alignment

The basic version is available without any additional licensing. The advanced version requires a purchased license, but it is available as a demo for the first 60 days after installing the basic version.

## Applications

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### See What's Happening in Your Relays

Open, visualize, and analyze the data from your event reports with a simple and intuitive interface. Compare any and all available signals on the analog charts while viewing time-aligned digital information.

### Perform Phasor Analysis

Use the automatically calculated phasor quantities and their symmetrical components to compare signals. Move a time cursor to a point of interest to compare phasor values at that instant.

## Calculate

Define analog, complex, and/or binary calculations to further enhance your analysis. Use the custom calculation feature to calculate signal properties, fault impedances, internal relay state, average and reactive power, and more.

## See the Impact of Harmonics

Display the full spectrum or just the harmonic components of any available signal to determine power quality, transformer heating, etc. Harmonic metrics of Total Harmonic Distortion, K-Factor, and Crest factor are automatically calculated and tabulated for your convenience.

## Understand Root Cause

Compare trip equation output with available digital signals to identify trip precursors.

## Compare Events

Open multiple event reports simultaneously to compare double-ended reports or compare to previous events.

## Jump to the Details You Need

Use the new flexible interface to quickly zoom and pan, to focus on the details you need. Drag a box around a point of interest to fill the screen with just the part you want to see. Zoom in/out with a simple mouse wheel movement. Pan the display back and forth with a simple click and drag.

# Installation and Licensing

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Run the installation executable on the computer on which you want to install SYNCHROWAVE Event.

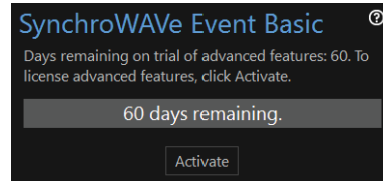
## Installation Steps

Locate or download the installation file for SYNCHROWAVE Event.

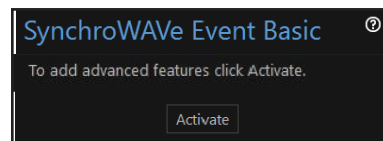
1. Double-click on the SEL SYNCHROWAVE Event Setup.exe icon.
2. Follow the installation instructions that appear on the computer screen while the software installs.
3. Launch SYNCHROWAVE Event by double-clicking on an event file or launching from the start menu: **All Programs > SEL Applications > SEL SynchroWAVE Event.**

From the date of installation, you will have a 60-day trial period to evaluate SYNCHROWAVE Event Advanced with full functionality. Once the trial period has expired, functionality will be limited to the features of SYNCHROWAVE Event Basic with analog and digital charts, phasor diagrams, complex charts, Harmonic Analysis charts, and Spectral Analysis charts only.

The software will display the SYNCHROWAVE Event trial window shown in *Figure 1* in the lower right corner, reminding you of the days remaining in the trial period. After the 60-day trial, the message will inform you that the software is licensed for SYNCHROWAVE Event Basic (as shown in *Figure 2*). Your installation includes a non-expiring license for SYNCHROWAVE Event Basic, but you will no longer have access to the advanced features of SYNCHROWAVE Event. You may license the features of SYNCHROWAVE Event Advanced at any time by selecting the **Activate** button in this message box.



**Figure 1** SYNCHROWAVE Event Basic Licensing Message During 60-Day Trial



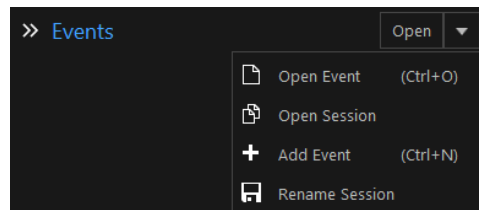
**Figure 2** SYNCHROWAVE Event Basic Licensing Message After 60-Day Trial

See *Appendix B: SYNCHROWAVE Event License Activation* on page 33 for information on licensing SYNCHROWAVE Event.

## Operating SYNCHROWAVE Event

Open SYNCHROWAVE Event by double-clicking an event report or launching it from the application icon. If launching from the application icon, select the **Open** button in the Events pane to choose an event or session. You can also replace an existing event or session by selecting the **Open** button. Alternatively, you can drag and drop an event file into the application window.

The **Open** button provides the drop-down options shown in *Figure 3*.




**Figure 3** Opening an Event


Use the **Add Event** option to add an additional event report to the existing event or session. Alternatively, you can drag and drop an event file into the application window. You can rename session files by using the **Rename Session** option (see *Views, Sessions, and Templates* on page 24 for details).

After the event is loaded, a default view displays the following three windows:

- Analog Chart: Current
- Analog Chart: Voltage
- Digital Chart

To meet your event analysis needs, you can add or remove windows through the use of the buttons in the upper right corner of each window  or by right-clicking on the applicable window. You can also add or remove quantities from any of these windows (see *Quantity Selection* on page 4).

# Quantity Selection

Use the **Quantity Selection** menu (see *Figure 4*) to add or remove quantities from any of the chart windows or phasor diagram windows. This popup menu can be accessed either by right-clicking the chart and choosing **Select Quantities** or selecting the  button in the upper right corner of the chart.

**NOTE**

The **1:** to the left of each of the quantities represents the index of the applicable event report. If multiple events (see *Events List* on page 18) are displayed, quantities prepended with **2:**, **3:**, etc. correspond to the index shown in the *Events list*.

The top portion of the **Quantity Selection** popup menu displays all available quantities for this type of chart. For example, the sampled data waveform (oscillography) VA has derived quantities of VA.Phasor (phasor quantity) and VA.Mag (phasor magnitude). VA and VA.Mag will be available for the analog chart but VA.Phasor will not; VA.Phasor will be available for the phasor diagram. The displayed list of available quantities can be filtered by entering text in the box at the top. For example, entering "V" and "V\*mag" results in the filtered list shown in the second and third frames of *Figure 4*. Select the **Add All** button to the right to add this search term to the *Selected Quantities* list. Any new quantities (see *Custom Calculations* on page 19) that match this form will be automatically included in the chart. Clearing the search box displays the full list again.

**NOTE**

Derived quantities are designed to work with filtered event reports and are only available for raw reports if the **Generate Raw Phasors** option is enabled. Viewing derived quantities on a raw event report exhibiting harmonics or dc offset may show unexpected behavior.

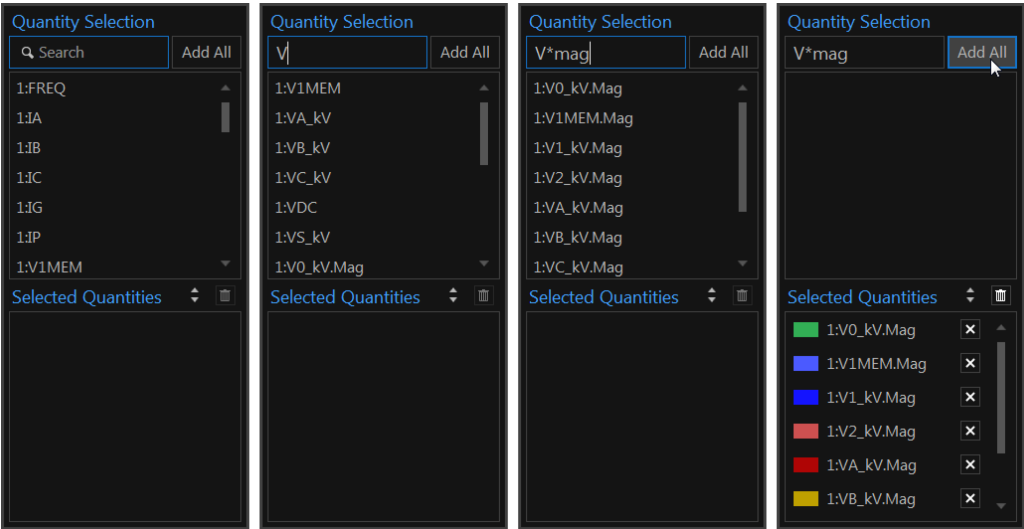



Figure 4    Quantity Selection

Other supported quantity filter wildcards are the question mark "?", which represents one unknown character, as opposed to the asterisk "\*", which represents zero or more unknown characters. Also, the period "." at the end indicates that quantities with characters after the period should be excluded (e.g., "VA." would show VA, VB, and VC, but not VA.Mag).

The bottom portion shows a list of the presently selected quantities. All selected quantities can be removed by selecting the  button or removed individually by selecting the **X** next to the quantity. The displayed color for each quantity is shown in the button to the left of the quantity name and can be changed by selecting that button.

Digital signals are added to charts in the order they are selected. For the default view, digital signals are displayed in alphabetical order. To more efficiently compare digital signals from the Quantity Selection menu, a user can easily reorder the signals for display.

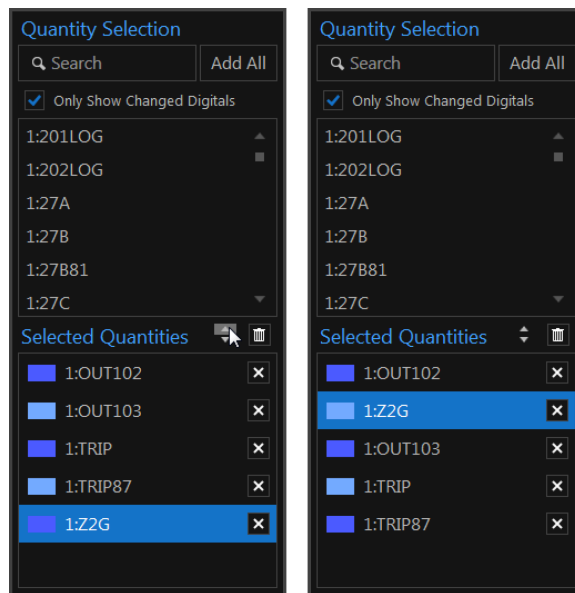


Figure 5 Reorder Selected Quantities

## Navigating the Analog and Digital Charts

The analog chart displays the measured data points with line segments connecting adjacent points (Linear interpolation) or with cubic splines passing through all points (Spline interpolation); see *Options on page 21*.

To fully explore the event data, the analog and digital charts support zooming and panning. When zooming, all charts display the same range on the time axis. When zoomed in sufficiently, data points will automatically become visible unless the **Hide data points** checkbox in the Options menu is selected. Pressing the <Z> key will set the zoom level to display all event data. Four methods of zooming are supported.

## Mouse Wheel and Up and Down Arrows

In the analog chart, rotating the mouse wheel or pressing the Up or Down arrows on the keyboard zooms in/out along the time axis centered on the location of the mouse. All charts similarly scale along the horizontal (time) axis.

**NOTE**

Right-click any window in SYNCHROWAVE Event to see a drop-down menu of available navigation options.

The mouse wheel behavior for the digital chart is the same if only a few signals are plotted so that no scrolling is necessary. If more signals than fit on the chart without scrolling are selected, you can hold down the <Ctrl> key and use the mouse wheel to scroll the digital chart up and down.

## Zoom to Cursor Range

Specify a horizontal range based on cursor position by moving the cursors to bound the desired time range, right-clicking within that chart, and selecting **Time Cursors > Zoom to Cursor Range (F2)**. All analog and digital charts will zoom to the specified time range. You may also access this feature via the keyboard shortcut <F2>.

## Double-Click

Double-clicking on a chart has the same effect as zooming in via the mouse wheel.

## Y-Axis Scaling

Specify the vertical range for a specific analog chart by right-clicking within that chart and selecting **Y-Axis Scaling > Scale this analog chart**. Perform similar steps for specifying the vertical range for all charts across all views, except change your last selection to **Scale all analog charts**. In the **Y-Axis Settings** dialog box that displays after either specification, clear the **Autoscale** checkbox, type the vertical range you want, and select **Apply**. Now, upon pressing <Z>, vertical scaling returns to your specified range. You can also use the following zoom and pan methods. Should you need to restore default vertical range settings, open the dialog box and select the **Autoscale** checkbox.

## Box Zoom

Holding down the <Ctrl> key and dragging a box inside a chart with the mouse will cause the contents of the selected box to zoom to fill the entire chart area. All other charts will scale along the horizontal axis to match the selected chart's horizontal axis.

**NOTE**

To aid use on laptop computers, the Box Zoom and Pan behavior can be swapped. By default, Box Zoom requires holding down the <Ctrl> key and Pan does not. Pressing <F5> swaps this behavior; Pan now requires the <Ctrl> key and Box Zoom does not. Press <F5> again to restore the default behavior.

## Pan

When you have zoomed in, you can click and drag with your mouse to pan within a chart. You can also press the Left or Right keyboard arrows to pan.

## Time Cursors

Two time cursors are available on charts to provide additional detail for analysis. Selecting a time cursor displays a popup dialog box that contains the value of all displayed quantities for that chart.

Time cursors are displayed by default, but they can be hidden by right-clicking on a chart and selecting **Time Cursors > Hide Cursor**. Keyboard shortcuts <F3> and <F4> center cursors on a chart, and <Shift+F3> and <Shift+F4> toggle on and off the cursor displays.

If two time cursors are displayed, the time difference between them displays on the chart in between the time cursors.

To move time cursors left/right using the arrow keys, first select the background of an analog or digital chart, then select the cursor in that chart. When moving the time cursor with the arrow keys, the time cursor skips the interpolated values, jumping directly to the next or previous point. If the time cursor is between data points, the time and data values shown in the popup window are interpolated.

Time cursors are displayed simultaneously on all charts and are required when using the phasor and mho diagrams. Two time cursors are required for the Spectral Analysis and Harmonic Analysis charts.

## Navigating the Phasor Diagram

You need one time cursor to operate the phasor diagram. Use the time cursor to specify the instant in the event report where SYNCHROWAVE Event should calculate the phasors. The phasor diagram will display the magnitude (if enabled from the phasor diagram chart options) and angle of all selected phasor quantities. You can select which time cursor affects a specific phasor diagram with the **Cursor Selection** box in the phasor diagram chart options. You may also select a reference quantity to aid in viewing relative phasor angles (see *Options on page 21*). By default, the reference quantity is set to None and the phasors will rotate with movement of the selected time cursor. If a reference quantity is chosen, the angle of the reference quantity will be subtracted from the angles of all phasor quantities derived from the sinusoidal waveforms in the event report. This angle normalization is applied prior to any custom calculations.

### NOTE

Following a trip, a voltage or current signal may be disconnected from power and go to zero. If one of these disconnected phasors is chosen as a reference, the reference angle may become unreliable following the trip.

## Navigating the Spectral Analysis Chart

You need two time cursors to operate the Spectral Analysis window. Use the two time cursors to specify the subset of data you wish to perform spectral analysis on (spectral analysis is only performed on the data between the two time cursors). Spectral analysis is only performed on actual data points, not the interpolated values. Therefore, the spectral analysis display will be blank when no data points are between the time cursors.

The range of the frequency axis is dependent on the sampling frequency in the event report. For example, the maximum frequency displayed for an event report with 4 samples per cycle at a nominal 60 Hz would be  $4 \cdot 60/2 \text{ Hz} = 120 \text{ Hz}$ . The number of points in the spectral analysis display is equal to half the number of points in the event report.

The range of the vertical axis is from 0 dB to –60 dB. Because the majority of signals to be analyzed by spectral analysis are expected to be voltages or currents, the Spectral Analysis window uses the  $-20 \log(x)$  definition of dB instead of the  $-10 \log(x)$  used for power signals.

## Navigating the Harmonic Analysis Chart

You need two time cursors to operate the Harmonic Analysis chart. Use the two time cursors to specify the subset of data to perform harmonic analysis. Harmonic analysis is only performed on actual data points, not the interpolated values.

The harmonic analysis algorithm processes data in units of integer cycles only. If the time cursors enclose more than an integer number of cycles, the algorithm rounds the selection down to the nearest whole cycle. The *number* Cycle(s) Selected indication (top left) displays this rounded cycle count. If the time cursors enclose less than one full cycle, the Harmonic Analysis chart displays a message indicating that the range is too small.

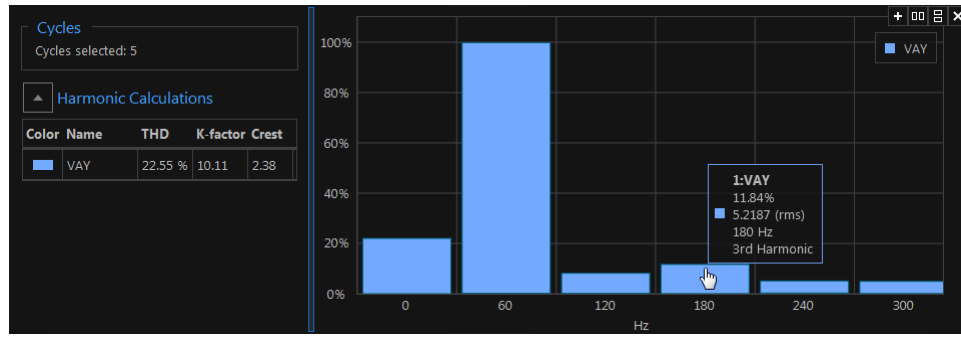
### NOTE

Harmonic and Spectral Analysis charts only provide meaningful analysis when used with raw event reports with sampling rates greater than or equal to 16 samples per cycle. Running harmonic analysis on a filtered event report will show severely attenuated harmonic information. Event reports with 8 or fewer samples per cycle cannot indicate more than 3 harmonics.

The range of harmonics, and therefore the harmonic frequency range, is dependent on the sampling frequency in the event report. The maximum displayed harmonic is calculated as  $h_{\text{MAX}} = 0.5 \cdot (\text{sample/cycle}) - 1$ , limited to a maximum of 64. For example, a 32 samples per cycle event report at a nominal 60 Hz would have  $h_{\text{MAX}} = 0.5 \cdot 32 - 1 = 15$ th harmonic, with a corresponding maximum frequency of  $60 \cdot h_{\text{MAX}} = 60 \cdot 15 = 900 \text{ Hz}$ . The display would therefore show 16 values starting with the dc offset (the 0th harmonic) up to the 15th harmonic. The horizontal axis is displayed in units of Hz (i.e., cycles per second).

The vertical axis displays the harmonic magnitudes as a percentage of the fundamental harmonic with a range set at 0 to 100 percent. To display the numerical values associated with each bar in the chart, hover the mouse over the bar of interest. The resulting hover-over message displays the following: quantity name, percentage of fundamental magnitude, raw magnitude in root-mean-square (rms), frequency in Hz, and harmonic number. *Figure 6* shows the Harmonic Analysis chart with a hover-over message for the 3rd harmonic. If a signal exceeds 100 percent, the hover-over displays the correct numerical values while the bar-height is limited to a maximum of 110 percent.





**Figure 6 Harmonic Analysis Chart**

The Harmonic Calculations portion of the Harmonic Analysis chart window displays the following derived values, useful in harmonic analysis: Total Harmonic Distortion (THD), K-Factor, and Crest factor.

## Total Harmonic Distortion

THD is a measure of the signal distortion resulting from higher frequency signals (harmonics) overlaying the nominal signal frequency. The THD calculation is shown below where  $\text{Harmonic}[k]$  is an array of the magnitudes of the harmonic components indexed from 0 to  $h_{\text{MAX}}$  where 0 is dc, 1 is fundamental, etc.

$$\text{THD} = \frac{\sqrt{\sum_{k=2}^{h_{\text{MAX}}} (\text{Harmonic}[k])^2}}{\text{Harmonic}[1]} \cdot 100\%$$

## K-Factor

K-Factor is a measure of the harmonic current and is useful for determining transformer thermal limits. The K-Factor calculation is shown below.

$$\text{K\_Factor} = \frac{\sum_{k=1}^{h_{\text{MAX}}} (k \cdot \text{Harmonic}[k])^2}{\sum_{k=1}^{h_{\text{MAX}}} (\text{Harmonic}[k])^2}$$

## Crest

Crest factor gives a measure of how extreme the peaks are in a waveform. Specifically, Crest factor is the ratio of the maximum absolute value of the signal oscillography divided by the rms value of that same signal. For example, a dc signal or a square wave has a Crest factor of 1 and a pure sinusoid has a Crest Factor of  $\sqrt{2}$ .

$$\text{Crest Factor} = \frac{\max(\text{abs}(\text{raw signal}))}{\text{rms}(\text{raw signal})}$$

## Navigating the Bewley Diagram (Traveling Wave)

### NOTE

This section only applies to the advanced version.

Fault initiation results in traveling waves that traverse an overhead transmission line at near the speed of light, partially reflecting off the line terminals, fault, and other discontinuities. Relays featuring traveling-wave-based fault locating contain specialized hardware to record and analyze the traveling-wave signal to calculate a high-precision fault location. The Bewley diagram can be used to visualize the traveling-wave propagation along the line and fine-tune the fault location analysis.

**Table 1 Plottable Signals<sup>a</sup>**

Raw Signal	Low Frequencies Removed	Derivative With Low and High Frequencies Removed
<b>SEL-411L</b>		
Not available	$TWI(\phi)(IT)$	$TWI(C)$
<b>SEL-T400L</b>		
$I(\phi)(IT)$ , $I(\phi)R$ , $V(j)$ , $V(\phi)R$	$TWI(\phi)(IT)$ , $TWI(\phi)R$ , $TWV(\phi)$ , $TWV(\phi)R$	$TWI(C)$ , $TWV(C)$
<b>SEL-T401L</b>		
$I(\phi)(IT)$ , $I(\phi)R$ , $V(\phi)(VT)$ , $V(\phi)R$ , $VS(n)$	$TWI(\phi)(IT)$ , $TWI(\phi)R$ , $TWV(\phi)(VT)$ , $TWV(\phi)R$ , $TWVS(n)$	$TWI(C)$ , $TWV(C)$

<sup>a</sup> Phase (#) = A, B, or C

n = 1, 2, or 3

Current Terminal (IT) = W, X, or blank for line current

Voltage Terminal (VT) = Y or blank for line voltage

Clark Component (C) = 0.zero, OR.zero, #.alpha (phase-to-ground), #R.alpha (phase-to-ground), ##.beta (phase-to-phase), and ##R.beta (phase-to-phase)

R = Remote Terminal (Signals from the remote terminal are only available for the SEL-T400L and SEL-T401L.)

Raw traveling-wave data are filtered to reduce measurement noise and emphasize traveling-wave arrival times. The filtered signals (see *Table 1* for details) can be added to the diagram. The first added signal is assigned the local terminal (left side of the diagram). Additional signals showing traveling waves that arrived at the same terminal also display to the left. Signals showing traveling waves that arrived at a second terminal can be added and are assigned to the remote terminal (right side of the diagram).

The time and fault location information from the event report, if available, are used to draw the initial lattice. The initial state of the diagram can be restored by selecting **Reset Bewley Settings**. Time cursor stubs are provided to allow adjustment of secondary pulse locations to further refine the accuracy of the fault location estimate. Numerical controls are provided on the left of the diagram to modify values for various system parameters.

### NOTE

The line length, TW line propagation time, and TW propagation velocity can be adjusted to account for wave speed variations resulting from line sag, humidity, temperature, etc.

In the numerical controls section, you can choose to lock either the TW Line Propagation Time (TWLPT) or the TW Propagation Velocity (LPVEL). You can manually change the parameter that is unlocked by either typing in a value or using the up and down arrows next to the entry box to modify the value. LL is held constant when changing the unlocked parameter, causing the locked parameter to change. Changing the Line Length (LL) value causes the unlocked entry to automatically update.

## Principles of Operation

The arrangement of the Bewley lattice is governed by four parameters:

- Fault initiation time:  $T_0$
- Fault position:  $m$
- Line propagation time (TWLPT):  $T$
- Time skew between devices: skew

Manipulation of the cursors on the Bewley Diagram to align with specific traveling wave arrival times adjusts these parameters to refine the TW fault location provided by the relay. Cursors can be pinned along the time (vertical) axis to fix that cursor's position while manipulating other cursors.

For the SEL-T400L and SEL-T401L, the  $T$  parameter is the same as the TWLPT (Traveling Wave Line Propagation Time) setting. For the SEL-411L, the applicable setting is LPVEL (Line Propagation Velocity) and is related to  $T$  as  $LPVEL = LL / (T \cdot c)$ , where  $c$  is the speed of light.

The parameters are solved simultaneously depending on the pinned cursors. For the purposes of discussing the calculations, the cursor presently being moved is also considered to be pinned.

### NOTE

When applied to hybrid lines with overhead and cable sections, the double-ended TW-based fault locating method in the SEL-T400L and SEL-T401L compensates for line nonhomogeneity and provides accurate results. If analyzing a TW event report from a hybrid line, the fault location displayed by the Bewley Diagram will be the uncompensated fault location and may not match the compensated fault location reported by the relay.

Because the cursor equations and the parameters are interdependent, the ability to pin a cursor depends on which cursors are already pinned. Cursors can only be unpinned in the reverse order they were pinned. A pinned cursor that cannot be unpinned displays a push-pin icon that is grayed out. A pinned cursor that can be unpinned displays a push-pin icon that is white on a black background or black on a white background. An unpinned cursor is displayed as a dashed line; a pinned cursor is displayed as a solid line. The cursors are assigned colors depending on the order pinned: first pinned cursor is green, second is red, third is cyan, fourth is purple.

When opening the Bewley diagram, the green cursor will automatically be pinned to the first TW that arrived at the left pane and aligned with the first TW arrival time reported by the relay, if available. If a signal that shows TWs from the remote terminal is also added, the first TW that arrived at the right pane will be aligned to the first TW arrival time for the remote terminal and will correspond to the first TW arrival time reported by the relay for that terminal, if available.

**NOTE**

Moving a dashed-green cursor or moving the solid green cursor when it is the only pinned cursor are examples of the "one cursor pinned" scenario.

**One Cursor Pinned:** When calculating the parameters with one cursor pinned, the calculation involves one equation and one unknown. The equation is the definition of that cursor's position in terms of  $T_0$ ,  $m$ ,  $T$ , and skew;  $T_0$  is solved for with the other parameters held constant. Thus, since only  $T_0$  is being modified, moving the green cursor has the effect of shifting the lattice in relation to that cursor.

**NOTE**

Moving a dashed-red cursor or moving either of the solid cursors when two cursors are pinned are examples of the "two cursors pinned" scenario.

**Two Cursors Pinned:** When calculating the parameters with two cursors, the calculation involves two equations and two unknowns. The software solves the equations for  $T_0$  and  $m$  with  $T$  and skew held constant. Moving one of the two pinned cursors keeps the other cursor static and adjusts the fault position to correspond to both cursor positions.

**Three Cursors Pinned:** When three cursors are pinned, the calculation solves for  $T_0$ ,  $m$ , and  $T$ , with skew held constant. This adds a third degree of freedom ( $T$ ) to account for changes in line propagation velocity or dispersion.

**Four Cursors Pinned:** When four cursors are pinned, the calculation solves for all four parameters,  $T_0$ ,  $m$ ,  $T$ , and skew. This adds a fourth degree of freedom (skew) to compensate for time source accuracy and TW attenuation and dispersion. A fourth cursor is only available when analyzing double-ended data.

## Single-Ended Fault Locating

When performing traveling-wave-based fault locating with data from only one relay (see *Figure 7*), the green time cursor is automatically aligned with the first TW arrival time. The dashed-red cursors can be aligned with other TW arrivals to initially identify the fault location. If refinement of the propagation time or velocity is desired, pinning a red cursor makes cyan cursors available. Aligning a cyan cursor to another TW arrival time will simultaneously adjust the fault location, propagation time, and propagation velocity.

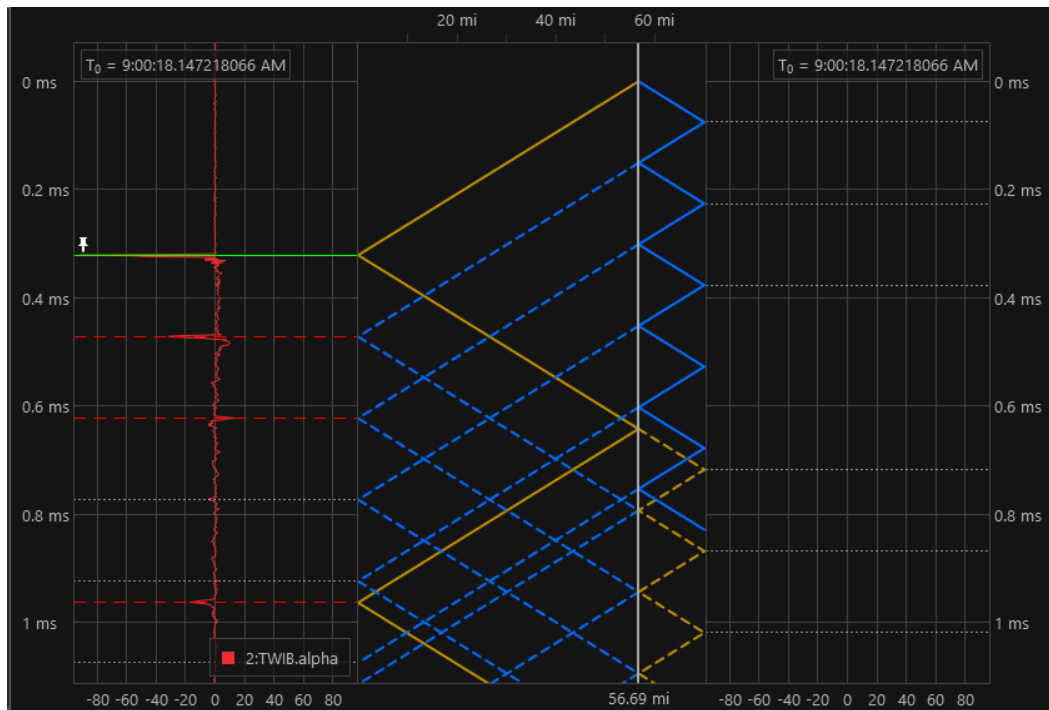


Figure 7 Bewley Diagram Analyzing Single-Ended Traveling-Wave Data

## Double-Ended Fault Locating

When performing traveling-wave-based fault locating with data that show traveling waves at both ends of the line (see *Figure 8*), the green time cursor is automatically aligned and pinned to the first peak detected at the local terminal. A red time cursor is aligned with the first detected peak at the remote terminal but is not pinned. If refinement of the propagation time or velocity is desired, pinning a red cursor makes cyan cursors available. Aligning the cyan cursor to another TW arrival time will simultaneously adjust the fault location, propagation time, and propagation velocity. If further refinement is required to make the TW arrival times line up with the lattice reflections, pinning the cyan cursor will make purple cursors available to refine the time skew between the terminals.

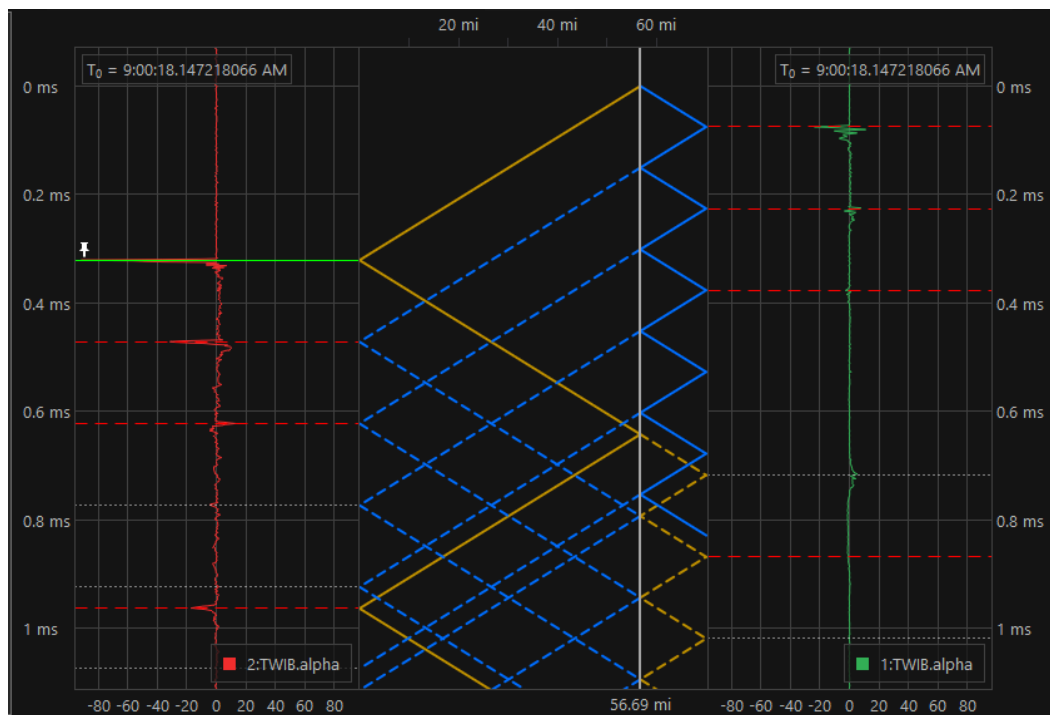


Figure 8 Bewley Diagram Analyzing Double-Ended Traveling-Wave Data

## Navigating the Mho Circle Diagram (Impedance Plane)

### NOTE

This section only applies to the advanced version.

The mho diagram (see *Figure 9*) allows for analysis of distance element operation by providing an Impedance Plane plot on which apparent impedance and distance element characteristics may be plotted. This tool supports analysis of event reports generated by SEL-311, SEL-321, SEL-411, and SEL-421 series relays.

The apparent impedance path appears for the time period beginning at the start of the event file and ending with the cursor position that is farthest to the right. To display the full impedance trajectory, move one of the cursors fully to the right. The two time cursors appear on the apparent impedance plot as a dot representing the apparent impedance at the instant specified by the time cursor. Apparent impedance values are available at quarter-cycle increments. One of the two time cursors specified in the **Chart Options** menu identifies the voltage measurements used for mho element polarization. Moving this time cursor results in movement of the circle characteristic in addition to the apparent impedance dot.

### NOTE

The calculations to draw the mho circle are dependent on the associated currents. When the currents are very small (following a trip, for example), the mho characteristic can become unpredictable and should not be used. SEL relays automatically disable the distance element in these situations.

The display of individual zone characteristics is configurable from checkboxes under the **Chart Options** menu in the left pane. A time cursor selection option in this menu lets you configure which time cursor specifies the polarizing voltage for the mho circle characteristics for mho expansion.

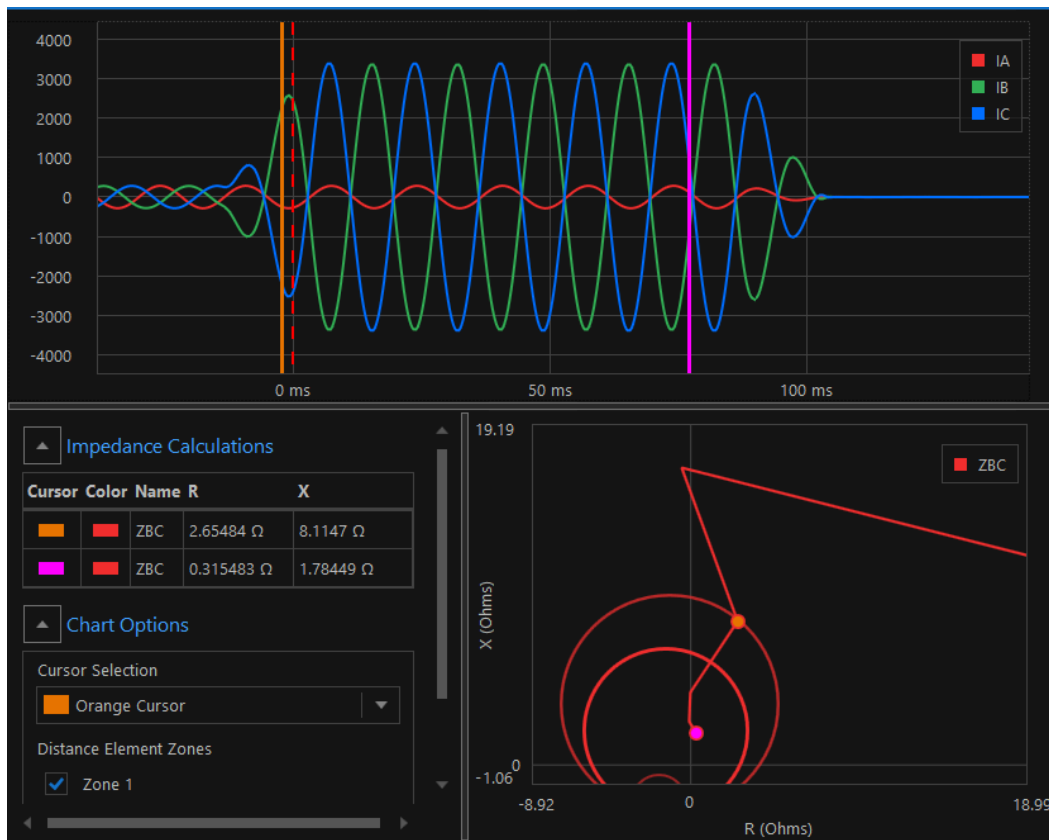


Figure 9 Mho Diagram

## Navigating the Alpha Plane Diagram (Differential Element)

### NOTE

This section only applies to the advanced version.

The alpha plane (see *Figure 10*) allows for analysis of differential element operation by providing a complex plane plot on which the current differential signals can be plotted. The plots are overlaid with the associated restraint regions. This tool supports analysis of event reports generated by SEL-311L, SEL-311N, SEL-387L, and SEL-411L relays.

For two-terminal lines, the differential quantities are calculated as the quotient of the remote current phasor divided by the local current phasor. One quantity per phase or sequence current is available with names ending in "\_2T" to indicate it is calculated from two terminals. For multiterminal lines, the differential quantities are calculated as the quotient of the local current phasor divided by the sum of all available remote current phasors. The calculation of differential quantities is repeated from the perspective of each terminal as local. For example, an SEL-311L protecting a three-terminal line will show the following three differential quantities for the A-phase current: 87AL\_3T, 87AX\_3T, and 87AY\_3T, where the L (local), X, and Y indicate which terminal is considered local for the calculation.

The present location, as specified by the selected time cursor position, appears as a highlighted dot on the alpha plane diagram, with the numerical value displayed on the panel to the left under **Displayed Quantities**.

Additional options are available under the **Chart Options** drop-down list on the panel to the left. Selecting the **Show Point Trails** checkbox displays the full path of the differential quantity in addition to the highlighted dot. Selecting the **Show Custom Restraint Area** checkbox displays an alternate restraint region. The radius and angle of this region can be manually adjusted to explore alternate settings for the differential element.

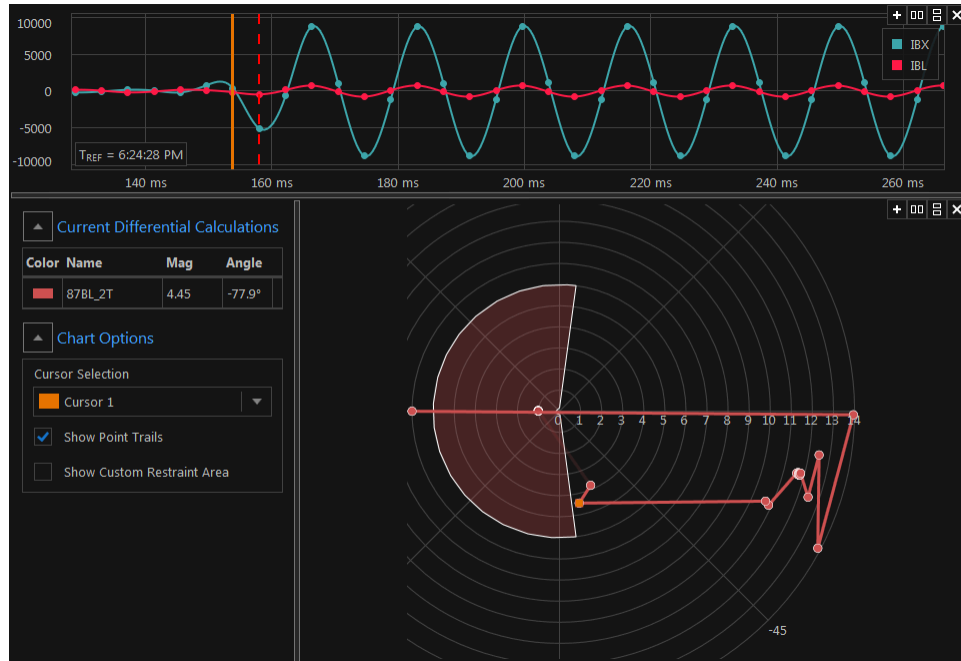


Figure 10 Alpha Plane Diagram

## Navigating the Complex Chart

The complex chart allows for analysis of any complex value signal on a Cartesian plane. Automatically calculated phasor values are available when analyzing filtered event reports, as shown in *Figure 11*. The calculation engine may also be employed to create arbitrary complex signals for plotting. The function `COMPLEX_RI` creates a complex signal by assigning the first argument to the real part (horizontal-axis) and the second argument to the imaginary part (vertical-axis). The function `COMPLEX_MA` creates a complex signal by assigning the first argument to the magnitude and the second argument to the angle (in degrees). By using these functions, arbitrary signals can be plotted in a Cartesian or polar representation.

The complex chart includes a data table that displays the value of the complex signal at cursor locations. The complex chart allows limiting the portion of the signal to be plotted using the cursors and zoom level.

Complex chart advanced options are also available to customize the display on a per-signal basis. Signals may be set to display independently of cursor or zoom, display or hide cursor dots, display or hide the legend, and include or exclude from the data table.



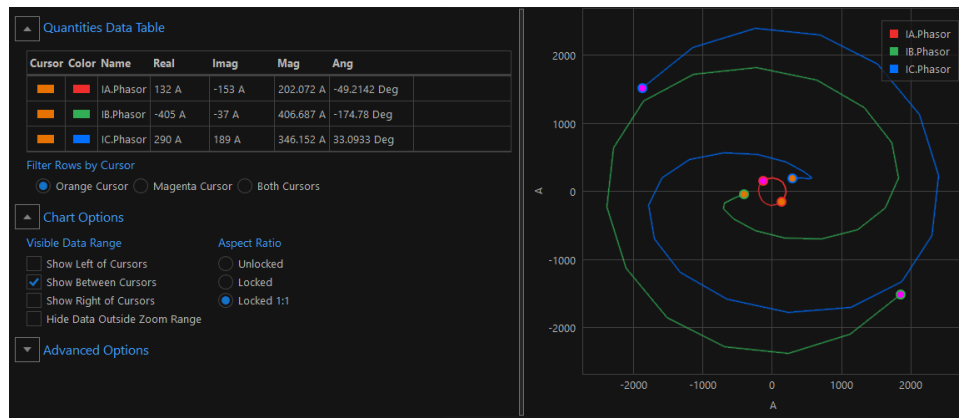


Figure 11 Complex Chart

## Calculated Quantities

### NOTE

Calculated phasor values are only an approximation of the internally calculated phasors used by the relays for protection. Values may differ significantly during a transient.

SYNCHROWAVE Event loads the sampled data waveforms directly from the event report. From these waveforms, several additional quantities are automatically calculated as follows:

Type	Example	Description
Sample Data:	1:VAX	Original data from event report.
Phasor Data: <sup>a</sup>	1:VAX.Phasor	Phasor quantity derived from sample data, peak magnitude.
Sequence Phasor: <sup>a</sup>	1:V1X.Phasor	Symmetrical component calculated from A, B, C phasors, using the ABC or ACB rotations in the <b>Options</b> menu.
Phasor Magnitude: <sup>a</sup>	1:VAX.Mag	Magnitude of the derived phasor.
Relay Settings:	1:51PIP.Set	Constant values from the relay settings are available as analog quantities.

<sup>a</sup> Only calculated for filtered oscillographic signals unless the **Generate Raw Phasors** option is enabled.

If available within the event report, relay settings are created as constant analog values. These values are available for plotting on the analog chart and for use in calculations.

## Common Displays


The following are common for all of the different display types. Each of these displays is collapsible and resizable.

## Events List

The Events list provides descriptive information for each of the loaded events. Events are assigned an event number for the session, which is used to uniquely identify quantities. For example, if two events are loaded from the same relay, the quantity name for the A-phase voltage at the Y terminal is 1:VAY for the first event and 2:VAY for the second event.

Each event report in the list has the options shown by the following icons in the upper right corner of each window .

## Relay Settings

Displays additional information available from the protective relay such as settings, line parameters, etc. Settings display in a filterable grid layout. Advanced search options are described in detail by selecting the help  icon. A searchable view of the raw text is additionally available by selecting the **View Raw Text** button.

Sequential Events Recorder (SER) data is also viewable and filterable via the settings grid.

## Adjust Time

Two different devices can capture event reports for the same event. These reports may not be time-aligned. Select the **Adjust Time** icon to display a menu with the following options:

- **Adjust Time Earlier (– delta time):** Shifts the time of the selected event report forward by the time difference between the cursors.
- **Adjust Time Later (+ delta time):** Shifts the time of the selected event report backwards by the time difference between the cursors.

### NOTE

Delta is the time interval between the time cursors.

- **Advanced:** Selecting the Advanced menu option (*Figure 12*) allows you to time-shift an event report to a specified value.
- **Reset to Original Time:** Restores the original event time if previously shifted. This option is hidden if the report time has not been adjusted.

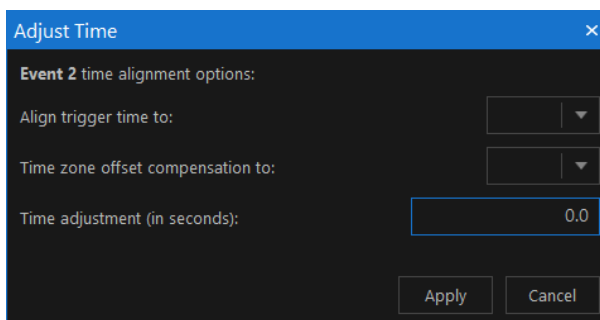


Figure 12 Time Alignment

When you are viewing multiple unrelated events, the various events can be separated by large periods of time. The detailed waveforms may display poorly because of the wide time scale. When you initially load SYNCHROWAVE Event, it will ask if you wish to align the trigger times for time-separated events. Selecting **Yes** will align the events, **No** will keep them at their present time. If you select **Yes** to align the events, the event data will be translated along the time axis by the time difference to facilitate event comparison. If the events are within 1 second of a 30 minute interval (as might be because of a time zone difference), and the offset is not greater than 12 hours, then the time is adjusted to the closest 30 minute increment instead of setting the trip times equal.

When using the **Advanced Adjust Time** dialog, a desired time adjustment in seconds may be entered directly. Alternatively, you may select another event with which to align the trigger times. When another event is selected from the drop-down, the Time adjustment text entry box will populate with this offset value. If the criteria for time zone adjustment is met, the **Time zone offset compensation** option is displayed. Selection of another event will populate the adjustment entry box with the time zone adjustment.

## Export

Exports the associated event file in IEEE C37.111 COMTRADE format.

## Edit




### NOTE

Renaming events does not update chart or custom calculation references.

Updates the event number to a specified value.

## Parse Log

Displays information relating to file parsing process. The icon is only displayed if parse logs are generated.

Parse Log Level	Icon
Info / Debug	
Warning	
Error / Fatal	

## Remove

Removes the event from the event list.

## Custom Calculations

### NOTE

This section only applies to the advanced version.

In addition to the automatically calculated quantities, SYNCHROWAVE Event supports custom declarative (i.e., not procedural) calculations. Many standard spreadsheet and SELOGIC operators are supported. Some of the supported calculations are shown in *Table 2*.

**Table 2 Supported Calculations**

Analog Number Functions	SQRT, ABS, SIN, COS, ASIN, ACOS, EXP, LN, LOG, CEIL, POW, FLOOR, MIN, MAX, LIMIT, TAN, ATAN, ATAN2, SHIFT
Digital Functions	TIMER_CYC
Complex Number Functions	CONJ, MAG, ANG, REAL, IMAG, POW, COMPLEX_MA, COMPLEX_RI, LIMIT
Power System Functions	SEQ0, SEQ1, SEQ2, LINE_Z, LINE_Y

The operators shown in *Table 3* are supported.

**Table 3 Supported Operators**


Analog/Complex Operators:	*, /, +, -, <, =, >, >=, <=
Digital Operators:	AND, *, OR, +, NOT, !, <, =, >, >=, <=

**NOTE**

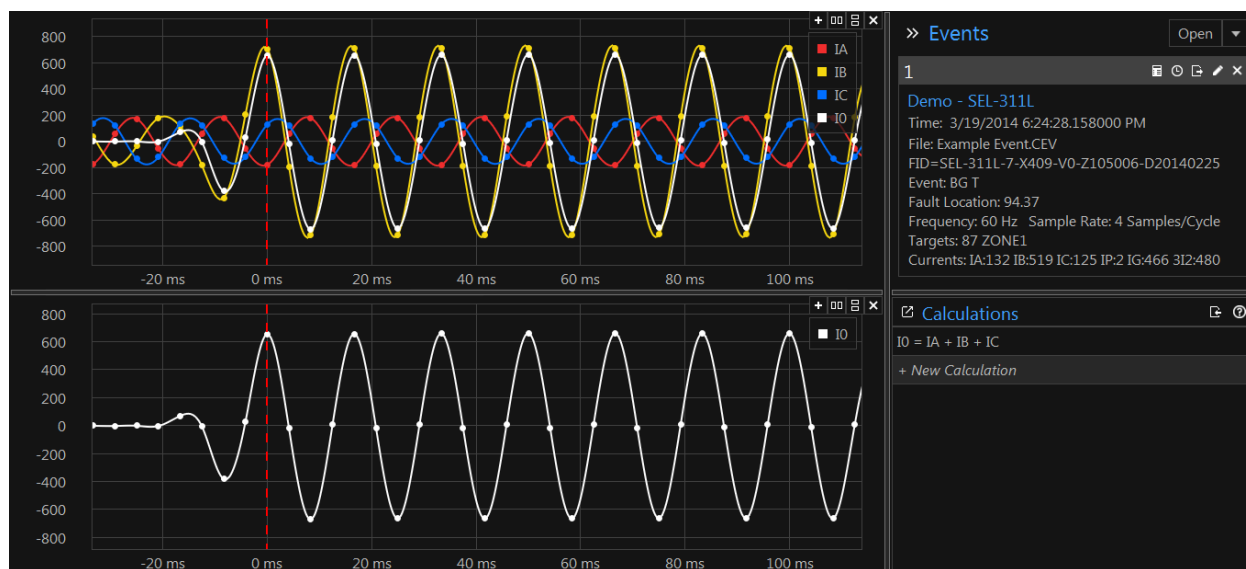
If a phasor reference quantity is selected, the reference angle is subtracted from all phasor quantities prior to performing any custom calculations.


**NOTE**

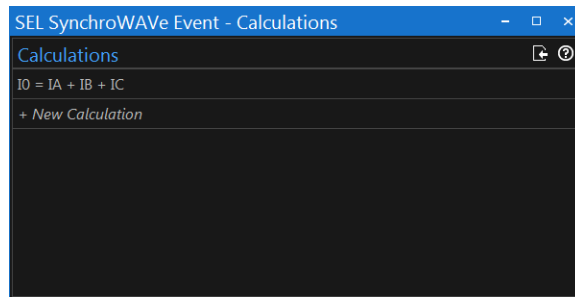
Phase rotation and phase reference do not affect the operation of the SEQ functions. See online help for additional information.

A more detailed explanation of the calculation capability is available by selecting the  button in the **Custom Calculations** area.


For example, if you wanted to display the sample waveform equivalent of the ground current, you can enter the equation  $I_0 = I_A + I_B + I_C$ . The result is shown in *Figure 13*.

**Figure 13 SYNCHROWAVE Event Custom Calcululations**

For additional Custom Calculations workspace, you can select the popout  button. The Custom Calculations popout display can be moved to a second monitor and expanded for greater visibility.

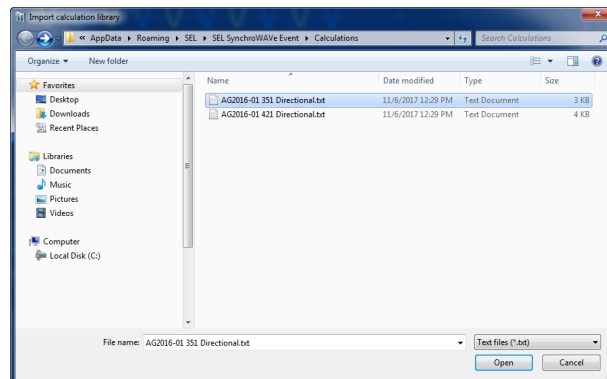


**Figure 14 Custom Calculations Popout**

Import predefined and archived calculations from the Calculation Library by selecting the Import button . See the Calculation help guide within the software for additional details regarding Calculation Library functionality.


## NOTE

The calculation library is located at: C:\Users\<UserID>\AppData\Roaming\SEL\SEL SynchroWAVE Event\Calculations.



**Figure 15 Custom Calculations Library**

## Options

You can display the options window (*Figure 16*) by selecting the settings button  in the upper right corner of the SYNCHROWAVE Event application.

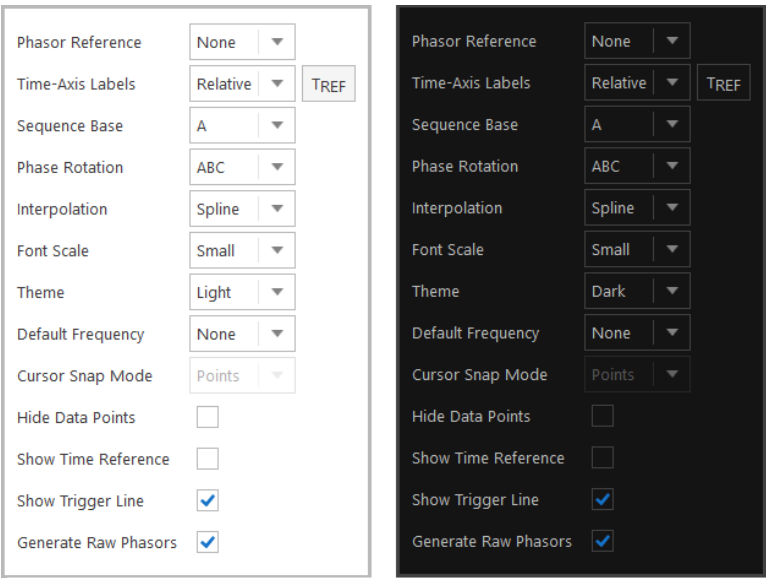


Figure 16 SYNCHROWAVE Event Options

The **Phasor Reference** option specifies which quantity will serve as a reference for the rotating phasor reference frame. If **None** is selected, the phasors will rotate with movement of the selected time cursor. When a quantity is selected as a reference, the angle of the reference quantity is subtracted from the angle of all automatically calculated phasors.

The **Time-Axis Labels** option allows you to select the horizontal axis to be labeled in either time stamps or cycles (*Figure 16*). Selecting **Absolute** will display the least significant nonzero portion of the time stamp values based on the event report time stamps. For example, the time-axis labels in *Figure 17* relate to the underlined portion of each time stamp shown in *Figure 18*.

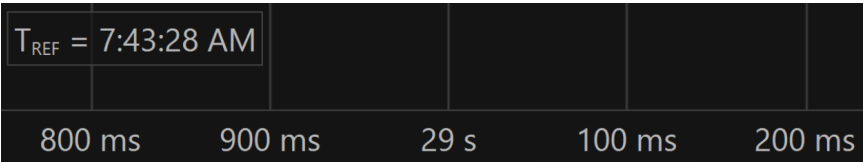


Figure 17 Absolute Time-Axis Labels

Specifically, the numbers relate to the underlined portion of each time stamp shown in *Figure 18*.

07:43:28. <u>800</u>	800 ms
07:43:28. <u>900</u>	900 ms
07:43: <u>29.000</u>	29 s
07:43:29. <u>100</u>	100 ms
07:43:29. <u>200</u>	200 ms

Figure 18 Time Stamps Associated With Absolute Time-Axis Labels

Selecting either **Relative** or **Cycles** will initially display seconds or cycles, respectively, referenced from the event trigger time. You can change the relative time reference by moving the orange cursor to the desired reference and selecting the **T<sub>REF</sub>** button in the Options menu. The **Cycles** option is only available for event reports opened individually.

### NOTE

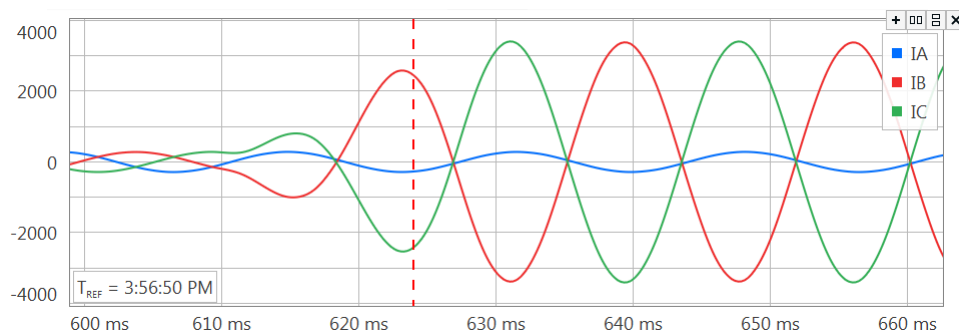
The Cycles option is only available for event reports opened individually.

The **Sequence Base** and **Phase Rotation** options specify parameters for the automatic computation of symmetrical component waveforms (e.g., positive sequence, negative sequence, zero sequence) for both currents and voltages at each terminal. The generated sequence quantities are automatically added to the quantity selection list. After you first load a file, phase rotation is set to be consistent with the rotation the event report identifies. If you override this phase rotation, the new phase rotation is saved in the .session file and persists when you open the file in the future.

The **Interpolation** option allows you to select which of two interpolation methods (Linear or Spline) SYNCHROWAVE Event uses to estimate values between data points. SYNCHROWAVE Event uses interpolated values both for displaying continuous curves on the analog chart and for comparing values from multiple reports for which samples do not align. Select **Linear** to connect data points through use of straight line segments. Select **Spline** to connect data points through use of cubic splines.

The **Font Scale** option allows you to select a larger than default font size for use in creating screen captures suitable for publications. Small is the default, Medium is 25 percent larger than Small, and Large is an additional 50 percent larger.

The **Theme** option allows you to change the default dark theme to a light theme, which may be more suitable for incorporating screen captures into technical articles.



**Figure 19** Light Theme for Analog Chart

The **Default Frequency** option allows you to set a default frequency of 50 Hz or 60 Hz to be applied to event reports which are recorded using a rate in units of samples per cycle and do not include system frequency information. If set to **None**, a dialog will allow you to select a frequency for each file that requires but does not contain frequency information.

The **Cursor Snap Mode** option switches the snap functionality of the cursor from raw data points to interpolated peaks in the waveform. The peak option is only available for high-resolution traveling-wave event files. See the software help menu within the software for additional details on this functionality.

The **Hide Data Points** checkbox changes the behavior of the analog chart with respect to when points are displayed. When the checkbox is empty, data points are automatically displayed when zoomed in sufficiently. When the checkbox is selected, the data points remain hidden regardless of zoom level.

The **Show Time Reference** checkbox enables or disables the time reference display on analog and digital charts.


The **Show Trigger Line** checkbox enables or disables the trigger line on the analog and digital charts.

The **Generate Raw Phasors** checkbox enables or disables the automatic calculation of quadrature phasors and their derived quantities from unfiltered oscillographic waveforms. This option is disabled by default.

To generate phasors, SYNCHROWAVE Event uses the original waveform as the real part and the waveform shifted by one quarter cycle as the imaginary part. The result is an approximation of the complex phasor values generated and applied internal to the device, as long as no harmonic or dc offset components are present.


## Other Controls

### Data Export


To export time-series data presently displayed on all analog charts to a comma-separated value (CSV) or COMTRADE file, select the Share  button in the top right, then select **Export Data (CSV)** or **Export Data (COMTRADE)** from the drop-down list. The local computer's time zone settings are used to calculate timestamps in UTC for the exported data.

## Views, Sessions, and Templates

### Views


Multiple views can be created and saved via the **+** button located at the bottom left of the screen. Custom view templates can be loaded by using the  button.

### Sessions and Templates

To simplify analysis, view configuration and custom calculations persist between analysis sessions. The configuration information of single or multiple events is automatically saved in a .session file  alongside the event report under analysis every 10 seconds. Session files can be renamed, which modifies the existing .session file to the specified name. It can be discarded between analysis sessions by deleting the .session file.

#### NOTE

When opening an event file, such as **event.eve**, the associated session file will be stored in a file named **event.eve.session**.

A session configuration can be saved as a template for analysis of other event files via the  button. A session can be saved as a relay-specific default template via **Auto-Template**. If a template is needed for a specific event report type, it can be saved as **User-Template**. All templates are saved with a .template file name extension. If a session file exists for a specific event report, the template does not override the saved .session file.



NOTE

Template files must be loaded and cannot be opened like session files.

Screen Capture

The **Share > Screenshot** button in the top right corner of the software captures the full application window to a JPG-format image and prompts for a file save location. You can also take a screen capture by choosing **Copy Chart to Clipboard** or **Save Chart as Image** from the right-click menu on a chart.

Specifications

General	
Operating Systems Supported	
Microsoft Windows 10 (64-bit) Microsoft Windows 11 (64-bit)	
System Hardware Requirements	
Recommended Minimum Configuration:	2 GHz processor 2 GB RAM
Supported File Formats	
Import	
IEEE C37.111-1991, -1999, and -2013 COMTRADE (.CFG, .DAT, .HDR, .CFF) SEL Compressed ASCII (.CEV) event report SEL ASCII (.EVE) event report SEL Zipped Event (.EVZIP) SEL-T400L and SEL-T401L Event Playback (.PLY) file Sequential Events Recorder (.SER and .CSER) Motor Start Reports (.MSR and .CMSR ) Comma-Separated Values (.CSV) Meter LDP and SER data (.bin) Voltage Sag, Swell, and Interruption Report (.txt)	
Export	
IEEE C37.111-1999 COMTRADE IEEE C37.111-2013 COMTRADE Comma-Separated Values (.CSV)	
Basic Features	
Oscillography, phasors, and digital quantities displays Spectral and harmonic analysis Multiple background themes Phasor value calculations for filtered reports Exporting of data and screen captures Automatic saving of views and calculations between sessions Searchable signal names and relay settings	
Advanced Features	
Traveling-wave, alpha plane, and mho characteristic analysis Custom calculations Simultaneous viewing of multiple event reports	
Product Configuration	
Licensing	
Advanced Mode:	Nonexpiring individual license Free 60-day trial
Basic Mode:	Free operation post-trial

# Appendix A: Software and Manual Versions

Table 4 lists the software versions, a description of the modifications, and the instruction manual date code that corresponds to these versions. The most recent version is listed first.

Starting with revisions published after March 1, 2022, changes that address security vulnerabilities are marked with "[Cybersecurity]". Other improvements to cybersecurity functionality that should be evaluated for potential cybersecurity importance are marked with "[Cybersecurity Enhancement]".

**Table 4 Software Revision History**

Version Number	Summary of Revisions	Manual Date Code
1.9.1	<ul style="list-style-type: none"> <li>➤ Updated the SYNCHROWAVE Event application installer so that all dependencies are included. Previously, SYNCHROWAVE Event did not include dependencies in its install package and instead downloaded the required .NET packages from Microsoft's website.</li> <li>➤ Reduced the time required to parse custom calculations.</li> <li>➤ Corrected an issue where the sequence components for events after the first event were not calculated correctly when multiple events were loaded.</li> <li>➤ Updated the spectral chart so that signals that are combinations of regular signals and calculated signals created using the SHIFT function are plottable.</li> <li>➤ Updated all error message dialogues so that they can be copied to the clipboard.</li> <li>➤ Updated the event report parse log warning when the event report length is less than the PRE setting. Previously, when an event report ended before the event trigger, the warning did not clearly indicate that the problem was most likely caused by a truncated file.</li> <li>➤ Inhibited phasor calculation for the motor start reports. Previously, SYNCHROWAVE Event would attempt to calculate phasors on the current and voltage magnitude signals of motor start reports.</li> <li>➤ Corrected an issue where the calculation engine would not recognize unmatched closing parentheses as an error.</li> <li>➤ Corrected an issue where the calculation engine would not recognize duplicate signal names defined in COMTRADE files if they differed only by case.</li> <li>➤ Corrected an issue where loading a template containing calculations, changing a visible calculation, and then reloading the template could cause a crash.</li> <li>➤ Updated the analog chart to be able to display the full precision of the 32-bit, IEEE 754 format (up to eight digits) on the Y-axis scale. Previously, the analog chart Y axis would truncate digits beyond the seventh.</li> <li>➤ Updated the SYNCHROWAVE Event settings parser to accept "Sys.PhRot" as well as the PHROT setting to determine phase rotation.</li> <li>➤ Added support in the Bewley Diagram for the new SEL-TWFL Dual Traveling-Wave Fault Locator.</li> <li>➤ Updated SciChart libraries to version 8.3.</li> <li>➤ Updated .NET libraries to version 8.0.</li> <li>➤ Updated Protobuf libraries to version 3.25.2.</li> </ul>	20240321

Version Number	Summary of Revisions	Manual Date Code
1.9.0	<ul style="list-style-type: none"> <li>➤ Improved the default digital chart on the default screen to include digitals from all variants of the TR equation (e.g., TR, TRA, TR3P).</li> <li>➤ Corrected an issue where COMTRADE Exports did not include complex channels stored per C37.111-2013 Annex H format.</li> <li>➤ Added units to the quantity selection dialogue.</li> <li>➤ Improved the Harmonic chart's calculation accuracy for cases where the sample rate did not correspond to an integer number of samples per cycle.</li> <li>➤ Added a symmetrical component calculation for delta voltage values.</li> <li>➤ Updated .NET to version 6.0.</li> <li>➤ Updated SciChart to version 7.</li> <li>➤ Improved number entry in custom calculations to support "NaN" and numbers in floating-point notation with negative exponents (e.g., 1.602E-19).</li> </ul>	20231026
1.8.5	<ul style="list-style-type: none"> <li>➤ Corrected an issue where files opened through ACSELERATOR QuickSet would not open.</li> <li>➤ Corrected an issue where the harmonic chart was using the wrong number of samples to calculate harmonics when multiple events were loaded.</li> <li>➤ Corrected an issue where typing the Z key when selecting quantities caused the software to zoom out to full time range.</li> </ul>	20230510
1.8.4	<ul style="list-style-type: none"> <li>➤ Corrected an issue where files on a network drive would not open if the drive was not mapped as a local drive.</li> <li>➤ Corrected an issue where the SERIES_MAX custom calculation function, when called with two arguments, could return an incorrect value.</li> <li>➤ Added support for COMTRADE digital name disambiguation by augmenting channel ID with CCBM field.</li> </ul>	20230223
1.8.3	<ul style="list-style-type: none"> <li>➤ Corrected issue where units were not always included in COMTRADE 2013 exported configuration file.</li> <li>➤ Added global setting to set default system frequency.</li> <li>➤ Phasor reference is now saved in .session files.</li> <li>➤ Added support for file path/names exceeding 260 characters.</li> </ul>	20230125
1.8.2	<ul style="list-style-type: none"> <li>➤ Added FIRST_AVAILABLE calculation engine function.</li> <li>➤ Improved harmonic chart performance for high data rate files.</li> <li>➤ Added Zoom to cursor range &lt;F2&gt; option.</li> </ul>	20220727
1.8.1	<ul style="list-style-type: none"> <li>➤ Corrected an issue where version 1.8.0 could become unresponsive when the Windows Display Scale is set to a value other than 100 percent.</li> <li>➤ Added IIR, FIR, BOXCAR, and SUMMATION calculation engine functions.</li> <li>➤ Combined Settings Grid and Raw Settings View into common Settings Viewer window.</li> </ul>	20220531
1.8.0	<ul style="list-style-type: none"> <li>➤ Added SERIES_MAX, SERIES_MIN, ORANGE_CURSOR_VALUE, and MAGENTA_CURSOR_VALUE calculation engine functions.</li> <li>➤ Extended applicability of SHIFT function to complex and digital signals.</li> <li>➤ Corrected issue where shifting signals in the digital chart quantity selection would cause the application to unexpectedly exit.</li> <li>➤ Corrected issue where the security restraint area would not display on the Alpha Plane diagram.</li> <li>➤ Improved settings grid search and formatting.</li> <li>➤ Added Complex Chart.</li> <li>➤ Added functionality to Bewley Diagram.</li> <li>➤ Corrected issue where the TIMER_CYC function returned an incorrect value.</li> </ul>	20220322

Version Number	Summary of Revisions	Manual Date Code
1.7.1	<p><b>Note:</b> This software did not production release.</p> <ul style="list-style-type: none"> <li>➤ Added ability to assign units to user calculations.</li> <li>➤ Improved search for settings grid.</li> <li>➤ Improved time adjustment options.</li> </ul>	20211116
1.7.0	<ul style="list-style-type: none"> <li>➤ Replaced readER32.exe parser with parSELy.exe to improve event file parsing and support more devices.</li> <li>➤ Added new Settings Grid for improved search and visualization of settings.</li> <li>➤ Added indications in event summary showing if report is raw or filtered and an icon for parse logs.</li> <li>➤ Moved all automatic phasor calculations for raw events to a new user option.</li> </ul>	20210928
1.6.5	<ul style="list-style-type: none"> <li>➤ Resolved an issue with Harmonic Chart that caused charts in saved event reports to not be displayed when a report was opened.</li> </ul>	20210422
1.6.4	<ul style="list-style-type: none"> <li>➤ Improved performance of custom calculations.</li> <li>➤ Added COMTRADE file format to Data Export option.</li> <li>➤ Removed automatic calculation of phasors for unfiltered COMTRADE event reports, which could cause incorrect event analysis.</li> </ul>	20210218
1.6.3	<ul style="list-style-type: none"> <li>➤ Resolved issue where default screen would not load correctly for some events.</li> </ul>	20201026
1.6.2	<ul style="list-style-type: none"> <li>➤ Improved performance of custom calculations.</li> </ul>	20200923
1.6.1	<ul style="list-style-type: none"> <li>➤ Improved performance of the digital chart.</li> <li>➤ Added support for peak to rms scaling of event report phasors.</li> <li>➤ Improved Bewley diagram.</li> <li>➤ Changed secondary quantity suffix from ".Secondary" to ".Sec".</li> </ul>	20200814
1.6.0	<ul style="list-style-type: none"> <li>➤ Improved load times for multiple and large event files.</li> <li>➤ Improved flexibility of COMTRADE file parsing.</li> <li>➤ Simplified the licensing process.</li> <li>➤ Made Harmonic and Spectral Analysis charts available in the basic (unlicensed) version.</li> <li>➤ Improved the mho diagram and allowed the cursor position to control the impedance trajectory plot.</li> <li>➤ Simplified automatic color assignment when adding signals to charts.</li> </ul>	20200228
1.5.1	<ul style="list-style-type: none"> <li>➤ Resolved a potential buffer overflow condition.</li> <li>➤ Fixed integration with QuickSet Device Manager.</li> <li>➤ Added a warning when plotting phasor quantities.</li> <li>➤ Improved search performance for digital quantities.</li> </ul>	20190322
1.5	<ul style="list-style-type: none"> <li>➤ Added the ability to remove event reports.</li> <li>➤ Added the ability to adjust event report time via cursor delta time.</li> <li>➤ Added support for multiple event reports during session load.</li> <li>➤ Added an option to hide the trigger indicator.</li> <li>➤ Improved the user interface.</li> </ul>	20180911
1.4.1	<ul style="list-style-type: none"> <li>➤ Added additional SEL-551 event report support.</li> <li>➤ Added support for COMTRADE 2013 time-zone field.</li> <li>➤ Improved user interface.</li> </ul>	20180315

Version Number	Summary of Revisions	Manual Date Code
1.4	<ul style="list-style-type: none"> <li>➤ Added cursor snap to peak for traveling-wave files.</li> <li>➤ Added support for SEL-T400L playback files.</li> <li>➤ Added support for SEL Zipped Event file format.</li> <li>➤ Added Custom Calculations popout for more calculation space.</li> <li>➤ Added calculation import capability to Custom Calculations.</li> <li>➤ Added TIMER_CYC() and SHIFT() functions to the calculation engine.</li> </ul>	20171101
1.3	<ul style="list-style-type: none"> <li>➤ Improved user interface design.</li> <li>➤ Improved performance for large files.</li> <li>➤ Removed Microsoft Silverlight requirement.</li> <li>➤ Improved screen capture capability.</li> </ul>	20170801
1.2.3	<ul style="list-style-type: none"> <li>➤ Resolved installation issue affecting some customers.</li> </ul>	20170323
1.2.2	<ul style="list-style-type: none"> <li>➤ Improved interpretation of phase rotation from event files.</li> <li>➤ Improved custom calculations entry interface.</li> <li>➤ Added ability to merge event reports and export COMTRADE data.</li> <li>➤ Added switching between linear and spline interpolation in analog charts.</li> <li>➤ Added ability to adjust the reference for the time axis.</li> <li>➤ Resolved issue where the mho diagram may not calculate memory voltage correctly for SEL-300 series relays event reports.</li> </ul>	20170317
1.2.1	<ul style="list-style-type: none"> <li>➤ Fixed issue with Compass shortcut locations.</li> <li>➤ Fixed UAC permissions issue on Windows 10.</li> <li>➤ Fixed root-mean-square (rms) scaling issues on SEL-487V, SEL-734, and SEL-735 relays.</li> </ul>	20160302
1.2.0	<ul style="list-style-type: none"> <li>➤ Added Differential Element (Alpha Plane) diagram.</li> <li>➤ Improved support for large event files when using 64-bit Windows OS.</li> <li>➤ Added autocomplete for Custom Calculations.</li> <li>➤ Added COMTRADE export feature.</li> </ul>	20160212
1.1.1	<ul style="list-style-type: none"> <li>➤ Resolved issue where combined digital signals from .EVE files (e.g., "IN 1&amp;2") displayed incorrectly if both signals were asserted.</li> </ul>	20150107
1.1.0	<ul style="list-style-type: none"> <li>➤ Added Traveling Wave (Bewley) Lattice diagram.</li> <li>➤ Added Distance Element (Mho) characteristic impedance plane diagram.</li> <li>➤ Added views and custom templates.</li> </ul>	20141117
1.0.0	<ul style="list-style-type: none"> <li>➤ Initial version.</li> </ul>	20140709

*Table 5* lists the parSELy software versions, a description of the modifications, and the instruction manual date code that corresponds to these versions. The most recent version is listed first.

Table 5 parSELY Software Revision History

Version Number	Summary of Revisions	Manual Date Code
1.10	<ul style="list-style-type: none"> <li>► Updated the parser for the SEL-387E CEV reports to include units for voltage on the WX terminal.</li> <li>► Added support for converting CEV and COMTRADE files to a format useable by the SEL-5401 Relay Test System software for use with the SEL-AMS Adaptive Multichannel Source.</li> <li>► Improved the date stamp parsing by reading the DATE_F setting in SEL relays.</li> <li>► Added a log message when parsing COMTRADE files where the rev_year field does not match a valid standard revision.</li> <li>► Added the ability to detect and correct for an issue where event reports from an SEL-400G with firmware revision R103 or previous could cause incorrect scaling in the COMTRADE channel definitions.</li> <li>► Corrected an issue where the SEL-T400L, SEL-T401L, and SEL-451 playback (.ply) files created in parSELY had the wrong channel order.</li> </ul>	20240321
1.9	<ul style="list-style-type: none"> <li>► Corrected an issue with the SEL-487V where the delta voltage signals on the V terminal were not <math>\sqrt{2}</math> scaled.</li> <li>► Added support for VSSI files.</li> <li>► Added support for the SEL-2411 version R500 with no ACI card .EVE and several other .EVE file formats.</li> <li>► Improved SEL 400-series SER parsing to better handle digital states with the text "ASSERTED" or "DEASSERTED" included in the state name.</li> </ul>	20231026
1.8	<ul style="list-style-type: none"> <li>► Improved parsing for SEL-352 and SEL-751.</li> <li>► Corrected an issue where the command line conversion utility could report incorrect values for max/min in COMTRADE channel definitions.</li> <li>► Improved load time for ASCII COMTRADE files.</li> <li>► Improved support for corrupted analog values in EVE files.</li> </ul>	20230510
1.7	<ul style="list-style-type: none"> <li>► Improved parsing of digitals for SEL-587 EVE reports.</li> </ul>	20230223
1.6	<ul style="list-style-type: none"> <li>► Added support for customizable digital lists for SEL-400 series EVE files.</li> <li>► Corrected issue where trigger time was incorrect for SEL-321.</li> <li>► Added support for SEL-351HQ, SEL-551HQ, and SEL-352HQ.</li> </ul>	20230125
1.5	<ul style="list-style-type: none"> <li>► Added support for PLY data format export.</li> </ul>	20230125
1.4	<ul style="list-style-type: none"> <li>► Added support for 8 sample/cycle reports from the SEL-551.</li> <li>► Fixed signal scaling for the SEL-587Z.</li> </ul>	20220727
1.3	<ul style="list-style-type: none"> <li>► Added support for Binary LDP reports from SEL meters.</li> <li>► Corrected issue where SEL-400 series relay SER reports could fail to parse date stamps correctly.</li> <li>► Compensated for issue where legacy SEL-300 series relays can corrupt .CEV files with large negative values.</li> </ul>	20220531
1.2	<ul style="list-style-type: none"> <li>► Added signal name disambiguation for COMTRADE reports.</li> </ul>	20220322
1.1	<ul style="list-style-type: none"> <li>► Added support for Motor Start Reports.</li> <li>► Added support for SER reports.</li> <li>► Corrected units and rms scaling issues in some SEL ASCII reports.</li> <li>► Added support for .CEV reports from SEL-321 relays.</li> </ul>	20211116
1.0	<p>Initial release of parSELY, replacing readER32, included the following:</p> <ul style="list-style-type: none"> <li>► Improved the ability to parse corrupted or incorrectly formatted event files.</li> <li>► Added support for .EVE reports from SEL-400, SEL-600, and SEL-700 series relays.</li> </ul>	20210928

## Determining the Manual Version

The date code at the bottom of each page of this manual reflects the creation or revision date.

*Table 6* lists the product manual release dates and a description of modifications. The most recent product manual revision is listed at the top.

**Table 6** Manual Revision History

Date Code	Summary of Revisions
20240321	<ul style="list-style-type: none"> <li>➤ Updated <i>Installation Steps</i>.</li> <li>➤ Updated <i>Calculated Quantities</i>.</li> <li>➤ Updated for software version 1.9.1.</li> <li>➤ Updated for parSELy software version 1.10.</li> </ul>
20231026	<ul style="list-style-type: none"> <li>➤ Updated <i>Installation and Licensing</i>.</li> <li>➤ Updated <i>Options</i> in <i>Operating SYNCHROWAVE Event</i>.</li> <li>➤ Updated <i>Table 4: Software Revision History</i>:               <ul style="list-style-type: none"> <li>➤ Updated for version 1.9.0.</li> <li>➤ Updated Summary of Revisions for version 1.8.5 to change the wording of the "Z key" note.</li> <li>➤ Moved "symmetrical component calculation" note in Summary of Revisions from version 1.8.3 to 1.9.0.</li> </ul> </li> <li>➤ Updated for parSELy software version 1.9.</li> <li>➤ Updated <i>Appendix C: Troubleshooting</i>.</li> <li>➤ Added <i>Appendix D: SYNCHROWAVE CSV Format</i>.</li> </ul>
20230510	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.8.5.</li> <li>➤ Updated for parSELy software version 1.8.</li> <li>➤ Updated <i>Appendix C: Troubleshooting</i>.</li> </ul>
20230223	<ul style="list-style-type: none"> <li>➤ Updated <i>Installation Steps</i>.</li> <li>➤ Updated for software version 1.8.4.</li> <li>➤ Updated Summary of Revisions for software version 1.8.3.</li> <li>➤ Updated for parSELy software version 1.7.</li> <li>➤ Updated Summary of Revisions for parSELy software version 1.6.</li> </ul>
20230125	<ul style="list-style-type: none"> <li>➤ Updated <i>Options</i>.</li> <li>➤ Updated for software version 1.8.3.</li> <li>➤ Updated for parSELy software version 1.5.</li> <li>➤ Updated <i>Overview</i> in <i>Appendix B: SYNCHROWAVE Event License Activation</i>.</li> <li>➤ Updated <i>Appendix C: Troubleshooting</i>.</li> </ul>
20220727	<ul style="list-style-type: none"> <li>➤ Updated <i>Introduction</i>.</li> <li>➤ Added <i>Zoom to Cursor Range</i>.</li> <li>➤ Updated <i>Time Cursor</i>.</li> <li>➤ Updated <i>Navigating the Harmonic Analysis Chart</i>.</li> <li>➤ Updated for software version 1.8.2.</li> <li>➤ Updated for parSELy software version 1.4.</li> </ul>
20220531	<ul style="list-style-type: none"> <li>➤ Updated <i>Figure 11: Complex Chart</i>.</li> <li>➤ Updated for software version 1.8.1.</li> <li>➤ Added <i>Table 5: parSELy Software Revision History</i>.</li> <li>➤ Added <i>Appendix C: Troubleshooting</i>.</li> </ul>

Date Code	Summary of Revisions
20220322	<ul style="list-style-type: none"> <li>➤ Updated <i>Introduction</i>.</li> <li>➤ Added <i>Principles of Operation</i>.</li> <li>➤ Added <i>Single-Ended Fault Locating</i>.</li> <li>➤ Added <i>Double-Ended Fault Locating</i>.</li> <li>➤ Added <i>Navigating the Complex Chart</i>.</li> <li>➤ Updated <i>Calculated Quantities</i>.</li> <li>➤ Updated <i>Custom Calculations</i>.</li> <li>➤ Updated <i>Specifications</i>.</li> <li>➤ Updated for software version 1.8.0.</li> <li>➤ Updated Description for software version 1.7.1.</li> </ul>
20211116	<ul style="list-style-type: none"> <li>➤ Added <i>Parse Log</i>.</li> <li>➤ Updated <i>Relay Settings</i>.</li> <li>➤ Updated <i>Adjust Time</i>.</li> <li>➤ Updated <i>Specifications</i>.</li> <li>➤ Updated for software version 1.7.1.</li> <li>➤ Updated description of software version 1.7.0.</li> </ul>
20210928	<ul style="list-style-type: none"> <li>➤ Added SEL-T401L signals to <i>Table 1: Plottable Signals</i>.</li> <li>➤ Updated <i>Options</i>.</li> <li>➤ Updated <i>Specifications</i> to remove unsupported operating systems.</li> <li>➤ Updated for software version 1.7.0.</li> <li>➤ Updated email address in <i>Appendix C: Technical Support</i>.</li> </ul>
20210422	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.6.5.</li> <li>➤ Revised software version information for 1.6.4.</li> </ul>
20210218	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.6.4.</li> </ul>
20201026	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.6.3.</li> </ul>
20200923	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.6.2.</li> </ul>
20200814	<ul style="list-style-type: none"> <li>➤ Updated <i>Figure 7: Bewley Diagram Analyzing Single-Ended Data</i> and <i>Figure 8: Bewley Diagram Analyzing Double-Ended Data</i>.</li> <li>➤ Updated for software version 1.6.1.</li> </ul>
20200228	<ul style="list-style-type: none"> <li>➤ Updated <i>Introduction</i> and <i>Operating SYNCHROWAVE Event</i> for basic and advanced versions.</li> <li>➤ Updated for software version 1.6.0.</li> <li>➤ Updated <i>Appendix B: SYNCHROWAVE Event License Activation</i> for the new licensing process.</li> </ul>
20190322	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.5.1.</li> </ul>
20180911	<ul style="list-style-type: none"> <li>➤ Updated information in <i>Operating SYNCHROWAVE Event</i>.</li> <li>➤ Updated information in <i>Common Displays</i>.</li> <li>➤ Updated information in <i>Views, Sessions, and Templates</i>.</li> <li>➤ Updated for software version 1.5.</li> </ul>
20180315	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.4.1.</li> </ul>



Date Code	Summary of Revisions
20171101	<ul style="list-style-type: none"> <li>➤ Added <i>Figure 5: Reorder Selected Quantities</i>, <i>Figure 13: Custom Calculations Popout</i>, and <i>Figure 14: Custom Calculations Library</i>.</li> <li>➤ Updated <i>Figure 3: Licensing Your Software</i>, <i>Figure 4: Quantity Selection</i>, <i>Figure 12: SYNCHROWAVE Event Custom Calculations</i>, and <i>Figure 15: SYNCHROWAVE Event Options</i>.</li> <li>➤ Updated information in <i>Quantity Selection</i>.</li> <li>➤ Updated information in <i>Custom Calculations</i>.</li> <li>➤ Added Cursor Snap Mode option in <i>Options</i>.</li> <li>➤ Updated <i>Supported File Formats</i> in <i>Specifications</i>.</li> <li>➤ Updated for software version 1.4.</li> </ul>
20170801	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.3.</li> </ul>
20170323	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.2.3.</li> </ul>
20170317	<ul style="list-style-type: none"> <li>➤ Updated <i>Figure 1: Trial Period Message</i>, <i>Figure 2: Unlicensed Operation Message</i>, <i>Figure 3: Licensing Your Software</i>, <i>Figure 12: SYNCHROWAVE Event Options</i>, and <i>Figure 14: Licensing Example</i>.</li> <li>➤ Updated information and added Y-Axis Scaling option in <i>Navigating the Analog and Digital Charts</i>.</li> <li>➤ Added Interpolation option in <i>Options</i>.</li> <li>➤ Updated <i>Operating Systems Supported</i> in <i>Specifications</i>.</li> <li>➤ Updated for software version 1.2.2.</li> </ul>
20160302	<ul style="list-style-type: none"> <li>➤ Updated for software version 1.2.1.</li> </ul>
20160212	<ul style="list-style-type: none"> <li>➤ Added <i>Navigating the Alpha Plane Diagram (Differential Element)</i>.</li> <li>➤ Updated for software version 1.2.0.</li> </ul>
20150107	<ul style="list-style-type: none"> <li>➤ Updated <i>Operating SYNCHROWAVE Event 2015</i>.</li> <li>➤ Updated for software version 1.1.1.</li> </ul>
20141117	<ul style="list-style-type: none"> <li>➤ Added <i>Navigating the Bewley Diagram (Traveling Wave)</i>.</li> <li>➤ Added <i>Navigating the Mho Circle Diagram (Impedance Plane)</i>.</li> <li>➤ Updated <i>Other Controls</i>.</li> <li>➤ Updated for software version 1.1.0.</li> </ul>
20140709	<ul style="list-style-type: none"> <li>➤ Initial version.</li> </ul>

## Appendix B: SYNCHROWAVE Event License Activation

### Overview

SYNCHROWAVE Event software includes a full-featured, 60-day free trial. After 60 days, basic analysis features are still available for use. To purchase a SYNCHROWAVE Event license, visit [selinc.com/products/5601-2](http://selinc.com/products/5601-2) or contact your local SEL sales representative.

Once you have purchased a license, perform the following steps as necessary to activate the license:

- *Internet Activation on page 34*
- *Manual Activation on page 35*

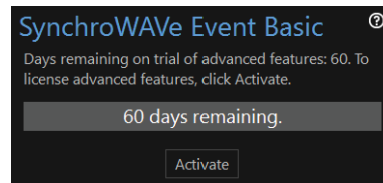
When upgrading to a new machine, you may Rehost your license by performing a Deactivate procedure on your old machine then an Activate procedure on your new machine. Perform one of the following to deactivate the license on your old machine:

- *Internet Deactivation on page 39*
- *Manual Deactivation on page 40*

The license for SYNCHROWAVE Event does not expire. Once you have licensed SYNCHROWAVE Event, you may use that licensed version in perpetuity. The license is applicable to any upgrades with the same major version number. For example, the major version number for version 1.3.2 refers to the first digit, so this would be a 1.x.x major version. The license does not work with a 2.x.x version of SYNCHROWAVE Event.

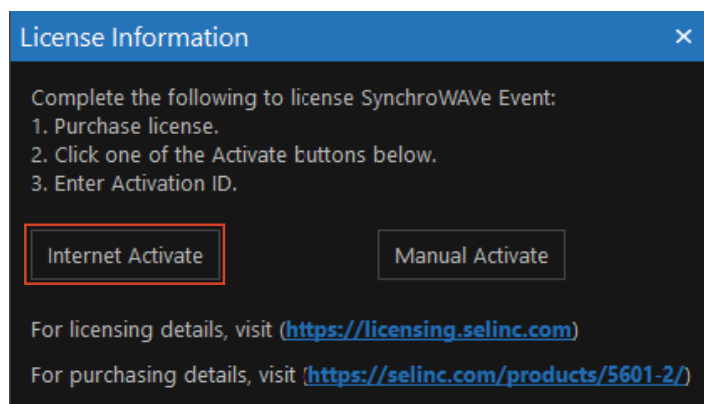
## Internet Activation

- Step 1. Download SYNCHROWAVE Event from the SEL website ([selinc.com/products/5601-2](http://selinc.com/products/5601-2)).
- Step 2. Install SYNCHROWAVE Event.
- Step 3. Open SYNCHROWAVE Event.
- Step 4. Select the **Activate** button in the lower right corner of the display.



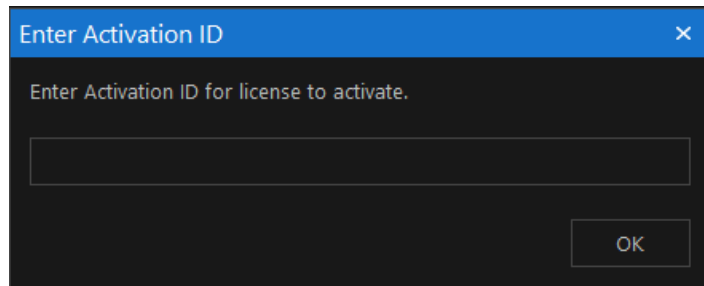
**Figure 20 SYNCHROWAVE Event Basic Licensing Message**

- Step 5. From the License Information form, select **Internet Activate**.



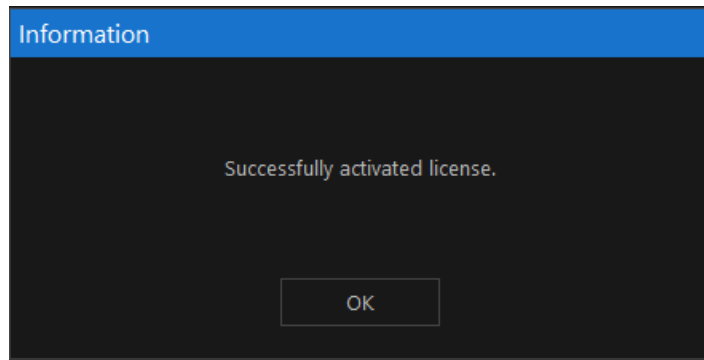
**Figure 21 Internet Activate**

- Step 6. At the Enter Activation ID window, enter the Activation ID you received via email when you purchased your license.



**Figure 22 Enter Activation ID**

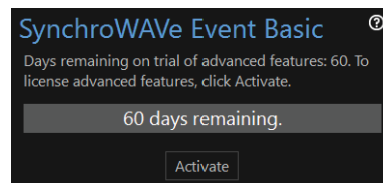
- Step 7. Select **OK**. SYNCHROWAVE Event automatically restarts after successful activation. The license activation box in the lower right disappears when the license is activated.
- Step 8. You can always find license information by navigating to **Help > About > Manage License** from within SYNCHROWAVE Event.



**Figure 23 Successful License Activation**

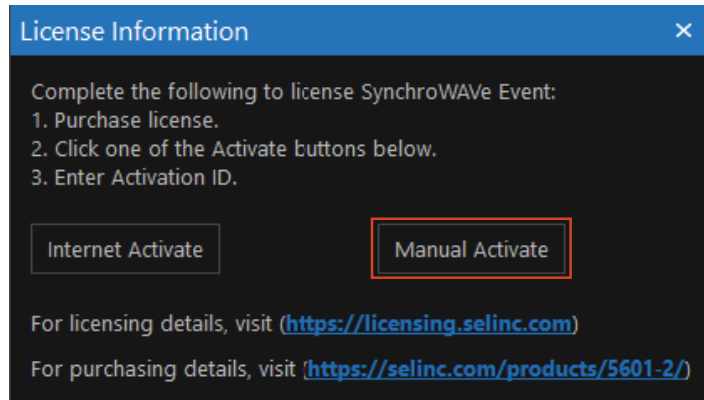
## Manual Activation

- Step 1. Download SYNCHROWAVE Event from the SEL website ([selinc.com/products/5601-2](http://selinc.com/products/5601-2)).
- Step 2. Install SYNCHROWAVE Event.
- Step 3. Open SYNCHROWAVE Event.
- Step 4. Select the **Activate** button in the lower right corner of the display.



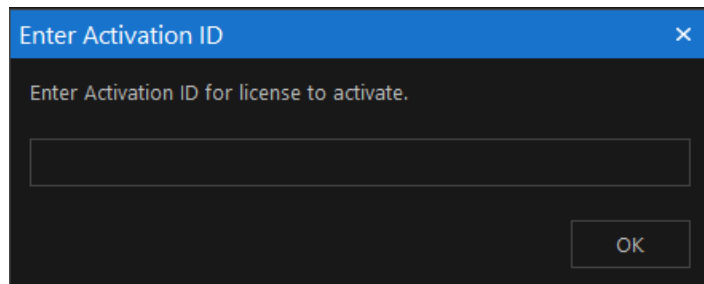
**Figure 24 SYNCHROWAVE Event Basic Licensing Message**

Step 5. From the License Information window, select **Manual Activate**.



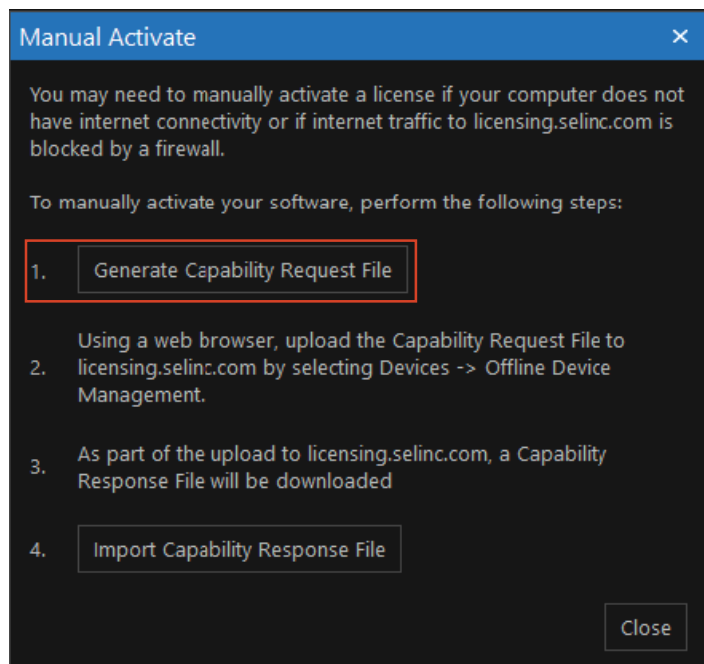
**Figure 25 Manual Activate**

Step 6. At the Enter Activation ID window, enter the Activation ID you received when you purchased your license.



**Figure 26 Enter Activation ID**

Step 7. From the Manual Activate window, select **Generate Capability Request File**.



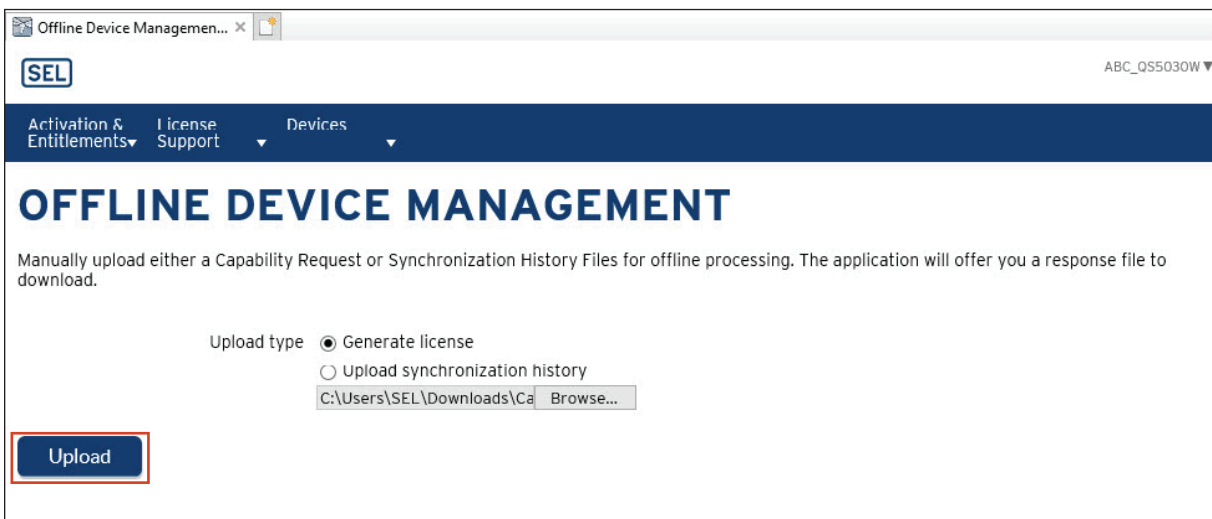
**Figure 27 Generate Capability Request File for Manual Activation**

- Step 8. Save the Capability Request File to a thumb drive or a network drive that can be accessed by a separate computer that has internet access, or email the Capability Request File to SEL.
- Step 9. From a computer that has internet access, go to <https://licensing.selinc.com> and log in with the License Authorization Code (LAC), also called Activation ID, of the license you are activating.

The image shows a login page for SEL. At the top center is the SEL logo. Below it, the word "LOGIN" is displayed in a large, bold, blue font. Underneath "LOGIN" is a text input field labeled "Activation ID" in a light gray font. Below this field is a dropdown menu currently showing "English (United States)" with a downward arrow icon. At the bottom right of the form is a blue button with the text "Log in" in white.

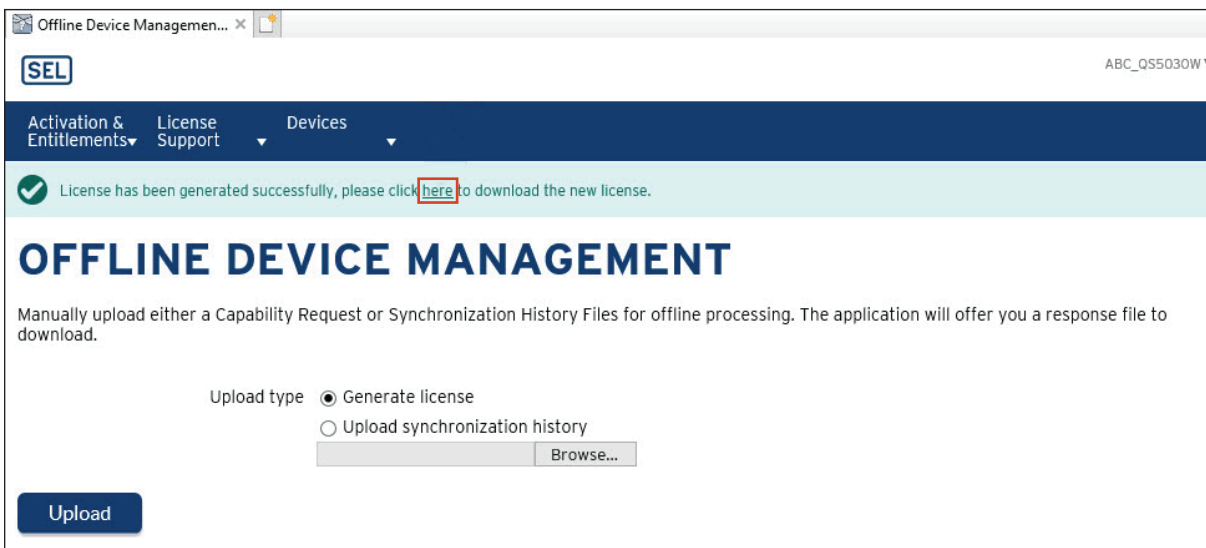
**Figure 28 Log In With Activation ID**

- Step 10. From the License & Delivery Portal page, select the **Devices** tab and select **Offline Device Management**.
- Step 11. From the **Offline Device Management** page, select **Browse** and select the Capability Request File generated in *Step 7*. Select **Upload**.

The image shows a web browser window with the title "Offline Device Management...". The page features the SEL logo in the top left and a user identifier "ABC\_QS5030W" in the top right. A navigation bar contains three tabs: "Activation & Entitlements", "License Support", and "Devices". The "Devices" tab is selected, and a dropdown menu is open, showing "Offline Device Management" as the selected option. The main heading is "OFFLINE DEVICE MANAGEMENT" in a large, bold, blue font. Below the heading is a paragraph: "Manually upload either a Capability Request or Synchronization History Files for offline processing. The application will offer you a response file to download." Underneath this is the "Upload type" section, which has two radio buttons: "Generate license" (which is selected) and "Upload synchronization history". Below the radio buttons is a text input field containing the path "C:\Users\SEL\Downloads\Ca" followed by a "Browse..." button. At the bottom left of the form is a blue button with the text "Upload" in white, which is highlighted with a red border.

**Figure 29 Upload Capability Request**

Step 12. Select the link highlighted in *Figure 30* to download the Capability Response file.



**Figure 30** Link to Download Capability Response File

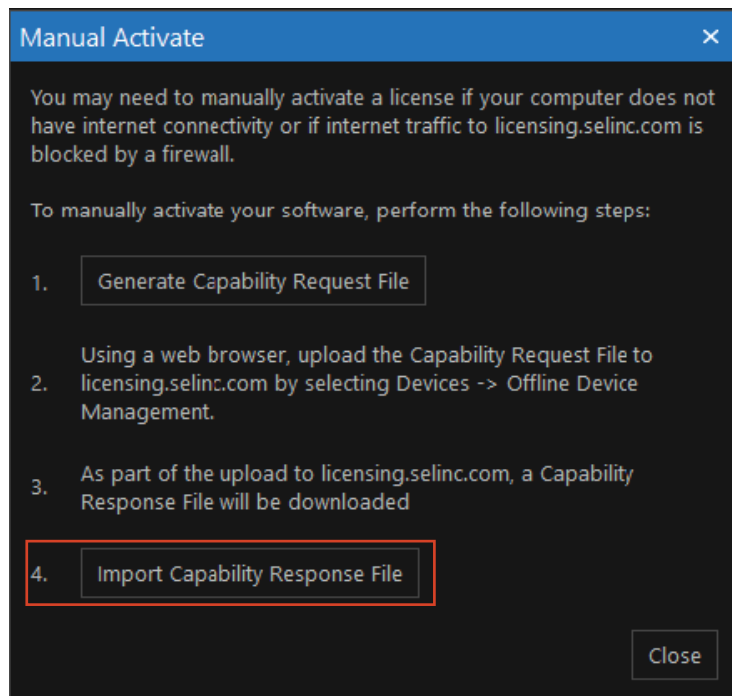
Step 13. Select **Save**.



**Figure 31** Save the Request File

Step 14. With the Capability Response File saved in *Step 13*, return to the computer where the SYNCHROWAVE Event license is being activated.

Step 15. From the Manual Activate form, select **Import Capability Response File**.



**Figure 32 Import Capability Response File**

Step 16. Navigate to the location of the Capability Response File saved in *Step 13* and select **Open**.

Step 17. Select **OK** on the confirmation message that indicates the file was successfully imported.

SYNCHROWAVE Event automatically restarts after successful activation. The license activation box in the lower right disappears when the license is activated.

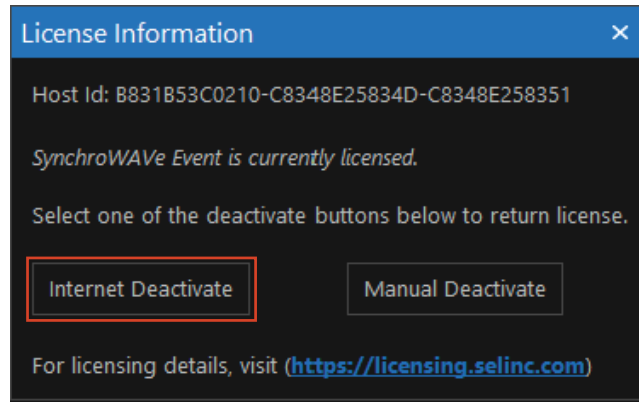
Step 18. You can always find license information by navigating to **Help > About > Manage License** from within SYNCHROWAVE Event.

## Internet Deactivation

Step 1. Open SYNCHROWAVE Event.

Step 2. Select **Help > About > Manage License**.

Step 3. From the License Information window, select **Internet Deactivate**.



**Figure 33 Internet Deactivate**

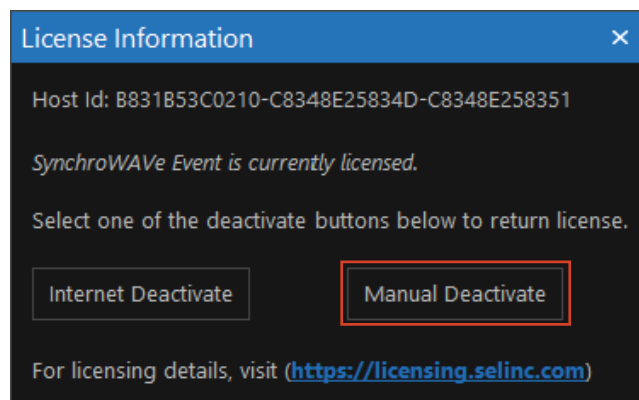
Step 4. Select **Close**.

## Manual Deactivation

Step 1. Open SYNCHROWAVE Event.

Step 2. Select **Help > About > Manage License**.

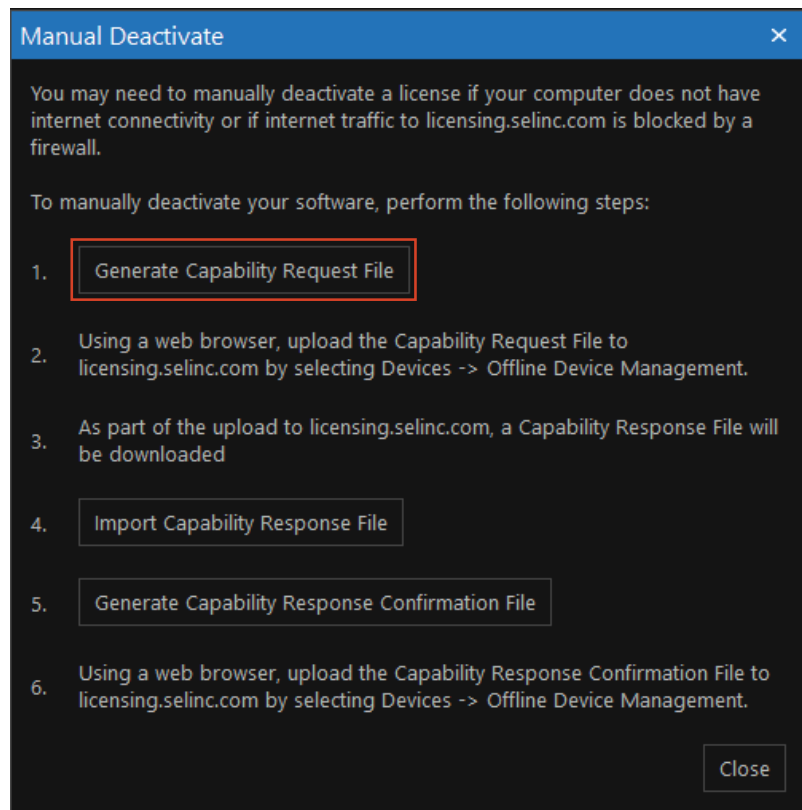
Step 3. From the License Information window, select **Manual Deactivate**.



**Figure 34 Manual Deactivate**



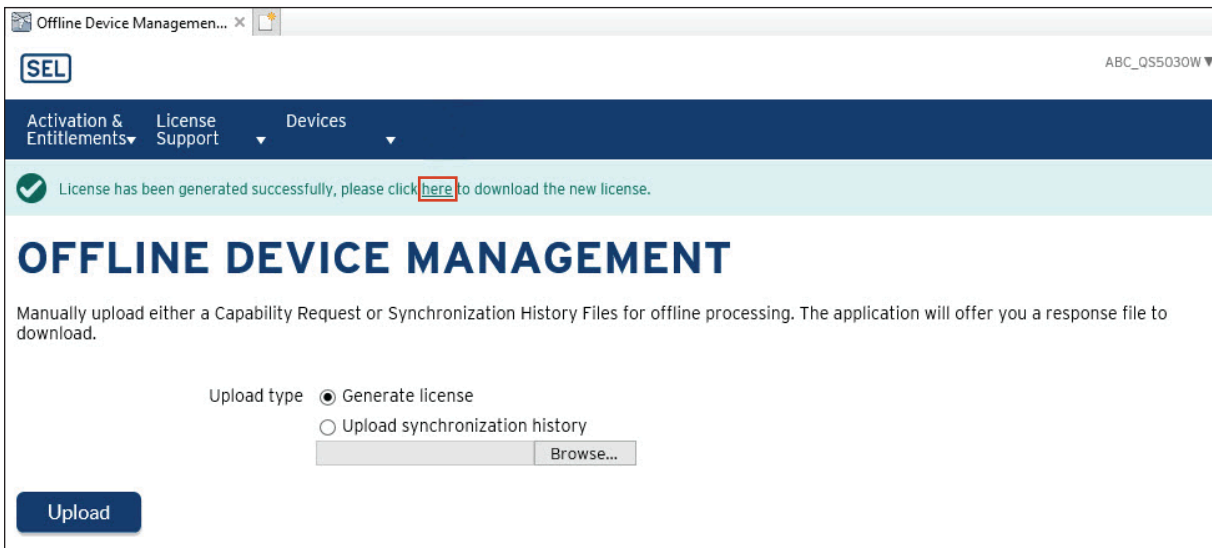
Step 4. From the Manual Deactivate screen, select **Generate Capability Request File**.



**Figure 35 Generate Capability Request File for Manual Deactivation**

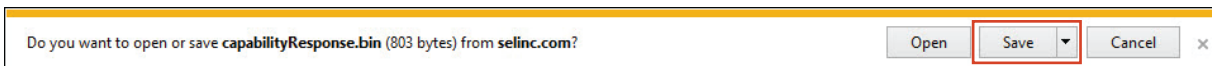
- Step 5. Save the Capability Request File to a thumb drive or a network drive that can be accessed by a separate computer that has internet access, or email the Capability Request File to SEL.
- Step 6. From a computer that has internet access, go to <https://licensing.selinc.com> and log in with the License Authorization Code (LAC), also called Activation ID, of the license you are deactivating.
- Step 7. From the License & Delivery Portal page, select the **Devices** tab and select **Offline Device Management**.
- Step 8. From the Upload Capability Request page, select **Browse** and select the Capability Request File generated in *Step 4*. Select **Upload**.

Step 9. Select the link highlighted in *Figure 36* to download the Capability Response file.



**Figure 36** Link to Download Capability Response File

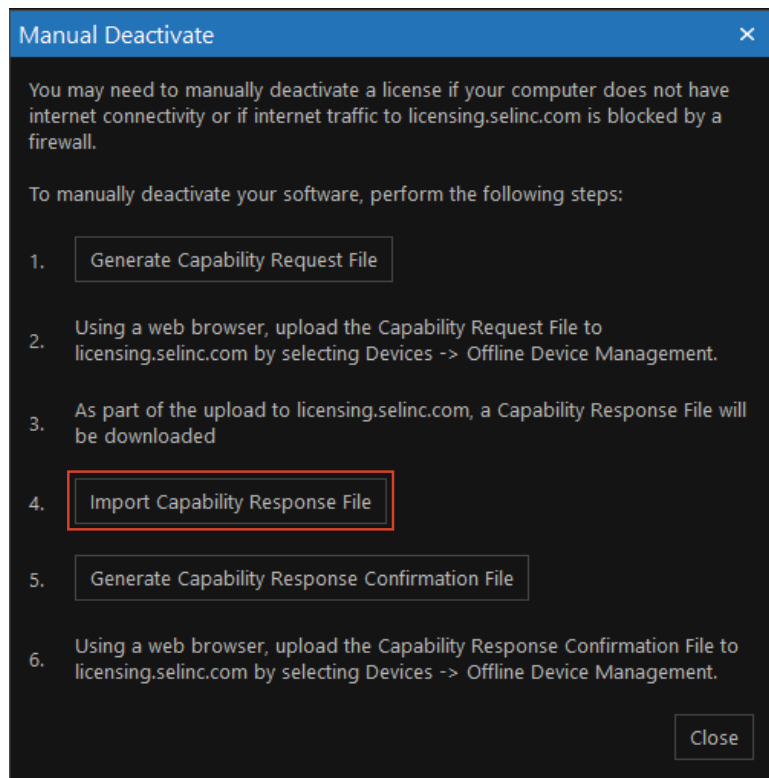
Step 10. Select **Save** on the message similar to *Figure 37*.



**Figure 37** Save Capability Request File

Step 11. With the Capability Response File saved in *Step 10*, return to the computer where the SYNCHROWAVE Event license is being deactivated.

Step 12. From the Manual Deactivate window, select **Import Capability Response File**.

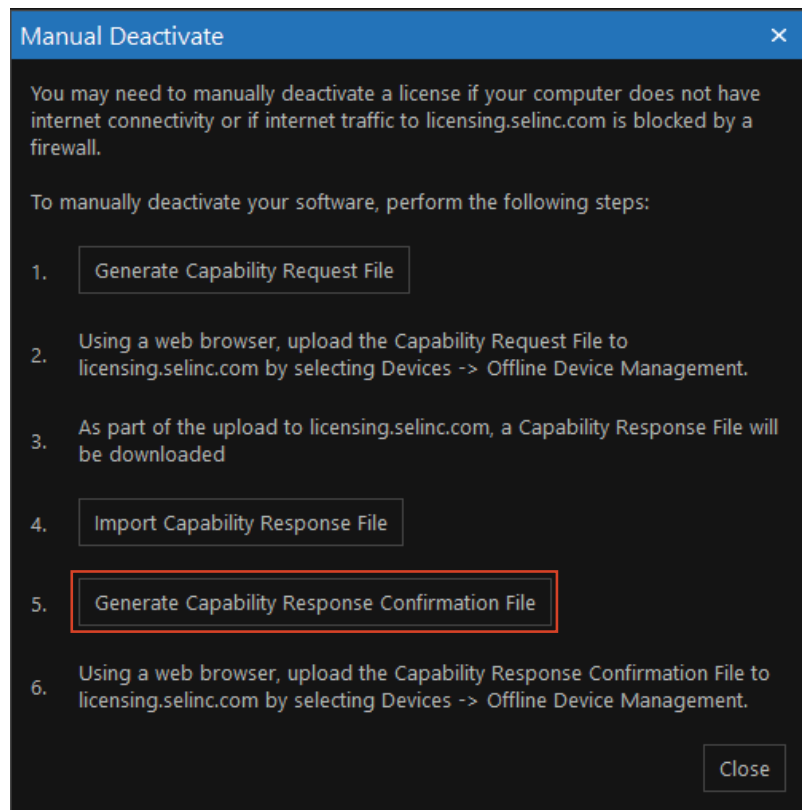


**Figure 38 Import Capability Response File**

Step 13. Browse to the location of the Capability Response File saved in *Step 10* and select **Open**.

Step 14. Select **OK** on the confirmation message that indicates the file was successfully imported.

Step 15. From the Manual Deactivate screen, select **Generate Capability Response Confirmation File**.



**Figure 39 Generate Capability Response Confirmation File**

- Step 16. Provide a name and location for the Capability Response Confirmation File and select **Save**.
- Step 17. From a computer that has internet access, go to <https://licensing.selinc.com> and log in with the License Authorization Code (LAC), also called Activation ID, of the license you are deactivating.
- Step 18. From the License & Delivery Portal page, select the **Devices** tab and select **Offline Device Management**.
- Step 19. From the Upload Capability Request page, select **Browse**, select the **Capability Response Confirmation File** generated in *Step 16*, and select **Upload**. After you upload the confirmation file, the FlexNet software generates another response file. This additional response file is not required and does not need to be downloaded.
- Step 20. Select **Close** on the Manual Deactivate form. The Activation ID of the license that was deactivated no longer shows in the License Information screen.

## Appendix C: Troubleshooting

Problem	Possible Cause	Solution
"Host Mismatch" error displayed when Licensing	This computer already has an activated license that is associated with a different customer.	Email SEL Support (synchrowave@selinc.com) with a screenshot of the error message. This error occurs when the company name in the SYNCHROWAVE Event license does not match the company name in other SEL software on the same computer.
"Entitlements Exceeded" error displayed when Licensing	License entitlements were not deactivated before retiring an old computer or trying to activate more licenses than entitlements on Activation ID.	If you have access to the machine SYNCHROWAVE Event was previously licensed on, deactivate the license from that machine. Otherwise, contact SEL Support (synchrowave@selinc.com) with a screenshot of the error message and Activation ID. This error is caused by more devices trying to use a license than the license supports.
Zooming causes axes but not signals to change or adding signals to chart has no effect until chart is resized	Outdated Intel graphics driver installed.	Update your Intel graphics driver: <ol style="list-style-type: none"> <li>1. Check the driver version. Verify that it is earlier than 30.0.100.9667.</li> <li>2. Go to the Intel driver download page and download the latest driver: <a href="https://www.intel.com/content/www/us/en/download/19344/intel-graphics-windows-dch-drivers.html">https://www.intel.com/content/www/us/en/download/19344/intel-graphics-windows-dch-drivers.html</a></li> <li>3. Install the driver.</li> <li>4. Reboot the system.</li> <li>5. Verify the driver version actually updated to 30.0.101.1191 or later. Sometimes, running the installer only installs and does not actually set the new driver as active. If this is the case, you need to manually set the active driver.</li> </ol>
Phasors are not showing up when viewing a COMTRADE or Raw report	Missing one of the required COMTRADE files (both .CFG and .DAT files are mandatory).	COMTRADE event reports comprise multiple files. Both the configuration (.CFG) and data (.DAT) files are required to view the data. Make sure .CFG and .DAT files are both present in the folder and named identically.
	Attempting to open COMTRADE file from within a ZIP archive.	Make sure to unzip any ZIP files before opening COMTRADE event reports.
Upon opening an .EVE file SYNCHROWAVE Event throws an error "Fatal - failed to parse event"	Parser support for that specific FID not yet implemented.	Contact SEL Support (synchrowave@selinc.com) with a copy of the file that would not open and a screenshot of the error message so we can contact you when support is added. This error occurs when attempting to open an unsupported file type.

## Appendix D: SYNCHROWAVE CSV Format

### Timestamp Columns

SYNCHROWAVE Event can import files in comma-separated value (CSV) format. The first column should be labeled "Timestamp" and contain time stamps in the format "YYYY/MM/DD hh:mm:ss.000". SYNCHROWAVE Event recognizes up to 9 digits of precision on the fractional seconds.

### Data Columns

After the time stamp columns are analog and digital data columns.

For analog columns, the first entry is the channel name. Units may optionally be specified in brackets following the name. For example, the channel name "VA" with units of volts is represented by the string "VA [V]" in the first entry. Below the channel name is the data, represented as integer or floating point representation. Invalid data are represented by the string "NaN".

For digital columns, the first entry is the channel name. Below the channel name are the data, represented with the values 1 or 0.

Note that any analog channel with only 1s and 0s will be treated as a digital channel. To specify an analog channel, ensure at least one fractional digit is included, resulting a column of 0.0 s and 1.0 s.

## Technical Support

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We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

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