

WAVEWEB

ADVANCED ANALYSIS

QUICK START

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Last Update: 08/20/2013

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C H A P T E R 1

Analysis Quick Start

This chapter describes the main features of the Analysis Display.

Analysis Features

The Analysis Display offers a high-resolution graphical interface for displaying, analyzing, and manipulating analog and digital channels of an oscillography record or a periodic load file. Displayed channels can be marked, moved, zoomed, removed, restored, superimposed, scaled, numerically processed, exported and summarized.

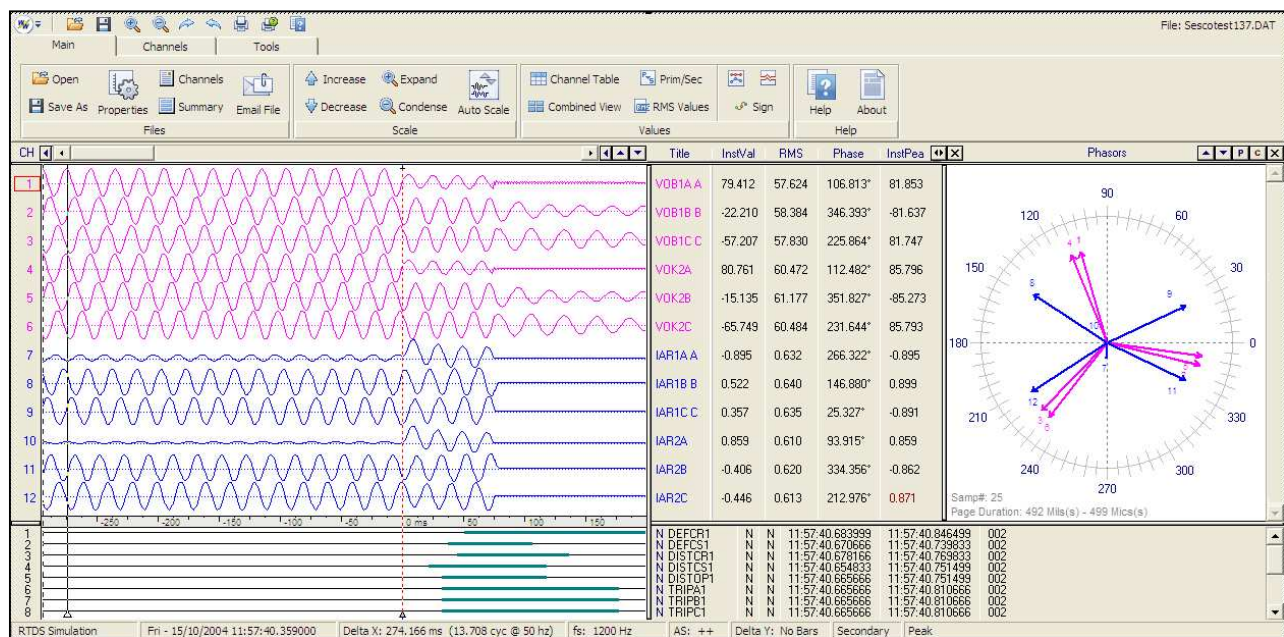



Figure 1.1 Analysis Display


The Analysis Display contains two sections: the analog view and the digital view. The analog view plots the oscillography or load data. The analog table displays values such as the channel's highest peak, RMS, phase, reference, instantaneous, maximum, and minimum values. The cursor bars are used to view the data values. The digital view plots the events and sensors and displays the channel's original state, the channel's final state, time of the first change, time of the last change, and the number of times the channel changed state.

Up to 256 analog and 1024 digital channels can be displayed. The main features are described below.

PHASORS

The phasor diagram shows a vector for each visible analog channel. The diagram is displayed to the right of the analog information window. To increase or decrease the size of the phasor window place the cursor over the vertical separator between the analog information window and the phasor window and drag the mouse to the left to increase or to the right to decrease. To close the phasor window click the close button located in the header. To navigate the phase angles use the left arrow, right arrow, home, end, page up

and page down keys or the data scroll bar. To increase/decrease the length of a channel's vector, mark the channel and use the increase/decrease amplitude menu buttons or the Ctrl-Up and Ctrl-Down keys. To increase/decrease only the length of the vectors, use the up and down phasor buttons. 

To toggle between the phasor display and the circular chart display click the “P” button above the phasor display for phasors or the “C” button for a circular chart. 

There are two types of phasor displays: non-referenced and referenced. The non-referenced display shows the phase angle for each sample in the display. The reference display shows the phase angle for each sample with respect to the reference channel. The reference channel is the first marked channel in the window. All angles at a sample are subtracted from the reference angle. If there are no marked channels the non-referenced display is shown.

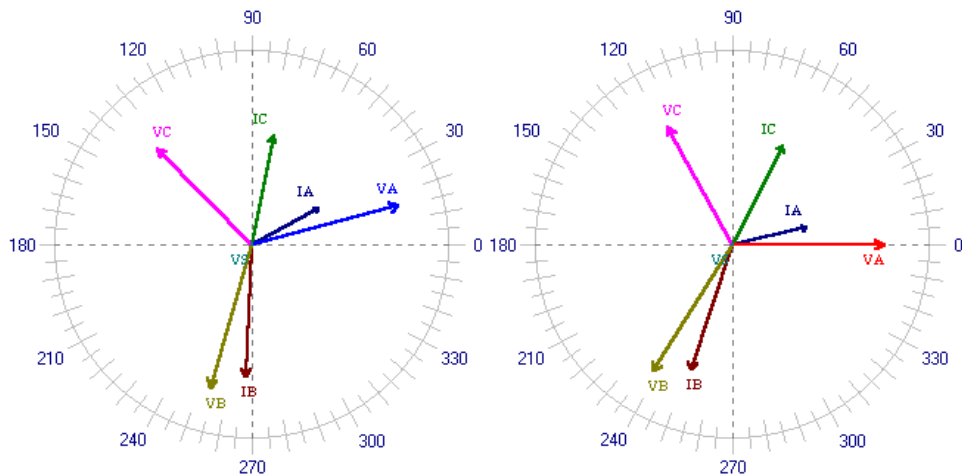





Figure 1.2 (a) Non-Referenced Phasors

(b) Referenced Phasors

HARMONICS

The harmonics window displays as many harmonics as possible based on the file's sampling frequency. A maximum of 200 harmonics can be displayed in the table. To display the harmonics window click on the  menu button or select the Harmonics table menu option under the “View” menu. The harmonics window displays the first marked analog channel or if no channels are marked, the first visible channel. Changing the marked channel in the data plotting window will update the harmonics window with the appropriate channel.

The harmonic calculation is performed on a one cycle window, starting at the RMS bar and going forward to the data bar. There are three fields displayed at the bottom of the harmonics table and histogram; TrueRMS, CalculatedRMS and Total Harmonic Distortion (THD). The TrueRMS field displays the RMS value calculated by using the samples in the active cycle displayed in the waveform trace window. The CalculatedRMS field displays the square root of the summation of the squares of the DFT Magnitudes from harmonics 2 to the maximum harmonic divided by square root of 2. The THD field displays the square root of the summation of the squares of the DFT Magnitudes from harmonics 2 to the maximum harmonic and that quantity divided by the DFT Magnitude of the Fundamental.

The harmonics can be viewed in a table format or in a histogram. Click on the  harmonics toggle button  to change the view. The histogram can show only one column from the table. To change the data displayed click the histogram drop down menu and select the column. The default view is the % of Fundamental.

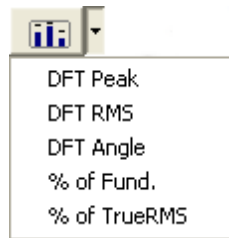




Figure 1.3 Histogram Drop Down Menu

The harmonic histogram bars can be resized using the resize up and down arrows  to display more or less harmonics in the window. The text displayed above the histogram bars can be shown or hidden by clicking on the Show/Hide text bar button . The harmonics window can be resized by dragging the edge of the window to show more or less harmonics per window.

Also, a vector for each harmonic is displayed in the phasor diagram. To hide/show the harmonic vectors toggle the "Vector Harmonics" menu option under the "View" menu from checked=on to unchecked=off.

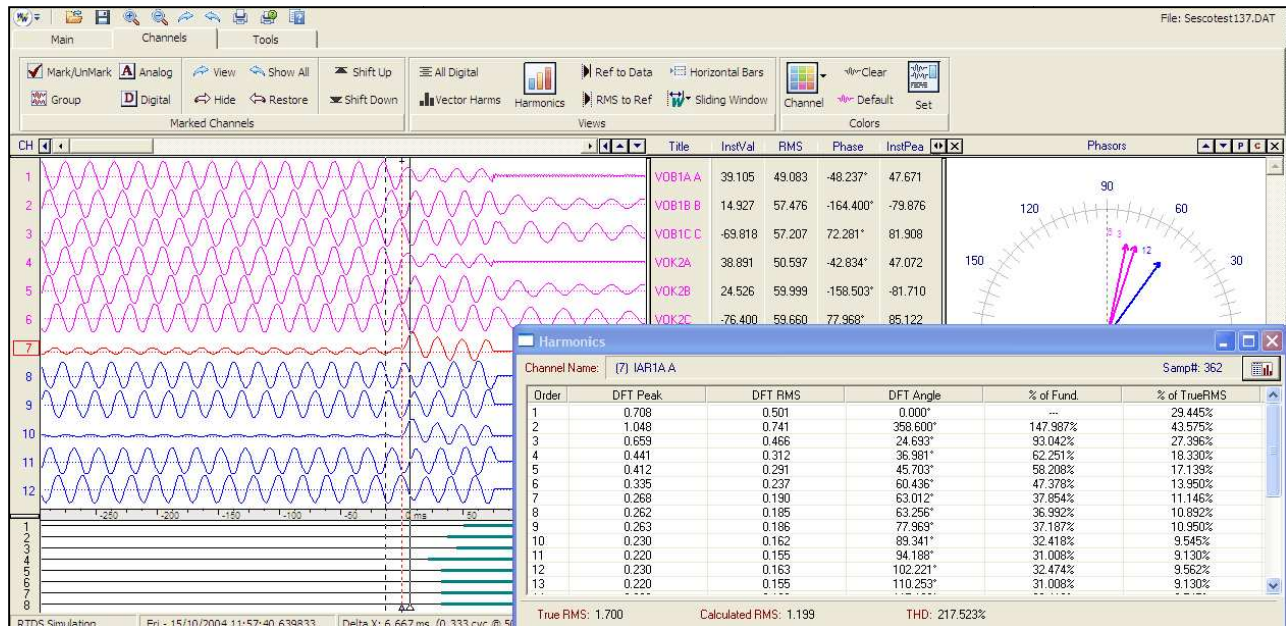


Figure 1.4 Harmonics Table View

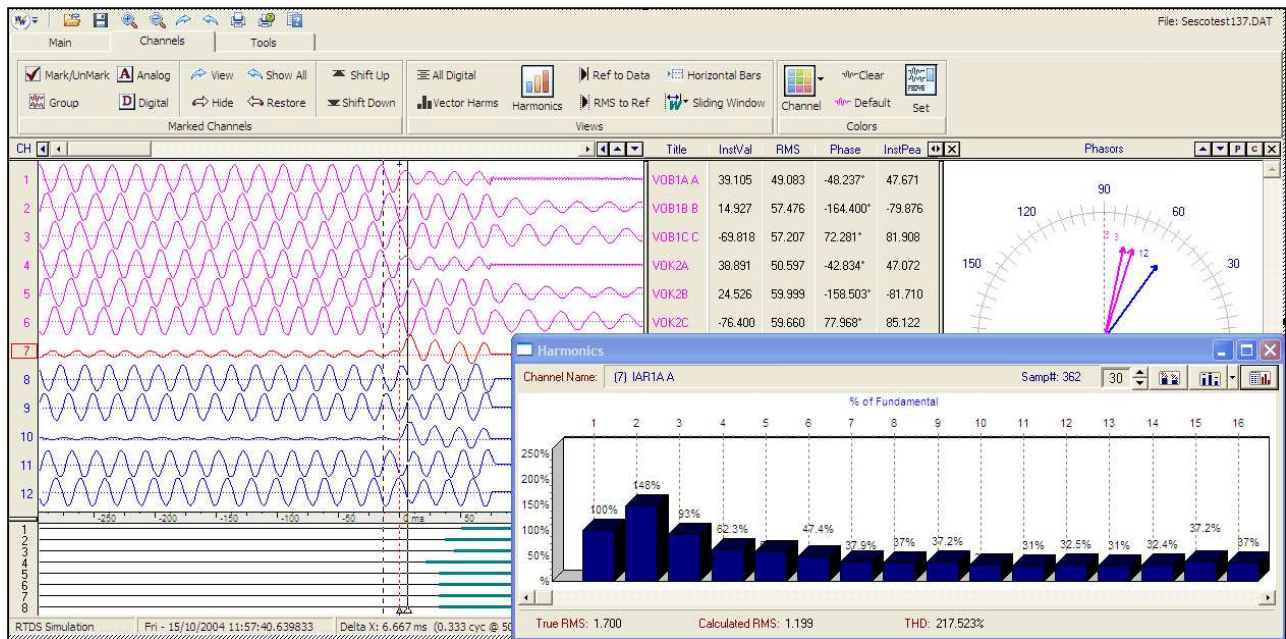


Figure 1.5 Harmonics Histogram View

PERIODIC LOG FILES

The periodic log viewer allows for viewing and analyzing large amounts of event data in a single display. The data is displayed in envelope form and may contain one day, one week, one month or one year of event data. This feature is useful for load flow analysis.

A circular chart of the data displayed in the trace window is plotted to the right of the channel information window. The circular chart cursor is positioned on the sample at the waveform data bar. The duration of the data displayed also is shown below the circular chart along with the sample number at the cursor bar.

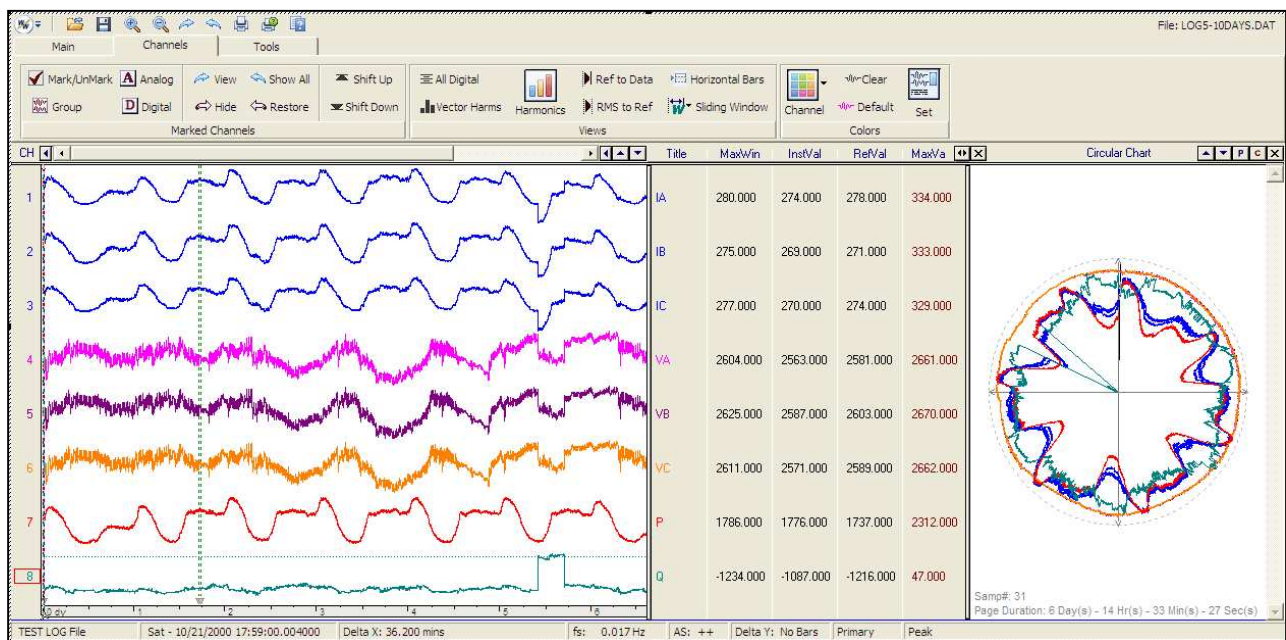




Figure 1.6 Periodic Log File

CIRCULAR CHART

The Circular Chart diagram shows a circular display for each visible channel. The diagram is displayed to the right of the analog information window. The amount of data displayed in the circular chart is equal to the amount of data displayed in the waveform trace window. The duration of the data displayed is shown at the bottom of the circular chart. To increase or decrease the size of the circular chart window place the cursor over the vertical separator between the analog information window and the circular chart window and drag the mouse to the left to increase or to the right to decrease. To close the circular chart window click the close button  located in the header.

To navigate the circular chart use the left arrow, right arrow, home, end, page up and page down keys or the data scroll bar. The cursor bar on the circular chart displays where the data bar is in the chart. To increase/decrease the display area of a channel on the circular chart, mark the channel and use the increase/decrease amplitude menu buttons or the Ctrl-Up and Ctrl-Down keys or use the up and down arrow button  located in the circular chart header.

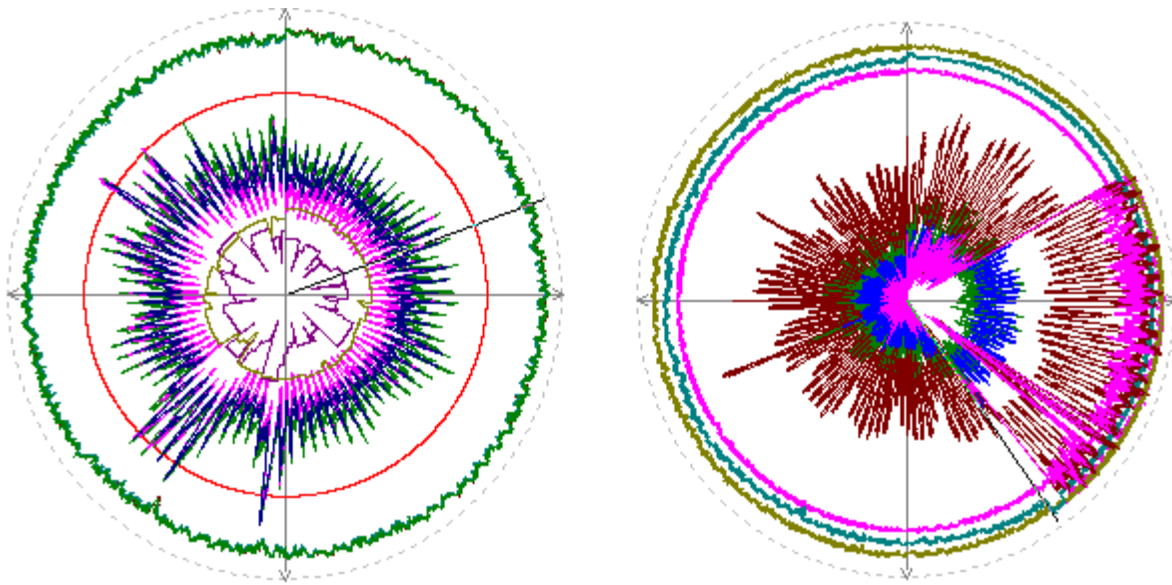



Figure 1.7 Circular Charts

DISPLAY DRIVER'S DATA TYPE

The data stored in the displayed file can be instantaneous values or RMS values. The default setting for all drivers is instantaneous values. If the Comtrade file saves the sample values as RMS calibrated, set the display driver's data type to RMS Type (Root 2 Multiplier). If the display driver is not set properly the analog column data will be displayed incorrectly. To set the driver's data type click the "Window

Properties"  menu button from the speed bar or select the "Window Properties" option under the "File" menu. Click the "Driver Data Type" tab and set the "Display Device's Data Type" field to "RMS Type" for RMS calibrated values and "Peak Type" for instantaneous values.

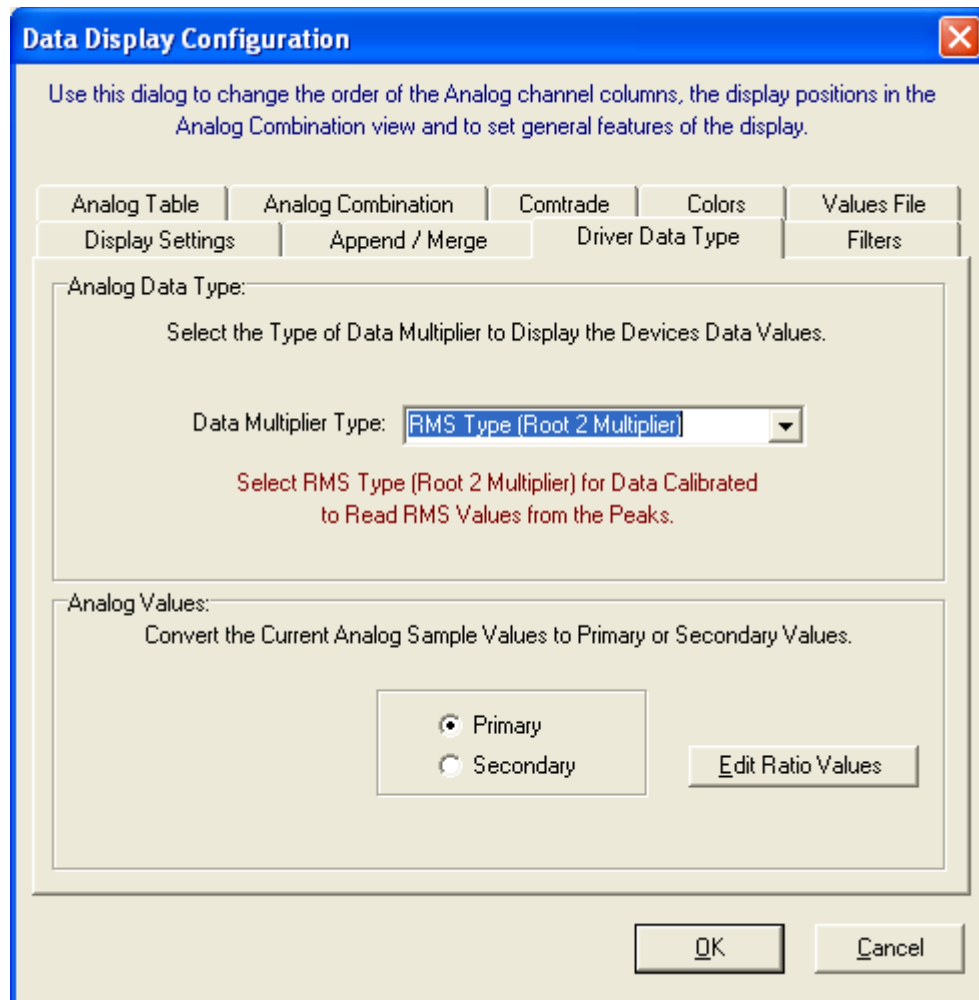



Figure 1.8 Analog Data Type Setting

OPEN WAVEFORM FILE

To open a waveform file click the open menu button  and select a files from the dialog.

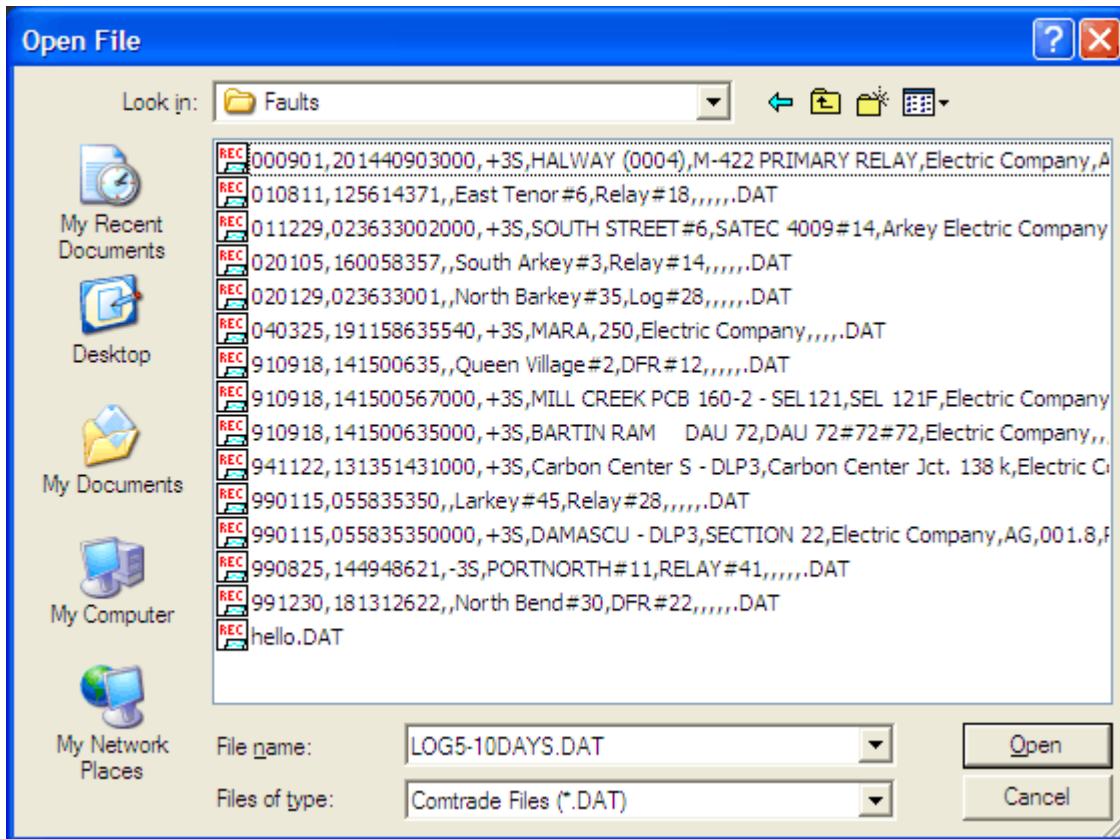



Figure 1.9 Open Data File




EMAIL ACTIVE FILE


The active data file can be emailed by clicking on the email  menu button or by selecting “Email Active File” from the “File” menu. The data file displayed and all the support files associated with the file are included as attachments. The users default email program will be displayed to email the file(s).

NAVIGATING

Use the up and down arrow keys or the vertical scroll bar to browse the analog channels. The tab key toggles between the analog and digital views.

The analog and digital values are displayed in a table to the right of the channel traces. Hold the mouse button down and drag the table separator bars to resize the viewing area. To view the analog sample values use the following navigation tools:

- Left and right arrow keys to navigate sample by sample
- Ctrl+left or ctrl+right keys to peak navigate
- Shift+ctrl+left or shift+ctrl+right keys to cycle hop
- Home and end keys to display the channel's first and last samples
- Triangle  at the bottom of the data bar to drag the data bar through the samples
- Page up and page down keys to page through the samples
- Left button  displayed to the left of the data scroll bar to move the sample at the data bar to the position of the first sample displayed
- Left button  displayed to the right of the data scroll bar to move the trace and table separator to the position of the data bar

Click the left/right arrow button  (located to the right of the analog table headers) or use the shift-right/left arrows to scroll through the analog table columns. Refer to the “Viewing Analog Data” section for field descriptions.

NOTE: If no channels are marked then the peak navigate and cycle hop features navigate through the first channel's data.


SETTING THE CURSOR BARS

Four vertical cursor bars are displayed in the analog view. The blue dotted line represents the reference bar, the black solid line represents the data bar, the black dotted line represents the RMS bar and the red dotted line represents the fault position defined in the file's configuration information. There are also two horizontal bars displayed when the “Horizontal Bars” menu option under the “View” menu is checked.


DATA BAR

The data bar is displayed as a black solid line with a white triangle below the line. The data bar is automatically displayed at the end of the first cycle in the data window when it is first displayed. To move the data bar use the left and right arrow keys to move one sample, use the Ctrl-left and Ctrl-right keys to peak hop, use the Shift-Ctrl-left and Shift-Ctrl-right keys to cycle hop, use the page up and page down keys to move one page up or down or left click the mouse to move to any position in the data or drag the triangle to scroll through the data. When the mouse is held over the triangle a hint message displays the sample number at the data bar and the delta time from the first sample. The time of the sample at the data bar is displayed in the second status bar field. The channel values at the data bar are displayed to the right of the traces in the analog channel information table.

REFERENCE BAR

The reference bar is displayed as a blue dotted line. The reference bar is defaulted to the fault time specified in the file. To move the reference bar to the position of the data bar use the "Move Reference Bar to Data Bar" option inside the “View” menu or press Ctrl-A or click the **SetRef** menu button . Click the opposite mouse button to move the reference bar to any position in the data area. The status field Delta X in the status bar at the bottom of the screen shows the time difference (in milliseconds or seconds) between the reference bar and the data bar. It also shows how many cycles are between the two bars.

RMS BAR

The RMS bar is displayed as a black dotted line. The RMS bar is defaulted to one cycle away from the data bar, except when the data bar is positioned at the beginning of the data. This bar is used for calculating the RMS value displayed in the analog information table. The RMS value in the analog table is calculated using all of the sample values displayed between the data bar and the RMS bar. To move the RMS bar to the position of the reference bar (blue dotted line) use the "Move RMS Bar to Reference Bar" option inside the “View” menu or press Ctrl-Z or click the **SetRMS**  menu button.



FAULT BAR

The fault bar is displayed as a red dotted line. The fault bar is fixed and positioned at the fault time defined in the file's configuration information. The fault bar can be shown or hidden by selecting the “Yes” or “No” options for the “Show Vertical Fault Bar” field in the properties dialog under the “Display Settings” tab.

HORIZONTAL BARS

When the “Horizontal Bars” menu option under the “View” menu is checked two horizontal bars will be displayed. The solid black line follows the data bar and the dotted blue line follows the reference bar.

The bars will be positioned at the first marked analog channel (displayed in red), if no channels are marked, then they are positioned at the first displayed channel. The Delta Y field in the status bar shows the difference between the two bars.

To automatically resize the RMS sliding window click on the **Resize Sliding Window** menu button . To manually resize the RMS sliding window click the opposite mouse button to set the reference position and the mouse button to set the data bar position then click the **SetRMS**  menu button. The RMS bar is moved to the reference position. The Delta X field displayed in the status bar at the bottom of the screen shows the time difference (in milliseconds or seconds) between the date bar and reference bar and the number of cycles between the two bars. Use the left, right, ctrl+left, and ctrl+right, shift+ctrl+left, and shift+ctrl+right keys or the horizontal scroll bar to move the sliding window.

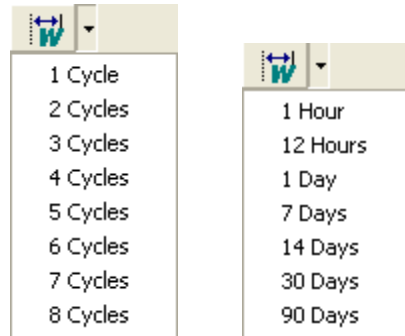


Figure 1.10 Resize Sliding Windows Drop Down Menus


MARKING, DELETING, AND RESTORING CHANNELS

To mark or unmark a channel, mouse click on the channel ID or channel title, or use the space bar. To mark a group of channels click on the first channel then shift click on the last channel. Marked channels are displayed in red.







To mark/unmark all analog and digital channels select the “Mark/UnMark All” menu option under the “Channels” menu option. If no channels are marked, all of the analog and digital channels will be marked. If any channels are marked, all of the channels will be unmarked. To mark/unmark all the analog channels select the “Analog Mark/Unmark All” menu option under the “Channels” menu. To mark/unmark all of the digital channels select the “Digital Mark/Unmark All” menu option under the “Channels” menu.



Channels must be marked to delete them from the display window. The Delete key removes the marked channels and the Insert key restores all the deleted channels.

SCALING ANALOG CHANNELS

When the analysis display is initially opened, all the analog channels are scaled to one value. To scale the channels according to the maximum space allocated for display, click the **Auto Scale**  menu button. This option toggles among the three views: On, Off and ++. The active auto scale state is displayed in the “AS” status field. Each view is defined below:



- **ON** – The On view plots the channel data scaled to the maximum value allocated along the zero reference line.
- **OFF** – The Off view plots all of the channels that are scaled to the maximum value in the file.
- **++** – The ++ view plots the signal using the number of maximum pixels allocated for the channel. The highest value is plotted at the maximum position and the smallest value is plotted at the lowest position. This feature was added to clearly show the profile of a frequency channel, a Vdc channel and load data channels.

To increase or decrease a channel's amplitude, along with the phasors and circular chart first mark the channels then click the **AmpUp**  or **AmpDn**  menu buttons or use the ctrl+up/down arrow keys. The auto scale multiplier (ASM) is used to amplify or attenuate the channel's data values. For example, when the amplitude increases the ASM value is multiplied by the channel's current "Pixsdisp" and when the amplitude decreases the ASM value is divided by the channel's current "Pixsdisp". To change the ASM value, select the "Properties" menu option under the "File" menu then click the "Display Settings" tab, enter a number and click **OK**. This value is initially defaulted to 2.00. To increase/decrease only the analog channels amplitude, click the up and down arrow buttons   located to the right of the data scroll bar. To increase/decrease only the phasor magnitude or circular chart click the up and down arrow buttons   located in the phasor/circular chart header.

To increase or decrease the channel's time scale, click the **Condense**  or **Expand**  menu buttons or press the ctrl+page up and ctrl+page down keys.

NOTE: If no channels are marked all the visible channels are scaled accordingly.

ZOOMING CHANNELS

To zoom in on specific analog or digital channels, first mark the channels then press <enter> or click the **ViewMrks**  menu button. The unmarked channels are removed from the display window and the marked channels are rescaled to fit in the window. To restore the hidden channels press the <esc> key, the <backspace> key, or click the **ViewAll**  menu button.


When returning to the original view all channels in the previous view remain marked for quick selection of additional channels for a new view.

REPOSITIONING CHANNELS

Analog channels can be repositioned in the display window. To move an analog channel up one position mark the channel and press the "+" key or select "Shift Marks Up" from the "Channel" menu. To move a channel down one position mark the channel and press the "-" key or select "Shift Marks Down" from the "Channel" menu. To move a group of analog channels, mark all the desired channels then press the "+" or "-" keys.

SAVING AS

The visible analog and digital channels can be saved in the COMTRADE ASCII or Binary format or in a CSV format. The Comtrade versions supported are: the 1991 and 1999 format. The CSV formats supported are: RMS Values, Instantaneous Values, Vector Values (Mag &Ang or RMS & Ang).

Mark the analog and digital channels to save and press <enter> or click the **ViewMrks** menu button . To save the channel values file select the "Save as" menu option from the "File" menu. Enter the destination path and filename (do not define the filename extension) and select the Save Type then click **OK**.

To automatically name the file using the IEEE long file naming format check the "Use the ComNames Naming Convention to Name the Comtrade File(s)" field in the "Save As" dialog and leave the "File Name" field empty. The selected channels are converted to the specified format and are named using the IEEE long file naming convention.

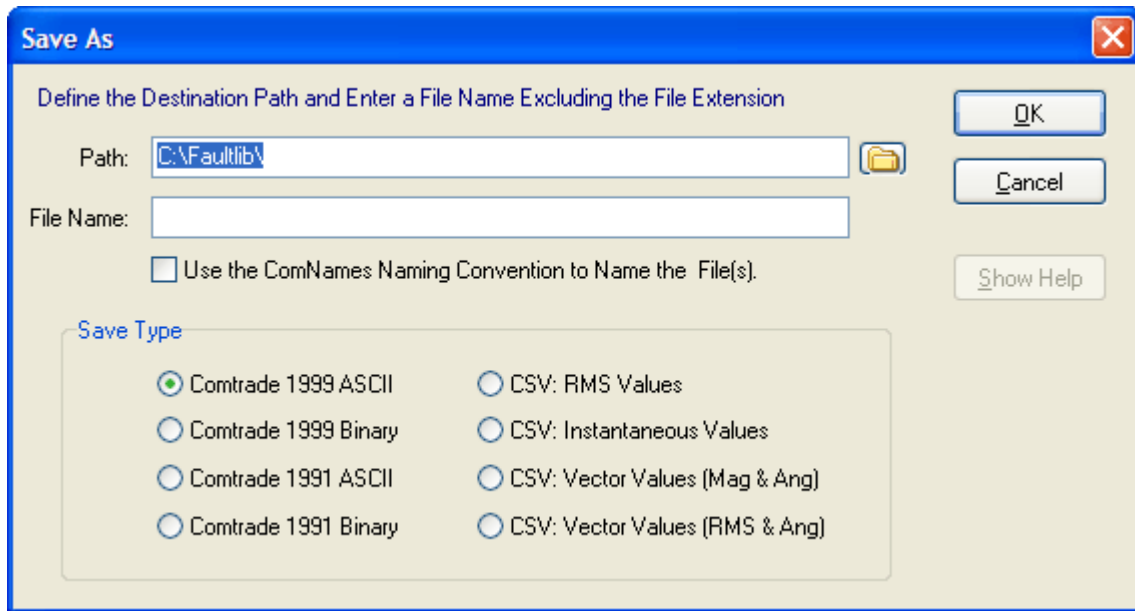



Figure 1.11 Save As


VIEWING ANALOG DATA

The values displayed in the analog view can be presented in tabular form (analog table) or in a concentrated form (combination view). Press F4 to toggle between the two views. The concentrated view can only be displayed if there is enough room to display 2 lines of data values between each channel. To navigate through the analog table columns use the View  button (located to the right of the analog table headers) or the shift-right/left arrow keys. To close the analog table, click the Close button located in the header. Valid analog channels are displayed in the left portion of the window and the analog information in the center table. An analog channel is marked as invalid if the title is empty, or it contains any of the following strings in the beginning of the title.

- UNUSE
- UNDEF
- NOT D
- NOT U
- NOT I
- NAT A
- UNDEF
- {
- N/A
- ANALOG INPUT
- ANALOG CHANNEL
- EXTERNAL INPUT
- EVENT CHANNEL
- CHANNEL
- DIGITAL TRACE #
- SPARE

A maximum of 256 analog channels can be displayed in one window. The values displayed in the analog table and combination view are described below.

Analog Table View:

The analog table view is the default view. Use the view button  or the shift-right/left arrow keys to navigate through the columns of the table. The original sample values are plotted according to one of the following data types:

- Peak to Peak data
- RMS Calibrated data
- Log files.

All of the display drivers in the system are defaulted to peak to peak except the predefined log drivers. To change the settings for a driver select the "Window Properties" option under the "File" menu. Click on the "Driver Data Type" tab and select the type from the "Data Multiplier Type" drop down list. Periodic Log File's data type cannot be changed.

The following tables describe the analog data for the sinusoidal peak-to-peak, non-sinusoidal, and sinusoidal RMS data types:

Peak to Peak

Field	Description
Title	The analog channel titles.
RMS	The TrueRMS value is calculated by taking the summation of the square of all the sample values that are between the RMS bar (black dotted line) and the data bar. The result is divided by the total number of samples between the two bars and takes the square root of that result.
InstPeak	The highest absolute value of all of the samples between the two zero reference crossings surrounding the data bar (black solid line).
Phase	The phase angle of each channel.
InstVal	The sample value at the data bar (black solid line).
RefVal	The sample value at the reference bar (blue dotted line).
MaxPeak	The maximum peak value of the channel.
MinPeak	The minimum peak value of the channel.
Units	The analog channels prefix and units.
PixsDisp	The number of pixels allocated for displaying the trace.
DFT Peak	The DFT Magnitude calculated between the RMS bar (black dotted line) and the data bar (solid data bar).
Crest	The DFTMag column divided by the RMS column.

Sinusoidal RMS Calibrated

Field	Description
Title	The analog channel titles.
RMS	The RMSVal column calculates an RMS value for all of the samples between the RMS bar (black dotted line) and the data bar (black solid line). Since the data is RMS calibrated each sample value is multiplied by the square root of 2 before it is squared.
InstPeak	The square root of 2 multiplied by the peak value measured between the two reference crossings surrounding the data bar (black solid line).
Phase	The phase angle of each channel.
InstVal	The RMS sample value at the data bar (black solid line) multiplied by Root 2.
RefVal	The RMS sample value at the reference bar (blue dotted line) multiplied by Root 2.
MaxPeak	The RMS maximum peak value of the channel multiplied by Root 2.
MinPeak	The RMS minimum peak value of the channel multiplied by Root 2.
Units	The analog channels prefix and units.
PixsDisp	The number of pixels allocated for displaying each trace.

Field	Description
DFT Peak	The DFT Magnitude calculated between the RMS bar (black dotted line) and the data bar (solid data bar).
Crest	The DFTMag column divided by the RMS column.

Non-Sinusoidal (Load Files)

Field	Description
Title	The analog channel titles.
MaxWin	The absolute maximum value between the sliding window bar (black dotted line) and the data bar (black solid line).
InstVal	The sample value at the data bar (black solid line).
RefVal	The sample value at the reference bar (blue dotted line).
MaxVal	The maximum value of the channel.
MinVal	The minimum value of the channel.
Units	The analog channels prefix and units.
PixsDisp	The number of pixels allocated for displaying the trace.
AvgWin	The average value of all of the samples between the sliding window bar (black dotted line) and the data bar (black solid line)

Combination View:

The combination view shows all of the channel information in a signal view. This view is only available if there is sufficient room between analog channels to display two or more lines of text.

Default Display format:

Peak to Peak:

Channel Title			
RMS	MaxPeak	RefVal	
InstVal	MinPeak	Units	ASV

RMS Calibrated:

Channel Title			
RMS	MaxPeak	RefVal	
InstVal	MinPeak	Units	ASV


Load Files:

Channel Title			
MaxWin	MaxVal	RefVal	
InstVal	MinVal	Units	ASV

The peak sample values are displayed in red when the data bar is on the channel's maximum value and displayed in blue when the data bar is on the channel's minimum value. Use the Tab key to toggle between the analog and digital channels. To hide the channel information, select the "Channel Information" menu option from the "View" menu.

The analog table and combination views can be resized by selecting the vertical separator bar and dragging it to the right or left. The mouse icon changes to the vertical resize cursor when the mouse is positioned over the separator bar.

To change how the analog data is displayed in the analog table and combination view select the

"Properties" menu option from the "File" menu or click on the "Properties"  menu button from the speed bar. The "Analog Table" tab and the "Analog Combination" tab allows for changing the appearance of the analog information window.

Some of the functions of the “Properties” dialog are reordering, hiding, and showing the analog table columns; changing the data positions in the combination view; changing the background colors and trace colors; and for changing the drivers data type and trace/phasor scale multipliers.

VIEWING DIGITAL DATA

The default digital view consists of only the triggered digital channels, which are displayed at the bottom of the screen. To view all of the digital channels including the unused channels select “All Digital Channels” from the “View” menu.

The digital trace is displayed as a thin black line when the sample value equals the original state defined in the displayed format and is displayed as a thick green line when the sample value differs from the original state. The Cursor State column in the digital table displays an “A” for Alarm and “N” for Normal. These values are set by comparing the sample value at the data bar with original state, “A” = different than original state, “N” = same as original state.

The digital information is displayed in tabular form. The data columns are described below:

Column Number	Description
1 – Cursor State	The digital state of the sample at the cursor position (A=Alarm, N=Normal).
2 – Title	The channel title, a maximum of 40 characters can be displayed.
3 – Fst	The digital state of the first sample (A=Alarm, N=Normal).
4 – Lst	The digital state of the last sample (A=Alarm, N=Normal).
5 – Fst-Change	The time the channel first changed state.
6 – Lst-Change	The time the channel last changed state.
7 – Changes	The number of times the channel-changed state.

Use the scroll bar or the up and down arrow keys to navigate through the digital channels and use the tab key to toggle between the analog and digital views.

CUSTOMIZING THE ANALYSIS DISPLAY

The “Properties” option in the “File” menu allows for customizing the analysis display window. Below is a definition of each tab:

- **Analog Table** – The Analog Table tab is used to reorder, hide and show the columns in the Analog Table.
- **Analog Combination** – The Analog Combination tab is used to change the position of the data values in the Combination view.
- **Comtrade** – The Comtrade tab is used to define the Comtrade format for saving, the date and time format for display and for setting automatic conversion from RMS data to Peak data when using the “Save As Comtrade” feature.
- **Colors** – The Colors tab is used to define the background colors of each display section and to set the default analog channel colors.
- **Values File** – The Values File tab is used to define the Values File and general information used when saving samples values to a file.
- **Display Settings** – The Display Settings tab is used to define the Scale Multiplier for the traces and phasor/circular chart scaling. It also can define general display information for the window such as: setting the display trace type (sample based or time based), defining the Phase Angle Convention (Sine or Cosine), showing the time reference bar between the analog channels and

the digital channels, showing the separator bar between multiple events displayed in one window, showing or hiding the fault bar (red dotted vertical bar), and defining the option to reference angles across windows when Sync mode is active. When “Yes” is defined for reference angles across windows all phase angles for the currently opened windows will be referenced from the first marked channel in the active window.

- **Append / Merge** – The Append/Merge tab is used to define from which file the samples will be discarded from when the discard common times option is used. It also is used to determine whether the station name should be added to the analog/digital titles when an append/merge option is executed.
- **Driver Data Type** – The Driver Date type tab is used to define the type of data that is saved to the displayed device’s data file: RMS Type or Peak Type, convert the analog sample values between primary and secondary and for editing the ratio values.
- **Filters** – The Filters tab is used to define if spikes detected in the data file should be ignored when the maximum and minimum values are calculated and at what level they should be ignored.

TIME & SAMPLE BASED DISPLAYS

The “Trace Display Type” field located in the “Display Settings” tab of the “Properties” dialog allows for toggling between the “Time Based” display and the “Sample Based” display. The sample based display plots the channel data with one pixel distance between each displayed sample. Sample based displays are useful for showing changes in sampling frequency. The time based display plots the channel data in time. Time based displays are useful for showing changes in line frequency.

To change the trace display type open the “Properties” dialog under the “File” menu. Click the “Display Settings” tab and change the “Trace Display Type” field to time based or sample based.

FAULT REFERENCE TIME BAR

The Fault Reference Time Bar is displayed between the analog and the digital traces. It displays the time difference from the fault time defined in the displayed file. The units are displayed in the Delta X status field.

To show or hide the fault reference time bar open the “Properties” dialog under the “File” menu. Click the “Display Settings” tab and select “Yes” or “No” for the “Show Reference Time Bar” field.

SUPERIMPOSING ANALOG CHANNELS

To superimpose two or more analog channels, mark the channels and press F7 or select the “Super Impose” menu option from the “Data” menu. The marked channels are superimposed and placed at the top of the display. If no channels are marked, all channels are superimposed. Press F7 to turn this feature ON/OFF.

CHANGING ANALOG CHANNEL COLORS

To change the color of an analog channel, click the opposite mouse button on the channel ID. Select the channel color from the list or click “More Colors” to select from the color palette. Channels must be unmarked to change their colors.

MARK RAW VALUES

Mark Raw Values marks the raw values saved in the active waveform file on disk. A small hollow blue circle is placed at the raw value. This feature is helpful in highlighting the raw sample values saved in low sampling rate files.

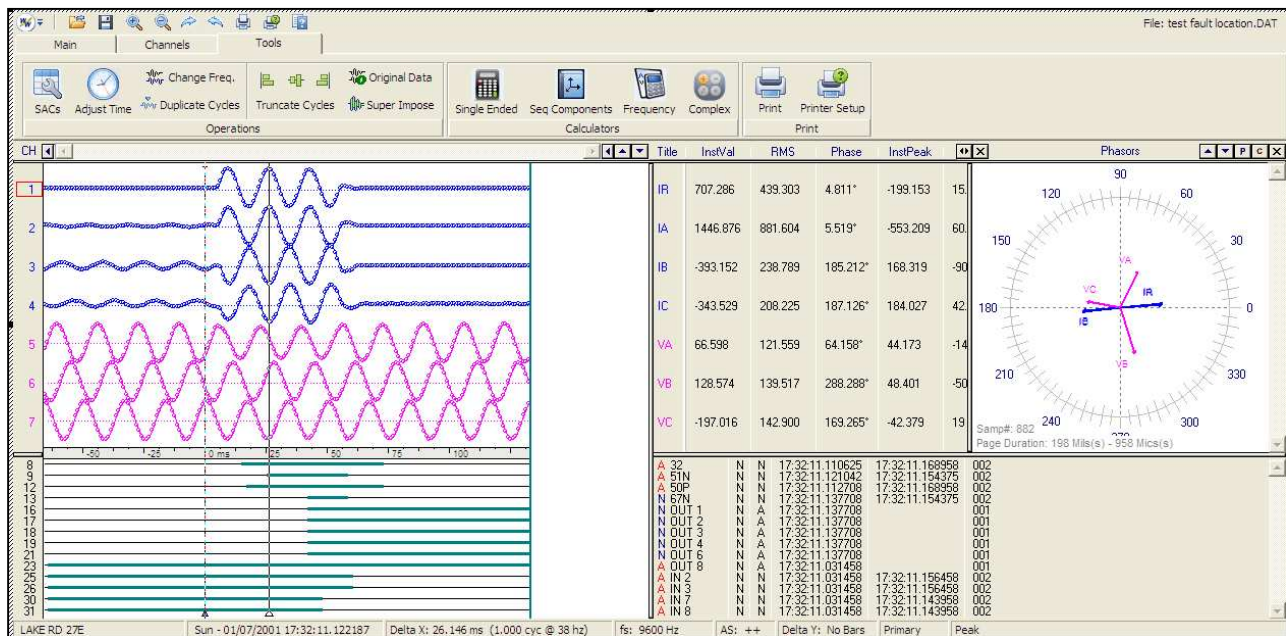


Figure 1.12 Mark Raw Values

MARK PEAK VALUES

Mark Peak Values marks the peak sample values for all visible analog traces. A small solid gray square is placed at the peak values. This feature is helpful in highlighting the positive and negative peak values.

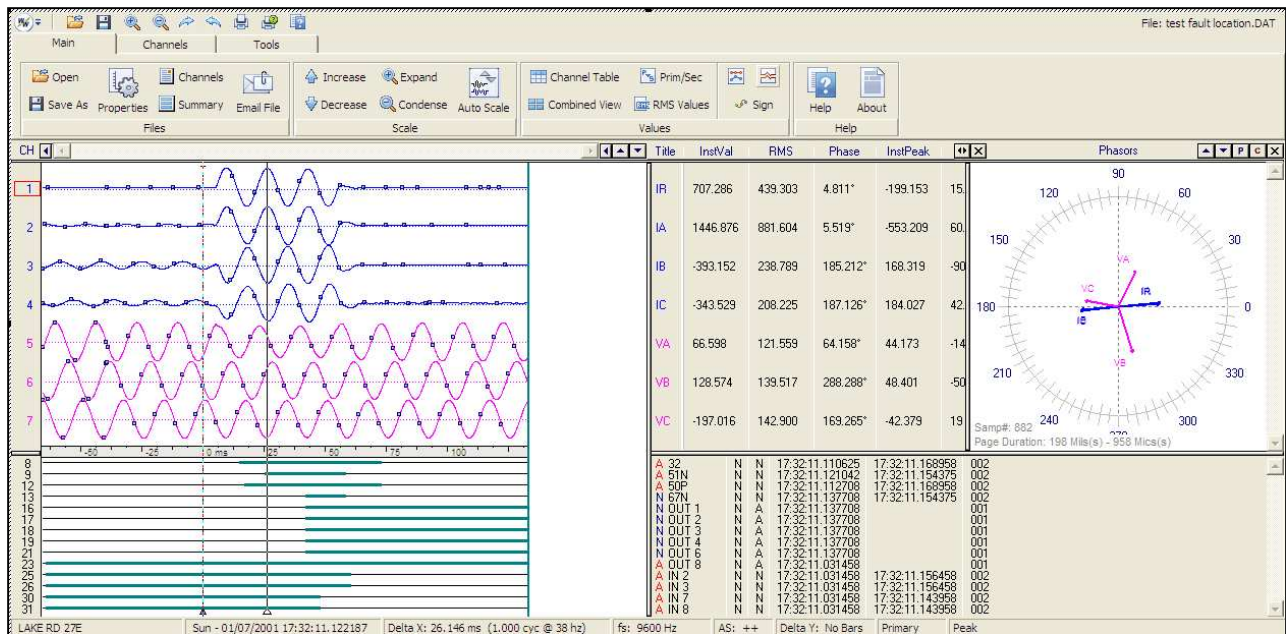


Figure 1.13 Mark Peak Values

MARK CHANGE IN SIGN VALUES

Mark Change In Sign marks all samples where a change in sign occurs. A small solid gray triangle is placed at the change position. This feature is helpful in highlighting the position where a change in sign occurs in the signal.

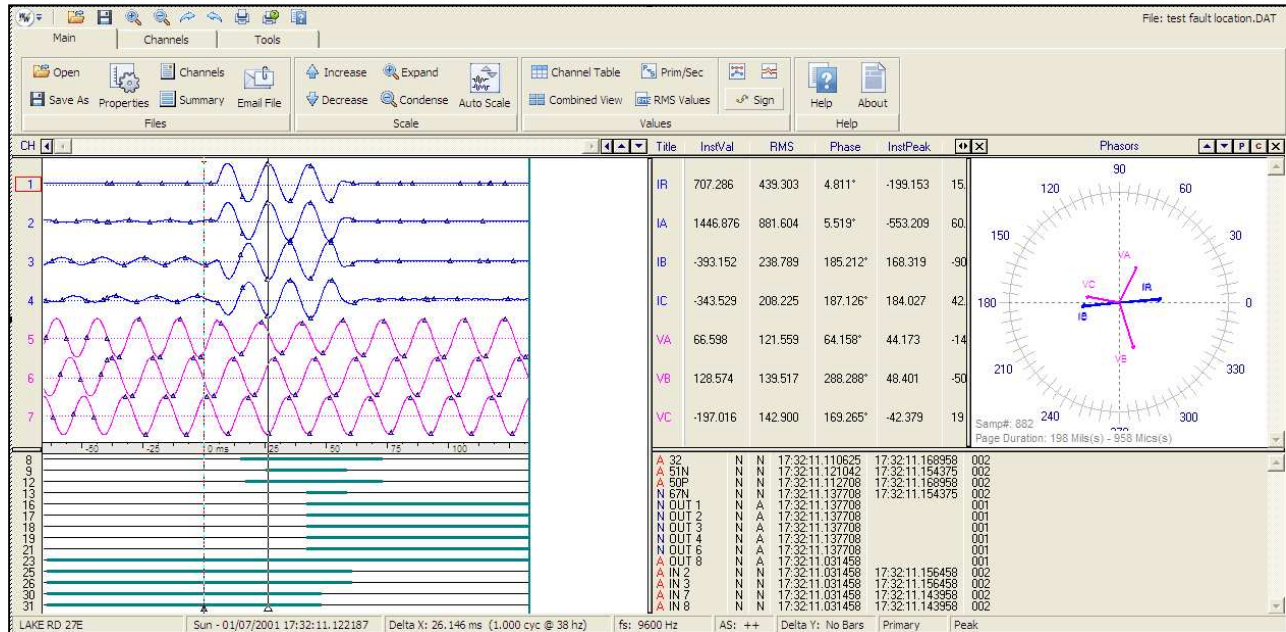


Figure 1.14 Mark Change in Sign

CHANGE ANALOG VALUES (PRIMARY ↔ SECONDARY)

The values displayed in the analog table are either in primary or secondary quantities. If the file defines the type of values saved the type is displayed in the status bar. Also, if the CT and PT ratios are defined in the configuration file the values can be changed from primary to secondary and vice versa. To change the values open the properties dialog and click on the “Driver Data Type” tab, and select the Primary or Secondary radio button to switch between values.

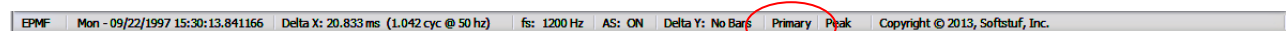


Figure 1.15 Type of Analog Values Displayed

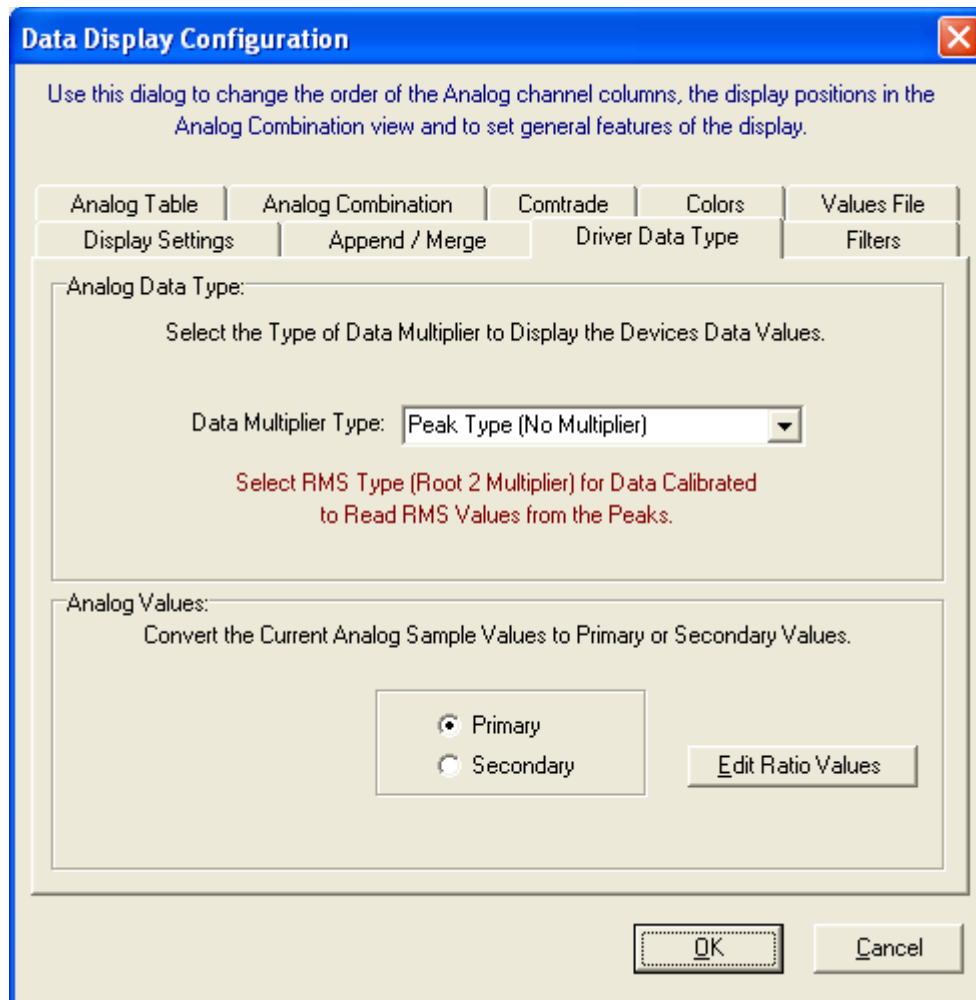


Figure 1.16 Change Analog Values (Primary ↔ Secondary)

The CT and PT ratio values can be edited by clicking on the “Edit Ratio Values” button in the “Driver Data Type” tab. The values are listed in a table format for each analog channel. The modified ratio values are not saved to the original file. To save the edited ratio values use the “Save As: Comtrade” option under the “File” menu.

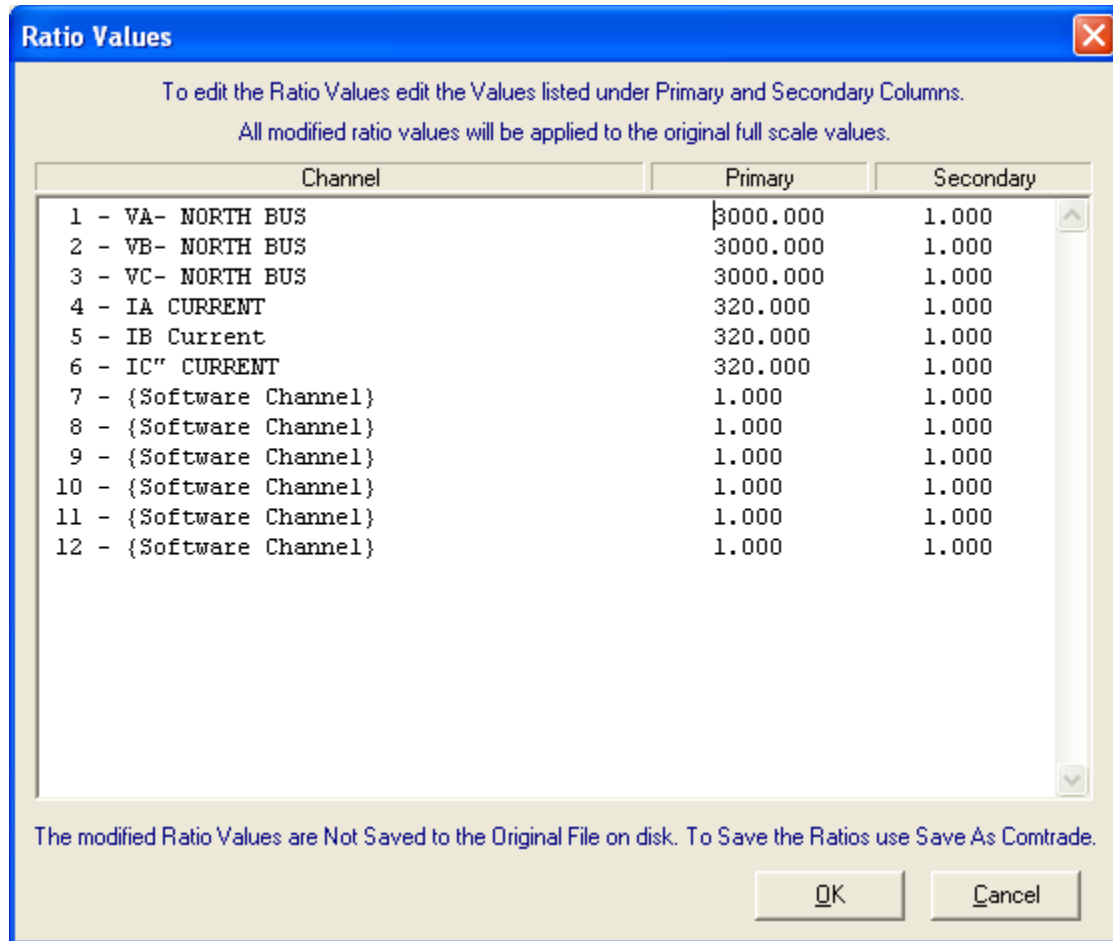


Figure 1.17 Ratio Values

CREATING VIRTUAL CHANNELS

The analysis window allows for six software analog channels (SAC). These additional virtual channels exist only in RAM. The sample values are created using a function of the existing analog channels. Predefined operators can be used to calculate a missing phase, create positive/negative and zero sequence channels; convert channels to secondary or primary values; calculate V/I for fault resistance/impedance, multiply, divide, add and subtract multiple channels; multiply, divide, add and subtract channel data by a constant value; create an envelope of an analog channel; define over-trigger or under-trigger values; calculate a missing phase; define the prefix and unit for the channel.

All calculations are designed to operate "on the fly". For the forward looking SAC operator ("@" some positive angle) care must be taken. Upon opening a file and while the system is reading the data samples, the forward samples are not available. In that case, the system uses the current sample instead of the requested forward sample. To execute forward looking SAC instructions, wait until the file is read and displayed.

SAC title and operators can be saved to an ASCII text file on disk by using the "Save" and "Save As" buttons located to the right of the SAC operators. The "Open" button allows for opening existing SAC files without having to manually enter the SAC titles and operators. These features are useful for reusing existing SAC operations on like files. The "New" button clears the existing SAC title and operators.

The SAC and SDC instructions are composed of an operator and an operand. An operand can be a channel defined by the channel number or a constant. Constant values must have a "^" operator before

each value to distinguish between channel numbers and constant values. To phase shift analog channels, use the “@” sign before each angle defined. All angles must be defined in degrees. Following is a list of all the software operators that are available:

- “+” - Add (Analog),
- “-” - Subtract (Analog),
- “*” - Multiply (Analog),
- “/” - Divide (Analog),
- “^” - Constant value (Analog),
- “@” - Phase Shift (Analog),
- “e” - Adjusted envelope (Analog),
- “a” - Envelope (Analog),
- “<” - Under-trigger (Analog),
- “>” - Over-trigger (Analog),
- “h” - Harmonic for Channel (Analog),
- “h=” - Harmonic for all Back Operations (Analog),
- “x” - real component (Analog),
- “y” -imaginary component (Analog),
- “m” -magnitude (Analog),
- “d” -angle (Analog),
- “r” -true RMS (Analog),
- “f” -cyclic frequency (Analog),
- “q” -instantaneous frequency (Analog),
- “t” -delta time frequency (Analog),
- “s” - sin operator (Analog),
- “c” - cos operator (Analog)
- “b” -operate between bars only (Analog),
- “|” - Absolute Value (Analog),
- “p=” - Prefix (Analog),
- “u=” - Unit (Analog),
- “+” - And (Digital),
- “ ” - Or (Digital),
- “/” - Instruction terminator (Analog & Digital)

NOTE: All SAC operations are performed in Reverse Polish Notation (one operation at a time). The instruction set must always terminate with a “/”. An operation error is generated if the instruction formats are not followed.

Operators are formatted as a stacked set of instructions. An instruction is composed of four attributes:

1. The operator: +, -, *, /, ...
2. The operand: channel index (1, 2, 3, ...) or constant value (such as ^3.14)
3. The function: @, h, x, y, m, d, f, ...
4. Instruction terminator: /

To display the SAC dialog select “Software Analog Channels” from the Channels menu. Below are some examples:

Operations	Example	Description
Addition	+7/+8/+9/	Add channels 7, 8, & 9 and store the result in the SAC.

Operations	Example	Description
Subtraction	+7/-8/-9/	Subtract channel 8 from channel 7, and store the result in the SAC then subtract channel 9 from the SAC and restore the values in the SAC.
+ Sequence	+1/+2@120/+3@240/:^3/p=k/u=volt/	Calculate the + sequence components and store the result in the SAC then set the SAC's prefix and unit.
- Sequence	+1/+2@240/+3@120/:^3/p=k/u=volt/	Calculate the - sequence components and store the result in the SAC then set the SAC's prefix and unit.
0 Sequence	+1/+2/+3/:^3/p=k/u=volt/	Calculate the zero sequence components and store the result in the SAC then set the SAC's prefix and unit.
Harmonics	+16/h=1/p=k/u=volt/	Extract the 1 st Harmonic component from Channel 16 and store in the SAC then set the SAC's prefix and unit.
Multiplication	+3/*^2.66/	Multiply all sample values in channel 3 with the constant value 2.66 and store the result in the SAC.
Division	+7/:3/	Divide all samples values in channel 7 by the sample values in channel 3 and store the result in the SAC.
Half Cycle Envelope	+2/e/	Calculate the half cycle envelope of channel 2 and store the result in the SAC.
Envelope	+12/a/	Calculate the envelope of channel 12 and store the result in the SAC.
Under-trigger	+4/<135/	Store all the sample values from channel 4 that are < 135 in the SAC.
Over-trigger	+62/>500/	Store all the sample values from channel 62 that are > 500 in the SAC.
Absolute Value	+7/+8/+9/ p=k/u=Volts/	Add channels 7, 8, & 9 and store the absolute value of the result in the SAC then set the SAC's prefix and unit.
Frequency	+7f/u=Hz/	Store the cyclic frequency of channel 7, and set the SAC's unit to Hertz.
Frequency	+7q/u=Hz/	Store the instantaneous frequency of channel 7, and set the SAC's unit to Hertz.
Magnitude	+11m/u=V/p=k/	Store the magnitude of channel 11, and set the SAC's unit to Volt and the prefix to k.
Real	+4x/+5x/+6x/u=V/	Store the real components of the fundamental of 4, 5 and 6 and set the SAC's unit to Volts.
Imaginary	+4/+5/+6/y2/u=V/	Store the imaginary components of 2nd harmonic of 4, 5 and 6 and set the SAC's unit to Volts.
Secondary	+1/:^3000/u=V/	Store channel 1 values divide by 3000 and set the SAC's unit to V.
Impedance (V/I)	+4/:6/h=1/u=mho/	Store the fundamental of channel 6 (V) divided by channel 1 (I) and set the SAC's unit to mho.
Differential Current	+1/+2/+3/+4/ u=A/	Store the absolute value of the sum of channels 1 2 3 and 4 and set the SAC's unit to A.
Apparent Power (1=V,	*1m/*4m/p=k/u=Watts/	Store the magnitude of channel 1 multiplied by the magnitude of channel 4 and set the

Operations	Example	Description
4=l)		SAC's prefix to k and the units to Watts.
Power Factor	+1d/-4d/c/u=Deg/	Store the cosine of the angle of channel 1 minus the angle of channel 4 then set the SAC's unit to Deg.
Active Power	+1d/-4d/c/*1m/*4m/p=k/u=Watts/	Calculate the cosine of channel 1 angles minus channel 4 angles, then store the calculated value multiplied by channel 1 magnitudes and channel 4 magnitudes, set the SAC's prefix to k and the unit to Watts.
Reactive Power	+1d/-4d/s/*1m/*4m/p=k/u=Vars/	Calculate the sine of channel 1 angles minus channel 4 angles, then store the calculated value multiplied by channel 1 magnitudes and channel 4 magnitudes, set the SAC's prefix to k and the unit to Watts.

Software Analog Channels for: C:\Faultlib\000508,123456789,-5S,DESSEX SUBSTATION,501 R...

Station: EPMF
Device ID: 250

Chan	Titles	Operators
17	Add Channels 1 2 3	+1/+2/+3/u=Volts/
18	V / I	+1/:5/h=1/u=ohm/
19	Zero Sequence	+1/+2/+3/^(3/u=Volts/
20	{Software Channel}	
21	{Software Channel}	
22	{Software Channel}	

File: Untitled Modified

Buttons: OK, Cancel, Apply, Open, New, Save, Save As, Show Help

Figure 1.18 SAC Dialog



Figure 1.19 SAC Results

Engineers can use the additional channels as a generic tool for monitoring or modeling tasks. A virtual channel can be used to compute one of the phases of a monitored line by adding the remaining phases then subtracting the result from the residual channel. This in turn frees up a hardware channel for other monitoring needs.

The SAC operators and titles can be saved to an ASCII text file on disk to save time when re-entering SAC operator and titles. The SAC files can have any filename but the extension must be .SAC. If an extension is entered when saving a SAC file then the extension is deleted and .SAC is added to the filename. The active SAC path and filename is displayed in the first status field. The second status field indicates if the SAC title or operator fields were modified.

There are 4 options for the SAC files, Open, New, Save and Save As. Each option is explained below:

SAC File Operator	Description
Open	Open an existing SAC file. The Window's open file dialog is displayed. Navigate to the desired folder and double click on the SAC file. The SAC title and operator fields are populated with the contents of the selected file. If the file is not a valid SAC file then an error message is displayed.
New	Clear the current SAC title and operators and change the SAC filename in the first status field to Untitled. If the previous SAC title and operators were modified then a message will be prompted asking to save the existing SACs before clearing the fields.
Save	Save the active SAC title and operators to the SAC file listed in the first status field. If the SAC filename is listed as Untitled then the "Save As" dialog is displayed.
Save As	Save the existing SAC title and operators to a new SAC file. The Window's "Save As" dialog is displayed. Navigate to the desired folder and enter the new name in the "File name" field and click the "Save" button or press enter.

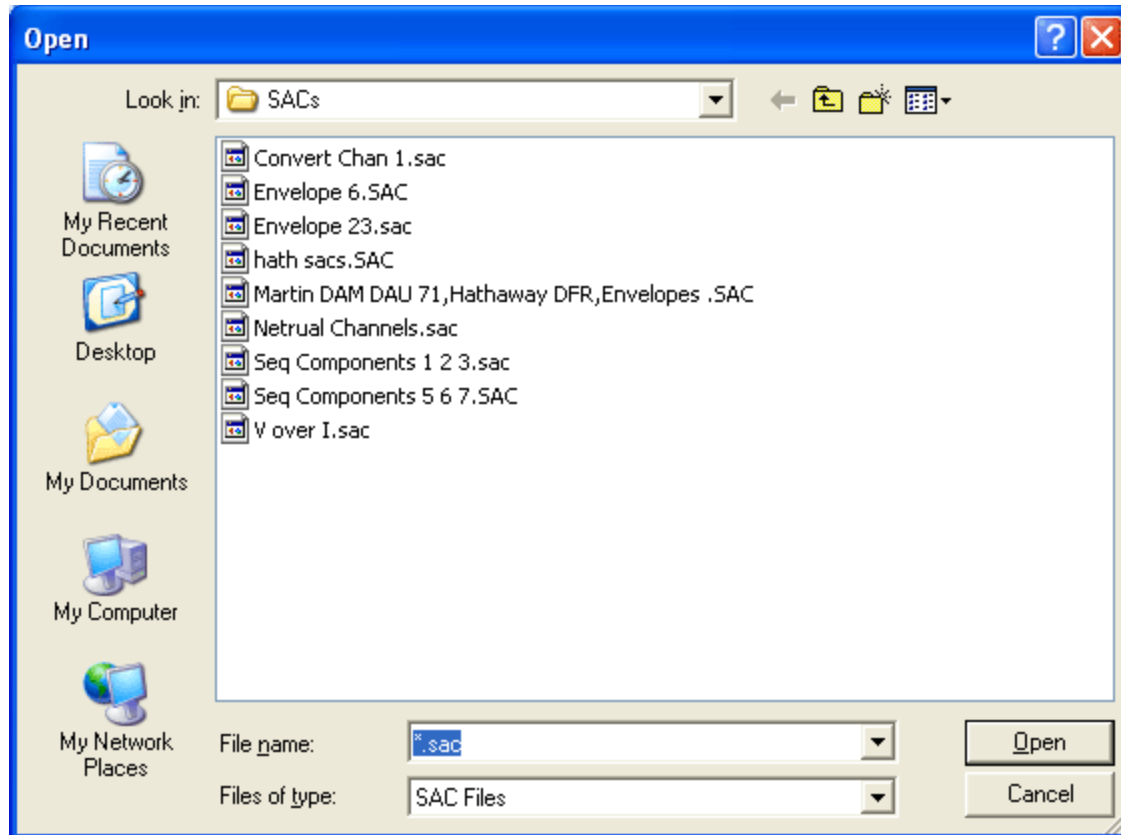


Figure 1.20 Open SAC File

SAVE AS: CSV FORMAT

The save as CSV format allows for saving specific analog information into a CSV comma delimited format. The "CSV Format" will save the RMS, Instantaneous or Vector (Magnitude and Angle or RMS and Angle) values to a comma delimited text file.

To save the analog channels in a CSV format select the Save As menu option under the "File" menu.

The first line in the CSV file is the header information for each channel. All the analog channels displayed in the active data plotting window are saved.

A dialog box is displayed to enter the destination path and the filename. The filename can be directly entered into the "File Name" field or the file can be automatically named using the IEEE C37.232 long file naming format. To have the file automatically named click on the "ComNames" check box. If the "ComNames" check box is checked then the File Name field will be disabled. To enter a file name make sure the "ComNames" check box is unchecked.

The four Save As CSV options are:

- Save As CSV - RMS Values: Save the RMS Values in a comma delimited format.
- Save As CSV - Instantaneous Values: Save the Instantaneous Values in a comma delimited format.
- Save As CSV - Vector Values (Mag & Ang): Save the DFT Magnitude and Angle in a comma delimited format.
- Save As CSV - Vector Values (RMS & Ang): Save the RMS Value and Angle in a comma delimited format.

The file format saved is a comma delimited text file and the .CSV extension is automatically assigned. The first line in the file defines the header information. The first two columns are the samples date and time. Below is an example of the header:

DATE(0/DATE),TIME(1/TIME),IA(4/Amps),IB(4/Amps),IC(4/Amps),VA(4/Volts),VB(4/Volts),VC(4/Volts)

A P P E N D I X A



















System Keys

This section lists the function keys, cursor keys, and menu buttons available in the device manager, query fields and DXF display.

Analysis

Cursor Keys	Description
Left Arrow	Move the data bar to the left one sample.
Right Arrow	Move the data bar to the right on sample.
Ctrl+Right Arrow	Move the data bar to the next peak for the first display channel or the first marked channel.
Ctrl+Left Arrow	Move the data bar to the previous peak for the first display channel or the first marked channel.
Shift+Ctrl+Right Arrow	Move the data bar ahead one cycle for the first displayed channel or the first marked channel.
Shift+Ctrl+Left Arrow	Move the data bar back one cycle for the first displayed channel or the first marked channel.
Shift+Left Arrow	Shift the analog information table to the left by one column.
Shift+Right Arrow	Shift the analog information table to the right by one column.
Page Up	Page up through the data.
Page Down	Page down through the data.
Home	Move the data bar to the first data sample.
End	Move the data bar to the last data sample.
Ctrl+Up Arrow	Increase the amplitude for all or marked channels.
Ctrl+Down Arrow	Decrease the amplitude for all or marked channels.
Ctrl+Page Up	Expand the time scale for all visible channels.
Ctrl+Page Down	Condense the time scale for all visible channels.
Tab	Toggle between the analog and digital channels.
Up Arrow	Move the cursor up one channel.
Down Arrow	Move the cursor down one channel.
Shift+Page Up	Display the analog/digital channels on the previous page.
Shift+Page Down	Display the analog/digital channels on the next page.
Ctrl+Home	Display the first page of the analog/digital channels.
Ctrl+End	Display the last page of the analog/digital channels.
Spacebar	Mark or Unmark the channel at the cursor position.
Shift+Up Arrow	Mark or Unmark a group of channels while moving the cursor up.
Shift+Down Arrow	Mark or Unmark a group of channels while moving the cursor down.
Insert	Display the hidden channels that were removed by the delete keys.
Delete	Hide the marked channels and respace the unmarked channels.
Enter	Hide the unmarked channels and respace the marked channels.
Esc	Display all the hidden channels or exit the data window.
Backspace	Display all the hidden channels.

+	Shift all the marked channels up one position.
-	Shift all the marked channels down one position.
Ctrl-A	Move the reference bar to the sample at the cursor bar.
Ctrl-Z	Move the RMS bar to the sample at the reference bar.

Menu Buttons	Description
 Open File	Open a new waveform file.
 Email Active File	Email the active file and any support files needed.
 Properties	Display the Window Properties dialog.
 Summary	View the Analog/Digital Summary of the active displayed file.
 Recorder Chans	Display the waveform's analog/digital channel headers and scale factors.
 Inc	Magnify the amplitude of the marked channels.
 Dec	Attenuate the amplitude of the marked channels.
 ASV	Turn auto scaling ON/OFF for all visible channels.
 In	Condense the time scale of the visible channels.
 Out	Expand the time scale of the visible channels.
 View Marked	Hide the unmarked channels and respace the marked channels.
 View All	Replot all the hidden channels.
 Set Ref Bar	Move the reference bar to the sample at the cursor bar.
 SetRMS Bar	Move the RMS bar to the sample at the reference bar.
 Resize Sliding Window	Resize the RMS sliding window.
 Channel Color	Change the Analog channels color at the cursor position.
 Harmonics	Display the Harmonics table / histogram window.
 Vector Harmonics	Show / Hide the vector harmonics in the phasor display.

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