ELECTROTEK CONCEPTS

TOP, The Output Processor®

an Electrotek Visualization Program

Excellence in Engineering

User's Guide

TOP, Version 6.2

April 14, 2003

Electrotek Concepts, Inc.
408 North Cedar Bluff Road, Suite 500
Knoxville, Tennessee 37923
Phone (865) 470-9222 / Fax (865) 470-9223
www.electrotek.com/top

Legal Notice

Abstract

TOP is an acronym for "The Output Processor", a program that reads data from a variety of sources and transforms it into a consistent-looking high quality graphics for inclusion in reports and documents. The program has been designed to enable electric power engineers to visualize data from a variety of simulation and measurement tools. Visualization capabilities include simultaneous waveform and tabular data display from multiple simulation programs and monitoring devices. These functions are extended though post processing of simulation and measurement data using commonly-required mathematical and statistical functions.

Credits

The TOP Development Team:

Program Authors:	Erich Gunther Tom McDermott Kelley Flatford
Documentation Author:	Tom Grebe
Marketing:	Sandy Smith

C O N T E N T S

I N T R O D U C T I O N I

Getting Started i

What is TOP? iii

TOP's Data Capabilities iii

Data Management Capability iv

Data Display Capability iv

Data Processing Capability v

Data Formatting Capability vi

Data Sharing Capability vii

How to Use This Manual vii

Introduction vii

Using TOP vii

Stack Management vii

Working with Graphs vii

Working with Tables vii

Installing and Uninstalling TOP viii

Computer Requirements viii

Program Installation viii

Uninstall xiv

Starting the Program xiv

The TOP Interface xiv

User Preferences xvi

Getting Help xix

World Wide Web xix

Training xix

C H A P T E R 1 1-19

Using TOP 1-19

Creating Graphs and Tables 1-4

Opening a Data File 1-4

Loading Data onto the Stack 1-4

Discarding Data from the Stack 1-5

Creating a Graph 1-6

Creating a Table 1-7

Printing 1-9

Printer Setup 1-9

Printing TOP Displays 1-10

Using the Help System 1-10
Using TOP with other Applications 1-11
Copying to the Window's Clipboard 1-11
Pasting Data from the Clipboard 1-11
Exporting to a Disk File 1-11
Exporting Trend Time Stamps 1-12
PQDIF Export Limitations 1-12
Text-to-PQDIF Configuration Export 1-13
Using TOP Utilities 1-14
Building an EMTP SOS File 1-14
Starting the Windows Calculator 1-15
Viewing a Text File 1-15
Executing SuperHarm Macro Files 1-15
TOP Macro Commands for SuperHarm 1-15

CHAPTER 2 2-1

Stack Management 2-1
What is the Stack? 2-3
Stack Object Identifiers 2-4
Modifying Stack Objects 2-6
Base Quantities Option 2-6
Units Option 2-7
Using TOPCalc 2-9
The Procedure 2-11
Single Argument Operations 2-12
Fourier Transforms 2-14
Single FFT Type 2-14
Sliding FFT Type 2-15
Statistical Functions 2-17
Mixed Argument Operations 2-17
Using Expressions 2-18
Expression Notation 2-21
Expression Operators 2-22
Expression Precedence 2-25
Capacitor Switching Transient Expression 2-25
TRV Capability Expression 2-26

CHAPTER 3 3-28

Working with Graphs 3-2
Graphing Options 3-4
Changing Graph Items 3-6
Formatting Options 3-6
Graph Scaling 3-7
Zooming with the Mouse 3-8
Grid Options 3-8
Label, Legend, and Annotation Options 3-9
Graph Customization 3-10

Crosshair Mode 3-12

CHAPTER 4 4-1

Working with Tables 4-1

What Types of Tables are Available? 4-3

Creating Tables 4-4

Changing Table Column Widths 4-4

Sharing Tables with other Applications 4-5

Table Derived Quantities 4-6

Example TOP Tables 4-9

Curve Minimum and Maximum 4-9

Waveform Summary 4-10

Time Domain Data Points 4-10

Frequency Domain Data Points 4-11

Harmonic Summary Table 4-12

Magnitude vs. Switch Operation 4-13

IEEE 519 Current Limits 4-14

APPENDIX A A-2

TOP Data Filters A-2

COMTRADE Objects A-4

EMTP/ATP Objects A-6

EMTDC Objects A-8

HARMFLO Objects A-9

SuperHarm Objects A-10

V-HARM Objects A-13

Dranetz Objects A-14

FlukeView Objects A-15

PQNode Objects A-17

Square D / DADisp Objects A-18

SuperTran Objects A-19

EPRI Lightning Transients Objects A-20

PQDIF Objects A-23

APPENDIX B B-2

Text-to-PQDIF Conversion B-2

Overview of Text-to-PQDIF Utility B-4

File Controls B-4

Series Page B-7

General Page B-9

Sample B-10

Data Source Page B-11

Notes Page B-12

Trigger Page B-13

[page intentionally left blank]

INTRODUCTION

Getting Started

This introduction serves as a starting point for those users who are not familiar with **TOP, The Output Processor**® (hereafter referred to as TOP). This introduction is also intended to make the installation process of TOP a trouble-free experience. The following sections provide a step-by-step procedure on how to install and configure TOP. Finally, at the end of this introduction is an overview of the TOP User's Guide and how to receive technical support.

This guide assumes you know the basics of using Microsoft Windows. You should know how to point, click, double-click, shift-click, control-click, and drag. You should also know how to choose commands from menus, select options in dialog boxes, and enter, select, and edit text. See *your Microsoft Windows User's Guide* for details.

In This Chapter

- What is TOP?
- TOP's Data Capabilities
- How to Use this Manual
- Installing TOP
- The TOP Interface
- Getting Help

[page intentionally left bank]

What is TOP?

TOP is an acronym for "The Output Processor", a program that reads data from a variety of sources and transforms it into consistent-looking, high quality graphics for inclusion in reports and documents. The program has been designed to enable electric power engineers to visualize data from a variety of simulation and measurement tools. By providing a single program that can manipulate data from a variety of sources, significant gains in productivity can be realized. Data formats currently supported include

- ASCII Text
- COMTRADE: IEEE Standard C37.111-1991
- PQDIF - Power Quality Data Interchange Format (IEEE Standard P1159-3)
- Dranetz-BMI 8010 PQNode® and 8020 PQNode®
- Dranetz-BMI 65x Series
- Electrotek SuperHarm®
- EPRI/DCG EMTP for Windows (Electromagnetic Transients Program)
- ATP (Alternative Transients Program)
- Manitoba HVDC Research Centre's EMTDC/PSCAD v3
- EPRI HARMFLO for Windows
- Cooper V-HARM®
- EPRI SDWorkstation
- EPRI LPDW (CFlash, DFlash, TFlash)
- EPRI PQ Diagnostic System (Capacitor Switching & Lightning)
- Square D DADisp
- Fluke 41

The Microsoft Windows operating environment was chosen for the program due to its popularity, graphical user interface, multitasking ability, ease of use, and inherent capability to facilitate data sharing between applications. The program has also been designed using an open architecture to accommodate additional data input filters. Computing requirements include a 486/Pentium-based personal computer using Microsoft Windows 95/98 or greater.

TOP's Data Capabilities

This section provides a detailed account of the program's structure and methodology for data import and processing. The following capabilities will be discussed:

- Data Management
- Data Display

- Data Processing
- Data Formatting
- Data Sharing

These capabilities will be discussed in detail in Chapters 1 - 4.

TOP uses a method of data management called the *stack* to simplify handling of data from various sources. The stack holds the data selected by the user from each source file. This process is analogous to selecting a file folder from a file cabinet, selecting specific papers in the file that are of interest, and piling them in a stack on your desk.

The stack concept is described in Chapter 2 and is summarized as:

The user selects the file that contains the data to be displayed.

1. TOP then provides a dialog box that displays all of the quantities available in the current file.
2. The user selects the items of interest that TOP loads into memory.
3. The user may reactivate the dialog box at any time and load more data objects onto the stack. The user may also select another file at any time and load data from that file onto the stack. The result is a stack of data objects of different types and origins that are available for display.

Data Display Capability

TOP provides a variety of ways to visualize the data of interest in the form of tables and graphs. Display options include:

- Waveform and Spectrum Plots
- Frequency Response Plots
- Summary Tables
  - Waveform Summary
  - Curve Minimum and Maximum
  - Time Domain Data Points
  - Magnitude vs. Switch Operation
  - Harmonic Summary Data
  - Frequency Domain Data Points

  - IEEE 519 Current Limits
- Summary Bar/Column Charts
- Cumulative Probability Charts
- Probability Density Charts
- Magnitude-Duration Scatter Plots of RMS Variations
- 3D Histograms of RMS Variations

TOP utilizes Microsoft's Multiple Document Interface (MDI) standard to allow a user to view several different plots in multiple windows simultaneously. The user can move, size, and arrange the windows on the screen as desired. Any window can be printed with a simple menu option. In addition, TOP does not need to be updated every time a new hardcopy device is installed. This is because printer/plotter support is provided through the Windows environment.

TOP uses *windows* to display selected data. In addition, stacked graph plots allow multiple sets of axes in one window. One advantage of this option is that measured and simulated data can be displayed in the same window. For printing, each window corresponds to a (printed/plotted) page.

Data Processing Capability

A very useful post-processing feature in TOP is called TOPCalc. This feature allows a user to perform mathematical operations on the various data objects supported by the program. Operations include:

- Addition, subtraction, multiplication, division
- Inversion, negate, absolute value
- Fast & discrete Fourier transformers (FFT, DFT)
- Inverse discrete Fourier transform (IDFT)
- Power, energy and I^2T
- Integration, square, square root
- X-Y combine
- Filter (high, low pass), time shift
- Sampling
- V, I, and power dB ratio
- Cumulative probability, probability distribution

This facility provides a means for creating new stack objects by specifying mathematical operations to be performed on existing objects. Objects derived through TOPCalc are identical to raw data loaded from input files and can be used as arguments for subsequent TOPCalc

operations. TOPCalc requires one or two arguments, depending on the operation selected. Argument #1 is always a stack object. Argument #2, if required, is usually an object, but may be a constant. Simple single argument operations include invert (1/X), negate (-X), square (X^2), square root ($\sqrt{X}$), and absolute value (|X|). Mixed argument operations include addition, subtraction, multiplication, division, power, energy, dB ratio, and X-Y combine. In addition, TOPCalc includes several sophisticated mathematical operations. The filter operation provides high pass, low pass, band pass, and band reject options. The FFT operation performs a Fast Fourier Transform on the desired waveform. The FFT operation includes both single and sliding options, as well as control over the weighting function window. The sliding FFT option is used to produce a trend object of a single harmonic vs. time.

The Expression Dialog lets you create stack objects by typing in expressions. This feature is useful for comparing simulated or measured results to rated capabilities, or to idealized results.

Data Formatting Capability

TOP provides the capability to format the data display based on user preferences. Functions under user control include:

- Base quantities (per-unitizing)
- Units (axis labels and multipliers i.e. kA)
- Data, comment, and legend blocks
- Display colors
- Axis scaling, grid lines, labels, fonts

The **Stack Base Quantities** command allows the user to control scaling for each stack object individually. This command may seem redundant, given that TOPCalc allows division by a constant; however, the effect is not the same because TOPCalc creates a new object while base quantities act directly upon the selected object. This feature is useful for displaying measured and simulated data on the same axis.

Another TOP function available to the user is the **Stack Units** command. This option is used when the user needs to assign a different set of units to the displayed object. Although TOP automatically assigns units to the X and Y variables of an object when it is created, there are instances when the user will need to change the values. An example of this is energy in an EMTP PL4 file. Due the structure of an EMTP output file, TOP assumes that the object is a current and the user must change the Y-axis display from "Current" to "Joules". When TOP loads a stack object, it prepares information for a data block. The contents of the data block vary depending on the object and input file type. As an example, the data block for a simulated dc drive harmonic spectrum would include the following information:

```
Freq: 60    (fundamental freq)
Fund: 293.9 (fundamental value)
THD:  35.2  (harmonic distortion)
```

```
RMSh: 103.5 (harmonic rms)
RMS:  311.6 (total rms)
ASUM: 455.1 (arithmetic sum)
TIF:  353.1 (telephone influence)
```

TOP also provides the user with the flexibility to control the display colors, X and Y-axis zooming (keyboard or mouse controlled), tick marks and grid lines, and axis labels.

Data Sharing Capability

The data being visualized in a window can be exported to a variety of other file formats, including:

- Portable Network Graphics (.PNG)
- Windows Metafile (.WMF)
- ASCII Tabbed Text (.TXT)
- Comma Separated Values (.CSV)
- IEEE COMTRADE (.CFG)
- Power Quality Data Interchange Format (.PQD)

In addition, the Windows Clipboard can be used to transfer formatted graphs to many other Windows applications.

How to Use This Manual

This User's Guide is divided into the following parts:

Introduction

This chapter contains an overview of the program.

Using TOP

This chapter contains information pertaining to the usage and configuration of the program.

Stack Management

This chapter discusses how to open simulation and measurement program output files, and how to retrieve quantities of interest from them. It also covers how to per-unitize quantities, and how to create new quantities with TOPCalc or by typing in expressions.

Working with Graphs

This chapter explains the various types of TOP displays, how to create them, and how to manipulate them. Beginners should become comfortable with the *New Graph* option before moving on to the more advanced options.

Working with Tables

Tabulating harmonic summaries, frequency scans, transient peak magnitudes and other data is covered in this chapter. Like the advanced graphing options, new users can defer this topic.

Installing and Uninstalling TOP

This section describes the procedure for installing the TOP program on your computer. The program is designed for the Microsoft Windows 95/98, NT 4.0, 2000, or XP operating systems. If your computer has sufficient memory to run Windows 95/98, and if the mouse and other peripherals are compatible with Windows 95/98, then the program should install and run without problems.

Computer Requirements

TOP is a 32-bit application for Windows 95/98, Windows NT 4, Windows 2000, or Windows XP. This means that you must install it on a 486 or later-based computer with at least 16 MB of RAM. Approximately 10 MB of hard disk space will be required to install TOP.

Program Installation

To begin the installation, select the **TOPSetup.exe** file shown in Figure i-1. This launches the TOP setup program.

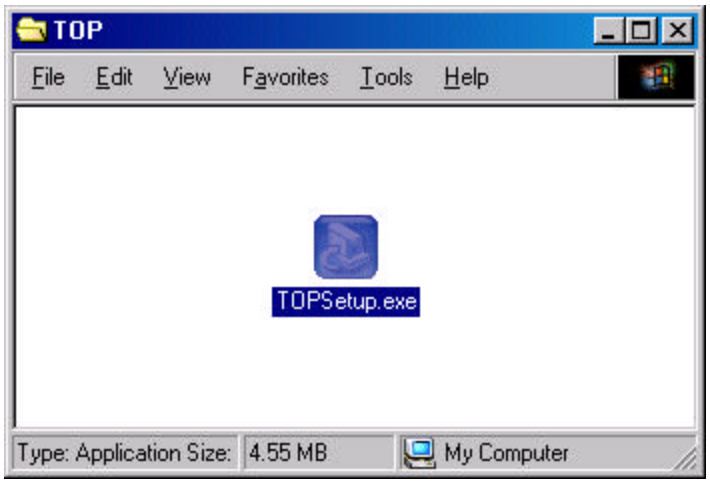


Figure i-1: TOPSetup.exe Setup File

The opening screen, shown in Figure i-2, of the TOP setup program provides a welcome message. Select **Next** to continue to the next screen.

Figure i- 2: Welcome Window

The files for installation will be extracted. If this version of TOP has already been installed, a window as displayed in *Figure i- 1* will be displayed. Select **Next** to perform the selected action. Select **Cancel** to leave the current installation.

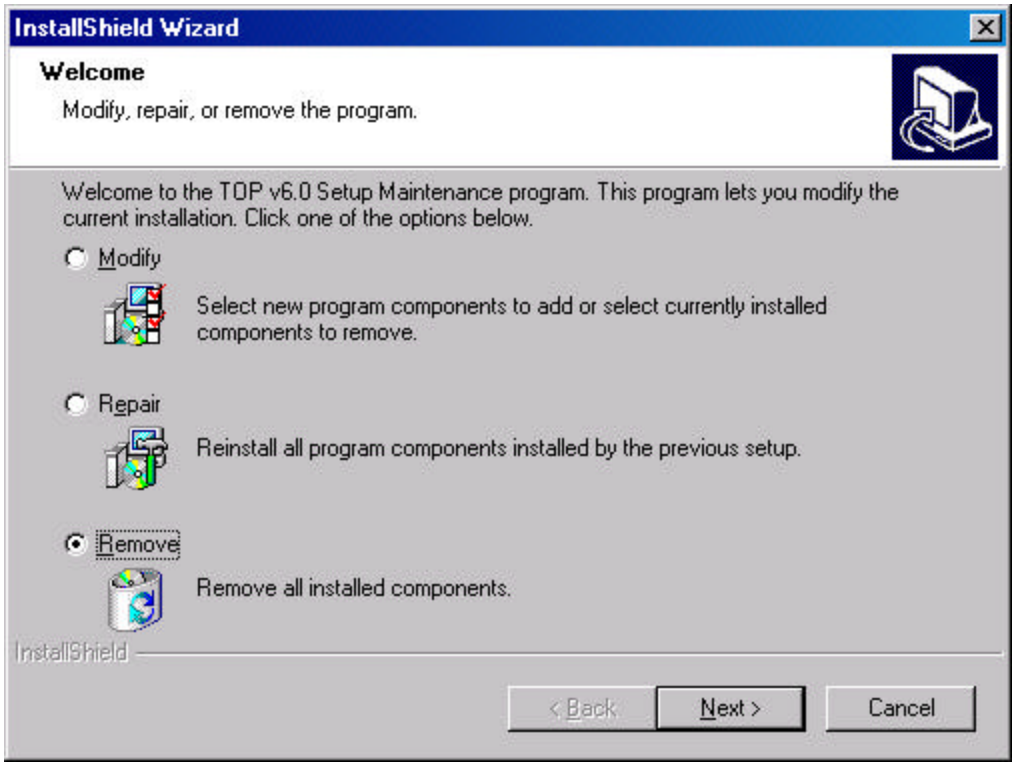


Figure i- 3: Previous TOP Installation

The installation program will then display windows welcoming the user to the installation(select **Next** to continue), containing the license agreement (select **Yes** to continue).

The installation program then offers the option of changing directories if you do not want the program installed in the default directory. Simply click on the **Browse** button as shown in *Figure i- 4*. Select **Next** to continue to the next screen.

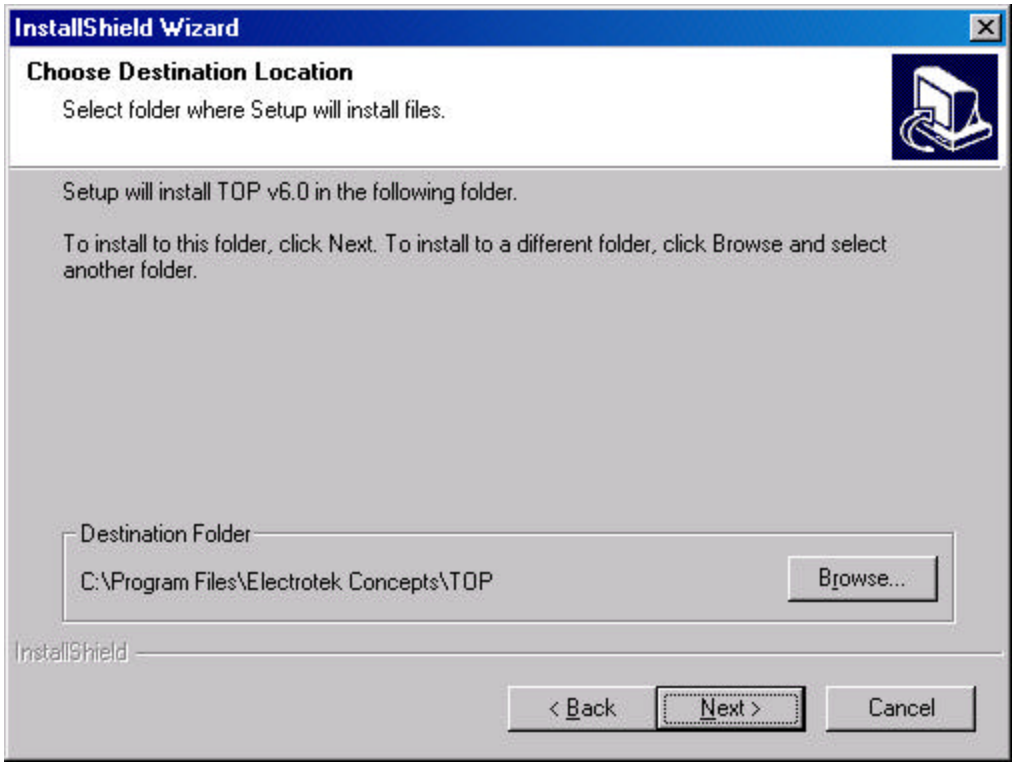


Figure i- 4: Choose Destination Location

The installation program prompts for the folder where the program icons will be added. Select the desired folder, as illustrated Figure i- 5, and click the **Next** button.

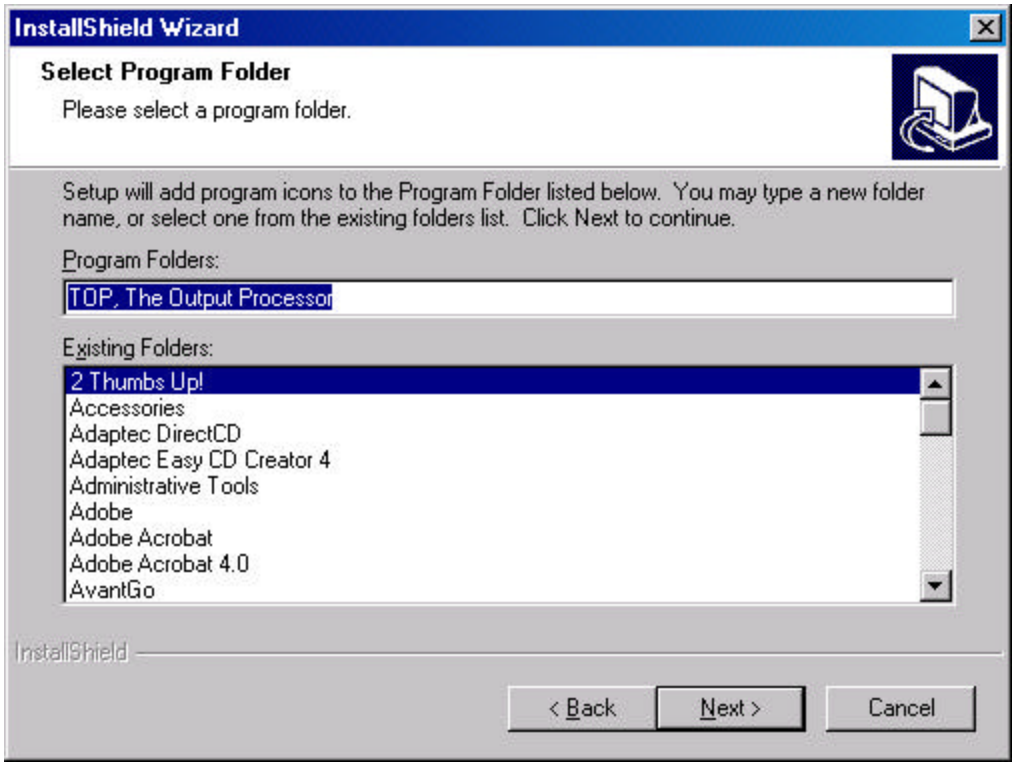


Figure i-5: Select Program Folder

The installation then prompts for file extension associations. Select the desired associations (Figure i-6), and click the **Next** button. Click the **Finish** button (Figure i-7) to complete the setup.

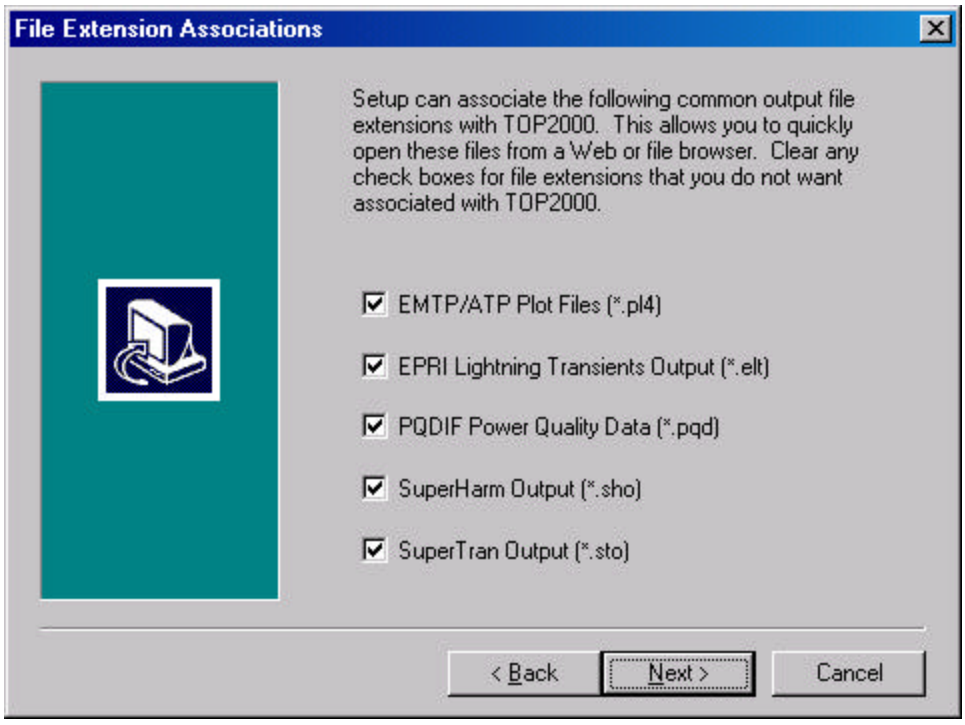


Figure i- 6:File Extension Assocations

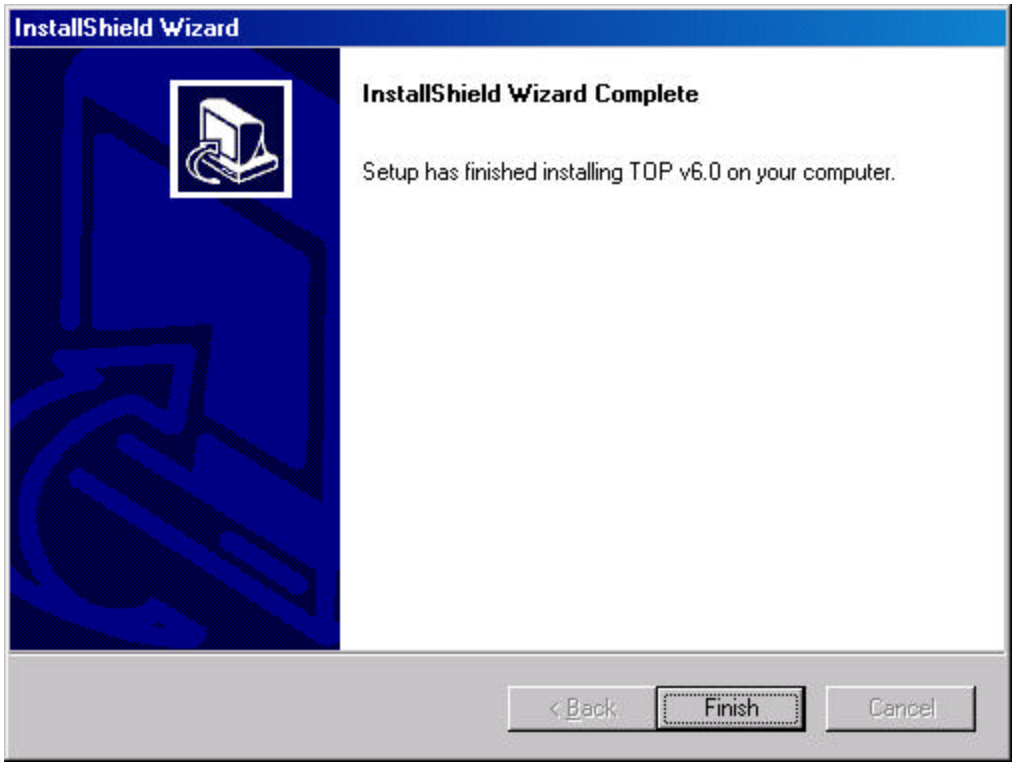


Figure i- 7:Setup Complete

Uninstall

To uninstall the TOP program, go to the Control Panel and open the Add/Remove Programs Properties dialog box. Follow the instructions given on the window.

Starting the Program

To start TOP in Windows 95/98/NT/2000,XP, click the **Start** button on the taskbar and choose TOP from the Start > Programs > {installation icon folder selection} menu. The TOP program window (shown in Figure i- 8) appears.

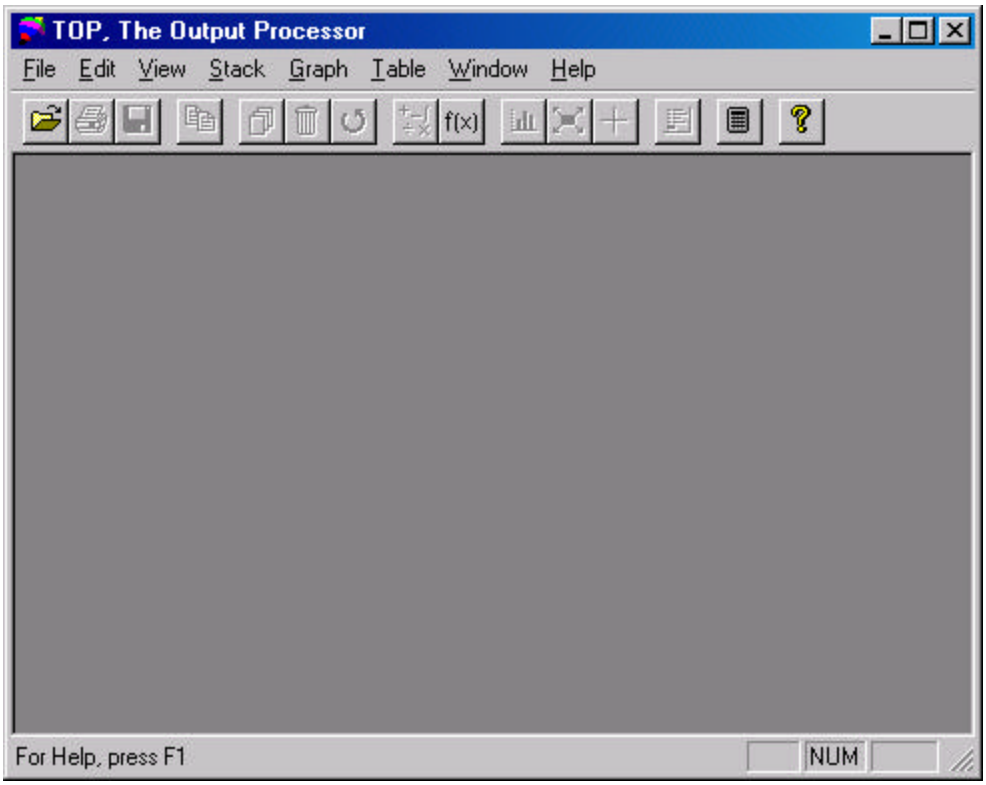


Figure i- 8:TOP Window

The TOP Interface

TOP user interface preferences include display of the tool and status bars. The tool and status bars may be toggled on/off by selecting the **View** / **Tool Bar** and **View** / **Status Bar** menu options respectively. The tool bar), shown in Figure i- 9, includes a number of command buttons that simplify the selection of common menu commands. Viewing from left to right, equivalent menu commands include:

(1) File, Open (2) File, Print (3) File, Export

(4) Edit, Copy (5) Stack, Load (6) Stack, Discard

(7) Stack, TOPCalc (8) Graph, New Graph (9) Graph, Autoscale

(10) Graph, Crosshairs (11) Table, Select (12) File, Calculator

(13) Help, Help Topics

Figure i-9: TOP Tool Bar

User Preferences

User preferences are illustrated in Figure i- 10. The preferences dialog may be displayed by selecting the **Edit**, **Preferences...** menu command.

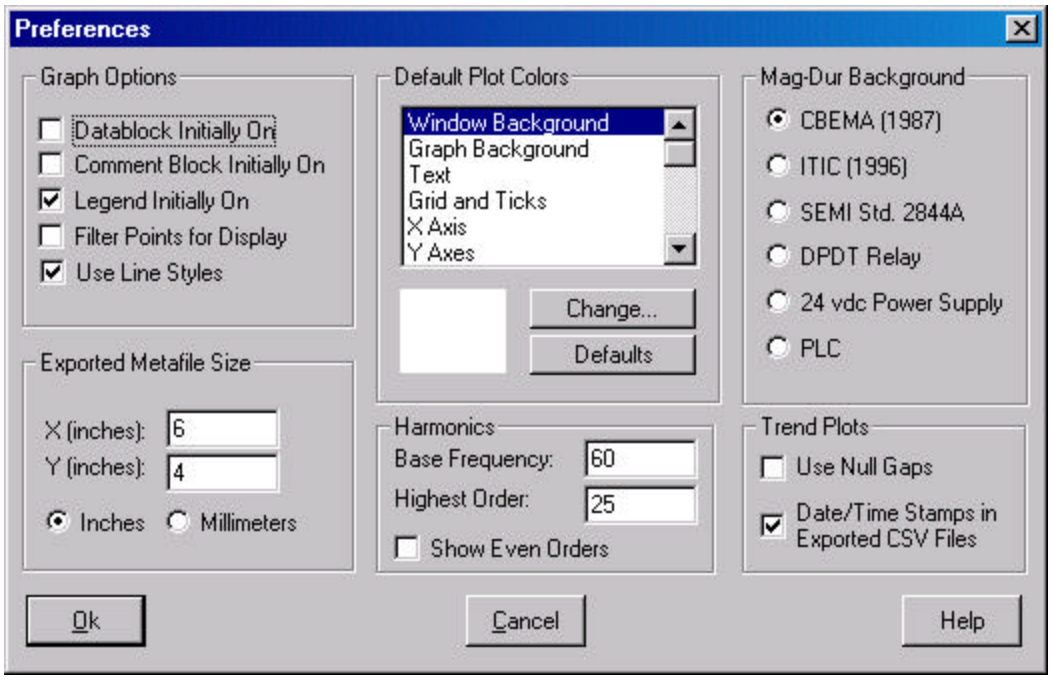


Figure i- 10: TOP Preferences Dialog

The check boxes for **Data Block**, **Legend**, and **Comment Block** control whether certain annotations from the Text Dialog appear on all new graphs. Turn these check boxes off to suppress these extra labels on new graphs.

Use the check box for **Use Line Styles** to let TOP automatically choose a different line style for each curve on a graph that has multiple curves.

Filter Points for Display - when this option is active, and there are more than 3000 points in a curve, the software constructs a reduced data set for plotting so that window repainting will occur much faster. The software will plot the min and max value within each x-axis pixel width, so visually there should be no difference in the graph with this option. However, you may wish to turn this option off if you plan to zoom into a small area of the graph. Also, the filtering logic assumes that X axis values increase monotonically, so you may need to turn this option off when working with large data sets that violate this assumption.

Exported WMF size - when exporting Windows Metafile (WMF) from a graph, the exported size is fixed as specified in this dialog, regardless of the graph window size on your screen. This feature allows for precise and consistent control of graphic sizes exported for use in other software.

Colors – select a graphical element from the list box, and then click the color button to open a standard Windows color selection dialog. Changes to the color scheme will appear in all new graphs.

Fundamental Frequency – specify the default value used in various harmonic analysis operations and tables.

Null Gaps in Trend Plots - if the spacing between successive TRND points increases by a factor of 2 or more, insert a gap in the plot rather than connect the two samples with a straight line. This can help identify missing data or instrument down times.

Date/Time Stamps in Exported Trend CSV Files - write the date and time in ASCII format for each exported TRND sample. The previous behavior was to write the number of seconds from the TRND starting time.

Mag-Dur Backgrounds - for magnitude-duration plots of RMS variations, choose a background curve for comparison. The two most commonly used are the traditional CBEMA and the newer ITIC for general electronic equipment. The last three choices (DPDT relay, 24-volt power supply, and PLC) are from IEEE Std. 1346-1998.

Click **OK** to complete the operations, **Cancel** to abort.

Global scale and grid preferences are accessed by the **Edit, Global Scale...** and **Edit, Global Grid...**menu commands respectively. Figure i- 11 and Figure i- 12 illustrate the resulting dialog boxes.

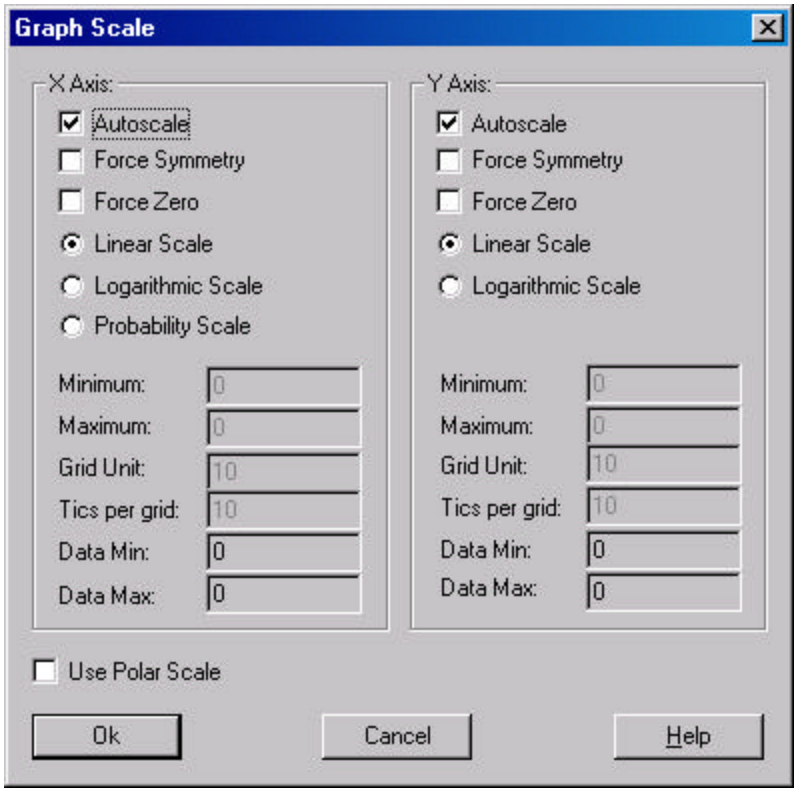


Figure i- 11: TOP Global Scale Preferences Dialog

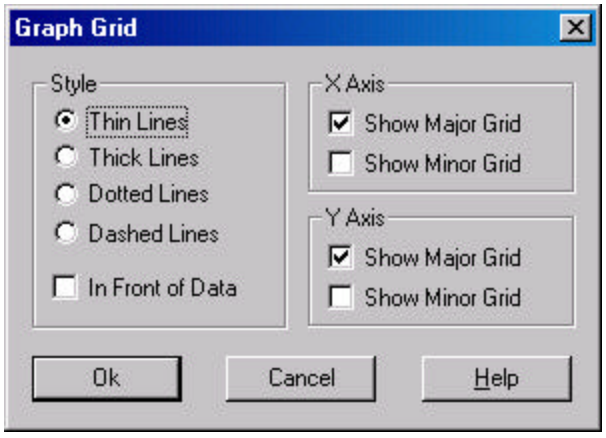


Figure i- 12:TOP Global Grid Preferences Dialog

Getting Help

The TOP help file may be accessed by selecting the **Help**, **Help Topics** menu option. Technical support may be obtained by calling Electrotek at (800) 554-4767 or (865) 470-9222. Application support is provided by PQSoft.

World Wide Web

The TOP website may be accessed at

http://www.pqsoft.com/top

The site contains version and download information for the current version of the program. In addition, a forum for bug reporting and usage questions is provided via Electrotek's PQ Network®.

You can obtain additional information about Electrotek and its products and services from the World Wide Web at

http://www.electrotek.com/.

Training

Electrotek offers comprehensive in-house and offsite training for SuperHarm and the Electromagnetic Transients Program (EMTP), which both utilize TOP for visualization of simulation results. This training provides an informal atmosphere, allowing attendees to progress at their own speed. The training sessions consist of two, three, or five days of case study analysis and practical applications. These sessions are based on existing course material but may be customized to meet the customer's requirements.

CHAPTER 1

Using TOP

This chapter describes the main features available in TOP and how to use them in the Windows environment. Commonly utilized features such as creating graphical and tabular outputs, printing, and using TOP with other applications are discussed.

TOP's utilities are introduced at the end of this chapter. This consists of; building an EMTP SOS file, starting a calculator, viewing a text file, and using TOP macros for SuperHarm.

In This Chapter

- Creating Graphs and Tables
- Printing
- Using the Help System
- Using TOP with other Applications
- Using TOP Utilities

[page intentionally left bank]

Creating Graphs and Tables

Opening a Data File

The ***File, Open...*** menu option is used to open a data file. The **Open** dialog box, shown in Figure 1-1, is displayed, prompting the user to select a file type and name. Select the desired file type in the **Files of Type** drop-down list box. Select the data file you want to open, and click **Open**. Note that you may shorten the operation by simply double-clicking on the desired file.

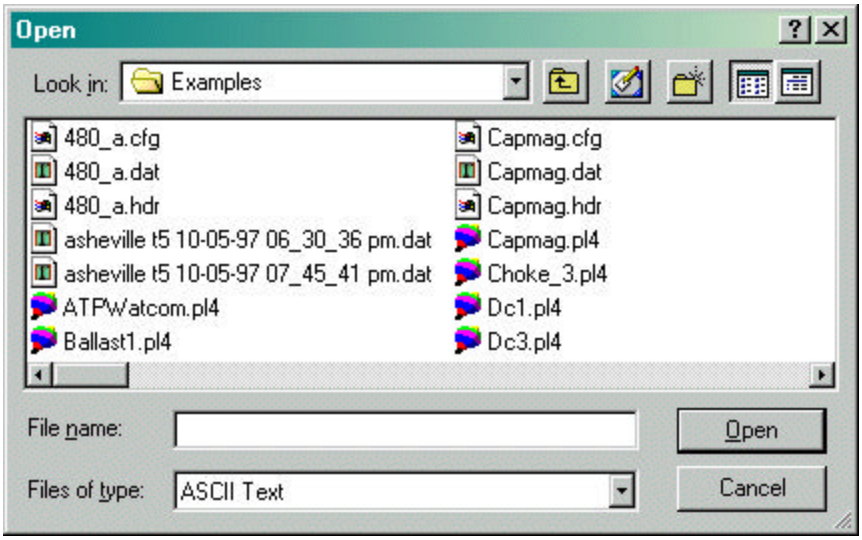


Figure 1-1: TOP's Open (File) Dialog Box

Once a file has been opened, it becomes the current data file - the target of most of the operations described in the following pages. The name of the current data file is displayed in the title bar at the top of the TOP main window.

Loading Data onto the Stack

After a data file is opened, TOP automatically displays the "stack load" dialog box (also activated using the ***Stack, Load...*** menu command). A select quantities to be processed dialog box (example shown in Figure 1-2) is displayed, prompting the user to select objects to be loaded. It should be noted that different types of data formats have different dialog boxes for loading data initially on the stack. Figure 1-2 illustrates the dialog box for initially loading IEEE COMTRADE CFG files.

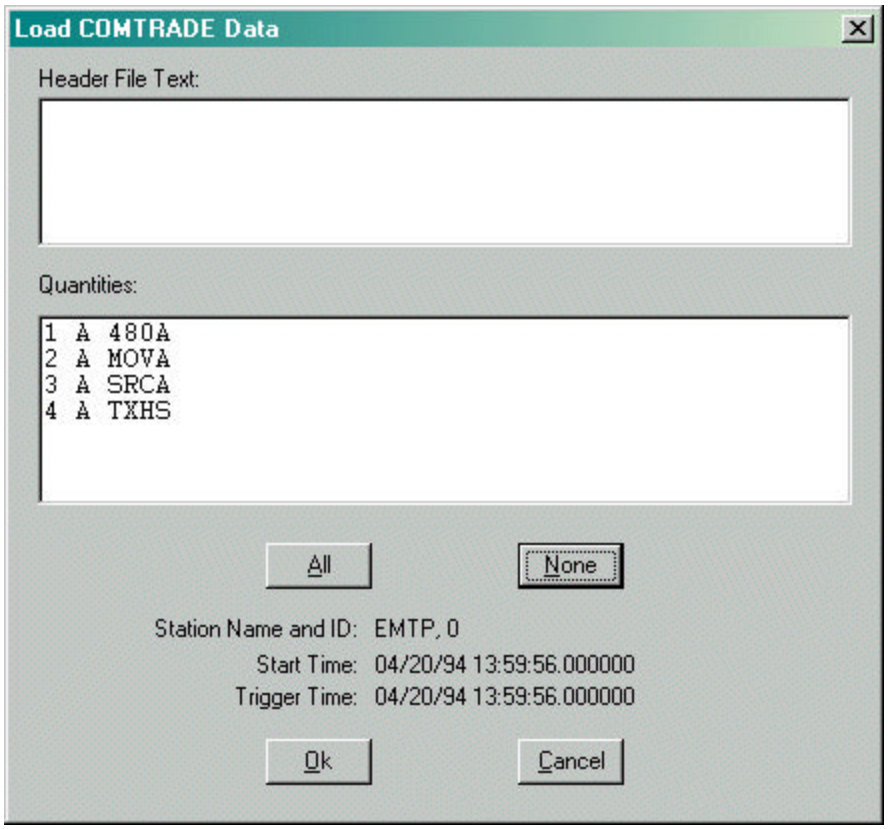


Figure 1-2: TOP's Dialog Box for IEEE COMTRADE

The equivalent ***Stack, Load...*** button on the ribbon can also be used to access data objects after they have been opened. This feature is useful if additional items need to be added to the stack.

Discarding Data from the Stack

Once quantities have been loaded on the stack, one can discard/delete them at any point. This can be accomplished by going to the ***Stack*** menu option and selecting ***Discard...*** or by simply pressing the equivalent ***Stack, Discard...*** button on the ribbon. The **Select Quantities to be Discarded** dialog, shown in Figure 1-3, is then displayed, prompting the user to select objects to be deleted.

TIP: TOP will not allow you to load a quantity of the same name onto the stack. Therefore, it is necessary to rename the quantity or simply discard the previous object before loading the new one. Deleting an object will cause any window containing the object to be closed. This may not be your intention if the window contains other objects that are not being deleted, so be careful when using this command.

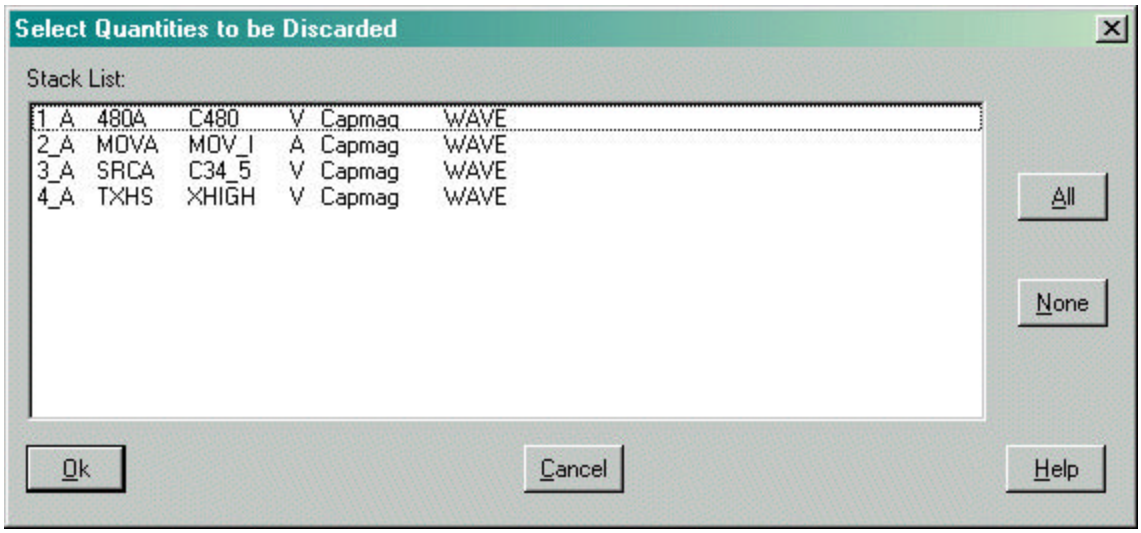


Figure 1-3: TOP's Dialog Box Selecting Quantities to be Discarded

Creating a Graph

Once the output file has been opened, and the desired quantities loaded on the stack, a graph can be displayed. The ***Graph, New Graph...*** menu option is used to display the available stack items. Figure 1-4 shows the resulting **Plot Quantity Select** dialog box. Select one or more stack objects from the list box and click **Ok** to continue, **Cancel** to abort.

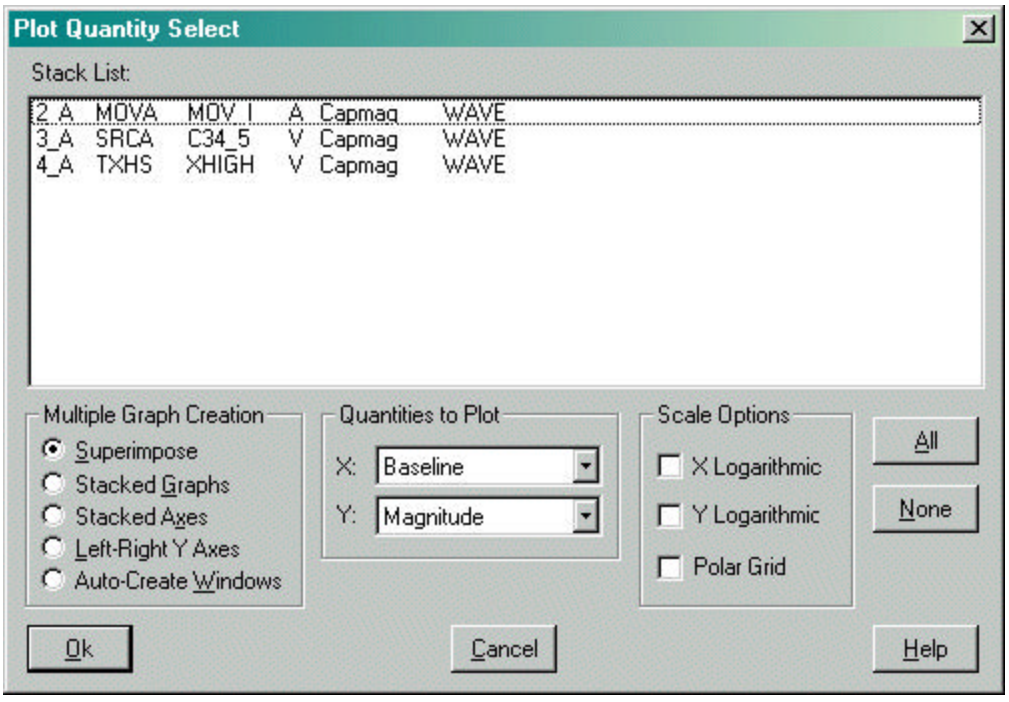


Figure 1-4: TOP's Plot Quantity Select Dialog Box

If you selected more than one object for plotting, you may also select one of the following display options (radio buttons):

- **Superimpose** (default) to place all selected objects in a single window (illustrated in Figure 1-5).
- **Stacked Graphs** to place each object in a separate frame in a single window (1 object wide by n objects high).
- **Stacked Axes** to place all selected objects in a single window with stacked axes on the left side.
- **Left-Right Y Axes** to place all selected objects in a single window with left and right Y axes.
- **Auto-Create Windows** to place each object in a separate window

Windows created with **New Graph** by default use a Cartesian grid with linear scaling. The axes will be scaled such that the all data points are displayed. Additional graphing options will be discussed in Chapter 3, "Working with Graphs."

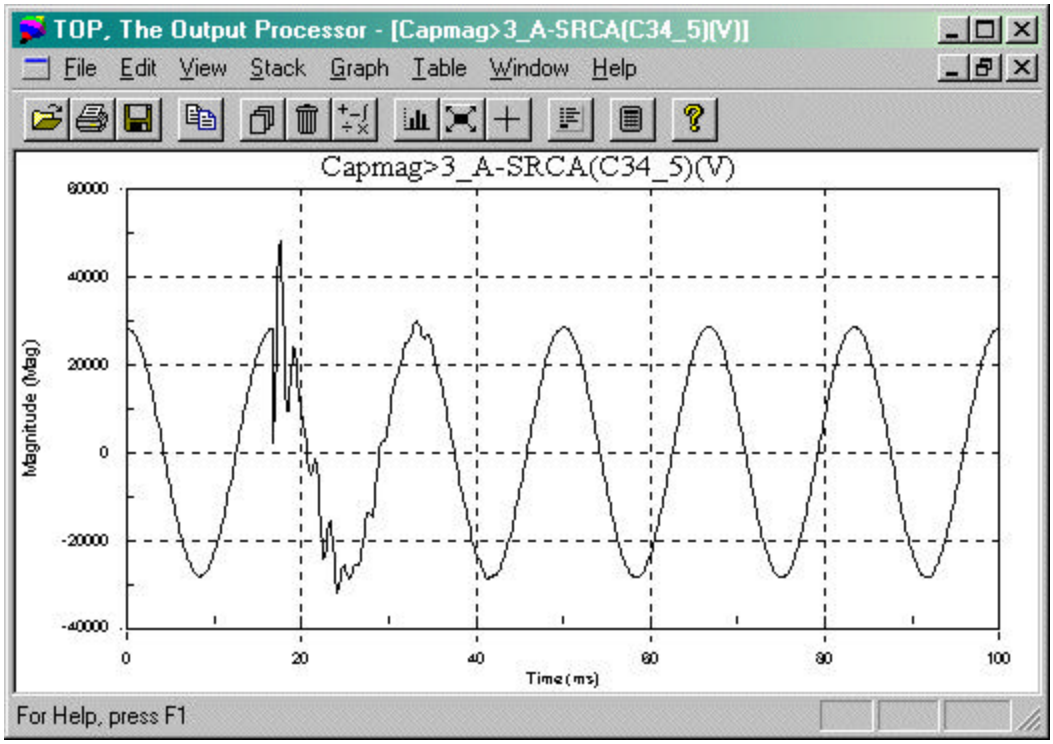


Figure 1-5: TOP's Plot Display Window

Creating a Table

Stack data may also be displayed using tables. The ***Table, Select...*** menu option is used to display the available stack items. Figure 1-6 illustrates the resulting **Table Quantity Select** dialog box. Select the **Table Type** from the drop-down list, one or more stack objects from the list box and click **Ok** to continue, **Cancel** to abort.

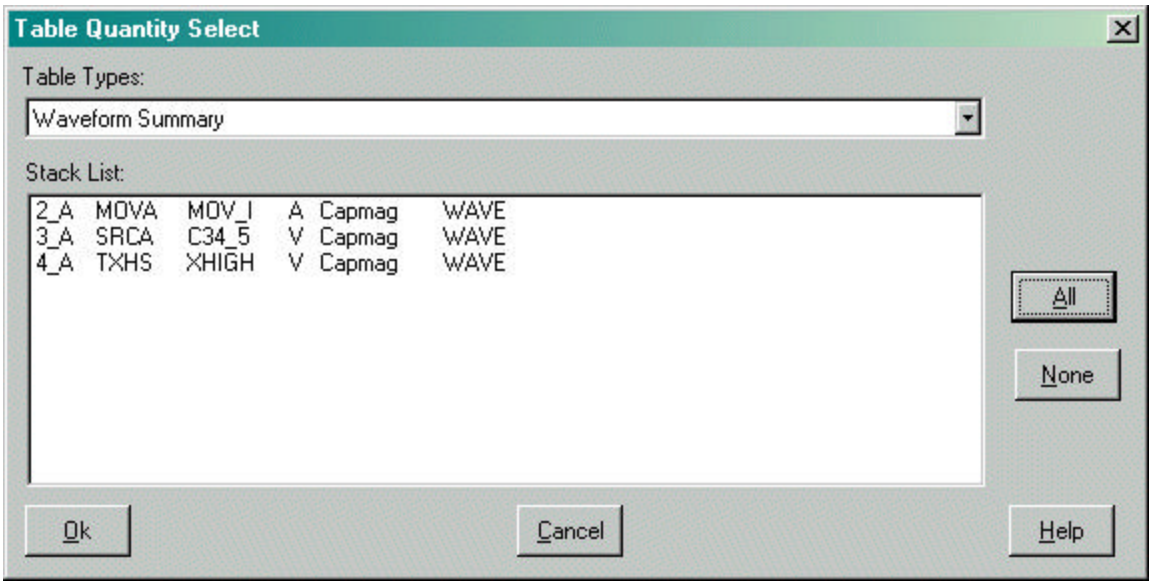
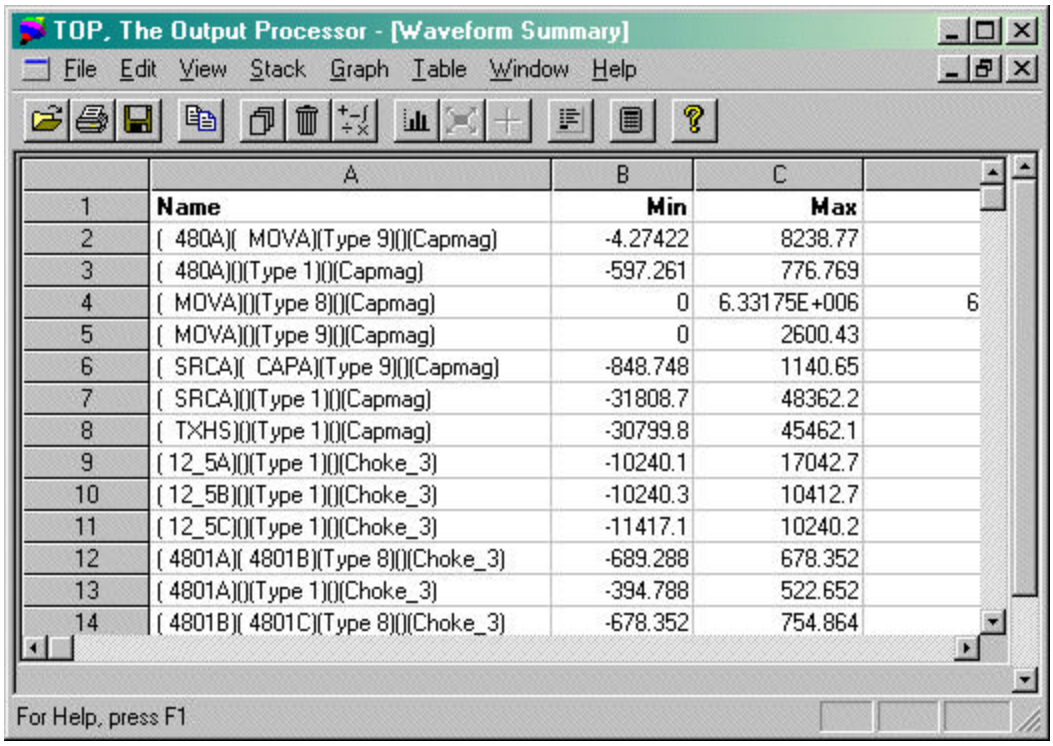


Figure 1-6: TOP's Table Quantity Select Dialog Box

TIP: TOP will only list the stack objects that are compatible with each table type.

TOP then opens a display window that includes the specified table (shown in Figure 1-7). TOP includes several different types of tables to examine quantities of interest. The tables provided in TOP are discussed in detail in Chapter 4, "Working with Tables."



	A	B	C	
1	**Name**	**Min**	**Max**	
2	(480A)(MOVA)(Type 9)()(Capmag)	-4.27422	8238.77	
3	(480A)()(Type 1)()(Capmag)	-597.261	776.769	
4	(MOVA)()(Type 8)()(Capmag)	0	6.33175E+006	6
5	(MOVA)()(Type 9)()(Capmag)	0	2600.43	
6	(SRCA)(CAPA)(Type 9)()(Capmag)	-848.748	1140.65	
7	(SRCA)()(Type 1)()(Capmag)	-31808.7	48362.2	
8	(TXHS)()(Type 1)()(Capmag)	-30799.8	45462.1	
9	(12_5A)()(Type 1)()(Choke_3)	-10240.1	17042.7	
10	(12_5B)()(Type 1)()(Choke_3)	-10240.3	10412.7	
11	(12_5C)()(Type 1)()(Choke_3)	-11417.1	10240.2	
12	(4801A)(4801B)(Type 8)()(Choke_3)	-689.288	678.352	
13	(4801A)()(Type 1)()(Choke_3)	-394.788	522.652	
14	(4801B)(4801C)(Type 8)()(Choke_3)	-678.352	754.864	

Figure 1-7: TOP's Table Display Window

Printing

This section explains the procedures for producing a hardcopy of TOP's graphs and tables. Most of the commands discussed in this chapter affect the active display window.

Printer Setup

This option allows you to select the target printer, and to change printer settings such as paper size and orientation. The ***File, Printer Setup...*** menu option is used to display the print setup dialog box shown in Figure 1-8. Click **OK** to continue, **Cancel** to abort.

Printer options that may be changed include specifying the desired printer (use the drop-down list box to select), page orientation (use the portrait and landscape radio buttons to select), paper size (use the drop-down list box to select), and paper source (use the drop-down list box to select). The choices available depend on the printer selected.

Additional printer configuration features may be accessed through the **Properties** button. Options are controlled by the Windows driver corresponding to the printer that you select. Refer to your *Windows Users Manual* and system documentation for additional information.

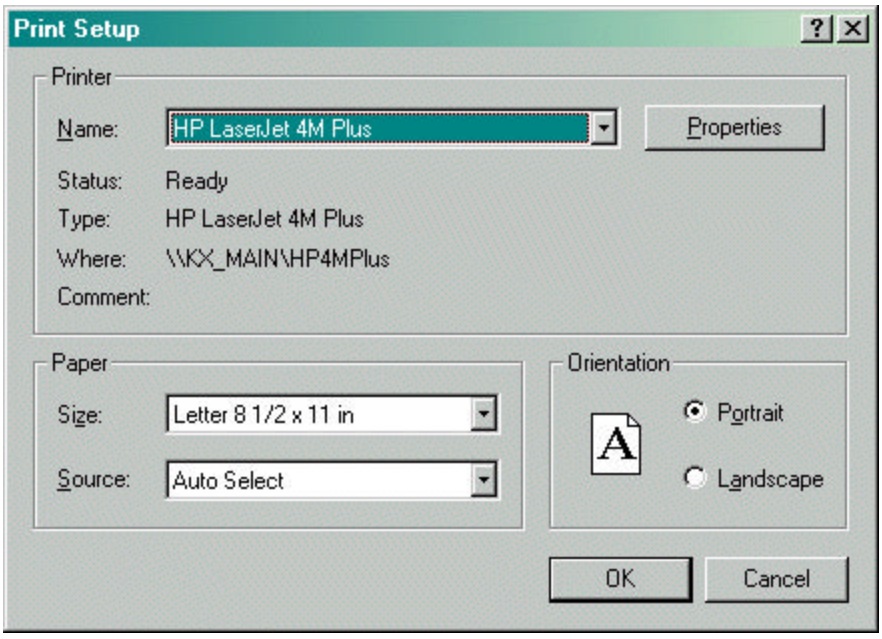


Figure 1-8: Windows Print Setup Dialog

Printing TOP Displays

If the target window is a graph, the image shown in the window when it is maximized is printed on a single page. Tabular windows may require multiple pages. To print the *active window*, Select the ***File, Print...*** menu option. Click **OK** to print, **Cancel** to abort.

A preview of the page(s) to be printed may be viewed by selecting the ***File, Print Preview...*** menu option.

Using the Help System

The Help system in TOP can be prompted from the menu or the ribbon.

To activate the system from the menu, the ***Help, Help Topics...*** menu option should be selected. To accomplish this from the ribbon bar, the Help button may be selected.

Specialized help for the third-party graphing tool that was used in the development of TOP may be accessed by right clicking a plot and selecting Help from the menu items.

Using TOP with other Applications

Copying to the Window's Clipboard

This section explains the procedures for copying TOP's graphs and tables to another application, and for pasting data from another application into TOP. TOP's export commands provide tremendous flexibility in customizing the program's output. You can use these commands to

- Include TOP plots or tables directly into a report by exporting to a word processing program.
- Annotate a graph by exporting it to a graphical design, drawing, or spreadsheet program.
- Create special types of graphs by exporting a table to a spreadsheet, and then using the spreadsheet's charting commands.

TOP provides two types of export:

- *To the clipboard*. This is the standard way to transfer data between two Windows applications. After placing the data on the clipboard in TOP, you can switch to the target application and retrieve the data using its Paste command.
- *To a file*. This method is used to transfer data to a Windows or a non-Windows application. You can export to one of several standard file formats.

To copy the active window to the clipboard, select the ***Edit, Copy...*** menu option (or press **Ctrl+Insert** or **Ctrl+C**). Note that the ***Edit, Copy...*** command causes data currently on the clipboard to be overwritten (erased) by the contents of the active TOP window.

Pasting Data from the Clipboard

This option allows you to create objects directly from data on the clipboard, bypassing the ***File, Open...*** and ***Stack, Load...*** procedures described earlier. The application that places the data on the clipboard must use the appropriate format.

Note that the only paste option available for this version is the PQNode CSV data type. Select the ***Edit, Paste PQNODE to Stack and Plot...*** menu option to paste the clipboard data to the stack and immediately produce a plot.

Exporting to a Disk File

The active TOP display window can be saved to disk in one of the following formats:

Tables:

- ASCII Text (.TXT)
- Comma Separated Values (.CSV)

Graphs:

- Windows Metafile (.WMF)
- ASCII Tabbed Text (.TXT)
- Comma Separated Values (.CSV)
- IEEE COMTRADE (.CFG)
- Power Quality Data Interchange Format (.PQD)
- Configuration Files for the Text-to-PQDIF Utility (.CFG)

To export the active window, select the ***File, Export...*** menu option. The **Export Graph** (shown in Figure 1-9) or **Export Table** dialog will be displayed depending on the active window type. Select the desired format using the **Save File as Type** list box. Enter the desired file name (long file names are allowed) and Click **Save** to export the data, **Cancel** to abort.

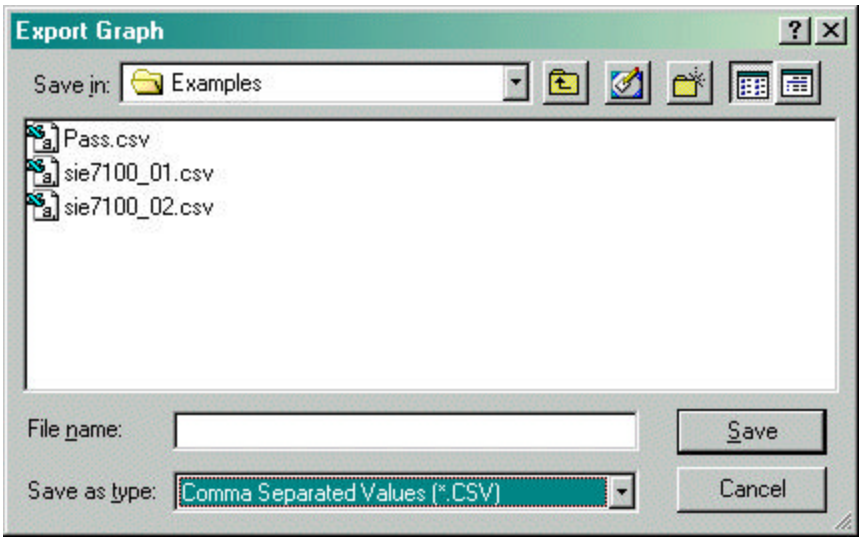


Figure 1-9: TOP's Export Graph Dialog

Exporting Trend Time Stamps

When exported TRND objects to a text format, see the Preferences Dialog to choose Date and Time stamp export for the first column.

PQDIF Export Limitations

If you load a PQDIF file and then export some of the plotted stack objects, there will most likely be some information lost in the export. This happens because the TOP stack object structure is not as complete or flexible as the PQDIF structure. In future versions, TOP may become more completely based on PQDIF as a native file format.

Even so, an exported PQDIF file can be loaded later to recreate the same graphs in TOP, **except for the SCAN objects**. Because the appropriate PQDIF tags have not been defined yet, an

exported SCAN object will be loaded as a SPEC object and plotted with bars. To work around this, you can right-click on the graph window and change the plotting method from bars to lines in the graph customization dialog.

When you export a PQDIF file, the base quantity will be exported. When reading it back in, the base quantity will only be activated if you choose one of the normalization radio buttons in the PQDIF loading dialog. The base quantity is exported as a series nominal quantity, so that separate series and observation base quantities in the PQDIF file will be lost. Trigger channels and times are preserved in the exported file.

The exported HIST and HIST3D objects do not fully comply with the PQDIF standard, because they are missing some series for bin upper boundaries. The exported series are sufficient for TOP to read them back in.

If the stack object was originally loaded from a PQDIF file, the actual phase designations are exported. If the stack object came from another source (EMTP, for example), then TOP will attempt to guess the phase from the stack object name. This only works if the phase naming convention is ABC.

When downloading a PQDIF file from PQWeb, you may wish to save the file to disk first rather than directly open it from the browser, especially if you might want to process it later using another PQDIF viewing program. This will preserve the full information downloaded in the PQDIF file.

Text-to-PQDIF Configuration Export

This feature is provided as an aid for using the Text-to-PQDIF utility in conjunction with text data export. Create a graph with all the stack objects you will be exporting. Export the Text-to-PQDIF configuration file from that graph. Then open that file in the Text-to-PQDIF utility to inspect and correct the results. Phase designations may be wrong if TOP had to guess them from the stack object names. You may also need to add a first column for the time points.

Once the configuration file has been created, you can export the graph in a text data format for use with the Text-to-PQDIF utility to create a PQDIF file. See Appendix B for a description of the Text-to-PQDIF utility. You can often use the same configuration with data exported from similar graphs, as long as the plotting order is the same. This should be the case unless the number or the names of the quantities plotted have changed.

Using TOP Utilities

Building an EMTP SOS File

This utility allows the combination of multiple statistics output files generated by the EMTP to create a "Statistics Output Salvage" (SOS) file. To use this utility, select the ***File, Build SOS File...*** menu option. The **OPEN** dialog box (Figure 1-10) will appear and ask for the EMTP `st9lg*` data file with the required extension of `DAT`.

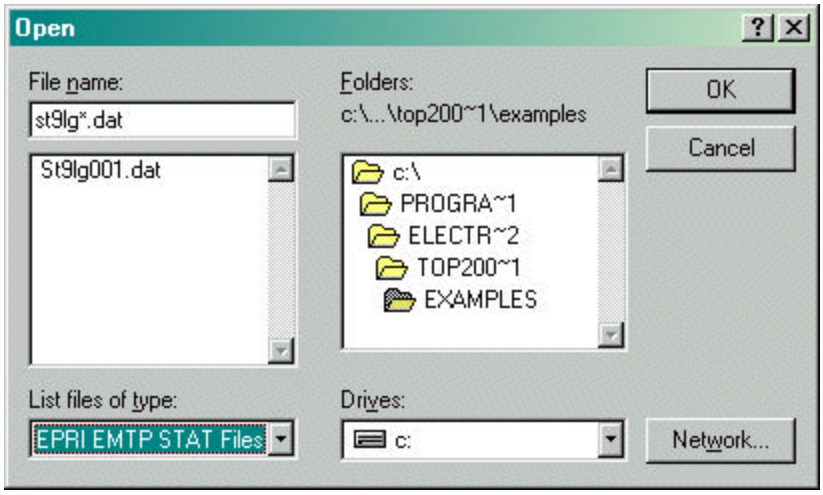


Figure 1-10: TOP's Open (Build SOS File) Dialog

After selecting the appropriate `DAT` file, the **SAVE AS** dialog box, shown in Figure 1-11, will appear requesting the name of the output `SOS` file. The extension for this file must be `SOS`. Click **Save** to save the file, **Cancel** to abort

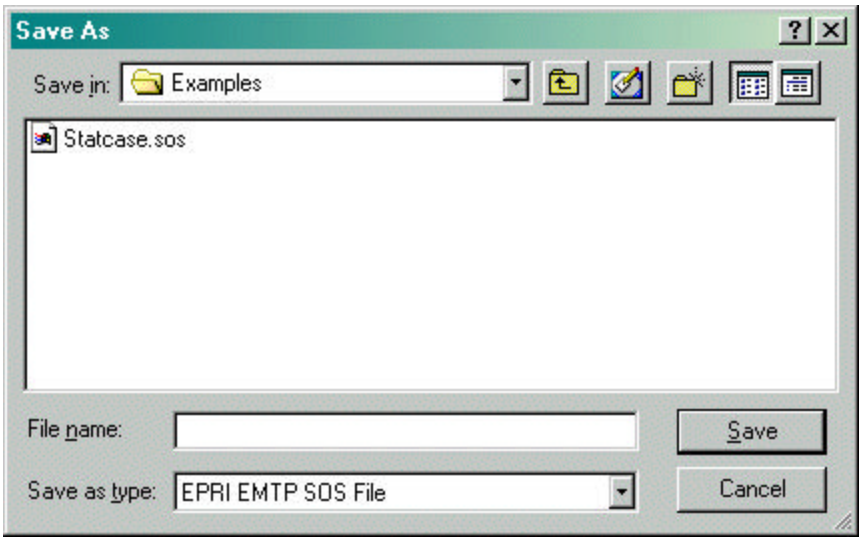


Figure 1-11: TOP's Save As (Build SOS File) Dialog

Starting the Windows Calculator

Another utility option available in TOP is to start the built-in Windows calculator from the program. The calculator may be started by select the ***File, Calculator...*** menu option.

Viewing a Text File

The ***File, Open...*** menu option is used to open a text file. The **Open** dialog box, shown in Figure 1-12, is displayed, prompting the user to select a file type and name. Select the **ASCII Text** file type in the **Files of Type** drop-down list box. Select the text file you want to open, and click **Open**. Note that you may shorten the operation by simply double-clicking on the desired file.

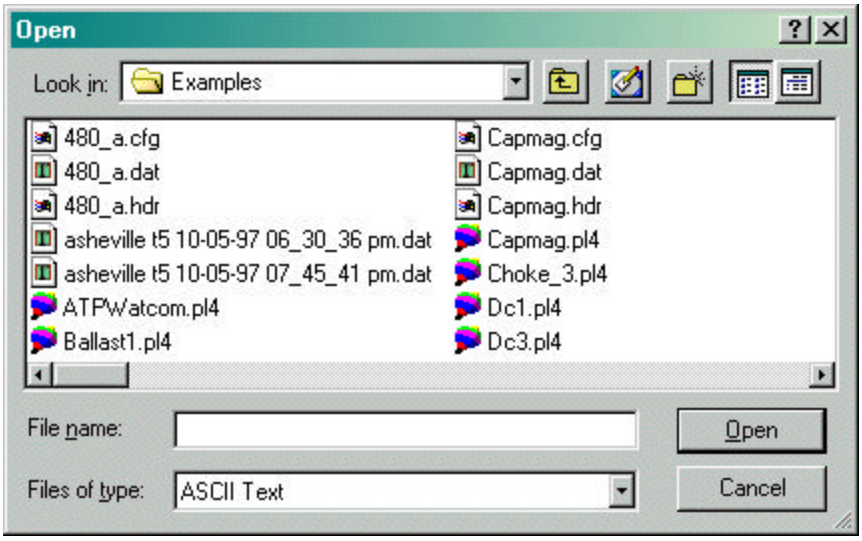


Figure 1-12: TOP's Open Dialog

Executing SuperHarm Macro Files

TOP macros for processing SuperHarm output files allow users to open files, load items onto the stack, and produce graphical plots without having to repeatedly step through this process manually.

The ***File, Open...*** menu option is used to open a SuperHarm macro file. The **Open** dialog box, previously shown in Figure 1-12, is displayed, prompting the user to select a file type and name. Select the **TOP Macro for SuperHarm** file type in the **Files of Type** drop-down list box. Select the macro file you want to open, and click **Open**. Note that you may shorten the operation by simply double-clicking on the desired file.

TIP: It's usually best to clear the stack before running a macro, because existing stack objects may conflict with your load and plot commands.

TOP Macro Commands for SuperHarm

The macro language includes four commands:

```
open filename
load parameters
loadfiles filespec parameters
quickgraph ALL idmode
```

The **open filename** command opens the specified file and makes it the current file for subsequent load commands. The **load** command is followed by parameters that tell the program what to load onto the stack. The following syntax is used to load SuperHarm files:

For a voltage quantity:

```
load 0 busname [optionalgroupname]
```

For a current quantity:

```
load 1 devicename.terminalname [optionalgroupname]
```

The **loadfiles** command is the most often used. It issues the same load command for all files that match the **filespec**.

For example:

```
loadfiles *.sho 0 bus5
```

would open each file in the current directory with the `.SHO` extension and load the `bus5` voltage onto the stack.

The **quickgraph all** command allows you to quickly graph all of the objects on the stack. The **idmode** parameter specifies the graph mode where:

idMode:

```
0 = superimpose
1 = stack graphs
2 = stack axes
3 = left-right y axes
4 = auto-create windows
```

For example, executing the following commands (saved in the file `testall.tm`) produces the graph shown in Figure 1-13:

```
loadfiles ex1scan*.sho 0 44kvbus
quickgraph all 0
```

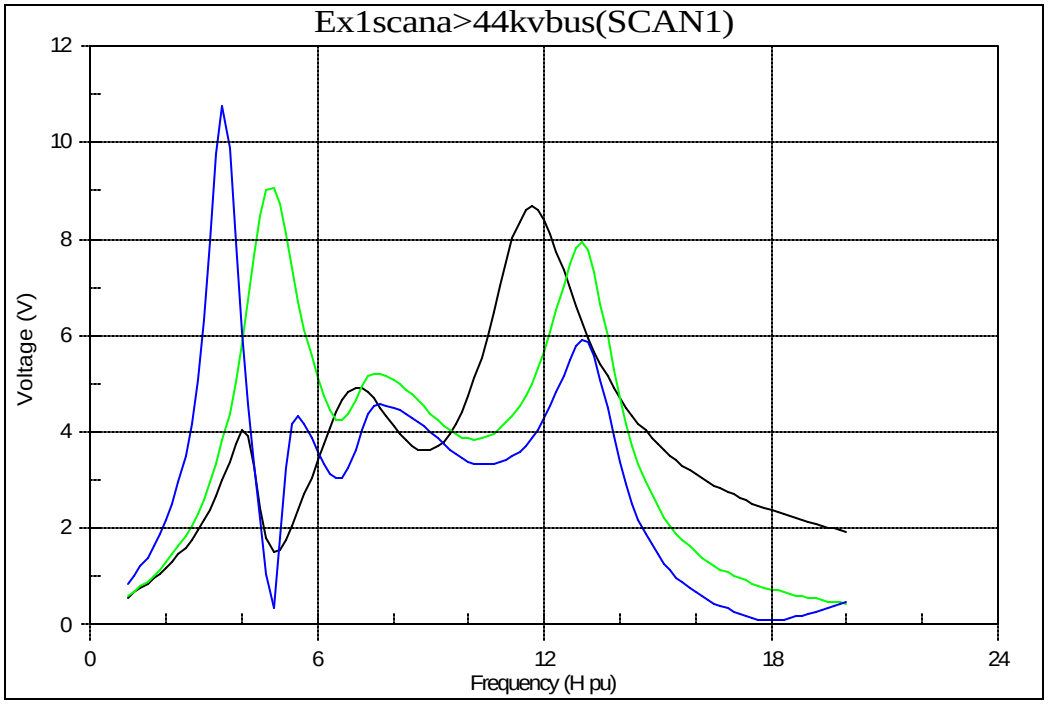


Figure 1-13: Plot Resulting from TOP/SuperHarm Macro Execution

CHAPTER 2

Stack Management

This chapter describes the process for opening simulation and measurement output files, and how to retrieve quantities of interest from them by appropriate stack management. It also provides an introduction into the usage of the tools available. The TOPCalc mathematical post-processing utility is also discussed.

In This Chapter

- What is the Stack?
- Stack Object Identifiers
- Modifying Stack Objects
- Using TOPCalc
- Using Expressions

[page intentionally left bank]

What is the Stack?

One feature of TOP that sets it apart from other programs is its ability to work with any number of *objects* (node voltages, branch currents, measurement data, etc.) at the same time. Moreover, it is an *interactive* program, which means that you do not need to know what type of output you want before you start the process of opening files and manipulating data.

The program uses a method of data management called the *stack* to simplify handling of data from various sources. The stack holds the data selected by the user from each source file. This process is analogous to selecting a file folder from a file cabinet, selecting specific papers in the file that are of interest, and piling them in a stack on your desk.

In order to provide this flexibility, yet keep the program easy to use, TOP employs a holding queue for stack objects. In Figure 2-1, output files from monitoring equipment and simulation programs are shown as input to the stack. TOP allows stack objects, from each of the formats supported, to exist simultaneously.

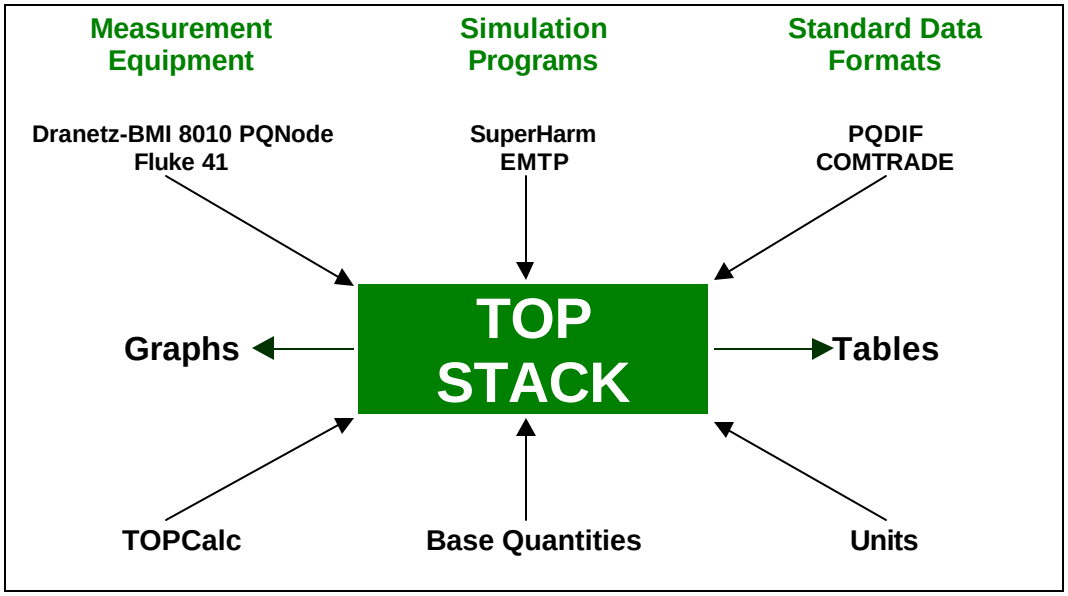


Figure 2-1: TOP's Stack Concept

Stack Object Identifiers

Names given to stack objects consist of six fields, each field enclosed in parenthesis. These fields are

field 1	field 2	field 3	field 4	field 5	field 6
Name1	Name2	Qualifier1	Qualifier2	Origin	Type

Thus, the information contained in the first four fields depends on where the object came from. The fifth and sixth fields, on the other hand, are the same for all objects. Origin is the name of the output file from which the object was loaded, or "DERIVED" if the object was created with TOPCalc, or "CLIP" if the object was copied from the Windows clipboard. The Type field contains one of the following keywords:

Raw Objects (loaded directly from output files)

- SCAN Frequency scan from HARMFLO, SuperHarm or V-HARM (EMTP scans use the WAVE keyword)
- SPEC Harmonic spectrum from SuperHarm and V-HARM
- STAT EMTP SOS file (statistical) data
- TRND RMS steady-state trend data and RMS disturbances from measuring devices
- WAVE Waveform data (waveform, spectrum, or frequency scan)
- XY X vs. Y data loaded from PQDIF
- HIST Histogram loaded from PQDIF
- PROB Cumulative probability distribution loaded from PQDIF
- HIST3D 3D histogram of RMS variations loaded from PQDIF
- MAGDUR magnitude-duration scatter plot of RMS variations loaded from PQDIF

Derived Objects (produced by TOPCalc)

- HIST Histogram
- PROB Cumulative probability curve
- SCAN Frequency scan
- SPEC Harmonic spectrum
- TRND Sliding FFT, RMS trend or disturbance
- WAVE Waveform

  May be a spectrum or frequency scan if the object was derived from an EMTP spectrum or frequency scan.

Expression Objects

These may include WAVE, SCAN, SPEC, XY, PROB, and HIST objects.

Modifying Stack Objects

Base Quantities Option

The **Stack Base Quantities** command is used to per-unitize objects on the stack. This command may seem redundant, given that TOPCalc allows you to multiply an object by a constant, but the effect is not quite the same. TOPCalc creates a *new* object, leaving the original object unchanged. On the other hand, when you per-unitize (or undo a base value setting) with this command, all windows containing the object are changed.

To set base quantities, select the ***Stack, Base Quantities...*** menu option. The **Set Per-Unit Base Quantities** (shown in Figure 2-2) dialog is displayed.

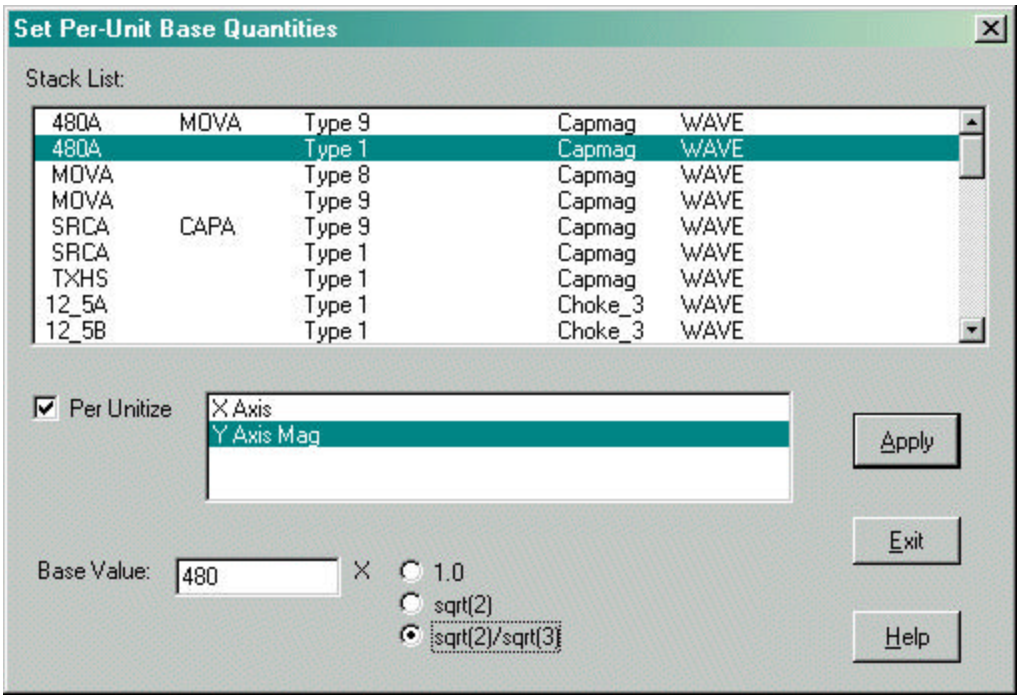


Figure 2-2: TOP's Set Per-Unit Base Quantities Dialog

Complete the following steps to complete the base quantities process:

– Select one or more **Objects** from the Stack List to per-unitize on a common base.

- Select the scale to per unitize from the list box: **X Axis** or **Y Axis**.
- Enter a **Base Value**. If desired, you can adjust this value by selecting the **sqrt(2)** or **sqrt(2)/sqrt(3)** radio buttons. For example, the objects selected in Figure 2-2 are line-to-neutral voltages on a 480 V rms system. To per unitize these voltages on peak line-to-neutral voltage, the base value should be

$$V_{base} = \sqrt{2} * \frac{480}{\sqrt{3}} = 39192$$

- You can enter this value, or you can enter 480 and select the **sqrt(2)/sqrt(3)** radio button.
- Set the **Per Unitize** check box to per unitize the selected objects, or clear the check box to undo the per-unitization.
- Select **Apply** to update the selected objects.
- Repeat these steps as often as desired. Select **Exit** when the process is complete.

Units Option

TOP automatically assigns units to the X and Y variables of an object when it is created. However, TOP must assume units if the object comes from an output file that doesn't identify them. Use this option to enter the correct units if the assumed units are wrong. This option also provides a way to specify a more aesthetically pleasing unit - replacing volts with kilovolts, for example.

To set base quantities, select the ***Stack, Units...*** menu option. The **X vs. Y Type Data Units** (shown in Figure 2-3) dialog is displayed. Complete the following steps to complete the units update process:

- Select one or more **Objects** from the list box.
- Select the unit to change - X Axis, Y Axis Magnitude, or Y Axis Angle.
- TOP highlights the current **Unit Name** for the selected unit in the list box. Select a different name, if desired.
- If desired, select a **Prefix** to apply to the unit. For example, if the unit is Volts, selecting the kilo radio button replace V labels with kV. TOP scales voltage magnitudes appropriately.
- Select **Apply** to update the selected objects.

– Repeat these steps as often as desired. Select **Exit** when the process is complete.

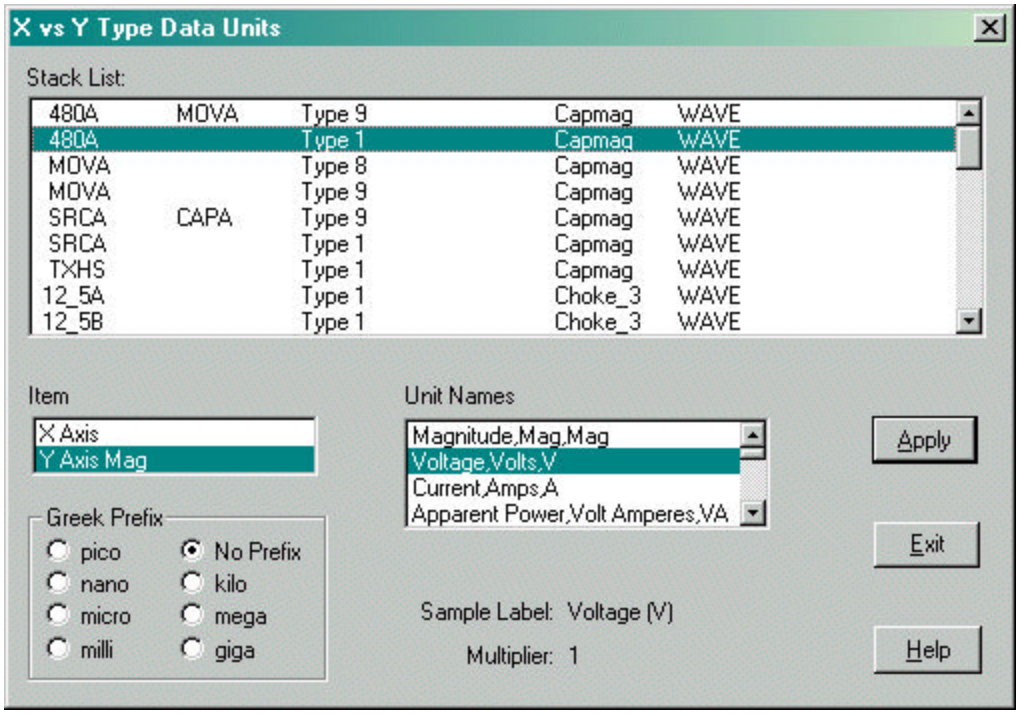


Figure 2-3: TOP's X vs. Y Type Data Units Dialog

Using TOPCalc

This facility provides a means for creating new stack objects by specifying mathematical operations to be performed on existing objects. Objects derived through TOPCalc are treated no differently than raw objects loaded from output files. They can, for example, be used as arguments in subsequent TOPCalc operations. TOPCalc requires single or dual arguments, depending on the operation selected. Argument #1 is always a stack object. Argument #2, if required, is usually a stack object, but may be a constant.

If Argument #2 is a stack object, it must be the same type as Argument #1 - you can't, for example, add a WAVE and a SPEC. Unless stated otherwise, the new object is of the same type as the argument(s) that were used to create it. Table 2-1 indicates the operations available in TOP as well as the compatible argument types. Most operations can accept arguments of type SCAN, SPEC, TRND, STAT or WAVE; exceptions are noted in the table. The table also relates whether the operation requires single or dual arguments. Dual arguments would mean Argument#1 as a stack object and Argument #2 as a constant or another stack object.

Table 2-1: TOPCalc Operations

TOPCalc Operation	Args	Acceptable Raw Objects								
		WAVE	SPEC	TRND	SCAN	STAT	XY	PROB	HIST	MAGDUR
Add	**2**	4	4	4	4		4			4
Subtract	**2**	4	4	4	4		4			
Multiply	**2**	4	4	4	4		4	4	4	
Divide	**2**	4	4	4	4		4	4	4	
Negate	**1**	4	4	4	4		4	4	4	
Invert	**1**	4	4	4	4		4	4	4	
FFT	**1**	4								
DFT	**1**	4								
IDFT	**1**		4							
Power	**2**	4								
Energy	**2**	4								
I^2T	**1**	4								
X-Y Combine	**2**	4					4	4	4	
Square	**1**	4	4	4	4		4			
Square Root	**1**	4	4	4	4		4			
Abs Value	**1**	4	4	4	4		4			
V,I dB Ratio	**2**	4	4	4	4		4			
Pwr dB Ratio	**2**	4	4	4	4		4			
Integrate	**2**	4					4			
Cum Prob	**1**					4	4			
Prob Dist	**1**					4	4			
Filter	**1**	4								
Sampling	**1**	4	4		4		4			
Time Shift	**1**	4								

The Procedure

To access TOPCalc, select the ***Stack, TOPCalc...*** menu option. The **TOPCalc** (illustrated in Figure 2-4) dialog is displayed.

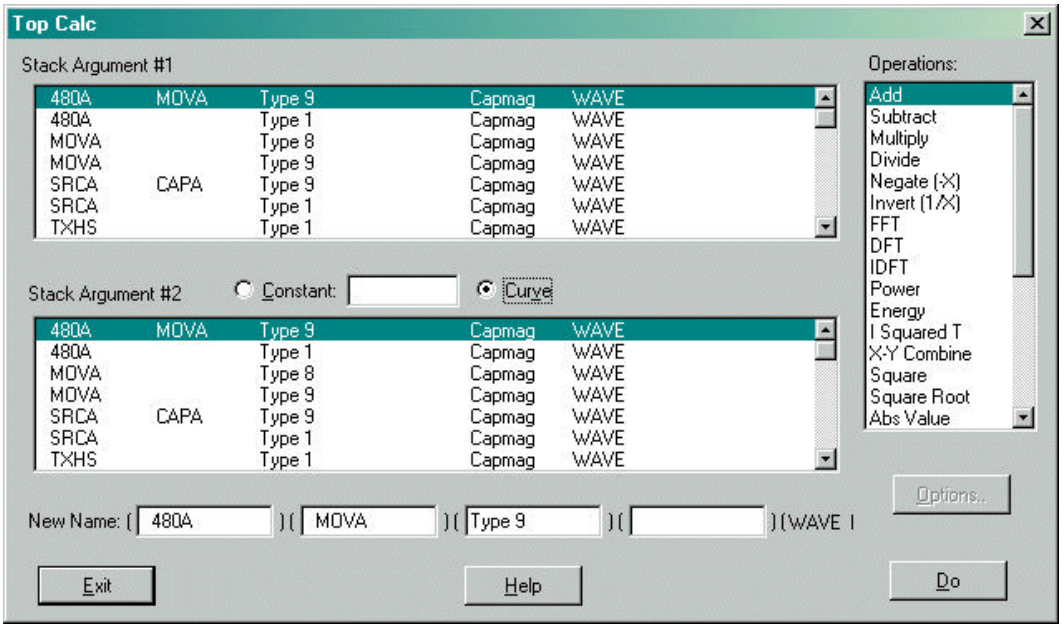


Figure 2-4: TOP's TOPCalc Dialog

Complete the following steps to complete the units update process:

- Select **Stack Argument #1** from the list box.
- Select the **Operation** from the list box.
- If appropriate select the **Options** button to set parameters for this operation. Values that you enter will remain in effect until you exit TOPCalc. It should be noted that only seven TOPCalc functions allows the ability to set parameters; FFT, DFT, IDFT, Prob Dist, Filter, Sampling and Time Shift.
- If argument #2 is a constant, select the **Constant** radio button, and type the value in the text box adjacent to the radio button.
- If argument #2 is a stack object, select the **Curve** radio button. This causes TOP to fill the **Stack Argument #2** list box. Select the desired object from the list.
- Enter the **Name** fields for the new object in the text boxes at the bottom of the dialog box.
- Select the **Do** button to create the new object.
- Repeat these steps as often as desired to derive more objects. Select the **Exit** button when done.

Single Argument Operations

The following operations all require single arguments. These are compatible with arguments of all type excluding STAT.

– Invert (1/x) Negate (-x) Abs Value (|x|)

The functions below are compatible with only arguments of the type WAVE.

– Square (X^2) Square Root ($\sqrt{X}$) I Squared T (I^2t)

These are functions of time, and therefore, can be applied only to WAVE objects.

Filter

This function allows the addition of a filter in series with the argument. The compatible argument for this function is of the type WAVE. Figure 2-5 shows the dialog box prompted by the **Options** button for this operation.

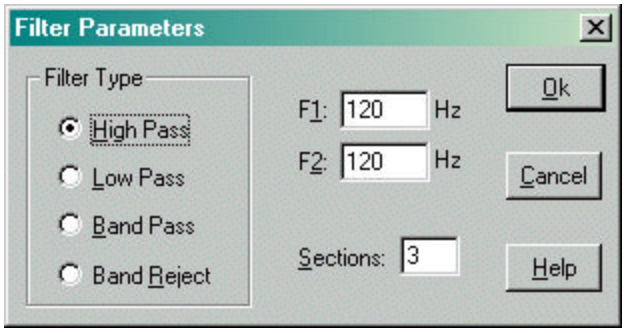


Figure 2-5: TOP's Filter Parameters Dialog

Filter Type allows the selection of the filter desired. **F1:** and **F2:** indicate the beginning and ending 3 dB frequencies. The **Sections:** input box allows the user to enter the number of filter sections desired in series (N sections translates to 2N poles). The default for this is 3. The digital filter functions used produce Butterworth-type filters, i.e., filters with smooth, ripple-free power gain characteristics. The filters implemented in TOP are taken from *Digital Signal Analysis* by Samuel D. Stearnd, Chapter 12 and Appendix C (Hayden Book Company, 1975, ISBN 0-8104-5828-4). Each filter is actually executed twice — once in normal forward time order, and then a second time in reverse time order. This results in an overall transfer function with zero phase shift. Please refer to Chapter 9 of the above referenced book for details on the Linear Phase Shift Theorem.

Time Shift

This function simply allows the shifting of a parameter based on time. The only compatible argument type for this operation is WAVE. The dialog box shown in Figure 2-6 is prompted by selecting the time shift

operation and the **Options** button. Enter the time the waveform should be shifted by and press **Ok** to continue, **Cancel** to abort.

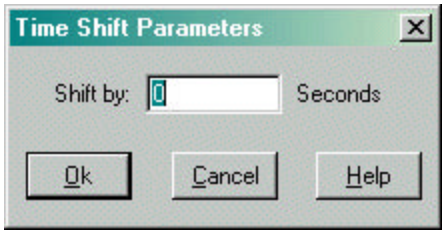


Figure 2-6: TOP's Time Shift Parameters Dialog

Sampling

This function permits a uniform sampling of a function, with optional truncation. The compatible argument types for this operation are WAVE, SPEC, SCAN, and XY. The dialog box shown in Figure 2-7 is prompted by selecting the sampling operation and the **Options** button.

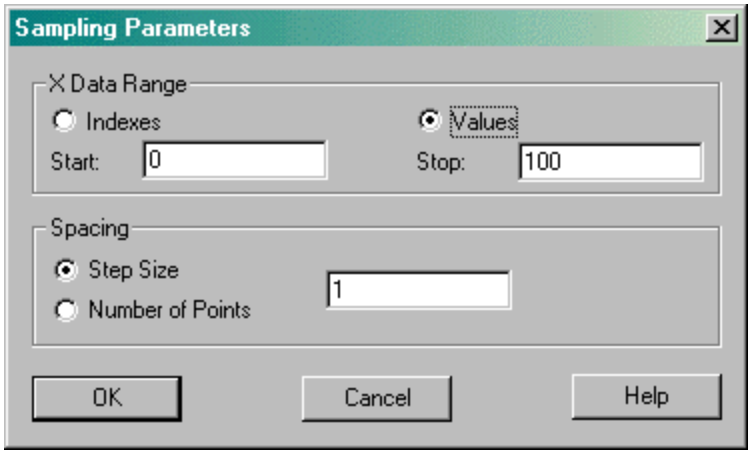


Figure 2-7: TOP's Sampling Parameters Dialog

The sampling operation allows you to extract a uniformly spaced subset of the stack object, using linear interpolation as needed. The sample can chop from the beginning or end of the stack object data. The sample can also extend beyond either end of the sample data with zero padding.

Four sampling methods are provided:

1. **By Point Index and Total Number of Points** - select the radio buttons for Indexes and Number of Points. Enter the starting and stopping point indices for the X Data Range, and the number of points for the Spacing. Note that for 1000 uniform sample steps, the number of points should be 1001.
2. **By X Value and Total Number of Points** - select the radio buttons for Values and Number of Points. Enter the starting and

stopping X values for the X Data Range, and the number of points for the Spacing.

3. **By Point Index and Step Size** - select the radio buttons for Indexes and Step Size. Enter the starting and stopping point indices for the X Data Range, and the step size for the Spacing.
4. **By X Value and Step Size** - select the radio buttons for Values and Step Size. Enter the starting and stopping X values for the X Data Range, and the step size for the Spacing.

Fourier Transforms

The FFT (Fast Fourier Transform) and DFT (Discrete Fourier Transform) operations require a single argument, which must be a WAVE. The new object is of type SPEC. The IDFT operation (inverse discrete Fourier transform) requires a single argument, which must be a SPEC. The new object is of type WAVE. FFT, DFT and IDFT have variable parameters.

FFT

The dialog box shown in Figure 2-8 is prompted by selecting the FFT operation and the **Options** button.

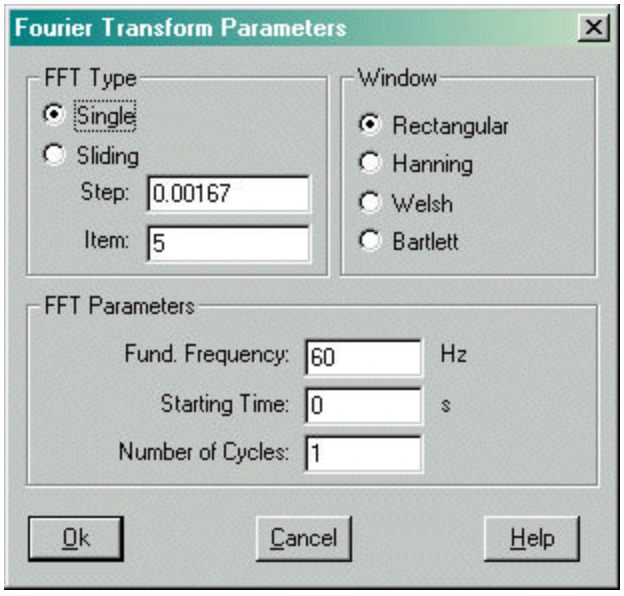


Figure 2-8: TOP's Fourier Transform Parameters Dialog

Single FFT Type

The single FFT produces a SPEC object, calculated from **Starting Time**, **Fundamental Frequency**, and **Number of Cycles**.

As shown in Figure 2.7, TOP assumes that the FFT is to be taken over one 60 Hz cycle starting at 0.0 seconds. You will need to override these values if the fundamental frequency is not 60 Hz, or if the waveform is not in steady-state at time zero.

If you can't specify the fundamental frequency precisely (e.g., measurements of an adjustable-speed drive), then the FFT window will not capture an integer number of fundamental frequency cycles, and the end of the window will contain a truncated cycle. Increasing the size of the window reduces error due to this "end effect." The number of cycles required to yield acceptable accuracy can be reduced by multiplying the waveform by a weighting function before taking the FFT. The weighting function is bell shaped, thus the multiplication reduces end effect. You can select one of four weighting functions with the **Window** radio buttons:

- Rectangular
- Hanning
- Welsh
- Bartlett

The default radio button — **Rectangular** — corresponds to a multiplication by unity; in other words, no weighting is used. The art of applying weighting functions is well beyond the scope of this manual, and we refer you to a text on digital signal processing for further information on this subject.

Sliding FFT Type

The **Sliding** radio button is used to produce a TRND object of a single harmonic vs. time. To use this option, specify the **Fundamental Frequency** and the **Harmonic** number to trend (an integer, entered in the **Item** field). The trend is produced by computing an FFT every **Step** seconds over **Number of Cycles** from **Starting Time**. For example, if the fundamental frequency is 60 Hz and the time step is 0.0016667 seconds, 10 FFT computations are required per cycle. Thus, TOP may take several minutes to produce a sliding FFT object. Smoother trend plots can be obtained by applying a weighting function, as discussed above.

TIP: You can also trend the RMS value, Peak value, Crest Factor, or Form Factor using the sliding FFT. This is done by specifying one of the following keywords in the harmonic number windows instead of an integer - rms, peak, ff, or cf..

DFT

The discrete Fourier transform, like the FFT, is used to generate a spectrum from a waveform. The dialog box shown in Figure 2-9 is prompted by selecting the DFT operation and the **Options** button.

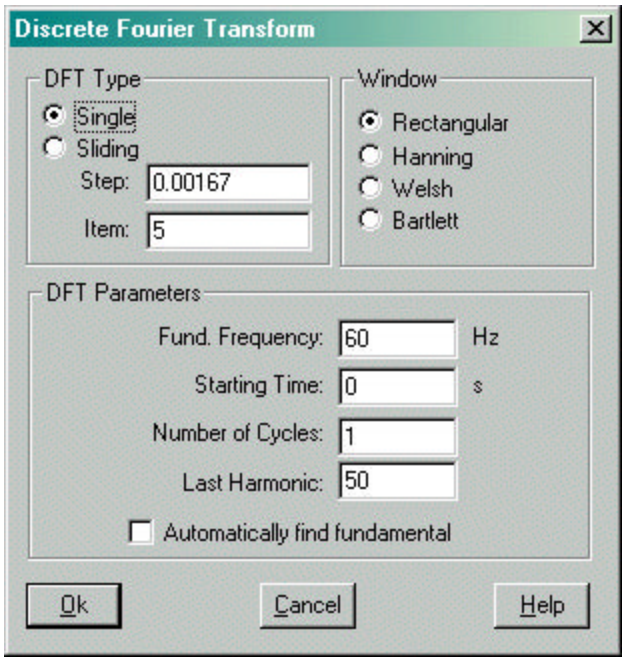


Figure 2-9: TOP's Discrete Fourier Transform Dialog

Similar to the FFT function, you can select one of four weighting functions with the **Window** radio buttons:

- Rectangular
- Hanning
- Welsh
- Bartlett

The other options available in this parameters dialog box are similar to those discussed in the previous section for FFT. The primary difference between the FFT and the DFT is that the DFT is slower yet you can operate on any number of points by specifying the frequencies you want as outputs.

IDFT

The inverse discrete Fourier transform is used to generate a waveform from a spectrum object. To do this, TOP needs to know if the phase angle spectrum is based on a sine reference or a cosine reference.

The default selection, **Sine Series**, will correctly display HARMFLO, SuperHarm, and V-HARM data generated using analytic harmonic source models such as CONVERTER (SuperHarm, V-HARM). You will need to use **Cosine Series** if you used arbitrary harmonic sources such as ISOURCE (SuperHarm) or HARMC (V-HARM), and the phase angles that you entered were based on a cosine series. At times, it may be necessary to attempt both series options and then view the derived solution for verification.

The second option tells TOP the number of **Cycles** that should be calculated for derived waveforms. The dialog box shown in Figure 2-10 is prompted by selecting the IDFT operation and the **Options** button.

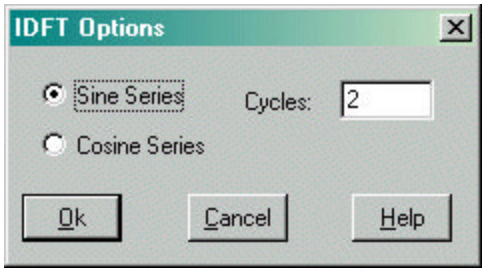


Figure 2-10: TOP's IDFT Options Dialog

Statistical Functions

There are two Statistical Functions available, Cum Prob and Prob Dist operations. These functions can be applied only to STAT objects. It should be noted that before applying any of these statistical operations the object needs to be per-unitized to an appropriate base quantity.

Cum Prob

This function takes a statistics case (e.g. SOS) stack item and creates a cumulative probability curve and puts in on the stack. Cum Prob (cumulative probability) produces an object of type PROB.

Prob Dist

This function takes a statistics case (e.g. SOS) stack item as its argument and creates a probability distribution histogram curve and puts in on the stack. Prob Dist (probability distribution) produces an object of type HIST. The dialog box shown in Figure 2-11 is prompted by selecting the Prob Dist operation and the **Options** button.

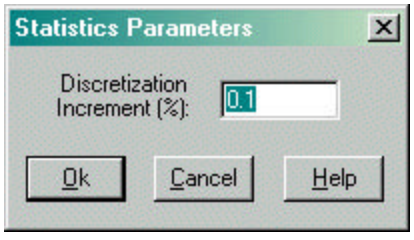


Figure 2-11: TOP's Statistics Parameters Dialog

Mixed Argument Operations

Add, Subtract, Multiply, & Divide

Add, Subtract, Multiply, and Divide all take two arguments. The second argument may be a constant as well as a stack object. These operations can be used on all object types, excluding STAT.

Integrate

Integration can be applied to WAVE objects (integration with respect to time).

Power and Energy

Both of these operations require one voltage argument and one current argument. Power will calculate the instantaneous power and energy will calculate the integral of the product of voltage and current. These functions are compatible with arguments of the type WAVE.

dB Ratios

Two operations are provided one for voltages and currents, the other for powers. These operations are defined as follows:

$$\text{V,I dB Ratio:} \quad 20 * \log\left(\frac{\text{Arg\#2}}{\text{Arg\#1}}\right)$$

$$\text{Pwr dB Ratio:} \quad 10 * \log\left(\frac{\text{Arg\#2}}{\text{Arg\#1}}\right)$$

These are only compatible with arguments of the type WAVE and SPEC. The new object is the same as the initial object type.

X-Y Combine

This operation plots the Y values of the first argument against the Y values of the second argument. (Argument #2 values become the X values for the new object.) The argument can only be of the type WAVE.

Using Expressions

The dialog box in Figure 2-12 appears when you select the ***Stack, Expression…*** menu command. This dialog box allows you to create a stack object by entering an expression.

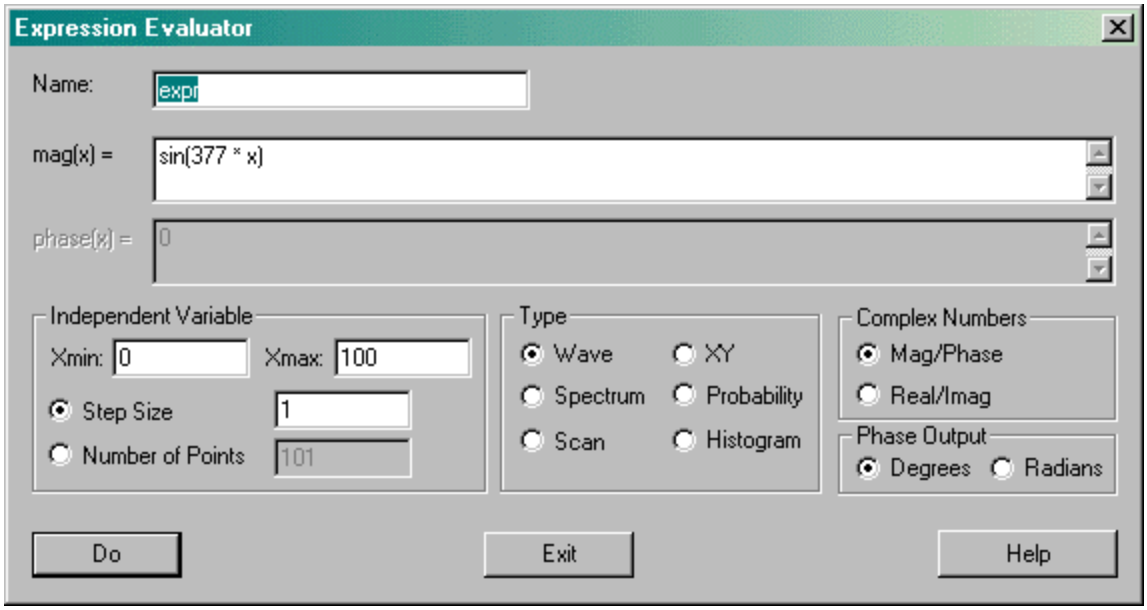


Figure 2-12: TOP's Expression Dialog

Name

Enter a 20-character name for the new stack object. The new object will have the qualifier EXPRESSION (note objects produced by the calculator have the qualifier DERIVED). The name entered is checked for uniqueness within other EXPRESSION stack objects.

Mag(x)/Real(x)

Enter the expression for magnitude or real part, using x as the independent variable. Use Ctrl-Enter to add a new line in this edit box. The Complex Number radio buttons toggle between magnitude and real part expressions.

Phase(x)/Imag(x)

Enter the expression for the phase or imaginary part, using x as the independent variable. Use Ctrl-Enter to add a new line in this edit box. The Complex Number radio buttons toggle between phase and imaginary part expressions. The Phase Output radio buttons toggle between units of degrees and radians - but note that arguments to trig functions are always in radians. This edit box is only enabled when creating XY, SPEC, and SCAN stack objects.

Independent Variable

Enter the start and stop values for the independent variable, X. Use the radio buttons and edit boxes to enter either a uniform step size, or a total number of points for the new stack object.

Type

Choose a radio button for the type of stack object you wish to create:

- WAVE - real, X will be in seconds, Y will be in volts.
- SPEC - complex, X will be in Hz, Y magnitude will be in volts, Y phase units controlled by the Phase Output radio buttons.
- SCAN - complex, X will be in Hz, Y magnitude will be in volts, Y phase units controlled by the Phase Output radio buttons.
- XY - complex, X and Y magnitude units are "magnitude", Y phase units controlled by the Phase Output radio buttons.
- PROB - real, X units are "magnitude", Y units are percent.
- HIST - real, X units are "magnitude", Y units are percent.

Complex

Choose to enter magnitude and phase, or real and imaginary parts, for complex numbers.

Phase Output

Choose the Y phase units. This does not affect the input arguments to trig functions, which are always in radians.

Expression Notation

The syntax for expressions is similar to that of Visual Basic. This component also supports alternative notations, as shown in the list of built-in operators, as well as the following enhancements.

Implicit Multiplication

When multiplication is implied, the times symbol (*) can often be omitted, as in Table 2-2.

Table 2-2: Expression Notation Examples

Expression	Equivalent
X y	x*y
3pi + 10	3*pi + 10
5(4+8)	5*(4+8)
(5+5)(3+9)	(5+5)*(3+9)
(3+2)8	(3+2)*8

Implicit multiplication has the same priority as regular multiplication. For instance '1/2q' is translated as '1/2*q' not '1/(2q)'. This is subject to change in future versions. To avoid such ambiguity, the multiplication symbol (*) should be used explicitly as much as possible.

Numeric Bases

This component supports notations for binary, octal, and hexadecimal numbers. These numbers must be preceded by the character # followed by b, o, or h for binary, octal, or hexadecimal. Numbers may include a floating point.

Expression Operators

Table 2-3 lists the functions and operators available in TOP's expression evaluator.

Table 2-3: Expression Evaluator Functions and Operators

Symbol	Equivalent	Description	Example
( )		Prioritizes an expression	5*(1+1) = 10
!	FACT	Factorial	5! = 120fact(5) = 120
%		Percentage	35% = 0.35
^	**	Raised to the power of	4 ^ 5 = 1024
*		Multiply by	3 * 6 = 18
/		Divide by	9 / 2 = 4.5
\	DIV	Integer divide by	9 \ 2 = 4
MOD		Modulo (remainder)	7 mod 4 = 3
+		Add	1 + 1 = 2
-		Subtract	9 - 5 = 4
>		Greater than	9 > 2 = 1 * see note
<		Less than	7 < 4 = 0
==	=	Equal test	5 == 4 = 0
>=	=>	Greater or equal	3 >= 3 = 1
<=	=<	Less or equal	#h3E <= 9 = 0
<>		Not equal	#b10101 <> 20 = 1
NOT		Bitwise NOT	NOT(15) = -16
AND	&	Bitwise AND	#b101 AND #h1E=4
OR	|	Bitwise OR	13 OR 6 = 15
XOR		Bitwise Exclusive OR	9 XOR 3 = 10
EQV		Bitwise Equivalence	6 EQV 9 = -16
IMP		Bitwise Implication	1 IMP 5 = -1
IIF		If condition	IIf(1+1=2,4,5) = 4
MIN		Minimum value	min(10,3,27,15) = 3
MAX		Maximum value	max(1,9)=9 *see note
SIN		Sine	sin(pi) = 0 *see note
COS		Cosine	cos(pi) = -1
TAN		Tangent	tan(pi) = 0
ASIN		Arc sine	asin(1) = 1.570
ACOS		Arc cosine	acos(-1) = 3.141

ATAN	ATN	Arc tangent	atan(0) = 0
SEC		Secant	sec(0) = 1
CSC		Cosecant	csc(1) = 1.18
COT		Cotangent	cot(1) = 0.642
SINH		Hyperbolic sine	sinh(3) = 10.01
COSH		Hyperbolic cosine	cosh(2) = 3.76
TANH		Hyperbolic tangent	tanh(1) = 0.76
COTH		Hyperbolic cotangent	coth(1) = 1.31
SECH		Hyperbolic secant	sech(0) = 1
CSCH		Hyperbolic cosecant	csch(1) = 0.85
ASINH		Hyperbolic arc sine	asinh(2) = 1.44
ACOSH		Hyperbolic arc cosine	acosh(9) = 2.89
ATANH		Hyperbolic arc tangent	atanh(.1) = 0.10
ACOTH		Hyperbolic arc cotangent	acoth(7) = 0.14
ASECH		Hyperbolic arc secant	asech(.3) = 1.87
ACSCH		Hyperbolic arc cosecant	acsch(2) = 0.48
ABS		Absolute value	abs(-8) = 8
EXP		e to the power of	exp(3) = 20.08
EXP2		2 to the power of	exp2(3) = 8
EXP10		10 to the power of	exp10(3) = 1000
LOG	LN	Natural log	log(16) = 2.77
LOG2		Log base 2	log2(8) = 3
LOG10		Log base 10	log10(100) = 2
CEIL		Round up	ceil(6.2) = 7
RND		Random number	rnd(1) = .969
INT		Truncate to an integer	int(6.8) = 6
SGN	SIGN	Sign of expression (-1, 0, or 1)	sgn(-9) = -1
SQR	SQRT	Square root	sqr(64) = 8
STEP		Unit step function, 1 when first arg exceeds second arg, 0 otherwise	step(-1,0) = 0 step(2.6,0)=1

Notes:

1. Relational operators (>, <, <=, >=, ==, <>) return a 1 or a 0 (for true or false).
2. "pi" is an available defined constant, and the trig mode is set to radians.
3. Functions and operators are not case sensitive.

4. The MIN and MAX functions accept up to 32 parameters.
5. The definition for the IIF function is as follows: IIF(condition, true, false). If the value of condition is true, then the value of true is returned, else the value of false is returned.
6. CONCATENATE is a function used internally. Although it can be used in expressions, it is preferable to use the + and & symbols instead, to concatenate strings, since they are easier.

Expression Precedence

Table 2-4 shows the expression evaluator precedence list from highest to lowest priority. When consecutive operators have the same priority, they are evaluated from left to right. This means that an expression such as "a-b-c" is evaluated as "(a-b)-c".

Table 2-4: Expression Precedence

Anything inside parenthesis is performed first	( )
Factorial, percentage	!, %
Exponentiation	^
Negation (unary)	-
Multiplication, division	*, /
Integer division	\
User defined operator	(default position)
Modulo (remainder)	MOD
Addition, subtraction	+, -
Relational operators	<, >, >=, <=, =, <>
AND operator	
OR, XOR (exclusive or)	
EQV (equivalence)	
IMP (implication)	

Capacitor Switching Transient Expression

This example uses the Expression feature to create an idealized capacitor switching transient. It might be useful to plot the result superimposed on a measured waveform, to help identify equivalent circuit parameters. The input expression for Figure 2-12 is:

```
sin(377 x) – step(x,4.2e-3) * 0.8 cos(3000 x)
* exp(-(x-4.2e-3)/7e-3)
```

The output voltage will actually be perunit. The **sin(377 x)** term creates the base 60-Hz voltage. At 4.2 ms, the step function turns on the switching transient with 0.8 per unit magnitude. The **cos(3000 x)** defines a transient at 477.46 Hz. The **exp** term causes the transient to decay with a time constant of 7 ms, measured from the transient starting time of 4.2 ms. The total time range is from 0 to 20 ms, with 1001 points in the new stack object. Note the step size of 20 µs is automatically filled in. Figure 2-13 shows the plotted result.

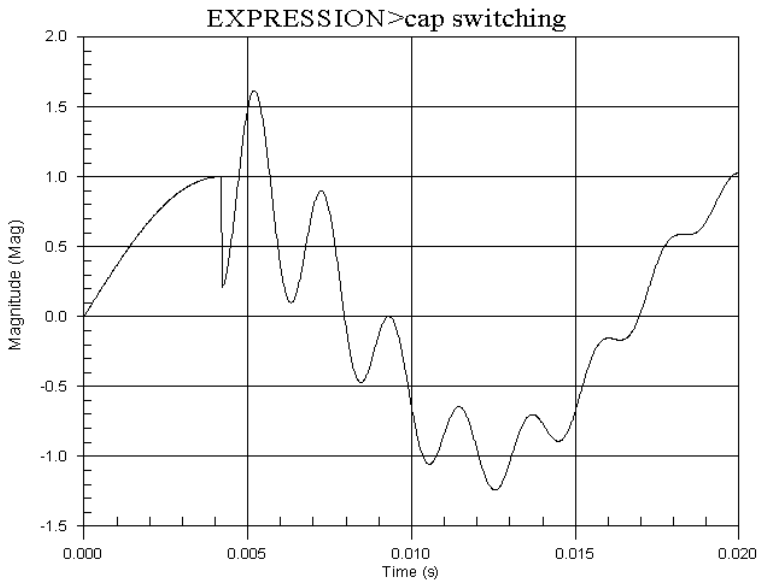


Figure 2-13: Plotted Expression for Capacitor Switching Transient

TRV Capability Expression

This example uses the Expression feature to plot the ANSI standard transient recovery voltage (TRV) capability for a 145-kV breaker at 40 kA fault current. In TRV studies, it is very helpful to plot this curve superimposed on the simulated TRV waveforms.

From ANSI standards, the TRV capability follows the maximum of a delayed 1-exponential and 1-cosine component, up to the peak of the 1-cosine component. The defining parameters for this breaker voltage and fault current rating are T2 = 310 µs, R = 1.8 kV/µs, and T1 = 2 µs. E1 = 1.225 * 145 = 177.6 kV. E2 = 1.76 * 145 = 255.2 kV.

The input expression for Figure 2-11 is:

```
max(127600 * (1-cos(10134.17 * x)),
step(x,2e-6)*177600 * (1-exp(-(x-2e-6)/98.67e-6)))
```

The **max** function selects the greater of the 1-cosine or the 1-exponential terms. The magnitude of the 1-cosine component is half of E2, or 127600 volts. The frequency of the 1-cosine component comes from T2, as f = 0.5 / 310 µs = 1612.9 Hz. The corresponding angular frequency is 10134.17 radians per second. The 1-cosine component will reach a peak of 255.2 kV at 310 µs.

The **step** function delays the 1-exponential component by 2 microseconds. The asymptotic peak of this component is E1 = 177600 volts. The exponential argument must be offset by 2 µs. The

maximum derivative of this component, occurring when the argument is zero at 2 μs, must be equal to R. This determines the time constant as τ = 177.6 kV / 1.8 kV/μs = 98.67 μs.

The plotted result is shown in Figure 2-14. The ANSI standard states that application engineers need not calculate short-line faults, because the breaker must withstand all short-line fault TRV conditions. In some circumstances, it may still be useful to add the sawtooth-shaped short-line withstand component to the plot.

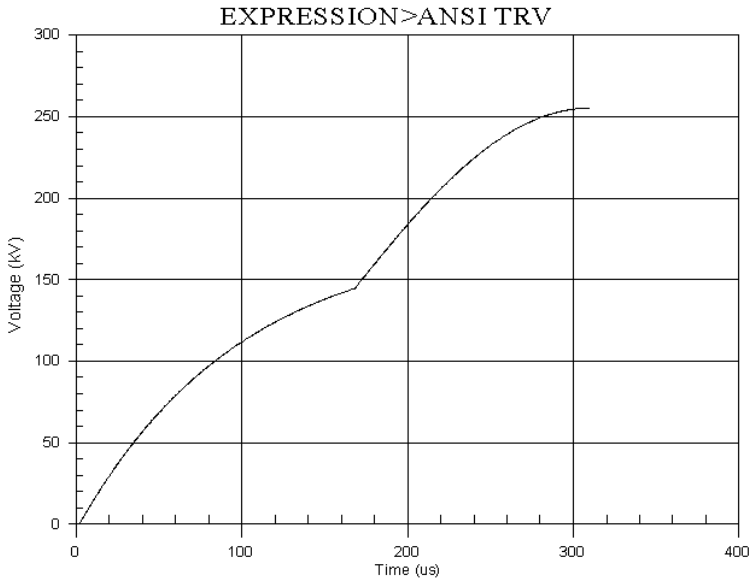


Figure 2-14: Plotted Expression for TRV Capability

[page intentionally left bank]

CHAPTER 3

Working with Graphs

TOP provides a wide variety of graph styles and options. This chapter covers **New Graph**, and options for formatting such as labeling, changing the grid and scale, and so on. It does not cover graph window operations, such as sizing, arranging and closing. These are standard Windows commands. See *your Microsoft Windows User's Guide* for details.

In This Chapter

- Graphing Options
- Changing Graph Items
- Formatting TOP Graphs
- Graph Customization
- Crosshair Mode

[page intentionally left bank]

Graphing Options

The ***Graph, New Graph...*** menu option is used to display the available stack items. Figure 3-1 shows the resulting **Plot Quantity Select** dialog box. Select one or more stack objects from the list box and click **Ok** to continue, **Cancel** to abort.

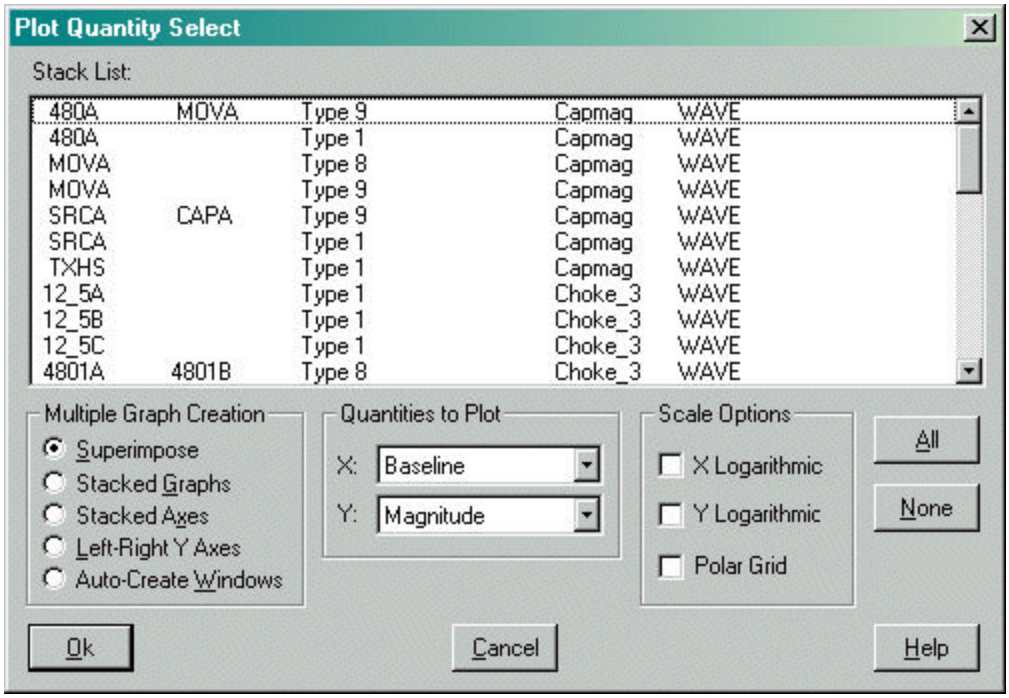
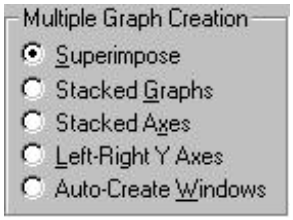


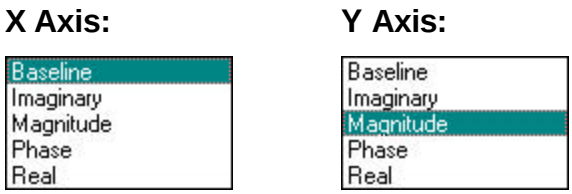
Figure 3-1: TOP's Plot Quantity Select Dialog Box

If you selected more than one object for plotting, you may also select one of the following display options (radio buttons):



- **Superimpose** (default) to place all selected objects in a single window
- **Stacked Graphs** to place each object in a separate frame in a single window
- **Stacked Axes** to place all selected objects in a single window with stacked axes on the left side
- **Left-Right Y Axes** to place all selected objects in a single window with left and right Y axes
- **Auto-Create Windows** to place each object in a separate window

Windows created with **New Graph** by default use a Cartesian grid with linear scaling. **X Axis** and **Y Axis** specification may be selected for each new plot (default x = baseline, y = magnitude). Options available (drop-down boxes) include:



Set the appropriate Scale Option (check box) to apply log scaling to the X and/or Y axes.

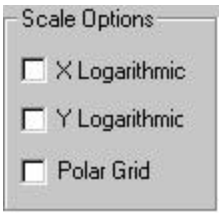


Figure 3-2 shows the resulting plot for a typical EMTP object using the default graphing options.

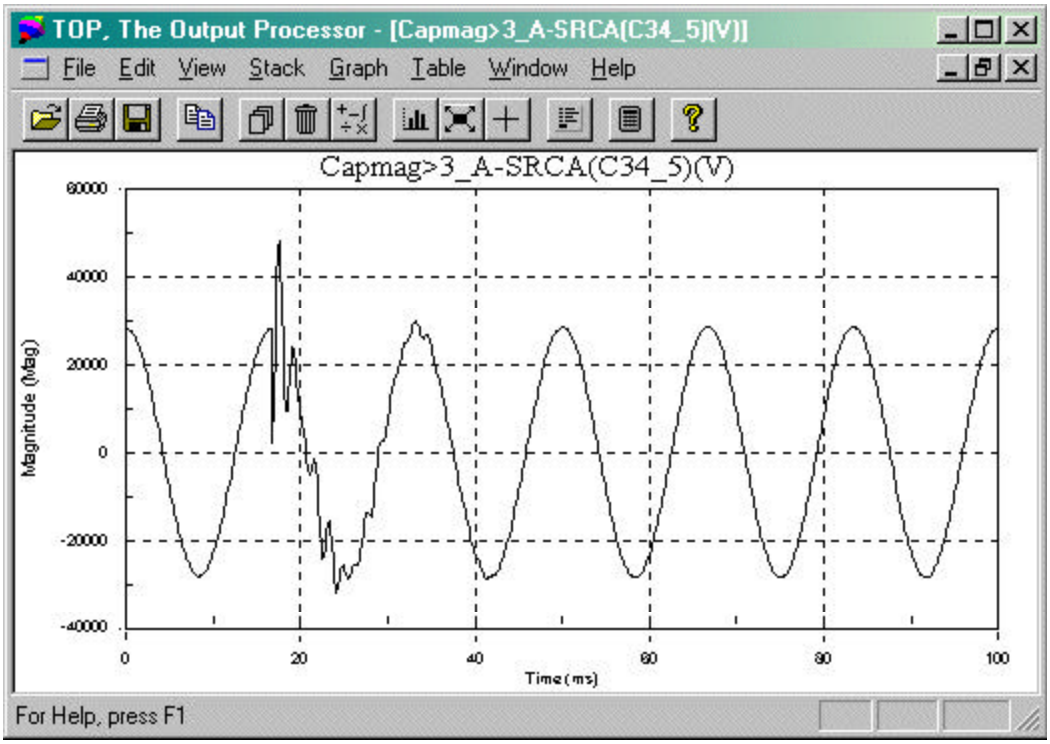


Figure 3-2: TOP's Plot Display Window

Changing Graph Items

The ***Graph, Re-select...*** menu option is used to display current graph items in the *Active* graph window and the available stack items. Figure 3-3 shows the resulting **Re-select Items to Plot** dialog box. Additional stack items may be added (**Add** button) to the graph, or graph items may be removed (**Delete** button) from the current graph and replaced with other stack items. Click **Ok** to complete the operation, **Cancel** to abort.

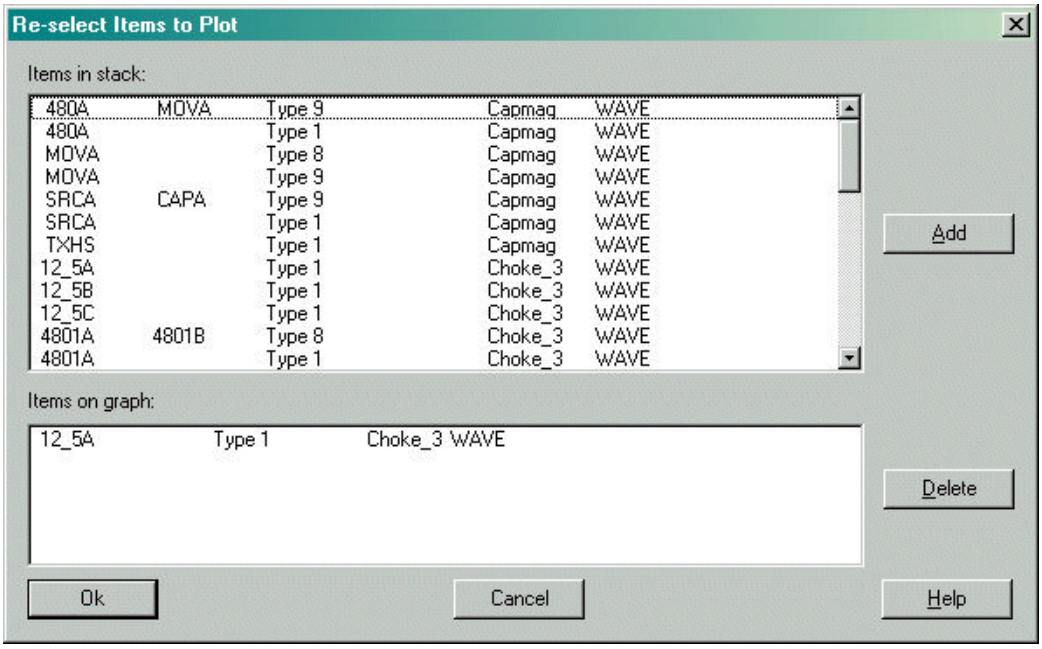


Figure 3-3: TOP's Re-select Items to Plot Dialog Box

Formatting Options

The following graph options are available in TOP:

- **Scale** - used to select linear or logarithmic scaling, and to show or hide a polar grid.
- **Grid** - used to show or hide grid lines and axis tick marks.
- **Label** - used to specify a plot and axis titles.
- **Annotate** - used to place a text label on the graph.
- **Data Block** - used to show or hide an overlay containing summary data for the graphed object.
- **Legend** - used to clarify more than one plot on the same graph by creating a legend.

Graph Scaling

You will use this option most often to set the minimum and maximum values of the X and Y axes. Changing these parameters allows you to zoom in to cover a smaller area of the plot in greater detail, zoom out to cover a larger area in less detail, or move different regions of the plot into the window.

The ***Graph, Scale...*** menu option is used to select scaling parameters. Figure 3-4 shows the resulting **Graph Scale** dialog box.

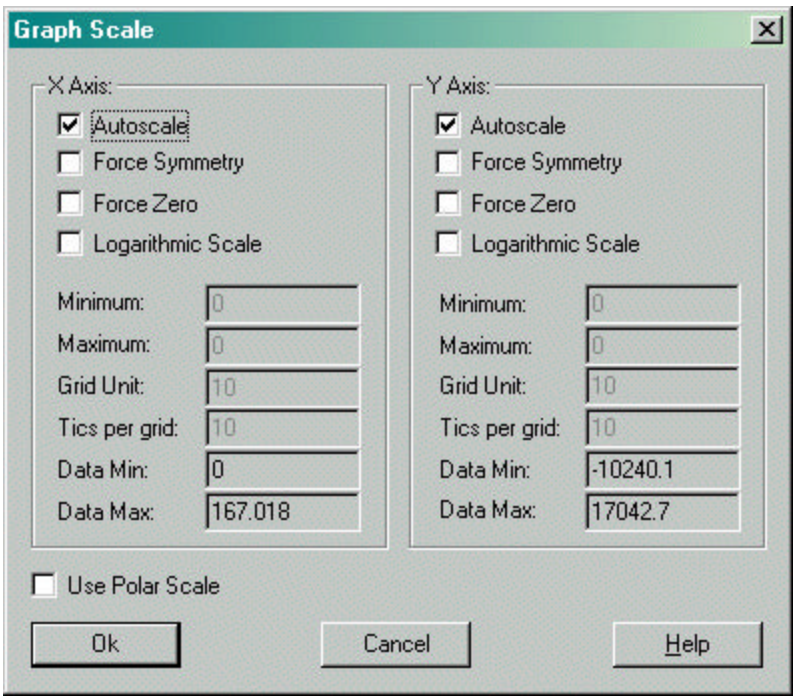


Figure 3-4: TOP's Graph Scale Dialog Box

TIP: To allow TOP to automatically calculate the default value for any of the above parameters, set the Autoscale check box.

Complete the following steps to modify the scale settings:

- Enter the **Minimum** and **Maximum** value for each axis in the appropriate text boxes.
- Enter the **Grid Unit** and **Ticks per grid** values for each axis in the appropriate text boxes. Note that **Data Min** and **Data Max** values are shown for reference.

- Set the appropriate **Force Symmetry** check box to force the minimum and maximum values to be equal and opposite.
- Set the appropriate **Force Zero** check box to force zero to be located somewhere along the axis.
- To apply logarithmic scaling to an axis, set the appropriate **Logarithmic Scale** check box. Clear the check box to restore linear scaling.
- Set the **Use Polar Scale** check box to display the plot using a polar grid.

Click **Ok** to complete the operation, **Cancel** to abort. The ***Graph, Autoscale...*** menu command returns the active window to the default autoscale settings.

Zooming with the Mouse

To zoom in on a portion of a graph, visualize a rectangle containing the portion of the graph that you wish to enlarge. Position the mouse cursor (arrow) to any corner of this rectangle. Press and hold the **left button**. Drag the mouse to the diagonally opposite corner of the imaginary rectangle, then release the button.

Grid Options

The ***Graph, Grid...*** menu option is used to select grid parameters. Figure 3-5 shows the resulting **Graph Grid** dialog box. Options include displaying major and minor grid lines and setting the grid line type and relative position. Click **Ok** to complete the operation, **Cancel** to abort.

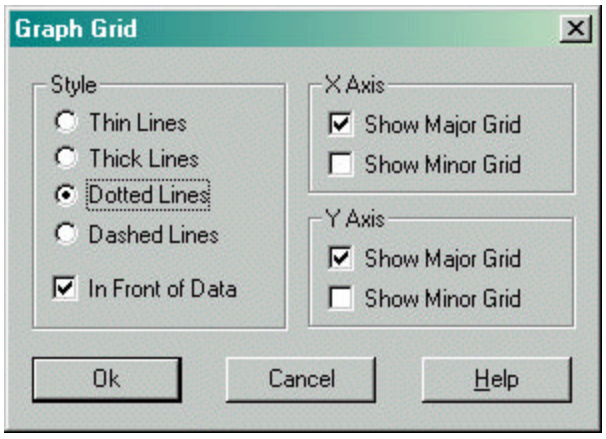


Figure 3-5: TOP's Graph Grid Dialog Box

Label, Legend, and Annotation Options

The ***Graph, Text...*** menu option is used to specify label, legend and annotation parameters. Figure 3-6 shows the resulting **Graph Text** dialog box.

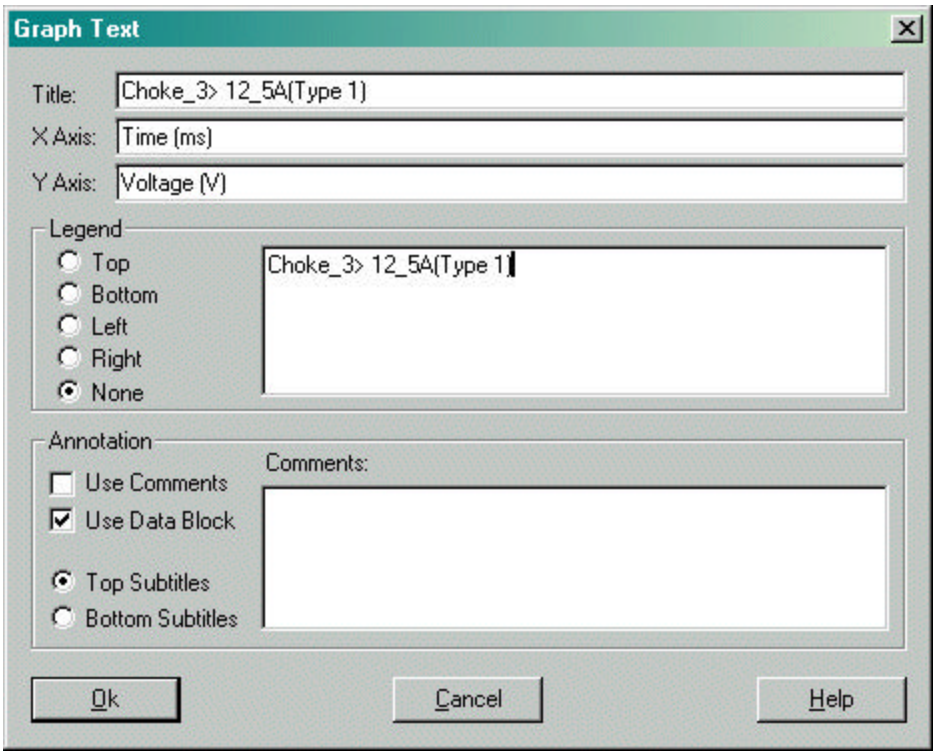


Figure 3-6: TOP's Graph Text Dialog Box

Complete the following steps to modify the scale settings:

- Enter text values for graph **Title**, **X Axis**, and **Y Axis**.
- Enter text for **Legend** and select (radio button) the desired location (select **None** for no legend). Note: use **Ctrl+Enter** to add new lines of text to the legend.
- Enter text for **Annotation** and select (check box) the **Use Comments** option.
- Select the Use **Data Block** option (check box) to add the data block to the annotation.
- Select the **Top Subtitles** or **Bottom Subtitles** option (radio buttons) to specify the location of the annotation.

Click **Ok** to complete the operation, **Cancel** to abort. Figure 3-7 shows an example graph that contains these text parameters.

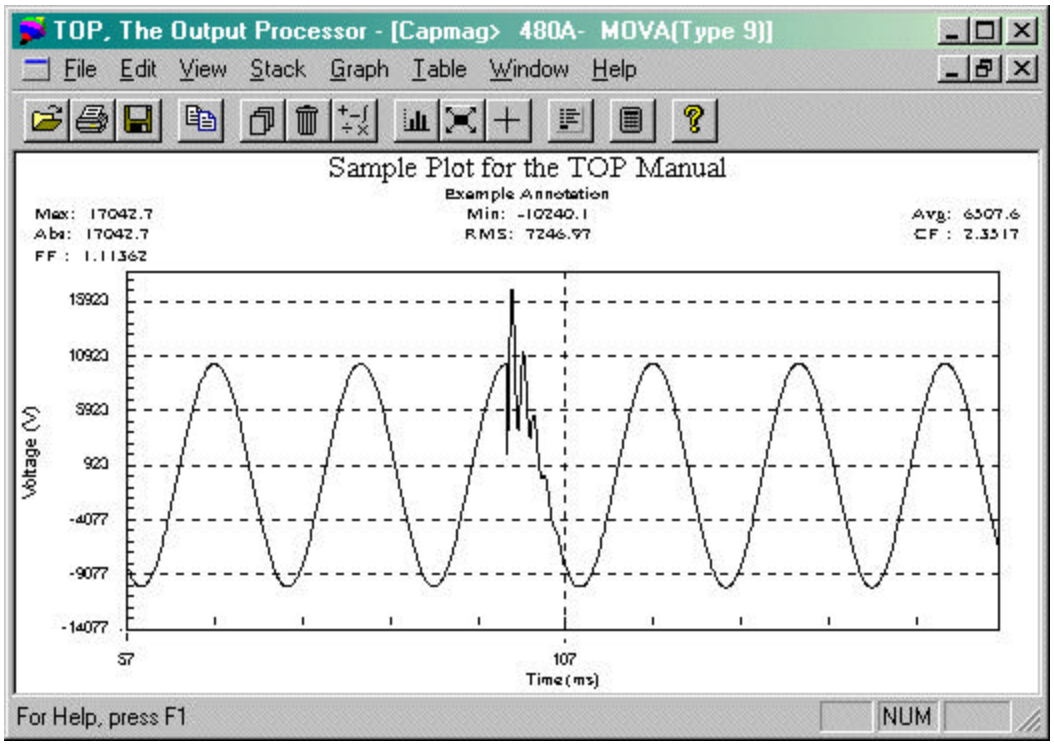
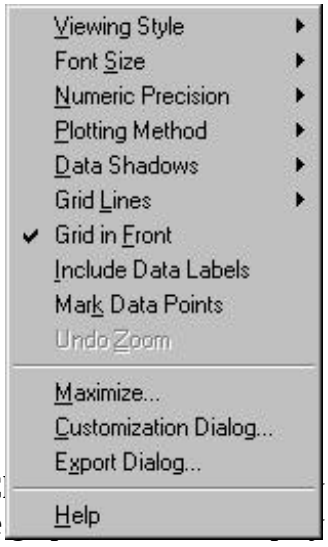


Figure 3-7: Example TOP Graph Illustrating Text Parameters

Graph Customization

A number of graph customization options are available to the user:

- Viewing Style
- Font Size
- Numeric Precision
- Plotting Method
- Grid Lines / Grid in Front
- Include Data Labels
- Mark Data Points
- Maximize



There are two method for accessing the customization options**; Right C**
to display the menu items shown in Figure 3-8; **Double Clicking** on the
the customization dialog shown in Figure 3-9.

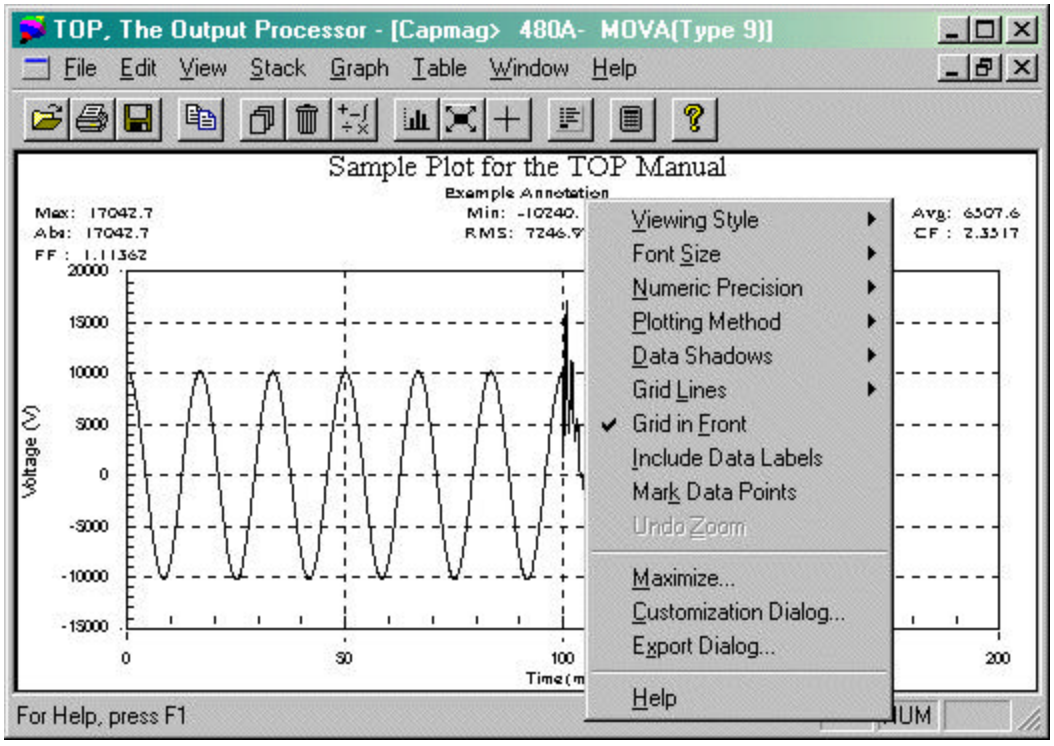


Figure 3-8: Accessing Customization Menu via Right Click

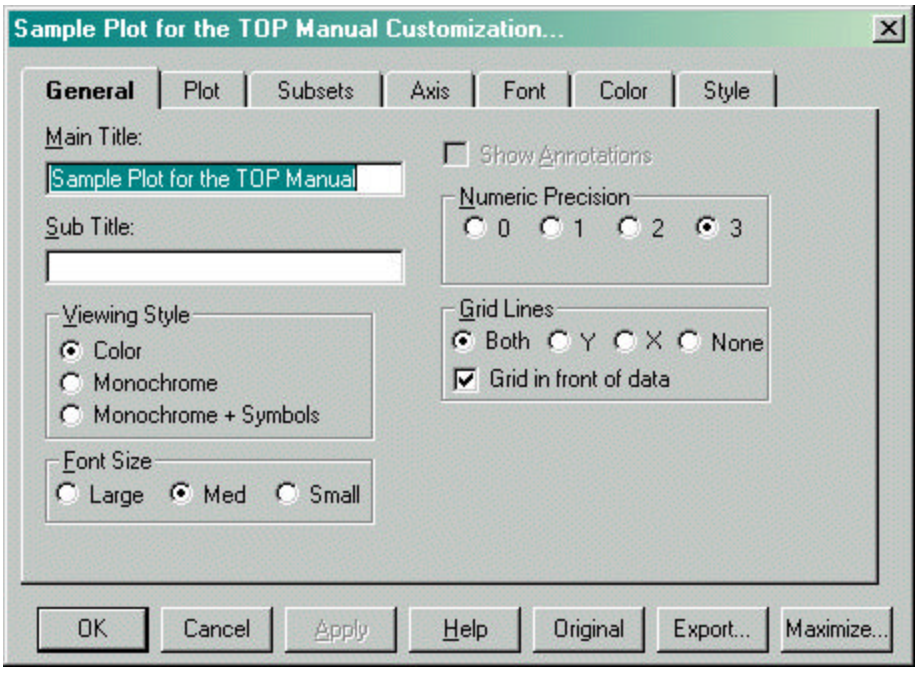


Figure 3-9: Accessing Customization Dialog via Double Click

Specialized help for the customizatio n options provided by the third-party graphing tool can be accessed by selecting **Help** from the customization menu or dialog.

Crosshair Mode

The ***Graph, Crosshair Mode...*** menu option is a toggle to enter/exit crosshair mode. Crosshair operation is started by placing the cursor over the waveform (cursor will change to +) and selecting the waveform (left clicking the mouse over the waveform). X, Y values will be displayed in the upper left corner of the graph window (shown in Figure 3-10). The crosshair may be moved along the waveform by using the left and right cursor (mouse buttons or keyboard keys).

The **Home** and **End** keys move the crosshair to the far left and far right respectively. The **Page Up**, and **Page Down** keys move the crosshair left or right by a larger increment than one point. You can use the up and down arrows to move the cursor to different curves, if there is more than one curve on the graph.

Exit this mode by selecting the ***Graph, Crosshair Mode...*** menu option again.

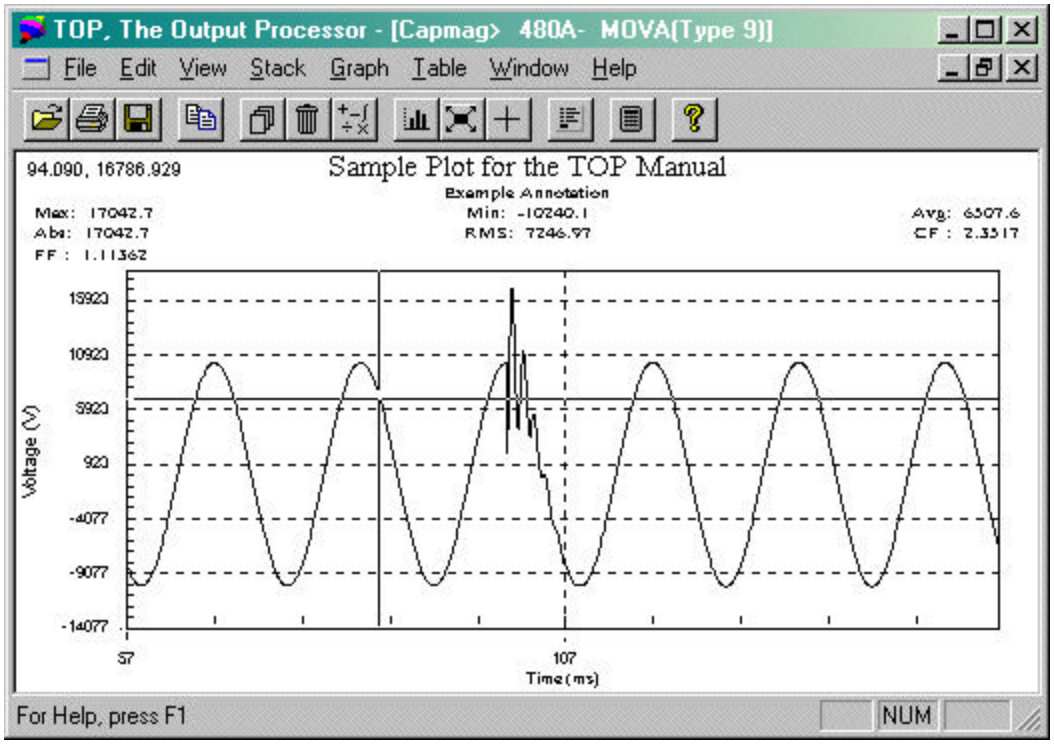


Figure 3-10: Crosshair Mode

CHAPTER 4

Working with Tables

Creating a table is less complicated than creating a graph; there are only so many ways to view a list of numbers, after all. Moreover, the concept of table creation is identical to that of graphs. Thus, you will find working with tables very easy. This chapter will go over the different types of tables available in TOP and how to format them accordingly.

In This Chapter

- What Types of Tables are Available
- Creating Tables
- Editing Column Widths
- Sharing Tables with other Applications
- Table Derived Quantities
- Example Tables

[page intentionally left bank]

What Types of Tables are Available?

The following object types can be output as tables or graphs.

- Waveform Data Points (WAVE, TRND)
- Frequency Domain Data (SCAN, SPEC)
- Cumulative Probability (PROB)
- Probability Density (HIST)
- Raw statistical data (STAT)
- XY Data (XY)
- Magnitude-Duration Data (MAGDUR, HIST3D)

Table 4-1 indicates the Tables available in TOP along with the objects supported and the quantities obtained.

Table 4-1: Tables Supported in TOP

Summary Table	Objects Supported	Summary Quantities
Curve Minimum and Maximum	WAVE SPEC SCAN PROB HIST XY	Min, Max, Abs Max, Avg
Waveform Summary	WAVE	Min, Max, Avg, Abs, RMS, CF, FF
Time Domain Data Points	WAVE PROB HIST XY MAGDUR	Time, Value Value, Probability Bin Midpoint, Probability X Value, Y Value Duration, Magnitude
Frequency Data Points	SPEC SCAN XY HIST3D	Freq, Magnitude, Angle Freq, Magnitude, Angle X Value, Y Mag, Y Phase Mag Bin, Count, Duration Bin
Harmonic Summary Data	SPEC	Freq, Fund, %THD, %RMS, %ASum, RMS_h, RMS, ASum, TIF, IT, H3 - H25
Magnitude vs. Switch Operation	STAT	Switch,TimeClosed1, TimeClosed2, TimeClosed3

IEEE 519 Current Limits	SPEC	Summary Table, Detail Table

Creating Tables

The ***Table, Select...*** menu option is used to display the available stack items. Figure 4-1 illustrates the resulting **Table Quantity Select** dialog box. Select the **Table Type** from the drop-down list, one or more stack objects from the list box and click **Ok** to continue, **Cancel** to abort. TOP then opens a display window that includes the specified table.

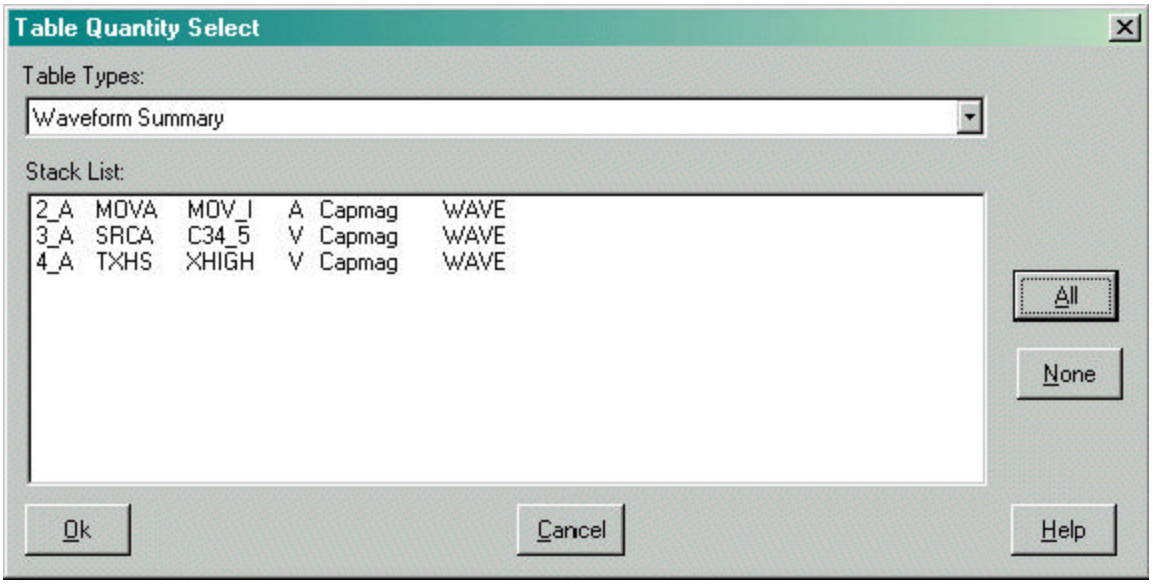


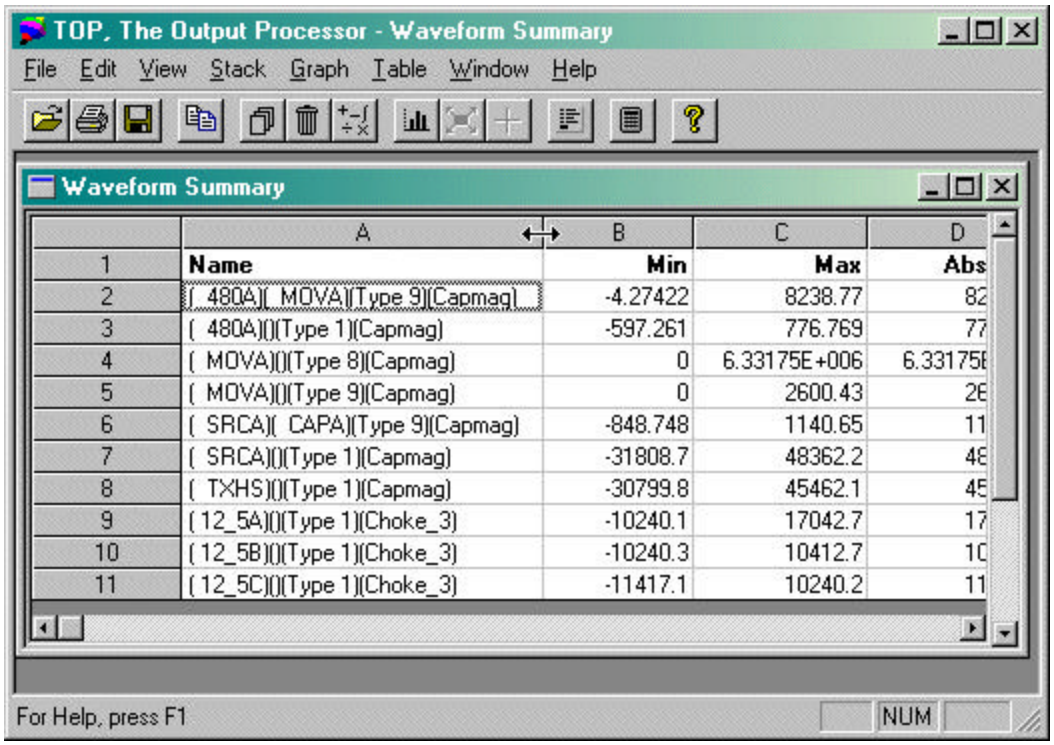
Figure 4-1: TOP's Table Quantity Select Dialog Box

TIP: TOP will only list the stack objects that are compatible with each table type.

Changing Table Column Widths

Figure 4-2 illustrates one of the tables created in TOP. Note that the table has column and row identifiers similar to spreadsheets. Column resizing can be done directly in TOP. This is accomplished in the following procedure:

- Set the cursor of the mouse directly between the two columns be resized (see Figure 4-2, cursor between columns A and B).
- Click and hold the left button on the mouse.
- Drag to obtain the desired size and then release.



	A	B	C	D
1	Name	Min	Max	Abs
2	(480A)(MOVA)(Type 9)(Capmag)	-4.27422	8238.77	82
3	(480A)()(Type 1)(Capmag)	-597.261	776.769	77
4	(MOVA)()(Type 8)(Capmag)	0	6.33175E+006	6.33175E
5	(MOVA)()(Type 9)(Capmag)	0	2600.43	26
6	(SRCA)(CAPA)(Type 9)(Capmag)	-848.748	1140.65	11
7	(SRCA)()(Type 1)(Capmag)	-31808.7	48362.2	48
8	(TXHS)()(Type 1)(Capmag)	-30799.8	45462.1	45
9	(12_5A)()(Type 1)(Choke_3)	-10240.1	17042.7	17
10	(12_5B)()(Type 1)(Choke_3)	-10240.3	10412.7	10
11	(12_5C)()(Type 1)(Choke_3)	-11417.1	10240.2	11

Figure 4-2: Editing Table Column Widths

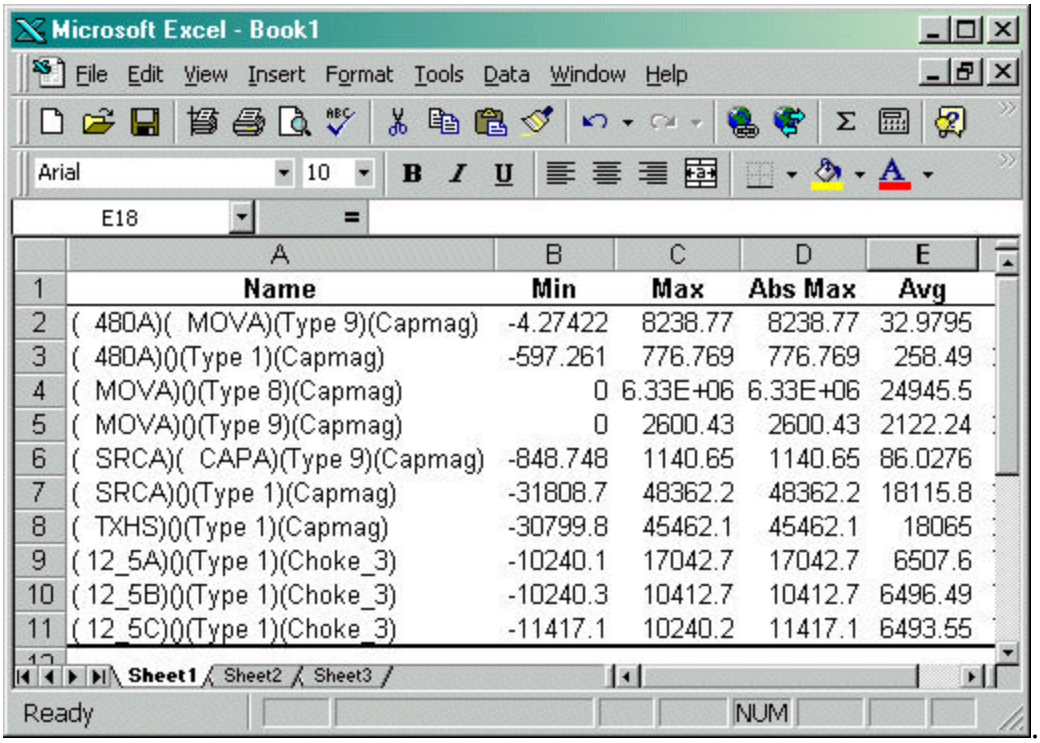
Figure 4-2 illustrates the methods available in TOP to view and edit table column widths. For more detailed editing, the table can be easily copied and then pasted into a spreadsheet program. The scroll bar is included in the table window when the quantities displayed do not fit in the initial window settings. The window can be re-sized by expanding with the mouse.

Sharing Tables with other Applications

The ***Edit, Copy...*** menu option is used to copy the selected table area to the Clipboard. This data can then be inserted (pasted) into a spreadsheet program such as Microsoft Excel. This is accomplished in the following procedure:

- Create the desired table in TOP.
- Select **Edit, Copy...** from the TOP menu bar (**Ctrl+C** or Ctrl+Insert).
- Start the desired spreadsheet or word processor program.
- Select **Edit, Paste** from the applications tool bar. This imports the table from TOP to the selected application (**Ctrl+V** or **Shift+Insert**).

Another method of sharing the data in a TOP table is to export the table to a file (TXT or CSV). This can be done by simply using the ***File, Export***... menu command (refer to Chapter 1). Figure 4-3 shows the resulting Excel spreadsheet that had a TOP table copied to it (with auto formatting applied).



	A	B	C	D	E
1	Name	Min	Max	Abs Max	Avg
2	(480A)(MOVA)(Type 9)(Capmag)	-4.27422	8238.77	8238.77	32.9795
3	(480A)()(Type 1)(Capmag)	-597.261	776.769	776.769	258.49
4	(MOVA)()(Type 8)(Capmag)	0	6.33E+06	6.33E+06	24945.5
5	(MOVA)()(Type 9)(Capmag)	0	2600.43	2600.43	2122.24
6	(SRCA)(CAPA)(Type 9)(Capmag)	-848.748	1140.65	1140.65	86.0276
7	(SRCA)()(Type 1)(Capmag)	-31808.7	48362.2	48362.2	18115.8
8	(TXHS)()(Type 1)(Capmag)	-30799.8	45462.1	45462.1	18065
9	(12_5A)()(Type 1)(Choke_3)	-10240.1	17042.7	17042.7	6507.6
10	(12_5B)()(Type 1)(Choke_3)	-10240.3	10412.7	10412.7	6496.49
11	(12_5C)()(Type 1)(Choke_3)	-11417.1	10240.2	11417.1	6493.55

Figure 4-3: TOP Table Copied to Excel

Table Derived Quantities

Before proceeding to the example tables, it is necessary to be familiar with some of the derived quantities. Table 4-2 summarizes the mathematical expressions utilized to calculate some of the obtained values in the following tables. Note that in spectral calculations, TOP assumes that the fundamental frequency is the lowest frequency component in the spectrum.

Table 4-2: Table Derived Quantities

Quantity	Definition
Abs Maximum Absolute Value	$X_{abs} = \mathrm{Max}\{\lvert X_{max}\rvert, \lvert X_{min}\rvert\}$
ASum Arithmetic Sum	$\mathrm{ASum} = \sum_{f} X_{peak_f}$
Avg Average Value	$X_{avg} = \frac{1}{T}\int_0^T X(t)\,dt$
CF Crest Factor	$CF = \frac{\mathrm{Max}\,X(t)\rvert_{1cycle}}{X_{rms_{fund}}}$
FF Form Factor	$FF = \frac{X_{rms}}{\lvert X\rvert_{avg}} = \frac{\sqrt{\frac{1}{T}\int_0^T X(t)^2\,dt}}{\frac{1}{T}\int_0^T \lvert X(t)\rvert\,dt}$
Freq Fundamental Frequency	f_{min}
Fund Fundamental Magnitude	$X_{rms_{fund}}$
IT IT Product	$IT = TIF * X_{rms}$
Max **Min** Maximum & Minimum Values	$X_{max} = \mathrm{Max}(X)\rvert$ $X_{min} = \mathrm{Min}(X)\rvert_{\substack{f_{min} \le f \le f_{max} \\ t_{min} \le t \le t_{max} \\ 1cycle}}$ SCAN TRND WAVE

Table 4-2: Table Derived Quantities (contined)

Quantity	Definition
RMS Root Mean Square Value	$X_{rms} = \sqrt{\sum_f X^2_{rms_f}}$ SPEC $X_{rms} = \sqrt{\frac{1}{T}\int_0^T X(t)^2\,dt}$ WAVE
RMS_h RMS Value of Harmonics	$X_{rms_h} = \sqrt{\sum_{f>fund} X^2_{rms_f}}$
THD Total Harmonic Distortion	$THD = \frac{X_{rms_h}}{X_{rms_{fund}}}$
TIF Telephone Influence Factor	$TIF = \frac{\sqrt{\sum_f (X_f * W_f)^2}}{X_{rms}}$ W from table, $f = 60 * h$

h / W Table

h	W	h	W	h	W
1	0.5	21	6050	41	10340
3	30	23	6370	43	10600
5	225	24	6650	47	10240
6	400	25	6680	49	9820
7	650	27	6970	50	9670
9	1320	29	7320	53	8740
11	2260	30	7570	55	8090
12	2760	31	7820	59	6730
13	3360	33	8330	61	6130
15	4350	35	8830	65	4400
17	5100	36	9080	67	3700
18	5400	37	9330	71	2750
19	5630	39	9840	73	2190
				83.3	840

Example TOP Tables

Curve Minimum and Maximum

The Curve Minimum and Maximum table creates the following values:

Min	minimum Value
Max	maximum Value
Abs Max	maximum Absolute Value
Avg	average Value

The compatible objects are **WAVE, SPEC, SCAN, XY**, **PROB** and **HIST**. Figure 4-4 illustrates selection of this table in the dialog box prompted by ***Table, Select...*** menu command, and Figure 4-5 shows a portion of the resulting table.

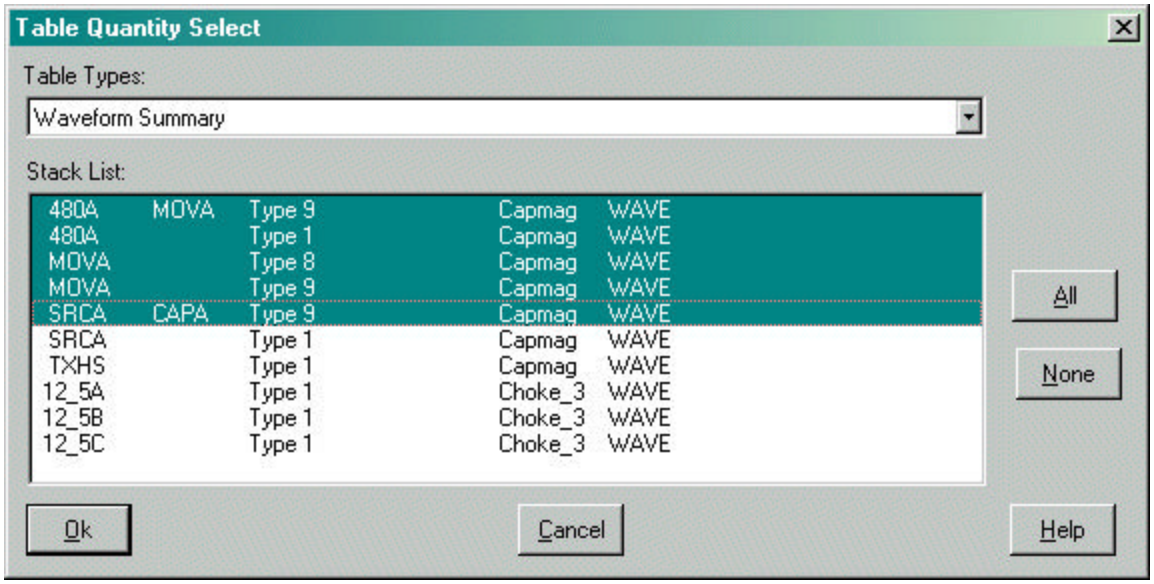


Figure 4-4: TOP Table Quantity Select Dialog

	A	B	C
1	**Name**	**Min**	**Max**
2	(480A)(MOVA)(Type 9)	-4.27422	8238.77
3	(480A)()(Type 1)	-597.261	776.769
4	(MOVA)()(Type 8)	0	6.33175E+006
5	(MOVA)()(Type 9)	0	2600.43
6	(SRCA)(CAPA)(Type 9)	-848.748	1140.65

Figure 4-5: TOP Curve Min and Max Table

Waveform Summary

The Waveform Summary table is accessible for any object in a raw object form of **WAVE**. The obtained values for this table are:

Min	minimum Value
Max	maximum Value
Abs Max	maximum Absolute Value
Avg	average Value
RMS	root Mean Square Value
CF	crest Factor
FF	form Factor

Figure 4-6 shows a portion of this table as created in TOP.

	A	B	C	D	E	F	G
1	**Name**	**Min**	**Max**	**Abs Max**	**Avg**	**RMS**	**CF**
2	[480A][MOVA	-4.27422	8238.77	8238.77	32.9795	443.29	18.5855
3	[480A][](Type 1	-597.261	776.769	776.769	258.49	291.207	2.66742
4	[MOVA][](Type	0	33175E+006	33175E+006	24945.5	338252	18.719
5	[MOVA][](Type	0	2600.43	2600.43	2122.24	2343.82	1.10949
6	[SRCA][CAPA	-848.748	1140.65	1140.65	86.0276	136.294	8.36903
7	[SRCA][](Type	-31808.7	48362.2	48362.2	18115.8	20247.6	2.38853
8	[TXHS][](Type	-30799.8	45462.1	45462.1	18065	20178.7	2.25297
9	[12_5A][](Type	-10240.1	17042.7	17042.7	6507.6	7246.97	2.3517
10	[12_5B][](Type	-10240.3	10412.7	10412.7	6496.49	7214.84	1.44323
11	[12_5C][](Type	-11417.1	10240.2	11417.1	6493.55	7216.68	1.58205
12	[BUS_B][CAP1	0	376535	376535	15943.3	67228.2	5.60084
13	[BUS_B][CAP1	-314.599	314.574	314.599	62.7519	125.436	2.50804
14	[BUS_B][MOV1	0740984	1677.73	1677.73	3.0987	65.6738	25.5464
15	[BUS_B][](Type	-188793	357476	357476	120429	134388	2.66002

Figure 4-6: TOP's Waveform Summary Table

Time Domain Data Points

This table provides the data points of selected waveforms and plots. Any object in a raw form of **WAVE, PROB, HIST, MAGDUR** or **XY** can be used to create this table. The obtained quantities for WAVE and XY are described as

Time	time in seconds
Value	magnitude at corresponding time

For PROB objects, the first column is the magnitude and the second column is the cumulative probability in percent. For HIST objects, the first column is the bin midpoint and the second

column is the probability in percent. For MAGDUR objects, the first column is the duration in seconds and the second column is the magnitude in percent.

Figure 4-7 illustrates this table as created in TOP.

	A	B	C
1	**Name**	**Time**	**Value**
2	480A	0	389.822
3	480A	0.15	389.935
4	480A	0.3	388.802
5	480A	0.45	386.425
6	480A	0.6	382.814
7	480A	0.75	377.978
8	480A	0.9	371.934
9	480A	1.05	364.701
10	480A	1.2	356.302
11	480A	1.35	346.764
12	480A	1.5	336.117
13	480A	1.65	324.396
14	480A	1.8	311.638
15	480A	1.95	297.884

Figure 4-7: TOP's Time Domain Data Points Table

Frequency Domain Data Points

The Frequency Domain Data Points Table provides the frequency, magnitude and angle for each point in any raw object file in a **SPEC**, **SCAN,** or **XY** format. For **HIST3D** objects, the output columns include the lower histogram bin boundaries for magnitude in percent, the count, and the lower bin boundary for duration in seconds.

Frequency	frequency in per unit
Magnitude	corresponding magnitude
Angle	corresponding angle

Figure 4-8 shows this table as created in TOP.

	A	B	C	D
1	**Name**	**Frequency**	**Magnitude**	**Angle**
2	44kvbus	1	25559.6	-3.01212
3	44kvbus	5	85.7581	119.831
4	44kvbus	7	178.714	68.7012
5	44kvbus	11	131.698	-34.4902
6	44kvbus	13	76.741	-138.036
7	44kvbus	17	15.9098	108.45
8	44kvbus	19	9.00782	53.2279
9	44kvbus	23	4.30098	-61.4896
10	44kvbus	25	3.43209	-114.875
11	44kvbus	29	2.24315	147.181
12	44kvbus	31	1.76224	99.6249
13	44kvbus	35	1.04035	0.836956
14	44kvbus	37	0.813061	-51.7375

Figure 4-8: TOP's Frequency Domain Data Points Table

Harmonic Summary Table

Raw data files in a **SPEC** format can be used to create a Harmonic Summary Table. The obtained values from this table are

Frequency	fundamental frequency
Fundamental	magnitude at fundamental frequency
%THD	% of total harmonic distortion
%RMS	% of root mean square value
%ASum	% arithmetic sum
RMSh	root mean square value of harmonic content
RMS	root mean square value
ASum	arithmetic sum
TIF	telephone interference factor (normalized with voltage)
IT	current telephone interference factor (normalized with current)
H3-H25	magnitude content in each odd harmonic

Figure 4-9 shows a portion of this table as created in TOP. At the top left corner of this table is the following check box:

If this box is checked, harmonic magnitude content for each of the odd harmonics will be in percent based on the fundamental frequency value.

	A	B	C	D	E	F	G
1	**Name**	**Freq**	**Fund**	**% THD**	**% RMS**	**% ASUM**	**RMSh**
2	44kvbus	1	25559.6	0.981241	100.005	102.001	250.801
3	bus1	1	25545.5	0.98091	100.005	102	250.578
4	BUS2	1	25504.3	0.988843	100.005	101.723	252.198
5	bus2l	1	7553.82	1.65696	100.014	102.916	125.164
6	BUS3	1	25683.7	0.820807	100.003	101.696	210.813
7	bus3l	1	7572	1.89196	100.018	102.555	143.259
8	BUS4	1	25470.1	1.0795	100.006	102.123	274.95
9	bus4l	1	7338.38	1.94026	100.019	103.17	142.383
10	bus6	1	25084.9	2.04506	100.021	105.047	513.001
11	BUS7	1	25030.1	2.25093	100.025	105.653	563.409
12	bus7l	1	2344.76	4.19742	100.088	111.25	98.4195
13	RECT	1	2047.81	6.84763	100.234	117.158	140.226

Figure 4-9: TOP's Harmonic Summary Table

Magnitude vs. Switch Operation

This table can be created in TOP from any raw object file in the **STAT** format. Figure 4-10 shows this table as created in TOP. The values given in this table give the magnitudes at the switches in a file at the time of closing.

	A	B	C	D	E
1	**Node Name**		**Highest**	**Second Highest**	**Third Highest**
2		**Switch**	**Time Closed 1**	**Time Closed 2**	**Time Closed 3**
3	480A		-1154.59	-1153.8	1152.85
4		(SRCA)(CAPA)	0.0241476	0.0240807	0.0160248
5	SRCA		-49320.9	49312.4	49284.9
6		(SRCA)(CAPA)	0.0245734	0.0162774	0.0163007
7	TXHS		-46598.3	46566.1	46566.1
8		(SRCA)(CAPA)	0.0244328	0.0160248	0.0160233

Figure 4-10: TOP's Magnitude vs. Switch Operation Table

IEEE 519 Current Limits

This table provides a check of spectral data with the IEEE 519 Current Standards. The raw data object files should be of the **SPEC** format. Figure 4.11 shows a portion of this table as created in TOP.

	A	B	C	D	E	F	G
1	**PCC Bus Voltage**	**13800**	Volts (L-L		Isc	4183.7	Amps
2	**PCC Short Circuit MVA**	**100**	MVA		IL	4.1837	Amps
3	**Avg. Max Demand kVA**	**100**	kVA		Isc/IL	1000	
4	**I*T Limit**	**1500**					
5							
6	Summary Table						
7		h<11	11<=h<17	17<=h<23	23<=h<35	h>=35	TDD
8	IEEE 519 Limits	15	7	6	2.5	1.1	20
9	equivB	OK	OK	OK	OK	OK	OK
10							
11	Detail Table						
12		I*T	TDD	H3	H5	H7	H9
13	IEEE 519 Limits	1500	20	15	15	15	15
14	equivB	4661.01	0.245853	0.137185	0.140859	.118067	053468

Figure 4-11: TOP's IEEE 519 Current Limits Table

Unlike the previous tables discussed, the IEEE 519 Table requires user inputs for cells B1 to B4 as shown in Figure 4-12. Cell B1 is the Point of Common Coupling kV, **PCC kV** (13.8kV). Cell B2 is the **PCC Short Circuit MVA** (100 MVA). Cell B3 is the **Avg. Max Demand kVA** (100 kVA). Finally, cell B4 is the I*T Limit (1500).

Upon input (click **Calculate** to update) of these critical values depicting the system, the Summary and Detail Tables are completed as necessary. In this example the currents calculated are within IEEE 519 limits.

TOP will remember the last user inputs into the table, even if the program is shut down and restarted. Therefore, it is necessary to remember to update these parameters accordingly.

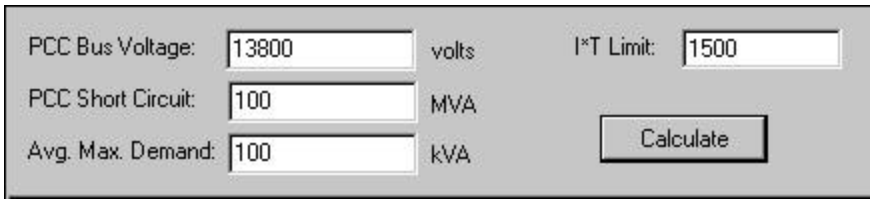


Figure 4-12: TOP's Data Input for IEEE 519 Table

I N D E X

A

Abs 4-7
annotation 3-8
ASCII 1-15
ASum....4-7
Avg 4-7
axis 3-4

B

base quantities 2-6

C

calculator....1-15
CF....4-7
clipboard....1-10
crosshair....3-11

D

data file 1-3
derived quantities 4-6
DFT 2-15
discard....1-4

E

EMTP 1-14
exporting....1-11
expression dialog 2-18
expression operators 2-21

F

Fast Fourier Transform....2-13
FF....4-7
FFT....2-13
filter....2-11
formatting 3-5

G

Getting Help....i-21
graph 1-5, 3-3
grid....3-6

H

help system 1-9

I

IDFT....2-16
idMode....1-17
IEEE 519 4-14
IT 4-7

L

label 3-8
legend....3-8

M

macro....1-15

O

object identifiers 2-4

P

PATH Users Group 0-21
PCC....4-14
PQDIF....1-12, A-22, B-3
preferences....i-18
print preview 1-9
printer setup 1-8
printing....1-8
Program Installation i-9

R

re-select....3-5
ribbon....i-17
rms....4-8

S

scale 3-4, 3-6
SOS....1-14

stack....1-3, 2-3
stacked axes....1-6
stacked graphs....1-6
statistics output salvage....1-14
subtitles....3-8
superimpose....1-6

T

tables....1-7, 4-3
THD....4-8
TIF....4-8
tool bar....i-17
TOPCalc....2-8
Training....i-21

U

units....2-7

W

World Wide Web....i-21

Z

zoom....3-7

APPENDIX A

TOP Data Filters

TOP has the ability of interacting with a number of different types of data files. Each of the available data filters will be discussed in detail in the following sections.

It is important to note that some data types share the same file extension (e.g. DAT, CFG). You must know the source of the file to correctly select the file type when completing the **File**, **Open...** process.

[page intentionally left bank]

COMTRADE[1] Objects

The COMTRADE data object consists of three files; HDR, CFG and DAT. The *.HDR file (header file) is intended to be printed and read by the user. The *.CFG (configuration file) is needed to properly interpret the transient data, *.DAT file. Finally, the *.DAT file (data file) contains the value of each sample of each input channel. Upon loading an IEEE COMTRADE data object, only the *.CFG file needs to be opened. The *.HDR and *.DAT can only be viewed or printed in TOP as an ASCII file.

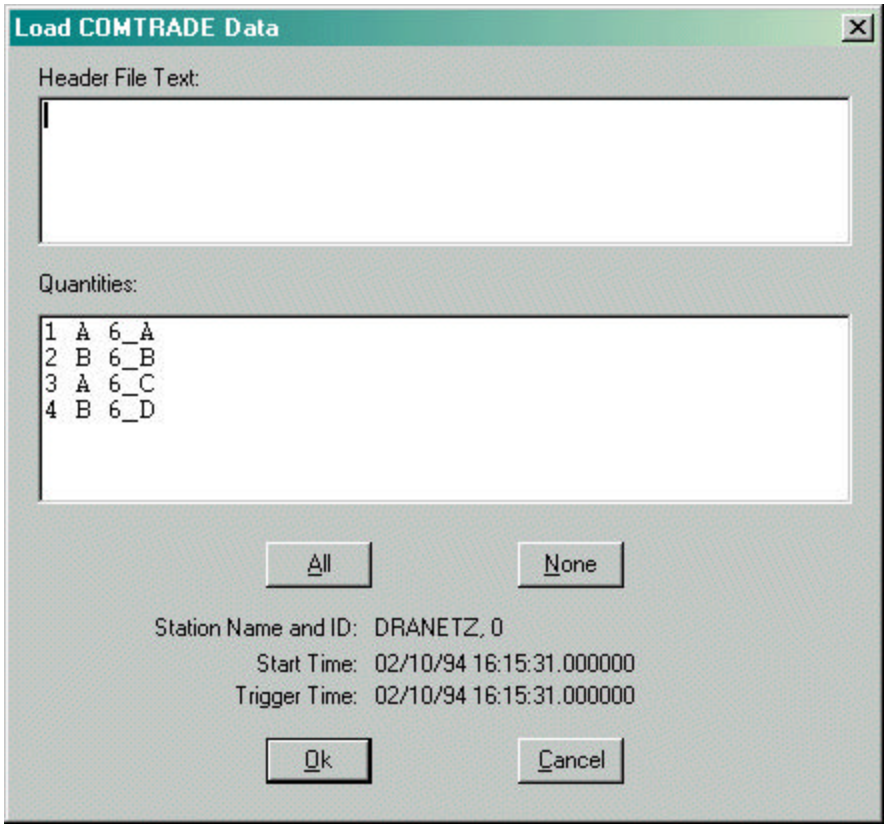


Figure A-1: TOP's Load COMTRADE Data Dialog

- Select one or more objects in the list box. The **All** and **None** buttons allow you to select or unselect all objects in the list box at once.
- Select the **Ok** button to load the selected objects, or **Cancel** to quit the operation.

[1]IEEE STD C37.111 - 1991"IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems" issued by the Power Systems Relaying Committee out of the Power Engineering Society.

If the COMTRADE data files are produced by anything other than TOP then the following name configuration is assigned.

Name1	Channel ID underscore (_) and Phase ID
Name2	Name channel was given.
Qualifier1	Circuit ID or name
Qualifier2	Units Specified

If the data files were exported using TOP, then the COMTRADE data filter tries to restore the original TOP stack name.

EMTP/ATP Objects

TOP allows EMTP (Electromagnetic Transients Program)/ATP (Alternative Transients Program) objects with the extensions SOS, PL4 and OUT to be opened. Upon opening the EMTP OUT file, TOP displays the text output file. There is no dialog box associated with this. The dialog box used for PL4
(Figure A-2) and SOS (Figure A-3) files are shown below.

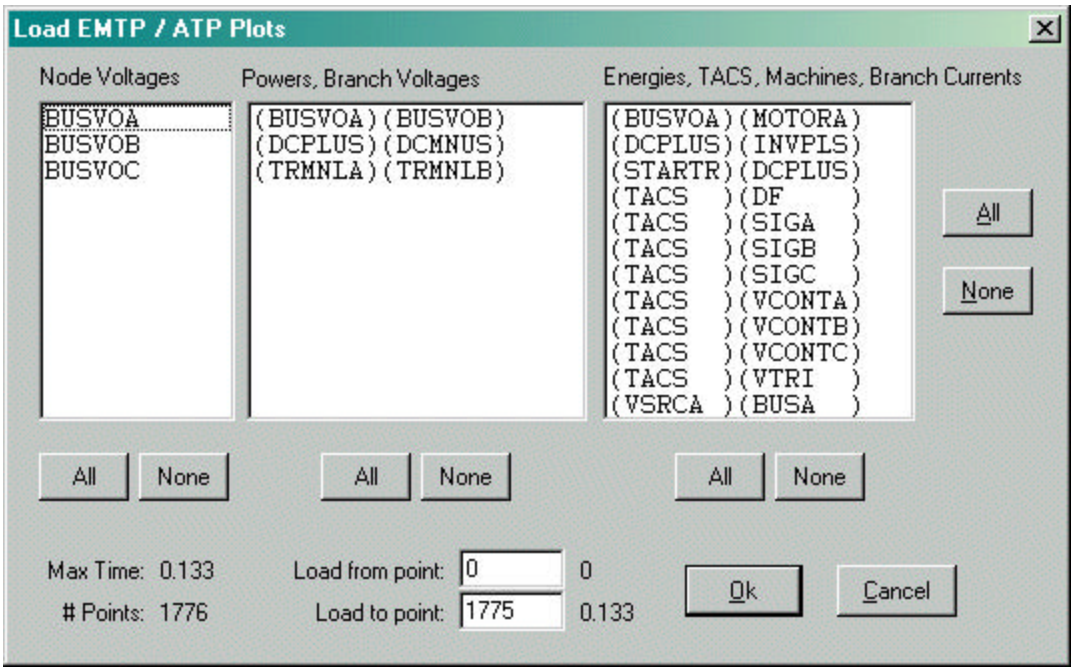


Figure A-2: TOP's Load EMTP/ATP Data Dialog

TOP sorts the objects according to the EMTP-assigned type and displays them in the three list boxes shown above. The name (and an example) TOP assigns to EMTP objects can be seen in the description below:

Name1 (BUS1)	Name2 (BUS2)	Qualifier1 (TYPE 8)	Qualifier2	Origin (SYS)	Type (WAVE)

```
Name1        Name of "from" node

Name2        Name of "to" node

Qualifier1   Type identifier given by the EMTP

Qualifier2   This field is not used.
```

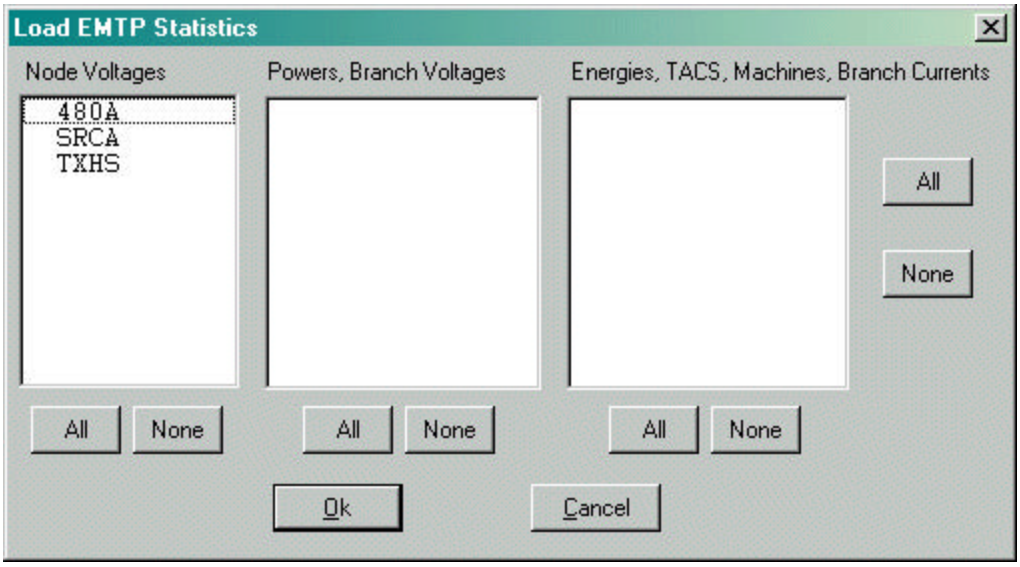


Figure A-3: TOP's Load EMTP Statistics Data Dialog

EMTDC Objects

TOP reads data from EMTDC version 3 and version 4 text output data files. The output channels are defined in a file with file extension INF, and the data is stored in one or more files with file extension OUT. Up to 10 channels of output, plus the times, will be stored in one OUT file.

All EMTDC outputs are time-domain waveforms, and will be assigned type WAVE in TOP. There is no means of identifying voltage, current, or other type of quantity from either the INF or OUT file. Therefore, TOP assigns units of seconds to the X axis and magnitude to the Y axis.

Through the PSCAD interface, an EMTDC user can specify description and unit strings for plots. Because the units label does not consistently identify any physical units, TOP does not use it. Each EMTDC component that generates output will have been placed on a "page" in the PSCAD interface. TOP uses the user-supplied output description, and up to three nested "page" labels, to make stack names for EMTDC objects:

Name1 (BUS1)	Name2 (BUS2)	Qualifier1 (TYPE 8)	Qualifier2	Origin (SYS)	Type (WAVE)

```
Name1        User-specified name from the PSCAD
             interface

Name2        Top-level page, typically "Main"

Qualifier1   Second-level page, or blank

Qualifier2   Third-level page, or blank
```

HARMFLO[2] Objects

TOP allows the viewing and solving of HARMFLO objects with the extensions of HFW, HFS, HFZ and HFO. These ASCII text files are used to obtain harmonic load flow solutions. Although not much graphical interactive capability is featured with the results, this provides an excellent source for comparisons with other solved values. Upon the opening of HARMFLO object files, TOP brings up the text file with the solution, therefore, there is no dialog box.

[2]Available from EPRI: publication number EL-4920-CCCM, project number 2444-1 "HARMFLOW Code: Version 5.0 User's Guide"

SuperHarm Objects

Source Groups

SuperHarm provides an option that allows you to specify a *source group* - a set of one or more harmonic sources that should always be applied to the system together. When source groups are used, SuperHarm calculates a solution for the system with each group applied in turn. In TOP, when you load a SuperHarm object, you also select one or more source groups for that object. TOP adds the solution for each of the selected groups to obtain the total solution for the object.

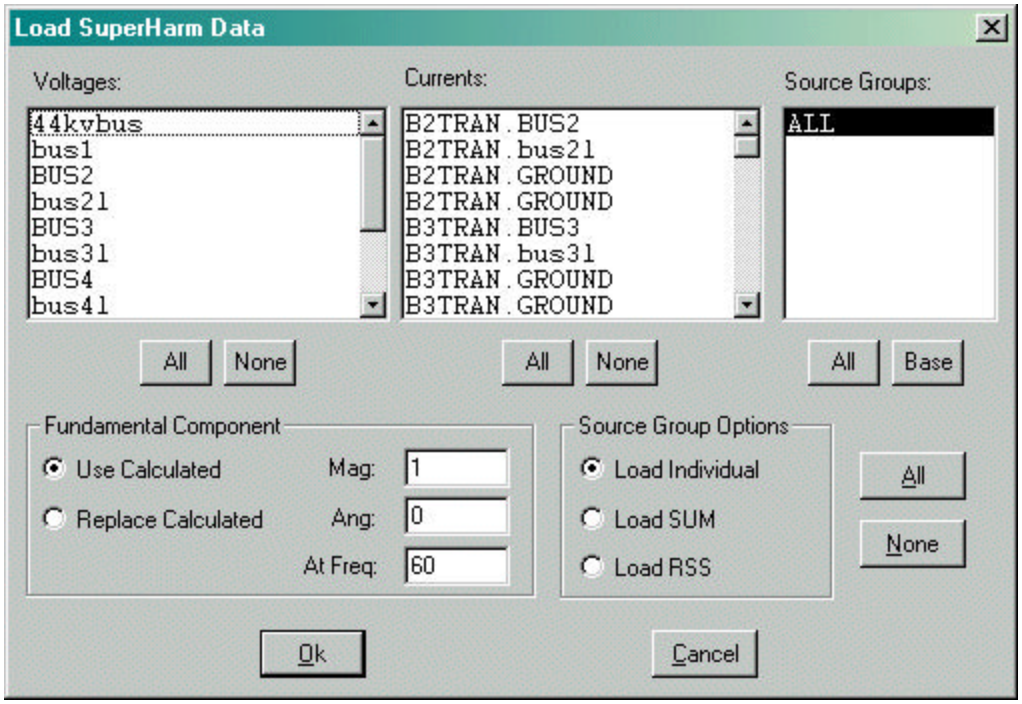


Figure A-4: TOP's Load SuperHarm Data Dialog

The Procedure

- Node voltages and device currents are displayed in separate list boxes. Select the desired items from each box. (Device current labels use the device name and the name of the terminal node, separated by a dot.)
  The **All** and **None** buttons under each list box select and unselect all quantities in the list. The **All** and **None** buttons in the lower left corner of the dialog box select/unselect all voltages *and* currents.
- If sources are grouped in the SuperHarm data file, select one or more groups in the **Source** list box. The **All** button selects all groups. The **Base** button selects the

first group in the list box. If sources are not grouped, the list box contains a single entry - ALL.

– If you are using source groups and have selected more than one group in step 2, select the desired **Source Option** radio button.

– **Load Individual:** TOP loads a solution for one group at a time. Suppose, for example, that you have selected only one quantity in step 1 - a node voltage called NODE1. If you select two source groups in step 2 - GROUP1 and GROUP2 - then selecting **Load Individual** will create the following objects:

Name1	Name2	Qualifier1	Qualifier2
(NODE1)		(GROUP1)	(BASE)
(NODE1)		(GROUP2)	(BASE)

The first object is the NODE1 voltage with the GROUP1 solution, the second is the NODE1 voltage with GROUP2 solution.

– **Load Sum:** TOP calculates each voltage or current through strict linear superposition using the source groups selected in step 2. For each node voltage or device current X, the value at each harmonic frequency is calculated as:

$$X = \sum_{G=Group1}^{GroupN} X_G$$

– If **Load Sum** were selected instead of **Load Individual** in the example given above, only one stack object would be created:

Name1	Name2	Qualifier1	Qualifier2
(NODE1)		(SUM###)	(BASE)

where ### is a number assigned by TOP to help you keep track of which sources are applied to which objects.

– **Load RSS**: This RSS (Root Squared Sum) method uses a modified linear superposition technique. It may be appropriate for cases where strict linear superposition is

too conservative. The fundamental component magnitude is calculated as the arithmetic average over all source groups. Each harmonic component is calculated as the RSS over all source groups:

$$X = \sqrt{\sum_{G=Group1}^{GroupN} X_G^{\,2}}$$

– If **Load RSS** were selected instead of **Load Individual** in the example given above, only one stack object would be created:

Name1	Name2	Qualifier1	Qualifier2
(NODE1)		(RSS###)	(BASE)

where ### is a number assigned by TOP to help you keep track of which sources are applied to which objects.

– If desired, you can re-specify a fundamental frequency component magnitude for the selected objects with the **Fundamental Mode** radio buttons. Select the **Replace Calculated** button to override the values calculated from the SuperHarm data. Enter the magnitude, phase angle, and frequency of the fundamental in the **Mag, Ang,** and **Freq** text boxes, respectively. TOP searches for a component at the frequency specified; if found, TOP replaces the magnitude, angle (in degrees) with the values you entered.

– The default button, **Use Calculated**, tells TOP to use fundamental values from the SuperHarm output file. If this button is selected, the magnitude, phase angle, and frequency text boxes should be left blank.

– Select ***OK*** or ***Cancel***.

V-HARM Objects

The procedure for loading V-HARM objects is similar to that for loading SuperHarm objects. There are two differences:

- V-HARM does not use source groups. In effect, TOP treats a V-HARM source as a group of one source. With this in mind, all comments made above concerning SuperHarm apply to V-HARM as well.

- The V-HARM **Stack, Load...** dialog box has a check box called **Harmonic Mode Solution**. This check box is required because TOP can't distinguish between V-HARM frequency scans and spectra. Unless the check box is set, TOP assumes that the objects being loaded are frequency scans.

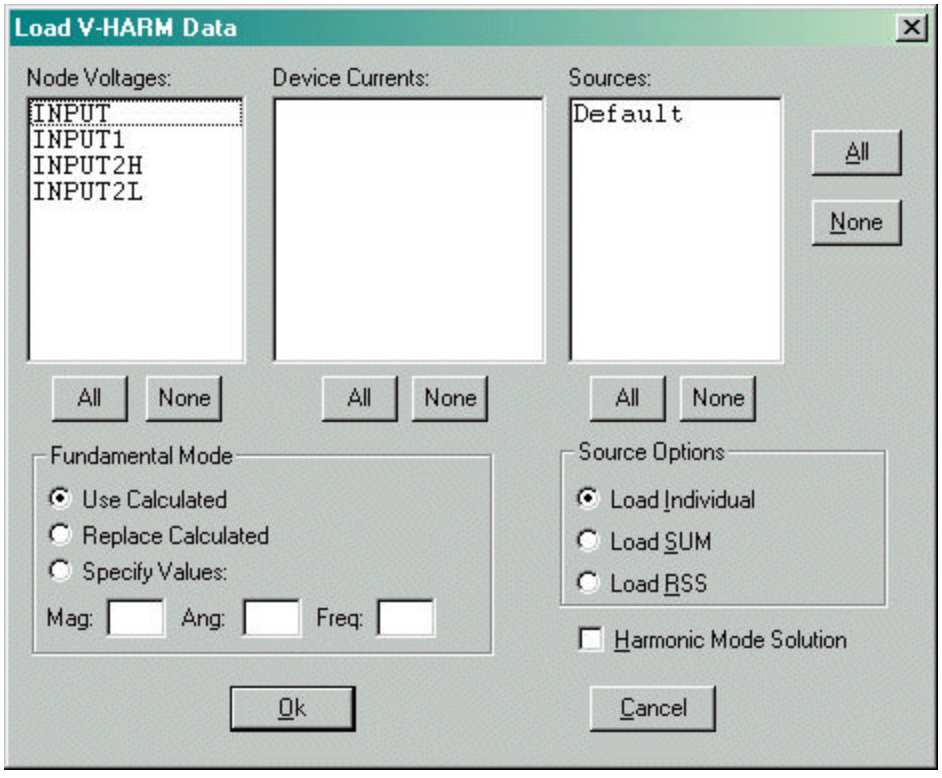


Figure A-5: TOP's Load V-HARM Data Dialog

Dranetz Objects

Before opening a Dranetz file in TOP, it is necessary to run the ASCII 65X.EXE converter. After running this, the file **must** be saved with a .DRZ extension. If this is not done TOP will not open the file. In TOP, when you load a Dranetz object with the .DRZ extension, the number of snapshot events is first counted. The following dialog box appears after the events are counted.

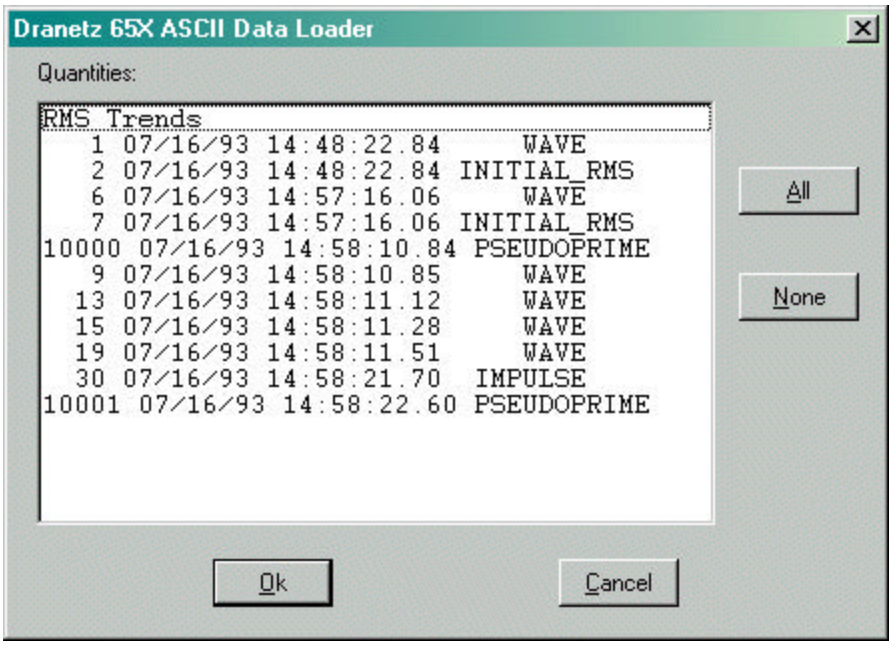


Figure A-6: TOP's Dranetz 65x ASCII Data Loader Dialog

Currently TOP will only allow WAVE, IMPULSES and RMS Trends to be loaded on the stack for a Dranetz object file. The loading procedure is the same as noted before. The name assigned to this type of object file is explained in the example below. Given an object file called DRANZ.DRZ with an impulse snapshot taken on channel B on July 16, 1993 at 2:58:22 pm:

Name1	Name2	Qualifier1	Qualifier2	Origin	Type
(34_B)	(IMPULSE)	(07/16/93)	(14:58:22)	(DERIVED)	(WAVE)

Name1: Event ID and Channel
Name2: Label of the graph, either IMPULSE or WAVE, given by TOP.
Qualifier1, 2: Date and Time of when the snapshot was taken by Dranetz.

FlukeView Objects

The load dialog boxes for FlukeView `F41` and `CUR` files are shown in Figure A-7 and A-8 respectively.

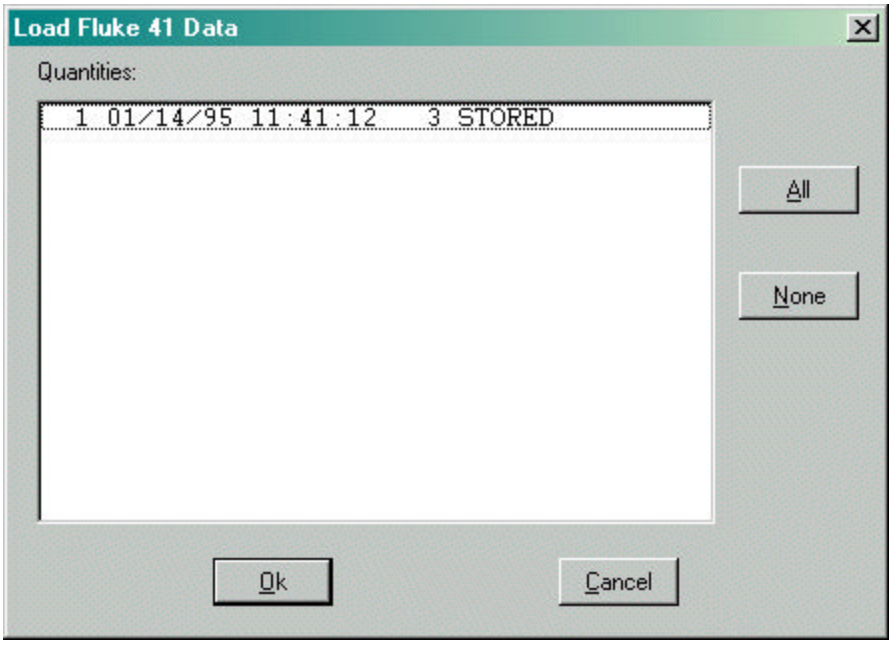


Figure A-7: TOP's Fluke 41 Data Dialog

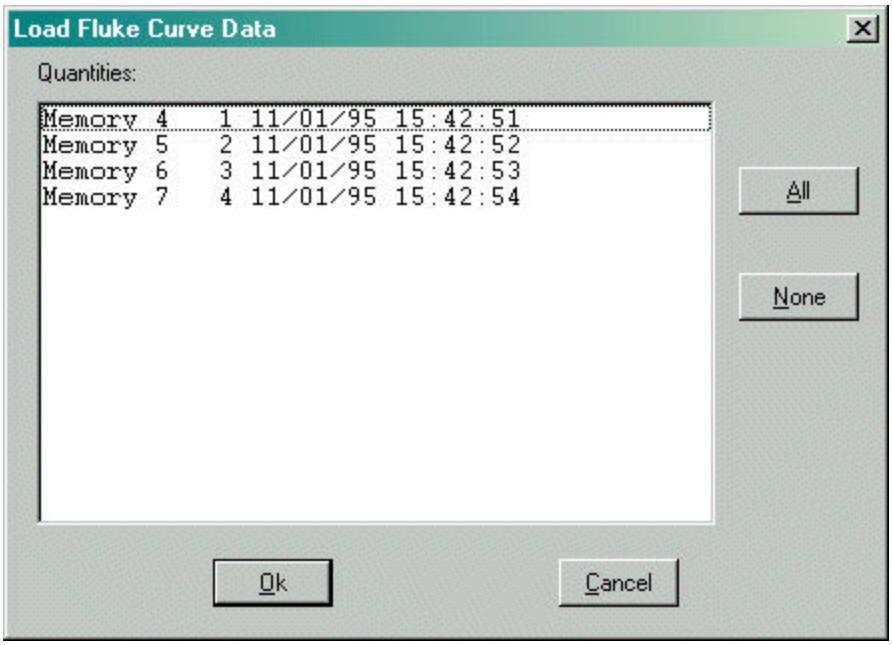


Figure A-8: TOP's Load Fluke Curve Data Dialog

If a FlukeView file called FLUKE_1.F41 is loaded with a snapshot of the current from memory channel 9. The following name will be assigned.

Name1	Name2	Qualifier1	Qualifier2	Origin	Type
(Memory 6)	(Amp_109)	(2/12/93)	(10:14:20)	(FLUKE_!)	(WAVE)

Name1: Eight characters of the title of the FlukeView graph.

Name2: Label of the graph, either Volts or Amps, followed by underscore(_) and the memory register.

Qualifier1, 2: Date and Time of when the graph was exported from Fluke software.

PQNode Objects

There is no dialog box for PQNode CSV files, as they contain only one object. When a CSV file is opened, TOP assigns a name to the object and then loads the object on the stack automatically. Loading a Cold Load Pickup or RMS disturbance will create two objects - a WAVE and a TRND. As an example, a PQNode plot file called WAVE1.CSV contains the waveforms of all phase voltages and currents for October 1, 1993 at 4:22:39 for node 1590. TOP would label the current for phase A as:

Name1	Name2	Qualifier1	Qualifier2	Origin	Type
(1590)	(IA_WF)	(10/01/93)	(04:22:39)	(WAVE1)	(WAVE)

IA - Phase A Current
WF - Waveform

Name1: Eight characters from the title of the PQNode plot.

Name2: phase voltage or current _ type of plot (defined below)

WF	Wave Fault Disturbance
RD	RMS Variation
TD	Trend
WV	Waveform Capture
IM	Impulse
CL	Cold Load Pickup

Qualifier1, 2 Date and Time of when the snapshot was recorded by the PQNode.

Square D / DADisp Objects

The Square D / DADisp filter automatically loads the files (DAT) to the stack. Once the file is opened you are ready to graph the files using **New Graph...** menu command.

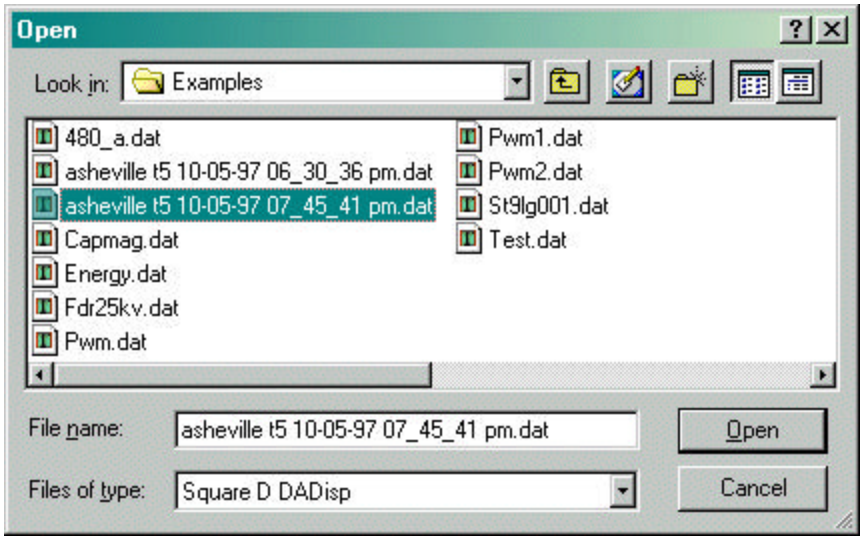


Figure A-9: TOP's Open Square D DADisp Dialog

SuperTran Objects

SuperTran writes output files with STO file extensions. The outputs include node voltages to ground, which appear in the left-hand list box shown in Figure A-10, and branch terminal currents, which appear in the right-hand list box shown in Figure A-10. The name of a SuperTran output current consists of the device name, followed by a period, and then the terminal name. The sign convention for currents is into the device.

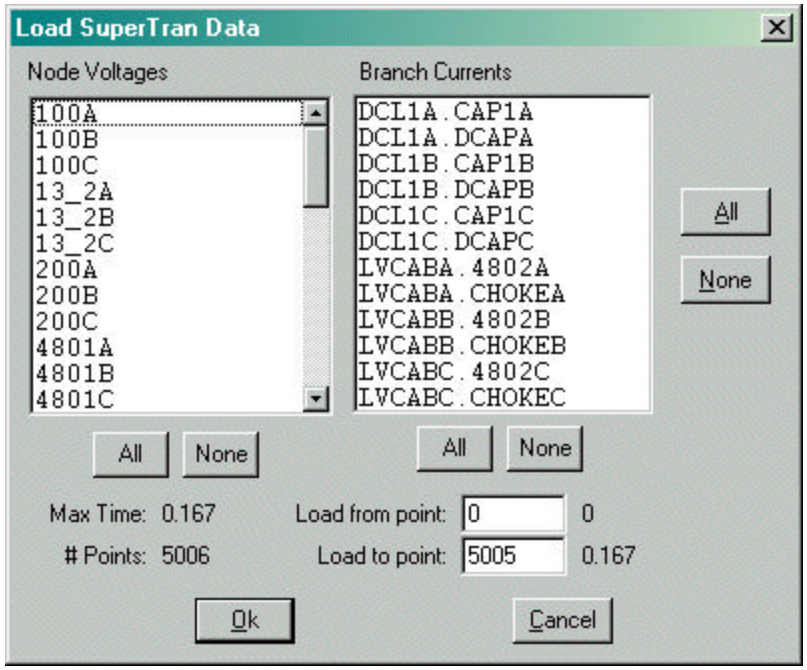


Figure A-10: TOP's Load SuperTran Data Dialog

Clicking an item in either list box toggles the selection state of that item. Quantities already loaded on the stack are highlighted in dark gray. Use the **All** and **None** buttons under either list box to select or unselect all items in that list box. Use the **All** and **None** buttons at the right to select or unselect all items in both lists. If you wish to load only part of the data for each waveform, you can edit the starting and ending point indices in the edit fields. By default, these edit fields are filled in to load all of the data. Click **Ok** to load the selected items, or click **Cancel** to dismiss the dialog without loading data.

EPRI Lightning Transients Objects

The EPRI Lightning Protection Design Workstation (LPDW) writes binary plot files in the same format as SuperTran, but with ELT file extensions. The Surge Analysis module of EPRI's Substation Design Workstation (SDWorkstation) also writes binary plot files in this format.

To obtain these outputs from LPDW, either set the menu toggle for saving plots in DFlash, or use the Export TOP button from a TFlash oscillograph window. The plot files from CFlash are saved automatically. You must launch TOP manually in order to plot these waveforms in TOP, although CFlash and TFlash have built-in plotting with less capability than TOP.

In **DFlash, line section flashover simulations** are saved in files named such as,

fo_project_linesect_median_pole#_pc.elt

fo_project_linesect_critical_pole#_pc.elt

where:

median is for the median stroke current to pole#, pc

critical is for lowest stroke current causing flashover

pole# is the pole number for the stroke location

pc is the wire designator for stroke location

Wire designators *pc* are

p can be A, B, C, N, or S

c is the circuit number if there are 2 or 3

Graph quantity names are like:

Ia #_pc

V #_pc

where:

is the pole number

pc is the phase and circuit (wire designator)

PG = pole ground current

Ia = arrester current

V = insulator voltage

In a line section flashover plot file, the waveform pole numbers will always include the struck pole (coded in the file name), and possibly one or more adjacent poles.

The **DFlash transformer protection simulation** writes a file named like

xf_project_pole design.elt

The struck pole is always number 2. The graph names are designated by

Ia, V = primary arrester current and voltage

PG = pole ground

HG = house ground current

X2 = transformer secondary X2 current

The **CFlash arrester simulations** are saved in a file named like:

CFlash case name.elt

The arrester discharge currents are named *Ia open, Ia riser,* etc. The node voltages to ground are named *V open, V riser, V xfmr,* and *V tap_AG.*

The **exported TFlash plot file** is always named like:

Tflash project name.elt

You may need to rename or copy this file to avoid overwriting it with subsequent export operations. The graphs are named like:

T1Vg = tower 1 base voltage

T11Vc = tower 1, phase 1 voltage to ground

T11Vi = tower 1, phase 1 insulator voltage

T1Ig = tower 1 ground current

T11Ia = tower 1 arrester current, phase 1

T11E = tower 1 arrester energy, phase 1

SDWorkstation creates plot files automatically, when simulating incoming lightning surges. The base file name is supplied by the user when initiating the analysis for a specific bus voltage level in the substation. The incoming surge is applied to each line

entrance at that voltage level and saved in files *basename_1*, *basename_2*, etc. The outputs include arrester discharge currents, arrester node voltages, and insulator node voltages corresponding to equipment terminals in the substation. SDWorkstation launches TOP automatically upon completing the surge analysis.

The quantities in TOP are indicated by SDWorkstation component numbers. To match these component numbers with user-defined labels, consult the text output of severity index in SDWorkstation's transient analysis results. In the example below, taken from an SDWorkstation tutorial example, component 44:1 is an arrester at bus voltage level 1. Component 24 is a closed circuit breaker at voltage level 1. If it were open, there would be two output voltages for this breaker, designated 24:1 and 24:2. Component 26 is a transformer with terminals at two different bus voltages; one of these voltage waveforms will be zero. The transformer is modeled with a capacitor/insulator, and will not transfer surges between voltage levels.

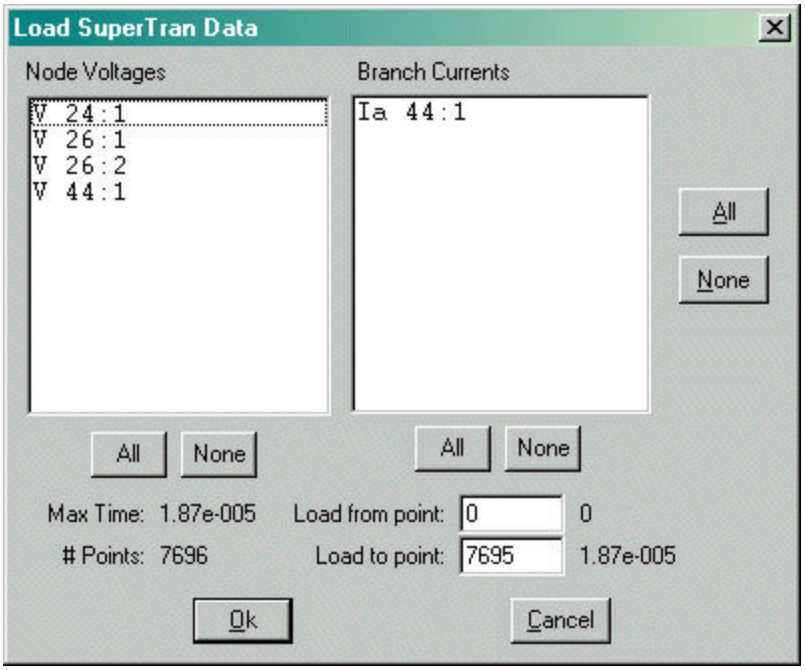


Figure A-11: TOP's Load SuperTran Data Dialog for EPRI Lightning Transients Output

PQDIF Objects

The Power Quality Data Interchange Format (PQDIF) is a draft IEEE standard (P1159-3 D2) for exchanging transients, harmonics, and steady-state power quality data. PQDIF stores records in a hierarchy shown in Figure A-12, with record-level compression for space efficiency.

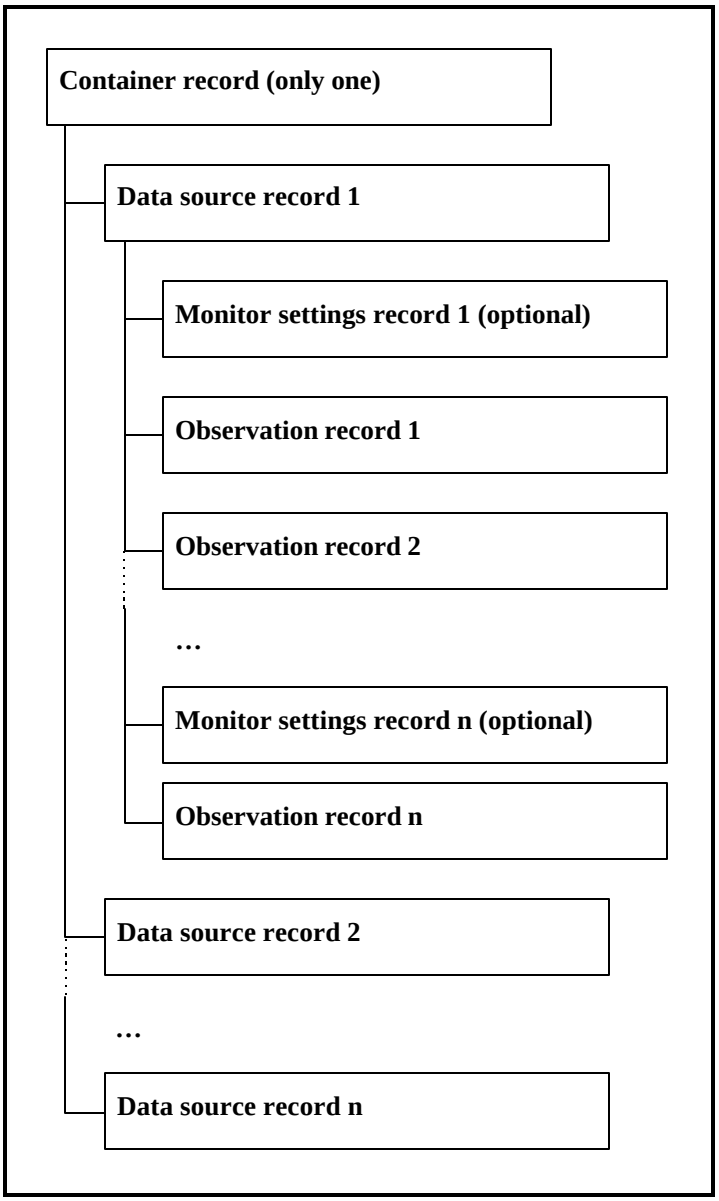


Figure A-12: PQDIFF Record Layout

The levels in the hierarchy are:

- **Container** – a top-level collection of data sources.

- **Data Source** – similar to a "sub-file", typically contains data from one instrument or one simulation program study. The Data Source record contains the channel definitions for subsequent observation records. Typically a waveform channel definition will have two series definitions for the X and Y variables. Subsequent channel definitions can refer back to series defined in earlier channel definitions, for example, to share a time or frequency scale.

- **Monitor Settings** – nominal voltage, transducer ratio, and calibration data for instruments. Typically not used for simulation program outputs.

- **Observation Record** – contains the actual data for one instrument trigger, one simulation case, etc. The observation record refers to the currently active channel definitions and monitor settings.

Note that several Data Sources may appear in the same file, and that several Monitor Settings records may appear in the same Data Source. These are both time stamped for the date they become effective.

Several power quality instrument vendors provide an option to write data in PQDIF format. This allows you to more easily analyze instrument data from different vendors. TOP comes with a utility program to create PQDIF files from text data files. This program is installed under "Text-to-PQDIF" in the same Start menu folder as TOP. The help file and examples for this utility describe how to convert a tabular text data file to PQDIF.

When you load a PQDIF file in TOP, the dialog appears as shown in Figure A-13. First, select a **Data Source** from the combo box at the top of the dialog. The Data Source name, rather than the containing file name, will appear in the name of any stack objects loaded. To avoid naming conflicts, you can replace this data source name by entering a new name in the edit field below the combo box.

A PQDIF data source can store the nominal value for each series along with the channel definitions, or with each observation. The **Normalization** radio buttons allow you to set

the base quantities in TOP from either the channel definition or observation record, so long as the PQDIF nominal values are greater than zero.

Once you select a data source from the combo box, the two boxes for series definitions and observations fill with corresponding data. The observation list box is extended selection, so you can **Shift-Click** or **Ctrl-Click** the mouse to select multiple items from the list. Shift-click selects a range of contiguous items, while ctrl-click toggles the selection state of non-contiguous items. The series definitions tree allows for multiple selection by clicking on the check boxes to the left of an item. When an item is selected or deselected, all items below it will also be selected or deselected. The **All** and **None** buttons below each box will select and unselect all items in the corresponding box.

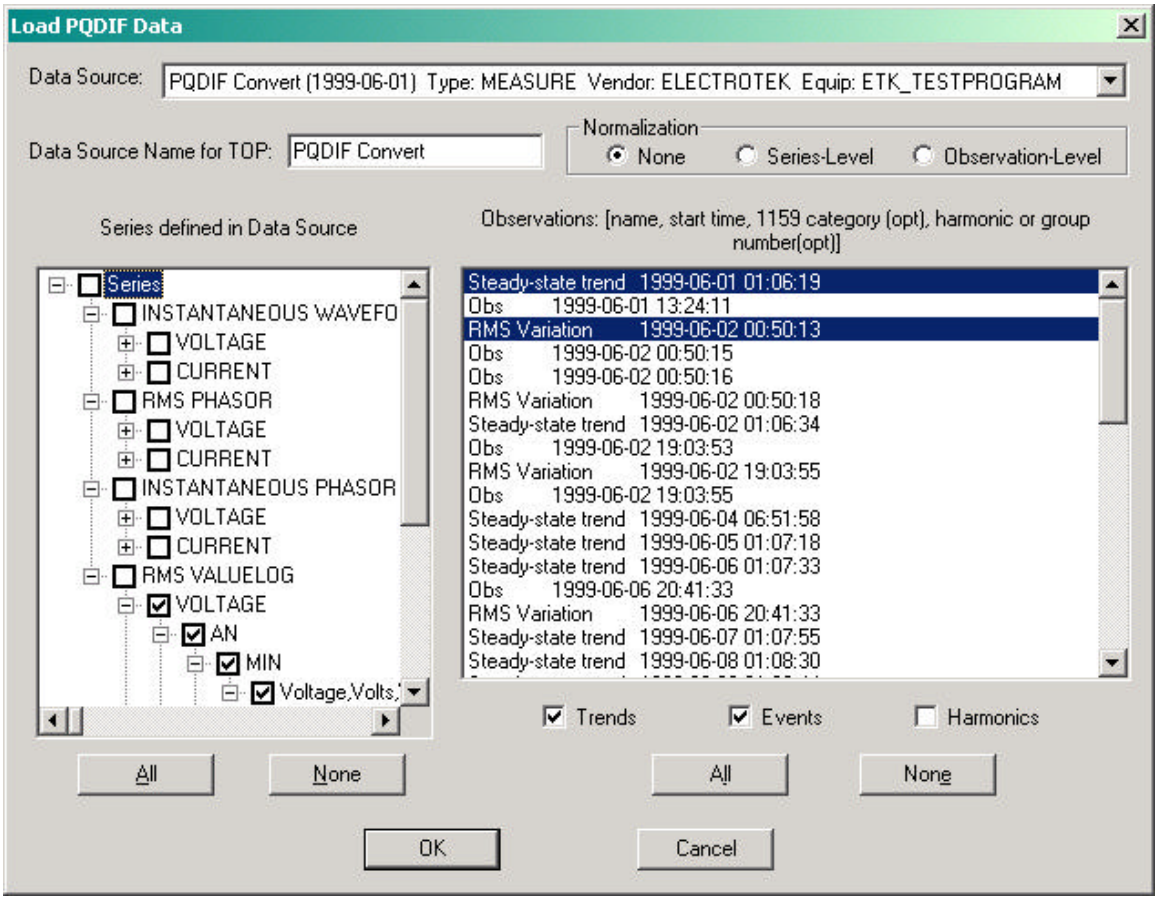


Figure A-13: TOP's Load PQDIF Data Dialog

The tree of "series definitions" comes from the channel definitions in the selected data source. Each dependent variable in a channel definition appears as a series in this list box, while the independent variables are not shown in the list. The levels are defined as follows: quantity type and characteristic of the series; quantity measured; phase; series

value type; units; nominal. The information in the tree comes from required or optional PQDIF tags in the file, and helps to identify each series.

The list box of observations displays a name and time stamp for each observation in the file. The name need not be unique, but the time stamp generally will be. Some instruments and software may categorize the observation by IEEE 1159 category, and if present, this tag will be shown in the lower list box. Some instruments may record harmonic data, this tag will be displayed when available.

When you click **Ok**, TOP will attempt to load all selected series definitions for all selected observations. A PQDIF data source may contain a number of channel definitions, not all of which need be used in a specific observation record. The observation records can be mixed steady-state trends, waveforms, harmonic spectra, etc. In Figure A-13, a steady-state and waveform observation has been selected along with a steady-state series definition. This will result in loading only the steady-state data, because the waveform series definition has not been selected. By selecting **All** series definitions, and then clicking **Ok** with the observations selected, a total of 42 steady-state trends are loaded into TOP. The dialog shown in Figure A-14 shows a partial list of channels that were loaded.

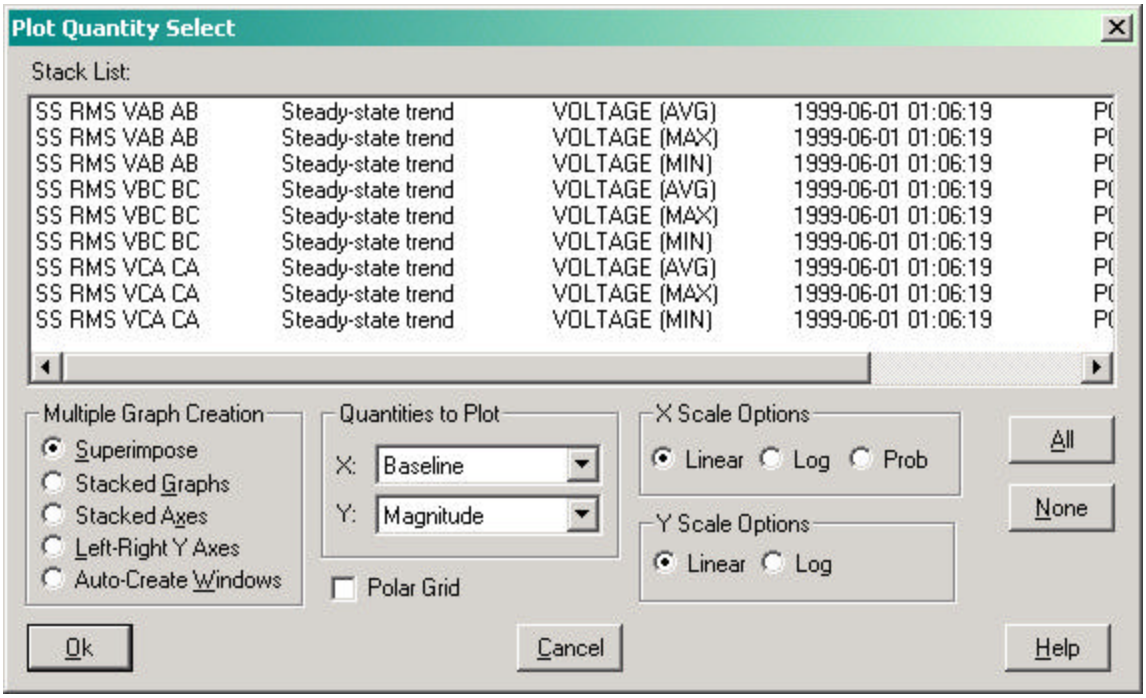


Figure A-14: TOP's Plot Quantity Select Dialog with PQDIF Data Loaded

The names that TOP constructs for PQDIF objects contain

- Series Name plus Phase Designator
- Observation Name
- Quantity Measured, plus Min/Max/Avg value type designator if applicable
- Observation Time Stamp
- Data Source Name
- Stack Object Type
  (TRND, WAVE, SPEC, HIST, PROB, XY, MAGDUR, or HIST3D)

The types of stack objects that TOP will create for each PQDIF quantity type are

PQDIF Quantity Type	**TOP Stack Object Type**
CPF	PROB
FLASH	not supported
HISTOGRAM	HIST
HISTOGRAM3D	HIST3D
MAGDUR	MAGDUR
MAGDURCOUNT	TRND
MAGDURTIME	TRND
PHASOR	TRND
RESPONSE	SPEC
VALUELOG	TRND
WAVEFORM	WAVE
XY	XY
XYZ	XY (two instances for Y and Z)

In the current version of PQDIF, it is not possible to distinguish between SPEC and SCAN objects.

APPENDIX B

Text-to-PQDIF Conversion

TOP comes with a utility program that converts text files to the Power Quality Data Interchange Format (PQDIF). The text data must be organized like a spreadsheet, with each sample in its own row. Several files with the same column definition may be converted to a single compressed PQDIF file.

You can also export PQDIF directly from TOP, using the **File, Export…** menu command.

[page intentionally left bank]

Overview of Text-to-PQDIF Utility

The Text-to-PQDIF utility provides a convenient way of making Power Quality Data Interchange Format (PQDIF) files from text data files. The premise is that you will have one or more text data files organized in a row and column format. After providing a definition for each column, the software will convert each text file to PQDIF and write them to a single output file, using record-level compression. Thus, the output is efficient in terms of both file size and the number of output files (i.e., one).

The output is PQDIF version 1.5, which is not backward compatible with PQDIF version 1.0. All of the required tags are supported. Several optional tags are supported, for user comments and for the WPT Signature System™ characterizer. Most of these optional tags can be left alone if not used, or selected from combo boxes. The user interface includes several combo boxes that make it simple to select only valid PQDIF identifiers. Some of the required tags, such as compression type, file creation time, and language are set to default values without user input. The goal was to provide a simple method of generating valid PQDIF files.

In the text input, each data point must be separated with a line feed. Each row must have the same number of columns. If you are converting multiple files, each file must have the same number of columns but need not have the same number of rows. Each column must be separated with white space, a comma, a colon, or a semi-colon.

The software comes with two sample text input files, sie7100_01.csv and sie7100_02.csv, and a default configuration file that matches the sample files. The sample text files contain 9 columns; the first column is for time and the remaining 8 columns are voltage and current data for phases A, B, C, and Neutral. The first time you run the software, you can review how the column definitions are provided on the Series Page. After defining the series, use the File Controls to specify the input and output files for conversion.

The series definitions and other configuration data are saved automatically in a file ***txt_pqdif.cfg***, and reloaded when you run the program again. You can also save configurations to different file names, and re-load them in a later session.

File Controls

The main program window, shown in Figure B-1, contains file management controls in the top half, and tabbed pages for configuration in the bottom half. The list boxes and buttons above the tab pages allow you to specify the configuration file, the text input files, the PQDIF output file, and perform the conversion.

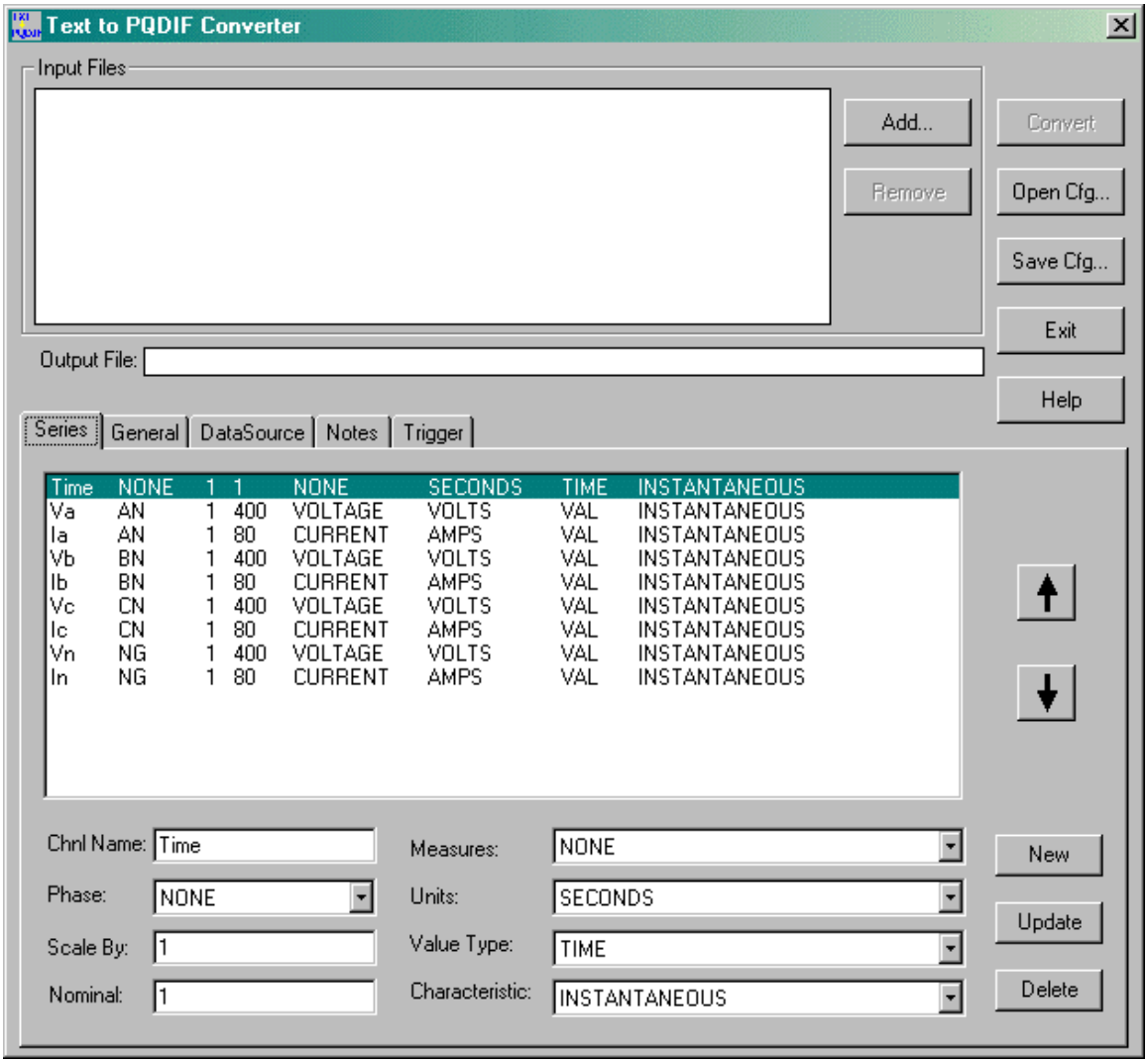


Figure B-1: Main Window in Text-to-PQDIF Converter with File Controls and Series Tab Page

Input Files – each file in this list box will be included in the output PQDIF file. Each of these files must have the same organization, including column order and definition from the Series Page, and supplemental input as defined by check boxes on the General Page. You can multi-select items in this list box to remove.

Output File – type a PQDIF output file name in this edit control. If necessary, the software will add a file extension of .pqd. Any existing file will be overwritten without warning.

Add – invokes a File/Open dialog, from which you can select one or more text input files to convert. These are added to the input file list box.

Remove – deletes all selected items from the input file list box. Enabled when there is at least one item in the input file list box.

Convert – converts each of the listed input files, and writes them to one PQDIF file. You will see an acknowledgement dialog when the conversion is finished. Enabled when there is at least one item in the input file list box.

Open Cfg – reads the channel definitions and other settings from a file with extension .cfg, and updates all of the tab pages. When you start the program, the configuration is automatically read from txt_pqdif.cfg.

Save Cfg – saves the current channel definitions and other settings to a file you specify, with a file extension .cfg. When you exit the program, the current configuration is automatically saved to txt_pqdif.cfg.

Exit – exits the program.

Help – opens this help file on the active tab page.

Series Page

This page, shown in Figure B-1, allows you to edit, add, and delete channel and series definitions corresponding to the data columns in your text files. There must be one, and only one, series definition for each column in your text file. The sample configuration that comes with the software has 9 data columns and 9 series definitions, but the first one is for time. Thus, there are only 8 "channels" in PQDIF terms. In most cases you will have to specify a series for the independent variable, which will not be a "channel" on its own. You can also use the Auto X Increment feature instead of providing independent variable data in the file, in which case each of your series will also be a channel.

List box – there will be one text string describing each of your series definitions. When you select a list item, the edit controls and combo boxes underneath the list box update with data for that series definition, so that you can edit it. The order of definitions in this list box must match the order of columns in your text files.

 – click these buttons to move the selected list item up or down in the order.

New – adds a new item to the end of the list, copying data from the edit controls and combo boxes.

Update – updates the selected list item to reflect any changes made in the edit controls and combo boxes. You must use this button to commit any changes.

Delete – deletes the selected list item.

Chnl. Name – enter a unique name for the channel. Each dependent variable series that has the same channel name will be collected into the same channel definition. Two additional sample files, rmsvar.cfg and rmsvar.csv, illustrate how to define the series for min, max, and average RMS values of a voltage channel.

Phase – pick the phase connection from the combo box. This should be NONE for the time series.

Scale by – enter a scaling value for the data in this series. If not equal to 1, the data is scaled before output, so the scaling factor does not appear in the PQDIF output.

Nominal – enter a base quantity for the series. Enter the instantaneous value for waveform channels and the RMS value for phasor or valuelog channels. This is stored in both the monitor settings and observation data in the PQDIF output, and it is required for the WPT Signature SystemTM characterizer.

Measures – pick a PQDIF tag from the combo box. For waveform data, typical selections would be NONE for time, VOLTAGE, or CURRENT.

Units – pick a PQDIF tag from the combo box.

Value Type – pick a PQDIF tag from the combo box. For waveform data, this would be either TIME or VAL.

Characteristic – pick a PQDIF tag from the combo box. For waveforms, this would be INSTANTANEOUS.

General Page

This page, shown in Figure B-2, allows you to set some input file options and general parameters.

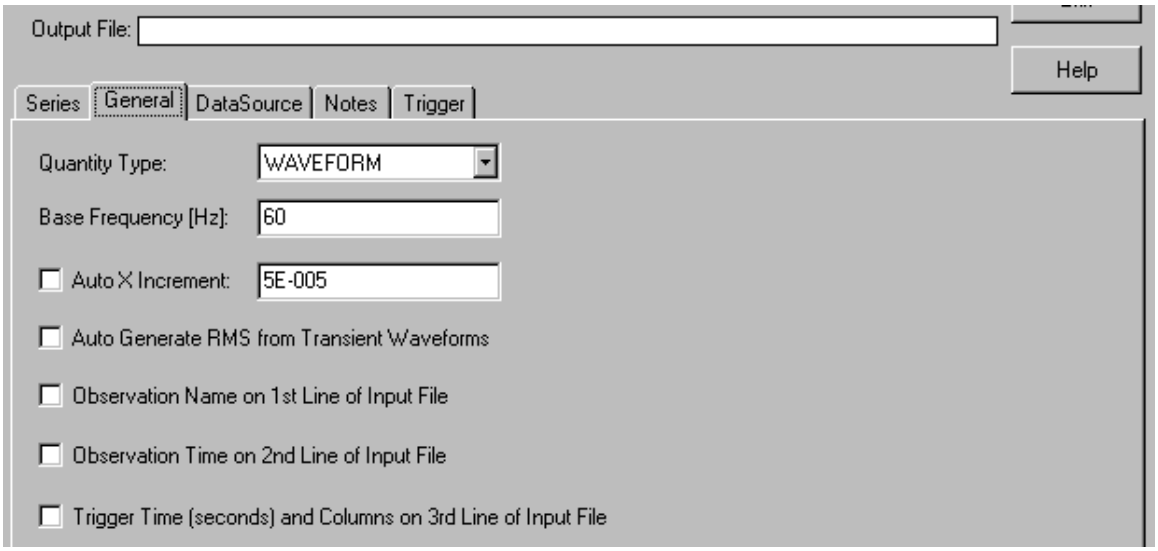


Figure B-2: General Tab Page in the Text-to-PQDIF Converter

Quantity Type – select a type such as WAVEFORM or VALUELOG. You may not mix types in the output from this program.

Base Frequency – enter the base frequency for the instrument or simulation, typically 60 Hz. This value is needed by the WPT Signature System™ characterizer.

Auto X Increment – set this check box and enter a time step if your text files do not include a column for time (or other independent variable). The first data point will start at time zero, and increment by the value specified.

Auto Generate RMS from Transient Waveforms – set this check box to generate RMS minimum, maximum, and average traces from transient waveforms. A simulated RMS sample is generated every half cycle of the base frequency. Enter instantaneous nominal values for each series; these will be converted to RMS in the generated channels. The minimum, maximum, and average traces will be identical. The WPT Signature System™ characterizer expects to receive these RMS channels, along with transient waveforms, for RMS variations.

Observation Name on 1st Line of Input File – set this check box if you wish to enter an observation title at the top of each text file. If not active, the observation name will be the text file name.

Observation Time on 2nd Line of Input File – set this check box if you wish to enter the observation time in the form year-month-day hour:minute:seconds on the second line of the input files. The year should be four digits, the month ranges from 1 to 12, and the hour ranges from 0 to 23. All values are integers, except for seconds, which may be a real number. The value is taken as local time, and then converted to UTC for the output. If not specified, the observation time will be the time that the text file was converted to PQDIF.

Trigger Time (seconds) and Columns on 3rd Line of Input File – set this check box if you wish to specify channels that triggered for each observation on the third line of text input; this is the only way to specify trigger time and channels. First specify the trigger time in seconds relative to time zero in the record. Then specify one or more column numbers for the channel(s) that triggered – the column numbers start with zero. If no trigger channels are specified, the observation trigger method will be "none".

Text file input for these last three check boxes must appear in the order specified, but some check boxes may be omitted. For example, you can set the check boxes for name and trigger, and leave the check box for observation time inactive. The first line of each text file must then contain an observation name, and the second line must contain the trigger information.

Sample

Shown below are the first five lines of an input file with all three check box options active. The fourth and fifth lines of input are the first two data points in the record. Column zero is the time, and there are eight more columns of voltage and current data. The first line of input is an observation title. The second line of input is a local date and time in the proper format (August 10, 1999 around 4:30 p.m.). The third line of input indicates the trigger point was 0.01 seconds into the waveform, and that column 1 triggered (column 1 is the first column of actual data, after the time values, with value –335.346222 at time zero).

```
Observation Name Goes Here
1999-8-10  16:30:40.837
0.01 1
0,-335.346222,-39.014793,-16.051914,24.972294,352.31546,7.794848,0.483208,0
0.00013,-323.266022,-39.50248,-35.508781,24.972294,360.486481,10.230739,0,0
```

Data Source Page

This page, shown in Figure B-3, allows you to enter summary information for the output PQDIF file. The first tag, for datasource name, is required in PQDIF. The other tags are optional, but have been provided as a convenience.

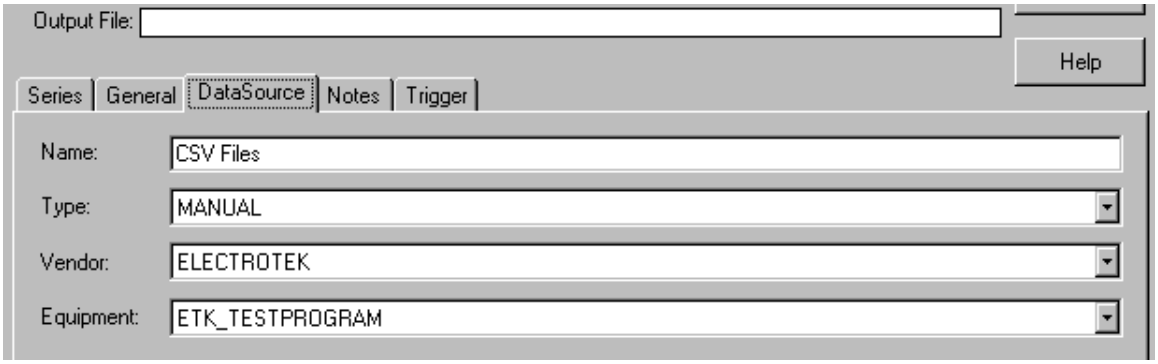


Figure B-3: Datasource Tab Page in the Text-to-PQDIF Converter

Name – enter a descriptive data source name; this is a required PQDIF tag. Note that each observation (text file) can also have its own name.

Type – pick a PQDIF tag from the combo box.

Vendor – pick a PQDIF tag from the combo box.

Equipment – pick a PQDIF tag from the combo box.

Notes Page

This page, shown in Figure B-4, allows you to enter comments into the PQDIF output file. All of these tags are optional in PQDIF, but have been provided as a convenience.

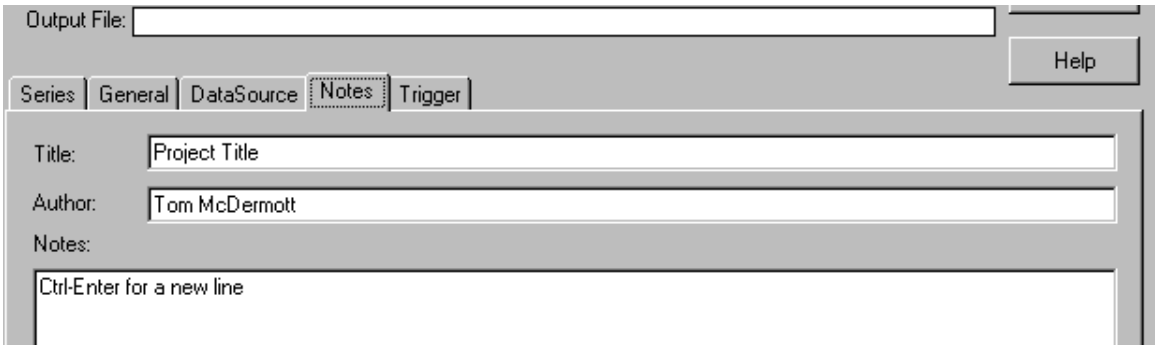


Figure B-4: Notes Tab Page in the Text-to-PQDIF Converter

Title – enter descriptive information.

Author – enter a name.

Notes – enter one or more lines of description. Use Ctrl-Enter to insert line breaks in this edit control.

Trigger Page

This page, shown in Figure B-5, allows you to enter trigger levels for each series definition. The trigger data is optional, but should be entered if your data comes from an actual instrument, or if the PQDIF output will be processed in the WPT Signature System™ characterizer.

If the data is from simulation, the trigger levels can usually be left at the default zero values. In that case, the trigger type in the PQDIF monitor settings will be ID_TRIG_NONE.

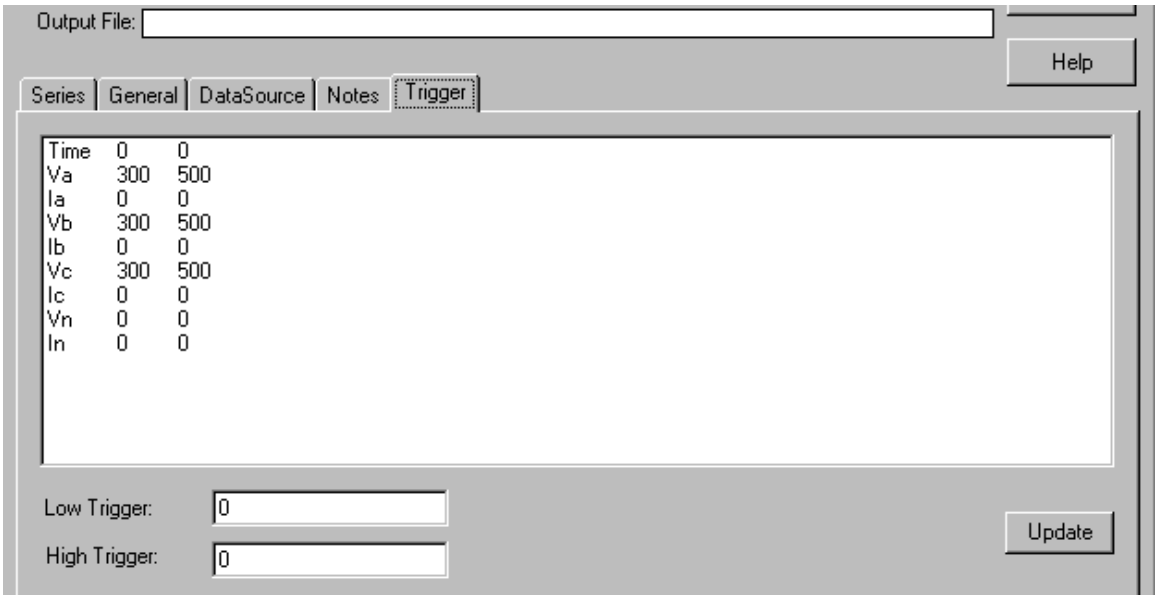


Figure B-5: Trigger Tab Page in the Text-to-PQDIF Converter

List box – contains the channel name, low trigger level, and high trigger level. This list box is synchronized with the Series Page; you cannot add or delete a series definition, nor change the channel name, on the Trigger Page. Selecting an item from the list box updates the edit controls for trigger levels, so you can edit them.

Update – updates the selected list item to reflect any changes made in the edit controls. You must use this button to commit any changes. All series definitions that have the same channel name will be updated together, so that they always have the same trigger levels.

Low Trigger– sets the trigger level for sags. Enter the instantaneous level for waveform channels, and the RMS level for phasor and valuelog channels. If greater than zero, the trigger type in the PQDIF monitor settings will include ID_TRIG_LOW.

High Trigger – sets the trigger level for swells. Enter the instantaneous level for waveform channels, and the RMS level for phasor and valuelog channels. If greater than zero, the trigger type in the PQDIF monitor settings will include ID_TRIG_HIGH.