

INFFIELD

USER MANUAL

dmodes.sif - Strain a1

Time(sec)
dmodes.sif - Strain a23

Time(sec)
dmodes.sif - Strain b6

SOMAT[®]

This manual is for use with SoMat Corporation InField Software. This information is subject to change at any time.

SoMat Corporation makes no warranties, expressed or implied, that the information described in this manual is free from error or is consistent with any particular standard of merchantability, or that it will meet your requirements for any particular application. These products should not be relied upon to solve a problem where an incorrect solution could result in injury to a person or loss of property. SoMat Corporation disclaims all liability for direct or consequential damages resulting from your use of this information.

InField User's Guide: © 2003, SoMat Corporation. All Rights Reserved.
InField Software: © 2003, SoMat Corporation. All Rights Reserved.

No parts of this document may be copied or reproduced in any form or by any means without prior written consent of SoMat Corporation.

The SoMat logo is registered trademark of SoMat Corporation. InField is a trademark of SoMat Corporation. All other product names and trademarks mentioned herein are the property of their respective owners.

For more information, please contact SoMat Corporation or your sales representative.

SoMat Corporation
PO Box 2457
Champaign, IL 61825-2457
Phone: 217-328-5359
Fax: 217-328-6576
Email: info@somat.com
Web: www.somat.com

SoMat Systems (UK) Ltd.
230 Woodbourn Road
Sheffield
South Yorkshire S9 3LQ
United Kingdom
Phone: +44 (1922) 42 1769
Email: info-uk@somat.com

About InField and This Guide

Selecting Data	1
Viewing Data	1
Editing Data	1
Data Validation	1
Exporting Data	2
Exporting Plots	2
About this Manual	2
Contents of this Manual	2
Conventions Used	3

Installation

Computer Requirements	4
Software Installation	4
Installation Procedure	4
Re-Installation of InField	5

Start-up and Application Window

Starting InField	6
Passwords	6
Quitting InField	6
InField Application Window	7
Channels List Window	8
Channels List tab	8
Output List tab	8
InField Menus	9
File Menu	9
Edit Menu	9
Display Menu	10
Tools Menu	10
Window Menu	10
Help Menu	11
InField Toolbars	11
Application Toolbar	11
Channels List Toolbar	13

Selecting Data

Channels List	15
Accessing the Channels List	15
Channels List Right-Click Menu	16
Channels List Configuration	16
Adding Columns	17
Removing Columns	17
Move up/Move down	17
Buttons	17
Resizing Columns	18
Viewing Channels by Criteria	18
Loading Channels	18
Selecting Data	19
Selecting Channels from the Channels List	19
Selecting Channels Using the Mouse	20
Selecting Single Channels	20
Selecting Multiple Channels	20
Selecting Channels Using the Keyboard	20
Selecting Single Channels	20
Selecting Multiple Channels	20

Viewing Data

Data Windows	21
Plotting Data	22
Plotting One Channel	23
Single Plot	23
Plotting Multiple Channels	24
One Plot Per Window	24
Multi Plot	24
Over Plot	25
Cross Plot	26
Zoom	27
Selecting a Range of Values	27
Range of X Values	27
Range of X and Y Values	28
Zooming	28
Scrolling Data	28
Export Plot	28
Export Format	28
Buttons	29

Viewing Data Points	29
Selecting a Data Point	29
Cursor Movement Using the Keyboard	29
Viewing Data Points in a Single Plot	30
Viewing Data Points in a Multi Plot	30
Viewing Data Points in an Over Plot	31
Viewing Data Points in a Cross Plot	31
Viewing Data Points in a Histogram Plot	32
Tabular Data Display	33
Viewing Metadata	34
Arranging Windows	36
As a Group	36
Individually	36
Printing	37

Editing Data

Plot Configuration	38
Scale Axes To	38
Plot Font	39
Spreadsheet Information	39
Buttons	40
Delete Data	40
Interpolate	40
Poke	41
Buttons	41
Scale and Offset	41
Buttons	42
Edit Metadata	42
Editing Modes	42
Saving changes to Metadata	43
Saving modified channels for use in future sessions of InField	43
Buttons	43

Saving Data Files

Saving an Active Data Set to a File	44
Available File Formats	44
Selecting Data to be Saved	44

Validation Tools

General Information	45
Script Player	45
Statistics	45
Signal Calculator	45
DataModes	45
Time History	46
Burst History	46
Peak Valley	46
Peak Valley Matrix	46
Rainflow	47
Time-At-Level	47
Fatigue Damage Calculator	47
Strain Life Fatigue Analysis	48
Stress Life Fatigue Analysis	48
Load Life Fatigue Analysis	48
Weld Life Fatigue Analysis	48
Crack Growth Fatigue Analysis	49
Filtering	49
Digital Filter Design	49
Resampling	49
Upsampling	49
Frequency Analysis	50
AutoPower Spectrum Analysis	50
FRF (Frequency Response Function)	50
FFT (Fast Fourier Transform)	50
IFFT (Inverse Fast Fourier Transform)	50
Rosette Analysis	50
Relative Damage Comparitor	51
Script Player	51
Buttons	51
Statistics	52
Evaluations	52
Parameters	52
Buttons	53
Signal Calculator	53
Creating Trigger Channels	53
Parameters	54
Channel Definition	54
Equation Definition	55
Input Channels	55
Operators	55
Buttons	56

Rosette Analysis	57
Parameters	57
Gage and Material Information	57
Angles	58
Rosette Output Options	58
Buttons	58
Relative Damage Comparator	59
Parameters	59
Outputs	59
Buttons	60
Derivation of Relative Life	61
Derivation of Relative Life (continued)	62

DataModes

General Information	63
Time History	63
Burst History	63
Time-At-Level	63
Peak Valley	63
Peak Valley Matrix	63
Rainflow	63
Use of Triggers	64
Analysis Procedure	64
Time History	65
Data Analyzed	65
Parameters	65
Triggering	65
DataMode Properties	66
Buttons	66
Burst History	66
Data Analyzed	66
Parameters	67
Triggering	67
DataMode Properties	67
Buttons	68
Peak Valley	68
Data Analyzed	68
Parameters	69
Triggering	69
DataMode Properties	69
Buttons	69

Peak Valley Matrix	69
Data Analyzed	70
Parameters	70
Triggering	70
DataMode Properties	71
Buttons	72
Rainflow	72
Data Analyzed	72
Parameters	73
Triggering	73
DataMode Properties	74
Buttons	75
Time-At-Level	75
Data Analyzed	75
Parameters	76
Triggering	76
Buttons	77
Triggering Considerations	77
Triggering Overview	77
Trigger States	78
Standard Triggers	78
Burst Triggers	78
Editing Bin Information	79
Parameters	79
DataMode Properties	79
User Bin Table	80
Buttons	80

Fatigue Calculator

Load Life Fatigue	81
Parameters	81
Parameters	81
Component	82
Constant Amplitude	82
Buttons	82
Load Life Fatigue - Details Dialog	83
General	83
Component Properties	83
Output Options	84
Load Life Fatigue - Constant Amplitude (CA) Prediction Dialog	84
Load Life Estimate	84
Component Properties	84

Load Life Fatigue Report	85
Load Life Estimate	85
Input Channel Information	85
Component Properties	86
Stress Life Fatigue	86
Parameters	87
Parameters	87
Material	87
Constant Amplitude	87
Buttons	87
Stress Life Fatigue - Details Dialog	88
General	88
Material Properties	89
Output Options	89
Stress Life Fatigue - Constant Amplitude (CA) Prediction Dialog	89
Stress Life Estimate	90
Stress Life Parameters	90
Material Properties	90
Stress Life Fatigue Report	91
Stress Life Estimate	91
Input Channel Information	91
Stress Life Parameters	92
Material Properties	92
Strain Life Fatigue	92
Parameters	93
Parameters	93
Material	93
Constant Amplitude	94
Buttons	94
Strain Life Fatigue - Details Dialog	95
General	95
General Material	96
Tensile Strain Life	96
Shear Strain Life	96
Output Options	96
Strain Life Fatigue - Constant Amplitude (CA) Prediction Dialog	97
Strain Life Estimate	97
Strain Life Parameters	98
Stresses and Strains	98
Material Properties	98

Strain Life Fatigue Report	99
Strain Life Estimate	99
Input Channel Information	100
Strain Life Parameters	100
Stresses and Strains	100
Component Properties	100
Weld Life Fatigue	102
Parameters	102
Parameters	102
Weld Class	102
Constant Amplitude	103
Buttons	103
Weld Life Fatigue - Details Dialog	104
General	104
Weld Class Properties	104
Output Options	105
Weld Life Fatigue - Constant Amplitude (CA) Prediction Dialog	105
Weld Life Estimate	106
Weld Component Properties	106
Weld Life Fatigue Report	107
Weld Life Estimate	107
Input Channel Information	108
Weld Component Properties	108
Crack Growth Fatigue	109
Parameters	109
Parameters	109
Material	111
Constant Amplitude	111
Buttons	111
Crack Growth Fatigue - Details Dialog	112
General	112
Crack Geometry	112
Material Properties	113
Output Options	113
Crack Growth Fatigue - Constant Amplitude (CA) Prediction Dialog	114
Crack Growth Estimate	114
Crack Growth Parameters	114
Material Properties	115
Crack Growth Fatigue Report	116
Crack Growth Estimate	116
Input Channel Information	116
Crack Growth Parameters	117
Material Properties	117

Material Properties	118
Parameters	118
Spreadsheet Information	118
Parameters	119
Buttons	119

Frequency Analysis

Analysis Procedure	120
AutoPower Spectrum Analysis	121
Data Analyzed	121
Parameters	121
Buttons	123
FRF (Frequency Response Function) Analysis	123
Parameters	124
Buttons	125
FFT (Fast Fourier Transform) Analysis	125
Parameters	126
Buttons	126
Inverse FFT (Fast Fourier Transform) Analysis	127
Parameters	127
Buttons	127

Filtering

Filtering Procedure	128
Digital Filtering	129
Parameters	129
Filter Type	129
Filter Parameters	129
Filter Cutoff Frequencies	130
Filter Design FRF	130
Buttons	130
Resampling	131
Parameters	131
Buttons	131
Upsampling	132
Parameters	132
Buttons	133

About InField and This Guide

InField is a Windows® based software tool for management, control, and graphical analysis of engineering test data. InField features:

- Options to select and validate multiple data channels from different locations, files, and file formats
- Results can be saved and translated to a number of different file formats and exported to other software programs, such as to a spreadsheet in Microsoft® Excel
- A comprehensive set of data validation tools

Selecting Data

Data can be selected from a number of different file formats. These formats include *. SI F, *. RSP, *. DAC, *. ASC, *. TXT, *. DAT, *. CYH, *. TH, *. PV, *. MD, *. 1D, *. 2D, and *. MAT.

Viewing Data

Data can be viewed as sequential plots, bar charts, color histograms, X-Y plots, and tables (depending on the type of data within the Channels List.) Sequential and histogram plots can be zoomed (enlarged).

Sequential channels can be plotted in individual windows (Single Plot), superimposed in one plot window (Over Plot), or grouped together in one plot window (Multi Plot).

A single data point can be selected, and its numerical coordinates can be viewed using a crosshair pointer.

When enlarging a section of a plot, a scroll function will be available to view data on either side of the enlarged portion.

Editing Data

The InField edit functions are used primarily with sequential data. Options are available to cut, copy, and paste selected data to and from other programs. Options are also available to rescale and offset plots, interpolate a section of data, or replace a section of data with a specific value.

Data Validation

InField includes a variety of data validation tools used to verify that good data has been collected when working either in the field or in-house. These can be used to save time and reduce the need to perform multiple tests due to: data that was collected improperly, full-scale ranges that weren't calibrated and caused missed data points, or faulty transducers that may not work or work intermittently.

In addition, these tools can be used to filter out unnecessary data that has been collected, leaving only the most useful data for analysis. One such case may be when looking for an anomaly, where a particular range, or group of data values, is causing the most significant amount of damage. Using one of the DataModes within InField simplifies searching for these situations.

Exporting Data

Selected channels can be saved to a file using the Save As command. If a particular data format is required, simply select the format from the list of file formats supported in InField. Currently InField supports *. SIF, *. RSP, *. DAC, *. CYH, *. ASC, *. TXT, *. MAT, *. CHL and *. WRK. Data and Metadata (header values) may also be copied to the Windows Clipboard.

Exporting Plots

InField can also be used to export plots to either a file or the Windows Clipboard. The following options are available when exporting plots:

- Enhanced Metafile – Used to save data as an Enhanced Metafile. This option allows saving data directly to the Windows Clipboard or to a new file.
- Windows Bitmap – Used to save data as a Windows Bitmap. This option allows saving data directly to the Windows Clipboard or to a new file.
- InField Plot Script – Used to save a script describing the current plot for playback at a future time.

About this Manual

The primary purpose of this manual is to introduce InField and provide information on how to use its many features. This manual is intended for engineers, scientists, technicians, and others who want to use InField to display and report test data.

A basic working knowledge of Microsoft Windows is an important prerequisite for installing and using InField. For those not familiar with using Windows, completion of the tutorials provided with the Windows operating system is suggested.

Contents of this Manual

The contents of the sections in this operating manual are:

About InField and This Guide

Provides an overview of InField and describes the most basic information about InField.

Installation

Presents the install procedure for InField and describes the computer requirements to run InField.

Start-up and Main Window

Describes starting and exiting Infield, the InField main window, and the Channels List window.

Selecting Data

Covers selecting channels from the Channels List and selecting data or a data set for plotting or validation. Understanding the concepts presented in this chapter are important, as they are fundamental in the use of InField.

Viewing Data

Describes the various methods to display and manipulate channel data.

Editing Data

Explains how to edit data in plot displays. It provides information needed to perform activities described in later sections.

Saving Data Files

Describes the procedure for saving data to a file or other programs.

Validation Tools

Introduces the data validation tools provided in InField.

DataModes

Describes the various DataModes available within InField and the correct procedures and practical application of these tools.

Fatigue Calculator

Describes the use of the Fatigue Calculator analysis tools available within InField.

Frequency Analysis

Describes the use of the Frequency Analysis tools available within InField and the correct procedures for use with these tools.

Filtering

Describes the use of the Filtering tools available within InField and the correct procedures for use with these tools.

Conventions Used

Standard engineering abbreviations and the the following conventions are used throughout this manual.

The figures and instructions in this manual are based on the use of InField with Windows 2000, except as noted.

The InField functions and their operation are the same regardless of the version of Windows used, although certain visual aspects of the dialog boxes and windows may differ.

File names and information to be entered exactly as presented will be presented in a fixed-width font to differentiate it from the descriptive information found in this manual.

Installation

Computer Requirements

The following are the minimum computer requirements for the installation of InField.

- Microsoft® Windows® 98 Second Edition, Windows NT 4.0 with Service Pack 6a* and Internet Explorer 5 or greater, Windows 2000, Windows XP
- Pentium® class PC (300 MHz or higher recommended)
- 32 MB RAM (64 MB recommended)
- 50 MB free disk space
- 16 bit (or higher) color display
- CD-ROM Drive
- Mouse or other pointing device

* Service Pack 6a can be found at www.microsoft.com.

Software Installation

You should be familiar with the Windows operating system before starting this procedure. If you are not, complete the tutorial available in the Windows Help System.

Installation Procedure

Use the following procedure to install InField. Administrator rights must be available before installing InField on a Windows NT, 2000, or XP system.

1. Start Windows (if it is not already running).
2. Insert the InField CD.
3. In the Start menu, select Run... or use the Windows Add/Remove Program control panel.
4. In the command line text box of the Run dialog box, type in `d:\InField.exe`, where d is the drive letter for the CD-ROM. Press Enter.

The installation is completed by InstallShield® Wizard, which will guide you through the process. To continue the process, select the Next > button at each dialog box. To return to a previous action, select the < Back button.

The installation process can be cancelled at any time. Simply select the Cancel button at any installation dialog box, and InstallShield® will remove the files installed thus far on your hard drive.

5. When you are prompted for a destination location, select the default unless it is necessary to use a different destination.

To specify another destination, click Browse..., specify the directory to use via the dialog box, and continue the process.

6. At the Setup Complete dialog box, select the Finish button to complete the installation. Restart your computer if prompted to do so at this time.

InField will now appear in the Programs section of the Start menu.

The first time InField is run, you will be prompted to enter a password. This will either be included with the CD or can be obtained by contacting SoMat at (217) 328-5359 or sales@somat.com.

Re-Installation of InField

If InField should require re-installation, simply run the installation program (InField.exe) again. Click yes to the prompt that appears asking to un-install InField. Click Yes to all dialog boxes that appear during the un-install. Any data files or scripts generated WILL NOT be deleted. All user configuration settings WILL be deleted. After un-installation is complete, run the installation program again to re-install.

Start-up and Application Window

This section describes starting up and exiting InField, the InField main window, the various menu commands, and the toolbar.

Starting InField

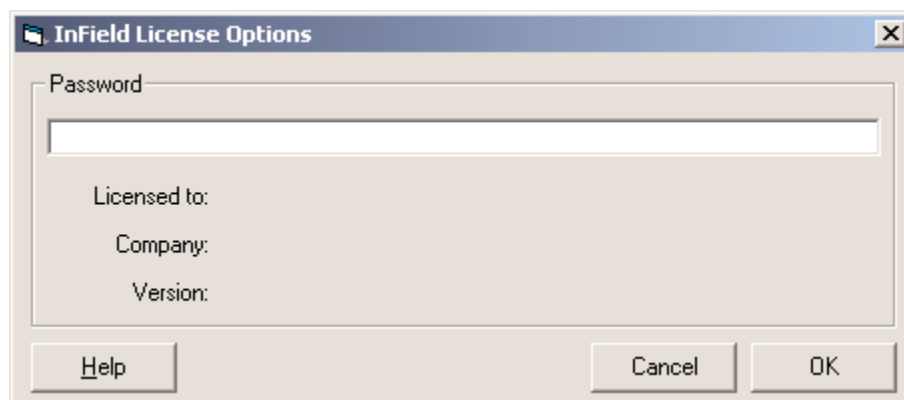
Select InField from the Windows Start menu to start the program.

If InField is used frequently, find the file InField.exe in the subdirectory where InField was installed and create a shortcut. This is done by right-clicking the icon and selecting Create Shortcut from the menu that appears. This shortcut can then be placed on the desktop for easy access.

Passwords

A password is required the first time InField is started. This password is either included with the CD if InField was purchased from a SoMat Sales Representative or through a Sales Representative if InField was downloaded from the Internet.


The following image shows the password entry window without a password. Enter the password then click OK to continue.



Password Entry Window

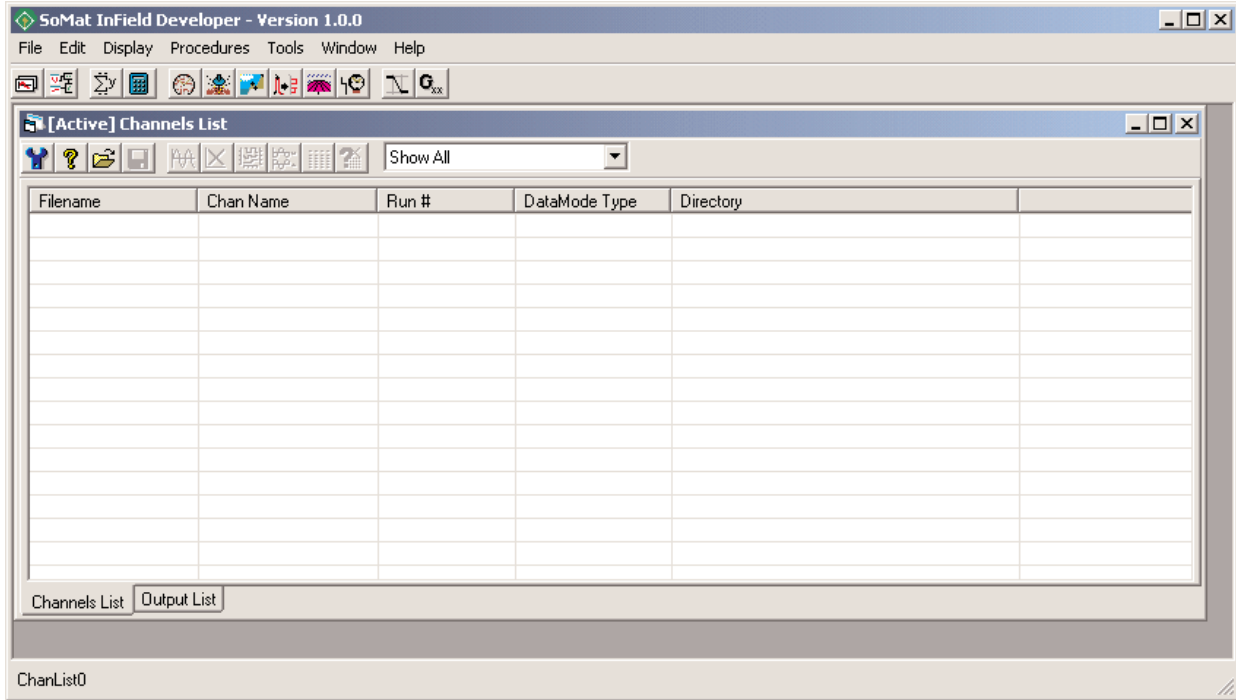
Quitting InField

To quit InField, use one of the following:

- Select Exit from the File menu
- Press ALT+F4 (this is a standard Windows command to quit a program)
- Click on the Window Close button, , in the title bar.
- Click on the InField icon or control menu box at the left end of the title bar, and then select Close from the drop-down menu

InField Application Window

The InField application window shown below has the title bar, menu bar, toolbar, and status bar like many other Windows-based applications. Also shown in the main work area is the Channels List window, in which channels are loaded and selected for display or verification.

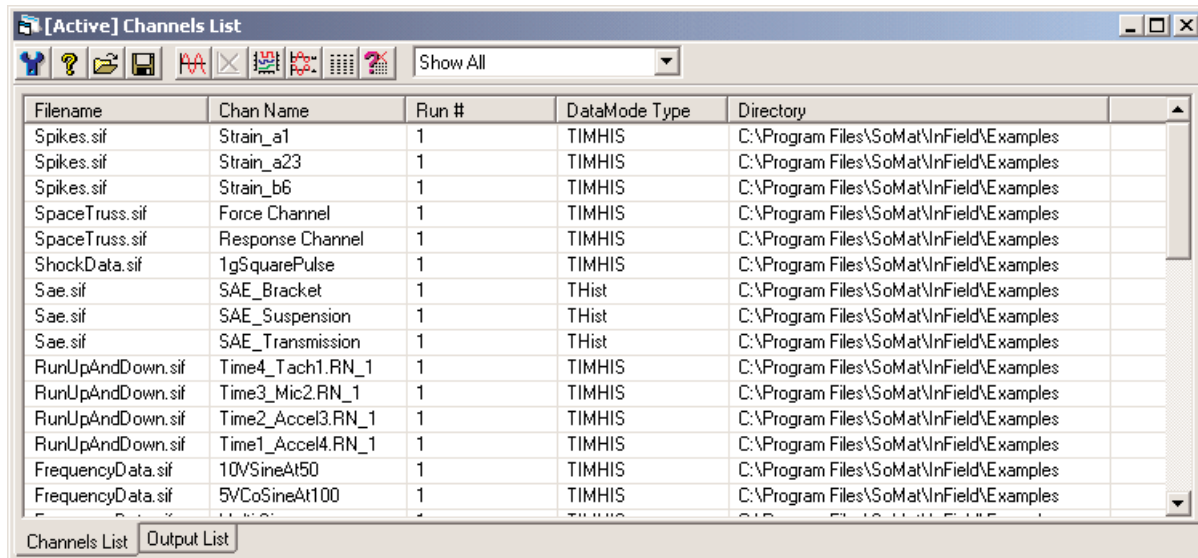


InField Main Window

Channels List Window

Channels List tab

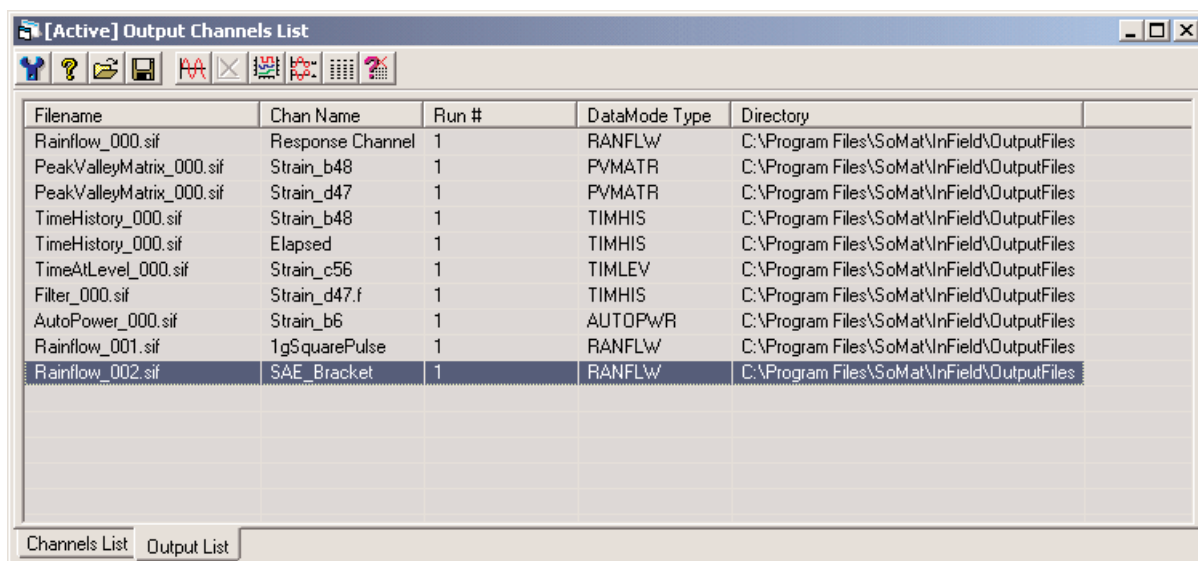
The Channels List tab contains all new data channels once loaded into InField. They can be plotted or validated using the various tools accessible from the menu system and the toolbars of the Channels List window and the main InField window.



Channels List Window

Output List tab

The Output List tab contains any analysis or validation channels created from filters or DataModes will be located and is accessed by clicking on the Output List tab located at the bottom of the Channels List window. These new channels can be manipulated in the same fashion as those in the Channels List tab.



Output List Window

InField Menus

The menu bar contains the available menu selections. Descriptions of the commands and options available within each of these menus follows.

File Menu

Open – Open test data files. The dialog that opens is a standard Windows File Open dialog; use this window to locate and open the files requiring viewing and analysis. The different file types available for use in InField can be selected by using the down arrow to the right of the **Files of type** drop-down list. Channels will be placed into the Channels List.

Save As – Save channels selected in the Channels List or active plot window to a new data file. The window that opens will be a standard Windows File Save dialog. Select the file type from the **Save As Type** drop-down list before clicking Save to ensure the file is saved in the proper format.

Export Plot – Export a plot either to a file or to the Windows Clipboard.

Print – Print plots or tables.

Exit – Close InField in a controlled manner.

Recent Data Files – Show the most recent data files opened within InField.

Edit Menu

Copy – Export the Channels List as text to the Windows Clipboard.

Select All – Select all of the channels in either the Channels List or the Output List. Although using the mouse to highlight all of the channels would work, using Select All (CTRL+A) will guarantee all channels are selected. This also saves time if there is a long list of channels to select.

Copy As – Export a plot to either a file or to the Windows Clipboard.

Delete Data – Remove sections of data from sequential data. The collection of data before and after the removed section will then be joined together to create a new data channel. This feature may be used to remove unwanted spikes or noise from data before applying a Histogram-type DataMode analysis. For more information, see [Editing Data - Delete Data](#).

Interpolate – Replace selected data values within an active plot with a smooth transition line between the last data point prior to the selected range and the first data point after the selected range. For more information, see [Editing Data - Interpolate](#).

Poke – Replace either a value or a group of values with another value that is user-defined. For more information, see [Editing Data - Poke](#).

Scale and Offset – Alter data using a user-defined scale factor and offset factor. For more information, see [Editing Data - Scale and Offset](#).

Display Menu

Single Plot – Plot one or multiple channels in individual windows.

Cross Plot – Plot one sequential data channel versus another, point for point. The first channel selected plots on the X-axis, and the second channel plots on the Y-axis. This allows for plots of two channels in direct comparison, eliminating the time dimension (X-axis) from both channels. At least two data channels must be selected for Cross Plot to work.

Over Plot – Plot two or more sequential data channels in the same plot graph, one data channel over the other.

Multi Plot – Plot selected sequential channels within the same window, one below the other. In a Multi Plot, the time base (X value) is the same for every channel selected. When plotting, the plot will begin with the smallest X value and end with the largest X value. This ensures that every channel selected will be plotted.

Tabular – Plots the selected data in a table format. This provides a method to view the specific value for each sample in sequential data. Bin counts will be displayed when viewing histogram data.

Metadata – View the information that is tied directly to a particular channel or channels.

Tools Menu

Script Player – Automate various InField procedures. This is useful when there are a number of different analysis functions that may be required for individual or groups of channels. Rather than running a channel selection, DataMode, plot procedure, etc. as individual items, a script may be used to combine these functions into one item that can then be repeated for multiple tests and channels.

Statistics – Evaluate the basic statistics for sequential and histogram channel data and display those statistics in a text window. The contents of the window can then be copied to applications, such as Excel, using the Copy As command under the Edit menu.

Signal Calculator – Use mathematical expressions to combine sequential data channels to create virtual data channels known as computed channels. Most arithmetic, Boolean, trigonometric, and logarithmic functions are supported by the Signal Calculator.

DataModes – Open a submenu that contains the various DataModes that can be performed in InField.

Fatigue Damage – Open a submenu that contains the various Fatigue Damage calculating methods

Frequency Analysis – Open a submenu containing commands used to investigate the frequency content of measured signals, displacements, loads, strains, velocities, acceleration, sound pressure, etc.

Filtering – Open a submenu containing commands for FIR/Butterworth filtering, resampling, and importing filter characteristics.

Options – Access selections for saving certain aspects of InField when closed.

Password Information – Open a window with the licensing information regarding the installed version of InField.

Window Menu

Cascade – Resize all open windows to the same size and then stack them, starting in the upper left corner of the work area. Each successive window will be offset down and to the left of the previous window. The amount of offset will allow the title bar of each window to be shown.

Tile Horizontally – Resize all of the windows so they are visible and the same size, one above the other. With two or three windows, they will span the entire width of the InField work area. With four or more windows, they will be in various columns and rows based on the number of windows and the size of the work area.

Tile Vertically – Resize all of the windows so they are visible and the same size, one beside the other. With two or three windows, they will span the entire height of the InField work area. With four or more windows, they will be in various columns and rows based on the number of windows and the size of the work area.

Close All – Close all of the open windows located within InField. The only window that will remain open is the Channels List window.

Show Channels List – Open the Channels List when not present in the InField work area. It can also be used to bring the Channels List window to the front when obscured by other windows.

Help Menu

Contents – Display the main contents page of the Help System. The main Help menu is also available from any screen by selecting F1 from the keyboard.

About SoMat InField – Display the InField version number, copyright data, SoMat's email address, and the URL for the SoMat website.

InField Toolbars

Application Toolbar

The application toolbar is located in the application window and contains buttons to access the Channels List, DataModes, and data validation tools. A brief description of these buttons follows:



Show Channels List – Open the Channels List when not present in the InField work area. It can also be used to bring the Channels List window to the front when obscured by other windows.



Script Playback – Automate various InField procedures. This is useful when there are a number of different analysis functions that may be required for individual channels or groups of channels. Rather than running channel selections, DataModes, plot procedures, etc. as individual items, a script may be used to combine these functions into one item that can then be repeated for multiple tests and channels.



Statistics – Evaluate the basic statistics for sequential and histogram channel data and display those statistics in a text window. The contents of the window can then be copied to applications, such as Excel, using the Copy As command under the Edit menu.



Signal Calculator – Use mathematical expressions to combine sequential data channels to create virtual data channels known as computed channels. Most arithmetic, Boolean, trigonometric, and logarithmic functions are supported by the Signal Calculator.



Time History DataMode – Convert a series of time histories into another series of time histories created by using one of the channels as a data trigger. This allows data to be removed before certain conditions occur or data to be sampled every time a certain condition occurs.



Burst History DataMode – Convert a series of time histories into a series of burst histories by using one of the channels as a data trigger. This allows data around certain conditions to be sampled for predefined periods of time.



Peak Valley DataMode – Convert a series of time histories into a series of successive peaks and valleys. One of the input channels is selected as a master channel. Whenever there is a peak or valley on the selected channel, all of the channels are sampled. A trigger channel can be defined, which allows for pre-filtering the data.



Peak Valley Matrix DataMode – Convert time histories into Peak Valley Matrices. One of the input channels may be used as a trigger channel if desired.



Rainflow Matrix DataMode – Convert sequential data channels into rainflow matrices that are typically used in low-cycle fatigue damage analyses. One of the input channels may be used as a trigger channel if desired. The Rainflow DataMode only accepts sequential data. If the channels have different sample rates, the triggering options are disabled.



Time-At-Level Matrix DataMode – Convert a series of time histories into a multidimensional time-at-level matrix. For each input channel, there will be one dimension. For each sample, the algorithm classifies each input channel amplitude into a bin with its respective dimension. The maximum number of input channels is six, limiting the output dimensions. Plotting and displaying a large amount of data can be very laborious for a large matrix (approximately 12MB of data if each dimension was classified into 10 bins). A data trigger can be defined if required.



Digital Filter Design – Configure and apply a digital filter to selected data.



AutoPower Spectrum Analysis – Investigate the frequency content of measured signals, displacements, loads, strains, velocities, acceleration, sound pressure, etc.



FFT Analysis – Translate the selected input channel from the time domain, amplitude versus time, to the frequency domain, amplitude versus frequency.



Inverse FFT Analysis – Translate the selected input channels from the frequency domain, amplitude versus frequency, to the time domain, amplitude versus time.



Resampling – Change the number of samples taken from an input channel. This may be necessary when using a DataMode to combine two channels that have been collected using different sample rates.



Frequency Response Analysis – Evaluate the relationship between channels in the frequency domain.



Rosette Analysis – Convert the three strains from a rosette strain gage (rectangular or delta) into orthogonal axial strains and/or stresses. These can be further resolved into principal strains, principal stresses, tensile or shear strains at arbitrary angles, Von Mises stress, etc.



Strain Life – Model actual stress-strain behavior at the critical location in a component. Plastic strains that may occur infrequently during service loading are accounted for in this analysis. Cycle-dependent material properties provide a more accurate estimate of the service performance of the material than traditional tensile test data. Use of the Strain Life method is limited to situations where crack nucleation consumes the majority of the service life. This is typical of smaller components rather than of full-scale engineering structures.



Stress Life – Used for long lives where plastic strains can be ignored. The approach assumes that the nominal stress and fatigue limit of the material control the behavior of the structure. Alternatively, the relationship between the fatigue life and nominal stress on a complex component such as a weld could be experimentally determined. Many empirical relationships have been developed during the last 100 years. Standard weld SN curves such as those from the BS5400 can be used, although InField provides a specific BS5400 analysis module.



Load Life – Test components under constant amplitude loading in the laboratory to establish baseline data for their durability. This data is then used to estimate how long a component can be expected to last during variable amplitude service conditions.



Weld (BS5400) – Analyze the welded areas of structures.



Crack Growth – Use linear elastic fracture mechanics and related crack growth material properties to determine how fast a crack or crack-like defect will spread under service loading conditions. This analysis in turn provides an estimate of the remaining safe life of the structure or component.

Channels List Toolbar

The toolbar available from the Channels List is used in the plotting and manipulation of data located in the Channels List. A brief description of each of the items on the Channels List toolbar follows:



Configure Channels List – Add or remove columns in the Channels List window. Columns include Filename, Channel Number, Run #, DataMode Type, Directory, Sample Rate, and Channel number.



Help for Channels List – Open the help file associated with the Channels List.



Open Data Files – Open test data files. Currently, InField supports *. SIF, *. RSP, *. DAC, *. CYH, *. ASC, *. TXT, *. DAT, *. TH, *. PV, *. MD, *. 1D, *. 2D, and *. MAT.



Save As – Save the selected channels in the Channels List to a new data file.



Edit Metadata - Modify the metadata associated with a particular channel or set of channels.



Single Plot – Plot a single channel per plot window.



Cross Plot – Plot one channel versus another, point for point. The first channel selected plots on the X-axis, and the second channel plots on the Y-axis. This allows for plots of two channels in direct comparison, eliminating the time element (X-axis) from both channels. At least two channels must be selected as data for Cross Plot to work.



Over Plot – Plot two or more sequential data channels in the same plot graph, one data channel over the other.



Multi Plot – Plot selected sequential channels within the same window, one plot below the other. In a Multi Plot, the time base (X value) is the same for every channel selected. When plotting, the plot will begin with the smallest X value and end with the largest X value. This ensures that every sample point in the selected channel(s) will be plotted.




Tabular Display – Plot the selected data in a table format. This provides a method to view the specific value for each sample in sequential data. Bin counts will be displayed when viewing histogram data. The names of the source file and channels are located in the title bar.

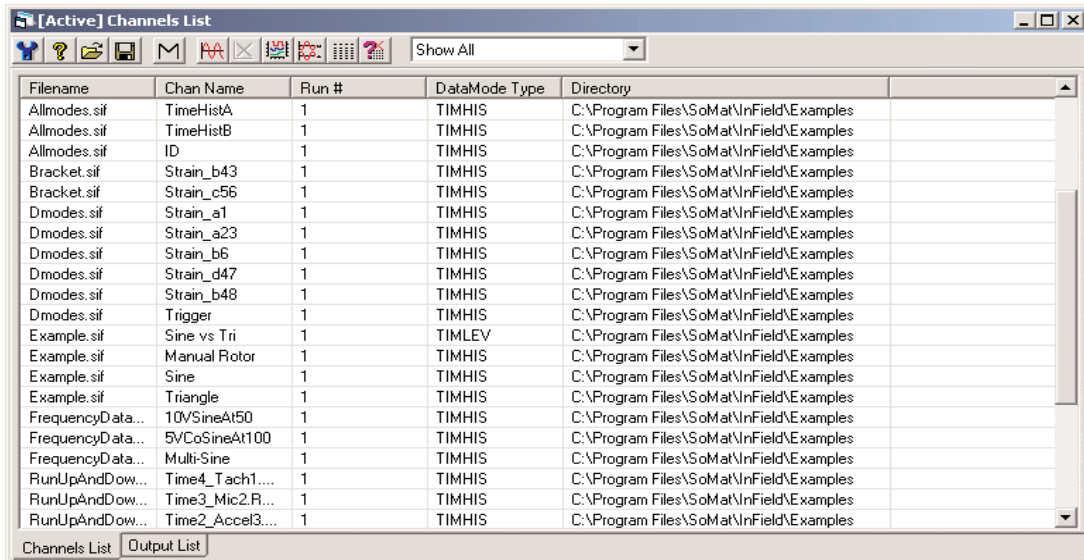


Preferred Plot – Plot the selected channel according to pre-defined parameters embedded in the channel by the analysis program that created the channel. For a channel to be plotted using Preferred Plot, it must contain at least one of the Preferred Plot Keywords. If these keywords are not present, the Preferred Plot function is identical to the Single Plot function.

Selecting Data

Channels List

The Channels List window is where data is selected for plotting and analysis. Channels are loaded into the Channels List using the Open button, , on the Channels List toolbar or by selecting Open from the File menu.




InField Channels List

The Channels List, by default, displays the name of the file, the channel name, run number, DataMode type, and the subdirectory where the file is stored for each open channel.

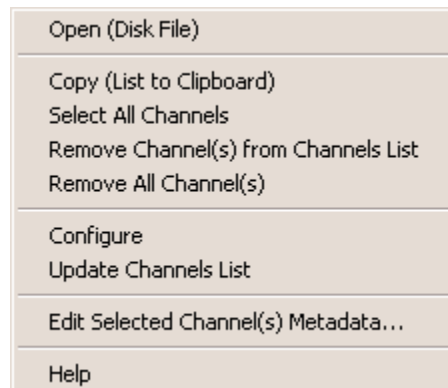
Accessing the Channels List

The Channels List can be opened using one of the following options:

- Click the Show Channels List button 
- From the Window menu, select Show Channels List
- Press F2 on the keyboard

Channels List Right-Click Menu

Several commands related to the Channels List window are available via a menu that opens with a right-click of the mouse.



Channels List Right-Click Menu

Open (Disk File) - Open test data files. The window that opens will be a standard Windows File Open dialog. Locate and open the files that require viewing and analysis. Different file format types can be selected by using the down arrow to the right of the **Files of type** box.

Copy (List to Clipboard) - Copy the Channels List to the Windows clipboard for use in other programs.

Select All Channels - Select all of the channels in the Channels List.

Remove Channel(s) from Channels List - Remove selected channels from the Channels List. Highlight the channel(s) to remove, then right-click and select Remove channel(s) from Channels List.

Remove All Channel(s) - Remove all channels from the Channels List without the need to pre-select the channels.

Configure - See [Channels List Configuration](#) in the next section.

Update Channels List - Place the contents of the Channels List back in the order in which it was developed. Also turn off any refinements that were made to the channels in the Channels List.

Edit Selected Channels(s) Metadata... - Open the Edit Metadata dialog. Allows a method to edit values associated with metadata keywords embedded within channel data.

Help - Open the help topic directly related to the Channels List.

Channels List Configuration

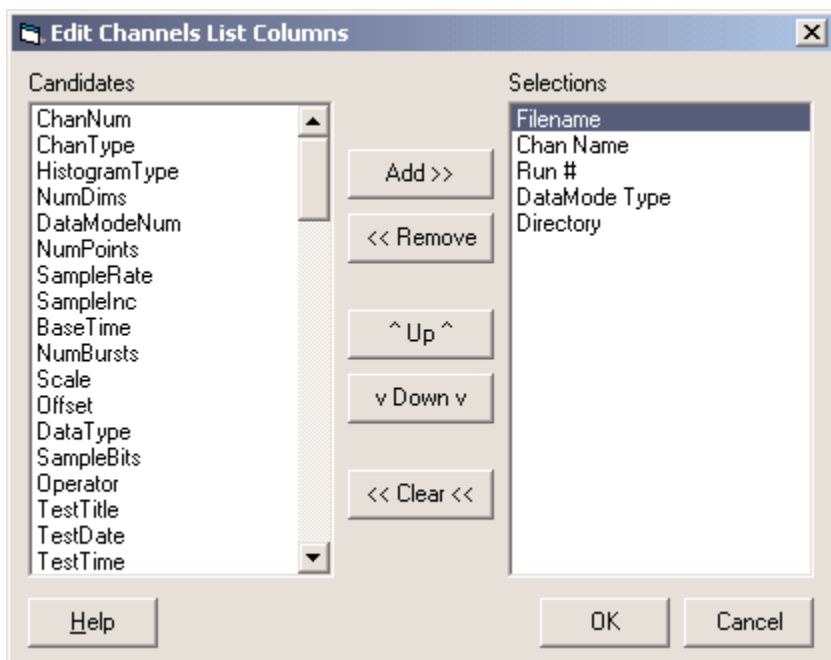
Configuration is used to add or remove columns in the Channels List window. Columns include Filename, Channel Number, Run #, DataMode Type, Directory, and Sample Rate. These columns make it easy to keep track of test data during the analysis.

To open the Edit Channels List Columns dialog either:

- Click on the Configure button, , in the Channels List or
- Right-click on the Channels List and select Configure from the menu.

The titles in the left window are available columns.

The titles in the right window are the active columns in the Channels List and Output List tab of the Channels List window.



Channels List Configuration Window

Adding Columns

To add columns, select the name of the column to be added from the list on the left. Click Add.

Removing Columns

To remove a column, select the name of the column to be removed from the list on the right. Click Remove.

Move up/Move down

To rearrange the columns, select the column name in the right window. Use the Up and Down buttons to move the column within the list (and therefore in the Channels List window.) The alignment of the columns in the Channels List is associated with the position of the column in the list. Names higher on the list will be positioned toward the left of the window, and names lower on the list will be toward the right.

Buttons

Help - Open the InField help system to the topic directly related to configuration of the Channels List window.

OK - Record and incorporate changes and exit the window.

Cancel - Exit the window without making any changes to the columns.

Resizing Columns

There are two methods to resize the width of a column:

- Position the mouse pointer over the right edge of the column to resize. Click and drag the column to the desired width.
- Position the mouse pointer over the right edge of the column to resize. Double-click the edge. This will automatically resize the width of the column to fit the widest item contained in the column.

Viewing Channels by Criteria

The Channel Drop-down List Box is used to view the channels in the Channels List according to a variety of parameters. This makes it much easier to locate channels based on certain criteria. The available options are:

Show All - Show all channels loaded into the Channels List.

Show Only Files - Show only the first channel from each file loaded into the Channels List.

Show Only Files and Runs - Show only the first channel of each run from the files in the Channels List.


Show Selected Runs - Show the channels based on the run. By highlighting a particular run number and selecting Show Selected Runs, only the run number (i.e. 1, 2, 3, etc.) will be available in the Channels List.

Show Selected Channel Name - Show the channels according to the channel name. This is useful to view a particular channel when multiple runs are associated with the channel.

Show Selected Mode Type - Show the channels according to the mode. Highlight the channel with the mode type to view (i.e. TIMHIS, TIMLEV, RANFLW, etc.) and select Show Selected Mode Type. Only the channels associated with a particular DataMode will be displayed.

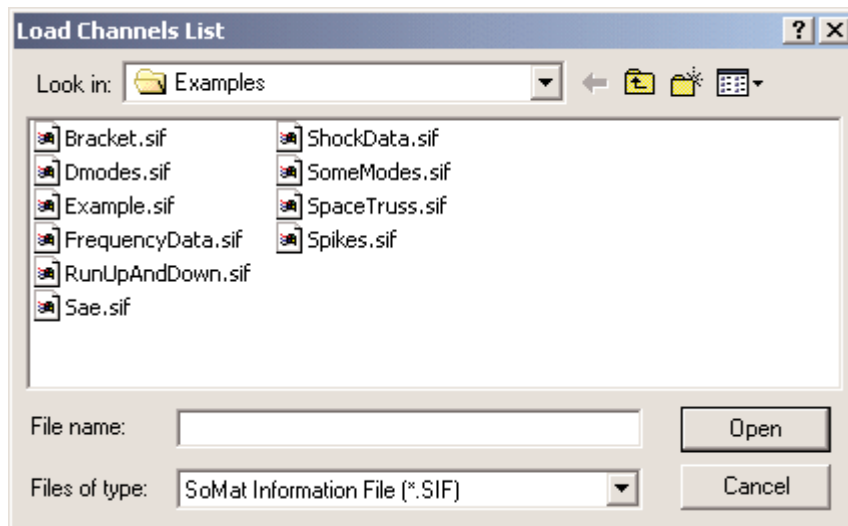
Loading Channels

Use one of the following methods to open channels in the Channels List:

- Click the Open button, , from the Channels List toolbar
- Select Open from the File menu
- Press CTRL+O on the keyboard

Each of these methods will open a standard Windows dialog for selecting a file to open.

NOTE: The first time InField is opened, this dialog will open to the default location, the Examples directory of the InField installation.



Load Channels List Dialog Box

Currently, InField supports *.SIF, *.DAT, *.DAC, *.CYH, *.ASC, *.TXT, *.RSP, *.TH, *.PV, *.MD, *.1D, *.2D and *.MAT.

The different file types can be selected by opening the **Files of type** drop down list with the down arrow to the right of the text box.

Select the file(s) by either highlighting them in the file list box or typing their name(s) in the **File Name** box. To select two or more files, hold down the CTRL key and click each file to open. The Shift key can also be used to select a group of files. Complete the process by clicking the Open button.

If opening only one file, the process can be simplified into a single step - double-click the filename.

Selecting Data

Data channels must be selected before any of the analysis or plotting functions can be used within InField. The data set can be one channel or several channels selected from the Channels List.

Knowing how to select a data set is essential to understanding the rest of this manual and how to use the many functions within InField.

Selecting Channels from the Channels List

Channels highlighted in the Channels List window make up a data set. This data set can be a single channel or a selection of multiple channels.

Selecting Channels Using the Mouse

Use the following methods to select channels from the Channels List using the mouse:

Selecting Single Channels

To select a single channel, click on the channel to be selected.

Selecting Multiple Channels

There are two methods to select multiple channels from the Channels List.

- 1) To select adjoining channels, use the mouse to click and drag from the first channel to the last channel to select.
- 2) To select multiple, individual channels, click on each channel while holding the Control (CTRL) key. Channels can be removed from a selection using the same method.

Selecting Channels Using the Keyboard

The keyboard can also be used to select channels from the Channels List.

Selecting Single Channels

To select a single channel, use the arrow keys to move the highlight bar to the desired channel.

Selecting Multiple Channels

To select multiple channels, use the arrow keys to highlight the first channel in the group of channels. While holding the shift key, use the arrow keys to select the group of channels. It should be noted that only adjacent channels can be selected when using the keyboard.

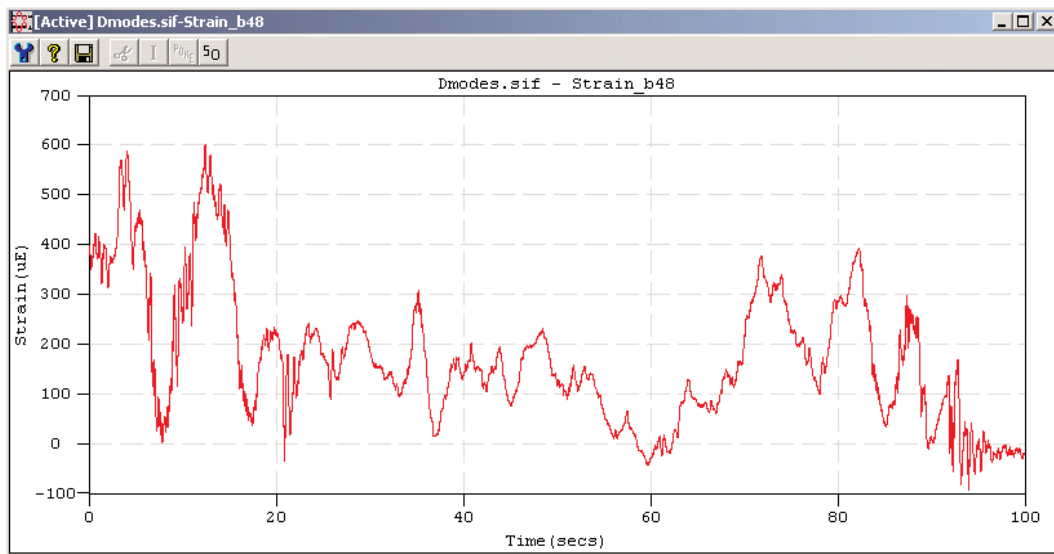
Viewing Data

This section introduces the data and text display windows in InField, as well as information on plotting channel data, configuring plots, and exporting data from InField.

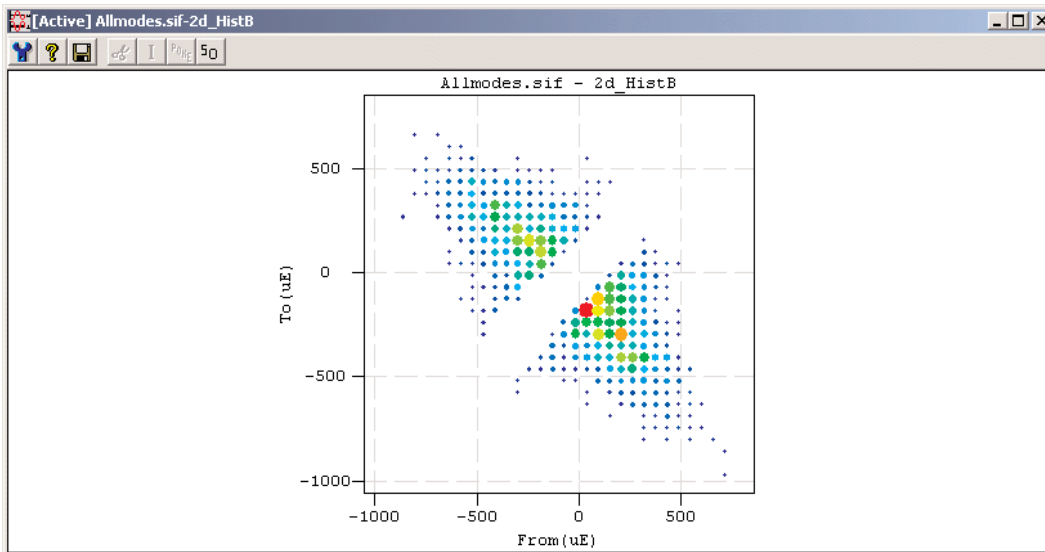
The basis for viewing data is the data selected—the active data set. It is essential to be familiar with the information in [Selecting Data](#) in order to best understand how data is selected for use within InField. Arbitrary data selection instructions are used for this section. Refer to [Selecting Data](#) for more details on selecting data.

Data Windows

There are three basic types of InField data windows: sequential data plot, histogram data plot, and tabular display. The following images show the three data window types.



Sequential Data Plot



Histogram Data Plot

Time	Strain_b43 Strain Gage	Strain_c56 Strain Gage	Strain_a1 Strain	Strain_a23 Strain	Strain_b6 Strain	Strain_d47 Strain
Secs	ustrain	ustrain	uE	uE	uE	uE
0	9.99212	-0.0216571	797.984	795.398	802.7	160.318
0.00333333	20.0288	-0.0216571	--	--	--	--
0.00666667	20.0288	-0.0216571	--	--	--	--
0.01	9.99212	-0.0216571	797.984	795.398	802.7	160.68
0.01333333	9.99212	9.00765	--	--	--	--
0.01666667	-0.0117326	9.00765	--	--	--	--
0.02	-0.0117326	-0.0216571	797.984	795.398	802.7	160.63
0.02333333	-10.0156	-0.0216571	--	--	--	--
0.02666667	-10.0156	-0.0216571	--	--	--	--
0.03	-0.0117326	-0.0216571	797.984	795.398	802.7	160.068
0.03333333	-0.0117326	-0.0216571	--	--	--	--
0.03666667	-0.0117326	-0.0216571	--	--	--	--
0.04	-0.0117326	-0.0216571	797.984	795.398	802.7	159.144
0.04333333	-10.0156	-0.0216571	--	--	--	--
0.04666667	-10.0156	-0.0216571	--	--	--	--
0.05	-20.0522	-0.0216571	797.984	795.398	802.7	158.07
0.05333333	-40.0927	-0.0216571	--	--	--	--
0.05666667	-40.0927	-0.0216571	--	--	--	--
0.06	-40.0927	-0.0216571	797.984	795.398	802.7	157.384
0.06333333	-20.0522	-0.0216571	--	--	--	--

Tabular Data Display

InField data windows have the standard title bar, control buttons, and border of Windows-based applications, and they can be moved and resized. The title bar displays the names of the source file and channel(s) displayed.

Plotting Data


InField automatically plots sequential and histogram data in the appropriate format. Histograms are plotted on two axes. If the data for a histogram includes a third axis, InField will prompt the user to select two axes to be used in the histogram.

Plotting One Channel

Single Plot


Use the following procedure to plot a single sequential data channel.

1. Load the channel(s) into the Channels List. For more information regarding loading channels into the channels list, see [Selecting Data - Loading Channels](#).

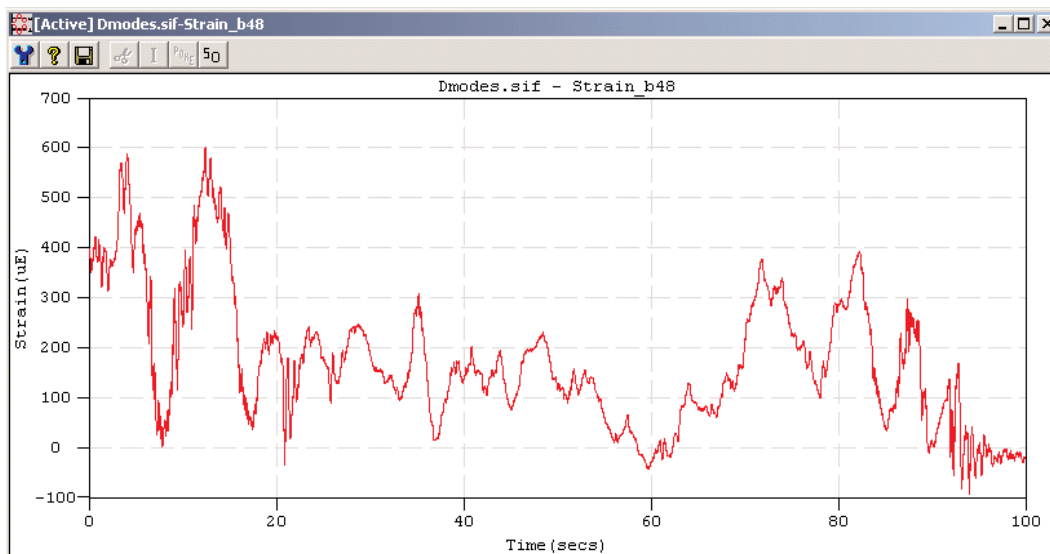
If the Channels List window is not open, open it by either selecting Show Channels List from the Window menu, clicking the Show Channels List button, , or pressing F2.

2. Select the channel(s) to plot in the Channels List. For more information regarding selecting channels see [Selecting Data - Selecting Data from the Channels List](#).

3. The data can be plotted using any one of the following commands:

- Click the Single Plot button, , on the Channels List toolbar.
- Select Single Plot from the Display menu
- Double-click the channel in the Channels List

The plot shown is Strain_b48.sif from the example file Dmodes.sif. The file name and channel name are provided in the title bar of the plot.



Strain_b48 Single Channel Plot

Once plotted, sections of the data can be zoomed (enlarged), or data points within the plot can be selected with x , y and n (scan index) or z (bin count) values displayed. Zooming and Viewing data points are covered later in this section.

Plotting Multiple Channels

Two or more channels can be plotted at the same time, as long as all of the selected channels are the same type of data. When the channels are all sequential data, they can either be plotted in separate windows or all together in one window. Histogram data channels are always plotted in separate windows. The plots are generated in the same order in which the channels were selected in the Channels List.

There are several options available for plotting multiple channels. These options include a separate graph for each channel plotted in individual windows, a separate graph for each channel in a single plot window, all plots overlaid in a single window, and an X vs. Y plot in a single window.

One Plot Per Window

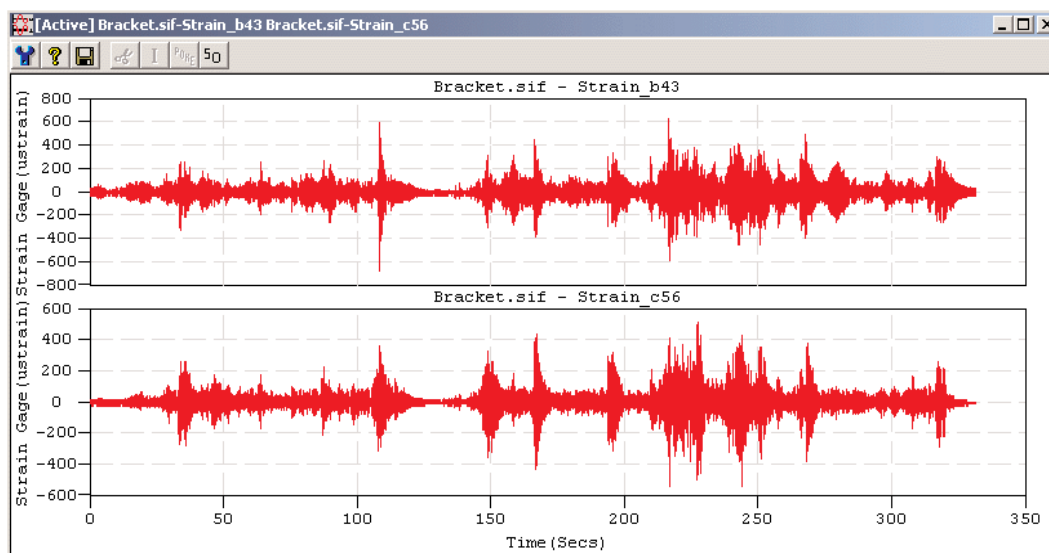
With the one plot per window option, a separate plot window is opened for each of the selected channels.

To use this option, select the channels to be plotted and then either:

- Click the Single Plot button, , on the Channels List toolbar.
- Select Single Plot from the Display menu.

Multi Plot

The InField Multi Plot option plots selected sequential data channels within the same window, one below the other. The plot shown is a Multi Plot of Strain_b43 and Strain_b_56 from the example file Bracket.sif.



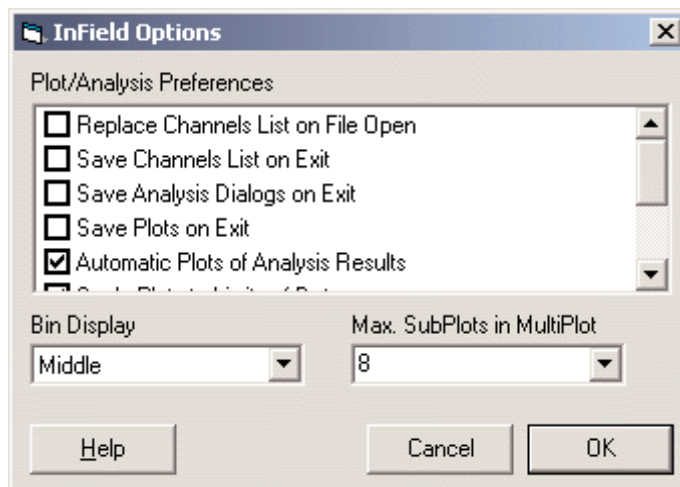
Multi Plot Window

In a Multi Plot, the time base (X-axis) is the same for each plot. InField starts with the smallest X value from the channels selected and ends with the largest X value from the channels selected. This allows each channel to be fully plotted.

To use the Multi Plot option, select the channels to be plotted and then either:

- Click the Multi Plot button, , on the Channels List toolbar.
- Select Multi Plot from the Display menu.

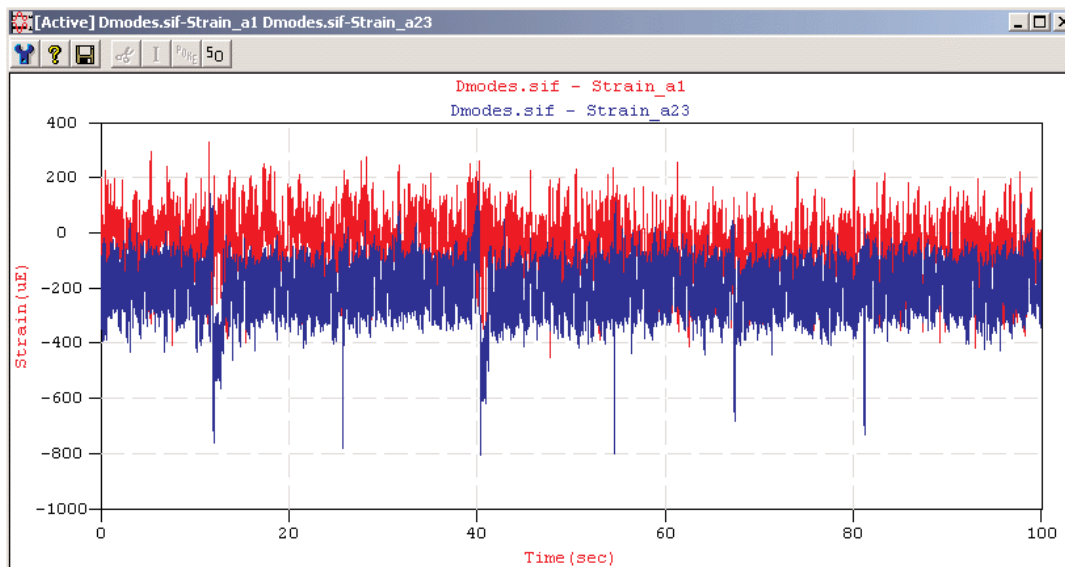
The maximum number of plots visible in a Multi Plot window can be set in the InField Options dialog accessible from the the Tools Menu. Available options for the number of plots are located in the Max. SubPlots in MultiPlot drop-down box.



InField Options Display

Over Plot

The InField Over Plot function plots two or more sequential data channels in the same plot graph, one data plot overlaid on the other.



Over Plot Window

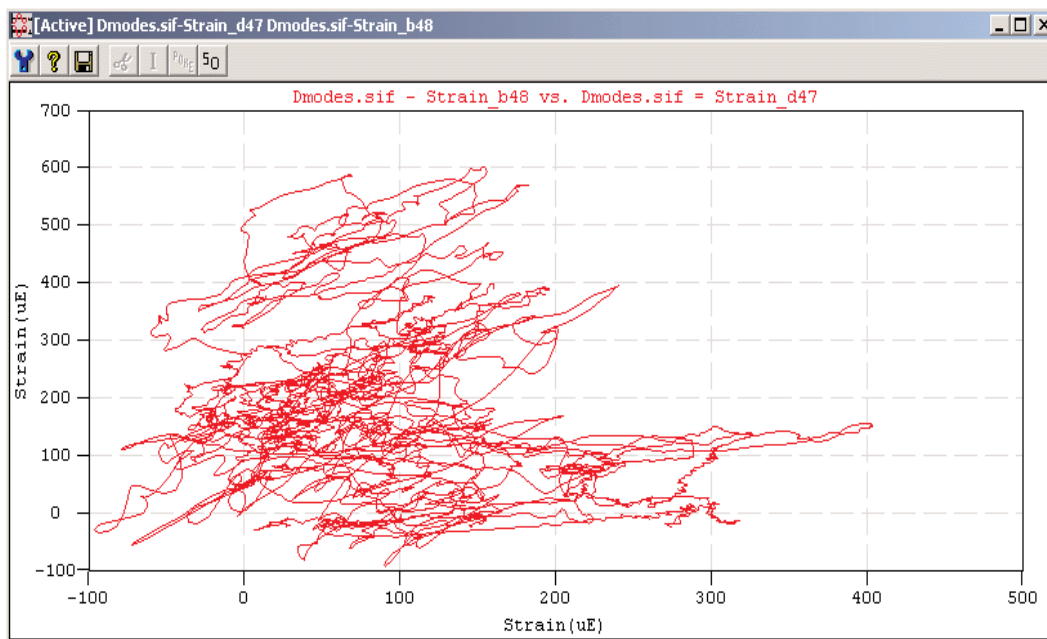
When plotting data using the Over Plot function, the X-axis range will start at the smallest value for the data selected. The greatest X value of the data will determine the upper limit of the X-axis for the data plot. This method allows all of the data to be displayed in the Over Plot window.

To use this option, select the channels to be plotted, and either:

- Click the Over Plot button, , on the Channels List toolbar.
- Select Over Plot from the Display menu.

Cross Plot

The InField Cross Plot function plots one channel versus another, point for point. The first channel plots on the X axis, the second on the Y axis.



Cross Plot Window

Plotting of an X vs.Y plot ends when all of the points in the channel with the least number of points have been plotted. This ability to plot one channel versus another is possible by eliminating the time dimension (X axis) from both channels.

To use this option, select the channels to be plotted and either:

- Click the Cross Plot button, , on the Channels List toolbar.
- Select Cross Plot from the Display menu.

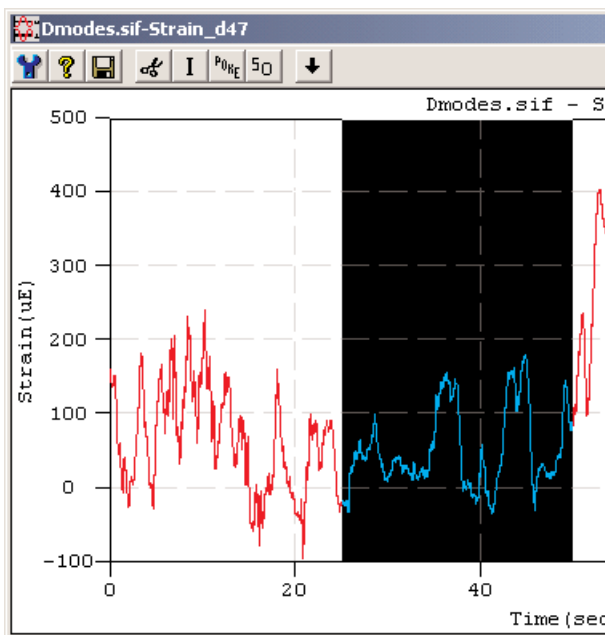
Zoom

The InField Zoom function provides a method to enlarge a section of the data in a sequential data plot. The selected data is plotted in the same window, and the original plot window is obscured until the data is unzoomed. Zooming in on data can be done repeatedly until the necessary details are shown.

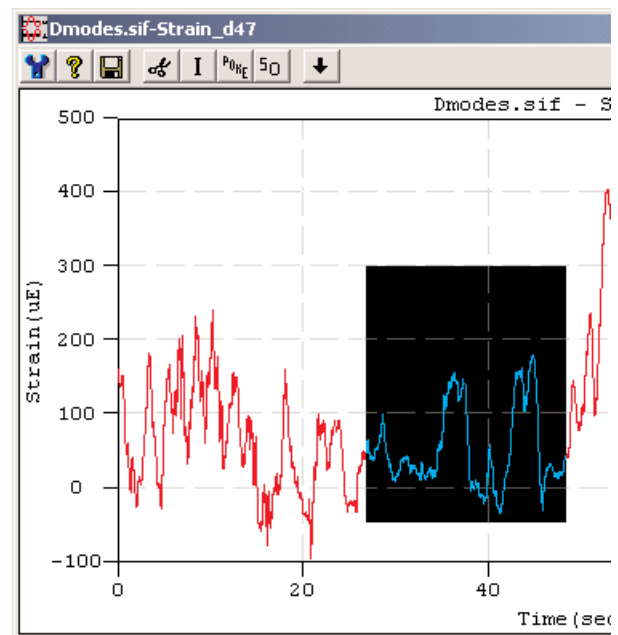
Selecting a Range of Values

When selecting a range of values to enlarge, either a set of X values or a set of X and Y values can be selected. The following figures show both selection methods.

With the range of X values selection method, only the data along the X axis is selected. All Y values will be included in the data selection. With the range of X and Y values, data is selected both vertically and horizontally. With both methods, the selected X values set the number of points on the X axis in the plot window.



Range of X values



Range of Y Values

Range of X Values

The following procedure describes how to select a range of X values.

1. Place the crosshair pointer at the starting point for the range of data to be enlarged.
2. Press and hold down the left mouse button.
3. Drag the edge of the highlight area until the desired range is highlighted. Release the button once the data has been highlighted.

Steps 2 and 3 of the above procedure are commonly referred to as "click and drag."

Range of X and Y Values

Selecting a range of X and Y values is the same as selecting a range of X values, except in this case the shift key is held down while selecting the values.

1. Place the crosshair pointer at the starting point for the X and Y values to be enlarged.
2. Press and hold down one of the Shift keys, then click and hold down the left mouse button.
3. Drag the edge of the highlight area until all the X and Y values are highlighted. Release the button once the data has been highlighted.


Zooming


Once a selection of data has been highlighted, a down arrow  will appear in the plot window toolbar. Clicking on this button will activate the Zoom function.

Scrolling Data

Once data has been selected and enlarged, the following items will be available to navigate through the data values.

 Unzoom - Clicking the Unzoom button will exit the current zoomed selection of data and return to the previous data.

 Scroll Left - The Scroll Left button will move the cursor left within the data window, toward data of a previous time. The cursor can also be moved by using the left arrow key on the keyboard.

 Scroll Right - The Scroll Right button will move the cursor right within the data window, toward data of a greater time. The cursor can also be moved by using the right arrow key on the keyboard.

Export Plot

Export Plot is used to export the plot to either a file or to the Windows Clipboard. Selecting this function will open a dialog with the following available options:

Export Format

There are three different export formats available in InField.

Enhanced Metafile - Save the plot as an Enhanced Metafile. This option allows saving the plot directly to the Windows Clipboard or as a new file.

Windows Bitmap - Save the plot as a Windows Bitmap. This option allows saving the plot directly to the Windows Clipboard or as a new file.

InField Plot Script - Save the plot as an Enhanced Metafile. This option only allows saving the plot as a new file. This new file will only be compatible for use with InField.

Size - A method to control the image size for export. This can be useful when the file may be used within other applications.

Buttons

Export to File - Save the plot image to a file format. Formats are listed under Export Format.

Copy to Clipboard - Save the plot image to the Windows Clipboard.

Cancel - Exit the Export Plot window without performing any functions.

Help - Open the InField help system to the topic directly related to Export Plot.

Viewing Data Points

The x and y values for a data point (sample) in a data plot can be displayed in the plot window. For all plots except Cross Plots, a third value is also displayed. For sequential data, this third value is labeled n and indicates the sample index. For histogram data, this third value is labeled z and indicates the bin count.

Selecting a Data Point

Move the pointer to the desired point (or area) within the plot. Click to place the crosshair on the plot. The intersection of the two lines indicates the selected data point.

Once the crosshair has been placed within the plot, the following methods can be used to select a new data point for viewing:

- Use the right and left arrow buttons in the display window to move the location of the data point along the X axis of the graph.
- Use the right and left keys on the computer keyboard to move the location of the data point along the X axis of the graph.
- For histogram plots, use the up and down arrow keys on the computer keyboard to move the location of the data point along the Y axis of the graph.
- The mouse can be used to click on the new data point

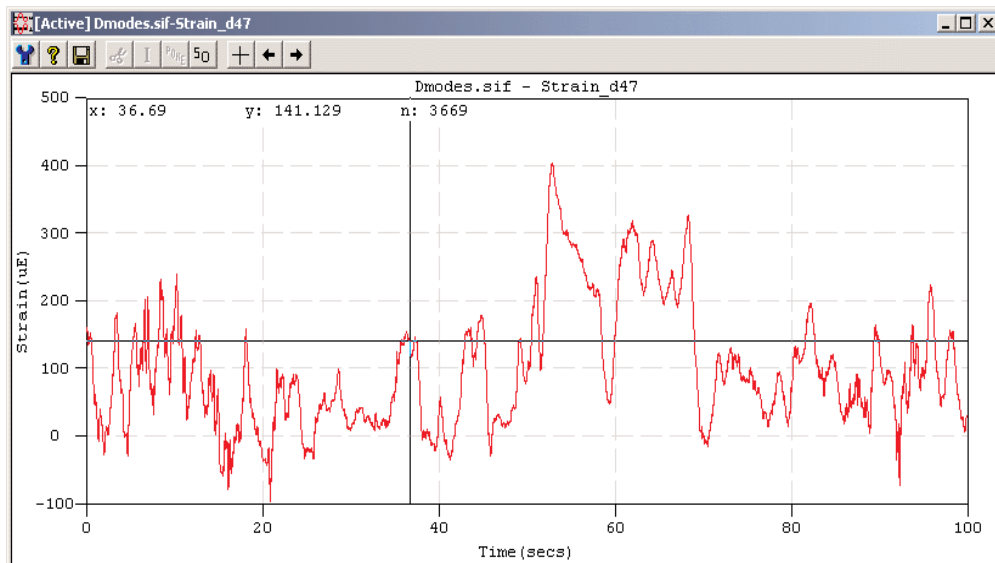
Cursor Movement Using the Keyboard

When using the keyboard or the buttons in the display window, the cursor will move along the X axis in increments equivalent to the sample rate.

Different keystroke combinations provide for incremental navigation of data points along the X-axis.

- Holding down the SHIFT key while pressing the arrow keys will move the cursor in *current sample index + 10* increments.
- Holding down the CTRL key while pressing the arrow keys will move the cursor in *current sample index + 100* increments.
- Holding down the SHIFT and CTRL keys while pressing the arrow keys will move the cursor in *current sample index + 1000* increments.

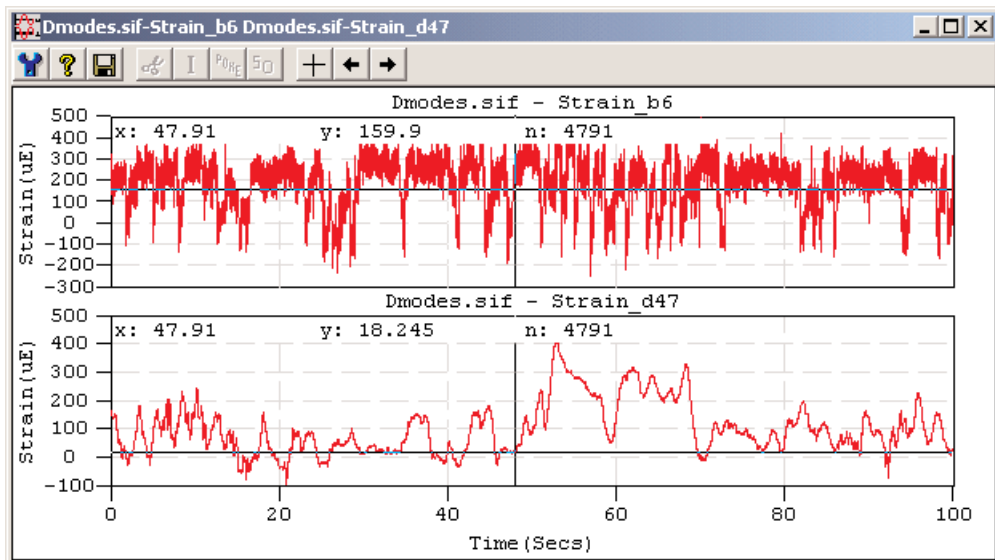
Viewing Data Points in a Single Plot



Viewing a Data Point - Single Plot Window

In a Single Plot window the x , y , and n values of the selected data point will be displayed along the upper edge of the graph.

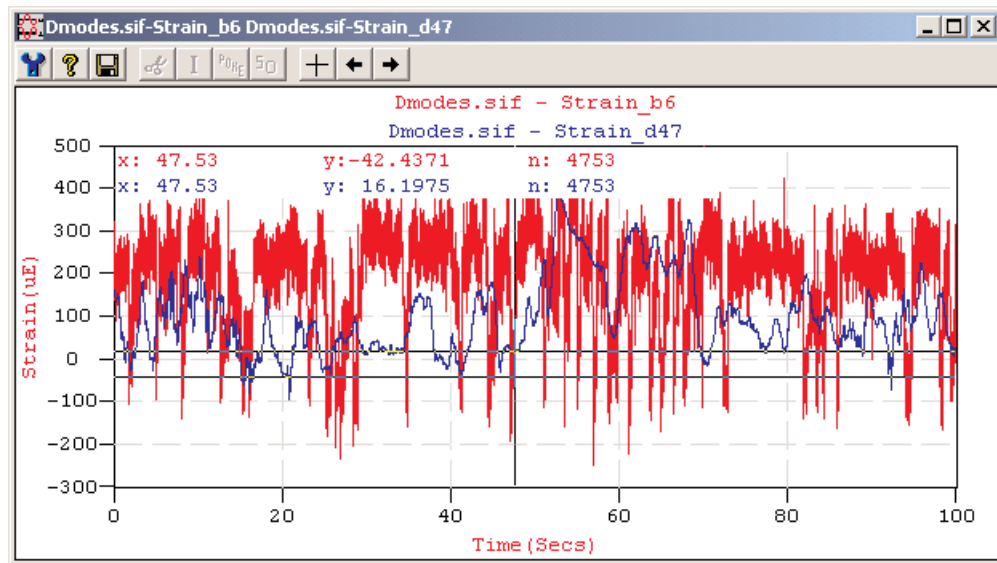
Viewing Data Points in a Multi Plot



Viewing a Data Point - Multi Plot Window

In a Multi Plot window the x , y , and n values of the selected data point will be displayed along the upper edge of each graph.

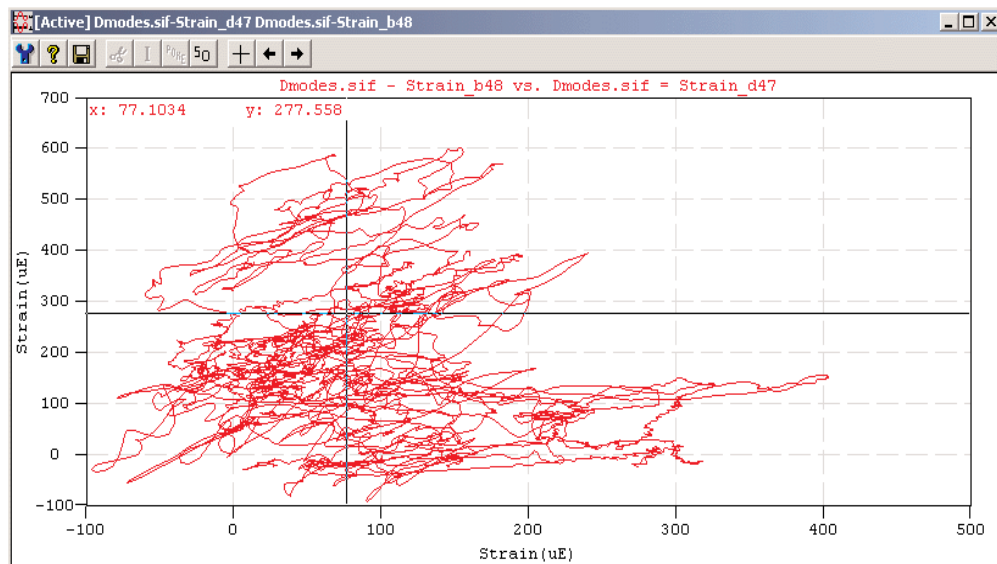
Viewing Data Points in an Over Plot



Viewing a Data Point - Over Plot Window

In an Over Plot window the x , y , and n values of the selected data points will be color coded to coordinate to the plot data and displayed along the upper edge of the graph.

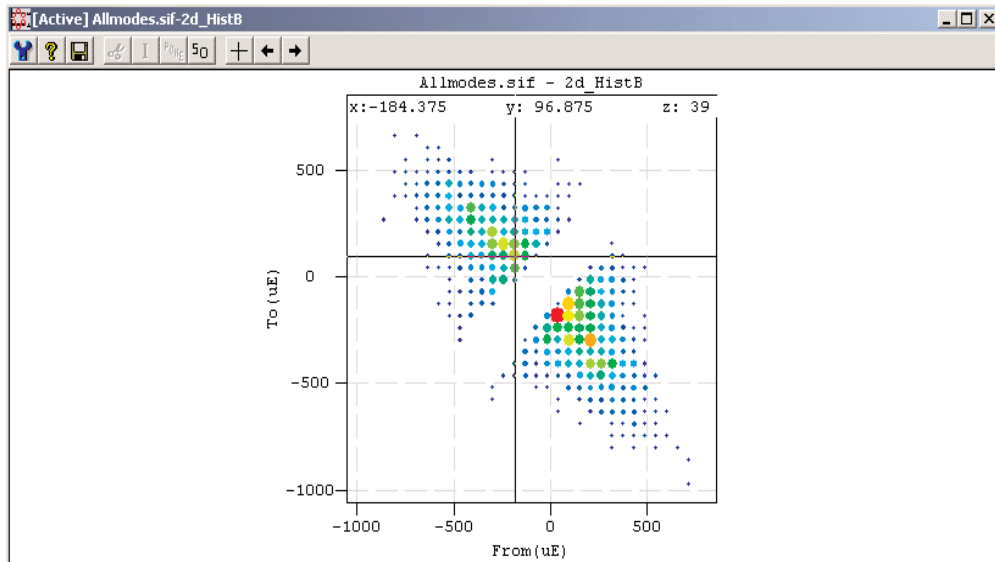
Viewing Data Points in a Cross Plot



Viewing a Data Point - Cross Plot Window

In a Cross Plot window the x and y values of the selected data point will be displayed along the upper edge of the graph.

Viewing Data Points in a Histogram Plot




Viewing a Data Point - Histogram Plot

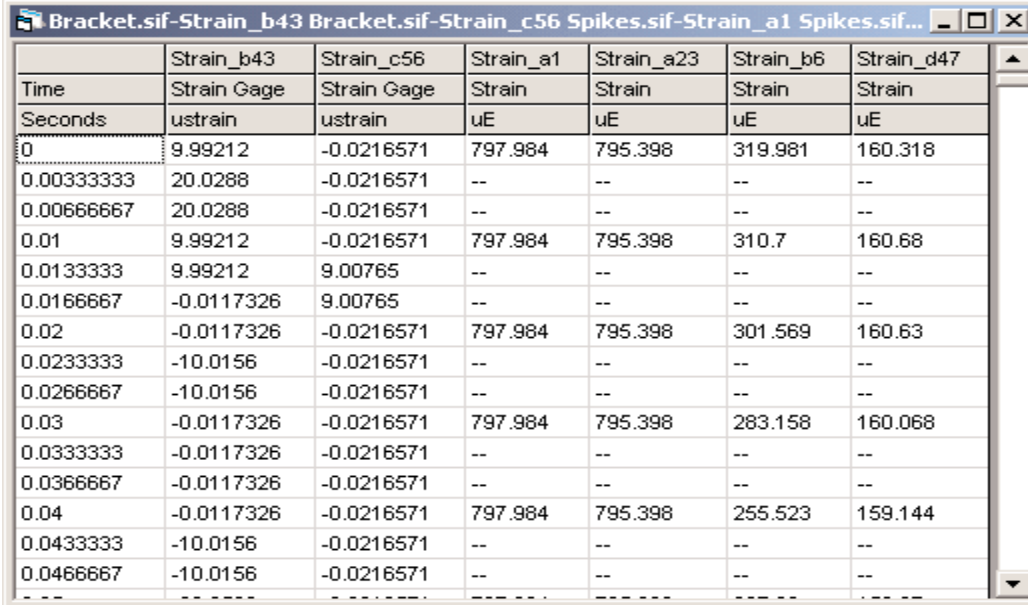
In a Histogram plot the x , y , and z values of the selected data point will be displayed along the upper edge of the graph.

Tabular Data Display

The Tabular Display command plots the selected data in a table format. This provides a method to view the specific value of each sample in sequential data or the bin counts in histogram data.

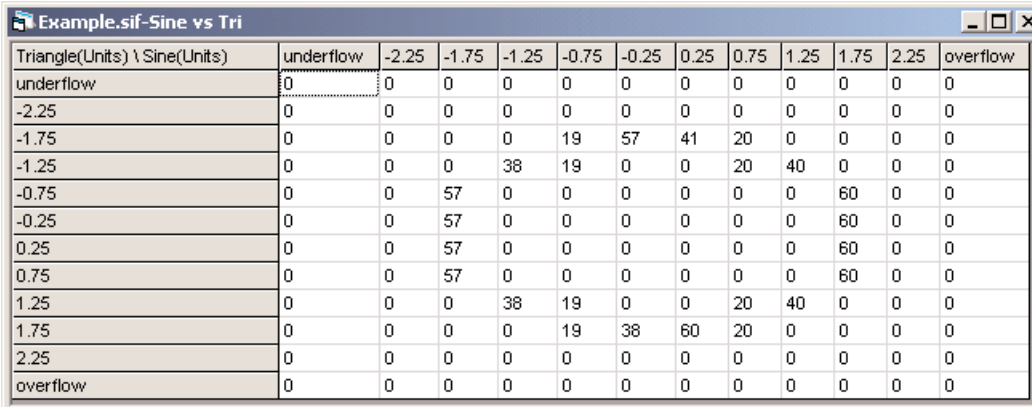
To use this option, select the channel(s) to be plotted then:

- Click the Tabular button, , on the Channels List toolbar.
- Select Tabular from the Display menu.



	Strain_b43	Strain_c56	Strain_a1	Strain_a23	Strain_b6	Strain_d47
Time	Strain Gage	Strain Gage	Strain	Strain	Strain	Strain
Seconds	ustrain	ustrain	uE	uE	uE	uE
0	9.99212	-0.0216571	797.984	795.398	319.981	160.318
0.00333333	20.0288	-0.0216571	--	--	--	--
0.00666667	20.0288	-0.0216571	--	--	--	--
0.01	9.99212	-0.0216571	797.984	795.398	310.7	160.68
0.01333333	9.99212	9.00765	--	--	--	--
0.01666667	-0.0117326	9.00765	--	--	--	--
0.02	-0.0117326	-0.0216571	797.984	795.398	301.569	160.63
0.02333333	-10.0156	-0.0216571	--	--	--	--
0.02666667	-10.0156	-0.0216571	--	--	--	--
0.03	-0.0117326	-0.0216571	797.984	795.398	283.158	160.068
0.03333333	-0.0117326	-0.0216571	--	--	--	--
0.03666667	-0.0117326	-0.0216571	--	--	--	--
0.04	-0.0117326	-0.0216571	797.984	795.398	255.523	159.144
0.04333333	-10.0156	-0.0216571	--	--	--	--
0.04666667	-10.0156	-0.0216571	--	--	--	--

Tabular Data Display - Sequential Data



Triangle(Units) \ Sine(Units)	underflow	-2.25	-1.75	-1.25	-0.75	-0.25	0.25	0.75	1.25	1.75	2.25	overflow
underflow	0	0	0	0	0	0	0	0	0	0	0	0
-2.25	0	0	0	0	0	0	0	0	0	0	0	0
-1.75	0	0	0	0	19	57	41	20	0	0	0	0
-1.25	0	0	0	38	19	0	0	20	40	0	0	0
-0.75	0	0	57	0	0	0	0	0	60	0	0	0
-0.25	0	0	57	0	0	0	0	0	60	0	0	0
0.25	0	0	57	0	0	0	0	0	60	0	0	0
0.75	0	0	57	0	0	0	0	0	60	0	0	0
1.25	0	0	0	38	19	0	0	20	40	0	0	0
1.75	0	0	0	0	19	38	60	20	0	0	0	0
2.25	0	0	0	0	0	0	0	0	0	0	0	0
overflow	0	0	0	0	0	0	0	0	0	0	0	0

Tabular Data Display - Histogram Data

The names of the source file and channels are located in the title bar. For sequential data the left column lists the times at which the samples were taken, and the other columns show the sample value for each channel at the corresponding time. For histogram data the left column reflects the data selection for the Y-axis, and the other columns reflect the data selection for the X-axis. The data displayed within the table reflects bin counts, including the underflow and overflow bins.

Viewing Metadata

Viewing Metadata provides a method of viewing the information that is tied directly to a particular channel or channels.

To use this option, select the channel(s) to view, and then select Metadata from the Display menu.

Channel	Dmodes.sif	Dmodes.sif	Dmodes.sif	Example.sif	Example.sif	Example.sif
FileName	Dmodes.sif	Dmodes.sif	Dmodes.sif	Example.sif	Example.sif	Example.sif
ChanName	Strain_d47	Strain_b48	Trigger	Sine vs Tri	Manual Rotor	Sine
ChanNum	4	5	6	1	2	3
ChanType	SEQUENTIAL	SEQUENTIAL	SEQUENTIAL	HISTOGRAM	SEQUENTIAL	SEQUENTIAL
RunNum	1	1	1	1	1	1
DataModeType	TIMHIS	TIMHIS	TIMHIS	TIMLEV	TIMHIS	TIMHIS
HistogramType	N/A	N/A	N/A	TAL	N/A	N/A
NumDims	2	2	2	3	2	2
DataModeNum	1	1	1	1	2	2
NumPoints	10001	10001	10001	10	976	976
SampleRate	100	100	100	2	100	100
SampleInc	0.01	0.01	0.01	0.5	0.01	0.01
BaseTime	0	0	0	-2.5	0	0
NumBursts	0	0	0	0	0	0
Scale	0.0124844	0.0173229	0.006375	1	0.00741847	9.9781716745362e-005
Offset	-220.894	-265.518	-63.75	0	-11.0435	-3.00379
DataType	UINT_16BIT	UINT_16BIT	UINT_16BIT	FLOAT_32BIT	UINT_16BIT	UINT_16BIT
SampleBits	N/A	N/A	N/A	N/A	N/A	N/A
Operator	N/A	N/A	N/A	N/A	N/A	N/A
TestTitle	N/A	N/A	N/A	N/A	N/A	N/A
TestDate	N/A	N/A	N/A	1994-03-27	1994-03-27	1994-03-27
TestTime	N/A	N/A	N/A	1921:09:58.000	1921:09:58.000	1921:09:58.000
PhysicalChanNum	N/A	N/A	N/A	N/A	N/A	N/A
FileType	EASE::Data::Sif	EASE::Data::Sif	EASE::Data::Sif	EASE::Data::Sif	EASE::Data::Sif	EASE::Data::Sif
FileDate	1999-02-22	1999-02-22	1999-02-22	1999-03-16	1999-03-16	1999-03-16
FileTime	18:10:48.000	18:10:48.000	18:10:48.000	09:50:52.000	09:50:52.000	09:50:52.000
FileSize	130865	130865	130865	10931	10931	10931
NumChans	6	6	6	4	4	4
AxisLabel Dim 0	Time	Time	Time	Sine	Time	Time
AxisUnits Dim 0	secs	secs	secs	Units	secs	secs
MaxValue Dim 0	100	100	100	3	9.75	9.75
MaxScan Dim 0	10000	10000	10000	N/A	975	975
MinValue Dim 0	0	0	0	-3	0	0
MinScan Dim 0	0	0	0	N/A	0	0
FlexMax Dim 0	N/A	N/A	N/A	N/A	N/A	N/A

Metadata Display

Information common to all data channels:

File Name - The name of the data file or test run.

ChanName - The name of the channel selected.

ChanNum - The location of the channel within a particular data run.

ChanType - The type of data stored in the channel.

RunNum - The run in which the channel is located. This is useful when analyzing data from multiple runs within a group of test runs.

DataMode Type - The DataMode that was used to collect the data.

Histogram Type - The type of histogram associated with the selected channel(s). This is used when analyzing or plotting the channel.

NumDims - The number of dimensions that will be used when plotting the selected channel.

DataModeNum - The number of the DataMode associated with the channel. This number represents the placement of the DataMode in relationship to the other DataModes in a particular test run.

NumPoints - The number of sample points contained in the selected channel.

SampleRate - The sample rate for a selected channel.

SampleInc - The time increment for the sample. It is equal to 1/sample rate

BaseTime - The time of the first data point in a channel. It is usually zero if the data came from a test system.

Run Time - The total time that the data acquisition hardware was collecting data on this channel. It is used by all fatigue analyses for calculating hours to failure.

Acq Time - The total time that data samples were actually being recorded by the data acquisition hardware. It is always derived from the number of points and the sample rate: $AcqTime = NumPoints/SampleRate$. It is used by all fatigue analyses for calculating hours to failure.

NumBursts - The number of bursts in a Burst History. The value will be zero if the channel is not a Burst History.

Scale - Factor by which to multiply (or scale) data prior to plotting.

Offset - Factor to add to (or offset) data prior to plotting.

Data Type - Precision with which the data is recorded.

SampleBits - The number of bits at which the data was sampled; the resolution of the data.

Operator - The operator (person) associated with a test setup procedure for a particular data collection device.

Test Title - The title of the test as entered during the test setup procedure for a particular data collection device.

TestDate - The date the test was run.

TestTime - The time the test was run.

PhysicalChannelNum - The hardware channel number from which the data was collected.

FileType - The type of file in which the data is stored (i.e. SoMat Information File is *.SI F.)

FileDate - Creation date of file containing channel data.

FileTime - Creation time of file containing channel data.

FileSize - Size in bytes of file containing channel data.

NumChans - The number of channels within the open Channels List.

Each dimension of the selected data will have the following set of information associated with it:

AxisLabel - The label that will be used for the plot axis reflecting that dimension of data.

AxisUnits - The units that will be used for the plot axis reflecting that dimension of data.

MaxValue - The maximum value for a data sample in that dimension.

MaxScan - The index of the maximum value for a data sample in that dimension.

MinValue - The minimum value for a data sample in that dimension.

MinScan - The index of the minimum value for a data sample in that dimension.

UserMax - The maximum limit of the dynamic range of the channel.

UserMin - The minimum limit of the dynamic range of the channel.

NumBins - The number of bins for histogram data.

Additional information may be displayed that is specific to particular channels.

Arranging Windows

The plot windows in InField can be manipulated, moved, sized, and closed either as a group using items in the Window menu or individually using the mouse.

As a Group

Tile Vertically

Tile Vertically resizes all of the plot windows so they are visible and the same size, one beside the other. With two or three windows, they will span the entire height of the InField work area. With four or more windows, they will be in various columns and rows based on the number of windows and the size of the work area.

Tile Horizontally

Tile Horizontally resizes all of the plot windows so they are visible and the same size, one above the other. With two or three windows, they will span the entire width of the InField work area. With four or more windows, they will be in various columns and rows based on the number of windows and the size of the work area.

Cascade

Cascade resizes all open plot windows to the same size and then stacks them, starting in the upper left corner of the work area. Each successive window will be offset down and to the left of the previous window. The amount of offset will allow the title bar of each window to be shown.


Individually

Moving Windows

To move a window, position the cursor on the title bar and then click-and-drag the window to its new location within the InField work area.


Minimize Windows

To minimize a window (reduce it to a title bar icon), use the the following:

- Click the Minimize button  in the title bar.
- Click on the icon at the left end of the title bar and select Minimize from the window control menu.


Maximize Windows

To maximize a window (make it fill the entire InField work area), use the the following:

- Click the Maximize button  in the title bar.
- Click on the icon at the left end of the title bar and select Maximize from the window control menu.

Restoring Windows

To restore a window (return it to its original size), use the the following:

- Click the Restore button  in the title bar.
- Click on the icon at the left end of the title bar and select Restore from the window control menu.


Changing Window Sizes

The size of each individual window can be changed in several ways:

- Adjust the window borders or a corner using the click-and-drag method.
- Use the Cascade or Tile commands from the Window menu.
- Use the minimize, maximize and restore functions.

Closing Windows

Use the following to close only the active window:

- Click the Window Close button, , in the title bar.
- Double-click on the icon at the left end of the title bar.
- Click once on the icon at the left end of the title bar and select Close from the window control menu.

To close (remove) all of the windows in the work area, select Close All from the Window menu.

Printing

Using the Print command provides a method to print out the data within a data display window.

Use the following procedure to print data.

1. Make the window to print active.
2. Select Print from the File menu, or press CTRL+P.
3. Click the Page Setup button to change the selected printer, page layout, and paper size and source.
4. Click OK to send the information to the selected printer.


The only window in InField that cannot be printed using this method is the Channels List.

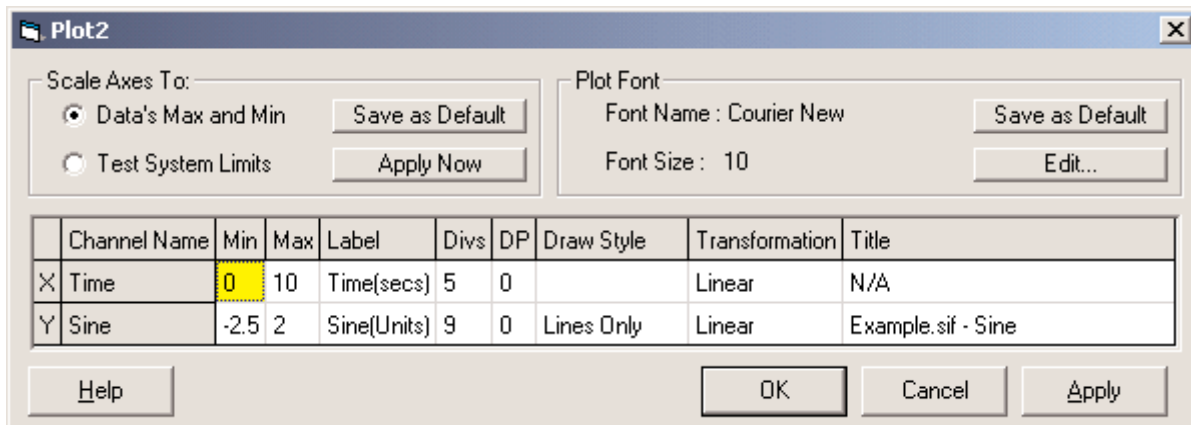
To print the information from the Channels List, select the channels, or press CTRL+A to select all the channels. Select Copy As from the Edit menu. This will open the InField Copy As dialog box. Select As Metadata, and then click Copy. This will place the information on the Windows Clipboard, where it can be pasted into other programs such as Excel. This will also provide information regarding the channels such as file name, directory, channel number, channel name, channel type, run number, etc. For more information, see Viewing Metadata covered previously in this section.

Editing Data

This section covers the editing of plotted data and text variables within the plotted data.

Plot Configuration

Use the configuration button, , in any plot window to open the Plot Configuration dialog.



Plot Configuration Dialog Box

When selected, Plot Configuration allows for a method to change the following items:

Scale Axes To

Data's Max and Min - Automatically scale the window to the maximum and minimum of the limits of the data.

Test System Limits - Plot the data to the Y-axis limits specified by the data acquisition system that collected the data. In this mode, the Y-axis limits of the plot should be equal to fullscalemin and fullscalemax.

Save as Default - Apply the changes made to either the Data's Max and Min and/or the Test System Limits selections and apply these changes to all future plots.

Apply Now - Apply the changes made in the Scale Axes To dialog box.

Plot Font

Save as Default - Save any changes to the fonts and apply the current font selections to all future plot windows.

Edit Font - Change the font for Title, Label, and Divisions. Use of this button will open a Windows dialog enabling selection of a different font, font style, size, script, color and effects. The fonts available will be those already installed on the computer.

- Some fonts will not work, and InField will default to Courier New. An example is Webdings, where the character representations are not compatible with InField.
- It is suggested to use fonts that would normally be installed from a standard Windows install. Using fonts that are not normally part of the Windows operating system may cause problems if files are transferred to computers where these fonts may not exist.

Spreadsheet Information

The following items listed in the spreadsheet can be changed by double-clicking on the item:

Min - The minimum, or lowest point, of the data. It might be necessary to change this value to show more detail regarding the data.

Max - The maximum, or highest point, of the data. It might be necessary to change this value to show more detail regarding the data.

Label - The title located to the left of the graph. The label can be changed to help distinguish the data. It may also be necessary to change the label if the data will be used for a report, where changing the name will help clarify the type of data.

Divs - The number of horizontal lines (axis divisions) in the graph. Each line will be labeled to indicate the value represented. It may be necessary to change this item to help distinguish the Y-value of data at a certain point on the graph.

DP - The number of decimal points available for data precision. As an example, if DP is set to 2, then the values will have two decimal positions (x.xx). If DP were set to 3, then the values would have three decimal positions (x.xxx).

Draw Style - The type of the plot. The default is Lines Only. A drop-down list of styles will be made available when the style type is selected by mouse click. Options available are:

Lines Only - Plot a continuous line connecting data points without differentiating between individual data points and the interval between them.

Points Only - Plot each individual data point.

Lines + Points - Plot each individual data point and a continuous line connecting them.

Bars - Plot a solid line extending from the X-axis to the continuous line connecting the data points. This option results in a graph "filled" from the X-axis to the data line.

Transformation - Change how the graph is represented along the time, or X, axis.

Linear - Display the time scale in a standard linear form.

Log - Change the X-axis of the graph to a logarithmic scale. This may be necessary to display data that may have been taken over a long period of time.

Title - The title, or header, of the graph

Buttons

Help - Open the InField help system to the topic directly related to Plot Configuration.

OK - Apply the changes to the open plot window and close the configuration dialog.


Cancel - Exit the dialog box discarding any changes. Changes made and applied with the Apply button will be reversed by selecting Cancel.

Apply - Apply changes to the open plot window.

Delete Data

Delete Data is used to remove sections of data from sequential data. The collection of data before and after the removed section will be joined together to create a new data plot.

This feature may be used to remove unwanted spikes or noise from data before applying a histogram-type DataMode analysis.

Click-and-drag within the plot to select the section of data to be deleted. Select Delete Data from the Edit menu or click the Delete Data button, , on the plot window toolbar. A new window will be generated to contain a plot which reflects the modified data set.


I Interpolate

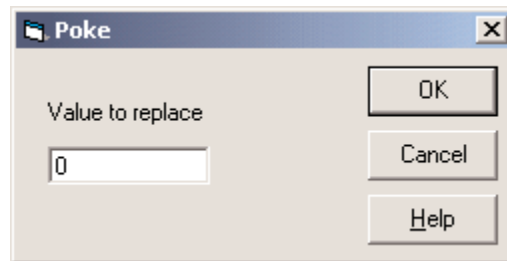
Interpolate is used to replace selected data values within an active plot with a smooth transition line between the last data point prior to the selected range and the first data point after the selected range.

Click-and-drag within the plot to select the section of data to Interpolate. Select Interpolate from the Edit menu or click the Interpolate button, **I**, on the plot window toolbar. A new window will be generated to contain a plot which reflects the modified data set.

Poke

Poke is used to replace a value, or group of values, with another value that is user-defined.

Click-and-drag within the plot to select the section of data to Poke. Select Poke from the Edit menu or click the Poke button, , on the plot window toolbar. A menu will open prompting for the value to use as the replacement value. Once the Value to replace has been provided and OK selected, a new window will be generated to contain a plot which reflects the modified data set.



Poke Dialog Box

Buttons


OK - Close the dialog box and open a new plot window reflecting the changes to the data.

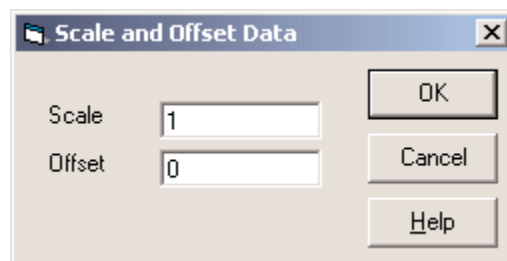
Cancel - Close the dialog box.

Help - Open the InField help system to the topic directly related to Poke.

Scale and Offset

Scale and Offset allows for alteration of data by a user-defined scale factor and offset factor.

Click-and-drag within the plot to select the section of data to Scale and Offset. Select Scale and Offset from the Edit menu or click the Scale and Offset button, , on the plot window toolbar. A menu will open prompting for the values to use as the Scale and Offset. Once the values have been provided and OK selected, a new window will be generated to contain a plot which reflects the modified data set.



Scale and Offset Dialog Box

Buttons

OK - Close the Scale and Offset dialog box and open a new plot window reflecting the change(s) made to the data.

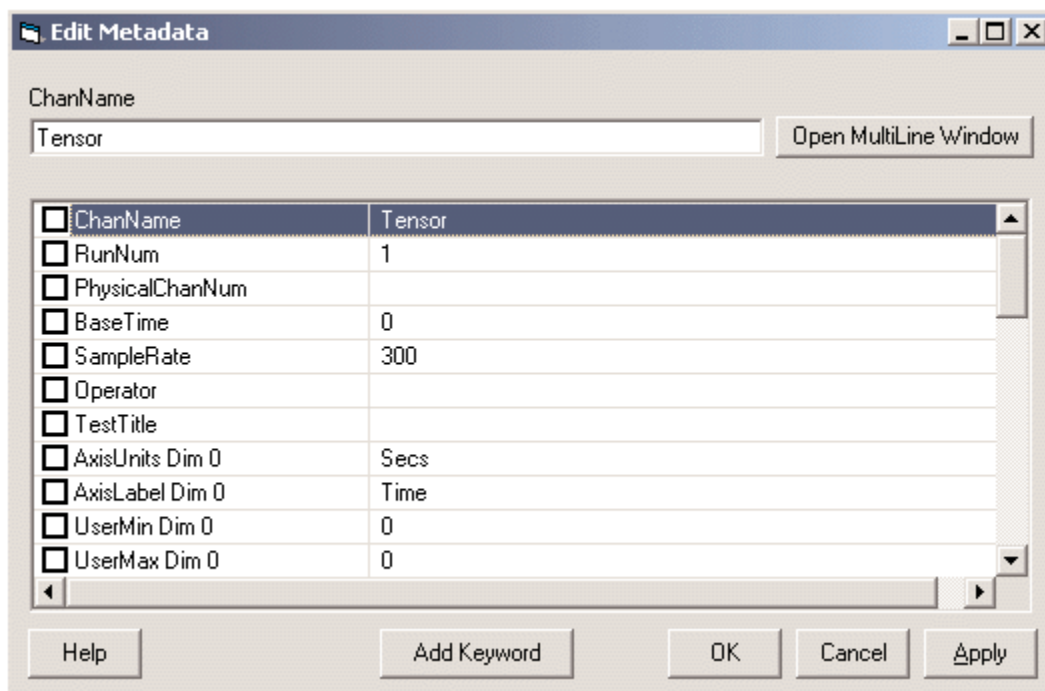
Cancel - Exit without making any changes.

Help - Open the InField help system to the topic directly related to Scale and Offset.

Edit Metadata

Edit Metadata is used to modify the metadata associated with a particular channel or set of channels of data.

The Edit Metadata dialog can be opened by clicking the Metadata button, **M**, on the Channels List toolbar or by selecting Edit Selected Channel(s) Metadata from the right-click menu in the Channels List.




Edit Metadata Dialog Box

Editing Modes

The default editing mode allows for modification of keyword values as a single line. The highlighted keyword-value pair in the lower section of the window is reflected in the upper section of the window with the keyword as the textbox title and the value as the text in the textbox.

When the value contains more than a single line of information, it may be necessary to view and edit it as multiple lines. This is accomplished by entering MultiLine edit mode via the **Open MultiLine Window** button. When in MultiLine edit mode, the lower section of the dialog expands to allow viewing of multiple lines, simplifying the editing process for larger values.

Once changes are complete, use the  button to return to the SingleLine editing mode where all keyword-value pairs are visible.

Note that when editing multiple channels at once, there are fewer items available for modification than when editing a single channel.

Saving changes to Metadata

When viewing metadata in SingleLine editing mode, keyword-value pairs containing changes that should be saved for the current session of InField must be marked with a check in the checkbox for that line of metadata. Any changes not marked by a checkmark will not be saved.

To discard changes and restore the channel(s) back to their original state, select Update Channels List from the right-click menu in the Channels List.

Saving modified channels for use in future sessions of InField

Changes made in the Edit Metadata dialog are made only within the current session of InField. To permanently preserve changes to a file, select the channels and use the Save As item in the Tools menu.

Buttons

Help - Open the InField help system to the topic directly related to the Edit Metadata function.

Add Keyword- Add a keyword-value pair to the metadata of the selected channel. There is no requirement that keyword names begin with 'DM_', 'DK_', etc.

OK - Save the information entered to the metadata associated with the selected channel for the duration of the current session of InField.

Cancel - Exit without making any changes. Any changes made and applied using the Apply button will be reversed.

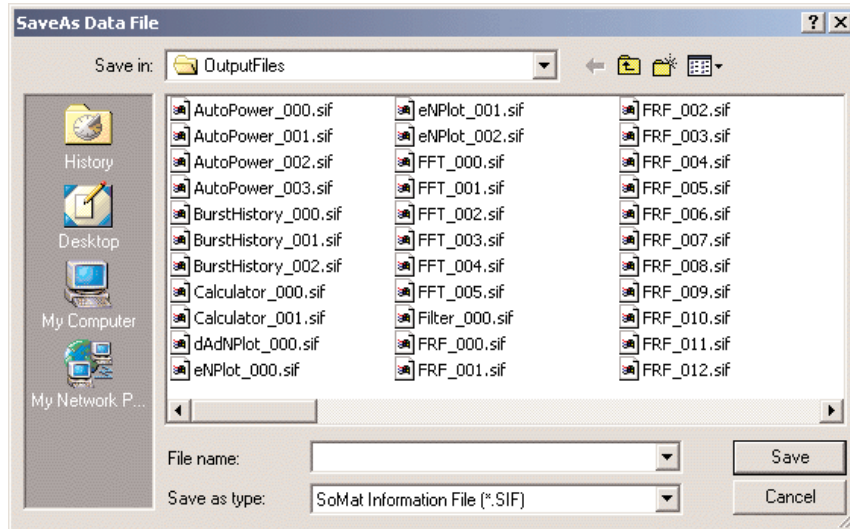
Apply - Apply changes to associated metadata without closing the Edit Metadata dialog box.

Saving Data Files

Saving an Active Data Set to a File

Saving data to a different file format is performed using the Save As command in the File menu.

To save an active data set to a file, select Save As from the File menu. The SaveAs Data File dialog will open. This dialog is a standard Windows file save dialog.



SaveAs Data File Dialog Box

Available File Formats

The file formats available in the **Save as type** drop-down list correspond to the data file translators present within InField. The default file format will be *.SIF, which is the standard SoMat Information File format. Other available file types and their extensions are:

SoMat Information File	*.SIF	GPS Microsoft Streets & Trips 2003	*.TXT
nCode DAC	*.DAC, *.CYH	GPS Delorme Street Atlas 2003	*.TXT
ASCII	*.ASC, *.TXT	Entire Channels List	*.CHL
MTS RPC III	*.RSP	Current Workspace	*.WRK
Matlab	*.MAT		

Selecting Data to be Saved

If multiple channels have been loaded into the channels list, data can be saved as a single channel to a file or as a group of channels to a file. Multiple channels can be selected by using SHIFT and the arrow keys on the keyboard (adjacent channels only), CTRL+mouse-click, or select all channels in the Channels List using CTRL+A.

Validation Tools

InField has a powerful set of data validation tools to assess the performance and durability of mechanical systems and materials. This section provides an introduction to these tools and assists in selecting the correct tool for data validation needs.

General Information

Script Player

Script playback allows for a method to automate various InField procedures. This is useful when there are a number of different analysis functions that may be required for individual or groups of channels. Rather than running a channel selection, DataMode, plot procedure, etc. as individual items, a script may be used to combine these functions into one item that can be repeated for multiple tests and channels.

For more information see [Script Player](#).

Statistics

The Statistics tool extracts industry standard information from a list of selected sequential or histogram data channels. That information contains basic parameters such as maximum, minimum, mean, and standard deviation, as well as advanced signal statistics such as crest factor, irregularity factor, kurtosis, etc.

For more information see [Statistics](#).

Signal Calculator

The Signal Calculator can be used to create virtual data channels by mathematically combining data channels that have the same sample rate. Most arithmetic, Boolean, trigonometric, and logarithmic functions are supported. The created channels may also be referred to as computed channels.

For more information see [Signal Calculator](#).

DataModes

Use one of the DataModes to reduce data channels into more concise data sets that better indicate:

- How mechanical systems are used and perform
- Distribution of extreme inputs
- Ability to repeat load history
- Mechanical system durability

The reduced data sets can be histograms or more concise sequential channels.



Time History

A Time History is a sequence of constantly sampled data channel values continuously stored in a data file.

This DataMode converts time history data channels into a shorter time history by using one of the input channels as a data trigger. The data trigger channel (a computed channel) must be created using the Signal Calculator before the Time History DataMode is run. This triggering allows removal of data before specific conditions occur or sampling of data each time a specific condition occurs.

The Time History DataMode accepts only time history data. The channels selected must all have the same sample rate.

For more information see [DataModes - Time History](#).



Burst History

A Burst History is a series of fixed-length time histories that are triggered by a user-defined event.

This DataMode converts a series of time histories into a series of burst histories by using one of the input channels as a data trigger. The data trigger channel (a computed channel) must have been previously created using the Signal Calculator. This triggering allows removal of data before specific conditions occur or sampling of data every time a specific condition occurs.

The Burst History DataMode only accepts time history data.

The Burst History DataMode is used primarily to examine high speed, rare events, that may affect both product performance and reliability, without the overhead of continuously storing all channels.

For more information see [DataModes - Burst History](#).



Peak Valley

Peaks and valleys are data values where signals change direction. A Peak Valley history is a collection of successive peaks and valleys in the data. Data between these signal reversal points (peaks and valleys) is not stored. In order to be recorded, the span between successive peaks and valleys must exceed a user specified hysteresis value. A trigger channel can also be specified, providing a method to pre-filter the data.

The Peak Valley DataMode accepts sequential data. It is used primarily as an input to product durability analysis and to determine extreme loading on a mechanical system.

For more information see [DataModes - Peak Valley](#).



Peak Valley Matrix

Peaks and valleys are data values where signals change direction. A Peak Valley Matrix is created by categorizing successive peak-valley pairs and representing their frequency of occurrence in a fixed sized matrix.

The Peak Valley Matrix DataMode converts a series of sequential histories into a series of peak-valley matrices. One of the input channels can be used as a trigger channel, if desired.

Peak Valley Matrix accepts only sequential data. If the channels selected for the DataMode have different sample rates, the triggering options will be disabled.

The Peak Valley DataMode is used primarily for load history characterization and product usage. For example, a Peak Valley Matrix of gear positions stored in the To-From mode summarizes all of the gear changes made by a driver over a period of time.

For more information see [DataModes - Peak Valley Matrix](#).



Rainflow

Rainflow counting identifies specific peak valley pairs that contribute to fatigue damage. A rainflow matrix is created by categorizing rainflow peak-valley pairs and representing their frequency of occurrence in a matrix that is fixed in size.

The Rainflow DataMode converts a series of sequential data channels into a series of rainflow matrices. These matrices are typically used in low-cycle fatigue damage analysis. One of the input channels can be used as a trigger channel if required.

The algorithm used is based on the “one-pass” algorithm described in the paper “Simple Rainflow Counting Algorithms” by S. Downing and D. Socie published in *International Journal of Fatigue*, January 1982. The algorithm generates a set of closed cycles for the input peak-valley sequence, assuming the sequence repeats itself.

The Rainflow DataMode accepts only sequential data. If the selected channels have different sample rates, the triggering options will be disabled.

The Rainflow DataMode is used for assessing product durability and as a metric for characterizing load histories.

For more information see [DataModes - Rainflow](#).



Time-At-Level

A Time-At-Level matrix is formed by categorizing constantly sampled data channels and representing their frequency of occurrence in a matrix that is fixed in size. Each input channel occupies one dimension of the matrix. This results in a single data object that contains the amount of time spent at unique combinations of variables.

The Time-At-Level DataMode converts a series of time histories into a multidimensional time-at-level matrix. The maximum number of input channels, and therefore the number of output dimensions, is six (6).

The Time-At-Level DataMode accepts sequential data. All the input channels must have the same sample rate.

The Time-At-Level DataMode is primarily used for evaluating product performance and usage. For example, a three dimensional Time-At-Level matrix of torque vs. engine RPM vs. gearshift position is useful for determining how a vehicle's engine is used by customers.

For more information see [DataModes - Time-At-Level](#).

Fatigue Damage Calculator

The fatigue analysis functions can be used to estimate component life, crack growth, and weld life under certain fatigue conditions. Three (3) different methodologies are available to calculate component life: Stress Life, Strain Life, and Load Life. Available in conjunction with these functions is the Material Property Editor which allows for creation of InField Material Files (*.MAT) for use with the Strain Life and Crack Growth fatigue analysis functions.

Strain Life Fatigue Analysis

Strain Life analysis models actual stress-strain behavior at the critical location in a component. Plastic strains that may occur infrequently during service loading are accounted for in this analysis. Cycle-dependent material properties provide a more accurate estimate of the service performance of the material than traditional tensile test data. Use of the Strain Life method is limited to situations where crack nucleation consumes the majority of the service life. This is typical of smaller components rather than of full-scale engineering structures.

For more information see [Fatigue Calculator - Strain Life Fatigue Analysis](#).

Stress Life Fatigue Analysis

Stress Life analysis is often used for long lives where plastic strains can be ignored. The approach assumes that the nominal stress and fatigue limit of the material control the behavior of the structure. Alternatively, the relationship between the fatigue life and nominal stress on a complex component such as a weld could be experimentally determined. Many empirical relationships have been developed during the last 100 years. Standard weld SN curves such as those from BS5400 can be used, although InField provides a specific BS5400 analysis module.

The primary limitation of Stress Life analysis is that plastic strains, which are known to be critical to fatigue as well as the sequence effects that alter the mean stresses at stress concentrations are ignored .

For more information see [Fatigue Calculator - Stress Life Fatigue Analysis](#).

Load Life Fatigue Analysis

Load life or component life analysis tests components under constant amplitude loading in the laboratory to establish baseline data for their durability. This data is then used to estimate how long a component can be expected to last during variable amplitude service conditions.

The advantage of Load Life analysis is that all variables affecting the fatigue life of the component are included in the data base (processing variables, local stress concentrations, etc.) Changes in service usage can be assessed with this approach.

The obvious limitation of Load Life analysis is that it requires extensive testing. It cannot be used to assess design modifications, nor can mean stress effect be included.

For more information see [Fatigue Calculator - Load Life Fatigue Analysis](#).

Weld Life Fatigue Analysis

Weld Life or BS5400 analysis is used for analyzing the welded areas of structures. It uses a series of predefined curves. To pick the SN curve for a particular problem, first classify the weld in accordance with the BS5400 standard. There are seven weld classes: B, C, D, E, F, F2, and W where B is the strongest.

For more information see [Fatigue Calculator - Weld Life Fatigue Analysis](#).



Crack Growth Fatigue Analysis

Crack growth analysis uses linear elastic fracture mechanics and related crack growth material properties to determine how fast a crack or crack-like defect will spread under service loading conditions. This analysis in turn provides an estimate of the remaining safe life of the structure or component.

For more information see [Fatigue Calculator](#) - [Crack Growth Fatigue Analysis](#).

Filtering

The Filtering tools are used to selectively remove unwanted frequency components from sequential data channels and to upsample or downsample time history data.



Digital Filter Design

The Digital Filter Design provides a method to design Low Pass, High Pass, Band Stop, and Band Pass filters for use in data analysis. Filter types include Finite Impulse Response (FIR) and Butterworth.

For more information see [Filtering](#) - [Digital Filter Design](#).



Resampling

Resample provides a method to change the number of samples taken from an input channel. This may be necessary when using a DataMode to combine two channels that may have been collected using different sample rates.

For more information see [Filtering](#) - [Resampling](#).

Upsampling

Integer Upsampling analysis uses linear interpolation to upsample time history data channels by whole integer multiples in order to bring two or more channels up to the same sample rate. The two (2) primary purposes for this are 1) so that visual data comparisons (with Tabular display, OverPlot, MultiPlot, e.g.) can be performed and 2) so that channels can be plotted against each other using CrossPlot.

Integer Upsampling works only on Time History channels and uses simple linear interpolation; therefore the frequency content of the channel(s) is distorted. To preserve frequency content, use Resampling analysis.

For more information see [Filtering](#) - [Upsampling](#).

Frequency Analysis

The Frequency Analysis tools are used to determine significant frequencies in time histories and establish the functional relationships between mechanical system inputs with frequency response functions.



AutoPower Spectrum Analysis

Using the AutoPower Spectrum Analysis function provides a method to investigate the frequency content of measured signals, displacements, loads, strains, velocities, accelerations, sound pressure, etc. The methodology reduces large time histories into smaller amounts of information. Commonly investigated items are:

- Content of steady state sinusoids within complex signals
- Overall signal energy as a function of frequency for optimal sample rate selection
- Broad band signal energy, as a function of frequency, for vibration testing
- Product comparison

The output can be in the form of a Linear Spectrum, AutoPower Spectrum, Power Spectral Density (PSD), or Energy Spectral Density (ESD).

For more information see [Frequency Analysis - AutoPower Spectrum Analysis](#).



FRF (Frequency Response Function)

The FRF analysis function provides a method for evaluating the relationship between channels in the frequency domain. Outputs may include autopower, crosspower, coherence, and frequency response.

For more information see [Frequency Analysis - FRF \(Frequency Response Function\) Analysis](#).



FFT (Fast Fourier Transform)

The FFT analysis function provides a method to translate the selected input channel from the time domain, amplitude versus time, to the frequency domain, amplitude versus frequency.

For more information see [Frequency Analysis - FFT Analysis](#).



IFFT (Inverse Fast Fourier Transform)

The IFFT analysis function provides a method to translate the selected input channels from the frequency domain, amplitude versus frequency, to the time domain, amplitude versus time.

For more information see [Frequency Analysis - Inverse FFT \(Fast Fourier Transform\)](#).

Rosette Analysis

The Rosette Analysis function provides a method for converting the three strains from a rosette strain gage (rectangular or delta) into orthogonal axial strains and/or stresses. Optionally, these can be further resolved into principal strains, principal stresses, tensile or shear strains at arbitrary angles, Von Mises stress, etc. Rosette strain gages eliminate the problem of perfectly orienting single strain gages; strain at any angle can be later computed.


For more information see [Rosette Analysis](#).

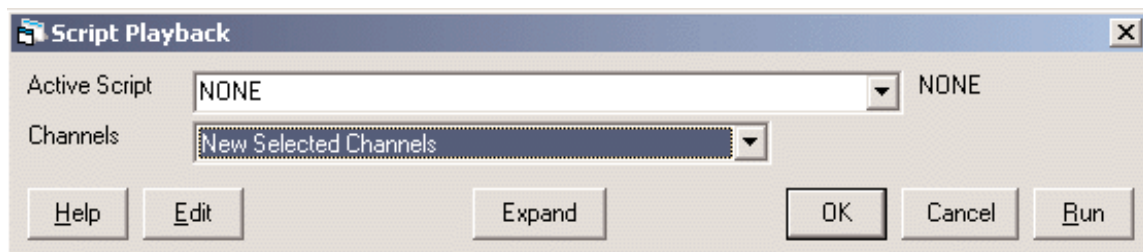
Relative Damage Comparitor

The Relative Damage Comparitor analysis module calculates the fatigue life of load histories in comparison to each other. It is primarily used to quickly determine the most damaging load histories from a series of data channels. The analysis accounts for varying time length channels and uses the total elapsed time to compensate for the relative fatigue life. Both time and burst histories can be analyzed.

Script Player

The Script Playback dialog is used to activate *Visual Basic*[®] scripts containing instructions for sequences of actions within InField. To start Script Playback either select it from the Tools menu or click the Script Playback button,

, on the toolbar.



Script Playback dialog

The Active Script drop-down list contains previously selected scripts allowing for quick selection of commonly used scripts. The Channels drop-down list contains channel list modifiers which allow for the narrowing of the channels upon which Script Playback will run.

Buttons

Help - Open the InField help system to the topic directly related to the Script Playback dialog.

Edit - Open a Windows Notepad style window containing the selected script

Expand - Expand the lower section of the window to a Windows file selection type dialog allowing for easy browsing of the computer file system to locate scripts.

Collapse - Collapse the lower section of the window displaying a Windows file selection type dialog.


OK - Place the Active Script at the default location for the session. This makes running a particular script faster as it won't require loading each time the Script Playback dialog is selected.

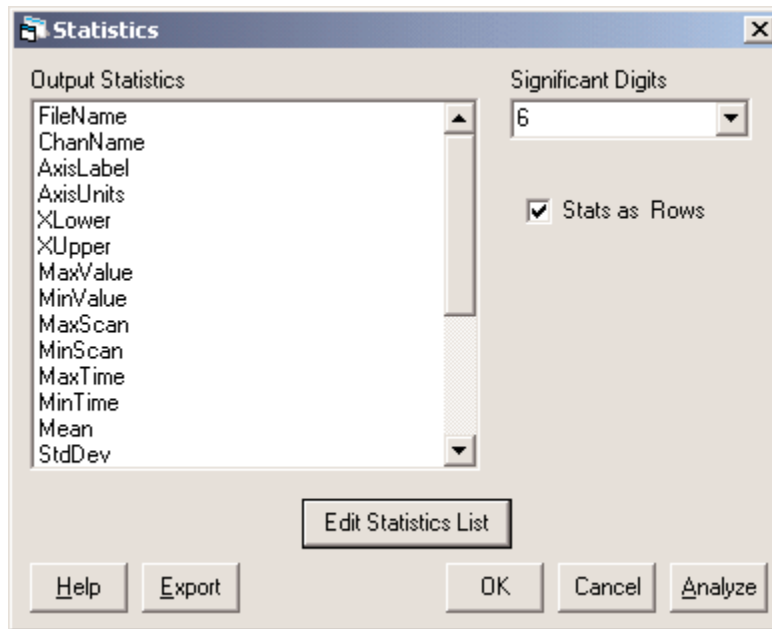
Cancel - Exit the Script Playback dialog.

Run - Execute the script with the selected parameters.

Statistics

The Statistics function evaluates the basic statistics for channel data and displays those statistics in a text window.

To start Statistics, either select it from the Tools menu or click the Statistics button, , on the application toolbar.



Statistics Dialog Box

Evaluations

The Edit Statistics List button can be used to open a dialog allowing user selection of the fields included in the evaluation.

The statistics generated depend on the type of data selected from the Channels List. Fields included that do not apply to the input data will be assigned a value of "N/A."

Available fields are:

FileName, Channel Name (ChanName), AxisLabel, AxisUnits, XLower, XUpper, MaxValue, MinValue, MaxScan, MinScan, MaxTime, MinTime, Mean, StdDev, RMS, Variance, Kurtosis, Skewness, CrestFactor, UserMax, UserMin, OverloadTime and OverloadCounts.

Parameters

The following options are available within the Statistics menu:

Significant Digits - This is the number of significant digits used when displaying the data.

Stats as Rows - Selecting Stats as Rows will display the information as rows rather than columns. This is beneficial when reviewing large amount of data, and comparing a specific row of this data.

Buttons

Edit Statistics List - Open a dialog allowing for selection of the fields included for evaluation and modification of the order in which they are presented after evaluation.

- To remove a field, highlight the field to remove in the right-hand (Selections) window, then click Remove.
- To add a field, highlight the field to add in the left-hand (Candidates) window and click Add.
- To move a field, highlight the field to move and use the Up or Down buttons to relocate the column.

Help - Open the InField help topic directly related to the Statistics tool.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis function with the InField Script Player playback dialog.

OK - Save the information entered for future use.

Cancel - Exit Statistics without making any changes or applying any analysis functions.

Analyze - Evaluate the statistics according to the parameters provided and display the information in a new window. The statistics data entry window will remain visible behind the window generated from the analysis.

Signal Calculator

The Signal Calculator allows the use of mathematical expressions to combine sequential data channels to create virtual data channels known as computed channels. Most arithmetic, Boolean, trigonometric, and logarithmic functions are supported by the Signal Calculator.

Calculations are performed using the individual sample data points of the input channel(s). Computations involving more than one channel are performed using data points of the same sample index from each channel. For example, the addition of two channels would require adding the first sample data point in each input channel to achieve the first data point in the computed channel. The second data point in the computed channel would be the result of the addition of the second data sample point in each of the input channels, and so on.


The number of data points in the resulting computed channel is determined by the number of sample data points of the input channel(s). The created channel will have the same number of data points as the input channel with the fewest number of sample data points.

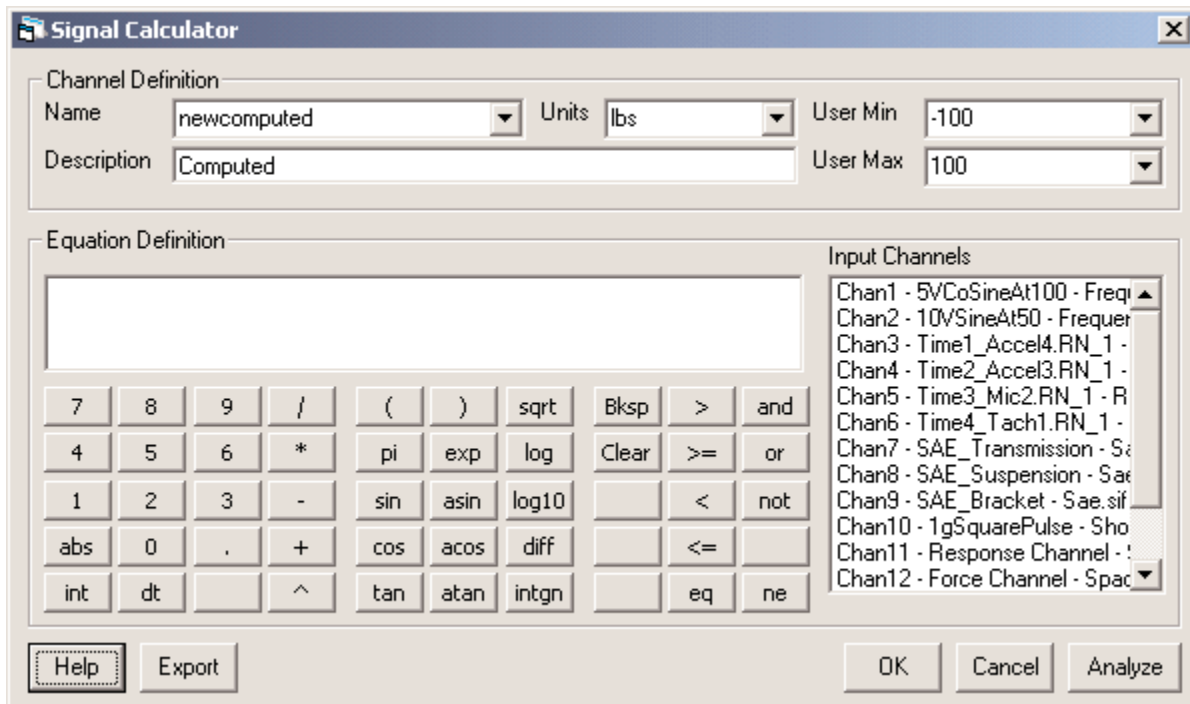
Creating Trigger Channels

To create trigger or logical data channels, enter equations in the Equation Definition box using operators such as $>$ $>=$ $<$ $<=$.

Logical/Trigger channels will contain the same number of data points as the data used to create them. The amplitude value will be 1 when the condition is true and 0 when the condition is false.

Trigger channels are used with DataModes within InField.

To start the Signal Calculator, either select it from the Tools menu or click the Signal Calculator button, , on the application toolbar.



Signal Calculator Dialog Box

Parameters

Channel Definition

Name - The name used to identify a particular Signal Calculator function. This name will also appear in the Output List to help locate the channel created for future reference.

Units - The units for the resultant data channel. If Default was selected from the drop-down menu, a best-fit default units string will be applied; it will be the units from the original data-set if all of the combined channels have the same units.

User Min - User-defined minimum value for the resultant data channel. Two options are available in the drop-down list:

Default - If the combined channels all have the same user-defined minimum value, it is applied here.

None - A user-defined minimum value is not added to the resultant channel.

User Max - User-defined maximum value for the resultant data channel. Two options are available in the drop-down list.

Default - If the combined channels all have the same user-defined maximum value, it is applied here.

None - A user-defined maximum value is not added to the resultant channel.

Description - Used to help identify the channel created by the Signal Calculator. The name entered here will be shown to the left of the window. (It will also be associated with the entry from the Units field.)

Equation Definition

The area where the actual equations will be entered. There are two ways to enter information:

1. Type the channels and operators. Items must be entered correctly to operate.
2. Using the mouse, select the channels from the Input Channels box and the functions from the Equation Definition box. Use of this method will help to eliminate any errors caused by typographical errors.

Input Channels

To be available for use the channels must be selected prior to opening the Signal Calculator dialog. If no channels are listed, see [Selecting Data - Selecting Channels from the Channels List](#).

Operators

This section describes a list of valid operators for the Signal Calculator. Operators work with one or two operands. The operands can be constants or data channels. Brackets can be used to indicate precedence. All logical operators are either 0 (false) or 1 (true).

Operator	Operands	Meaning	Example
-	2	Subtraction	Chan 1 - 42
*	2	Multiplication	Chan 1 * Chan 2
/	2	Division	Chan 1 / Chan 2
^	2	Raise to an exponent	Chan 1 ^ 2
+	2	Addition	Chan 1 + Chan 2
<	2	Less than	Chan 2 < 2
<=	2	Less than or equal to	Chan 6 <= 7.049
>	2	Greater Than	Chan 1 > 21
>=	2	Greater than or equal to	Chan 1 >= 2.875
abs	1	Absolute Value	abs (Chan 1)
dt	1	Δ_t ; sample increment; 1/sample rate	dt (Chan 1) * Chan 2
eq	2	Equal to	(Chan 1) == (Chan 2)
exp	1	10 raised to an exponent	exp (Chan 1)
int	1	Integer value - truncate decimal	int (Chan 1)
log	1	Natural logarithm (base e)	log (Chan 5)
log 10	1	Logarithm (base 10)	log10 (Chan 2)
ne	1	Not Equal to	(Chan 1) != (Chan 2)
not	2	Binary Not	(Chan 1) ! (Chan 2)
or	2	Binary Or	(Chan 1) (Chan 2)
pi	1	Value of pi	Chan1 * pi
sqrt	1	Square Root	sqrt (Chan 3)
cos	1	Cosine	cos (Chan 3)
acos	1	Arccosine	acos (Chan 3)
and	2	Binary And	(Chan 1) && (Chan 2)
sin	1	Sine	sin (Chan 2)

Desk Calculator Operators (continued)

Operator	Operands	Meaning	Example
asin	1	Arcsine	asin (Chan 1)
tan	1	Tangent	tan (Chan 4)
atan	1	Arctangent	atan (Chan 2)
diff	1	Derivative	diff (Chan 1)
intgn	1	Integral	intgn (Chan 1)

Buttons

Help - Open the InField help system to the topic directly related to the Signal Calculator.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.


OK - Save the information entered for future use.

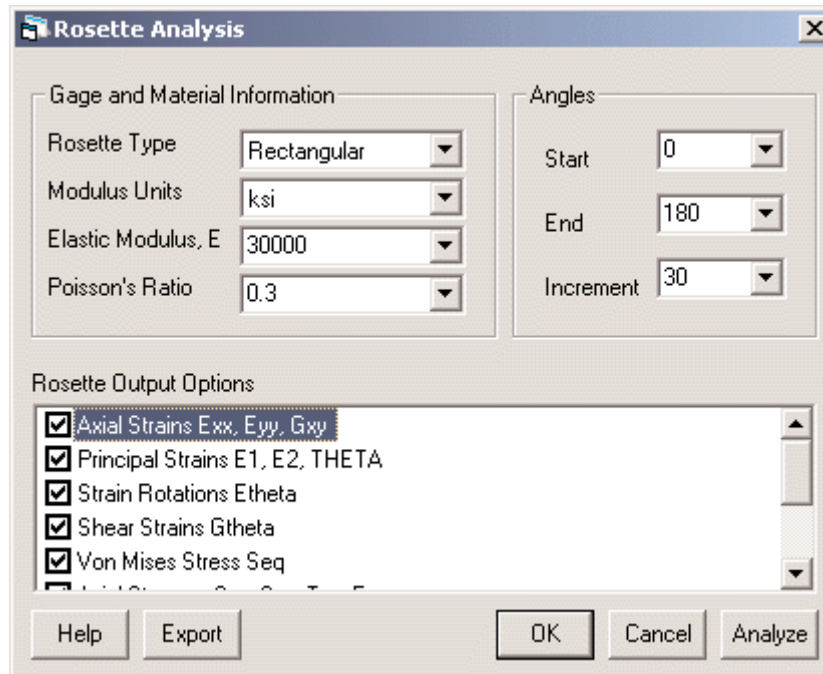
Cancel - Exit the Signal Calculator without making any changes or applying any analysis functions.

Analyze - Perform the functions entered into the Signal Calculator Equation Definition window. The Signal Calculator dialog will remain visible behind the graph that is generated from the analysis. The Signal Calculator will also generate a new channel under the Output List tab in the Channels List window.

Rosette Analysis

Rosette Analysis converts three strains from a rosette strain gage (rectangular or delta) into orthogonal axial strains and/or stresses. Optionally, these can be further resolved into principal strains, principal stresses, tensile or shear strains at arbitrary angles, Von Mises stress, etc. Rosette strain gages eliminate the problem of perfectly orienting single strain gages; strain at any angle can be later computed with Rosette Analysis.

To start the Rosette Analysis, select it from the Tools menu, or click the Rosette Analysis button, , on the application toolbar.



Rosette Analysis Dialog Box

Parameters

Gage and Material Information

Rosette Type

Rectangular - L1, L2, and L3 are the gauges placed at the 0, 45, and 90 degree positions, respectively.

Delta - L1, L2, and L3 are the gauges placed at the 0, 120, and 240 degree positions, respectively.

- L1, L2 and L3 are Exx, Eyy, Gxy.

None - The input channels are assumed to be Exx, Eyy, and Gxy respectively.

Modulus Units

MPa

ksi

Elastic Modulus, E - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Poisson's Ratio - Poisson's Ratio is defined as the ratio of lateral strain and axial strain in a cylindrical uniaxial tension specimen. The value for most metals falls between 0.25 and 0.35. The Poisson's Ratio is bounded by two theoretical limits: it must be greater than -1 and less than or equal to 0.5.

Angles

Start - The beginning angle for use in calculations.

End - The ending angle for use in calculations.

Increment - The step or increment of the angles to be used in calculations.

Rosette Output Options

Multiple output channels can be generated and placed in the Output List tab of the Channels List window. A check in the checkbox preceding each option indicates that data should be generated upon analysis.

Axial Strains Exx, Eyy, Gxy

Principal Strains E1, E2, THETA

Strain Rotations Etheta

Shear Strains Gtheta

Von Mises Stress Seq

Axial Stresses Sxx, Syy, Txy, Ezz

Principal S1, S2, THETA

Stress Rotations Stheta

Shear Stresses Ttheta

Buttons

Help - Open the InField help system to the topic directly related to Rosette Analysis.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without making any changes.

Analyze - Perform the Rosette Analysis according to the parameters provided. The Rosette Analysis dialog box will remain visible behind the graph that is generated from the analysis. In addition, the Rosette Analysis will generate a new channel under the Output List tab in the Channels List window.

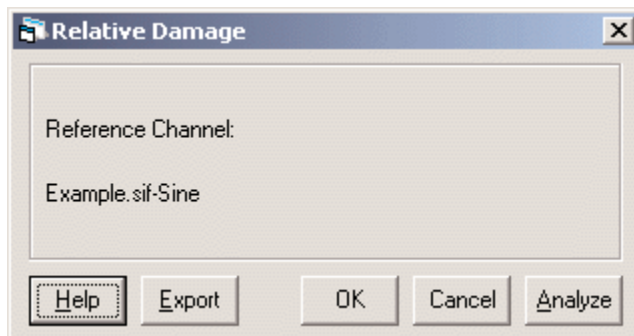
Relative Damage Comparator

The Relative Damage Comparator analysis module calculates the fatigue life of load histories in comparison to each other. It is primarily used to quickly determine the most damaging load histories from a series of data channels. The analysis accounts for varying time length channels and uses the total elapsed time to compensate for the relative fatigue life. Both time and burst histories can be analyzed.

At least two channels must be selected from the Channels List. The first channel selected will be used as the reference channel to which all subsequent channels will be compared. The reference channel is reported in the dialog box.

After the analysis is complete, a tabular display appears presenting the results of the analysis. The first three columns report the relative life. The reference channel will always be reported first and will always have a relative life of 1. All other channels will be referenced to 1. If a channel has a relative life greater than 1, it indicates that the channel has a longer fatigue life than the reference channel and therefore is a less damaging load history. If a channel has a relative fatigue life less than 1, it indicates that the channel has a shorter fatigue life than the reference channel and therefore is a more damaging load history.

To start the Relative Damage Comparator, select it from the Tools menu.



Relative Damage Dialog Box

Parameters

Reference Channel - The host file and channel name of the selected channel.

Outputs

The columns in the output table

Relative Life - There are three relative lives reported for each channel. The three lives are calculated using damage slopes of 3, 5, and 10. Choosing which damage slope to consider is a function of the characteristics of the load history. Load histories characterized by a few large damaging cycles would best be modeled by a damage slope of 10. Load histories characterized by a moderate number of intermediate cycles would best be modeled by a damage slope of 5. Load histories characterized by a large number of small cycles would best be modeled by a damage slope of 3.

Min - The minimum load of the channel.

Max - The maximum load of the channel.

Range - The load range of the channel, max minus min. Also the biggest load cycle.

Elapsed Time - The total elapsed time of the channel. In the case of burst histories, it is the summation of the elapsed times of each burst.

Cycles - The total number of load cycles in the history.

Seq - The equivalent constant amplitude load. A constant amplitude load history of this magnitude and number of cycles would do as much damage as the actual data history being analyzed. The equivalent constant amplitude load is used in the derivation of relative life.

Buttons

Help - Open the InField help system to the topic directly related to the Relative Damage Comparator.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the analysis using the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without performing any analysis.

Analyze - Perform the Relative Damage comparison. The Relative Damage dialog box will remain visible behind the report that is generated from the analysis.

Derivation of Relative Life

The Load-Life Power Function:

$$S = S_0 \cdot N_f^b \quad (1)$$

where S = load

S_0 = intercept of load – life curve at one cycle

N_f = cycles to failure

b = slope of load – life curve

$$N_f = \left(\frac{S}{S_0} \right)^{\frac{1}{b}} \quad (2)$$

The Linear Damage Rule (Miner's Rule):

$$\frac{1}{B_f} = \frac{1}{N_1} + \frac{1}{N_2} + \dots \quad (3)$$

where B_f = Blocks to failure

N_i = Cycles to failure of cycle i

substituting (2) into (3)

$$\frac{1}{B_f} = \frac{1}{\left(\frac{S_1}{S_0} \right)^{\frac{1}{b}}} + \frac{1}{\left(\frac{S_2}{S_0} \right)^{\frac{1}{b}}} + \dots \quad (4)$$

$$\frac{1}{B_f} = \left(\frac{S_1}{S_0} \right)^{-\frac{1}{b}} + \left(\frac{S_2}{S_0} \right)^{-\frac{1}{b}} + \dots \quad (5)$$

$$\frac{1}{B_f} = \left(\frac{1}{S_0} \right)^m \sum S_i^m \quad (6)$$

where m = damage slope = $-\frac{1}{b} = 3, 5, 10$

Equivalent Load:

$$Seq = \sqrt[m]{\frac{\sum S_i^m}{N}} \quad (7)$$

where S_i = load of cycle i

N = number of cycles

$$Seq^m N = \sum S_i^m \quad (8)$$

substituting (8) into (6)

$$\frac{1}{B_f} = \left(\frac{1}{S_0} \right)^m Seq^m N \quad (9)$$

$$\frac{1}{B_f} = N \left(\frac{Seq}{S_0} \right)^m \quad (10)$$

$$B_f = \frac{1}{N} \left(\frac{S_0}{Seq} \right)^m \quad (11)$$

Derivation of Relative Life (continued)

Relative Life:

$$\text{Relative Life} = \frac{\text{Life of Channel } i}{\text{Life of Reference Channel}} = \frac{B_{f_i} \cdot \Delta t_i}{B_{f_{ref}} \cdot \Delta t_{ref}} \quad (12)$$

where $B_{f_{ref}}$ = blocks to failure of reference channel
 B_{f_i} = blocks to failure of channel i
 Δt_{ref} = elapsed time of reference channel
 Δt_i = elapsed time of channel i

substituting (11) into (12)

$$\text{Relative Life} = \frac{\frac{1}{N_i} \left(\frac{S_0}{Seq_i} \right)^m \cdot \Delta t_i}{\frac{1}{N_{ref}} \left(\frac{S_0}{Seq_{ref}} \right)^m \cdot \Delta t_{ref}} \quad (13)$$

$$\text{Relative Life} = \left(\frac{Seq_{ref}}{Seq_i} \right)^m \cdot \frac{N_{ref} \cdot \Delta t_i}{N_i \cdot \Delta t_{ref}} \quad (14)$$

DataModes

DataModes determine how and in what form test data will be stored and displayed (i.e. sequential or histogram plot.) A DataMode definition consists of a list of input channels, a data storage/processing rate, triggering conditions, and other parameters specific to the DataMode.

General Information

Time History

A sequence of constantly sampled data channel values are continuously stored in the output data file. This DataMode is used to convert time history data channels into shorter time history data by using one of the input channels as a data trigger. This triggering allows for removal of data before or sampling of data after the occurrence of a specific data condition.

Burst History

A series of fixed-length time histories that are triggered by a user-defined event are stored in the output data file. This DataMode is used to convert a series of time histories into a series of burst histories by using one of the input channels as a data trigger. This triggering allows for removal of data before or sampling of data after the occurrence of a specific data condition.

Time-At-Level

A Time-At-Level matrix, a fixed size matrix formed by categorizing constantly sampled data channels and calculating their frequency of occurrence, is stored in the output data file. Each input channel occupies one dimension of the matrix resulting in a single data object containing the amount of time spent at unique combinations of variables.

Peak Valley

A collection of successive peaks and valleys, data values where signals change direction, which exceed a user-specified hysteresis value is stored in the output data file. The data between the signal reversals is not stored.

Peak Valley Matrix

A Peak-Valley matrix, a fixed size matrix formed by categorizing successive peak-valley pairs in sequential data and representing their frequency of occurrence, is stored in the output data file. An input channel may be used as a data trigger only if all input channels were generated using the same sample rate.

Rainflow

A Rainflow matrix, a fixed size matrix formed by categorizing rainflow peak-valley pairs and representing their frequency of occurrence, is stored in the output data file. An input channel may be used as a data trigger only if all input channels were generated using the same sample rate.

Use of Triggers

Triggers can be used in DataModes to control or gate the data being processed so as to eliminate undesirable segments of input data channels. More information regarding triggers and their use can be found under [Triggering Considerations](#) later in this section.

Analysis Procedure

The suggested procedure for running a data validation using InField DataModes is as follows:

NOTE: DataMode dialog boxes are modeless. Clicking outside of a DataMode dialog box will allow the use of other windows and functions in the open InField session. Click on the related dialog to return to the DataMode.

1. Select the channel(s) to be validated from the InField channels list. Ensure they are the proper type for the validation to be performed.
2. Open the dialog box for the DataMode to use and set its analysis parameters as necessary.
3. Click Analyze to run the validation according to the parameters entered.

When the validation is complete, InField will plot the results and add the output channel to the Output List. If Add Elapsed Time Channel is an available option and is selected, a plot for that time channel will also be graphed and added to the Output List.

The title bar of each plot window will have the name of the DataMode and the name of the channel being validated.

The default file name for the analysis file(s) containing output channels is made up of the DataMode name and the analysis sequence number with a . SI F extension (SoMat Information File). Sequences start at 000. The sequence number is determined by the previously created output files for the selected function that exist in the InField installation *Output Files* directory. The next available sequence number is used for the newly created file and plot. For example, if there are existing files titled *BurstHistory_000. si f* and *BurstHistory_001. si f*, selecting the Analyze button within a Burst History dialog will create a file titled *BurstHistory_002. si f*.

NOTE: Files created in the *Output Files* directory of the InField installation are not deleted when InField is exited. Periodic, manual deletion of unnecessary files in this directory is strongly recommended to conserve disk space on the computer.

4. Examine the validation results. Channel plot data can be viewed, edited, copied, and pasted using the functions described in [Viewing Data](#) and [Editing Data](#).
5. Review the Output List. Save the channels to keep, and remove the channels to be discarded.
 - To save output channels to a file (other than the default), select them and use Save As in the InField File menu. The saved files will appear in the Output List with the file name specified during the save. The original, temporary channels can be removed from the Output List.
 - To remove channels from the Output List, select the channel(s) to remove and then right-click. Use the option **Remove Channel(s) from Channel List** to remove the unwanted channels. It is not necessary to remove the channels from the Output List. This is really just a way to keep the list manageable and avoid clutter when validating data.


NOTE: Exiting InField will not prompt to save the Output List items. Make sure, if there are any items in the Output List worth saving, to do so before exiting InField.

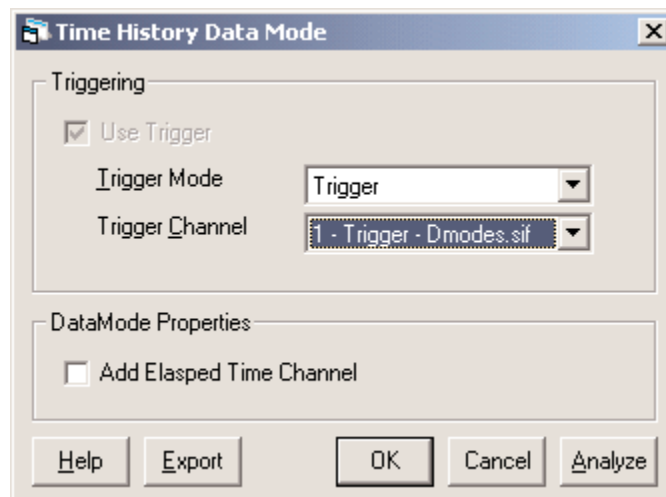
Time History

The Time History DataMode is used to convert a series of time histories into another series of time histories by using one of the input channels as a data trigger. The data trigger channel has to be created before the DataMode is run. This allows removal of data before or sampling of data after the occurrence of a specific data condition.

Data Analyzed

The Time History DataMode can only be used on time history data. All input channels must have the same sample rate. At least two channels must be selected before using the Time History DataMode. The required channels are a trigger and a channel for validation.

To start the Time History DataMode, either select it from the DataMode sub-menu of the Tools menu or click the Time History button, , on the application toolbar.



Time History DataMode Dialog Box

Parameters

Triggering

Trigger Mode - Type of trigger to be used. Available choices are:

Gate - Sample data only when the trigger channel's state is "On".

Trigger - When the trigger channel's state first changes from "Off" to "On", start sampling and continue until the end of the data, regardless of any subsequent change in the trigger channel's state.

One-Shot - Each time the trigger channel's state changes from "Off" to "On", sample data once. As a special case, if the trigger channel is "On" during the first sample of the data, one data sample is taken.

Trigger Channel - The channel to be used as the trigger channel. The channels selected from the Channels List will be available in this drop-down box.

DataMode Properties

Add Elapsed Time Channel - This option is available to add an Elapsed Time Channel to the data being validated. This may be useful in determining when particular events happened during the test.

Buttons

Help - Open the InField help system to the topic directly related to the Time History DataMode.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without making any changes or applying any analysis functions.


Analyze - Perform the Time History DataMode according to the parameters selected. The Time History DataMode dialog box will remain visible behind the graph that is generated from the analysis. In addition, the Time History DataMode will generate a new channel under the Output List tab in the Channels List window.

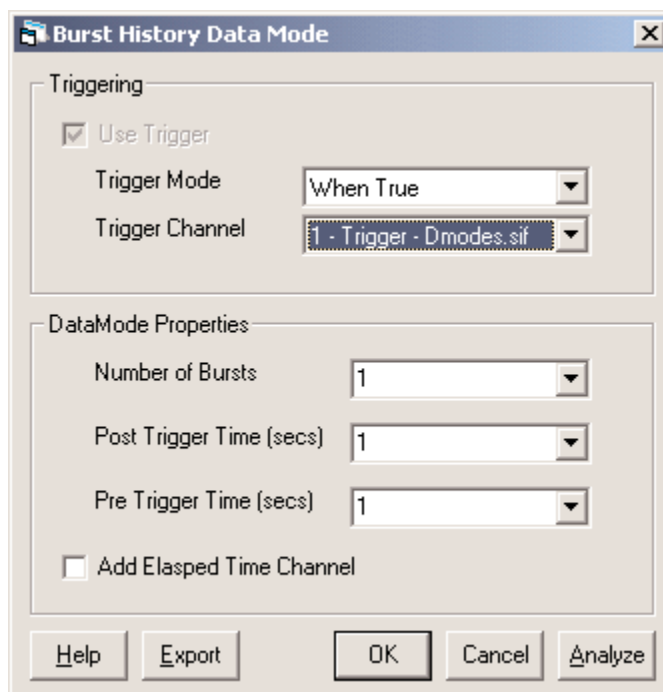
Burst History

The Burst History DataMode is used to convert a series of time histories into a series of burst histories created by using one of the channels as a data trigger. The data trigger channel must be created before this DataMode is run. This allows data around certain conditions to be sampled for predefined periods of time.

Data Analyzed

The Burst History DataMode can only be used on time history data. All input channels must have the same sample rate. At least two channels must be selected before using the Burst History DataMode. The required channels are a trigger and a channel for validation.

To start the Burst History DataMode, either select it from the DataMode sub-menu of the Tools menu, or click the Burst History button, , on the application toolbar.



Burst History DataMode Dialog Box

Parameters

Triggering

Trigger Mode - Type of trigger to be used. The following are the selections available:

When True - Sample data only when the trigger channel state is True.

On False-True Transition - Sample bursts only when the trigger channel state changes from False to True.

Trigger Channel - The channel to be used as the trigger channel. The channels highlighted in the Channels List will be available in this drop-down box. Make sure the channel is an appropriate channel for use as a trigger, or the Burst History DataMode may not analyze data correctly.

DataMode Properties

Number of Bursts - The maximum number of bursts to record. The number of bursts recorded may be less than the selected value if the trigger condition is not met as many times as the selected value.

Post Trigger Time (secs) - Amount of data, in seconds, to store after the burst occurrence.

Pre Trigger Time (secs) - Amount of data, in seconds, to store before the burst occurrence.

Add Elapsed Time Channel - This option is available to add an Elapsed Time Channel to the data being validated. This may be useful in determining when particular events happened during the test.

Buttons

Help - Open the InField help system to the topic directly related to Burst History DataMode.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without making any changes or applying any analysis functions.


Analyze - Perform the analysis according to the parameters selected. The Burst History DataMode analysis dialog will remain visible behind the plot window that is generated by the analysis. The analysis will also generate and add a data channel to the Output List tab in the Channels List window.

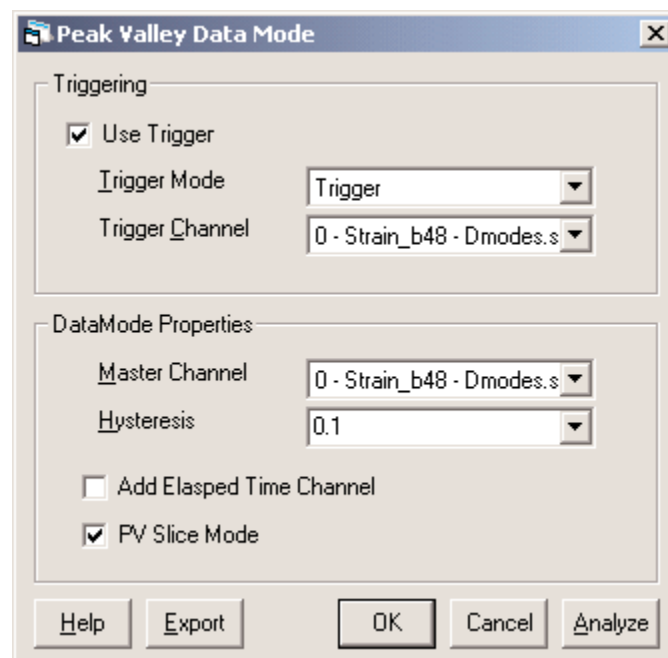
Peak Valley

The Peak Valley DataMode is used to convert a series of time histories into a series of successive peaks and valleys. One of the input channels is selected as a master channel. Whenever there is a peak or valley on the selected channel, all of the channels are sampled. A trigger channel can be defined, which allows for pre-filtering the data.

Data Analyzed

The Peak Valley DataMode accepts any sequential data. The selected channels must have the same sample rate.

To start the Peak Valley DataMode, either select it from the DataMode sub-menu of the Tools menu, or click the Peak Valley button, , on the application toolbar.



Peak Valley DataMode Dialog Box

Parameters

Triggering

Trigger Mode - Type of trigger to be used. The following selections are available:

Gate - Sample data only when the trigger channel's state is "On".

Trigger - When the trigger channel's state first changes from "Off" to "On", start sampling and continue until the end of the data, regardless of any subsequent change in the trigger channel's state.

One-Shot - Each time the trigger channel's state changes from "Off" to "On", sample data once. As a special case, if the trigger channel is "On" during the first sample of the data, one data sample is taken.

Trigger Channel - The channel to be used as the trigger channel. The channels selected from the Channels List will be available in this drop-down box.

DataMode Properties

Master Channel - Only valid while in PV Slice mode. The channel from which the peaks and valleys are extracted.

Hysteresis - The hysteresis value is used to eliminate small reversals in the peak valley data stream and should be expressed in the same units as the data being analyzed. Adjacent peaks and valleys will always differ by more than the hysteresis value. A value of 0 causes all reversals to be stored.

- This may also be referred to as noise band, gate, and hysteresis gate.

Add Elapsed Time Channel - This option is available to add an Elapsed Time Channel to the data that is being analyzed. This may be useful in determining when particular events happened during the test.

PV Slice Mode - When a peak or valley occurs in the Master Channel, the values in all other channels (slaves) will be sampled simultaneously. The results of the slave channels will not be peaks or valleys but rather the data at the peak or valley in the Master Channel.

Buttons

Help - Open the InField help system to the topic directly related to Peak Valley DataMode.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without making any changes or applying any analysis functions.


Analyze - Perform the Peak Valley DataMode according to the parameters provided. The Peak Valley DataMode window will remain visible behind the graph that is generated from the analysis. In addition, the Peak Valley DataMode will generate a new channel under the Output List tab in the Channels List window.

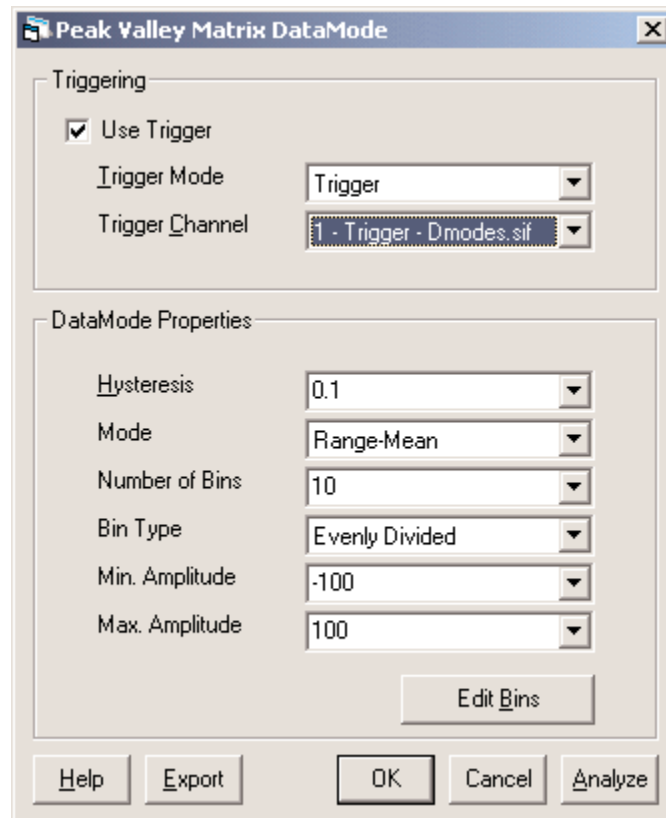
Peak Valley Matrix

The Peak Valley Matrix DataMode converts time histories into Peak Valley Matrices. One of the input channels can be used as a trigger channel, if so desired.

Data Analyzed

The Peak Valley Matrix DataMode accepts only sequential data. Triggering options will be available only if the input channels have the same sample rate.

To start the Peak Valley Matrix DataMode, either select it from the DataMode sub-menu of the Tools menu or click the Peak Valley Matrix button, , on the application toolbar.



Peak Valley Matrix DataMode Dialog Box

Parameters

Triggering

Trigger Mode - Type of trigger to be used. The following selections are available:

Gate - Sample data only when the trigger channel's state is "On".

Trigger - When the trigger channel's state first changes from "Off" to "On", start sampling and continue until the end of the data, regardless of any subsequent change in the trigger channel's state.

One-Shot - Each time the trigger channel's state changes from "Off" to "On", sample data once. As a special case, if the trigger channel is "On" during the first sample of the data, one data sample is taken.

Trigger Channel - The channel to be used as the trigger channel. The channels selected from the Channels List will be available in this drop-down box.

DataMode Properties

Hysteresis - The hysteresis value is used to eliminate small reversals in the peak valley matrix data stream and should be expressed in the same units as the data being analyzed. Adjacent peaks and valleys will always differ by more than the hysteresis value. A value of 0 causes all reversals to be stored.

- This may also be referred to as noise band, gate, and hysteresis gate.

Mode - Type of matrix in which the results will be stored. Selections available are Range-Mean, Range-Only, and To-From.

Number of Bins - Number of bins into which the dimension is to be divided. There will always be an underflow and overflow in addition to the number specified.

Bin Type - Type of bin to be used in storing data. There are two choices for bin type:

Evenly Divided - All the bins are the same size, divided equally across the data range.

User Defined - The maximum amplitude value for each bin is user-defined. This also includes defining the underflow bin. When User Defined is selected, the User Bin Table becomes available for editing.

Min Amplitude - Lower limit of amplitude analysis range.

Max Amplitude - Upper limit of amplitude analysis range.

Edit Bins - Open the User-Defined Bin Setup dialog box. Number of Bins, Bin Type, Min and Max Amplitude are repeated in the sub-window. New options within this window are:

User Bin Table - Only available for editing when User Defined is selected as Bin Type. Used to specify the maximum amplitude value for each bin, including the underflow bin. The number of available entries will be the number of bins plus 1. If 10 bins are selected in the Number of Bins, there will be 11 entries required, due to the underflow entry required. See [Editing Bin Information](#) later in this section for more information.

Import - Provides a method to load a user bin definition previously saved using the Export button. When Import is selected, a dialog box will open, providing a method to select any previously saved user-defined bins.

Export - Provides a method to save a user bin definition previously created in the User Bin Table. When Export is selected, a dialog box will open, providing a method to name and save any definitions created or modified.

Fill In Even Bins - Provides a method to fill in the values of the bins with a predefined set of values as determined in InField. These values will reflect the Max and Min values, as well as the number of bins selected.

Buttons

Help - Open the InField help system to the topic directly related to Peak Valley Matrix DataMode.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be default.

Cancel - Exit without making any changes or applying any analysis functions.


Analyze - Perform the Peak Valley Matrix DataMode according to the parameters selected. The Peak Valley Matrix DataMode dialog box will remain visible behind the graph that is generated from the analysis. In addition, the Peak Valley Matrix DataMode will generate a new channel under the Output List tab in the Channels List window.

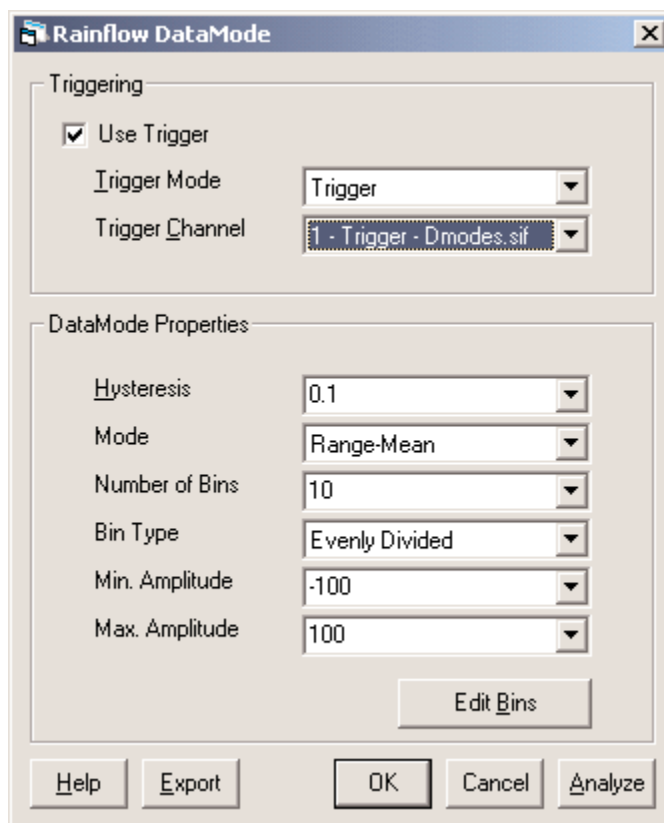
Rainflow

The Rainflow DataMode converts sequential data channels into rainflow matrices that are typically used in low-cycle fatigue damage analysis. One of the input channels can be used as a trigger channel, if so desired.

Data Analyzed

The Rainflow DataMode accepts only sequential data. Triggering options will be available only if the input channels have the same sample rate.

To start the Rainflow DataMode, either select it from the DataMode sub-menu of the Tools menu or click the Rainflow button, , on the application toolbar.



Rainflow DataMode Dialog Box

Parameters

Triggering

Trigger Mode - Type of trigger to be used. The following selections are available:

Gate - Sample data only when the trigger channel's state is "On".

Trigger - When the trigger channel's state first changes from "Off" to "On", start sampling and continue until the end of the data, regardless of any subsequent change in the trigger channel's state.

One-Shot - Each time the trigger channel's state changes from "Off" to "On", sample data once. As a special case, if the trigger channel is "On" during the first sample of the data, one data sample is taken.

Trigger Channel - The channel to be used as the trigger channel. The channels selected from the Channels List will be available in this drop-down box.

DataMode Properties

Hysteresis - The hysteresis value is used to eliminate small reversals in the peak valley matrix data stream, and it should be expressed in the same units as the data being analyzed. Adjacent peaks and valleys will always differ by more than the hysteresis value. A value of 0 causes all reversals to be stored.

- This may also be referred to as noise band, gate, and hysteresis gate.

Mode - Type of matrix into which the results will be stored. Selections available are Range-Mean, Range-Only, and To-From.

Number of Bins - Number of bins into which the dimension is to be divided. There will always be an underflow and overflow in addition to the number specified.

Bin Type - Type of bin to be used in storing data. There are two choices for bin type:

Evenly Divided - All the bins are the same size, divided equally across the data range.

User Defined - The maximum amplitude value for each bin is user-defined. This also includes defining the underflow bin. When User Defined is selected, the boxes for specifying the minimum and maximum values for each bin become available.

Min Amplitude - Lower limit of amplitude analysis range.

Max Amplitude - Upper limit of amplitude analysis range.

Edit Bins - Open the User-Defined Bin Setup dialog box. Number of Bins, Bin Type, Min and Max Amplitude are repeated in the sub-window. New options within this window are:

User Bin Table - Only available for editing when User Defined is selected as Bin Type. Used to specify the maximum amplitude value for each bin, including the underflow bin. The number of available entries will be the number of bins plus 1. If 10 bins are selected in the Number of Bins, there will be 11 entries required, due to the underflow entry required. See [Editing Bin Information](#) later in this section for more information.

Import - Provides a method to load a user bin definition previously saved using the Export button. When Import is selected, a dialog box will open, providing a method to select any previously saved user-defined bins.

Export - Provides a method to save a user bin definition previously created in the User Bin Table. When Export is selected, a dialog box will open, providing a method to name and save any definitions created or modified.

Fill In Even Bins - Provides a method to fill in the values of the bins with a predefined set of values as determined in InField. These values will reflect the Max and Min values, as well as the number of bins selected.

Buttons

Help - Open the InField help system to the topic directly related to Rainflow DataMode.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be default.

Cancel - Exit without making any changes or applying any analysis functions.


Analyze - Perform the Rainflow DataMode analysis according to the parameters selected. The Rainflow DataMode dialog box will remain visible behind the graph that is generated from the analysis. In addition, the Rainflow DataMode will generate a new channel under the Output List Tab in the Channels List window.

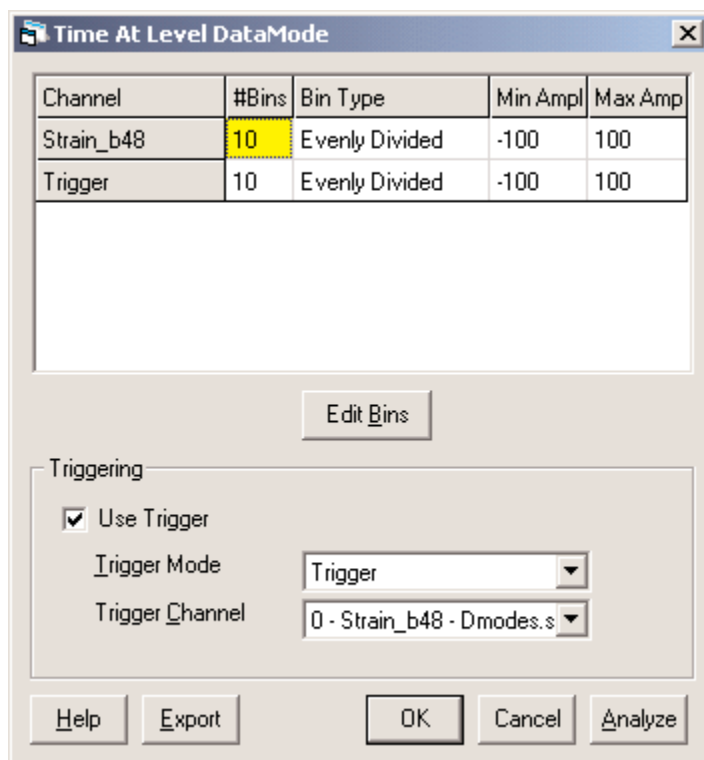
Time-At-Level

The Time-At-Level DataMode converts a series of time histories into a multidimensional Time-At-Level Matrix. For each input channel, there will be one dimension. For each sample, the algorithm classifies each input channel amplitude into a bin within its respective dimension. The maximum number of input channels is six, limiting the output dimensions. Plotting and displaying large amounts of data can be very laborious for a large matrix (approximately 12MB of data if each dimension was classified into 10 bins). A data trigger can be defined if required.

Data Analyzed

Time-At-Level DataMode accepts only sequential data. All input channels must have the same sample rate.

To start the Time-At-Level DataMode, either select it from the DataMode sub-menu of the Tools menu or click the Time-At-Level button, , on the application toolbar.



Time-At-Level DataMode Dialog Box

Parameters

Triggering

Trigger Mode - Type of trigger to be used. The following selections are available:

Gate - Sample data only when the trigger channel's state is "On".

Trigger - When the trigger channel's state first changes from "Off" to "On", start sampling and continue until the end of the data, regardless of any subsequent change in the trigger channel's state.

One-Shot - Each time the trigger channel's state changes from "Off" to "On", sample data once. As a special case, if the trigger channel is "On" during the first sample of the data, one data sample is taken.

Trigger Channel - The channel to be used as the trigger channel. The channels selected from the Channels List will be available in this drop-down box.

Edit Bins - Open the User-Defined Bin Setup dialog box. Number of Bins, Bin Type, Min and Max Amplitude are repeated in the sub-window. New options within this window are:

User Bin Table - Only available for editing when User Defined is selected as Bin Type. Used to specify the maximum amplitude value for each bin, including the underflow bin. The number of available entries will be the number of bins plus 1. If 10 bins are selected in the Number of Bins, there will be 11 entries required, due to the underflow entry required. See [Editing Bin Information](#) later in this section for more information.

Import - Provides a method to load a user bin definition previously saved using the Export button. When Import is selected, a dialog box will open, providing a method to select any previously saved user-defined bins.

Export - Provides a method to save a user bin definition previously created in the User Bin Table. When Export is selected, a dialog box will open, providing a method to name and save any definitions created or modified.

Fill In Even Bins - Provides a method to fill in the values of the bins with a predefined set of values as determined in InField. These values will reflect the Max and Min values, as well as the number of bins selected.

Buttons

Help - Open the InField help system to the topic directly related to the Time-At-Level DataMode.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. The parameters will then be the default.

Cancel - Exit without making any changes or applying any analysis functions.

Analyze - Perform the Time-At-Level DataMode according to the parameters selected. The Time-At-Level DataMode dialog box will remain visible behind the graph that is generated from the analysis. In addition, the Time-At-Level DataMode will generate a new channel under the Output List tab in the Channels List window.

Triggering Considerations

Triggering Overview

Triggering provides a method to eliminate unwanted data from input data channels before the data stream is processed by a DataMode. Within InField, a trigger acts as a pipe or filter to the input data, thus controlling the data stream passed into a DataMode.

All the DataModes that allow for triggering will accept a data channel as a trigger. The trigger channel is not analyzed.

To create a trigger channel, use the InField Signal Calculator. See [Validation Tools - Signal Calculator](#) in this manual.

Two sets of trigger types are used in InField: a standard set for all DataModes (except for Burst Histories) and a set for Burst Histories. These trigger-type sets are described below.

Trigger States

The trigger channel is assumed to be in an Off state when the channel's value is in the range of ± 0.01 ; otherwise, it is assumed to be On.

Standard Triggers

The available standard trigger types (excluding bursts) are:

Always On - Sample all the data (no trigger in use).

Gate - Sample data only when the trigger channel's state is "On".

Trigger - When the trigger channel's state first changes from "Off" to "On", start sampling and continue until the end of the data, regardless of any subsequent change in the trigger channel's state.

One-Shot - Each time the trigger channel's state changes from "Off" to "On", sample data once. As a special case, if the trigger channel is "On" during the first sample of the data, one data sample is taken.

Burst Triggers

A burst trigger acts to cause a burst to be recorded. Two different burst triggers are available.

When True - Sample bursts only while the trigger channel state is True.

On False-True Transition - Sample bursts only when the trigger channel state changes from False to True.

Editing Bin Information

When the Edit Bin button is selected, the User-Defined Bin Setup dialog box will open. The dialog box shown below is used in common between Peak Valley Matrix, and Rainflow, and Time-At-Level DataModes.

Bin	Low Limit	High Limit
uflw	- INFINITY	0
1	0	10
2	10	20
3	20	30
4	30	40

Edit Bins Dialog Box

It is here that the definitions of the bins for each dimension of histograms can be edited. The figure shown above is as it initially appears (the default Bin Type is Evenly Divided).

Click OK to close and save the changes made in the Edit Bins dialog box. Click Cancel to exit without making changes.

Parameters

DataMode Properties

Number of Bins - Number of bins into which the dimension is to be divided. There will always be an underflow and overflow in addition to the number specified.

Bin Type- Type of bin to be used in storing data. There are two choices for bin type:

Evenly Divided - All the bins are the same size, divided equally across the data range.

User Defined - The maximum amplitude value for each bin, including the underflow bin, is user-defined. When User Defined is selected, the User Bin Table becomes available for editing.

Min Amplitude - Lower limit of amplitude analysis range.

Max Amplitude - Upper limit of amplitude analysis range.

User Bin Table

Used to specify the maximum amplitude value for each bin, including the underflow bin. The number of available entries will be the number of bins plus 1. If 10 bins are selected in the Number of Bins, there will be 11 entries required, due to the underflow entry required.

Import - Provides a method to load a user bin definition previously saved using the Export button. When Import is selected, a dialog box will open, providing a method to select any previously saved user bin definition.

Export - Provides a method to save a user bin definition previously created in the User Bin Table. When Export is selected, a dialog box will open, providing a method to name and save any definitions created or modified.

Fill In Even Bins - Provides a method to fill in the values of the bins with a predefined set of values as determined in InField. These values will reflect the Max and Min values, as well as the number of bins selected.

Buttons

OK - Save the information entered for future use. These parameters will then be default.

Cancel - Exit without making any changes.


Fatigue Calculator

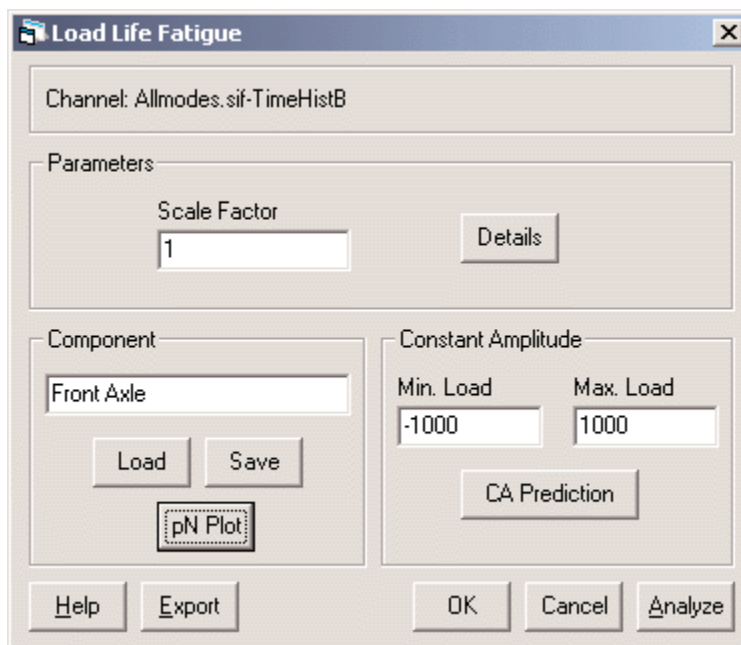
Load Life Fatigue

Load Life or Component Life Analysis tests components under constant amplitude loading in the laboratory to establish baseline data for their durability. This data is then used to estimate how long a component can be expected to last during variable amplitude service conditions.

The advantage of Load Life Analysis is that all variables affecting the fatigue life of the component are included in the data base (processing variables, local stress concentrations, and so on). Changes in service usage can be assessed with this approach.

The obvious limitation of Load Life Analysis is that it requires extensive testing. It cannot be used to assess design modifications, nor can mean stress effect be included.

To start Load Life Analysis, select it from the Fatigue Damage sub-menu of the Tools menu, or click the Load Life button, , on the toolbar.



Load Life Fatigue Dialog Box

Parameters

Channel - The first channel selected in the Channels List is the variable amplitude service history to be analyzed.

Parameters

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the fatigue life.

Details - Display a special dialog for specifying all of the parameters for the analysis. See [Load Life Fatigue - Details Dialog](#) for more information.

Component

Description of the component load-life curve used in this analysis.

Load - Browse the computer file system for an InField Load Life Component File (*.LLF) to load. After the file is loaded, the Details dialog is opened.

Save - Save an InField Load Life Component File (*.LLF) for future use.

pN Plot - Display the load amplitude versus life plot for the component properties specified.

Constant Amplitude

Min. Load - Minimum load (valley) of the constant amplitude cycle to be analyzed. It should be in the same units as the load-life curve.

Max. Load - Maximum load (peak) of the constant amplitude cycle to be analyzed. It should be in the same units as the load-life curve.

CA Prediction - Predict the number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum loads specified above. See [Load Life Fatigue - Constant Amplitude \(CA\) Prediction Dialog](#) for more information.

Buttons

Help - Open the InField help system to the topic directly related to Load Life Fatigue Analysis.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

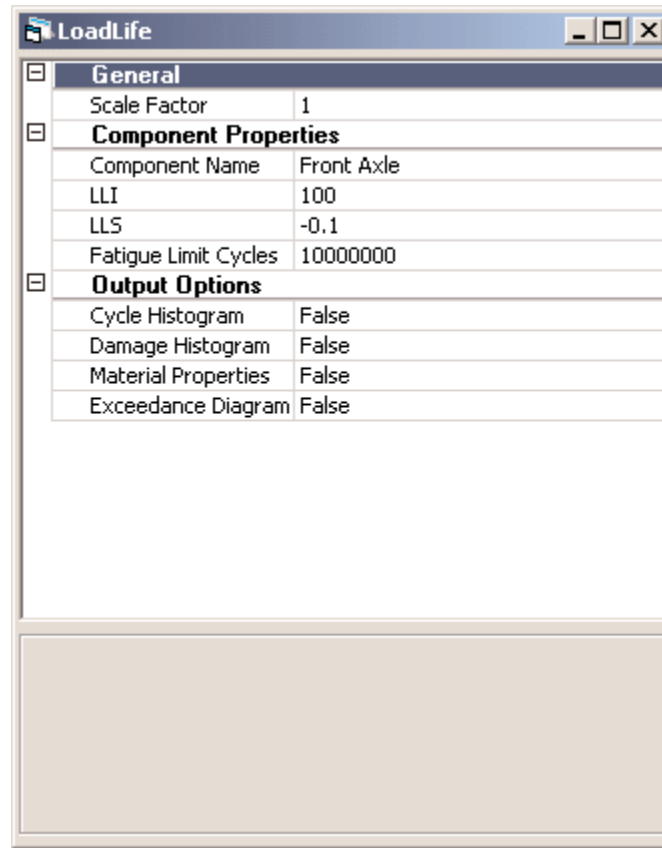
OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without saving changes or applying any analysis functions.

Analyze - Perform the Load Life Fatigue Analysis according to the parameters provided. The Load Life Fatigue dialog box will remain visible behind the Load Life Fatigue Report that is generated from the analysis.

Load Life Fatigue - Details Dialog

This standard properties dialog lets you edit all of the available parameters for Load Life Analysis.



Load Life Details Dialog Box

General

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the fatigue life.

Component Properties

Component Name - A brief description of the component being analyzed.

LLI - The intercept at 1 cycle on a log-log plot of load amplitude versus cycles to failure. It should be in the same units as the signal being analyzed.

LLS - The slope of the straight line from a log-log plot of load amplitude versus cycles to failure. It should be a negative number of magnitude less than 1.

Fatigue Limit Cycles - The number of cycles considered to represent infinite life.

Output Options

Cycle Histogram - Add a range versus mean cycle histogram to the results file.

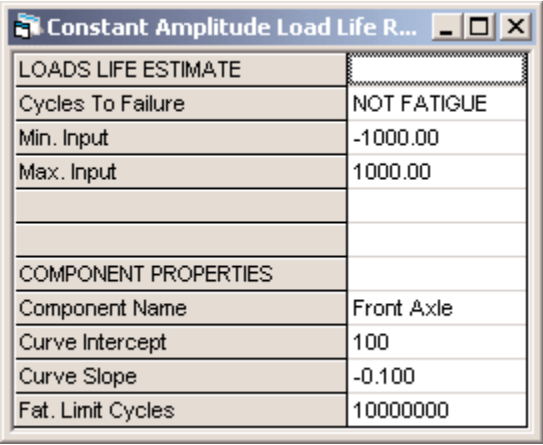
Damage Histogram - Add a range versus mean histogram indicating the damaging cycles to the results file.

Material Properties - Add an XY channel containing a load amplitude versus life diagram to the results file.

Exceedance Diagram - Add a cumulative count to the results file of how many times peaks in the data exceeded a specified level. How long the peaks exceed the level is not measured. The exceedance diagram can be either peak-valley or range-pair.

Load Life Fatigue - Constant Amplitude (CA) Prediction Dialog

Constant amplitude Load Life Analysis produces the following results table.



LOADS LIFE ESTIMATE	
Cycles To Failure	NOT FATIGUE
Min. Input	-1000.00
Max. Input	1000.00
COMPONENT PROPERTIES	
Component Name	Front Axle
Curve Intercept	100
Curve Slope	-0.100
Fat. Limit Cycles	10000000

Load Life Constant Amplitude Prediction Dialog Box

Load Life Estimate

Cycles to Failure - Number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum loads specified below. NOT FATIGUE means the input load amplitude exceeds the load-life curve intercept. INFINITE means the input load amplitude is less than the load-life curve value at the fatigue limit cycles.

Min. Input - Minimum load (valley) of the constant amplitude cycle analyzed.

Max. Input - Maximum load (peak) of the constant amplitude cycle analyzed.

Component Properties

Component Name - Description of the component analyzed.

Curve Intercept - The intercept at 1 cycle on a log-log plot of load amplitude versus cycles to failure.

Curve Slope - The slope of the straight line from a log-log plot of load amplitude versus cycles to failure.

Fat. Limit Cycles - The number of cycles considered to represent infinite life.

Load Life Fatigue Report

A successful variable amplitude Load Life Analysis produces the following results table.

Load Life Report	
LOADS LIFE ESTIMATE	
Blocks To Failure	NOT FATIGUE - Maximum Data Amplitude of 668.64 is larger than the Load life Intercept of 100
Hours To Failure	N/A
Min. Input	-999.00
Max. Input	338.28
INPUT CHANNEL INFORMATION	
Filename	C:\Program Files\SoMat\InField\Examples\Allmodes.sif
ChannelName	TimeHistB
Channel Label	Strain
Channel Units	uE
TimeSlice	0.000 to 2784.444 seconds
COMPONENT PROPERTIES	
Component Name	Front Axle
Curve Intercept	100
Curve Slope	-0.100
Fat. Limit Cycles	10000000

Load Life Report Dialog Box

Load Life Estimate

Blocks to Failure - Number of repeats of the service history (input channel) the component can withstand before failure. NOT FATIGUE means the maximum input load amplitude from the service history exceeds the load-life curve intercept. INFINITE means the maximum input load amplitude from the service history is less than the load-life curve value at the fatigue limit cycles.

Hours to Failure - Number of hours corresponding to the blocks to failure. It equals blocks to failure times the number of hours in one history repeat.

Min. Input - Minimum data point in the input service history.

Max. Input - Maximum data point in the input service history.

Input Channel Information

Filename - Path and file name of the service history analyzed.

Channelname - Channel name identifier of the service history analyzed.

Channel Label - Extended channel descriptor of the service history analyzed.

Channel Units - Engineering units of the service history analyzed.

TimeSlice - The beginning and ending times for the segment of service history analyzed. Expressed in seconds.

Component Properties

Component Name - Description of the component analyzed.

Curve Intercept - The intercept at 1 cycle on a log-log plot of load amplitude versus cycles to failure.


Curve Slope - The slope of the straight line from a log-log plot of load amplitude versus cycles to failure.

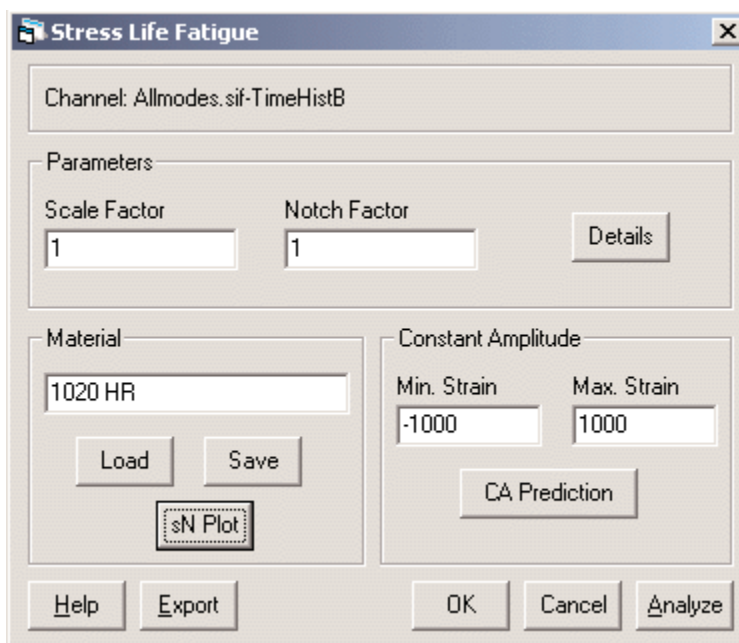
Fat. Limit Cycles - The number of cycles considered to represent infinite life.

Stress Life Fatigue

Stress Life Analysis is often used for long lives where plastic strains can be ignored. The approach assumes that the nominal stress and fatigue limit of the material control the behavior of the structure. Alternatively, the relationship between the fatigue life and nominal stress on a complex component such as a weld could be experimentally determined. Many empirical relationships have been developed during the last 100 years. Standard weld SN curves such as those from BS5400 can be used, although InField provides a specific BS5400 analysis module.

The primary limitation of Stress Life Analysis is that plastic strains, which are known to be critical to fatigue, as well as the sequence effects that alter the mean stresses at stress concentrations are ignored.

To start Stress Life Analysis, select it from the Fatigue Damage sub-menu of the Tools menu, or click the Stress Life button, , on the toolbar.



The dialog box titled "Stress Life Fatigue" contains the following fields and controls:

- Channel: Allmodes.sif-TimeHistB
- Parameters section:
 - Scale Factor: 1
 - Notch Factor: 1
 - Details button
- Material section:
 - Material: 1020 HR
 - Load button
 - Save button
 - sN Plot button
- Constant Amplitude section:
 - Min. Strain: -1000
 - Max. Strain: 1000
 - CA Prediction button
- Bottom row of buttons: Help, Export, OK, Cancel, Analyze

Stress Life Fatigue Dialog Box

Parameters

Channel - The data file and channel name to analyze.

Parameters

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the component life.

Notch Factor - Fatigue notch factor value related to the theoretical stress concentration factor of a given notch geometry. This should be greater than or equal to 1; a value of 1 represents no notch intensification.

Details - Display a special dialog for specifying all the parameters for the analysis.

Material

Description of the stress-life curve used in this analysis.

Load - Browse the computer file system for an InField Materials File (*. I I f) to load. After the file is loaded, the Details window is opened.

Save - Create an InField Stress Life Material file (*. sI f).

sN Plot - Displays a plot of the stress life curve for the material based on the defined parameters.

Constant Amplitude

Max. Strain - The minimum strain (valley) of the constant amplitude strain cycle to be analyzed. It should be in units strain or microstrain.

Min. Strain - The maximum strain (peak) of the constant amplitude strain cycle to be analyzed. It should be in units strain or microstrain.

CA Prediction - Predict the number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum strains specified above.

Buttons

Help - Open the InField help system to the topic directly related to Stress Life Fatigue Analysis.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

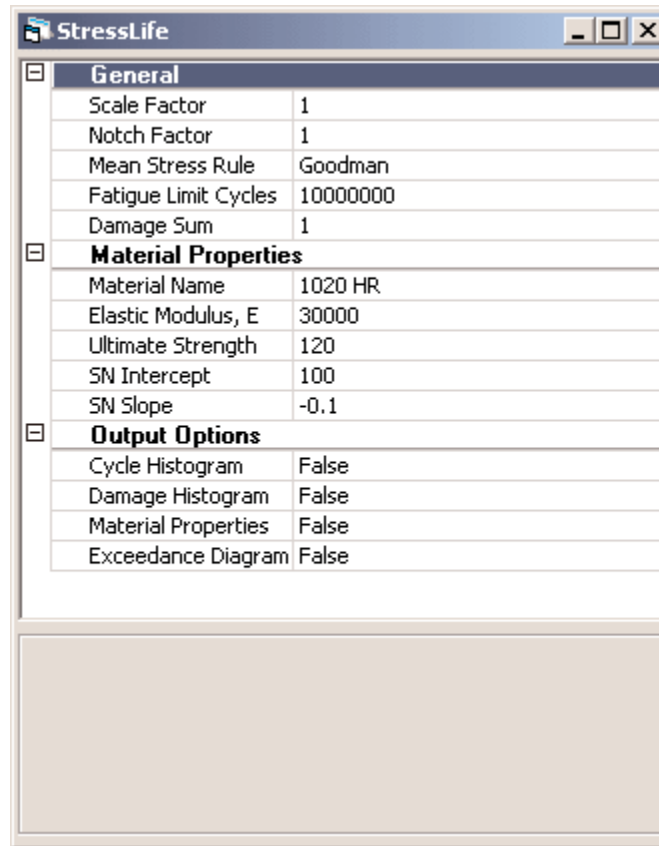
OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without saving changes or applying any analysis functions.

Analyze - Perform the Stress Life Fatigue Analysis according to the parameters provided. The Stress Life Fatigue dialog box will remain visible behind the Stress Life Fatigue Report that is generated from the analysis.

Stress Life Fatigue - Details Dialog

This standard properties dialog lets you edit all of the available parameters for Stress Life Analysis.



The screenshot shows a dialog box titled "StressLife" with three expandable sections: "General", "Material Properties", and "Output Options". Each section contains a list of parameters and their values.

General	
Scale Factor	1
Notch Factor	1
Mean Stress Rule	Goodman
Fatigue Limit Cycles	10000000
Damage Sum	1

Material Properties	
Material Name	1020 HR
Elastic Modulus, E	30000
Ultimate Strength	120
SN Intercept	100
SN Slope	-0.1

Output Options	
Cycle Histogram	False
Damage Histogram	False
Material Properties	False
Exceedance Diagram	False

Stress Life Details Dialog Box

General

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the component life.

Notch Factor - Fatigue notch factor value related to the theoretical stress concentration factor of a given notch geometry. This should be greater than or equal to 1; a value of 1 represents no notch intensification.

Mean Stress Rule - Stress model used: either the Goodman model, Gerber model, or None (no mean stress correction). Mean stress correction accounts for the fact that cycles with equivalent amplitudes but higher mean stresses are more damaging in fatigue.

Fatigue Limit Cycles - The number of cycles considered to represent infinite life.

Damage Sum - The damage summation in Miner's Law can be set to a number other than 1.0.

Material Properties

Material Name - Brief description of the material whose parameters are defined.

Elastic Modulus, E - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

SN Intercept - Intercept at 1 cycle on a log-log plot of stress amplitude versus cycles to failure. If this value is changed, the Fatigue Limit Stress field will be reevaluated.

SN Slope - Slope of the straight line from a log-log plot of stress amplitude versus cycles to failure. It should be a negative number less than 1. If this value is modified, the Fatigue Limit Stress field will be reevaluated.

Output Options

Cycle Histogram - Add a range versus mean cycle histogram to the results file.

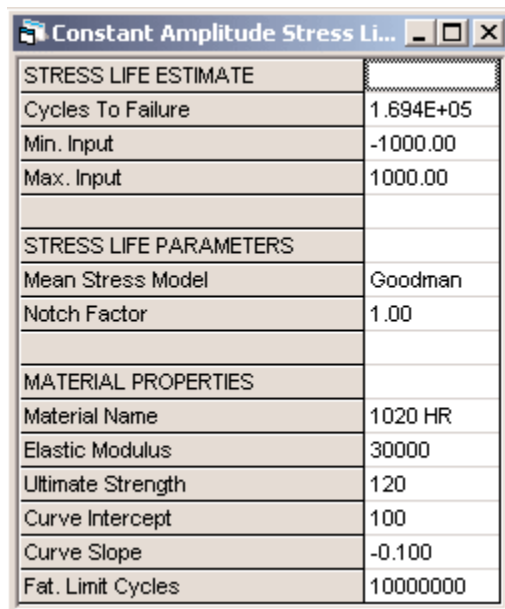
Damage Histogram - Add a range versus mean histogram indicating the damaging cycles to the results file.

Material Properties - Add an XY channel containing a stress amplitude versus life diagram to the results file.

Exceedance Diagram - Add a cumulative count to the results file of how many times peaks in the data exceeded a specified level. How long the peaks exceed the level is not measured. The exceedance diagram can be either peak-valley or range-pair.

Stress Life Fatigue - Constant Amplitude (CA) Prediction Dialog

Constant amplitude Stress Life Analysis produces the following results table.



STRESS LIFE ESTIMATE	
Cycles To Failure	1.694E+05
Min. Input	-1000.00
Max. Input	1000.00
STRESS LIFE PARAMETERS	
Mean Stress Model	Goodman
Notch Factor	1.00
MATERIAL PROPERTIES	
Material Name	1020 HR
Elastic Modulus	30000
Ultimate Strength	120
Curve Intercept	100
Curve Slope	-0.100
Fat. Limit Cycles	10000000

Stress Life Constant Amplitude Prediction Dialog Box

Stress Life Estimate

Cycles to Failure - Number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum loads specified below. NOT FATIGUE means the input load amplitude exceeds the load-life curve intercept. INFINITE means that the input load amplitude is less than the load-life curve value at the fatigue limit cycles.

Min. Input - Minimum strain (valley) of the constant amplitude cycle analyzed.

Max. Input - Maximum strain (peak) of the constant amplitude cycle analyzed.

Stress Life Parameters

Mean Stress Model - Stress model used: either the Goodman model, Gerber model, or None (no mean stress correction). Mean stress correction accounts for the fact that cycles with equivalent amplitudes but higher mean stresses are more damaging in fatigue.

Notch Factor - Fatigue notch factor value related to the theoretical stress concentration factor of a given notch geometry. This should be greater than or equal to 1; a value of 1 represents no notch intensification.

Material Properties

Material Name - Brief description of the material whose parameters are defined.

Elastic Modulus - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

Curve Intercept - Intercept at 1 cycle on a log-log plot of stress amplitude versus cycles to failure.

Curve Slope - Slope of the straight line from a log-log plot of stress amplitude versus cycles to failure. It should be a negative number less than 1.

Fat. Limit Cycles - The number of cycles considered to represent infinite life.

Stress Life Fatigue Report

A successful variable amplitude Stress Life Analysis produces the following results table.

Stress Life Report	
STRESS LIFE ESTIMATE	
Blocks To Failure	INFINITE - Maximum Data Amplitude of 20.06 is smaller than the stress at the fatigue limit of 19.
Hours To Failure	N/A
Min. Input	-999.00
Max. Input	338.28
INPUT CHANNEL INFORMATION	
Filename	C:\Program Files\SoMat\InField\Examples\Allmodes.sif
ChannelName	TimeHistB
Channel Label	Strain
Channel Units	uE
TimeSlice	0.000 to 2784.444 seconds
STRESS LIFE PARAMETERS	
Mean Stress Model	Goodman
Notch Factor	1.00
MATERIAL PROPERTIES	
Material Name	1020 HR
Elastic Modulus	30000
Ultimate Strength	120
Curve Intercept	100

Stress Life Report Dialog Box

Stress Life Estimate

Blocks to Failure - Number of repeats of the service history (input channel) the component can withstand before failure. NOT FATIGUE means the maximum input load amplitude from the service history exceeds the load-life curve intercept. INFINITE means the maximum input load amplitude from the service history is less than the load-life curve value at the fatigue limit cycles.

Hours to Failure - Number of hours corresponding to the blocks to failure. It equals blocks to failure times the number of hours in one history repeat.

Min. Input - Minimum data point in the input service history.

Max. Input - Maximum data point in the input service history.

Input Channel Information

Filename - Path and filename of the service history analyzed.

ChannelName - Channel name identifier of the service history analyzed.

Channel Label - Extended channel descriptor of the service history analyzed.

Channel Units - Engineering units of the service history analyzed.

TimeSlice - The beginning and ending times for the segment of service history analyzed. Expressed in seconds.

Stress Life Parameters

Mean Stress Model - Stress model used: either the Goodman model, Gerber model, or None (no mean stress correction). Mean stress correction accounts for the fact that cycles with equivalent amplitudes but higher mean stresses are more damaging in fatigue.

Notch Factor - Fatigue notch factor value related to the theoretical stress concentration factor of a given notch geometry. This should be greater than or equal to 1; a value of 1 represents no notch intensification.

Material Properties

Material Name - Brief description of the material whose parameters are defined.

Elastic Modulus - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

Curve Intercept - Intercept at 1 cycle on a log-log plot of stress amplitude versus cycles to failure.

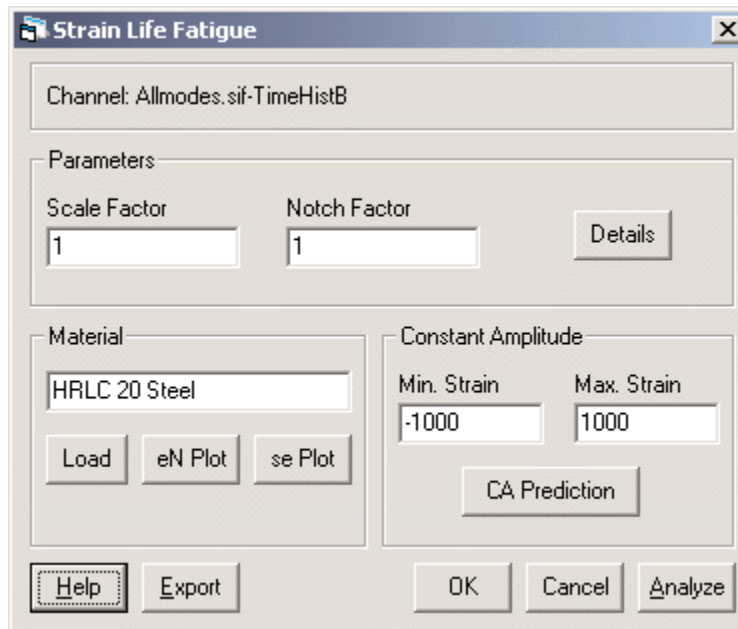
Curve Slope - Slope of the straight line from a log-log plot of stress amplitude versus cycles to failure. It should be a negative number less than 1.

Fat. Limit Cycles - The number of cycles considered to represent infinite life.

Strain Life Fatigue

Strain Life Analysis models actual stress-strain behavior at the critical location in a component. Plastic strains that may occur infrequently during service loading are accounted for in this analysis. Cycle-dependent material properties provide a more accurate estimate of the service performance of the material than traditional tensile test data. Use of strain life method is limited to situations where crack nucleation consumes the majority of the service life. This is typical of smaller components rather than of full-scale engineering structures.

To start Strain Life Analysis, select it from the Fatigue Damage sub-menu of the Tools menu, or click the Strain Life button, , on the toolbar.



Strain Life Fatigue Dialog Box

Parameters

Channel - The data file and channel name to analyze.

Parameters

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the fatigue life.

Notch Factor - Fatigue notch factor value related to the theoretical stress concentration factor of a given notch geometry. This should be greater than or equal to 1; a value of 1 represents no notch intensification.

Details - Display a special dialog for specifying all of the parameters of the analysis.

Material

Description of the material properties curves used in this analysis.

Load - Browse the computer file system for an InField Material File (*.MAT) to load. After the file is loaded, the Details window is opened.

eN Plot - Displays a plot of the strain life curve for the material based on the defined parameters.

se Plot - Displays a plot of the cyclic stress/strain curve for the material based on the defined parameters.

Constant Amplitude

Min. Strain - The minimum strain (valley) of the constant amplitude strain cycle to be analyzed. It should be in units strain or microstrain.

Max. Strain - The maximum strain (peak) of the constant amplitude strain cycle to be analyzed. It should be in units strain or microstrain.

CA Prediction - Predict the number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum strains specified above.

Buttons

Help - Open the InField help system to the topic directly related to Strain Life Fatigue Analysis.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

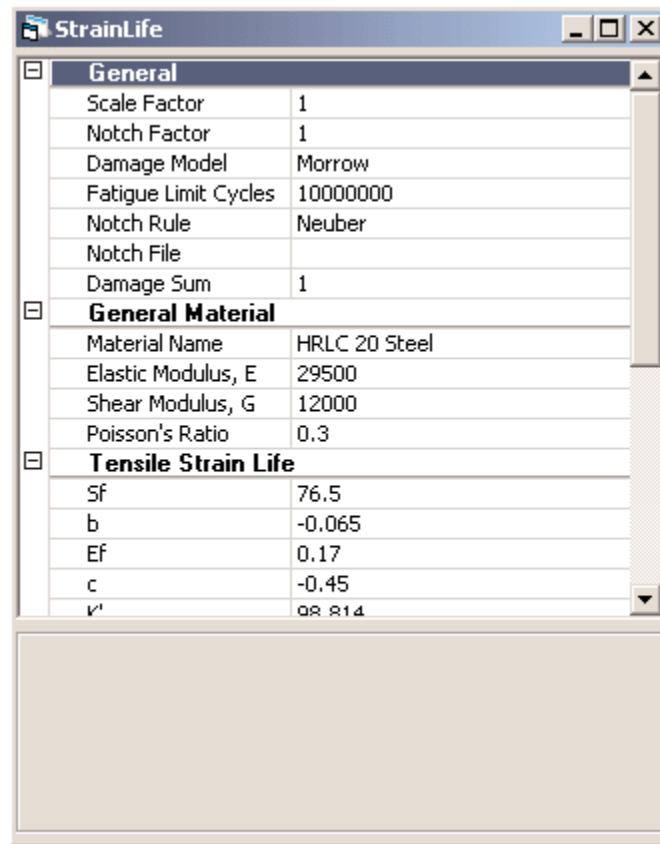
OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without saving changes or applying any analysis functions.

Analyze - Perform the Strain Life Fatigue Analysis according to the parameters provided. The Strain Life Fatigue dialog box will remain visible behind the Strain Life Fatigue Report that is generated from the analysis.

Strain Life Fatigue - Details Dialog

This standard properties dialog lets you edit all of the available parameters for Strain Life Analysis.



Strain Life Details Dialog Box

General

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the fatigue life.

Notch Factor - Fatigue notch factor value related to the theoretical stress concentration factor of a given notch geometry. This should be greater than or equal to 1; a value of 1 represents no notch intensification.

Damage Model - Damage (mean stress) model used: either the Morrow model, Smith-Watson-Topper (SWT), Epsilon, Gamma, or Fatemi. Mean stress correction accounts for the fact that cycles with equivalent amplitudes but higher mean stresses are more damaging in fatigue.

Fatigue Limit Cycles - The number of cycles considered to represent infinite life.

Notch Rule - Notch rule used: either Neuber, Neuber ($S=Ee$), Glinka, Glinka ($S=Ee$), or Experimental. The designator, $S=Ee$, indicates that the nominal behavior is considered to be elastic. If Experimental is selected, a valid notch file must be specified.

Notch File - Name of file containing a curve of input load versus notch root strain.

Damage Sum - The damage summation in Miner's Law can be set to a number other than 1.0.

General Material

Material Name - Brief description of the material whose parameters are defined.

Elastic Modulus, E - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Shear Modulus, E - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic torsion test.

Poisson's Ratio - Poisson's Ratio is defined as the ratio of lateral strain and axial strain in a cylindrical uniaxial tension specimen. The value for most metals falls between 0.25 to 0.35. The Poisson's Ratio is bounded by two theoretical limits: it must be greater than -1 and less than or equal to 0.5.

Tensile Strain Life

Sf - The Fatigue Strength Coefficient, Sf, is the intercept at 1 reversal on a log-log plot of stress amplitude versus reversals to failure.

b - The Fatigue Strength Exponent, b, is the slope of the straight line from a log-log plot of stress amplitude versus reversals to failure.

Ef - The Fatigue Ductility Coefficient, Ef, is the intercept at 1 reversal on a log-log plot of plastic strain amplitude versus reversals to failure.

c - The Fatigue Ductility Exponent, c, is the slope of a straight line from a log-log plot of plastic strain amplitude versus reversals to failure.

K' - The Cyclic Strength Coefficient, K', is the intercept at a plastic strain amplitude of 1 on a log-log plot of stress amplitude versus plastic strain amplitude.

n' - The Cyclic Strength Exponent, n', is the slope of the straight line on a log-log plot of stress amplitude versus plastic strain amplitude.

Shear Strain Life

Tf' - The Fatigue Strength Coefficient measured in a torsion test.

b0 - The Fatigue Strength Exponent measured in a torsion test.

gf' - The Fatigue Ductility Coefficient measured in a torsion test.

c0 - The Fatigue Ductility Exponent measured in a torsion test.

K'-90 - The Cyclic Strength Coefficient measured in a torsion test.

Output Options

Cycle Histogram - Add a range versus mean cycle histogram to the results file.

Damage Histogram - Add a range versus mean histogram indicating the damaging cycles to the results file.

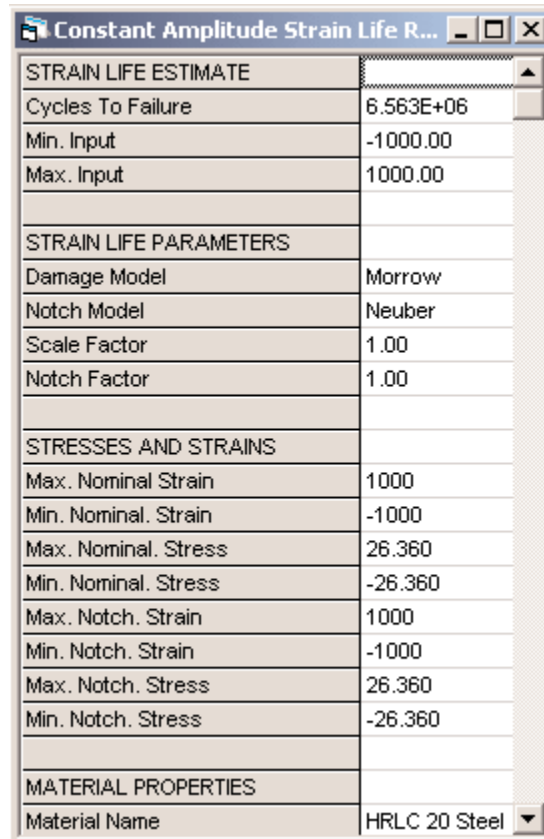
Material Properties - Add an XY channel containing a strain amplitude versus life diagram to the results file. Also, add an XY channel containing a cyclic stress-strain curve to the results file.

Hysteresis Loops - Add an XY channel containing the largest stress-strain hysteresis loops to the results file.

Exceedance Diagram - Add a cumulative count to the results file of how many times peaks in the data exceeded a specified level. How long the peaks exceeded the level is not measured. The exceedance diagram can be either peak-valley or range-pair.

Strain Life Fatigue - Constant Amplitude (CA) Prediction Dialog

Constant amplitude Strain Life Analysis produces the following results table.



STRAIN LIFE ESTIMATE	
Cycles To Failure	6.563E+06
Min. Input	-1000.00
Max. Input	1000.00
STRAIN LIFE PARAMETERS	
Damage Model	Morrow
Notch Model	Neuber
Scale Factor	1.00
Notch Factor	1.00
STRESSES AND STRAINS	
Max. Nominal Strain	1000
Min. Nominal Strain	-1000
Max. Nominal Stress	26.360
Min. Nominal Stress	-26.360
Max. Notch Strain	1000
Min. Notch Strain	-1000
Max. Notch Stress	26.360
Min. Notch Stress	-26.360
MATERIAL PROPERTIES	
Material Name	HRLC 20 Steel

Strain Life Constant Amplitude Prediction Dialog Box

Strain Life Estimate

Cycles to Failure - Number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum loads specified below. NOT FATIGUE means the input load amplitude exceeds the load-life curve intercept. INFINITE means the input load amplitude is less than the load-life curve value at the fatigue limit cycles.

Min. Input - Minimum strain (valley) of the constant amplitude cycle analyzed.

Max. Input - Maximum strain (peak) of the constant amplitude cycle analyzed.

Strain Life Parameters

Damage Model - Damage (mean stress) model used: either the Morrow model, Smith-Watson-Topper (SWT), Epsilon, Gamma, or Fatemi. Mean stress correction accounts for the fact that cycles with equivalent amplitudes but higher mean stresses are more damaging in fatigue.

Notch Model - Notch rule used: either Neuber, Neuber ($S=Ee$), Glinka, Glinka ($S=Ee$), or Experimental. The designator, $S=Ee$, indicates that the nominal behavior is considered to be elastic. If Experimental is selected, a valid notch file must be specified.

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the fatigue life.

Notch Factor - Fatigue notch factor value related to the theoretical stress concentration factor of a given notch geometry. This should be greater than or equal to 1; a value of 1 represents no notch intensification.

Stresses and Strains

Max. Nominal Strain - Highest strain detected in the nominal stress field.

Min. Nominal Strain - Lowest strain detected in the nominal stress field.

Max. Nominal Stress - Highest stress detected in the nominal stress field.

Min. Nominal Stress - Lowest stress detected in the nominal stress field.

Max. Notch Strain - Highest strain detected in the notch stress field.

Min. Notch Strain - Lowest strain detected in the notch stress field.

Max. Notch Stress - Highest stress detected in the notch stress field.

Min. Notch Stress - Lowest stress detected in the notch stress field.

Material Properties

Material Name - Brief description of the material whose parameters are defined.

Elastic Modulus - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Poisson's Ratio - Poisson's Ratio is defined as the ratio of lateral strain and axial strain in a cylindrical uniaxial tension specimen. The value for most metals falls between 0.25 to 0.35. The Poisson's Ratio is bounded by two theoretical limits: it must be greater than -1 and less than or equal to 0.5.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

Yield Strength - Value indicating the stress at the onset of yielding as determined from a monotonic tensile test.

Fatigue Strength Coeff, S_f - The intercept at 1 reversal on a log-log plot of stress amplitude versus reversals to failure.

Fatigue Strength Exp, b - The slope of the straight line from a log-log plot of stress amplitude versus reversals to failure.

Fatigue Ductility Coeff, E_f - The intercept at 1 reversal on a log-log plot of plastic strain amplitude versus reversals to failure.

Fatigue Ductility Exp, c - The slope of a straight line from a log-log plot of plastic strain amplitude versus reversals to failure.

Cyclic Strength Coeff, K' - The intercept at a plastic strain amplitude of 1 on a log-log plot of stress amplitude versus plastic strain amplitude.

Cyclic Strength Exp, n' - The slope of the straight line on a log-log plot of stress amplitude versus plastic strain amplitude.

Fatigue Limit Cycles - The number of cycles considered to represent infinite life.

Strain Life Fatigue Report

A successful variable amplitude Strain Life Analysis produces the following results table.

STRAIN LIFE ESTIMATE	
Blocks To Failure	INFINITE - Notch Data Amplitude of 0.00086 is smaller than the Strain at the Fatigue Limit of 0.00
Hours To Failure	N/A
Min. Input	-990.32
Max. Input	738.00
INPUT CHANNEL INFORMATION	
Filename	C:\Program Files\SoMat\InField\Examples\Allmodes.sif
ChannelName	TimeHistA
Channel Label	Strain
Channel Units	uE
TimeSlice	0.000 to 6595.556 seconds
STRAIN LIFE PARAMETERS	
Damage Model	Morrow
Notch Model	Neuber
Scale Factor	1.00
Notch Factor	1.00
STRESSES AND STRAINS	
Max. Nominal Strain	738
Min. Nominal Strain	-990

Strain Life Report Dialog Box

Strain Life Estimate

Blocks to Failure - Number of repeats of the service history (input channel) the component can withstand before failure. NOT FATIGUE means the maximum input load amplitude from the service history exceeds the load-life curve intercept. INFINITE means the maximum input load amplitude from the service history is less than the load-life curve at the fatigue limit cycles.

Hours to Failure - Number of hours corresponding to the blocks to failure. It equals blocks to failure times the number of hours in one history repeat.

Min. Input - Minimum data point in the input service history.

Max. Input - Maximum data point in the input service history.

Input Channel Information

Filename - Path and filename of the service history analyzed.

Channelname - Channel name identifier of the service history analyzed.

Channel Label - Extended channel descriptor of the service history analyzed.

Channel Units- Engineering units of the service history analyzed.

TimeSlice - The beginning and ending times for the segment of service history analyzed. Expressed in seconds.

Strain Life Parameters

Damage Model - Damage (mean stress) model used: either the Marrow model, Smith-Watson-Topper (SWT), Epsilon, Gamma, or Fatemi. Mean stress correction accounts for the fact that cycles with equivalent amplitudes but higher mean stresses are more damaging in fatigue.

Notch Model - Notch rule used: either Neuber, Neuber ($S=E\epsilon$), Glinka, Glinka ($S=E\epsilon$), or Experimental. The designator, $S=E\epsilon$, indicates that the nominal behavior is considered to be elastic. If Experimental is selected, a valid notch file must be specified.

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the fatigue life.

Notch Factor - Fatigue notch factor value related to the theoretical stress concentration factor of a given notch geometry. This should be greater than or equal to 1; a value of 1 represents no notch intensification.

Stresses and Strains

Max. Nominal Strain - Highest strain detected in the nominal stress field.

Min. Nominal Strain - Lowest strain detected in the nominal stress field.

Max. Nominal Stress - Highest stress detected in the nominal stress field.

Min. Nominal Stress - Lowest stress detected in the nominal stress field.

Max. Notch Strain - Highest strain detected in the notch stress field.

Min. Notch Strain - Lowest strain detected in the notch stress field.

Max. Notch Stress - Highest stress detected in the notch stress field.

Min. Notch Stress - Lowest stress detected in the notch stress field.

Component Properties

Material Name - Brief description of the material whose parameters are defined.

Elastic Modulus - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Poisson's Ratio - Poisson's Ratio is defined as the ratio of lateral strain and axial strain in a cylindrical uniaxial tension specimen. The value for most metals falls between 0.25 to 0.35. Poisson's Ratio is bounded by two theoretical limits: it must be greater than -1 and less than or equal to 0.5.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

Yield Strength - Value indicating the stress at the onset of yielding as determined by a monotonic tensile test.

Fatigue Strength Coeff, S_f - The intercept at 1 reversal on a log-log plot of stress amplitude versus reversals to failure.

Fatigue Strength Exp, b - The slope of the straight line from a log-log plot of stress amplitude versus reversals to failure.

Fatigue Ductility Coeff, E_f - The intercept at 1 reversal on a log-log plot of plastic strain amplitude versus reversals to failure.

Fatigue Ductility Exp, c - The slope of a straight line from a log-log plot of plastic strain amplitude versus reversals to failure.

Cyclic Strength Coeff, K' - The intercept at a plastic strain amplitude of 1 on a log-log plot of stress amplitude versus plastic strain amplitude.

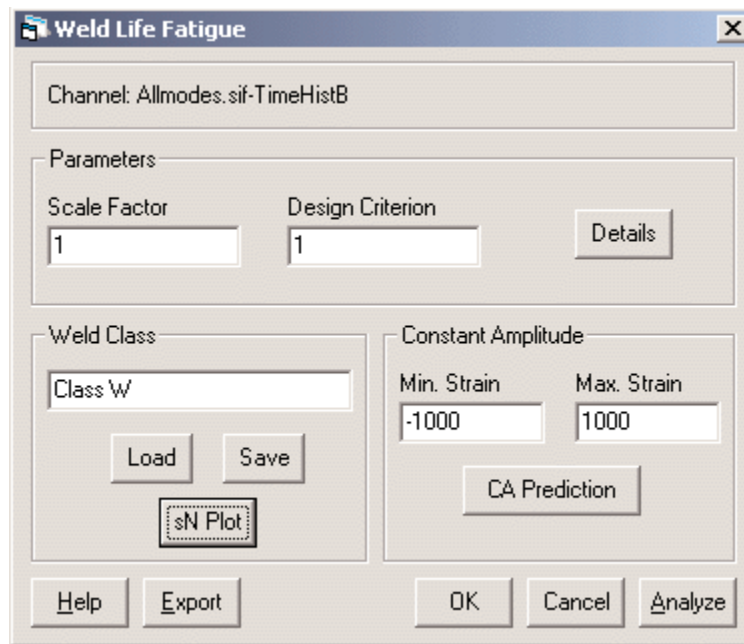
Cyclic Strength Exp, n' - The slope of the straight line on a log-log plot of stress amplitude versus plastic strain amplitude.

Fatigue Limit Cycles - The number of cycles considered to represent infinite life.

Weld Life Fatigue

BS5400 Analysis is used for analyzing the welded areas of structures. It uses a series of predefined curves. To pick the SN curve for a particular problem, you must first classify the weld in accordance with the BS5400 standard. There are seven weld classes: B, C, D, E, F, F2 and W, where B is the strongest.

To start Weld Life Analysis, select it from the Fatigue Damage sub-menu of Tools menu, or click the Weld Life button, , on the toolbar.



Weld Life Fatigue Dialog Box

Parameters

Channel - The data file and channel name to analyze.

Parameters

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects fatigue life. The default value is 1.

Design Criterion - Design Criterion is related to the probability of failure and is expressed as the number of Standard Deviations. A value of 0 represents a 50% failure rate, 1 represents 15.9%, 3 represents 2.2%, etc.

Details - Display a special dialog for specifying all of the parameters for the analysis.

Weld Class

Description of the BS5400 Weld Class used in this analysis.

Load - Browse the computer file system for an InField Weld Class File (*.WLD) to load.

Save - Create an InField Weld Class file (*.WLD).

sN Plot - Display a plot of the stress-life curve for the chosen weld class based on the defined parameters.

Constant Amplitude

Min. Strain - The minimum strain (valley) of the constant amplitude strain cycle to be analyzed. It should be in units strain or microstrain.

Max. Strain - The maximum strain (peak) of the constant amplitude strain cycle to be analyzed. It should be in units strain or microstrain.

CA Prediction - Predict the number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum strains specified above.

Buttons

Help - Open the InField help system to the topic directly related to Weld Life Fatigue Analysis.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

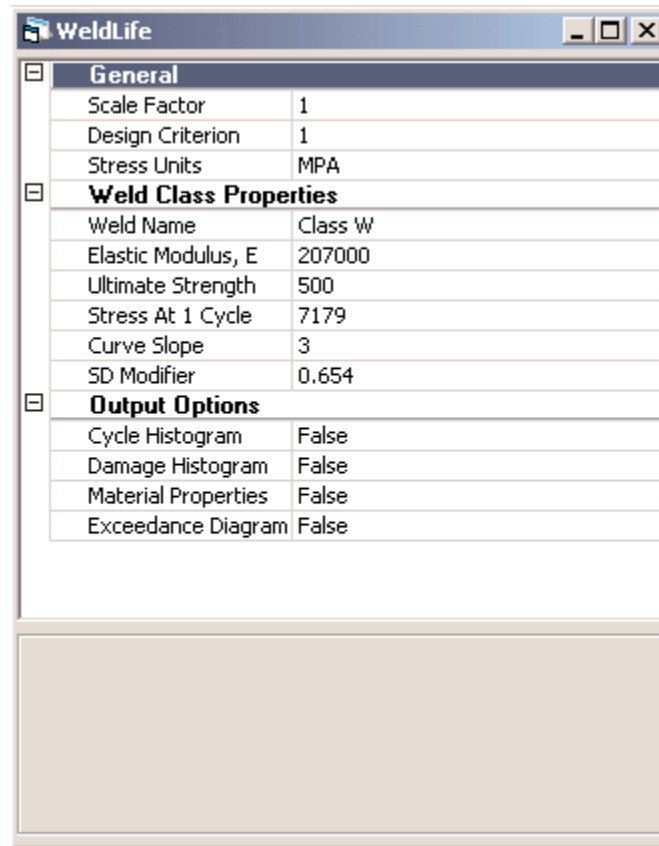
OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without saving changes or applying any analysis functions.

Analyze - Perform the Weld Life Fatigue analysis according to the parameters provided. The Weld Life Fatigue dialog box will remain visible behind the Weld Life Fatigue Report that is generated from the analysis.

Weld Life Fatigue - Details Dialog

This standard properties dialog lets you edit all of the available parameters for Weld Life Analysis.



The screenshot shows a dialog box titled "WeldLife" with three expandable sections:

- General**
 - Scale Factor: 1
 - Design Criterion: 1
 - Stress Units: MPA
- Weld Class Properties**
 - Weld Name: Class W
 - Elastic Modulus, E: 207000
 - Ultimate Strength: 500
 - Stress At 1 Cycle: 7179
 - Curve Slope: 3
 - SD Modifier: 0.654
- Output Options**
 - Cycle Histogram: False
 - Damage Histogram: False
 - Material Properties: False
 - Exceedance Diagram: False

Weld Life Details Dialog Box

General

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects fatigue life. The default value is 1.

Design Criterion - Design Criterion is related to the probability of failure and is expressed as the number of Standard Deviations. A value of 0 represents a 50% failure rate, 1 represents 15.9%, 3 represents 2.2%, etc.

Stress Units - Units for the SN curve of the selected weld class. Either Mpa or Ksi.

Weld Class Properties

Weld Name - Description of the Weld Class.

Elastic Modulus, E - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test. This value should be in the same units as those in the Stress Units field.

Ultimate Strength - (Su) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test. This value should be in the same units as those in the Stress Units field.

Stress at 1 Cycle - Theoretical Stress Range at 1 cycle of a log-log plot if stress range versus cycles to failure is extended back.

Curve Slope - Slope of the straight line from a log-log plot of stress range versus cycles to failure. It is generally 3 or 4 for weld classes.

SD Modifier - Standard Deviation Modifier defined for the Weld Class.

Output Options

Cycle Histogram - Add a range versus mean cycle histogram to the results file.

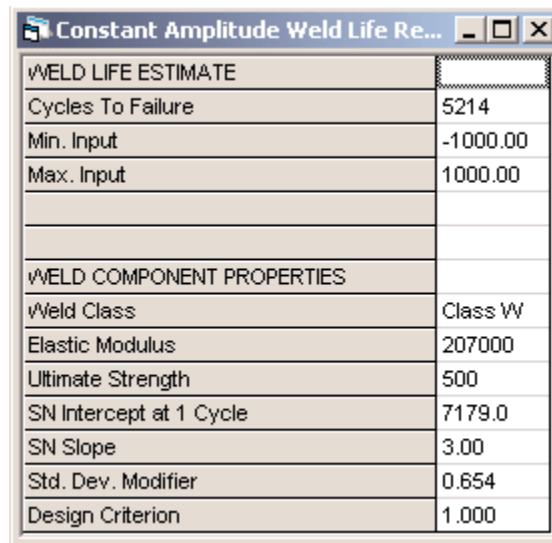
Damage Histogram - Add a range versus mean histogram indicating the damaging cycles to the results file.

Material Properties - Add an XY channel containing a stress amplitude versus life diagram of the Weld Class to the results file.

Exceedance Diagram - Add a cumulative count to the results file of how many times peaks in the data exceeded a specified level. How long the peaks exceed the level is not measured. The exceedance diagram can be either peak-valley or range-pair.

Weld Life Fatigue - Constant Amplitude (CA) Prediction Dialog

Constant amplitude Weld Life Analysis produces the following results table.



WELD LIFE ESTIMATE	
Cycles To Failure	5214
Min. Input	-1000.00
Max. Input	1000.00
WELD COMPONENT PROPERTIES	
Weld Class	Class W
Elastic Modulus	207000
Ultimate Strength	500
SN Intercept at 1 Cycle	7179.0
SN Slope	3.00
Std. Dev. Modifier	0.654
Design Criterion	1.000

Weld Life Constant Amplitude Prediction Dialog Box

Weld Life Estimate

Cycles to Failure - Number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum loads specified below. NOT FATIGUE means the input load amplitude exceeds the load-life curve intercept. INFINITE means the input load amplitude is less than the load-life curve value at the fatigue limit cycles.

Min. Input - Minimum strain (valley) of the constant amplitude cycle analyzed.

Max. Input - Maximum strain (peak) of the constant amplitude cycle analyzed.

Weld Component Properties

Weld Class - Weld Class used in this life prediction.

Elastic Modulus - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

SN Intercept at 1 Cycle - SN Intercept at 1 cycle of the Weld Class used in this life prediction.

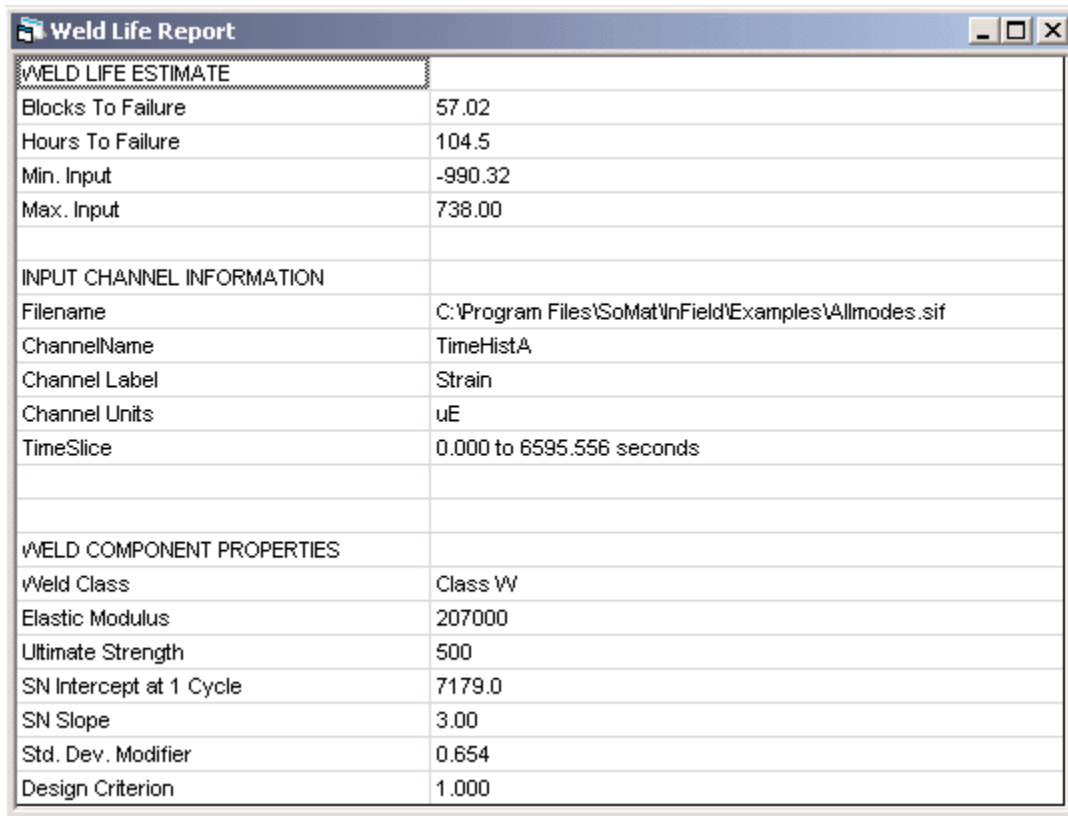
SN Slope - Slope of the straight line from a log-log plot of stress range versus cycles to failure. It is generally 3 or 4 for weld classes.

Std. Dev. Modifier - Standard Deviation Modifier defined for the Weld Class.

Design Criterion - Design Criterion is related to the probability of failure and is expressed as the number of Standard Deviations. A value of 0 represents a 50% failure rate, 1 represents 15.9%, 3 represents 2.2%, etc.

Weld Life Fatigue Report

A successful variable amplitude Weld Life Analysis produces the following results table.



The screenshot shows a dialog box titled "Weld Life Report" with a table of results. The table is organized into three sections: WELD LIFE ESTIMATE, INPUT CHANNEL INFORMATION, and WELD COMPONENT PROPERTIES.

WELD LIFE ESTIMATE	
Blocks To Failure	57.02
Hours To Failure	104.5
Min. Input	-990.32
Max. Input	738.00
INPUT CHANNEL INFORMATION	
Filename	C:\Program Files\SoMat\InField\Examples\Allmodes.sif
ChannelName	TimeHistA
Channel Label	Strain
Channel Units	uE
TimeSlice	0.000 to 6595.556 seconds
WELD COMPONENT PROPERTIES	
Weld Class	Class W
Elastic Modulus	207000
Ultimate Strength	500
SN Intercept at 1 Cycle	7179.0
SN Slope	3.00
Std. Dev. Modifier	0.654
Design Criterion	1.000

Weld Life Report Dialog Box

Weld Life Estimate

Blocks to Failure - Number of repeats of the service history (input channel) the component can withstand before failure. NOT FATIGUE means the maximum input load amplitude from the service history exceeds the load-life curve intercept. INFINITE means the maximum input load amplitude from the service history is less than the load-life curve value at the fatigue limit cycles.

Hours to Failure - Number of hours corresponding to the blocks to failure. It is blocks to failure times the number of hours in one history repeat.

Min. Input - Minimum data point in the input service history.

Max. Input - Maximum data point in the input service history.

Input Channel Information

Filename - Path and filename of the service history analyzed.

ChannelName - Channel name identifier of the service history analyzed.

Channel Label - Extended channel descriptor of the service history analyzed.

Channel Units - Engineering units of the service history analyzed.

TimeSlice - The beginning and ending times for the segment of service history analyzed. Expressed in seconds.

Weld Component Properties

Weld Class - Weld Class used in this life prediction.

Elastic Modulus - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

SN Intercept at 1 Cycle - SN Intercept at 1 cycle of the Weld Class used in this life prediction.

SN Slope - Slope of the straight line from a log-log plot of stress range versus cycles to failure. It is generally 3 or 4 for weld classes.

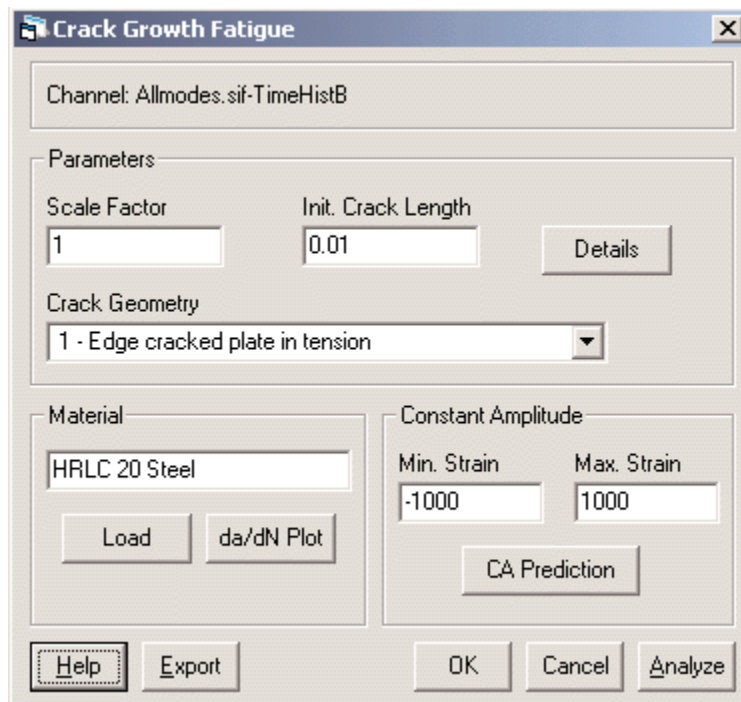
Std. Dev. Modifier - Standard Deviation Modifier defined for the Weld Class.

Design Criterion - Design Criterion is related to the probability of failure and is expressed as the number of Standard Deviations. A value of 0 represents a 50% failure rate, 1 represents 15.9%, 3 represents 2.2%, etc.

Crack Growth Fatigue

Crack Growth Analysis uses linear elastic fracture mechanics and related crack growth material properties to determine how fast a crack or crack-like defect will spread under service loading conditions. This analysis in turn provides an estimate of the remaining safe life of the structure or component.

To start Crack Growth Analysis, select it from the Fatigue Damage sub-menu of the Tools menu, or click the Crack Growth button, , on the toolbar.



Crack Growth Fatigue Dialog Box

Parameters

Channel - The data file and channel name to analyze.

Parameters

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the fatigue life.

Init. Crack Length - The assumed initial size of an existing crack whose growth is to be modeled.

Crack Geometry - A description of the object to be modeled. If USER STRESS INTENSITY FILE is selected, a valid crack geometry file must be specified in the parameter details.

Available options are:

- 1 - Edge cracked plate in tension
- 2 - Edge cracked plate in bending
- 3 - Double edge cracked plate in tension
- 4 - Double edge cracked plate in bending
- 5 - Center cracked plate in tension
- 6 - Center cracked plate in bending
- 7 - Center cracked rod in tension
- 8 - Center cracked rod in bending
- 9 - Center cracked rod in torsion
- 10 - Edge cracked rod in tension
- 11 - Edge cracked rod in bending
- 12 - Edge cracked rod in torsion
- 13 - Hole - Center edge crack in tension
- 14 - Hole - Center dbl edge crack in tension ($R=.5b$)
- 15 - Hole - Center dbl edge crack in tension ($R=.25b$)
- 16 - Corner crack
- 17 - SAE keyhole specimen
- 18 - Shallow notch - edge crack in tension (1)
- 19 - Shallow notch - edge crack in tension (2)
- 20 - Rectangular tube in bending
- 21 - Double butt weld - toe crack in tension
- 22 - Double butt weld - toe crack in bending
- 23 - Surf crack unwelded in tension ($a/2c=.1$)
- 24 - Surf crack unwelded in tension ($a/2c=.5$)
- 25 - Surf crk dbl fillet weld - tension ($a/2c=.1$)
- 26 - Surf crk dbl fillet weld - tension ($a/2c=.5$)
- 27 - Dbl fillet weld - toe crack in bending
- 28 - Dbl fillet weld - root crack in tension
- 29 - Dbl fillet weld - root crack in bending
- 30 - One side lap weld - root crack in tension

31 - One side lap weld - root crack in bending

32 - Surf crack in tension ($a/c=1-2(a/b)^2$)

33 - Edge crack in tension without bending

USER STRESS INTENSITY FILE

Details - Display a special dialog for specifying all of the parameters for the analysis.

Material

Description of the material properties curves used in this analysis.

Load - Browse the computer file system for an InField Material File (*. MAT) to load. After the file is loaded, the Details window is opened.

da/dN Plot - Display a plot of the crack growth rate, da/dN, versus stress intensity, delta-K, for the material based on the defined parameters.

Constant Amplitude

Min. Strain - The minimum strain (valley) of the constant amplitude strain cycle to be analyzed. It should be in units strain or microstrain.

Max. Strain - The maximum strain (peak) of the constant amplitude strain cycle to be analyzed. It should be in units strain or microstrain.

CA Prediction - Predict the number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum strains specified above.

Buttons

Help - Open the InField help system to the topic directly related to Crack Growth Fatigue Analysis.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

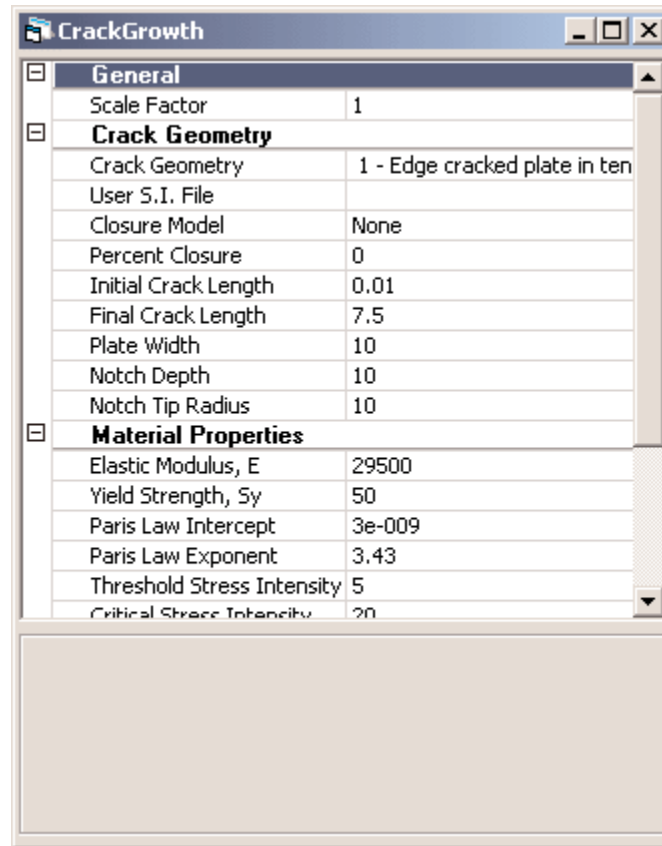
OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without saving changes or applying any analysis functions.

Analyze - Perform the Crack Growth Fatigue analysis according to the parameters provided. The Crack Growth Fatigue dialog box will remain visible behind the Crack Growth Fatigue Report that is generated from the analysis.

Crack Growth Fatigue - Details Dialog

This standard properties dialog lets you edit all of the available parameters for Crack Growth Analysis.



Crack Growth Details Dialog Box

General

Scale Factor - Multiplier value for the input data. Changing this value illustrates how increasing or decreasing the amplitude of the service history affects the fatigue life.

Crack Geometry

Crack Geometry - A description of the object model. If USER STRESS INTENSITY FILE is selected, a valid crack geometry file must be specified.

User S.I. File - Name of the file containing a valid stress intensity geometry file. Required if Crack Geometry choice is USER STRESS INTENSITY FILE.

Closure Model - The analytical model which accounts for crack closure effect.

Closure at percentage of max. stress

Closure calculated from service history

None

Percent Closure - The value in percent used by the closure model.

Initial Crack Length - The assumed initial size of an existing crack whose growth is to be modeled.

Final Crack Length - The assumed final size of a crack whose growth is to be modeled. This analysis predicts the time required for the crack to grow from initial to final size.

Plate Width - The width of the cracked object being modeled.

Notch Depth - The notch depth of the cracked object being modeled.

Notch Tip Radius - The notch tip radius of the cracked object being modeled.

Material Properties

Elastic Modulus, E - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test. This value should be in the same stress units as the da/dN (Paris Law) material properties.

Yield Strength, Sy - Value indicating the stress at the onset of yielding as determined from a monotonic tensile test. This value should be in the same stress units as the da/dN (Paris Law) material properties.

Paris Law Intercept - Intercept at a stress intensity of 1 on a log-log plot of crack growth rate versus stress intensity.

Paris Law Exponent - Slope of the straight line from a log-log plot of crack growth rate versus stress intensity. It should be a positive number around 3 for steels.

Threshold Stress Intensity - Value indicating the minimum stress intensity required for crack growth. This value should be in the same stress intensity units as the da/dN (Paris Law) material properties.

Critical Stress Intensity - Value indicating the minimum stress intensity required for unstable crack growth. This value should be in the same stress intensity units as the da/dN (Paris Law) material properties.

Ratio of Matl Prop - The stress ratio, S_{min}/S_{max} , for which the da/dN (Paris Law) material properties were determined.

Output Options

Cycle Histogram - Add a range versus mean cycle histogram to the results file.

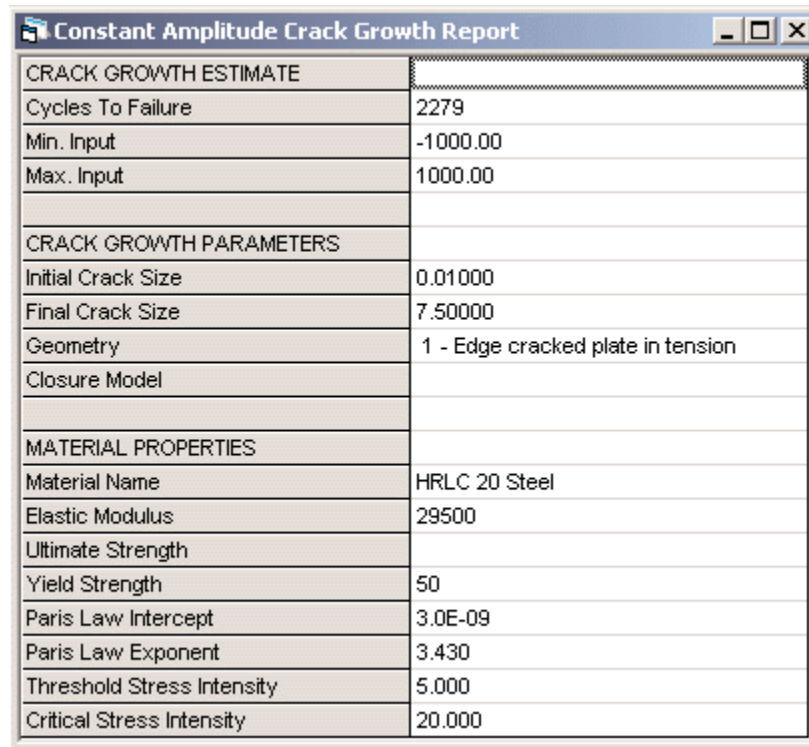
Damage Histogram - Add a range versus mean histogram indicating the damaging cycles to the results file.

Material Properties - Add an XY channel containing a crack growth rate versus stress intensity curve to the results file.

Exceedance Diagram - Add a cumulative count to the results file of how many times peaks in the data exceeded a specified level. How long the peaks exceed the level is not measured. The exceedance diagram can be either peak-valley or range-pair.

Crack Growth Fatigue - Constant Amplitude (CA) Prediction Dialog

Constant amplitude Crack Growth Analysis produces the following results table.



CRACK GROWTH ESTIMATE	
Cycles To Failure	2279
Min. Input	-1000.00
Max. Input	1000.00
CRACK GROWTH PARAMETERS	
Initial Crack Size	0.01000
Final Crack Size	7.50000
Geometry	1 - Edge cracked plate in tension
Closure Model	
MATERIAL PROPERTIES	
Material Name	HRLC 20 Steel
Elastic Modulus	29500
Ultimate Strength	
Yield Strength	50
Paris Law Intercept	3.0E-09
Paris Law Exponent	3.430
Threshold Stress Intensity	5.000
Critical Stress Intensity	20.000

Crack Growth Constant Amplitude Prediction Dialog Box

Crack Growth Estimate

Cycles to Failure - Number of constant amplitude cycles the component can withstand before failure. The cycle is defined by the maximum and minimum loads specified below. NOT FATIGUE means the input load amplitude exceeds the load-life curve intercept. INFINITE means the input load amplitude is less than the load-life curve value at the fatigue limit cycles.

Min. Input - Minimum strain (valley) of the constant amplitude cycle analyzed.

Max. Input - Maximum strain (peak) of the constant amplitude cycle analyzed.

Crack Growth Parameters

Initial Crack Size - The assumed initial size of an existing crack whose growth is to be modeled.

Final Crack Size - The assumed final size of a crack whose growth is to be modeled. This analysis predicts the time required for the crack to grow from initial to final size.

Geometry - Description of the object modeled.

Closure Model - The analytical model which accounts for crack closure effect.

Material Properties

Material Name - Description of the material whose parameters are defined

Elastic Modulus - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test. This value should be in the same stress units as the da/dN (Paris Law) material properties.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

Yield Strength - Value indicating the stress at the onset of yielding as determined from a monotonic tensile test. This value should be in the same stress units as the da/dN (Paris Law) material properties.

Paris Law Intercept - Intercept at a stress intensity of 1 on a log-log plot of crack growth rate versus stress intensity.

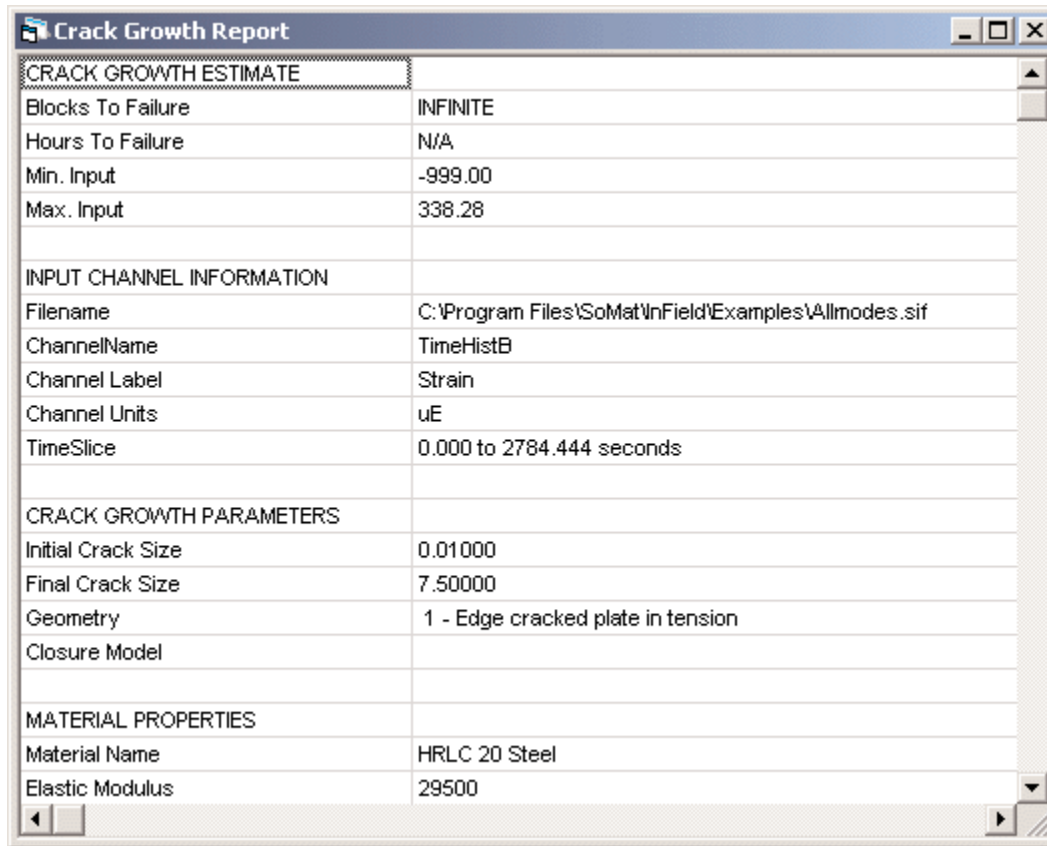
Paris Law Exponent - Slope of the straight line from a log-log plot of crack growth rate versus stress intensity. It should be a positive number around 3 for steels.

Threshold Stress Intensity - Value indicating the minimum stress intensity required for crack growth. This value should be in the same stress intensity units as the da/dN (Paris Law) material properties.

Critical Stress Intensity - Value indicating the minimum stress intensity required for unstable crack growth. This value should be in the same stress intensity units as the da/dN (Paris Law) material properties.

Crack Growth Fatigue Report

A successful variable amplitude Crack Growth Analysis produces the following results table.



CRACK GROWTH ESTIMATE	
Blocks To Failure	INFINITE
Hours To Failure	N/A
Min. Input	-999.00
Max. Input	338.28
INPUT CHANNEL INFORMATION	
Filename	C:\Program Files\SoMat\InField\Examples\Allmodes.sif
ChannelName	TimeHistB
Channel Label	Strain
Channel Units	uE
TimeSlice	0.000 to 2784.444 seconds
CRACK GROWTH PARAMETERS	
Initial Crack Size	0.01000
Final Crack Size	7.50000
Geometry	1 - Edge cracked plate in tension
Closure Model	
MATERIAL PROPERTIES	
Material Name	HRLC 20 Steel
Elastic Modulus	29500

Crack Growth Report Dialog Box

Crack Growth Estimate

Blocks to Failure - Number of repeats of the service history (input channel) the component can withstand before failure. NOT FATIGUE means the maximum load amplitude from the service history exceeds the load-life curve intercept. INFINITE means the maximum input load amplitude from the service history is less than the load-life curve value at the fatigue limit cycles.

Hours to Failure - Number of hours corresponding to the blocks to failure. It equals blocks to failure times the number of hours in one history repeat.

Min. Input - Minimum data point in the input service history.

Max. Input - Maximum data point in the input service history.

Input Channel Information

Filename - Path and filename of the service history analyzed.

ChannelName - Channel name identifier of the service history analyzed.

Channel Label - Extended channel descriptor of the service history analyzed.

Channel Units - Engineering units of the service history analyzed.

TimeSlice - The beginning and ending times for the segment of service history analyzed. Expressed in seconds.

Crack Growth Parameters

Initial Crack Size - The assumed initial size of an existing crack whose growth is to be modeled.

Final Crack Size - The assumed final size of a crack whose growth is to be modeled. This analysis predicts the time required for the crack to grow from initial to final size.

Geometry - Description of the object modeled.

Closure Model - The analytical model which accounts for crack closure effect.

Material Properties

Material Name - Brief description of the material whose parameters are defined.

Elastic Modulus - Value indicating the elastic (Young's) modulus ratio of stress to strain of the material as determined from a monotonic tensile test. This value should be in the same stress units as the da/dN (Paris Law) material properties.

Ultimate Strength - (S_u) Value indicating the ultimate strength of the material - the highest engineering stress that was reached by a material specimen during a monotonic tensile test.

Yield Strength - Value indicating the stress at the onset of yielding as determined from a monotonic tensile test. This value should be in the same stress units as the da/dN (Paris Law) material properties.

Paris Law Intercept - Intercept at a stress intensity of 1 on a log-log plot of crack growth rate versus stress intensity.

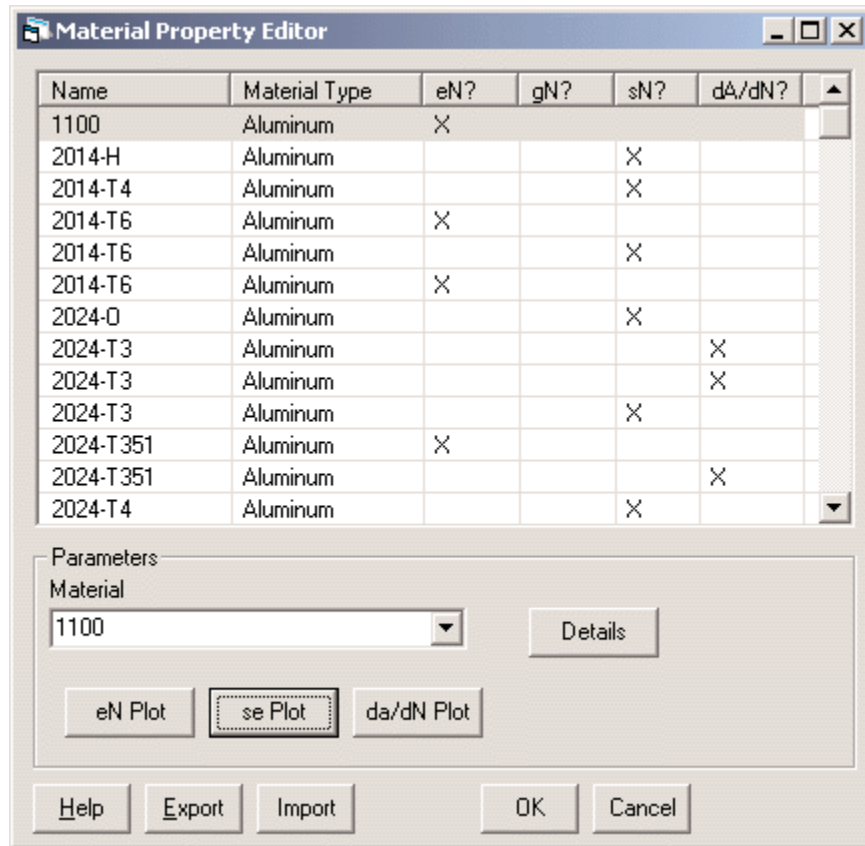
Paris Law Exponent - Slope of the straight line from a log-log plot of crack growth rate versus stress intensity. It should be a positive number around 3 for steels.

Threshold Stress Intensity - Value indicating the minimum stress intensity required for crack growth. This value should be in the same stress intensity units as the da/dN (Paris Law) material properties.

Critical Stress Intensity - Value indicating the minimum stress intensity required for unstable crack growth. This value should be in the same stress intensity units as the da/dN (Paris Law) material properties.

Material Properties

To start Material Properties Editor, select it from the Fatigue Damage sub-menu of the Tools menu.



Material Property Editor Dialog Box

Parameters

Spreadsheet Information

Name - The material name for which properties are available.

Material Type- The material type for which properties are available.

eN? - An X in this column indicates there is sufficient information about this material to perform a Tensile Strain Life Fatigue Analysis.

gN? - An X in this column indicates there is sufficient information about this material to perform a Shear Strain Fatigue Analysis.

sN? - An X in this column indicates there is sufficient information about this material to perform a Stress Fatigue Analysis.

dA/dN? - An X in this column indicates there is sufficient information about this material to perform a Crack Growth Fatigue Analysis.

Parameters

Material - Brief description of the material whose properties are defined.

eN Plot - Display a plot of the strain life curve for the material based on the defined parameters.

se Plot - Display a plot of the cyclic stress/strain curve for the material based on the defined parameters.

da/dN Plot - Display a plot of the crack growth rate, da/dN , versus stress intensity, ΔK , for the material based on the defined parameters.

Details - Display a special dialog for specifying all of the parameters for the material selected.

Buttons

Help - Open the InField help system to the topic directly related to the Material Properties dialog.

Export - Save the information entered directly to an InField Material File (*. MAT). This makes it possible to easily load the properties into a future session.

Import - Open an InField Material File (*. MAT) for use.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without saving changes or applying any analysis functions.

Frequency Analysis

Analysis Procedure

The procedure for performing a frequency analysis is as follows:

NOTE: Frequency Analysis dialog boxes are modeless. Clicking outside of a Frequency Analysis dialog box will allow the use of other windows and functions in the open InField session. Click on the related dialog to return to the Frequency Analysis.

1. Select the channel(s) to be analyzed from the InField Channels List.
2. Open the dialog box for the analysis to use and set its parameters.
3. Click Analyze to run the analysis according to the parameters entered.

When the analysis is complete, InField will plot the results, add the output channel to the Output List, and create an output file in the InField installation *Output Files* directory.

The title bar of each plot window will have the name of the analysis and the name of the channel being validated.

The default file name for the analysis file containing output channels is made up of the function name and analysis sequence number with a . SI F extension (SoMat Information File). Sequences start at 000. The sequence number is determined by the previously created output files for the selected function that exist in the InField installation *Output Files* directory. The next available sequence number is used for the newly created file and plot. For example, if there are existing files titled AutoPower_000. si f and AutoPower_001. si f, selecting the Analyze button within a AutoPower Spectrum dialog will create a file titled AutoPower_002. si f.

NOTE: Files created in the *Output Files* directory of the InField installation are not deleted when InField is exited. Periodic, manual deletion of unnecessary files in this directory is strongly recommended to conserve disk space on the computer.


4. Examine the analysis results. Channel plot data can be viewed, edited, copied, and pasted using the functions described in [Viewing Data](#) and [Editing Data](#).
5. Review the Output List. Save the channels to keep, and remove the channels to be discarded.
 - To save output channels to a file (other than the default), select them and use SaveAs in the InField File menu. The saved files will appear in the Output List with the file name specified during the save. The original, temporary channels can be removed from the Output List.
 - To remove channels from the Output list, select the channel(s) to remove then right-click. Use the option **Remove Channel(s) from Channel List** to remove the unwanted channels. It is not necessary to remove the channels from the Output List. This is really just a way to keep the list manageable and avoid clutter when analyzing data.

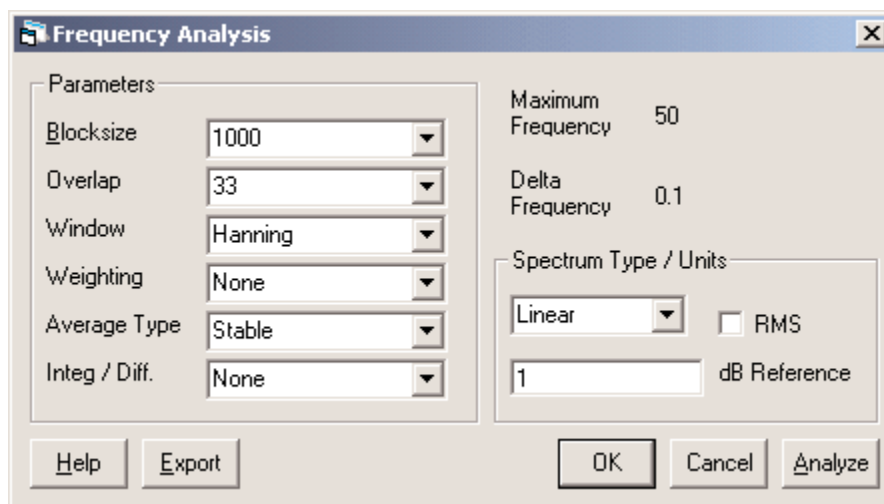
AutoPower Spectrum Analysis

AutoPower Spectrum Analysis is used to investigate the frequency content of measured signals, displacements, loads, strains, velocities, acceleration, sound pressure, etc. The methodology reduces large time histories into a smaller amount of information.

Data Analyzed

The AutoPower Spectrum Analysis accepts only time history data. If any other type of data is selected, the Frequency Analysis will not operate.

To start the AutoPower Spectrum Analysis, either select it from the Frequency Analysis sub-menu of the Tools menu, or click the AutoPower Spectrum Analysis button, , on the application toolbar.



AutoPower Spectrum Analysis Dialog Box

Parameters

Block size - The size of the time block to be used in the computation. The maximum size is limited by either the size of the time history selected or the memory installed and available to the computer.

Overlap - The amount of data used from the previous time history slice (specified in percentages from 0% to 99%). A block size of 1000 and an overlap of 25% will use 250 points from the previous time block and include them with the next 750 points in the time history to compute the next spectrum.

Window - The type of time domain window to be used to weight the time block of data before it is transformed.

Uniform - Using Uniform is essentially the same as not using a window at all. Amplitude accuracy can be affected by as much as 36%. This window is only useful when an integer number of periods of the time waveform is included in the time block.

Hanning - Hanning is useful for resolving closely-spaced frequencies where amplitude accuracy (18%) is not important.

Hamming - Hamming is useful for searching operations where good frequency resolution is needed, but accuracy of amplitude (15%) is not important. It is particularly useful when a large dynamic range between spectral lines occurs.

Flat Top - Ideal for accurate amplitude measurements (+/- 0.1%) of spectral lines that are not closely spaced (8-10 lines) or where a large dynamic range is needed.

Weighting - Used in rescaling the spectrum so it conforms to the sensitivity of the human ear. A, B, and C weighting are supported.

Average Type - The following types are available:

Stable - Computes the average value observed at a given spectral line per FFT taken.

Peak Hold - Retains the largest value observed at a given spectral line for each FFT taken.

NOTE: Peak hold is not truly an averaging method.

Integration/Differentiation - Besides the option of none, there are four options to select from. The options and the formulas are:

Differentiate Once - $S(w) \times (w)$

Differentiate Twice - $S(w) \times (w^2)$

Integrate Once - $S(w) \times (1/w)$

Integrate Twice - $S(w) \times (1/w^2)$

where $S(w)$ is the spectrum and w is the angular frequency expressed in radians/second ($w = f \times 2 \times \pi$, where f is frequency expressed in Hz). This is a stable computation in the frequency domain. For integration, $S(w)=0$ when $w = 0$.

Spectrum Type/Units

The following parameters are selectable from the drop-down list to control the units of the resulting spectrums:

Linear - EU

Power - EU^2

PSD (Power Spectral Density) - EU^2/Hz

ESD (Energy Spectral Density) - $EU^2 (sec)/Hz$, where EU is engineering units

RMS - A method to store the data in Root Mean Square format (EU RMS, EU^2 RMS, etc.). RMS is computed using:

Linear - Spectral Line Value/Sqrt(2)

Power - PSD, ESD: Spectral Line Value/2

dB Reference - A number can be entered as the dB reference. The units must be in the time history's native units (e.g. Volts).

Decibels = $20 \log_{10}(S(w)/dbRef)$ or $10 \log_{10}(S(w)/dbRef^2)$, depending on the units of $S(w)$, where $S(w)$ is the spectrum

Buttons

Help - Open the InField help system to the topic directly related to AutoPower Spectrum Analysis.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.


Cancel - Exit without making any changes or applying any analysis functions.

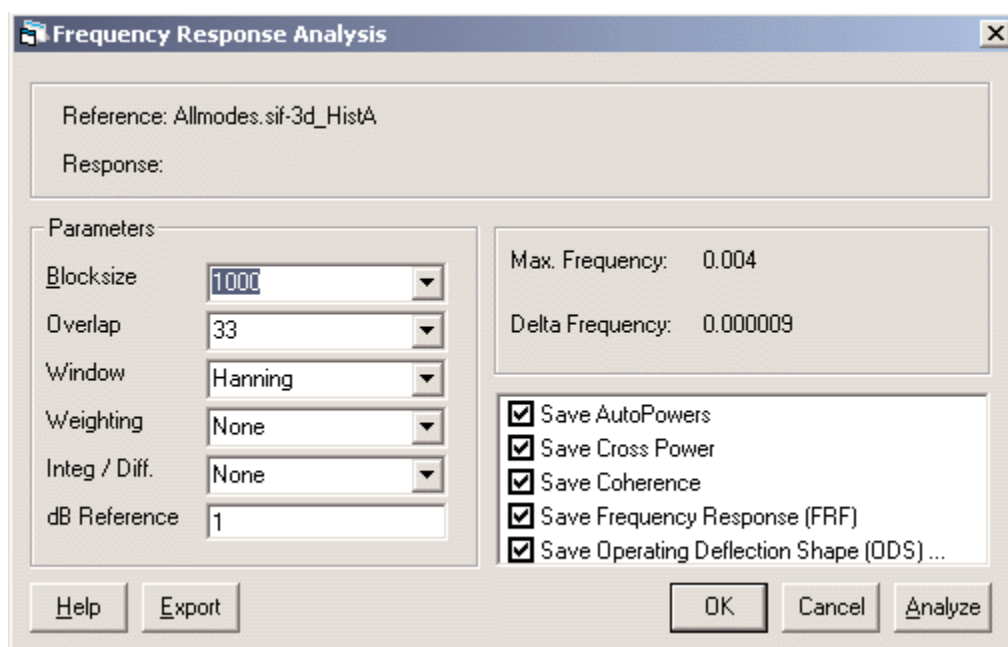
Analyze - Perform the analysis according to the parameters selected. The Frequency Analysis dialog will remain visible behind the plot window that is generated by the analysis. The analysis will also generate and add a data channel to the Output List tab in the Channels List window.

FRF (Frequency Response Function) Analysis

Frequency Response Function (FRF) Analysis is used to evaluate the relationship between channels in the frequency domain. Outputs may include autopower, crosspower, coherence, and frequency response.

FRF Analysis accepts only time history data. Two channels must be selected before starting the analysis (the Reference and the Response channels.) Typically the data was acquired simultaneously.

To start FRF Analysis either select it from the Frequency Analysis sub-menu in the Tools menu, or click the Frequency Response Analysis button, , on the application toolbar.



FRF (Frequency Response Function) Dialog Box

Parameters

Blocksize - The size of the time block to be used in the computation. The maximum size is limited by either the size of the time history selected or the memory installed and available to the computer.

Overlap - The amount of data used from the previous time history slice (specified in percentages from 0% to 99%). A block size of 1000 and an overlap of 25% will use 250 points from the previous time block and include them with the next 750 points in the time history to compute the next spectrum.

Window - The type of time domain window to be used to weight the time block of data before it is transformed.

Uniform - Using Uniform is essentially the same as not using a window at all. Amplitude accuracy can be affected by as much as 36%. This window is only useful when an integer number of periods of the time waveform is included in the time block.

Hanning - Hanning is useful for resolving closely-spaced frequencies where amplitude accuracy (18%) is not important.

Hamming - Hamming is useful for searching operations where good frequency resolution is needed, but accuracy of amplitude (15%) is not important. It is particularly useful when a large dynamic range between spectral lines occurs.

Flat Top - Ideal for accurate amplitude measurements (+/- 0.1%) of spectral lines that are not closely spaced (8-10 lines) or where a large dynamic range is needed.

Weighting - Used in rescaling the spectrum so it conforms to the sensitivity of the human ear. A, B, and C weighting are supported.

Integration/Differentiation - Besides the option of none, there are four options to select from. The options and the formulas are:

Differentiate Once - $S(w) \times (w)$

Differentiate Twice - $S(w) \times (w^2)$

Integrate Once - $S(w) \times (1/w)$

Integrate Twice - $S(w) \times (1/(w^2))$

where $S(w)$ is the spectrum and w is the angular frequency expressed in radians/second ($w = f \times 2 \times \pi$, where f is frequency expressed in Hz). This is a stable computation in the frequency domain. For integration, $S(w)=0$ when $w = 0$.

dB Reference - A number can be entered as the dB reference. The units must be in the time history's native units (e.g. Volts).

Decibels = $20 \log_{10} (S(w)/\text{dbRef})$ or $10 \log_{10}(S(w)/\text{dbRef}^2)$, depending on the units of $S(w)$, where $S(w)$ is the spectrum

Max Frequency - The maximum frequency for which values are computed.

Delta Frequency - Resolution or spacing between spectral data points. This value is based on the Nyquist frequency and equals the sample rate divided by 2.

Output Options - Multiple output channels can be generated and placed in the Output List tab of the Channels List window. A check in the checkbox preceding each option indicates that output data should be generated upon analysis.

Save AutoPowers

Save Cross Power

Save Coherence

Save Frequency Response (FRF)

Save Operating Deflection Shape

Buttons

Help - Open the InField help system to the topic directly related to Frequency Response Function Analysis.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.


OK - Save the information entered for future use. These parameters will then be the default.

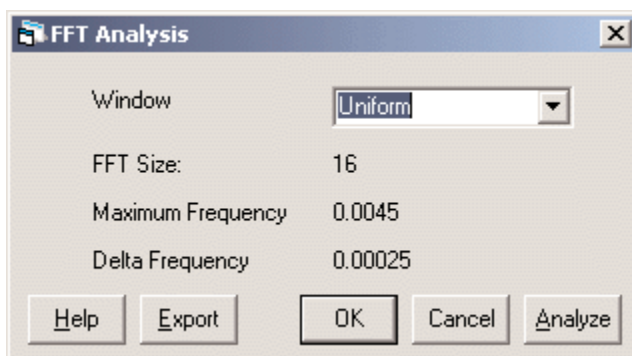
Cancel - Exit without making any changes or applying any analysis functions.

Analyze - Perform the Frequency Response Function (FRF) analysis according to the parameters provided. The Frequency Response Function window will remain visible behind the graphs generated from the analysis. In addition, new channels will be generated under the Output List tab in the Channels List window.

FFT (Fast Fourier Transform) Analysis

FFT (Fast Fourier Transform) Analysis provides a mathematical method to view the input data in the frequency domain, amplitude versus frequency, rather than the time domain, amplitude versus time.

To start FFT Analysis select it from the Frequency Analysis sub-menu of the Tools menu, or click the FFT Analysis button, , on the application toolbar.



FFT Analysis Dialog Box

Parameters

Window - The type of time domain window to be used to weight the time block of data before it is transformed.

Uniform - Using Uniform is essentially the same as not using a window at all. Amplitude accuracy can be affected by as much as 36%. This window is only useful when an integer number of periods of the time waveform is included in the time block.

Hanning - Hanning is useful for resolving closely-spaced frequencies where amplitude accuracy (18%) is not important.

Hamming - Hamming is useful for searching operations where good frequency resolution is needed, but accuracy of amplitude (15%) is not important. It is particularly useful when a large dynamic range between spectral lines occurs.

Flat Top - Ideal for accurate amplitude measurements (+/- 0.1%) of spectral lines that are not closely spaced (8-10 lines) or where a large dynamic range is needed.

FFT Size - The number of data points for which a value is computed.

Maximum Frequency - The maximum frequency for which values are computed.

Delta Frequency - Resolution or spacing between spectral data points. This value is based on the Nyquist frequency and equals the sample rate divided by 2.

Buttons

Help - Open the InField help system to the topic directly related to FFT Analysis.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use.


Cancel - Exit the FFT Analysis without making any changes or applying any analysis functions.

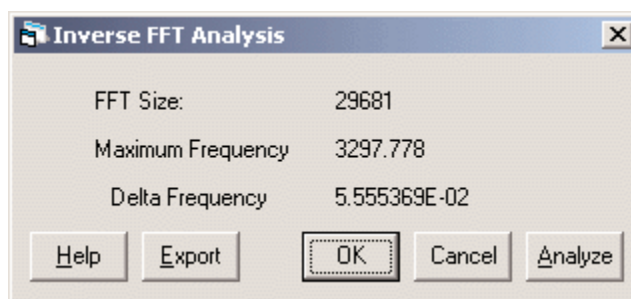
Analyze - Perform the FFT Analysis according to the parameters selected. The FFT Analysis window will remain visible behind the graph that is generated from the analysis. In addition, the FFT Analysis will generate a new channel under the Output List Tab in the Channels List window.

Inverse FFT (Fast Fourier Transform) Analysis

Inverse FFT (Fast Fourier Transform) provides a mathematical method to view the input data in the time domain, amplitude versus time, rather than in the frequency domain, amplitude versus frequency.

Inverse FFT (Fast Fourier Transform) requires the selection of exactly two (2) channels, the real and imaginary computed channels generated from a previously performed FFT analysis.

To start Inverse FFT Analysis select it from the Frequency Analysis sub-menu of the Tools menu, or click the Inverse FFT button, , on the application toolbar.



Inverse FFT Analysis Dialog Box

Parameters

IFFT analysis provides the following information on the input channels selected:

FFT Size - The number of data points for which a value is computed.

Maximum Frequency - The maximum frequency for which values are computed.

Delta Frequency - Resolution or spacing between spectral data points. This value is based on the Nyquist frequency and equals the sample rate divided by 2.

Buttons

Help - Open the InField help system to the topic directly related to Inverse Fast Fourier Transform (IFFT) Analysis.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without making any changes or applying any analysis functions.

Analyze - Perform the Inverse Fast Fourier Transform analysis. The IFFT analysis will generate a new channel under the Output List tab in the Channels List window.

Filtering

Filtering Procedure

The procedure for performing data filtering is as follows:

NOTE: Filtering dialog boxes are modeless. Clicking outside of a filtering dialog box will allow the use of other windows and functions in the open InField session. Click on the related dialog to return to the data filtering function.

1. Select the channel(s) to be filtered from the InField Channels List.
2. Open the dialog box for the filtering function and set its parameters.
3. Click Analyze to run the filter according to the parameters entered.

When the filter is complete, InField will plot the results, add the output channel to the Output List, and create an output file in the InField installation *Output Files* directory.

The title bar of each plot window will have the name of the analysis and the name of the channel being validated.


The default file name for the analysis file containing output channels is made up of the function name and sequence number with a .SIF extension (SoMat Information File). Sequences start at 000. The sequence number is determined by the previously created output files for the selected function that exist in the InField installation *Output Files* directory. The next available sequence number is used for the newly created file and plot. For example, if there are existing files titled Filter_000.sif and Filter_001.sif, selecting the Analyze button within a Digital Filtering dialog will create a file titled Filter_002.sif.

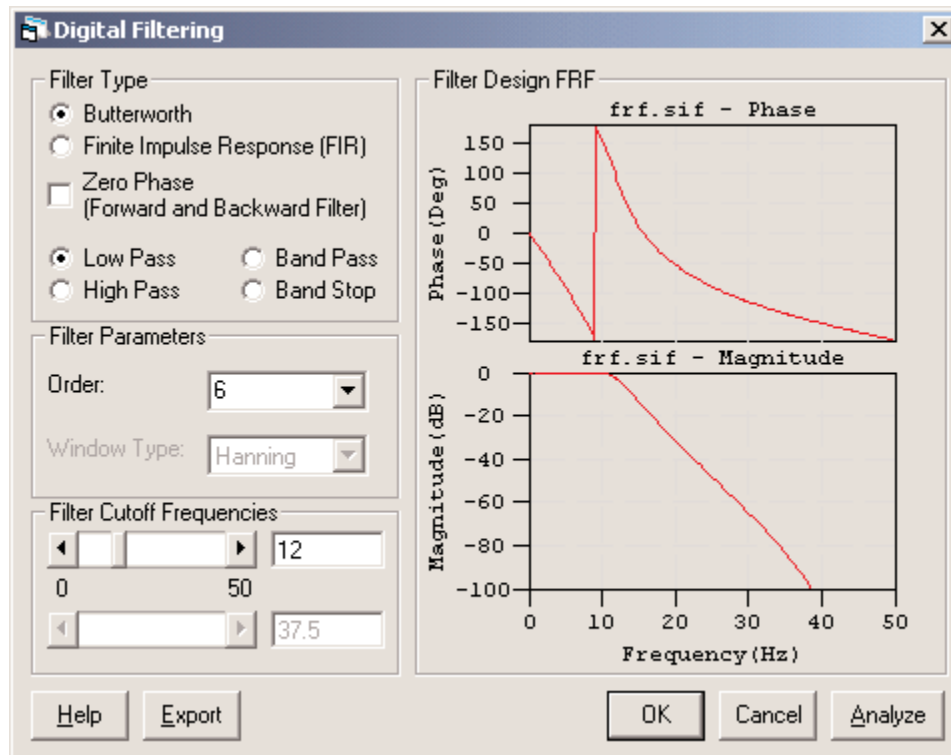
NOTE: Files created in the *Output Files* directory of the InField installation are not deleted when InField is exited. Periodic, manual deletion of unnecessary files in this directory is strongly recommended to conserve disk space on the computer.

4. Examine the analysis results. Channel plot data can be viewed, edited, copied, and pasted using the functions described in [Viewing Data](#) and [Editing Data](#).
5. Review the Output List. Save the channels to keep, and remove the channels to be discarded.
 - To save output channels to a file (other than the default), select them and choose Save As from the File menu. The saved files will appear in the Output List with the file name specified during the save. The original, temporary channels can be removed from the Output List.
 - To remove channels from the Output list, select the channel(s) to remove then right-click. Use the option **Remove Channel(s) from Channel List** to remove the unwanted channels. It is not necessary to remove the channels from the Output List. This is really just a way to keep the list manageable and avoid clutter when analyzing data.

Digital Filtering

The Digital Filtering dialog box is used to configure and apply a Digital Filter.

To start Digital Filtering, either select it from the Filtering sub-menu of the Tools menu or click the Digital Filter Design button, , on the application toolbar.



Digital Filtering Dialog Box

Parameters

Filter Type

Butterworth or **Finite Impulse Response**

Zero Phase - Forward and backward Filter

Filter Frequencies - Low pass, high pass, band pass, and band stop

Filter Parameters

The Filters Parameters group box will have one or two parameters to set based upon the filter used.

Order - Integer indicating the filter order. Ranges available are 1 to 40 for Butterworth filters, 1 to 398 for FIR filters.

The larger the order, the flatter the passband response, the lower the stopband attenuation, and the sharper the filter rolloff. The trade-offs are increased time for computation and increased phase distortion/delay.

Window Type - Applies only to Finite Impulse Response Filters (FIR). If you are using a FIR, you need to specify the type of window to be applied to the filter coefficients. The Filtering module includes four standard window types:

Uniform - Using Uniform is essentially the same as not using a window at all. Amplitude accuracy can be affected by as much as 36%. This window is only useful when an integer number of periods of the time waveform are included in the time block.

Hanning - Hanning is useful for resolving closely-spaced frequencies where amplitude accuracy (18%) is not important.

Hamming - Hamming is useful for searching operations where good frequency resolution is needed, but accuracy of amplitude (15%) is not important. It is particularly useful when a large dynamic range between spectral lines occurs.

Flat Top - Ideal for acute amplitude measurements ($\pm 0.1\%$) of spectral lines that are not closely spaced (8-10 lines) or where a large dynamic range is needed.

Filter Cutoff Frequencies

Used to determine break frequencies. The top slider is used with all filters; the bottom slider will only be available when using either the Band Pass or Band Stop filters. Frequency can be specified by using either the scroll bar or entering a value in the text box to the right of the sliders.

Break frequency values range from 0 Hz to the Nyquist frequency of the first channel selected from the Channel List.

If the channels selected are sampled at 1 kHz and 2 kHz respectively, and a four-pole, low-pass Butterworth filter with a cutoff at 500 Hz is designed, the second channel is filtered with a four-pole, low-pass Butterworth filter with a cutoff at 1 kHz.

Filter Design FRF

Two graphs on the right side of the dialog box show the frequency response functions (FRFs) for the filter. The top graph will show the phase, while the bottom graph shows the gain or frequency roll-off. These graphs will vary according to the filter type, response, and cutoff frequency selected.

Once all of the parameters have been entered, click in the area to the right of the Digital Filter dialog box, which is the area where the graphs will be located. If the filter is feasible, the graphs will then be presented.

Buttons

Help - Open the InField help system to the help topic directly related to Digital Filtering.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.


OK - Save the information entered for future use. These parameters will then be the default.

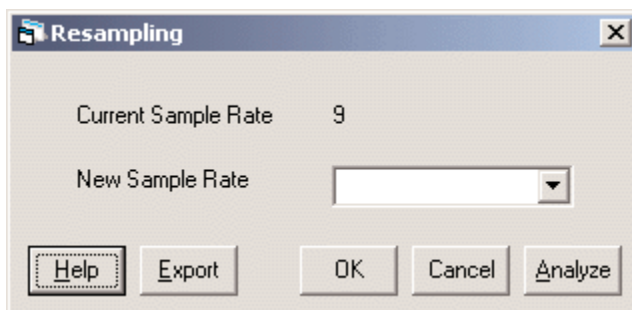
Cancel - Exit without making any changes, or applying any filtering functions.

Analyze - Run the filter according to the parameters selected. The Digital Filtering dialog will remain visible behind the plot window that is generated by the analysis. The Digital Filter will generate a new filtered channel under the Output List tab in the Channels List window.

Resampling

Resampling provides a method to change the number of samples taken from an input channel. This may be necessary when using a DataMode to combine two channels that may have been collected using different sample rates.

To start Resampling, either select it from the Filtering sub-menu of the Tools menu or click the Resampling button, , on the application toolbar.



Resampling Dialog Box

Parameters

Current Sample Rate - The current sample rate of the selected channel.

New Sample Rate - The sample rate to which the channel should be modified.

Buttons

Help - Open the InField help system to the topic directly related to Resampling.

Export - Save the information entered directly to an analysis script (*. ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit the dialog box without making any changes.

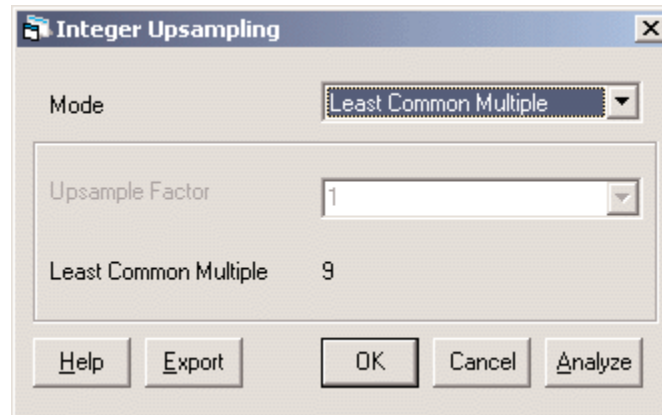
Analyze - Perform an analysis according to the parameters provided. The Resample dialog will remain visible behind the graph that is generated from the analysis. In addition, the Resample will generate a new channel under the Output List tab in the Channels List window.

Upsampling

Integer Upsampling Analysis uses linear interpolation to upsample time history data channels by whole integer multiples in order to bring two or more channels up to the same sample rate. The two primary purposes for this are 1) so that visual data comparisons (e.g. with Tabular display, OverPlot, MultiPlot, etc.) can be performed and 2) so that channels can be plotted against each other using CrossPlot.

Integer Upsampling works only on Time History channels and uses simple linear interpolation; therefore the frequency content of the channel(s) is distorted. To preserve frequency content, use Resampling Analysis.

To start Upsampling, select it from the Filtering sub-menu of the Tools menu.



Upsampling Dialog Box

Parameters

Mode - There are two mutually exclusive modes available in Integer Upsampling Analysis.

Least Common Multiple - Upsample all selected channels to the same sample rate. The sample rate is computed by finding the least common multiple of all selected channels and is displayed in the "Least Common Multiple" field. For example, if two channels of sample rates 100 Hz and 60 Hz are selected, both output channels will have a sample rate of 300 Hz.

The analysis engine will attempt to determine multiples of channels with decimal sample rates, but if no multiple rate can be determined, the analysis engine will report an error. For example, two channels with sample rates of 2.5 Hz and 7.5 Hz have a least common multiple of 7.5 Hz. But if two channels with sample rates of 2.6 Hz and 7.5 Hz are chosen, an error will be generated.

- Caution should be exercised when using "Least Common Multiple" mode, as the resulting output channels can be quite large. For example, if two channels of sample rates 1000 Hz and 999 Hz are selected, the channels will be upsampled to the common sample rate of 999000 Hz.

Upsample Factor - Upsample all selected channels by the same whole integer multiple. For example, if two channels of sample rates 100 Hz and 60 Hz are selected and an upsample factor of 3 is entered, then the two output channels will have sample rates of 300 Hz and 180 Hz respectively.

Upsample Factor - User-specified factor by which to upsample the selected channel(s). Available only when selected Mode is Upsample Factor.

Least Common Multiple - Calculated least common multiple of the sample rate(s) of the selected channel(s).
Applicable only when selected Mode is Least Common Multiple.

Buttons

Help - Open the InField help system to the topic directly related to Integer Upsampling.

Export - Save the information entered directly to an analysis script (*.ANA) file. This makes it possible to rerun the same analysis with the InField Script Player playback dialog.

OK - Save the information entered for future use. These parameters will then be the default.

Cancel - Exit without making any changes or applying any analysis functions.

Analyze - Perform the Integer Upsample analysis according to the parameters provided. The Integer Upsample dialog box will remain visible behind the graph that is generated from the analysis. In addition, the Integer Upsample analysis will generate a new channel under the Output List tab in the Channels List window.