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SANDIA REPORT

SAND96–2836 • UC–705
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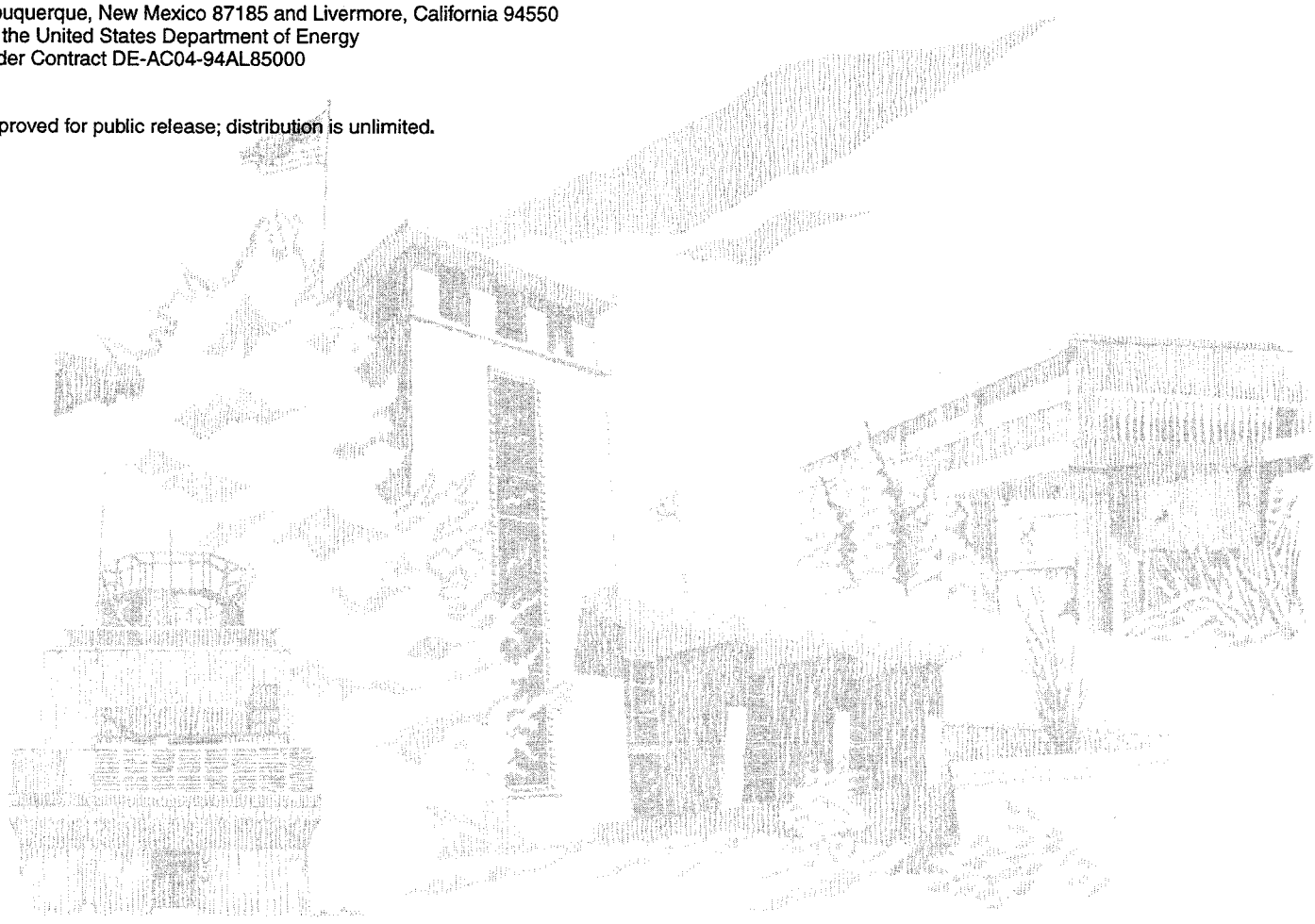
Printed December 1996

Supercedes SAND94-2391
Printed April 1995

xdamp Version 2: An IDL®-based Data Manipulation Program

William P. Ballard

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-94AL85000



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Printed copy: A04
Microfiche copy: A01

SAND96-2836
Unlimited Release
Printed December 1996

Distribution
Category UC-705

Supercedes SAND94-2391
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xdamp Version 2: An IDL®-based Data Manipulation Program

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Abstract

The original DAMP (DAta Manipulation Program) was written by Mark Hedemann of Sandia National Laboratories and used the CA-DISSPLA™ (available from Computer Associates International, Inc., Garden City, NY) graphics package as its engine. It was used to plot, modify, and otherwise manipulate the one-dimensional data waveforms (data vs. time) from a wide variety of accelerators. With the waning of CA-DISSPLA and the increasing popularity of UNIX®-based workstations, a replacement was needed. This package uses the IDL® software, available from Research Systems Incorporated in Boulder, Colorado, as the engine, and creates a set of widgets to manipulate the data in a manner similar to the original DAMP. IDL is currently supported on a wide variety of UNIX platforms such as IBM® workstations, Hewlett Packard workstations, SUN® workstations, Microsoft® Windows™ computers, Macintosh® computers and Digital Equipment Corporation VMS® systems. Thus, *xdamp* is portable across many platforms. We have verified operation, albeit with some minor IDL bugs, on IBM PC computers using Windows, Windows 95 and Windows NT; IBM UNIX platforms; DEC Alpha and VMS systems; HP 9000/700 series workstations; and Macintosh computers, both regular and PowerPC™ versions. Version 2 updates *xdamp* to require IDL version 4.0.1, adds many enhancements, and fixes a number of bugs.

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Table of Contents

List of Figures

List of Tables

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Introduction

xdamp is licensed software. To obtain a license, contact William P. Ballard at wpballa@sandia.gov. If you are licensed, you will receive automatic notification of updates, available at the restricted web site http://stl.sandia.gov/www/xdamp.html.

PHILOSOPHY

xdamp relies, in as many places as possible, on IDL maintained routines. This choice should allow *xdamp* to age gracefully as Research Systems, Inc. will do most of the updating of the operations that actually modify the internal data. Nearly all of the procedures are precompiled when *xdamp* is started because the IDL macro programming language is interpreted at run time. Precompiling causes *xdamp* to pause while nearly everything is compiled but results in faster execution times when manipulating data.

xdamp loads all the data into a set of working waveforms and then closes the data file. It creates a button for each waveform and all manipulations can be done by pushing waveform buttons, followed by operator buttons. The original contents of the file are unchanged until you actively overwrite the original file. When attempting to overwrite a file, you are asked if you are sure you want to do this. However, *xdamp* minimizes how often it asks for confirmation of an action.

xdamp only saves data using the Hierarchical Data Format (HDF) developed by the National Center for Supercomputing Applications (NCSA). IDL provides all the requisite HDF file handling utilities for all of the computing platforms of interest. This format is already compressed so further data compression techniques are not needed Full libraries of FORTRAN and C routines are available from NCSA at http://hdf.ncsa.uiuc.edu/.

Whenever an operation is performed, the results are immediately and automatically plotted out, if the automatic plot feature is set on. Also, the relevant pulse parameters (maximum, minimum, pulse width, rise time, and fall time) are calculated. You can choose whether the stack is maintained between operations or is automatically cleared.

xdamp is designed to be self documenting. There are areas in the data file for notes relating to the overall data set and notes for each individual waveform. *xdamp* keeps an audit trail of the operations performed on each waveform that change its contents. The audit trail and the individual notes are displayed whenever a single waveform is graphed.

Automatic execution of command (macro) files is supported. This feature allows the user to create new procedures from combinations of existing operations. These files can be nested 10 deep to create complicated operations from a sequence of simple macros.

xdamp automatically creates a journal file named xdamp.jnl in the current directory. The journal file can be copied and edited to create a macro file. Whenever a summary operation is performed, a spreadsheet file called xdamp.ss is created. This contains space delimited information with the name, the maximum and minimum values, the rise and fall times, as well as the full-width-at-half-maximum pulse widths for all selected waveforms.

There is a powerful and flexible initialization file called xdamp.ini that can be used to customize each session for the desires of the particular user. Even the maximum size and number of arrays can be optimized in this file.

When performing any operation with an inherent order, the ENTER button must be used to define one of the waveforms. Usually this defines the waveform to be overwritten; for instance, when performing a waveform addition. In some instances the ENTER button is used to define the reference waveform (COMPARE, time aligning waveforms, and when generating cable compensators). In the case of inverse fast Fourier transforms (IFFTs), the ENTER button is used to designate the real portion of the waveform to be transformed.

The limits on the number of possible waveforms and their maximum size is relatively arbitrary. These limits can be seen by using the TOOLS.SHOW LIMITS menu selection. The system manager can increase the defaults at will (in the XDsys_ini.pro module in the XDsys_sp.pro file) but the user has independent control through his individual initialization file. Extremely long waveforms are possible but may create difficulties on computers with limited memory. We recommend that you keep the maximum number and maximum length of arrays close to what your problem actually requires.

Many of the operators create new waveforms, if space permits. If space does not permit, the original waveform is *overwritten* unless more than one waveform is generated, in which case the operation fails with an error message. To conserve waveform space, if an operation that creates new waveforms is repeated, and would duplicate some waveform names, the old waveforms are automatically overwritten.

INSTALLATION

The xdamp source code is provided in a tar file named xdamp.tar or xdamp.zip. It should be installed in the directory $IDL_PATH/lib/xdamp using the command "tar -xvf xdamp.tar" or an appropriate PKUNZIP utility. Be certain the directory has public read permission and that all files in the directory also have this permission. Almost all system-specific information is contained in the file XDsys_sp.pro. The system manager must edit the XDsys_queue.pro module in this file and fix the print queue command to use the appropriate printer. However, VMS systems use the XDAMP$PRINTER logical for this and don't need editing, just definition of the logical. The default limits for the number of waveforms (maxarrays), their maximum length (maxsize), and the default graphics area (xgsize, ygsize) can be changed in the XDsys_ini module in this file also. Finally, some customizing of the waveform button area is possible in this file.

RESTRICTIONS

***xdamp* Version 2.1 and higher must use IDL version 4.0.1 or later, otherwise the long variable and procedure names are not properly recognized. *xdamp* requires a three-button mouse (most seem to work) to operate on windows computers. There are also some known Macintosh-specific problems discussed later. Unix computers work better with IDL version 4.0.1 or later rather than 4.0 because of a widget problem. Beware of using IDL version 4.0.1b - a bug in the code will cause the file handling software to fail. You must change all occurrences of hdf_ishdf to test_ishdf for *xdamp* to function.**

GETTING STARTED

The IDL environment variables must be defined as described in the IDL installation instructions for the specific computer environment. The *xdamp* files must be installed in the (publicly accessible) $IDL_PATH/lib/xdamp directory. Then the user can access

xdamp simply by initiating IDL (type idl at the prompt) and then typing *xdamp* at the first IDL prompt. All subsequent inputs are funneled through the main *xdamp* window. If you install *xdamp* elsewhere, the system manager will need to modify the !HELP_PATH variable in the XD_help module in the XDsys_sp.pro file.

For UNIX systems, you can control the background color of the IDL widgets and the text font used for these widgets (the graphics font is completely independent). The following lines (with sample colors and font) may be inserted in your Xdefaults file. Be careful, if you choose too large a font, the graphics area will not be next to the controls and will be too small; if the screen does not appear similar to Fig. 1, then reduce the font size. I have had good success using a bold font for the widget font. Alternatively, reduce the graphics area size using the GRAPHIC AREA=XSIZExYSIZE in the initialization file (see next topic). You can also reserve a block of color indices so that other applications won't destroy the color maps with the last entry in the list below.

Idl*background: LightSteelBlue

Idl*foreground: Black

Idl*fontList: ROMB12

Idl.colors: 64 (the period, rather than asterisk, is correct here)

For PC systems, the File/Preferences/General menu allows control of the default fonts for buttons and the default appearance of IDL in general. Macintosh computers have a similar capability.

INITIALIZATION FILE

There is an optional initialization file that may reside in the subdirectory in which you will run *xdamp*. Its name must be xdamp.ini. Different versions may be in different subdirectories. The following commands, one per line, may be in this file and will define the options preferences. The commands are not case sensitive, although the argument may be (for instance, the file filter). Further information on these controls may be found in the Options section (page 27). A sample xdamp.ini file resides in $IDL_PATH/lib/xdamp.

TABLE 1. xdamp.ini Initialization File Commands

Controls this feature	Default	Alternates
Maximum number of arrays	Maxarrays=	Default in XDsys_sp.pro
Maximum length of arrays	Maxsize=	Default in XDsys_sp.pro
Cursor or prompt inputs	Cursor On	Cursor Off
Automatic plotting	Autoplot On	Autoplot Off
Clear Stack After Operation	Clear Stack Off	Clear Stack On
Print device	PS	CPS, EPS, ECPS
Screen plot colors	Monochrome	Color
Unix print queue	Queue Name=	Default in XDsys_sp.pro
Plots/page	One/page	Two/page, Four/page

TABLE 1. xdamp.ini Initialization File Commands

Controls this feature	Default	Alternates
Date on plots	Todays Date	Shot Date
Plot with symbols	Symbols Off	Symbols On
Grid appearance	Grid Off	Grid On, Grid Zero
Line thickness	Line thick=1.0	Number >0.2, <5.0
Graphics font type	Hardware Font	Vector Font
Graphics Hardware Font[a]	Gfont=FONT	Font must be fully qualified[b]
Vector font size multiplier[c]	Font size = 1.0	Number >0.2, <5.0
Compare baseline fixed or variable during curve fit	Compare baseline variable	Compare baseline fixed
Display max/min information	Max/min On	Max/min Off
Display FWHM information	FWHM On	FWHM Off
Display rise/fall information	Rise/fall On	Rise/fall Off
Pulse parameter method	Best Guess	Peak Down, Ends In
Default file filter	File filter=*.hdf	Any wildcard string
File data encoding	HDF	DAMP, SICDAS, EXCEL, ASCII, USER
Graphic area dimensions in pixels	Graphic Area=800x750	Default in XDsys_sp.pro
X-axis	Xlinear	Xlog
X-axis endpoints	Xrounded	Xexact, Xextended
X-axis zero in graphics area	Xzero On	Xzero Off
X-axis minor tick marks	Xminor Auto	Xminor Off
Y-axis	Ylinear	Ylog
Y-axis endpoints	Yrounded	Yexact, Yextended
Y-axis zero in graphics area	Yzero On	Yzero Off
Y-axis minor tick marks	Yminor Auto	Yminor Off

a. Valid only if Hardware Font selected

b. Example: -adobe-helvetica-medium-r-normal--14-140-75-75-p-77*

c. Valid only if Vector Font selected

You must be exceedingly careful when setting the graphics hardware font to choose a legal definition. If in doubt, leave this blank and use the xfont utility in the OPTIONS window to find a legal font name and then include it in the initialization file.

FINISHING UP

To leave *xdamp*, select FILE.EXIT from the *xdamp* menu. This action returns you to the IDL prompt. Then type EXIT to return to the system prompt. On a Macintosh, *DO NOT*

use the FILE.QUIT on the screen menu bar because this will not properly close the journal file or any other open files.

CHANGES IN VERSION 2

Almost every feature of xdamp has been preserved in version 2. Old macro files have only two significant changes. The command TIMEALIGN must have the additional command PEAKALIGN added after the TIMEALIGN command. Additionally, the EDGEALIGN command needs to have TIMEALIGN inserted in the line prior to the EDGEALIGN command. The ZOOM command now requires the four inputs on sequential lines, not on one line separated by commas. This allows registers to be input for ZOOM variables. The INTERPOLATE command now also requires two inputs on separate lines but allows registers as responses.

The TIMEFLIP command has been replaced by the MIRROR command that reverses the waveform about zero time instead of reversing the waveform while maintaining the start and end times.

The user section of the read file has been moved into the XD_user.pro module. We have added four user-addressable buttons under the MISCELLANY button. There are dummy routines in XD_user.pro for you to modify. This allows you to easily create custom routines. The USER1 and USER2 buttons are default as single waveform operators and the USER3 and USER4 buttons are default as multiple waveform operators that require some waveform to be ENTERed prior to execution.

Unix users can now control the print queue during execution and initialize any desired print queue in their xdamp.ini file.

Most of the additional changes are to take advantage of features specific to IDL version 4.0 and later, thus compatibility with version 3.6.1 is lost.

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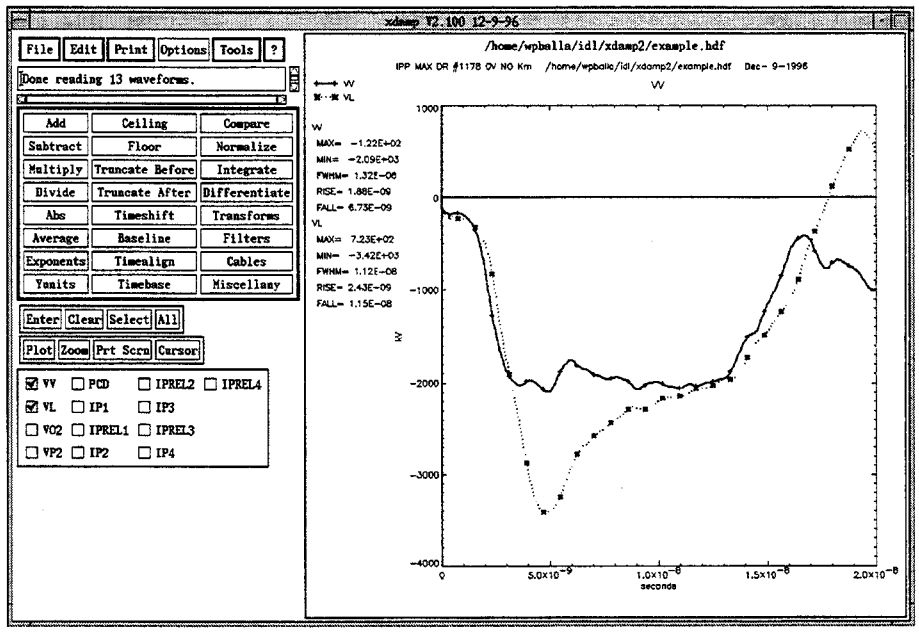
Screen Layout

The *xdamp* screen (Fig. 1) is designed so that input from a virtual terminal is never needed. The xdamp title bar displays the current version number and the date of that version. The left portion of the screen contains all the menus and buttons needed. The right portion of the screen contains the graphics region and a label area for the active file name.

FIGURE 1. *xdamp* Screen Layout



Across the top of the left portion of the *xdamp* screen is a series of "menu" buttons, not all of which actually lead to menus. The FILE, EDIT, PRINT, and TOOL buttons lead to menus, the OPTIONS button pops a window with available option selections, and the ? button pops a widget that allows you to obtain help on any aspect of IDL or *xdamp*.

The space immediately below the menu bar contains a scrollable message area in which *xdamp* places output. Informational messages, general messages, error messages, and cursor values are shown in this area. For the sake of sanity, *xdamp* does not beep at you to alert you that a message is present.

Below the message area is the operator box. Each button causes the operation described to be performed. In a few cases, such as the TRANSFORM button, subsets of further buttons appear. Only one operator button can be pressed at a time.

Below the operator area is the speed button area where buttons used extremely frequently are placed. In most cases, the same operation executed by pressing one of these buttons is available from one of the menus.

Below the speed button area are the waveform buttons. One button is present for each of the waveforms. Multiple waveforms can be selected simply by pressing multiple buttons. Pressing an already set button deselects that waveform. Buttons may also be selected using wildcard strings by using the EDIT.SELECT menu selection or the Select speed button.

The following sections describe each of these actions in detail, beginning with the menus and proceeding down the left side of the screen. For the command equivalent, inputs that you choose are shown enclosed by the brackets <>. *The punctuation in the command equivalent is critical.* Also, although the command equivalents are shown with varying cases, the actual commands are converted to uppercase so the commands are case insensitive except for waveform names and file names. The capitalization comes from what appears in the xdamp.jnl journal file.

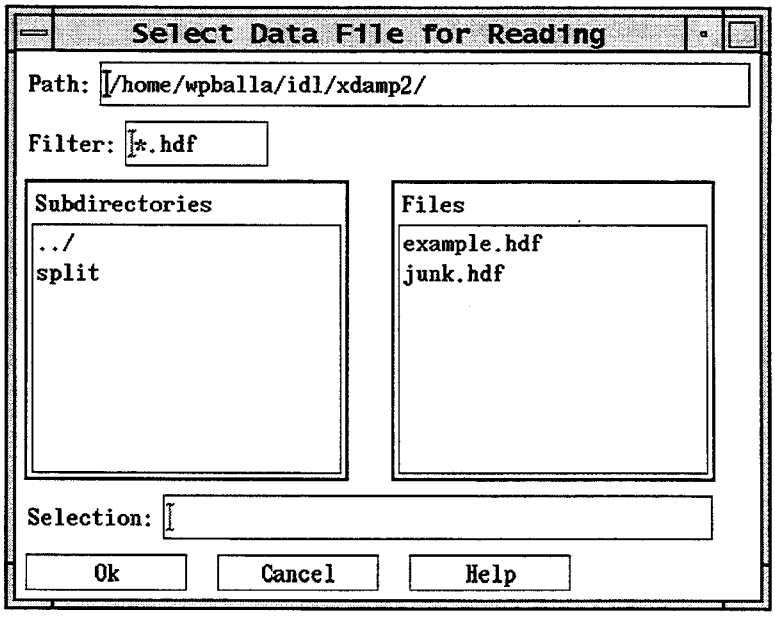
File Menu

FILE.OPEN

The FILE.OPEN menu selection pops a "pickfile" widget (Fig. 2) to allow you to choose the data file to open. The default extension is defined by the case sensitive file filter defined in the initialization file or by the FILE.SET FILTER menu selection. It may be temporarily edited within the pickfile widget. The widget allows you to move relatively freely between various directory tree structures. *Beware, only single mouse clicks are needed to move around on UNIX systems.* You should set the data storage type using the FILE.DATA TYPE menu item or the equivalent in the OPTIONS widget. This command *automatically* discerns if the data file was written in HDF, and reads in the data appropriately. DAMP files must be in the latest variable record length format. When opening or saving a DAMP file, it is assumed that the header file exists with the same name but with extension .list. If this is not true, you are prompted for the header filename with the pickfile widget. If records longer than the current maximum allowed are present, then the data are averaged over sets of points to reduce the record size. SIC-DAS data files from the SPHINX accelerator are in ASCII format but have the header information in the file and use a format that saves the starting and ending times of the waveforms, rather than the entire time data set. ASCII input data are in the format: name, horizontal axis units, vertical axis units, number of points and a set of x-y pairs, delimited by white space. The ASCII data need not be in order or have equally spaced points, *xdamp* will sort and then resample the waveform using the smallest time interval. In automatic execution mode, you will *not* be queried about whether to save a currently open file when opening a new file.

Command Equivalent
FILE.OPEN
<full path + file name>

FIGURE 2. UNIX Pickfile Widget



FILE.CLOSE

The FILE.CLOSE menu selection will close the active data set. If any modifications to the original data have been made, then you will be asked if you wish to save the data set before the waveforms are cleared out. If you answer yes, then the SAVE AS submenu will appear to obtain a file name for saving the data. If you have already saved the file, then the NO in the command equivalent is not needed.

Command Equivalent
FILE.CLOSE
NO

FILE.APPEND

The FILE.APPEND menu selection also uses the pickfile widget to choose a file to be appended to the currently opened file. Each waveform in the appended file will have the shot number from the file name (if any) prefixed to the waveform name. If there is no shot number, then one or more ampersands (&) are prefixed to the waveform name. The number of ampersands is determined by the number of append operations performed. The addition of the shot number or ampersands to each file name makes certain that the names are unique. When saving a file after an append operation, the default file name is still that of the initial file opened.

Command Equivalent
FILE.APPEND
<full file name>

FILE.GET ARRAY

The FILE.GET ARRAY menu selection uses the pickfile widget to choose a data file. This file is opened and a widget with buttons for each waveform is presented. You choose which waveforms (which are automatically plotted) you want to append to the currently opened data set and then press the DONE button. The waveform names will either have the shot number from the file name prefixed to the waveform names or a number of ampersands (&) that depends on the number of files opened. These waveforms are added to the current data set. Do not use this command if the target file has only one waveform, instead use FILE.APPEND. The command equivalent is shown below for adding two waveforms "WVFM1" and "WVFM2".

Command Equivalent
FILE.GET ARRAY
<full file name>
WAVEFORM.WVFM1
WAVEFORM.WVFM2
DONE

FILE.SAVE

The FILE.SAVE menu selection overwrites the original data file with the current contents of the waveforms using the Hierarchical Data Format (HDF). If you have performed an append operation, the name of the first file opened is used. You are asked if you are certain that you want to overwrite the original file before continuing with this operation *unless* you are in automatic execution mode.

Command Equivalent
FILE.SAVE

FILE.SAVE AS

The FILE.SAVE AS menu selection prompts for a new file name via the pickfile widget so you can alter the directory, file name, or file extension before actually saving the waveforms using Hierarchical Data Format (HDF). The default file extension for a save

as operation is .hdf. If the new and old file names are identical, you are asked if you are certain that you want to overwrite the original file before continuing with this operation. If you are in automatic execution mode and use a ? instead of a full file name, you will be prompted for the desired file name. You can modify the prompt by placing your query string after the ?

Command Equivalent
FILE.SAVE AS
<full file name> or ?

FILE.SAVE ASCII

The FILE.SAVE ASCII menu selection saves the selected waveforms in an x-y pair ASCII file suitable for editing and use by many external graphics packages. The output data format is the name, the horizontal axis units label, the vertical axis units label, the number of points, and then a series of x-y pairs separated by white space. If more than one waveform is selected, all waveforms are output in a single file. If no waveforms are selected, then all waveforms are written to the output file. The output file name is chosen by the pickfile widget with a default extension of .asc. If you are in automatic execution mode and use a ? instead of a full file name, you will be prompted for the desired file name You can modify the prompt by placing your query string after the ?.

Command Equivalent
FILE.SAVE ASCII
<full file name> or ?

FILE.SET FILTER

The FILE.SET FILTER menu selection asks for the new case sensitive file filter to be applied in future OPEN, SAVE, and SAVE AS operations. The file filter can be very sophisticated and use multiple wildcard characters (*) or simply specify the desired file extension. Example formats are ***.hdf** or **saturn_023*.dat**.

Command Equivalent
FILE.SET FILTER
<filter string>

FILE.SET DATA TYPE

The FILE.SET DATA TYPE menu selection pops a widget to set the format the data were stored in. Possible responses are HDF, DAMP, SICDAS, EXCEL (comma delimited), USER, or ASCII formats as well as a CANCEL button if you don't want to change the current selection. File save operations always use the HDF format, no matter what data type is set. The USER format is distributed in the XD_user.pro procedure. The user may define this subroutine if desired.

Command Equivalent
FILE.SET DATA TYPE
HDF or DAMP or SICDAS or EXCEL or USER or ASCII

FILE.EXIT

The FILE.EXIT menu selection exits *xdamp*. Prior to exiting, a FILE.CLOSE operation is performed, allowing you to save the current data set if you desire. Then, if any data remains in the print file, you are asked if you wish to spool it to the printer before exiting. This operation returns you to the IDL prompt, not the operating system. In command mode, the following sequence assumes you do not wish to save the active file.

Also, an additional Yes or No may be needed if there is a print file open. The print question is asked before the question about saving the file.

Command Equivalent
FILE.EXIT
YES or NO

Edit Menu

In this context, all editing is done on waveforms or a set of special storage registers. There are two methods to create new waveforms, NEW and COPY. These are very similar in end effect. There is no method to create a new register; you must use the predefined registers #R0 through #R9. Be aware that *xdamp* is case sensitive for waveform names so the names VV Vv, vV, and vv are unique.

EDIT.STORE

The EDIT.STORE menu selection allows you to store a number in one of the predefined registers. A constant or the contents of another register can be stored in these registers.

Command Equivalent
EDIT.STORE
<value or #register>
<0 through 9>

EDIT.NEW

The EDIT.NEW menu selection creates a new waveform. It prompts for the desired name of the new waveform. This name must be different from all other names in the current data base. All other data about the waveform is assumed to be blank until some operation targeting this waveform is performed. Then, the new waveform takes its properties (number of points, time span) from the other waveform in the operation.

Command Equivalent
EDIT.NEW
<waveform name>

EDIT.COPY

The EDIT.COPY menu selection copies the last waveform selected to a new waveform. You are prompted for the new waveform name. If the new name is identical to an existing one, you will be asked if you are certain you wish to overwrite the old waveform. Should you answer affirmatively, the copy command will proceed, writing over the old data with the selected waveform. All other data are identical to the old waveform.

Command Equivalent
EDIT.COPY
<waveform name>

EDIT.SORT

The EDIT.SORT menu selection sorts the waveform buttons in alphanumeric order from a to z. The buttons are then rearranged.

Command Equivalent
EDIT.SORT

EDIT.RENAME

The EDIT.RENAME menu selection renames the last waveform selected to a new name obtained from a prompt window. The new name is forced to be unique compared to all current waveforms or the operation is not performed.

Command Equivalent
EDIT.RENAME
<waveform name>

EDIT.SELECT

The EDIT.SELECT menu selection asks for a wild card waveform designation and then selects all of the waveforms meeting that criteria. At least one asterisk must be present in the response. For example, PIN* as the wild card input would select PIN, PIN1, and PIN007. If more than 8 waveforms are selected, then they will NOT be automatically plotted. If 8 or fewer are chosen, autoplot operates normally. This feature prevents plotting, which is slow, when you are preparing to delete a large number of waveforms. The PLOT button still operates normally if you do wish a plot of the selected waveforms.

Command Equivalent
EDIT.SELECT <wildcard string>

EDIT.DELETE

The EDIT.DELETE menu selection deletes all the selected waveforms and their buttons. There is no "Are you sure?" prompt. If you have insufficient memory failures, edit the XD_edit.pro file and find the XDedit_delete section. There is a comment with a note to uncomment one line and comment out another line to improve the memory management at the expense of speed.

Command Equivalent
EDIT.DELETE

EDIT.KEEP

The EDIT.KEEP menu selection deletes all waveforms except the selected waveforms. There is no "Are you sure?" prompt. If you have insufficient memory failures, edit the XD_edit.pro file and find the XDedit_keep section. There is a comment with a note to uncomment one line and comment out another line to improve the memory management at the expense of speed.

Command Equivalent
EDIT.KEEP

EDIT.RESTORE

The EDIT.RESTORE menu selection restores all the currently selected waveforms from the data file to their state after the last save operation.

Command Equivalent
EDIT.RESTORE

EDIT.NOTES

The EDIT.NOTES menu selection allows you to edit notes attached to each waveform. (Notes appear in the lower left corner of the graphics area when a single waveform is plotted.) Editing areas for notes about all of the selected waveforms, or all waveforms if none are selected, will appear. In automatic execution, this command returns control to you for the input of notes. Automatic execution continues when you press the DONE button.

Command Equivalent
EDIT.NOTES

EDIT.FILE NOTES

The EDIT.FILE NOTES menu selection allows you to edit notes attached to the overall data set. An editing area for the notes will appear. In automatic execution, this command returns control to you for the input of file notes. Automatic execution continues when you press the DONE button.

Command Equivalent
EDIT.FILE NOTES

EDIT.TITLE

The EDIT.TITLE menu selection allows you to edit the shot title information attached to the overall data set. An editing area for the title will appear. In automatic execution, this command returns control to you for the input of the shot title. Automatic execution continues when you press the RETURN key or DONE button.

Command Equivalent
EDIT.TITLE

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Print Menu

All printing is done using PostScript, or Encapsulated PostScript and goes to a temporary file named xdamp.out in your current directory. To minimize paper, all printing occurs in append mode until you request that the file be queued. *xdamp* overrides the font selections when using PostScript output to be certain output will fit on the page.

PRINT.SCREEN

The PRINT.SCREEN menu selection causes the current graphics view to be redrawn to a file that can be printed later (see PRINT.QUEUE OUTPUT).

Command Equivalent
PRINT.SCREEN

PRINT.ALL

The PRINT.ALL menu selection causes all of the waveforms to be drawn to a file for later printing using the current selection of one, two, or four plots per page.

Command Equivalent
PRINT.ALL

PRINT.SELECTED

The PRINT.SELECTED menu selection causes all of the selected waveforms to be drawn to a file for later printing. The number of plots per page selection is honored for this process but only one plot to a plot area.

Command Equivalent
PRINT.SELECTED

PRINT.REGISTERS

The PRINT.REGISTERS menu selection causes the contents of the registers to be sent to the print file.

Command Equivalent
PRINT.REGISTERS

PRINT.SUMMARY

The PRINT.SUMMARY menu selection places a summary sheet in the file. The summary sheet contains the waveform name, maximum, minimum, vertical units, full width at half maximum, rise time, fall time and time units for each selected waveform. If no waveforms are selected, the information for all waveforms is printed. This command also creates an ASCII file called xdamp.ss suitable for inclusion in a spreadsheet using single spaces as delimiters.

Command Equivalent
PRINT.SUMMARY

PRINT.HEADER

The PRINT.HEADER menu places the header (if one exists) of the original file opened, in the file for later printing.

Command Equivalent
PRINT.HEADER

PRINT.NOTES

The PRINT.NOTES menu selection places the notes for all the selected waveforms in the file for later printing. If no waveforms are selected, then all of the notes are printed.

Command Equivalent
PRINT.NOTES

PRINT.AUDIT TRAIL

The PRINT.AUDIT TRAIL menu selection places the audit trails for all the selected waveforms in a file for later printing. If no waveforms are selected, then all of the audit trails are printed.

Command Equivalent
PRINT.AUDIT TRAIL

PRINT.FILE NOTES

The PRINT.FILE NOTES menu selection places the file notes in the printer file for later printing.

Command Equivalent
PRINT.FILE NOTES

PRINT.PRINTER TYPE

The PRINT.PRINTER TYPE menu selection pops a selection widget to choose the type of printer you have. You can either have PS (PostScript), CPS (Color PostScript), EPS (Encapsulated PostScript). or ECPS (Encapsulated Color PostScript) type printers as well as a Cancel button if the current selection is adequate. This can also be changed in the OPTIONS widget.

Command Equivalent
PRINT.PRINTER TYPE PS or CPS or EPS or ECPS

PRINT.QUEUE OUTPUT

The PRINT.QUEUE OUTPUT menu selection closes the current print file and queues it to the line printer for UNIX systems. For Macintosh computers, you need to print out the xdamp.out file manually. One way to accomplish this is to use the shareware program DropPs available from mac.archive.umich.edu via anonymous ftp. For DOS/Windows machines, you need to make certain that the idlspawn.pif file was moved to the windows\system directory and was edited (using the PIF editor) to have the exclusive attribute set. On DOS/Windows machines, you will be stuck in DOS mode for the duration of the print..

Command Equivalent
PRINT.QUEUE OUTPUT

PRINT.QUEUE NAME

The PRINT.QUEUE NAME menu selection allows unix system users to change print queue commands. The default is set in the XDsys_sp.pro file by the system manager. The full command is required, for instance lpr -Psata002 would use the print command lpr with queue sata002.

Command Equivalent
PRINT.QUEUE NAME <queue print command + name>

PRINT.PRINTER RESET

The PRINT.PRINTER RESET menu selection closes the current print file and does not queue it to the printer. The second argument in the command equivalent is only required if there is an uncleared print file in the queue.

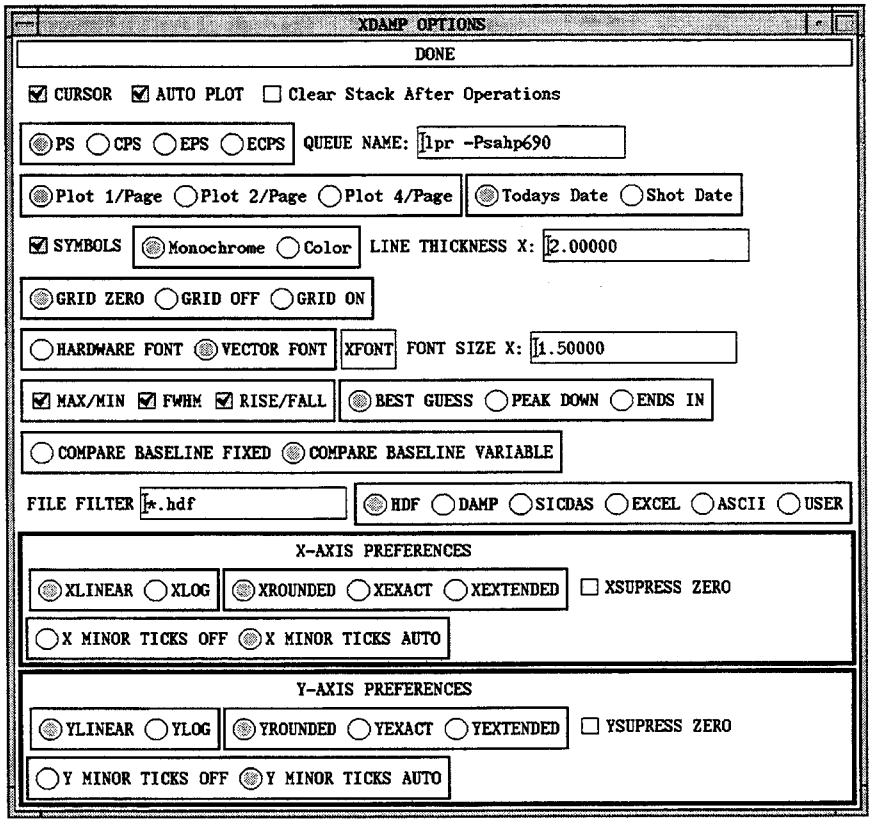
Command Equivalent
PRINT.PRINTER RESET YES or NO

Options Window

Unlike the prior menus, the OPTIONS menu button pops up a window (Fig. 3) with a series of push buttons and input boxes. These allow you to select your preferred mode of viewing the data. All of the OPTIONS options may be set in the xdamp.ini file. The x- and y-axis preferences selections are identical and are only discussed under the equivalent x-axis heading. Multiple OPTIONS options may be placed in a series with the block of commands surrounded by the following commands. However, to perform even a single options command, you must surround it by these.

Command Equivalent
OPTIONS
Other commands here
DONE

FIGURE 3. Options Window Layout



CURSOR

The CURSOR preference button determines how inputs will be given to *xdamp* for truncation, time shifting, zooming, and baselining operations. If the cursor button is down it is ON and the cursor will become active for these inputs. The current cursor coordinates are shown continuously in the message window. You must press a mouse button to pick

the final desired cursor-input position. If cursor mode is not selected, a numeric input box will automatically appear. Only a few operators, shown in Table 2, use the cursor.

TABLE 2. Operations that can use the cursor

BASELINE
TIMESHIFT
CEILING
FLOOR
TRUNCATE BEFORE
TRUNCATE AFTER
DEFIDU
CONCATENATE
CALORIMETER

The CURSOR command equivalent toggles the current state. In command mode, if the cursor preference is on, the automatic execution pauses for cursor input. If the cursor preference is off, the cursor position was saved (in data units) and is reused. Alternatively, you may use CURSOR ON or CURSOR OFF (with or without the OPTIONS and DONE) if you are uncertain of the state of the CURSOR command.

Command Equivalent
CURSOR or CURSOR ON or CURSOR OFF

AUTO PLOT

The AUTO PLOT preference button determines whether selected waveforms will be immediately plotted, or if the PLOT button must be used to make a plot. This is a toggle button. The command equivalent to toggle the state is shown below. Alternatively, you may use AUTO PLOT ON or AUTO PLOT OFF (with or without the OPTIONS and DONE) if you are uncertain of the state of the AUTOPLOT command.

Command Equivalent
AUTO PLOT or AUTO PLOT ON or AUTO PLOT OFF

Clear Stack After Operations

The Clear Stack after Operations preference button determines whether the stack will be automatically cleared after each operation. This is a toggle button. The command equivalent to toggle the state is shown below.

Command Equivalent
CLEAR STACK

PS
CPS
EPS
ECPS

The PS, CPS, EPS, and ECPS buttons are mutually exclusive. These determine what type of output device is in use. All PS type buttons use PostScript. The PS button is monochrome PostScript, the CPS button is color PostScript, the EPS button is encapsulated monochrome PostScript, and the ECPS button is encapsulated color PostScript. .

Command Equivalent
PS or CPS or EPS or ECPS

QUEUE NAME

The QUEUE NAME input area allows unix system users to change print queue commands. The default is set in the XDsys_sp.pro file by the system manager. The full com-

mand is required, for instance lpr -Psata002 would use the print command lpr with queue sata002.

Command Equivalent
QUEUE NAME, <Queue command and name>

PLOT #/PAGE

The PLOT 1/PAGE, PLOT 2/PAGE, and PLOT 4/PAGE buttons are mutually exclusive. These determine whether one, two, or four plots per page will be shown both on the screen and for hardcopies.

Command Equivalent
PLOT 1/PAGE or PLOT 2/PAGE or PLOT 4/PAGE

SHOT DATE
TODAYS DATE

The SHOT DATE and TODAYS DATE buttons are mutually exclusive. If a shot date was encoded in the data file, then that date and time are shown on each plot when SHOT DATE is selected. Otherwise, if TODAYS DATE is selected, the current date is placed on each plot.

Command Equivalent
SHOT DATE or TODAYS DATE

SYMBOLS

The SYMBOLS button determines whether symbols will be used on each plot in addition to the line. If it is pressed, then symbols will be used. In command mode, this is a toggle command. Alternatively, you may use SYMBOLS ON or SYMBOLS OFF (with or without the OPTIONS and DONE) if you are uncertain of the state of the SYMBOLS command.

Command Equivalent
SYMBOLS or SYMBOLS ON or SYMBOLS OFF

MONOCHROME
COLOR

The MONOCHROME and COLOR buttons are mutually exclusive and choose what type of screen display will be generated. If COLOR is chosen, then all linetypes are solid while if MONOCHROME is chosen, all lines are different. The color map only contains 7 colors (plus black) and cycles through the colors.

Command Equivalent
MONOCHROME or COLOR

LINE THICKNESS

The LINE THICKNESS MULTIPLIER determines how thick the graphics lines will be. The default is 1.0 and making lines too thick significantly slows down the graphics response. Valid values are between 0.2 and 5.0. The comma in the command equivalent is important.

Command Equivalent
LINE THICKNESS, <Line Thickness Multiplier>

GRID TYPE

The GRID ZERO, GRID OFF and GRID ON buttons are mutually exclusive. If GRID OFF is selected, no grid is shown. If GRID ON is selected, then a dotted grid is shown at the major tick marks. If GRID ZERO is selected, then only the x and y axis zero values of the grid are drawn as bold lines.

Command Equivalent
GRID ON or GRID OFF or GRID ZERO

HARDWARE FONT
VECTOR FONT

The VECTOR FONT button selects the IDL Hershey vector fonts for the graphics area. The HARDWARE FONT button selects the terminal default as specified in the .Xdefaults file. The hardware fonts can be changed through either the XFONT button or the TOOLS.XFONT menu item.

Command Equivalent
VECTOR FONT or HARDWARE FONT

GRAPHICS FONT SIZE

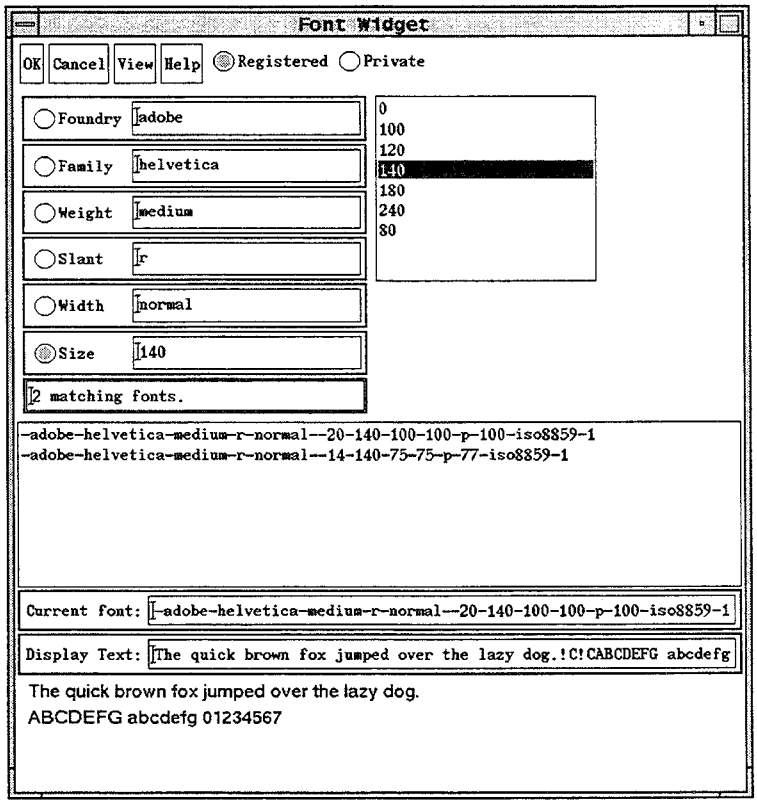
The GRAPHICS FONT SIZE MULTIPLIER is only active for vector fonts. It modifies all the text in the graphics window. Valid values are 0.2 to 5.0. If you have selected hardware fonts, this field is inactive and the font size multiplier is set to 1.0. The comma in the command equivalent is important.

Command Equivalent
FONT SIZE, <Font Size Multiplier>

XFONT

The XFONT button pops up the xfont selector widget (Fig. 4) if HARDWARE FONT has been selected on UNIX computers. This widget allows you to preview and select a hardware font from all of those available to your terminal. This font becomes the graphics area font. This application has no command equivalent but a desired font can be placed in the xdamp.ini file. This application does not function for Macintosh or Windows computers.

FIGURE 4. Xfont widget



MAX/MIN

The MAX/MIN toggle button selects whether the maximum and minimum values of the selected waveforms will be shown on the left side of each plot (in ONE/page mode). This button is not mutually exclusive with either the FWHM or RISE/FALL buttons. These quantities are calculated every time a waveform is plotted, whether or not MAX/MIN is selected, and are stored in registers. Alternatively, you may use MAX/MIN ON or MAX/MIN OFF (with or without the OPTIONS and DONE) if you are uncertain of the state of the MAX/MIN command

Command Equivalent
MAX/MINor MAX/MIN ON or MAX/MIN OFF

FWHM

The FWHM toggle button selects whether the full-width at half-maximum (FWHM) values of the selected waveforms will be shown on the left side of each plot (in ONE/page mode). This button is not mutually exclusive with either the MAX/MIN or RISE/FALL buttons. This quantity is calculated every time a waveform is plotted, whether or not FWHM is selected, and is stored in a register. Alternatively, you may use FWHM ON or FWHM OFF (with or without the OPTIONS and DONE) if you are uncertain of the state of the FWHM command

Command Equivalent
FWHM of FWHM ON or FWHM OFF

RISE/FALL

The RISE/FALL toggle button selects whether the 10%-to-90% rise-time and fall-time values of the selected waveforms will be shown on the left side of each plot (in ONE/page mode). This button is not mutually exclusive with either the MAX/MIN or FWHM buttons. These quantities are calculated every time a waveform is plotted, whether or not RISE/FALL is selected, and are stored in registers. Alternatively, you may use RISE/FALL ON or RISE/FALL OFF (with or without the OPTIONS and DONE) if you are uncertain of the state of the RISE/FALL command

Command Equivalent
RISE/FALL or RISE/FALL ON or RISE/FALL OFF

BEST GUESS

The BEST GUESS button is mutually exclusive with the PEAK DOWN and ENDS IN buttons. It selects the mode used to calculate the FWHM and rise and fall times. The algorithm used calculates all parameters using both the PEAK DOWN and ENDS IN techniques. The longest FWHM and the shortest rise and fall times are then selected.

Command Equivalent
BEST GUESS

PEAK DOWN

The PEAK DOWN button is mutually exclusive with the BEST GUESS and ENDS IN buttons. It selects the mode used to calculate the FWHM and rise and fall times. The algorithm is to calculate all parameters starting from the waveform peak and proceeding outward to find the first 90%, 50%, and 10% values for the calculations.

Command Equivalent
PEAK DOWN

ENDS IN

The ENDS IN button is mutually exclusive with the BEST GUESS and PEAK DOWN buttons. It selects the mode used to calculate the FWHM and rise and fall times. The

algorithm is to calculate all parameters starting from the beginning and the end of the waveform to find the first 10%, 50% and 90% values for the calculations.

Command Equivalent
ENDS IN

COMPARE BASELINE FIXED

The COMPARE BASELINE FIXED button is mutually exclusive with the COMPARE BASELINE VARIABLE button. These buttons control how the COMPARE routine performs its curve fits. In fixed mode, the baseline is not allowed to vary and the two waveforms are fit by the equation Reference= Scale*Variable. No offset is allowed.

Command Equivalent
COMPARE BASELINE FIXED

COMPARE BASELINE VARIABLE

The COMPARE BASELINE VARIABLE button is mutually exclusive with the COMPARE BASELINE FIXED button. These buttons control how the COMPARE routine performs its curve fits. In variable mode, the baseline is allowed to vary and the two waveforms are fit by the equation Reference= Scale*Variable + Offset.

Command Equivalent
COMPARE BASELINE VARIABLE

FILE FILTER

The FILE FILTER entry box allows you to change the default file filter to be applied in future OPEN, SAVE, and SAVE AS operations. This is identical to changing the filter in the FILE.SET FILTER menu selection. The file filter can be very sophisticated and use multiple wild card characters (*) or simply specify the desired file extension. Example formats are ***.hdf** or **saturn_012*.dat**.

Command Equivalent
FILE FILTER, <filter string>

DATA FORMAT

The DATA FORMAT selection buttons allow you to change the default data structure for the input file. This is identical to changing the selection in the FILE.SET DATA TYPE menu selection. As distributed, the EXCEL format reads comma delimited spreadsheet format data. The USER format is in the file XD_user.pro and must be written by the user. Whatever the selection is, HDF files are always automatically recognized for reading.

Command Equivalent
HDF or DAMP or SICDAS or EXCEL or USER or ASCII

LINEAR

The LINEAR button is mutually exclusive with the LOG button. This selects whether the axis will be linear or logarithmic.

Command Equivalent
XLINEAR or YLINEAR

LOG

The LOG button is mutually exclusive with the LINEAR button. This selects whether the axis will be linear or logarithmic. For log axes, negative and zero values are ignored.

Command Equivalent
XLOG or YLOG

ROUNDED

The ROUNDED button is mutually exclusive with the EXACT and EXTENDED buttons. This selects rounded axis limits where IDL chooses the axis limits after examining the waveforms.

Command Equivalent
XROUNDED or YROUNDED

EXACT

The EXACT button is mutually exclusive with the ROUNDED and EXTENDED buttons. This selects exact axis limits and IDL chooses the axis limits after examining the waveforms.

Command Equivalent
XEXACT or YEXACT

EXTENDED

The EXTENDED button is mutually exclusive with the ROUNDED and EXACT buttons. This selects extended axis limits where IDL chooses the axis limits after examining the waveforms and then adds approximately 20% to both ends.

Command Equivalent
XEXTENDED or YEXTENDED

SUPPRESS 0

The SUPPRESS 0 toggle button is not mutually exclusive with the ROUNDED, EXACT and EXTENDED buttons. Normally, IDL will choose to have the value 0 included in the axis limits for both axes. This button removes this restriction and is akin to ac-coupling an oscilloscope.

Command Equivalent
XSUPPRESS ZERO or YSUPPRESS ZERO

MINOR TICKS AUTO

The MINOR TICKS AUTO button is mutually exclusive with the MINOR TICKS OFF button. This enables minor axis tick marks and IDL chooses the spacing after examining the waveforms.

Command Equivalent
X MINOR TICKS AUTO or Y MINOR TICKS AUTO

MINOR TICKS OFF

The MINOR TICKS OFF button is mutually exclusive with the MINOR TICKS AUTO button. This disables minor axis tick marks.

Command Equivalent
X MINOR TICKS OFF or Y MINOR TICKS OFF

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Tools Menu

TOOLS.MACRO

The TOOLS.MACRO menu has two sub-menu selections: Single File and Sequence of Files. Both of these modes require a command file (the default extension is .dcf) composed of a sequence of *xdamp* commands. The appropriate command file equivalent is listed at the end of each command description. You can incorporate comments into your command files by placing a semicolon at the beginning of the line. These comments will be echoed in the message area of the xdamp window during execution. Whitespace lines are ignored and can be inserted to make the command file easier to read but do not end a file with whitespace or comments. The single file version of this command can be used to nest macros up to 10 deep. You cannot recursively call the sequence of files version but single macros can be executed from within a sequence of files macro.

The single-file mode will pop the pickfile widget to select an *xdamp* command file. This command file will then be executed and you will be returned to *xdamp*. The xdamp.ini file is not executed and the waveform buttons are left as is. Thus, you can select a waveform and then perform a calculation on that waveform. To add a macro within another macro, use the following command syntax.

Command Equivalent
TOOLS.MACRO.SINGLE FILE <full file name>

The sequence-of-files selection pops the pickfile widget three times. The first time, you are asked to pick the beginning data file of a sequence, the second time you pick the final data file, and the third time you choose the command file to operate on each of these files. Each file is automatically opened and closed, so you do not need to perform these operations in the command file. However, you must perform an explicit FILE.SAVE operation in the command file or the results will not be permanently saved. The xdamp.ini file will be automatically executed prior to opening each file so that a known initial state is present. This option allows an easy way to translate a group of files to HDF format. Simply create a one line command file containing the command FILE.SAVE. Modify your xdamp.ini to reflect the data format and extension that you will be translating from. When you perform automatic multiple file execution, the original data files will be overwritten with HDF data files.

You need to be very careful of the state of *xdamp* when you begin an automatic execution. *xdamp* does not clear all of the waveform selection buttons and does not initialize many variables in single execution mode. However, the initialization file is executed for the initial command file of a nested set and for each pass through a sequence of files loop. If you are assuming a particular waveform selection state, it is wise to perform a CLEAR operation in your command file.

TOOLS.SHOW REGISTERS

The TOOLS.SHOW REGISTERS menu selection pops a widget that shows the name and contents of each register. No action is taken and the widget remains visible until you press the DONE button. This selection has the command equivalent shown below but you must manually press the DONE button to continue with automatic execution.

Command Equivalent
TOOLS.SHOW REGISTERS

TOOLS.SHOW LIMITS

The TOOLS.SHOW LIMITS menu selection pops a widget that displays the current limits on the number and length of waveforms. This selection has the command equivalent shown below but you must manually press the DONE button to continue with automatic execution. To change the limits, you must exit xdamp and edit your initialization file to change the MAXARRAYS= and/or MAXSIZE= commands to the new limits.

Command Equivalent
TOOLS.SHOW LIMITS

TOOLS.SHOW NOTES

The TOOLS.SHOW NOTES menu selection pops a widget that shows the name and contents of each note associated with a waveform. No action is taken and the widget remains visible until you press the DONE button. You cannot edit the notes with this selection, instead use EDIT.NOTES. This selection has the command equivalent shown below but you must manually press the DONE button to continue with automatic execution.

Command Equivalent
TOOLS.SHOW NOTES

TOOLS.SHOW FILE NOTES

The TOOLS.SHOW FILE NOTES menu selection pops a widget that shows the file notes. No action is taken and the widget remains visible until you press the DONE button. You cannot edit the file notes with this selection, instead use EDIT.FILE NOTES. This selection has the command equivalent shown below but you must manually press the DONE button to continue with automatic execution.

Command Equivalent
TOOLS.SHOW FILE NOTES

TOOLS.SHOW HEADER

The TOOLS.SHOW HEADER menu selection pops a widget that shows the file header information. No action is taken and the widget remains visible until you press the DONE button. You cannot edit the header information with this selection, instead use EDIT.HEADER. This selection has the command equivalent shown below but you must manually press the DONE button to continue with automatic execution.

Command Equivalent
TOOLS.SHOW HEADER

TOOLS.XFONT

The TOOLS.XFONT menu selection pops up the xfont selector widget. This widget allows you to preview and select a hardware font from all of those available to your terminal. This font becomes the graphics area font. This application has no command equivalent but can be placed in the xdamp.ini file.

TOOLS.CALCULATOR

The TOOLS.CALCULATOR menu selection pops up a calculator widget. The results of all calculations are only visible in the widget window and are not returned to *xdamp*. This application has no command equivalent.

TOOLS.COLOR TABLE

The TOOLS.COLOR TABLE menu selection pops up a widget used to load color tables. Use this application to change to reverse video mode in the graphics area. This

selection has the command equivalent shown below but you must manually press the DONE button to continue with automatic execution.

Command Equivalent
TOOLS.COLOR TABLE

TOOLS.PALETTE

The TOOLS.PALETTE menu selection pops up a widget used to select color palettes. This selection has the command equivalent shown below but you must manually press the DONE button to continue with automatic execution.

Command Equivalent
TOOLS.PALETTE

TOOLS.XMANAGERTOOL

The TOOLS.XMANAGERTOOL menu selection pops up the widget used to investigate what widgets are currently managed by the IDL Xmanager. This application has no command equivalent.

POWER

POWER is a single-waveform operator that takes a waveform or register to an *integer* power. This command modifies all of the selected waveforms. For non-integer powers, use EXP(f*LN(array)) where f is the non-integer power.

INVERSE

INVERSE is a single-waveform operator that takes the inverse (1/x) of waveforms or a register. This command modifies all of the selected waveforms.

SQRT

SQRT is a single-waveform operator that takes the square root of waveforms or registers. This command modifies all of the selected waveforms.

EXP

EXP is a single-waveform operator that takes *e* raised to the waveform or *e* to the register. This command modifies all of the selected waveforms.

LN

LN is a single-waveform operator that takes the natural logarithm of the waveform or register. This command modifies all of the selected waveforms.

PWR10

PWR10 is a single-waveform operator that takes 10 raised to the waveform or register. This command modifies all of the selected waveforms.

LOG10

LOG10 is a single-waveform operator that takes the base-10 logarithm of the waveform or register. This command modifies all of the selected waveforms.

YUNITS

YUNITS is a single-waveform operator that allows you to change the vertical-axis-units label for one or more waveforms. This command modifies all of the selected waveforms. Its command equivalent requires an additional input.

Command Equivalent
YUNITS
<vertical units string>

CEILING

CEILING is a single-waveform operator that truncates the waveforms at values above those determined by the cursor or manual input. This command modifies all of the selected waveforms.

FLOOR

FLOOR is a single-waveform operator that truncates the waveforms at values below those determined by the cursor or manual input. This command modifies all of the selected waveforms.

TRUNCATE BEFORE

TRUNCATE BEFORE is a single-waveform operator that truncates the waveforms prior to a time determined by the cursor or manual input. This command modifies all of the selected waveforms.

TRUNCATE AFTER

TRUNCATE AFTER is a single-waveform operator that truncates the waveforms after a time determined by the cursor or manual input. This command modifies all of the selected waveforms.

TIMESHIFT

TIMESHIFT is a single-waveform operator that timeshifts the waveforms according to the cursor or an entered value. For cursor inputs, the cursor location becomes the new location of time zero. For entered inputs the value is subtracted from the starting time of the waveform. This command modifies all of the selected waveforms.

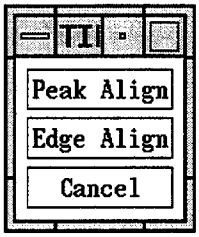
BASELINE

BASELINE is a single-waveform operator that "baselines" the waveforms according to the cursor or an entered value. The cursor or entered input defines a time at which the integral of all the selected waveforms is set to zero. Thus, offset before the main pulse can be removed from the overall integral. This command modifies all of the selected waveforms.

TIMEALIGN

TIMEALIGN pops a window (Fig. 7) that allows you to choose either peak alignment or leading edge alignment

FIGURE 7. TIMEALIGN subwindow



PEAKALIGN

PEAKALIGN is a multiple-waveform operator that time aligns the selected waveforms using the cross-correlation algorithm of the COMPARE routine. This command modifies all of the selected waveforms except the ENTERed reference waveform..

Command Equivalent
TIMEALIGN
PEAKALIGN

EDGE ALIGN

EDGE ALIGN is a multiple-waveform operator that time aligns all waveforms with the ENTERed waveform based on some fraction of the leading edge. The user is prompted for this fraction so in automatic execution mode, a fraction between 0 and 1 is needed. The alignment is done ignoring the polarity of the waveforms. The numerical argument may be a register..

Command Equivalent
TIMEALIGN
EDGE ALIGN
<number>

TIMEBASE

TIMEBASE is a single-waveform operator that modifies the time axis by a multiplicative constant and/or allows you to change the time units. This command modifies all of the selected waveforms. Because this accepts two inputs, the command equivalent has an additional line as shown below. The first input may have a register as its argument..

Command Equivalent
TIMEBASE
<multiplier>
<units string>

COMPARE

COMPARE is a multiple-waveform operator that compares two waveforms. This command *must* have the reference waveform selected and ENTERed. Then the variable

waveform to be compared to the reference is selected and the COMPARE button is pressed. A copy of the variable waveform is used for all operations so the original is not modified. First, the two waveforms are resampled to the same time intervals. Then a cross-correlation operation is performed to find the optimum time shift to best time align the two waveforms and the variable waveform is time shifted and truncated to completely overlap the reference waveform. Finally, an IDL polynomial fitting routine is used to fit the equation:

$$\text{REFERENCE} = \text{SCALE}*\text{VARIABLE} + \text{OFFSET}. \quad \textbf{(EQ 1)}$$

Here, the scale is the multiplier that should be applied to the variable waveform to best fit it to the reference waveform and the offset is the constant that must be added to it. There are two possible modes for the COMPARE operation: BASELINE FIXED and BASELINE VARIABLE. If the fixed mode is chosen, then the offset is zero. The reference waveform and the best fit variable waveform are plotted with the scale, offset, time shift, standard deviation, and correlation coefficient of the fit shown on the left side of the graphics area. The fitting parameters are stored in registers that can be used as input for subsequent operations according to the following scheme.

TABLE 4. Register Names and Contents from COMPARE Operation

Register Name	Quantity
#SCALE	Scale factor
#OFFSET	Baseline offset
#TSHIFT	Time shift

After the compare operation is complete, you can press the PRINT button to generate a hardcopy or press the ZOOM button to zoom in on the compared plot (and print this if you desire).

NORMALIZE

NORMALIZE is a single-waveform operator that divides each selected waveform by the absolute value of its peak value thus maintaining the waveforms polarity. This command modifies all of the selected waveforms which will afterwards range from -1 to 1.

INTEGRATE

INTEGRATE is a single-waveform operator that integrates the waveforms point by point using Simpson's rule. A new waveform is created for each one integrated if sufficient waveform memory is available; otherwise, the old waveforms are overwritten. These new waveforms are named the same as the original waveforms except the names are prefixed with "INT_". This command does not modify any of the waveforms if sufficient memory exists.

DIFFERENTIATE

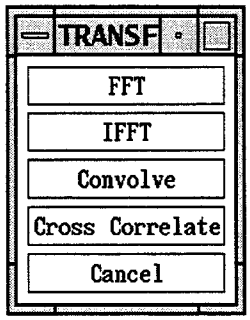
DIFFERENTIATE is a single-waveform operator that differentiates the waveforms point by point using a three-point central differencing technique. A new waveform is created for each one differentiated if sufficient waveform memory is available; otherwise, the old waveforms are overwritten. These new waveforms are named the same as the original waveforms except the names are prefixed with "DIF_". This command does not modify any of the waveforms if sufficient memory exists.

TRANSFORMS

The TRANSFORMS button pops a window (Fig. 8) with all available transforms accessed by buttons. This was done to save window space for the infrequently called routines: FFT, IFFT, CONVOLVE, and CROSS CORRELATE described below. The command mode operation is a bit different for these operators because an additional level of widgets exists. The following sequence would work for FFT with similar sequences for the others.

Command Equivalent
WAVEFORM.name
TRANSFORMS
FFT

FIGURE 8. TRANSFORMS subwindow



FFT

FFT is a single-waveform operator that takes the discrete Fourier transform of the selected waveforms. It returns complex waveforms, so for each waveform with name "DATA" three new waveforms ("RE_FFT_DATA", "IM_FFT_DATA", and "MAG_FFT_DATA") are created. The first waveform contains the real component, the second contains the imaginary component, and the third contains the magnitude of the FFT. Time-phase information is lost during this process because it cannot be easily removed from the inverse operation IFFT. Therefore, if you transform a waveform and then invert the transform you will recover the shape but the waveform will start at t=0. FFT results are displayed from the negative Nyquist frequency to the positive Nyquist frequency. If the original waveform has an even number of points, one point is removed in the FFT so that the dc component will fall at 0 Hz on the plot.

IFFT

IFFT is a multiple-waveform operator that takes the inverse discrete Fourier transform of the selected waveforms. The real component must be designated with the ENTER button, followed by selecting the imaginary component. This operation returns complex waveforms, so for each waveform "DATA" two new waveforms ("RE_IFFT_DATA" and "IM_IFFT_DATA") are created. The first waveform contains the real component and the second contains the imaginary component of the IFFT. Time-phase information is lost during this process. Therefore, if you transform a waveform and then invert the transform you will recover the shape but the waveform will start at t=0. A typical command sequence is shown below.

Command Equivalent
WAVEFORM.RE_Waveform
ENTER

Command Equivalent
WAVEFORM.IM_Waveform
TRANSFORMS
IFFT

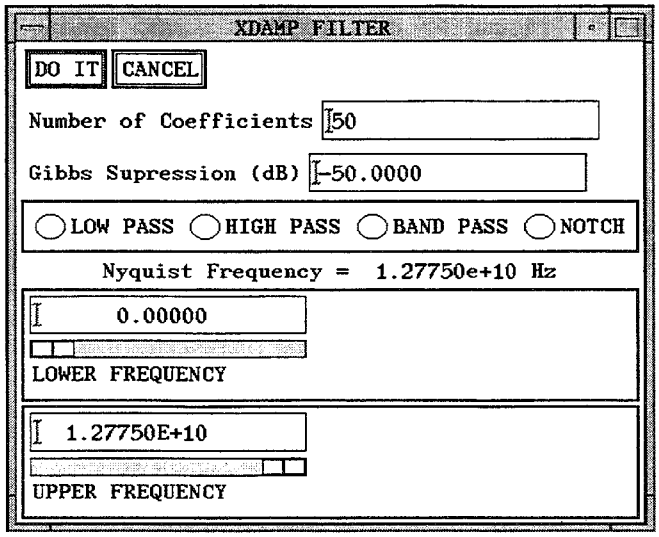
CONVOLVE

CONVOLVE is a multiple-waveform operator that performs the mathematical convolution operation by serial addition (rather than an FFT/IFFT pair). The first waveform must be ENTERed even though the operation is commutative. A new waveform, containing the convolution of the two will be created with its name based on the ENTERed waveform name prefixed with "CONV_". The new waveform is longer than either original waveform.

CROSS CORRELATE

CROSS CORRELATE is a multiple-waveform operator that performs a cross correlation by serial addition (rather than an FFT/IFFT pair). The first waveform must be ENTERed because this operation is not commutative. A new waveform, containing the cross correlation of the two will be created with its name based on the ENTERed waveform name prefixed with "XCOR_". The new waveform is longer than either original waveform.

FIGURE 9. FILTERS input window



FILTERS

FILTERS is a multiple-waveform operator that performs low-pass, high-pass, band-pass and notch filtering. The maximum filtering frequency depends on the waveform with the largest sampling interval of those selected. The FILTERS button pops a widget (Fig. 9) to obtain information about the desired filter and the filter frequencies desired. The original waveforms are overwritten. The filter algorithm uses a non-recursive digital filter with 50 coefficients and a 50dB Gibbs peak roll off obtained from a Kaiser windowing function. The number of coefficients and the Gibbs roll off are variable. For notch filters in the command equivalent, simply set f_{lower} greater than f_{upper}. These frequencies are in Hz in the command file. The Gibbs suppression number controls a Kaiser window. For

very steep filters, set this number near 0dB. Register inputs are allowed in the command mode.

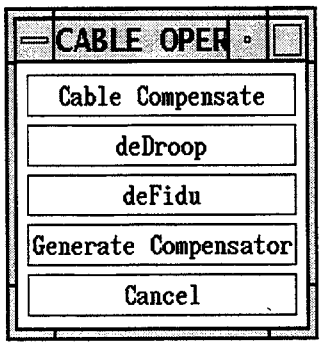
Command Equivalent
FILTERS,
<lower frequency (Hz)>
<upper frequency (Hz)>
<# Coefficients>
<Gibbs roll off (dB)>

CABLES

The CABLES button pops a window (Fig. 10) with all available cable operations accessed by buttons. This was done to save window space for the infrequently called routines (CABLE COMPENSATE, DEDROOP, DEFIDU, and GENERATE COMPENSATOR) described below. The command mode operation is a bit different for these operators because an additional level of widgets exists. The following sequence would work for DEDROOP with similar sequences for the others.

Command Equivalent
WAVEFORM.name
CABLES
DEDROOP

FIGURE 10. CABLES subwindow



CABLE COMPENSATE

CABLE COMPENSATE is a multiple-waveform operator that performs the mathematical convolution operation by serial addition of a response waveform with a cable compensator waveform. The first waveform must be ENTERed and then the cable compensator selected. The original waveform is overwritten and is not lengthened.

DEDROOP

DEDROOP is a single-waveform operator that removes an RC type roll off from a set of waveforms. This is done by serial convolution with a correction waveform. The original waveforms are overwritten.

DEFIDU

DEFIDU is a single-waveform operator that removes a positive fiducial marker from a set of waveforms. If the cursor preference is on, a cursor appears to define the portion of the waveform containing the cursor. Otherwise, it is assumed that the fiducial marker is within the first 10% of the waveform. The fiducial is assumed to define time zero and the waveform is deleted up to the point at which the fiducial drops to 10% of its peak plus three points. The original waveforms are overwritten.

GENERATE COMPENSATOR

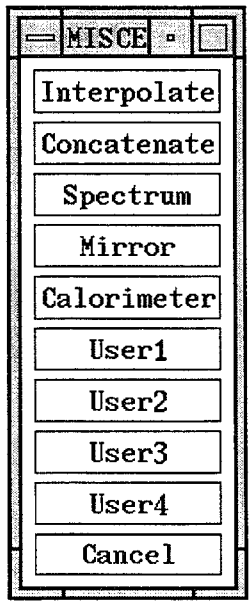
GENERATE COMPENSATOR is a multiple-waveform operator that performs the mathematical deconvolution operation to find the cable compensator waveform. The reference waveform (directly into the digitizer) must be ENTERed and then data with the cable in place is selected. Next you are prompted for the truncation fraction (0.5 is a good start) and the desired length of the compensator array. The desired length defaults to a multiple of 500 but may need to be a power of two for some digitizers. This operation performs the serial deconvolution operation described in Boyer's report SAND87-3072. The cable compensator is given the name of the second waveform prefixed by "COMP_". The reference data, cable data, and compensated cable data are then plotted. If you repeat the operation with a different truncation fraction, then the compensator waveform is overwritten.

MISCELLANY

The MISCELLANY button pops a window (Fig. 11) with additional miscellaneous operations, accessed by buttons. This was done to save window space for the infrequently called routines: INTERPOLATE, SPECTRUM, MIRROR, CALORIMETER and the USER editable routines described below. The command mode operation is a bit different for these operators because an additional level of widgets exists. The following sequence would work for MIRROR with similar sequences for the others.

Command Equivalent
WAVEFORM.name
MISCELLANY
MIRROR

FIGURE 11. MISCELLANY subwindow



INTERPOLATE

INTERPOLATE is a single-waveform operator that allows you to change a waveform to the values linearly interpolated between two defined times. In cursor mode, a box to define the times appears and in non-cursor mode, you are prompted for the two times. The box may be moved by pressing and holding the left mouse button, resized by press-

ing and holding the middle mouse button, and exited by pressing the right mouse button. (Mac users will need to use special keys with the single mouse key to perform these acts.) This command modifies all of the selected waveforms. In command mode, the two times must be entered on separate lines and may contain register references.

Command Equivalent
MISCELLANY
INTERPOLATE
<tmin>
<tmax>

CONCATENATE

CONCATENATE is a dual-waveform operator to paste two waveforms together. A time is defined using either the cursor or a numeric time input, depending on the cursor preference. The late time portion of the second waveform is appended to the early-time portion of the entered waveform. The entered waveform is overwritten.

SPECTRUM

SPECTRUM is a dual-waveform operator to calculate the electron spectrum given the voltage and current waveforms in a diode. You must select the voltage waveform and ENTER it followed by the current waveform. The procedure assumes that these two waveforms are properly time aligned. Then you are prompted for the number of spectral bins and the desired maximum energy. If the voltage or current are negative polarity, they are converted to positive polarity so the maximum spectral energy is always positive. SPECTRUM creates two new pseudo-waveforms, ESPECTRUM and CUMSPECTRUM. ESPECTRUM contains the differential electron energy number spectrum, normalized to an integral of one electron. The CUMSPECTRUM pseudo-waveform contains the cumulative number spectrum integral of ESPECTRUM, normalized to unity. The standard INTEGRATE command is not proper because of some tricks used in the binning of the electron spectrum to make the ESPECTRUM histogram look nice. The bottom bin begins at $\Delta E_{bin}/2$ and will have the number of particles with energies between 0 and ΔE_{bin}. All other bin widths are ΔE_{bin}. The peak bin ends at the maximum energy plus $\Delta E_{bin}/2$. For CUMSPECTRUM, the bottom bin begins at 0.0 and the top bin ends at the maximum energy. Note that any waveform with SPECTRUM in the name will be plotted as a histogram. The original two waveforms are not altered by this process. If you repeat the operation, the existing ESPECTRUM and CUMSPECTRUM waveforms will be overwritten unless you rename them.

MIRROR

MIRROR is a single-waveform operator that time reverses the waveforms about zero time. This command modifies all of the selected waveforms.

CALORIMETER

CALORIMETER is a single-waveform operator that calculates the value of the selected waveform at the time t=0 by linear extrapolation. The peak of the waveform is used as one point and the second is determined by the cursor or a delta time can be entered in an input box if the cursor preference is off.

USER1
USER2
USER3
USER4

USER1 through USER4 are distributed as template procedures that every user can modify easily to create their own operators. USER1 and USER2 are designed as single waveform operators while USER3 and USER4 are designed as dual waveform operators. To create your own procedures, copy the XD_user.pro file from the xdamp library location to your local directory. Edit the file appropriately, but do not change the names of the operators from USERN to something else. When you run xdamp, your own rou-

tine will be compiled and executed when these buttons are pushed. The distribution file has sufficient boiler plate information to show how to construct an operator. Knowledge of IDL programming language is assumed.

Speed Buttons

A series of speed buttons are placed immediately above the waveform button area and just below the operator area. These are for the most commonly used tasks and some of the buttons are also available from the menus.

ENTER

The ENTER button is used to designate one waveform as special. For operations adding, subtracting, multiplying, or dividing two waveforms, the ENTER button designates the waveform to be overwritten. It is best thought of as a reverse Polish notation (RPN) style ENTER button. For operations that use one waveform as a reference (i.e. COMPARE or cable compensator creation) the ENTER button designates the reference waveform.

CLEAR

The CLEAR button deselects all waveforms, clears the plot area, and clears the message box.

Command Equivalent
CLEAR

SELECT

The SELECT button selects waveforms based on an input string containing wildcard characters (*) in the specification. For instance V* would select all waveforms beginning with the capital letter V. The string specification is case sensitive.

Command Equivalent
SELECT <wildcard selection string>

ALL

The ALL button selects all of the waveforms.

Command Equivalent
ALL

PLOT

The PLOT button causes all waveforms selected to be immediately plotted. If no waveforms have been selected, then all the waveforms are plotted sequentially with a two second delay.

Command Equivalent
PLOT

ZOOM

The ZOOM button replots the selected waveforms and places a zoom box on the screen if the cursor preference is on. The zoom box may be moved by pressing and holding the left mouse button, resized by pressing and holding the middle mouse button, and exited by pressing the right mouse button. (Mac users will need to use special keys with the single mouse key to perform these acts and Windows users must have a three-button mouse.) The zoomed image is then plotted. If the cursor preference is off, you are prompted for the four limits of the zoom plot. In the command equivalent, the last four inputs are only needed if you are not in cursor mode. You may use register inputs in this

case. Note that older versions of xdamp placed all four numbers on one line, separated by commas. Now each number must be on a separate line.

Command Equivalent
ZOOM
<tmin in data units>
<tmax in data units>
<ymin in data units>
<ymax in data units>

PRT SCRN

The PRT SCRN button causes whatever is in the current plot window to be placed in a print file. This is also accessible via the PRINT menu as PRINT.SCREEN. The print file is not spooled until you exit the program or force a spool through the PRINT menu.

Command Equivalent
PRT SCRN

CURSOR

The CURSOR button allow you to move the cursor on the screen and observe values in the message window. When you click on the left mouse, the current cursor values are loaded in the registers CURSORT and CURSORY. You may then perform register operations using these values. This command ignores the cursor preference and always places a cursor on the screen, even in automatic execution mode where it is effectively interactive.

Command Equivalent
CURSOR

Waveform Buttons

The names of the waveform buttons vary with the application. The technique used to select any waveform is identical; simply push the button. To deselect a waveform, simply push the button again. The command syntax is shown below for a waveform named Example. Note that the names are case sensitive.

Command Equivalent
WAVEFORM.Example

If too many waveforms exist to fit in the waveform button box, then the box becomes a scrolling region and you may need to use the scroll bars to find the waveforms to select. These scrolling regions do not work on Macintosh computers for any version or Unix computers for Version 4.0 of IDL. Use version 4.0.1 or later to solve the Unix problem.

Beware of two things. The waveform selection process is a toggle that may cause problems in automatic execution mode if a waveform is selected for a second time and becomes deselected. Also, waveform names are case sensitive.

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Problems and Troubleshooting

If you experience a problem, *first* look in the message area for an informational message about anything that may be illegal such as performing an operation that requires an ENTER without performing the ENTER or opening a file with the incorrect format.

If you can't get xdamp to start properly on a DOS computer, be certain that the IDL-SPAWN.PIF file has been moved to the windows subdirectory and edited to be exclusive. (This does not appear to be necessary on Windows 95 or Windows NT computers.)

If your display does not appear similar to Figure 1, "xdamp Screen Layout," on page 15, then you probably need to reduce the widget font size in your .Xdefaults file (See "GETTING STARTED" on page 10.) and then reboot. PC's and Macintosh computers can adjust this font size in the IDL preferences menus. If this doesn't work, reduce the size of the graphics font area according to your display's limitations by using the GRAPHIC AREA command in the xdamp.ini file.

If you have trouble when opening a file, you may need to edit the XDsys_sp.pro file and increase the maximum length of allowable waveforms or create an xdamp.ini file that modifies these limts. For efficiency, be sure that this length is not appreciably longer than necessary for your longest record. You can use TOOLS/LIMITS to see what the current values are.

If *xdamp* fails when you first try to plot a waveform, then you probably have an illegal font name in your xdamp.ini file. Remove the GFONT=font_string line from this file and try *xdamp* again.

Difficulties with the UNIX pickfile widget are usually due to rapid multiple clicking on selections. This widget wants *single* clicks (on UNIX systems) and is not particularly fast because it must spawn system commands to obtain the directory information. Be patient. The pickfile widget is also case sensitive.

A common difficulty is not recognizing that waveform names *are* case sensitive when defining a select string with wild cards. Similarly, the file filter definition must contain an asterisk like *.hdf and the file names are also case sensitive. *Without a wild card, nothing will be selected.*

The single file automatic execution mode does not initialize many variables (for maximum flexibility). Therefore, you should start your macro file assuming that the waveform selection state is ill-defined. However, multiple file automatic execution re-initializes based on your xdamp.ini file for each new file opened.

When using automatically loaded registers, remember that the pulse parameter values come from the last waveform selected, not the first waveform selected. When in doubt, just plot one waveform at a time. The pulse parameters are generated whether or not you elect to have the results displayed on the screen.

The xfont widget application is not very robust. Frequently, it will have conflicts if another application (FrameMaker) is using display PostScript. It is best to set the font

by using this widget *immediately* after starting only IDL, reading the font in the message window and placing this in the xdamp.ini file with the GFONT=font_string command.

Color table problems can occur in this application. A specific symptom is if the zoom box is not visible. Other applications and IDL can use the same color map, not always with benign interactions. For UNIX systems, use the Idl.colors: 64 command in your .Xdefaults file to reserve some colors to IDL. PC systems seem to operate best if only 256 colors are enabled for the display. For other systems, the order in which applications are started can affect what happens.

If you have insufficient memory failures while deleting or keeping waveforms, edit the XD_edit.pro file and find the XDedit_delete section. There is a comment with a note to uncomment one line and comment out another line to improve the memory management at the expense of speed. Do the same thing with the XDedit_keep section. This will slow the delete and keep commands but generally prevents insufficient memory failures.

In automatic execution mode, if you are automatically clearing the stack after each operation and are using a journal file generated with this setting disabled, very strange things can occur. Many of the operators are overloaded and think that trying to add without any waveform selected means that you want to add a constant to a register. When there is no valid information for the register arithmetic, the whole automatic execution will fail. This cannot be trapped easily so you must generate command files with the stack clearing preference you will use when executing them.

Do not end a macro file with a comment or blank line. *xdamp* thinks another command follows this and fails when it reaches the end of file unexpectedly.

Do not use FILE.GET ARRAY to add files with only a single array. Instead use the FILE.APPEND which is faster and requires less input from the user.

Macintosh Specific Issues

There are problems with Macintosh operating system 7.5.3 and IDL version 4.0.1. If you upgrade your Macintosh operating system you must upgrade to IDL version 4.0.1b and apply the following patch. Edit the XD_file.pro procedure and change all occurrences of HDF_ISHDF to TEST_ISHDF. Apparently, this patch will not be required in future versions of IDL

.On Macintoshes, IDL cannot handle the waveform button widget very well in this release. Therefore, if you have more than about 80 waveforms, you will exceed the screen size. Converting this area to a scrolling region doesn't work (yet). Try to keep the number of waveforms down or use a smaller font. You will also observe an annoying flickering as the buttons are created. RSI indicates that this will be fixed in version 5.0 of IDL.

If your display does not appear like Figure 1, "xdamp Screen Layout," on page 15, then you probably need to reduce the widget font size via the preferences section. If this doesn't work, then reduce the size of the graphics font area in the file XDsys_sp.pro or with the GRAPHIC AREA command in the xdamp.ini file according to your display's limitations.

Do not use the close window box to complete data entries. Use the DONE button in the widget instead. Otherwise, IDL will not receive an event to process the input stream.

Macintosh output cannot be automatically spooled. You must print the xdamp.out file yourself after performing a PRINT.QUEUE command. This can be done using the shareware program DropPs available from mac.archive.umich.edu via anonymous ftp.

Macintosh journal file output will appear on a single line if you are using the Power PC version. Using an editor, change all the linefeeds (ASCII 10) to carriage returns and continue to edit the file normally. This is a known IDL bug.

To use the ZOOM, you need three mouse buttons. The left button is the normal Mac button, the center button is the Option key with the mouse button and the right button is the Apple key with the mouse button.

The Xfont application does not function for Macintosh computers. Instead, use the preferences section of the Macintosh menu bar to set the desired font for the application.

On a Macintosh, DO NOT use the FILE.QUIT on the screen menu bar because this will not properly close the journal file.

Windows Specific Issues

Due to an error in the installation procedure of IDL, you need to manually move the file IDLSPAWN.PIF from the RSI subdirectory to the WINDOWS subdirectory. To have it work properly with *xdamp*, you need to run the PIF editor and set the exclusive check box for the IDLSPAWN.PIF file. This does not appear to be necessary for Windows 95 or Windows NT installations.

The *xdamp* HELP application won't close properly on Windows machines. Simply iconize the help window and continue on.

After some operations, you sometimes wind up back at the main IDL window instead of at the *xdamp* window. Use CONTROL-TAB to switch back to the desired window.

If you don't have a postscript printer and want to print the manual or xdamp files, download the Ghostscript, Ghostview, GSview freeware from:

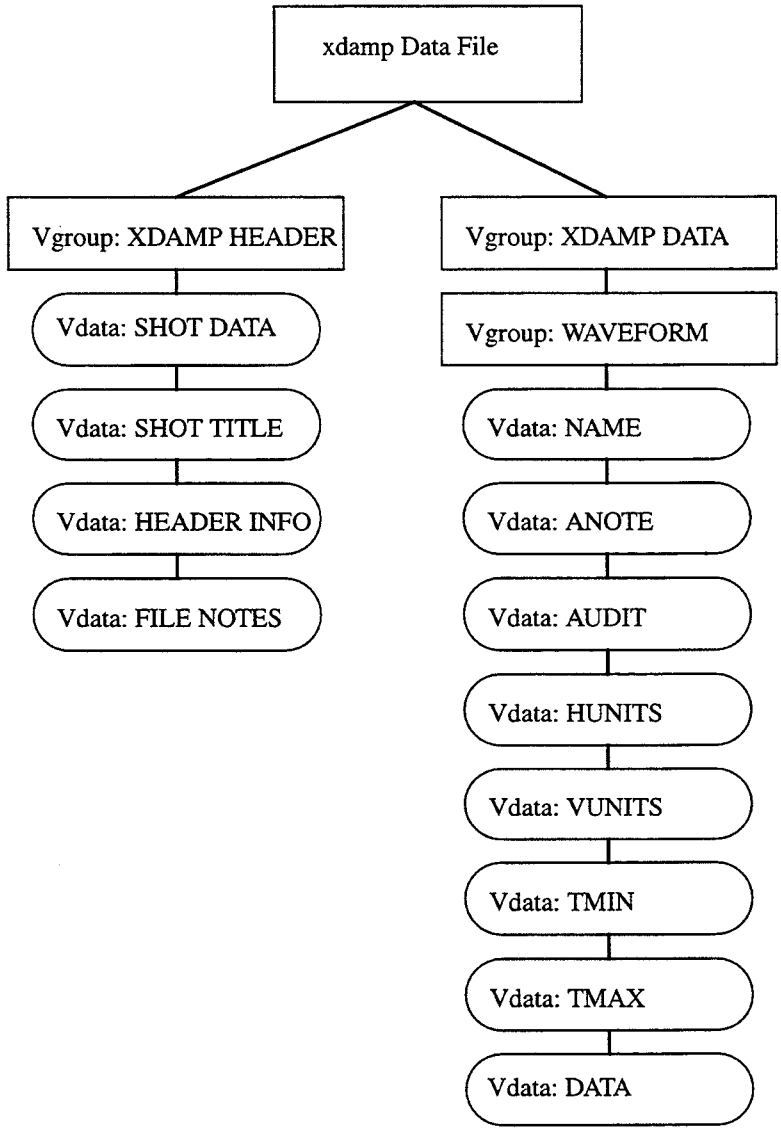
http://www.cs.wisc.edu/~ghost/index.html

and install it on your system.

To use zoom, you need a three button mouse and appropriate mouse driver software. So far, Mouse Systems and Logitech mice have been tested and work, without bothering with the driver.

HDF Data File Organization

Vgroup and Vdata structure for xdamp HDF file format with field names.



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HDF read and write IDL procedures

READ HDF FILE PROCEDURE

```
;+
; Copyright (c) 1995, Sandia Corporation. The United States Government
; retains a nonexclusive license in this software as prescribed in
; AL 88-1 and AL 91-7. Export of this program may require a license from
; the United States Government.
;+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
; procedure XD_readfile, filename, append keyword, overwrite keyword,
;    getarray keyword
;
; Internal routine that opens the file, reads the data from HDF, sicdas, DAMP,
; or ASCII format and loads the data common block.
; HDF, sicdas and DAMP formats are something you either have correctly or not.
; The assumed ASCII format is as follows:
;    waveform name string
;    x-axis units label string
;    y-axis units label string
;    number of points in waveform
;    x, y data pairs
; The above structure can be repeated until all waveforms are defined. If the
; ASCII data are not evenly spaced or are out of time order, the data will be
; re-ordered and then resampled to the smallest time increment.
;-------------------------------------------------------------------------
PRO XD_readfile, fname, APPEND = append, OVERWRITE = overwrite, $
          GETARRAY = getarray

@XD_bases.cmn
@XD_data.cmn
@XD_jrnl.cmn
@XD_stack.cmn

XD_print, "Reading "+fname

IF KEYWORD_SET(OVERWRITE) THEN over = 1 ELSE over = 0
IF KEYWORD_SET(APPEND) THEN appnd = 1 ELSE appnd = 0
IF KEYWORD_SET(GETARRAY) THEN geta = 1 ELSE geta = 0

;*** figure out the prepend string
str = XDfile_pre(fname)
IF (geta OR over OR nfiles EQ 1) THEN str = ""
IF (auto_flag AND NOT over AND NOT appnd AND NOT geta) THEN str = ""

;*** loop through the file reading the information and saving it
IF (narrays EQ 0) THEN i=1 ELSE i=narrays+1
IF (over + appnd + geta EQ 0) THEN BEGIN
  shot_title = " "
  shot_date = " "
ENDIF
```

```
anote = " "
audit = " "
npts = 0L
s_buffer = "abcdefghijklmnopqrstuvwxyabcdefghijklmnopqrstuvwxy"+ $
        "abcdefghijklmnopqrstuvwxyabcdefghijklmnopqrstuvwxy"+ $
        "abcdefghijklmnopqrstuvwxyacdefgh"

;*** HDF FORMAT
IF (HDF_ISHDF(fname)) THEN BEGIN
  hdf_handle = HDF_OPEN(fname, /READ)

;*** find header Vgroup
  vgxh = -1
  REPEAT BEGIN
    t = vgxh
    vgxh = HDF_VG_GETID(hdf_handle, t)
    vid = HDF_VG_ATTACH(hdf_handle, vgxh, /READ)
    HDF_VG_GETINFO, vid, NAME=tname
    HDF_VG_DETACH, vid
  ENDREP UNTIL (tname EQ "XDAMP HEADER")
  vgxhh = HDF_VG_ATTACH(hdf_handle, vgxh, /READ)

;*** find shot information Vgroup
  vgxi = -1
  inote = 0
  ihead = 0
  REPEAT BEGIN
    t = vgxi
    vgxi = HDF_VG_GETNEXT(vgxhh, t)
    IF (HDF_VG_ISVD(vgxhh, vgxi)) THEN BEGIN
      vid = HDF_VD_ATTACH(hdf_handle, vgxi, /READ)
      HDF_VD_GET, vid, FIELDS=tname
      IF (NOT appnd AND NOT geta) THEN BEGIN
      CASE tname OF
            "SHOT DATE":   k = HDF_VD_READ(vid, shot_date, FIELDS="SHOT
DATE")
            "SHOT TITLE":  k = HDF_VD_READ(vid, shot_title, FIELDS="SHOT
TITLE")
        "HEADER INFO": BEGIN
                  k = HDF_VD_READ(vid, stg, FIELDS="HEADER INFO")
                  header(ihead) = STRING(stg)
                  ihead = ihead+1
                ENDCASE
        "FILE NOTES":  BEGIN
                  k = HDF_VD_READ(vid, stg, FIELDS="FILE NOTES")
                  fnotes(inote) = STRING(stg)
                  inote = inote+1
                ENDCASE
        ELSE:
      ENDCASE
```

```
      ENDIF
      HDF_VD_DETACH, vid
    ENDIF
  ENDREP UNTIL (vgxi EQ -1)
  IF (NOT appnd AND NOT geta) THEN BEGIN
    shot_date = STRING(shot_date)
    shot_title = STRING(shot_title)
  ENDIF
  HDF_VG_DETACH, vgxhh

;*** find data Vgroup
  vgxd = -1
  REPEAT BEGIN
    t = vgxd
    vgxd = HDF_VG_GETID(hdf_handle, t)
    vid = HDF_VG_ATTACH(hdf_handle, vgxd, /READ)
    HDF_VG_GETINFO, vid, NAME=tname
    HDF_VG_DETACH, vid
  ENDREP UNTIL (tname EQ "XDAMP DATA")
  vgxdh = HDF_VG_ATTACH(hdf_handle, vgxd, /READ)

;*** find wavform Vgroup
  vgwd = -1
  REPEAT BEGIN
    t = vgwd
    vgwd = HDF_VG_GETNEXT(vgxdh, t)
    IF (HDF_VG_ISVG(vgxdh, vgwd)) THEN BEGIN
      vid = HDF_VG_ATTACH(hdf_handle, vgwd, /READ)
      HDF_VG_GETINFO, vid, NAME=tname
      HDF_VG_DETACH, vid
    ENDIF
  ENDREP UNTIL (tname EQ "WAVEFORM")
  vgwdh = HDF_VG_ATTACH(hdf_handle, vgwd, /READ)

;*** now loop through the waveforms
  id = -1
  done = 0
  id = HDF_VG_GETNEXT(vgwdh, id)
  REPEAT BEGIN
    flag = 0
    REPEAT BEGIN
      vds = HDF_VD_ATTACH(hdf_handle, id, /READ)
      HDF_VD_GET, vds, FIELDS=testfield
      CASE testfield OF
        "NAME":    k = HDF_VD_READ( vds, aname, FIELDS="NAME")
        "ANOTE":   k = HDF_VD_READ( vds, anote, FIELDS="ANOTE")
        "AUDIT":   k = HDF_VD_READ( vds, audit, FIELDS="AUDIT")
        "HUNITS":  k = HDF_VD_READ( vds, hunit, FIELDS="HUNITS")
        "VUNITS":  k = HDF_VD_READ( vds, vunit, FIELDS="VUNITS")
        "TMIN":    k = HDF_VD_READ( vds, tmin,  FIELDS="TMIN")
```

```
        "TMAX":     k = HDF_VD_READ( vds, tmax,  FIELDS="TMAX")
        "DATA":     BEGIN
                      k = HDF_VD_READ( vds, ary, FIELDS="DATA")
                      flag = 1
                    ENDCASE
        ELSE:
      ENDCASE
      HDF_VD_DETACH, vds
      id = HDF_VG_GETNEXT(vgwdh, id)
    ENDREP UNTIL flag
    dbase(0).name = str+STRING(aname)
    dbase(0).anote = STRING(anote)
    dbase(0).audit = STRING(audit)
    IF (STRLEN(STRCOMPRESS(dbase(0).audit,/REMOVE_ALL)) EQ 0) THEN $
      dbase(0).audit = dbase(0).name+":"
    npts = N_ELEMENTS(ary)
    IF (npts GT maxsize) THEN BEGIN
      XD_print, "Data arrays too large, increase maxsize."
      RETURN
    ENDIF
    dbase(0).npts = npts
    dbase(0).xunits = STRING(hunit)
    dbase(0).yunits = STRING(vunit)
    dbase(0).tmin = tmin
    dbase(0).tmax = tmax
    dbase(0).yarray(*) = 0.0
    dbase(0).yarray = ary
    IF (over) THEN BEGIN
      FOR j = 0, next_stack-1 DO BEGIN
        k = stack(j)
        IF dbase(k).name EQ dbase(0).name THEN dbase(k) = dbase(0)
      ENDFOR
    ENDIF ELSE BEGIN
      dbase(i) = dbase(0)
      i = i+1
      IF (i GT maxarrays) THEN BEGIN
        id = -1
        XD_print, "Too many waveforms, increase maxarrays."
      ENDIF
    ENDELSE
  ENDREP UNTIL (id EQ -1)
  HDF_VG_DETACH, vgwdh
  HDF_VG_DETACH, vgxdh
  HDF_CLOSE, hdf_handle

ENDIF

IF (NOT over) THEN narrays = i-1

;*** run through strings, stripping out any exclamation points, they are bad
```

```
FOR i = 1, narrays DO BEGIN
  j = STRPOS(dbase(i).name,"!")
  WHILE (j NE -1) DO BEGIN
    a = dbase(i).name
    STRPUT, a, "|", j
    dbase(i).name = a
    j = STRPOS(dbase(i).name,"!")
  ENDWHILE
  j = STRPOS(dbase(i).yunits,"!")
  WHILE (j NE -1) DO BEGIN
    a = dbase(i).yunits
    STRPUT, a, "|", j
    dbase(i).yunits=a
    j = STRPOS(dbase(i).yunits,"!")
  ENDWHILE
  j = STRPOS(dbase(i).xunits,"!")
  WHILE (j NE -1) DO BEGIN
    a = dbase(i).xunits
    STRPUT, a, "|", j
    dbase(i).xunits = a
    j = STRPOS(dbase(i).xunits,"!")
  ENDWHILE
ENDFOR

IF (narrays EQ 0) THEN XD_print, "Incorrect format or bad data, select another." $
ELSE XD_print, "Done reading "+STRTRIM(STRING(narrays),2)+ $
        " waveforms."

RETURN
END ;==================== end of XD_readfile routine ================
```

WRITE HDF FILE PROCEDURE

```
;+
; Copyright (c) 1995, Sandia Corporation. The United States Government
; retains a nonexclusive license in this software as prescribed in
; AL 88-1 and AL 91-7. Export of this program may require a license from
; the United States Government.
;++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
;  procedure XD_savefile, filename
;
;  Internal routine that actually writes a file in sicdas format
;-------------------------------------------------------------------------
PRO XD_savefile, new_filename

@XD_data.cmn

;*** declare variables
XD_fields = ["NAME", "ANOTE", "AUDIT", "VUNITS", "HUNITS", $
        "TMIN", "TMAX", "DATA"]
XD_ftype = ["BYTE", "BYTE", "BYTE", "BYTE", "BYTE", $
        "FLOAT", "FLOAT", "FLOAT"]
```

```
nfields = N_ELEMENTS(XD_fields)
s_buffer = "abcdefghijklmnopqrstuvwxyabcdefghijklmnopqrstuvwxy"+ $
        "abcdefghijklmnopqrstuvwxyabcdefghijklmnopqrstuvwxy"+ $
        "abcdefghijklmnopqrstuvwxyacdefgh"
f_buffer = 1.0

;*** open a new HDF file, get the file handle
hdf_handle = HDF_OPEN(new_filename, /WRITE, /CREATE)

;*** create a vgroup id, attach it and set the name
vg_header = HDF_VG_ATTACH(hdf_handle, -1, /WRITE)
HDF_VG_SETINFO, vg_header, NAME="XDAMP HEADER"

;*** do another for the data
vg_data = HDF_VG_ATTACH(hdf_handle, -1, /WRITE)
HDF_VG_SETINFO, vg_data, NAME="XDAMP DATA"

;*** this will go inside data in case other types are added someday
vg_wvfm = HDF_VG_ATTACH(hdf_handle, -1, /WRITE)
HDF_VG_SETINFO, vg_wvfm, NAME="WAVEFORM"

;*** first write shot date and shot title
vds = HDF_VD_ATTACH(hdf_handle, -1, /WRITE)
HDF_VD_FDEFINE, vds, "SHOT DATE", /BYTE
HDF_VD_WRITE, vds, "SHOT DATE", STRTRIM(shot_date)
HDF_VD_INSERT, vg_header, vds
HDF_VD_DETACH, vds
vds = HDF_VD_ATTACH(hdf_handle, -1, /WRITE)
HDF_VD_FDEFINE, vds, "SHOT TITLE", /BYTE
HDF_VD_WRITE, vds, "SHOT TITLE", STRTRIM(shot_title)
HDF_VD_INSERT, vg_header, vds
HDF_VD_DETACH, vds

;*** now write in header stuff
FOR i = 0, N_ELEMENTS(header)-1 DO BEGIN
  temp = STRTRIM(header(i))
  IF (STRLEN(temp) GT 0) THEN BEGIN
    vds = HDF_VD_ATTACH(hdf_handle, -1, /WRITE)
    HDF_VD_FDEFINE, vds, "HEADER INFO", /BYTE
    HDF_VD_WRITE, vds, "HEADER INFO", temp
    HDF_VD_INSERT, vg_header, vds
    HDF_VD_DETACH, vds
  ENDIF
ENDFOR

;*** now add in the file notes to the header
FOR j = 0, N_ELEMENTS(fnotes)-1 DO BEGIN
  temp = STRTRIM(fnotes(j))
  IF (STRLEN(temp) GT 0) THEN BEGIN
    vds = HDF_VD_ATTACH(hdf_handle, -1, /WRITE)
```

```
    HDF_VD_FDEFINE, vds, "FILE NOTES", /BYTE
    HDF_VD_WRITE, vds, "FILE NOTES", temp
    HDF_VD_INSERT, vg_header, vds
    HDF_VD_DETACH, vds
  ENDIF
ENDFOR

;*** now build a waveform description
;*** first get a set of vdata ids to put a waveform in
FOR j = 1, narrays DO BEGIN
  FOR i = 0, nfields-1 DO BEGIN
    vds = HDF_VD_ATTACH(hdf_handle, -1, /WRITE)
    CASE XD_ftype(i) OF
      "BYTE":   HDF_VD_FDEFINE, vds, XD_fields(i), /BYTE
      "LONG":   HDF_VD_FDEFINE, vds, XD_fields(i), /LONG
      "FLOAT":  HDF_VD_FDEFINE, vds, XD_fieldS(i), /FLOAT
    ENDCASE
    CASE XD_fields(i) OF
      "NAME":   HDF_VD_WRITE, vds, "NAME", dbase(j).name
      "ANOTE":  HDF_VD_WRITE, vds, "ANOTE", dbase(j).anote
      "AUDIT":  HDF_VD_WRITE, vds, "AUDIT", dbase(j).audit
      "HUNITS": HDF_VD_WRITE, vds, "HUNITS", dbase(j).xunits
      "VUNITS": HDF_VD_WRITE, vds, "VUNITS", dbase(j).yunits
      "TMIN":   HDF_VD_WRITE, vds, "TMIN", dbase(j).tmin
      "TMAX":   HDF_VD_WRITE, vds, "TMAX", dbase(j).tmax
      "DATA":   HDF_VD_WRITE, vds, "DATA", dbase(j).yarray(0:dbase(j).npts-1)
      ELSE:
    ENDCASE
    HDF_VG_INSERT, vg_wvfm, vds
    HDF_VD_DETACH, vds
  ENDFOR
ENDFOR

;*** finished writing stuff, close file
HDF_VG_INSERT, vg_data, vg_wvfm
HDF_VG_DETACH, vg_wvfm
HDF_VG_DETACH, vg_data
HDF_VG_DETACH, vg_header
HDF_CLOSE, hdf_handle

RETURN
END ;==================== end of XD_savefile routine ================
```

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R. Bracewell, *The Fourier Transform and Its Applications*, McGraw-Hill, New York, 1965.

R. B. Spielman, *A Non-Recursive Lowpass Digital Filter Algorithm*, Sandia National Laboratories Report No. SAND82-0930, November 1982.

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List of Distribution Files

In xdamp.tar file

xdamp.pro	Main procedure
xdamp.ini	sample xdamp initialization file
manual.ps	PostScript version of manual
xdamp.help	IDL-style help file
XD_auto.pro	automatic execution files
XD_edit.pro	edit menu procedures
XD_etest.pro	error testing procedure
XD_file.pro	file menu procedures
XD_fltr.pro	filter procedures
XD_input.pro	input procedures
XD_legnd.pro	legend procedure
XD_ops_1.pro	single waveform operators procedures
XD_ops_2.pro	dual waveform operators procedures
XD_user.pro	user modifiable operators procedures
XD_optns.pro	options procedures
XD_print.pro	print menu procedures
XD_pulse.pro	pulse parameter calculation procedures
XD_query.pro	query box procedures
XD_subs.pro	sub-widget box procedures
XD_tools.pro	tools menu procedures
XD_user.pro	user modifiable procedures
XD_utils.pro	utility procedures
XDsys_sp.pro	system specific procedures
XD_anote.cmn	array notes common
XD_bases.cmn	widget bases common
XD_data.cmn	data block common
XD_fltr.cmn	filter widget common
XD_fnote.cmn	file notes common
XD_geta.cmn	get array common
XD_jrnl.cmn	journal common
XD_optns.cmn	options widget common
XD_plot.cmn	plot information common
XD_query.cmn	query widget common
XD_regs.cmn	registers common
XD_stack.cmn	data stack common
example.hdf	sample hdf data file

separately

AAREADME.TXT	Installation advice

Distribution

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5	MS0899	Technical Library, 13414
2	MS0619	Review & Approval Desk, 12630 For DOE/OSTI
3	MS0161	Patent and Licensing Office, 11500