WAVECREST Corporation

VISI 5

Virtual Instruments Signal Integrity™ 5

User's Guide for Advanced dataCOM and Clock Analysis Tools

DTS-2079™, DTS-2077™ and DTS-2075™

Windows™ NT 4.0, 98 and 95,
Hewlett-Packard™ and SUN/Solaris™ Workstations

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CONTENTS

SECTION 4 – MENU BAR AND PULL–DOWN DIALOG WINDOWS

SECTION 5 – DEFAULT SETTINGS: STARTUP (TUTORIAL)

SECTION 6 – PANEL DESCRIPTIONS AND EXAMPLES

6.0 PANEL DESCRIPTIONS

Section 1 Figures

Section 2 Figures

Section 3 Figures

Section 4 Figures

Section 5 Figures

Section 6 Figures

INTRODUCTION

The DTS-207(x)™ *Virtual Instruments Signal Integrity* (Patent pending) software provides all the major features of the instrument through graphical displays of statistics and waveforms via a PC or workstation. This version of the *Virtual Instruments Signal Integrit*y software operates on an IBM PC, or compatible, using Microsoft® Windows™ 95, 98 or NT 4.0 as well as SUN/ Solaris® and Hewlett-Packard® Workstations. For specific information on hardware and soft ware requirements see **Section 1 – Hardware & Software Requirements**. *Virtual Instruments Signal Integrity*™ provides access to the following features of the DTS-207(x)™ :

- Select and execute the 16 measurement functions
- Set measurement reference voltages
- Select external or automatic arming
- Choose external arm reference voltages and edge senses
- Enable arming event gating
- Perform pulse find on input signals
- Select pulse find method
- Select trip level percentages or "user" voltages
- Set sample size
- Filter with the instrument and/or software filters
- Digitize signal envelopes using strobing
- Set arm-on-*n*th counts to 131,071
- Gate Arm Mode Time Stamp
- Gate Arm Mode Event counting
- Burst on Trigger with Elapsed Time Stamp

DTS features not available in the *Virtual Instruments Signal Integrity*™ software program are:

- Manual trigger mode
- Cable measurement
- DC input measurement with the comparator A/D
- Setting the DTS-207(x)™ front panel display (LCD) units
- Setting "sets" count
- Setting SCSI addresses
- Memory clear to defaults

WINDOW / INSTRUMENT PANEL

Nine separate window panels are used to display the results of DTS-207(x)™ operations in various formats in the dataCOM version while seven panels are available in the PLL version of *Virtual Instruments Signal Integrity*™. The PLL version does not have the dataCOM or Eye Histogram window panel options.

- **OSCILLOSCOPE** – Digitized waveform(s) found using the strobe function. Fast Fourier Transform Available.
- **HISTOGRAM** – Histogram of acquired samples. Tail-Fit option available.
- **JITTER ANALYSIS** – Graph of measured jitter vs. some *n*th stop event count. Fast Fourier Transform Available.
- **FUNCTION ANALYSIS** – Analysis of measurement with respect to cycle count. Fast Fourier Transform Available.
- **TIME DIGITIZER** – Graph of samples acquired in single burst. Fast Fourier Transform Available.
- **dataCOM** – Graphs of DCD + DDJ Jitter, Bathtub Curve, 1-Sigma vs. UI, Fast Fourier Transform and Unit Interval Distribution (dataCOM version only).
- **EYE HISTOGRAM** – Graphs of Tail-Fit and Bathtub Curve (dataCOM version only).
- **TIME SERIES** – Strip chart of low frequency variations with Allan Variance.
- **STATISTICS** – Text display of time measurements, voltage levels and duty cycle.

SECTION 1 – HARDWARE & SOFTWARE REQUIREMENTS

Virtual Instruments can be installed/used under the following software platforms:

- ***Windows NT 4.0***
- ***Windows 95/98***
- ***SUN/Solaris***
- ***HP - UNIX***

The following hardware and software is required to execute the utility software.

1.0 HARDWARE REQUIREMENTS

Windows 95/98/NT 4.0

- Minimum extended memory: 32 megabytes for Windows 95/98
48 megabytes for Windows NT 4.0
- VGA Monitor
- Video Graphics card with minimum of 256 colors and minimum display area of 1024x768 pixels
- National Instruments GPIB card:
PCI-GPIB recommended, PCMCIA or AT-GPIB
- Hard drive with 8 megabytes of unused space
- Printer is configured through Windows printer Setup feature

SUN/Solaris

- SPARC Workstation
- National Instruments GPIB Interface Card (GPIB-SPRC B), or external (GPIB/SCSI-A) interface box

Hewlett Packard

- Hewlett–Packard 9000, Model 715 and above
- National Instruments GPIB Interface: a) EISA-GPIB for HP-UX or
b) GPIB-SCSI-A Controller
- HP E2070 Card (ISA HP-IB Interface Card)
or,
HP E2071I Card (ISA/EISA High Speed HP-IB Interface Card).

1.1 SOFTWARE REQUIREMENTS

Windows 95/98/NT 4.0

- MS Windows 95, 98 or NT 4.0 Operating System
- National Instruments GPIB driver to match GPIB card used

SUN/Solaris

- Solaris version 1.x (SunOS 4.1.x), or
- Solaris version 2.x (SunOS 5.x), and
- National Instruments GPIB driver: NI-488.2M

Hewlett Packard

- HP 9000 O/S 10.x and above
- National Instruments GPIB driver: a) NI-488.2M for HP-UX
  b) No driver software is required for the SCSI-A Controller
- HP E2091 HP I/O Libraries for HP 9000 series 700. (See Appendix B for installation)

1.2 VIRTUAL INSTRUMENTS SOFTWARE INSTALLATION

Windows 95/98/NT 4.0

If a previous version of *Virtual Instruments* has been installed, backup copies of existing files should be made, or a different installation directory should be chosen during Step 4 below.
To install *Virtual Instruments*:

1. Insert VIW diskette into the 3-1/2 inch drive or VIW CD into the CD-ROM drive.
2. For 3-1/2 inch disk, click the **Start** button and then click **Run**.
   For installation from CD, wait for Autostart program to run setup program. If Autostart does not start installation program, click the **Start** button and then click **Run**.
3. Type **a:\setup** (or appropriate drive letter) and select **OK**.
4. Follow the instructions on the screen to complete the installation.

Setup will create a *Virtual Instruments* program folder in the **Programs** menu. To run the *Virtual Instruments* program, click the **Start** button, point to **Programs** and click on *Virtual Instruments*. The **Control Panel** and *WAVECREST* flag will be displayed (See Figure 1.0).

Figure 1.0 ***Virtual Instruments*** **Control Panel and Flag for Windows 95/98/NT 4.0**

SUN/Solaris

- **CHECKING, INSTALLING and CONFIRMING GPIB DRIVER**

  Before loading the *Virtual Instruments* software, check to see if a National Instruments GPIB driver is installed. If an incorrect driver is installed, it must be removed/unloaded before the correct one can be installed. Also correct driver installation must be confirmed before *Virtual Instruments* can be successfully installed.

  - For Solaris 1.x systems, see Appendix C.
  - For Solaris 2.x systems, see Appendix D.

  The *Virtual Instruments* software can be installed in any directory on the system including user and system directories. SuperUser access may be required for installation depending on where VIW is installed.

- **CREATING A VIW DIRECTORY**

  The following command is used to create the VIW directory which will later be set as the '**`VIWHOME`**' environmental variable. Any directory within the OS install or /home partition can be used, however, the typical installation directory would use '**`/usr/local/viw`**'.

  ```
  mkdir /usr/local/viw
  ```

- **INSTALLING VIW FILES**

  Installation can be done via 4mm (DAT), 8mm, 1/4 in. tape devices or CD-ROM.

  On Solaris version 1.x (SunOS 4.1.x) based workstations, these tape devices are typically '**`/dev/rst0`**' or '**`/dev/rst1`**'.

  On Solaris version 2.x (SunOS 5.x) based workstations, these tape devices are typically '**`/dev/rmt/0`**' or '**`/dev/rmt/1`**'.

  Insert the VIW installation tape. Change to the VIW install directory. For the install directory created above, this would be done with the following command:

  ```
  cd /usr/local/viw
  ```

* For Solaris version 1.x (SunOS 4.1.x) tape device, '**`/dev/rst0`**', copy the VIW files into the install directory with the following command:

  ```
  tar xvf /dev/rst0
  ```

* For Solaris version 2.x (SunOS 5.x) tape device, '**`/dev/rmt/0`**', copy the VIW files into the install directory with the following command:

  ```
  tar xvf /dev/rmt/0
  ```

* For installation via CD-ROM, mount the CD using the normal procedure for your workstation. Create a target software installation directory by issuing the command:

  ```
  mkdir   viw
  ```

  while residing in the directory in which you would like the software installation placed.

  Make that directory current by issuing the command:

  ```
  cd   viw
  ```

  The software installation for each platform is combined into a single tar file on the CD-ROM. To install the software issue the command:

  ```
  tar   xvf   /cdrom_mount_point/platform.tar
  ```

  Replace cdrom_mount_mount with the full path to the CD-ROM mount point for your workstation. Replace platform.tar with the appropriate filename for your workstation based on the following list:

  ```
  sunos.tar, solaris2.tar
  ```

- **VIW ENVIRONMENTAL VARIABLES**

  VIWHOME

  An environmental variable, '**VIWHOME**', must be set for the VIW program. This defines the top directory.

  For C shell users, this environmental variable can be set in the '**.cshrc**' file in the user's home directory or entered on the command line. For the above install directory, use the following command:

  ```
  setenv VIWHOME /usr/local/viw
  ```

  For Bourne and Korn shell users this environmental variable can be set into the '**.profile**' file in the user's home directory or entered on the command line. For the above install directory, use the following commands:

  ```
  VIWHOME=/usr/local/viw
  export VIWHOME
  ```

  VIW_DEVICE

  An additional environmental variable, '**VIW_DEVICE**', must be set. This defines the device file in '**/dev**' that corresponds to the DTS GPIB address. For example, if the GPIB address is 5, the value for '**VIW_DEVICE**' might be '**dev5**' and the command to set this would be:

  ```
  setenv VIW_DEVICE dev5
  ```

- **EXECUTING VIW**

  VIW requires two executable files: 1) viw, the main program; and 2) *import**, used to capture the screen to a disk file (See **Section 4.0**, **Print** option). Both executables are in '**$VIWHOME/bin**'. The PATH environmental variable must be modified to contain this bin directory.

  For C shell users, $PATH can be set in the '**.cshrc**' file in the user's home directory or entered on the command line with the following command:

  ```
  setenv PATH ${PATH}:$VIWHOME/bin
  ```

  For Bourne and Korn shell users, '**$PATH**' can be set in the '**.profile**' file in the user's home directory or entered on the command line with the following commands:

  ```
  PATH={PATH} :$VIWHOME/bin
  export PATH
  ```

  NOTE: *It may be necessary to enter the command 'rehash' for the viw executable file to be found.*

- **TO RUN VIW**, enter the following command:

  NOTE: *The following command assume the user has logged in, via the above 'dot' file commands, i.e., '.profile', '.cshrc':*

  ```
  viw
  ```

  The **Control Panel** will be displayed (See Fig. 1.1).

Hewlett Packard

The *Virtual Instruments* software can be installed in any directory on the system including user and system directories. SuperUser access may be required for installation depending on where VIW is installed.

- **CREATING A VIW DIRECTORY**

  The following command is used to create the VIW directory which will later be set as the VIWHOME environmental variable. Any directory within the OS install or /home partition can be used, however,the typical installation directory would use '`/usr/local/viw.`'

  `mkdir /usr/local/viw`

- **INSTALLING VIW FILES**

  Installation is done via 4mm (DAT) or CD-ROM. On an *HP* based workstation, these devices are typically:

  `'/dev/rmt/0m'.`

  Insert the VIW installation tape. Change to the VIW install directory. For the install directory created above, this would be done with the following command:

  `cd /usr/local/viw`

  For the tape device, /dev/rmt/0m, copy the VIW files into the install directory with the following command:

  `tar xvf /dev/rmt/0m`

* For installation via CD-ROM, mount the CD using the normal procedure for your workstation. Create a target software installation directory by issuing the command:

  `mkdir   viw`

  while residing in the directory in which you would like the software installation placed.

  Make that directory current by issuing the command:

  `cd   viw`

  The software installation for each platform is combined into a single tar file on the CD-ROM. To install the software issue the command:

  `tar   xvf   /cdrom_mount_point/platform.tar`

  Replace cdrom_mount_mount with the full path to the CD-ROM mount point for your workstation. Replace platform.tar with the appropriate filename for your workstation based on the following list:

  `hp9x.tar, hp10x.tar`

- **VIW ENVIRONMENTAL VARIABLES**

VIWHOME

An environmental variable, '**VIWHOME**', must be set for the VIW program. This defines the top directory. For C shell users, this environmental variable can be set in the '**.cshrc**' file in the user's home directory or entered on the command line. For the above install directory, use the following command:

```
setenv VIWHOME /usr/local/viw
```

For Bourne and Korn shell users this environmental variable can be set into the '**.profile**' file in file in the user's home directory or entered on the command line. For the above install directory, use the following commands:

```
VIWHOME=/usr/local/viw
export VIWHOME
```

VIW_DEVICE

An additional environment variable, 'VIW_DEVICE' may be set to explicitly define the device to be used. If it is not set, the device used will be hpib,# where # is the GPIB Device number set in the GPIB and Display Dialog Box. Here are additional examples of possible explicitly set devices:

setenv VIW_DEVICE hpib,5 Device at bus address 5, and symbolic name hpib.

setenv VIW_DEVICE 7,5 Device at bus address 5, and connected to an interface card at logical unit 7.

setenv VIW_DEVICE lan[128.10.0.3]:hpib,5
Connect to a LAN server at IP address 128.10.0.3 which contains an hpib interface with device at bus address 5.

setenv VIW_DEVICE lan[hpibsrv.wave.com]:7,5
Connect to a LAN server named hpibsrv.wave.com which contains an interface card at logical unit 7 with primary device at bus address 5.

Reference the HP Standard Instrument Control Library manual for additional information and device examples.

- **Executing VIW**

  VIW requires two executable files: 1) viw, the main program; and 2) *import**, used to capture the screen to a disk file (See **Section 4.0**, **Print** option). Both executables are in $VIWHOME/

  bin. The PATH environmental variable must be modified to contain this bin directory.

  For C shell users, $PATH can be set in the '.cshrc' file in the user's home directory or entered on the command line with the following command:

  ```
  setenv PATH ${PATH}:$VIWHOME/bin
  ```

  For Bourne and Korn shell users, '$PATH' can be set in the '.profile' file in the user's home directory or entered on the command line with the following commands:

  ```
  PATH={PATH} :$VIWHOME/bin
  export PATH
  ```

  NOTE: *It may be necessary to enter the command 'rehash' for the viw executable file to be found.*

- **To Run VIW**, enter the following command:

  NOTE: *The following command assumes the user has logged in with environmental variable 'dot' files set into the user's home directory, i.e., '.profile', '.cshrc':*

  ```
  viw
  ```

  The **Control Panel** will be displayed (See Fig. 1.1).

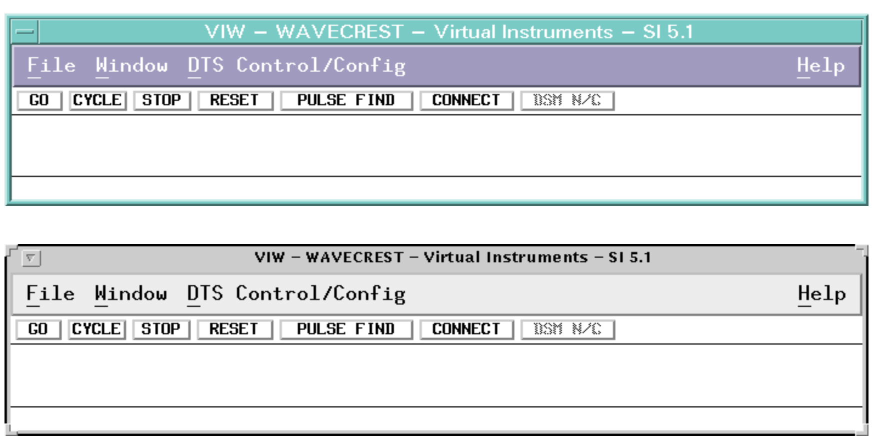


Figure 1.1 ***Virtual Instruments*** **Control Panel for HP/SUN**

* *import* is part of the ImageMagick package developed by John Cristy, E.I. DuPont De Nemour and Company Incorporated, copyright 1996 .

SECTION 2 – GENERAL DISCUSSION OF CONTROL PANEL

2.0 DISPLAY AND MENU CHARACTERISTICS

The graphical user interface incorporates Motif/X Windows as the graphical display utility. A control panel "window" is displayed on the screen after execution of the VIW program. A menu bar across the top, under the title bar, presents selections that are activated via a pointing device (mouse) or keyboard with a pull-down menu being displayed. The pull-down menu contains a list of options which may have either an immediate effect or cause a pop-up menu window to be displayed. The pop-up window will present the user with data entry prompts to set operation parameters. The dialog windows across the panels work together in a coordinated manner. The same instrument parameters can be used for all panels or changed for individual panels. A tool (button) bar under the menu bar provides one-button activation of application functions common to all display panels. Refer to the Motif User and Style Guides for more information on working with Motif.

2.1 CONTROL PANEL

The **Control Panel** displays the program title, version number, menu bar, function tool (button) bar and the status bar (See Figure 1.0, Control Panel).

2.2 VERSION NUMBER

The **Version Number**, following the program title, is used to track version levels and should be available anytime questions or comments are discussed.

2.3 MENU BAR DESCRIPTION

When *Virtual Instruments* is first activated, an initial menu bar is displayed below the title bar in the **Control Panel**. This initial **Menu Bar** activates pull-down menus which allow the user to access all instrument panels and system help files or exit *Virtual Instruments*.

Figure 2.0 Initial Menu Bar

Once an instrument panel has been entered through the **Window** pull-down menu, the full **Menu Bar** is displayed and provides access to Save/Load options, panel options, DTS control functions and Help files.

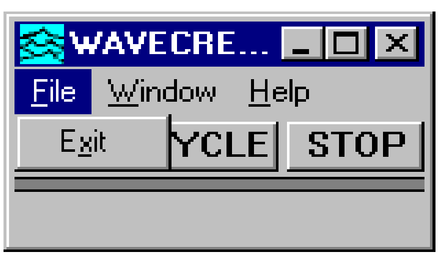
The full **Menu Bar** selections are:

- **File –** Set instrument panel parameters to default, load and save specific configurations save graph bitmaps, print display panels and exit *Virtual Instruments.*
- **Window –** Select instrument panels or calibration panel.
- **DTS Control/Config –** Select panel parameters for controlling measurements at the instrument
- **Help –** Provides user access to file manager and system help files

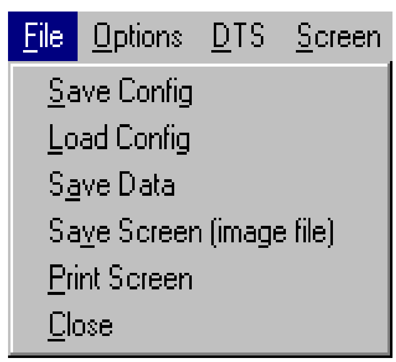
Figure 2.1 Full Menu Bar - Control Panel

FILE

The **File** pull-down menu on the **Control Panel** is used for exiting *Virtual Instruments* while the **File** pull-down menu for each Window panel permits system type functions to be selected. See **Section 4.0** for a detailed explanation of the **Window/File** selection.



File Selection



Window/File Selections

Figure 2.2 File Menus

WINDOW

The **Window** pull-down menu provides access to the different instrument panels as well as the internal and external calibration of the instrument. See **Section 3.1** for details on specific panels.

Figure 2.3 Window Selections

DTS CONTROL/CONFIG

The **DTS Control/Config** pull-down menu provides access to the **GPIB and Display Config** dialog window. The user can customize GPIB board and device addresses, signal trace display colors and the window background color. For Channel colors to be activated after being changed, *Virtual Instruments* must be exited and restarted. Background default color is white.

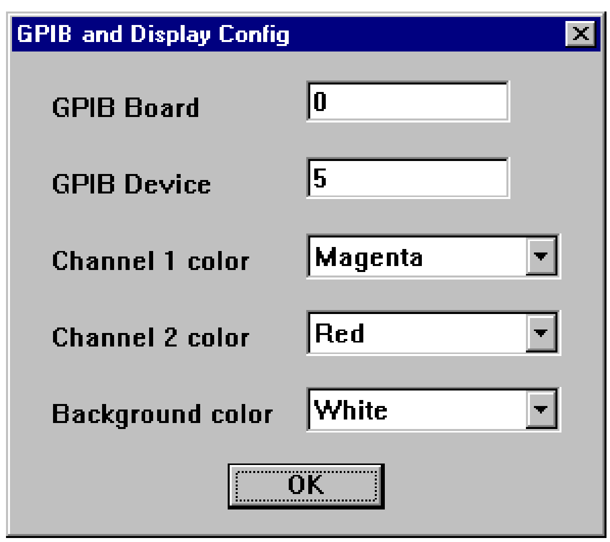


Figure 2.4 DTS Control/Config Selection

HELP

The **Help** command provides the user access to system help files.

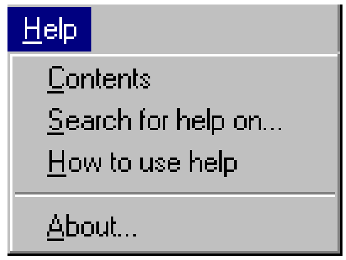


Figure 2.5 Help Menu

2.4 FUNCTION TOOL BAR

The **Function Tool Bar** provides one-button activation of common application functions. The tool bar is used in all *Virtual Instruments* panels.

Figure 2.6 Function Button Tool Bar

- **GO –** Starts single measurement function.
- **CYCLE –** Starts continuous measurement function.
- **STOP –** Interrupts continuous measurement function.
- **RESET –** Resets data registers and plot scaling.
- **PULSE FIND –** Initiates a pulse find.
- **CONNECT –** Initiates communication link between host computer and DTS unit.
- **DSM 1/1 –** Select from which channel(s) of the DSM16 to acquire measurements.

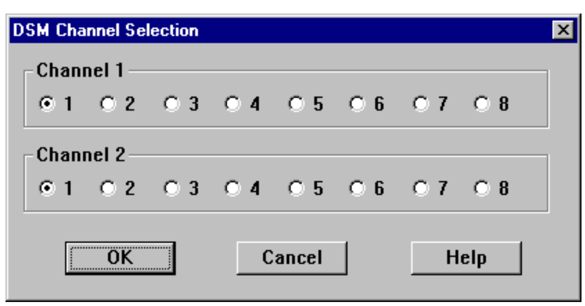


Figure 2.7 DSM Channel Selection

2.5 STATUS BAR

Communication between the DTS-207x and *Virtual Instruments* is automatically established when a *Virtual Instruments* panel is activated (See **Section 3.0** for a detailed explanation of accessing test panels). The **Status Bar** in the lower left-hand corner of the **Control Panel** shows the instrument/interface channel designation and displays communi cation status as **CON**nected or **N**ot **C**onnected.

If communication is lost, usually by turning off the power or performing a **Clear** from the DTS unit front panel, communication can be reestablished by clicking the **Connect** button on the **Function Tool Bar**.

Figure 2.8 Status Bar

The **Status Bar** also displays the x, y coordinates of the cursor location with respect to its position on or near a point or plot line.

2.6 ZOOM IN/OUT

The **Zoom In/Out** features are activated using the left button of a pointing device (mouse). To **Zoom In**, click and drag using the left mouse button until the area to be enlarged is highlighted. This can be done repeatedly until the desired magnification is achieved. To **Zoom Out**, double click the left mouse button. Double-clicking will zoom out one level each time. If the user has zoomed inthree times, it will take three double-clicks to return to normal view.

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SECTION 3 - GENERAL DISCUSSION OF INSTRUMENT PANELS

3.0 GENERAL INSTRUMENT PANEL DESCRIPTION

An instrument panel will display the last measurement taken as a graphical representation accompanied by its associated data. The **Statistics Panel** displays the measurement data in a text format.

After starting the *Virtual Instruments* program, with the entry panel displayed, click on the **Window** selection of the menu bar (See Fig. 3.0).

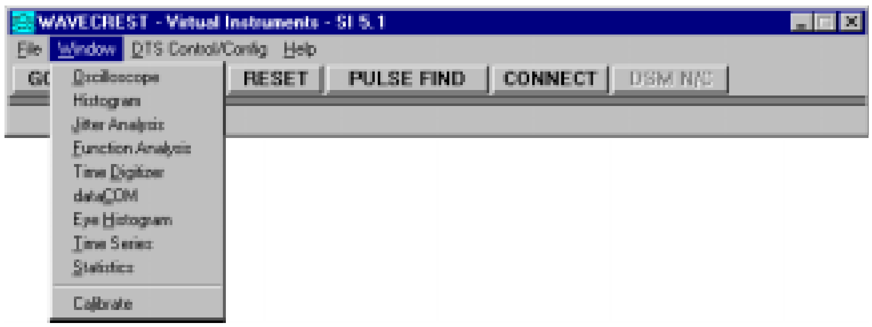


Figure 3.0 Entry to Instrument Panels

Click on the **Histogram** selection and the Histogram panel will be displayed (See Fig. 3.1).

The **Histogram** instrument panel will be used to describe general panel characteristics Some information will be slightly different for specific panels. Refer to the appropriate panel explanation in **Section 4.1** for the exact format.

The menu bar across the top provides access for setting up instrument and panel configurations. The name of the selected panel is given across the top of the graphical display area. If applicable, the instrument function and channel will also be displayed at the right.

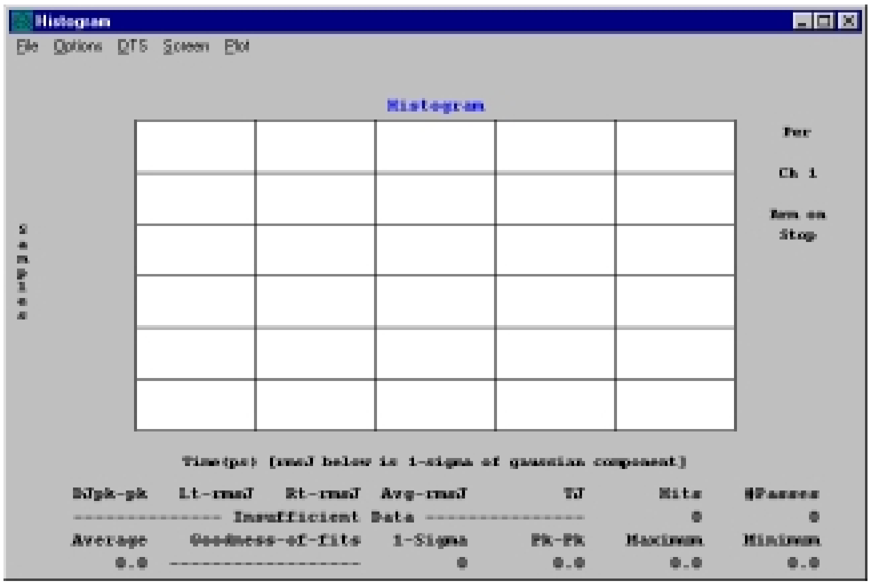


Figure 3.1 General Panel Format

An hourglass symbol is displayed while a measurement is in progress. If the panel is in repeat mode, additional measurements will be taken after the display of the last data. Statistics of the most current measurement, and the overall statistics of a series of measurements, are displayed at the bottom of the instrument panel.

Clicking on a pull-down menu item will initiate an action or display a pop-up dialog window. Click the mouse on the **Options** selection and then click on **Histogram** to display the Histogram pop-up dialog window (See Fig. 3.2) for additional parameter options.

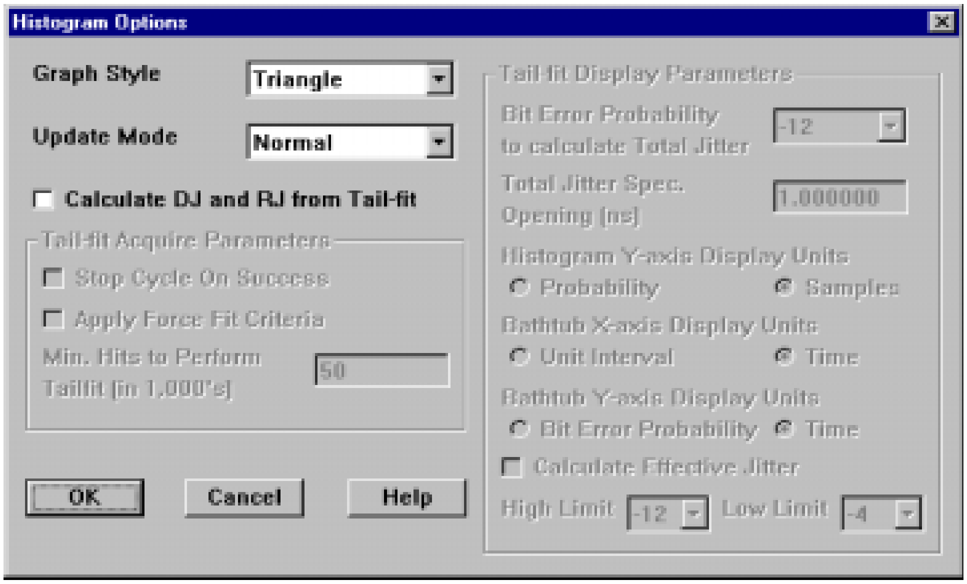


Figure 3.2 Pop-Up Dialog Window

The dialog parameters can be changed repeatedly to fit operator needs using the scroll keys or check boxes. The **OK** button can be clicked to accept the settings and return to previous menus.

3.1 SPECIFIC INSTRUMENT PANEL DESCRIPTION

The **Window** selection on the menu bar is used to activate one or more instrument panels. All other menus are used to configure the instrument and *Virtual Instruments* features.

Once all configuration parameters are set, the user can then move from one panel to another and collect test data.

Clicking on the **Window** selection displays the respective pull-down menu:

Figure 3.3 Window Pull-Down Menu

The first ten menu selections will bring up an individual measurement panel. The last menu selection presents the user with instrument calibration options.

OSCILLOSCOPE PANEL

The **Oscilloscope** panel graphically presents the results of the strobe function. This uses the strobe window GPIB command which takes starting, ending and incremental delay times and then strobes the target signal at the specified time points to get a profile of voltage vs. time. In addition, voltage vs. frequency can be plotted using the Fast Fourier Transform option (See Fast Fourier Transforms, page 36, for more information on FFTs). The strobe, or trigger, input can be CH1, CH2, ARM1 or ARM2 and can target either a single channel or both.

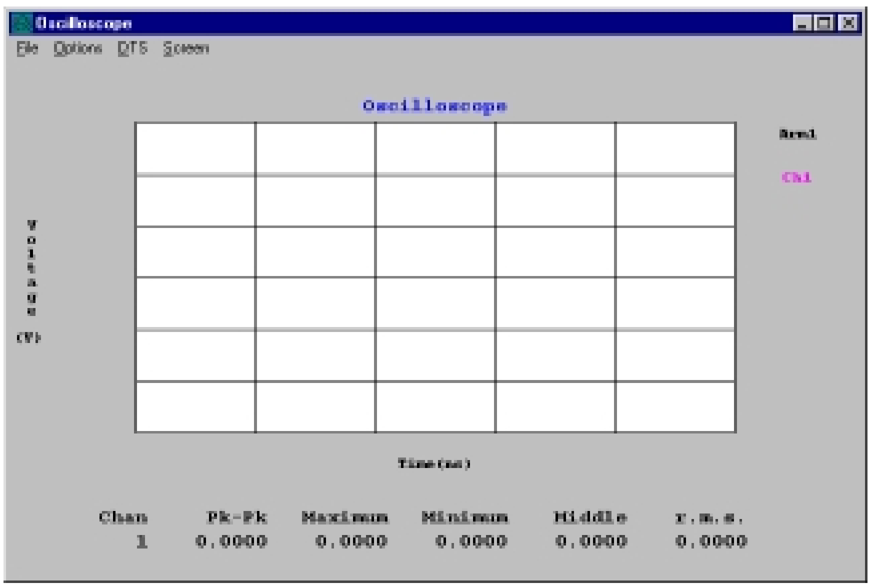


Figure 3.4 Oscilloscope Panel

STROBING ARM and INPUT SIGNAL RELATIONSHIP

The strobing digitizing feature requires that the trigger must not repeat less than the time to be strobed. The trigger can be selected from one of the following signals: CH1, CH2, Arm1 or Arm2.

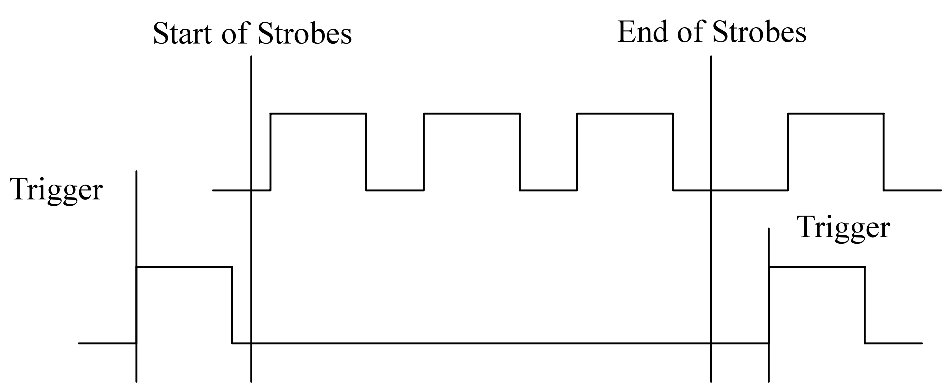


Figure 3.5 Strobe Arming Relationship

HISTOGRAM PANEL

The **Histogram** panel displays a histogram of the individual samples taken during a single burst. It also has the capability of persistence which is to accumulate data from a sequence of measurements. The histogram may be drawn in one of three styles: Straight line point-to-point between bin centers, stepped to show each bin, or as triangles with the peak on each bin center.

In addition, there is a Tail-fit option available which detects the tail region on the far left and right extremes and provides estimates for Random and Deterministic Jitter. This tool is useful when the basic statistical analysis tools fail due to the presence of a Deterministic Jitter component and can be used on all dual channel measurements as well as single channel measurements. When operating in the Tail-fit mode, there is also a Bathtub Curve plot available which provides additional information concerning the Error Probability.

For a more detailed explanation of the Tail-Fit feature, see **Section 6.0, Eye Histogram**.

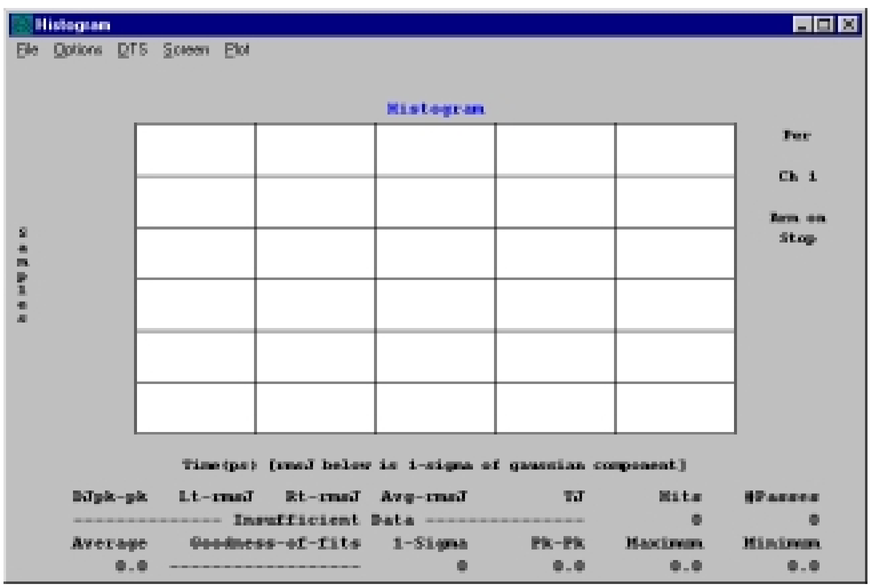


Figure 3.6 Histogram Panel

JITTER ANALYSIS PANEL

The **Jitter Analysis** panel is used to display a graph of the jitter/peak values from a series of measurements. Each measurement, except for the first, is taken with one more stop event. A summary is given at the bottom of the panel with the average, peak-to-peak, maximum and minimum values.

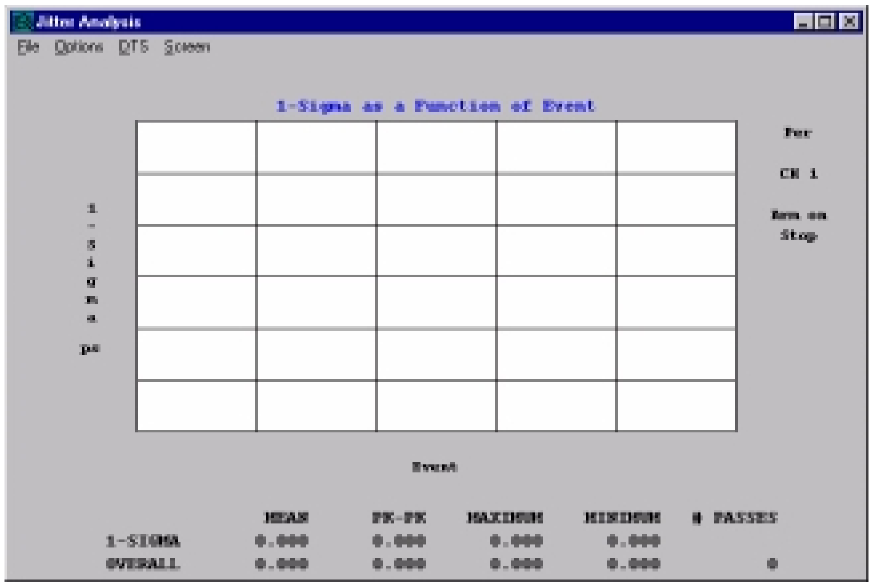


Figure 3.7 Jitter Analysis Panel

FUNCTION ANALYSIS PANEL

The **Function Analysis** panel uses the Arm-On-Nth event capability of the instrument to examine individual pulses in a train. Given a range of pulses to examine, this panel will repeatedly set the START and STOP counts and make measurements of the function selected. The resultant measurements are plotted on the vertical axis with the horizontal axis representing either pulse count or elapsed time.

Function statistics are displayed at the bottom of the panel including: Average, Peak-to-Peak and Maximum and Minimum Jitter, or Fast Fourier when selected.

The derivative, the difference between the current and previous measurement, can be plotted instead of the measurement value.

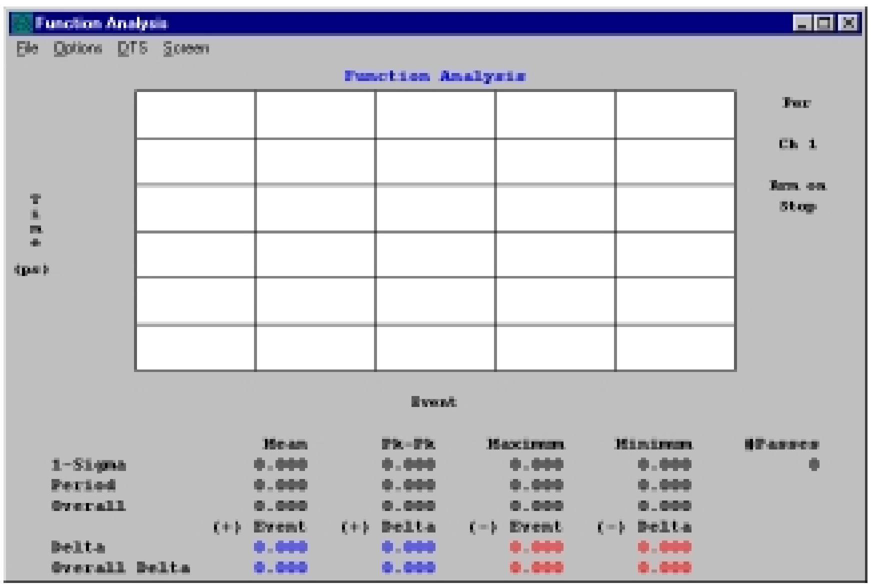


Figure 3.8 Function Analysis Panel

TIME DIGITIZER PANEL

The **Time Digitizer** panel presents the samples taken during a single burst in sequential, graphical form. The individual datum are plotted with the Y-axis being the measured value and the X-axis being the order in which the samples were acquired. A trigger burst mode with an elapsed timer that time stamps each one-shot measurement is provided. The X-axis scale can be selected to represent time or number of events. The **Time Digitizer** panel also includes the Latest and Overall statistics.

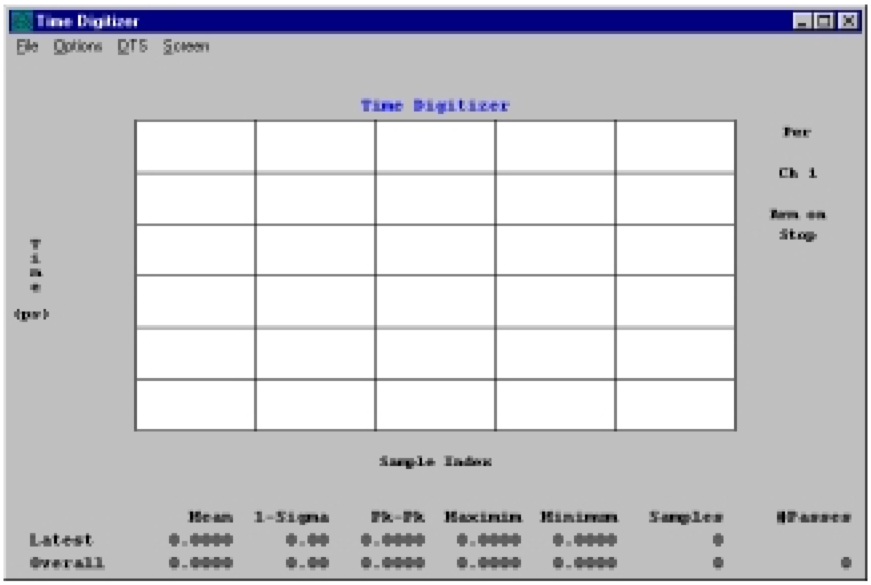


Figure 3.9 Time Digitizer Panel

dataCOM PANEL

The **dataCOM** panel has several features one of which is used to analyze bit error probability utilizing deterministic and random jitter components. Features include: DCD + DDJ Histogram, All Measurements Histogram, Bathtub Curve, Autocorrelation, 1-Sigma vs. Unit Interval, Fast Fourier Transform and Unit Interval Distribution. See **Section 4.4** for a more detailed explanation of each **Plot** option.

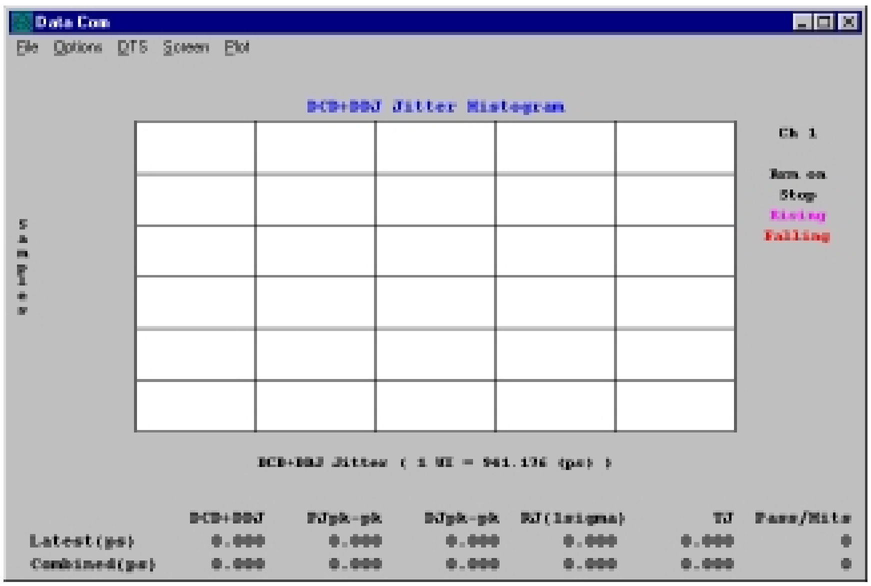


Figure 3.10 dataCOM Panel

EYE HISTOGRAM PANEL

The Eye Histogram panel provides a tool for creating a Histogram of readings when a bit clock is available. A Tail-fit algorithm may then be applied to provide Random Jitter and Deterministic Jitter estimates. The Eye Histogram will automate this process on data patterns where a bit clock is available. Essentially all initial steps involved in filtering the data is done for you. Samples for both rising and falling edges are also overlaid on top of each other. The Bit Clock also has a tail-fit performed on it which causes an additional delay to occur only on the first pass.

For a more detailed explanation of the Eye Histogram and Tail-Fit feature, see **Section 6.0, Eye Histogram**.

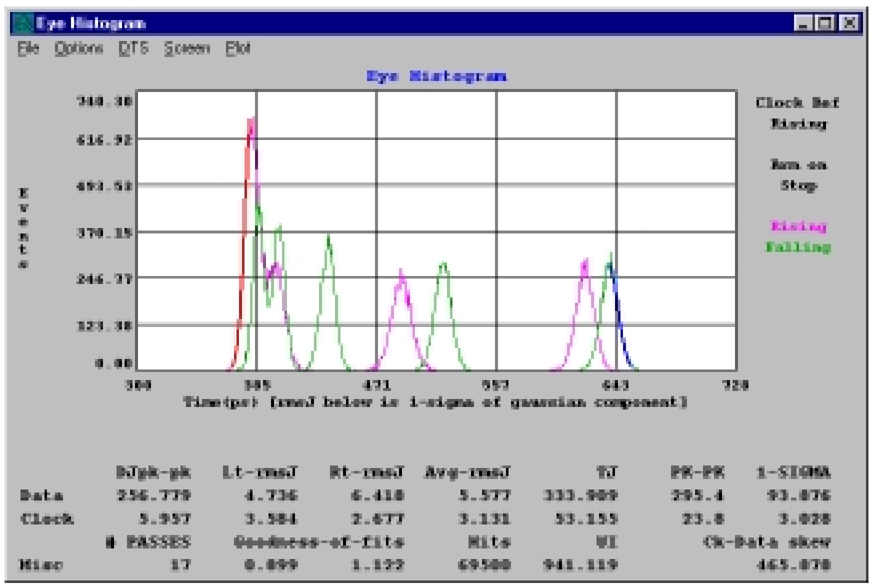


Figure 3.11 Eye Histogram Panel

TIME SERIES PANEL

The **Time Series** panel presents a sequential strip chart display of measurements. The chart has a “width” of 500 samples after which it begins to scroll to the left with new data added on the right. The data presented may be one of three sets; Average only, Max./Min. Average or Peak/Jitter, and can be acquired one-by-one on user’s command, in a free-running “continuous” mode, or in a continuous mode with a given time spacing between points by selecting from the **Time Series** options menu. Along with the strip chart, the **Time Series** window presents the statistics from the latest sample as well as cumulative (overall) statistics. For the overall values, the measurements’ averages and jitters are themselves averaged with subsequent readings. When the number of readings used to form the average reaches 10000, the algorithm switches from straight averaging to an exponential decay method in order to avoid loss of accuracy when dealing with very large numbers of samples. The overall max. and min. are the most extreme values of all samples. Optionally, this window may display the Root Allan Variance of the sequential measurements.

The Allan Variance is calculated from two data sources: the samples still residing in the strip chart (the last 500) and also from all measurements taken. As with computing the overall average, a two-stage algorithm is used with the first 5000 samples used explicitly and subsequent samples being incorporated with an exponential decay technique. See **Section 4.1, Options** under **Time Series** for further information.

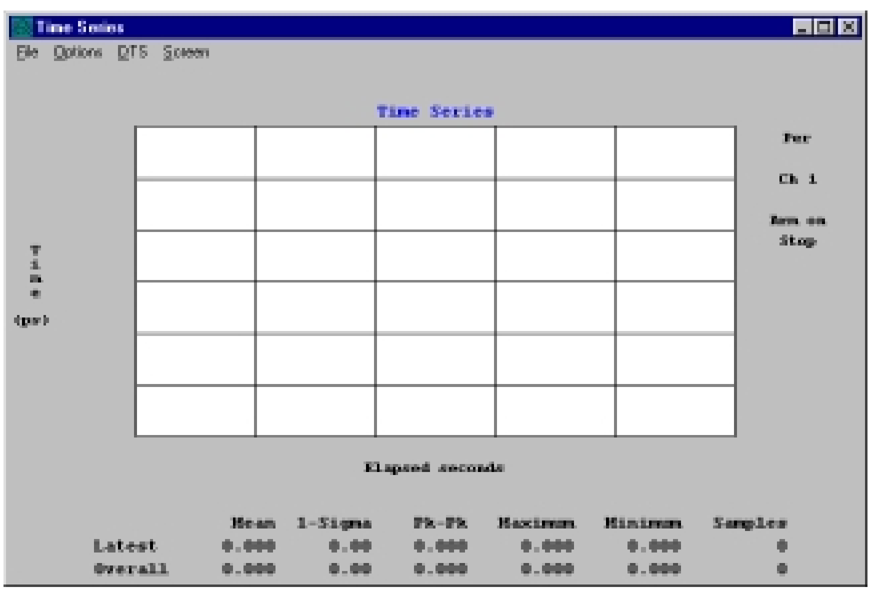


Figure 3.12 Time Series Panel

STATISTICS PANEL

The **Statistics** panel presents the results of time measurements in a text format: Average, maximum, minimum, peak, jitter, samples done and samples requested. Also presented are the measured VOH, VOL and Vp-p of the two input channels. The corresponding **Options** pull-down menu selects a **Pulse Find** to be performed following each time measurement with the new results displayed.

See **Section 4.1** for more on the **Options** pull-down menu selections and **Section 4.2** for more on the **DTS** pull-down menu selections.

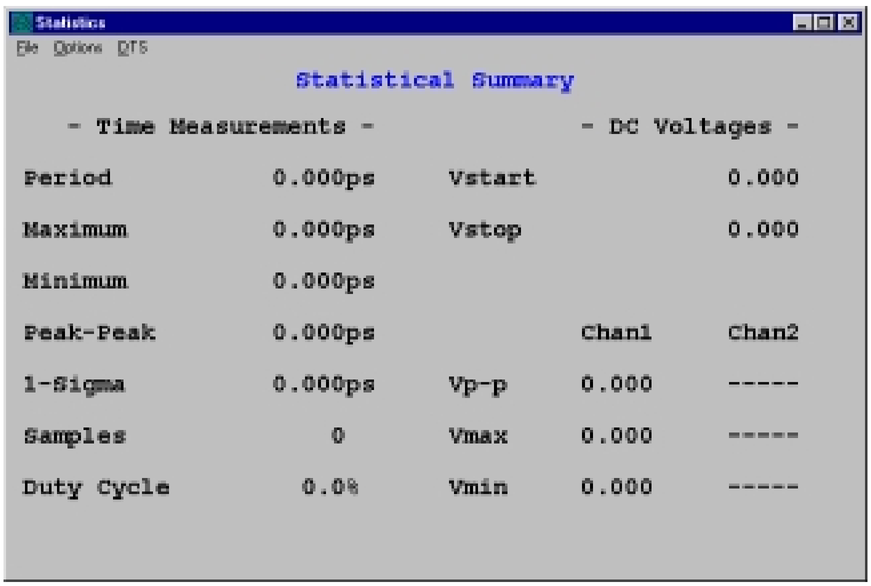


Figure 3.13 Statistics Panel

3.2 INSTRUMENT CALIBRATION

CALIBRATE

The **Calibrate** selection is used to calibrate the instrument and has a button for each of the following calibration choices:

- **Internal Calibration**
- **Extended (Internal) Calibration**
- **External AC Calibration**
- **External AC & DC Calibration**
- **Strobe Calibration**

The instrument firmware version is used by *Virtual Instruments* to determine which features the instrument can support and is displayed at the top of the dialog window.

A time/date stamp below the firmware identifier is a log of when the instrument was last calibrated through *Virtual Instruments*.

***NOTE**: The instrument could have been calibrated through the front panel at a later date.*

When having comments or questions about *Virtual Instruments*, the instrument firmware version and the *Virtual Instruments* version on the entry panel should be available.

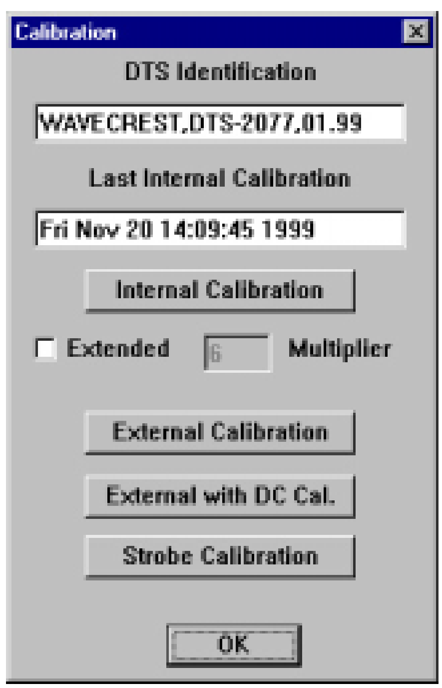


Figure 3.14 Calibration Window

INTERNAL CALIBRATION

Internal Calibration calibrates the instrument to ensure the instrument meets specifications. The calibration data is stored in the instrument and used each time a measurement is taken.

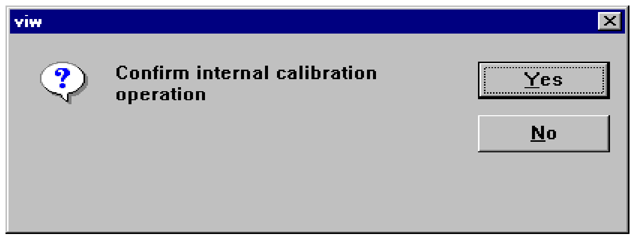


Figure 3.15 Starting Internal Calibration

The instrument should be warmed up at least 30 minutes before calibration. The instrument should also be on at least 30 minutes after power down to ensure the calibrated data is used in a stable condition. Internal calibration takes 5 minutes and a countdown is displayed on the instrument's front panel.

EXTENDED INTERNAL CALIBRATION

Extended Internal Calibration allows the user to reduce jitter due to the noise floor of the instrument through the use of longer internal calibration periods. The selected multiplier, from 1 to 25, extends the base calibration period of approximately 5.5 minutes by that factor. The table below shows typical results using the selected multipliers. Calibration times are approximate.

Multiplier Factor	Cal Time	1-sigma jitter	0db Peak Noise Floor
1	5.5 min	3.36	2.68ps
2	11 min	2.56	1.46ps
6	33 min	2.24	849fs
24	132 min	2.19	827fs

*****Embedded code version 1.98 or greater must be installed for extended internal calibration to work.**

*****The extended internal calibration can only be initiated via GPIB commands with a user program or with Virtual Instruments™ version 3.20 or greater. See GPIB manual for command.**

EXTERNAL CALIBRATION

External calibration measures the difference between the channel paths in order to ‘zero’ out those differences when taking a measurement. External calibration also ‘zeros’ out any DC difference between the channel inputs.

Virtual Instruments has two external calibration buttons. See Figure 3.14, Calibration Window. The **External Calibration** button will guide the user through the measuring of the channel paths (AC external calibration).

The **External with DC Cal** button will guide the user through both the AC and DC calibrations. After external calibration is complete, a quick check of the instrument can be done by placing the reference voltages to 0.0000 volts and measuring any of the following functions:

- TPD++, TPD--, TT+, TT- .... 0ps ± 10ps
- PW+, PW-, TPD+-, TPD-+ .... 2500 ps ± 10ps
- PER 5000ps .... ± 10ps
- FREQ .... 200 MHz ± 1kHZ

STROBE CALIBRATION

Strobe calibration will calibrate the signal digitizing hardware of the instrument and will guide the user through steps to move the cables. One portion of the strobe calibration takes 10-20 seconds during which a “Please wait” message is displayed on the instrument’s front panel and the right side of the **Status Bar**. To exit the calibration window and return to the menu bar, click **OK**.

SECTION 4 – MENU BAR AND PULL-DOWN DIALOG WINDOWS

4.0 DETAILED MENU BAR DESCRIPTION

- **File –** Save or load specific *Virtual Instruments* panel parameter configurations, save or load test data, save displayed panel in bitmap file, print current panel and exit *Virtual Instruments*.
- **Options –** Select panel specific parameters.
- **DTS –** Select DTS configuration settings for controlling instrument measurements.
- **Help –** Provides access to help files and file manager.

FILE

The **File** pull-down menu presents options for loading and storing DTS instrument configurations and measurement data, saving displayed window/screen to operator named bitmap file, printing a hard copy of the displayed window/screen or exiting *Virtual Instruments*. Clicking on the **File** command will display the respective pull-down menu (See Fig. 4.0).

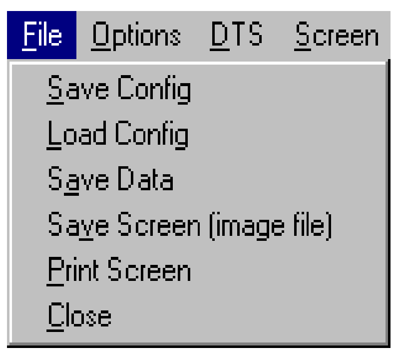


Figure 4.0 File Menu Commands

SAVE CONFIG

The **Save Config** dialog window provides the user with a method of saving the current parameter configuration in a user named setfile in the *Virtual Instruments* directory.

These setfiles can later be recalled through the **Load Config** selection. See the Default Parameters selection under the menu bar **DTS** command in **Section 4.2** for selecting a specific panel default configuration set.

Selecting the **Save Config** command will display a dialog window where the user can assign a file name to the current parameter configuration. Clicking on **Open** will store the settings in the *Virtual Instruments* directory where it can be recalled at anytime.

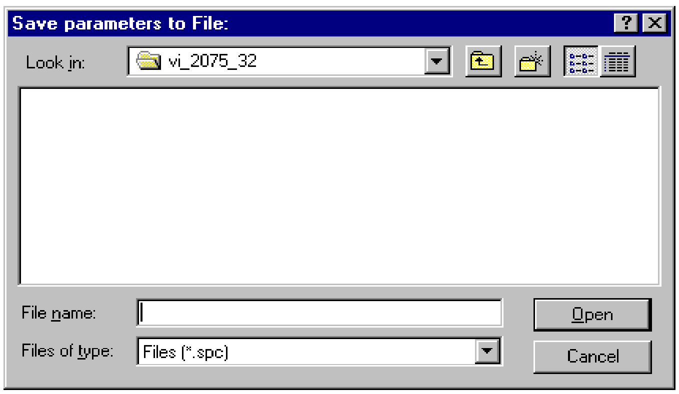


Figure 4.1 Save Config Dialog Window

LOAD CONFIG

The configuration files containing parameter configuration settings for the DTS are stored in setfiles in the *Virtual Instruments* directory for use in the utility program.

To load a specific setfile, select **Load Config** and click on the appropriate setfile. Click on **Open** and the parameters will be loaded into *Virtual Instruments*.

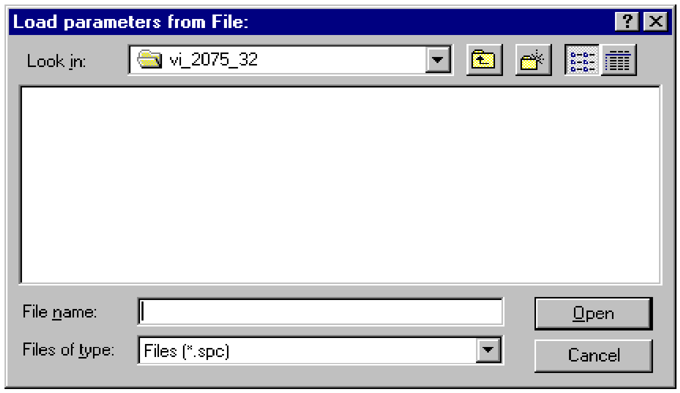


Figure 4.2 Load Config Dialog Window

SAVE DATA

The **Save Data** dialog window provides the user with a method of saving statistical data in a user named file in the *Virtual Instruments* directory. The infomation can be retrieved from the user-named file in the *Virtual Instruments* directory using a text editor or spread-sheet program of the user's choice. The file is saved in a tab delimited column oriented manner and is directly importable to Microsoft Excel.

The files are also self-documenting. Comment lines precede the data indentifying the fields that follow. All comment lines begin with a semi-colon (;).

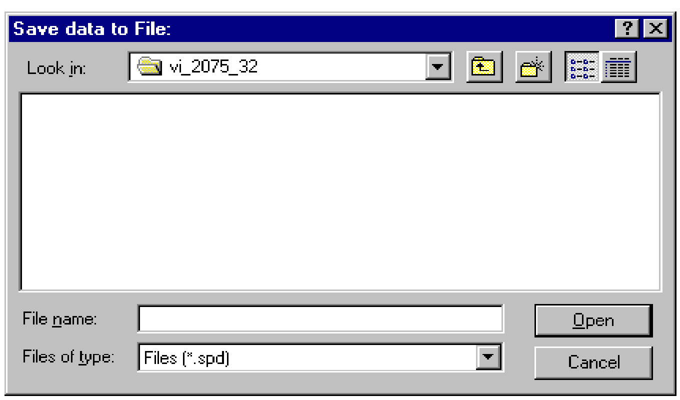


Figure 4.3 Save Data Dialog Window

SAVE SCREEN (image file)

The **Save Screen (image file)** command saves the displayed panel, including graphs and current data, into a user-named bitmap file in the *Virtual Instruments* directory or other specified directory. The user can then access this file through a draw or paint program.

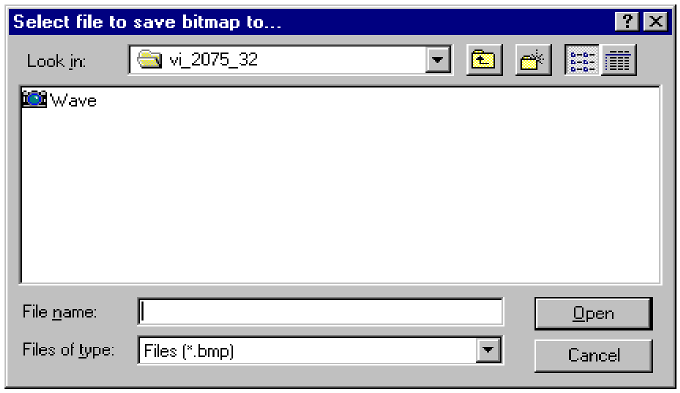


Figure 4.4 Save Screen (bitmap)

PRINT SCREEN

The **Print Screen** selection will display a Windows print setup dialog window for selecting print parameters.

If print fails, check the following:

- Printer is powered ON
- Printer cable is connected and seated properly
- Printer is on-line

If the above doesn't correct the problem, see your printer's operation manual.

CLOSE

The **Close** selection will terminate *Virtual Instruments*.

4.1 OPTIONS

The **Options** pull-down window presents the user with option parameters for the active instrument panel. These option parameters are specific to the associated instrument panel.

Figure 4.5 Options Pull-Down Menu

OSCILLOSCOPE

The **Oscilloscope Options** dialog window presents options of which channel(s) to be displayed, the parameters for the voltage strobes, as well as Fast Fourier options. See **Appendix A, Using Fast Fourier Transforms**.

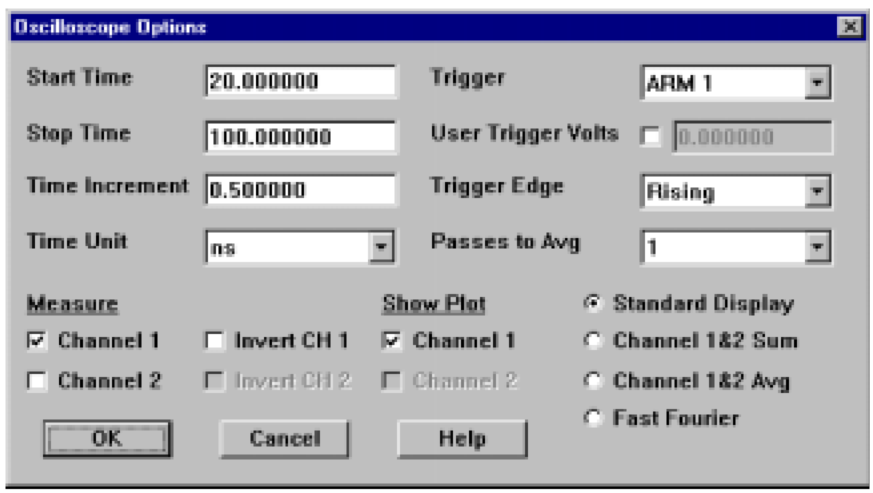


Figure 4.6 Oscilloscope Options

- **Start Time** - Sets the delay of the first strobe point. The limits are from 25ns to 3µs.
- **End Time** - Sets the delay of the last strobe point. The limits are from 25ns to 3µs.
- **Time Increment** - Sets the increment value between each strobe point, such as 0.1ns. The resolution is 10 ps.
- **Time Unit** - The units of entry for the strobe start, end and increment can be changed to femto-, pico-, nano-, micro-, milliseconds or seconds.
- **Trigger** - Enable check box to set the trigger for Arm1, Arm2, CH1 or CH2.
- **User Trigger Volts** - Sets the trigger strobe arm trip voltage. The limits are ±1.1 volts.
- **Trigger Edge** - Selects the rising or falling edge that the arm voltage will trip.

- **Passes to Average** - The output of multiple passes can be averaged thereby lowering the error as a result of sampling noise.
- **Measure** - Select Channel to measure and whether to invert signal when displayed: Channel 1, Channel 2, Invert CH 1 and Invert CH 2.
- **Show Plot** - Displays the selected waveform(s): Channel 1 or Channel 2.
- **Standard Display** - Displays the selected waveform from **Show Plot**.
- **Chan 1& 2 Sum** - Displays Sum of Channel 1 and Channel 2.
- **Chan 1& 2 Avg** - Displays Average of Channel 1 and Channel 2.
- **Fast Fourier** - Provides a frequency domain display based on the oscilloscope waveform. For more information on Fast Fourier Transforms, see **Appendix A, Using Fast Fourier Transforms**.

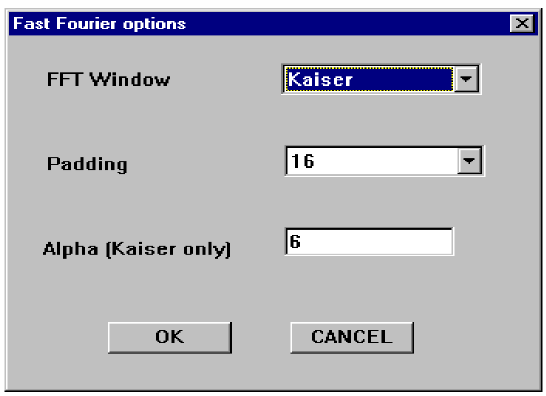


Figure 4.7 Oscilloscope Fast Fourier Transform

FFT Window - Rectangular, Kaiser, Triangular, Hamming, Hanning, Blackman and Gaussian. Default window is Kaiser. See **Appendix A, Using Fast Fourier Transforms**.

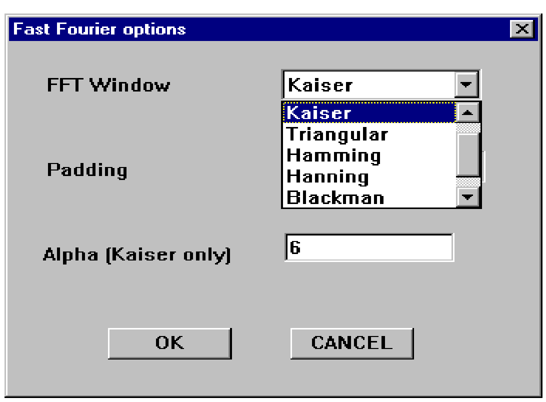


Figure 4.8 Oscilloscope FFT Window Selection

Padding - Padding increases the frequency resolution of the FFT. Default is 16. Generally, a higher padding value will increase transformation processing time.

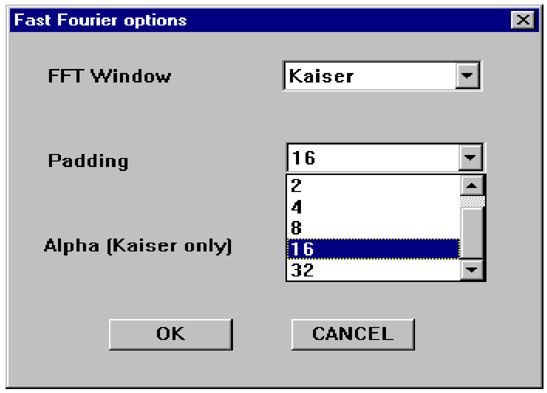


Figure 4.9 FFT Padding Selection

Alpha (Kaiser only) - Default is 6.

HISTOGRAM

The **Histogram Options** dialog window presents the user with options of selecting graph styles and data update modes as well as the Tail-fit option and parameters.

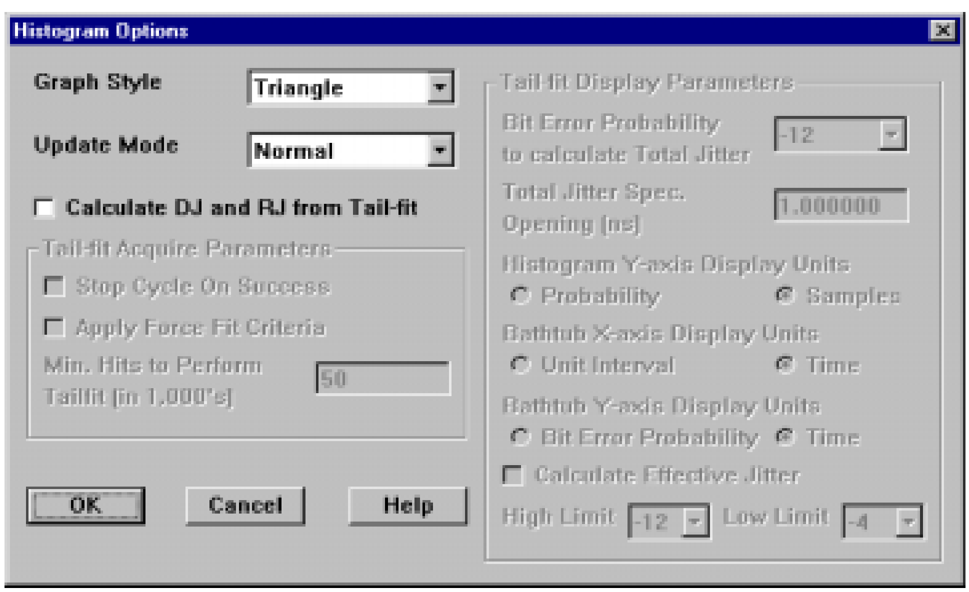


Figure 4.10 Histogram Options

- ## Graph Style

Graph Style provides for the selection of three different line drawing styles on the **Histogram** instrument panel:

Stepped - Stepped levels for each bin.

Straight- Straight line point-to-point between bin centers.

Triangle - Vertical line representing size at each bin.

Figure 4.11 Histogram Graph Style

- ## Update Mode

The **Update Mode** provides for the selection of three different displays of the measured data:

Normal - The Normal selection displays only the last data measured for the most current burst.

Accumulate - The Accumulate selection adds the data measured at a specific point to an accumulative value at that point and displays the accumulative value.

Overlay - The Overlay selection displays the largest value of all previous measurement bursts at a specific point.

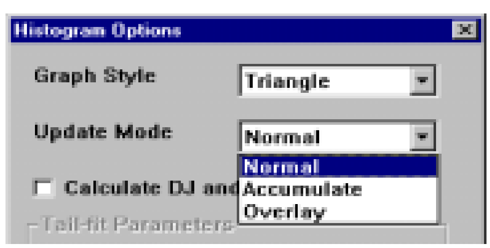


Fig. 4.12 Histogram Update Mode

- ## Calculate DJ and RJ from Tail-fit

Checking the **Calculate DJ and RJ from Tail-fit** box enables the Tail-fit algorithm for providing Random Jitter and Deterministic Jitter estimates and activiates the **Tail-fit Parameters** options.

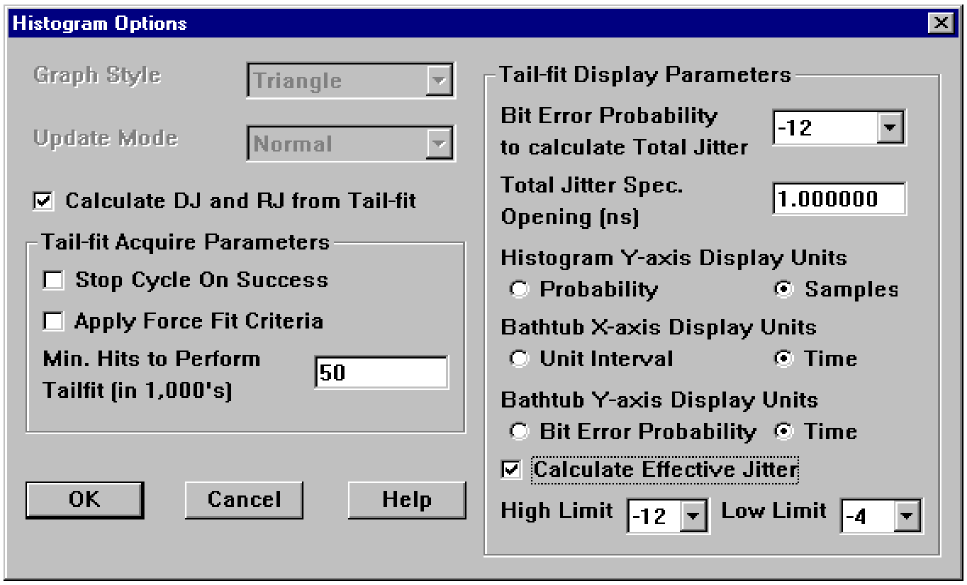


Figure 4.13 Calculate DJ and RJ from Tail-fit

- ## Tail-fit Parameters

Stop Cycle on Success - The Tail-fit option has certain quality requirements that must be met before an estimate is given. In the case of a high Deterministic Jitter component these requirements may require several passes. Enable this option and then use Cycle in order to accumulate until the requirements are met.

Apply Force Fit Criteria - The default tail-fit method uses a number of statistics to assess that the quality of solution is sufficient before returning a result. The Force Fit method relaxes these constraints and assumes the user has determined that the Min. Hits to Perform Tail-fit specified is sufficient to return valid results.

Minimum Hits to Perform Tailfit - A Tail-fit is not attempted until the number of points specified is acquired. This applies to the default mode as well as the Force fit method. The value is input in 1,000's. Default is 50.

Bit Error Probability to calculate Total Jitter - The Bit Error Probability at which the Total Jitter will be calculated. Default is -12

Total Jitter Spec. Opening - The width used in the Bathtub Plot to assess the Error Probability in nanoseconds.

Bathtub X-axis Display Units - Determines the units to display along the X-axis of the Bathtub Plot (UI or Time).

Bathtub Y-axis Display Units - Determines the units to display along the Y-axis of the Bathtub Plot (Bit Error Probability or Time).

Histogram Y-axis Display Units - Determines the units to display along the Y-axis of the Histogram Plot (Probability or Samples).

Calculate Effective Jitter - Several Bit Error Rate Testers (BERT) offer the ability to derive Deterministic Jitter and Random Jitter from a Bathtub Curve. Since this method is based on a pure DCD/RJ jitter model, it tends to generate lower DJ and higher RJ values. This option is offered in the event values are desired that are determined on a comparable basis to a BERT.

High Limit and **Low Limit** - Defines the Bit Error Rate range over which the Effective Jitter is derived.

JITTER ANALYSIS

The **Jitter Analysis Options** dialog window presents options for selecting the type of analysis, stop event pulse (cycles) ranges, stop event increment value, x-axis scale, data compiling method or Fast Fourier Transform. For more information on FFTs, see **Appendix A, Using FFTs**.

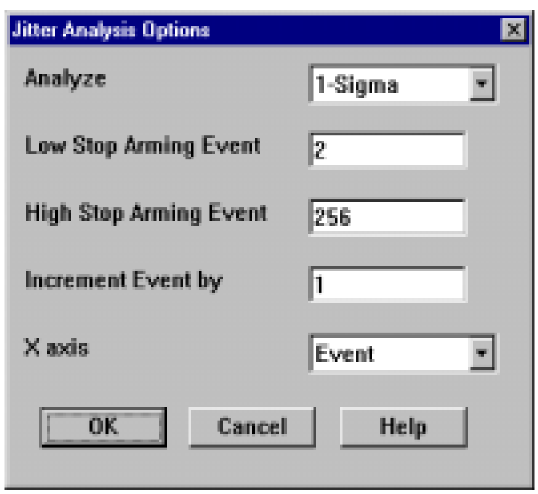


Figure 4.14 Jitter Analysis Options

- **Analyze** - Provides option of selecting 1-Sigma jitter, Peak, Variance or Fast Fourier values to plot.

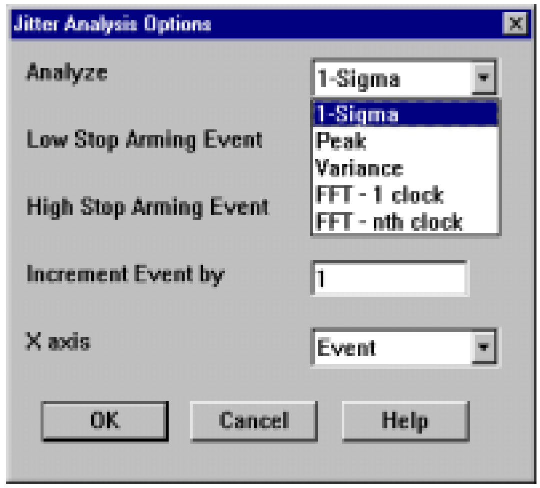


Figure 4.15 Jitter Analysis Analyze Options

- **Fast Fourier** - Transforms time-based analysis of jitter into a frequency domain analysis display. For more information on Fast Fourier Transforms, see **Appendix A, Using Fast Fourier Transforms**.

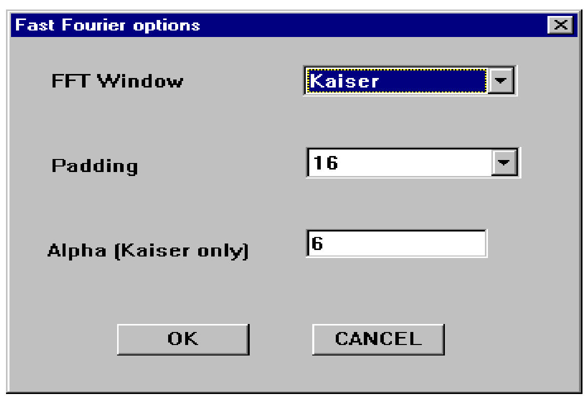


Figure 4.16 Jitter Fast Fourier Transform

FFT Window options - Rectangular, Kaiser, Triangular, Hamming, Hanning, Gaussian and Blackman. Default window is Kaiser. For more information on Fast Fourier Transforms, see **Appendix A, Using Fast Fourier Transforms**.

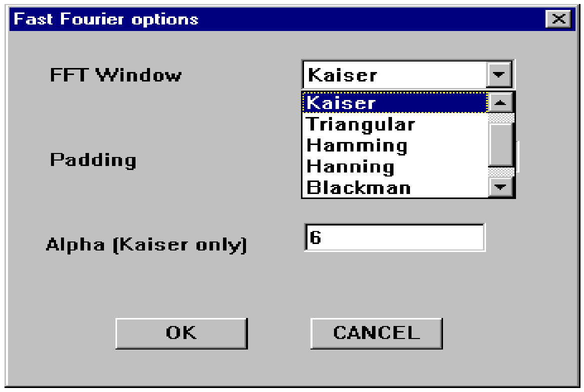


Figure 4.17 Jitter FFT Window Selection

Padding - Padding increases the frequency resolution of the FFT. Default is 16. Generally, a higher padding value will increase transformation processing time.

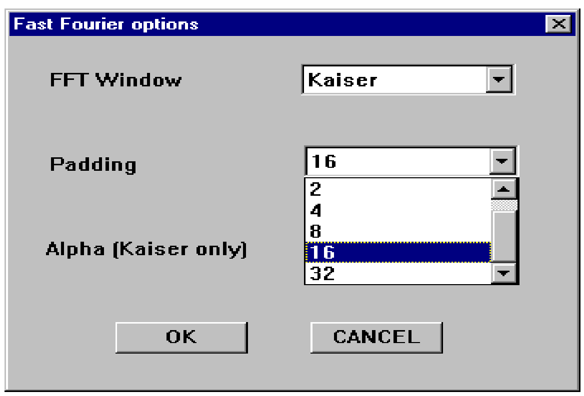


Figure 4.18 Jitter FFT Padding Selection

Alpha (Kaiser only) - Default is 6.

- **Low Stop Arming Event** - Select from 1 to 131,071 as the first stop event.
- **High Stop Arming Event** - Select from 1 to 131,071 as the last stop event.

*NOTE: **The High Stop Arming Event should always be at least 1 more than the Low Stop Arming Event.***

- **Increment Event By** - Sets increment value of Stop Arming Event.
- **X Axis** - Select either an Event or Time-based horizontal scale.

FUNCTION ANALYSIS

The **Function Analysis Options** dialog window presents selections for choosing which pulse cycles to measure and to plot the data or display it in a **Fast Fourier Transform** format. For more information on FFTs, see **Appendix A, Using Fast Fourier Transforms**.

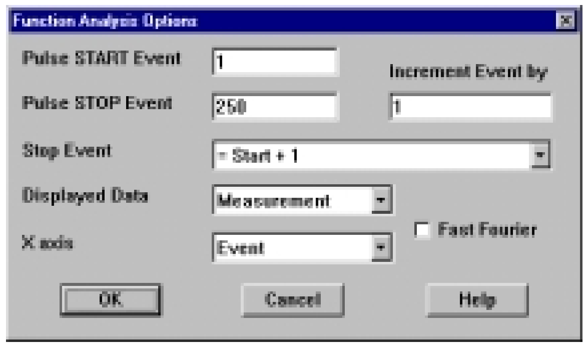


Figure 4.19 Function Analysis Options

- **Pulse START Event**: Enters the cycle event which starts the functional analysis.
- **Pulse STOP Event**: Enters the cycle event which stops the functional analysis.
- **Stop event**: Determines the Arming and/or Stop Event (Fig. 4.20):

  Arm Start First Stop = 1: Sets the arming sequence Stop Event to the first stop event.

  Start + 1: The Stop Event is set one past the Start Event. (Start = 10; Stop = 11 . . . Start = 20; Stop = 21)

  Start Event: Sets Stop Event equal to the Start Event.

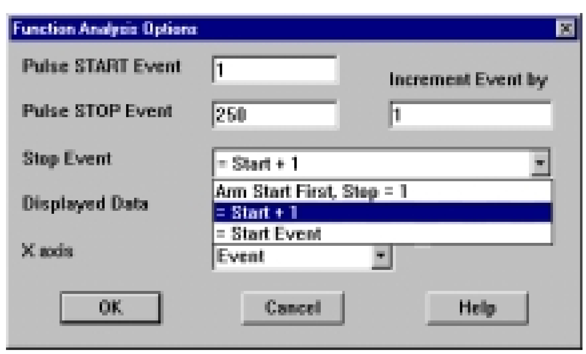


Figure 4.20 Function Stop Event

- **Displayed Data**: Select method of displaying data (See Fig. 4.21):

  Measurement: Plots the measured value.

  Derivative: Plots the difference between the current measurement and the previous measurement.

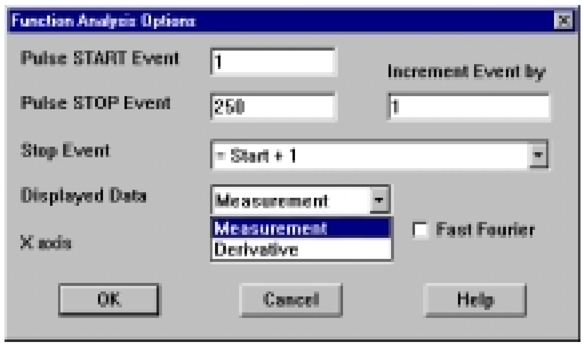


Figure 4.21 Function Displayed Data

- **X Axis**: Select the horizontal plot axis (See Fig. 4.22):

  Event: Take a measurement for each event from START event to STOP event and plot these values versus the count.

  Time: Take a measurement and plot the value versus time.

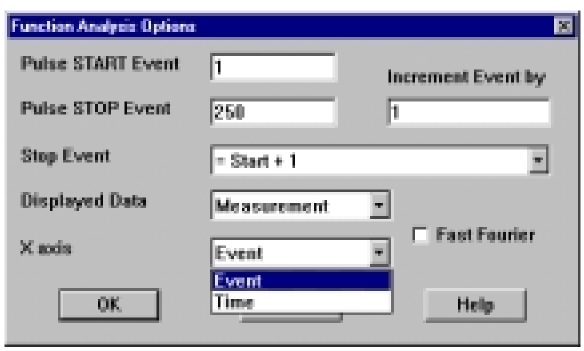


Figure 4.22 Function X-Axis

- **Increment**: Will increment pulse event by user-defined amount.

- **Fast Fourier**: Transforms time-based analysis of cyclical jitter into a frequency domain analysis display. For more information on Fast Fourier Transforms, see **Appendix A, Using Fast Fourier Transforms**.

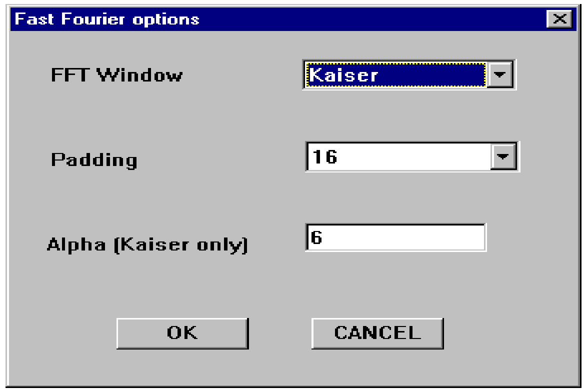


Figure 4.23 Function Analysis Fast Fourier Transform

FFT Window options - Rectangular, Kaiser, Triangular, Hamming, Hanning, Blackman and Gaussian. Default window is Kaiser. For more information on Fast Fouier Transforms, See **Appendix A, Using Fast Fourier Transforms**.

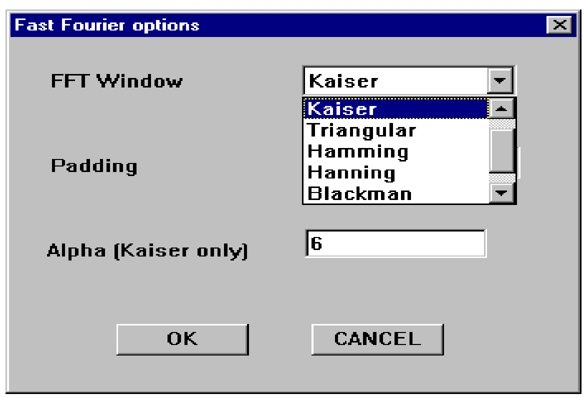


Figure 4.24 Function Analysis FFT Window Selection

Padding - Padding increases the frequency resolution of the FFT. Default is 16. Generally, a higher padding value will increase transformation processing time.

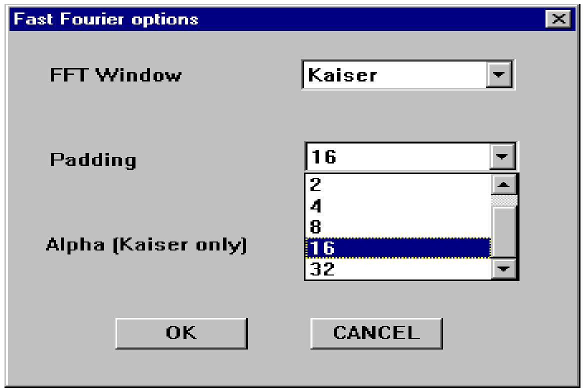


Figure 4.25 Function Analysis FFT Padding Selection

Alpha (Kaiser only) - Default is 6.

TIME DIGITIZER

The **Time Digitizer** option dialog window presents options of transforming time-based signals into frequency domain-based signals or selecting **Fast Fourier Transform**.

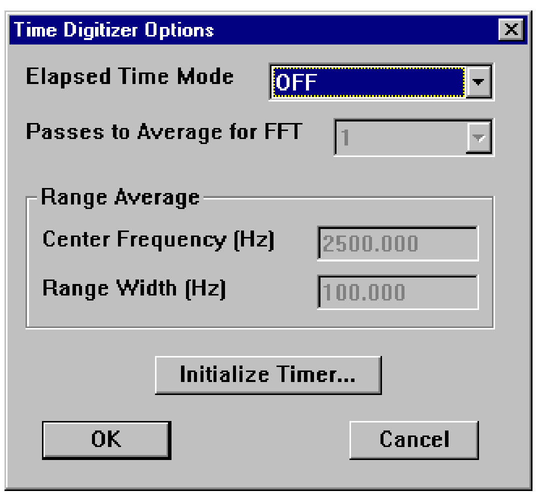


Figure 4.26 Time Digitizer Options

- **Elapsed Time Mode** - When selected, transforms time-based signal into frequency domain based signal and displays waveform.

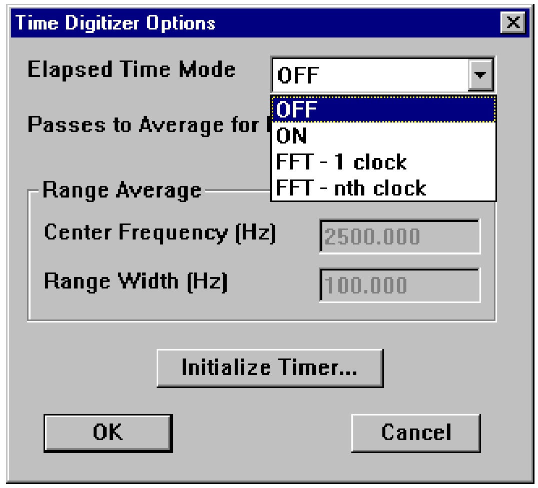


Figure 4.27 Elapsed Time Mode

- **Fast Fourier -** Transforms time-based analysis of cyclical jitter into a frequency domain analysis display. For more information on Fast Fourier Transforms, see **Appendix A, Using Fast Fourier Transforms**.

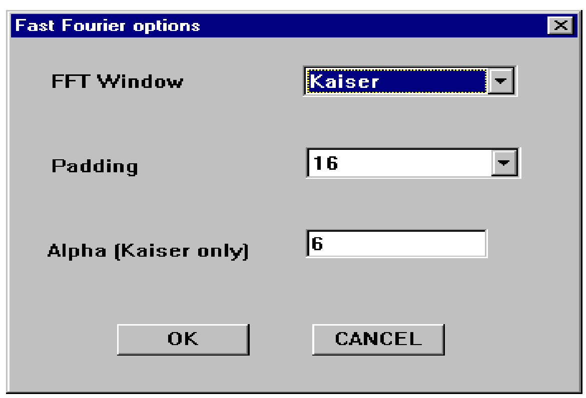


Figure 4.28 Time Digitizer Fast Fourier Transform

FFT Window options - Rectangular, Kaiser, Triangular, Hamming, Hanning, Blackman and Gaussian. Default window is Kaiser. For more information on Fast Fouier Transforms, See **Appendix A, Using Fast Fourier Transforms**.

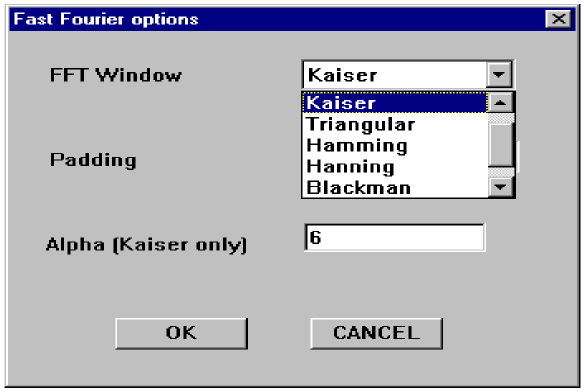


Figure 4.29 Time Digitizer FFT Window Selection

Padding - Padding increases the frequency resolution of the FFT. Default is 16. Generally, a higher padding value will increase transformation processing time.

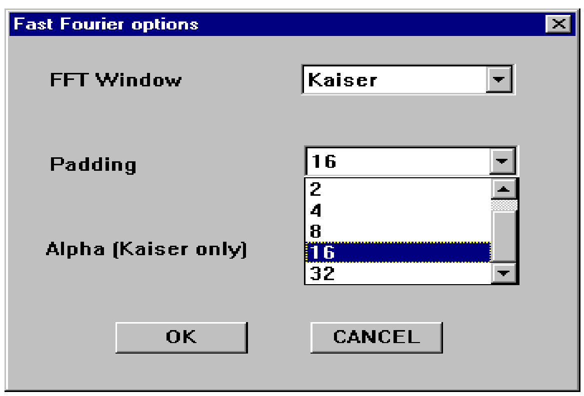


Figure 4.30 Time Digitizer FFT Padding Selection

Alpha (Kaiser only) - Default is 6.

- **Passes to Average for FFT** - Selects the number of passes to average for the FFT output.
- **Range Average** - For FFT modes only, this option will set the Center Frequency and Range Width parameters for FFT measurements. This feature provides the ability to measure data which may be away from the peak measurement.
- **Initialize Timer** - Starts time logging feature. A toggling signal must be present on EXT ARM 2 for time logging to be in effect. Calibration signal produced by DTS is suitable for this purpose.

dataCOM

The **dataCOM Acquire Option** and **Display Option** dialog windows present options for establishing deterministic and random jitter measurement parameters. These window options include: defining pattern, Bit Rate and corner frequency values; Bit Rate, DCD + DDJ, RJ and PJ sampling parameters; Random Jitter Sigma Multiplier and measurement display parameters.

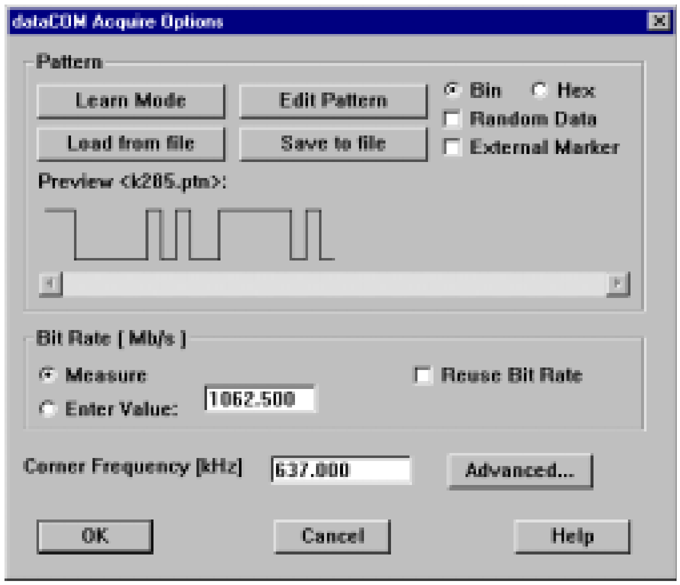


Figure 4.31 dataCOM Options

- **Learn Mode** - Provides a means for directly defining a pattern based on a data stream. The data stream must be relatively jitter free and a suitable pattern marker must be available as an external arm.

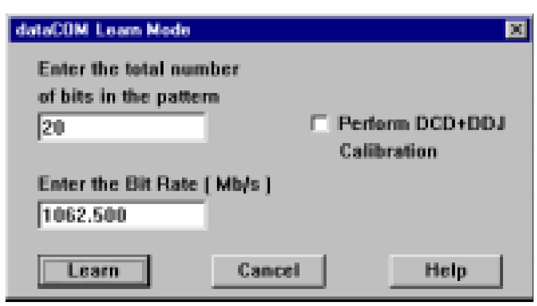


Figure 4.32 dataCOM Learn Mode

Perform DCD + DDJ Calibration - The DCD+DDJ Calibration routine is used to minimize the effect of the instrument on DCD+DDJ measurements. This routine is intended for DCD+DDJ measurements which do not exceed .05 UI. This selection gives the user the option to perform a baseline DCD+DDJ calibration. This can help isolate the DCD+DDJ observed in the device under test. In order to perform a DCD+DDJ calibration a relatively clean data source is required. Subsequent measurements will apply offsets determined during this phase on an edge by edge basis. Calibration data is pattern specific - if a pattern is saved, the calibration data will be saved along with it. Since DCD + DDJ is frequency dependent, the frequency at which the pattern was acquired is also stored. If the pattern file is used at another frequency, a warning will be issued.

- **Edit Pattern** - Directly input data patterns in either binary or hexidecimal form. Select **Bin** or **Hex** before selecting this option
- **Random Data** -This mode provides the means to analyze random data streams. No pattern definition is required, and all pattern options are disabled while in this mode. The Bit Rate cannot be measured while in this mode, and must be manually entered. Results while operating in this mode should not be considered as reliable as those when operat ing with a known pattern definition.
- **External Marker** - Enables the use of a pattern marker to provide more accurate jitter measurements. Advanced configuration of the marker can be made in the Arming Dialog.

Figure 4.33 dataCOM Edit Pattern

- **Load from file** - Load previously defined pattern file (See Appendix E).
- **Save a file** - Store a defined pattern to file after using Edit Pattern or Learn Mode.
- **Preview** - Permits visual inspection of a pattern definition. If the pattern has been saved, its file name will appear above it.
- **Scroll bar** - If a pattern is longer than 40 UI, the scroll bar is enabled to allow the entire pattern to be viewed.
- **Measure Bit Rate (Mb/s)** - Provides the means to directly measure the Bit Rate based on the pattern having been correctly defined.
- **Enter Value** - Manually enter Bit Rate.

- **Reuse Bit Rate** - If selected, the Bit Rate measured on the first pass will be used for all subsequent jitter calculations.
- **Corner Frequency** (kHz) - Used to determine the maximum measurement interval to be used in sampling.
- **Advanced** - Provides access to additional acquisition parameters. (See Figure 4.34.)

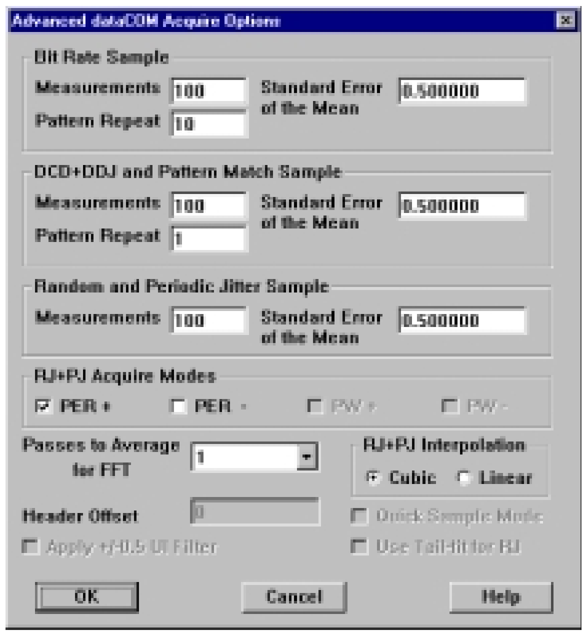


Figure 4.34 Advanced Acquire Options

- **Bit Rate Sample**: Measurements - Determines number of single shot measurements used to quantify a given time interval and its statistical properties.
  Standard Error of the Mean - Indicates when suspect measurements have been taken, usually as a result of improper pattern selection.
  Pattern Repeat - Permits measurements to be taken across multiple pattern intervals.
- **DCD + DDJ and Pattern Match Sample**- See Bit Rate Sample for explanation of options.
- **Random and Periodic Jitter Sample**- See Bit Rate Sample for explanation of options.
- **RJ + PJ Acquire Modes** - Selects which of the data types to acquire for subsequent output of Random and Periodic Jitter plots and statistics.
- **Passes to Average for FFT** - Selects number of passes to average for the FFT output.
- **Header Offset** - This option allows you to skip a given number of edges after the external pattern marker before sampling. This can be helpful in applications such as Hard Drives where a header precedes a repetitive data sequence in the data stream. This option is only available when using external arming, and it applies to all Datacom sampling including learn mode.

- **Apply +/- 0.5 UI Filter** - Available when a pattern marker is being used and quick-mode is not enabled. Eliminates stray errors due to insertion of extra IDLE characters compensating for device re-clocking which disrupts standard Fibre Channel test patterns. Filters are automatically calculated and applied to throw away any measurements which are more then +/- 0.5 UI away from their expected positions. If more than 5% of the edges are filtered, an error will be reported.
- **RJ + PJ Interpolation** - This option selects the means of filling the gaps in the auto-correlation function which naturally occur in a pattern. In general, the **Cubic** interpolation will produce the best results in the presence of periodic jitter. Selection of **Linear** interpolation may be preferred in the presence of purely random jitter, in which case the presumption of a smooth autocorrelation function cannot be made.
- **Quick Sample Mode** - This option enables a sparse sampling protocol for RJ+PJ data acquisition which reduces the time required to obtain data. It is only available when using an external arm. This method is appropriate for use only when there is insignificant higher frequency jitter present. In the presence of high frequency jitter, the standard sampling protocol will reduce the amount of harmonic distortion which can occur.
- **Use tail-fit for RJ** - This option enables the tail-fit algorithm for calculation of Random Jitter. It may only be used in conjunction with an external pattern marker. It eliminates the inflation of RJ which can occur due to the presence of PJ.

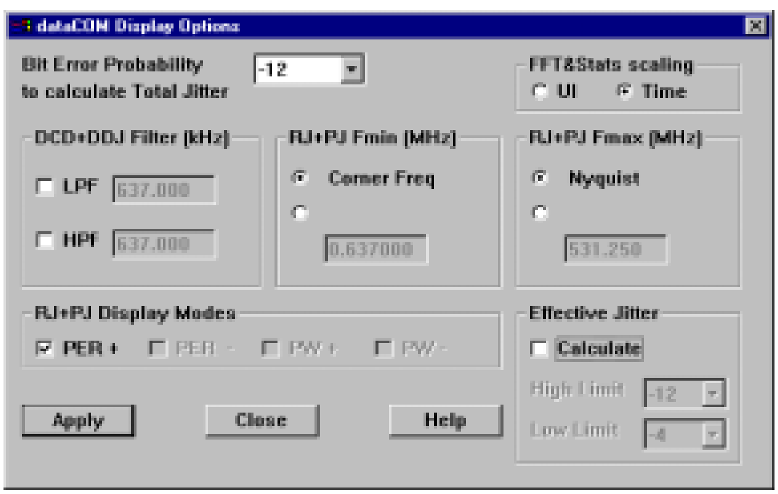


Figure 4.35 dataCOM Display Options

- **Bit Error Probability** - Bit error rate parameter used for calculating Total Jitter. Default is -12 (10^{-12}).
- **FFT & Stats scaling** - Selects display units.
- **DCD+DDJ Filter (kHz)** - This option applies a Low Pass or a High Pass Filter to the DCD+ DDJ data. The resulting filtered data is plotted on top of the raw DCD+DDJ data in the DCD+ DDJ vs. Unit Interval plot window. It is only available when external arming is being used.

- **RJ + PJ F_{min} (MHz)** - Lower limit for the window over which RJ and PJ is calculated. Default is Corner Frequency.
- **RJ + PJ F_{max} (MHz)** - Upper limit for the window over which RJ and PJ is calculated. Default is Nyquist.
- **RJ + PJ Display Modes** - Selects which of the data types are displayed for output of Random and Periodic Jitter plots and stats. The data type must have also been selected to be acquired in order to beavailable for selection.
- **Calculate Effective Jitter** - Several Bit Error Rate Testers (BERT) offer the ability to derive Deterministic Jitter and Random Jitter from a Bathtub Curve. Since this method is based on a pure DCD/RJ jitter model, it tends to generate lower DJ and higher RJ values. This option is offered in the event values are desired that are determined on a comparable basis to a BERT.

  High Limit and **Low Limit** - Defines the Bit Error Rate range over which the Effective Jitter is derived.

EYE HISTOGRAM

The **Eye Histogram** option dialog window provides access to Tail-fit and Bathtub Curve measurement parameters and display characteristics. When a tail-fit is successfully completed the calculated tail-fits are plotted on top of the raw histogram, and values for the Deterministic Jitter, Random Jitter, Chi-square goodness of fit, and Total Jitter are displayed (See Figure 6.7). You can also view the resulting Bathtub Plot which is based on the PDF of the raw histogram with extrapolated tails calculated from the tail-fit (See Figure 6.8). The Total Jitter is extracted directly from the Bathtub Plot. Note: For Spectrum panel only - The Total Jitter Specification (UI) that is used for this calculation is User Defined. Make sure that reasonable values are assigned for this as well as the Bit Error Probability.

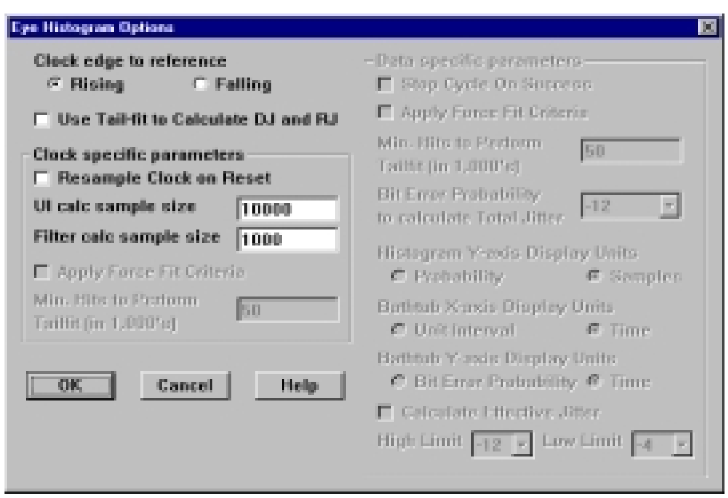


Figure 4.36 Eye Histogram Option

- **Clock edge to reference** - Select the Bit Clock edge which will be used to trigger the readings.
- **Use Tail-fit to calculate DJ and RJ** - Enables the Tail-fit algorithm for providing Random Jitter and Deterministic Jitter estimates.
- **Resample Clock on Reset** - Determines whether the clock and filters will be analyzed every time the Reset button is pressed.
- **UI calc sample size** - Determines the number of measurements to take in order to analyze the bit clock.
- **Filter calc sample size** - Determines the number of measurements to take in order to determine the correct placement of filters.
- **Apply Force Fit Criteria** - The default tail-fit method uses a number statistics to assess that the quality of solution is sufficient before returning a result. The Force Fit method relaxes these constraints and assumes the user has determined that the Min. Hits to Perform Tailfit specified is sufficient to return valid results.
- **Min. Hits to Perform Tailfit** - A Tailfit is not attempted until the number of points specified is acquired. This applies to the default mode as well as the Force fit method. The value is input in 1,000's.
- **Stop Cycle on Success** - The Tail-fit option has certain quality requirements that must be met before an estimate is given. In the case of a high Deterministic Jitter component theserequirements may require several passes. The accumulation of additional points from subsequent passes will normally lead to these requirements being met. Enable this option and then use Cycle in order to accumulate until these requirements are met and then stop.
- **Bit Error Probability to calculate Total Jitter** - The Bit Error Probability at which the Total Jitter will be calculated.
- **Bathtub X-axis Display Units** - Determines the units to display along the X-axis of the Bathtub Plot (UI or Time).
- **Bathtub Y-axis Display Units** - Determines the units to display along the Y-axis of the Bathtub Plot (Bit Error Probability or Time).
- **Histogram Y-axis Display Units** - Determines the units to display along the Y-axis of the Histogram Plot (Probability or Samples).
- **Calculate Effective Jitter** - Several Bit Error Rate Testers (BERT) offer the ability to derive Deterministic Jitter and Random Jitter from a Bathtub Curve. Since this method is based on a pure DCD/RJ jitter model, it tends to generate lower DJ and higher RJ values. This option is offered in the event values are desired that are determined on a comparable basis to a BERT.

  High Limit and **Low Limit** - Defines the Bit Error Rate range over which the Effective Jitter is derived.

TIME SERIES

The **Time Series Options** dialog window allows for selection of the type of data to be plotted and the rate at which to take these measurements.

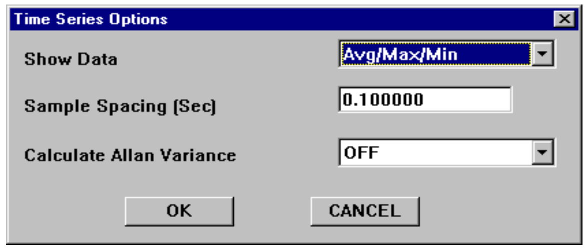


Figure 4.37 Time Series Options

- **Show data** - Selects the data to be plotted
  - **Average**
  - **Average/Minimum/Maximum**
  - **Peak/Jitter**
- **Sample Spacing** (sec.) - Selects time between measurements. Minimum resolution is 100ms.
- **Calculate Allan Variance** - When ON the Allan Variance is calculated and displayed after each measurement.

The Allan Variance is a measure of frequency stability. It is a non-dimensional factor giving the variance of the signal frequency over a given period of time. To correctly measure the Allan Variance, *Virtual Instruments* should be in repeat cycling mode and have the time delay set to a specific interval. The value presented in *Virtual Instruments* is the Allan Variance proper and not the Root Allan Variance.

The Allan Variance is typically done over one second periods. The frequency is measured each second and compared to the frequency of the previous second. The discrete frequency change is then divided by the nominal (first sample) frequency before being included in a variance calculation. The resultant number is not based on the input frequency thus allowing quality comparisons between signals of differing frequencies.

STATISTICS

The **Statistics** option dialog window presents the user with the option to do a **Pulse Find** after each burst.

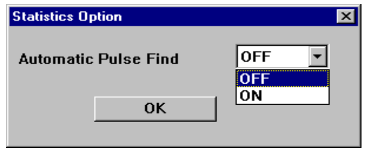


Figure 4.38 Statistics Options

4.2 DTS

The **DTS** selection on the menu bar provides access to all the configuration parameters of the DTS. The pull-down menu presents options for setting the DTS control parameters. These values can be stored as distinct setups using the **Save Config** option under **File** in **Section 4.0**. By selecting and changing setups, DTS measurement configurations may be shared between display windows. These options are desensitized when not applicable. The **Function** and **Arming** selections contain the primary configuration options for the DTS-207x. **Filter** is used to filter measurements at the instrument. The **Pulse Find** sets start and stop threshold reference voltages based on the minimum and maximum pulse level found on each channel. The **Reset To Defaults** command resets the user defineable parameters to the default configuration. The **Front Panel On** menu controls the operation of the DTS front panel.

Clicking on the **DTS** command will bring up the respective menu:

Figure 4.39 DTS Pull-Down Menu

- **Function** – Presents user with primary configuration options for the DTS unit.
- **Arming** – Presents user with instrument arming options.
- **Filter** – Presents user with data filtering options for the next, and subsequent, measurement.
- **Pulse Find** – Presents user with Pulse Find options used by the instrument and initiates a Pulse Find.
- **Scaling** – Presents user with panel scaling options.
- **Reset To Defaults** – Selects which parameters are to be used as default settings for a specific panel.
- **Front Panel On** – Presents user with the option to display the results of a measurement on the DTS unit front panel. By deselecting **Front Panel On**, the instrument is able to execute measurement functions faster. This mode is recommended.

FUNCTION

The **Function** dialog window contains the primary configuration options for the DTS. The data is updated to be an accurate reflection of the instrument state. When the user selects a new function, the DTS is set to that function and then the other parameters are readback to the PC. This allows the Utility program to pick up default settings for the functions from the DTS. When a **Pulse Find** is performed, the new trip levels are retrieved and displayed. When percentage trip levels are selected, the **Start volt** and **Stop volt** selections are desensitized to demonstrate that those levels are being computed, not entered. When the function selected is a two-channel operation, the Channel selection is desensitized.

The **Function** pop-up dialog window options are (See Fig. 4.40):

- **Function** – Select primary configuration function for the DTS unit (Fig. 4.41).
- **Channel** – Select Channel 1 or 2 for single channel functions. Default is BOTH for TPD functions.
- **Start volt** – Enter trip level for the start event. Used for display only if a percentage is selected for pulse find.
- **Stop volt** – Enter trip level for the stop event. Used for display only if a percentage is selected for pulse find.
- **Sample size** – Enter number of measurements to be taken in each burst.
- **Pulse Find %** – Presents user with options to select which percentage range of Pulse Find to be used by the instrument (Fig. 4.42).
- **Arming** – Presents user with instrument arming options (Fig. 4.43).
  Arm On Start - Arm the instrument for the first start event.
  Arm On Stop - Arm the instrument for the first stop event.
  Arm Start First - Arm the instrument as specified but only after the Start event has occurred.
- **Start arming event** – Enter the start event for Arm-on-Nth event (1 to 131,071).
- **Stop arming event** – Enter the stop event for Arm-on-Nth event (1 to 131,071).

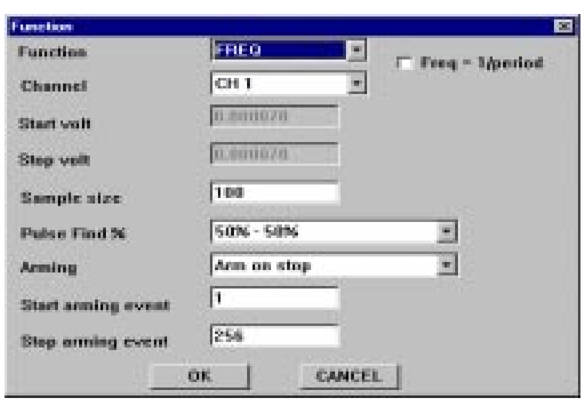


Figure 4.40 Function Pop-Up Dialog Window

Figure 4.41 Function Selection

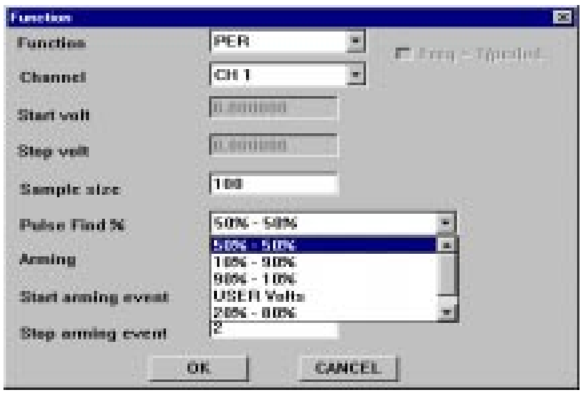


Figure 4.42 Function Pulse Find Percentage Selection

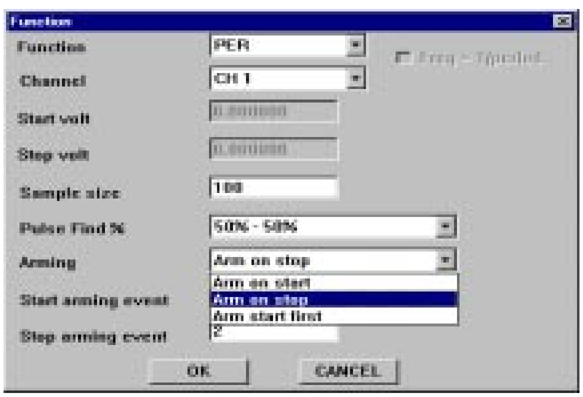


Figure 4.43 Function Arming Selection

ARMING

The **Arming** dialog window contains settings for External arming and Gating. The options give full control over the use of the ARM1 and ARM2 inputs of the DTS.

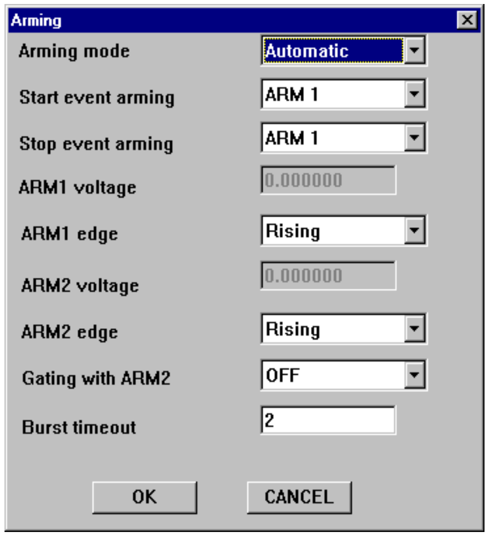


Figure 4.44 DTS Arming Selections

- **Arming mode** – Selection of automatic arming (arming from input signal) or external arming (arming from ARM1 or ARM2 inputs).
- **Start event arming** – Selection of ARM1 or ARM2 for the start event.
- **Stop event arming** – Selection of ARM1 or ARM2 for the stop event.
- **ARM1 voltage** – Entry of trip voltage of ARM1 input and selection of RISING or FALLING edge. Trip level limits are +/- 1.1 volts.
- **ARM2 voltage** – Entry of the trip voltage of ARM2 input and selection of RISING or FALLING edge. Trip level limits are +/- 1.1 volts.
- **Gating with ARM2** – Selection to use ARM2 input as a "gating" input. With gating ON the trip voltage set by ARM2 voltage is used. Rising sets gating high and falling sets gating low.
- **Burst Timeout in seconds** – Sets the time-out period, in seconds, before the instrument will report the error, '**No Pulses Found**', after initiating a measurement.

  The default time period is 10 sec.

FILTER

The **Filter** dialog window allows the time-range filtering of the DTS to be specified as either a **Window** (max./min.) or **Bandpass** (center/width) filter. If both are toggled on, the **Window** limits will be used after a warning dialog box is displayed (Figure 4.45).

Figure 4.45 Filter Warning Message

The **DTS Filter** options are (See Fig. 4.46):

- **Bandpass Filter** – Select bandpass filtering of measurements.
- **Bandpass Center** – Enter center reference time of a timeband to be used in calculating statistics when **Bandpass Filter** on.
- **Bandpass Width** – Enter filter range (0 to ±2.49 seconds) of **Bandpass Filter**.
- **Bandpass Unit** – Enter time unit of bandpass filter.
- **Window Filter** – Select window filtering of measurements. Takes precedence if both types of filtering are on.
- **Window Filter Max**. – Enter maximum filtering time.
- **Window Filter Min**. – Enter minimum filtering time.
- **Max. Unit** – Enter time unit of Window Filter Max.
- **Min. Unit** – Enter time unit of Window Filter Min.

Max./Min. times can be entered in seconds, milli-, micro-, nano- or picoseconds.

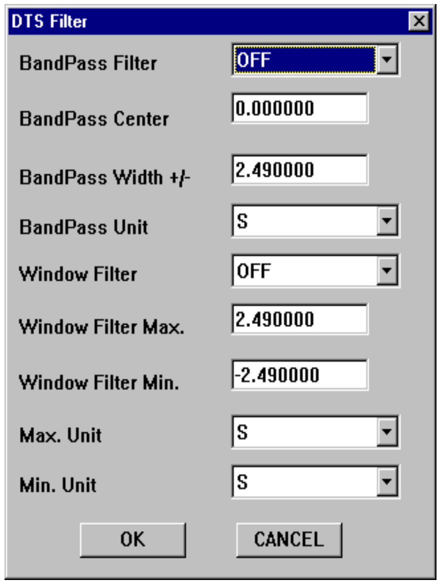


Figure 4.46 DTS Filter Options Window

PULSE FIND

The **Pulse Find** dialog window allows selection of PEAK, FLAT or STROBE pulse find methods and pulse find activation. It then displays the VOH, VOL, Vp-p for CH1, CH2, ARM1 and ARM2 channels as appropriate for the function setup. It also presents the PEAK values when finding FLAT. Clicking on **Pulse Find** will display the respective window with the voltages that are not applicable desensitized.

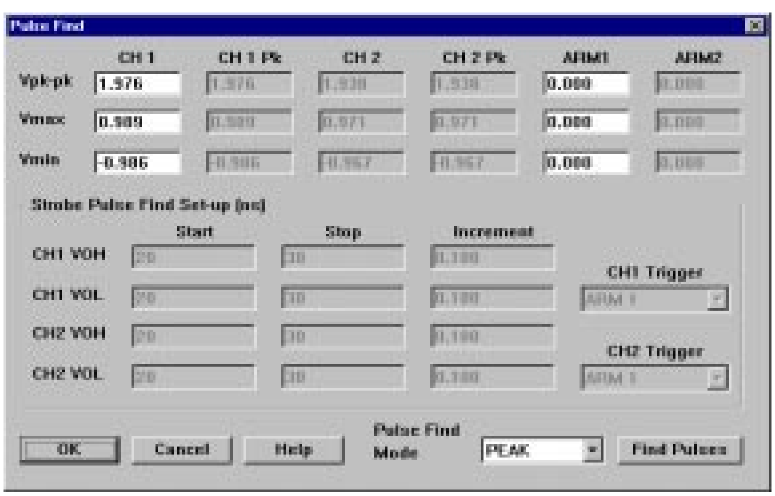


Figure 4.47 Pulse Find Dialog Window

- **Pulse Find Mode** – Presents selection of PEAK, FLAT or STROBE as the type of pulse find to be performed.

  Peak - Finds the positive and negative peaks of the input signals selected under DTS FUNCTION/CHANNEL. CH X and CH X Peak entries will be the same.

  Flat - Finds the peaks the same as PEAK selection and then finds the Vmax and Vmin flat areas of the pulse positive (Vmax) and negative (Vmin).

  Strobe - Finds the average voltage of a strobe window area based on the entry times of entry boxes and Strobe Pulse find Setups (in picoseconds). For each channel selected (under DTS FUNCTION/CHANNEL) a VOH (positive peak) Start, Stop and Increment times, as well as a VOL (negative peak) Start, Stop and Increment times must be set.

  Find Pulses - Click on button to initiate a pulse find and observe voltage windows changing.

The ARMING input for each channel must be set as either ARM1 or ARM2. The arming voltages must be set up under DTS/ARMING.

SCALING

The **Scaling** dialog window allows the user to select Auto or Fixed graph scaling modes as well as Upper and Lower limits, Units and Event max:

- **Scale mode**

  Auto - This mode will "hold the extreme" values encountered in a series of measurements.

  Fixed - When in Fixed, the user can specify the upper and lower limits to plot. The fixed limits are applied to the measured value axis.

- **Upper limit** – Set the maximum scale limit in fixed mode.
- **Lower limit** – Set the minimum scale limit in fixed mode.
- **Unit** – Set unit of measure: seconds, milli-, micro-, nano- and picoseconds.

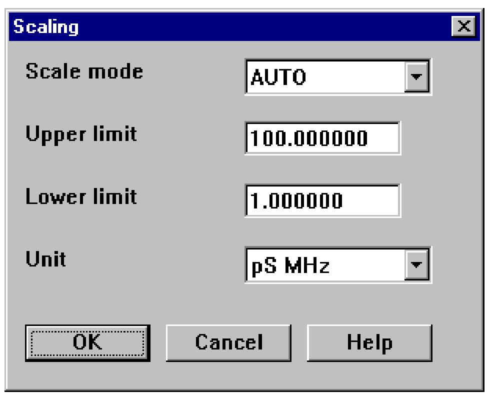


Figure 4.48 Scaling Dialog Window

RESET TO DEFAULTS

Each display window has one DTS configuration set specified as the "preset default" for that window. The pop-up menu provides the choice of enabling or disabling the default feature. If the "preset default" configuration is not used, the DTS configuration from the last use of the window is reloaded. When the user changes parameters and exits a panel, the changes will be saved as the default parameters for that panel. On reentry into that panel, the new defaults will be used.

FRONT PANEL ON

The **Front Panel On** selection turns the instrument's LCD front panel on or off during operation.Measurement cycle time will be decreased if the front panel display does not have to be updated. When the utility package is finally exited, the display function of the DTS will be turned on for normal operation.

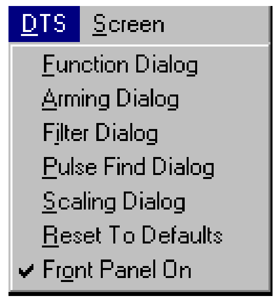


Figure 4.49 Front Panel On Selection

4.3 SCREEN SELECTIONS

The **Screen** options pull-down menu on each panel's menu bar (except STATISTICS panel) provides access to display characteristics. Selections under **Screen** include **Show Grid**, **Markers**, **Zoom** and **Overlays**.

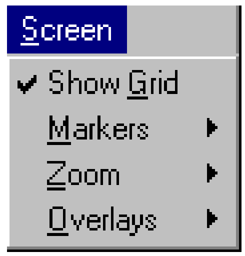


Figure 4.50 Screen Options Pull-down Menu

- **Show Grid** turns on/off the vertical and horizontal grid lines of the activated panel.
- **Markers** provides movable grid lines which are controlled by the up/down/left/right keys on the keyboard. The four movable markers can be displayed all at once, horizontal markers only, vertical markers only or no markers at all. The Bottom and Right markers are controlled by pressing the Shift key and then an arrow key. Red colored text near the top of the panel displays the position of each marker and the difference between them.

  Markers can also be positioned by using the right button of a pointing device (mouse). Click and drag near the marker to be repositioned using the right mouse button. Release the mouse button when the marker is positioned in the desired location. Note that you do not need to click directly on top of a marker in order to select it. The marker nearest your pick point will be selected.

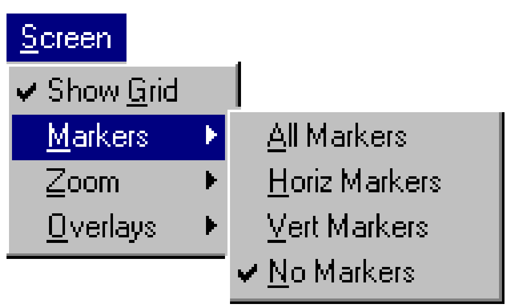


Figure 4.51 Markers Pull-down Menu

- **Zoom** selection under **Screen** options allows the selection of zooming only the x-axis or both the x- and y-axes when utilizing the **Zoom In/Out** feature described in Section 2.6.

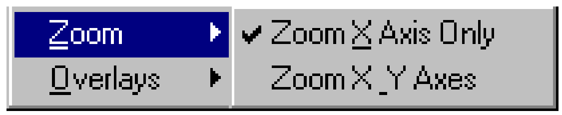


Figure 4.52 Zoom Pull-down Menu

The **Zoom In/ZoomOut** feature is activated using the left button of a pointing device (mouse). To **Zoom In**, click and drag using the left mouse button until the area to be enlarged is high lighted. This can be done repeatedly until the desired magnification is achieved. To **Zoom Out**, double click the left mouse button. Double-clicking will zoom out one level each time. If the user
has zoomed in three times, it will take three double-clicks to return to normal view.

- **Overlays** selection is available on the JITTER, TIME DIGITIZER, OSCILLOSCOPE, FUNCTION ANALYSIS and dataCOM panels. This feature gives the user the option of displaying up to 10 measurements, or sets of measurements, on top of each other for comparison.

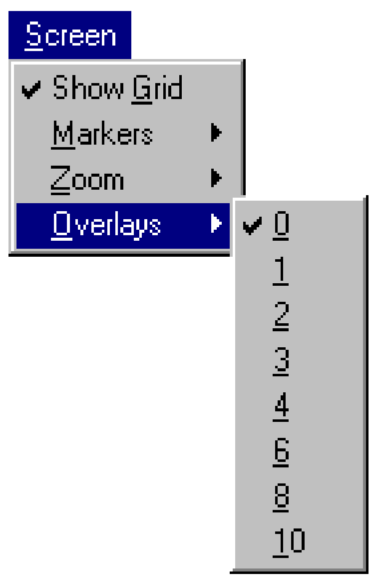
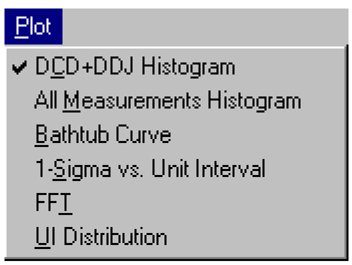


Figure 4.53 Overlays Pull-down Menu

4.4 PLOT

This feature is applicable to the the dataCOM panel, the Eye Histogram panel and, when the Tail-fit option is selected, the Histogram panel.

- **DCD + DDJ Histogram** - Displays a histogram of the data dependant jitter.
- **All Measurements Histogram** - Displays a composite histogram of the normalized raw jitter readings.
- **Bathtub curve** - Displays bit error probability vs. Unit interval.
- **1-Sigma vs. Unit Interval** - Plots 1-Sigma vs. Unit Interval.
- **FFT** - Fast Fourier Transform of Autocorrelation Function.
- **Unit Intervals Distribution** - Displays events vs Unit Interval.



dataCOM Plot Options

Eye Histogram and Spectrum Plot Options

Figure 4.54 Plot Options

See Section 6.1 for examples of **Plot** option graphs.

SECTION 5 – DEFAULT SETTINGS: STARTUP (TUTORIAL)

The following section will present the user with a step by step procedure for changing specific parameter configurations for the **Statistics** and **Histogram** windows and then performing a measurement.

5.0 VIRTUAL INSTRUMENTS DEFAULT CONFIGURATION

Virtual Instruments defines the initial defaults as:

- **Function**: PER
- **Channel**: 1
- **Start Voltage**: From pulse find
- **Stop Voltage**: From pulse find
- **Sample Size**: 500
- **Arming**: Auto trigger on stop
- **Pulse Find %**: 50%-50%
- **Arming Mode**: Auto
- **Start Ext. Arm**: Arm 1
- **Stop Ext. Arm**: Arm 1
- **Band Pass filter**: Off
- **Window Filter**: Off
- **Start Arming Count**: 1
- **Stop Arming Count**: 2
- **Arm 1 Voltage**: 0.0
- **Arm 1 Edge**: Rising
- **Arm 2 Voltage**: 0.0
- **Arm 2 Edge**: Rising
- **Gate**: Off

OTHER SETTINGS

- **Cycling**: Single
- **Scaling**: Auto

The examples in this section will list only those parameters that are changed from the default settings. The two (2) examples given are a tutorial which will guide the user through each step to set the instrument up to operate with minimal parameter changes. Each example starts by selecting a panel from the **WINDOW** pull-down menu.

The **Statistics** and **Histogram** examples will utilize the 200 megahertz calibration signal used to externally calibrate the instrument as the input signal.

Connect the instrument as follows:

- CAL1 to Channel 1
- CAL2 to Channel 2

5.1 STATISTICS TUTORIAL

Select **Statistics** from the **Window** pull-down menu. The Statistics panel will be displayed without any data in the window (See Fig 5.0).

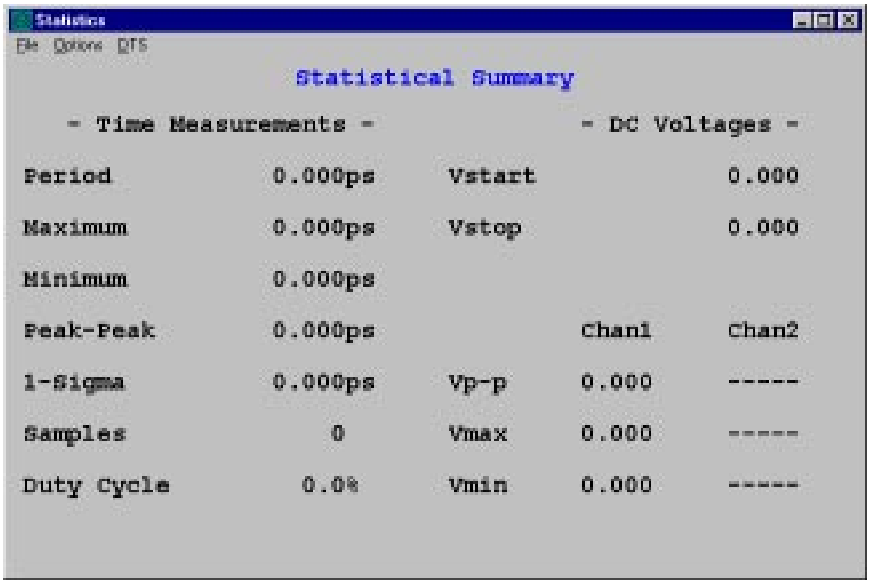


Figure 5.0 Statistics Panel

Click the mouse on the **DTS** selection of the menu bar.

Select **Pulse Find** and the pop-up window will appear (See Fig. 5.1):

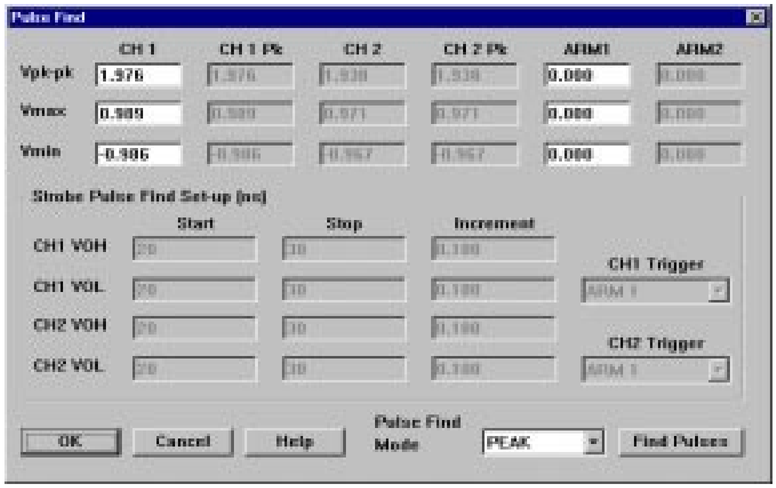


Figure 5.1 Pulse Find Menu

- Check that the **Pulse Find Mode** is set to PEAK.
- Click on **Find Pulses** – The Peak to Peak, Max and Min voltage values will be found and displayed.
- Click the mouse on **OK** to return to the Statistics panel.

Click the mouse on **GO** and the measured data statistics will be displayed. To verify these values are correct, compare these values with those on the front panel of the instrument. If verification fails, start this section over.

If the values are correct, the instrument is connected properly with the host computer and further measurements can be taken.

NOTE: **If the instrument is powered down or a CLEAR is performed from the front panel menu, use the CONNECT button to reestablish communications.**

To automatically perform a **Pulse Find** before each measurement:

- Select **Options** from the menu bar and dialog window will be displayed.
- Toggle the **Automatic Pulse Find** selection from **OFF** to **ON** (See Fig. 5.2).

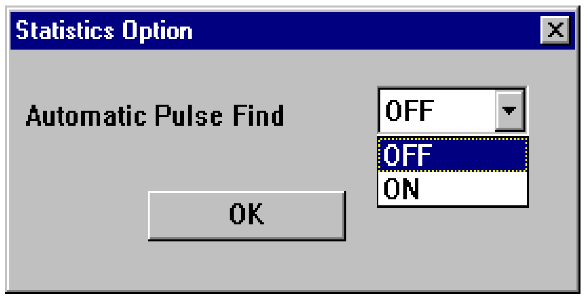


Figure 5.2 Statistics Options Dialog Window

- Click **OK** to exit dialog window.
- Click **GO** to initiate measurement and view voltage values on the **Statistics** panel.

5.2 HISTOGRAM TUTORIAL

The **Histogram** panel displays a histogram of the individual samples taken in a single burst. The histogram may be drawn in one of three styles: straight line point-to-point between bin centers, stepped to show each bin or as triangles with a line to each peak on each bin center.

The data displayed can be presented in one of three sequences:

- **Normal** - The data of each burst presented by itself.
- **Accumulate** - The new data at each bin is added to the previous data at that bin.
- **Overlay** - The maximum data measured at a bin, cumulatively, is presented.

The **Histogram** panel includes the Latest and Overall statistics which are displayed at the bottom of the panel (See Fig. 5.3).

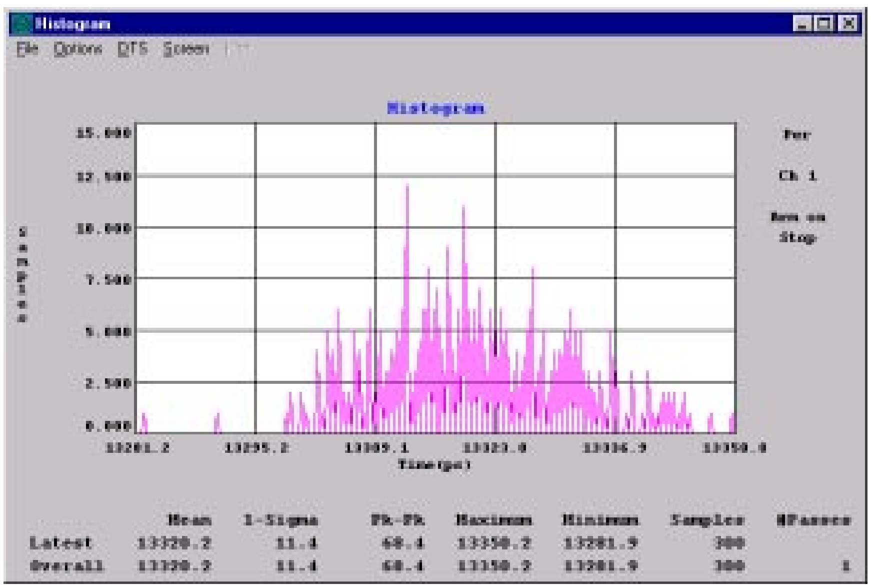


Figure 5.3 Histogram Window

Select **Options** on the menu bar and ensure the Histogram options are:

Graph style = Triangle and **Update mode = Normal** (See Fig. 5.4).

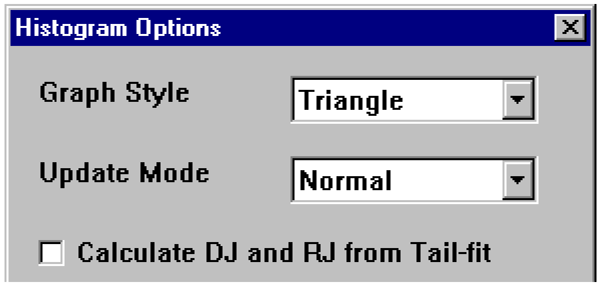


Figure 5.4 Histogram Option Dialog Window

Click mouse on **OK** to return to the **Histogram** panel.

Click on **GO**. A measurement will be taken and the data plotted. Also, the statistics of that measurement will be displayed at the bottom of the panel.

Using **GO**, repeat the measurement a few times and the overall statistics will start to be different from the latest statistics.

- **Graph Plotting Style**

Click **Options** on the menu bar and select the different graph styles, **Stepped, Straight** and **Triangle,** taking measurements using each to become familiar with the different results. (See Fig. 5.5.)

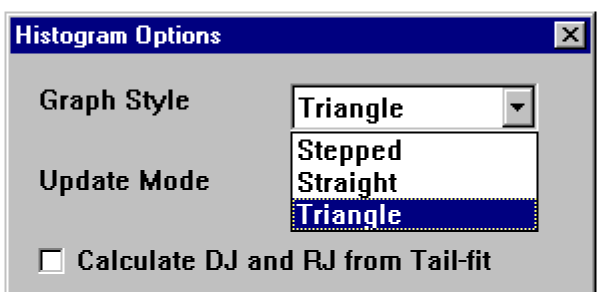


Figure 5.5 Histogram Graph Styles

- **Update Mode**

  Click on **Options** on the menu bar and click **Accumulate** under the **Update mode** selection.

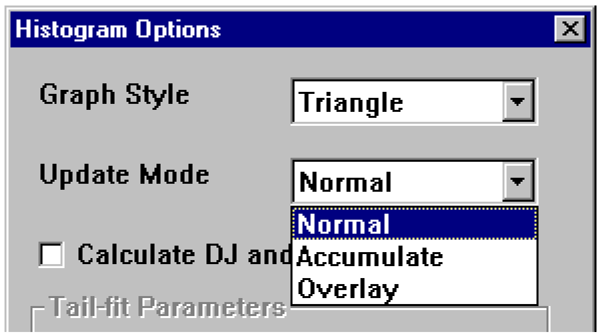


Figure 5.6 Histogram Update Mode

Click **OK** to return to the **Histogram** panel.

Using **GO**, take a few measurements and watch the highest vertical scale number get larger. With the **Accumulate** option, the value, at each time measurement, is added to the previous accumulated value at that time and the result is plotted.

Click on the **RESET** button. Click on **GO** to take a measurement. Notice, because autoscale is selected as default, the graph scaling is reset as well as the overall statistics at the bottom of the panel.

Click on **Options** and select **Overlay**. Click **OK** and return to the **Histogram** panel.

Take a few measurements in the Overlay mode and observe how the graph expands vertically only if the data, at a particular time bin, is greater than previous measurements.

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SECTION 6 – PANEL DESCRIPTIONS AND EXAMPLES

The following section will present specific panel configurations that will display relative graphs of measurement acquisitions demonstrating how *Virtual Instruments* can analyze real-world situations.

Each example will:

- *Identify the measurement purpose*
- *Identify the panel parameters that are different from the default settings*
- *Show the resultant graph*

6.0 PANEL DESCRIPTIONS

STROBING DIGITAL VOLTMETER (OSCILLOSCOPE)

The DTS has a Macro GPIB statement enabling the user to set the starting time, stopping time, and scan resolution for the programmable delay used in conjunction with the built-in strobing digital voltmeter, SDVM. When this statement is executed, the DTS takes voltage measurements at the times specified and stores all of the voltage data points within the DTS memory. The DTS then calculates statistics on the voltage points measured. The Middle voltage of all the points is calculated, the MAX and MIN voltages are found and the root mean square, r.m.s., of the volt age points is also calculated.

The statistics are then passed to the *Virtual Instruments* software along with each of the data points. All of the measurements taken are displayed in the OSCILLOSCOPE window in *Virtual Instruments*, see Figure 6.10. The graphic display in Figure 6.20 is showing both channel outputs of an HP8110A data generator on a color screen with each channel being displayed in a different color.

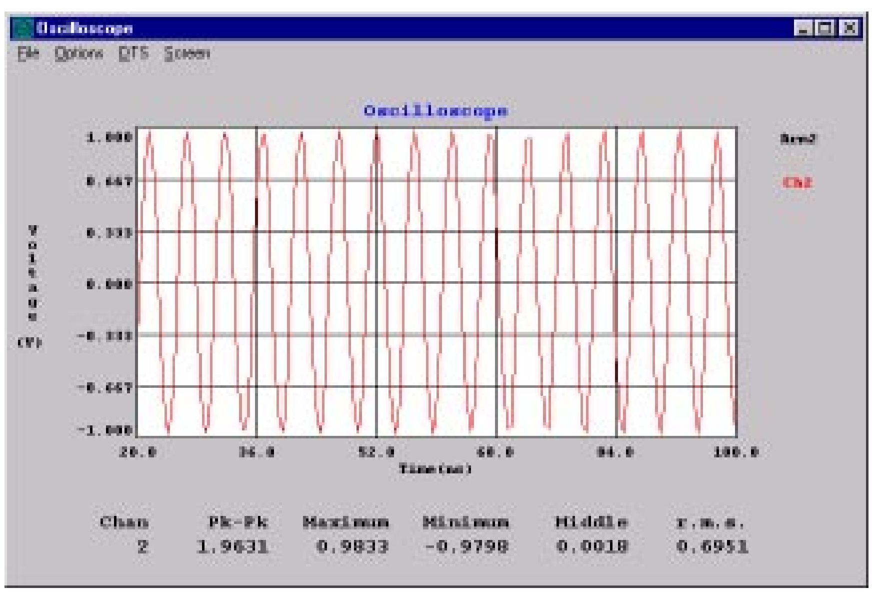

Figure 6.0 Strobing Oscilloscope

Virtual Instruments automatically scales the vertical voltage resolution to fit the pulse amplitude on the screen. The Horizontal scale is set by the user by entering the starting and ending times into the OPTION/OSCILLOSCOPE window. The starting time is referenced to a positive or negative going signal on the External Arm input 1 or 2. This Arming signal acts similar to a trigger pulse in an oscilloscope. The graphics display software automatically sets the horizontal scale by taking the ending time minus the starting time and dividing by 8 for the time between divisions.

At the bottom of the graphics printout in Figure 6.9 is a legend showing each channel's statistical information . This information is useful when the user is trying to find and define glitches for glitch energy parameters of a pulse, how flat is the top or bottom of a pulse or what is the average/Max/Min/StdDevof the VOH or VOL of a pulse.

Figures 6.13 and 6.14 show using the SDVM to improve the repeatability of determining the VOH/VOL of a pulse with distortion or ringing on it's high and low levels. This is especially useful in tri-state testing where the VOHZ/VOLZ are specified as 0.3 volts below/above the VOH/VOL levels respectively. Because the tri-state rise/fall times are very slow, the TPHZ/TPLZ propagation delays are not repeatable if the VOH/ VOL levels are not stable. The SDVM, time window feature reduces the testing guardband required by the manufacturer for the specifications on devices of this nature. See Section 3.1, Oscilloscope Panel, for strobe arming information.

HISTOGRAM ANALYSIS

The DTS, when measuring time using it’s Time Measurement Unit, acts like a one-shot time domain spectrum analyzer. When the user Auto Arms and does a measurement burst of some number of time measurements, lets say 1000, the DTS measures the function specified by the user occurring on the channel(s) and displays the results as multiple jitter histograms. See Figure 6.18 for an example of many different jitter histograms occurring on the same channel during the time the DTS was executing a burst of measurements.

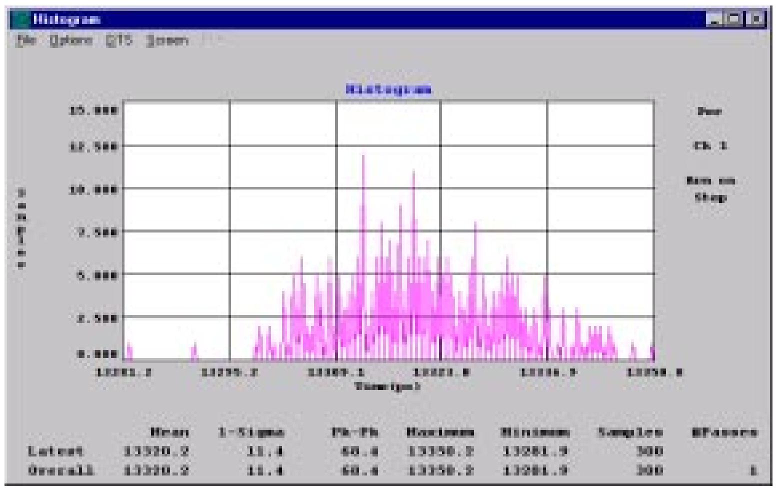

Figure 6.1 Histogram Panel

The legend at the bottom of the graph indicates the average of all of the data displayed, the rms jitter, or one standard deviation of the data displayed, the ± peak jitter of the data displayed and the Min. time measured and the Max. time measured during the burst. If the data filters (see Section 4.2, DTS/FILTERS) are used to isolate one of the histograms in Figure 6.18, then the legend at the bottom would only display the statistics for the filtered data as shown in the histogram in Figure 6.20. The user can display all of the data taken by the DTS using the histogram window: pulse width, TT+, TT-, TPD++, TPD—, TPD+-, TPD-+, period and frequency.

JITTER ANALYSIS

This feature of the DTS (See Figure 6.25) uses the 'Arm on Nth event' or 'Arm on Count' feature of the Arming circuitry to start a measurement at a count within a pulse stream and stop the measurement at another point within the same pulse stream. (See Applications Note 115, "Arming the DTS" for details on how to use this feature.)

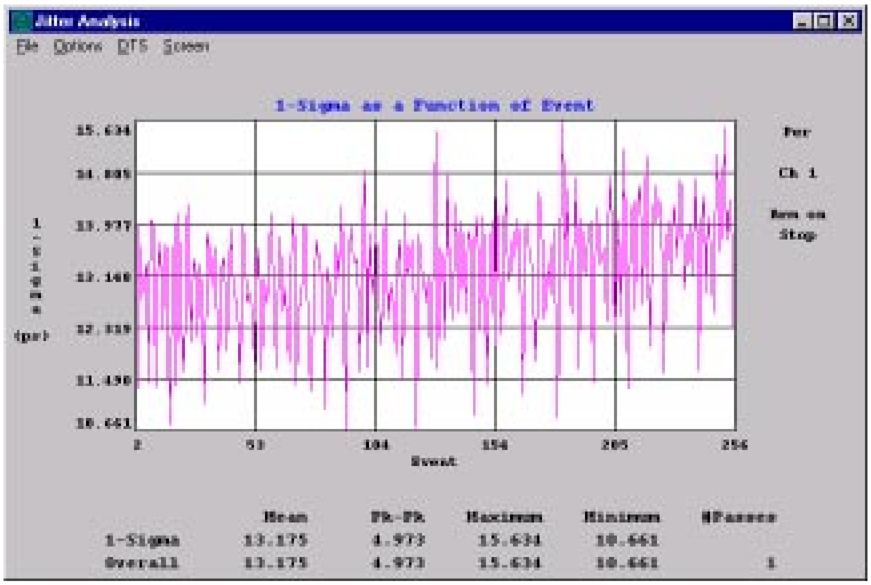

Figure 6.2 Jitter Analysis Graph

For example, if we have a perfect square wave clock pulse with only 10ps rms jitter on the period caused by electron noise only. The jitter on one period could measure 10ps and if the user measured the jitter over a double or triple period, the user would still measure 10ps rms jitter over many hundreds of periods. This occurrence is only true in very low phase noise oscillators and is seldom the case with PLL's used in noisy digital environments. Consequently, the user must have tools to analyze and define phase jitter from multiple sources.

The *Virtual Instruments* jitter analysis window enables the user to scan a range of periods, or other functions, to measure the jitter over the specified count delta and graphically display the results. Figure 6.25 shows the range of 200 periods measured and the rms jitter measured at each period. For example, in Figure 6.25, the user selected from 1 period to 200 periods to measure the jitter. The burst count was set at 100 measurements and the GO button pressed. The results are shown in Figure 6.25, 6.26 and 6.27. The legend at the bottom of the figure shows the average rms jitter displayed, the ± range and the min and max jitter measured.

FUNCTION ANALYSIS

Function Analysis enables the user to view the measured value of the signal on either or both channels with respect to its cycle count starting from some trigger/arming point supplied by the pulse generator, ATE system or circuit under test. Figures 6.29 through 6.35 demonstrates the information available using this window.

For example, Function Analysis would be used to measure PLL frequency or period settling time from the point where the change was initiated, see Figure 6.31 through 6.34. The stair step display shows the time for that pulse cycle in the figures presented. In Figure 6.29, the HP 8110A data generator was programmed to generate a 20 MHz RZ clock pattern which repeated every 150 pulses. It can be seen that every other clock period toggles by as much as 150ps and that the first two pulses after the generator pattern repeats, deviate even more. Consequently, the Function Analysis window will help the user view any synchronous jitter pattern that may exist and also view the cycle to cycle measurements within the pattern.

Function Analysis can also display measurements as a function of time by selecting that option in the FUNCTION ANALYSIS/OPTION window. Also the user may want to view the derivative of each consecutive measurement with respect to the last measurement. To do that, the user can select DERIVATIVE in the FUNCTION ANALYSIS/OPTION window. At the bottom of the graph are the function and jitter statistics for the displayed data.

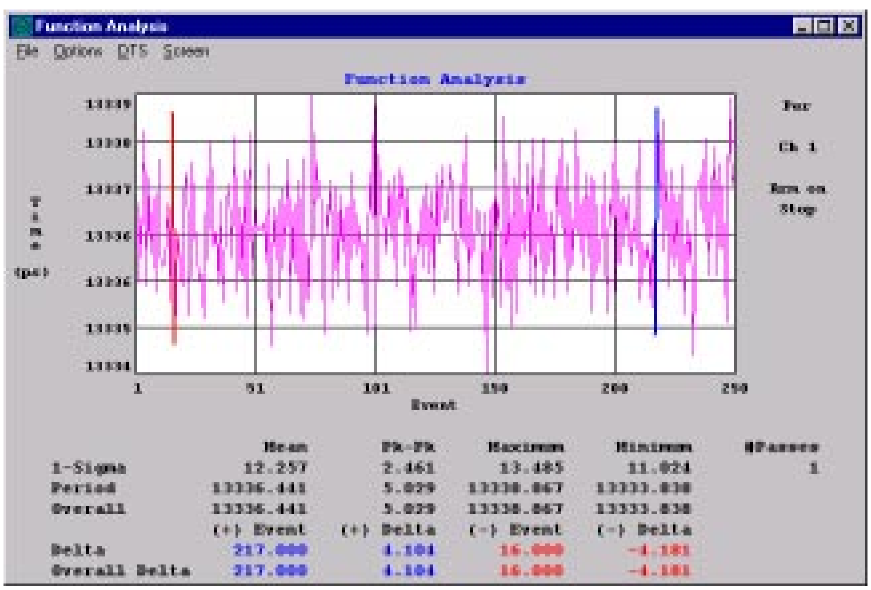

Figure 6.3 Function of Event Analysis

The Function Analysis window can be used in the AUTO ARM mode as well as in the EXTERNAL ARM mode. In auto arm mode the data represents overall measurement variations or peak to peak, while, in external arm mode, the data displayed will show cycle dependent anomalies with respect to the external arm point.

One of the main features of *Virtual Instruments* is its ability to view any of the measurement functions using this window. For example, in the above examples period and frequency were being viewed in this mode, but, pulse width, rise/fall times and the delay between channels can also be viewed for these pattern dependent anomalies.

TIME DIGITIZER

The Time Digitizer enables the user to view a BURST of data taken by the DTS sequentially with the first one-shot measurement taken being placed on the left side of the graph and the last one-shot measurement taken being placed on the far right side of the graph. Each dot represents a one-shot measurement within the burst and the dots are connected together with lines to make pattern recognition easier for the user to see.

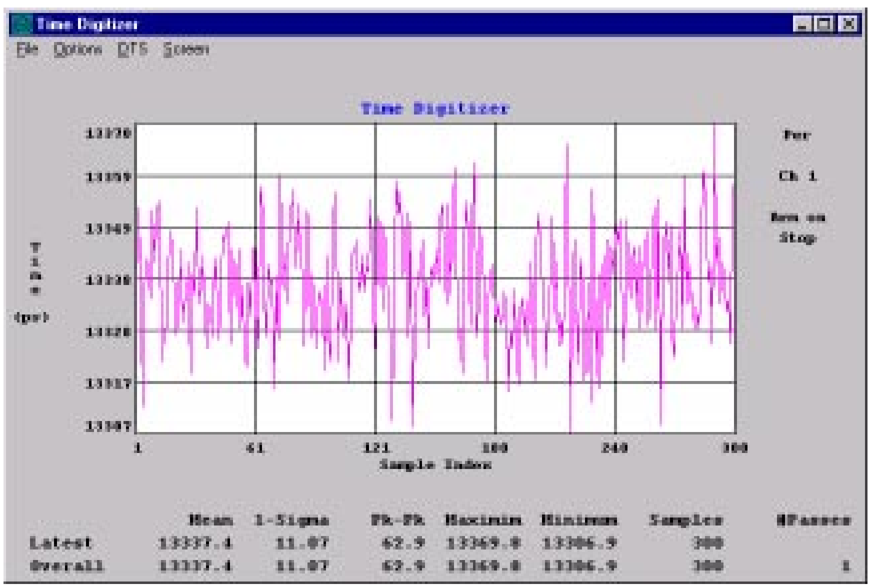

Figure 6.4 Time Digitizer

TheTime Digitizer is useful for power up testing of PLL circuits, viewing low frequency jitter problems both synchronously and asynchronously with either the AUTO ARM and EXTERNAL ARM modes being enabled. As with all of the other *Virtual Instruments* windows, Time Digitizer can be used with all of the DTS measurement functions. In Figures 6.36 and 6.37, low frequency pattern problems are displayed using time digitizer. In the examples, the duty cycle of the data varies depending on the pattern being transmitted over the channel. By arming the DTS with the beginning of the data pattern, the exact location of the anomalies can be detected. The DTS can look out up to 300ms in time using the Time Digitizer window.

dataCOM

ThedataCOM features of *Virtual Instruments* are best illustrated in Figures 6.38 through 6.45. For these examples, a fibre channel data pattern has been simulated and inputted to the DTS. When using the Data Com panel, the same measurement data can be analyzed using all **Plot** features: DCD + DDJ Histogram, All Measurements Histogram, Bathtub Curve, 1-Sigma vs. Unit Interval, FFT and Unit Interval Distrubution. The same data "snapshot" is used when plotting across all dataCOM window features.

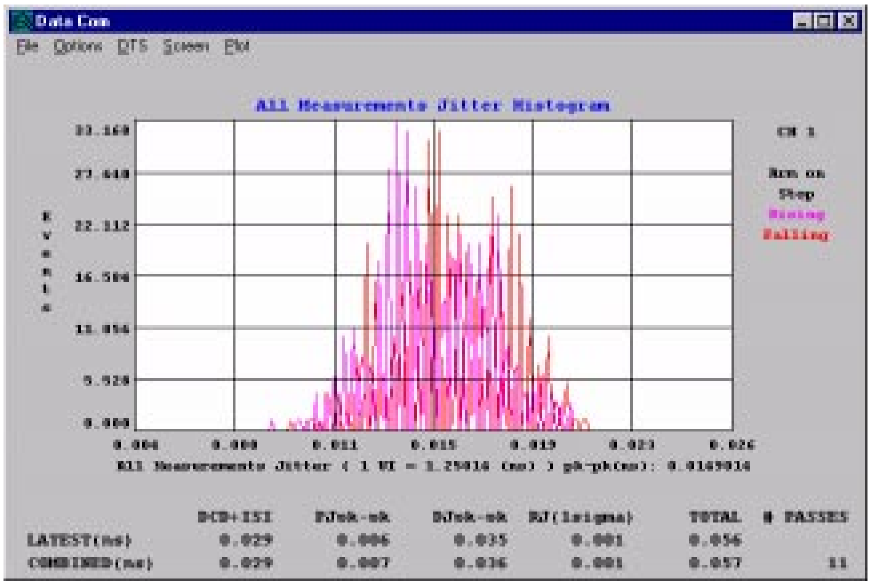

Figure 6.5 dataCOM - Deterministic Jitter Histogram

EYE HISTOGRAM

The Eye Histrogram provides a tool for creating a Histogram of readings when a bit clock is available. A Tail-fit algorithm may then be applied to provide Random Jitter and Deterministic Jitter estimates.

In theory, the tail-part of a histogram distribution reflects the random jitter process. Physically, random jitter is due to the random motion of particles within a device or transmission medium. The random velocity of these particles in an equilibrium state is best described as a Gaussian distribution. Therefore, random jitter is naturally modeled by a Gaussian function. Since multi-temperature particle distribution is possible, a multi-Gaussian distribution function may be needed to model certain random jitter processes.

Based on their definitions, deterministic jitter (DJ) is bounded and random jitter (RJ) is unbounded. The measured total jitter histogram represents the scaled-up, total jitter probability distribution function (PDF). On the other hand, the convolution of RJ PDF with DJ PDF gives the total PDF if DJ and RJ processes are independent. In most cases, such an assumption is valid. Therefore the tail part of the distribution is mostly determined by the random jitter, which, in general, has a Gaussian-type distribution. The random noise can be quantified by the standard deviation (or 1 σ rms value) of the Gaussian distribution. Depending on the error coverage range, the total RJ can be a multiple of the σ, determined from the Gaussian distribution.

In the absence of DJ, a histogram of the jitter should roughly be a Gaussian distribution. Under this condition, there is only one peak in the distribution which corresponds to zero DJ. The rms RJ is the σ value. When both DJ and RJ are present, the measured jitter distribution will be broadened and non-Gaussian as a whole. On the other hand, both ends of the distribution should retain Gaussian-type components. These tail component distributions can be used to determine the RJ number. Because of the DJ, the mean of each tail is no longer the same and multi-peaks can be present in the histogram.

If there is no bias or statistical sampling noise in the measurement, the two tails, which represent the random process, should be symmetrical. Since it is not possible to completely randomize measurements and reduce the sampling noise to zero, the σ values for the far left and right Gaussian tails may not be the same. The total RJ value should be the average of these two.

A fitting algorithm that weights the data record based on the quality of each datum should be used. The bigger the error, the smaller role it should play in minimizing the difference between the model's expected and measured values. Thus, goodness-of-fit is used as a gauge to determine how "good" the fit is. The fitting function is Gaussian and the fitting algorithm is nonlinear so it can handle both linear and non-linear fitting functions.

The modified least-square fitting is an iterating process, in contrast to linear equation solving in the case of linear least-squared fitting. The final answer is obtained when the iteration converges. For this reason, initial values of the fitting parameters are needed.

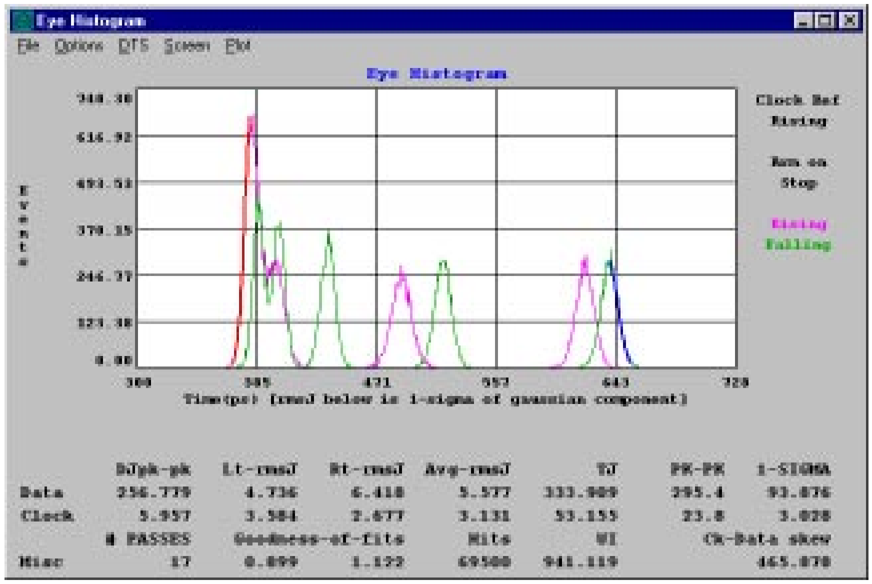

Figure 6.6 Eye Histogram

To use the Histogram Tail-Fit feature, connect a data signal to Channel 1 of the DTS and the bit clock to Channel 2. Open the VI Histogram Window, select TPD++ as the function type and take a sample to determine where the distributions are grouped based on the particular signal being analyzed. Assuming a data pattern is being used, there should be a number of distinct distributions resulting from the various spans in the pattern. Determine the approximate position midway between the rightmost distribution and it's nearest neighbor to the left. Use the DTS filter function to remove all but the rightmost distribution. Take an additional sample to verify that this is the case. Set the Sample Size to 32,000 and enable the tail-fit calculation.

The standard tail-fit method will not return a result until a number of statistical checks are achieved. Therefore it is suggested that the CYCLE button is used along with the "Stop Cycle on Success" option. In this manner data is collected until the criteria is met, and then an answer is returned and the data acquisition halted.

When a tail-fit is successfully completed the calculated tail-fits are plotted on top of the raw histogram, and values for the Deterministic Jitter, Random Jitter, Chi-square goodness of fit, and Total Jitter are displayed (See Figure 6.6). You can also view the resulting Bathtub Plot which is based on the PDF of the raw histogram with extrapolated tails calculated from the tail-fit (See Figure 6.7). The Total Jitter is extracted directly from the Bathtub Plot. Note: For Histogram panel only - The Total jitter Specification (UI) that is used for this calculation is User Defined, make sure that reasonable values are assigned for this as well as the Bit Error Probability.

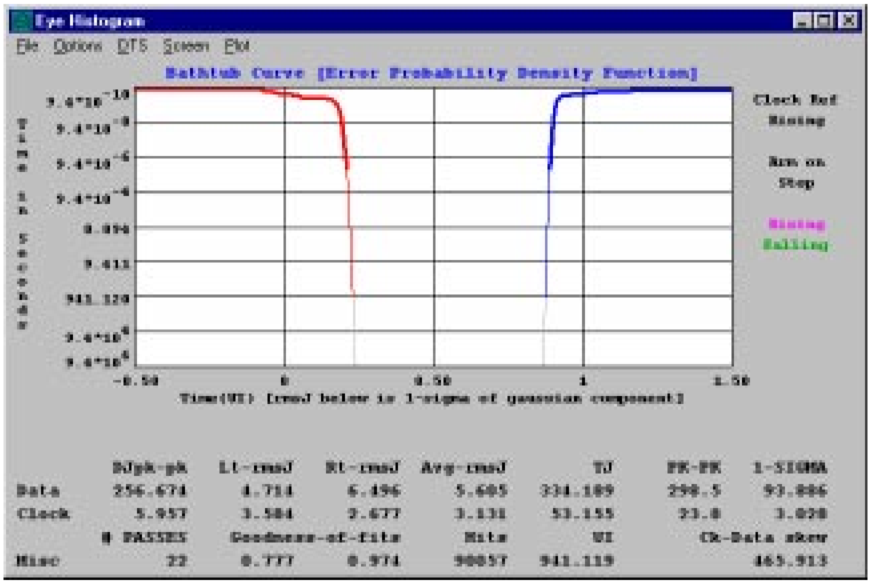

Figure 6.7 Eye Histogram - Bathtub Curve

The default tail-fit employs statistical criteria in order to insure that only quality results are returned. It is, therefore, open-ended in nature. This is suitable for initial characterization, however, it does not lend itself to a production environment. Therefore, a "forced-fit" is also provided in which the number of hits is specified and a single tail-fit is subsequently performed. This option should only be used after initial characterization has been performed and the minimum number of hits required to produce a repeatable tail-fit has been determined.

The Histogram Tail-fit has been designed to be a general purpose tool and can be used on all dual channel measurements, as well as single channel measurements such as period. The general procedure in all cases remains the same as outlined above.

The Eye Histogram will automate this process on data patterns where a bit clock is available. Essentially all initial steps involved in filtering the data is done for you. Samples for both rising and falling edges are also overlaid on top of each other. The Bit Clock also has a tail-fit performed on it which causes an additional delay to occur only on the first pass.

TIME HISTORY (SERIES) STRIP CHART

Figure 6.48 displays time and frequency data in a horizontal format with the most vertical data being the highest one-shot measurement of jitter taken and the lowest line being the most negative one-shot measurement of jitter made. The line in the middle is the measurement AVERAGE of all the data taken by the DTS.

The user can select to view the AVERAGE of the measurements and/or the AVERAGE plus the rms Jitter or the ± peak jitter. This is selected in the TIME SERIES/OPTION window.

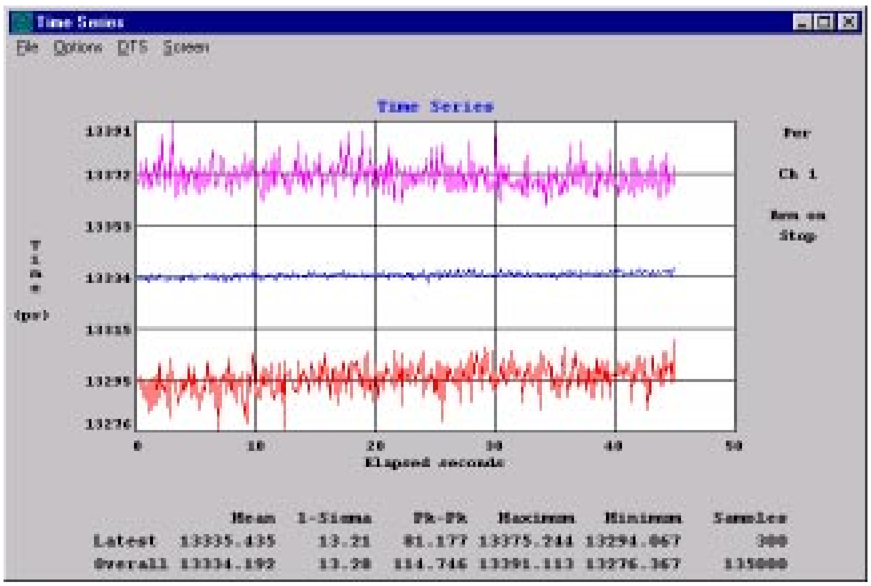

Figure 6.8 Time Series Strip Chart

The “Elapsed Seconds” displayed on the horizontal scale indicates the time over which the burst results are graphically being displayed. In all, the data for up to 500 bursts are displayed across the screen. The Elapsed Time for those 500 bursts depends on the time entered into “Sample Spacing (sec)”, which is in the TIME SERIES/OPTION window. When the user selects “Cycle” from the Tool Bar, the display will continuously move from right to left with the “Elapsed Seconds” time stamping the burst data being displayed within the graph. See Section 4.1, Time Series Panel/Options, for information on Allan Variance.

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6.1 EXAMPLES – SPECIFIC MEASUREMENT FUNCTIONS

The following are a group of examples that show how *Virtual Instruments* can be used to provide the measurement information in a way specific to that need. These examples are presented with the thought that the user has worked through the tutorials of Section 5.0. Only the parameters different from *Virtual Instruments* defaults will be listed.

- **OSCILLOSCOPE DATA vs. CLOCK**
  (Refer to Figure 6.9)

  This is a view of Data on Channel 1 and Clock on Channel 2 for an “Eye Pattern”.

  - Channel .... Both
  - Start .... 10 ns
  - Stop .... 60 ns
  - Increment .... 0.5 ns
  - Trigger ARM1
  - Trigger Voltage .... Rising

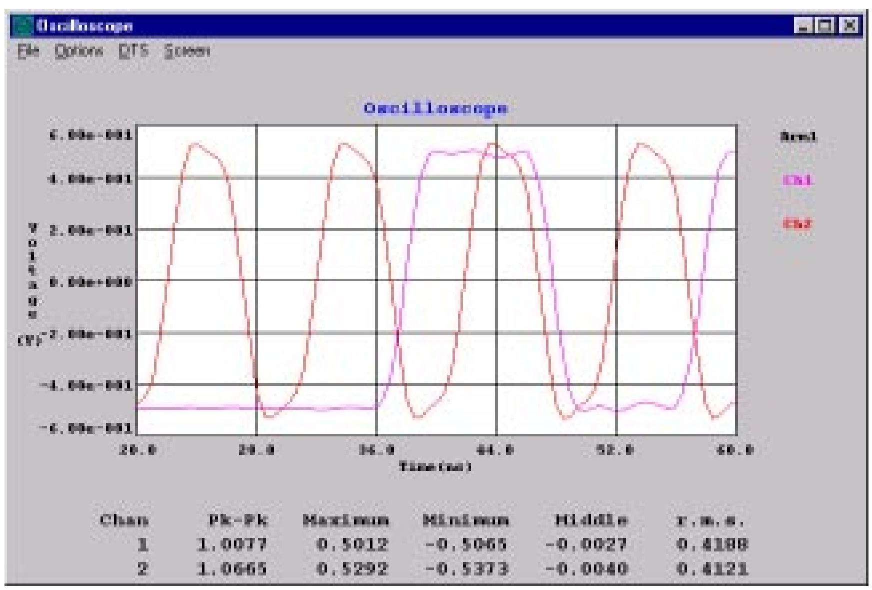

Figure 6.9 Oscilloscope Data vs. Clock

- **OSCILLOSCOPE OF TPD++**
  (Refer to Figure 6.10)

  Oscilloscope software autoscales the vertical axis.

  - Channel .... Both
  - Start .... 20 ns
  - Stop .... 60 ns
  - Increment .... 0.2 ns
  - Trigger ARM1
  - Trigger Voltage .... Rising

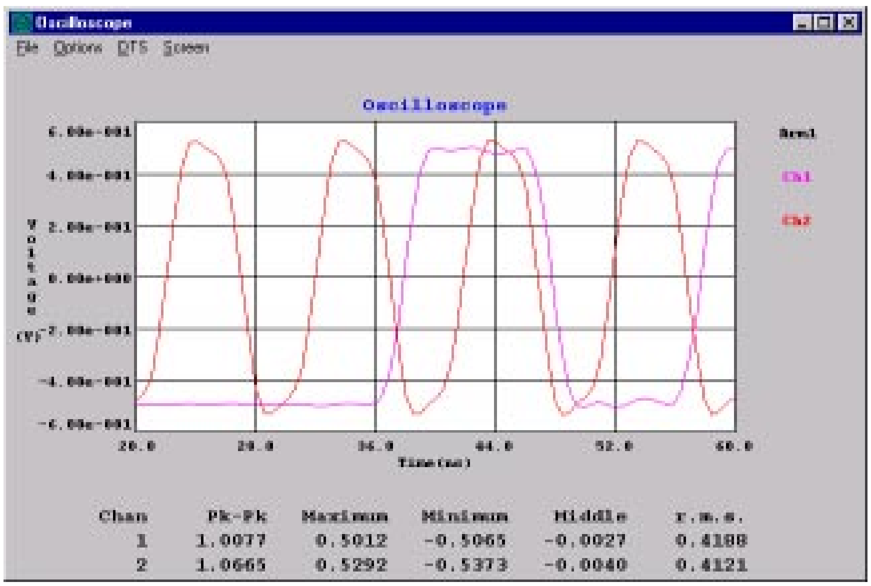

Figure 6.10 Oscilloscope of TPD++

Statistics at the bottom of the graph indicate the Peak to Peak, Maximum, Minimum, Middle and r.m.s. voltages on each channel.

- **OSCILLOSCOPE OF TPD++ (CHANNEL 2 POSITIVE OFFSET)**
  (Refer to Figure 6.11)

  Same as 6.24, except Channel 2 was offset +100 mV.

  - Channel .... Both
  - Start .... 20 ns
  - Stop............................... 60 ns
  - Increment .... 0.5 ns
  - Trigger........................... ARM1
  - Trigger Voltage.............. Rising

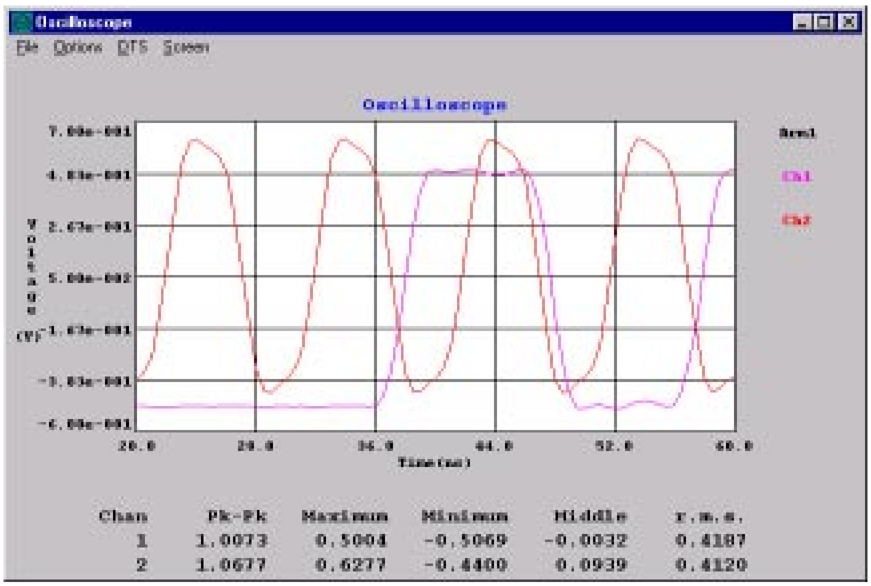

Figure 6.11 Oscilloscope of TPD++ (Channel 2 Positive Offset)

- **OSCILLOSCOPE OF TPD++ (CHANNEL 2 NEGATIVE OFFSET)**
  (Refer to Figure 6.12)

  Same as 6.10 & 6.11 except Channel 2 was offset -100 mV.

  - Channel .... Both
  - Start .... 20 ns
  - Stop .... 60 ns
  - Increment .... 0.5 ns
  - Trigger ARM1
  - Trigger Voltage .... Rising

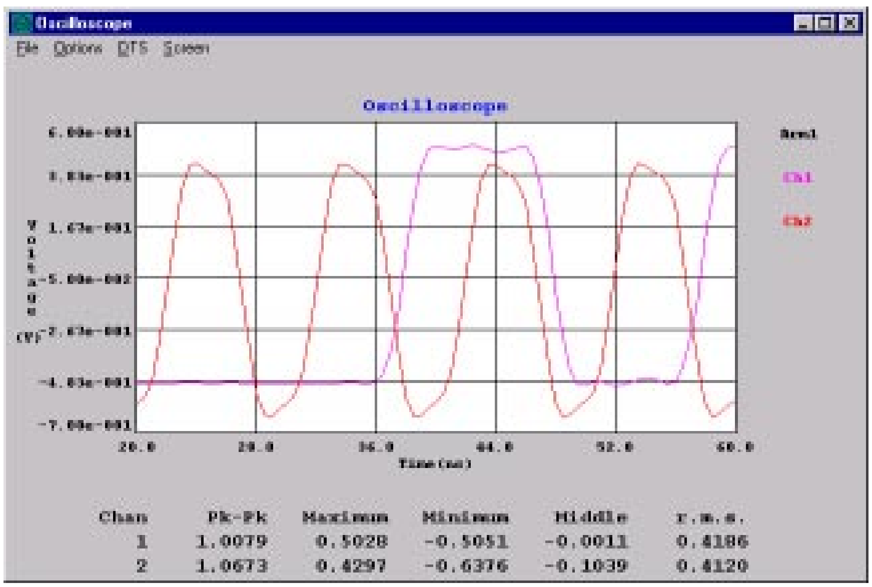

Figure 6.12 Oscilloscope of TPD++(Channel 2 Negative Offset)

- **OSCILLOSCOPE OF VOH**
  (Refer to Figure 6.13)

  Same signal as Channel 1 (Data).

  - Channel 1
  - Start .... 30 ns
  - Stop............................... 40 ns
  - Increment .... 5 ps
  - Trigger........................... ARM1
  - Trigger Voltage.............. Rising

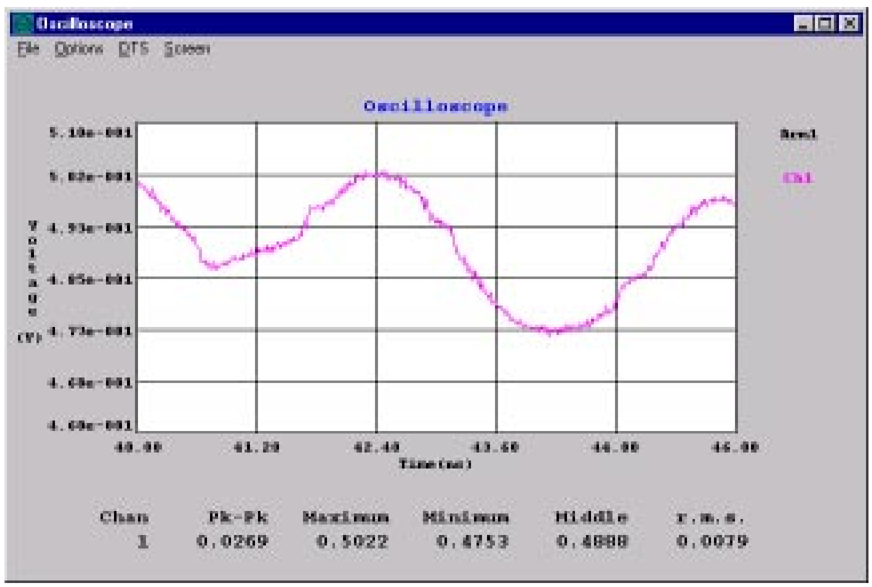

Figure 6.13 Oscilloscope of VOH

Statistics at bottom of graph display the VOH of the “Data” pulse with the peak to peak voltages along with the “mean” VOH. This is useful for determining the actual 100% point for percentage based rise & fall time measurements.

- **OSCILLOSCOPE OF VOL**
  (Refer to Figure 6.14)

Same as 6.13.

- Channel 1
- Start .... 49 ns
- Stop............................... 64 ns
- Increment .... 10 ps
- Trigger........................... ARM1
- Trigger Voltage.............. Rising

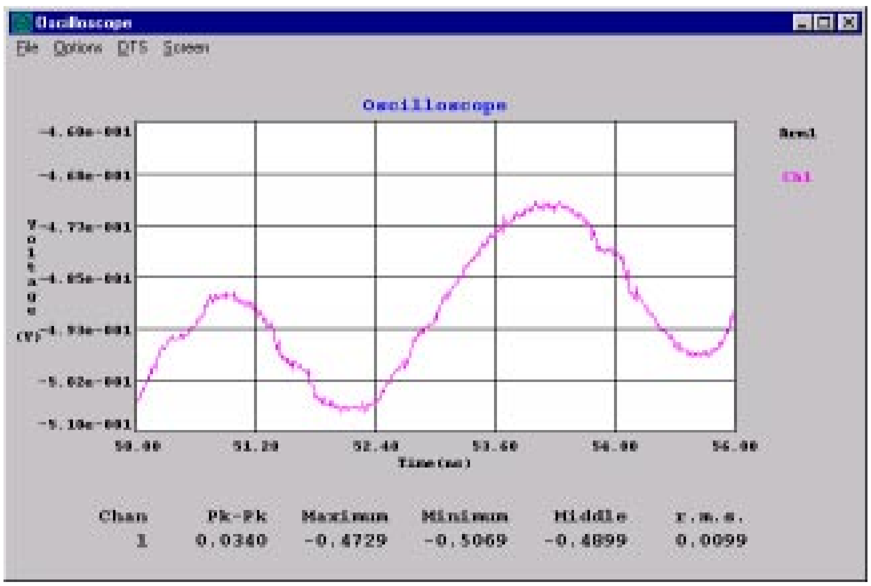

Figure 6.14 Oscilloscope of VOL

Statistics are for the VOL of the “Data” pulse on Channel 1.

- **OSCILLOSCOPE FFT**

  (Refer to Figure 6.15)

  - Channel 2
  - Start .... 10 ns
  - Stop .... 50 ns
  - Increment .... 0.5 Ns
  - Trigger ARM1
  - Trigger Voltage .... Rising
  - Fast Fourier Transform ...... Enabled

    FFT Window .... Kaiser

    Padding 16

    Alpha 6

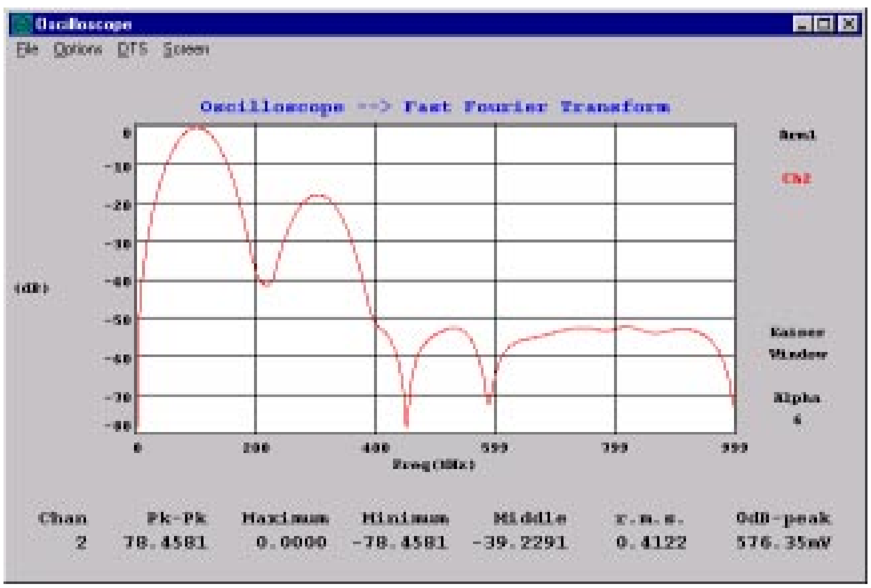

Figure 6.15 Oscilloscope Fast Fourier Transform

Figure 6.14 displays the FFT of the CAL1 200Mhz signal. In addition to the main 200Mhz lobe, the second harmonic frequency can be seen at 600MHz.

- **HISTOGRAM ANALYSIS WITH STEPPED PERIODS (OVERLAY)**
  (Refer to Figure 6.16)
  - Function .... Period
  - Channel.............. 1
  - Update Mode ..... Overlay

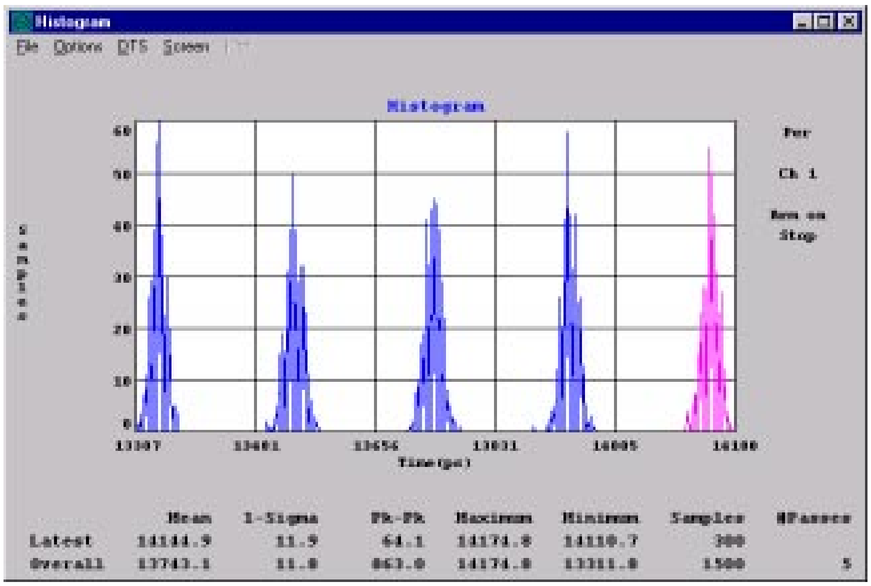

Figure 6.16 Histogram Analysis with Stepped Periods (Overlay)

The signal being measured has each succeeding period increase by 100 picoseconds.

- **HISTOGRAM ANALYSIS (ACCUMULATIVE)**
  (Refer to Figure 6.17)
  - Function .... Period
  - Channel 1
  - Update Mode .... Accumulate
  - Cycle .... Repeat (30 seconds)

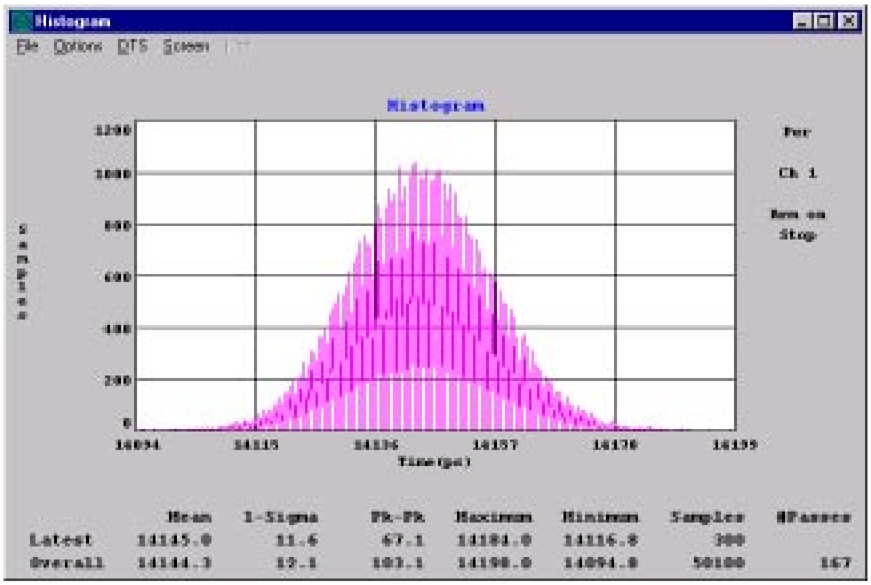

Figure 6.17 Histogram Analysis (Accumulative)

- **HISTOGRAM ANALYSIS WITH RANDOM PERIODS (AUTO SCALE)**
  (Refer to Figure 6.18)

  Auto scaling enables the user to see all the events measured by the DTS. The Event on the vertical axis is equivalent to how often that period occurs on that channel.

  - Function .... Period
  - Channel 2
  - Sample Size 7000

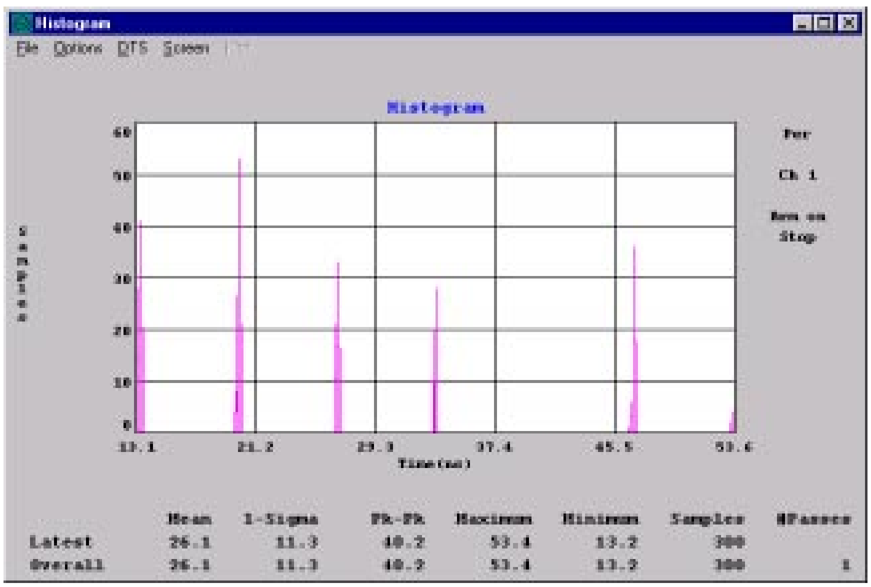

Figure 6.18 Histogram Analysis with Random Periods (Auto Scale)

The random data pattern is a PRBS $2n^{-7}$ with a 20 ns period, RZ, 50% duty cycle.

- **HISTOGRAM ANALYSIS WITH RANDOM PERIODS (FIXED SCALE)**

  (Refer to Figure 6.19)

  The Fixed Scaling feature enables the user to get a closer look at particular distributions in the pattern.

  - Function .... Period
  - Channel 2
  - Sample Size 7000
  - Scaling.................... Fixed, Upper Limit = 25 ns, Lower Limit = 10 ns,

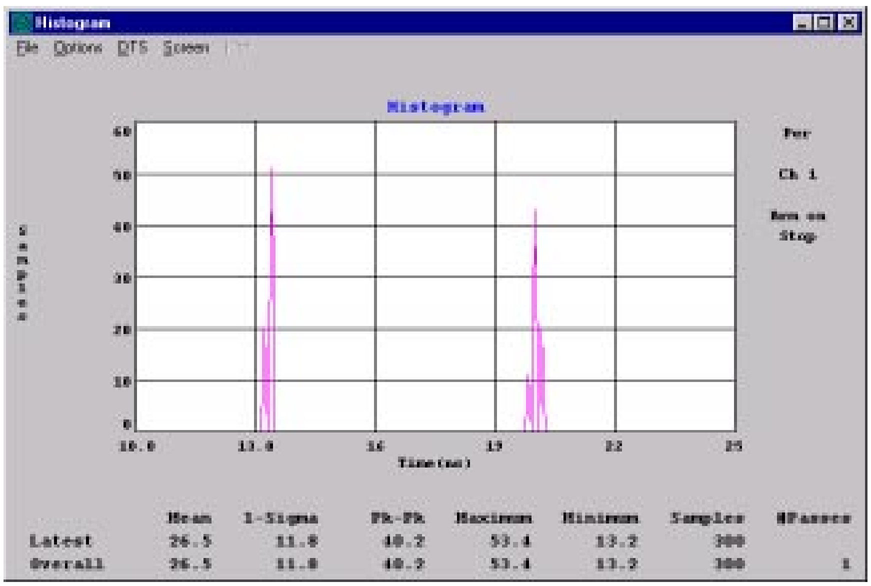

Figure 6.19 Histogram Analysis with Random Periods (Fixed Scale)

- **HISTOGRAM ANALYSIS WITH RANDOM PERIODS (FILTERING)**
  (Refer to Figure 6.20)

  Using the Digital Filter features of the DTS, the user can now get a better look at the statistics and distribution shape of the data period out at 46 ns ± 1 ns. With the filters, specific data can be isolated to measure jitter accurately.

  - Sample Size 7000
  - Cycle .... Repeat
  - Update Mode .... Accumulate Mode

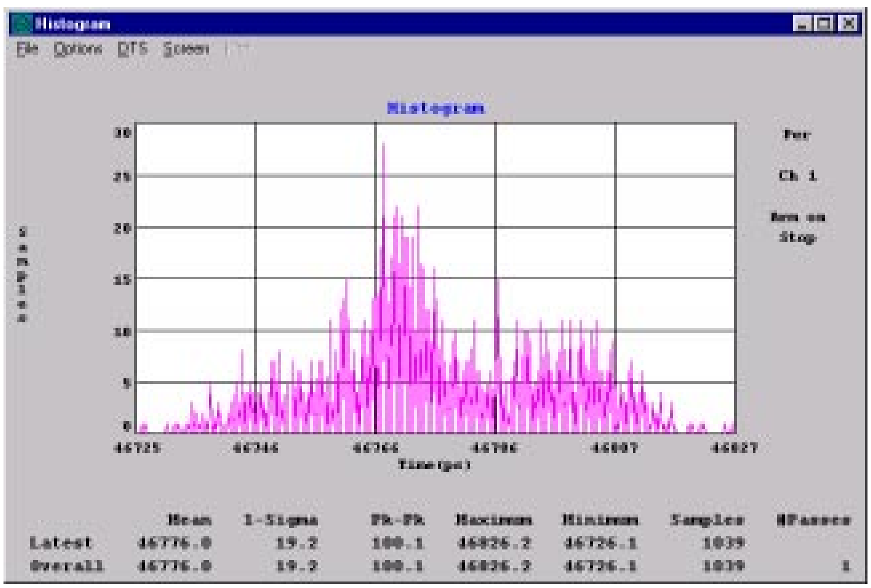

Figure 6.20 Histogram Analysis with Random Periods (Filtering)

The statistics at the bottom of the graph reflect only the 46 ns period.

- **HISTOGRAM ANALYSIS WITH RANDOM PERIODS (FILTERING)**
  (Refer to Figure 6.21)

  Same as 6.19 & 6.20, except the filters are set to 33 ns ± 1 ns to look at the 33 ns distribution. We see here that at 33 ns, due to the random pattern, the period of the data is bimodal.

  - Sample Size 7000
  - Cycle .... Repeat
  - Update Mode .... Accumulate
  - Filters .... ON

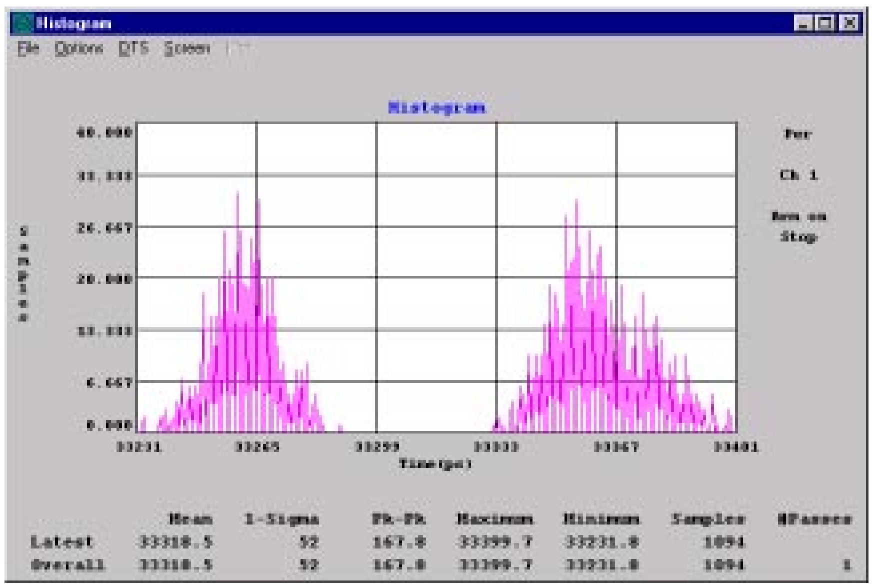

Figure 6.21 Histogram Analysis with Random Periods (Filtering)

- **HISTOGRAM ANALYSIS WITH RANDOM PERIODS (FILTERING)**
  (Refer to Figure 6.22)

  Same as 6.19 & 6.20, except the filter is set at 26 ns ± 1 ns to look at the 26 ns data cell.

  - Sample Size 7000
  - Cycle .... Repeat
  - Update Mode .... Accumulate

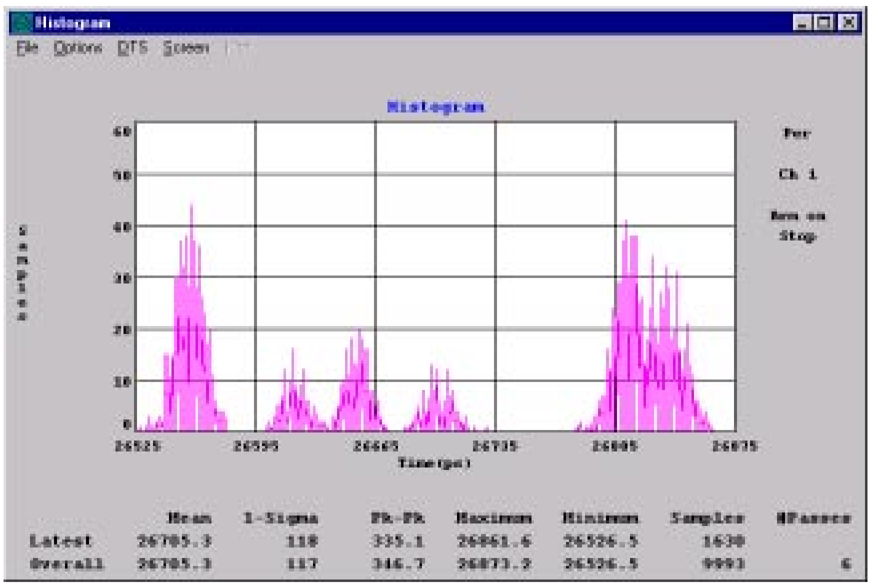

Figure 6.22 Histogram Analysis with Random Periods (Filtering)

- **HISTOGRAM ANALYSIS TPD++ DATA vs. CLOCK**
  (Refer to Figure 6.23)

  See TPD++ data to clock setup time of 9115 ps ± 106 ps. Also notice a bimodal distribution.

  - Data signal connected to CH1 and Clock connected to CH2.
  - Function .... TPD++
  - Arming Sequence .... Start First

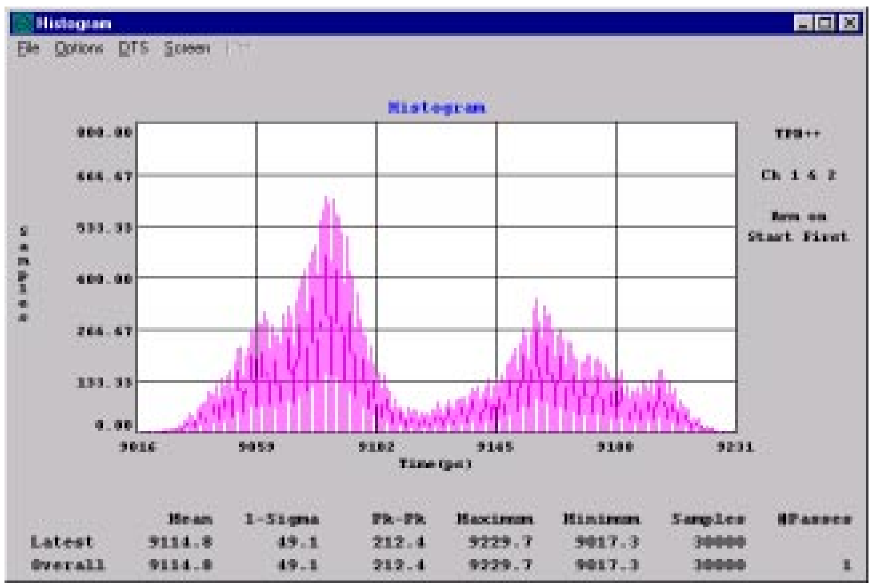

Figure 6.23 Histogram Analysis TPD++ Data vs. Clock

- **HISTOGRAM ANALYSIS TPD-+ DATA vs. CLOCK**
  (Refer to Figure 6.24)

  Same as 6.23, but TPD-+ is centered at 9198 ps ±129 ps.

  - Function .... TPD-+
  - Arming Sequence .... Start First

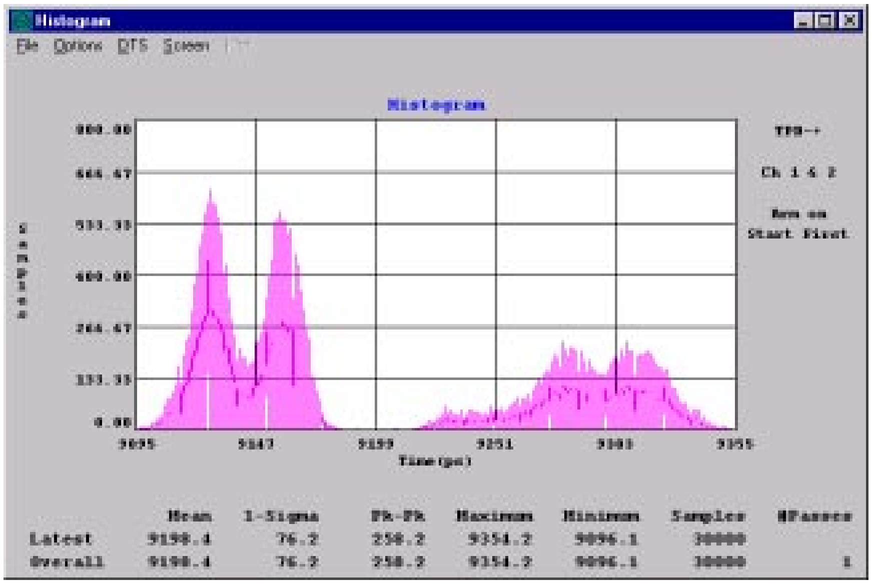

Figure 6.24 Histogram Analysis TPD -+ Data vs. Clock

- **JITTER ANALYSIS - (200 EVENTS)**
  (Refer to Figure 6.25)

  The Jitter Analysis plots display the low frequency jitter content of the function being measured, i.e., Period, Pulse Width, Propagation Delay, etc. This plot can be run synchronous or asynchronous by turning the arming mode from EXT to AUTO.

  - Function .... PER
  - Sample Size 100
  - Arming Input ARM2
  - Start Event 2
  - Channel 2
  - Arming Mode .... External
  - Display .... OFF
  - Stop Event 200

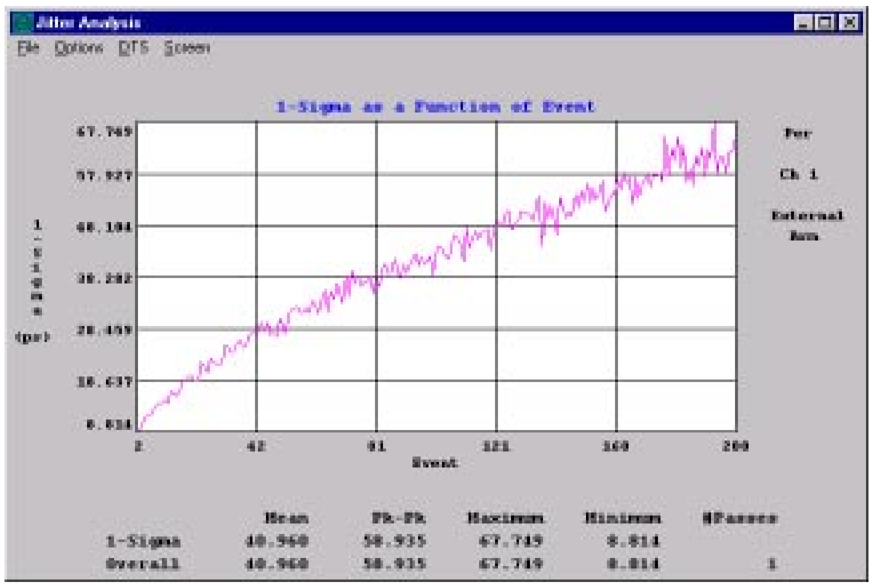

Figure 6.25 Jitter Analysis (200 Events)

Signal on Channel 2 is a random data pattern with a base period of 20 ns. The “jitter analysis” was done with EXT ARM “ON” so all the jitter measurements started at the beginning of a 300 address long data pattern. The displayed jitter is synchronous to the device.

- **JITTER ANALYSIS - (42 EVENTS)**
  (Refer to Figure 6.26)

  Same as 6.25.

  - Function .... PER
  - Channel 2
  - Sample Size 100
  - Arming Mode .... External
  - Arming Input ARM2
  - Display .... OFF
  - Start Event 2
  - Stop Event 42

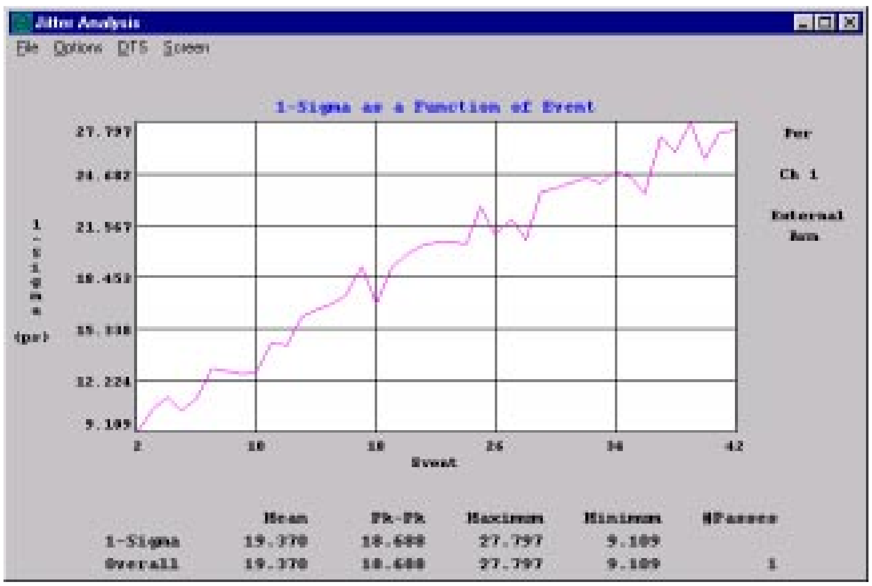

Figure 6.26 Jitter Analysis (42 Events)

This graph magnifies the first 42 pulses of 6.25 for a better view.

- **JITTER ANALYSIS**
  (Refer to Figure 6.27)

  - Function .... PER
  - Channel 2
  - Sample Size 100
  - Arming Mode .... Automatic
  - Display .... OFF
  - Start Event 2
  - Stop Event 200

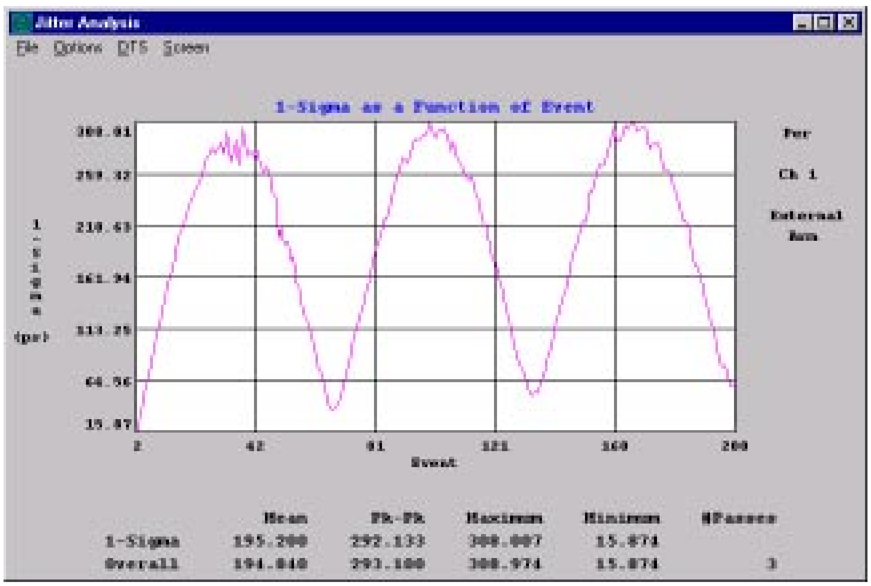

Figure 6.27 Jitter Analysis

This graph shows the reoccurring pattern as a function of jitter. This is the same signal as in 6.25. By Auto Arming, the user gets an asynchronous view not seen when synchronizing.

- **JITTER ANALYSIS – Fast Fourier Transform**
  (Refer to Figure 6.28)

  - Function .... PER
  - Channel 2
  - Sample Size 100
  - Arming Mode .... Automatic
  - Display .... OFF
  - Start Event 2
  - Stop Event 200
  - Fast Fourier Transform . Enabled
    FFT Window .... Kaiser
    Padding 16
    Alpha 6

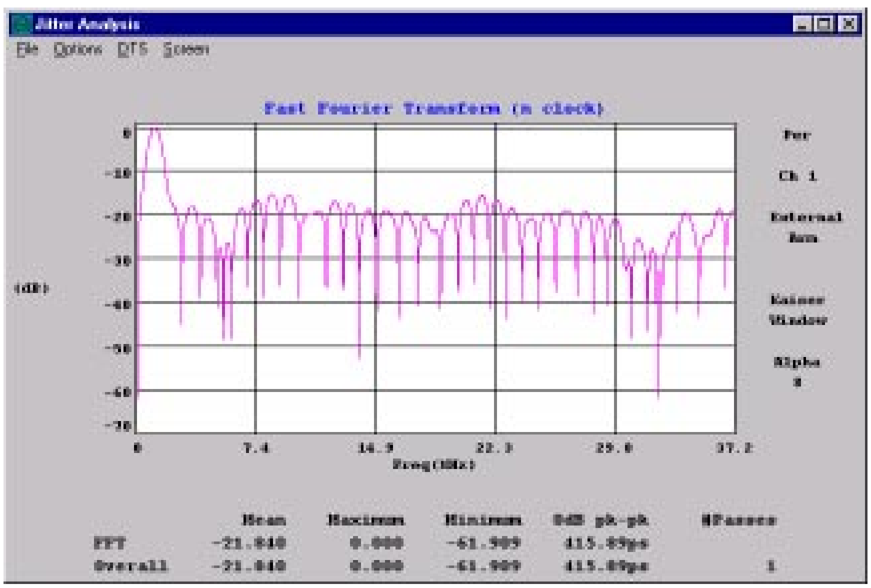

Figure 6.28 Jitter Analysis - Fast Fourier Transform

This graph shows the FFT of the signal in Figure 6.27.

• FUNCTION ANALYSIS - PERIOD AS A FUNCTION OF EVENT

(Refer to Figure 6.29)

- Function .... PER
- Channel 2
- Sample Size.................. 100
- Stop Event 200
- Arm EXT ARM1

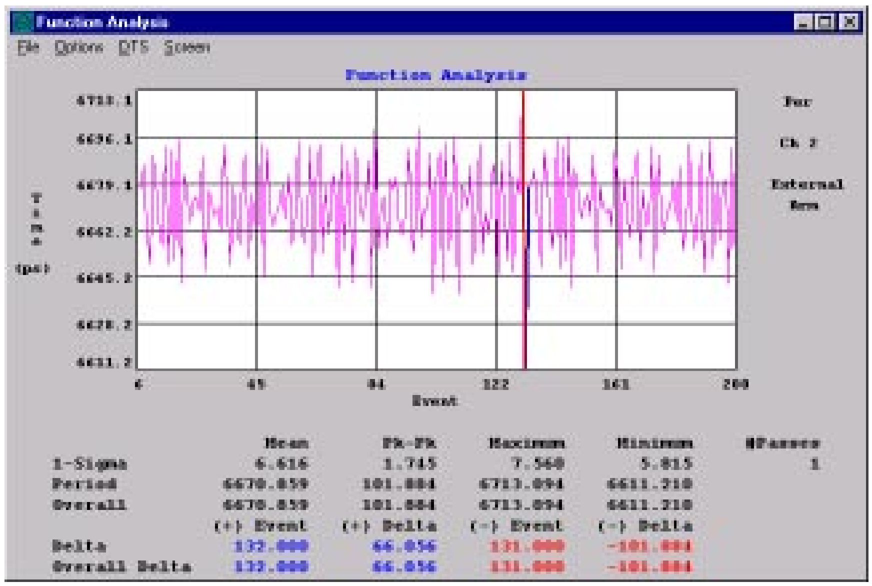

Figure 6.29 Function Analysis - Period as a Function of Event

The pattern repeats itself every 150 pulses. The ARM1 input has a start pulse at the beginning of the pattern.

The “Period vs. Event” display shows that the first 2 periods after the pattern restarts are skewed by ± 20 ps more than all of the other 148 pulses.

- **FUNCTION ANALYSIS - PERIOD AS A FUNCTION OF EVENT (DERIVATIVE)**
  (Refer to Figure 6.30)

  Same as 6.29, except derivative display was selected.
  This graph shows the additional ± 20 ps that the period of the patterns are skewed.

  - Function .... PER
  - Channel 2
  - Sample Size 100
  - Stop Event 200
  - Arm EXT ARM1

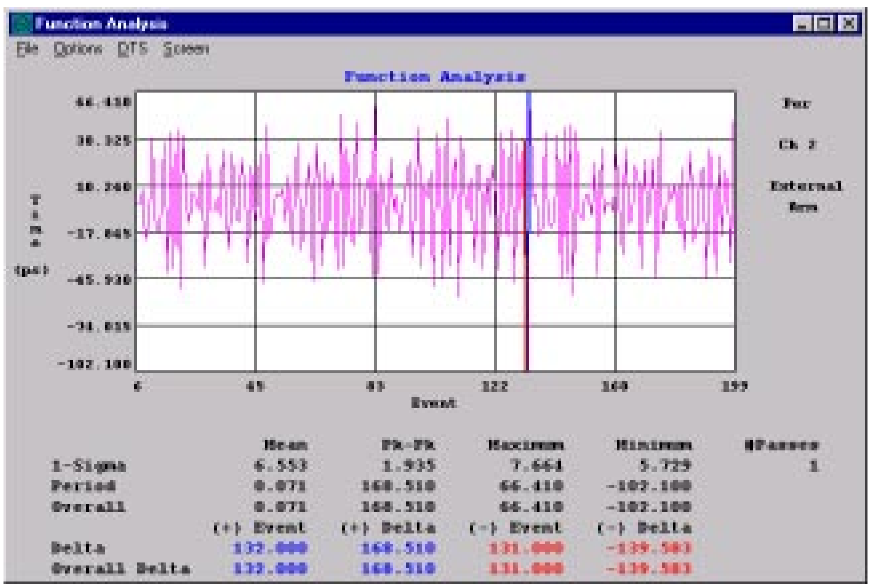

Figure 6.30 Function Analysis - Period as a Function of Event(Derivative)

The Peak to Peak jitter of from around +66.4ps to around -102.1ps represents about a 168.5ps Peak to Peak nominal jitter variance on the signal on Channel 2.

- **FUNCTION ANALYSIS – FREQUENCY AS A FUNCTION OF EVENT**
  (Refer to Figure 6.31)

  - Function .... FREQ
  - Channel 2
  - Sample Size 100
  - Stop Event 50

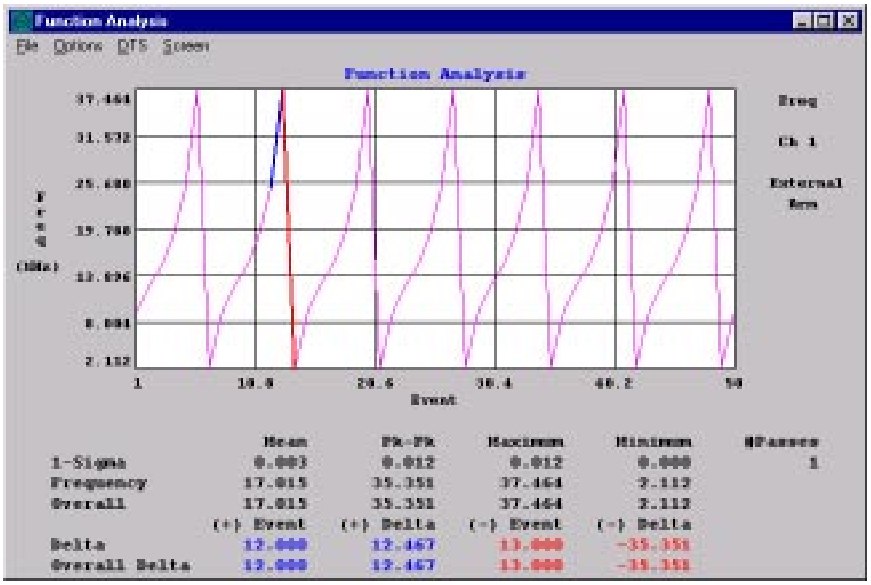

Figure 6.31 Function Analysis - Frequency as a Function of Event

This graph shows the signal on Channel 2 skewing from about 2 MHz to 38 MHz and then back to 2 Mhz. The stair step display represents each pulse/cycle of the signal after the Arm inputs arm the DTS. The “event” represents the actual pulse/cycle position after the Arm.

- **FUNCTION ANALYSIS – FREQUENCY AS A FUNCTION OF TIME**
  (Refer to Figure 6.32)

Same as 6.31.

- Function .... FREQ
- Channel 2
- Sample Size.................. 100
- Stop Event 50
- Arm EXT ARM1
- Arm Sequence .... Start first

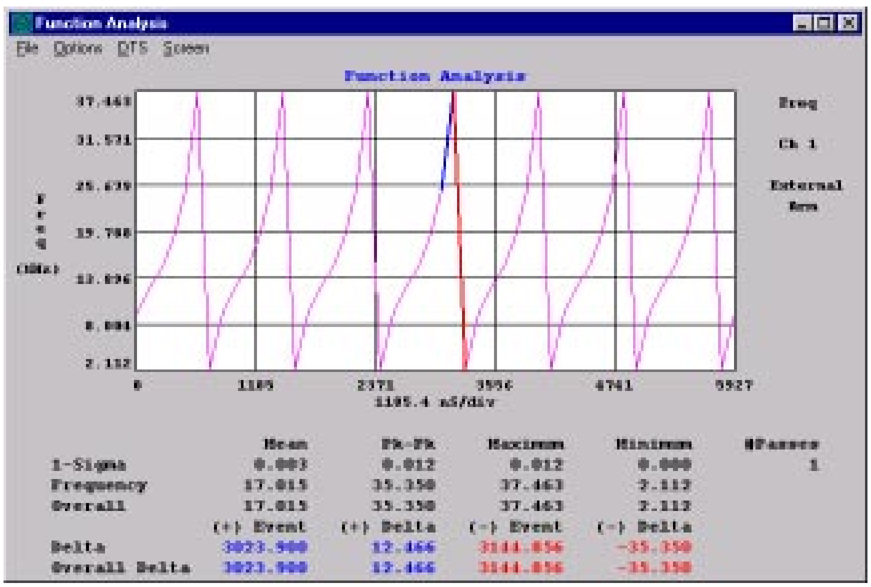

Figure 6.32 Function Analysis - Frequency as a Function of Time

This graph shows the same exact signal shown in 6.30, except the time deviation from ARM1 is displayed on the horizontal axis. The stair step display is showing how long the cycle is at that frequency.

- **FUNCTION ANALYSIS – FREQUENCY AS A FUNCTION OF TIME (DERIVATIVE)** **(Refer to Figure 6.33)**

Same as 6.32.

- Function .... FREQ
- Channel 2
- Sample Size 100
- Stop Event 50
- Arm EXT ARM1
- Arm Sequence .... Start first

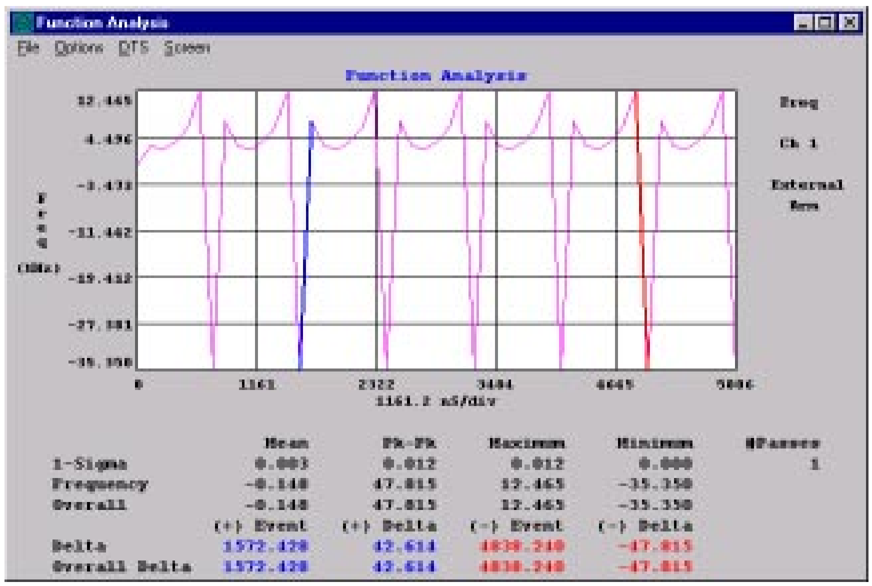

Figure 6.33 Function Analysis - Frequency as a Function of Time (Derivative)

This graph shows the "derivative" of the signal in Figure 6.32.

- **FUNCTION ANALYSIS – FREQUENCY AS A FUNCTION OF TIME (FIRST DERIVATIVE)** **(Refer to Figure 6.34)**

Same as 6.33.

- Function .... FREQ
- Channel 2
- Sample Size 100
- Stop Event 13
- Arm EXT ARM1
- Arm Sequence .... Start first

Figure 6.34 Frequency as a Function of Time (First Derivative)

Enlarges view of Figure 6.33, showing the first frequency derivative.

- **FUNCTION ANALYSIS - FAST FOURIER TRANSFORM**
  (Refer to Figure 6.35)

The signal in this example is a 1MHz fundamental carrier sine wave modulated with a 30kHz sine wave. The deviation of modulation is 20kHz.

- Function .... PER
- Channel 2
- Sample Size 100
- Stop Event 250
- Arm EXT ARM2
- Fast Fourier Transform . Enabled
  FFT Window .... Kaiser
  Padding 16
  Alpha 6

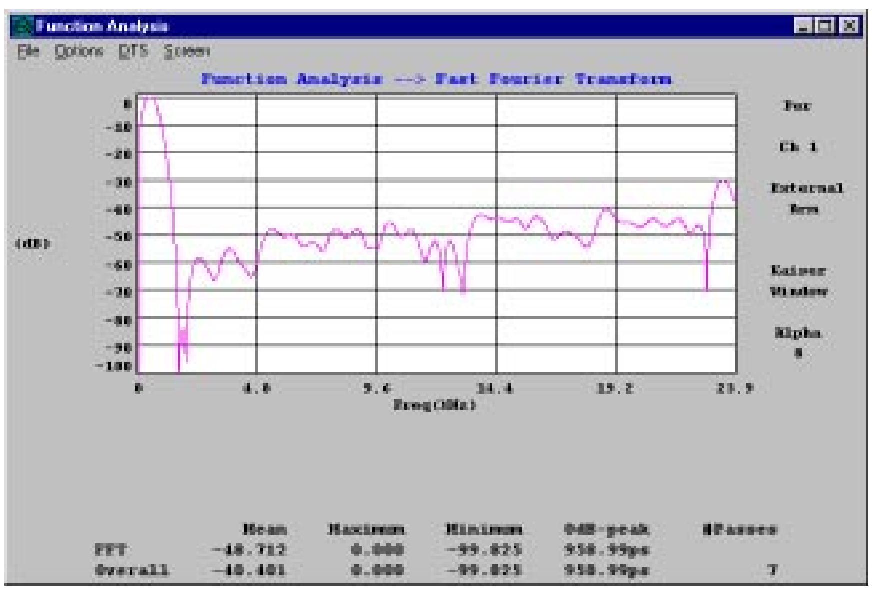

Figure 6.35 Function Analysis - Fast Fourier Transform

This graph shows the 30kHz modulating frequency as the central peak.

- **TIME DIGITIZER - Elapsed Time**
  (Refer to Figure 6.36)

  - Function .... PER
  - Channel 2
  - Sample Size.................. 1000
  - Arming Sequence .... Arm on Start
  - Arming Mode................. External
  - ARM2 Voltage .... Rising
  - Elapsed Time .... On

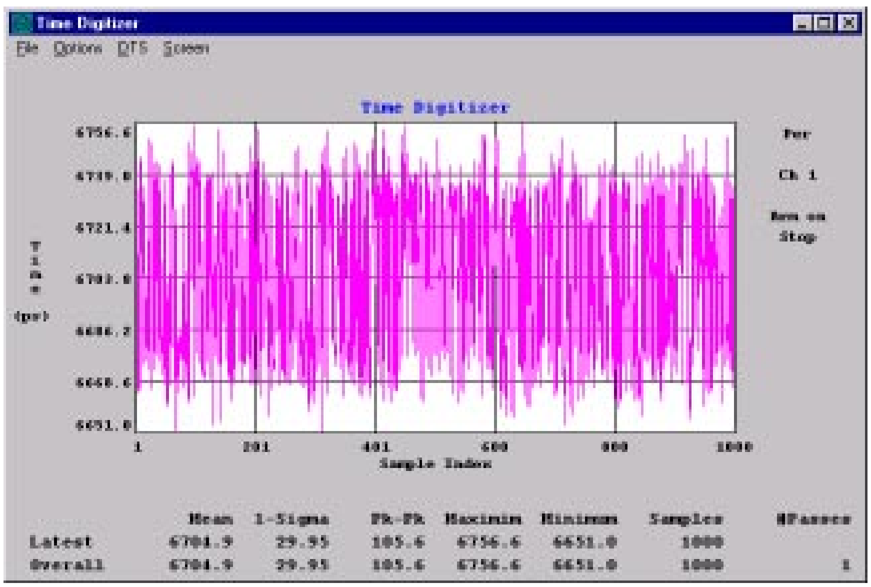

Figure 6.36 Time Digitizer - Elapsed Time

- **TIME DIGITIZER - Fast Fourier Transform**
  (Refer to Figure 6.37)

  - Function .... PER
  - Channel 2
  - Sample Size.................. 1000
  - Arming Sequence .... Arm on Start First
  - Arming Mode................. External
  - Gating with ARM2 .... ON
  - ARM2 Voltage .... Rising
  - Fast Fourier Transform . Enabled
    FFT Window .... Kaiser
    Padding 16
    Alpha 6

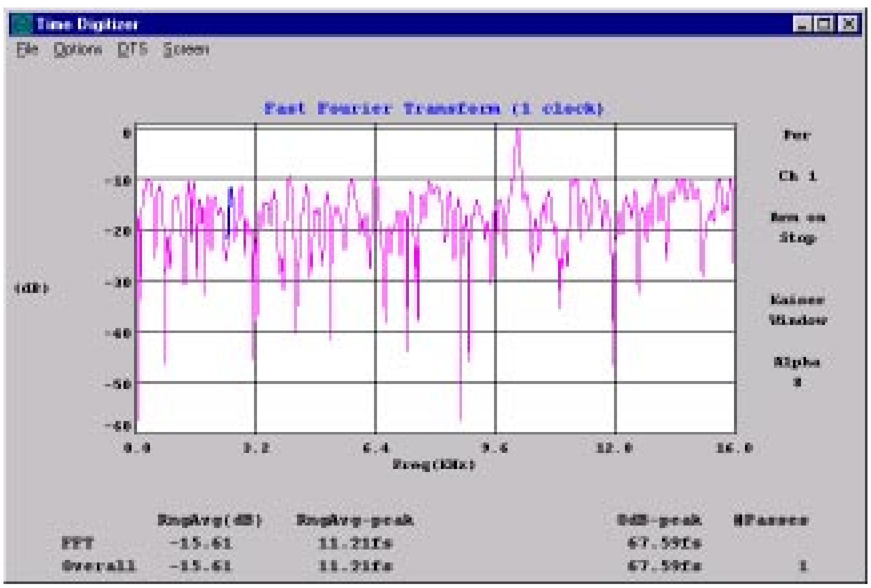

Figure 6.37 Time Digitizer - Fast Fourier Transform

- **dataCOM**
  (Refer to Figures 6.38 through 6.45)

DTS/Function

Channel .... 1 or 2
All Others .... Default

Screen

Overlay 1
All Others .... Default

Option Dialog

Pattern K28.5
Corner Frequency .... 63.7 kHz
All Others .... Default

Display Dialog

RJ+PJ Fmin (MHz) .... Default

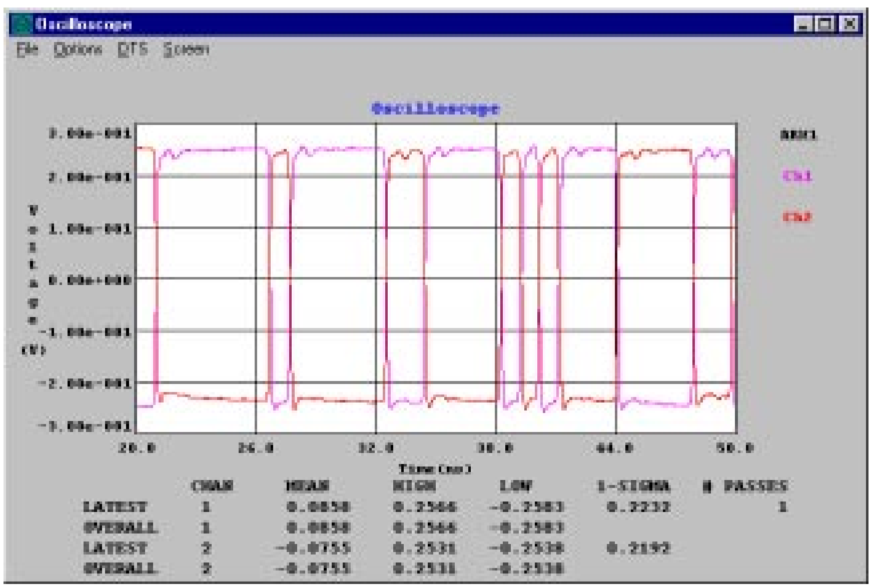

Figure 6.38 dataCOM Plot - Oscilloscope Display of Input Signals on Channel 1 and 2.

The input signal to Channels 1 and 2 is from a Fibre' Channel pattern generator. The signal is a K28.5 pattern with differential outputs connected to the two inputs of the DTS-2075™. The trigger for the display is coming from the pattern generator's pattern marker signal. That signal is going to the ARM1 input of the DTS and acts as a trigger for the oscilloscope function. The signals on the channels were ±0.25 volts in amplitude.

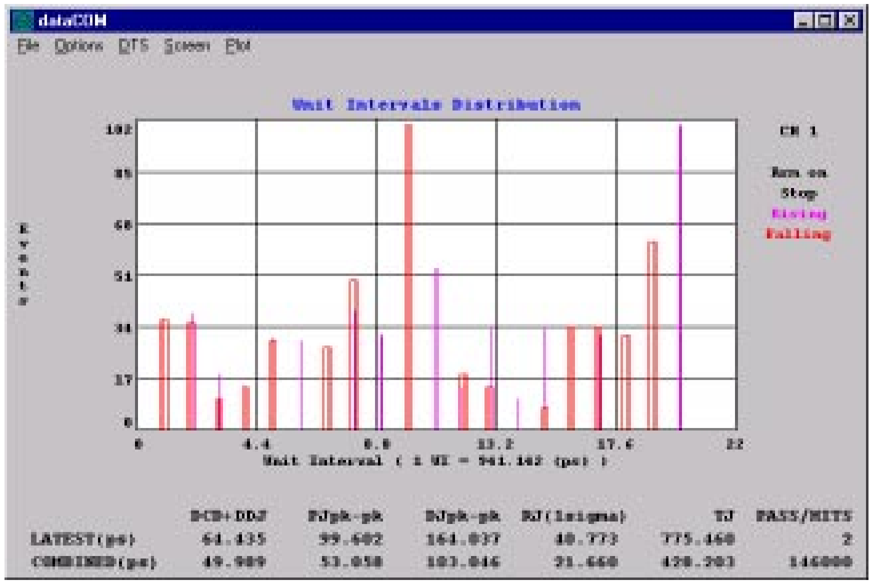

Figure 6.39 dataCOM Plot – Unit Intervals Distribution

The Unit Intervals Distribution plot in Figure 6.39 is showing all measurement data taken of the Fibre' Channel serial data signal on Channel 1.

Notice the legend "1 UI = 941.192 (ps)." This Unit Interval number is directly measured by the system. Accuracy of the Unit Interval is important because it is used in the calculations to separate the Total Jitter into its various components. As long as the correct pattern was selected, this value can be accurately measured.

If you were to zoom in on a very narrow region of the Unit Interval Distribution you would see a graph similar to the one in Figure 6.40 which is displaying the jitter distribution for a single edge.

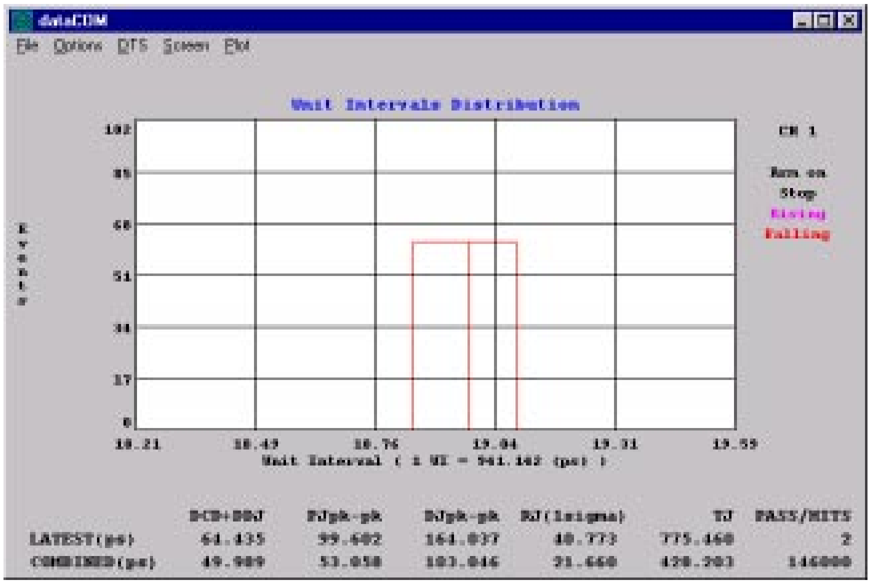

Figure 6.40 Zoomed dataCOM Plot – Unit Intervals Distribution

Figure 6.40 graphically displays the jitter distribution for a single edge. The leftmost vertical line represents its earliest occurrence while the rightmost vertical line represents its latest occurrence. The middle vertical line represents its mean occurrence. The edge occurrence information can be compared with theoretical edge positions based on the Unit Interval to isolate the jitter into various components.

In the legend at the bottom of each plot, components of the jitter spectrum are reported and summed to arrive at a TOTAL JITTER number. All values in the legend are shown in the units (UI or Time) selected in the **Display Options** window. The Total Jitter number is derived directly from the Bathtub Curve based on the Bit Error Probability specified in the Display Options window. The method used to construct a Probability Density Function and extract Total Jitter is based on Appendix A of the ANSI T11.2 Jitter Methods Document.

The DCD+DDJ number comes from the maximum deviation of mean edge positions from their theoretical positions. The distributions of the data shown in Figure 6.40 around their mean edge positions is the result of the Periodic Jitter (PJ) and the Random Jitter (RJ). The PJ component is the measured "peak-peak" spectral component computed from an FFT of the variance data (shown in Figure 6.44). The RJ component is calculated using the RMS sum of each frequency bin between the RJ Fmax and Fmin frequencies. This technique is called the "Blackman-Tukey" algorithm for power spectral analysis and has been well documented in other text.

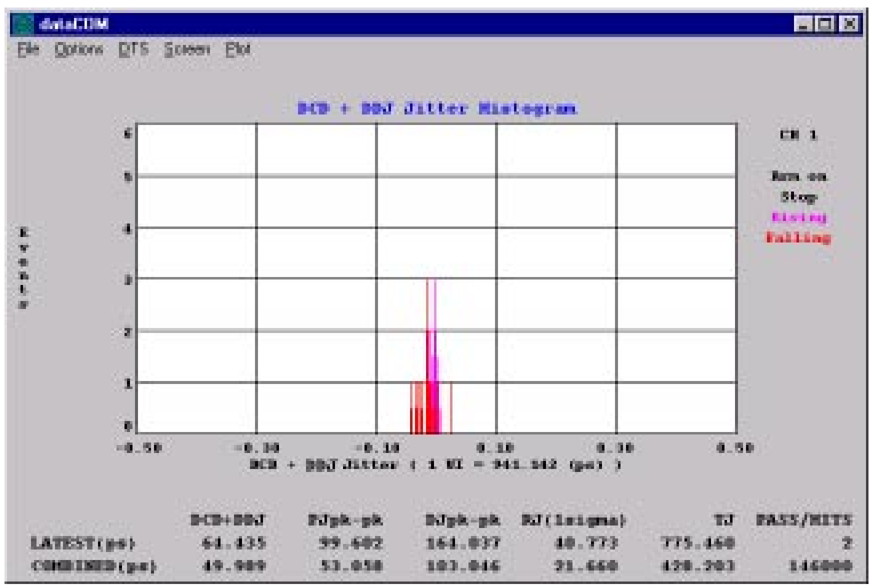

Figure 6.41 dataCOM Plot – DCD + DDJ Jitter Histogram

The Data Com "DCD + DDJ Jitter Histogram" panel in Figure 6.41 is displaying the "normalized accumulation" of all the DCD + DDJ measurements taken during the run shown in Figure 6.40. The width of this plot is normalized to one Unit Interval of the data period.

When using Auto-arming or Random Modes, it is also possible to include the other jitter components in this graph using an **All Measurements Jitter Histogram** by selecting the option from the **Plot** window. Reasonable results for DCD+DDJ can be expected when using either Auto-arming or Random Modes. However, extremely accurate results can be expected if an external pattern marker is available. When an external marker is being used, this plot is replaced by a DCD+DDJ vs. Unit Interval plot which also offers the ability to apply a High or Low Pass Filter to simulate the frequency response of the target receiver. When this option is enabled in the **Display Options** window, an overlay of the resulting filtered response is provided, and the calculated DCD+DDJ value reflects the High Pass Filtered value (See Figure 6.42). This option is especially useful in conjunction with the longer patterns such as CJTPAT which is specifically designed for this purpose.

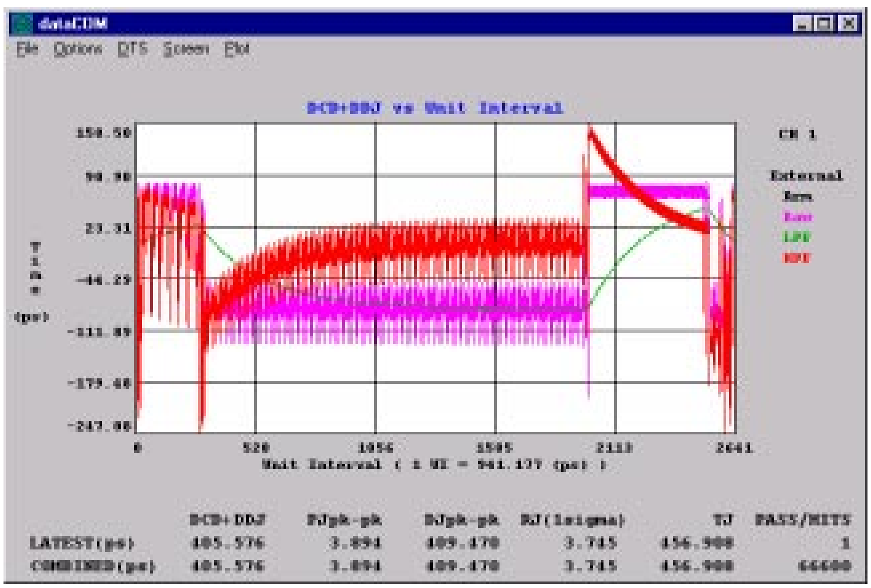

Figure 6.42 dataCOM - Filtered

In this series of figures, the Overlay switch was set to One Overlay so we are able to compare two different data runs. In this case, one with a 100kHz sinusoidal periodic line added and one without the sinusoidal line. (Note that overlays are only available in dataCOM if a single measurement type [PER+, PER-, PW+, or PW-] is selected.)

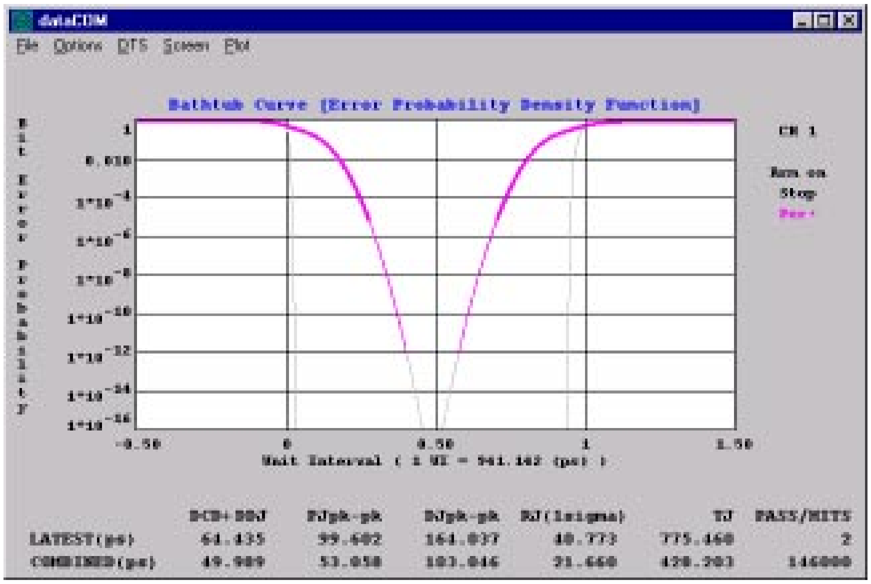

Figure 6.43 dataCOM Plot – Bathtub Curve

In the Bathtub Curve plot shown in figure 6.43, we see the “Error Probability” of a data or clock signal with the jitter characteristic measurements displayed in the legend at the bottom of the plot. As with figure 6.41, the plot is normalized to one UI. The space between the curved lines, at the error probability of interest, indicates the “Eye opening”.

For example, an “Error Probability” of 10^{e-12} for a Fibre’ Channel link running at 1.0625Gbit/Sec would be an error free data run of about 1000 Seconds. An Error Probability of 10^{e-16} would be a third of a year for the same network. By measuring the Deterministic and Random jitter components of the network, it is possible to estimate the network’s reliability without having to test it for that length of time.

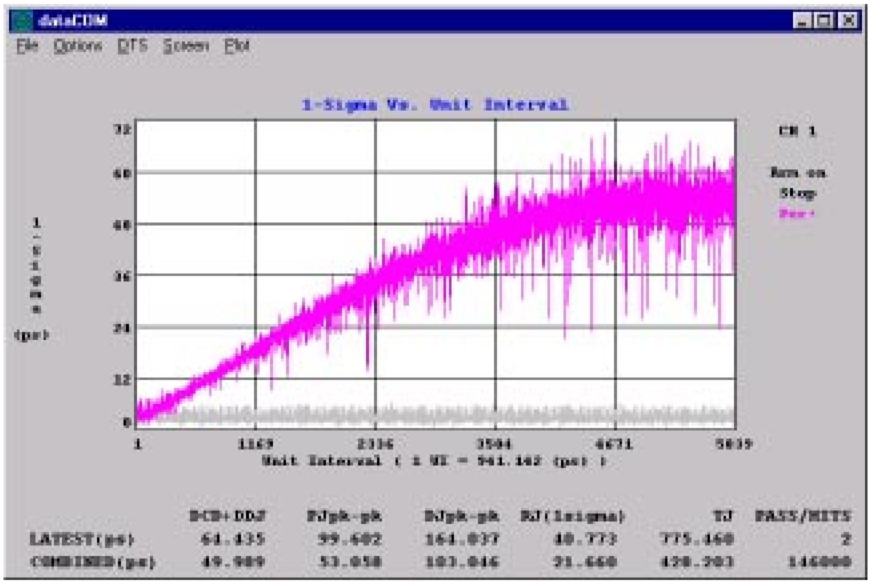

Figure 6.44 dataCOM Plot – Autocorrelation Function

Figure 6.44 is showing the 1-Sigma vs. Unit Interval plot, which is the distribution of the measurements <u>within</u> each bin. The horizontal trace indicates the network with NO sinusoidal modulation, while the curved trace indicates a very low frequency jitter modulation on the same network. See Figure 6.45 for the frequency components and amplitude of this jitter.

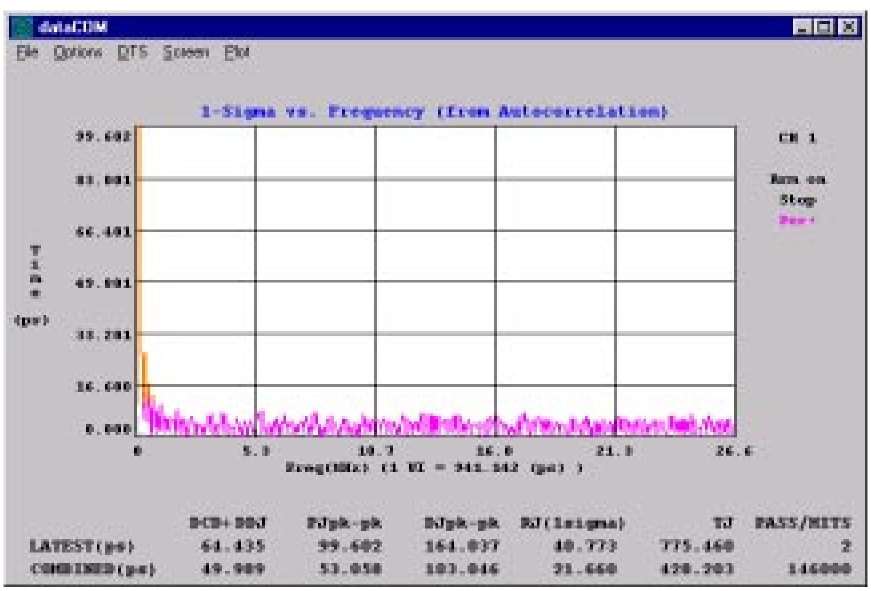

Figure 6.45 dataCOM Plot – Fast Fourier of Autocorrelation

Figure 6.45 is showing a ZOOMed view of part of a larger FFT of the Autocorrelation shown in Figure 6.44. Notice the overlay of two traces. One with a very low frequency spectral line and one that is relatively flat showing no spectral lines, just noise.

Note that these measurements were taken with the corner frequency set to 63.7 kHz. Below this point the frequency content of the jitter spectrum will have a first order roll-off of 20dB per octave. This corner frequency can be extended or shortened to cover the desired range. Note that lower corner frequencies require longer run times.

It is also possible to average the data displayed in the FFT plot over successive runs in order to filter out some noise. A Triangular Window function is automatically applied to the FFT in order to reduce spectral information distortion. Refer to **Appendix A** - Using Fast Fourier Transforms for further information concerning window weighting.

The RJ(1sigma) and PJpk-pk values in the legend are calculated over the bandwidth set in the **Display Options** panel by RJ+PJ Fmin and Fmax. By changing these frequency limits the user is able to vary the bandwidth over which the data is evaluated. In the case of Fibre' Channel, the low frequency limit is set by ANSI standard. Currently, its value is 637 kHz. The high frequency limit is the Nyquist of the apparent data sampling rate.

When sampling using Auto-Arming a special technique is employed to prevent the contamination of RJ and PJ values by the presence of DCD+DDJ. Basically the RJ+PJ measurements are taken by setting the stop count increment equal to the number of edges necessary to measure across the entire pattern length. This prevents the introduction of variance due to DCD+DDJ from combining from multiple edges. However, it has the side effect of lowering the effective sampling rate. For this example the apparent Nyquist is lowered from it's normal value of 1/2 the carrier frequency (531 MHz) to a value of 26.6 Mhz. Therefore the RJ noise floor will be analyzed over the range of 63.7 kHz to 26.6 MHz. The pattern length determines the effective reduction in sampling rate, shorter patterns have less impact, longer patterns are more severely effected. This limitation is not imposed on measurements taken using external arming from a pattern marker.

By selecting the "Random" option in the **Options Dialog** this sampling technique is no longer used when using auto-arming. This allows the effective sampling rate to be extended to it's normal value of 1/2 the carrier frequency. However, the presence of DCD+DDJ can manifest itself in higher than expected RJ and PJ values.

In the case of SONET ATM specifications, this "random noise calculation" is equivalent to the rms "Jitter Generation" number specified in the BELLCORE specifications. For example, on a 155Mbit/sec SONET network, the Jitter Generation specification calls for measuring the rms spectral noise between 65 kHz and 1.3 MHz. By setting the RJ Fmin and Fmax to the appropriate frequencies, the RJ (1sigma) value will be the "rms" value of the spectral content over that band-pass.

The parameters in the **Display Options** can be adjusted without the need to acquire new data. Simply adjust the desired parameter and select **Apply** to see the effect of your changes.

Users should be aware that the presence of a large periodic jitter source will cause the RJ number to be inflated due to an increase in the statistical sampling error. Increasing the sample size will help to decrease this inflation to some extent. However, if an external pattern marker is available, there is an option of using a “Tail-fit” algorithm in order to determine the correct RJ value. This option may be selected in the **Options Dialog - Advanced...** selection screen and will prevent this inflation from occurring. However, due to the greater sample size requirements longer acquisition times will be realized.

Note that when making measurements with an external pattern marker where you know there is no higher frequency periodic jitter present, a “quick” mode can be used to speed the acquisition process. In it’s default configuration a rigorous sampling technique is used in conjunction with external arming to reduce harmonic distortion which can occur as the result of “holes” which are naturally present in a data pattern. This harmonic distortion is much greater in the presence of high frequency jitter. When you know no such high frequency jitter is present selection of the “quick” mode from the **Options Dialog - Advanced...** selection screen can speed data acquisition by as much as 10x. This can be especially beneficial when the “Tail-fit” algorithm is being employed. See the Help Screens available from within the VI/Datacom module for additional information on the options available when using the VI/Datacom software.

- **EYE HISTOGRAM**
  (Refer to Figures 6.46 and 6.47)

  Option Dialog

  Use Tail-Fit to Calculate DJ and RJ ..... Enabled
  Stop Cycle on Success .... Enabled

  All Others Options .... Default

  DTS Inputs

  Channel 1 .... 1.0625 Gb/s
  Channel 2 .... 1.0625 GHz

  If any changes occur to the data signal, reset Virtual Instruments™ and resume taking measurements.

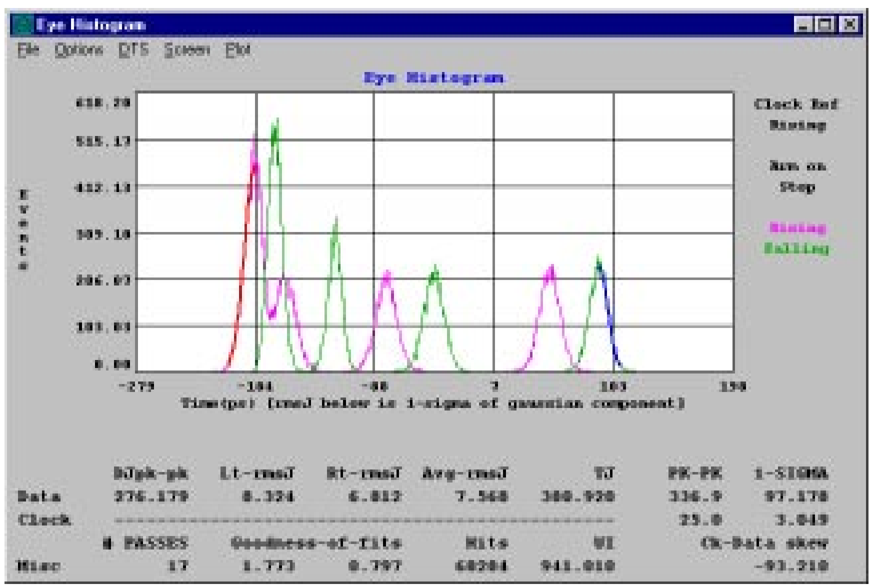

Figure 6.46 Eye Histogram

The input signal to Channel 1 is is a K28.5 pattern from a Fibre' Channel pattern generator. The pattern generator's clock signal is connected to the Channel 2 input of the DTS. The signals on the channels were ±0.25 volts in amplitude.

When the tail-fit is successfully completed, the calculated tail-fits are plotted on top of the raw histogram, and values for the Deterministic Jitter, Random Jitter, Chi-square goodness of fit, and Total Jitter are displayed (See Figure 6.46). Note that the Clock-Data skew (`Ck-Data skew`) is the mean time displacement between the clock edge and the data edge.

To view the Bathtub plot, select the **Plot** pull-down menu and choose **Bathtub Curve**. The resulting Bathtub plot (See Figure 6.47) is based on the total jitter probability distribution function (PDF) of the raw histogram with extrapolated tails calculated from the tail-fit. The Total Jitter is extracted directly from the Bathtub Plot. Note: For Spectrum Panel only - The Total jitter Specification (UI) that is used for this calculation is User Defined, make sure that reasonable values are assigned for this as well as the Bit Error Probability.

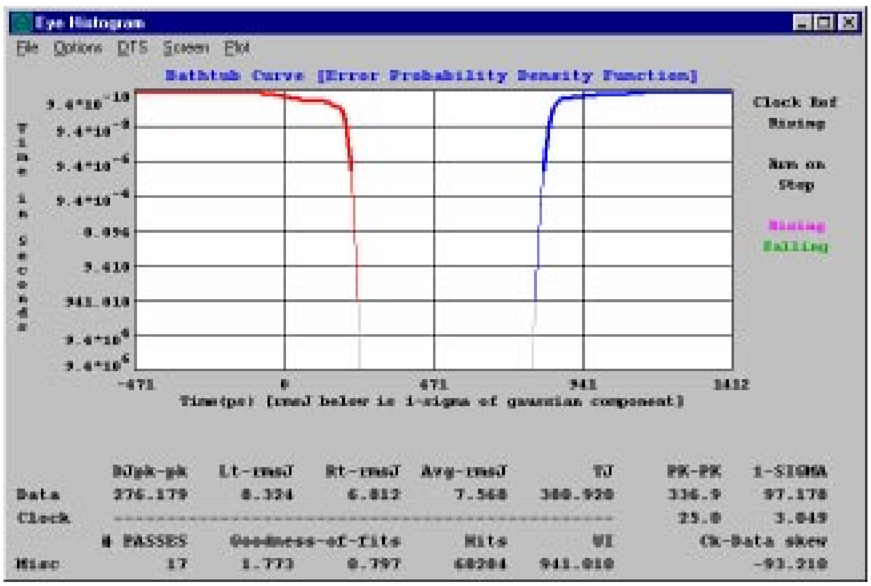

Figure 6.47 Eye Histogram - Bathtub Curve

- **TIME SERIES**
  (Refer to Figure 6.486)

  - Function .... PER
  - Sample Size 100
  - Channel 1
  - Allan Variance .... ON

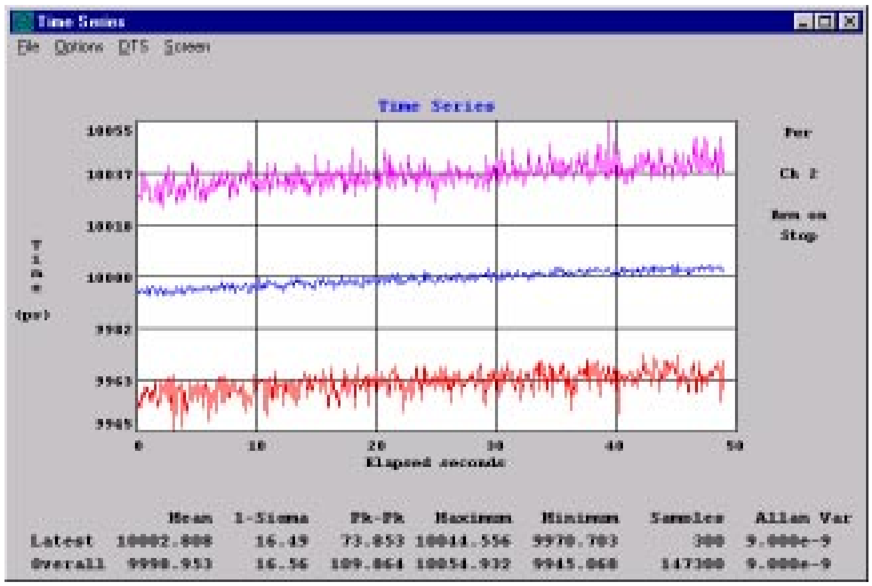

Figure 6.48 Time Series

Figure 6.26 shows the warm-up drift of the oscillator being tested. The Allan Variance is calculated to give the user an indication as to the long term stability of the signal being tested.

- **TIME SERIES**
  (Refer to Figure 6.49)

  - Function .... PER
  - Sample Size.................. 100
  - Channel 1
  - Allan Variance .... ON

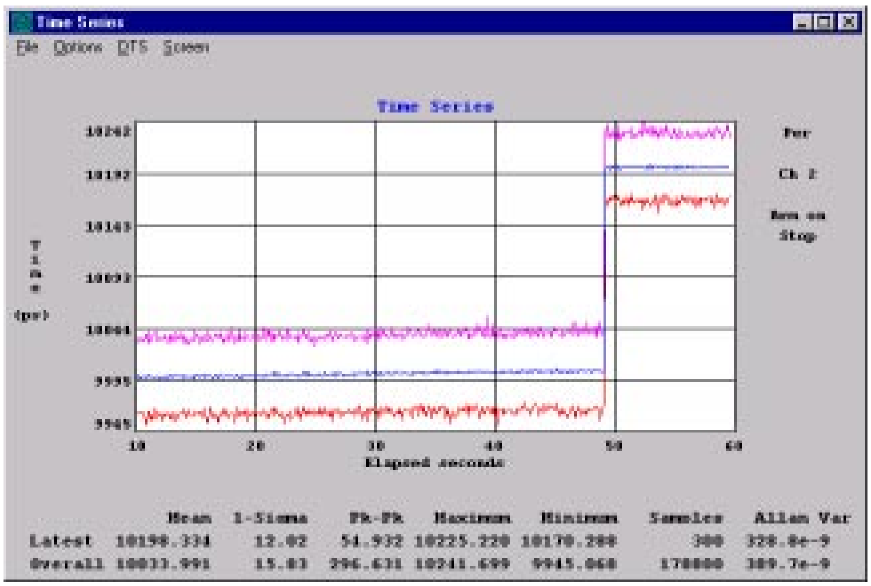

Figure 6.49 Time Series

The Time Series display is useful in showing slow, low frequency drift anomalies. In this graph, the period of the generator is drifting up in period. The period was also programmed to make a 200 ps jump.

- **TIME SERIES**

  (Refer to Figure 6.50)

  - Function .... PER
  - Sample Size.................. 100
  - Channel 1
  - Allan Variance .... ON

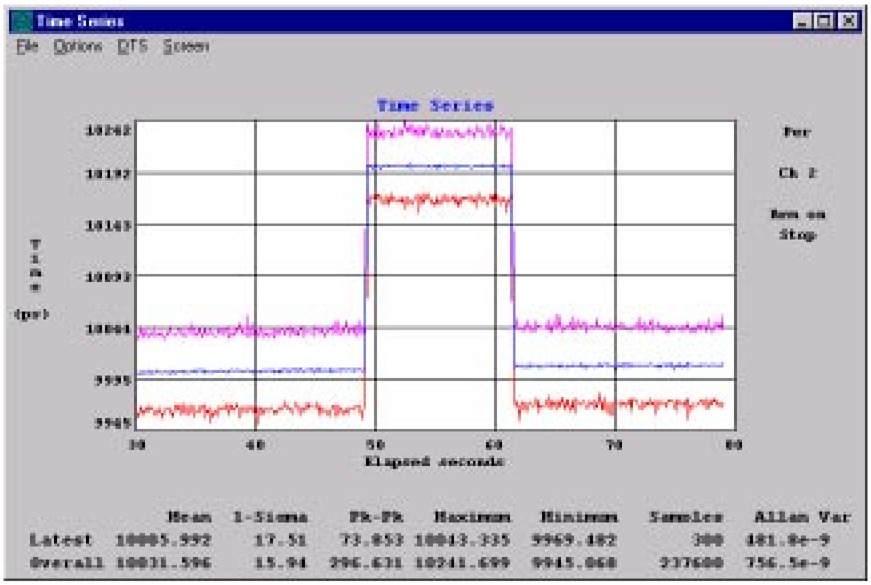

Figure 6.50 Time Series

Graph is showing a 100 ps jump in the period on the data pulse on Channel 1. Also shown is the AVG measurement along with the maximum & minimum measurement taken for 512 consecutive bursts of 100 one-shot measurements.

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APPENDIX A - Using Fast Fourier Transforms

This appendix presents a more detailed look into FFT windowing. The transformation of time domain data using the FFT windows found in *Virtual Instruments* will be illustrated as well as each window effect on the measured sine wave input signal.

Window Characteristics

For the Kaiser-Bessel FFT, several graphs are presented with the Alpha factor increased from two to 10, in increments of two. This varying of the Alpha factor illustrates the inverse proportionality relationship between the spectral peak width and the sidelobe rejection of the Kaiser-Bessel window. As the Alpha factor increases, the spectral peak widens and the sidelobes shrink. As the Alpha factor decreases, the spectral peak narrows and the sidelobes increase in amplitude.

The Kaiser-Bessel FFT is the only FFT that has the Alpha factor feature which contributes to the versatility of this FFT. The Kaiser-Bessel examples, along with the other window examples, illustrate the different characteristics of each window. One window may have a narrow spectral peak with big sidelobes while another may have a broad spectral peak and little sidelobes. Each window has its own characteristics and the user should become familiar with them to use them effectively.

Window Weighting

To reduce spectral information distortion of FFTs, the time domain signal is multiplied by a window weighting function before the transform is performed. The choice of window will determine which spectral components will be isolated, or separated, from the dominant frequency(s). Each window function has advantages/disadvantages over other windows.

General Summary of Window Functions[1]

Rectangular - No window weighting.

Kaiser - Very narrow apectral peak. Very large sidelobes.
Alpha factor affects spectral peak and sidelobes.

Triangular - Narrow spectral peak. Large sidelobes. Moderate fall off.

Hamming - Moderately sharp central peak. Poor sidelobes. First sidelobe cancellation.

Hanning -Reasonable sidelobe rejection. Central peak as narrow as triangular window.
Faster sidelobe fall off than triangular window.

Blackman - Broad central peak. Good sidelobe rejection.

Gaussian - Very broad central peak. No sidelobes.

[1] Higgens, Richard J., Digital Signal Processing in VLSI, Prentice-Hall, 1990, pp118-19.

Fast Fourier Transform Examples

The windowed input record is 128 points long of a sine wave at a frequency of 65/128 times the Nyquist frequency. The windowed record is padded to 4096 points in length (padding factor of 32) and the FFT is run with the results displayed.

Notice that the vertical scale changes from one window to the next.

The vertical scale for the graphs is correct except for FFT use in the jitter analysis function and the data communications function. In these cases, the vertical scale on the graphs must be divided by 2.

The graphs extreme right hand frequency, 1.0, is the Nyquist frequency: this is one-half of the sampling frequency.

The -3.01 dB and -6.02 dB bandwidths are for a 128 point input signal. For inputs other than 128 points, the bandwidths may be scaled by:

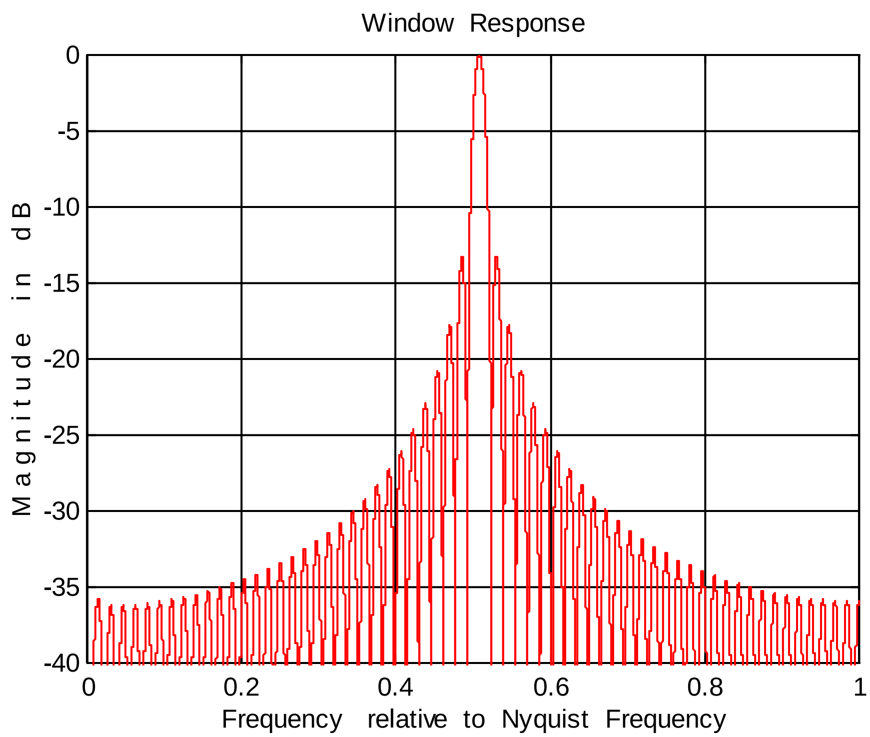
scaled bandwidth = bandwidth * 128 / # of points

Example: The -3.02 dB bandwidth of a rectangular window is 0.0138 for a 128 point input. If a 512 point input is used:

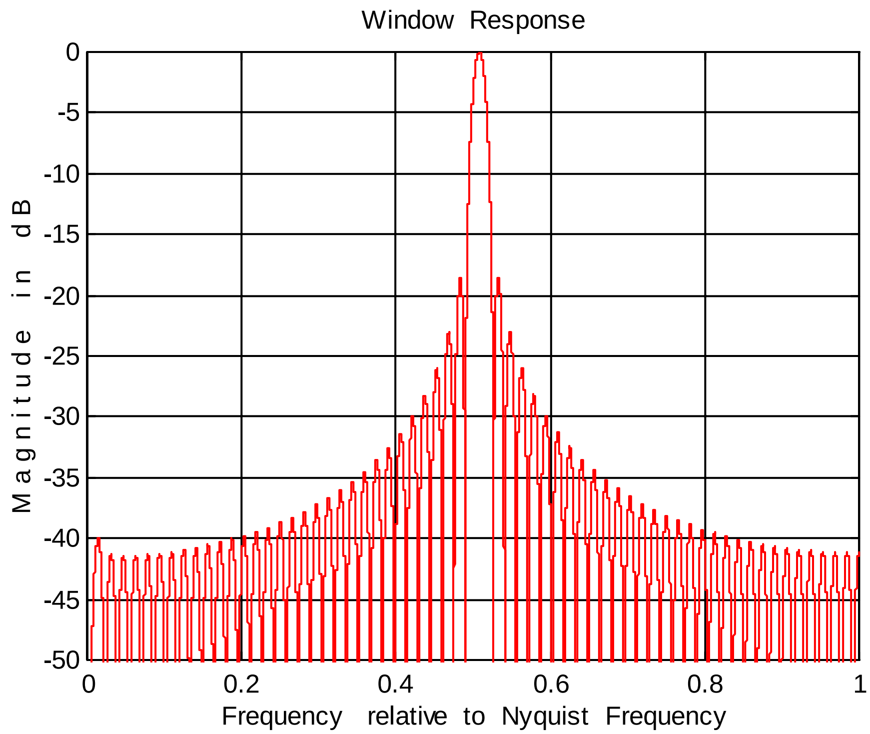
scaled bandwidth = 0.0138 * 128 / 512 = 0.00345

The -3.02 dB bandwidth for a 512 point input using a rectangular window is 0.00345 times the Nyquist frequency.

The following graphs show window behavior.



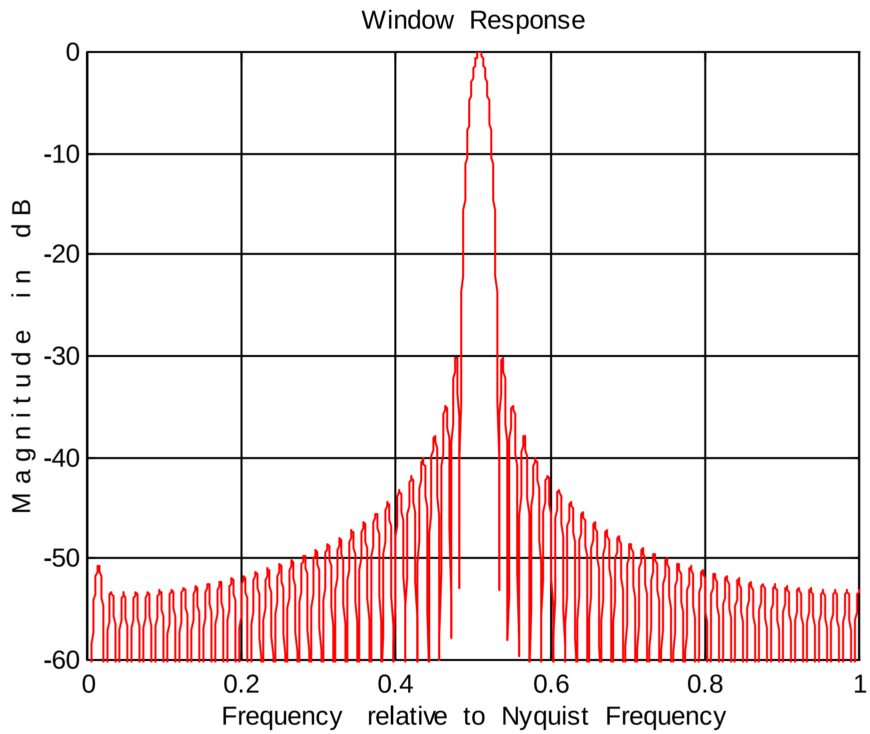

```
Rectangular window

-3.01 dB bandwidth is 0.0138 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0189 times the Nyquist frequency.

The largest sidelobes are -13.2 dB down.
```



Kaiser-Bessel window Alpha=2

-3.01 dB bandwidth is 0.0155 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0213 times the Nyquist frequency.

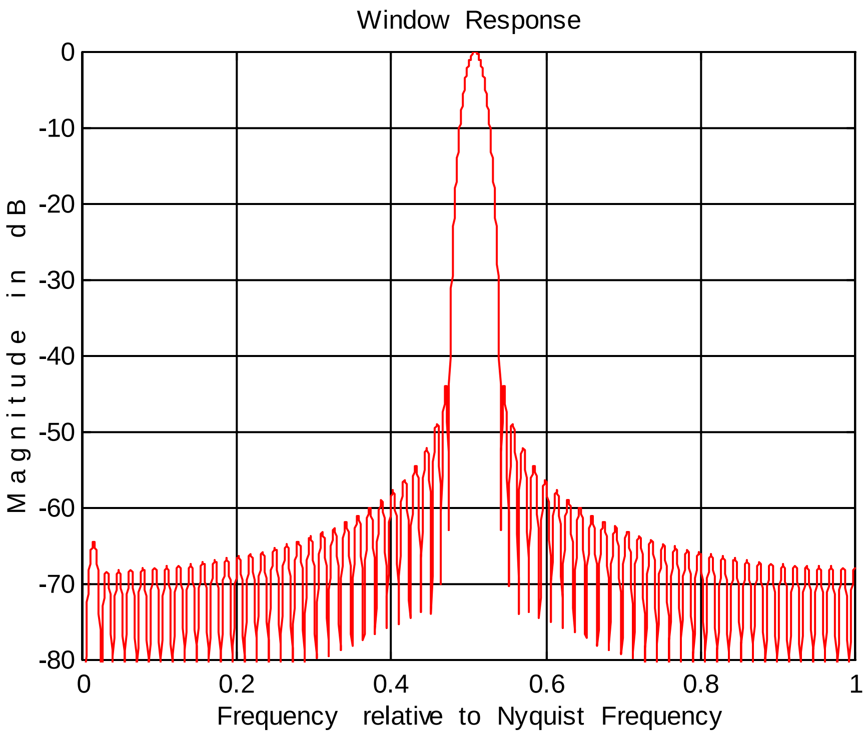
The largest sidelobes are -18.5 dB down.



Kaiser-Bessel window Alpha=4

-3.01 dB bandwidth is 0.0188 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0261 times the Nyquist frequency.

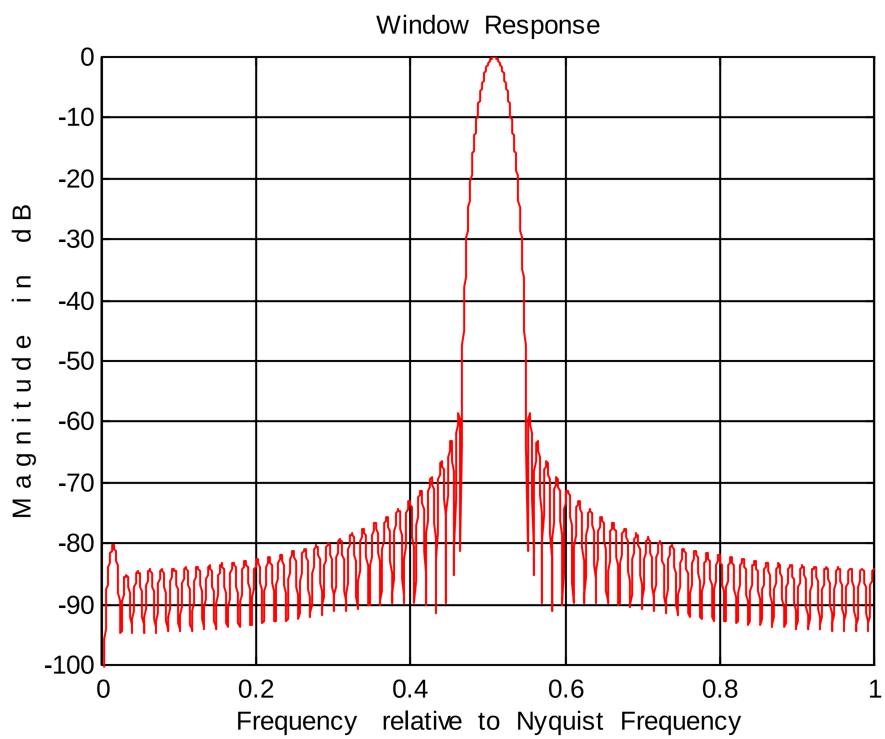
The largest sidelobes are -30.2 dB down.



Kaiser-Bessel window Alpha=6

-3.01 dB bandwidth is 0.0221 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0308 times the Nyquist frequency.

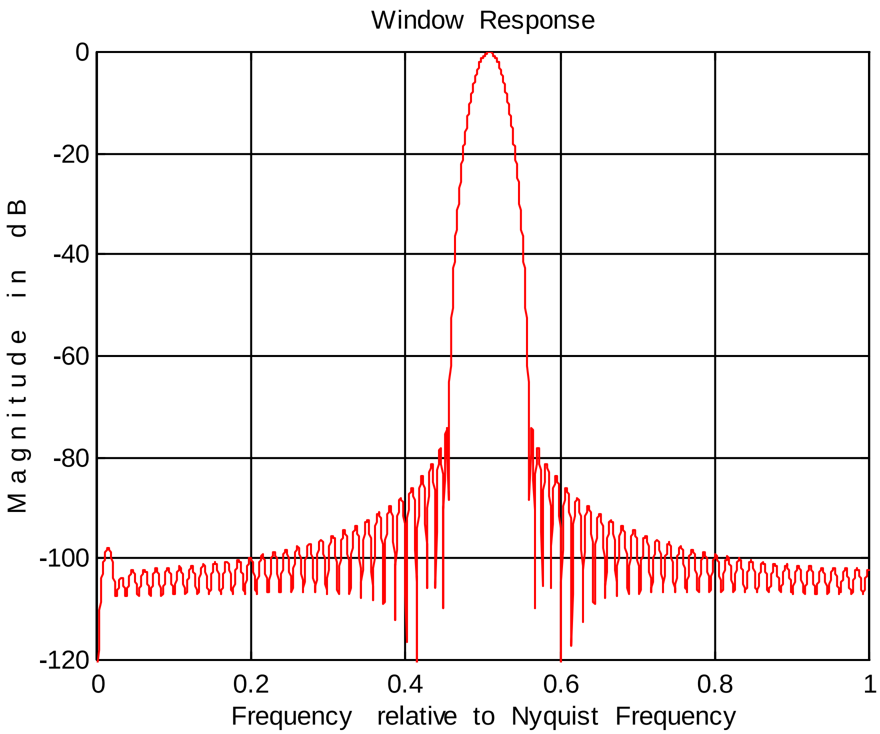
The largest sidelobes are -43.9 dB down.



Kaiser-Bessel window Alpha=8

-3.01 dB bandwidth is 0.0250 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0349 times the Nyquist frequency.

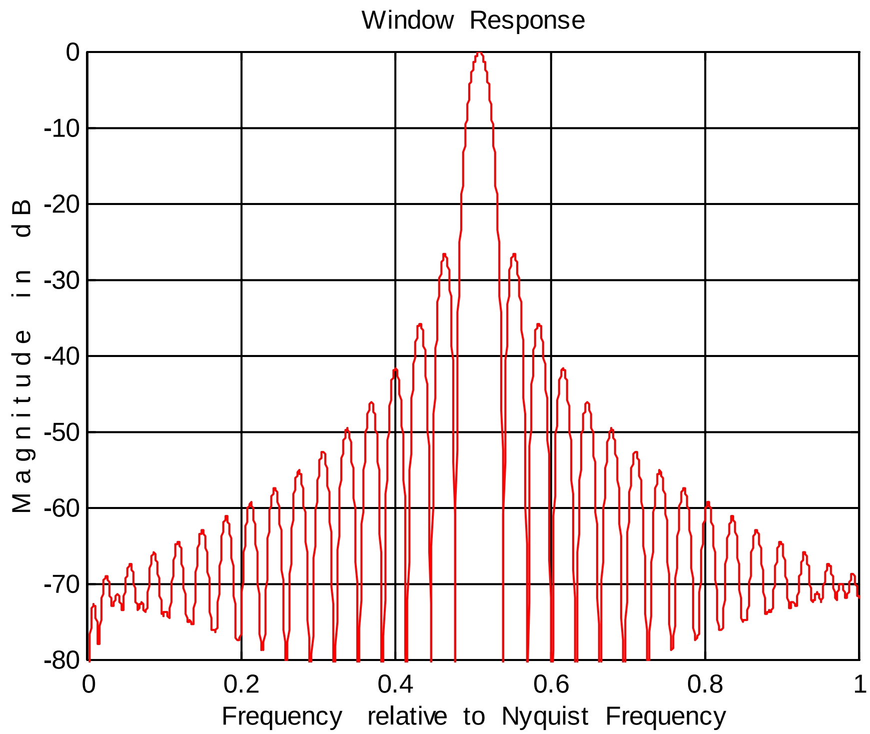
The largest sidelobes are -58.4 dB down.



Kaiser-Bessel window Alpha=10

-3.01 dB bandwidth is 0.0276 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0387 times the Nyquist frequency.

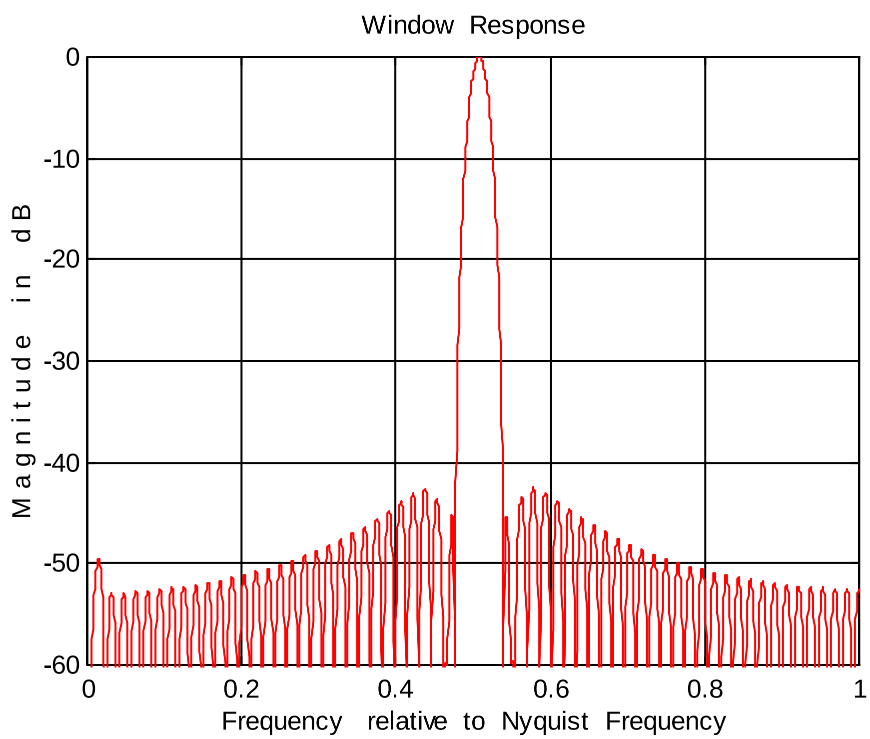
The largest sidelobes are -74.1 dB down.



Triangular window

-3.01 dB bandwidth is 0.0199 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0277 times the Nyquist frequency.

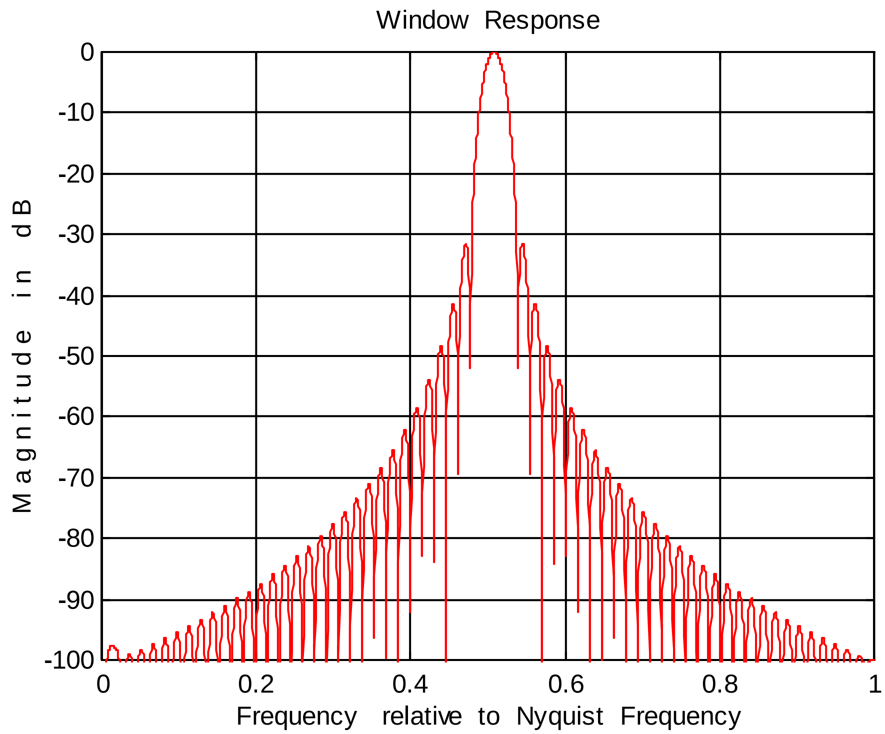
The largest sidelobes are -26.5 dB down.



Hamming Window

-3.01 dB bandwidth is 0.0205 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0285 times the Nyquist frequency.

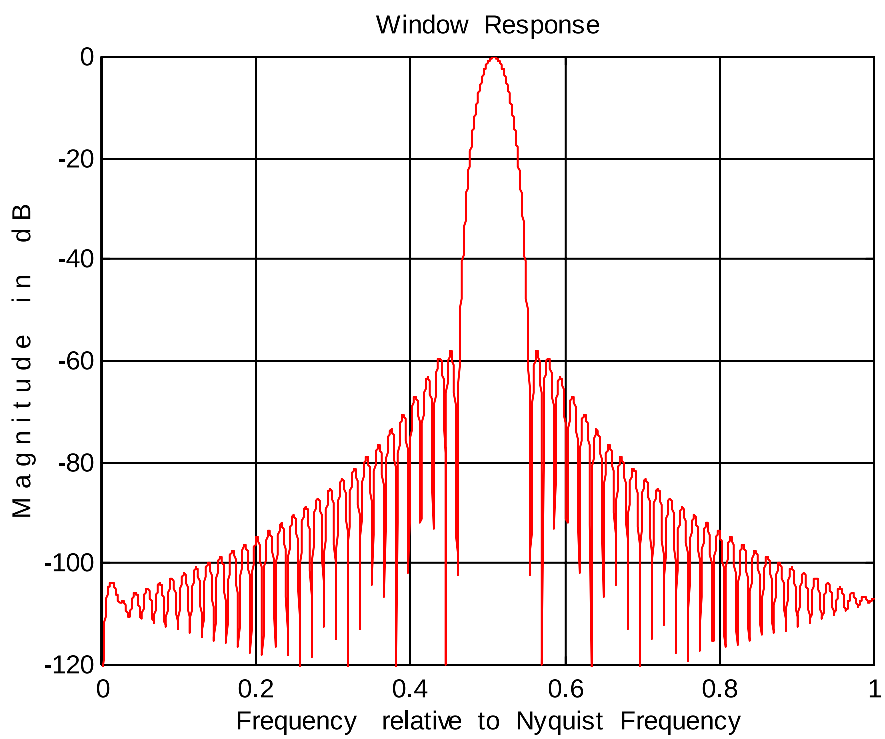
The largest sidelobes are -42.5 dB down.



Hanning window

-3.01 dB bandwidth is 0.0223 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0310 times the Nyquist frequency.

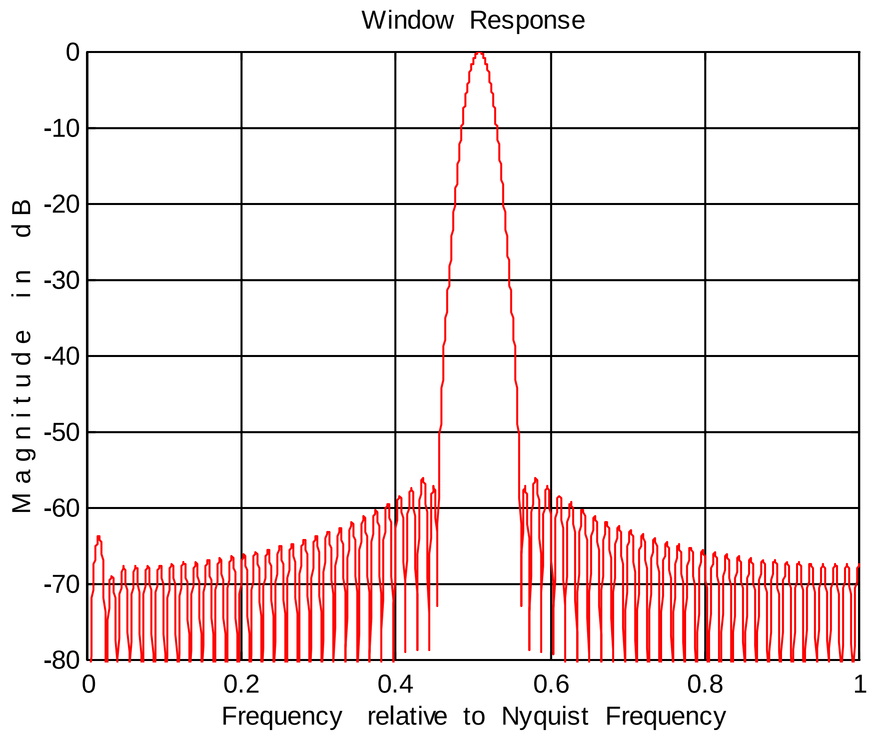
The largest sidelobes are -31.5 dB down.



Blackman window

-3.01 dB bandwidth is 0.0259 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0362 times the Nyquist frequency.

The largest sidelobes are -58.1 dB down.



Gaussian window

-3.01 dB bandwidth is 0.0251 times the Nyquist frequency.
-6.02 dB bandwidth is 0.0353 times the Nyquist frequency.

The largest sidelobes are -56.0 dB down.

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Appendix B – HP E2091 I/O Library Installation

The HP-IB interface card must be installed before the I/O libraries are configured.

The HP E2091 I/O libraries must be installed and configured on a series 700 HP-UX system before the HP E2070 or HP E2071I HP-IB interface card can be used. Refer to the *HP I/O Libraries Installation and Configuration Guide for HP-UX* (document E2091-90002) for the installation and configuration of the HP I/O libraries.

Only the Standard Instrument Control Library (SICL) needs to be installed and configured for the above HP-IB interface cards.

Chapter 2 of the guide contains the procedure to install HP SICL on an HP-UX 9 system. Once the installation has been verified the SICL package can be configured for your HP-IB interface card.

The configuration file, '**hwconfig.cf**,' in '**/usr/pil/etc**' must be updated to reflect your HP-IB interface card. This is done with the graphical user interface program, '**/usr/pil/bin/iosetup**.'

The procedure is also described in chapter 2 of the document. Appendix A of the document also explains how the configuration file can be edited. This can be done instead of updating the configuration file with '**/usr/pil/bin/iosetup**.' Once the file has been modified, the program, '**/usr/pil/bin/pilconf**,' must be run to update the system to recognize the new configuration. At the end of the procedure, it will be necessary to reboot the system.

The above procedure must be done by the super-user. After the system has rebooted, the program, '**/etc/dmesg**,' can be run to display the log from the boot process. If the HP-IB interface card was configured correctly, the following lines will be displayed:

```
1 Slot EISA Expander Initialized: HWPC000
Slot 1: PIL:  HP E2071 HPIB: sys-ctrler, type = 4
PIL:  HP E2071 HPIB: Initialized, slot = 1, symbolic name = hpib
```

NOTE*: This example corresponds to the configuration of an HP E2071I interface card .*

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Appendix C– Solaris 1.x (SunOS 4.1.x)

The information contained in this section supplements previous sections. Only one (1) National Instruments driver can be installed at any one time. If an incorrect driver is installed, it must be removed/unloaded before the correct one can be installed. If no GPIB driver is installed, proceed to step C.2.

C.1 UNLOADING AN INSTALLED DRIVER

- INTERNAL GPIB BOARD:

  The driver is unloaded with the command,

  /dev/ib.UNLOAD

  Remove the file, '**/etc/loadable**', which causes the driver to be automatically loaded at boot time. Also, remove the following files:

  rm /dev/ib.*

- EXTERNAL GPIB-SCSI-A BOX:

  Since this driver is part of a newly rebuilt kernel instead of being loaded at boot time, the kernel that was built for this driver must removed and the original SunOS kernel reinstalled for the internal GPIB board driver to work. Copy the original kernel (which was saved as '**/vmunix.old**' when a new kernel was made for this driver) back to '**/vmunix**'.

If either of these drivers is to be fully removed from the system, the following files **MUST** be removed to install a different driver:

rm /dev/dev*
rm /dev/gpib*
/usr/bin/ibic
/usr/bin/ibconf
/usr/bin/ibtsta

NOTE: The C library, '/lib/libgpib.a', does not need to be removed when switching from one driver to another. Once it is installed for either driver, it will work with the other.

C.2 INSTALLING A DRIVER

Change to the directory that contains the appropriate GPIB driver distribution files.

- INTERNAL GPIB BOARD

  It may be necessary to reboot the system if a new kernel was copied as '**/vmunix**' when the external GPIB-SCSI box was removed.

Copy the administrative files with the following commands:

cp ibic /usr/bin/ibic

cp ibconf /usr/bin/ibconf

cp ibtsta /usr/bin/ibtsta

Build the C library (if it does not exist) with the following commands:

cc -c cib.c

ar rv /lib/libgpib.a cib.o

ranlib /lib/libgpib.a

- EXTERNAL GPIB-SCSI-A BOX

Run the script, '**instgpib'**. Go with the defaults from the script and enter the SCSI address for the GPIB box. All of the required files needed by this driver are automatically copied to the appropriate directories.

A new kernel will be made and (by default) be named '**/vmunix**'. The original kernel (by default) will be named '**/vmunix.old**'. It might be necessary to reboot the system with the different kernel.

C.3 LOADING A DRIVER

- INTERNAL GPIB BOARD

Load the driver from the directory that contains the distribution files with the command:

./ib.INSTALL

- EXTERNAL GPIB-SCSI-A BOX

No loading process needs to be done; the driver is part of the kernel. The driver's parameters are changed with the command, '**ibconf**'. Even if no changes are made, '**ibconf**' must be run to create the required device files in '**/dev**' for either driver. First, remove the following files before running '**ibconf**':

rm /dev/dev*

C.4 CONFIRM INSTALL/LOAD

- Run '**ibconf**'. Press any key. Then enter ^O to exit and 'y' to exit to create the

'**/dev/dev*'** files. The driver install/load process can be checked with the command

'**ibtsta**'

This step might also require a reboot of the system.

Appendix D – Solaris 2.x (SunOS 5.x)

The information contained in this section supplements previous sections. Only one (1) National Instruments driver can be installed at any one time. If an incorrect driver is installed, it must be removed/unloaded before the correct one can be installed.

D.1 CHECKING FOR RESIDENT GPIB DRIVER

Check to see if the correct National Instruments GPIB driver is installed by entering the following (Sun) command:

pkginfo | grep NIC

- If '**NICsbgpib**' is returned, the installed driver is for the internal GPIB board.
- If '**NICscsia**' is returned, the installed driver is for the GPIB-SCSI-A external box.

If no GPIB driver is installed, proceed to step D.3.

D.2 REMOVING AN INSTALLED DRIVER

Before switching from one GPIB interface to another, enter the following (Sun) command to remove an installed driver package:

pkgrm PACKAGE_NAME,

where **PACKAGE_NAME** is the string returned from step D.1.

NOTE: The user must be super-user to remove a driver from the system.

D.3 INSTALLING A DRIVER

Presently, only one driver can be installed at any given time. Driver packages are installed with the (Sun) '**pkgadd**' command.

NOTE: The user must be super-user to install a driver into the system.

The '**pkgadd**' software-transfer-package program was changed with Solaris release 2.4. Some third party packages may no longer be compatible with the latest version of '**pkgadd**'. Primarily, keyboard input might not be processed throughout the entire installation. To resolve this problem, the environmental variable, '**NONABI_SCRIPTS**' must be set to TRUE by the super-user prior to a package installation.

From the C-shell, this is done with the following command:

setenv NONABI_SCRIPTS TRUE,

or from the Bourne shell, this is done with the following commands:

NONABI_SCRIPTS=TRUE

export NONABI_SCRIPTS

Copy the National Instruments driver software distribution (typically on a floppy) to the Sun's file system. Change to the directory in the distribution whose name identifies the driver package. This may be down a few directories from the top distribution directory.

- For the Internal GPIB Board:

  cd NICsbgpib

- For the GPIB-SCSI-A External Box:

  cd NICscsia

Start the install process with the following Sun command:

pkgadd -d

Choose the default selections throughout the install process.

If you are replacing a previously installed driver with another driver, the system must be restarted before the driver can be used.

D.4 CONFIGURING DRIVER (For Solaris 2.X systems.)

For proper operation of the DTS unit, the **Auto Serial Poll** feature of the National Instrument driver **MUST** be disabled using the '**ibconf**' program included during the N.I. driver installation.

To start '**ibconf**,' enter:

/usr/bin/ibconf

from the top screen.

Press '**Control I**' keys to edit the driver parameters.

Set the 'Disable auto serial polling' entry to NO by using the 'j' key to scroll down and the 'l' key to toggle the selection to yes.

Press '**Control O**' to return to the top ibconf window and then enter '**Control O**' again to exit.

Press 'y' to save the configuration if any changes were made for the new driver to be created.

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