Tektronix®

80SJNB
Jitter, Noise, BER, and Serial Data Link Analysis (SDLA) Software

Printable Application Help

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Printable Application Help

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- In North America, call 1-800-833-9200.
- Worldwide, visit www.tek.com to find contacts in your area.

Table of Contents

Parameters

Remote control

Algorithms

Correlations

Third Party Licenses

Index

Welcome to the 80SJNB jitter, noise, BER, and serial data link analysis software

The 80SJNB analysis software enhances the capabilities of the DSA8300 Digital Serial Analyzer. Several versions are available: 80SJNB Essentials, 80SJNB Advanced with Serial Data Link Analysis, and 80SJNB-PAM4 with advanced PAM4 signaling analysis.

80SJNB Essentials provides the following features:

- Perform advanced jitter and noise analysis (RJ, DDJ, PJ, DCD, BUJ, TJ@BER, and RN, DDN(high) and DDN(low), BUN, TN@BER, vertical and horizontal eye opening at BER)

- Perform mask testing on PDF eyes and BER contours

- Acquire complete pattern waveform at 100 Samples/UI

- Perform random and deterministic jitter analysis including BER estimation

- Isolate and measure crosstalk in form of bounded uncorrelated jitter (BUJ)

- Display results graphically including histograms, spectra, and bathtub curves

- Display 2-D eye diagrams (correlated eye, probability density function (PDF) eye, and bit error ratio (BER) eye)

- Save complete acquisition results to a data file

- Analyze jitter, noise, and BER in the presence of spread spectrum clocking (SSC)

80SJNB Advanced adds:

- Signal path emulation, allowing you to emulate the environment your signal encounters from the transmitter to the receiver. Feature include:
  - Supports CTLE, FFE, and DFE equalization
  - Allows user-defined arbitrary filters (use for de-embedding, CTLE Transmitter equalization, and other applications)
  - Supports channel emulation (TDR/TDT and S-parameter based channel descriptions)
  - Other features commonly known as SDLA (Serial Data Link Analysis)

80SJNB PAM4 adds:

- Comprehensive jitter, noise and BER analysis for each eye

- Global PAM4 signal characterization measurements

- Full signal path emulation support

- Rise/Fall measurements

What do you want to do?

Related documentation

The following links contain other information on how to operate the oscilloscope and applications:

- Relevant Web Sites (see page 3)
- GPIB Information (see page 3)
- Types of Online Help Information (see page 4)

GPIB information

For information on how to operate the oscilloscope and use the application-specific GPIB commands, refer to the following items:

- The online programmers guide for your oscilloscope can provide details on how to use GPIB commands to control the oscilloscope.
- The 80SJNB remote control functions (see page 95)

Relevant Web sites

The Tektronix Web site offers the following information:

- Understanding and Characterizing Jitter Primer, literature number 55W-16146-x.
- Jitter analysis details on the www.tektronix.com/jitter Web site
- Information on fixture de-embedding, channel emulation, equalization, pre-emphasis, and de-emphasis on the www.tektronix.com/sdla Web site

You can also find useful information in the Fibre Channel - Methodologies for Jitter and Signal Quality Specification – MJSQ on the www.t11.org Web site.

Conventions

Online help topics use the following conventions:

- The terms "80SJNB application" or "application" refer to the 80SJNB Jitter, Noise and BER Analysis software.

- The term "oscilloscope" or "TekScope" refers to the product on which this application runs.

- The term "select" is a generic term that applies to the two mechanical methods of choosing an option: with a mouse or with the Touch Screen.

- The term "DUT" is an abbreviation for Device Under Test.

- When steps require a sequence of selections using the application interface, the ">" delimiter marks each transition between a menu and an option. For example, one of the steps to recall a setup file would appear as **File > Recall Settings**.

Types of application help information

The online help contains the following topics:

- Getting Started topics briefly describes the application and its requirements.

- Operating Basics topics cover basic operating principles of the application. The sequence of topics reflects the steps you perform to operate the application.

- Parameters topics cover the Analysis and Configuration default settings.

- Application Examples topics show how to use jitter measurements to identify a problem with a waveform. This should give you ideas on how to solve your own measurement problems.

- GPIB Command Syntax topics contain a list of arguments and values that you can use with the remote commands and their associated parameters.

See also:

Using Online Help (see page 5)

Application help use

Application help has many advantages over a printed manual because of advanced search capabilities. The main (opening) Help screen shows a series of book icons and three tabs along the top menu, each of which offers a unique mode of assistance:

- ■ Contents tab - organizes the Help into book-like sections. Select a book icon to open a section; select any of the topics listed under the book.

- ■ Index tab - enables you to scroll a list of alphabetical keywords. Select the topic of interest to display the corresponding help page.

- ■ Search tab - enables you to search the entire help contents for keywords. Select the topic of interest to display the corresponding help page. Search results do not include text contained within illustrations or screen shots.

NOTE. *Blue-underlined text indicates a hyperlink to another topic. For example, select the blue text to jump to the topic on [Feedback to Tektronix. (see page 6)](#)*

TIP. *When you use a mouse, the normal cursor changes to a link cursor when over an active hyperlink.*

Feedback

Tektronix values your feedback on our products. To help us serve you better, please send us suggestions, ideas, or other comments you may have about your application or oscilloscope. Send your feedback to techsupport@tektronix.

Please be as specific as possible and include the following information:

General information

- Oscilloscope model number, firmware version number, and hardware/software options, if any.

- Module and probe configuration. Include model numbers and the channel/slot location.

- Serial data standard.

- Signaling rate.

- Pattern type and length.

- Your name, company, mailing address, phone number, FAX number.

NOTE. Please indicate if you would like Tektronix to contact you regarding your suggestion or comments.

Application-specific information

- 80SJNB Software version number.

- Description of the problem such that technical support can duplicate the problem.

- If possible, save the oscilloscope waveform file as a .wfm file.

- If possible, save the 80SJNB data to a .mat file (**File > Save Data**).

- If possible, save the 80SJNB and oscilloscope settings to a .stp file (**File > Save Settings**).

Once you have gathered this information, contact technical support by phone or through email. If using email, be sure to enter "80SJNB Problem" in the subject line, and attach the .stp and .wfm files.

Product description

The 80SJNB software application enhances the capabilities of the DSA8300 Digital Serial Analyzer by providing Jitter, Noise, and BER analysis (Essentials) and features for de-embedding the fixture, channel emulation, and FFE/DFE equalizer support (Advanced). The PAM4 option adds comprehensive analysis of PAM4 signals to 80SJNB Advanced

You can use this application to do the following tasks:

- Jitter and noise analysis from DC to 400 Gb/s and beyond

- Jitter and noise separation (see the Importance of Jitter and Noise Separation (see page 9))

- Perform random and deterministic jitter and noise analysis, and TJ@BER, TN@BER and BER estimation

- Isolate jitter and noise due to crosstalk, and make random and deterministic estimations in the presence of crosstalk

- Show results as numeric and graphical displays

- Display 2-D eye diagrams (Correlated Eye, Probability Density Function (PDF) Eye, and Bit Error Rate (BER) Eye) for both NRZ and PAM4 signals

- Perform mask testing on PDF eyes and BER contours

- Support for CTLE, FFE and DFE equalization

- Allow user-defined linear arbitrary filters

- Support for Channel Emulation (from TDR/TDT and S-parameter based channel descriptions)

- Analyze jitter, noise, and BER in the presence of Spread Spectrum Clocking (SSC)

- Save results to a PDF file

- Save and recall instrument setups

See also:

Review Requirements and Restrictions (see page 7)

Requirements and restrictions

Operating system.   Microsoft Windows 7 Ultimate (32 bit) operating system operating on the DSA8300 Digital Serial Analyzer oscilloscope.

ADVTRIG option.   80SJNB requires the Advanced Trigger option (ADVTRIG). Contact Tektronix about purchasing this option.

82A04/82A04B Phase Reference module. For acquisition in the presence of Spread Spectrum Clocking (SSC), this application requires that the sampling oscilloscope be equipped with a Tektronix 82A04 or 82A04B Phase Reference module. The 82A04/4B also lowers the jitter floor to 100 fs. Contact Tektronix about purchasing the module for your sampling oscilloscope.

Keyboard and mouse. You must use a keyboard to enter names for some save and export operations. A mouse is not required but simplifies screen selections.

Accessories

There are no standard accessories for this product. Refer to the product data sheet available on the Tektronix Web site for information on optional accessories relevant to your application.

A second monitor connected to the TekScope is recommended for simultaneous viewing of the oscilloscope screen and the 80SJNB application screen.

Refer to Requirements and Restrictions (see page 7) for additional items required to use the 80SJNB application.

Connecting to a device under test (DUT)

You can use any compatible probe or cable interface to connect your DUT and the instrument.

⚠ **WARNING.** *To avoid electric shock, remove power from the DUT before attaching probes. Do not touch exposed conductors except with the properly rated probe tips. Refer to the probe manual for proper use.*

Refer to the General Safety Summary in your oscilloscope manual.

See also:

Deskewing Probes and Channels (see page 9)

An Application Example (see page 81)

Deskewing probes and channels

To be sure of accurate results for two-channel measurements, it is important to first deskew the probes or cables and oscilloscope channels before you take measurements.

NOTE. *Deskewing is performed from the TekScope application, not from the 80SJNB application. Refer to the DSA8300 Quick Start User Manual and the DSA8300 Online Help for information and procedures for deskewing probes and channels.*

The importance of jitter and noise separation

Jitter is an important characteristic to analyze for serial data links, but the analysis should not stop at just jitter. To properly evaluate a data link, it is necessary to analyze both jitter and noise.

Two components need to be added to the traditional jitter analysis:

- The noise/vertical eye closure should be considered similar to that of jitter/horizontal eye closure.

- Jitter measurements based on the threshold crossing of a finite-speed transition should include vertical noise influence.

- Noise measurements and jitter and noise separation and reconciliation is performed on all 4 levels of a PAM4 signal.

Depending on the magnitude of the vertical noise and the transient response of the transmitter and transmission channel, the magnitude of this influence can vary widely. Ultimately the jitter and noise analysis allows for accurate BER projections for the targeted communication link.

Go to www.tek.com/jitter for additional jitter and timing analysis information.

Jitter and noise separation methods
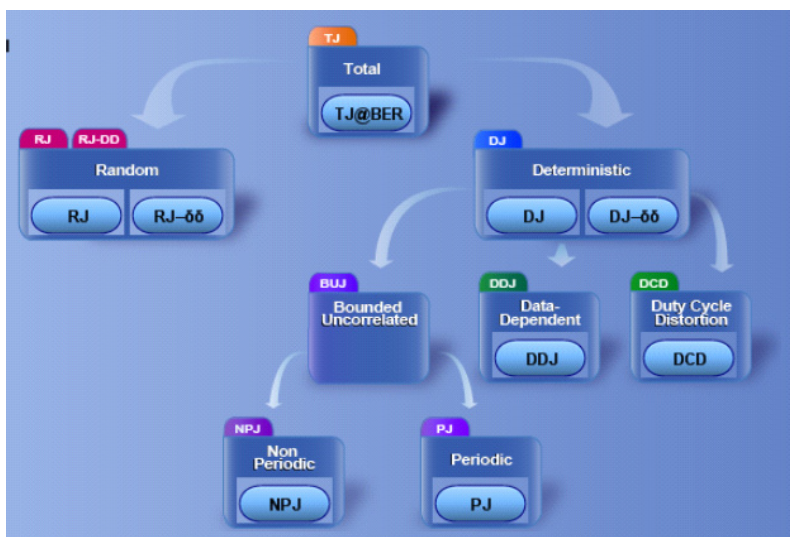
Bit error rates (BER) of a serial data stream are impacted by both jitter and noise. An accurate decomposition of jitter and noise in the sources of impairments is critical to correctly estimate the signal path behavior at larger BER. The jitter and noise maps are critical to help debugging the devices under test.

Since jitter and noise analysis follows a similar path, this discussion covers just the jitter decomposition.

The basic separation of jitter in data-dependent and uncorrelated elements is accomplished by two targeted acquisition steps:

- **Correlated Acquisition Step**: the application filters a high resolution acquisition of the full pattern to eliminate the uncorrelated elements. The analysis of the filtered pattern yields the data dependent characteristics, such as Data Dependent Jitter (DDJ) and Duty Cycle Distortion (DCD).

- **Uncorrelated Acquisition Step**: the uncorrelated elements of jitter are isolated by acquiring on well defined single spots in the pattern, thus eliminating the dependency on the pattern itself. The data acquired in the uncorrelated acquisition step is then further analyzed to isolate random unbounded components from the bounded deterministic components. This extended analysis is critical to help predict long term behavior of the DUT.

Historically only spectral separation was used for separation (available still as the **Spectral (Legacy)** analysis method). This method improperly qualifies certain complex bounded uncorrelated components as unbounded, which inflates the random jitter (RJ) measurement result.

Spectral separation with isolation of bounded uncorrelated jitter (**Spectral + BUJ**) works by also analyzing the cumulative distribution function (CDF) of the uncorrelated non periodic jitter data. In the spectral separation of Periodic Jitter from the Random Jitter, the distinct spectral lines are removed from the frequency domain representation of the global uncorrelated jitter data to quantify the periodic jitter components, PJ. In the legacy method, the spectral method evaluated the remaining spectral data as Random Jitter (RJ).

The presence of complex bounded uncorrelated impairments (for example, originating from crosstalk) requires significant additional steps to isolate the bounded, uncorrelated jitter (BUJ) from the periodic jitter (PJ), nonperiodic jitter (NPJ), and random jitter (RJ) components.

The CDF analysis is performed in two steps: before and after the spectral separation that identifies the periodic spectral components. The first analysis step yields the total bounded uncorrelated jitter, while the second analysis step yields the nonperiodic elements, and finally the random jitter components.

A parallel analysis track develops the noise map, and a combination of the two analysis tracks characterizes the behavior of the link in terms of bit error ratio (BER).

About operating basics

These topics cover the following tasks:

- Navigating the user interface (see page 23)

- User interface information (see page 22)

- Using oscilloscope functions (see page 20)

- Setting up the application (see page 28)

- Viewing the measurement results as plots (see page 21)

- Exporting Plot Files (see page 68)

- Saving (see page 64) and recalling (see page 64) setup files

- Saving (see page 65) and recalling (see page 65) data files

What do you want to do?

- Start the 80SJNB Application (see page 13)

See also:

File Name Extensions (see page 17)

File Menus (see page 18)

Starting the 80SJNB application

There are several ways to start the 80SJNB application.

- If the TekScope application is minimized, double-click the 80SJNB application icon on the Windows desktop to start the 80SJNB application.

- If the TekScope application is running and open, select **Applications > 80SJNB**.
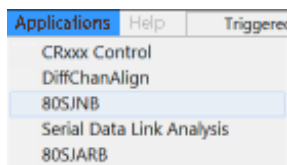
- In Windows, select **Start > All Programs > Tektronix Applications > 80SJNB > 80SJNB.exe**.

> *TIP. With a second monitor connected to the TekScope, you can move the 80SJNB application display to the second monitor, allowing you to view both screens at the same time.*

See also:

Returning to the 80SJNB Application (see page 15)

Returning to the Oscilloscope Application (see page 14)

Returning to the oscilloscope application

The 80SJNB application fills the entire screen and hides the TekScope application. To return to the TekScope display, click the Back to Scope button in the toolbar.

You can also minimize the 80SJNB application or exit the 80SJNB application entirely.

See also:

Minimizing and Maximizing the Application (see page 15)

Exiting the Application (see page 16)

Returning to the 80SJNB application

The TekScope application fills the entire screen. If the 80SJNB application is already running but the TekScope application is displayed on top, bring the 80SJNB application to the front using one of the following methods.

■ Click the **App** button on the TekScope toolbar.

■ Select **Applications > Switch to 80SJNB**.
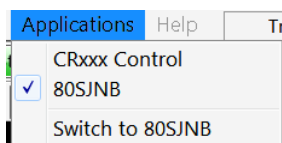
TIP. *If you have a keyboard attached, you can switch between running applications by pressing the Alt + Tab keys.*

Minimizing and maximizing the application window

To minimize the application to the Windows task bar, select the command button in the application menu bar.

To maximize the application, select the minimized application from the Windows task bar. Alternately, if you have a keyboard attached, switch between displayed applications by pressing Alt + Tab keys.

Exiting the application

To exit the application, select File > Exit or the ☒ command button in the application menu bar.

Software and file installation directory

The 80SJNB software is installed in the following directory:

C:\Program Files\TekApplications\80SJNB

Save and recall directory

The directory structure for saving and recalling setup and data files and exporting data is:

    C:\Users\<user name>\Documents

The default user name is:

    Tek_Local_Admin

Standard masks are installed at:

C:\Users\Public\Documents\Tektronix\Masks

See also:

File name extensions

Extension	Description
.bmp	File that uses a bitmap format
.csv	File that uses a comma separated value format
.flt	80SJNB application filter file
.jpg	File that uses a joint photographic experts group format
.mat	File that uses native MATLAB binary format to store data acquired by 80SJNB
.msk	Tektronix mask file (Mask file structure (see page 90))
.png	File that uses a portable network graphics format
.s1p .s2p .s4p	Files that define 1-port, 2-port, and 4-port frequency domain S-parameters
.stp	80SJNB application setup file
.tap	80SJNB application equalization tap file
.txt	File that uses an ASCII format
.wfm	File that defines time domain waveforms or a frequency domain 1-port S-parameter (created by IConnect) for channel emulation 80SJNB accepts both DSA8300 and IConnect .wfm files

File menu

The File menu lets you save and recall application setups, data files, and recently accessed files.

⚠ **CAUTION.** *Do not edit a setup file or recall a file that was not generated by the application.*

Menu item	Description
Save Settings	Saves the current application settings in a .stp file
Recall Settings	Browse to select an application setup (.stp) file to recall; restores the application and oscilloscope to the values saved in the setup file
Save Data	Saves the current acquired data in a .mat file for later analysis
	Saving is disabled if there is no acquired data to save or an acquisition is now in process
Recall Data	Recall a saved data file for analysis
	All plots and results are based on the recalled data
	Recalling is disabled if an acquisition is now in process
Export Results	Exports jitter and noise analysis results to a csv format user specified file.
	Signal attributes and analysis configuration parameters are added to the report to qualify the measurement results.
Export Waveform	Acquired exports the raw acquired pattern before processing of the data
	Correlated exports the acquired waveform after filtering out the uncorrelated components
Print	Prints the displayed plots and all numeric results
Print to File	Print the displayed plots and all numeric results to a .pdf file
Exit	Exits the application

See also:

View menu

The View menu lets you configure the display of plots and/or numerical data. The menu contents depend on the current acquisition mode (NRZ or PAM4).

NRZ acquisition mode View menu

Menu item	Description
1-up	Displays a single plot on the screen
2-up	Displays two plots on the screen
4-up	Displays the maximum of four plots on the screen
Plots Only	Hides all numeric data, expands the displayed plot(s) to fill the screen
Numeric Summary	Displays the plots and a summary of the analysis results
Full Numeric Results	Displays the plots and the full results table (JNB or Mask)
Global Results	Displays a summary of Jitter and Noise measurements, Rise/Fall, and level measurements
JNB Results	Displays the JNB Results tab, which contains the JNB results table
Mask Results	Displays the Mask Results tab, which contains the Mask test results table

PAM4 acquisition mode View menu

Menu item	Description
1-up	Displays a single plot on the screen
2-up	Displays two plots on the screen
4-up	Displays the maximum of four plots on the screen
Plots Only	Hides all numeric data, expands the displayed plot(s) to fill the screen
Numeric Summary	Displays the plots and a summary of the analysis results
Full Numeric Results	Displays the plots and the full results table (JNB or Mask)
Global Results	Displays the global PAM4 results tab containing global and summary information
JNB Results: Eye0	Displays the JNB Results tab for eye 0, which contains the eye 0 results table
JNB Results: Eye1	Displays the JNB Results tab for eye 1, which contains the eye 1 results table
JNB Results: Eye2	Displays the JNB Results tab for eye 2, which contains the eye 2 results table
Mask Results	Displays the Mask Results tab, which contains the Mask test results table
Rise/Fall Measurements	Displays the Rise/Fall measurements and their statistical analysis

See also:

Setup menus

The Setup menus provide access to the various configuration menus.

Menu item	Description
Acquisition	Displays the Acquisition setup dialog screen to select and configure the source for measurements and control key oscilloscope setups
Signal Path	Displays the Signal Path dialog screen to define the signal path characteristics to simulate the actual conditions your signal may encounter
Analysis	Displays the Analysis dialog screen to change settings that affect how measurements are made and displayed
Mask Test	Displays the Mask Test Setup dialog screen to load a mask and define the mask test parameters
Default Setup	Returns the Acquisition, Signal Path, and Analysis settings to their default values
	See About Application Parameters (see page 87) to view the default settings for each configuration menu

About the 80SJNB Tool Bar (see page 24)

Oscilloscope settings

All relevant oscilloscope settings are accessible using the Acquisition dialog box of the 80SJNB application.

To bring the TekScope application to the front of the display, click the **Back to Scope** button or minimize the 80SJNB application. Alternately, you can use the Alt + Tab keys to switch between applications if you have a keyboard attached.

See also:

About Configuring the Application for Analysis (see page 28)

Returning to the Application (see page 14)

Minimizing and Maximizing the Application (see page 15)

About the results

There are two ways to view analysis results: as numeric data and as graphical plots.

You can log the results data to .csv files for viewing in a spreadsheet, database, text editor or data analysis program.

There are several results tables: Global measurements, Jitter and Noise and BER analysis for each of the eyes (3 for PAM4), Mask analysis results, and statistical analysis for the Rise and Fall measurements.

See also:

Working with Results (see page 77)

Clearing Results (see page 21)

Exporting Plot Files (see page 68)

Exporting Results from the File Menu (see page 18)

Clearing results

Click the Clear Data button to remove the existing plot displays and results. You may want to clear the data before acquiring new data or between cycles when the sequence mode is set to Free run.

NOTE. *The numeric results and plot files are erased each time a new acquisition cycle is started.*

About plotting

The application displays the results as plots for more comprehensive analysis. Before or after you take measurements, you can select to display a single plot, two plots or four plots. You can select the type of data you want to view in each plot window.

See also:

Working with Plots (see page 66)

Plot Type Definitions (see page 66)

About Working with Results (see page 77)

About the user interface

The application uses a Microsoft Windows-based user interface.

NOTE. *The TekScope application is hidden when the 80SJNB application is running and not minimized.*
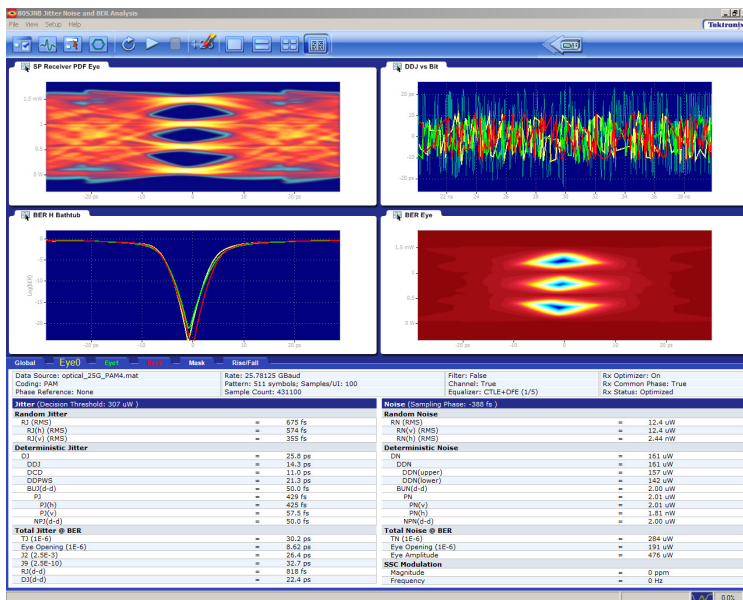
See also:

Starting the Application (see page 13)

Definitions of the application user interface items (see page 22)

Minimizing and Maximizing the Application (see page 15)

Exiting the Application (see page 16)

User interface items definitions

Item	Description
Area	Visual frame that encloses a set of related options
Box	Use to define an option; enter a value with the Keypad or a Multipurpose knob
Browse	Displays a window where you can look through a list of directories and files
Check box	Use to select or clear an option

Item	Description
Command button	Initiates an immediate action, such as the Start command button in the Control panel
Keypad	On-screen keypad that you can use to enter numeric values
Menu	All options in the application window (except the Control panel) that display when you select a menu bar item
Menu bar	Located along the top of the application display and contains application menus
Status bar	Line located at the bottom of the application display that shows the acquisition status and the latest Warning or Error message
Virtual keyboard	On-screen keyboard that you can use to enter alphanumeric strings, such as for file names
Scroll bar	Vertical or horizontal bar at the side or bottom of a display area that you use to move around in that area
Tool bar	Located along the top of the application display and contains application quick launch buttons

About navigation

The application provides you with several ways to display the results:

■ The drop-down menus available in the menu bar allows for screen configuration (one, two, or four plots, summary or full numeric results table)

■ The buttons in the tool bar allow for screen configuration

■ The drop-down menus available in the plot display windows allow you to choose from the available plots, and Copy, Examine, and Export plots

■ The status bar at the bottom of the screen contains progress information and displays error conditions detected

■ Double clicking on a displayed graph opens the plot in a MATLAB window. MATLAB provides additional display capabilities such as panning, zooming, data cursors, and 3D rotation. The Examine button from the drop-down menu of the plot also opens the MATLAB window.
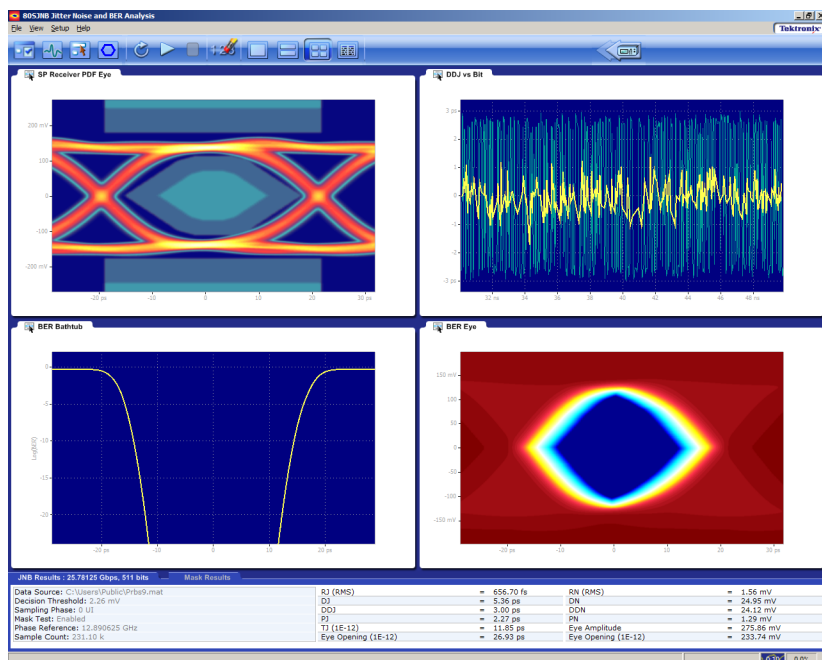
See also:

Windows User Interface (see page 22)

About the 80SJNB Toolbar (see page 24)

About Configuring the Application for Analysis (see page 28)

About the 80SJNB tool bar

The toolbar provides quick access to the most common functions you need to configure the settings, start the acquisition, and control the numerical and plot displays. Most tasks are also available using the drop-down lists from the File menu bar.

- **Acquisition** button. Use the Acquisition button to select and configure the source for measurements and control key oscilloscope setups. Any change in the Acquisition settings clears all the data. The Acquisition button is disabled during the acquisition and processing cycle.

- **Signal Path** button. Use the Signal Path button to define the signal path characteristics to simulate the actual conditions your signal may encounter. Changes made in the signal path settings

does not clear the data, only the results. The Signal Path button is disabled during the acquisition and processing cycle.

- **Analysis Setup** button. Use the Analysis Setup button to change settings that affect how measurements are made and displayed. Changes made in the analysis settings does not clear the data, only the results are updated. The Analysis Setup button is disabled during the acquisition and processing cycle.

- **Mask test** button. Use the Mask Test button to select a mask and configure the mask test.

- **Free Run On/Off** button. Use the Free Run button to select the sequence mode (free run on or off).

   When OFF, the button remains blue and the acquisition and processing cycle completes one pass over the entire pattern. Off is the default mode.

   When Free Run is ON, the button turns green indicating that the acquisition and processing cycle repeats until stopped. The correlated components are averaged with previous data while the uncorrelated components are accumulated for increased statistical content. At the completion of each acquisition cycle, the plots and measurements are updated.

   Free Run mode is recommended when:

   There is a doubt that one acquisition cycle is enough. A change in the results indicate that additional acquisition cycles was needed.

   The correlated waveform shows irregular disturbances. It is possible that uncorrelated information can leak into the single-pass correlated filtering. Acquiring a larger statistical sample improves analysis in the presence of crosstalk.

   Several Standards specify the size of the data samples to be used for measurements. See the Stop on Conditions setup in Acquisition dialog.

To halt a Free Run cleanly, deselect the button. This converts the Free Run mode back to Single Sequence mode, so that the acquisition stops when the cycle is complete.

- **Run** button. Use the Run button to start the acquisition and processing cycle. Once the run button is pressed, do not change any instrument settings. When the Run button is pressed, all current measurement data and plot displays are cleared. During the acquisition and processing cycle, the Signal Path, Analysis, Acquisition, and Run buttons are disabled.

   During the acquisition and processing cycle, the Run button is replaced with the Pause button . Click Pause to interrupt the current acquisition and processing cycle. Click the button again to resume

the cycle. This is useful when the acquisition is set to Free Run, allowing you to halt the acquisition and processing cycle so you can view and save the measurement data between cycles.

■ **Stop** button. Use the Stop button to end the acquisition and processing cycle. While in Single Sequence mode, stopping the cycle produces no results and you must click the Start button to start a new cycle.

■ **Clear Data** button. Use the Clear Data button to clear all results and plot displays. If Free Run is set to ON (cumulating previous data with new), you can clear the existing results and plots during the processing cycle, thus starting a new acquisition and processing cycle.

■ **Plot Display** buttons. Use the window pane buttons to display between 1, 2, or 4 plots. You can change the number of plot displays at any time.

■ **Numeric Results Display** button. The results button changes the display to a complete list of statistics. If the application is displayed on a larger screen, the numeric results display shows all the results at once.

■ **Back to Scope** button. Use this button to bring the TekScope display to the front of the screen.

See also:

About Configuring the Application for Analysis (see page 28)

About Analysis Settings (see page 52)

About measurement results tabs

The application shows several measurement results tabs depending on the coding of the signal (NRZ or PAM4) being measured.
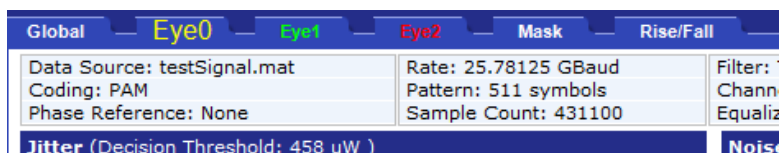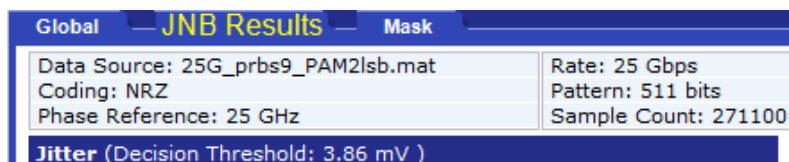
The three NRZ tabs are labeled Global, JNB Results and Mask. These tabs show the same graphs but display different numeric results. Global results display a summary of Jitter and Noise measurements, Rise/Fall, and level measurements. Tab JNB Results displays all jitter, noise, and BER results. The Mask tab displays all mask results such as hit ratio, margins, and BER limit.

For PAM4 signals, six tabs are available. The Global tab displays both global PAM4 results and summary results across all eyes. The JNB Results tab is replaced by three tabs, one per eye, labeled Eye0, Eye1 and Eye2. Eye0 is the lowest eye. These tabs display all jitter, noise and BER results for their respective eyes. The Rise/Fall tab displays the Rise/Fall measurements and their statistical analysis.

The currently selected tab is labeled with a larger font. In addition, the three Eye tab labels are color coded to match the figures having one graph per eye. In such figures, the yellow, green and red graphs represent the data for eyes 0, 1 and 2, respectively.

MATLAB user interface

The 80SJNB application includes MATLAB® plots to provide further data analysis and visualization of the plot displays.

MATLAB provides multiple capabilities to display and annotate the plot diagrams, including:

- Pan and Zoom

- 2D and 3D visualization

- Rotation

- Data Cursors

- Color enhancements

MATLAB is a product distributed by MathWorks. You can view the MATLAB documentation and tutorials on their Web site: http://www.mathworks.com
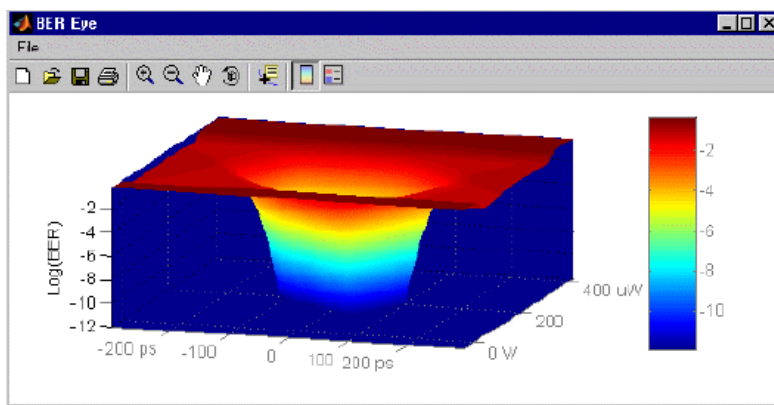
About configuring the application for analysis

The tool bar provides an Acquisition (see page 29) button [icon] to configure the application to acquire data, a Signal Path (see page 40) button [icon] to set signal path conditions, an Analysis (see page 52) button [icon] to change settings that affect how measurements are made and displayed, and a Mask test (see page 90) button [icon] to set the mask test parameters.

NOTE. The Acquisition settings must be set before starting an acquisition cycle. You can modify the Signal Path and Analysis settings without the need to reacquire data. You can also change the Mask Test without the need to reacquire data.

Use the Sequence button to have the acquisition and processing of data run continuously (free run) or stop after one cycle is complete.

After setting up the application, you can select the Run button to start the acquisition and processing cycle.

After the acquisition and processing cycle has completed, you can view the results as numerical (see page 77) statistics or graphically (see page 21).

A typical scenario to setup the 80SJNB application and acquire data involves the following steps:

1. Set the Source, Data Rate, and Pattern Length.

2. Select a Stop on Condition.

3. Set the required Count.

4. From the tool bar, select Free Run mode.

5. Issue a Run command.

6. Wait until the 80SJNB application finishes running and then stops.

See also:

About Acquiring Data (see page 29)

About acquiring data

Before making jitter and noise measurements, you need to select and configure the signal source.

Use the Acquisition button to display the Acquisition dialog box.

In the Acquisition dialog box, select the signal source and signal coding (NRZ or PAM4), and define the acquisition parameters. Some parameters (such as the Clock Recovery, Phase Reference Sources, and the optical signal conditioning) are copied from the oscilloscope state.

One of the key acquisition parameters is the number of samples per unit interval. The default is 100 samples per unit interval. For higher throughput and support of longer record lengths than PRBS13, you can optionally select 40 samples per unit interval.

Click the AutoSync to Selected Source button to have the 80SJNB application automatically obtain and enter the following information from the signal applied to the channel defined as the Signal Source:

■   Data Pattern Rate

■   Data Pattern Length

■   Recommended Data:Clock Ratio (when Spread Spectrum Clocking (SSC) signaling is used)

NOTE. *Acquisition in the presence of SSC requires certain cabling propagation delays to be preserved. Please contact Tektronix for an up-to-date diagram of cabling lengths.*

NOTE. *Tektronix recommends running this functionality in the oscilloscope (the equivalent menu exists in Setup > Mode/Trigger > Pattern Sync/FrameScan Setup). The important difference is that the oscilloscope UI/PI allows manual entry of some of the parameters of the AutoSync, which dramatically improves the success rate of AutoSync. For example, manually entering the Data Pattern Length, and then unchecking the pattern length item from the AutoSync search, makes the data pattern length much more likely to succeed. Refer to the DSA8300 TekScope application online help for details about the Pattern Sync settings.*
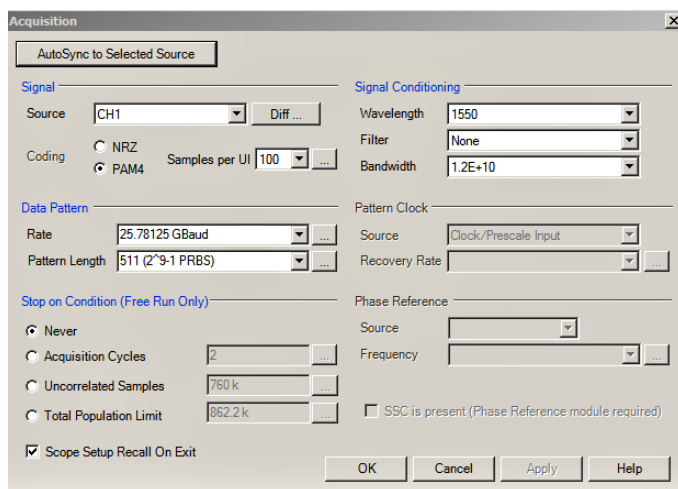
See also:

[Selecting a Stop on Condition (see page 31)](#)

[Selecting Scope Setup Recall On Exit (see page 32)](#)

[Selecting Clock Recovery (see page 33)](#)

[Selecting Phase Reference (see page 34)](#)

[Selecting the Data Pattern (see page 35)](#)

[Selecting the Signal Conditioning (see page 36)](#)

[Selecting the Pattern Clock (see page 37)](#)

[Selecting the Source (see page 37)](#)

Selecting a Stop on Condition

The Stop on Condition selections allow you to control the amount of data to be acquired and processed before stopping.

NOTE. *The Free Run mode has to be selected for the Stop on Conditions to be active. Use the Sequence button* *to select the continuous acquisition and processing mode.*

There are four options to control the stop condition:

Never.   This is the default condition. The acquisition and processing of data runs continuously until explicitly stopped by user by clicking on the Stop button.

Acquisition cycles.   Acquisition Cycles instructs the 80SJNB application to continue acquiring and processing data until the defined number of cycles have completed. Note that changing the number of Acquisition Cycles coerces the numbers associated with the other two options. Each acquisition cycle includes a number of uncorrelated samples, selected by design, and a number of samples correlated with the data pattern, which depends on the pattern length and the number of samples per data bit – which is also selected by design.

The following equation describes the relationship between these parameters:

Total Population Limit = Acquisition Cycles * (Uncorrelated_Samples_Per_Cycle + Samples_Per_Bit * Pattern_Length)

Uncorrelated samples.   Uncorrelated Samples instructs the 80SJNB application to continue acquiring and processing data until the data required for jitter and noise processing exceeds the specified number. The default count is a number that represents 2 acquisition cycles.

Total population limit.   Total Population Limit instructs the 80SJNB application to continue acquiring and processing data until the total number of samples exceeds the specified number. The default count is a number that represents 2 acquisition cycles, and reflects the selected Pattern Length.

The actual number of acquired and processed samples is displayed in Sample Count (see below), and corresponds to the nearest integer number of acquisition and processing cycles.
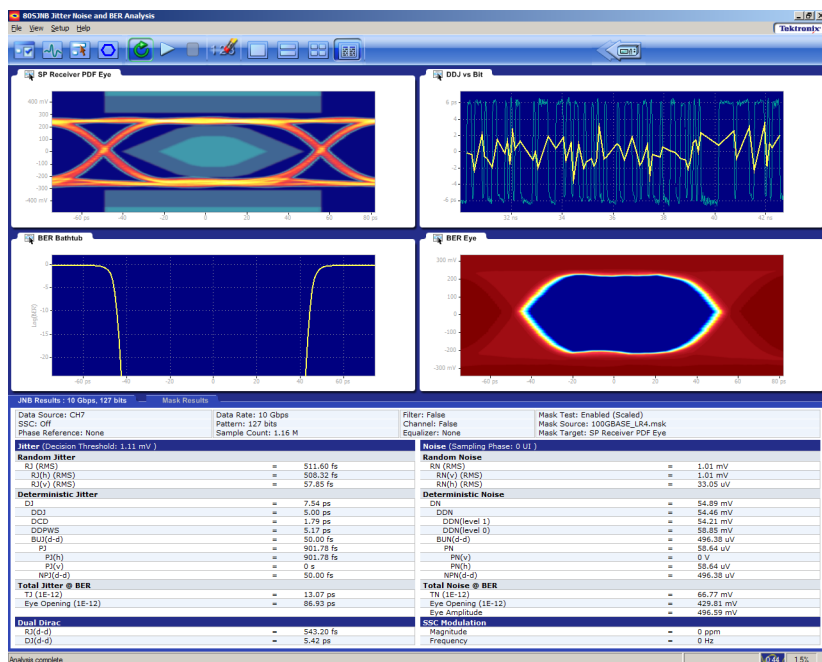
Selecting scope setup recall on exit

Acquiring data for jitter and noise analysis requires the 80SJNB application to fully control the oscilloscope state. When this control is checked, exiting the 80SJNB application (File > Exit) restores the oscilloscope to the state which was stored when 80SJNB application was launched.
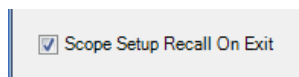
Selecting clock recovery

The Advanced Trigger option (ADVTRIG) that generates the pattern synchronous triggers requires a clock source synchronous with the signal. When using a clock derived from a clock-recovery module installed in the oscilloscope (such as optical sampling modules), use the Pattern Clock fields to select the source module, the configuration and its frequency.
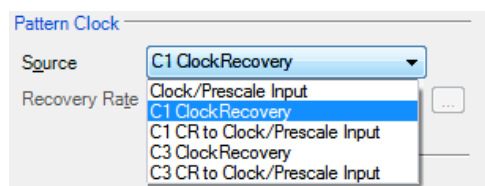
All native clock recovery modules support two different configurations: one that connects the recovered clock from the back of the module to the internal pattern synchronous trigger generator; and, for optimal jitter performance, the module full rate clock output can be connected to the front panel Clock/Prescale Input.

These settings are grayed out if no modules with clock recovery are detected at application startup.

The Rate setting is limited to the capabilities of the selected module. The numeric keypad is unavailable for use unless the module can accept USER defined rates.

Selecting phase reference

You can use a Phase Reference module (such as the Tektronix 82A04B) to reduce the trigger jitter of the signal source, thus increasing the jitter measurement accuracy. If analyzing a signal using Spread Spectrum Clocking (SSC), a Phase Reference module is required.

If using a Phase Reference module, set the channel source and the frequency of the applied clock.

These settings are grayed out if a Phase Reference module is not detected at application startup. If a Phase Reference module is detected, you have the option to not use the module by selecting None as the Source.

TIP. Selecting a Phase Reference module dramatically improves the accuracy of DDJ (Data Dependent Jitter) and the correlated waveforms. However, the throughput is lowered in this mode.
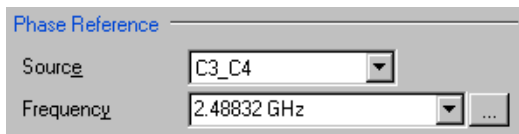
NOTE. When using a recalled data file, the Phase Reference Frequency field is updated to indicate the frequency when the data was acquired. The Source field remains unchanged regardless if phase reference was used when the recalled data file was created.

Selecting the data pattern

Defining the Data Pattern requires that you define both the data rate of the signal source and the pattern length in bits. You can choose the data rate from a predefined set of lengths or enter a value with the numeric keypad.

NOTE. Selecting a data rate that does not match the communication standard that is set in the instrument's Horizontal Communication Standard setting dialog box causes the oscilloscope setting to change to User.

When selecting the pattern length, only the length is important. The precise bit sequence is unimportant if it is repetitive.
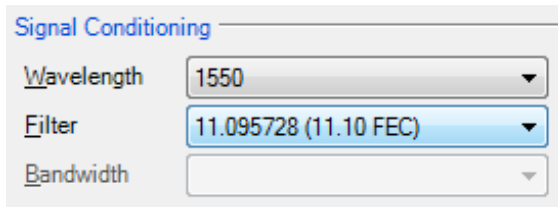
To analyze a clock pattern, select a 2 bits pattern (or a multiple). The analysis is performed on both edges.
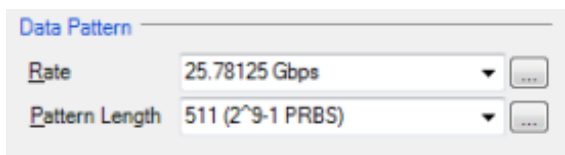
NOTE. When using a recalled data file, the Data Pattern fields are updated to indicate the state of the settings when the data was acquired.

Selecting the signal conditioning

Use this control to select what type of filtering, if any, you want performed on the selected channel. The available filters depend on the capabilities of the module.

If the Filter is set to None, you can use the Bandwidth box to select the bandwidth of the channel. The available bandwidth selections depend on the capabilities of the module. Refer to the documentation for the module about its filter or bandwidth settings.

The list of hardware filters are specific to the selected module as data source. A comprehensive list of the hardware filters, the standards they support, and the data rates, are listed in the DSA8300 Programmer Manual. The manual specifies the token names that are used by the programmatic interface to select a particular filter.

The range and resolution of scale values for a selected channel is dependent on multiple factors: module type, probe type if attached, and an external attenuation factor. Use the DSA8300 programmatic interface commands when an external attenuation factor is required. See the DSA8300 product documentation for details.

Selecting the pattern clock

The Pattern Sync built-in capability provides user pattern synchronous triggers. The feature, enabled by the Advanced Trigger Option (ADVTRIG), is driven by the Pattern Clock.

The available Pattern Clock sources depend on the instrument configuration. The default selection is Clock/Prescale Input, and this selection is available for all configurations. Connect the clock source to the CLOCK INPUT/PRESCALE TRIGGER front-panel connector.

When the oscilloscope is equipped with one or more clock recovery capable modules, the CR units are also available as sources for the Pattern Clock.

Each native clock recovery source appears on the Pattern Clock source list twice to allow for two different configurations:

- Selecting **Cx Clock Recovery** sets the instrument to pick up the recovered clock from the back of the module using and internal signal path.

- Selecting **Cx CR to Clock/Prescale Input** sets the instrument clock recovery signal source to the CLOCK INPUT/PRESCALE TRIGGER connector on the front panel. Connect the output of the clock recovery module to the front panel CLOCK INPUT/PRESCALE TRIGGER input.

Depending on the data rate, choosing one configuration over the other could result in different intrinsic jitter performance. See Selecting Clock Recovery (see page 33). In general, if there is SSC then a particular cabling setup is necessary; only external Clock Recovery (such as with a Tektronix CR286A) can be used. If the Tektronix 82A04/82A04B Phase Reference module is used in the absence of SSC, the 82A04/82A04B setup determines the jitter performance. The intrinsic jitter of the pattern trigger circuit becomes invisible.
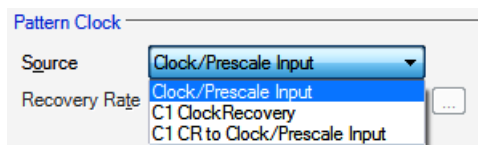
When the clock source is a dedicated Clock Recovery Unit, like the Tektronix CR125A, CR175A, or CR286A, the instruments are controlled by a USB-link to the oscilloscope. The syntax of the programmatic interface is specified in the *DSA8300 Programmer Manual*. The header of the commands are TRIGger:CLCRec:CRC.

Selecting the source

The application takes measurements on waveforms specified as sources (also called signal sources). The source can be a channel (CH1 through CH8) or a defined math waveform. You can use any defined math waveform, whether it is defined in the 80SJNB configuration as a differential setup or in the TekScope application.

Specify whether the source waveform is NRZ or PAM4.

NOTE. *Selecting PAM4 disables SSC.*

If your signal source uses Spread Spectrum Clocking (SSC), select the SSC check box so that the application can make accurate measurements that account for clock rate modulation

☐ SS<u>C</u> is present (Phase Reference module required)

NOTE. *If a saved data file is recalled, the signal source selection remains unchanged but all result panels will indicate the recalled data file as the source. The "SSC is present" field is updated to match the setting from the recalled data file.*

See also:

About Spread Spectrum Clocking (SSC) (see page 39)

Clicking the **Diff** button displays the dialog box to create a differential Math waveform by defining a positive and negative waveform source (the negative waveform source is subtracted from the positive waveform source). This generates a single mathematical waveform that the 80SJNB application can use as the waveform measurement source.

Create Difference Waveform

Data Sources

Positive   CH1

Negative   CH5

Expression

C1-C5

Assign to   MATH1: C1-C5

OK   Cancel
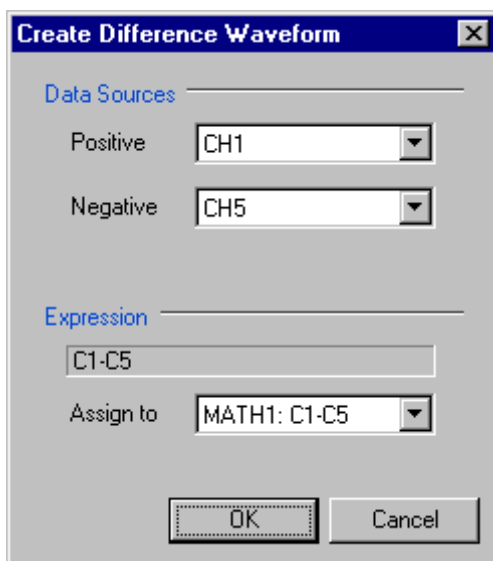
About spread spectrum clocking (SSC)

Spread Spectrum Clocking (SSC) is the technique of modulating the clock frequency to minimize EMI effects. SSC affects the analysis process and the results of jitter, noise and BER measurements. If SSC is not corrected for its effects, the results show as a large amount of periodic jitter components that are reflected in the total jitter and noise, and ultimately in the BER estimates.

When SSC is present, 80SJNB measures the attributes of SSC and corrects the results.

SSC configuration requirements

NOTE. *SSC is available only for NRZ coding measurements.*

If using clock recovery, the clock recovery unit must be able to handle SSC. Use one of the Tektronix BERTScope clock recovery instruments if SSC is present in the signal.

The TekScope must have an 82A04 or 82A04B Phase Reference Module installed. The module minimizes the effect of the SSC on the data by sampling synchronously the data and clock. Also, by acquiring the clock in the 82A04/4B module, 80SJNB characterizes the SSC present in the clock and uses that information to correct the jitter, noise, and BER measurements performed on the data.

TIP. *The "SSC is present" check box is disabled if the Phase Reference module is not installed in the instrument.*

Use the following settings to optimize the SSC phase correction for the signal you are measuring:

Data rate range	Clock recovery frequency [2]	Clock recovery output rate [1], [2]	Data:Clock ratio (JNB)	Phase reference frequency (JNB)
500 Mbps – 1 Gbps	Data Rate * 4	Standard	1:4	Data Rate * 4
1 Gbps – 2 Gbps	Data Rate * 2	Standard	1:2	Data Rate * 2
2 Gbps – 4 Gbps	Data Rate	Standard	1:1	Data Rate
4 Gbps – 8 Gbps	Data Rate	Subrate (1/2)	2:1	Data Rate/2
8 Gbps – 12.5 Gbps	Data Rate	Subrate (1/4)	4:1	Data Rate/4

[1] The Clock Recovery unit clock output is either Standard or Subrate Clock.

[2] Clock recovery is typically provided from a CR125A, CR175A, or CR286A BERTScope Clock Recovery Instrument.

When you instruct 80SJNB that the data has SSC (by checking the "SSC is present" check box), the following constraints are enforced based on the current Data Rate:

- Phase Reference source is selected.

- Phase Reference frequency is set to the recommended value in the table *Configuration Settings for SSC*.

- A recommended Data:Clock Ratio is displayed to suggest the recommended subrate clock.

NOTE. *Changes to the Data Rate are reflected in the Phase Reference Frequency and Data:Clock Ratio. You must make the appropriate changes to the Clock Recovery unit parameters.*

The Full Numeric Results page shows the status (on or off) of the SSC setting. The results of the SSC analysis are presented in two forms, numeric results and a plot. When viewing the full numeric results table, the SSC Modulation section has two fields: Magnitude and Frequency. Magnitude represents the depth of the SSC clock modulation in parts-per-million (ppm) and Frequency reflects the SSC modulation frequency.

To view the plot of the SSC modulation profile, select the Plot>SSC>SSC Profile.
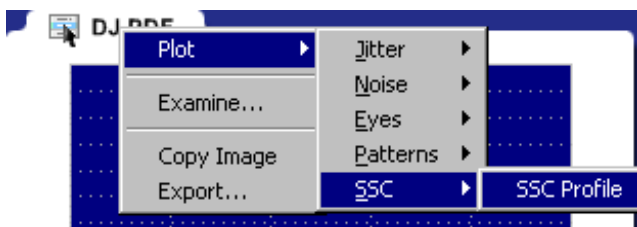
TIP. *The configuration settings are also available through the GPIB programming interface of the oscilloscope. Refer to the information provided with the oscilloscope.*

About Serial Data Link Analysis (SDLA) Signal Path Settings

The Signal Path Settings are available for use with the 80SJNB Advanced and PAM4 versions. If you are using the 80SJNB Essentials version, you're allowed to use the dialog boxes but are not allowed to place any of the functions into the signal path.

The Signal Path settings allow you to emulate the environment your signal encounters, all the way from the transmitter to the receiver. With the Signal Path dialog box, your signal path is represented by a line from the transmitter (Tx) to the Receiver (Rx). Along this line, you have the ability to emulate an arbitrary filter and/or a channel. You can then define an equalizer to compensate for the effects the filter and channel introduce. Also, fixture de-embed is supported.

Selecting a signal path arrow (Filter, Channel, or Equalizer) inserts or removes the function from the signal path. When inserting a function into the signal path, its dialog box automatically displays.

Selecting a signal path button (Filter, Channel, or Equalizer) displays the dialog box for that function without inserting or removing the function from the signal path.

By simulating the signal environment, you can effectively emulate probing the signal at the receiver rather than the output of the transmitter. With the use of the Equalizer, you can then design compensations to improve the signal quality at the receiver.

Full signal path functionality supports PAM4 signals.
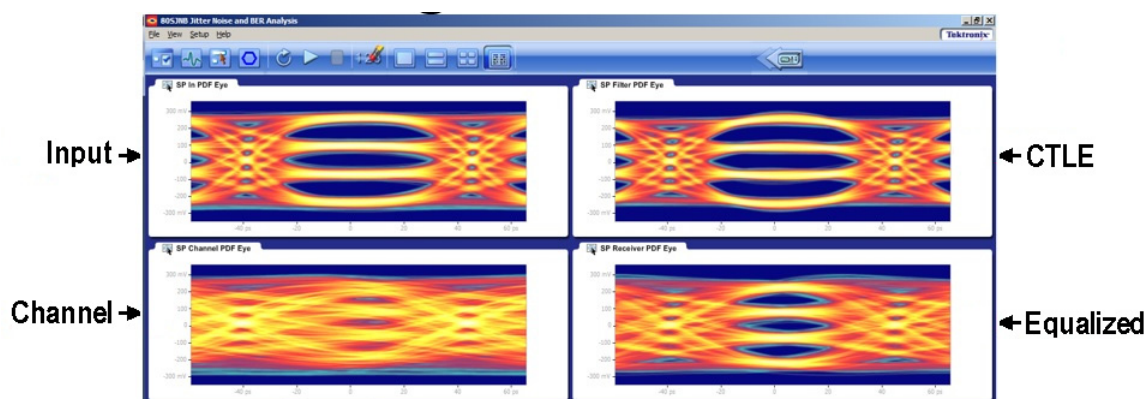
TIP. *You can move a function in and out of the signal path without affecting any settings.*

To learn more about each of the signal path settings, select the following:

Filter (see page 41)

Channel (see page 42)

Equalizer (see page 45)

Setting Filter Conditions

The Signal Path Filter allows you to specify an arbitrary linear FIR filter to be applied to the acquired data pattern. For instance, the transmitter may artificially enhance the signal at certain frequencies to overcome known problems in the channel. You can use a filter to emulate this action or compensate for transmitter signal pre-emphasis. Use the filter to insert a continuous-time linear equalizer (CTLE) in the signal path, which standards typically specify for PAM4 signaling.

You can define or load a CTLE from the Equalizer. Inserting a de-embed filter is the most common use of the Filter. Use the SDLA (Serial Data Link Analysis) tool to generate the de-embed filters. See details below.

To use the filter, move the Filter function into the signal path and use the Filter file box or browse button to specify the filter file. The default location for the filter files is in the Windows/Documents folder. A few filter files are provided as examples, but you are responsible for providing the filter files.

To use the Filter block for de-embedding, you will need an additional software tool to create a de-embedding filter from the S-parameters of the fixture. Please visit the www.tektronix.com/sdla Web site, or contact Tektronix Support for details.
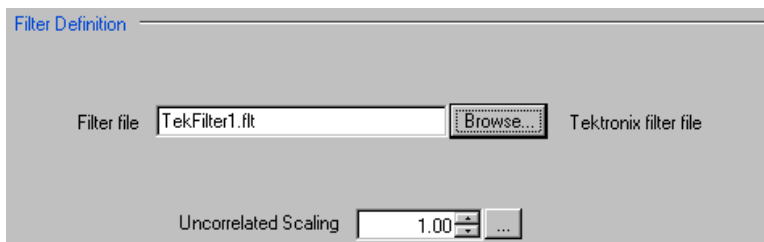
See Uncorrelated Scaling (see page 51) for information about this setting.

The following is an example of the filter file format:

`@ 5.7e-005, 2.4e-005, 5.4e-005, 2.1e-005, 5.1e-005`

- The '@' means that it is valid for all frequencies.
- Up to 20,000 coefficients may be specified.

Setting Channel Conditions

The Signal Path Channel allows you to emulate the channel (interconnect or lane) carrying the signal. There are two ways to define the channel, with Time Domain (see page 45) waveforms and Frequency Domain (see page 42) S-parameters.

See Uncorrelated Scaling (see page 51) for information about this setting.

Frequency Domain

With Frequency Domain selected, the channel is defined with an S-parameters file. Use the file selection box or Browse button to select the file. The default location for the files are in the Windows/Documents folder. You are responsible for providing the S-parameters file.
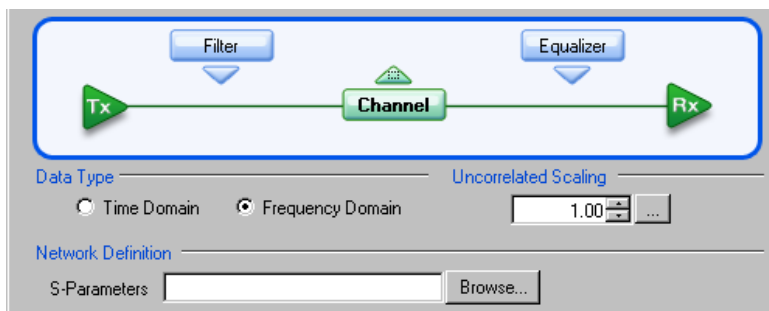
The S-parameters file can contain data for 1-port, 2-port, or 4-port devices. Once a file is selected, the application reads its contents and generates the appropriate dialog for you to select the particular S-parameter in the file to use.

1-Port. Files with 1 port of data contain only 1 S-parameter so they do not require any further input. These files may be IConnect 1-port files or Touchstone 1-port files.

2-Port. Files with data for 2 ports contain 4 S-parameters as a 2x2 matrix. These are Touchstone 2-port files. When the application recognizes such an S-parameter file, a dialog is created for you to select the S-parameter representing channel transmission. The typical selection is S_{21}, and is the default selection, but this may need to be changed if the file contains a 2x2 subset of the 4x4 matrix of S parameters defining a 4-port system.
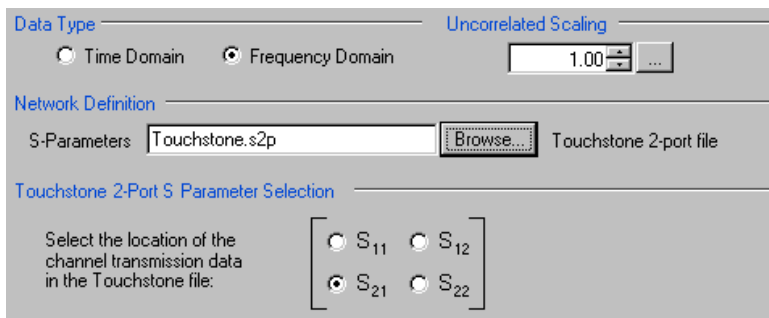
4-Port. Files with data for 4 ports may contain single-ended or mixed-mode data. These are Touchstone 4-port files.

If the data is single ended, you must map the port numbers as used in the file to physical locations in your link. A default mapping is assumed. The application will use this mapping to compute the S_{dd21} parameter (for transmission of a differential signal) from the appropriate four S-parameters measured using single ended data.

If the data is mixed mode, you must select the data layout in the file. The most common layout is DC12 and is the default selection. The application always uses the S_{dd21} parameter for computing the transmitted waveform no matter which mapping is selected.

NOTE. *80SJNB Advanced uses the 'insertion loss' information only.*

Time Domain

With Time Domain selected, the Reference waveform and Transmitted waveform generate the channel behavior. Use the file boxes or browse buttons to select the files you want to use. The default location for the files is in the Windows/Documents folder. You are responsible for providing the time domain waveform files.

NOTE. *We recommend that the waveform file be a measurement of the channel from a Tektronix TDR/TDT system. Required raw oscilloscope waveforms are:*

a. A reference throughput (no DUT is inserted, just a throughput connection between the TDR step source and the acquisition channel on the TDT end).

b. A DUT throughput measurement (the TDR step source and the TDT acquisition channel are connected through the DUT).
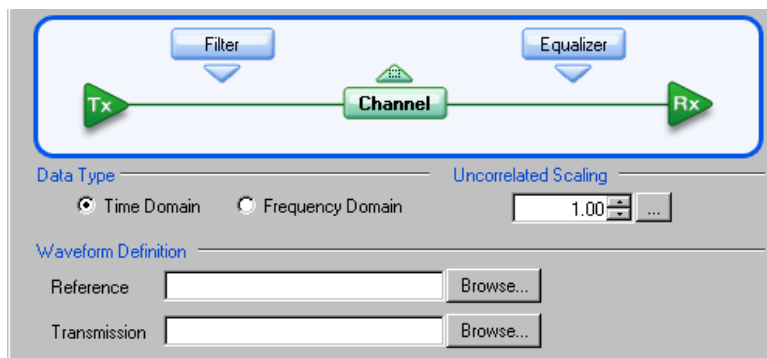
About the Equalizer

The equalizer compensates for transmission channel impairments in the form of frequency-dependent amplitude and phase distortions resulting in intersymbol interference (ISI) in the communication data stream.

80SJNB provides tools to support three types of equalizers: CTLE (Continuous Time Linear Equalizer), FFE (Feed Forward Equalizer), and DFE (Decision Feedback Equalizer). The linear feed-forward equalizer (FFE) is defined by a user specified number of taps, taps per symbol (or unit interval), and the weight of each tap. The equalizer becomes a decision-feedback equalizer (DFE) when the number of DFE taps is set to a number larger than 0.

NOTE. *Tap values and weights are used interchangeably.*
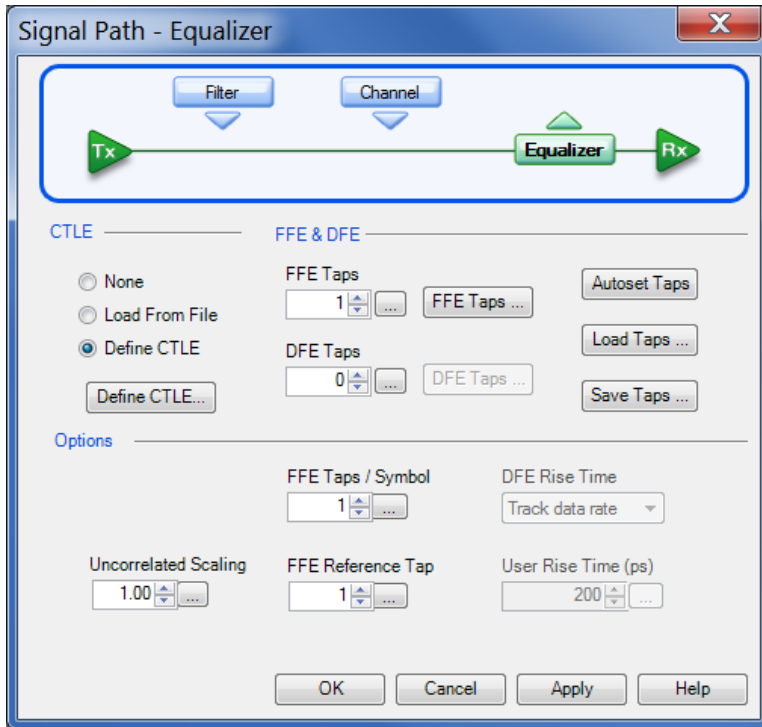
To learn about setting up the Equalizer, see:

Continuous Time Linear Equalizer CTLE (see page 46)

Equalizer Taps (see page 48)

Uncorrelated Scaling (see page 51)

Continuous Time Linear Equalizer (CTLE)

The equalizer includes an optional filter that is intended to be a Continuous Time Linear Equalizer. However, when loading the equalizer from a filter file (extension .flt) any filter may be used. If the radio button Define CTLE is selected the user can define a 1- or 2-stage CTLE.

The schematic in the CTLE Definition dialog portrays each stage (assuming 2 poles per stage) of the CTLE filter. The plotted function schematically shows the frequency response of the filter.

You can select a standard with a specified peaking in dB, which automatically fills in the remaining parameters of the dialog, or manually define the remaining parameters of the dialog.

- A_{DC} is the gain at DC.

- f_Z is the frequency of the zero of the filter.

- f_{P1} is the frequency of the first pole.

- For a 2-pole stage, f_{P2} is the frequency of the second pole. For a 1-pole stage, f_{P2} is not defined.

When 2 stages are defined, the filters defined by the separate stages are convolved to produce the filter.

NOTE. *Clicking Apply or OK causes the filter to be included in the updated definition of the Equalizer, but when you exit this dialog and return to the Signal Path – Equalizer dialog, you must click Apply or OK there, too, in order for the updated definition to now define the Equalizer. In addition, the Equalizer must be made active for its definition to be used at all.*

Equalizer Taps

The behavior of the equalizer is controlled by the number of taps and the tap values. Using the equalizer requires that you specify the number of FFE and DFE taps, and the FFE spacing of the taps. You can also incorporate an equalizer filter delay by specifying a reference tap to compensate for precursor channel effects.

You can manually set the FFE and DFE tap values, or you can use the Autoset Taps button to let the application calculate the tap values.
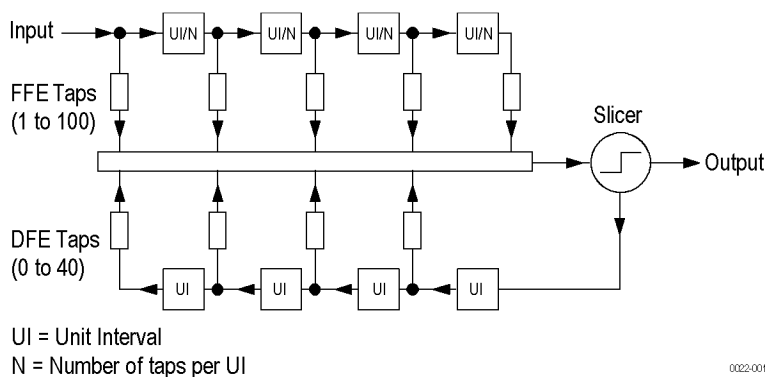
Go to FFE Taps description (see page 48)

Go to DFE Taps description (see page 49)

FFE Taps

The FFE Taps are weights applied to a set of samples taken from the data stream to compensate for channel impairments manifested in the form of ISI. The number of FFE Taps represent the length of history in data samples that contribute to the computation of a current bit. Data stream samples could be distanced at unit intervals, in which case the number of FFE taps represents the number of preceding bits that contribute to the correction of the current bit. Alternatively, the data stream could be sampled at a higher rate per bit, yielding a fractionally-spaced FFE tap set.

The number of FFE taps defaults to 1, with the capability to specify up to 100 taps. The default FFE tap spacing is at unit intervals. You can configure up to 10 taps per symbol.

The FFE Tap values could be specified by you using the FFE Taps dialog, or computed by the application with the Autoset Taps button.

Go to Autoset Taps description (see page 50)

Go to Saving and Loading Taps (see page 51)

Pressing the FFE Taps button displays a dialog showing the current FFE tap values. You can specify each FFE tap coefficient individually. Pressing the Defaults button sets the first FFE tap to 1 and the rest to 0.

You can use the Save Taps button to save a set of coefficients to a file. Use the Load Taps button to load saved Tap files.

DFE Taps

DFE taps are weights applied to the previous digital decisions made by the slicer (comparator + latch). The number of DFE Taps specifies the number of bits contributing to the current input to the slicer. The default number of DFE Taps is 0, in which case the equalizer is a linear FFE one. The maximum number of DFE Taps is 40. Weights are scalars specified by you or computed by the Autoset Taps function.

See for a description about using the autoset taps function.

Pressing the DFE Taps button displays a dialog showing the current DFE tap values. You can specify each DFE tap coefficient individually. Pressing the Defaults button sets all DFE tap values to 0.
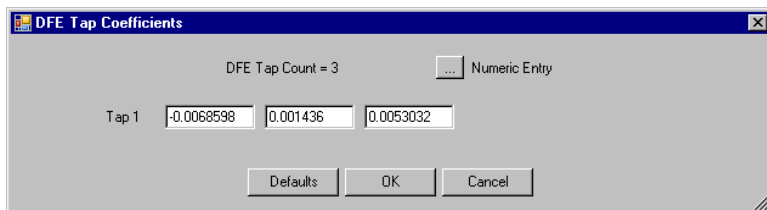
You can use the Save Taps button to save a set of coefficients to a file. Use the Load Taps button to recall saved Tap files.

TIP. When using the Equalizer, you are required to always have at least 1 FFE tap. DFE taps are optional.

Filter Settings

FFE Reference Tap.   The FFE Reference Tap is a filter delay in unit intervals that should be set to compensate for the delay between the transmitter output and the equalizer input. The value of the Reference Tap is constrained by the number of FFE Taps and the number of taps per symbol.

DFE Rise Time Selector.   The Rise Time Selector specifies the Gaussian filter used to emulate the DFE feedback path band-limited behavior. The rise time defaults to Track Data Rate, in which the configuration is set to 1/5 of the unit interval equivalent with the data rate. Track tap interval designs a Gaussian filter with a rise equal to 1/5 of the spacing between taps. Selecting User allows you to specify the rise time from 1 ps to 4 ns.

Uncorrelated Scaling.   See Uncorrelated Scaling (see page 51) for a description.

Autoset Taps

The tap autoset function computes a set of tap values that optimize the eye opening for the data pattern applied to the input of the equalizer. If the DFE tap number is 0, the algorithm yields an optimal set of FFE taps, while if the equalizer is specified as a DFE by a positive DFE tap number, the Autoset Taps algorithm jointly optimizes the forward and feedback loop tap coefficients. The optimization algorithm is the least-mean-square error (LMS) and the optimization targets the signal to noise ratio at the sampling phase.

The Autoset Taps will account for the FFE Taps/Symbol and Reference Tap specifications.

The tap autoset algorithms computes a set of FFE and DFE taps using a least-mean-square optimization algorithm. The optimization algorithm is the least-mean-square error (LMS) and the optimization targets the signal to noise ratio at the sampling phase.

NOTE. You can autoset tap values even if the Equalizer is not inserted in the signal path.

Saving and loading taps

Use these controls to save or load a set of taps from a file. The browse directory defaults to Windows/My Documents and the file extension is .tap.

The file format is the following:

```
<Tektronix>
    <TapFile>
        <FFE>
            <TapsPerSymbol>value<\TapsPerSymbol>
            <ReferenceTap>value<\ReferenceTap>
            <Tap1>value<\Tap1>
            <Tap2>value<\Tap2>

            ...
            <Tapn>value<\Tapn>
        </FFE>
        <DFE>
            <Tap1>value<\Tap1>
            <Tap2>value<\Tap2>

            ...
            <Tapn>value<\Tapn>
        </DFE>
    </TapFile>
</Tektronix>
```

Uncorrelated scaling

The signal path settings (Filter, Channel, Equalizer) each have an uncorrelated scaling setting. The Uncorrelated Scaling value multiplies the uncorrelated random noise RMS and uncorrelated periodic noise values. Uncorrelated noise scaling affects the uncorrelated jitter as projected through the average slew rate. The 80SJNB Signal Path does not process uncorrelated noise in any other way.
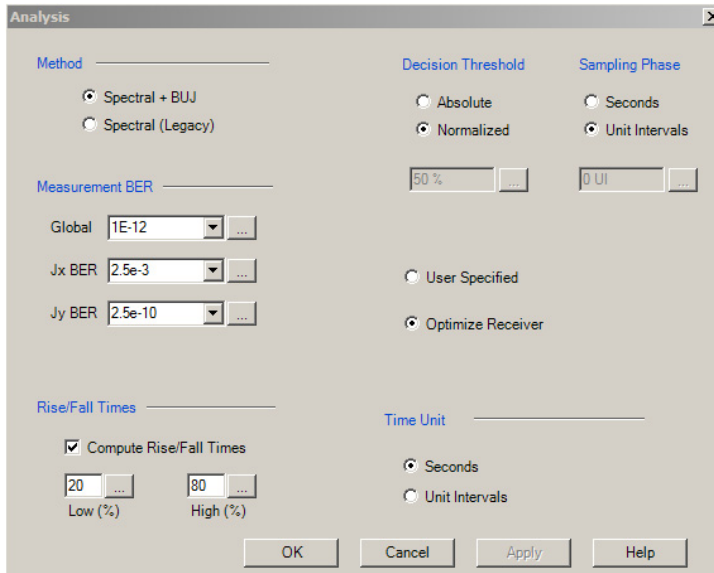
If you insert a default equalizer (an FFE Tap 1 value equal to 1, and zero DFE taps) in the Signal Path and set the Uncorrelated Scaling factor to its minimal value (0.01), the configuration will isolate the effects of noise on jitter measurements. This configuration produces results that correlate with "jitter only" type analysis tools.

NOTE. The overall Signal Path uncorrelated scaling factor is the product of all signal path uncorrelated scalar values of the active functions.

About analysis settings

The Analysis settings affect how measurements are made and displayed. The settings are saved with the 80SJNB application whenever it is closed so that restarting the application results in using the same settings.

NRZ Analysis dialog box

PAM4 Analysis dialog box

TIP. *Changes to Analysis settings are reflected in the current plots and results.*

Setting the analysis method

The Method selection sets which analysis methodology to use for the Jitter and Noise breakdown:

- The Spectral + BUJ (Bounded Uncorrelated Jitter) is using a combination of spectral isolation of the periodic components and the analysis of the cumulative distribution function (CDF) of the uncorrelated jitter and noise data, before and after spectral separation. The presence of crosstalk dictates the selection of this method.

- The Spectral (Legacy) mode relies on spectral separation of the periodic and random components.

The default setting is Spectral + BUJ. When switching the analysis method between the two options, the acquisition data is preserved, and new results are recomputed, displayed, and plots made available. When the selected coding scheme is PAM4, the Spectral+BUJ is the only analysis method available.

Setting the Rx optimizer

You can define the receiver slicers of the eye(s) or have the slicers determined automatically by the Rx Optimizer.

The Rx optimizer is a set of eye analysis algorithms that select the optimum point within each eye (both threshold and phase) for placing the receiver slicer. Values entered in the text boxes for decision thresholds and sampling phases are ignored save in extreme cases that the optimizer cannot analyze, e.g., a completely closed eye.

For NRZ the user selects one of the two radio buttons "User Specified" and "Optimize Receiver."

For PAM4 the "User Specified" control is still present but now there are two radio buttons for the optimizer, one for each of the optimizer's two modes. In the first mode, labeled Optimize to Center Eye (Common Phase), the receiver slicers of the three eyes are constrained to have the same sampling phase. The algorithm JNB uses in this mode is defined by the standards OIF CIE 2014.230 and IEEE 802.3bj.

In the second mode the three receiver slicers are separately optimized for each eye. This algorithm decides the relative importance of horizontal and vertical spacing around the receiver slicer. In cases where one is substantially more important than the other the optimum receiver slicer may be placed closer to an edge of an eye than might be expected. This is correct behavior.

The receiver slicers are denoted by white crosses in the SP Receiver PDF Eye figure (Matlab version of the figure only). The following figure shows receiver slicers with independent phases computed by the Rx Optimizer.
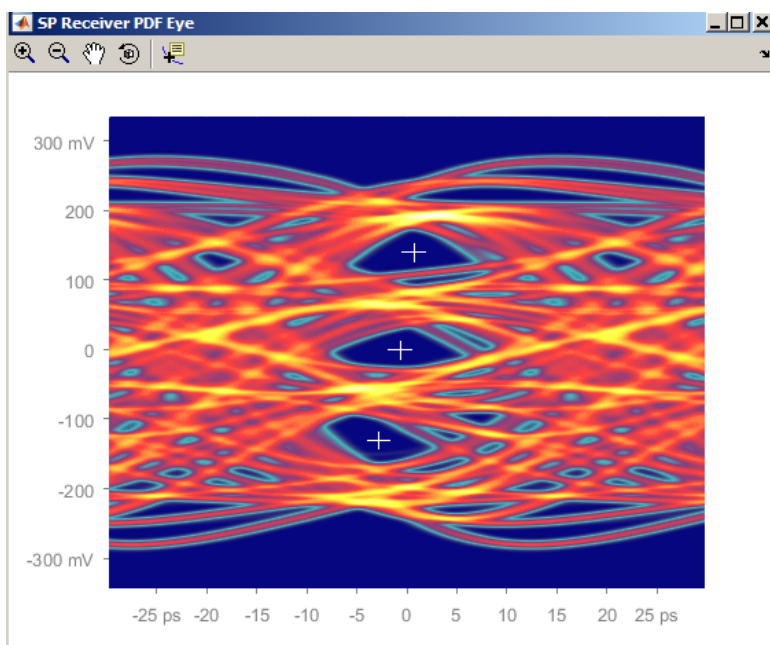
Setting the decision thresholds

The Decision Thresholds, one per eye (one for NRZ and three for PAM4), specify the boundary between two adjacent signal levels.

When Optimize Receiver is selected, the decision threshold text boxes are disabled and the Rx Optimizer computes the optimum decision points (both decision thresholds and sampling phases).

When Optimize Receiver is not selected, the decision threshold text boxes are enabled.

When Optimize Receiver is not selected and Absolute is selected, the decision thresholds use the absolute value provided in volts (electrical) or watts (optical).

When Optimize Receiver is not selected and Normalized is selected, the decision thresholds are calculated based on waveform data according to the percent value of the signal amplitude.

Setting the time unit

The Time Unit sets the units (Seconds or Unit Intervals) used when displaying the measurement results.

Setting the sampling phases

The Sampling Phases determine the times of the sampling points and of all noise and vertical eye opening measurements within the unit interval.

When a PAM4 signal is analyzed, either each eye can have its own Sampling Phase or all three phases can be set to the same time.

When Optimize Receiver is selected, the sampling phase text boxes are disabled and the Rx Optimizer calculates the optimum decision points (both decision thresholds and sampling phases).

For PAM4 there is the additional option **Optimize Using A Common Phase**:

■ If not selected, the optimization is unconstrained and the software calculates the optimum sampling point for each eye independently of the other eyes.

■ If selected the optimization is constrained so that all sampling points are the same. When Optimize Receiver is not selected the sampling phase text boxes are enabled.

When Optimize Receiver is not selected, and Seconds is selected, the sampling points use the absolute value entered. Zero seconds is the center of the unit interval.

When Optimize Receiver is not selected, and Unit Intervals is selected, the sampling point is calculated based on the fraction of a unit interval. Zero UI is the center of the unit interval.

Setting the measurement bit error rates (BER)

There are three BER values to set: Global, JxBER and JyBER. The Global BER is used for all measurements qualified by a BER value. Total jitter is also calculated for JxBER and JyBER.

All three total jitter values are displayed on the eye tabs. The JxBER and JyBER total jitter values are labeled Jx and Jy unless the specified BER has the values 2.5e^{-3} or 2.5e^{-10}, in which case they are labeled J2 or J9, respectively.

Computing rise/fall times

The transition times between signal levels are optionally computed by selecting the check box labeled Compute Rise/Fall Times. The definition of the reference levels can be set in percent using the Low and High text boxes.

For NRZ the rise/fall times are displayed on the Global tab. For PAM4 they are displayed on the Rise/Fall tab.

About mask test settings

The Mask Test setup dialog defines the target and parameters of mask testing.

There are two 80SJNB statistical analysis products on which mask testing can be performed, the SP Receiver PDF Eye and the BER Contours. Both of these are defined at the receiver side of the Signal Path emulator.

The mask definitions are loaded from Tektronix standard format mask files. These files include parameters that define the signal, the mask polygons, and the mask testing qualifiers.
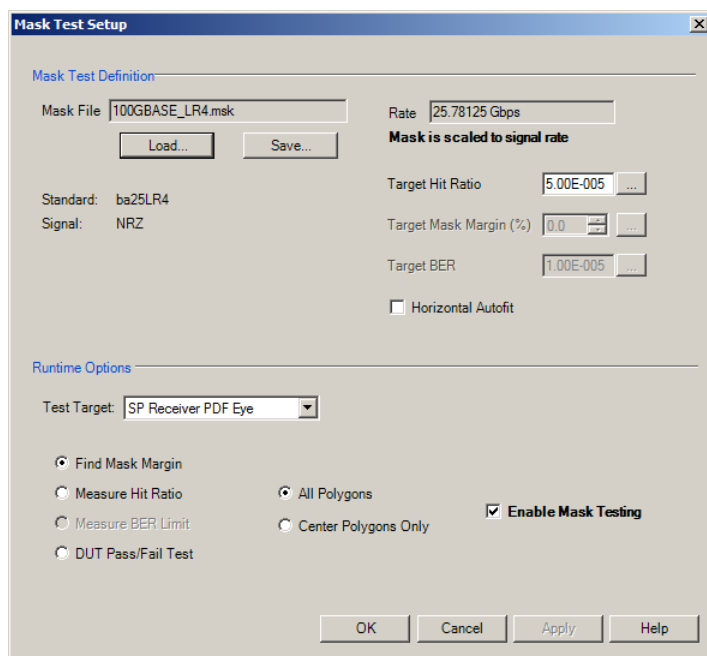
NOTE. *Changes to mask test settings are reflected in the current plots and results.*

Selecting the mask test

Click the Load button and browse to select a mask file, which has the extension .msk. Parsing the file fills in the Mask Test Definition fields of the setup dialog. These values can be edited and, by using the Save button, saved in another mask file.

A mask file contains the following information:

■   The name of the standard for which the mask was defined

■   Signal type (NRZ or PAM4)

■   Standard data rate. This rate can be edited, and if the acquired signal rate and mask file data rate do not match, a message "Mask is scaled to signal rate" is displayed

- The polygons that define the mask testing area, which are visible on the target plots

- Target Hit Ratio, defined as the sum of probabilities that the modeled signal is within the mask

- Target Mask Margin, defined as a positive or negative percentage of the specified mask size

- Target BER value that defines the curve of constant BER that will be used for the BER Contour mask testing

Checking Horizontal Autofit causes the mask test to be evaluated at all horizontal positions to obtain the best test result in terms of maximum mask margins or minimum hit ratios.

Selecting the runtime options

Check Enable Mask Testing button to perform mask testing.

The Test Target pull down list specifies the JNB analysis products to which the mask can be applied: SP Receiver PDF Eye or the BER Contour.

When changing the Mask Test Target the relevant plot with the Mask will be displayed. If the target plot is displayed already, the mask will be added to the plot. If the plot is not displayed, the test target plot will replace the upper left corner plot.

Consider the use cases for mask testing on the PDF Eye:

- Given a target Hit Ratio, find the largest mask margin that does not exceed that hit ratio.

- Given a target Mask Margin, find the actual hit ratio.

- Given a Target Hit Ratio and Mask Margin, determine the Pass or Fail status.

The use cases for mask testing on BER Contours are:

- Given a target BER, find the largest mask margin that does not exceed that BER.

- Given a target Mask Margin, find the BER Limit, which is the lowest BER contour that contains the mask.

- Given a target BER and Mask Margin, determine the Pass or Fail status.

For PDF Eye mask testing, there are three polygon areas to consider: overshoot, center and undershoot. You can choose to test against all regions or only the center polygon.

The settings are saved with the 80SJNB application whenever it is closed so that restarting the application results in using the same settings. Using the File > SaveSettings control saves the settings for later use.

About PAM4 signal analysis

The 80SJNB PAM4 option performs the full jitter, noise and BER analysis on the PAM4 modulated signals, to support measurement and analysis of 100-400 Gbps electrical and optical communication links.

Signal impairment sources for PAM4 are categorized in similar ways as for NRZ systems: uncorrelated jitter and noise sources, crosstalk, bounded and unbounded types. JNB will perform the full analysis on each PAM4 eye, and also performs a set of global PAM4 specific measurements.

The PAM4 signal analysis process is as follows:

1. The signal Coding is selected from the Analysis panel. Default is NRZ, and the user has the option to select PAM4.

2. If PAM4 is selected, the JNB Results tab changes to a set of 3 Results tabs (Eye0 lowest eye, Eye1 middle eye, and Eye2 upper eye). The content of each result tab is the same as for NRZ, and includes a comprehensive jitter and noise analysis with the BER estimations of total jitter and noise.

3. An additional Global tab specific to PAM4 displays a result panel containing a set of transmitter side and receiver side PAM4 specific measurements.

4. Each Plot will reflect the signal and processing characteristics of a PAM4 signal. Eye plots contain all three stacked eyes for PAM4. Horizontal and vertical Bathtub curves are composite plots of each individual eye.

Taking measurements

The most relevant oscilloscope measurement settings are accessible using the Configuration dialog box of the 80SJNB application.

Displaying measurements

You can use the tool bar to select how the results are displayed: numeric results, plots (up to four), or a combination.

What do you want to do?

Display the definitions of Jitter measurements (see page 59)

Display the definitions of Noise measurements (see page 60)

Measurement Algorithms (see page 125)

Go to Working with Numeric Results (see page 77)

Go to Working with Plots (see page 66)

Jitter measurement definitions

Jitter measurements	Description
Random Jitter	
RJ (RMS)	Measured Random Jitter
RJ(h) (RMS)	Horizontal component of random jitter
RJ(v) (RMS)	Vertical component of random jitter induced by noise converted to jitter through an average slew rate
Deterministic Jitter	
DJ	Measured Deterministic Jitter
DDJ	Data Dependent Jitter
DCD	Duty Cycle Distortion
DDPWS	Data Dependent Pulse Width Shrinkage
BUJ(d-d)	Measured Bounded Uncorrelated Jitter, Dual Dirac model
PJ	Measured Periodic Jitter (peak-to-peak)
PJ(h)	Horizontal component of periodic jitter (peak-to-peak)
PJ(v)	Vertical component of periodic jitter (peak-to-peak) induced by noise converted to jitter through an average slew rate
NPJ(d-d)	Measured NonPeriodic Jitter, Dual Dirac model
Total Jitter @ BER	
TJ (1E-12)	Total Jitter at user-specified BER
Eye Opening (1E-12)	Horizontal Eye Opening at user specified BER
Other Jitter measurements	
Jx (JxBER)	Total Jitter at second user-specified BER
Jy (JyBER)	Total Jitter at third user-specified BER
Rj(d-d)	Random jitter based on the dual Dirac model
Dj(d-d)	Deterministic jitter based on the dual Dirac model

NOTE. *J2 Jitter: For a BER specified as 2.5E-3, the Total Jitter becomes J2 Jitter. J2 Jitter measures all but 1% of the statistical total jitter distribution.*

J9 Jitter: For a BER specified as 2.5E-10, the Total Jitter becomes J9 Jitter. J9 Jitter represents an estimation of all but 10E-9 of the statistical total jitter distribution.

Noise measurement definitions

Noise measurements	Description
Random Noise	
RN (RMS) [1]	Measured Random Noise
RN(v) (RMS)	Vertical component of random noise
RN(h) (RMS)	Horizontal component of random noise induced by jitter converted to noise through an average slew rate
Deterministic Noise	
DN	Measured Deterministic Noise
DDN	Data Dependent Noise
DDN(level 1)	Data Dependent Noise on logical level 1
DDN(level 0)	Data Dependent Noise on logical level 0
BUN(d-d)	Measured Bounded Uncorrelated Noise, Dual Dirac model
PN [1]	Measured Periodic Noise
PN(v)	Vertical component of periodic noise (peak-to-peak)
PN(h)	Horizontal component of periodic noise (peak-to-peak) induced by jitter converted to noise through an average slew rate
NPN(d-d)	Measured NonPeriodic Noise, Dual Dirac model
Total Noise @ BER	
TN (1E-12)	Total Noise at user-specified BER
Eye Opening (1E-12)	Eye Opening at user-specified BER
Eye Amplitude	The amplitude of the eye computed as the mean-to-mean of logical 1 and logical 0 bit levels sampled at the user defined Sampling Phase.

[1]   Uncorrelated random noise (RN) and periodic noise (PN) measurements are performed on both logical levels 1 and 0 to account for significant differences, which may be the case when the measurements are performed on optical signals.

SSC Modulation Measurement Definitions

SSC modulation measurements	Description
Magnitude	Spread spectrum clock modulation magnitude of the clock in parts-per-million (ppm) units.
Frequency	Spread spectrum clock modulation frequency.

80SJNB PAM4 measurements

Eye and Level measurements for PAM4 and NRZ

Measurement	Description
Eye measurements	
RJ RMS	Standard deviation of the random (Gaussian) jitter
TJ	Total jitter at target BER
Width	Eye width at target BER
Decision Threshold	Decision thresholds for horizontal analysis
RN RMS	Standard deviation of the random (Gaussian) noise
TN	Total noise at target BER
Height	Eye height at target BER
Sampling Phase	Phase of the sampling point
Center Deviation	Sampling phase skew relative to middle eye
OMA or VMA	Optical or Voltage modulation amplitude
Level measurements	
Mean	Mean value (volts or watts) of the measurements defining this signal level
RMS	Standard deviation of the measurements
PkPk	Range of the measurements

NOTE. Width and Height: For a BER specified as 1E-6, the Width and Height become EW6 and EH6, as defined by OIF CIE 2014.230.

PAM4 global measurements

Measurement	Description	Ideal value
Minimum Signal Level	Half the smallest of the level separations	1/6 of peak–peak
Effective Symbol Level 1	Level linearity measure from Level0 and Level1	1/3
Effective Symbol Level 2	Level linearity measure from Level2 and Level3	1/3
Level Mismatch Ratio (R_{LM})	Minimum Signal Level relative to ideal Minimum Signal Level (if levels were evenly spaced)	1
Level Deviation	Average deviation of level spacing from ideal spacing	0%
Level Thickness	Averaged, normalized level standard deviation at minimum inter-symbol interference	0%
Level Time Deviation	Time deviations between levels measured at minimum inter-symbol interference positions	0%

PAM4 global measurements (cont.)

Measurement	Description	Ideal value
Vertical Eye Closure	Minimum eye amplitude loss	5 dB
OMA Outer or VMA Outer	Amplitude between Level0 and Level3	N/A

Mask test measurement definitions

Mask test measurements	Description
PDF Hit Ratio Per Region	
Overshoot	Measured hit ratio in the overshoot polygon
Center	Measured hit ratio in the center polygons
Undershoot	Measured hit ratio in the undershoot polygon
Results Over All Regions	
PDF Mask Margin	Measured mask margin given a target hit ratio
PDF Hit Ratio	Measured hit ratio over all tested polygons given a target mask margin
BER Mask Margin	Measured mask margin given a target BER
BER Limit	Measured BER Limit given a target mask margin
Pass/Fail	
Status	Pass or Fail given a target mask margin and either hit ratio or BER
Horizontal Shift	Amount the mask was shifted in time

Rise, Fall measurements

Measurement	Description
Mean	Mean transition time
Standard Deviation	Standard deviation of the transition times
Coefficient of Variation	Standard Deviation divided by the Mean
Minimum	Minimum of the transition times
Maximun	Maximum of the transition times
Count	Number of transitions

NOTE. *The Rise/Fall measurements for NRZ are on the Global tab.*

Sample Count

Both results tables, Summary and Full Results are displaying the Sample Count of the data used for the derivation of the measurements.

The Sample Count field represents the amount of statistical data acquired and analyzed, and contains the full pattern acquisition, the jitter and noise characterizing data.

When in Free Run, the count is continuously incremented with the newly acquired and processed data.

Steps to Acquire Data

To acquire data from acquisition channels and take measurements, follow these steps:

1. Select ⬛ to display the Acquisition dialog box and configure the application according to your setup and signal type.

2. Select ⬛ to toggle the acquisition mode between free run (continuous) and single acquisitions and processing cycles. When in Free Run mode, the following acquisition and processing continues until you stop it:

    -   acquisition and averaging of data-correlated patterns

    -   acquisition, accumulation and statistical analysis of uncorrelated data

3. Select ⬛ to start the acquisition and processing cycle.

To stop the acquisition, do one of the following:

-   If you wish to stop the acquisition and processing cycle before it completes, select ⬛. This may be useful if you have started a sequence on a long waveform and then realize you would like to change the configuration.

-   If you wish to interrupt the acquisition and processing cycle, select ⬛. Select a second time to resume the acquisition.

-   If you wish to halt a Free Run mode cleanly, toggle the Sequence ⬛ button. This will convert the Free Run mode (indicated by the green button) to Single cycle mode (indicated by the blue button) so that the acquisition stops when the cycle is complete. Single cycle is the default mode.

TIP. *Use the Clear Data ⬛ button to delete all measurement results and plots.*

Saving and Recalling Setup Files

You can use the File menus to save and recall different oscilloscope and application setups. Setup files store the oscilloscope and application settings.

⚠ **CAUTION.** *Do not edit a setup file or recall a file that was not generated by the application.*

See also:

Saving a Setup File

To save the 80SJNB application and oscilloscope settings to a setup file, follow these steps:

1. Select **File > Save Settings** to open the Save dialog box.

2. In the file browser, select the directory in which to save the setup file.

3. Use the keyboard to enter a new file name. The application appends a .stp extension to the file name.

4. Save the setup file. If the selected file name already exists, a confirmation dialog appears that allows you to cancel the operation.

NOTE. *The application saves the oscilloscope setup.*

Recalling a Saved Setup File

To recall the application and oscilloscope settings from saved setup files, follow these steps:

1. Select File > Recall Settings to open the Recall dialog box.

2. In the Recall dialog box, select the directory from which to recall the setup file.

3. Select a setup file name, and then select Open.

⚠ **CAUTION.** *Do not manually edit setup files. If you try to recall a setup file that was manually edited, the recall operation fails.*

Saving and Recalling Data Files

You can use the File menus to save acquired data and then recall it later for analysis.

⚠ **CAUTION.** *Do not edit a data file or recall a data file that was not generated by the application.*

See also:

Saving a Data File

To save the data acquired by the 80SJNB application, follow these steps:

1. Select File > Save Data to open the Save dialog box.

2. In the file browser, select the directory in which to save the data file.

3. Use the keyboard to enter a new file name. The application appends a .mat extension to the file name.

4. Save the data file. If the selected file name already exists, a confirmation dialog appears that allows you to cancel the operation.

Recalling a Saved Data File

To recall the acquisition data from saved data files, follow these steps:

1. Select File > Recall Data to open the Recall dialog box.

2. In the Recall dialog box, select the directory from which to recall the data file.

3. Select a data file name, and then select Open.

⚠ **CAUTION.** *Do not manually edit setup files. If you try to recall a setup file that was manuallyedited, the recall operation fails.*

About Working with Plots

You can display plots in a variety of layouts using the tool bar. One, two, or four plots can be displayed using the plot display buttons in the toolbar. When displaying plots, the results data table changes to a summary table of data. To remove the plots entirely from the display, select the Show Numeric Results button on the tool bar.

If the plots have been removed from the display, redisplay the plots by either selecting one of the plot display buttons or click the tab of the data table.

See also:

Plot Type Definitions (see page 66)

Functions in Plot Windows (see page 68)

About Exporting Plot Files (see page 68)

Selecting and Viewing Plots (see page 67)

Plot type definitions

Plot types are divided into the following categories:

- Jitter: See Jitter Plots (see page 72) for a list of the types of jitter plots and their descriptions.
- Noise: See Noise Plots (see page 75) for a list of plot types and descriptions.
- Eyes: See Eye Plots (see page 73) for a list of plot types and descriptions.
- Patterns: See Pattern Plots (see page 76) for a list of plot types and descriptions.
- SSC: See SSC Plot (see page 76) for a description.

Selecting and viewing plots

To select and view a plot, follow these steps:

1. Select one of the plot views [icons], (single plot, two plots, or four plots).

2. For each plot window, select a type of plot to display. Each plot display is based on the current analysis results. Plots are updated as new results are acquired.

To select a plot type for display in the plot window, click [icon] on the tab of the plot window. (Alternatively, you can right-click anywhere on the existing plot display.) From the drop-down menu, use the Plot menu to select a plot from the plot categories (Jitter, Noise, Eyes, Patterns, SSC).
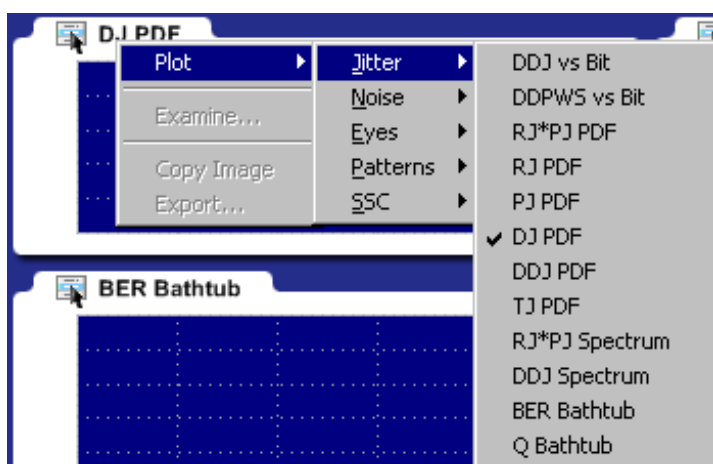
When the target signal has a PAM4 coding scheme, plots will include the relevant information for each of the three stacked eyes. The plots are color coded: yellow for eye0, green for eye1, and red for eye2.

See also:

About Exporting Plot Files (see page 68)

Examining plots

You can examine plots in greater detail by either double-clicking in the plot window or selecting **Examine** from the drop-down list in the plot window. Either of these actions launches a MATLAB plot window which provides advanced tools to examine graphical displays of data.
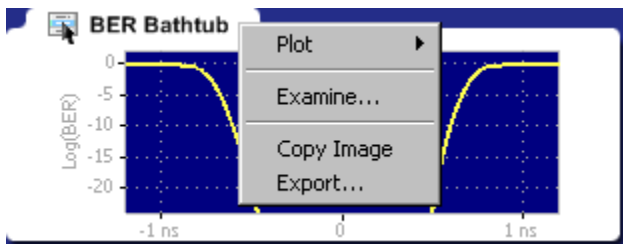
See also:

About exporting plot files

There are two ways to export plot information from the 80SJNB application for use in other applications:

■   You can export the numerical data that is represented in the plot figure. This may be useful for performing additional data processing.

■   You can create an image file that captures the current plot view. This is a useful way to document your results.

The application offers the following choices from the drop-down list (right-mouse click over the selected plot).
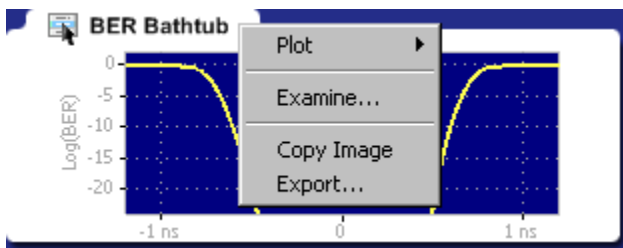
■   Plot lets you select a different plot to display in the window. The window displays the new plot based on the acquired data.

■   Examine opens a MATLAB plot window which provides additional tools to more closely examine plot characteristics.

- Copy Image saves the contents of the plot window as an image file.

- Export saves the numerical values from the plot window in text or MATLAB format.

NOTE. *Export plot functions are disabled whenever the application is actively sequencing.*

See also:

Exporting Raw Plot Data (see page 70)

Exporting Plot Images (see page 69)

File Name Extensions (see page 17)

Copying plot images

You can copy the plot image displayed in any one of the plot windows. The copy is placed in the Windows clipboard so you can paste the image into other Windows programs. This is convenient for creating reports and engineering records to share with others.

To create an image file of a plot, follow these steps:

1. Tap the [icon] area of the plot window of the plot that you want to copy. (If using a mouse attached to the instrument, right-click anywhere within the plot window of the plot you intend to copy.)

2. Select **Copy Image** from the drop-down list. This copies the image to the Windows clipboard.
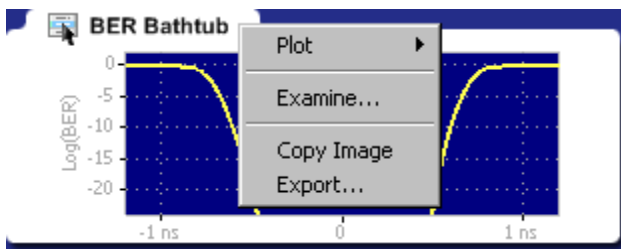
3. Open your destination program (such as WordPad or Paint) and paste the image into the application.

See also:

Exporting Raw Plot Data (see page 70)

Exporting raw data

The 80SJNB provides the following methods to export raw data:

- **Export Waveform**. Accessed from the File menu, exports the underlying acquired waveform and correlated pattern data used for processing.

- **Export Results**. Accessed from the File menu, exports the measurement results to a .csv text file that can be opened in a spreadsheet tool.

- **Export**. Accessed from the plot window, exports the data used to create the plot image. This method allows access to any node along the signal path.

Export Waveform data

To export the waveform data used for processing, follow these steps:

1. Select **File > Export Waveform > Correlated** or **File > Export Waveform > Acquired**:
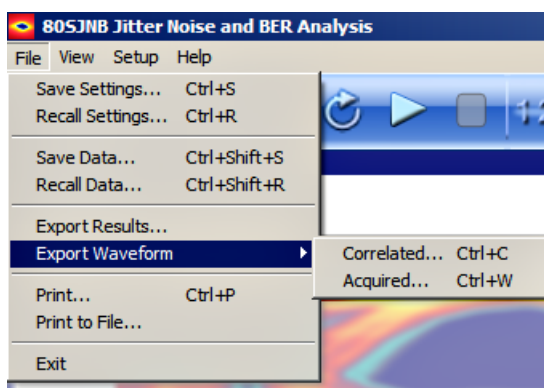
   The **Correlated** waveform is the result of filtering the Acquired Waveform to eliminate uncorrelated components (such as random and periodic jitter and noise).

   The **Acquired** waveform contains the raw acquired pattern before any processing is done on it. (The only processing on the raw data is interpolation for NULL points.)

2. Use the **Export Waveform** dialog box to specify the file name and path. The file name default is "Correlated" or "Acquired" (depending on the selection), with the default file location at Windows/Documents. Enter a new file name and/or directory location as needed.

3. Use the drop-down **Save as type** list to select the file type. The choices are:

   - Comma Separated Values (.csv): ASCII text that can be loaded into a spreadsheet. This is the default selection.

   - MATLAB (.mat): Binary data in the native MATLAB 7.0 format.

4. Click **Save**.

TIP. *Binary files typically use about 40% more disk space than .csv files.*

Export results

1. To export the measurement results to a .csv format text file, follow these steps:

2. Select **File > Export Results**.

3. Use the Export Results dialog box to set the file name and path. The file name default is "Results," with the default file location at Documents. Enter a new file name and/or directory location as needed.

4. Click **Save**.

All numeric results are exported. The following table shows some PAM4 numeric results as shown in a spreadsheet.

. . .

Decision Threshold	0.1297174	−0.006247496	0.1474331	V
RJ(RMS)	3.71E-13	3.72E-13	3.71E-13	s
RJ(h)(RMS)	3.64E-13	3.63E-13	3.65E-13	s
RJ(v)(RMS)	7.24E-14	7.44E-14	6.92E-14	s
DJ	2.83E-11	3.17E-11	3.78E-11	s
DDJ	1.83E-11	2.78E-11	2.18E-11	s
DCD	9.50E-12	9.94E-13	1.53E-11	s

. . .

Export graph (plot) data

To export the numeric data used to create a specific plot, follow these steps:

1. Touch the [icon] area of the plot window of the plot you want to export. (If using a mouse attached to the instrument, right-click anywhere within the plot window that you want to export.)

2. Select **Export** from the drop-down menu.
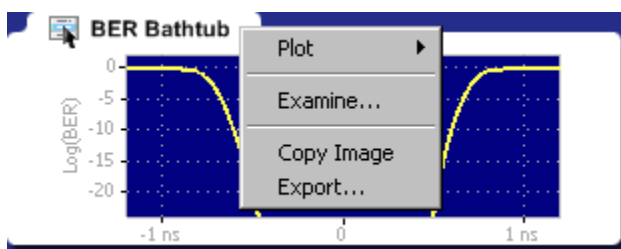
3. Use the **Export Graph** dialog box to specify the file name and path. The file name default is "Graph," with the default file location at Windows/Documents. Enter a new file name and/or storage location as needed.

4. Select the file type from the **Save as type**. The choices are:

- Comma Separated Values (.csv): ASCII text that can be loaded into a spreadsheet. This is the default format.

- MATLAB (.mat): Binary data in the native MATLAB 7.0 format.

Change in exported plot data with release 4.X. When exporting a .CSV file from the context menu of a noise graph depicting RN PDF or RN*PN PDF, 80SJNB V4.X writes the columns in a different order than was don in prior versions.

For all NRZ noise graphs, the data is exported in two columns:

- Column 1: voltage at which the noise was measured

- Column 2: probability of noise at the given voltage in the eye

Prior versions of 80SJNB (V3.X and earlier) swap these two columns when exporte the plot data.

For PAM4 plots, noise graphs are exported in four columns:

- Column 1: voltage at which the noise was measured

- Column 2: probability of noise at the given voltage in eye 0

- Column 3: probability of noise at the given voltage in eye 1

- Column 4: probability of noise at the given voltage in eye 2

See also:

Copying Plot Images (see page 69)

Jitter plots

Jitter plots	Description
DDJ vs Bit [1]	Data Dependent Jitter versus Bit displays the deviation of edge crossings at the user-specified Decision Threshold for each bit of the entire pattern. The pattern itself is shown in the background for cross reference. If the pattern is very long, the bits are visible only when opening the graph with Examine.
DDPWS vs Bit [1]	Data Dependent Pulse Width Shrinkage versus Bit displays the pulse width shrinkage for each isolated one and zero in the pattern.
DDJ PDF	Data Dependent Jitter Probability Density Function is the histogram of the data pattern correlated jitter, including Duty Cycle Distortion. The PDF is composed of the crossing deviations at the user specified Decision Threshold of all edges of the data pattern.
DDJ Spectrum [1]	The Data Dependent Jitter Spectrum is the result of the time domain to frequency domain transformation of the series of crossing deviations of data pattern edges at the user specified Decision Threshold.
RJ PDF	Random Jitter Probability Density Function shows the Gaussian distribution of the random, unbounded, uncorrelated jitter component. It is computed from data acquired on a single edge of the bit stream.

Jitter plots	Description
PJ PDF	Periodic Jitter Probability Density Function represents the histogram of the uncorrelated, bounded, periodic jitter component. It is computed by spectral separation of the jitter data acquired on a single edge of the bit stream.
RJ*PJ Spectrum [1]	Random and Periodic Jitter Spectrum represents the spectral distribution of the uncorrelated jitter acquired on a single edge. The spurs represent the periodic jitter spectral lines, and the rest of the evenly distributed spectral lines compose the random jitter spectrum.
RJ*PJ PDF	Random Jitter and Periodic Jitter Probability Density Function is the histogram of the uncorrelated jitter data acquired on a single edge of the pattern.
DJ PDF	Deterministic Jitter Probability Density Function shows the distribution of the bounded jitter component. The histogram is computed by convolving the DDJ PDF with the PJ PDF.
TJ PDF	Total Jitter Probability Density Function represents the computed histogram derived from all jitter components, correlated and uncorrelated, bounded and unbounded. The convolution of DJ PDF and RJ PDF yields the Total Jitter histogram.
BER Bathtub	The BER Bathtub curve is computed as a horizontal slice of the 3-dimensional BER Eye at the Decision Threshold. It represents the extrapolated total jitter and horizontal eye opening limits at projected bit error rates.
Q Bathtub	The Q-scaled curve is a linearized scale version of the BER Bathtub curve. It represents the extrapolated total jitter and horizontal eye opening limits at projected bit error rates.

[1]   The zoom feature defaults to horizontal zoom only.

Eye plots

Eye plots	Description
Correlated Eye [1]	The Correlated Eye is a color graded eye pattern built by folding the correlated pattern at clock rates. The correlated pattern is computed from the acquired full length data pattern by filtering out the uncorrelated components.
PDF Eyes	PDF Eye plots can be computed at various stages of the signal path emulator when using the 80SJNB Advanced version. When using the Essentials version of the 80SJNB, all PDF Eye plots are identical.
	If a signal path component is not inserted into the signal path, the PDF Eye plot for the output of the component is identical to the upstream PDF Eye plot. For example, if computing the PDF Eye plot for the output of the Channel function, but the Channel function is not inserted into the signal path, the PDF Eye plot will be identical to the PDF Eye plot of the output of the Filter function.

Eye plots	Description
SP In	The SP In PDF Eye is a color graded Probability Density Function representing the eye pattern at the transmission side of the signal path. It is constructed from the convolution of the Correlated Eye with uncorrelated jitter and noise probability distributions.
SP Filter [2]	The SP Filter PDF Eye is a color graded Probability Density Function representing the eye pattern at the output of the filter if the filter function is inserted in the signal path. It is constructed from the convolution of the Correlated Eye with uncorrelated jitter and noise probability distributions.
SP Channel [2]	The SP Channel PDF Eye is a color graded Probability Density Function representing the eye pattern at the output of the channel emulator if the Channel function is inserted in the signal path. It is constructed from the convolution of the Correlated Eye with uncorrelated jitter and noise probability distributions.
SP Receiver PDF Eye [2]	The PDF Eye is a color graded Probability Density Function representing the eye pattern at the output of the Equalizer if the Equalizer function is inserted in the signal path at the receiver side of the link. It is constructed from the convolution of the Correlated Eye with uncorrelated jitter and noise probability distributions.
	This selection was displayed as PDF Eye in 80SJNB application versions before version 2.1.
BER Eye [1]	The BER Eye is a three-dimensional color graded map representing the predicted bit error rates at all decision thresholds and sampling phases in the unit bit interval.
Q Eye [1]	The Q Eye is a three-dimensional color graded map representing the predicted bit error rates at all decision thresholds and sampling phases in the unit bit interval with a linearized Q-scale, rather than the BER logarithmic scale.
BER Contour [1]	The BER Contours show the boundaries of the eye opening at the projected bit error levels.

[1]   Eye plot is computed at the end of the signal path, regardless of using the 80SJNB Advanced or Essentials version.

[2]   Tthe 80SJNB Advanced version (with Signal Path emulator) provides PDF Eye plots at the various stages (functions) of the emulator. If the function is not inserted, the PDF Eye plot is identical to the upstream plot.

Noise plots

Noise plots	Description
DDN vs Bit [1]	Data Dependent Noise versus Bit displays the data levels sampled at the user specified Sampling Phase through the entire pattern. The pattern itself is shown in the background for cross reference. If the pattern is very long, the pattern bits are visible only when opening the graph with Examine.
RN*PN PDF	Random and Periodic Noise Probability Density Function is the histogram of the uncorrelated noise distribution on data acquired on a single flat spot of logic level 1 of the bit stream.
RN PDF	Random Noise Probability Density Function shows the Gaussian distribution of the random, unbounded, uncorrelated noise component. It is computed from data acquired on a single flat spot of logic level 1 of the bit stream.
PN PDF	Periodic Noise Probability Density Function represents the histogram of the uncorrelated, bounded, periodic noise component. It is computed by spectral separation of the noise data acquired on a single flat spot of logic level 1 of the data stream.
DN PDF	Deterministic Noise Probability Density Function shows the distribution of the bounded noise component. The histogram is computed by convolving the DDN PDF with the PN PDF.
DDN PDF	Data Dependent Noise Probability Density Function is the histogram of the data pattern correlated noise distribution on both logic levels 1 and 0. It includes the data levels at all user specified unit bit interval Sampling Phase.
TN PDF	Total Noise Probability Density Function represents the computed histogram derived from all noise components, correlated and uncorrelated, bounded and unbounded. The convolution of DN PDF and RN PDF yields the Total Noise histogram.
RN*PN Spectrum [1]	Random and Periodic Noise Spectrum represents the spectral distribution of the uncorrelated noise acquired on a single flat spot of logic level 1. The spurs represent the periodic noise spectral lines, and the rest of the evenly distributed spectral lines compose the random noise spectrum.
DDN Spectrum [1]	The Data Dependent Noise Spectrum is the result of the time domain to frequency domain transformation of the series of level samples taken on all bits at the user specified Sampling Phase of the unit bit interval.
BER Bathtub	The BER Bathtub curve is computed as a vertical slice of the 3-dimensional BER Eye at the user specified unit bit interval Sampling Phase. It represents the extrapolated total noise and vertical eye opening limits at projected bit error rates.
Q Bathtub	The Q-scaled curve is a linearized scale version of the BER Bathtub curves. It represents the extrapolated total noise and vertical eye opening limits at projected bit error rates.

[1] The zoom feature defaults to horizontal zoom only.

Pattern plots

Pattern plots can be computed at various stages of the signal path emulator when using the 80SJNB Advanced version. When using the Essentials version of the 80SJNB, all Pattern plots are identical.

If a signal path component is not inserted into the signal path, the plot for the output of the component is identical to the upstream plot. For example, if computing the pattern plot for the output of the Channel function, but the Channel function is not inserted into the signal path, the pattern plot will be identical to the pattern plot of the output of the Filter function.

Pattern plots	Description
SP_In [1]	The Signal Path Input signal plots the correlated pattern at the transmission side of the Signal Path, the input to the simulated serial link. The correlated pattern results when the acquired pattern is filtered for the removal of the uncorrelated jitter and noise components. For closer examination of the pattern, use Examine which provides pan and zoom capabilities, and data cursors.
SP_Filter [1]	The Signal Path Filter output plots the correlated pattern at the output of Filter, if the Filter function is inserted in the signal path. The selected Filter file determines the effects of the Filter function on the waveform. If the Filter function is not inserted in the signal path, The SP_Filter displays the upstream waveform, in this case SP_In.
SP_Channel [1]	The Signal Path Channel output plots the correlated pattern at the output of the Channel emulator if the Channel function is inserted in the signal path. The selected S-parameter or time domain waveform set determines the attributes of the signal at the output of Channel. If the Channel function is not inserted in the signal path, SP_Channel displays the upstream waveform which could be the SP_Filter or SP_In function of signal path configuration.
SP_Equalizer [1]	The Signal Path Equalizer output plots the correlated pattern at the output of the Equalizer if the Equalizer function is inserted in the signal path at the receiver side of the data link. The configuration of tap numbers and tap values determines the attributes of the equalizer and shapes the signal at the output. If the Equalizer function is not inserted, SP_Equalizer plot displays the upstream signal which could be any of the previous patterns, depending on the signal path configuration.

[1]   The zoom feature defaults to horizontal zoom only.

SSC plot

SSC plot	Description
SSC Profile [1]	The Spread Spectrum Clocking profile displays the function used for modulating the serial link clock frequency. If the "SSC is present" check box is checked in the Acquisition setup dialog, the profile plot is displayed.

[1]   The zoom feature defaults to horizontal zoom only.

Working with numeric results

After an analysis is complete, you can display the results as numeric data in either a summary or detailed (full) table. Use the View menu in the file menu bar to select how to display the data. A summary of data allows room to display the plots while the full results replaces the plot display entirely.

In both the summary and detailed views, the numeric panel has three or six tabs depending on the Coding (NRZ or PAM4).

Global	Eye0	Eye1	Eye2	Mask	Rise/Fall

Data Source: optical_25G_PAM4.mat	Rate: 25.78125 GBaud	Filter: False	Rx Optimizer: On
Coding: PAM	Pattern: 511 symbols; Samples/UI: 100	Channel: True	Rx Common Phase: True
Phase Reference: None	Sample Count: 431100	Equalizer: CTLE+DFE (1/5)	Rx Status: Optimized

BER = 1E-6	RJ (RMS)	TJ	EW6	Decision Threshold	RN (RMS)	TN	EH6	Sampling Phase	Center Deviation	OMA
Eye2	694 fs	29.1 ps	9.72 ps	1.24 mW	13.9 uW	252 uW	219 uW	-388 fs	0 s	509 uW
Eye1	688 fs	29.7 ps	9.09 ps	765 uW	13.5 uW	270 uW	188 uW	-388 fs	0 s	482 uW
Eye0	673 fs	29.7 ps	9.09 ps	311 uW	12.4 uW	284 uW	191 uW	-388 fs	0 s	499 uW

Tx Levels	Mean	StdDev	PkPk
Level3	2.02 mW	13.2 uW	114 uW
Level2	1.36 mW	12.1 uW	103 uW
Level1	737 uW	12.0 uW	110 uW
Level0	247 uW	11.1 uW	100 uW

Global Measurements	
Minimum Signal Level	245.10 uW
Effective Symbol Level 1	0.42
Effective Symbol Level 2	0.29
Level Mismatch (R_{LM})	0.83
Level Deviation	11.34%
Level Thickness	1.37%
Level Time Deviation	3.00%
Vertical Eye Closure	3.96 dB
OMA Outer	1.49 mW

The summary selections list the noise and jitter measurements but not the breakdown of the measurements. The results tabs display relevant jitter or mask test results.

Global	JNB Results	Mask

Data Source: CH1	RJ (RMS)	= 1.87 ps	RN (RMS)	= 778 uV
Decision Threshold: -33.3 mV	DJ	= 49.3 ps	DN	= 12.0 mV
Sampling Phase: 16 ps	DDJ	= 22.1 ps	DDN	= 10.9 mV
Mask Test: Enabled (Scaled)	PJ	= 8.78 ps	PN	= 788 uV
Phase Reference: None	TJ (1E-12)	= 65.5 ps	Eye Amplitude	= 475 mV
Sample Count: 232700	Eye Opening (1E-12)	= 1.54 ns	Eye Opening (1E-12)	= 454 mV

Global	JNB Results	Mask

Data Source: CH1	RJ (RMS)	= 1.87 ps	RN (RMS)	= 778 uV
Decision Threshold: -33.3 mV	DJ	= 49.3 ps	DN	= 12.0 mV
Sampling Phase: 16 ps	DDJ	= 22.1 ps	DDN	= 10.9 mV
Mask Test: Enabled (Scaled)	PJ	= 8.78 ps	PN	= 788 uV
Phase Reference: None	TJ (1E-12)	= 65.5 ps	Eye Amplitude	= 475 mV
Sample Count: 232700	Eye Opening (1E-12)	= 1.54 ns	Eye Opening (1E-12)	= 454 mV

Global	JNB Results	Mask

Test Type: PassFail	PDF Mask Margin	= 77.90%
Target Hit Ratio: 0.0E+00	PDF Hit Ratio	= 0.0E+00
Target Mask Margin: 0.0%	BER Mask Margin	= N/A
Target BER: 1.0E-05	BER Limit	= N/A
Test For Polygon Set: Center	Pass/Fail Status	= Pass
Horizontal Shifting Allowed: False	Horizontal Shift	= 0 s

Selected eye tab detail tables show more detail, as shown in the following:

Global — **JNB Results** — **Mask**

Data Source: CH1	Rate: 622.08 Mbps	Filter: False	Rx Optimizer: On
Coding: NRZ	Pattern: 127 bits	Channel: False	Rx Common Phase: N/A
Phase Reference: None	Sample Count: -----	Equalizer: None	Rx Status: -----

Jitter (Decision Threshold: -----)

Random Jitter

RJ (RMS)	=	-----
RJ(h) (RMS)	=	-----
RJ(v) (RMS)	=	-----

Deterministic Jitter

DJ	=	-----
DDJ	=	-----
DCD	=	-----
DDPWS	=	-----
BUJ(d-d)	=	-----
PJ	=	-----
PJ(h)	=	-----
PJ(v)	=	-----
NPJ(d-d)	=	-----

Total Jitter @ BER

TJ (1E-12)	=	-----
Eye Opening (1E-12)	=	-----
J2 (2.5E-3)	=	-----
J9 (2.5E-10)	=	-----
RJ(d-d)	=	-----
DJ(d-d)	=	-----

Noise (Sampling Phase: -----)

Random Noise

RN (RMS)	=	-----
RN(v) (RMS)	=	-----
RN(h) (RMS)	=	-----

Deterministic Noise

DN	=	-----
DDN	=	-----
DDN(upper)	=	-----
DDN(lower)	=	-----
BUN(d-d)	=	-----
PN	=	-----
PN(v)	=	-----
PN(h)	=	-----
NPN(d-d)	=	-----

Total Noise @ BER

TN (1E-12)	=	-----
Eye Opening (1E-12)	=	-----
Eye Amplitude	=	-----

SSC Modulation

Magnitude	=	-----
Frequency	=	-----

Eye tabs (both NRZ and PAM4)

Global — **JNB Results** — **Mask**

Data Source:	Rate:	Filter:	Mask Test:
Coding:	Pattern:	Channel:	Mask File:
Phase Reference:	Sample Count:	Equalizer:	Mask Target:

Mask Test Definitions

Mask Standard

Name	=	
Data Rate	=	
Modulation	=	

Test Specifications

Test Type	=	
Target Hit Ratio	=	
Target Mask Margin	=	
Target BER	=	

Run Time Options

Test For Polygon Set	=	
Horizontal Shifting Allowed	=	

Mask Test Results

PDF Hit Ratio Per Region

Overshoot	=	
Center	=	
Undershoot	=	

Results Over All Regions

PDF Mask Margin	=	
PDF Hit Ratio	=	
BER Mask Margin	=	
BER Limit	=	

Pass/Fail

Status	=	
Horizontal Shift	=	

Mask tabs (both NRZ and PAM4)

Global — **JNB Results** — **Mask**

Data Source: CH1	Rate: 622.08 Mbps	Filter: False	Rx Optimizer: On
Coding: NRZ	Pattern: 127 bits	Channel: False	Rx Common Phase: N/A
Phase Reference: None	Sample Count: 232700	Equalizer: None	Rx Status: Optimized

BER	RJ (RMS)	TJ	Eye Width	Decision Threshold	RN (RMS)	TN	Eye Height	Sampling Phase	Center Deviation	VMA
1E-12	1.54 ps	57.1 ps	1.55 ns	-30.5 mV	763 uV	20.2 mV	456 mV	16 ps	820 ps	480 mV

Rise/Fall	Mean(μ)	StdDev(σ)	CV(σ/μ)	Min	Max	Count
Rise	261 ps	10.4 ps	0.0400	241 ps	273 ps	32
Fall	226 ps	10.4 ps	0.0461	209 ps	241 ps	31

Levels	Mean	StdDev	PkPk
Level1	247 mV	798 uV	6.34 mV
Level0	-233 mV	748 uV	6.18 mV

Global tab for NRZ

Global tab for PAM4

Rise/Fall tab (PAM4 only)

NOTE. *If it happens that the specified reference levels are not crossed for at least one transition, the only statistic reported is the minimum of the measurements for that transition.*

You can easily switch between summary and detailed numeric displays by clicking the numeric results button and the plot window buttons .

Click on a results tab to display the results. The active tab is indicated by magnified label text.
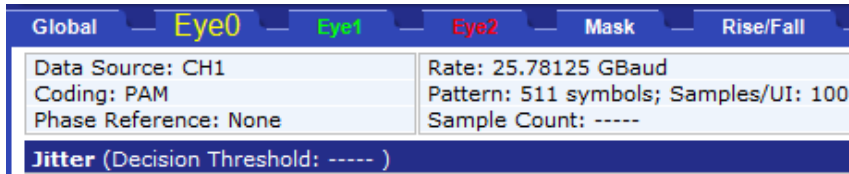
NRZ results tabs

PAM4 results tabs

To hide the summary table and provide more room for the plot displays, click the displayed tab. Click the tab again to show the summary data table.

Here you can see that the plot windows fill the entire screen and the numeric result tabs are at the bottom of the screen.
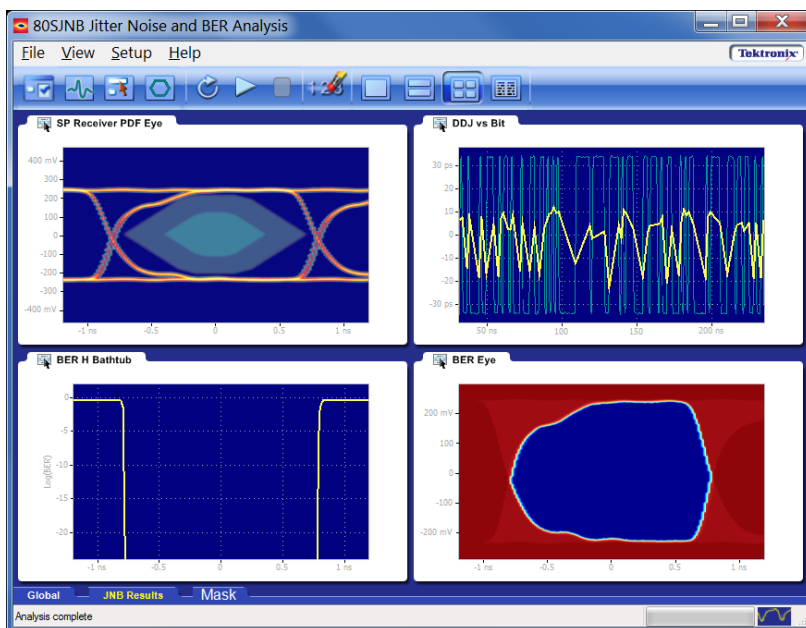
NRZ plots and results tabs
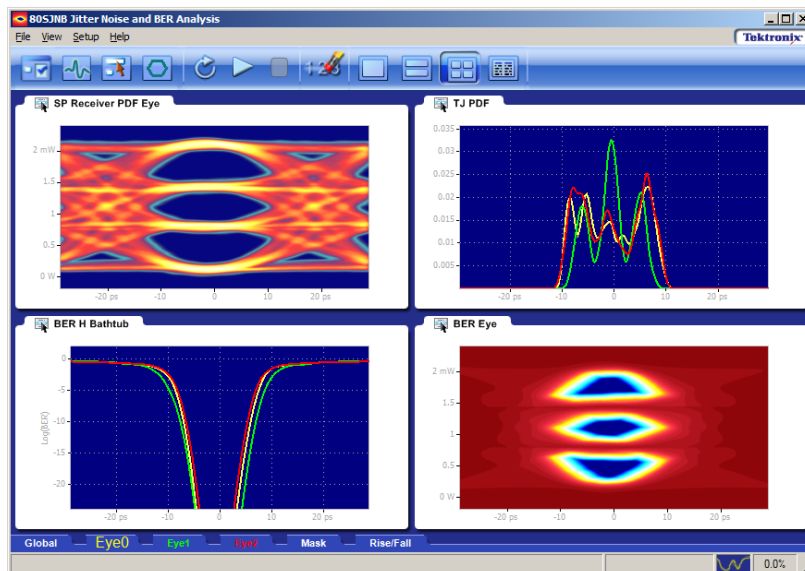
PAM4 plots and results tabs

See also:

Working with Plots (see page 66)

Noise Measurement Definitions (see page 60)

Jitter Measurement Definitions (see page 59)

SSC Modulation Measurement Definitions (see page 60)

An application example

The following example uses the 80SJNB application on an optical signal for fast analysis of BER, Jitter, and Noise. This simplified application example shows how to configure and use the application. This may help you when setting up your own test situation.

Requirements:

- DSA8300 oscilloscope

- 80SJNB software

- ADVTRIG Advanced Trigger Option installed

- Optical module with clock recovery. The following example uses the 80C11-CR4 Optical Sampling Module.

- SMA cables

Set up the oscilloscope

1. Install the modules and make the signal connections (the example assumes using channel 1 as the signal source).

2. Turn on the instrument and wait for instrument and application startup to complete.

3. Push the **Default Setup** front panel button.

4. Select **Channel 1**.

5. Push the **SETUP DIALOGS** button.

6. Click the **Horz** tab.

7. Set the Horizontal scale to **5 ns**.

8. Click the **Mode/Trigger** tab.
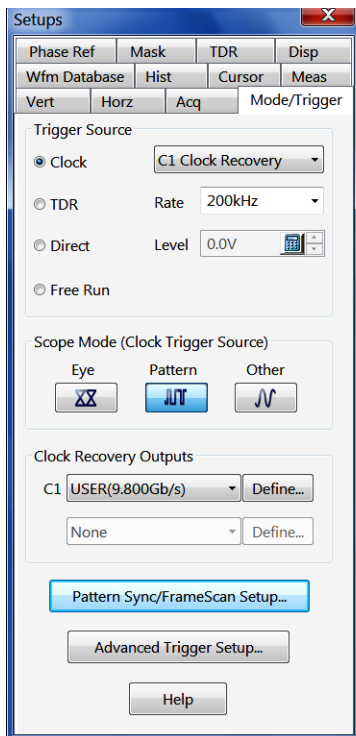
9. Verify that Trigger Source is set to **Clock** and select **C1 Clock Recovery** as the clock source.

10. Click the **Pattern** button in the Scope Mode (Clock Trigger Source) area.

11. Click the **Pattern Sync/FrameScan Setup** button.
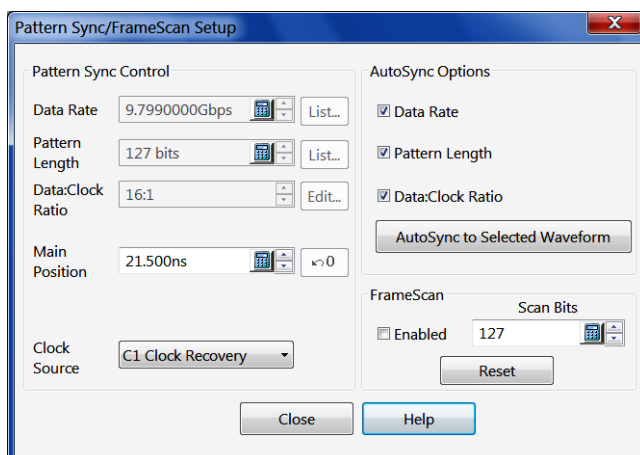
12. Enter the **Data Rate** parameter (for example, 9.8 Gbps).

13. Set the **Pattern Length** parameter (for example, 127 bits).

14. Click **Close**.

NOTE. You should now have a stable signal display on the DSA8300. If not, recheck all settings, signal source, and connections. The 80SJNB application requires a stable signal to acquire data for accurate measurements.

Set up the 80SJNB application

1. Click **Applications > 80SJNB** in the DSA8300 menu to start the 80SJNB application.
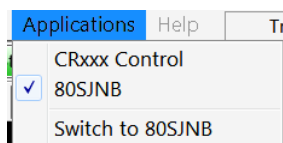
You can also use the Windows 80SJNB desktop shortcut or the Windows Start menu **Start > Programs > Tektronix Applications > 80SJNB > 80SJNB** to start the 80SJNB application.

1. Wait for the 80SJNB application to finish loading.

2. Click the Acquisition button ( ) to open the acquisition dialog box.

3. Most of the configuration settings are already filled in, as the 80SJNB application acquired the values from the oscilloscope configuration. If not, click the AutoSync to Selected Waveform button to sync the Source, Data Pattern, and Pattern Sync settings to the oscilloscope.

   Since this is an optical signal and we're using the clock recovery signal, you'll need to select the optical signal filter and select the clock recovery settings.

   The setup in this example does not include a Phase Reference module, so this field is grayed out.
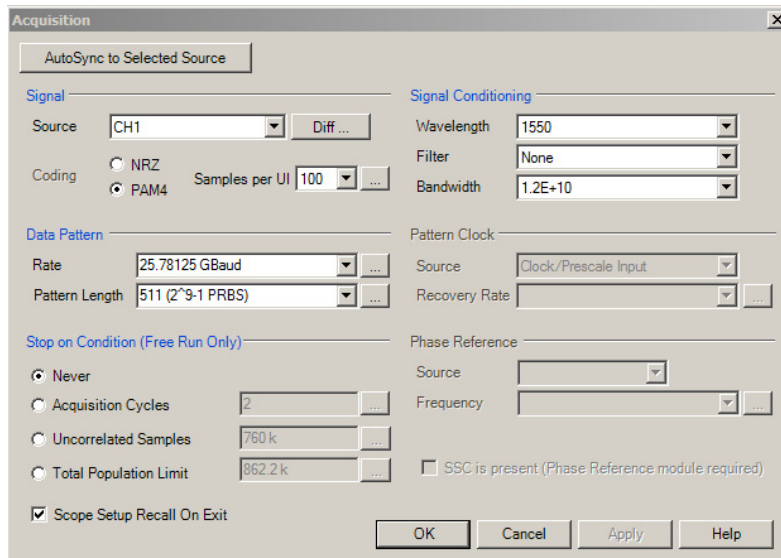
Click **OK** to apply the settings and close the dialog box.

4. Click to start the acquisition and processing cycle.

While the cycle is running, you'll see the sequence of events displayed at the bottom of the application display. When the cycle is complete, the application displays the message "Analysis Complete."

5. Once the cycle is complete, you'll see the displayed results. The example below shows a four plot display with the summary table of the numerical results.
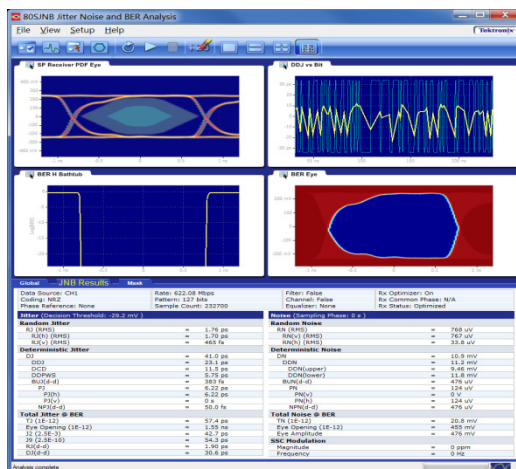
Working with the results

1. Click to minimize the plot displays and show the detailed results table.
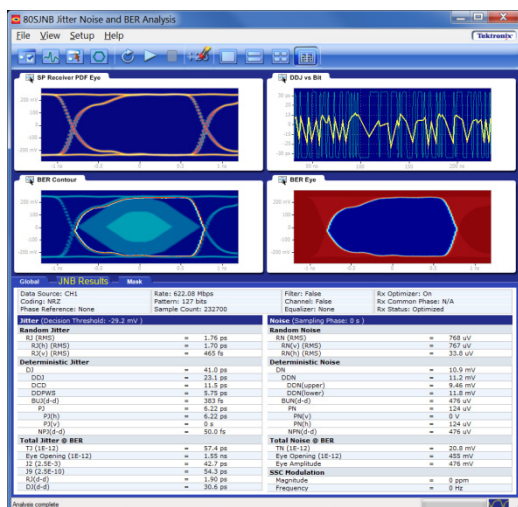
2. Redisplay the plot (or plots) by selecting one of the plot display buttons .

Click the **JNB Results** tab to minimize the detailed list to a summary list.

3. With the plots now redisplayed, click the Configure Plot icon ( ) on the plot tab to display a drop-down menu for that plot. The menu provides several functions, one of which is to select a different type of plot to display in that window.
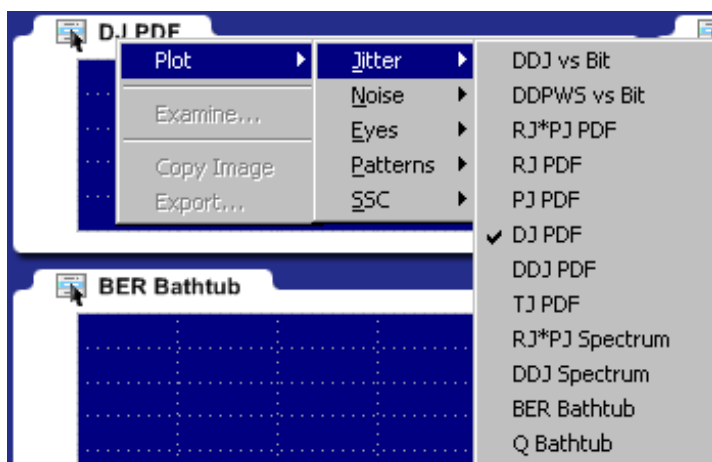
You can select any plot type. The plot is displayed based on the data based on the results of the last processing cycle.

4. To further examine a plot, you can display any plot in a MATLAB window, providing you with more tools to work with the data. Click the Configure Plot ( ) icon and choose **Examine**.

The plot opens in a new window to provide further data analysis and visualization of the plot displays.

MATLAB provides multiple capabilities to display and annotate the plot diagrams, including:

- Pan and Zoom

- 2D and 3D visualization

- Rotation

- Data Cursors

- Color enhancements

The following figure shows a 3D BER Eye plot using the rotate function.
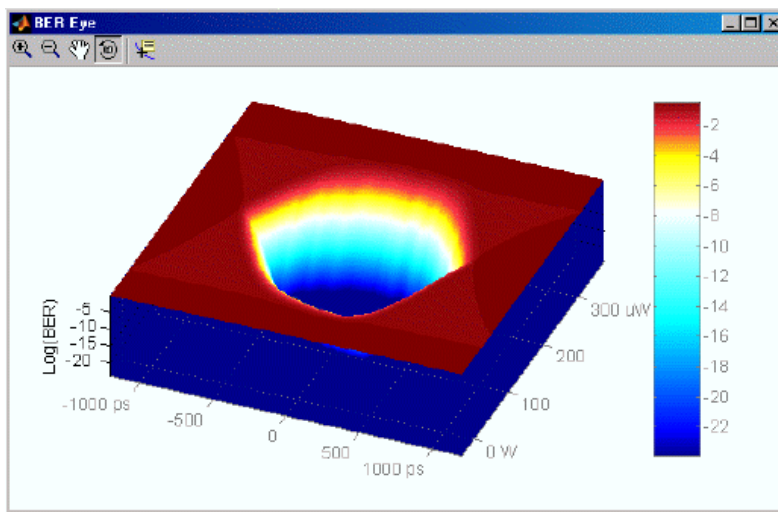
Close the window to return to the 80SJNB display.

This is the end of the example. You can continue on by acquiring new data, displaying various types of plots, and examine the plots with the various tools available.

About application parameters

These topics list the 80SJNB application parameters and include the menu default settings. The parameter tables list the selections and startup values for each option.

Refer to the GPIB topics for a list of the GPIB Command Syntax with the arguments, variables, and variable values that correspond to the 80SJNB parameters.

You should refer to the documentation for your TekScope for operating details of the oscilloscope controls.

See also:

Analysis settings

This table lists the default Analysis settings when the 80SJNB application is first started. If you change these settings, they remain in effect for all successive sessions of the application.

Control	Startup settings
Method	Spectral + BUJ
Decision Threshold	Normalized: 50%
Time Unit	Seconds
Sampling Phase	Unit Intervals: 0 UI
Global BER	1.00E-12
JxBER	2.5E-3
JyBER	2.5E-10
Rx Optimizer for NRZ	Optimize Receiver
Rx Optimizer for PAM4	Optimize to Center Eye (Common Phase)
Compute Rise/Fall Times checkbox	unchecked
Rise/Fall Low %	20
Rise/Fall High %	80

Acquisition settings

This table lists the default Acquisition settings when the 80SJNB application is first started. If you change these settings, they remain in effect for all successive sessions of the application.

Control	Startup settings
Signal	
Source	First valid input channel
Coding	NRZ
Difference Waveform	
Positive	First valid input channel
Negative	blank
Data Pattern	
Samples per UI	100
Rate	User defined
Pattern Length	User defined
Stop on Condition	Never
Scope Setup Recall On Exit	Checked
Signal Conditioning	
Wavelength	None
Filter	None
Bandwidth	blank
Pattern Clock	
Source	CLOCK INPUT/PRESCALE TRIGGER front panel connector
Recovery Rate	blank
Phase Reference	
Source	None
Frequency	blank
SSC is present	Not checked

Signal path settings

This table lists the default Signal Path settings when the 80SJNB application is first started. If you change these settings, they remain in effect for all successive sessions of the application.

Control	Startup settings
Filter	
Uncorrelated Scaling	1.00
Channel	
Data Type	Frequency Domain
Uncorrelated Scaling	1.00
Equalizer	
CTLE	None
Taps	
FFE Taps	1
FFE Taps/Symbol	1
DFE Taps	0
Options	
FFE Reference Tap	1
Uncorrelated Scaling	1.00
Rise Time Selector	Track Data Rate
User Rise Time (ps)	200

Mask test settings

This table lists the default Mask test settings. If you change these settings, they remain in effect for all successive sessions of the applications.

Control	Startup settings
Mask Test Definition	
Mask File	None
Load browser	C:\Users\Public\Documents\Tektronix\Masks
Save browser	C:\Users\Public\Documents\Tektronix\Masks
Rate	10 Gbps
Target Hit Ratio	5.00E-005
Target Mask Margin	0
Target BER	1.00E-005
Horizontal Autofit	unchecked
Runtime Options	
Test Target	SP Receiver PDF Eye
Find Mask Margin	selected
Measure Hit Ratio	unchecked
Measure Hit Ratio	disabled
DUT Pass/Fail Test	unchecked
All Polygons	checked
Center Polygons Only	unchecked
Enable Mask Testing	unchecked

Mask file structure

Tektronix mask files have extension .msk and are in XML format. This table describes the meaning of each field.

XML element	Description	Status
<?xml version="1.0" encoding="utf-8"?>	Standard xml header	Required
<Tektronix>	Root node of the file	Required
<FileVersion> Version x.y.z </FileVersion>	Version of the file	Required
<FileCreated>mm/dd/yyyy hh:mm:ss [AM|PM]</FileCreated>	Date and time the file was created	Required

XML element	Description	Status
<StandardName>StandardName</StandardName>	Name of the standard in this file	Required
<StandardVersion>StandardVersion</StandardVersion>	Version of the standard in this file	Required
<StandardDate>StandardDate</StandardDate>	Date of the standard for this file	Required
<StandardSub>Sub</StandardSub>	Additional standard subdivisions	Optional
<StandardData>	Data specific to the standard used for multiple sub-elements	Required
<SymbolRate>SymbolRate</SymbolRate>	Data (symbol) rate for this standard [numeric]	Required
<ModulationScheme>PAM4</ModulationScheme>	Modulation scheme for this standard [NRZ/PAM4]	Required
<Pattern>PRBS-7</Pattern>	Data pattern for this standard	Optional
</StandardData>	Close for StandardData	Required
<MaskTest>	Identifies a mask test set of elements	Required
<UIReadoutString>ReadoutString</UIReadoutString>	String displayed in the mask readout area (ex: SATA G2 Tx)	Required
<UISelectionString>SelectionString</UISelectionString>	String displayed in the selector or menu (ex: SATA G2 Tx (3.0 Gb/s))	Required
<PIToken>PIToken</PIToken>	String for standard selection from the PI (ex: ATATXG2)	Required
<TestParameters>	Standard specified parameters related to the mask	Optional
<TargetHitRatio>TargetHitRatio</TargetHitRatio>		Optional
<TargetHits>TargetHits</TargetHits>	Target number of hits for this standard [numeric] (ex: 100)	Optional
<UnitIntervalSamples>UIS</UnitIntervalSamples>	Required number of UI samples for this standard [numeric] (ex:1000000)	Optional
<TargetBER>TargetBER</TargetBER>	Target BER for this standard [numeric] (ex: 1e-12)	Optional
<BERTargetEnabled>bool</BERTargetEnabled>	Whether Target BER is used [True/False]	Optional
<HorizontalAdjustAllowed>bool</HorizontalAdjustAllowed>	Whether horizontal adjustment of the mask is allowed during testing	Optional
<VerticalAdjustAllowed>bool</VerticalAdjustAllowed>	Whether vertical adjustment of the mask is allowed during testing	Optional
</TestParameters>	Close for TestParameters	Optional
<Mask>	Identifies a set of mask polygons	Required
<Name>Rx Mask</Name>	Name of this mask	Optional
<MaskType>MaskType</MaskType>	Type of mask: Relative	Absolute	Required

XML element	Description	Status
<VerticalScale>VerticalScale</VerticalScale>	Vertical scale to use if mask is absolute [numeric]	Required
<PolygonGroup>	Groups of polygons for this mask	Required
<Name>GroupName</Name>	Name for this polygon group	Optional
<NumPolygons>n</NumPolygons>	Number of polygons in this group [numeric ≥1]	Required
<Polygon0>	First polygon definition	Required
<Name>PolygonName</Name>	Name of this polygon	Optional
<PolygonType>Overshoot</PolygonType>	Overshoot, Center, or Undershoot	Required
<Symmetry>VerticalAxisReflection</Symmetry>	HorizontalAxisReflection, VerticalAxisReflection, BothAxesReflection or None	Required
<NumVertices>m</NumVertices>	Number of vertices in this polygon [numeric]	Required
<PointX0>p</PointX0>	X value for the first vertex [numeric]	Required
<PointY0>p</PointY0>	Y value for the first vertex [numeric]	Required
<PointX1>p</PointX1>	X value for the second vertex [numeric]	Required
<PointY1>p</PointY1>	Y value for the second vertex [numeric]	Required
. . .	Additional vertices as needed	Optional
</Polygon0>	Close for Polygon0	
. . .	Additional polygons as needed	Optional
</PolygonGroup>	Close for PolygonGroup	Required
</Mask>	Close for Mask	Required
</MaskTest>	Close for MaskTest	Required
<Source>	Specification data for sources for this standard	Optional
<Amplitude>A</Amplitude>	Source amplitude specification for this standard	Optional
</Source>	Close for Source	Optional
</Tektronix>	Close for Root	Required

Notes:

■ **MaskType**: For Relative masks the X and Y coordinates of Center polygons are in the range [0-1], this being both the horizontal and vertical ranges of a unit interval.

■ **PolygonType**: A mask can have at most one Undershoot polygon and one Overshoot polygon. A PAM4 mask will usually have 3 Center polygons.

■ **Symmetry**: This field for a polygon is an indicator for a polygon editor as to the symmetry imposed on the polygon by the standard. It is up to the polygon editor to enforce this.

■ **NumVertices**: This field for a polygon must be at least 2 for an Overshoot or Undershoot polygon and at least 3 for a Center polygon.

Remote control introduction

The 80SJNB software application can be controlled programmatically through the programmatic interface of the sampling oscilloscope on which it is running. Communication with the application is accomplished using VARIABLE:VALUE remote GPIB commands.

Your program should comply with the following guidelines:

■   The application startup must complete before sending additional GPIB commands to the application. Querying the variable "Application" returns "80SJNB" when the application startup is complete.

■   The measurements cycle must complete before you query data. Querying the variable DataReady returns "True" when the data is ready.

Because the oscilloscope software hosts the GPIB interface for the 80SJNB application, there is some additional information that is helpful for successful programming.

See also:

GPIB Reference Materials (see page 95)

Programming Tips (see page 96)

Variable:Value Commands (see page 98)

Results Queries (see page 110)

Programming Examples (see page 116)

GPIB reference materials

To use GPIB commands with your TekScope, you can refer to the following materials:

■   The Programming Examples (see page 116) topic for guidelines to use while designing a GPIB program.

■   The online Programmer Guide for the TekScope.

See also:

Starting and Setting Up the Application Using GPIB (see page 95)

Programming tips

Launching 80SJNB

Use the following command (issued for the DSA8300 instrument) to launch the 80SJNB application:

```
APPLICATION:ACTIVATE "80SJNB"
```

How the variable value table works

Programmable Interface (PI) commands for the 80SJNB software package (JNB) are implemented using a variable|value table. This table associates named variables with text values. These values can be set (variable:value "VariableName","VariableValue") or queried (variable:value? "VariableName") from the PI. When a set command is received, if the variable does not already exist in the table, it is created and the specified value is associated with that variable. If the variable is already in the table, the specified value will replace the existing value. There is no checking done by the table on variable names or values. Since both items are strings, any arbitrary pair of strings can be associated with each other in this table.

Polling and limit of variable values

Each time a change is made to a variable's value in the table, an event is generated. The 80SJNB software application polls the oscilloscope software application every 200 ms to see if an event occurred. If so, JNB queries for the event information which tells JNB which variable changed and the new value. JNB parses this information to find the variables pertinent to its operation and reads the new values for those variables. These new values can change the state of JNB (for example selecting a new data source channel) or can cause JNB to perform an operation (for example, setting "SequencerMode" to "Run").

Because JNB polls for changes at a fixed rate, the oscilloscope application might indicate that a list of variables has changed since the last time JNB polled for changes. There are two consequences of this operation.

■   First, when JNB receives a list of changes, it does not necessarily execute those changes in the order in which they were sent to the oscilloscope from the PI. This means that sending a command to change the data source (for example, "DataSource","C1") followed immediately by starting sequencing ("SequencerState","Run") does not guarantee that the source channel is changed before JNB begins the sequencing operation. To be sure of proper execution order of these commands, a delay of at least 400 ms should be inserted before starting certain JNB operations.

Commands that should be preceded by a delay include:

- "SequencerState","Run"

- "ExportCurve","GO"

- "SaveRecallData","Save"

- "SaveRecallData","Recall"

- "Setup","Save"

- "Setup","Recall"

■ Second, there is a limit of 15 variable/value table changes that can be reported for any one polling event. If more than 15 changes have occurred between JNB polls of the oscilloscope software, the later changes will not be seen by JNB so it will not respond to those commands.

■ The following list specifies which commands require the PI program to query for the Done status - that is, the command execution is complete. Wait (loop in query command) until Done or Error is returned before proceeding with the command sequence.

- Application

- Clear

- EqAutosetTaps

- EqDefaultDFETaps

- EqDefaultFFETaps

- EqLoadTaps

- EqSaveTaps

- ExportCurve

- ExportResults

- PrintToFile

- SaveRecallData

- Setup

- SpCompute

How the variable value table is updated

JNB only updates table entries when it has new data to report. For example, if an error occurs during sequencing, the variables "ErrorCode" and "ErrorMessage" are updated by JNB with the appropriate values. However, JNB will only update those variables if another error occurs. If a subsequent sequence is run without errors, the "ErrorCode" and "ErrorMessage" variables will continue to report the old values. The user program must be written to explicitly clear these variables, setting the variables to null strings ("") before starting a new sequence.

Variables that should be set to null strings ("") before starting a sequence operation include:

- ErrorCode

- ErrorMessage

- DataReady

Determining if 80SJNB is running

The "Application" variable shows whether 80SJNB is running or not. When it is running, this variable is set to "80SJNB". When JNB exits normally, the variable is set to "Done". However, if JNB encounters an error and exits abnormally, it will not set the "Application" variable to "Done", leaving the variable set to "80SJNB". In this circumstance, it is not possible to use this variable to determine if JNB is running. One way to reliably determine if JNB is running is to set the "PatternLength" variable to "1". If JNB is running, it will set this variable to "2" since 2 is the minimum allowable value for "PatternLength". If JNB is not running, the variable value will remain at "1". Be sure to wait at least 400 ms after setting the value to "1" before querying the status of this variable.

Syntax

The VARIABLE:VALUE command accepts string arguments for a control or data variable and a value to which to set the argument.

To set a variable to a value, use the syntax:

```
VARIABLE:VALUE "<variableName>","<variableValue>"
```

For example, the following commands set the signal source channel, data rate, and pattern length to be analyzed.

```
VARIABLE:VALUE "DataSource","CH1"
VARIABLE:VALUE "DataRate","10.3125e9"
VARIABLE:VALUE "PatternLength","32767"
VARIABLE:VALUE "SamplesPerBit","40"
```

To query the value in a variable:

```
VARIABLE:VALUE? <variablename>
```

For example, the following commands query the state of the acquisition and processing cycle.

```
VARIABLE:VALUE? "DataReady"
```

```
VARIABLE:VALUE? "SequencerState"
```

NOTE. *The arguments <variableName> and <variableValue> are required in the order indicated with no spaces allowed.*

NOTE. *Commands are case and space sensitive. Your program will not operate correctly if you do not follow the capitalization and spacing precisely.*

See also:

Variable:Value Command Arguments and Queries (see page 99)

GPIB Commands Error Codes (see page 116)

Programming Examples (see page 116)

Variable name arguments and queries

Programming Examples (see page 116)

Variable name	Value	Function	Query form returns
AcqCycleCount	Positive integer number larger than 2	Sets or returns the acquisition cycle count	Current value
AnalysisMethod	{CDF | Spectral}	Sets the jitter and noise analysis method. Spectral is legacy. Default is CDF (Cumulative Distribution Function)	Current value
Application	Exit	Exits the application	Done
Application (Query only)		Returns which application is running	"80SJNB" if the application is running, or "Done" if application has exited. Wait for Done or Error before proceeding
Bandwidth	Any valid bandwidth as defined by the selected source module	Sets or returns the bandwidth in Hertz for use when Filter is set to None	Current value
BER	Any valid floating point value between 1e-3 and 1e-24 inclusive	Sets or returns the current BER value	Current value
CeActive	{True | False}	Activates or deactivates the channel emulator	True, False
CeDomain	Time | Frequency	Sets the domain in which the channel characteristics are defined	Current value
CeFdSParametersFile	Full path name of a file name	Defines the channel's S-parameter	Current value
CeFd2PortMatrixSelector	{11 | 12 | 21 | 22}	Selects an S-parameter when using a 2-port Touchstone file	Current value
CeFd4PortDataType	{SingleEnded | Differential}	Selects the type of data when using a 4-port Touchstone file	Current value

Variable name	Value	Function	Query form returns
CeFd4PortLayout	{DC21 | CD21 | 12DC | 12CD}	Sets the data arrangement used by a 4-port Touchstone file containing Differential data	Current value
CeFd4PortMapping	Any permutation of 1234 (for example, 1234, 1324 or 2143)	Sets the port mapping used by a 4-port Touchstone file containing SingleEnded data	Current value
CeTdReferenceFile	Full path name of a file name	Defines the time domain reference waveform	Current value
CeTdTransmissionFile	Full path name of a file name	Defines the time domain transmission waveform	Current value
CeUncorrelatedScaling	Any number in the range 0.01-100.0	Sets the Channel uncorrelated scaling factor Overall signal path uncorrelated scaling factor is a product of all active uncorrelated scaling values	Current value
ClockRecoveryRate	Valid values include any communication standard token for communication standards supported by the clock recovery module or a positive floating point value if the clock recovery unit supports user rates	Sets or returns the clock recovery rate	Current value
ClockSource	{ClockPrescale | C1ClockRecovery | C1CRClockPrescale | C3ClockRecovery | C3CRClockPrescale}	Sets or returns the clock source	Current value
Coding	NRZ | PAM	Sets the coding scheme of the signal	Current value
ComputeRiseFallTimes	{True | False}	Sets whether rise/fall times will be computed as part of a run	True or False
CTLE1ADC	Any valid positive floating point value	Sets the ADC value for stage 1 of the CTLE	Current value
CTLE1FPole1	Any valid positive floating point value	Sets the frequency of the first pole of the filter for stage 1	Current value
CTLE1FPole2	Any valid positive floating point value	Sets the frequency of the second pole of the filter for stage 1	Current value
CTLE1FZero	Any valid positive floating point value	Sets the frequency of the zero of the filter for stage 1	Current value

Variable name	Value	Function	Query form returns
CTLE1Include	{True | False}	Sets whether stage 1 should be included in the filter	True or False
CTLE1Standard	Index in the UI combo box; out of range values have same effect as 0	Select the standard for stage 1	Current value
CTLE1Use2Poles	{True | False}	Sets whether to use 1 or 2 poles for stage 1	True or False
CTLE2ADC	Any valid positive floating point value	Sets the ADC value for stage 2 of the CTLE	Current value
CTLE2FPole1	Any valid positive floating point value	Sets the frequency of the first pole of the filter for stage 2	Current value
CTLE2FPole2	Any valid positive floating point value	Sets the frequency of the second pole of the filter for stage 2	Current value
CTLE2FZero	Any valid positive floating point value	Sets the frequency of the zero of the filter for stage 2	Current value
CTLE2Include	{True | False}	Sets whether stage 2 should be included in the filter	True or False
CTLE2Standard	Index in the UI combo box; out of range values have same effect as 0	Select the standard for stage 2	Current value
CTLE2Use2Poles	{True | False}	Sets whether to use 1 or 2 poles for stage 2	True or False
CurrentTab	0 – PAM Global 1 – Eye0 / JNB Results 2 – Eye1 3 – Eye2 4 – Mask	Sets the number of the tab to display	Current value
DataRate	Any valid positive floating point value or communication standard	Sets or returns the expected data rate	Communication standard or current value
DataReady	{True | False}	Sets or returns a value indicating if sequencing is complete and data is ready to be read Setting this value to False before beginning a sequence prevents accidentally reading the DataReady value from a previous sequence before it is reset by the application	True, False

Variable name	Value	Function	Query form returns
DataSource	{CH1 | CH2 | CH3 | CH4 | CH5 | CH6 | CH7 | CH8 | MATH1 | MATH2 | MATH3 | MATH4 | MATH5 | MATH6 | MATH7 | MATH8 | <file name >}	Sets or returns the data source Math expressions must be programmed through the oscilloscope GPIB interface commands	Current value <file name> is the name of the file recalled
DecisionThresholdAbs DecisionThresholdAbs1 DecisionThresholdAbs2	Any valid floating point value	Sets or returns the absolute decision threshold value of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2	Current value as set by user; actual value used will differ if the Optimizer is both enabled and successful; see PI query DecisionThresholdEff
DecisionThresholdPct DecisionThresholdPct1 DecisionThresholdPct2	Any valid floating point value between 0.0 and 1.0 inclusive	Sets or returns the normalized decision threshold value of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2	Current value as set by user; actual value used will differ if the Optimizer is both enabled and successful; see PI query DecisionThresholdEff
DecisionThresholdUnits	{Absolute, Normalized}	Sets or returns the desired decision threshold value to use By setting the units to Absolute, the DecisionThresholdAbs value is used. If the units are set to Normalized, the decision threshold is calculated based on waveform data according to the DecisionThresholdPct normalized value.	Current value
EqActive	{True | False}	Activates or deactivate the equalizer	True or False
EqAutosetTaps	{Run}	Automatically computes the equalization coefficients SpCompute must be run first	Current value or Done, Error Wait for Done or Error before proceeding
EqDFETaps	An integer in the range 1-40	Sets the number of DFE taps	Current value
EqDFETapCoefficient<n> where <n> is in the range 1–40	Any number in the range -100.0 to +100.0	Sets the value of a DFE tap coefficient	Current value
EqDefaultDFETaps [2]	{Run}	Sets the DFE taps to default values	Current value or Done, Error Wait for Done or Error before proceeding
EqDefaultFFETaps [2]	{Run}	Sets the FFE taps to default values	Current value or Done, Error Wait for Done or Error before proceeding

Variable name	Value	Function	Query form returns
EqFFEReferenceTap	An integer in the range 1 – EqFFETaps	Selects the FFE reference tap EqFFEReferenceTap-1 must be an integer (possibly 0) multiple of EqFFETapsPerSymbol	Current value
EqFFETaps	An integer in the range 1-100	Sets the number of FFE taps	Current value
EqFFETapsPerSymbol	One of 1, 2, 5, 10 but not larger then EqFFETaps	Sets the number of FFE taps per symbol or unit interval	Current value
EqFFETapCoefficient<n> where <n> is in the range 1–100	Any number in the range -100.0 to +100.0	Sets the value of an FFE tap coefficient	Current value
EqLoadTaps [2]	{Run}	Loads the equalizer configuration from a file	Current value or Done, Error Wait for Done or Error before proceeding
EqRiseTimeSelector	{DataRate | TapInterval | User}	Defines how the equalizer rise time is determined	Current value
EqSaveTaps [2]	{Run}	Saves the equalizer configuration to a file	Current value or Done, Error Wait for Done or Error before proceeding
EqTapsFilename	Full path name of a file	Sets the file used for EqLoadTaps and EqSaveTaps	Current value
EqUncorrelatedScaling	Any number in the range 0.01-100.0	Sets the Equalizer uncorrelated scaling factor Overall signal path uncorrelated scaling factor is a product of all active uncorrelated scaling values	Current value
EqUseCTLEFilter	{True | False}	Sets whether to use the filter	True or False
EqUserRiseTime	An integer in the range 1-4000	When EqRiseTimeSelector is set to User, this defines the rise time in picoseconds	Current value
ErrorCode		Returns a numeric code corresponding to the last error or 0 if no error	Current value
ErrorMessage		Returns the last error message	Current value
ExportCurve [2] [3]	{GO}	Sets or returns the export action	Current value or Done, Error Wait for Done or Error before proceeding

Variable name	Value	Function	Query form returns
ExportFilename	<file name >[1]	Sets the file name used when exporting data	
ExportFormat	{CSV, MAT}	Sets or returns the current plot diagram export format	Current value
ExportResults	{GO}	Initiates the export results action to the file specified by ExportFilename	Export action status: Done or Error Wait for Done or Error before proceeding
ExportType	ACQWFM | CORRWFM, RJPDF | PJPDF | RJPJPDF | RJPJSPEC | DDJPDF | DJPDF | DDJSPEC | TJPDF | DDJ | HBATH | QHBATH | RNPDF | PNPDF | RNPNPDF | RNPNSPEC | DDNPDF | DNPDF | DDNSPEC | TNPDF | DDN | VBATH | QVBATH | BEREYE | QEYE | PDFEYE | CORREYE | BERCONTOUR | SPCHANPDFEYE | SPCHANWFM | SPFILTWFM | SPFILTPDFEYE | SPINPDFEYE | SPINWFM | SPEQWFM | SSCPROFILE	Sets or returns the type of export to perform	Current value
EyeGraphSelection	Integer from 0 to 7	Specifies which eye graphs to display in plots having one graph per eye. Bit N is for eye N, where N is 0, 1 or 2.	Current value
FiActive	{True | False}	Activates or deactivates the filter	True, False
FiFilename	Full path name of a file name	Defines the filter file	Current value
FiUncorrelatedScaling	Any number in the range 0.01-100.0	Sets the Filter uncorrelated scaling factor Overall signal path uncorrelated scaling factor is a product of all active uncorrelated scaling values	Current value
Filter	Any valid communication standard as defined by the selected source module	Sets or returns the communication standard of the source	Current value The list of tokens for the selection of a specific hardware filter is specified in the DSA8300 Programmer Manual. Please use the manual for cross-reference of the optical hardware filters.

Variable name	Value	Function	Query form returns
GraphMode	1, 2 or 4	Sets the number of graphs to display.	Current value
GraphSelection1	name of graph to display [4]	Sets or returns the graph in box 1	Current value
GraphSelection2	name of graph to display [4]	Sets or returns the graph in box 2	Current value
GraphSelection3	name of graph to display [4]	Sets or returns the graph in box 3	Current value
GraphSelection4	name of graph to display [4]	Sets or returns the graph in box 4	Current value
MaskFilename	path+name	Sets or returns the mask file being used	Current file
JxBER	Any valid floating point value between 1e-3 and 1e-24 inclusive	Sets the Jx auxiliary BER value	Current value
JyBER	Any valid floating point value between 1e-3 and 1e-24 inclusive	Sets the Jy auxiliary BER value	Current value
MaskHorShiftAllowed	"True" or "False"	Turn mask shifting on or off	Current setting
MaskTestEnabled	"True" or "False"	Turn mask testing on or off	Current setting
MaskPolygonSet	"All" or "Center"	Select mask polygons to use with PDF eyes	Current polygon set
MaskTarget	either "BER Contour" or "SP Receiver PDF Eye"	Select graph to apply mask to	Current graph
MaskTargetBER	number in range [0,1]	Set target BER	Current value
MaskTargetHitRatio	number in range [0,1]	Set target hit ratio	Current value
MaskTargetMaskMargin	number in range [-99,+100], not necessarily an integer	Set target mask margin	Current value
MaskTestType	"PassFail", "MaskMargin" or "HitRatio"	Select type of mask test	Current mask test
NumericMode	0 – Hidden 1 – Summary 2 – Full display	Sets the state of the numeric panel	Current Value
OptimizeReceiver	True | False	Sets whether the receiver optimizer should compute the optimum decision points	Current Value
OptimizeToCommonPhase	True | False	Sets whether the optimizer restricts all optimized decision points to have the same phase	Current Value

Variable name	Value	Function	Query form returns
PatternLength	Any integer value between 2 and 100,000	Sets or returns the data pattern length in bits	Current value
PhaseReferenceEnabled		Indicates whether the data was acquired with a phase reference unit active or not for both acquired and recalled data	True, False
PhaseReferenceFrequency	Any valid phase reference frequency as defined by the selected phase reference source module	Sets or returns the phase reference frequency	Current value
PhaseReferenceSource	{C1C2 -or- C1_C2, C3C4 -or- C3_C4, C5C6 -or- C5_C6, C7C8 -or- C7_C8}	Sets or returns the phase reference source module	Current value
PrintToFile	path\file	Print an image of all results to a file	"Run" when busy, "Done" or "Error" when complete Wait for Done or Error before proceeding
RecallDataFilename	<file name > [1]	Specifies the name of the file when recalling a saved data file	
RecallFilename	<file name > [1]	Sets the name of the file when recalling a setup	
RiseFallHigh	Integer from 1 to 99	Set percentage defining the high reference level	Current value
RiseFallLow	Integer from 1 to 99	Set percentage defining the low reference level	Current value
SamplesPerBit	Integer 100 or 40	Sets the number of samples per unit interval to be acquired. Default is 100	Current value
SamplingPhase SamplingPhase1 SamplingPhase2	Any valid floating point value between –0.5 and +0.5 inclusive	Sets or returns the normalized sampling point value of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2	Current value as set by user; actual value used will differ if the Optimizer is both enabled and successful; see PI query SamplingPhaseEff
SamplingPhaseAbs SamplingPhaseAbs1 SamplingPhaseAbs2	Any valid floating point value	Sets or returns the absolute sampling point value of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2	Current value as set by user; actual value used will differ if the Optimizer is both enabled and successful; see PI query SamplingPhaseEff

Variable name	Value	Function	Query form returns
SamplingPhaseUnits	{Absolute, Normalized}	Sets or returns the desired sampling point value to use. If the units are set to Absolute, the SamplingPhaseAbs value is used. If the units are set to Normalized, the sampling point is calculated based on waveform data according to the SamplingPhase normalized value.	Current value
SaveDataFilename	<file name > [1]	Sets the file name used when saving data files	
SaveFilename	<file name > [1]	Sets the file name used when saving setup files	
SaveRecallData [3]	{Save, Recall}	Save saves the acquired data to the file name specified by the command SaveDataFilename. Recall recalls the acquired data from the file name specified by the command RecallDataFilename	Done, Error. Wait for Done or Error before proceeding
ScopeSettingRecall	{True | False}	Sets or returns the option of recalling scope setup stored when starting the application	Current value
SequencerMode	{SingleSequence, FreeRun}	Sets the sequencer mode. Startup default is Free Run	Sequencer mode
SequencerState [3]	{Run | Pause | Stop}	Sets or returns the Measurement Sequencing or the Stop Sequencing command	Sequencer state
Setup [3]	{Recall | Save | Default}	Performs the Save/Recall/Default setup action	Current value or Done, Error. Wait for Done or Error before proceeding
SpCompute [2]	{Run}	Recomputes results with the latest Signal Path definition on the acquired data	Current value or Done, Error. Wait for Done or Error before proceeding
SSC	{True | False}	Selects whether SSC is present in the signal. Setting to True requires a phase reference module to be installed and configured	Current value

Variable name	Value	Function	Query form returns
StopOnCondition	{Never | AcqCycle | UncorrCount | TotalPopulation}	Sets or returns the selected Stop on Condition when in Free Run	Current value
SymbolRate [5]	Any valid positive floating point value	Sets the symbol rate in baud	Current value
TimeUnits	{S | UI}	Sets or returns the units for the time scale	S, UI
TotalPopCount	Positive integer number	Sets or returns the total sample count	Current value
UncorrCount	Positive integer number	Sets or returns the uncorrelated sample count	Current value
Version (Query only)		Returns the version number of the installed 80SJNB application	Current version number
WLength	Any valid wavelength as defined by the selected source module	Sets or returns the wavelength of the sources	Current value

[1]   <file name > is a string of 1 to 40 characters that are valid for file names according to the Windows file system standards.

[2]   After running the default setup command, this argument is not initialized and a query returns an empty string "".

[3]   Precede this command by a delay of at least 400 ms.

[4]   See Valid graph name strings for GraphSelection<n> command (see page 108).

[5]   SymbolRate is identical to DataRate when DataRate is used to specify a number.

Valid graph name strings for GraphSelection<n> command

The following strings are the valid graph names for use with the PI commands **GraphSelection1**, **GraphSelection2**, **GraphSelection3** and **GraphSelection4**. The names must be exact including spacing and, like all PI command arguments, enclosed within double quotes.

Example: `VARIABLE:VALUE "GraphSelection2","RJ*PJ Spectrum"`

Jitter Graph names

- `DDJ vs Bit`
- `DDPWS vs Bit`
- `RJ*PJ PDF`
- `RJ PDF`
- `PJ PDF`
- `DJ PDF`
- `DDJ PDF`

- TJ PDF

- RJ*PJ Spectrum

- DDJ Spectrum

- BER H Bathtub

- Q H Bathtub

Noise Graph names

- DDN vs Bit

- RN*PN PDF

- RN PDF

- PN PDF

- DN PDF

- DDN PDF

- TN PDF

- RN*PN Spectrum

- DDN Spectrum

- BER V Bathtub

- Q V Bathtub

Eye Graph names

- Correlated Eye

- BER Eye

- Q Eye

- BER Contour

PDF Eye Graph names

- SP In PDF Eye

- SP Filter PDF Eye

- SP Channel PDF Eye

- SP Receiver PDF Eye

Patterns Graph names

- `SP In`

- `SP Filter`

- `SP Channel`

- `SP Equalizer`

SSC Graph names

- `SSC Profile`

Variable:Value results queries

These values, when used with the Variable:Value command, return the results for the individual measurement results. These are query only variable

Variable value name	Function
Application	Returns the application name (80SJNB or 80SJARB)
BUJDD BUJDD1 BUJDD2	Returns the Bounded Uncorrelated Jitter measurement of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
BUNDD BUNDD1 BUNDD2	Returns the Bounded Uncorrelated noise measurement of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
CenterDeviation CenterDeviation1 CenterDeviation2	Returns the phase deviation of eye relative to sampling phase of eye 1 in picoseconds. For PAM measurements only.
DCD DCD1 DCD2	Returns the Duty Cycle Distortion measurement of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
DecisionThresholdEff DecisionThresholdEff1 DecisionThresholdEff2	Returns the effective value of the decision threshold, either the value entered by the user or the value computed by the Optimizer, depending on whether the Optimizer is both enabled and successful.
DDJ DDJ1 DDJ2	Returns the Data Dependent Jitter measurement of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
DDN DDN_1 DDN_2	Returns the Data Dependent Noise measurement of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.

Variable value name	Function
DDN0 DDN0_1 DDN0_2	Returns the Data Dependent Noise on logical level 0 value of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
DDN1 DDN1_1 DDN1_2	Returns the Data Dependent Noise on logical level 1 value of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
DDPWS DDPWS1 DDPWS2	Returns the measured Data Dependent Pulse Width Shrinkage measurement of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
DJ DJ1 DJ2	Returns the measured deterministic jitter value of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
DJDD DJDD1 DJDD2	Returns the Deterministic Jitter computed in the Dual Dirac model for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
DN DN1 DN2	Returns the measured deterministic noise measurement of eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
EA EA1 EA2	Returns the amplitude of the eye computed as the mean-to-mean of logical 1 and logical 0 bit levels sampled at the user defined Sampling Phase, for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
EffSymbolLevel1	Returns the effective symbol level 1 value. For PAM measurements.
EffSymbolLevel2	Returns the effective symbol level 2 value. For PAM measurements.
EOH EOH1 EOH2	Returns the Horizontal Eye Opening at user-specified BER, for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
EOV EOV1 EOV2	Returns the Eye Opening at user-specified BER, for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
Jx Jx1 Jx2	Returns the Total jitter at the BER given by JxBER, for PAM eyes 0, 1, or 2.
Jy Jy1 Jy2	Returns the Total jitter at the BER given by JyBER, for PAM eyes 0, 1, or 2.
Level0	Returns the voltage of the lowest signal level. For PAM measurements.
Level1	Returns the voltage of the second signal level. For PAM measurements.
Level2	Returns the voltage of the third signal level. For PAM measurements.
Level3	Returns the voltage of the highest signal level. For PAM measurements.
LevelDeviation	Returns the level deviation. For PAM measurements.
LevelMismatch	Returns the level separation mismatch ratio. For PAM measurements.

Variable value name	Function
LevelPkPk0	Returns the peak-to-peak range of the measurements of Level0. For PAM measurements.
LevelPkPk1	Returns the peak-to-peak range of the measurements of Level1. For PAM measurements.
LevelPkPk2	Returns the peak-to-peak range of the measurements of Level2. For PAM measurements.
LevelPkPk3	Returns the peak-to-peak range of the measurements of Level3. For PAM measurements.
LevelStdDev0	Returns the standard deviation of the measurements of Level0. For PAM measurements.
LevelStdDev1	Returns the standard deviation of the measurements of Level1. For PAM measurements.
LevelStdDev2	Returns the standard deviation of the measurements of Level2. For PAM measurements.
LevelStdDev3	Returns the standard deviation of the measurements of Level3. For PAM measurements.
LevelThickness	Returns the level thickness. For PAM measurements.
LevelTimeDeviation	Returns the global measure of the level time deviation. For PAM measurements.
MaskBERLimit	Returns a number in the range 1e-24 to 1.0.
MaskBERMaskMargin	Returns the BER mask margin in the range -99.0 to +100.0.
MaskCenterPolygon	Returns the hit ratio in the range 0-1.
MaskDataDefined	Returns ("True" or "False") whether the mask test is defined.
MaskGlobalHitRatio	Returns the global hit ratio in the range 0-1.
MaskGlobalMaskMargin	Returns the mask margin in the range -99.0 to +100.0.
MaskHorizontalShift	Returns the mask shift in seconds.
MaskModulation	Returns "NRZ" or "PAM".
MaskOvershootPolygon	Returns the hit ratio in the range 0-1.
MaskPassFailStatus	Returns "Pass", "Fail" or "N/A"
MaskStandardName	Returns the standard for which the mask was defined.
MaskUndershootPolygon	Returns the hit ratio in the range 0-1.
MinSignalLevel	Returns the minimum signal level. For PAM measurements.
NoiseRMSHigh NoiseRMSHigh1 NoiseRMSHigh2	Returns the random noise measurement on level high for NRZ or PAM4 lower eye 0 (NoiseRMSHigh), PAM4 middle eye 1 (NoiseRMSHigh1), or PAM4 upper eye 2 (NoiseRMSHigh2)
NoiseRMSLow NoiseRMSLow1 NoiseRMSLow2	Returns the random noise measurement on level low for NRZ or PAM4 lower eye 0 (NoiseRMSLow), PAM4 middle eye 1 (NoiseRMSLow1), or PAM4 upper eye 2 (NoiseRMSLow2)
NPJDD NPJDD1 NPJDD2	Returns the non periodic jitter measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.

Variable value name	Function
NPNDD NPNDD1 NPNDD2	Returns the non periodic noise measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
OMA OMA1 OMA2	Returns the optical modulation amplitude in watts (for optical signals) for PAM eyes 0, 1, or 2. OMA is also valid for NRZ.
OMAOuter	Returns the global value of OMA (Optical Modulation Amplitude). For PAM measurements.
PJ PJ1 PJ2	Returns the measured Periodic Jitter (peak-to-peak) measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
PJH PJH1 PJH2	Returns the Horizontal component of periodic jitter (peak-to-peak) measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
PJV PJV1 PJV2	Returns the Vertical component of periodic jitter (peak-to-peak) induced by noise converted to jitter through an average slew rate, for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
PN PN1 PN2	Returns the measured periodic noise measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
PNH PNH1 PNH2	Returns the Horizontal component of periodic noise (peak-to-peak) induced by jitter converted to noise through an average slew rate, for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
PNV PNV1 PNV2	Returns the Vertical component of periodic noise (peak-to-peak) measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
RiseFallCountAB	Returns the number of transitions from A to B. For all Rise/Fall queries, A is the number of the starting level while B is the number of the ending level. A and B are different numbers chosen from {0,1} for NRZ and are different numbers chosen from {0,1,2,3} for PAM4.
RiseFallCVAB	Returns the Coefficient of Variation of transition times from A to B or -1 if not computable. For all Rise/Fall queries, A is the number of the starting level while B is the number of the ending level. A and B are different numbers chosen from {0,1} for NRZ and are different numbers chosen from {0,1,2,3} for PAM4.
RiseFallMaxAB	Returns the maximum of transition times from A to B or -1 if not computable. For all Rise/Fall queries, A is the number of the starting level while B is the number of the ending level. A and B are different numbers chosen from {0,1} for NRZ and are different numbers chosen from {0,1,2,3} for PAM4.
RiseFallMeanAB	Returns the mean transition time from A to B or -1 if not computable. For all Rise/Fall queries, A is the number of the starting level while B is the number of the ending level. A and B are different numbers chosen from {0,1} for NRZ and are different numbers chosen from {0,1,2,3} for PAM4.

Variable value name	Function
RiseFallMinAB	Returns the minimum of transition times from A to B or -1 if not computable.
	For all Rise/Fall queries, A is the number of the starting level while B is the number of the ending level. A and B are different numbers chosen from {0,1} for NRZ and are different numbers chosen from {0,1,2,3} for PAM4.
RiseFallStdDevAB	Returns the standard deviation of transition times from A to B or -1 if not computable.
	For all Rise/Fall queries, A is the number of the starting level while B is the number of the ending level. A and B are different numbers chosen from {0,1} for NRZ and are different numbers chosen from {0,1,2,3} for PAM4.
RJ RJ1 RJ2	Returns the measured random jitter (RMS) measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
RJDD RJDD1 RJDD2	Returns the Random Jitter computed in the Dual Dirac model measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
RJH RJH1 RJH2	Returns the Horizontal component of random jitter (RMS) measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
RJV RJV1 RJV2	Returns the Vertical component of random jitter induced by noise converted to jitter through an average slew rate (RMS), for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
RN RN1 RN2	Returns the measured Random Noise measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
RNH RNH1 RNH2	Returns the Horizontal component of random noise induced by jitter converted to noise through an average slew rate, for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
RNV RNV RNV2	Returns the Vertical component of random noise measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
SampleCount	Returns the total sample count acquired and processed while running.
SamplingPhaseEff SamplingPhaseEff1 SamplingPhaseEff2	Returns the effective value of the sampling phase, either the value entered by the user or the value computed by the Optimizer, depending on whether the Optimizer is both enabled and successful.
SSCfreq	Returns the spread spectrum clock modulation frequency.
SSCmag	Returns the spread spectrum clock modulation magnitude.
TimeDeviation	Returns the time deviation.
TJ TJ1 TJ2	Returns the Total Jitter at user-specified BER measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.
TN TN1 TN2	Returns the Total Noise at user-specified BER measurement for eye 0 (NRZ eye or bottom eye for PAM) or PAM eyes 1 or 2.

Variable value name	Function
VerticalEyeClosure	Returns the vertical eye closure. For PAM measurements.
VMA VMA1 MVA2	Returns the voltage modulation amplitude in volts (for electrical signals) for PAM eyes 0,1, or 2. VMA is also valid for NRZ.
VMAOuter	Returns the global value of VMA (Voltage Modulation Amplitude). For PAM measurements.

GPIB commands error codes

Error code	Description
−1	Read error message, no error code available
	NOTE. *If an error code of −1 is returned, use the Error Message query for error condition details.*
1	The channel does not support bandwidth
2	Phase characterization failed
3	No data to export
4	Not allowed to change setting while sequencing
5	Invalid value
6	Argument cannot be null
7	Value is outside the range of acceptable values
8	Query curve returned no data
9	Unexpected GPIB response
10	No data source selected
11	One or more WfmDBs are on; turn them off to continue
12	Trigger failure, check your configuration
13	The pattern is not synchronized or is too small
14	Cannot export the curve
15	Could not analyze edge
16	Histogram testing is on; turn it off to continue
17	Mask testing is on; turn it off to continue
18	One or more measurements are on; turn them off to continue
19	Waveforms other than 80SJNB signal source are on; turn them off to continue
20	Save setup failed
21	Recall setup failed
22	The channel does not support wavelength
23	Curve has multiple components
24	A Mag View is on; turn it off to continue
25	SSC activation failed; phase reference module required
26	SSC activation failed; setup phase reference module
27	Save data failed
28	Recall data failed

Programming examples introduction

An example of communicating with the 80SJNB application using VARIABLE:VALUE remote GPIB commands is to simply start the application by sending the following command:

```
APPlication:ACTivate "80SJNB"
```

A more extensive program example steps you through the following actions:

1. Starting the application.

2. Configuration and setting analysis state variables.

3. Starting and checking the state of the acquisition and processing cycle.

4. Check for errors.

5. Query measurement results.

6. Export data.

Program examples:

Configure and Operate the 80SJNB (see page 117)

Measuring Jitter in Presence of SSC (see page 119)

Compensating for Signal Path Impairments with Equalization (see page 121)

See also:

About the GPIB Program and Guidelines (see page 95)

GPIB Reference Materials (see page 95)

Variable:Value Command (see page 98)

Results Queries (see page 110)

Program example: configure and operate 80SJNB

The following sequence of commands shows the GPIB commands used to configure and operate the 80SJNB jitter analysis application. All commands are sent to the instrument which hosts the programmable interface for the 80SJNB.

NOTE. *The examples presume that you are familiar with designing GPIB programs.*

All words within quotes are case sensitive and must be entered exactly as shown, including spaces and quotes.

1. Send the command to start the 80SJNB application.

```
APPLICATION:ACTIVATE "80SJNB"
```

2. Set the signal source channel, data rate, and pattern length to be analyzed.

```
VARIABLE:VALUE "DataSource","CH1"

VARIABLE:VALUE "DataRate","10.3125e9"

VARIABLE:VALUE "PatternLength","32767"
```

3. Set the following variables before starting the analysis. The application updates these values to signal the application's analysis state.

```
VARIABLE:VALUE "DataReady","False"

VARIABLE:VALUE "ErrorCode",""
```

4. Start the acquisition and processing cycle.

```
VARIABLE:VALUE "SequencerState","Run"
```

5. Check the state of the acquisition and processing cycle.

    Query the following variables:

```
VARIABLE:VALUE? "DataReady"

VARIABLE:VALUE? "SequencerState"
```

    Loop until DataReady is True or SequencerState is Stop.

6. Check to see if there were errors.

```
VARIABLE:VALUE? "ErrorCode"
```

    If the response for ErrorCode is not 0 then an error has occurred. Query

```
VARIABLE:VALUE? "ErrorMessage"
```

    to retrieve the error message.

7. If the DataReady variable is set to True (queried in step 5), you can query for measurement results. For example to query the deterministic jitter:

```
VARIABLE:VALUE? "DJ"
```

8. You can also export the plot data. The following commands set the format, data to export, file name, and then exports the data.

```
VARIABLE:VALUE "ExportFormat","CSV"

VARIABLE:VALUE "ExportType","DJPDF"

VARIABLE:VALUE "ExportFilename","C:\Users\<username>\Documents\
myDJPDF.csv"

VARIABLE:VALUE "ExportCurve","GO"
```

9. Query the ExportCurve variable to determine when the data export has completed:

```
VARIABLE:VALUE? "ExportCurve"
```

The application sets the ExportCurve value to "Done" when the data is exported.

Program examples:

Program example: measuring jitter in presence of SSC

The following instruction sequence shows jitter analysis in the presence of SSC and the measurement of the SSC characteristics.

NOTE. *The examples presume that you are familiar with designing GPIB programs.*

All words within quotes are case sensitive and must be entered exactly as shown, including spaces and quotes.

NOTE. *The measurement system configuration should include a correctly set up and configured Tektronix BERTScope CR series instrument (clock recovery instrument, or CRI) that supports SSC.*

A Tektronix 82A04 or 82A04B Phase Reference module is required for measuring signals that contain SSC.

1. Send the command to start the 80SJNB application.

   `APPLICATION:ACTIVATE "80SJNB"`

2. Set the signal source channel, data rate, pattern length, and data-to-clock ratio

   `VARIABLE:VALUE "DataSource","CH1"`

   `VARIABLE:VALUE "DataRate","3e9"`

   `VARIABLE:VALUE "PatternLength","127"`

3. Initialize analysis state and error code.

   `VARIABLE:VALUE "DataReady","False"`

   `VARIABLE:VALUE "ErrorCode",""`

4. Tell 80SJNB to look for SSC.

   `VARIABLE:VALUE "SSC","True"`

5. Set up the phase reference module source and frequency since it is required for SSC analysis

   `VARIABLE:VALUE "PhaseReferenceSource","C7_C8"`

   `VARIABLE:VALUE "PhaseReferenceFrequency","3e9"`

6. Set up the BERTScope clock recovery unit that supports SSC. Set clock frequency to **3e9**. Refer to the documentation for the BERTScope for more details.

The following table lists recommended settings:

Data rate range	Clock recovery frequency (CRI)	Clock recovery output rate (CRI)	Recommended Data:Clock ratio (JNB)	Phase reference frequency (JNB)
500 Mbps – 1 Gbps	Data Rate * 4	Standard	1:4	Data Rate * 4
1 Gbps – 2 Gbps	Data Rate * 2	Standard	1:2	Data Rate * 2
2 Gbps – 4 Gbps	Data Rate	Standard	1:1	Data Rate
4 Gbps – 8 Gbps	Data Rate	Subrate (1/2)	2:1	Data Rate/2
8 Gbps – 12.5 Gbps	Data Rate	Subrate (1/4)	4:1	Data Rate/4

7. Clear the error code to prepare for starting the application.

`VARIABLE:VALUE "ErrorCode",""`

8. Start the acquisition and processing cycle.

`VARIABLE:VALUE "SequencerState","Run"`

9. Check the state of the acquisition and processing cycle. Query the following variables:

`VARIABLE:VALUE? "DataReady"`

`VARIABLE:VALUE? "SequencerState"`

Loop until DataRead is True or SequencerState is Stop.

10. Check if there were errors:

`VARIABLE:VALUE? "ErrorCode"`

If the response for ErrorCode is not 0, then an error has occurred. Query:

`VARIABLE:VALUE? "ErrorMessage"`

11. If the DataReady variable is set to True, and no errors have occurred, you can query for measurement results.

For example to query the periodic jitter and total jitter:

`VARIABLE:VALUE? "PJ"`

`VARIABLE:VALUE? "TJ"`

12. Query for SSC measurements, magnitude and frequency.

`VARIABLE:VALUE? "SSCmag"`

`VARIABLE:VALUE? "SSCfreq"`

13. You can also export the SSC profile. The following commands set the format, data to export, file name, and then export the data.

`VARIABLE:VALUE "ExportFormat","CSV"`

`VARIABLE:VALUE "ExportType"," SSCPROFILE "`

```
VARIABLE:VALUE "ExportFilename","C:\Users\<username>\Documents\
mySSCprofile.csv"
```

```
VARIABLE:VALUE "ExportCurve","GO"
```

14. Query the ExportCurve variable to determine when the data export has completed.

```
VARIABLE:VALUE? "ExportCurve"
```

The application sets the ExportCurve value to "Done" when the data is exported.

Program examples:

Program example: compensating for signal path impairments with equalization

The following programming example shows a sequence of commands that configures the Signal Path with a Channel emulator that causes severe ISI. Then an Equalizer is inserted and configured to compensate for the effects of the ISI and assess the results of equalization by measuring data dependent jitter and vertical eye opening.

NOTE. *The examples presume that you are familiar with designing GPIB programs.*

All words within quotes are case sensitive and must be entered exactly as shown, including spaces and quotes.

NOTE. *The 80SJNB Advanced option must be enabled. The S-parameter file is available from examples, Sdd21.s1p, located in My Documents.*

1. Send the command to start the 80SJNB application.

```
APPLICATION:ACTIVATE "80SJNB"
```

2. Set the signal source channel, data rate, pattern length, and data-to-clock ratio.

```
VARIABLE:VALUE "DataSource","CH1"
```

```
VARIABLE:VALUE "DataRate","9.95328e9"
```

```
VARIABLE:VALUE "PatternLength","127"
```

3. Initialize the analysis state and error code.

```
VARIABLE:VALUE "DataReady","False"
```

```
VARIABLE:VALUE "ErrorCode",""
```

4. Start the acquisition and processing cycle.

    ```
    VARIABLE:VALUE "SequencerState","Run"
    ```

5. Check the state of the acquisition and processing cycle.

    Query the following variables:

    ```
    VARIABLE:VALUE? "DataReady"
    ```

    ```
    VARIABLE:VALUE? "SequencerState"
    ```

    Loop until DataRead is True or SequencerState is Stop.

6. Check if there were errors.

    ```
    VARIABLE:VALUE? "ErrorCode"
    ```

    If the response for ErrorCode is not 0, then an error has occurred. Query:

    ```
    VARIABLE:VALUE? "ErrorMessage"
    ```

7. If the DataReady variable is set to True and no error has occurred, you can query for measurement results. Query the data dependent jitter and vertical eye opening:

    ```
    VARIABLE:VALUE? "DDJ"
    ```

    ```
    VARIABLE:VALUE? "EOV"
    ```

8. Select an S-parameter file from the examples provided, and insert the Channel emulator into the Signal Path.

    ```
    VARIABLE:VALUE "CeDomain","Frequency"
    ```

    ```
    VARIABLE:VALUE "CeFdSParametersFile"," C:\Users\<username>\
    Documents\Sdd21.s1p"
    ```

    ```
    VARIABLE:VALUE "CeActive","True"
    ```

9. Recompute the Signal Path and measure DDJ and vertical eye opening again.

    ```
    VARIABLE:VALUE "SpCompute","Run"
    ```

    Wait and query the recomputation state for completion. When completed, SpCompute query will return Done, unless an error is encountered, in which case state will return Error.

    ```
    VARIABLE:VALUE? "SpCompute"
    ```

    ```
    VARIABLE:VALUE? "DDJ"
    ```

    ```
    VARIABLE:VALUE? "EOV"
    ```

NOTE. *Note the values of DDJ and EOV.*

---

10. Compute an optimal set of tap coefficients for a specified number of FFE and DFE taps by running Autoset Taps.

`VARIABLE:VALUE "EqFFETaps","20"`

`VARIABLE:VALUE "EqDFETaps","10"`

`VARIABLE:VALUE "EqAutosetTaps","Run"`

Test for completion by querying the state of autoset. It will return Run before completion, then Done or Error. If data is not recognized as a PRBS pattern, an error condition is returned.

`VARIABLE:VALUE? "EqAutosetTaps"`

11. Save the taps in a file.

`VARIABLE:VALUE "EqTapsFilename","C:\Users\<user name>\Documents\myTaps.tap"`

`VARIABLE:VALUE "EqSaveTaps","Run"`

Check for completion by querying:

`VARIABLE:VALUE? "EqSaveTaps"`

12. Insert the Equalizer in the Signal Path with the newly configured equalization taps.

`VARIABLE:VALUE "EqActive","True"`

13. Recompute the Signal Path again with the Equalizer inserted.

`VARIABLE:VALUE "SpCompute","Run"`

Wait and query the recomputation state for completion. When completed, query SpCompute until it is not Run. Then check to see if the result is Done or Error.

`VARIABLE:VALUE? "SpCompute"`

14. If SpCompute query is Done, ask for measurement results.

`VARIABLE:VALUE? "DDJ"`

`VARIABLE:VALUE? "EOV"`

NOTE. *Record the values of DDJ and EOV and compare with the previous two sets, looking for the effects of the Channel and the Equalizer.*

Program examples:

About measurement algorithms

Tektronix has developed a white paper detailing the algorithms used by the 80SJNB application to make the measurements. To download the document:

1. Go to the Tektronix Web site www.tektronix.com .

2. Enter "Jitter and Noise Analysis" in the Downloads **Enter Model Number** field.

3. Click **GO**.

Test methodology

The application performs the measurement according to the following steps:

1. Configures the oscilloscope and jitter application according to the Configuration settings and Analysis settings.

2. Performs an Autoset.

3. Scans part of the pattern.

4. Analyzes the edge.

5. Acquires the jitter data.

6. Acquires the noise data.

7. Scans the full pattern.

8. Analyzes the acquired data.

9. Displays the results as statistics. You can also log the results or data points to a .csv file.

10. Displays the plots if selected.

Correlation to real-time oscilloscope jitter measurements

Recent correlation studies are available upon request. Please contact your Tektronix Customer Support representative for more information. Jitter measurement and timing analysis information is available at www.tek.com (enter jitter in the **Enter Model Number** field, and select **Application Notes** as the document type).

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Index

Symbols and Numbers

80A06 PatternSync Trigger module, 7
80SJNB application description, 7

A

Accessories, 8
Acquiring Data, 29
Acquisition, 24
Acquisition Menu, 29
Acquisition Settings, 88
Algorithms, 125
Analysis Button, 24
Analysis Settings, 52
Analysis Setup, 28
Application Directory, 16
Application Example, 81
Application Parameters, 87
Area Definition, 22
Arguments and Queries, 99
Autoset Taps, 50
AutoSync, 29

B

Back Button, 5
Basic Operations, 13
Bit Error Rate, 52
.BMP File, 17
Box Definition, 22
Browse Definition, 22

C

Channel, 42
Channel Conditions, 42
Check Box Definition, 22
Clear Data, 24
Clearing, 21
Clock Recovery, 33
Command Syntax, 98
Commands, 99
Configuration, 29

Configuration Requirements
   SSC, 39
Configuration Settings, 88
   SSC, 39
Configure, 24
Conventions, 4
Copy Plot Image, 69
Correlation to Real-Time
   Oscilloscope, 127
.CSV (measurement results), 71
.CSV (plot/graph data), 71
.CSV (waveforms), 70
.CSV File, 17

D

Data Files, 65
Data Pattern, 35
Data Rate, 35
Decision Threshold, 56
Deskew, 9
Deskewing Probes, 9
Device Under Test, 8
DFE Taps, 49
Directory Structure, 16
Displaying Measurements, 58
Documentation, 3
DUT, 8
DUT Definition, 4

E

Equalizer, 40
Equalizer Taps, 48
Erase, 63
Error Codes, 116
Examine, 68
Example Application, 82
Example Program, 116
Exiting, 16
Exiting the Application, 16
Export Directory, 16
Export graph/plot data, 71
Export measurement results, 71
Export Waveform, 70

Export waveform data, 70
Exporting Plot Images, 69
Exporting Plot Information, 70
Extensions, file, 17
Eye Plots
   BER Contour, 73
   BER Eye, 73
   Correlated Eye, 73
   PDF Eyes, 73
   Q Eye, 73
   SP Channel (PDF Eye), 73
   SP Filter (PDF Eye), 73
   SP In (PDF Eye), 73
   SP Receiver (PDF Eye), 73

F

Features, 1
Feedback, 6
FFE Taps, 48
File Menus, 18
File Names, 17
File structure, mask (XML), 90
File Types, 17
Filter, 40
Filter Conditions, 41
Filter Files, 41
Filters, 50
.FLT File, 17
Free Run, 63
Frequency Domain, 42

G

Gaussian Filter, 50
GPIB, 116
GPIB Commands, 95
GPIB Commands Error
   Codes, 116
GPIB Guidelines, 95
GPIB Information, 3
GPIB Program, 95
GPIB Program Examples, 119
GPIB Programs, 117
GPIB Reference Materials, 95