The Measurement Tools and What They Do

JITTERWIZARD

The JitterWizard is a unique capability of the JitterPro package that performs the requisite scope setup chores while simplifying measurement procedures to a few menu selections or button pushes. When JitterWizard is engaged, the oscilloscope becomes a dedicated jitter analyzer. JitterWizard eases setup and operation of jitter measurement and maximizes the accuracy of the scope.

A quick setup tool that performs most setup functions automatically and allows you to customize them, JitterWizard may also be used for other types of analysis.

While JitterWizard is engaged, only two of the scope's front panel knobs will function: PRINT SCREEN (or SCREEN DUMP) and CLEAR SWEEPS. In this way JitterWizard maintains jitter measurement settings and runs the scope using the preferences selected for jitter analysis.

Note	**Always select how you wish to record your test results from PRINT SCREEN (or SCREEN DUMP) before engaging JitterWizard. Press UTILITIES, HARDCOPY SETUP to select what the PRINT SCREEN button will do.**

Before starting your measurements, use the Measurement or View Inputs Signal to verify that your signal is live and being seen properly by the scope. If the signal does not appear satisfactory, exit JitterWizard (by pressing RETURN three times) and correct it before you reenter the JitterWizard.

Hysteresis:
All JTA parameters and Jitter math functions use hysteresis in detecting crossings of a specified level. Hysteresis is the extra distance that the signal must go beyond threshold level before a crossing in the opposite direction will be recognized, improving the system immunity to noise,

By default, (which can be restored at any time from PANEL SETUP, Recall FROM DEFAULT SETUP) JTA parameters use one division of hysteresis, while Jitter math functions use half a division of hysteresis.

The default hysteresis setting is appropriate for most signals. In case of extremely noisy signals, it is possible to set the hysteresis value for all JTA parameters and Jitter math functions from UTILITIES, Special Modes, Cursors Measure. Set "Global JTA hysteresis control" to "Yes," then select 0.5, 1, 2, or 5 divisions, as needed.

***Note:** the hysteresis for all JTA parameters and Jitter math functions is set when the global value is first displayed and, thereafter, whenever it is changed. The hysteresis for each parameter or math function can be modified individually by remote commands.

Pressing "FIND LEVEL" sets the hysteresis for that parameter or math function if "Global JTA hysteresis control" is set to "NO" (the default), or for all JTA parameters and Jitter math functions if "Global JTA hysteresis control" is set to "YES." The hysteresis is set to either 0.5, 1, 2, or 5 divisions, based on the signal's amplitude, and on whether it appears to be a two- or three-level signal.

Figure 2.1. Setup/View Inputs menu in JitterWizard

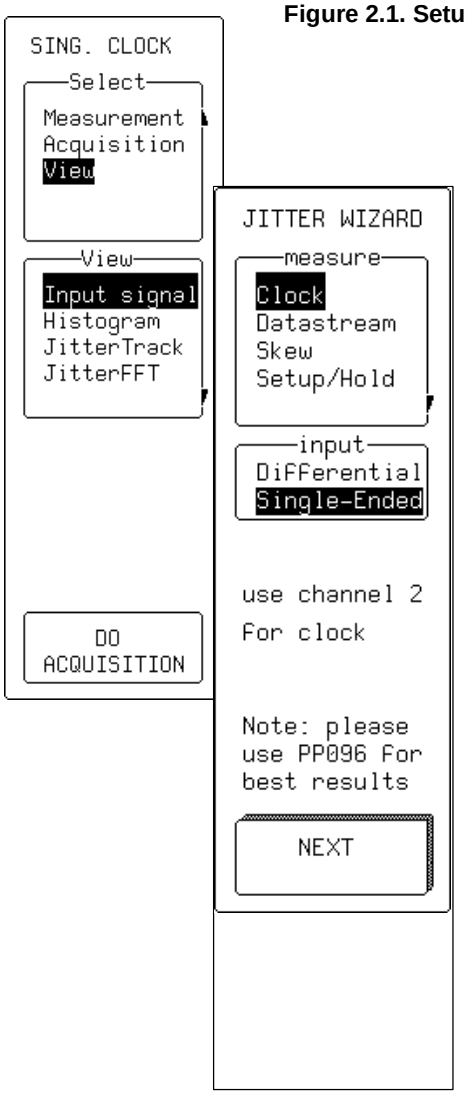
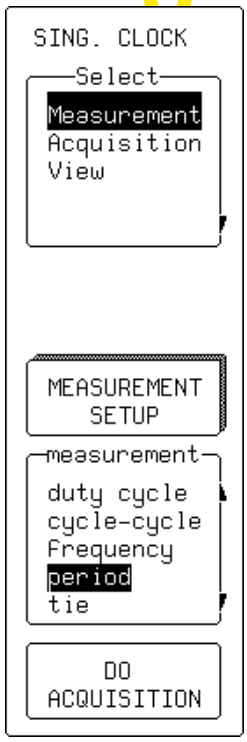


Figure 2-2. JitterWizard input and measure menus

Note	Because **Setup/View Inputs** captures a new signal, it should **only** be activated **before initiating measurements.**



From the “measure” menu, JitterWizard allows the following measurement types:

- **Clock** (single clock line)
- **Datastream** (telecom, datacom signals)
- **Skew** (skew-type measurement on two clock instruments or on identical data streams on different pins)
- **Setup/Hold** (data-clock relationship)

If you have a single line coming into the scope, or are using a differential probe, select **Single-Ended** from the “input” menu. For two lines going into the scope, choose **Differential**.

For each of the four measurement types, instructions are given on-screen for how to connect your inputs to the scope. For example, when you select **Setup/Hold** from the “measure” menu, you will be instructed to use Channel 2 for the clock reference and Channel 3 for data.

Figure 2-3. JitterWizard select and measurement menus, MEASUREMENT SETUP and DO ACQUISITION buttons

Note	For skew-type measurements, use Channel 2 for the clock reference and Channel 3 for the second clock. The reference clock must be of equal or higher frequency than Clock Two. If it is not, make Clock Two the reference clock.

- **Clock and Datastream,** from the original measure menu, take you to **select**, which offers three choices:
  - **Measurement**
  - **Acquisition**
  - **View**

  Measurement takes you to the “measurement “menu, where you can select the measurement parameter to be used. For **Clock**, these include:
    - **duty cycle**
    - **cycle-cycle**
    - **frequency**
    - **period**
    - **tie (time interval error)**
    - **width**

Note	When you first open JitterWizard, default settings are in place. When you exit, your current preferences are automatically saved.

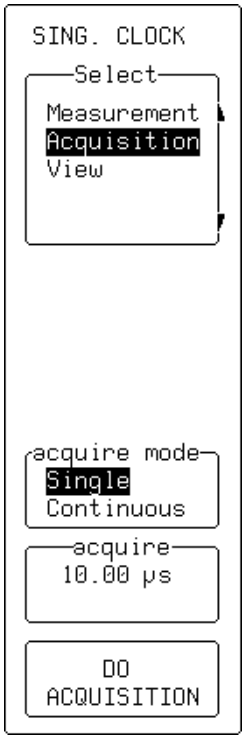
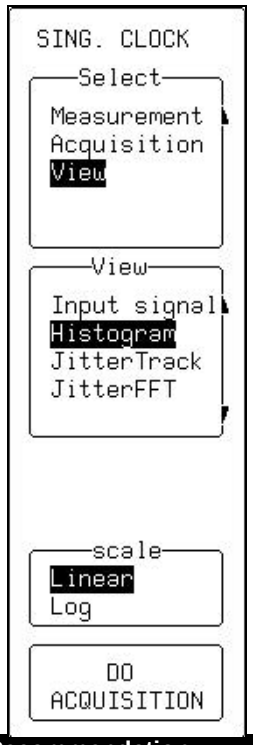


Figure. 2-4. JitterWizard Acquisition menu



To set the level, select **MEASUREMENT SETUP**. Set the **mV** level, and select **Pos** or **Neg** edge. (Cycle-Cycle and TIE have additional settings for this parameter.) Two-signal functions such as setup, hold, and skew allow you to set level and polarity for each signal. (Polarity can be set to Pos, Neg, or Both). Acquire the signal by selecting the **DO ACQUISITION** button to the right of the screen. Due to its large data acquisition duration and maximum sample rates based on long memory length, your LeCroy scope with JitterPro produces very accurate results and is easy to use.

About 20-30 seconds is as long a wait as you will encounter for a maximum acquisition. Whether you choose **SINGLE** or **CONTINUOUS** from the **acquire mode** menu, every acquisition brings more values into the histogram until **CLEAR SWEEPS** is pressed. For very high statistics, select Continuous mode.

Figure 2-5. View menu in JitterWizard

Recommendation:	**Your LeCroy scope can produce very complete histograms, so set maximum values — 1 ms or as high as your scope is capable.**

Note on Wizard Defaults:	Trigger is automatically set to be an edge trigger on Channel 2, and channel coupling is set to 50 Ohms.

View provides access to fast and accurate circuit debugging. Selections from the "View menu include:

- **Input Signal**
- **Histogram**
- **JitterTrack**
- **JitterFFT**

InputSignal is viewed to verify that the signal is live and being received properly by the scope. **Histogram** and **JitterTrack,** common to both JITTERPRO and JTA packages, are described under "Timing Functions" later on in this chapter. **JitterFFT** is the FFT of JitterTrack. This provides a spectral view of frequency that isolates jitter from the rest of the signal to give an accurate picture of the problem. By determining and correcting the causes of timing variation at observed spectral values, peak-to-peak jitter can be substantially lowered.

Note	*JitterFFT* uses lots of processor memory. JitterWizard may instruct you to shorten your acquisition duration.

To complete Histogram View setup, select **Linear** or **Log** from the "scale" menu.

Note	JitterWizard is set up so that you can do another signal acquisition (**DO ACQUISITION**) from anywhere within the program.

When either **JitterTrack** or **JitterFFT** is selected from the "view" menu, the **ZOOM TO CURSOR** and **cursor position** button will appear on the screen. Adjust the scope knob to the right of the screen to position the cursor at any point on the JitterTrack or JitterFFT view. The horizontal zoom and position knobs are active in these views. Also, the zoom RESET button is enabled for JitterTrack. While zooming makes the positioning of cursor easier, **Zoom to cursor** allows a fast and easy view of the cursor area. Read-out below the screen view gives the average value and time value spacing of modulation or timing events. Vertical and horizontal scale per division are given in the upper left corner of the screen. Using this feature, you can measure individual bins in the FFT view.

Recommendations:	**LeCroy recommends using the longest possible acquisition length for JitterFFT so that the resulting FFT view has the best frequency resolution. Also, at this point, you may wish to exit JitterWizard in order to use the scope controls to compare the JitterTrack or JitterFFT view with other signals in the system.**

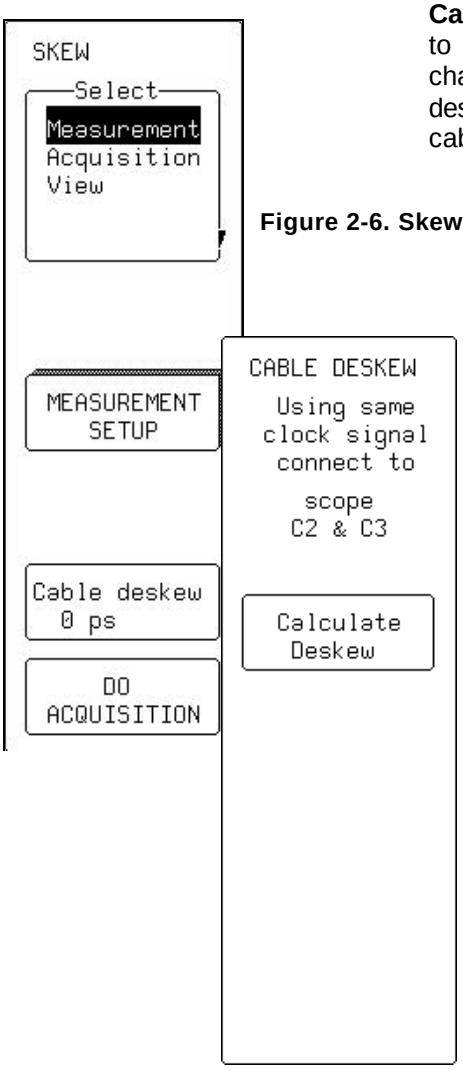
- **Skew** measurement is the next step after completing clock and datastream measurements. Skew indicates the time variation between two clocks.

Note	The two clock frequencies must be an *n* integer multiple relationship.

Recommendation:	**Reference Clock should be of equal or higher frequency than Second Clock. If this is not the case, reverse the order of the clocks and call the Second Clock the Reference Clock.**

Push the **MEASUREMENT SETUP** button to select (signal crossing) **level** and **neg** or **pos** edges.

Note	Perform a new acquisition immediately after resetting Acquisition.



Cable Deskew adjusts for the channel delay differences due to variations in cable length or in individual oscilloscope channels. Press the **Cable Deskew** button to calculate the deskew value. Check results from the same segment of both cables and zero it out.

Figure 2-6. Skew measurement selections in JitterWizard

Figure 2.7. Cable Deskew selections in JitterWizard

Setup/Hold measurements ensure that data will store properly by testing the relationship between data changes and clock edges, and verifying that sufficient space exists between them.

Push the **MEASUREMENT SETUP** button to select (threshold crossing) level and neg or pos edges.

Note	For maximum accuracy, set input signals at close to full scale and use the maximum sample rate. To do this, press the **SET INPUT TO MAX AMPL** button.

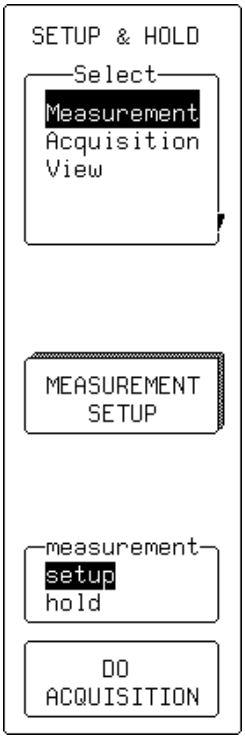


Figure 2-8. Setup/Hold selections in JitterWizard

Note: Leaving the JitterWizard	You can exit the wizard from anywhere in JitterWizard by pressing **RETURN** three times. On exiting, you have the choice to revert to the setup in use before you entered the Wizard, or to continue outside the Wizard with the setup established by it.

CCTM Wizard

This feature is unique to the clock certification test module (CCTM) add-on for JitterPro. It performs the scope setup chores for clock chip verification, and simplifies measurement procedures to a few menu selections and button pushes. *CCTM Wizard* is used specifically for clock certification for Rambus® compatible clock sources and generators. When *CCTM Wizard* is engaged, the oscilloscope becomes a dedicated Direct Rambus Clock Generator (DRCG®) test module. *CCTM Wizard* makes setup and performance of the complete suite of validation tests quick and easy while maximizing the accuracy of the scope.

A key feature of the CCTM package is its ability to capture long, continuous data records and to measure the distribution and full range of signal jitter during that capture window. This eliminates the effect of trigger jitter, since the position and width of each pulse can be determined relative to the other pulses in the signal (without any effect on, or reference to, the trigger edge). Since the signal (up to several hundred thousand pulses) is continuously recorded, there is zero dead-time during the capture window.

Note	Rambus validation requires that all necessary measurements be made on the same captured signal. Once a signal is captured, complete all test parameters before triggering a new acquisition.

The LeCroy Clock Certification Test Module (CCTM) has been designated by Rambus as the sole method for certification of jitter measurements. Because of the long memory of LeCroy scopes, signals are captured at durations sufficient to meet **at least** the minimum set by Rambus (10 000 clock cycles).

Note	The alternate choice for number of clock cycles is “max # cycles”, which acquires as long a record as possible. In general, peak-to-peak jitter (range) measurements are higher when more cycles are measured, since there is a greater chance that a rare outlier in the distribution occurred during the longer acquisition. The longer the tails of the distribution the more significant this is. "max # cycles" is a good way to see if the distribution was bounded, and if range was correctly characterized in the 10 kcycles testing mode. If range is significantly greater at "max # cycles" remember that, although it is unlikely, a range this great or even more could possibly be observed

	in a 10 kcycle acquisition. If range is not significantly greater at "max # cycles" then the jitter distribution is probably bounded, that is it does not have long tails of unlikely values.
Note	Before activating the *CCTM Wizard*, determine how you wish to record your test results. Set your LeCroy scope to print to: internal printer, external printer, or floppy disk. During testing procedures, the SCREEN DUMP button will enable you to record results from *CCTM Wizard*. All other front panel buttons (except CLEAR SWEEPS) will be inactive until you exit from *CCTM Wizard*.

The *CCTM Wizard* feature of this application module saves time and steps because setup is automatic. Once *CCTM Wizard* has set up the parameters for clock chip verification, a few simple button pushes complete the measurements necessary for jitter testing.

- **Application Setup** is completed by engaging the *CCTM Wizard* feature, verifying live signal capture, choosing the required measurements, interpreting and recording the values obtained. By the time you reach the third menu, *CCTM Wizard* has pre-set the parameters for Rambus validation. Of course, none of the other front panel buttons on the scope (except SCREEN DUMP and CLEAR SWEEPS) will respond until you exit *CCTM Wizard*.
  - Push the **ANALYSIS PACKAGES** on the WavePro DSO (or **CURSORS/MEASURE** button located on the LeCroy scope front panel immediately to the right of the screen.
  - On the next screen, select **CCTM Wizard**.

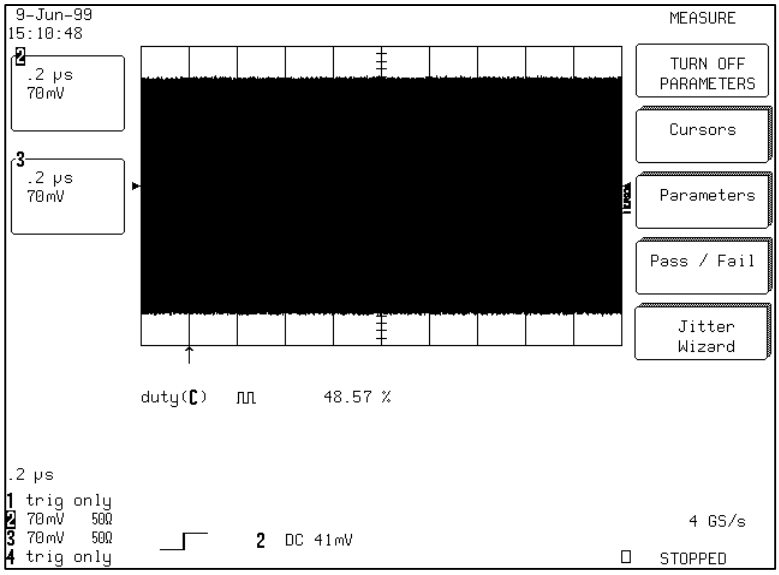


Figure 2-9. *CCTM Wizard* menu

- On the next screen, select **Differential Inputs**. This module allows a choice of **Differential Inputs** for differential clocks and **Single-Ended Input** for single-ended clocks. To perform Rambus validation, **use only differential signals**. *CCTM Wizard* will automatically set up to perform the jitter testing measurements.

- Before beginning measurements, use **Setup/View Inputs** to verify if your signal is live and being seen properly by the scope. Adjust until the signal looks clean. If the signal does not respond satisfactorily, press **RETURN** to go back to the previous menu.

Note	Please note that **SETUP/VIEW INPUTS** captures a new signal. It should only be activated **before** initiating measurements.

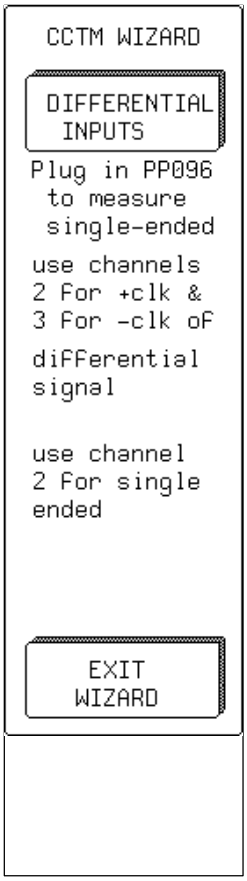


Figure 2-10. Differential Inputs

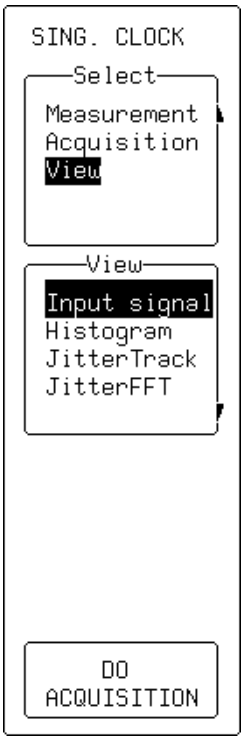


Figure. 2-11. Verify Signal with SETUP/VIEW INPUTS button

Measurement settings are selected from the **Using** and **Parameter** submenus.

- **"Using" is set to "10k cycles" for testing. Use the button to the right of the menu field to toggle between "10 kcycles" and "max # cycles."**
- **Use the button to the right of the** Parameter submenu to select the measurement to be made: Period, Cycle-to-Cycle, or ? Width.

➢ **Required measurements** for Rambus validation include the following. (As you make each measurement, you can record your findings by pressing **SCREEN DUMP**. You should make your choice of internal printer, external printer, or floppy disk **before** entering *CCTM Wizard*.)

- Select **Period** from the "Parameter" submenu. Interpret and record your measurement.
- Rambus validation requires **n-cycle** measurement of the captured signal. Select **Cycle-Cycle** from the "Parameter" submenu. Interpret and record.
- To display **cycle-to-cycle** jitter, select number of cycles to measure from the "Cycles" submenu. Cycle settings of 1-8 are available. (Rambus requires measurements up to 6 cycles).
- **Duty cycle error** is also a Rambus validation requirement. To obtain this measurement, select D**Width** from the "Parameter" submenu, interpret and record your measurement. D**Width** presents the times of positive or negative pulses; use the knob to right of the screen to move the cursor to select points on the histogram for comparison.
- Set threshold crossing **level** from the "Level" submenu. Rambus requires a mid-level setting; therefore, the *CCTM Wizard* default setting is 0 mV. To measure the times between the positive (rising) edges of the signal, select **Pos**. For times between negative (falling) edges, select **Neg**.

Note	Because Rambus requires that measurements be done on one signal, **do not use** the DO MEASUREMENT button, as that causes the scope to make a new signal acquisition. **Reminder:** SETUP/VIEW also triggers a new acquisition.

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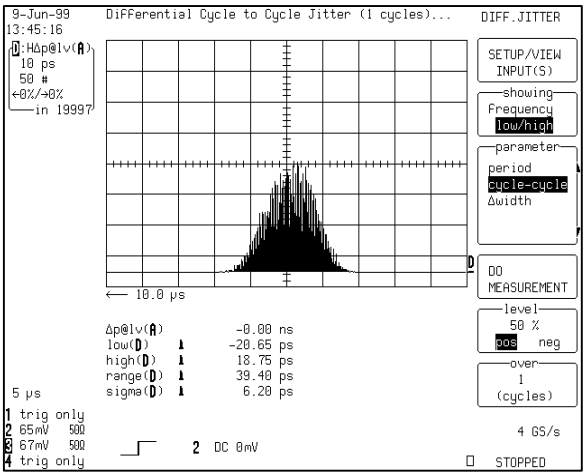


Figure 2-12. Period Low-High

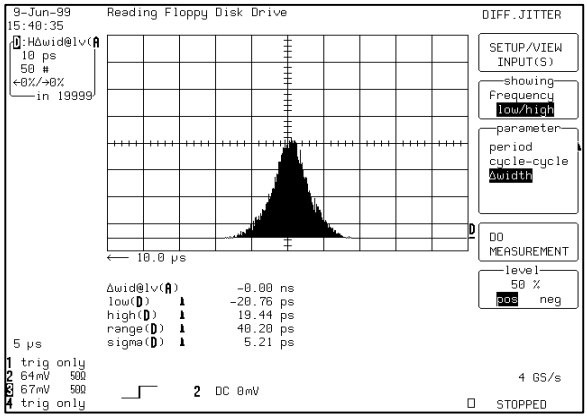


Figure 2-13. Cycle-to-Cycle

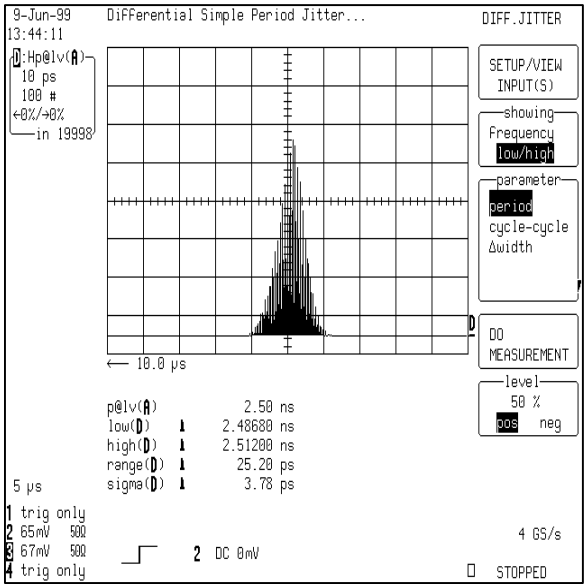


Figure 2-14. ? Width

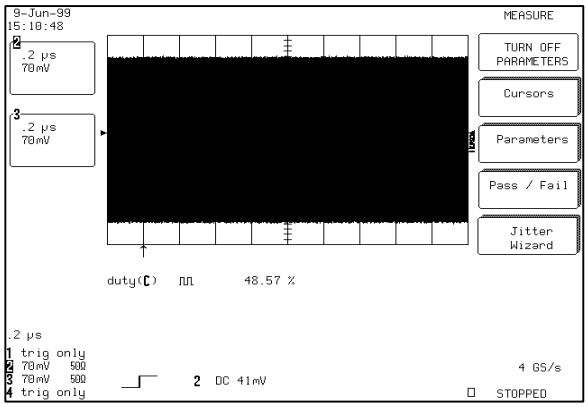


Figure 2-15. Avoid new acquisition

- **Interpreting Measurements** is assisted by a display of the results below the histogram and in the upper left-hand corner of the screen.
  - Below the histogram, the top line of the parameter read-out represents the average value of the jitter measure performed. **Frequency** is a separate measurement. **Low**, **High**, **Range**, and **Sigma** are characteristics of the performed measurement. **Range** is a peak-to-peak value equal to high minus low. Sigma is a property of the jitter distribution. Unlike low, high and range, it should not be significantly affected by changing "10 kcycles" to "max # cycles."
  - The upper left-hand corner of this screen contains information about the histogram itself: number of events recorded, bandwidth for horizontal accuracy, number of events per vertical division, and any events occurring outside the histogram.*

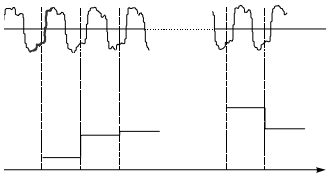
- **Recording Values** is accomplished by pressing the SCREEN DUMP button. Screens may be printed on the scope's internal printer, on an external printer, or saved onto a floppy drive. (Choose your recording medium before entering *CCTM Wizard*.)

- **Measuring Next Frequency** is accomplished by pressing the RETURN button and starting the validation procedure again from Fig. 2.1.

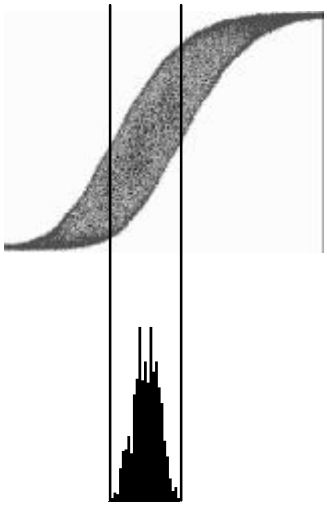
- **Exiting *CCTM WIZARD*** is accomplished by pressing the RETURN button, then selecting **Exit Wizard**. Pressing the RETURN button again will also exit the Wizard.

* *CCTM Wizard* automatically calculates and sets up the histogram such that there will be no events outside the histogram.

Timing Functions



***JitterTrack*ä , *PersistenceHistogram* and *PersistenceTrace* are timing functions in LeCroy's JITTERPRO and JTA jitter and timing analysis packages. The *JitterTrack* feature is key to identifying the source of excessive jitter or non-normal jitter characteristics. A timeline of signal jitter that is synchronous with the signal under test allows you to view patterns that would remain invisible using other systems, zoom to areas containing maximum jitter, and troubleshoot the problem. *PersistenceHistogram* is the ideal quantitative "companion" to persistence display. It histograms a horizontal or vertical slice of the persistence waveform. Utilizing *average*, *sigma,* and *range* settings, *PersistenceTrace* computes a vector trace from a bit map to give insight into edge details down to a few picoseconds.**



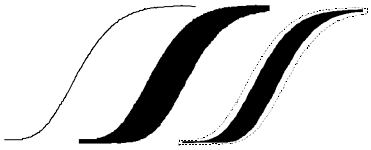
- **JitterTrack** graphically plots as a function of time the amplitude of the waveform attributes **Cycle-to-Cycle** variation, **Duty Cycle**, **Interval Error**, **Period**, **Width**, and **Frequency**.

  Interval Error, for example, calculates the timing error of a signal compared with an ideal, expected interval defined by a user-specified reference frequency, the most common estimator of jitter. "The short-term variations of a digital signal's significant instants, from their ideal positions in time,"† are plotted. This is the perfect tool for characterizing clocks in synchronized telecom networks such as SONET and SDH.

  A special **data** function, available for most of these attributes, enables work on random data streams. See **Chapter 3**.

- **Persistence Histogram** analyzes a vertical or horizontal slice of a persistence map of multiple waveforms. The resultant bar chart shows a numerical measurement of the timing variations of a signal, which are observed qualitatively in the persistence display of the signal. A typical application is characterizing the jitter in a communications signal eye diagram. See **Chapter 4**.

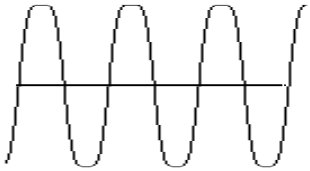
† As defined in Bellcore TR-499.

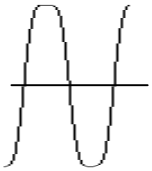


- **Persistence Trace** is a new concept for displaying the data acquired from multiple sweeps of a waveform. A vector trace is computed, based on the bit map of the underlying multiple signal acquisitions. Detail is then represented in a choice of three graphic forms, each representing a different characteristic of the waveform. Insight into edge details is given down to a few picoseconds — valuable in applications such as the examination of fast signal transitions. See **Chapter 5**.

Timing Parameters

Timing Parameters, too, can be used for measuring cycle-to-cycle jitter, the width of positive and negative pulses, the duty cycle of either polarity, and an infinite number of cycles on long records. Pulses or cycles can be counted using one of these parameters.



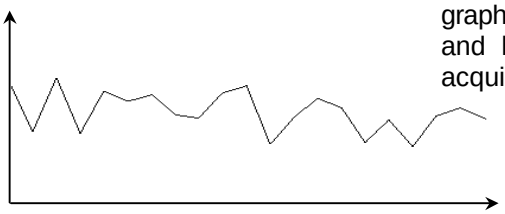


Applying interpolation filtering to signal edges in the vicinity of measurement points, timing parameters operate on acquired waveform levels that may be selected in either volts or percentages of signal amplitude. Each parameter calculation is performed over all cycles or edges present in the input signal, without limitations. See **Chapter 6**.

Statistical Tools

The information obtained from applying timing parameters can then be analyzed using the statistical tools, histograms and trends:

- **Histograms** characterize and present as a bar chart the statistical distribution of a timing parameter's set of values. In addition, there are 18 statistical histogram parameters, which operate directly on the histogram. See **Chapter 7**.



- **Trends** represent the evolution of timing parameters in line graphs whose vertical axes are the value of the parameter, and horizontal axes the order in which the values were acquired. See **Chapter 8**.

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