LeCroy

WaveSurfer MXs-B Basics

TUTORIAL

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Summary

Setting up the basic controls for vertical, horizontal, trigger, zoom and math & measurements is the first step to using an oscilloscope. Vertical controls include sensitivity (volts/div) and offset. The timebase, delay and memory length are in the horizontal menu. Edge trigger is the most commonly used trigger method. Basic math and measurements allow for numerical characterization of signal properties.

In this tutorial we will look at the operation of basic operation of a WaveSurfer oscilloscope.

Equipment Requirements

1 LeCroy WaveSurfer MXs-B series oscilloscope.
1 passive Probe (included with oscilloscope)

Displays shown in the tutorial are based on the following initial setup on a WaveSurfer Xs-B scope:

1. Recall the default setup: File pull down > Recall Setup> Recall Default.
2. Turn off Channel 2 by pressing the “2” button so that its light goes off.
3. Connect the passive probe to the channel 1 input of the oscilloscope and connect the probe tip to the Cal output test point. The associated probe ground lead should be connected to the adjacent ground lug.
4. Auto setup the scope by pressing the Scope Auto Setup button on the front panel twice.
5. Press the Normal button in the front panel trigger control group.
6. The scope display should appear a shown in Figure 1.

This completes the initial setup.

Vertical Controls

In the lower left corner of Figure 1 is a trace descriptor. “C1” means the data for this trace comes from the channel 1 input of the oscilloscope. The descriptor box says C1 is set for DC coupling and 1Mohm input impedance. It also shows the sensitivity setting is 200 mv/div and the DC offset is -508 mv. Note on the front panel of the scope that only the “C1” button is lighted. That is because C1 is the only channel which is in use. You can turn channels on/off by pressing their buttons in the Vertical section of the front panel. This section has one knob which controls sensitivity and one for DC offset. These knobs will control the volts/div and offset of the “active” channel. The active channel is depicted by highlighting of the descriptor box.

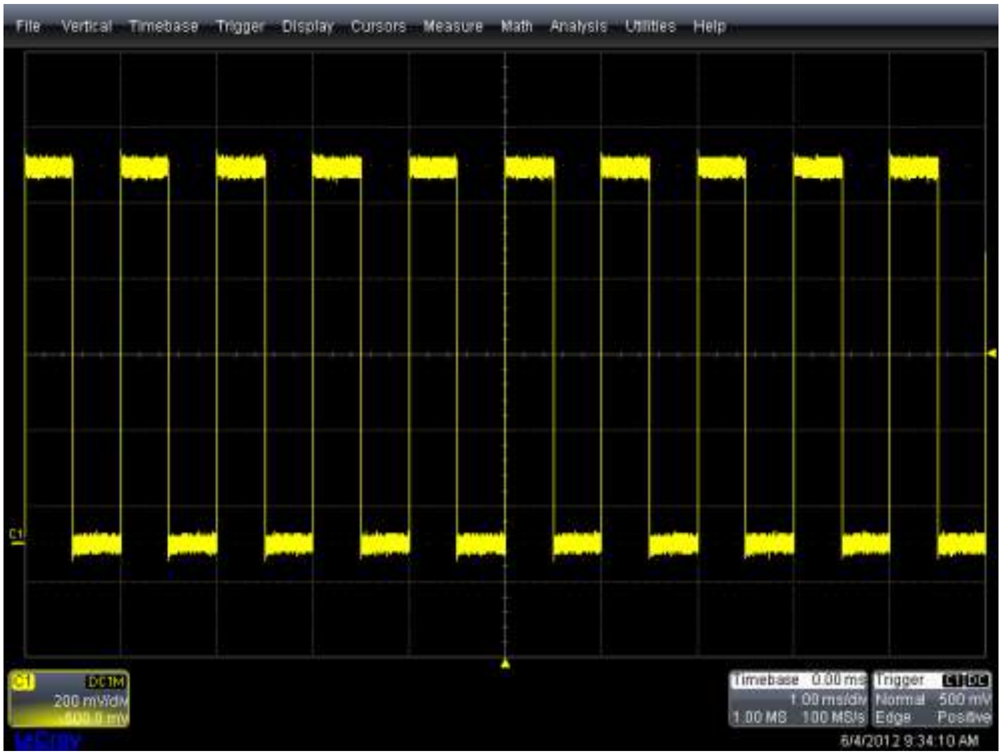
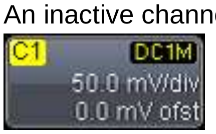


Figure 1 - The initial setup of the oscilloscope showing the 1 kHz cal signal in channel 1

An active channel

An inactive channel



Try using the offset to move the channel 1 trace up and down on the screen. The offset number in the trace descriptor box will change. Next, change the sensitivity setting. The trace will become larger/smaller and the volts/div number in the descriptor box will reflect the changes.

Horizontal Controls

The Horizontal controls affect all the input channels. The two knobs control the time/div and delay. The acquisition timebase is shown in a box toward the lower right corner of the screen. In Figure 1 the timebase is 1.00 ms/div and the delay is 0.00 ms. Note this box also reports the amount of samples which are being acquired (1.00 MS) and the sampling rate (100 MS/s). Try changing the time/div knob. The trace will expand/contract and the time/div will change in the timebase box. The WaveSurfer will automatically assign memory to keep the sampling rate as high as possible for each time/div setting. Figure 2 shows the menu that appears when the Timebase descriptor is touched. The user can assign less than the maximum memory if desired and can also tell the scope to go into 2 channel mode which doubles the sample rate and assigns twice as much memory to the two active channels. Normally it is best to use the maximum memory. If a shorter memory is selected, read the short description of the acquisition setup under the heading "Timebase Mode" to make sure the scope is doing what you want. In Figure 2 it says the scope will capture "1 MS at 100 MS/s ; 10 ns/pt for 10 ms."

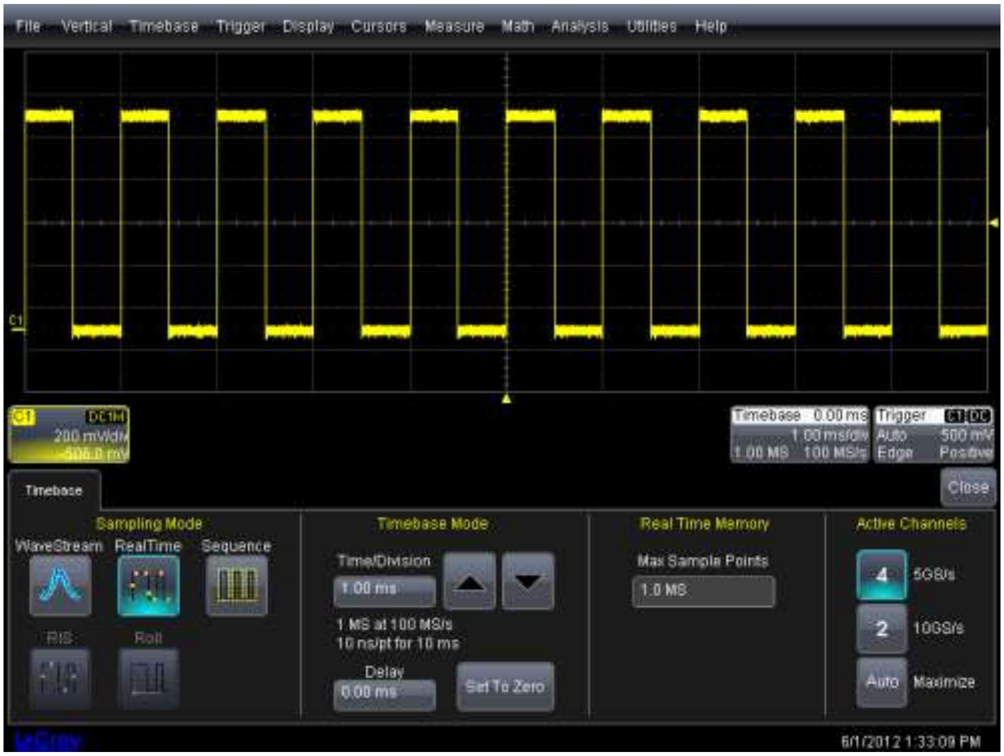


Figure 2 - Touch the Timebase descriptor box brings up these selections

Try changing the delay knob. This controls the delay time between the trigger and the signals on the screen. The trigger time is indicated by a yellow triangle at the bottom of the grid in Figure 1. Changing the delay setting moves the trigger time relative to the signal. The trigger time can be all the way on the right hand edge of the screen (meaning all the data is acquired pre-trigger) or it can be moved off the screen to the left (meaning the signal on the screen is being acquired post-trigger).

Basic Edge Triggering

Oscilloscopes require a trigger, usually derived from or synchronous with the waveform being acquired. The function of the trigger is to allow the acquired waveform to be displayed stably. The edge trigger is the traditional default trigger type. Other, more complex triggers, called SmartTriggers in LeCroy oscilloscopes, are available for more difficult triggering applications. With edge triggering the scope is triggered when the source trace crosses the trigger threshold level with the user specified slope (positive or negative)

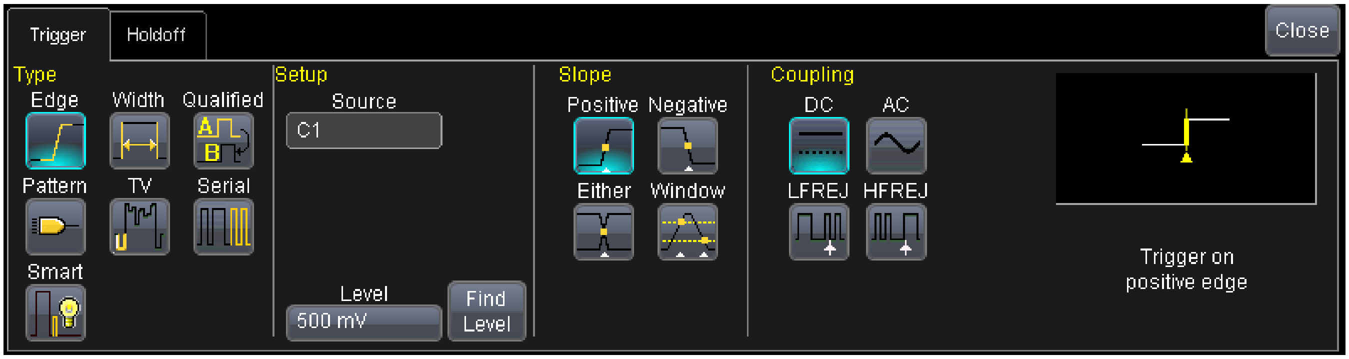


Figure 3 - The Trigger Dialog Box

Bring up the Trigger Setup dialog box by pressing the Trigger Setup button on the front panel or by touching the Trigger descriptor. The Trigger dialog box should be setup similar to Figure 3.

The Trigger dialog box is used to control the trigger setup. On the left hand side there is a selection for the trigger type. By default the Edge trigger type is selected. The other trigger types are specialized SmartTriggers which are discussed in other tutorials. We will be using only edge trigger in this tutorial.

The current scope settings are using channel 1 (C1) as the source of the trigger with a trigger threshold level of nominally 500 mV and a positive slope. These setting are summarized in the trigger descriptor box on the right side of the screen.

Touch or click on the Source field in the trigger dialog box. A popup will appear showing the possible trigger sources as shown in Figure 4. The trigger sources include any of the input channels, the Ext input connector on the front panel, the Ext input attenuated by a factor of 10, and the power line (mains). The scope is currently triggering on channel 1 (C1) and the displayed waveform is stable. Touch or click on the Line selection. Note that the channel 1 trace on the scope becomes unstable. Bring up the source popup and re-select C1, the trace is again stable.

Figure 4 - Trigger Source Choices

Look at the Coupling field in the trigger dialog box. It should appear like Figure 5.

Figure 5 - Trigger Coupling Choices

DC Coupling allows both DC and AC components of the trigger source into the trigger circuit.

AC Coupling blocks the DC component so only the AC component is used.

LF REJ (Low Frequency Reject) applies a high pass filter (nominally 50 kHz lower cutoff frequency) in the trigger signal path attenuating lower frequency component.

HF REJ (High Frequency Reject) applies a low pass filter (nominally 50 kHz) to the trigger signal path which attenuates high frequency components.

Select DC.

Review the Slope field in the trigger dialog box. It will show the possible slope choices as shown in Figure 6.

Figure 6 - Slope Selection

The trigger occurs on a Positive, Negative, Either or Window slope.

Change the slope from positive to negative. Note the change in the trigger point on the display as shown in Figure 7.

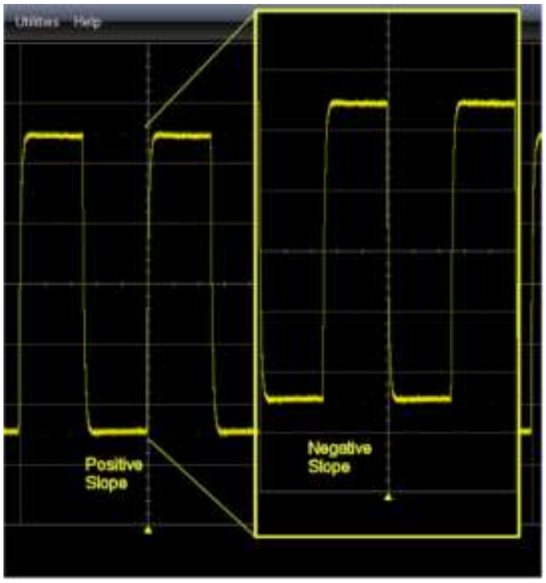


Figure 7 - The effect of changing the trigger slope

The trigger point is located above the small triangular symbol which marks the trigger point horizontal location on the screen. The trigger location can be moved using the horizontal delay control on the front panel or in the Timebase dialog box. As the slope setting is changed from positive to negative the displayed trace shifts to align the selected slope with the trigger point.

If the Either selection is made the waveform will 'jump' between the positive and negative slopes. Return the slope setting to Positive.

The Window trigger sets a threshold both above and below the nominal trigger level which the signal must exceed in order to trigger the scope. The slope can be either positive or negative for the window slope.

The Trigger level field in the trigger dialog box is used to set the signal level at which the trigger occurs. The trigger level can be controlled from this field or from the front panel Trigger Level control. The user can also have the oscilloscope find the trigger level by touching the Find Level button in the trigger dialog box or by pushing the Trigger Level knob on the front panel.

The trigger level is indicated by another triangular icon located on the right side of the display. In Figure 8 it is toward the lower edge of the grid. This icon is only visible when DC coupling is selected. Vary the trigger level up and down. Note that the waveform becomes unstable or the scope stops triggering if the trigger level is within about 0.3 divisions of the top or bottom of the waveform. This is due to a fixed hysteresis built into the scope's trigger circuit. Hysteresis helps the scope ignore noise on the signal. When the trigger level is outside the range of the signal the scope will stop triggering and flash a "Waiting for Trigger" warning message in the lower right corner of the display as shown in Figure 8. This indicates that the scope has stopped triggering.

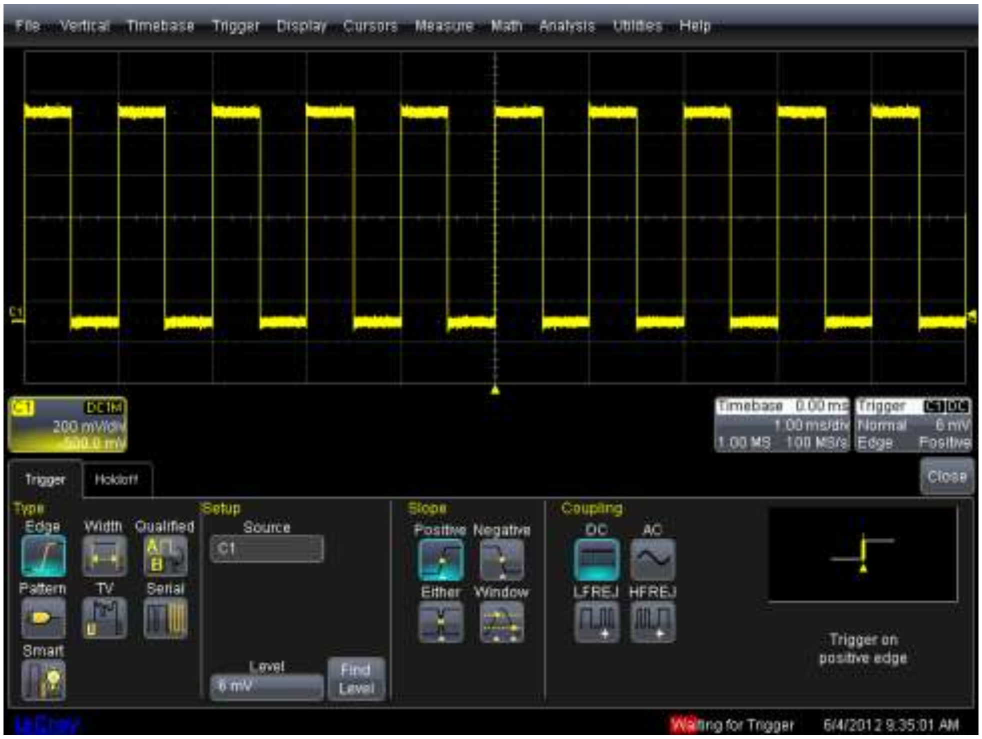


Figure 8 - The "Waiting for Trigger" message indicating the scope in not triggering

After investigating the trigger level setting press the trigger level control to restore the proper trigger level.

Basic Measurements

The power of digital scopes comes from the ability to numerically quantify signal/device performance. The most commonly used method for characterizing the shape of a signal is to use parameters. Find the Measure button on the front panel. Pressing it once opens a dialog box. Pressing it again closes the dialog. Parameters are pre-programmed measurements that eliminate the need to set up cursors for standardized measurements like rise time, fall time, peak-peak amplitude, etc. They automatically calculate many attributes of a signal. The WaveSurfer can make common measurements on one or more waveforms, and display up to six parameter measurements at one time. It can also display statistics – max, min, avg, standard deviation and the number of measurements that have been made. Note that when measuring rise time or other parameters that can occur many times across the screen in a single acquisition the WaveSurfer will measure all instances of the parameter.

Measurements are set up either by pressing the Measure button or by selecting Measure then Measure Setup from the pull down menu at the top of the screen. Either method brings up a display similar to Figure 9.

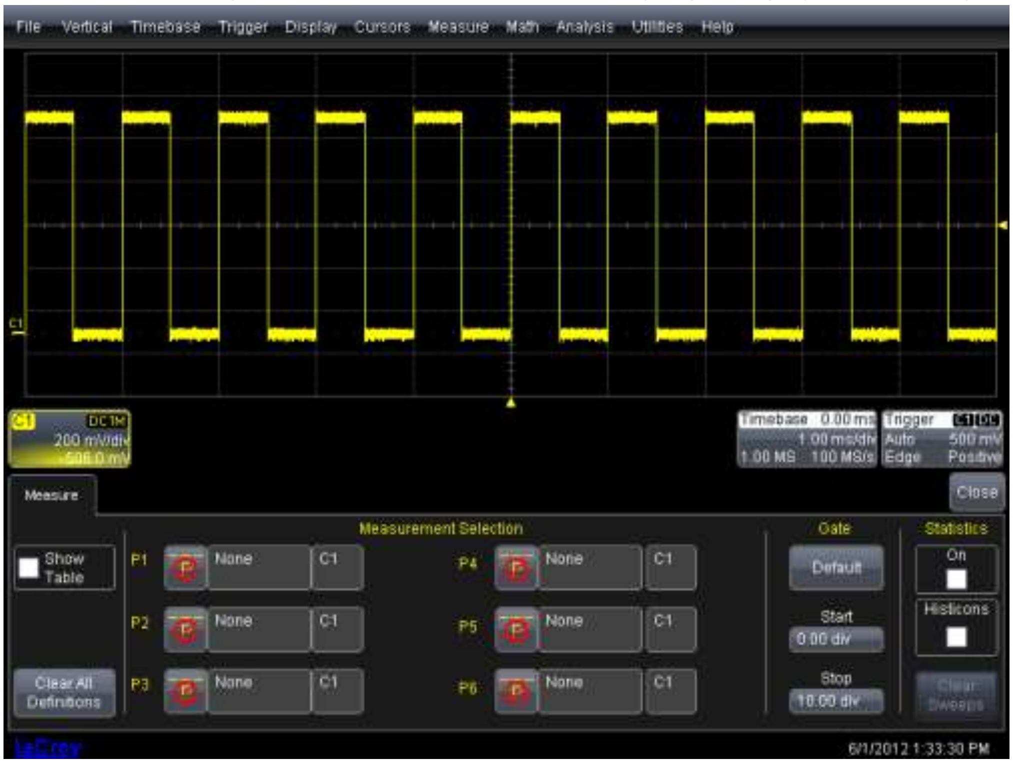


Figure 9 - The dialog box for setting up parameter measurements

Touch any of the icons for P1 – P6 and then choose a parameter to measure. Once a parameter is selected the user defines which channel is the source of the measurement (in this tutorial the only signal of interest is C1) and any other factors necessary to define the measurement.

Select a few parameters and put them on the display by checking the box labeled Show Table. Turn on statistics by also checking that box. The distribution of the set of measurements accumulated for each parameter can be displayed by checking the Histicons box. Figure 10 shows an example of four parameter measurements with statistics and histicons.

Figure 10 - Parameter measurements with statistics and histicons.

Basic Math

Math operations can be performed on waveforms by pressing the Math button on the front panel or by selecting Math then Math Setup from the menu bar at the top of the screen. Math traces are defined with an Operator and a Source. Examples of Operators include Add, Subtract, Multiply, Divide, and FFT. Sources are channels, zoom traces, or memories (reference waveforms). Some Operators require two sources, and some only one source.

Math traces are always displayed in a separate half-height grid at the bottom of the display, separate from other traces. This makes it easier to interpret Math information if the math scale is different from the channel scales. If the scope also has active Zoom traces then three grids are shown on the display, each at one-third the height. Figure 11 shows an FFT in the lower trace.

Figure 11 - An FFT of a square wave contains all the odd harmonics of the fundamental frequency

Try setting up the math function for average, reciprocal, square or FFT using C1 as the source. Check the box labeled Trace On in order to display the math trace. Note the math trace has a descriptor box similar to that of the input channel. In a math trace descriptor:

The top line contains information about how the Math trace is defined (for example, an average of C1).
The 2nd line contains vertical scaling information.
The 3rd line contains horizontal scaling information.

Touching the descriptor of a math trace makes it the active trace. This means the front panel horizontal and vertical controls can be used to change the position and scale of the math trace.

Using Zoom to see More Details

Long memory oscilloscopes contain many more points of data in their memory than the number of horizontal pixels on the screen. There are times when it is desirable to view more detail concerning the shape of a signal or a math trace. There are three ways to activate a zoom trace:

Drawing a box around the zoom area, using either your finger or a mouse/pointing tool.
Using the front panel QuickZoom button.
Using the software toolbar Zoom button in the Channel dialog.

The zoom trace will be displayed on a separate grid. The display timebase is different than the acquisition timebase because the zoom only contains a portion of the whole signal. In Figure 12 the acquisition timebase is 1 ms/div whereas the zoom detail is displayed at 50 usec/div. The zoom shows much more detail, but it is only 1/20 of the total signal. It is possible to zoom down to a display timebase that shows the individual data samples in great detail. For example the scope can show short glitches or the shape of fast overshoot on an edge.

The scope can perform parameter measurements or math operations on a zoom in the same fashion as for an acquisition channel. The source just needs to be defined as the zoom trace (for example Z1 in Figure 12). If there is interesting noise on a portion of a signal, just set the zoom on that portion and perform an FFT of the zoom to look at frequency components. Try setting up some parameters and math on a zoom of C1.

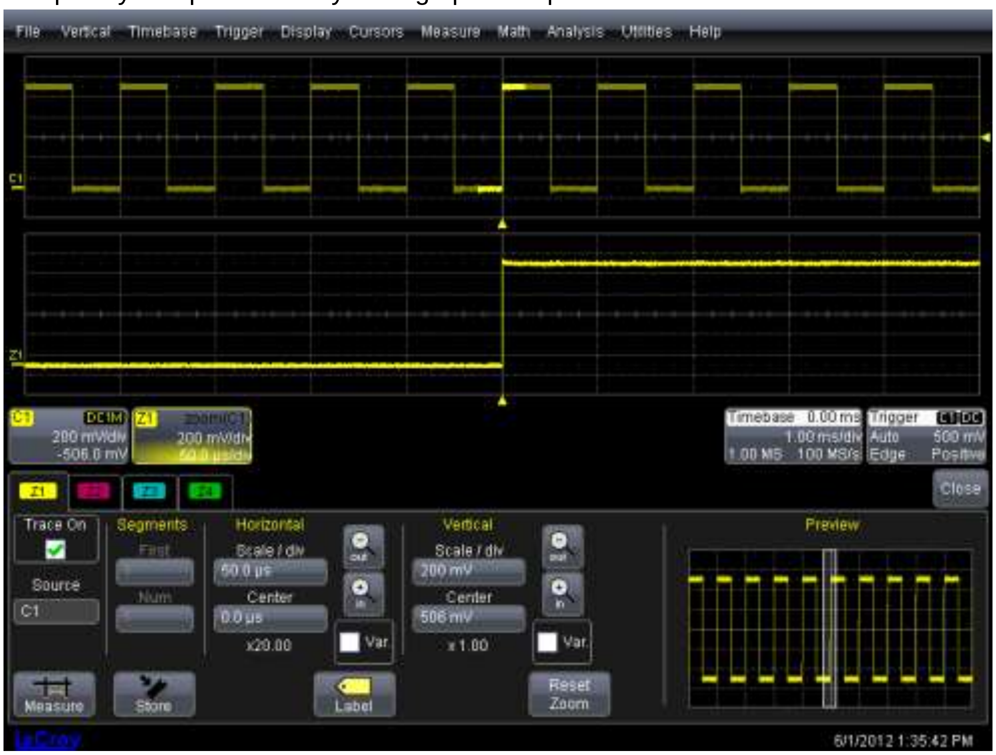


Figure 12 - Ten milliseconds are captured at 1 ms/div and a 500 usec portion is displayed in a zoom trace at 50 us/div

This completes this tutorial.