WaveSurfer MXs-B Basic Edge Trigger

TEN MINUTE TUTORIAL

February 13, 2012

Summary

Triggering synchronizes the acquisition of the oscilloscope to the waveform being acquired so that the resulting waveform display appears stable on the screen. The most basic trigger is the edge trigger.

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. In this tutorial we will look at the operation of basic edge triggers and the associated holdoff features.

Equipment Requirements

A LeCroy WaveSurfer MXs-B series oscilloscope.
1 passive Probe

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.
3. Verify that the input coupling on channel 1 is DC 1 MΩ: Touch or click the channel 1 annotation box>touch or click on the coupling field >select DC 1MΩ.
4. 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.
5. Auto setup the scope by pressing the Scope Auto Setup button on the front panel twice.
6. Press the Normal button in the front panel trigger control group.
7. The scope display should appear a shown in Figure 1.

This completes the initial setup.

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

Basic Edge Triggering

With edge triggering the scope is triggered when the source trace crosses the trigger threshold level with the user specified slope (positive or negative).

Bring up the Trigger Setup dialog box by pressing the Trigger Setup button on the front panel or by touching the Trigger Annotation box. The Trigger dialog box should be setup similar to Figure 2.

Figure 2: *The Trigger dialog box*

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 type are specialized SmartTriggers which are discussed in other tutorials. We will be using only edge trigger in this tutorial.

The current scope setting 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 icon on the right side of the dialog box and in the trigger annotation box.

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 3. 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), We are 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 is unstable. Bring up the source popup and re-select C1, the trace is again stable.

Figure 3: *Trigger Source choices*

Look at the Coupling field in the trigger dialog box. It should appear like Figure 4.

Figure 4: *Coupling popup*

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

AC Coupling blocks the DC component so on 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 5.

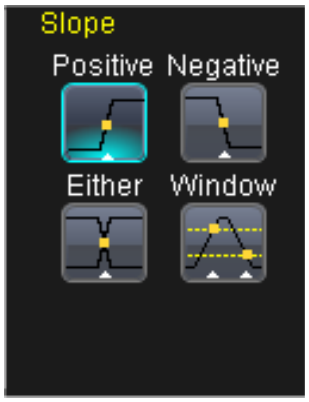

Figure 5: *Slope Selection*

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 6.

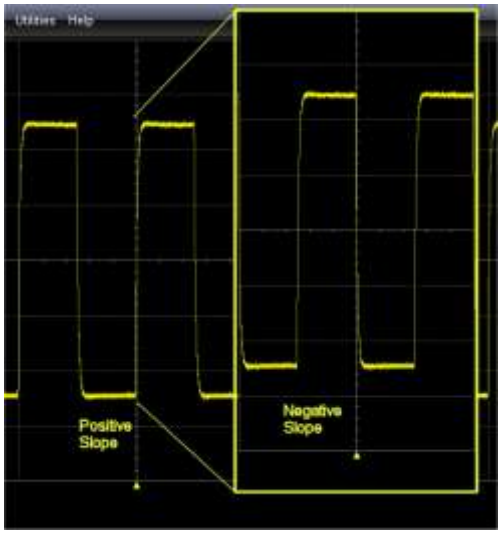

Figure 6: *The effect of changing the trigger slope setting*

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 control on the front panel.

The trigger level is indicated by another triangular icon located on the right side of the display. 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 7. This indicates that the scope has stopped triggering.

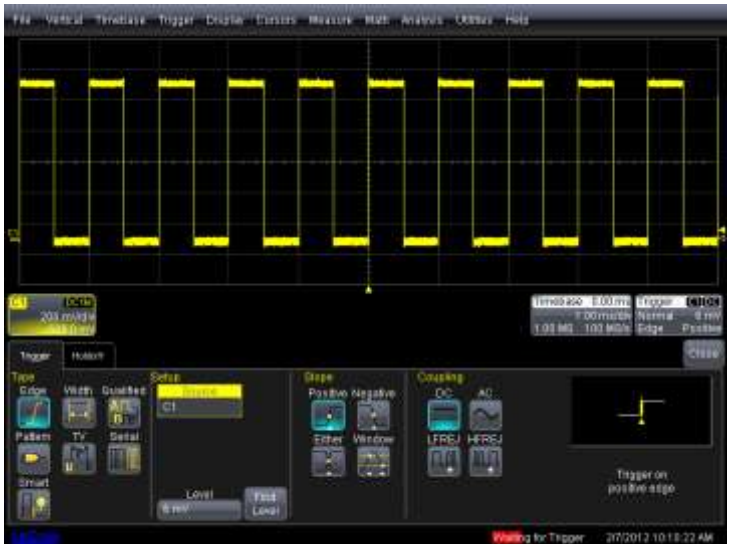

Figure 7: *The "waiting for Trigger" message indicating the scope is not triggering*

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

Holdoff

Holdoff is a trigger function which is used when there are multiple trigger events per acquisition. It allows the user to ignore extra trigger events and stabilize the display as if there was only a single trigger event per acquisition.

From the Trigger dialog box touch or click on the Holdoff tab. It will appear as shown in Figure 8.

Figure 8: *The Holdoff tab for setting trigger holdoff by time or events*

Holdoff can be set in either time or events. An event is a signal condition that would normally result in the oscilloscope triggering. Holdoff should be interpreted as a command to ignore the trigger for a specified time or event count. Let's take a look at how it works.

Open the Timebase dialog box by using the Timebase pull down menu (Timebase> Horizontal Setup) or by touching or clicking on the Timebase annotation box. Set the Time per division to 200 ns/division.

Place the scope into sequence mode acquisition by pressing the Sequence button in the Sampling Mode control group on the Timebase dialog. It will now acquire 10 segments with a very short dead time and Time stamp each trigger. Touch or click on the Sequence tab then press Show Sequence Trigger. The sequence mode Trigger times, shown in Figure 9, show that the time between triggers is nominally 1 ms.

Figure 9: *Using Sequence to time stamp each trigger*

Open the Trigger Setup dialog and then open the Holdoff Tab. Touch or click the button labeled with the clock face icon. This puts the trigger into holdoff by time. Set the time to 1 ms. Return to the Trigger Time tab. Note that the time between segments is now nominally 2 ms. Holdoff by time allows the scope to take every other trigger on the 1 kHz cal signal.

Bring up the Holdoff tab again. Change the holdoff type to holdoff by events. Set the number of events to 3. Check the time between segments. It should now be 4 ms. The scope triggers and then holds off or ignores the next 3 triggers. The scope then triggers on the next, or 4^{th}, trigger.

The Start Holdoff Counter determines if the holdoff counter is reset at the beginning of each acquisition (the Acquisition Start selection) or if it accumulates continuously (the Last Trigger time selection). For applications where the two trigger events have harmonically related frequencies we do not want to miss any trigger events in our count so the cumulative count is required. Keep in mind that the holdoff counter runs even when the scope is not acquiring. If we reset the counter on Acquisition Start then any trigger events that occurred between the earlier acquisition and the beginning of this one will be missed in the count and we will lose synchronization.

This is a simple use of holdoff. In general, holdoff can be used in several different applications:

1. When there are multiple trigger events in a signal.

2. Triggering on the higher frequency of two harmonically related signals (e.g. output of a PLL frequency multiplier while looking at both the output and input).

3. Trigger at a fixed time delay. (e.g. trigger a scope every 10 seconds for a data logging application).

4. Trigger on the clock repetition of a pseudo random process with a known, fixed number of states.

5. Triggering on every n^{th} event.

As you have seen Holdoff greatly improves the versatility of the basic edge trigger.

Turn Holdoff off.

This completes this tutorial.