

Lab 1 – Capture (30 Minutes)

Note:(Screenshots below show a white background configuration of your WaveAce to save black ink in printing, this configuration is explained in Lab 2 – VIEW)

Overview

The Capture Lab addresses the different acquisition modes found in modern digital oscilloscopes like the WaveAce.

A **test** at the end of the Lab allows you to check your knowledge.

It is recommended to start with this lab as the first part of your training.

Goal

Learn how to configure and use:

- Single Acquisition
- Normal Acquisition
- Auto Acquisition
- Roll Mode
- Equ (Equivalent) Time Mode
- Acquisition modes – Average and Peak Detect

In this Lab you will learn the differences between each of the acquisition modes and when they should be used.

Required Equipment

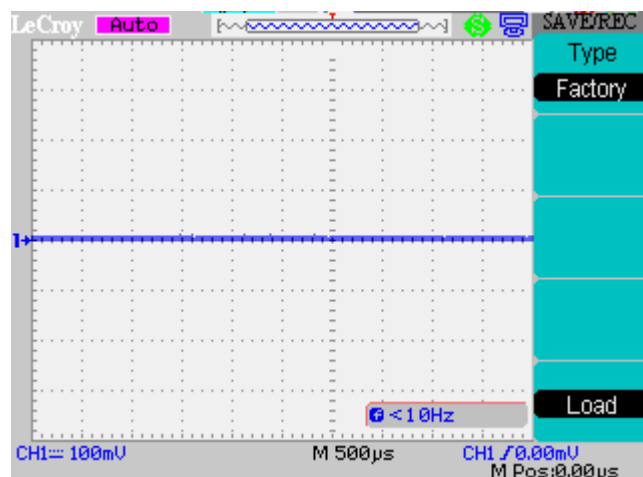
- 1 x WaveAce passive probe.

Setup

Connect the probe to Channel 2 and the probe top to the calibrator (CAL) output loop on the front panel. Use the sprung hook accessory of the probe to clip to the CAL output loop.

Step 1

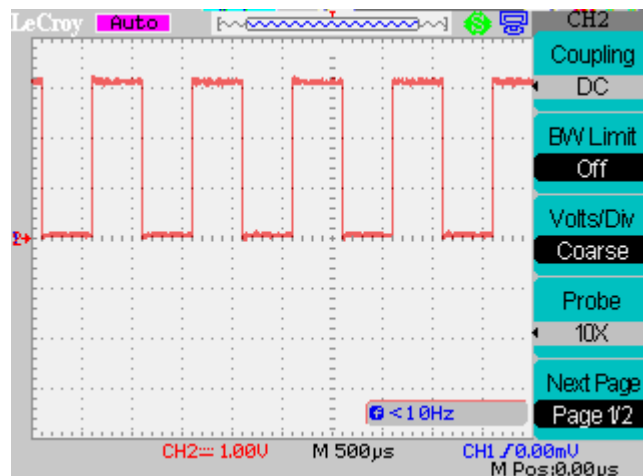
Reset the scope configuration to the default factory settings using the front panel DEFAULT SETUP button. An alternative method is to use the front panel SAVE/RECALL button, then press the Type button until Factory is displayed and finally press the Load button.



At any time the menu on the right-hand side of the screen can be removed/restored by pressing the front panel MENU ON/OFF button.

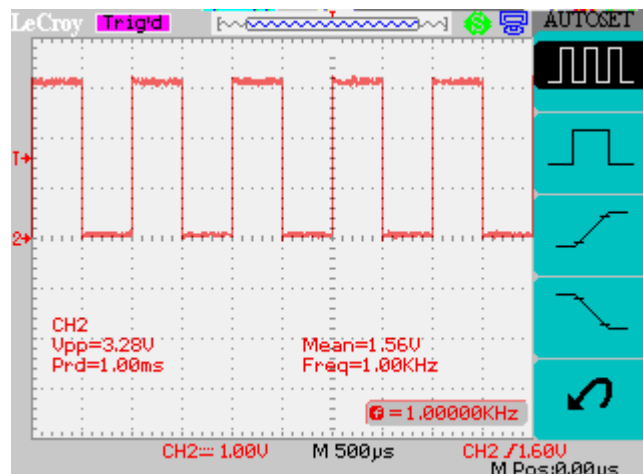
Step 2

Turn CH1 off and CH2 on by pressing the front panel CH1 and CH2 buttons. Pressing a channel button also displays the corresponding vertical settings. DC coupling on CH2 is selected by default. Check the slider switch on the probe is set to X10 and using the Probe button set 10X on the screen.



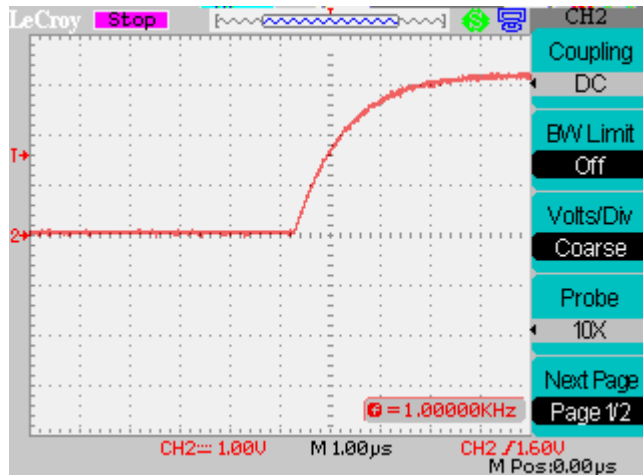
Step 3

Press the [blue] AUTO button on the front panel. In a few seconds you should have a triggered signal with a number of cycles shown on the screen.



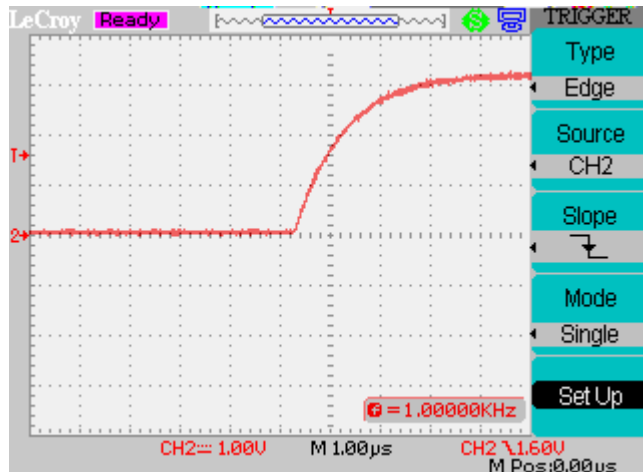
Step 4

Adjust timebase setting to 1 us/div using the Horizontal timebase control on the front panel. Press the front panel RUN/STOP button (LED goes red) to capture the data on the display. Pressing it a second time (LED goes green) will restart triggering. Press the front panel SINGLE button to select single acquisition mode. Now each time the RUN/STOP button is pressed a single acquisition will be performed.

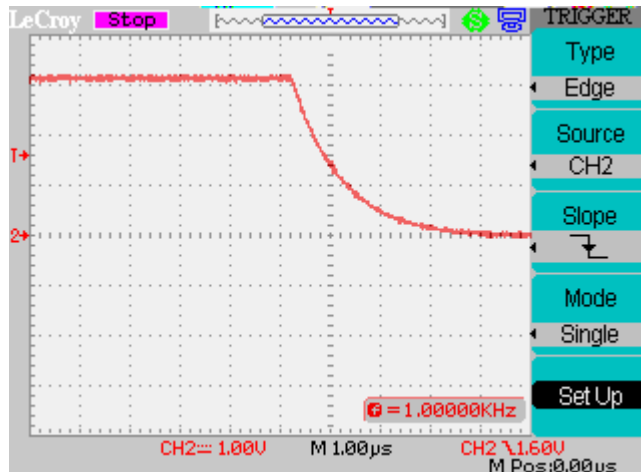


Step 5

Remove the probe from the CAL signal and on the front panel press TRIG MENU. Press the Slope button to select negative edge trigger and arm the scope by pressing RUN/STOP. As no trigger is available the RUN/STOP button will remain green with the Ready marker displayed at the top edge of the screen.



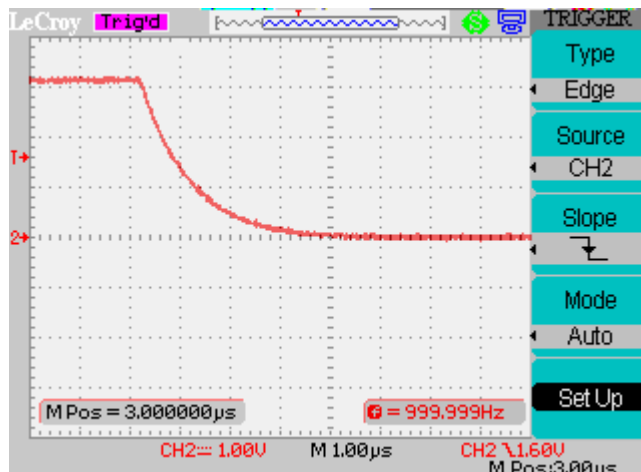
Re-connect the probe to the Cal signal to simulate an asynchronous pulse.



The scope should now trigger. The RUN/STOP button has changed to red and the marker displays Stop. If the edge displayed does not look like the above press RUN/STOP once more to capture a clean edge.

Step 6

Press the SINGLE button to revert to continuous mode and the marker now displays Trig'd. Using the front panel Horizontal Position control knob, position the falling edge to the left of center of the screen, as shown. The amount of delay is momentarily displayed on the screen.

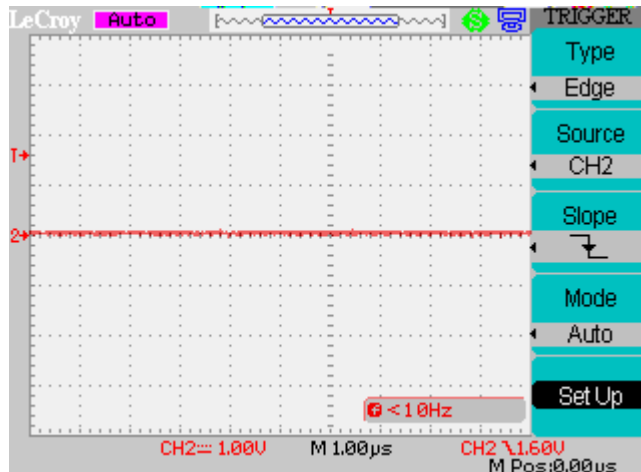


Push in the Position knob to see the trigger point revert to the center of the screen.

Step 7

Note: AUTO trigger mode is useful when the trigger setup is not correct, as you can see a 'live' trace on the screen which allows adjustment

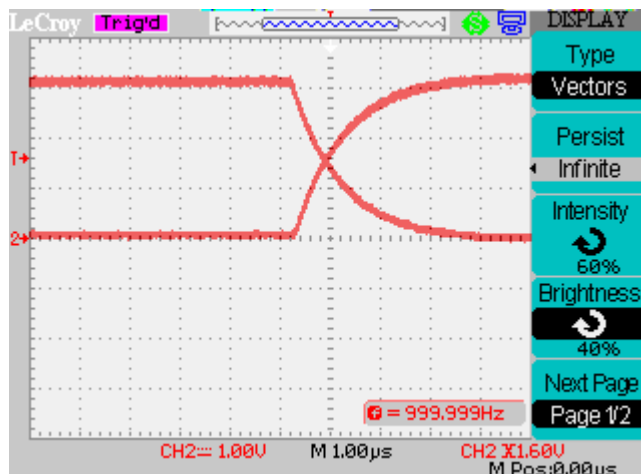
Press the Mode button to select Normal trigger mode. The screen marker continues to show Trig'd. Remove the probe from the Cal signal, the scope stops triggering and the marker changes to Ready. Press the Mode button to select Auto trigger mode and the scope now triggers even without a signal present and the marker displays Auto.



Connect the probe to show the edge and the marker changes back to Trig'd.

Press the Slope button to select both edges. Now the scope is triggering on both edges. If Single mode is selected (either by using the Mode button or pressing the Front Panel SINGLE button), each time RUN/STOP is pressed it triggers on one of the edges and the previous data is erased. Press the Mode button to select Normal trigger.

Press the front panel DISPLAY button and use the Persist button to select Infinite. The screen now maintains a record of all previous traces.

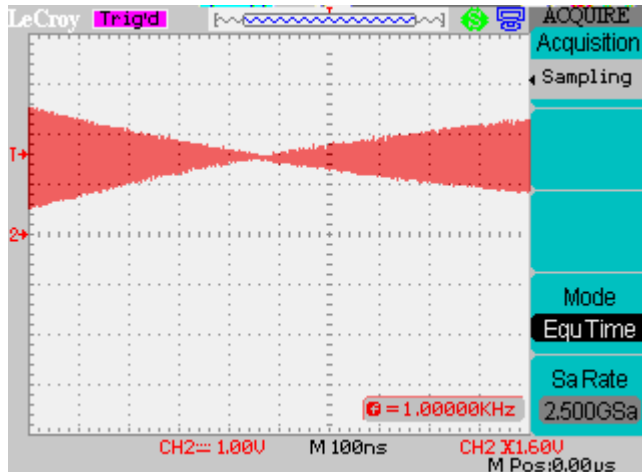


Select the Persist button again until Off is selected. The scope has now reverted to displaying single traces.

Step 8

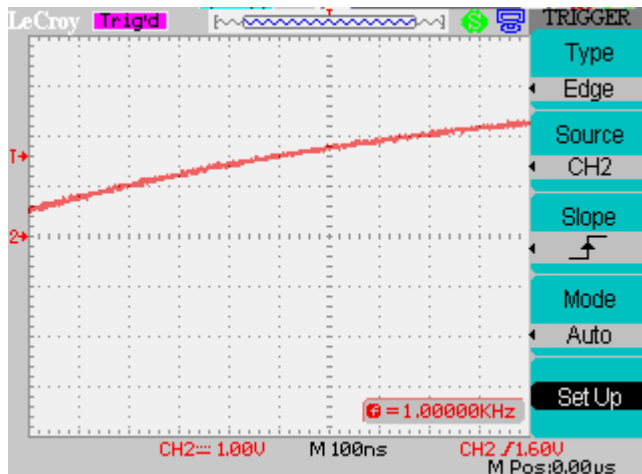
Adjust timebase setting to 100 ns/div and press the front panel ACQUIRE button to display the sampling options and note the sampling rate (Sa Rate). Select Equ Time using the Mode button. Although the sample rate increases to 2.5 GS/s, the display is now corrupted.

Note: Why do we need Equ(ivalent) Time sampling mode – Equ Time mode is only designed to be used for truly repetitive signals and with both edges enabled, we get both positive and negative slopes included, so the signal is not truly repeated each trigger. Once we use only rising or falling edges, then the signal is repeating itself from trigger to trigger and Equ Time mode works correctly.



In the TRIG MENU change the trigger slope back to positive or negative edge triggering and the signal is correctly represented on the scope display.

The advantage of Equ Time mode is that it provides higher sampling rates on the fastest timebases.



The disadvantage is that it requires repetitive signals and multiple acquisitions so the update rate is slower.

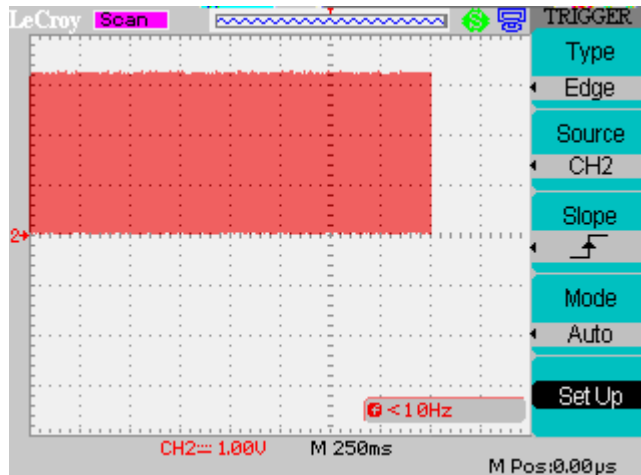
Change the timebase to 10 us/div and repeat Step 8. Note that now there is no change in the sampling rate. Equ Time mode is only useful on the faster timebases.

Step 9

Select each slower timebase in turn. For timebase settings of 100ms and slower we switch to roll mode acquisition (Scan is displayed on the top line of the screen) and the trace acts like a chart recorder, scrolling across the screen.

Select Normal trigger mode – how does the screen update change?
Now select Single trigger mode – how does the screen update change?

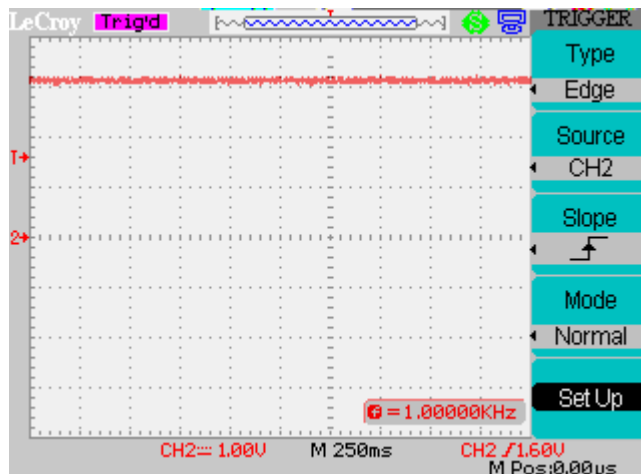
Return to Auto mode to compare. Notice that roll mode is only available when Auto trigger is selected



Step 10

The requirement to sample a signal at a minimum of 2 times its highest frequency component is known as the Nyquist–Shannon sampling theorem

Select Normal trigger and look at the signal on several of the slower timebase settings. Note that we may see only a horizontal line or depending on the sampling rate a square wave of much lower frequency. What has happened to the signal?



Press the front panel ACQUIRE button and note the sample rate. For the model 112 using a 250ms/div timebase this will be 1.000KSa/s.

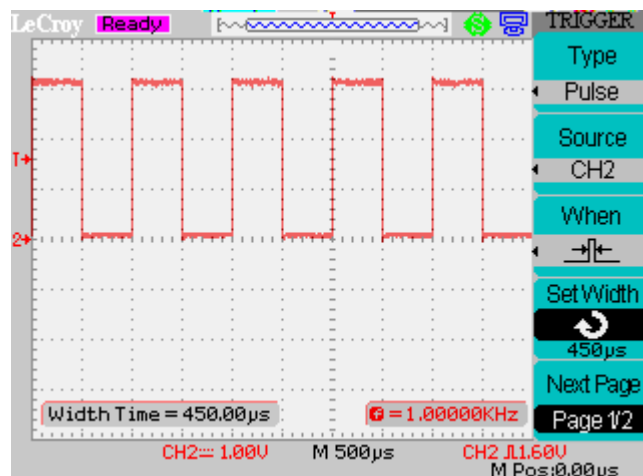
The signal is sampled at 1ms intervals but the signal frequency is 1kHz and therefore the period is also 1ms. The result is that we sample only part of the waveform cycle each time. This effect is known as aliasing and results from using too low a sampling rate. The absolute minimum is that we must use a sampling rate of at least 2 times the highest signal frequency.

Step 11

Select Auto trigger mode and 500us/div to display several cycles of the waveform. Adjust the front panel trigger Level knob. The small T marker to the left of the screen shows the trigger level with respect to the signal and in Auto mode the scope triggers even when the level is outside the signal. Select Normal trigger mode and now the scope triggers only when the level is inside the signal.

Center the level with the front panel SET TO 50% button.

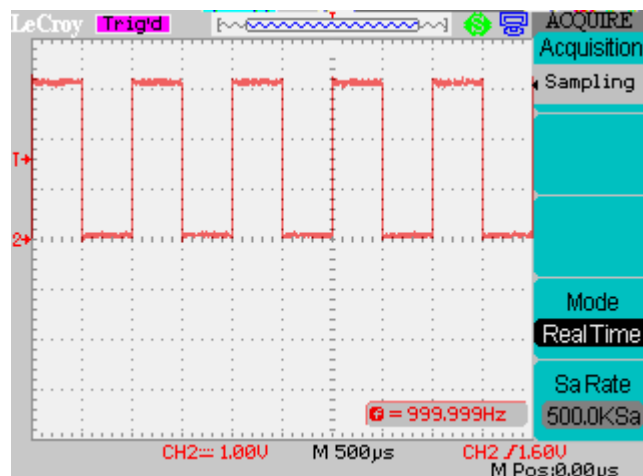
In the TRIG MENU select Pulse Type trigger and use the When menu button to select positive pulse width less than pulse width setting. Select Set Width and adjust the value to 450 us with the Intensity/Adjust knob. Observe that the scope stops triggering. Adjust to 550 us and the scope now triggers.



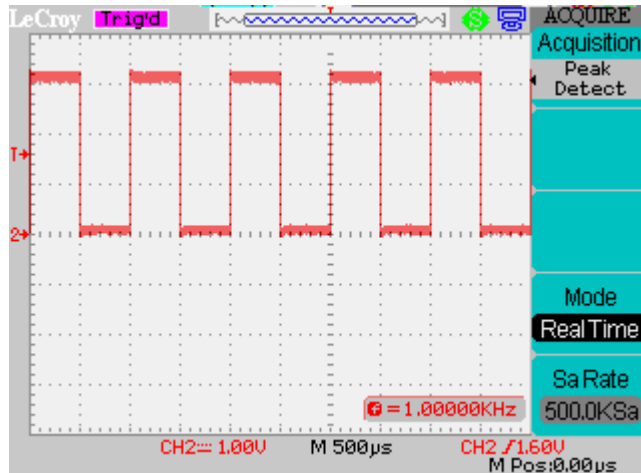
The positive pulse width for a 1kHz square wave is 500us. The Set Width control can be used to determine if we trigger on this pulse or not. As an experiment select one of the other options in the When menu and investigate the effect of changing the width setting. The Type menu also provides additional types of trigger. Operation of these trigger modes is described in more detail in the WaveAce operator's manual.

Step 12

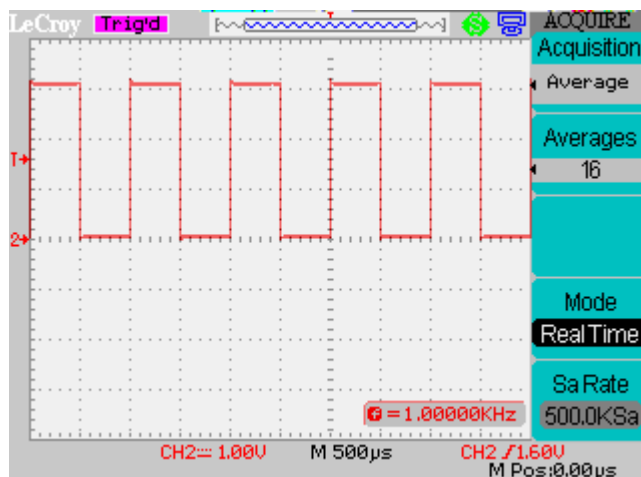
Revert to Edge type trigger and Auto trigger mode. Press the ACQUIRE button. Under Acquisition Sampling is displayed. Note the level of noise on the top and bottom levels of the calibration signal.



Now press the Acquisition button and Peak Detect is displayed. Allow the scope to run for several seconds. Note the level of noise on the signal.



Now press the Acquisition button to select Average and allow the scope to run for a few seconds. Again note the noise levels on the signal.



A sampling acquisition samples the waveform at uniform time intervals. A rapid variation in the signal such as a narrow pulse may therefore be missed. In Peak Detect the highest and lowest values in the signal are recorded so allowing even narrow pulses to be captured. Averaging is useful to reduce random noise. When using averaging you can also select the number of acquisitions to average. Higher values will give more noise reduction but the averaging will take longer.

Test

Question 1

What is Equivalent Time mode and where should it NOT be used?

.....
.....
.....
.....

Question 2

Name the 5 types trigger types in the WaveAce digital storage oscilloscope?

.....
.....
.....
.....
.....
.....

Question 3

Sampling is the standard acquisition type used in the WaveAce digital storage oscilloscope. There are also two additional acquisition types. What are they?

.....
.....
.....
.....
.....

On which type of signal, would you use these in preference to Sampling type?

.....
.....
.....
.....
.....
.....

Question 4

In Steps 2 and 3 the vertical scale is shown a 1V/div. In the remaining steps it is 100mV/div. The input signal has not changed, what have we forgotten?

.....
.....
.....

Summary

In this lab you learned how to configure the WaveAce to capture waveforms in the different acquisitions mode. You now know when to apply either Normal Mode or Auto Mode and when to acquire in Real Times or Equivalent Time Mode.