



Digital Oscilloscope  
User Manual  
Updated July 2017

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# 1 Overview

This manual describes the use of the Digital Oscilloscope.

The oscilloscope allows for setting the trigger mode, grid view, sweep rate, trigger level, trigger slope, and trigger delay as well as re-arming the trigger. The entire oscilloscope is pictured below.

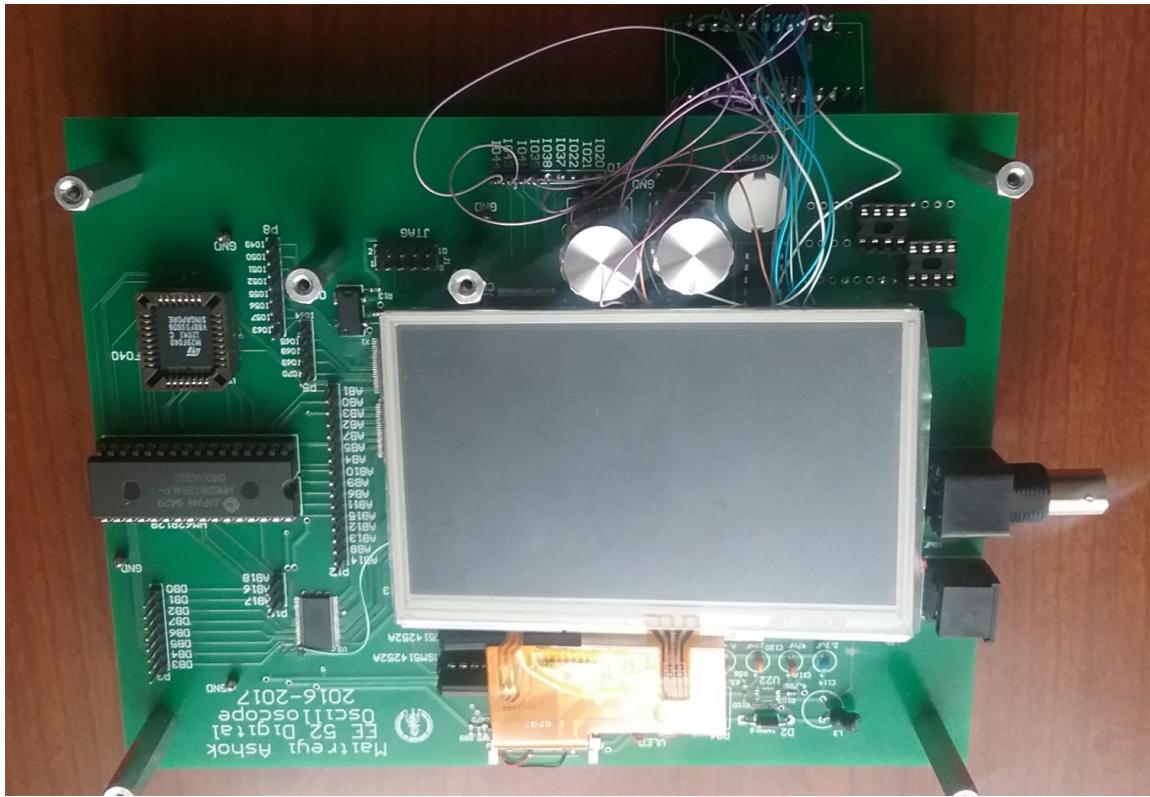


Figure 1: Oscilloscope PCB and display

## 2 Restarting/Power On

To power on the oscilloscope, plug the power cord into the black connector on the right in the following image. The power connector is on the right side of the oscilloscope, next to the power LEDs. If the oscilloscope is plugged into power correctly, three green LEDs will light up on the right side of the scope.



Figure 2: Power connector for oscilloscope

It is possible to reset the system without powering off the oscilloscope. This is done through the white reset switch shown at the left below (top right of oscilloscope).

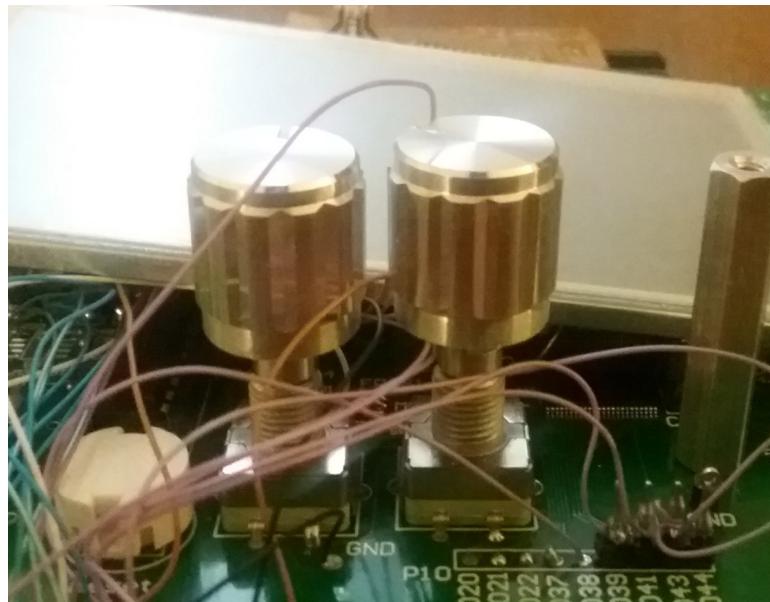


Figure 3: Reset push button (white)

When this button is pressed, the display is cleared, the settings are set to their initial values, and all saved signals are cleared from memory. The cleared display before the trace is redrawn is shown below, where all pixels are set to a default white color.



Figure 4: Display cleared when system is reset

When the system is powered on or reset, the default settings of the oscilloscope are as shown below.

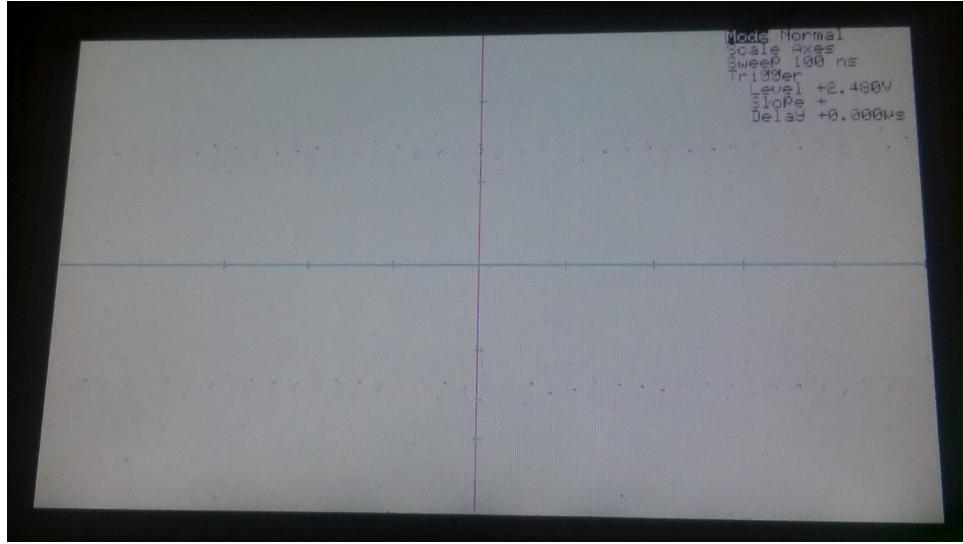


Figure 5: Default settings and display of oscilloscope

### 3 Menu

The menu is based on input through the dials. The results of the user selection can be viewed on the display, in the top right corner.

#### 3.1 Basic Menu Usage

The dials, pictured below can be turned either clockwise or counterclockwise, as well as pushed for various options.

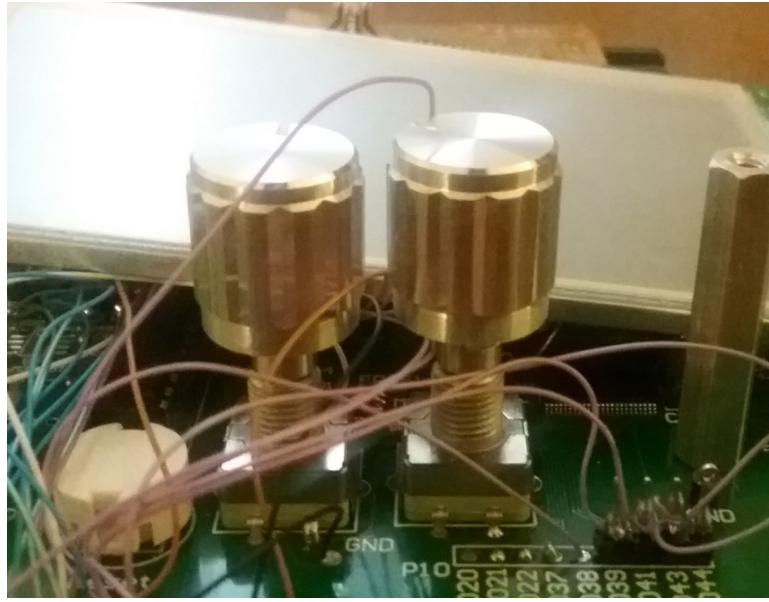


Figure 6: Two dials on oscilloscope (silver)

The corresponding menu on the display is shown below.

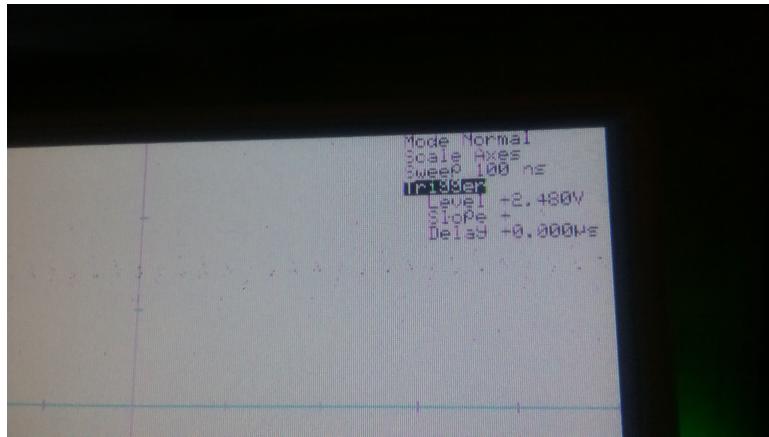


Figure 7: Basic Menu displaying options

When the right dial is pressed down, the menu is turned off. When the menu is off, none of the options on the menu can be selected by turning the dials. The selector bar will remain on the last chosen option regardless of the turns of the dials. To turn the menu selection back on, the same dial on the right must be pressed again.

Turning the dial on the right counterclockwise moves up in the list of options on the display. If the user is already on the topmost option (Mode), then the action has no effect. Turning the dial on the right clockwise moves down in the list of options on the display. If the user is on the Mode option, then turning one click clockwise will move to the Scale option. This will also move the black selector bar from highlighting Mode to instead highlight scale, as shown in the following image. If the current option is already at Trigger Delay, then moving the right dial clockwise has no effect.

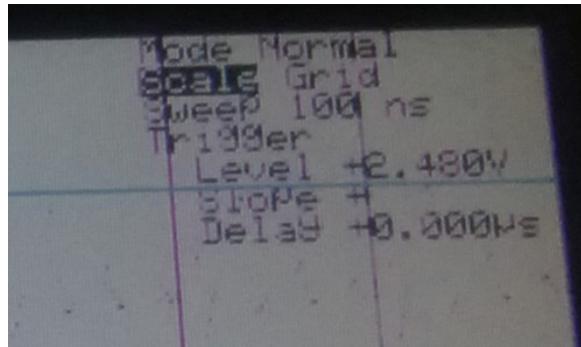


Figure 8: Move down to scale option in menu

Turning the dial on the left counterclockwise moves backwards in a list of settings for a specific option on the display. Turning that same dial clockwise moves forwards in a list of settings on the display. This can be used to change the value or choice for a option on the display (selected by the right dial). The option which is highlighted black will have all its possible settings gone through. If at the first possible setting, moving left (backwards) has no effect. If at the last possible setting, moving right (forward) has no effect either. For example, this dial can be used to change the scale to the next setting, as in the following image.

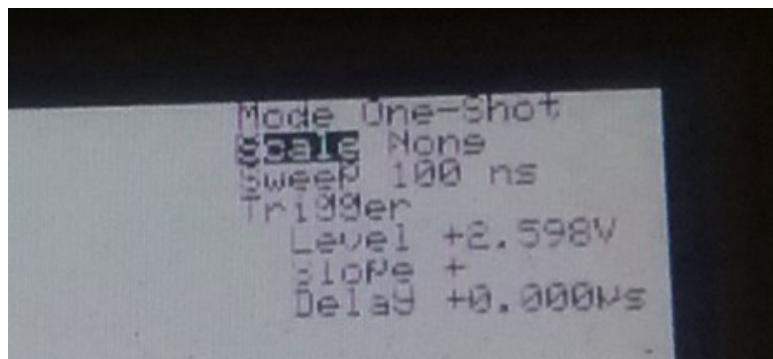


Figure 9: Move right between scale options in menu

Any changes done to the menu through the dials have effect immediately on the oscilloscope.

### 3.2 Mode

The **Mode** option changes what method of triggering is used for the analog signals entering the oscilloscope. When **Normal Mode** is used, only manual trigger events are used to generate a trigger. When the scope receives a trigger, then the trace will be redrawn. After the retrace of the analog signal on the display, the scope will wait for another trigger event.

When **Automatic Mode** is used, the same method of triggering will be used as for **Normal Mode**, except if a trigger event does not occur within 5 ms. In that case, the scope will trigger automatically, and a trace will be displayed for any data captured following this auto trigger event.

When **One Shot Mode** is used, the scope will only trigger once, immediately after this option is selected. After the trace is drawn for this trigger, the scope will not wait for another trigger. New triggers can only be generated if the right dial is used to scroll down to the **Trigger** option and the left dial is rotated either counterclockwise or clockwise. Each click of the left dial will cause one trigger event in the oscilloscope.

### 3.3 Scale

The **Scale** option is used to change the background of the trace being displayed. If **Axes** is selected, x (time) and y (voltage) axes are displayed behind the trace with regular tick marks along both axes. This is seen in the following image.

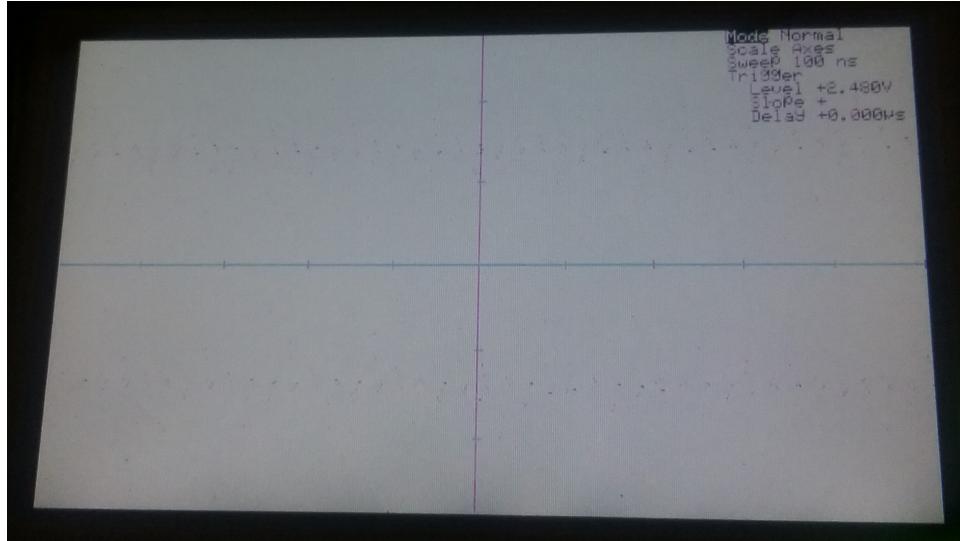


Figure 10: x and y axes shown with trace

If **Grid** is chosen, an x-y grid is shown behind the trace, with regular horizontal and vertical lines at the same locations as the tick marks in the **Axes** option. This allows for more easy reading of the exact time and voltage associated with any point on the trace.

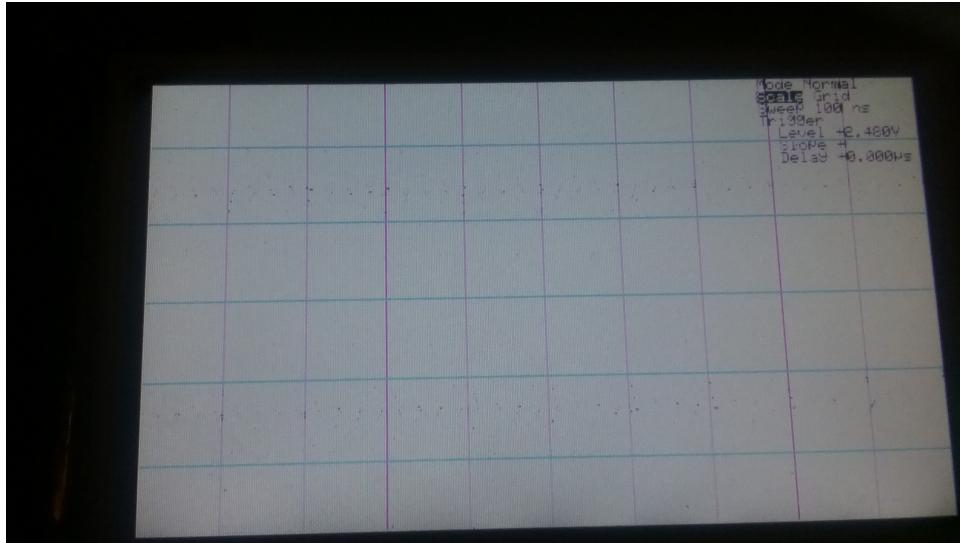


Figure 11: x and y grid shown with trace

If **Off** is chosen, no axes or grid is displayed, and the trace is shown on a plain white background.

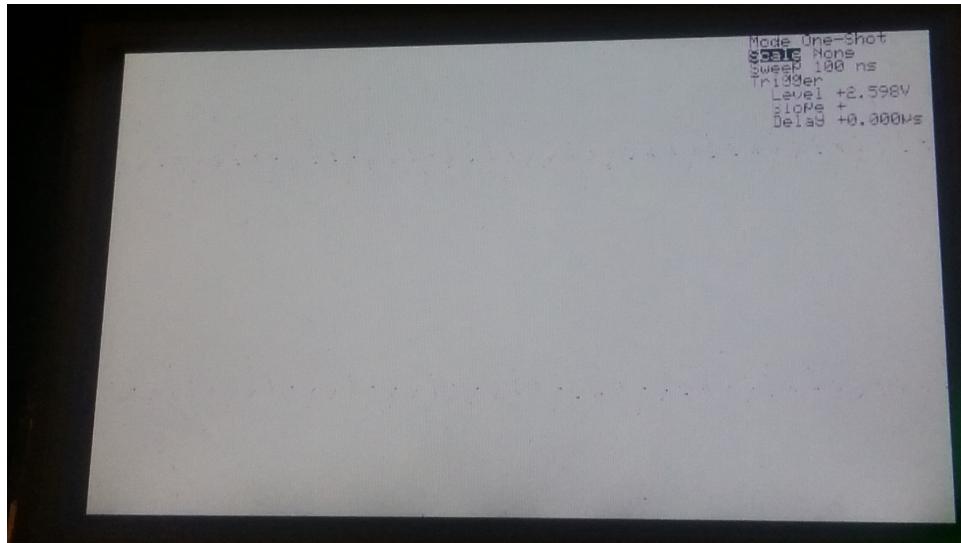


Figure 12: No x-y axes or grid shown with trace

### 3.4 Sweep

The **Sweep** option changes the sweep rate of the sample, which affects how often the analog signal will be sampled. The value is set in amount of time between samples of data, and the options are:

100 ns, 200 ns, 500 ns, 1 us, 2 us, 5 us, 10 us, 20 us, 50 us, 100 us, 200 us, 500 us, 1 ms, 2 ms, 5 ms, 10 ms, and 20 ms.

Moving the dial on the left clockwise causes the **Sweep** option to move to the right in the above list of sweep rates (increase sweep rate). Moving the dial on the left counterclockwise causes the **Sweep** option to move left in the above list of sweep rates (decreases sweep rate). Each pixel in the trace corresponds to a time equal to the sweep time. An example of the changed sweep rate is shown below.

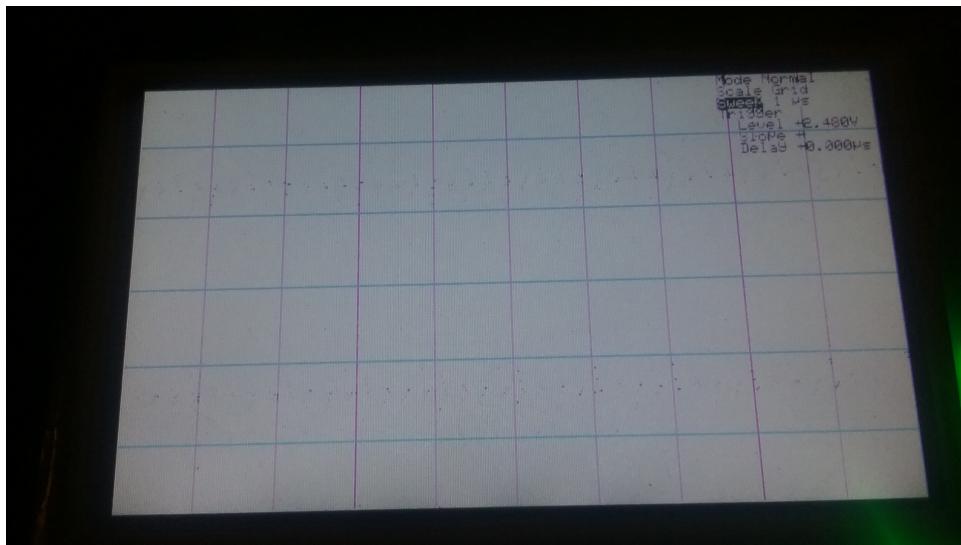


Figure 13: Sweep rate increased from 100 ns to 1 us

### 3.5 Trigger

The **Trigger** option is used only in **One-Shot Mode**. When this mode has been selected in the menu as well as the **Trigger** option, then turning the dial on the left clockwise or counterclockwise by one click will re arm the trigger in the scope. This will cause a new trace to be captured whenever the trigger level and slope allow a trace to be captured. If this does not happen, no trace will be displayed. Once a trace is captured, the scope will not capture any new traces until the dial is turned in either direction again.

### 3.6 Trigger Level

The **Level** option is used to set the trigger level of the scope. The trigger level can be set to any value between -12 V and 12 V, the minimum and maximum input voltages. The trigger level is increased in increments of slightly less than 200 mV. Moving the dial on the left clockwise when this option is selected increases the trigger level, and moving this dial counterclockwise decreases the trigger level. An example of increasing the trigger level is shown.

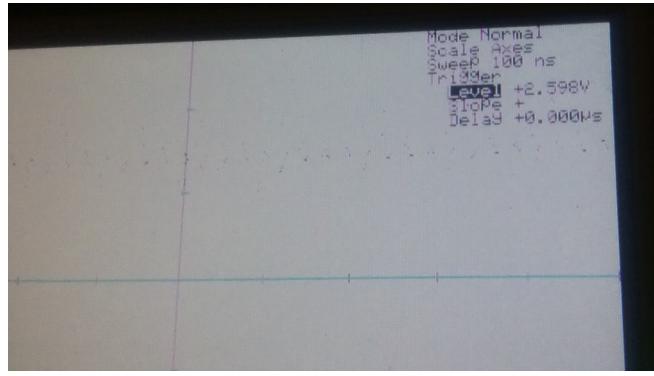


Figure 14: Trigger Level increased from 2.5 V to 2.598 V (Different minimum and maximum voltages in this display)

### 3.7 Trigger Slope

The **Slope** option is used to set the trigger slope of the scope. This value can either be + or -. If the slope is +, the scope will only be triggered when the signal passes the trigger level with a positive slope. If the slope is -, the scope will only be triggered when the signal passes the trigger level with a negative slope. The initial option is +, but moving the left dial (when the option is selected) clockwise will change the slope to be -. Moving the same dial counterclockwise when the slope is - will change the slope back to +. The following image shows the result of changing the trigger slope to -.

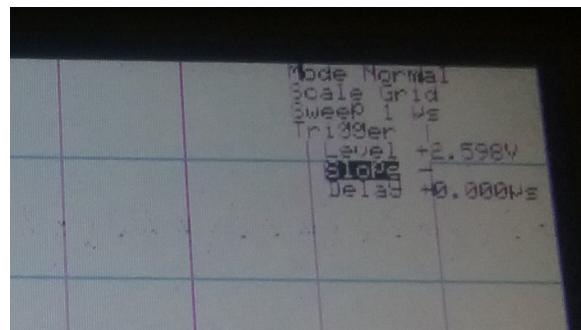


Figure 15: Trigger slope changed from positive to negative

### 3.8 Trigger Delay

The **Delay** option is used to set the trigger delay of the scope. The trigger delay determines how much time occurs between a trigger event and the trace starting (when the analog data is saved). The trigger delay can be set to any value between 0 and 50,000 times the current setting for sweep rate. In the case shown below, the sweep rate is 1 us and the trigger delay is 0.014 ms, so there are 14 samples between a trigger event and trace starting. Each click of the dial when changing delay indicates an increase or decrease by one sweep time, depending on the direction of rotation.

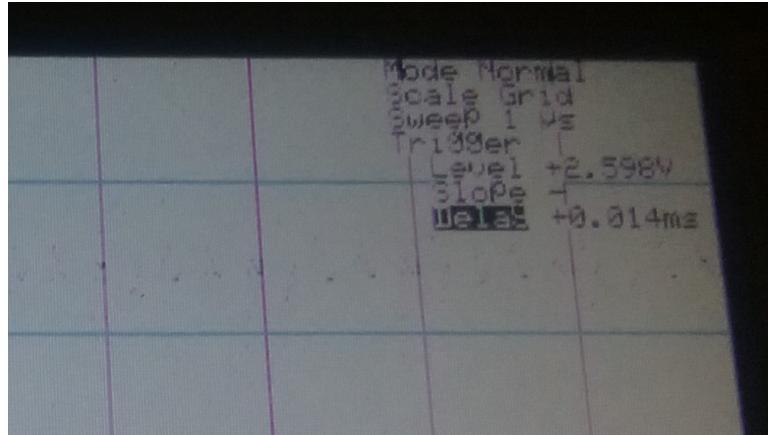


Figure 16: Trigger delay increased from no delay

## 4 Signals

Signals are input by connecting any signal source to the scope with a BNC cable, in the connector on the left in the below image. This connector is located on the right side of the oscilloscope.



Figure 17: Plug BNC cable into connector to input signals

The signals input can be analyzed on the display, which will display a trace for the signal generated based on the selected trigger level, slope, delay, sweep rate, and trigger mode. For example, a sine wave with a peak to peak amplitude of 7 V, slight positive DC offset, and frequency of 150 KHz would be displayed as follows. Since there is no trigger delay, the trace will start to be drawn immediately after the trigger level of 2.480 V is passed for the first time with a positive slope.

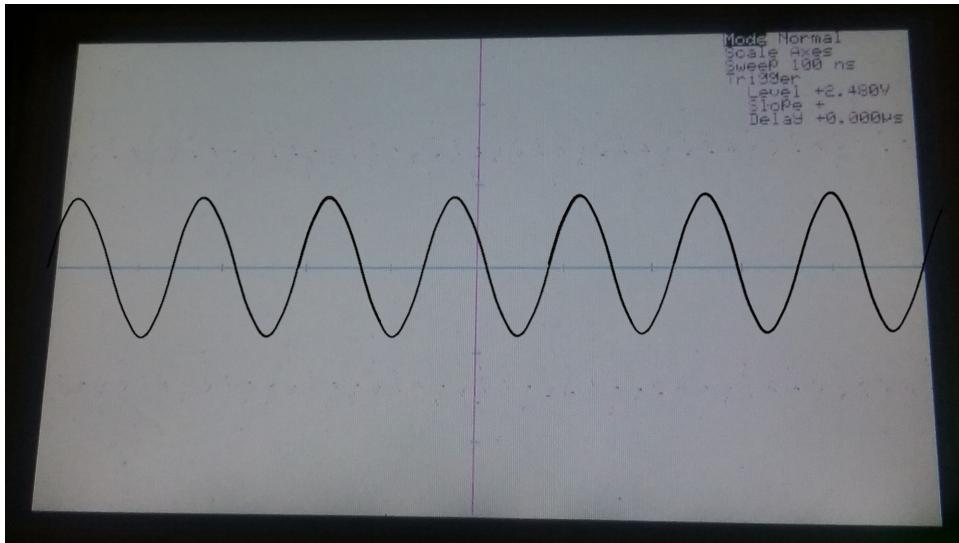


Figure 18: Theoretically, this is what the trace drawn will look like

Being able to visualize the signals input from the source rather than a constant ringing square wave trace will be included in the next release of the oscilloscope.

## 5 Safety, Handling, and Support

**Failure to read and follow instructions may result in injuries, or more likely, an inability to measure waveforms**

**Handling** Handle with care. Do not use if any wires are disconnected. If any components heat up excessively, unplug the oscilloscope as soon as possible

**Heat Protection** Some components in the oscilloscope may heat up after prolonged use. In this case, unplug the oscilloscope and wait for it to cool down before resuming use.

**Limits to Operation** The signal source has absolute ratings of between +12 V and -12 V. Signals input outside of this range will break the oscilloscope and may cause injury.

**Cleaning** For general use, the oscilloscope can be cleaned using rubbing alcohol. If the oscilloscope comes into contact with other substances, consult the manufacturer for specific instructions.

**Support** For more comprehensive information, the technical documentation is available. For personalized support, contact the manufacturer at [maashok@caltech.edu](mailto:maashok@caltech.edu).