Introduction to the Analog Discovery

The Analog Discovery from Digilent (http://store.digilentinc.com/all-products/scopes-instruments) is a versatile and powerful USB-connected instrument that lets you measure, visualize, analyze, record, and control mixed analog and digital signal circuits of all kinds. It replaces a number of much more expensive test equipment that would have been used in the past and uses your computer as the display and control interface.

There are two models of the Analog Discovery, either or which is acceptable:

- Analog Discovery – Used for a number of years in the ECE program, a number of used units should be available for purchase from old students. (https://www.youtube.com/watch?v=aYgFKIsrOYQ)
- Analog Discovery 2 – Released in 2016. Largely the same capability, but different packaging, and changed the fixed +/- 5 V supplies to two adjustable voltage supplies and added the option of using an external 5 V power source (as opposed to using power from the USB). (https://www.youtube.com/watch?v=2nAvh28o-t4)

The software that controls the Analog Discovery is called “Waveforms”. Previously, the original version of this software was used in various classes and so you may come across lab manuals written for the original version. This document will reference the new version of the software, called “Waveforms 2015”, which is compatible with both models of the Analog Discovery, and is compatible with Windows, Mac, and Linux.
1 Waveforms 2015 Software

1. The Waveforms 2015 software should be preinstalled on the various computers in the ECE labs. If you wish to use the Analog Discovery at home, download and install the software from:


   Select the appropriate operating system (Windows, MAC OS X, or Linux). At the time of the writing of this manual, the software version was 3.3.7.

2. Attach the Analog Discovery using the included USB cable to a USB port on the computer. If this is the first time, it sometimes takes a few minutes while it installs the proper USB driver, so you may have to be patient.

3. Start the WaveForms 2015 software. If everything is working properly, you should see something like Figure 1-1, with the device serial number displayed in the bottom of the window.

   ![Figure 1-1: Waveforms 2015 Main Window](image)

4. If you have problems, try unplugging and reconnecting the Analog Discovery from the USB port and restarting the WaveForms 2015 software.
2 Using Scope and Wavegen

One of the most frequent uses of electronic test equipment is to be able to observe constantly varying signal voltages, typically on a two-dimensional plot, with the horizontal axis representing time and the vertical axis representing the voltage of the signal(s). This function is referred to as “Scope” (which is an abbreviated form of the term “Oscilloscope).

For test purposes, it is also very important to be able to generate various “waveforms”, for example a sinusoid, and be able to set both the amplitude (in volts) and the frequency (in Hz) of the waveform(s). This function is referred to as “Wavegen”.

In this section, we will use the Analog Discovery to generate a waveform using one of its two “Wavegen” functions and view the waveform on one of its two “Scope” channels.

1. Connect "Waveform Generator 1" ("W1", yellow wire, see Appendix A) to "Scope Channel 1 Positive" ("1+", orange wire) and connect "Ground" (any one of the four black wires) to "Scope Channel 1 Negative" ("1-", orange-white wire) using one of the male to male connectors which came with your Analog Discovery (should look similar to Figure 2-1).

![Figure 2-1: Analog Discovery Connections](image)

2. To set up Wavegen Channel 1 (there are two independent waveform generators on the Analog Discovery), click the "WaveGen" button on the main WaveForms 2015 screen:

2.1. The screen should look similar to Figure 2-2.

2.2. Set "Frequency" to "2 kHz" and "Amplitude" to "2 V". Note that the time for one complete cycle of the sinusoid is shown as 500 µs (which corresponds to 2 kHz) and that “Disabled” appears with a red outline in the top-left corner of waveform plot (indicating that no signal is currently being output).

2.3. Make sure that Wavegen Channel 1 is generating its output by clicking on "Run". Note that the red “Disabled” should now be a green “Running”.

Rev B

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Note: The plot of the waveform shown is NOT the actual measured waveform, but rather a plot of waveform that the Analog Discovery is attempting to generate. To actually see the waveform, we use the “Scope” as outlined in the next section.

3. To set up Scope Channel 1 (there are two independent scope channels on the Analog Discovery although they are displayed on the same plot), click the “Welcome” tab on the Waveforms 2015 window to get back to the main screen and then click on “Scope”:

3.1. The screen should look similar to Figure 2-3.

3.2. Channel 1 is displayed in yellow and Channel 2 is displayed in blue. For now, turn off Channel 2 by unchecking “Channel 2” in the blue outlined panel on the right side of the screen.

3.3. Click on the “Single” button. This will attempt to capture one screen of waveform measurement. If everything is hooked up correctly and working, the screen should look similar to Figure 2-4. Note that the waveform is going from a maximum of 2 V to a minimum of -2 V as expected given the setting in Wavegen.

3.4. In the figure, the “Time Base” is set to “1 ms/div” with 10 divisions across the horizontal axis. Given we have a 2 kHz signal, we have two cycles per division. To be able to “zoom in” and see the signal a bit more clearly, we change the “Time Base”. Change “Time Base” to “200 us/div” and the screen should look similar to Figure 2-5.

3.5. Note that the waveform looks a bit “fuzzy”. This is due to the Waveforms 2015 software indicating the “noise” on the signal. To get a cleaner display, click on the setting button for Channel 1 (looks like a gear in the upper right corner of the yellow outlined panel) and uncheck “Noise”. Your screen should now look similar to Figure 2-6.
Figure 2-3: Initial Scope Screen

Figure 2-4: Scope with initial Single Capture
4. Waveforms 2015 provides some useful “Measurement” tools to measure various aspects of the captured waveform (although in our case, the waveform is quite simple and we can easily see the amplitude and verify the frequency):

4.1. Click on the “View” menu (part of the second menu “File | Control | View | Window”) and select “Measure”. This adds a “Measurements” panel to the Scope window (which should now look similar to Figure 2-7).
4.2. Click on “Add”, “Defined Measurement”, “Channel 1”, open the “Vertical” list, and click on “Amplitude”. Then click on the “Add” and “Close” buttons. The amplitude measurement for Channel 1 (indicated by “C1”), should now be shown.

4.3. Add a measurement for Channel 1 under the “Horizontal” list for “Frequency”. Your screen should now look similar to Figure 2-8.
3 Using a Second Wavegen and Scope

In this section, the goal is to add a second generated waveform and display it on Channel 2 simultaneously with Channel 1. The instructions will be much terser as this is meant to provide you with practice, using the information you learned in the previous sections.

1. Connect Wavegen Generator 2 to Scope Channel 2. Should be a total of four more wires (see section 2.1 for an example).
2. Go back to Wavegen (click on the Wavegen tab that should be visible). Under the “Channels” dropdown, click on “2”.
3. Set Wavegen Channel 2 to a 1 V (amplitude), 5 kHz Sine wave. Make sure both Wavegen channels are “running”.
4. Go back to Scope, enable Channel2 and turn off “Noise” on Channel 2.
5. Perform another “Single” capture.
6. Add measurements for Channel 2 for Amplitude and Frequency.
7. If everything is working correctly, you should see something similar to Figure 3-1.

![Figure 3-1: Scope with Two Channels Displayed](image-url)
Appendix A - Analog Discovery Pin Out

The Analog Discovery paired with the included 2x15 colored fly-wire:

- Trigger In (Gray)
- Ground (Black)
- Waveform Generator 1 (Yellow)
- V+ Power Supply (+5VDC) (Red)
- Ground (Black)
- Scope Channel 2 Positive (Blue)
- Scope Channel 1 Positive (Orange)
- Scope Channel 1 Negative (Orange/White)
- Scope Channel 2 Negative (Blue/White)
- Ground (Black)
- V- Power Supply (-5VDC) White
- Waveform Generator 2 (Yellow/White)
- Ground (Black)
- Trigger In (Gray/White)

Digital I/O Signals (Pink, Green, Purple, Brown)