

A Practical Exercise

Name: _____

Section: _____

I. Purpose.

1. Introduce the operation of the Oscilloscope.
2. Introduce the measurement of a DC voltage using the oscilloscope.

II. Equipment.

Agilent E3620A Dual DC Power Supply
Oscilloscope
560 Ohm resistor
220 Ohm resistor

III. Preparation.**IV. Lab Procedure.**

You must **read** and complete each step. **CHECK OFF EACH STEP as you complete it.**

Step One: Oscilloscope familiarization

The oscilloscope is basically a graph-displaying device. It draws a graph of an electrical signal. In most applications, the graph shows how signals change over time: the vertical (Y) represents voltage and the horizontal (X) axis represents time.

- Locate the oscilloscope and turn its power on. (Power push button is located on the top of the oscilloscope. Note the self-test sequence on power-up)

The oscilloscope can receive electrical signals from two probes, channel 1 (CH 1) and channel 2 (CH 2). We will attach adaptors to CH 1 and CH 2, so that they can receive electrical signals via our banana plugs.

- Locate the CH 1 input on your oscilloscope. Ensure that it has a two-input (RED / BLACK) banana plug adaptor.

Similar to the DMM, we can use the oscilloscope to measure voltage across elements in a circuit. E.g. via CH 1 RED / BLACK connections.

- Indicate on the circuit below (figure 1) how you connect CH 1 in order to measure the voltage across the voltage source.

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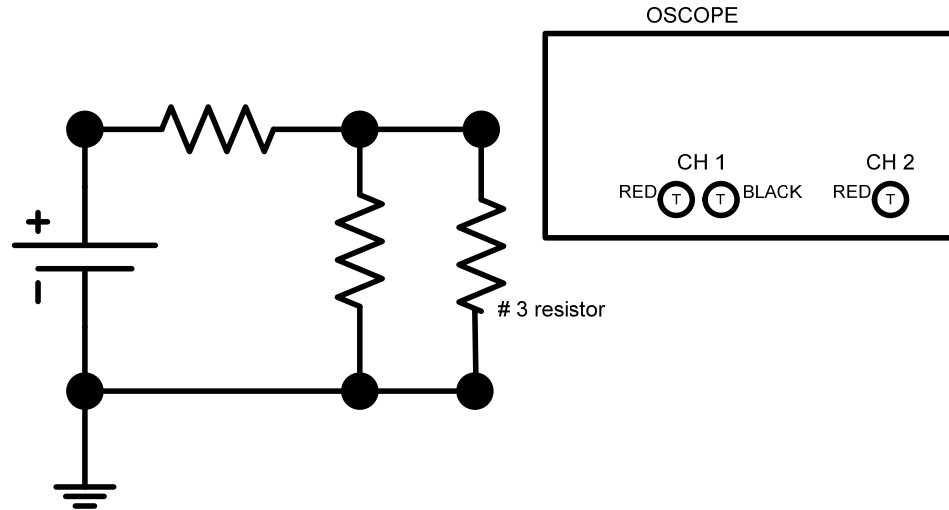


Figure 1

The oscilloscope has the ability to measure and display two different electrical signals, but only with respect to one common reference point. The BLACK CH 1 input provides this common reference point for CH 1 and CH 2. Therefore, CH2 has an adaptor for only one banana plug (RED).

- Locate the CH 2 input on your oscilloscope. Ensure that it has a one input (RED) banana plug adaptor.
- Indicate on the circuit above (figure 1) how you connect CH 2 in order to measure the voltage across the #3 resistor while CH 1 is still measuring the voltage source.

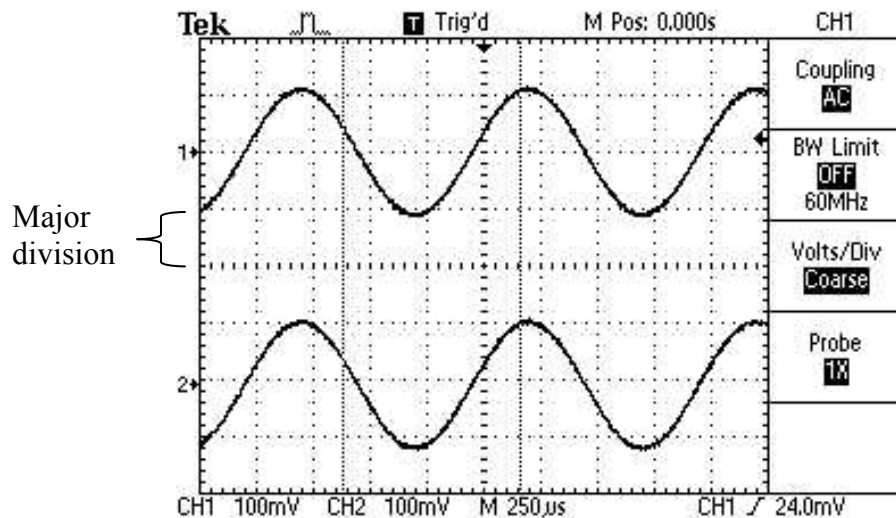
The oscilloscope has four different systems that affect the display for CH 1 and CH 2; a vertical system (voltage), a horizontal system (time), a trigger system, and a display system.

- Press CH 1 MENU on the oscilloscope. Note that this button will toggle on or off the display of channel 1.
- Using the buttons on the right side of the LCD screen, set CH 1 for:
 - Coupling: DC
Note that this button will toggle coupling between DC, AC, and GND. DC coupling allows all components of the electrical signal to be displayed. AC indicates alternating current. We will study alternating current in future lessons, but AC coupling only allows the alternating current component of the signal to be displayed. GND coupling disconnects the signal and displays where zero volts is located on the screen.
 - BW Limit: OFF
Note that this button reduces components of the electrical signal that you may not want to display. For the scope of EE 301 this is unnecessary, so BW (bandwidth) limit will remain off.

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- Volts/Div: COARSE
Note that this button sets the sensitivity level of the vertical display. For EE 301 we will always select coarse.
- Probe: 1X
Note that this button increases the voltage signal to be displayed. E.g. 1X means that the voltage is 1 times the displayed value.
- Invert: Off
Note that invert on will invert your signal on your display.

The oscilloscope display is divided up into major divisions (figure 2). Each major division represents a voltage unit for the selected Volts/Div. E.g. In figure 2 CH 1 and CH 2 indicate 100mV. Therefore each major division in the vertical axis represents 100mV. Similarly each major division in the horizontal axis represents the unit of time for the selected Sec/Div. E.g. In figure 2 each major division in the horizontal axis represents 250 μ s. Note that CH 1 and CH 2 can have different Volts/Div, but will always share the same Sec/Div.



100 mV per vertical division

Figure 2

250 μ sec per horizontal division

- With CH 1 menu selected adjust the position of the vertical axis zero level by rotating the position knob under the vertical section in the CH 1 column, so that the “1→” on the left side of the LCD is adjacent to the center horizontal major axis (centered vertically on the display).
- Adjust the VOLTS/DIV knob under the vertical section in the CH 1 column, so that CH 1 indicates 5 Volts/Div.
- Press CH 2 menu on the oscilloscope.

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- Using the buttons on the right side of the LCD screen, set CH 2 for:
 - Coupling: DC
 - BW Limit: OFF
 - Volts/Div: COARSE
 - Probe: 1X
 - Invert: Off

- Adjust the VOLTS/DIV knob under the vertical section in the CH 2 column, so that CH 2 indicates 5 Volts/Div.

- Adjust the position of the vertical axis zero level by rotating the position knob under the vertical section in the CH 2 column, so that the “2→” on the left side of the LCD is adjacent to the center horizontal major axis (centered vertically on the display).

- Press the HORIZONTAL MENU button on the oscilloscope.

- Using the buttons on the right side of the LCD screen, choose:
 - Main (not window zone or window)
Note that Main indicates that display adjustments will affect the main graph on the LCD.

 - Trig knob: Level
Note that Trig knob set to level allows the oscilloscope to trigger to an electrical signal when that electrical signal reaches a certain voltage level as determined by the Trig knob which we will discuss later.

- Adjust the SEC/DIV knob under the horizontal axis, so that the oscilloscope indicates 2.5 seconds per major division on the LCD.

- Press RUN/STOP button on the top right corner of the oscilloscope, so the ‘● STOP’ is indicated on the top on your LCD.

- Adjust the position of the horizontal axis zero level by rotating the position knob under the horizontal menu, so that the “↓” on the top of the LCD is adjacent to the center vertical major axis.

An oscilloscope’s trigger function allows you to stabilize repetitive electrical signals or capture a single-shot of an electrical signal.

- Press the TRIGGER MENU on the oscilloscope.

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- Using the buttons on the right side of the LCD screen, choose:
 - Edge
Note that Edge indicates that the oscilloscope display will begin on the edge of an electrical signal.
 - Slope: Rising
Note that slope rising indicates that the oscilloscope display will begin on the edge of a rising (increasing) signal. The oscilloscope display can also be selected to begin on a trailing (decreasing) signal.
 - Source: CH 1
The oscilloscope can use an alternate trigger source, whether or not it is displayed, so you should be careful not to unwittingly trigger on CH 1 while displaying CH 2.
 - Mode: AUTO
Auto mode causes the oscilloscope to sweep, even without a trigger. If no electrical signal is present, a timer in the oscilloscope triggers the sweep. This ensures that the display will not disappear if the signal does not cause a trigger. Normal mode causes the oscilloscope to sweep if the voltage signal reaches the set trigger point; otherwise the screen is blank or frozen on the last acquired waveform.
 - Coupling: DC
Note that this button will toggle coupling between DC and AC. DC coupling allows all components of the electrical to be displayed. AC indicates alternating current. We will study alternating current in future lessons, but AC coupling only allows the alternating current component of the electrical signal to be displayed.

- Adjust the LEVEL knob under the TRIGGER column, so that the “←” on the upper portion of the LCD is centered vertically.

- Press the DISPLAY push button on the oscilloscope.

- Using the buttons on the right side of the LCD screen, choose:
 - Type: Vectors
 - Persist: Off
 - Format: YT
 - Note that using the buttons for Contrast Increase and Contrast Decrease may make the LCD screen more viewable.

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- Press the CURSOR button on the oscilloscope.
- Press the top button (“Type”) on right side of LCD screen, to change cursor type. Cursor types are voltage, time, and off.
 - Voltage cursor
When the source indicates CH 1, adjust vertical position knobs to adjust voltage cursors to the top and bottom of CH 1 waveform. Note that the voltage values are displayed on the right side of the LCD screen.
 - Time cursor
Adjust vertical position knobs to adjust time cursors along the voltage signal. Note that the time differences between cursor are displayed on the right side of the LCD screen under period. Also displayed is frequency, the inverse of this period. Period and frequency are topic that will be covered later in this course.
- Press the second button from the top (“Source”) on right side of LCD screen to change the source. Sources can be CH1, CH2, MATH, REF A, and REF B. We will only use CH1 and CH2.
- Press the AUTOSET button on the oscilloscope.
If you cannot display the predicted electrical signal, you can try AUTOSET. AUTOSET will measure the input signals for the channels selected and attempt to display something meaningful. AUTOSET will not turn on a channel. After running AUTOSET, adjust the oscilloscope to display what you want.

Step Two: DC series circuit

- On a QUAD board construct the DC series circuit in figure 3.

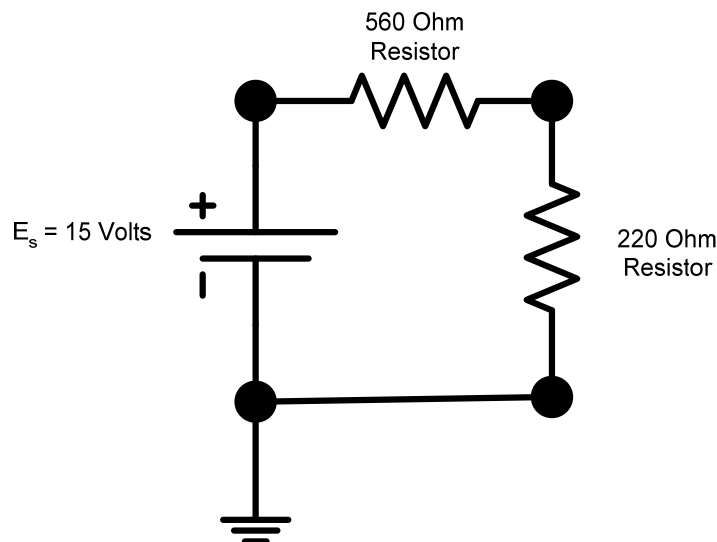


Figure 3

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Step Three: Measure voltage in the circuit with an oscilloscope.

- Connect Channel 1 of the oscilloscope to read the voltage source.
- Connect Channel 2 of the oscilloscope to read the voltage across the 220 ohm resistor.
- Adjust the oscilloscope as necessary to display CH 1 and CH 2 at the same time. Set both channels to 5 Volts/Div.

To display a steady state DC voltage in a purely resistive circuit, it may not be necessary to review all items in Step One. Consider the following items.

- With CH 1 and CH 2 connected and selected, press AUTOSET.
- Verify that DC coupling is selected for CH 1, CH 2, and TRIGGER.
- Verify the trigger mode is AUTO.
- Adjust CH 1 to 5 Volts/Div and CH 2 to 5 Volts/Div.
- Adjust the vertical positions for CH 1 and CH 2 so that each “→” points to the center major horizontal axis (i.e., is vertically centered).

Your LCD should be displaying steady state values (horizontal lines) for CH 1 and CH 2.

- Using the cursors on the oscilloscope measure the voltage values for CH 1 and CH 2, and complete the table below.

	Measured DC Voltage values
Voltage Source	
220 Ω resistor	