

California State University, Fresno

Department of Electrical and Computer Engineering

ECE 90L Principles of Electrical Circuits Laboratory
Experiment No. 1: Introduction to the Instruments

Objective

In this experiment you will become familiar with the instruments we will be using this semester. These instruments are:

DC Power Supply (Siglent)
Multimeter (BK Precision)
Synthesized Frequency Generator (GW Instek)
Oscilloscope (Tektronix)

Connectors, Cords, and Cables

A patch cord provides a single electrical path. A coaxial cable (coax) provides two parallel electrical paths. There are several types of connectors available to you: banana plug, alligator clip, and BNC connector. Refer to Appendix A of this document, and familiarize yourself with the connectors, cords and cables that are available in this laboratory.

Resistors

In this experiment, and indeed throughout this course, we will be measuring the voltage across a resistor in units of volts (V) and the current through that same resistor in units of amperes (A or “amps”). The voltage across a resistor and the current through that resistor are related by Ohm’s Law:

$$\text{Ohm's Law for a Resistor: Current (A)} = \frac{\text{Voltage (V)}}{\text{Resistance } (\Omega)}$$

DC Power Supply

The Siglent DC power supply has three DC voltage sources. Two have continuously adjustable voltages. The third voltage source offers a discrete selection of three different voltages.

As you face the Siglent unit, the channel 1 (CH1) source on the left has one black and one red terminal. The voltage provided by this source appears between the red and black terminals. There is a CH1 voltmeter and a CH1 ammeter built into the Siglent unit that measure the voltage and current, respectively, for the CH1 source.

In the middle is the channel 2 (CH2) source. This source also has one black and one red terminal. The source voltage appears between the red and black terminals. There is a CH2 voltmeter and a CH2 ammeter built into the Siglent unit.

The green terminal is ground. It is important to note that none of the black terminals are connected to ground (unless, of course, you make an external connection between a black terminal and the green terminal).

On the right is the third voltage source. It offers a discrete selection of three different voltages. The largest of these is approximately 5.0 V. The selected voltage appears between the red and black terminals. There are no meters in the Siglent unit for this third source.

We will usually refer to the red terminal of a voltage source as the + terminal and the black terminal as the – terminal. The + terminal has a higher potential than the – terminal.

Before a voltage appears between the red and black terminals, the source must be turned on. Each of the three sources has an On/Off button that is lit when that source is turned on and is unlit when that source is turned off. For each of these three sources, you can toggle between the on and off states by pressing the appropriate button.

The CH1 and CH2 sources can be used in any one of three different modes: independent, series, and parallel. In this course, you will use the independent and series modes. You will not use the parallel mode.

In the independent mode, the CH1 and CH2 sources are independent of each other. You can adjust the voltage of the CH1 source to one value, and the voltage of the CH2 source to another.

You can tell when the Siglent DC power supply is in independent mode because neither the Ser nor the Para buttons will be lit. If the Ser button is lit and you want to take the unit into independent mode, you will do this by pressing the Ser button. This has the effect of toggling the unit from series mode to independent mode (and, of course, the Ser button will then become unlit). Similarly, if the unit is in parallel mode (as indicated by a lit Para button), you will take the unit into independent mode by pressing the Para button.

In order to adjust the CH1 voltage, make sure that the CH1 voltmeter (V) setting is highlighted. If instead a CH2 meter setting is highlighted, press the 1 button. If the CH1 ammeter (A) setting is highlighted, press the left-pointing arrow button. Once the CH1 V setting is highlighted, use the Fine button to highlight the digit in the CH1 V setting that you wish to change, then use the tuning knob to change that digit. A similar procedure can be used to adjust the CH2 voltage. Once the CH1 or CH2 voltage is set to the desired value, that source must be turned on before the voltage becomes available across the red and black terminals.

Both the CH1 source and the CH2 source are current limited. This means that the source supplies the requested voltage only as long as a limit on the current is not exceeded. You can and should adjust the current limit of a source to a suitable value (in A) before connecting that source into a circuit. This helps protect the circuit and any instruments that you connect to the circuit. Use the following procedure to set the current limit for CH1. (A similar procedure is used to set the current limit for CH2.)

Set current limit for CH1

Use the following procedure to set the current limit for CH1 to 0.2 Amps (0.2 A). The current limit may already be set to 0.2 A because the Siglent power supply remembers the current limits that were in force the last time it was turned off. A current limit of 0.2 A should be used for all experiments in this laboratory.

1. If the left half of the display does not already have a green frame, press the 1 button.
2. If the CH1 current is not already highlighted, use the arrow buttons to highlight it.
3. Use the Fine button to select the digit to be changed.
4. Use the Large knob to change the digit.
5. Use the Fine button and the Large knob to adjust all digits to 0.20 A.

When a source supplies less than the maximum current, which will be the normal condition, C.V. is indicated with a green light and the requested voltage is supplied. When a source supplies the maximum current, C.C. is indicated with a red light and something less than the requested voltage is supplied.

Repeat the above procedure for CH2, so that it too has a current limit of 0.2 A.

Multimeter

The multimeter has numerous modes. Three of those modes are listed in Table 1.

Table 1: Some modes for the multimeter

Mode	Measurement	Red Terminal	Button
Ohmmeter	Ohms (Ω)	top	Ω
DC Voltmeter	Volts (V)	top	DC V
DC Ammeter	Amperes (A)	left	DC I (shift DC V)

In order to set the multimeter for one of these modes, it is necessary to plug cords into the correct terminals and to press the correct button. One cord (typically black) will go into the COM (black) terminal for every mode. The other cord (typically red) must go into the correct red terminal. (See Table 1.) The correct button is indicated in Table 1.

Ohmmeter

Use the multimeter in ohmmeter mode to measure resistance. You should use a resistance decade box and set it, initially, to 1 k Ω . Record the measured resistance. Complete the following table.

Table 2: Resistance Measurements

Resistor Setting (k Ω)	Measured Resistance (k Ω)	Percent Difference (%)
1		
5		
10		
50		

Study Figure A-6 of Appendix A, so that you understand how to use a BNC-to-bananas cable. Measure the resistance between the BNC connector's body and the banana plug nearest the tab. Measure the resistance between the BNC bayonet and the other banana plug. Both of these resistances should be relatively small (less than 100 Ω).

Study Figure A-7 of Appendix A, so that you understand how to use a BNC-to-alligators cable. Measure the resistance between the BNC connector's body and the black clip. Measure the

resistance between the BNC bayonet and the red clip. Both of these resistances should be relatively small (less than $100\ \Omega$).

DC Voltmeter

Use the multimeter in DC voltmeter mode to measure DC voltage. Voltage is a potential difference. A voltmeter measures the potential at the point of the voltmeter's red terminal minus the potential at the point of the voltmeter's black terminal.

On the Siglent DC power supply, select 5 V for the third source. Measure this voltage using the multimeter. Do this by connecting the COM (black) terminal of the multimeter to the $-$ terminal of the third source and connecting the correct red terminal of the multimeter to the $+$ terminal of the third source. The multimeter should indicate a voltage close to 5.0 V.

Reverse the roles of the multimeter terminals. In other words, connect the COM terminal of the multimeter to the $+$ terminal of the third source and connect the correct red terminal of the multimeter to the $-$ terminal of the third source. The multimeter should indicate a voltage of approximately -5.0 V.

If you think about it, you will realize that both of the above two voltmeter measurements tell the same story. The first measurement confirms that the $+$ terminal of the third source is about 5 V *higher* in potential than the $-$ terminal. The second measurement confirms that the $-$ terminal of the third source is about 5 V *lower* in potential than the $+$ terminal.

Measure the voltage of CH1. Do this by connecting the COM terminal of the multimeter to the $-$ terminal of CH1 and connecting the correct red terminal of the multimeter to the $+$ terminal of CH1. Adjust the CH1 voltage, initially, to 2 V. The voltage indicated by the multimeter should be close to the voltage indicated by the CH1 voltmeter. Complete the following table.

Table 3: CH1 Voltage Measurements

CH1 Voltage, as indicated by CH1 Voltmeter (V)	Voltage measured with Multimeter (V)	Percent Difference (%)
2		
5		
10		

Attempt to measure the voltage of the $+$ terminal of CH1 relative to ground. Do this by connecting the COM terminal of the multimeter to the ground (green) terminal and connecting the correct red terminal of the multimeter to the $+$ terminal of CH1. The multimeter will fail to

identify a stable, definite value for this voltage. The reason for this is that CH1 produces a definite voltage between its + and – terminals, but the potential of the + terminal is *not* defined relative to ground and the potential of the – terminal is *not* defined relative to ground. We say that the + and – terminals “float” relative to ground.

Connect the – terminal of CH1 to the ground (green) terminal, using a patch cord. This causes the – terminal to have the same potential as ground. (That is to say, the voltage between the – terminal and ground is 0.) We say that the – terminal is “grounded”. Since the potential of the + terminal is defined relative to that for the – terminal, the potential of the + terminal (with the patch cord in place between – terminal and ground) is now defined relative to ground. Use the multimeter to measure the voltage between the + terminal and ground. You should find that this voltage now has a definite value and that this value equals the voltage set for CH1.

Set the power supply for independent mode. Repeat the exercises that you did for CH1, but this time using CH2.

Table 4: CH2 Voltage Measurements

CH2 Voltage, as indicated by CH2 Voltmeter (V)	Voltage measured with Multimeter (V)	Percent Difference (%)
2		
5		
10		

DC Ammeter

Engineers define *conventional current* as flowing through a circuit from a point of *higher* potential to a point of *lower* potential. In the circuit of Figure 1(a), conventional current flows out of the + terminal of the source, down through the resistor, and into the – minus terminal of the source. We can envision this by imagining positive charges flowing out of the + terminal of the source, down through the resistor, and into the – minus terminal of the source. (Positive charges naturally want to flow toward a point of lower potential.)

The truth be told, what really happens at the atomic level inside this circuit is that negatively charged electrons flow out of the – terminal of the source, up through the resistor, and into the + terminal of the source. But the flow of negative charges in one direction is electrically equivalent to an equal number of positive charges flowing in the opposite direction. So we get the right answer here whether we think about positive charges flowing *down* through the resistor or about negative charges flowing *up* through the resistor.

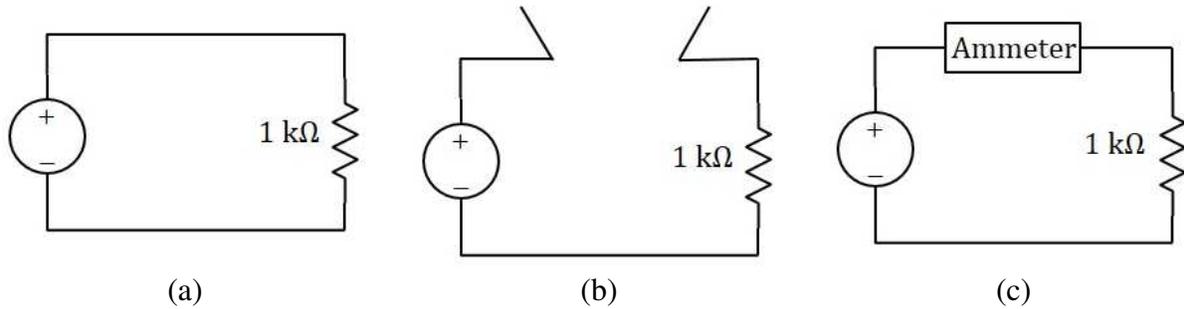


Figure 1: (a) We want to measure the current in this circuit. (b) We open the circuit.
(c) We insert the ammeter, closing the circuit.

By the way, it is not always the case in electronics that, at the atomic level, current is the result of flowing negative charges. Sometimes, current is the result of flowing positive charges. But inside metallic conductors (such as patch cords and coaxial cables) it is the flow of negatively charged electrons that produces current. In any event, in engineering we define conventional current as flowing through a circuit from a point of *higher* potential to a point of *lower* potential. For the rest of this course we will use the term “current” to mean conventional current.

There is something else you may be wondering about. Why do the positive charges (that we imagine flowing through the circuit) not take a short cut and flow from the + terminal of the source through the interior of the source to the – terminal of the source, bypassing the resistor? The answer is that the power supply works hard to force (conventional) current inside the source to flow from – terminal to + terminal. Of course, this is against the natural tendency of (conventional) current. So the power supply must consume energy in forcing the (conventional) current to flow in that direction through the source. That energy comes from the electric power grid. (You may have noticed that the Siglent power supply is connected to an electrical outlet.)

In order to measure the current in a circuit, it is necessary open the circuit, insert an ammeter, and then close the circuit. This is illustrated in Figure 1. The current to be measured must flow through the ammeter.

Use the following procedure to measure current:

1. Use either CH1 or CH2, and set its current limit to 0.2 A. (If you use CH2, make sure the power supply is in independent mode.)
2. Turn off the source (not necessarily the entire Siglent unit, just the voltage source that you will use for your measurement). It is good practice to have the power off when you are in the process of connecting it to a circuit.

3. Set one of the resistor decade boxes to 1 k Ω . (Verify this with the ohmmeter.)
4. Set the multimeter to DC ammeter mode.
5. Build the circuit of Figure 1(c) with the ammeter's red terminal connected to the + terminal of the source and the ammeter's COM terminal connected to the resistor.
6. Turn the voltage source back on.
7. Adjust the source voltage to 2 V, using the CH1 or CH2 voltmeter to make this adjustment.
8. Measure the current using the multimeter in ammeter mode.

The ammeter is designed so that when conventional current flows *into* its (left) red terminal and *out of* its COM terminal, the current is *positive*. In your measurement, the current was positive. (The displayed value was *unsigned*, which means that it was *positive*.)

Repeat the current measurement that you made above, but this time reverse the polarity of the ammeter in the circuit. In other words, the ammeter's COM terminal will now be connected to the + terminal of the source and the ammeter's red terminal will be connected to the resistor. Now the (conventional) current will be flowing "backwards" through the ammeter. You should find that the ammeter now indicates a negative current. You should recognize that in both of the two current measurements you have made, the (conventional) current flows *down* through the resistor.

Series Mode for DC Power Supply

When the Siglent power supply is set to series mode, the CH1 and CH2 voltages are the same. Series mode also causes the – terminal of CH2 to be internally connected to the + terminal of CH1. (By "internally connected", we mean that the connection occurs inside the DC power supply box.)

In the following exercise, the goal is to configure the Siglent unit to supply both +12 V relative to ground and –12 V relative to ground. Use the following procedure to accomplish this.

1. Set the Siglent unit for series mode.
2. Set the current limit to 0.2 A for both CH1 and CH2.

3. Place a patch cord between the CH2 – terminal and ground. (Instead, you could place a patch cord between the CH1 + terminal and ground. Since the CH2 – terminal and the CH1 + terminal are connected internally in series mode, this alternative placement of the patch cord achieves the same result.)
4. With the CH1 V setting highlighted, adjust the tuning knob for 12 V.

How does this work? By setting CH1 to 12 V, we cause the CH1 + terminal to have a potential that is 12 V higher than that of the CH1 – terminal. But because the CH1 + terminal is grounded, the CH1 – terminal is –12 V relative to ground. Because the Siglent unit is in series mode, CH2 also produces 12 V between its + and – terminals. Because the CH2 – terminal is grounded, the CH2 + terminal is +12 V relative to ground. Also, the CH2 + terminal is 24 V above the CH1 – terminal.

You should recognize that the grounding of the CH2 – terminal (or, equivalently, the grounding of the CH1 + terminal) is essential for this scheme to work. Without this grounding, the CH2 + terminal would be 24 V above the CH1 – terminal (as desired), but both terminals would (unfortunately) float relative to ground.

After following the above procedure, measure the voltage between the CH2 + terminal and ground. Use the multimeter in DC voltmeter mode for this measurement. This should be approximately +12 V. Measure the voltage between the CH1 – terminal and ground. This should be approximately –12 V.

Synthesized Frequency Generator and Oscilloscope

The synthesized frequency generator can produce a sinewave, square-wave, or triangle-wave. The frequency and amplitude can be selected. The main display shows either the frequency or the amplitude.

Program the synthesized frequency generator to produce a sinewave of frequency 5.0 kHz and amplitude 1.0 V. Figure 2 shows how to select a sinewave and how to activate the signal. **You must press the “OUTPUT ON” key, or there will be no signal at the main terminal.** Figure 3 shows how to set the frequency. Figure 4 shows how to set the amplitude.

Activate waveform

Sine / Square / Triangle



1. Press the wave key repeatedly. The corresponding indicator appears on the display.



Sine waveform



Square waveform



Triangle waveform



2. Press the output key. The LED turns On.

OUTPUT
50Ω



3. The waveform comes out from the main terminal.
10V_{p-p} (50Ω load)
20V_{p-p} (no load)

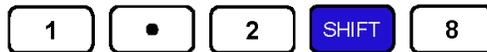
Figure 2: Synthesized frequency generator: activate waveform [GW Instek, “Synthesized Frequency Generator, SFG-1000 Series, User Manual”]

Set Frequency

Enter frequency

Enter the waveform frequency using the numerical keys.

1.2MHz



MHz

37kHz



kHz

45Hz



Hz

Figure 3: Synthesized frequency generator: set frequency [GW Instek, “Synthesized Frequency Generator, SFG-1000 Series, User Manual”]

Set Amplitude

Amplitude setting does not apply to TTL output (page25).

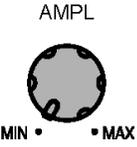
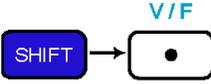
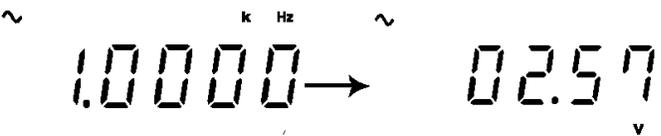
Set Amplitude		Turn the Amplitude knob right (increase) or left (decrease). The range is 2mVpp ~ 10Vpp for 50Ω output impedance.
View amplitude (SFG-1013)		To view the voltage level (amplitude), press the Shift key and dot (V/F) key. The display shows the voltage level. Repeat this procedure to go back to the frequency level view.
		

Figure 4: Synthesized frequency generator: set amplitude [GW Instek, “Synthesized Frequency Generator, SFG-1000 Series, User Manual”]

Connect the output of the synthesized frequency generator to channel 1 of the oscilloscope.

Read Appendix B of this document. In order to obtain a stationary display of the sinewave on the oscilloscope, the instrument’s settings must be set appropriately. It takes some skill to use an oscilloscope effectively, and you will develop this skill in this course. For now, try to get a stationary display of a few cycles of the sinewave. Adjust both the vertical and horizontal scales to achieve a good display.

Take the following actions, in order to get a feel for oscilloscope operation:

Initially set the trigger level to 0 V. You should be able to achieve a stationary display. If you have trouble with this, check that channel 1 is the trigger source and that the trigger level is really 0 V.

Turn off the channel-2 display. (You only have a signal on channel 1. There is no need to have a horizontal 0-V line displayed for channel 2.) If the Ch2 menu is not the active menu, then you can dismiss the channel-2 display by pressing the Ch2 menu button twice.

On the synthesized frequency generator, change the amplitude of the sinewave. Observe how the oscilloscope display has changed. Then return the sinewave amplitude to 1.0 V.

Adjust the trigger level. You should be able to change the point on the vertical axis through which the trace passes. As long as the trigger level remains between -1.0 V and $+1.0$ V, the display should remain stationary.

Set the trigger level to 1.5 V. The display should become non-stationary.

Return the trigger level to 0 V. The display should become stationary again.

Move the sinewave from channel 1 to channel 2.

Turn on the display for channel 2, and turn off the display for channel 1. If the Ch1 menu is not the active menu, then you can dismiss the channel-1 display by pressing the Ch1 menu button twice.

Change the trigger source to channel 2, and obtain a stationary display of the channel-2 signal.

Adjust both the vertical and horizontal scales to achieve a good display.

You may have noticed on the oscilloscope that a sinewave provided by the synthesized frequency generator has a small DC bias. You can adjust this DC bias using a knob on the synthesized frequency generator. Pull the offset knob towards you, and then turn the knob. Adjust the DC bias to zero. You can accomplish this by turning the offset knob (which has been pulled towards you) while simultaneously watching the oscilloscope to observe how the DC bias changes.

Edit the frequency of the synthesized frequency generator. Figure 5 shows how you can edit the frequency. For each new value, measure the frequency and peak-to-peak voltage on the oscilloscope using the Measure menu. Complete the following table.

Table 5: Voltage vs Frequency Measurements

Selected Frequency (kHz)	Measured Peak-to-Peak Voltage (V)	Measured Frequency (kHz)
5 kHz		
7 kHz		
9 kHz		

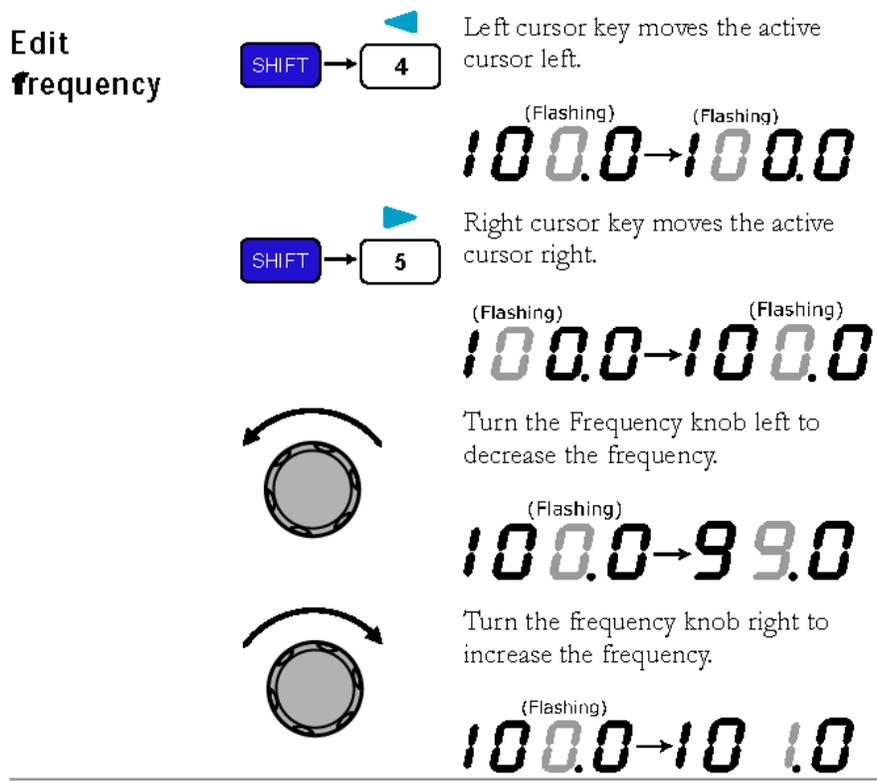


Figure 5: Synthesized frequency generator: edit frequency [GW Instek, “Synthesized Frequency Generator, SFG-1000 Series, User Manual”]

Change the frequency back to 5.0 kHz. Now change the sinewave to a square-wave, then to a triangle-wave. Observe these signals on the oscilloscope.

Appendix A: Connectors, Cords, and Cables



Figure A-1: Banana plugs



Figure A-2: Alligator clips (also known as “crocodile clips”)



Figure A-3: Patch cord with banana plugs, providing one electrical path

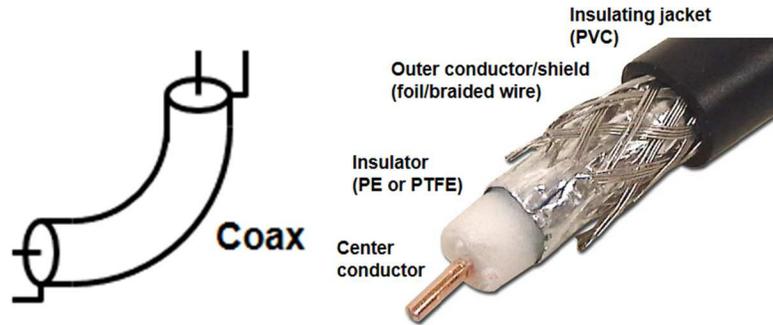


Figure A-4: Coaxial cable (coax), providing two parallel electrical paths



Figure A-5: BNC (Bayonet-Neill-Concelman) connectors, used with coaxial cables. Named for the bayonet locking mechanism and two inventors.

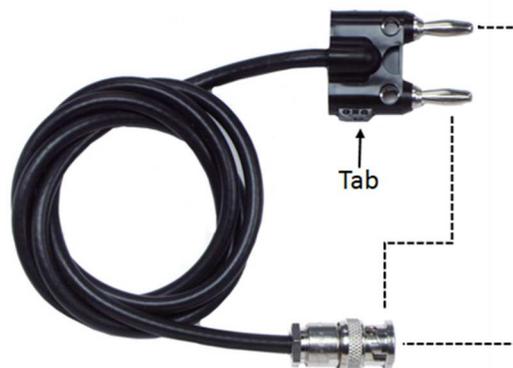


Figure A-6: BNC-to-bananas cable, providing two parallel electrical paths. The banana plug near the tab forms an electrical path with the cable's outer conductor and the BNC connector's body. The banana plug away from the tab forms an electrical path with the cable's center conductor and the BNC connector's bayonet.



Figure A-7: BNC-to-alligators cable, providing two parallel electrical paths. The black alligator clip forms an electrical path with the cable's outer conductor and the BNC connector's body. The red alligator clip forms an electrical path with the cable's center conductor and the BNC connector's bayonet.



Figure A-8: BNC T Adaptor

Appendix B: Digital Storage Oscilloscope

In this laboratory, a digital storage oscilloscope is available to you. The most common use of the oscilloscope is to display a voltage as a function of time. So, for example, if a signal with a voltage

$$y(t) = A \sin(2\pi ft)$$

is placed on one of the inputs (channel 1 or channel 2) of the oscilloscope and if the oscilloscope is properly configured, then the screen will display a two-dimensional plot of $y(t)$ that looks like the sine function. You can display two signals simultaneously: the channel-1 signal and the channel-2 signal. The remainder of this appendix explains more about how to properly configure an oscilloscope, in order to get a suitable display of the signal or signals.

Signal Display

The signal is displayed on a set of axes. The vertical axis is the vertical line that is horizontally centered in the display. The horizontal axis is the horizontal line that is vertically centered in the display. The intersection of these two axes is the origin.

There are ten horizontal divisions in the signal display area. (Some of those on the right-hand side may be obscured by a menu.) The time span for one division is displayed at the bottom of the screen. For example, “1.00 ms” means that each horizontal division represents 1.00 ms and the entire ten divisions represents 10.0 ms. The horizontal scale can be changed by the user; this is accomplished by rotating the Scale knob located just below the Acquire menu button.

There are eight vertical divisions in the signal display area. The channel-1 signal and channel-2 signal each have their own scales. For example, the channel-1 scale, which appears in yellow, might have 1.00 V per division while the channel-2 scale, which appears in blue, might have 2.00 V per division. For each channel there is a Scale knob to adjust the number of volts per division. These Scale knobs are located just below the Ch1 menu button and the Ch2 menu button.

The horizontal axis does not always represent 0 V. You can change the vertical position of a signal so that 0 V appears on, above, or below the horizontal axis; and you can accomplish this with a Position knob. The channel-1 Position knob is located just above the Ch1 menu button. The channel-2 Position knob is located just above the Ch2 menu button. It is recommended that you normally set the positioning such that the horizontal axis represents 0 V for both signals.

Menus and Submenus

As you look at the oscilloscope, to the right of the screen is a column of buttons. We call these “soft buttons” because each of these buttons is used to select an item from a menu, and the menus are prepared by software residing in the oscilloscope. For each soft button, the available items that may be selected are shown on the oscilloscope screen, to the left of the soft button. If you see no menus on the screen, it is because a hard button (that is, a non-soft button) must first be pressed in order to call the menu.

Here is the procedure for working with menus. First, press the hard button that calls the menu you want. That menu should then display on the screen. Second, press the appropriate soft button for the property you want to change. Pressing this soft button causes, in some cases, a second menu (a submenu) to appear on the screen. When the oscilloscope wants you to make a selection from a submenu, a green light will appear next to the Multipurpose knob. Third, use the Multipurpose knob to select an item from a submenu. You do this by rotating the Multipurpose knob until the desired item is highlighted and then pressing the Multipurpose knob.

You can dismiss a submenu or menu by pressing the round “menu off” button located below the column of soft buttons. It is recommended that you dismiss submenus and menus after you have made your selection, so that the entire screen can then be devoted to displaying the signal.

In this appendix, four menus are discussed, and each is invoked by the pressing of a hard button. There are more than four menus available, but for elementary operation of a digital storage oscilloscope, it suffices to be familiar with just these four: Ch1, Ch2, Trigger, and Measure.

Ch1 Menu

This menu presents options for a signal present on channel 1. The yellow button labeled 1 calls this menu. Below is a discussion of some (but not all) options on this menu.

Coupling If DC is selected, then the signal on the channel 1 input is displayed on the screen, as is, without filtering. (Even the DC component is included, hence the name DC for this selection.) Most of the time, you will want to use DC coupling.

If AC is selected, then the DC component is removed, so that only the AC component is displayed. For example, if the signal at the channel 1 input is $y(t) = C + A \sin(2\pi ft)$, then the DC component C is removed and only $A \sin(2\pi ft)$ is displayed on the screen. This option can be useful if you are not interested in the DC component of the signal.

If Ground is selected, then 0 V is displayed. You will probably want to select Ground coupling at the beginning of a laboratory session, in order to position the channel-1 signal so that the horizontal axis represents 0 V. Of course, once you have done this, you will want to make a new selection for Coupling.

Probe For this course, you will want the Probe selection always to be 1X. This means that the signal at the channel-1 input will not be multiplied before being displayed. (We can equivalently say that the signal will be multiplied by a factor of 1.)

An experienced oscilloscope user might employ an oscilloscope probe (the connection between the circuit under test and the oscilloscope input) that divides the signal by a number. For example, a probe might divide the signal by 10. If the oscilloscope is to display the true signal level, as it exists in the circuit (and *not* at the input of the oscilloscope), then the oscilloscope has to be told about this division by 10 that occurs within the probe, so that the oscilloscope can multiply the signal on its input by 10. In this case, the Probe selection should be 10X. (It is probably not obvious to you why someone would want to divide by 10 in the probe and then compensate within the oscilloscope with a multiplication by 10. There are situations where this is advantageous, but we will not face any of these situations in this course.)

Ch2 Menu

This menu presents options for a signal present on channel 2. The blue button labeled 2 calls this menu. The Ch2 menu has the same set of options as the Ch1 menu. When you select an option on the Ch2 menu, only the display of the channel-2 signal is affected, of course. You will make a separate selection from the Ch1 menu to affect the display of the channel-1 signal.

You should check that the Probe selection is 1X both on the Ch1 menu and on the Ch2 menu at the beginning of every laboratory session. You will probably want to define the horizontal axis as 0 V for each channel; you can accomplish this with Ground coupling and the Position knob for each channel.

Often you will want only one signal to appear on the oscilloscope display. For example, you might have a signal on the channel-1 input and nothing on the channel-2 input. In this case, you don't want to see a display of 0 V for channel 2 on the display. You only want to see the channel-1 signal on the display. To turn off the channel-2 display, do the following. First, make sure that the Ch2 menu appears; you may have to press the Ch2 menu button to make this happen. Second, press the Ch2 menu button again to dismiss the display of the channel-2 signal. So, for example, if some other menu is showing or no menu is showing, press the Ch2 menu button twice (once to call the Ch2 menu and a second time to dismiss the display of the channel-2 signal).

Trigger Menu

If a signal is not properly triggered, its display will not be stationary. We want a stationary display of the signal in order to make accurate measurements.

The Trigger menu is called by a button labeled Menu that is located in the Trigger group of two buttons and one knob. Below is a discussion of some (but not all) options on the Trigger menu.

Mode	We will normally want Auto mode.
Type	We will normally want Edge.
Slope	We will normally want Rising.
Source	Triggering is done on the signal from the Source that you select. For example, if you have a signal on channel 1 and nothing on channel 2, then you will want to trigger on the channel-1 signal. In this case, you will select Ch1 as the Source.

When selecting a Rising Edge for triggering, we are asking the oscilloscope to position the signal horizontally so that the signal trace passes the vertical axis with a positive slope (that is, a “rising edge”) at the trigger level. For example, if the trigger level is set to 0.5 V, the signal trace should be at 0.5 V with a positive slope where the trace crosses the vertical axis. The trigger level is indicated on the oscilloscope display.

You can change the trigger level. This is accomplished with the trigger-level knob, which is labeled Level and is located in the Trigger group of two buttons and one knob. You have a lot of flexibility in selecting the trigger level. However, the trigger level must lie within the range of voltages experienced by the signal. For example, if the signal is a sinewave with an amplitude of 1.0 V (so that the signal always lies between -1 V and $+1$ V), then the trigger level must lie between -1 V and $+1$ V.

Measure Menu

The Measure menu is called by the Measure button. This menu offers you a selection of measurements for the channel-1 signal and also a selection of measurements for the channel-2 signal. Examples of the measurements are: period, frequency, peak-to-peak voltage.