

Physics 251 Laboratory

Oscilloscopes, Signal Generators and Periodic Signals

Introduction:

An oscilloscope (often just called a 'scope) is an instrument that will plot a voltage versus time graph. The horizontal axis of the scope is time and the vertical axis is voltage. Both axes are calibrated so you can read voltages and times off the screen directly in seconds or volts. If a signal has a regular period, then it is possible (though not always easy) to make the oscilloscope trace out a regular pattern on the screen. Oscilloscopes are probably the single most powerful piece of test equipment in the electronics world. It is unlikely that anyone can pursue a career in science or engineering without having to use one once in a while. Oscilloscopes are not as easy to use as, say, a multimeter, but they are well worth the trouble.

A signal generator is a device that creates a periodic voltage signal. The amplitude, frequency and "waveform" (that is, sine wave, square wave, sawtooth wave, etc.) can all be controlled by adjustments on the device. We will use these generated signals as inputs to electronic circuits and observe the output of those circuits using the oscilloscope.

Equipment and Supplies

Signal Generator	Oscilloscope
Coaxial cables with clips (3)	Coaxial cables without clips (1)
Power supply	Capacitor (40 μ F)
Decade resistance box (Set at 50 Ω)	

Section 1

To set up the signal generator, follow this procedure

1. Connect a coaxial cable from the **MAIN** output of the signal generator to the **CH1** input of the 'scope.
2. Select **RANGE** to be **1K** from the upper row of buttons on the signal generator and select a sine wave **FUNCTION**.
3. Set the **Frequency** knob to **1.2** and turn the **AMPLITUDE** knob all the way up.
4. Select **VOLTS** to be 0-20V and be sure the **DC OFFSET** button is pushed in.
5. Turn the signal generator on; the red LED above the switch should glow.

At this point the signal generator will be producing a 1.2kHz sine wave with amplitude of 20V.

To set up the 'scope, follow this procedure

1. Push the **ON/STBY** button at the lower left corner of the 'scope. Allow the Oscilloscope to "power up".

2. Push the **CLEAR MENU** button on the lower right corner of the screen to get rid of the startup message.
3. If there is no display, press the button labeled **WAVEFORM OFF** which is at the bottom of the vertical row of buttons on the main panel to the right of the screen.
4. Keep pushing this button until all of the green LED's are off.
5. Press the **AUTOSET** button in the middle of the main pane.

At this point a stable sine wave should be displayed. If you get into trouble later, you can always follow steps 3,4 and 5 to get back to a stable point.

Now that a stable display has been achieved, turn your attention to the signal generator. Turn the frequency knob back and forth while observing the display on the 'scope. The sine wave will expand and contract. If you rotate the amplitude knob, the sine wave will rise and fall around a horizontal axis. If you push the other function buttons, the sine wave will be replaced by a square or sawtooth wave of equal amplitude and frequency. Using the range buttons, you can cover a large range of frequencies.

Adjusting horizontal and vertical scales on the oscilloscope

Adjust the horizontal scale using the **HORIZONTAL SCALE KNOB** so you can see the waveform as you scan through the range of frequencies.

Adjust the vertical scale using the **VERTICAL SCALE KNOB** so you can see the complete waveform as you scan through the amplitudes.

Push the **AUTOSET** button to return to the original display configuration.

Adjusting the position of the wave on the screen

Adjust the position of the sine wave using the **HORIZONTAL OR VERTICAL POSITION** knobs. Notice the **1->** at the left side of the screen. This is the zero for the wave on Ch1.

Measure period, frequency and amplitude of the sine wave on the oscilloscope.

There are two methods to do this – manually using screen cursors and automatically using the oscilloscope measure button.

Using screen cursors:

1. Push the **CURSOR** button to get the cursor menu on screen.
2. Push the button next to the **HBARS** display.
3. Move the solid line to the bottom of the sine wave using the **CURSOR** knob at the upper left of the main panel.
4. Push the **SELECT** button at the upper left end of the main panel, and the solid line turns into a fixed dashed line.
5. Now, the other cursor will be a solid line. Move it to the top of the sine wave using the same knob.

You can read the amplitude of your sine wave. It is displayed next to the Δ symbol at the upper right corner of the screen. Next, we will measure the period and frequency.

1. Push the **VBARS** button.

2. Adjust the vertical cursors using the procedure above. Bracket a single full wavelength of the sine wave.

You can now read the period and frequency of the sine wave in the same place you read the amplitude in the previous exercise. Pushing the **TIME UNITS** (in the horizontal row of buttons for the main menu below the screen) will allow you to switch back and forth between period and frequency.

Using 'scope **MEASURE** feature

These same measurements can be made automatically by pushing the **MEASURE** button in the upper-middle area of the main panel. Use the horizontal **SELECT MEASUREMENT FOR CH1** choices, and the vertical buttons to get the desired measurement. There are six screens of menus with useful measurements like period, frequency, Pk-Pk voltage, amplitude, RMS voltage, etc. To erase the measurements, use the horizontal menu **REMOVE MEASUREMENT** button to selectively remove one or all measurements.

The **CLEAR MENU** button removes the menu choices to decrease screen clutter.

Section 2

Your oscilloscope uses a feature called “triggering”, which synchronizes an observed signal with an external source. Normally, your scope automatically synchronizes two (or more) signals for ease of observation (not all oscilloscopes do) by triggering one signal to “begin” when the other signal reaches a pre-determined condition (slope of line or amplitude is most common). It is sometimes useful, however to alter these pre-determined conditions to suit one’s needs.

Triggering

Set up an example of how to use the triggering function on your 'scope

1. Disconnect the coaxial cable from the signal generator to the 'scope.
2. Set up a capacitor, a resistor decade box (set at 35Ω) and your signal generator in series (attach a coaxial cable with clips to the **MAIN** output terminal on the signal generator). Remember, a series circuit should make a circle.
3. Use the 'scope to observe the signal across the capacitor using a coaxial cable with clips on channel 1.
4. Attach a coaxial cable (without clips) from the **SYNC** output terminal on the signal generator to channel 2 of the oscilloscope.
5. Set the frequency on the signal generator to 1.2kHz and a square wave.

You will now see two signals on the screen. Channel 1 is across the capacitor and channel 2 is a signal in synch with the voltage source of the circuit. The display may not be stable at this point. To stabilize the display, locate the **TRIGGER MENU** button in the lower right area of your oscilloscope. Pressing the “trigger menu” will bring up a selection of options along the bottom of your screen.

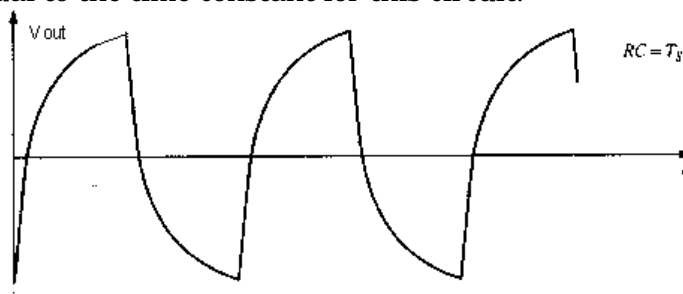
1. Press **TYPE** until the selection “edge” appears
2. Press **SOURCE**, then select “Ch2”

3. Press **COUPLING**, then select "AC"
4. Press **SLOPE**, then choose the upward slope (the top selection)
5. Press **LEVEL**, then use the general function knob (same knob that moves the cursor bars) to select "0 volts"

The above procedure sets the 'scope to trigger the signal on channel 1 to start when the signal on channel 2 is at 0,0 on the upward slope.

*Be careful. If you press **AUTOSET**, all of your selections will revert to factory programmed presets!*

1. What happens to the signal on channel 1 when you remove the black clip of the coaxial cable from the 'scope? Why?
2. Calculate the time constant for this circuit.
3. What happens to the waveform as you scan through the 1k frequency range? Draw pictures and label whether the period of the square wave is less than, greater than or equal to the time constant for this circuit.



4. Use the scope to measure the time constant for this circuit. Remember the change in current in a circuit with a charging or discharging capacitor is given by $i = I_0 e^{-t/RC}$ and $V=IR$.

Play with the trigger menu awhile...

1. What do you observe when you change your **SLOPE** and **LEVEL** selections?
2. What are you observing when you alter the source from Ch2 to Ch1?

NAME _____ DATE _____

LAB PARTNERS _____

Oscilloscopes, Signal Generators and Periodic Signals Results

Section 1

1. Using cursor bars, measure

amplitude _____ frequency _____ period _____

2. Using measure function, record

amplitude _____ frequency _____ period _____

RMS voltage _____

Section 2

1. What happens to the signal on channel 1 when you remove the black clip of the coaxial cable from the 'scope? Why? _____

2. What is the calculated time constant for this circuit? _____

3. What happens to the waveform as you scan through the 1k frequency range? Draw pictures and label whether the period of the square wave is less than, greater than or equal to the time constant for this circuit.

4. What is the 'scope measured time constant for this circuit? _____

5. What do you observe when you change your **SLOPE** and **LEVEL** selections? _____

6. What are you observing when you alter the source from Ch2 to Ch1? _____

Overall

Tell "the boss" about one other feature of the oscilloscope that we have not discussed today.

Hint: Use the menu buttons and see what else you can do with the oscilloscope.

What was good about this lab and what would you do to improve it?
