EE2111A Activity Sheet - Week 2 Studio 2

Review and revision of equipment

Start	Duration	Activity
0:10	30 mins	Briefing
0:40	30 mins	Activity #1: Oscilloscope - basic measurements
1:10	30 mins	Activity #2: Oscilloscope - triggering
1:40	20 mins	Activity #3: Oscilloscope - coupling
		Review of signal generator
2:00	30 mins	Activity #4: Capturing single-shot events

Group size: *Individual activity.*

Learning Objectives

To be able to

- observe and measure time-varying signals using oscilloscope,
- explain oscilloscope triggering,
- explain input coupling of oscilloscope,
- capture single shot event using oscilloscope,
- generate standard signals using signal generator.

Components:

- Electrolytic capacitor, $3300\mu F$
- Resistor, $220\Omega \times 2$

Equipment

- Oscilloscope
- Signal generator

Activity #1 : Oscilloscope - basic measurements

In this activity, you will learn

1. how to use the oscilloscope's horizontal and vertical scale controls for properly setting up the scope to display a repetitive waveform, and
2. how to make simple measurements of voltage and time.

Basic operation of the vertical axis and the horizontal axis control knobs:

- Turn the oscilloscope ON, and connect the CH1 probe to the test signal of the scope.
- Set the input coupling to DC for CH1 using the **menu** function.
- Use the **menu** function for trigger setting:
  - **Edge** for trigger mode,
  - **CH1** as trigger source,
  - **Rising edge** as slope, and
  - **Auto** as the sweep mode.
- **Trigger level setting:** Set the trigger level somewhere between the maximum level and the minimum level of the waveform.
- **Time-base setting:** Turn the time-axis control knob until you can see two/three cycles of the waveform. Take note of the time-axis scale (s/div, ms/div or us/div) of CH1 shown at the bottom of the display.

- Turn the time-axis position knob and observe the effect on the display.
- Turn the vertical-axis scale control knob and observe the effect on display. Vertical scale (V/div or mV/div) is shown at the bottom of the display.

Basic measurements

Horizontal-axis measurement: The horizontal axis of the oscilloscope display is divided into 12 major divisions, and each major division is further divided into 5 minor divisions. If the **horizontal scale** is set to 200 $\mu s/div$, then each major division is 200 μs and each minor division is

$$\frac{200}{5} = 40\mu s$$

Do the following and record your findings in the logbook.

1. Use cursors to measure the period (T) of the waveform.
2. Calculate the frequency (Hz).
3. Use cursor to measure the width of the positive section of the waveform.
4. Use cursor to measure (a) the maximum positive voltage, and (b) the peak-to-peak voltage.

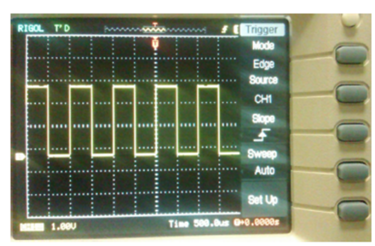

Figure 1: Menu for setting oscilloscope trigger. You will learn more about triggering in Activity #2.

Activity # 2: Oscilloscope triggering

Use the same test signal as in Activity #1.

- If the waveform is not at the center of the display, use the vertical position knob to center the waveform in the scope's display.
- Set the trigger level near the middle of the waveform, i.e., at the point equidistant from the positive maximum and the negative maximum of the waveform.
- Keep decreasing the horizontal scale until you see a waveform like the one shown below. In this image, the time base is 1.0 $\mu s/div$. The period of the test signal is approximately 1.0 μs.

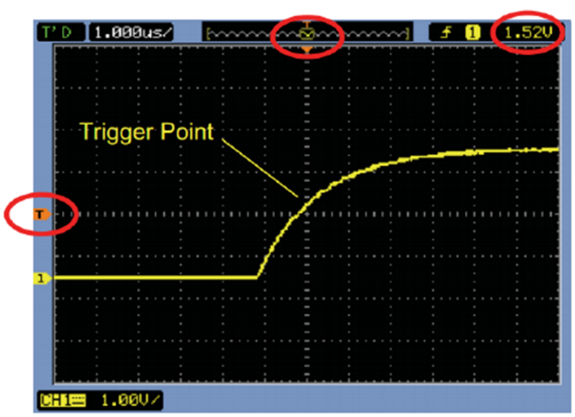

Figure 2: Notice the T symbol near the top of the display. This marks the triggering instant. The T symbol on the left side of the display marks the trigger level. The **Trigger Point** is the point of intersection of the vertical line drawn from trigger instant and the horizontal line drawn from the trigger level.

- If you rotate the trigger level knob clockwise, the trigger level will increase, and you will see the waveform sliding to the left. If you rotate the knob counterclockwise, the waveform will slide to the right.
- Use the **menu** function to change the slope in trigger settings to the falling edge, and observe the change in the display.

- Using the trigger level knob, set trigger level at higher than the positive maximum of the waveform or at lower than the negative maximum. You should observe a blurred waveform as the oscilloscope cannot find a voltage in the signal that is equal to the trigger level.
- While observing the test signal (from the oscilloscope) in channel-1 with properly set amplitude scale, time scale, and trigger, connect to CH2 a 1 kHz square wave signal generated by the signal generator. What do you observe in CH2?
- Now change the source of trigger from CH1 to CH2. What do you see?

Activity #3: Oscilloscope coupling and review of signal generator

After doing this activity, you will know how to control different properties of a signal generated by the signal generator. The activity will also help you to understand the **coupling function** of the oscilloscope.

Coupling refers to the way an input signal is connected to the oscilloscope. This can be set by the coupling function in the oscilloscope menu.

1. **DC Coupling:** this coupling shows all of the input signal, i.e., both DC component and the AC component. If the DC component of the input signal is non-zero, the displayed waveform is shifted up or down from the 0V level indicated on the display. The average value of the displayed waveform is the DC component of the signal.
2. **AC Coupling:** this coupling blocks the DC component of the input signal and shows the AC component only. The average of the displayed waveform shown is 0 V.
3. **Ground:** this setting disconnects the input signal from the vertical system of the oscilloscope. It lets you see where zero volt is located on the screen. With grounded input coupling, you see a horizontal line on the screen that represents zero volts.

To do:

- Connect the signal generator output to CH1 of the oscilloscope. Set the input coupling to **DC coupling.**
- Select the square wave function of the signal generator.
- Change the following properties of the signal using different buttons and knobs on the signal generator front panel
  1. frequency,
  2. amplitude, and
  3. dc offset.
- Keeping the DC offset of the signal generator at a non-zero value, change the input coupling of the oscilloscope channel from AC to DC, and vice versa. What do you observe?
- Observe different types of signal (sinusoidal, triangular etc.) that the signal generator can generate.

Activity #4: Capturing single-shot events

This is a revision of what you did in EPP1.

In the three activities done so far, repetitive signals were used. So time-scale, amplitude-scale, trigger etc. could be changed while observing the waveform.

Sometimes engineers need to capture single-shot events, *e.g.*, the voltage of a capacitor while it is being discharged. You cannot adjust the oscilloscope settings while capturing such an event. You need some prior knowledge of the approximate characteristics of the event, *e.g.*, amplitude and event duration, before you set up the scope to capture the event.

Steps for capturing a single-shot event

Connect the voltage that you want to observe as a single-shot event to an oscilloscope channel but **do not** activate the event. First, set up the oscilloscope properly for capturing the event, and then activate the event.

Suppose, you want to capture a single-shot event which is expected to have a 2V peak-to-peak amplitude, and is expected to last for approximately 10 ms. Set up the oscilloscope as described below to capture this event.

- Set the time-base to 1 ms/div so that the full screen width is greater than (at least equal to) the duration of the event.

- Set the vertical axis scale to 300 mV/div so that the full screen will show 2.4 V peak-to-peak (greater than the expected voltage range of 2 V).

- Set the trigger level to approximately 300 mV.

- Use the trigger menu to change the sweep from **Auto** to **Normal**.
- Activate the event that you want to capture and observe the event being displayed on the screen.

1. Use these guidelines to capture the capacitor voltage of the circuit shown in Figure 3 during (a) charging and (b) discharging.
2. After capturing the event (charging or discharging), use the cursors to measure the time constant (for both cases).

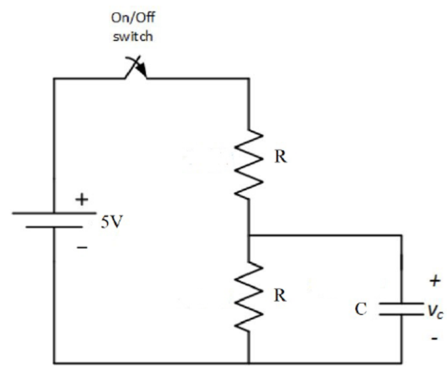

Figure 3: Capacitor charge-discharge circuit

E-Logbook:

1. Activity #1:
   - Image of the oscilloscope screen and the measurement results.
2. Activity #2:
   - Image of the screen that shows the effect of improper triggering.
   - What are the possible reasons when you see a blurred image.
3. Activity #3:
   - Images showing the effect of different coupling modes.
4. Activity #4:
   - Oscilloscope screen images during charging and discharging.
   - Measured values of two time constants
   - If the measured values differ from the theoretical ones, reasons for the discrepancy.