

# EE 2101 - EXPERIMENT 11 ADVANCED OSCILLOSCOPE OPERATIONS

## INTRODUCTION

The oscilloscope is the most versatile and most important tool in this lab and is probably the best tool an electrical engineer uses. This outline guides you through more advanced operations (triggering and dual signal operation) of a specific oscilloscope, an AGILENT DSO5012A, 2 channel, dual time base scope with a DC-100 MHz vertical-amplifier bandwidth. Almost any modern scope will have the same control functions, and a good understanding of this scope will give you confidence in the use of any scope.

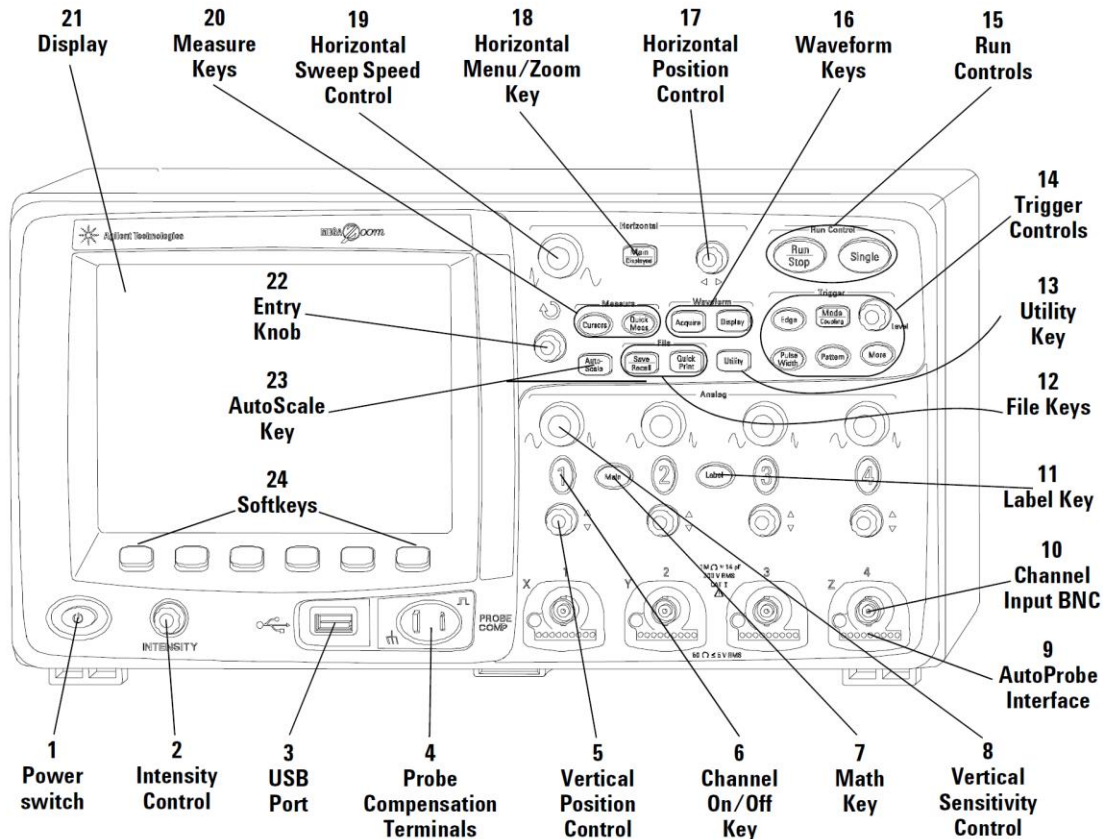
### Other Equipment

**DC Supply:** Tenma 72-6615

**Signal Generator:** GW Instek GFG-8250A

As you recall from experiment 1, the oscilloscope has the following main sections.

- ❖ The screen
- ❖ The Vertical (Analog) Section
- ❖ The Horizontal Section
- ❖ The Trigger Section
- ❖ The Measurement section
- ❖ Disk Storage Section



While doing the experiments and learning to use the oscilloscope, you will be required to record all observed data and waveforms. This oscilloscope has built in features to store the current screen in a few

formats. This part is explained to you first so that you don't need to draw the waveforms that you observe. Store them in a USB storage drive and attach them later to your final draft of the write up.

### **Saving the waveform:**

After stabilizing the waveform and obtaining all the required measurements pertaining to the waveform, perform the following steps to save the waveform. This is the simplest way of saving waveforms for future reference.

- Press the **Save/Recall** key to display the Save/Recall menu. You will find a menu pop-up (called the soft menu) on the bottom of the screen. Each displayed icon on the menu has a push button key associated with it located below the screen. These push buttons are called soft keys.
- Press the **Formats** soft key to display the Formats menu. The oscilloscope allows you to store the screen images in *BMP* and *PNG* formats, and into a *CSV* (Comma Separated Variable) file suitable for spread sheet analysis. *BMP* and *PNG* formats store the complete screen image, including the status line and soft keys. Do **NOT** use the *Trace & Setup* format, as it will not save any time or voltage information.
- Choose the *BMP* or *PNG* format and wait until you see a clear waveform and the measurements that you have taken.
- Press the front panel **Press to Save** key to start transfer to the drive.

In the following sections there are bold and italicized numbers in the font Copperplate Gothic Bold, i.e. **3**. When you encounter one of these numbers, entries in your lab note book will be expected. There are **5** of these in the trigger section, and **6** in the dual signal section. Note that these numbers are not intended to be steps, but points of entry in the lab notebook where your TA will be expecting an answer to a question or a result(s) noted from the oscilloscope.

## **OSCILLOSCOPE OPERATION A: LOOKING AT THE “TRIGGER SECTION”**

Triggering of the signal under observation is very important as it provides synchronization between the vertical and horizontal deflection system. Generally the signal under observation is used to extract the trigger signals that are needed to generate accurate horizontal sweep signals to display the waveform. Pressing the **Mode Coupling** button (in the Trigger section) brings up the trigger menu on the screen.

- Connect a 1 kHz sine wave to Channel 1 and stabilize it. By rotating the trigger knob (the knob right to the **Mode Coupling** button), you should notice the trigger level and the starting point of the signal changing. This will also depend on the position of the timing reference that you have set, the default setting is center.
- Pressing the **Mode** soft key brings up two options. **Auto**, and **Normal**. Rotate through these two options. Take the trigger level, using the trigger level knob beyond the display range and notice the affect and differences in the two modes. (The **Auto** mode tries to stabilize the signal for you but sometimes it doesn't actually stabilize well. **Normal** mode allows you to stabilize it yourself but it doesn't update automatically new signal inputs from waveform generator. You have to switch back to **Auto** to get it to update.)
- Reduce the frequency of the signal to about 5-10 Hz and try to stabilize the signal using all the modes.

- 1.** Which mode is most suitable for observing low frequency signals?
  - Pressing the **Coupling** soft key gives you a few choices on the type of coupling that is desired. Generally the signal under observation is given to the trigger circuit to extract the trigger signal. If the signal is composed of many frequencies or has DC offset added into it, you might have to choose the right coupling for the job. **DC** coupling allows all the components of the signal to the trigger circuit and can be used for all signals, but mostly suited for observing very low frequency signals. **AC** coupling removes any DC and very low frequency signals and is mainly suited for observing signals with DC offset. **LF** (low frequency) **reject** is mainly used for observing very high frequency signals, rejecting any low frequency noise.
- 2.** Practice stabilizing low frequency signals, high frequency signals and signals with offset using different types of coupling and note down your observations.
  - The **Noise Rej** soft key is used to remove any high frequency noise to allow a clean signal to enter the trigger circuit.
  - The **HF Reject** It is just the opposite of the **LF reject**.
  - **External Triggering** If you would like an external signal to trigger your signal under observation, then that signal can be connected to the external input located at the right hand corner of the front panel. Connect the calibrator signal to this input and connect a sine wave, from the signal generator, to Channel 1. Press the **Edge** button, then select **Source External**.
- 3.** Try to change the frequency of the input signal and observe and note which frequencies can be stabilized using the calibrator signal. *Hint: Integer multiples of the trigger signal frequency.*
  - If you have difficulty stabilizing the signal, try changing the trigger source to Channel 2, and connect the signal from the external trigger connection to Channel 2. This will allow you to observe both signals.
  - There are some ways in which the oscilloscope employs triggering of signals. We are going to observe the **EDGE Triggering** in detail. Press the **Edge** button on the front panel, which is lit and is the default method, brings up a trigger menu for the same. The default settings include the selection of the **positive edge** for triggering and Channel 1 as the **source**. The positive edge selected, try to vary the trigger level and observe the trigger being selected from the positive slope of the signal.
- 4.** Observe what happens when you choose the **negative edge** triggering and turn the trigger level knob.
  - Channel 1 will be chosen as the source of triggering since only Channel 1 has a signal connected to it. Remove the signal from Channel 1 and connect it to Channel 2, select Channel 2 (vertical section), deselect Channel 1 and press auto scale. Now checking the edge menu you will find that Channel 2 is the source of the signal. This feature will become more apparent when you do the dual signal operation.
  - Pressing the **Edge** button, then selecting **Source Line Triggering**. This feature connects the supply line voltage coming from the mains to the trigger circuit.
- 5.** Using this feature and changing the frequency of the input signal try to find the frequencies that you can stabilize. *Hint: See 3 above.*

## OSCILLOSCOPE OPERATION B: LOOKING AT THE “DUAL SIGNAL OPERATION”

- Connect the calibrator signal to Channel 1 and a 1 kHz sine wave to Channel 2. You will have to select both the channels to switch them on. Try to stabilize both the channels. Choose Channel 1 as your source for triggering and then choose Channel 2 as your source and note down your observations. What does this tell you about the two signals that you are trying to observe simultaneously? Now remove the calibrator signal from Channel 1 and connect the TTL output (use the sync port below the Trigger button) from the function generator and try to stabilize both the signals.
- 1.** Note down your observations and conclusion of the stability.
    - Using a BNC-Tee, connect a 1 kHz Sine wave to both the channels, stabilize them and press the math function button. You can perform a few math functions using the 2 signals under observation. Use AC signal coupling for both the channels.
  - 2.** How will you add and subtract the 2 waveforms?
  - 3.** Be sure to save the waveforms.
    - Change to Square wave, remove Channel 2 and try to observe the integrated and differentiated waveform by using the respective soft keys.
  - 4.** Do they match with the theoretical calculus?
    - Looking at the **XY** mode. In the XY mode the timing signal is removed from the horizontal deflection system, and Channel 2 signal is diverted to the horizontal deflection plates. Channel 1 is given to the vertical deflection system. This leads to an X-Y graph (the details and applications will be explained by your instructor). Connect 2 sine waves of the same frequency and observe the X-Y pattern. Try the same with two square waves and two triangular waves.
  - 5.** Note your observations in the difference between the X-Y pattern for the Sine wave and Triangular wave.
  - 6.** Save your waveforms for the Sine and Triangular inputs.