PART II - Introduction to the Tektronix 2215 Analog Oscilloscope

Overview:

An oscilloscope is an electronic measuring device which provides a two-dimensional visual representation of a signal. Because the oscilloscope allows the user to see the signal(s), their characteristics can be easily measured and observed. The oscilloscope displays a graph of voltage (on the vertical axis) versus time (on the horizontal axis). Most electrical circuits can be easily connected to the oscilloscope typically with probes.

- There are four major control groups on the Tektronix oscilloscope: (1) the **Display group**; (2)the **Vertical group**; (3) the **Horizontal group;** and (4) the **Trigger group**. See Figure 5, below.

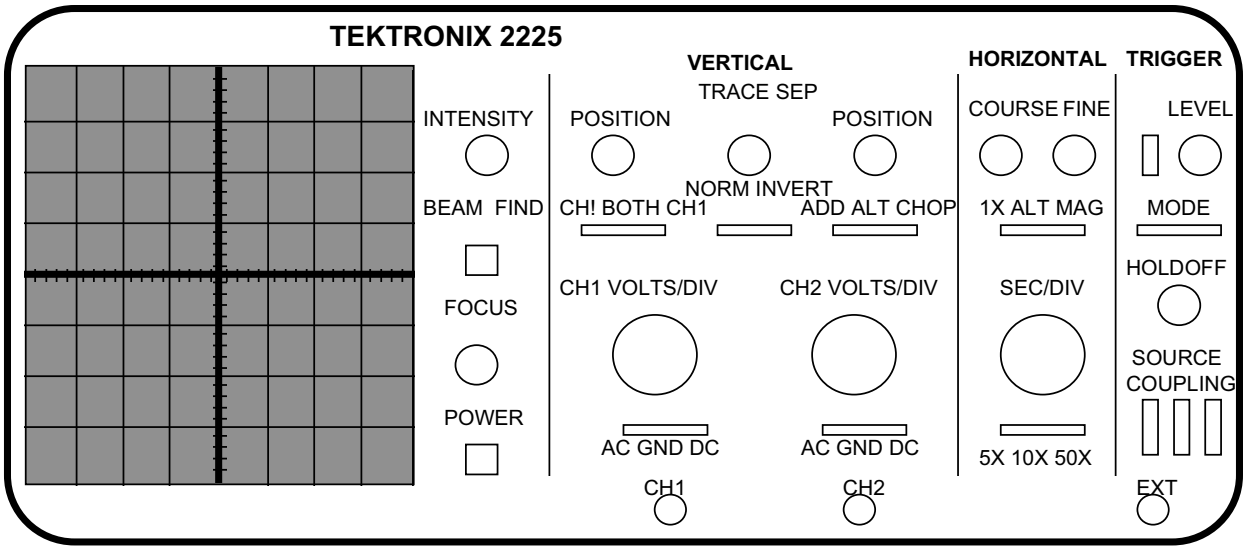

Figure 5: Front Panel of Analog Oscilloscope

Display Group

This group is used to display and adjust the signal for optimal viewing. It consists of the **display screen**, the **intensity-control knob**, the **beam-find button**, the **focus-control knob**, and the **power switch**.

- The **display screen** is laid out in a 8 by 10 centimeter grid. The oscilloscope draws a 'trace' or graph by moving an electron beam across the phosphor coating on the inside of the cathode-ray tube (CRT). The excited phosphorous glows for a short period of time, thereby tracing the path of the beam.

- The **intensity-control knob** is used to adjust the brightness of the trace. The level should be set to the user's preference; however, increasing the intensity beyond a certain point

will make the trace "fuzzy." The intensity level should never be increased past the point where the trace has sharply defined edges.

- The **beam-find button** allows the user to locate the electron beam anytime it's off-screen. Push the beam find button to temporarily reduce the vertical and horizontal deflection voltages so that the beam always appears within the 8 by 10 centimeter screen.

- The **focus-control knob** adjusts the electron beam for optimal trace resolution.

Vertical Group:

This group is used to adjust the vertical components (Y-axis) and the vertical position of the signal. This group consists of the **vertical-position knobs**, **channel-selector switch**, **volts-per-division-selector knobs**, **input-coupling switch**, the **channel-mode-selector switch**, the **channel-2-invert switch**, and the **BNC connectors.** Because the Tektronix 2225 oscilloscope is a two channel oscilloscope, there is one set of switches for each channel.

- The **vertical-position controls** are used to vertically move the trace of one channel or the other.

- The **channel-selector switch**, labeled 'CH1/BOTH/CH2', selects which channels are displayed on the screen.

- The **volts-per-division-selector knob** sets the vertical scale for each channel's trace.

    1. Since a 10X probe is used in this lab, all readings should be made from the '10X' box on the knob.

    2. Each channel can have a different vertical scale.

    3. A *division* is one "block" on the screen.

    4. Each *tick mark* is one-fifth (0.2) of a *division.*

    5. This knob is marked in both volts and millivolts.

- The **input-coupling switch**, labeled 'AC/GND/DC', selects the coupling mode of that channel's display. AC means that only the alternating portion of the signal is displayed. DC will display both the alternating portion of the signal, plus any DC component. GND shows the 0 V reference level.

- The **trace-separation knob** is used in conjunction with the **horizontal-magnification controls**, to be discussed later.

- The **channel-mode-selector switch**, labeled 'ADD/ALT/CHOP', is activated only when BOTH is selected on the **channel-selector switch**. ADD graphically adds the Channel 1 signal to the Channel 2 signal. If the **channel-2-invert switch** ('NORMAL/INVERT') is set to INVERT, then ADD will in fact subtract the Channel 2 signal from the Channel 1 signal. ALT traces one channel, then the next. CHOP works like ALT, but jumps back and forth between the two channels during a single trace.

Horizontal Control Group:

The Horizontal Control Group consists of the **coarse and fine position knobs**, the **horizontal-magnification switch**, the **seconds-per-division-selector knob**, and the **magnification-scale-selector switch**.

- The **coarse** and **fine-position-knobs** allow the horizontal movement of the traces in a rough manner and in a precise manner, respectively. These are used to position the traces in a manner that makes measurement both more convenient and more precise.

The **horizontal-magnification switch** ('X1/ALT/MAG') selects the regular (X1) and/or a horizontally magnified trace.

1. The **trace separation knob** in the Vertical-Control Group allows for the vertical separation of the X1 trace from the magnified trace when ALT is selected.

2. If ALT or MAG is selected, then the **magnification-scale-selector switch** ('5X/10X/50X') is activated.

- The **seconds-per-division knob** sets the time base (horizontal) scale. It is marked in seconds, milliseconds, and microseconds.

  Note: There is only one horizontal scale for both channels.

Trigger Group

In order to display a signal, the oscilloscope must be able to 'lock' onto that signal; the function of the triggering controls is to do just that. Triggering can be a complicated topic, and is beyond the scope of this lab. For more details, you are referred to the Tektronix manual. The trigger group is made up of the **trigger level knob**, the **rising/falling edge switch**, the **trigger mode switch**, the **holdoff knob**, the **trigger source switches**, and the **trigger coupling switch**.

- The **trigger-level knob** sets the voltage level at which the oscilloscope will 'trigger.' If a signal is 'running'--that is, not stable--the trigger level may be too high or too low for the oscilloscope to recognize the signal. Often you can lock in a running signal by rotating this knob to the left and to the right. This adjustment provides a mechanism for ignoring small (low voltage) signals that are well below the level of the signal you are interested in. This knob is not indexed.

- The **rising/falling-edge switch** selects whether the oscilloscope will trigger on the positive (rising) or negative (falling) edge of the signal.

- The **trigger-mode switch** will normally be set to AUTO, but sometimes it is necessary to use NORM. Other settings are not relevant to this lab.

- The **holdoff knob** affects the delay associated with triggering. You should consult the manual if more information is desired.

- The **trigger-source switches** select which signal the oscilloscope will attempt to lock onto. Possible choices include CH1, CH2, VERT MODE, or EXTERNAL. Selecting CH1 or CH2 will make the oscilloscope attempt to trigger on those channels. If no input is available on that channel, there may be problems when attempting to view both channels simultaneously. For this reason, *it is recommended that this switch be left on VERT MODE*, which provides an automatic trigger on either CH1 or CH2.

- The **trigger-coupling switch** is another more complicated feature which will not be discussed here. *This switch should typically be set to AC*.

How To Make Readings on the Oscilloscope:

- Peak-to-Peak Voltage:

  Use the vertical-position knob to place a peak (positive or negative) on a horizontal line, keeping the peak on the screen.

  Use the horizontal-position knob to set the next (opposite sign) peak on the center vertical line.

  Count the number of divisions between the positive and negative peaks.

  Note: The divisions are further subdivided into 1/5 (0.2) by the tick marks.

  Multiply the number of divisions from step 3 by the volts/div setting for the channel in use.

- Period:

  Use the horizontal-position knobs to align any edge of the signal with a vertical line.

  Use the vertical-position knob to place the next identical edge crossing on the X-axis.

  Count the number of divisions along the horizontal line to the next crossing in the same direction.

  Multiply the number of divisions from step 3 by the sec/div setting.

  Note: The divisions are subdivided into fifths (0.2) by the 'tick marks'.

- Frequency:

  Measure the period of the signal (T).

  Calculate frequency (f) using $f = 1 / T$.

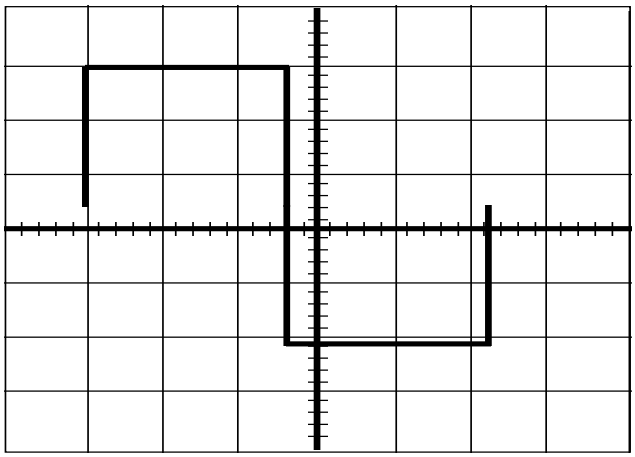

Figure 6: Measuring a Signal.

- Example:

  Assuming the **Volts/Div** knob reads 2 V/div, the above peak-to-peak voltage would be:

  V_{pp} = 2 volts/div * 5.2 div = 10.4 volts

  Assuming the **Sec/Div** control knob read 50ms, the above period would be:

  T = 50 milliseconds/div * 5.25 div = 262.50 milliseconds = 0.2625 seconds