Digital Storage Oscilloscope [DSO] Presentation based on the TDS210/TDS1002 Series user manual

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Oscilloscope

Oscilloscope is an electronic measuring instrument which is used to display and analyze various waveforms.

There are two types of oscilloscopes based on the mode of operation.

- Analog Oscilloscope
- Digital Storage Oscilloscope[DSO]

Cathode Ray Oscilloscope

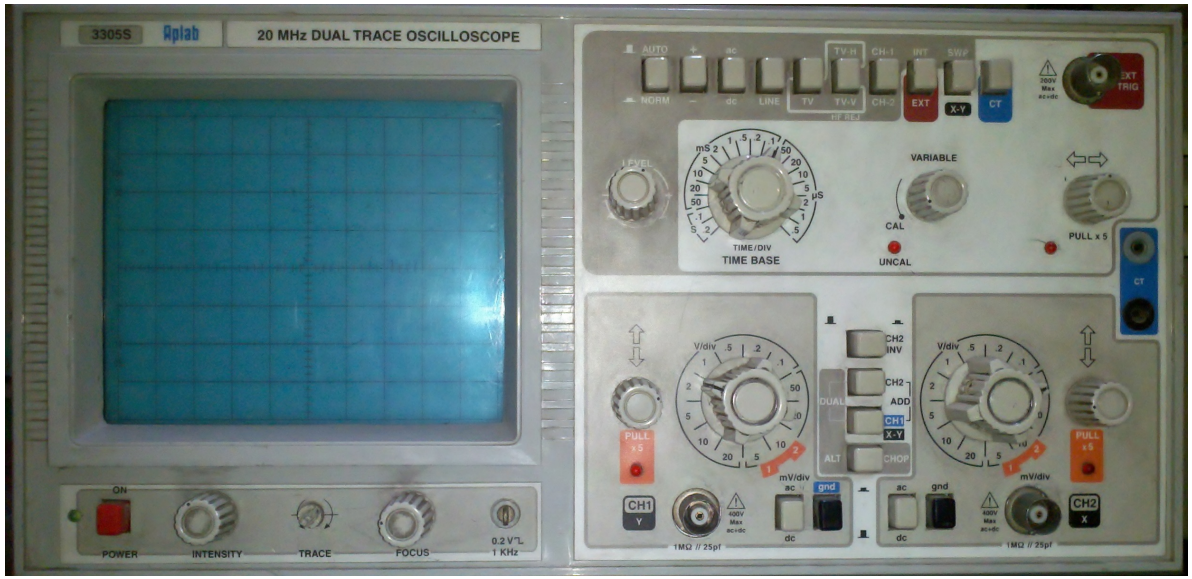

Figure: Front panel of CRO

A CRO uses analog circuits to sense and display information on a screen. Typically, it does not have the ability to store information about captured waveforms.

Working of CRO

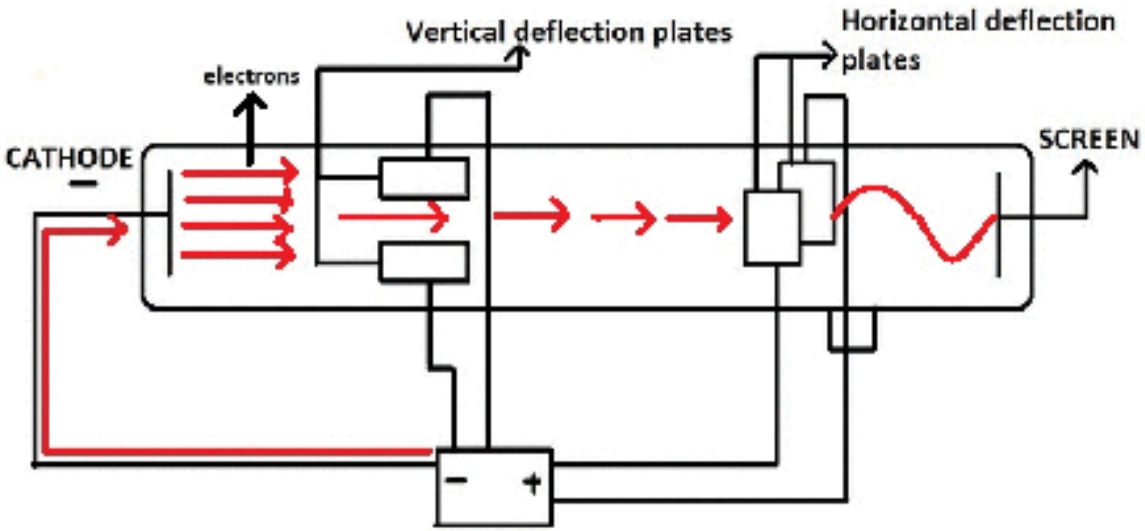

Figure: Working Principle of CRO

- Depicting the cathode ray tube which emits electrons from the (filament) cathode.
- The emitted electrons is then accelerated towards the screen and strikes on the fluorescent screen, due to its fluorescent properties it glows when electron strikes on it.
- The amplitude and frequency of the signal displayed on the screen depends on the voltages on vertical and horizontal deflection plates respectively.

Digital Storage Oscilloscope

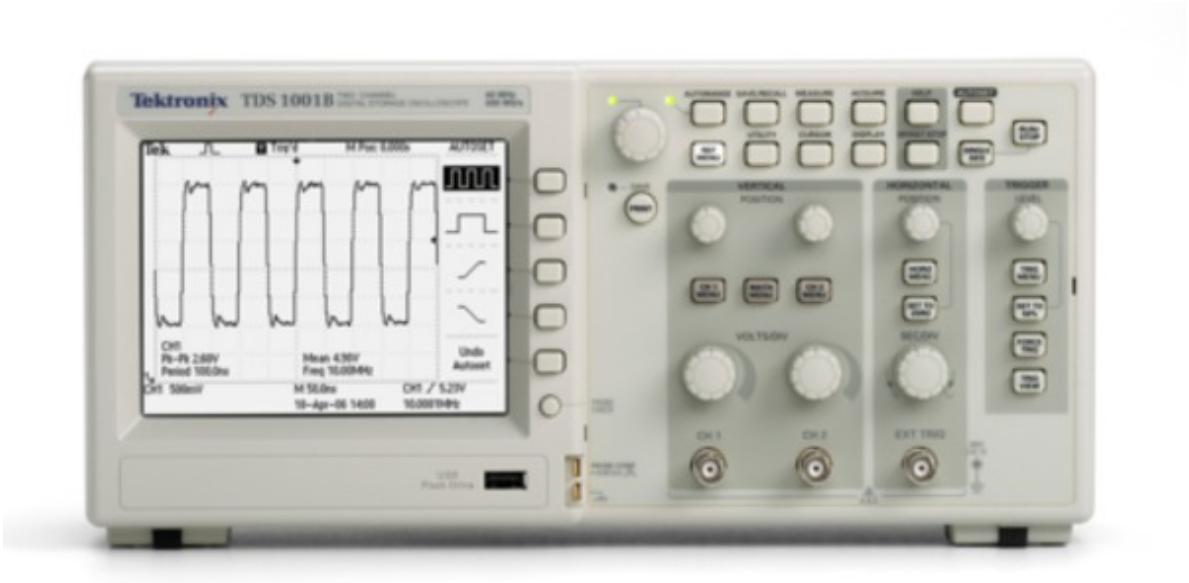

Figure: Digital Storage Oscilloscope

A DSO typically digitizes and stores captured signals in an internal memory. The stored signals can then be analyzed and displayed on a screen. This offers great flexibility in analysis of the captured waveforms.

Working of DSO

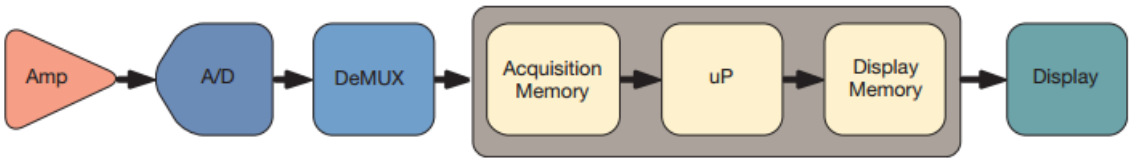

Figure: Block diagram of DSO

- DSO's first (input) stage is a vertical amplifier. Vertical controls allow you to adjust the amplitude and position range at this stage.
- ADC converts the signal's voltage at these points into digital values called sample points.
- The DSO's signal path includes a microprocessor through which the measured signal passes on its way to the display.

Front Panel

Figure: The front panel of TDS210/1002B

Some other DSOs available in the lab are TDS1002, TDS1002B and GDS-1072A-U- GW INSTEK

Checking the working of DSO

To verify the instrument is working properly.

- Take the signal probe (Eg: TDS2200). This probe has two attenuation settings, 1X and 10X. Set the attenuation button at the tip of the probe to 1X.
- Now, attach the probe tip to the PROBE COMP 5V connector and the probe reference lead to the PROBE COMP ground connector.
- Plug the probe into Channel 1 on the oscilloscope and push the AUTOSET2 button. On the display you should see a square wave of ap- proximately 5V peak-to-peak at 1KHz,

Triggering

The trigger determines when the oscilloscope starts to acquire data and display a waveform. When a trigger is set up properly, it can convert unstable displays or blank screens into meaningful waveforms

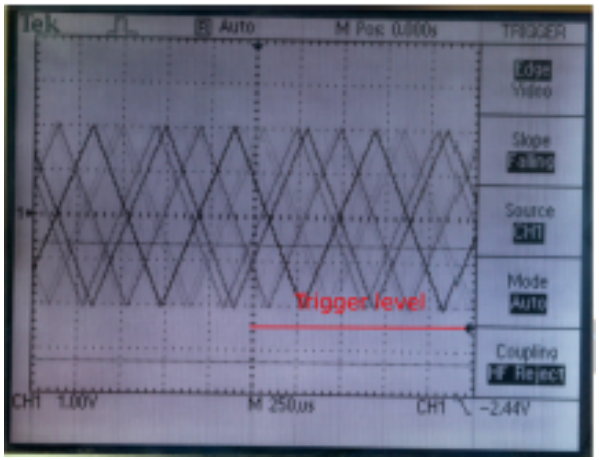

Figure: Untriggered Waveform

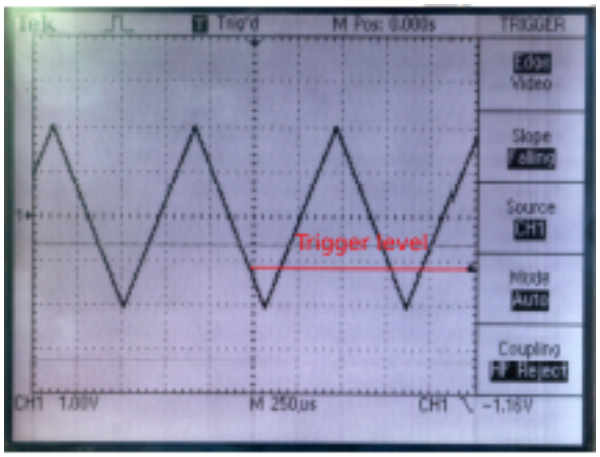

Figure: Triggered Waveform

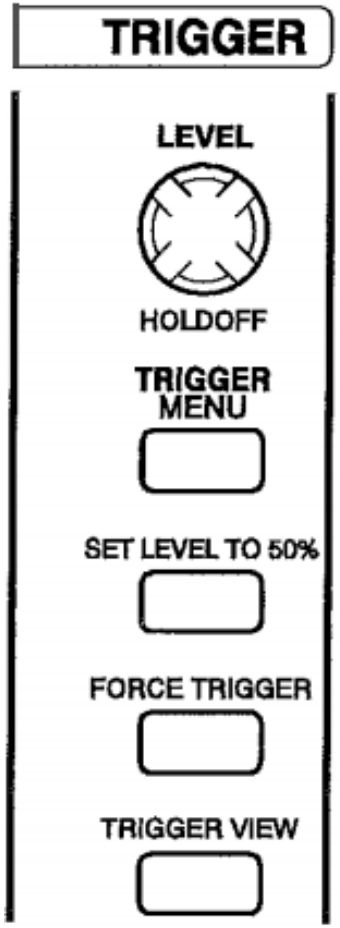

Figure: Triggering controls

- **Level and Hold Off** : Level sets the amplitude level and hold off sets the time before another trigger.
- **trigger Menu** : Displays the trigger menu.
- **Set level to 50%** Sets level to 50% of signal level.
- **Force trigger**: Starts an aquisition regardless of an adequate data.
- **Trigger View** : Displays trigger waveform in place of channel waveform when trigger knob is held.

Capturing A signal using a DSO

Assemble the circuit as shown in the figure

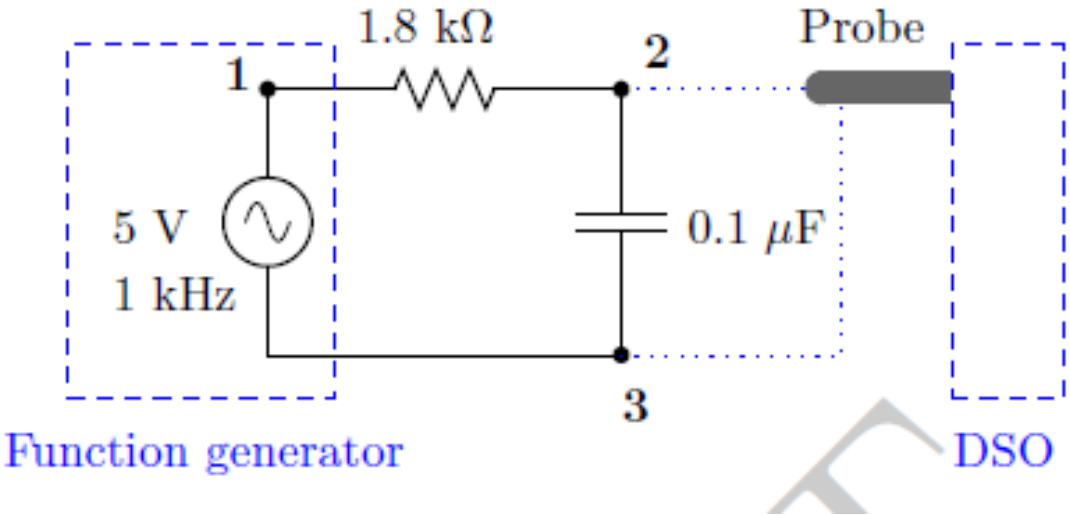

Figure: Test circuit

Connect the output of our circuit (node 2) to Channel 1 of the DSO. Are you able to see the signal properly on DSO?

To measure signal frequency, period peak-to-peak amplitude etc. of the output waveform follow the steps given below

- Push the *AUTOSET* button automatically sets the trigger levels and displays the waveforms
- Push the *MEASURE* button to go to the Measure menu
- Push the top menu box button to select Source
- Select *CH1* for the first three measurements.
- Push the top menu box button to select *Type*
- Push the first CH1 menu box button to select *Freq*
- Push the second CH1 menu box button to select *Period*
- Push the third CH1 menu box button to select *Pk-Pk*

Use cursors to take measurements

- Push the *CURSOR* button to go to the Cursor menu
- Push the top menu box button and select *Type* as *Voltage*[1]
- Set the *Source* option to *CH1*
- Vary the position of the two horizontal cursor lines using the *CURSOR 1* and *CURSOR 2* knobes
- Observe the voltage values corresponding to cursors under *Cursor 1* and *Cursor 2* the difference between them under *Delta*
- Push the top menu box button and select *Type* as *Time*
- Vary the cursors using the previous knobs and observe the time values

[1] Two horizontal lines will appear if you set *Type* as *Voltage* and two vertical lines will show up if you set it as *Time*

There are two channels in the DSO which can be controlled independently

- Take another probe and plug it to the *Channel 2* on the oscilloscope
- Connect its tip to the node 1 in the example circuit
- Push *AUTOSET* button
- Push *CH 1 MENU*
- Push the *Coupling* button on the right side of the display and see the various coupling options
- Push *Invert* button to invert polarity of the signal
- Push *CH 2 MENU*

You can also get a plot of one signal versus the other (its called XY mode). Follow the steps below to get a plot with channel-1 voltage on the X-axis and channel-2 voltage on the Y-axis

- Push *CH 1 MENU* and use *Coupling* button to change the coupling to *Ground*
- Use the *POSITION* knob of channel-1 to bring the ground line of channel-1 to the center of the display
- Change the coupling back to *AC*
- Push *CH 2 MENU* and use *Coupling* button to change the coupling to *Ground*
- Use the *POSITION* knob of channel-2 to bring the ground line of channel-2 to the center of the display
- Change the coupling back to *AC*
- Push the *DISPLAY* button
- Push the *FORMAT* button and select *XY* format
- You will see a ellipse shaped plot on the display
- Change the amplitude and frequency of the input sine wave. What do you observe?

Mathematical Operation

DSO has the capability to perform some basic mathematical operations with the input signals.

- Push *MATH MENU* button
- Push the *Operation* button to change the operation to $+$, - and *FFT*