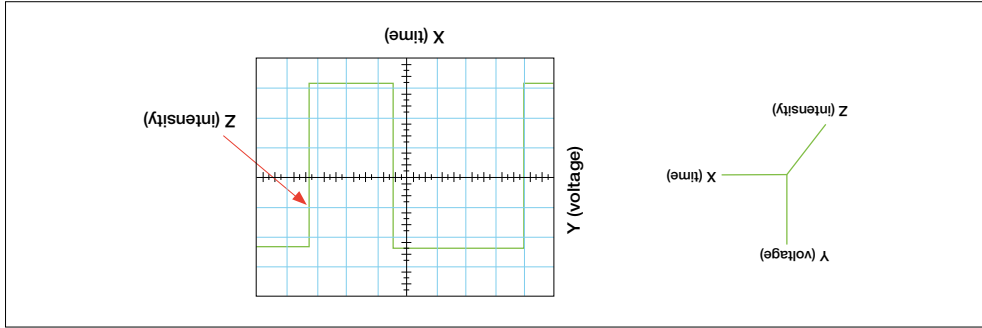


## What is an oscilloscope?

The oscilloscope is a device that draws a graph of an electrical signal. In most applications, the graph shows how signals change over time: the vertical (Y) axis represents voltage and the horizontal (X) axis represents time. The intensity or brightness of a waveform is sometimes called the Z axis.

## Key Oscilloscope Specifications

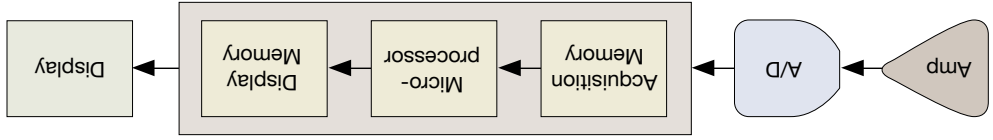
- **Bandwidth**  
The frequency range of the instrument.
- **Record Length**  
The number of waveform points used to create a record of a signal.
- **Sample Rate**  
How frequently a digital oscilloscope takes a sample of the signal, specified in samples per second (S/s).



## Oscilloscope Principles

**Learn More...**  
For everything you should know about the basics of oscilloscopes and probes, check out:  
- XYZs of Oscilloscopes  
- ABCs of Probes  
View these primers and more at:  
[www.tektronix.com/fundamentals](http://www.tektronix.com/fundamentals)

- First, the signal travels through the probe to the vertical amplifier.
- Next, an analog-to-digital converter (A/D) digitizes the signal by sampling the signal at discrete points in time and converts the signal's voltage at these points into digital values called sample points.
- The sample points from the A/D are stored in acquisition memory as waveform points. Together, the waveform points comprise one waveform record.



- The number of waveform points used to create a waveform is called the record length.
- The trigger determines the start and stop points of the record.
- The signal path includes a microprocessor which measures the signal and formats it for display.
- The signal then passes through the display memory and is displayed on the oscilloscope screen.

## How does a digital storage oscilloscope work?

## Basic and Bench Oscilloscopes from Tektronix



**TDS1000B and TDS2000C Series**

- 40 MHz to 200 MHz
- 2 or 4 analog channels
- Lifetime Warranty<sup>1</sup>



**TPS2000B Series**

- 100 MHz to 200 MHz
- 2 or 4 isolated analog channels
- Battery operation
- Power analysis



**TDS3000C Series**

- 100 MHz to 500 MHz
- 2 or 4 analog channels
- Optional battery operation



**MSO/DPO Series**

- 100 MHz to 1 GHz
- 2 or 4 analog channels
- Up to 16 digital channels
- Serial data triggering and analysis
- Power analysis



**TDS1000C-EDU Series**

- 40 MHz to 100 MHz models
- 2 analog channels
- Advanced Triggering
- Educator's Resource Kit<sup>2</sup>

<sup>2</sup> For more educational materials visit: [www.tektronix.com/fundamentals](http://www.tektronix.com/fundamentals)

## Pocket Guide to Oscilloscopes



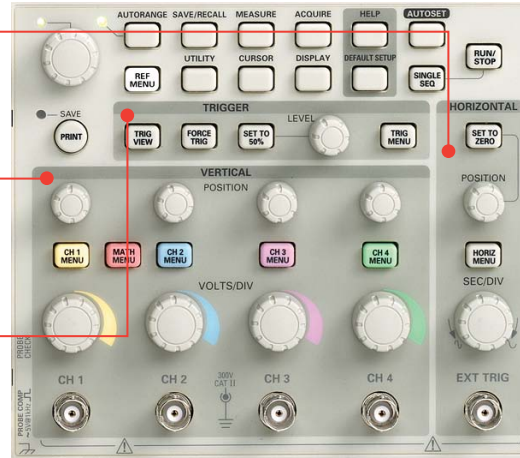
# Oscilloscope Front Panel

## 3 Main Sections:

### ② Horizontal Controls

### ① Vertical Controls

### ③ Trigger Controls



## 1. Vertical Controls

### Position and Volts-Per-Division (Volts/Div)

- The vertical position control allows you to move the waveform up and down on the display.
- The volts-per-division (volts/div) setting varies the size of the waveform on the screen. The volts/div setting is a scale factor. If the volts/div setting is 5 volts, then each vertical division represents 5 volts and an entire screen of 8 divisions can display 40 volts from top to bottom.

### Input Coupling

Determines which part of the signal presented to the oscilloscope's input is displayed on the screen.

- **DC coupling** shows all of an input signal.
- **AC coupling** blocks the DC component of a signal so that you see the waveform centered around zero volts.
- **Ground coupling** disconnects the input signal from the vertical system, which lets you see where zero volts is located on the screen.

## 2. Horizontal Controls

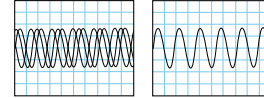
### Position and Seconds-Per-Division (Sec/Div)

- The horizontal position control allows you to move the waveform left and right on the display.
- The seconds-per-division (sec/div) setting varies the rate at which the waveform is drawn across the screen (also known as the time base setting or sweep speed). The sec/div setting is a scale factor. If the setting is 1 ms, then each horizontal division represents 1 ms and the entire screen of 10 divisions represents 10 ms.

## 3. Trigger Controls

Trigger controls allow you to capture single-shot waveforms and stabilize repetitive waveforms.

Imagine the jumble on the screen that would result if each time the trace is drawn across the screen, the drawing begins at a different part of the waveform. The trigger ensures the same part of the waveform is drawn each time, making repetitive waveforms appear static.



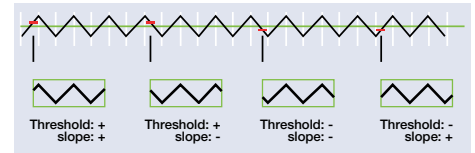
The trigger circuit acts as a comparator. When the signal matches the trigger setting, the oscilloscope generates a trigger and captures a signal. Edge triggering is used most often; it captures the signal on a rising or falling edge.

### Trigger level and slope

- The slope control determines whether the trigger point is on the rising edge (positive slope) or the falling edge (negative slope) of a signal.
- The level control determines where on the edge the trigger point occurs.

### Source

- Determines which signal is compared to the trigger settings.



### Modes

Determines whether or not the oscilloscope draws a waveform based on a signal condition.

- **Normal mode** - the oscilloscope only sweeps if the input signal reaches the set trigger point; otherwise the screen is frozen on the last acquired waveform.
- **Auto mode** - the oscilloscope sweeps, even without a trigger. If no signal is present, a timer in the oscilloscope triggers the sweep. This ensures that the display will not disappear if the signal does not cause a trigger.
- **Single sequence mode** - After the oscilloscope detects a trigger, the oscilloscope acquires and displays one triggered screen of a signal and then stops.

### Coupling

Similar to vertical coupling. High frequency, low frequency, and noise rejection trigger coupling are useful for eliminating noise from the trigger signal to prevent false triggering.

## Tips for Capturing your Signal

1. **Return the oscilloscope to a known state.**  
Press the Default Setup button.
2. **Connect the appropriate probe to the oscilloscope.**
  - Check that the oscilloscope and probe bandwidths match.
  - Check probe compensation.
3. **Connect your probe to the circuit signal.**

When using an oscilloscope, you need to adjust three basic settings to accommodate an incoming signal:

- The vertical scale (volts/div).
- The time base / horizontal scale (sec/div).
- The trigger level, slope, source, mode, and type.

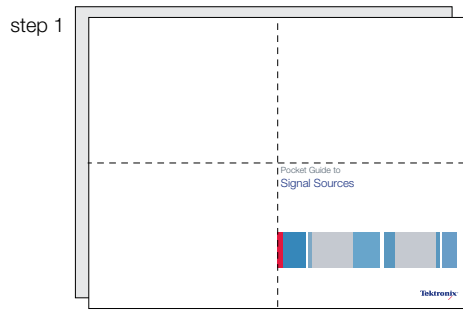
### If you do not see a signal, check the following:

- Is the channel on?
- Is the waveform off screen?
  - Adjust the vertical position and scale.
  - Adjust vertical coupling if signal has large DC component.

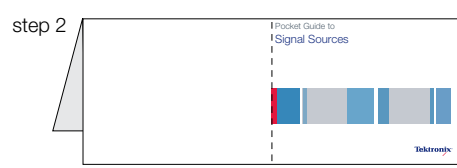
If your waveform is indistinguishable, adjust the horizontal scale.

If you can not get a stable trace, check the following:

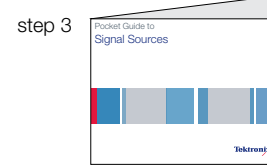
- Trigger level and source.
- For waveforms with events far apart in time, use normal mode.
- For single shot events, use single sequence mode.
- When using two or more traces, one trace may be stable while the others keep racing across the display. The frequencies of the waveforms are different.
  - Change trigger source to characterize each signal individually.
  - Or, use single sequence mode.



1. Print the four-panel guide on both sides of a single sheet of paper



2. Fold the guide in half with a horizontal fold



3. Fold the guide in half with a vertical fold