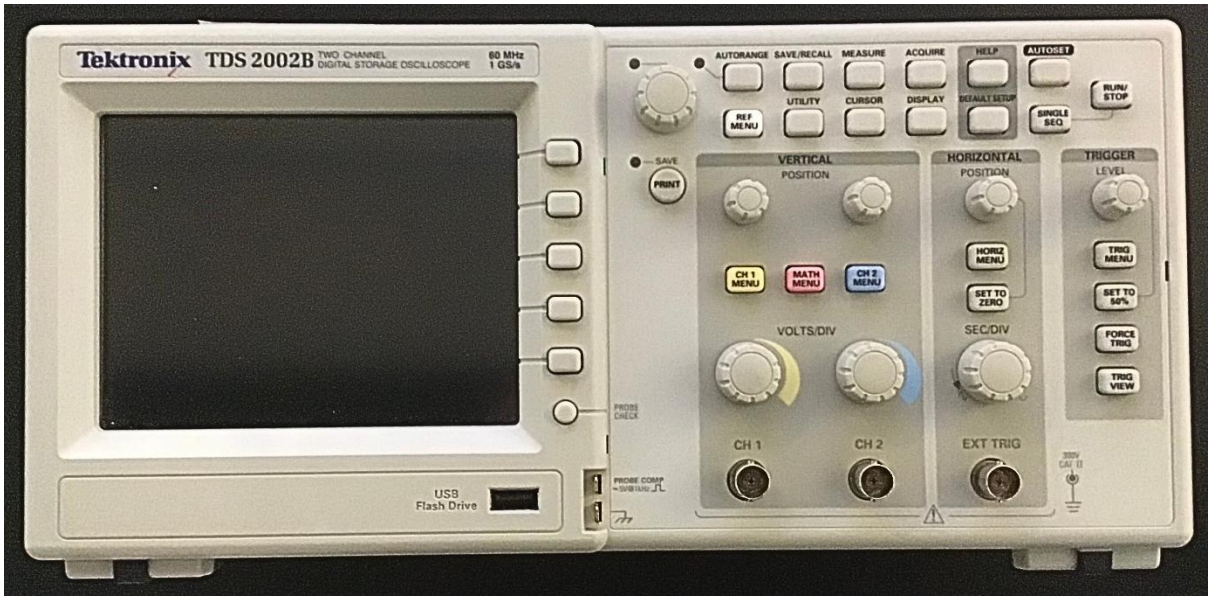
Makersplayce Machine Manual

Dual Channel Digital Oscilloscope

Tektronix TDS2002B



Introduction

This is the user manual for the Tektronix TDS2002B dual channel oscilloscope. This oscilloscope can be used to measure signals and voltages with different forms or time sensitive properties. It helps the user to troubleshoot and analyze their system. During the making of the manual, two datasheets/manuals [1] [2] were consulted from Tektronix

Reading through this manual before use is highly recommended, especially for beginners, as improper handling can lead to incorrect measurements. The goal of this manual is to help users understand how to operate the oscilloscope and to introduce its key features and functions.

Overview

In this section the different functions of the oscilloscope will be explained with the help of figure 1 below. The scope has a lot of functions.

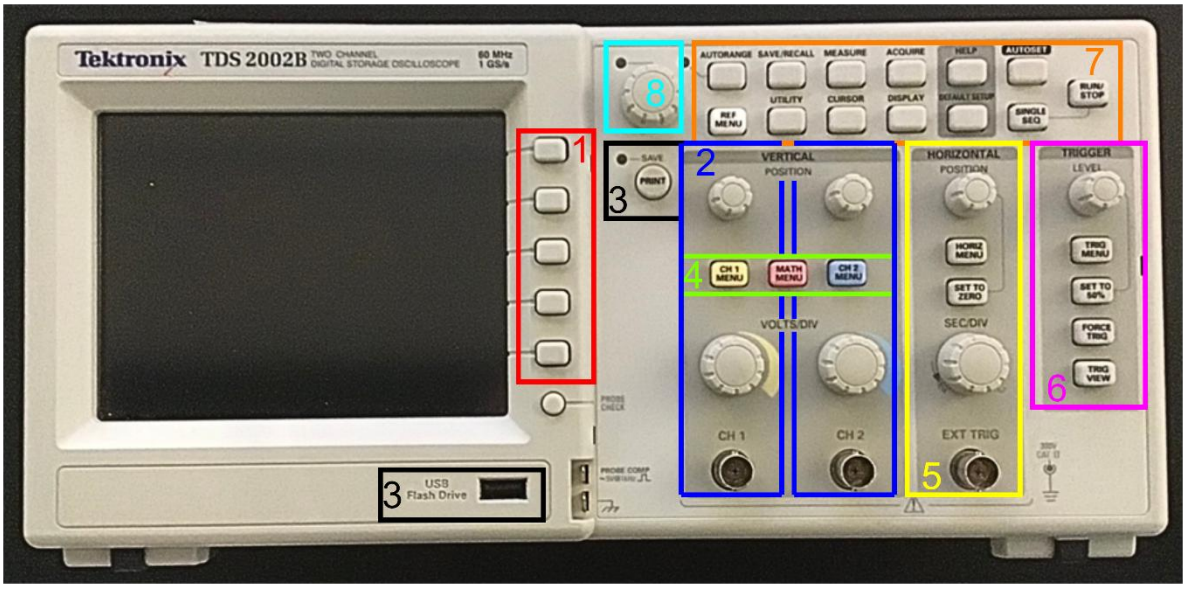


Figure 1: Overview of the oscilloscope with divided sections

1. Selection Buttons These buttons are used to change between different options and controls that are available, depending on the current control the oscilloscope is in (CH1 menu, CH2 menu, Measure, Autoset etc.).

3. Print & Save to USB The current displayed screen can be printed and saved to the USB flash drive that is inserted. The maximum memory size of the flash drive that can be inserted is 64 GB [1]. After inserting the flash drive to the USB port, the PRINT button can be used to save the current screen to the flash drive as an image.

During testing and writing this manual, we couldn't get this oscilloscope function to work. The port either didn't recognize the flash drive or said the drive was too large, even when using multiple flash drives under 64GB. Instead of saving the current screen to a USB flash drive, we recommend manually taking a photo of the oscilloscope with a mobile device.

2. Channel 1& Channel 2 (Vertical) Each channel has two knobs that control the vertical display of the signal. Position knob moves the waveform up or down on the screen without affecting the signal itself. This helps align the waveform for easier comparison between

channels or reference to the grid. Volts/Div knob adjusts the vertical scale, changing how many volts each division represents. Turning this knob allows you to zoom in or out on the amplitude of the signal. For example, if a signal with a 5Vp-p is connected to channel 1 and its at 5Vdiv, this signal will vertically take 1 block on the grid. If the V/div was at 500mV/div, then the oscilloscope would not display the signal properly, because there are only 8 vertical grid blocks and not 10.

4. Channel Menus & Math Channel menus can be used to change the following settings of the input channels, and you can switch between them by using the selection buttons:

- **Coupling (DC, AC, Ground):** Selects how the signal is passed to the display—DC shows all signal components, AC blocks DC offset, and Ground shows the zero-voltage reference line.
- **BW Limit (ON [20 MHz], OFF [60 MHz]):** Limits the bandwidth to reduce noise (ON) or allows full bandwidth for detailed signals (OFF).
- **Volts/Div (Coarse, Fine):** Adjusts the vertical scale in larger (Coarse) or smaller (Fine) steps.
- **Invert (ON, OFF):** Flips the waveform vertically.
- **Probe (Mode, Attenuation):** Mode selects the measurement type (Voltage or Current), and Attenuation adjusts the scaling to match the probe's setting (e.g., 1X, 10X, etc.). If the probe used has not attenuation setting slider, then its 1X standard.

The Math menu performs a certain operation chosen between CH1 and CH2:

- **Operation (+, -, x, FFT):** Performs math functions between channels; **+** adds, **-** subtracts, **x** multiplies signals, and **FFT** displays the frequency spectrum of the selected channel.
- **Source (CH1, CH2):** Selects which channel(s) to use for the chosen math operation.

5. Time Base (Horizontal) Two knobs allows the user to adjust the position and scaling of the horizontal axis, just like vertical channel adjustments. The Set to Zero buttons automatically sets the position to zero, and the Horizontal Menu button has a couple of its own features:

- **Main:** Displays the full waveform using the primary horizontal scale settings.
- **Window Zone (Adjustable with the general adjustment knob [8]):** Lets you select and adjust a zoomed-in portion of the waveform for detailed viewing.
- **Window:** Shows the zoomed-in view based on the selected window zone.
- **Set Trigger Holdoff (Adjustable with the general adjustment knob [8]):** Adjusts the time delay after a trigger event to stabilize complex or repetitive waveforms. For this oscilloscope it is set to 500ns by default.

6. Trigger Triggering is one of the most crucial elements of an oscilloscope. Triggering sets a reference point on the signal, so the oscilloscope displays a steady, repeatable waveform instead of a moving one. Triggering can happen via an external signal connected to the EXT TRIG input of the scope. Usually, trigger is not provided via an external signal but rather as a level that the scope sets itself. The trigger can also be manually adjusted using the knob at this section. Set To 50% automatically sets the trigger level at half of the displayed signal. Force Trig. Button makes the oscilloscope capture and display a waveform right away. The Trig View button displays the current trigger level on the screen with a striped line. And lastly the Trig Menu has a couple of selections:

- **Type:** Selects the trigger type: Edge triggers on signal edges, Video on video signals, and Pulse on specific pulse widths. (?)
- **Source:** Chooses which channel to provide the trigger signal to.
- **Slope:** Triggers on either the rising or falling edge of the signal.
- **Mode:** Auto triggers automatically if no signal is detected; Normal triggers only when a sudden or special event occurs. (?)
- **Coupling:** Filters the trigger signal DC passes all components, AC blocks DC offset, and Ground shows the zero reference.

7. Controls & Display These buttons allow you to observe the specifics of your signal better.

- **Autorange** Automatically adjusts the vertical and/or horizontal scales to display the signal without manual adjustments. When the button is pressed, the following will be selectable via de selection buttons on the right:
    a. **Autoranging:** Enables automatic scaling; pressing the autorange button again stops it, but you can go back to previous settings using this button again.
    b. **Vertical and horizontal:** Adjusts both amplitude (vertical) and time base (horizontal) scales automatically.
    c. **Horizontal only:** Automatically adjusts the time base while keeping the vertical scale fixed.
    d. **Vertical only:** Automatically adjusts the amplitude scale while keeping the time base fixed.
    e. **Undo autoranging:** Returns to the settings before autorange was activated
- **Save/Recall** Saves or loads waveforms and oscilloscope settings from internal memory or a USB flash drive. You can choose to save the current screen as a waveform, image, or setup file. Saved waveforms on the USB can be recalled for viewing, and you can also select the target folder for saving or loading files.
- **Measure** Displays automatic signal measurements. Available options include:
  Cyc RMS: RMS voltage over one cycle.
  Min: Minimum voltage, **Max:** Maximum voltage and **Pk-Pk:** Peak-to-peak voltage.
  Rise Time: Time for the signal to rise from low to high and **Fall Time:** Time for the signal to fall from high to low.
  Pos Width: Width of a positive pulse and **Neg Width:** Width of a negative pulse.
  Freq: Signal frequency and **Period:** Duration of one cycle. **Mean:** Average voltage and **None.**
  You can switch between measurement options by repeatedly pressing the same buttons until you reach the desired measurement. A maximum of five measurements can be displayed on the screen at once, as shown in Figure 2 above.

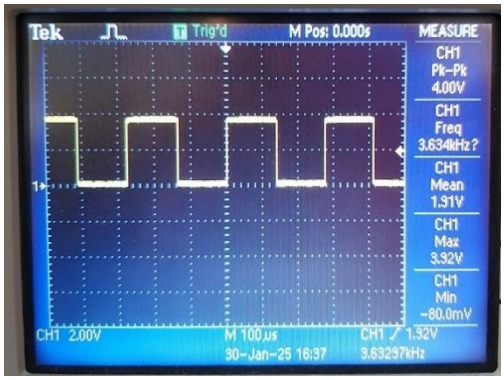


Figure 2: Measure function of the scope with 5 different signal specs

- **Acquire** Configures how the oscilloscope samples signals (e.g., normal, peak detect, or average mode). The default sample mode captures signal data at regular intervals. Peak detect captures faster signal peaks to detect glitches and lastly the average averages multiple waveforms to reduce noise. For averaging, 16, 64, or 128 samples can be selected to average over.
- **Ref Menu** Manages reference waveforms, allowing users to compare signals. Ref a ref b can be set via an external signal source from CH1 or CH2.

- **Utility** Provides system settings, self-calibration, and configuration options. You can check the system status, access extra settings, run a self-calibration, manage files, and change the display language. *We recommend avoiding this menu unless necessary.*
- **Cursor** Enables manual cursors for precise voltage and time measurements. You can select the type (amplitude or time), source (CH1, CH2, Math, Ref A, Ref B), and adjust Cursor 1 and Cursor 2 with the knobs to measure differences like ΔV or Δt, or measure specific values of the signals, which will be displayed on the right.
- **Display** Adjusts screen settings like grid visibility, intensity, and persistence. Type switches between vectors (connected lines, default) and dots (points only). Persist controls how long traces stay on-screen (1s, 2s, 5s, infinite—though infinite can lag the signal). Format changes the display to YT (voltage vs. time) or XY (signal comparison), and contrast adjusts screen brightness (up to 100%).
- **Help** Opens help documentation for oscilloscope functions on the screen.
- **Default Setup** Restores the oscilloscope to factory default settings. Undoes every trigger or autorange settings you might have selected, but undoing is possible via the selection buttons on the right.
- **Auto Set** Automatically adjusts the scaling settings for horizontal and vertical display just like Auto Range. On top of this, you can choose to display the signal with multiple periods, one period, or aligned to the rising or falling edge with the help of selection buttons on the right.
- **Single Seq.** Captures a single acquisition of a signal and then stops. When you press the button, the oscilloscope freezes the display at that exact moment, and the screen will not update even if the input signal changes. To resume live signal acquisition, press the Run/Stop button.
- **Run/Stop** Starts or stops waveform acquisition, allowing you to switch between continuous and static signal viewing. Like the Single Seq. button, it freezes the display, but pressing it again resumes live updates.

8. General Adjustment Knob This knob is used in multiple settings to adjust the level or the value of the selected option.

Starting Up

To start up the oscilloscope, first make sure it is plugged in. Then the switch on top of the oscilloscope on the left corner can be pressed to turn it on.

Shutting Down

Disconnect all the probes or cables that are connected at the inputs of the oscilloscope. If you changed any trigger or default settings, it is recommended that you undo them by clicking the Default Setup button before closing the device. Then use the switch on top again to turn it off.

How to Use

If you are new to this and do not know where to start, you can follow through the next steps to accurately measure and analyze the signal as needed. If for any reason you need help or are confused, this section can help with the most important functions of the oscilloscope, but playing around with the buttons and the settings is encouraged to get to know the device better. The scope is merely an analyzing tool, so it can't damage the system plugged to it, nor does it output any signals itself.

To properly display the signal on the screen, the scaling and the triggering are crucial. The vertical and horizontal controls (numbers 2, 4, 5 in the overview), the proper triggering of the signal (6), autorange and autoset buttons can help with the proper display of the signal. After you've determined what you expect the see on the scope (signal amplitude, freq etc.), and connecting your probe to one of the channel inputs, you can follow the next steps:

1- **Adjusting vertical scaling:** There are many ways to adjust the vertical scale settings of the scope. The autorange and autoset buttons scale the signal automatically for you. If both do not work, then your signal might not be outputting what you might expect as the scope is seeing either too high or too low of a signal. To fix this, you can check the attenuation of your probe and change it with the help of the channel menus (refer to **4. Channel Menus & Math** > probe and attenuation).
   You can also try to adjust the scaling manually, with the help of the position and volts/div knobs. Keep in mind that there are only 8 vertical grid blocks available, so choose the right volts/div for your signal (refer to **2. Channel 1& Channel 2 (Vertical)**).
2- **Adjusting horizontal scaling:** The autorange and autoset buttons should help with the proper horizontal scaling of the signal. If you want a specific scaling for vertical and horizontal, you can disable on of them in the autoranging tab with the help of selection buttons (refer to **7. Controls & Display** > Autorange). You can also manually change the position and timebase with the help of the knobs (refer to **5. Time Base (Horizontal)**).

After properly getting the signal to display on the screen, you can analyze and measure the signal with the help of cursors and the measure, autoset and cursor functions. With the help of autoset, you can select if you want to observe the rising edge, falling edge, one period or a couple of cycles on the screen. After you've selected your preference, you can add cursors to read out specific values, or difference between values (rising edge time, or deltaV etc.), you can refer to **7. Controls & Display** > Cursor to read how this function exactly works. If you also prefer, you can automatically get some of the characteristic values of the signal with the help of the measure function, refer to **7. Controls & Display** > Measure. With this function will give you most of the information you might need from your signal, all at once.

If any of the information above is unclear to you, feel free to consult one of the electrical engineering employees, or internet resources.

References

[1] Tektronix, "Tektronix TDS2002B Datasheet," Test Equipment Solutions, Bedford.

[2] Tektronix, „TDS1000B and TDS2000B Series Digital Storage Oscilloscopes User Manual," Tektronix, Beaverton.