

TDS210 Quick Reference Guide

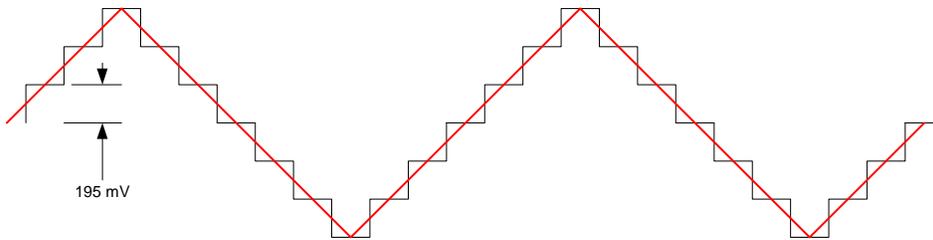


Introduction:

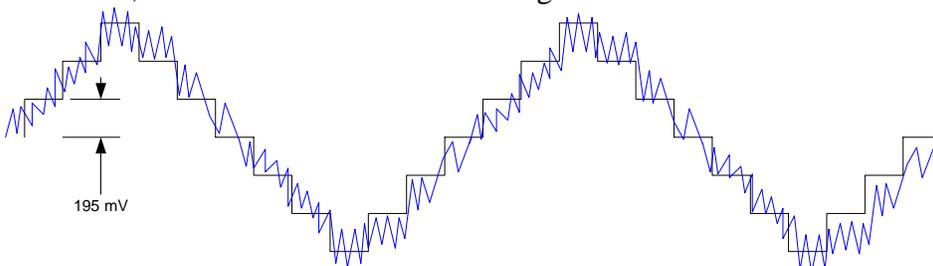
The TDS210 is a low end digital storage oscilloscope (DSO). This particular model, made by Tektronix, uses a variety of menu selections and multi-function knobs on the front panel to control the acquisition and presentation of data.

Vertical Controls:

The vertical section controls the input stage of the DSO. The acquisition input of this unit is an 8 bit acquisition system capable of scaling from 20mv to 50v full scale. This means that the system can measure a signal within the span range to 256 individual levels. This means that if you are set to 5 volts per division, (50V full scale) the maximum resolution is 195 millivolts. In other words, in this setting, the smallest increment of change the oscilloscope can measure and display is 0.195 Volts. The following triangle wave (shown in red) would be displayed as indicated by the black waveform.



However, the following blue waveform would also be displayed by the exact same waveform, the variations in the wave being smaller than the minimum increment.



There are two input channels controlled by the group of buttons and knobs shown at the right. Each channel is controlled separately. The VOLTS/DIV (Volts per division) knob for each of the two input channels, (CH 1 and CH 2) control the gain of the input section, adjusting it from a minimum of 2 mV / div to 5 V / div. Volts per division is the standard method of specifying amplitude on the display, with each division being one major graticule increment on the display.

The POSITION knob is used to adjust the position of the trace on the screen. It does NOT affect the amplitude, simply where on the display the trace is placed. In some cases you may want the two displays to be set with their zero reference at the exact same place, overlaying the two traces to compare them. In other situations you may want to move one trace completely away from the other to better visualize the waveforms.



The Menu button activates the selection menu on the right side of the display, and switches its selections to those appropriate for the input channel. For this scope you have the following settings that can be accessed.

Coupling [DC | AC | Ground]

This setting selects how the input is coupled. **DC** of course will allow both ac and dc signals to pass. **AC** coupling places a capacitor in series with the signal, eliminating any dc. This is useful for looking at small ac signals that may be riding on top of large dc levels. **Ground** turns the input to a 0 volts input mode, effectively disabling it.

BW Limit [Off (60 MHz) | ON (20 MHz)]

Bandwidth limit is used to control the acquisition and display of high frequency signals. For most conditions you will be operating with this on, eliminating unneeded high frequencies.

Volts/Div [Course | Fine]

This selection sets the function of the volts per division knob to an adjustment between a course setting, and a fine setting. Occasionally it is useful to match the size of two waveforms on the screen for comparison, but for most cases it will be used in course mode.

Probe [1X | 10X | 100X | 1000X]

This is probably the most important and most confusing setting. Many higher end scopes have the ability to determine if the input probe is a multiplying probe or not. A multiplying probe will drop the voltage it sees by some factor of ten. Since the scope can not read values greater than 50 volts peak, it would be impossible to read even the voltage on the wall outlet. This is solved by using a probe that will “attenuate” the signal by some factor. The most common is the 10X probe, however higher gain probes are available for uses with high voltages. A straight wire connection is always a 1X probe. This setting simply tells the scope that a different probe is attached so that readings from the screen or cursors are set at the proper level. ***This selection DOES NOT allow the scope to read higher voltages directly!!!***

Math / Menu button allows the system to do simple math on the two input channels. The available selections are:

- CH1 minus CH2
- CH2 minus CH1
- CH1 plus CH2
- CH1 inverted
- CH2 inverted

Horizontal controls:

The horizontal controls select all functions related to the time base, or x direction of the display. **Position**, similar to the vertical position, simply adjusts where on the display the image is, and does not modify the data or scaling in any way.

SEC/DIV control adjusts the horizontal scale of the display in the time mode. This adjustment, similar to the vertical controls, adjusts based on some time per major gratical division in the X direction. The range of this control is 5nS to 5 S per division.

The horizontal section of this scope is capable of displaying 2500 samples across the screen. The result is a sample rate of 50 samples per second to 1G samples per second.

The **HORIZONTAL MENU** button switches the soft buttons along the side of the display to the horizontal menu selections. These include the zoom function and the trigger level knob function.

The upper area is the zoom selection. In **Main**, the full acquisition window is displayed. By selecting **Window Zone**, you can use the **SEC/DIV** knob and the **POSITION** knob to move two vertical cursors (dotted lines). When **Window** is selected, the display will zoom to the width and location specified by the cursors.

The lower selection is the function of the trigger knob. The selections here are **Level**, the most common selection, and **holdoff**. We will discuss the level adjustment in the trigger section discussion. **Holdoff** determines how long the scope must wait before another trigger is accepted. This is normally set to the minimum level of 500.0 nS.



Trigger Section:

Acquiring the waveform is only part of the job. In order to display a quickly changing waveform, you need to have a common reference, or the image would be moving and changing so much you would never be able to see it. This is done by the trigger sections. The trigger function allows the acquisition process to start at the same point each time, giving the acquired data the same “window”. The trigger function can be done one of two ways; the first being a single input (or manual button) that says, “do it now” without any regard for the waveform. Under these conditions the scope assumes you know what your doing, and will dutifully start the acquisition process. The second method is to set a trigger criteria. The scope will then wait for the signal to meet those criteria, and start acquiring at that point in time. Typically the trigger criteria falls into two variables, a level and a slope. The trigger level sets a voltage level at which to begin the acquisition. The trigger slope determines if the signal is rising or falling through the specified level. When both of these are true, correct slope and level, the system will begin acquiring the data and then display it. If the trigger is set to “single” or “one shot” mode, the system will stop and wait for the user to “arm” the trigger again before it will take more data. In auto or “normal” mode the system immediately prepares for the next trigger event, and takes and displays another set of data when the next trigger event occurs.



Mentioned in the previous section was a function called **holdoff**. Trigger holdoff sets an amount of time that must elapse before the trigger is re-armed for the next cycle. This value is usually set to 500 nS, which is the fastest that this particular scope can re arm itself.

The trigger level knob adjusts either the holdoff time or the level depending on which mode was set by the horizontal section menu. In level mode this adjustment sets the analog level at which the trigger actuates. This level is indicated by a small arrow on the right side of the display screen, and a numeric indicator at the bottom of the display. It can be further viewed as a dotted line across the screen while holding in the **TRIGGER VIEW** button at the bottom of the trigger controls.

The **TRIGGER MENU** opens the soft button panel on the right side of the display to the trigger selections. These include selections for a trigger type, channel, slope, mode and coupling.

- **EDGE / VIDEO** : This selection changes the display from edge mode to video mode. Video mode is a special mode used for working with video data streams and will not be used in this class. This mode should always be set to **edge**.
- **SLOPE**: This setting can be used to change the slope of the detection from rising to falling edge. Just like the labels say, the voltage must be either rising or falling through the set level to initiate a trigger.
- **SOURCE**: This menu selection allows you to set which source you acquire the trigger data from. It can be from CH 1, CH 2, EXTernal, or LINE. EXT derives its trigger from the front panel connection labeled **EXT TRIG**. This mode will not normally be used in this class. **LINE** uses the 60 cycle line frequency for a trigger. This is useful when dealing with signals that are at the same or multiple

- frequency of the 60 cycle line voltage. CH1 and CH2 are the most commonly used, and select which input is used to derive the trigger voltage signals.
- **MODE:** The mode selection has three choices, AUTO, NORMAL and SINGLE. As you can imagine, SINGLE is the mode discussed earlier that allows a single trigger event to happen, and then waits for the operator to re-arm the trigger circuit before it starts the next cycle. NORMAL mode will display one trace each time the trigger event occurs. If no trigger events happen, then the last data remains displayed until the next trigger event, which could be now to never. AUTO mode allows the waveform to be displayed in roll, or untriggered mode while it is waiting for a trigger event. Once a trigger occurs, the scope will display the triggered data for a period of time, and then go back to untriggered display. This mode is most useful in setting the trigger level of a normally repetitive signal, since you can see the signal racing by and then freeze when you get the trigger set properly.
 - **Coupling:** is the selection that sets how the signal is fed to the trigger section. **DC** mode is as it says, all signals, including DC voltage levels are sent to the trigger. **AC** mode strips off the DC level and measures only the changing portion of the wave form. **Noise reject** is a special mode used to try to eliminate random noise from the trigger signal. This mode is not used in this class. **HF Reject** applies a low pass filter to the input, eliminating frequencies above 80 KHz. **LF reject** eliminates frequencies below 300 KHz.

The final group of controls is the selection buttons across the top of the control section.



These buttons provide a number of important functions, as well make other menus available. Starting at the far right, the **RUN/STOP** button does exactly what it says. It toggles the acquisition mode between run mode and stop mode.

HARDCOPY will generate a hard copy of the display to the attached printer. There is no printer currently connected to the scope.

AUTOSET is a useful button. This will attempt to adjust the input voltage and trigger settings to get a consistent waveform on the screen. This sometimes will generate results showing signals, but not the signals you were intending to see.

ACQUIRE: This button opens a set of menu selections that determine how data is acquired by the input sections. **SAMPLE** is the most common setting, however peak detect and average can be useful in some circumstances, each control doing exactly what they say.

Display: The display menu has a number of choices about how the data is displayed on the screen.

- The first choice you are given is to display only the **dots** for the data or to draw them as **vectors**, with lines connecting the 2500 dots.

- **Persist** determines how fast the screen is erased. Setting longer persist values is sometimes useful when looking for intermittent data.
- **Format** allows the user to change the display from **YT** (voltage vs time) to **XY** (channel one vs channel 2). Looking at one channel vs the other is sometimes useful when looking at the phase between signals.
- The last two settings allow you to change the contrast of the display.

MEASURE: This menu can be extremely useful. It is often desirable to make measurements on the voltage or time of a signal. This menu allows a number of measurements to be taken at the same time.

- The first button is a selector which affects the focus of each of the lower buttons. When **Source** is highlighted, all of the lower buttons will adjust where that measurement acquires its data. The choices for each measurement are CH1 or CH2. When **TYPE** is highlighted, you can select what the measurement type is for each of the lower buttons.
- Measurement functions include the following choices:
 - **Freq** : Frequency of the displayed signal (1/period)
 - **Period**: Time period of one cycle of the displayed signal. This is usually generated as the time period from trigger event to the next occurrence of a trigger qualifying event (level and slope)
 - **Mean**: Mean voltage of the signal
 - **Pk-Pk**: Peak to Peak voltage of the signal
 - **Cyc RMS**: True RMS voltage of one cycle of the displayed signal. (typically generated over one period as defined above.)

One important note on measurements. The accuracy of a measurement is limited to the resolution of the input amplifier. In this device it is an 8 bit or 256 increment resolution system. Changing the volts/div knob will change your measurement results. The most accurate voltage measurements occur with the largest unclipped (no part of the wave off the screen) display of the wave being measured.

CURSOR: The cursor button brings up a menu selection that allows you to turn on a set of cursors for making on screen measurements. These cursors are selected using the top button. The choices are:

- **OFF** : Turns the cursors off
- **Voltage**: Turns on two horizontal cursors
- **Time**: Turns on two vertical cursors.

The second button down selects the source for the cursor data. These selections include:

- **CH1** : Input channel 1
- **CH2**: Input channel 2
- **MATH**: The math trace, if it is turned on.
- **REFA**: Stored waveform A
- **REFB**: Stored waveform B

Time Cursors: These two cursors allow the measurement of time increments on the screen. The two cursors are controlled by the two vertical position knobs, and readouts

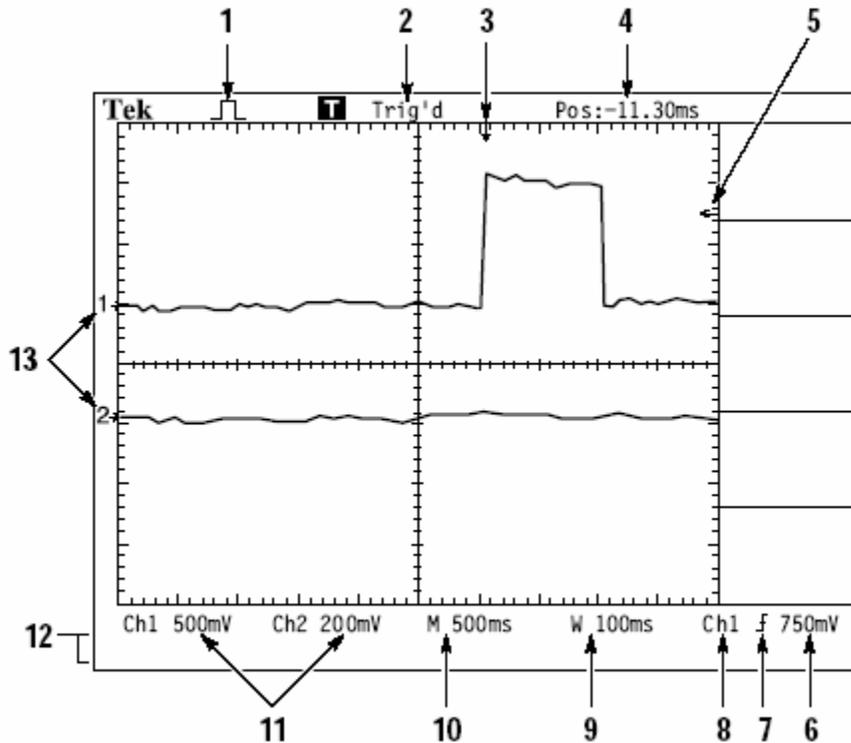
are available on the right side of the screen for the absolute time of each cursor as well as the delta time between them.

Voltage Cursors: These two cursors allow the measurement of voltage increments on the screen. The two cursors are controlled by the two vertical position knobs, and readouts are available on the right side of the screen for the absolute voltage of each cursor as well as the delta voltage between them

SAVE/RECALL: This button selects a set of menus to store and recall waveforms and scope setups in memory.

UTILITY: This menu is used mostly for service items, such as calibration and diagnostics.

DISPLAY AREA: The display contains a vast amount of information. The following section of this guide show what the various screen areas indicate.



1. Icon display shows acquisition mode.

-  Sample mode
-  Peak detect mode
-  Average mode

2. Trigger status indicates the following:
 - Armed. The instrument is acquiring pretrigger data. All triggers are ignored in this state.
 - Ready. All pretrigger data has been acquired and the instrument is ready to accept a trigger.
 - Trig'd. The instrument has seen a trigger and is acquiring the posttrigger data.
 - Auto. The instrument is in auto mode and is acquiring waveforms in the absence of triggers.
 - Scan. The instrument is acquiring and displaying waveform data continuously in scan mode.
 - Stop. The instrument has stopped acquiring waveform data.
3. Marker shows horizontal trigger position. This is adjusted by the Horizontal Position control.
4. Readout shows the time difference between the center graticule and horizontal trigger position. Center screen equals zero.
5. Marker shows trigger level.
6. Readout shows numeric value of the trigger level.
7. Icon shows selected trigger type as follows:
 -  – Edge trigger for the rising edge.
 -  – Edge trigger for the falling edge.
 -  – Video trigger for line sync.
 -  – Video trigger for field sync.
8. Readout shows trigger source used for triggering.
9. Readout shows window time base setting if it is in use.
10. Readout shows main time base setting.
11. Readouts show the vertical scale factors of the channels.
12. Display area shows on-line messages momentarily.
13. On-screen markers show the ground reference points of the displayed waveforms. No marker indicates the channel is not displayed.