Rigol DS1000E Digital Oscilloscope Short Guide

Background/Introduction

This guide discusses using a Rigol DS1000E Digital Oscilloscope to make *simple* voltage versus time measurements. Figure 1 shows the front panel of the oscilloscope. Digital storage oscilloscopes sample analog voltage signals <u>with respect to ground</u>, store the values (and corresponding times), and display them on the screen. These values are available for downloading and mathematical manipulations (e.g., FFT). In contrast, analog oscilloscopes use the measured analog signals to directly control the trace(s) on the screen (no stored data).
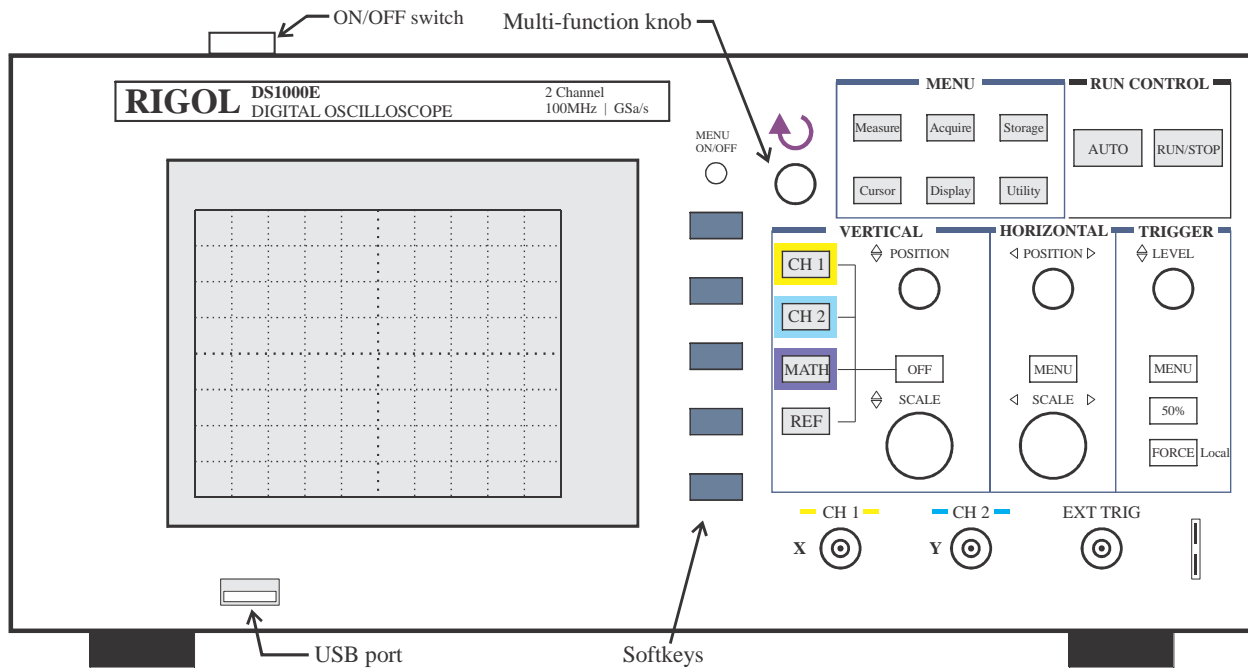

Figure 1 Front panel layout of Rigol DS1000E Digital Oscilloscope.

In order to make measurements, the oscilloscope must be connected to the components/devices being measured. On the front panel, there are three BNC (F) connectors for this purpose labeled-CH1, CH2, and EXT TRIG. Typically, an RP2200 passive oscilloscope probe with a BNC (M) connector on one end and a pin/hook on the other end is connected to CH1 and/or CH2 of the oscilloscope; EXT TRIG is most often used with digital circuits (e.g., sync with clock signal).

The following designations will be used to help give instructions on using/operating the oscilloscope.

- Front panel hardkeys/buttons will be depicted by a box outline, e.g. BUTTON . These are keys with fixed purposes.

- Boxed groups of related hardkeys/buttons will be referenced by the box name in quotes, e.g., "MENU".

- Softkeys on the oscilloscope display (located to right of screen) will be depicted using < >, e.g., <External>. These are keys whose purpose is flexible, i.e., they are changed, depending on context, by the software of the oscilloscope.

- Softkey options will be indicated by highlighting, e.g. **Bitmap**. They can be toggled by repeatedly pushing the softkey button or using the multi-function knob (rotate & push). The MENU ON/OFF button just above the softkeys will turn their display on or off.

To begin, turn oscilloscope on by pressing in the ON/OFF switch (on top). Then, it is a good idea to restore the oscilloscope to the factory presets in case someone has left it in an odd state. This is done by pressing the Storage button in the "MENU" group. This activates a softkey Storage menu. Press the <Waveform> softkey. Use the multi-function knob to select the **Factory** option (rotate & push) and then press the <Load> softkey that is activated.

"VERTICAL" group

CH1/CH2

The yellow CH1 and blue CH2 buttons are used to cause the oscilloscope to either display or hide the signal from the corresponding channel (yellow trace for CH1 and blue trace for CH2). A trace may be turned off by using the OFF button or repeatedly pressing the CH1 or CH2 buttons. In addition, when the particular channel is selected, a softkey menu for that channel will be activated. The particular softkey options are:

a) The <Coupling> softkey allows the user to select from **DC** (displays/measures both AC and DC signal components), **AC** (displays/measures only AC signal components), or **GND** (displays flat line at 0 V) options. Typically, **DC** coupling is most often used.

b) The <BW Limit> softkey allows the user to toggle between **OFF** (full 100 MHz) and **ON** (limit signals to frequencies less than 20 MHz). Typically, the BW limit will be left **OFF**.

c) The <Probe> softkey allows the user to select from **1X**, **5X**, **10X**, **50X**, **100X**, **500X**, and **1000X** to account for attenuation setting on the probes. Use **1X** (no attenuation) when the RP2200 probe switch is set to **1X** or a BNC-BNC cable is used. Select **10X** when the RP2200 probe switch is set to **10X**. The other setting options are meant for different probes.

d) The <Digital Filter > softkey allows the user to select **OFF** (no digital filtering) and **ON.** **ON** brings up new softkeys with filter options (e.g., lowpass, highpass, etc.) and cut-off frequencies. Typically, the digital filtering will be left **OFF**.

e) Pressing the <1/2> downarrow softkey brings up a second page of channel softkey options.

f) The <Volts/Div> softkey allows the user to toggle between **Coarse** (use oscilloscope defaults, e.g., 10 V/div, 5 V/div, 2 V/div, 1 V/div …) and **Fine** (allows for V/div selections in between the defaults). Typically, this option is left as **Coarse**.

g) The <Invert> softkey allows the user to toggle between **OFF** (display signal as-is) and **ON** (inverts signal). Typically, this option is left **OFF**.

MATH

Pushing the MATH button activates a purple trace on the display and a softkey menu that allows various waveform math operations to be performed on the input signal(s) from CH1 and CH2. It may be turned off by using the OFF button or repeatedly pressing the MATH button.

a) The <Operate> softkey allows user to select between **A+B**, **A-B**, **AxB**, and **FFT** options. Typically, the **A-B** option is used the find the voltage across a component not tied to ground.

b) The <Source A> softkey allows user to select either CH1 or CH2 to be source A.

c) The <Source B> softkey allows user to select either CH1 or CH2 to be source B.

d) The <Invert> softkey allows user to invert the resulting purple MATH trace.

The **A+B, A-B**, and **AxB** options will perform the operation for the CH1/CH2 signals *as shown on the display*. This means that if the signals are displayed with different vertical VOLTS/DIV SCALE settings, the result will **not** be a true sum, difference, or multiplication. For most

situations, it is best to set both waveforms to the same VOLTS/DIV scale before using these options.

REF

The REF button activates a softkey menu and displays a white reference trace. This button is not used in EE 220.

POSITION knob

Under the "VERTICAL" menu, the POSITION knob allows the user to move selected trace up or down on the display, without changing the vertical (e.g., voltage) scale. Essentially, this knob moves where the ground (0 V) reference level for each channel is placed. The reference level is indicated on the screen, e.g., a little yellow arrow labeled "1" is shown to the left of screen for CH1. When used, the oscilloscope displays colored-coded information regarding the position in the lower left corner, e.g., POS = 40.0 mV. Pushing in the POSITION knob will return the trace selected to the default middle position.

SCALE knob

Under the "VERTICAL" menu, the SCALE knob is used to adjust the vertical scale of the selected trace. The color-coded scale settings for each active trace will be shown at the lower left corner of the display, e.g., CH1= 1.00 V. This refers to the number of volts between each horizontal gridline on the display *for the selected trace*. It is possible for each trace to be at a different scale setting. By default, the SCALE knob will go in coarse steps, e.g., 500 mV, 1 V, 2 V, … However, by pushing in the SCALE knob, finer scale settings are possible, e.g., 990 mV, 1 V, 1.02 V …

"HORIZONTAL" group

POSITION knob

Under the "HORIZONTAL" menu, the POSITION knob allows the user to move <u>all</u> active traces left or right on the display, without changing the horizontal (e.g., time) scale. Essentially, this knob moves where the reference point (e.g., 0 s) is placed. The reference point is indicated on the screen, e.g., a little orange arrow labeled "T" is shown on the top of the screen. The oscilloscope displays colored-coded information regarding the position, e.g., T → 400.0us at the bottom. Pushing in the POSITION knob returns the trace(s) to the default middle position (0 s).

MENU

The MENU button activates a softkey menu. The default settings are adequate for EE 220 (e.g., Delayed = OFF, Time Base = Y-T, …). Therefore, this button is not used.

SCALE knob

Under the "HORIZONTAL" menu, the SCALE knob is used to adjust the horizontal scale of <u>all</u> active traces. The color-coded scale setting for each active trace will be shown at the lower right of the display, e.g., Time 2.000 ms. This refers to the number of seconds between each vertical gridline on the display. By default, the SCALE knob will go in coarse steps, e.g., 5 ms, 2 ms, 1 ms, … However, by pushing in the SCALE knob, a "Zoom" function is available (not used in EE 220).

"TRIGGER" group

<u>LEVEL knob</u>

The LEVEL knob allows the user to move the voltage level where the oscilloscope 'triggers' a sampling of data (i.e., takes a 'snapshot'). The trigger level is indicated by an orange dash-dot horizontal line across the display and an orange "T" is shown on the left. When used, the oscilloscope displays colored-coded information regarding the position, e.g., TRIG LVL = 163mV at the lower left. Pushing in the LEVEL knob returns the trigger level to zero (0 V). If the trace selected as the source for the trigger (default is CH1) does not pass through the trigger level the trace(s) will jump around randomly. This can happen for signals with DC offsets and when the probe for CH1 is disconnected.

MENU

The MENU button activates a softkey TRIGGER menu. The default settings are typically adequate for EE 220 (e.g., Mode = Edge, Source = CH1, …). Usually, this button does not need to be used unless it is desired to use another signal source for the trigger.

<u>50% and FORCE buttons</u>

These buttons are not used or needed for EE 220.

"MENU" group

Measure

The Measure button activates a softkey Measure menu. The particular softkey options are:
  a) The <Source> softkey allows the user to select to make measurements from **CH1** or **CH2**.
  b) The <Voltage> softkey allows user to make voltage measurements for the selected channel- **Vmax**, **Vmax**, **Vpp**, **Vtop**, **Vbase**, **Vamp**, **Vavg**, **Vrms**, **Overshoot**, and **Undershoot**.
  c) The <Time> softkey allows to make time measurements for the selected channel- **Period**, **Freq**, **Rise Time**, **Fall Time**, **+ Width**, **- Width** ...
  d) The <Clear> softkey clears all current measurement selections from the display.
  e) The <Display All> softkey allows the user to toggle **ON** or **OFF** a simultaneous display of all possible voltage and time measurements for the selected channel.

Cursor

The Cursor button activates a softkey Cursors menu. In EE 220, cursors are useful for manually selecting and measuring voltage levels or time differences. The particular softkey options are:
  a) The <Mode> softkey allows the user to select from **OFF**, **Manual**, **Track**, or **Auto**. In EE 220, we will only be concerned with the **OFF** and **Manual** options. The default **OFF** option has no further softkey menus. The **Manual** option brings up another softkey menu-
     i.   The <Type> softkey has **X** (e.g., time) and **Y** (e.g., voltage) options.
     ii. The <Source> softkey has **CH1**, **CH2**, or **MATH**.
     iii. The <CurA---> softkey tells oscilloscope to move cursor A with Multi-function knob.
     iv. The <CurB---> softkey tells oscilloscope to move cursor B with Multi-function knob.

Storage

The Storage button activates a softkey Storage menu. In EE 220, we will use this menu to store bitmap (*.bmp) screen shots to an external USB flash drive and to restore the oscilloscope to the factory presets (covered earlier). The initial softkey options are <Waveform>, <Internal>, <External>, and <Disk Mana.>. The last two softkey options are only active if an external drive (e.g., USB flash drive) is connected. Pressing the <Waveform> softkey allows the user to select from **Waveform**, **Setups**, **Bit map**, **CSV**, or **Factory** options.

a) Selecting the **Bit map** option leaves the following softkey options.

b) The <Para Save> softkey allows user to toggle **OFF** and **ON**. In EE 220, leave it **OFF**.

c) The <External> softkey allows the user to save a bitmap to an external USB flash drive. It freezes the screen display and brings up another softkey menu

   i.   The <Explorer> softkey has **Files**, **Path**, and **Directorys** options. Use **Files**.

   ii.   The <New File> softkey brings up a submenu that allows one to enter a *filename* or use the default NewFile0, NewFile1, … Press the <Save> softkey to save the bitmap. It is easier to use the defaults and rename files later. Press bottom return arrow softkey repeatedly to exit <New File> menu. Press RUN/STOP to resume operation.

   iii.   If files exist on the USB flash drive, the <Delete Files> softkey allows the user to delete a file highlighted/selected using the Multi-function knob.

d) The <Inverted> softkey allows user to toggle between **OFF** (black background on bitmap) and **ON** (white background on bitmap) options. Select **ON** to save ink when printing later.

e) The <Disk Mana.> softkey allows the user to do disk management functions. Typically, this is not done on an oscilloscope.

Acquire

The Acquire button activates a softkey Acquire menu. This button will not be used in EE 220.

Display

The Display button activates a softkey Display menu. This button will not be used in EE 220.

Utility

The Utilities button activates a softkey Utilities menu. Options include **IO Setting**, **Sound**, **Counter**, **Language** … The **Counter** softkey toggles **ON** or **OFF** a frequency counter display in the upper right corner. The other selections are typically not used in EE 220.

"RUN CONTROL" group

AUTO

Pressing the AUTO button causes the oscilloscope to automatically try and adjust all setting to measure the signal(s) it detects from channels 1 and 2. Do NOT use this button in EE 220.

RUN/STOP

The RUN/STOP button allows the user to 'freeze' the screen display or the reactivate active measurements/sweeps by the oscilloscope. It is lighted **green** when active and **red** when frozen.