Massachusetts Institute of Technology

Robotics: Science and Systems I
Tektronix 2445 150MHz Oscilloscope

Introduction

The oscilloscopes used in RSS are the Tektronix 2445 150MHz oscilloscopes. Those of you who have taken 6.002 or have previous experience with scopes likely used these same, analog scopes. These scopes are analog, so we use knobs rather than digital menus for inputs and adjustments. Each scope outputs its relevant measurement to the large blue screen, which is controlled in turn by four primary control sections on the rest of the device. We'll examine each of these five areas below.

- Scope Display
- Scope Channels, Top
- Scope Channels, Bottom
- Scope Trigger
- Screen
- Other

Scope Display

The Scope Display controls are directly beneath the screen. These controls are mostly for aesthetic uses: making the screen brighter or dimmer. From left to right, we have the following controls.

- **Intensity (knob)**: Modulates the brightness of the beams shown on the screen
- **Beam Find (button)**: Shrinks the display while the button is depressed, allowing for recentering of the beams after a mis-positioning movement.
- **Focus (knob)**: Modulates the focal point of the screen - can usually be left alone.
- **Readout Intensity (knob)**: Modulates the brightness of the measurements displayed at the bottom of the screen.
- **Scale Illum (knob)**: This is effectively the backlight to the screen; if the scale lines are hard to see, turn the knob clockwise away from the fully-left position.
- **Power (switch)**: Power switch; an internal green shell is revealed when in "on" position. Note that the device has a warm-up time of about ten seconds before any display will appear.

Scope Channels, Top

The scope can support up to four channels of input. We'll only be listening to at most two channels, CH1 and CH2. To control these inputs, we'll look first at the top portion of the device.

- **V. Position (knobs)**: Shift the vertical position of Channel 1 (left) and Channel 2 (right) signals, independent of everything else on the screen display. Useful for differentiating the two signals, if you're displaying both at the same time.

- **H. Position (knob)**: Shifts the horizontal position of all signals displayed on the screen, without modifying the measurement bars or the textual readouts. Generally not necessary.
- **X10 Mag (switch)**: When switched on, the given signal's time division is increased by a factor of 10 (from 100ms/div to 10ms/div, for instance). Generally not necessary.
- **Mode (switches)**: These are the various forms of displays for the screen. When a button is depressed, that information stream will be displayed at the proper position on the screen. CH 1 shows the signal from port 1; CH 2 shows the signal from port 2; ADD shows the sum of the signals from port 1 and port 2; Invert flips and displays the signal from port 2. CH 3 and CH 4 can be ignored. Chop and the BW Limit both lead to a cleaner, easier-to-read signal when switched on - we reccommend that you switch them both on and leave them.
- **Measurement Module**: These two buttons, switch, and two knobs compose an analog measurement system. To engage a horizontal measurement (time), press Δt; To engage a vertical measurement, press Δv; to turn off the measurement bars, press the current measurement type again. The Tracking switch should be left off (out) for proper movement of the measurement bars. When a measurement type is engaged, use the left knob to reposition the left/top bar, and the right knob to reposition the right/bottom bar. The measured distance between the bars will be displayed on the upper right of the screen.

Scope Channels, Bottom

The lower half of the scope channels section is dedicated to scaling of the outputs on each channel, as well as the selection of channel type. Briefly, the devices of interest in this region are the following.

- **Volts/Div (graded knobs)**: Adjusts the meaning of the static, vertical divisions on the screen. Each grade on the knob indicates the exact value of one row on the screen for the given channel. Note: the internal knobs are independent and not graded; make sure they are turned all the way Clockwise before taking measurements on the screen, as the changes to the scaling are not displayed anywhere.
- **A and B Sec/Div (graded knob)**: Adjusts the meaning of the static, horizontal divisions on the screen. Each grade on the knob indicates the exact value of one column on the screen for both Channel 1 and Channel 2. Note: the internal knob is independent and not graded; use this knob to fine-tune the time measurements made with the device, as the changes are printed to the screen
- **Channel Type (graded switch)**: Allows for switching input format from AC to DC and to Ground (... twice; don't ask). Depending on the measurement you're trying to make, you'll want to change the channel type to match accordingly.
- **Trace Sep (knob)**: No visible effect on the information displayed on the screen - can be ignored for our purposes.

Scope Trigger

This is the analog Trigger system. If you're comfortable with using trigger systems on oscilloscopes, this should be familiar. Making adjustments to this part of the machine is outside of our scope, however, so feel free to simply set the settings as shown and use only the Level knob to adjust your signal's display.

- **Holdoff (knob)**: Adjusts the holdoff between two successive signals if needed - we'll ignore this for our purposes.
- **Level (knob)**: Fine-tune adjustment of the signal display. By adjusting this knob, you should be able to make any waveform you're tracking with the scope appear to be a standing wave. When a waveform is standing, measurements become far easier to make; learn to use this knob to make waveforms static on the screen.

- **Trig & Slope (switches)**: Ignore these switches - they don't play any part on the work we'll be doing with the oscilloscope.
- **Mode (graded switch)**: This sets the mode which the oscilloscope uses for display of incoming signals. Leave this switch set to "auto" to get optimal displays from the scope.
- **Source (graded switch)**: Indicates the source signal to be handled by the trigger system. Set this switch to CH 1 in order to have your modifications apply to the signal coming off of channel 1's probe, which will be our default.
- **Coupling (graded switch)**: Indicates the signal about which we'll be performing our filtering. As a general rule, the LF setting leads to the best visualization of the signals we deal with in this class - leave the switch on LF unless otherwise noted.

Screen

On the screen, all of the information that you want to track will be displayed. The top right of the screen is reserved for information about measurements made with the Measurement Module. The top left of the screen is reserved for readouts from the Trigger Module. The bottom of the screen is reserved for readouts on the horizontal (Channel 1 and Channel 2, respectively) and vertical scales currently in use. Beyond that, the screen is yours to use for positioning of the signals you're tracking.

Other

For Further information on using the Tektronix oscilloscopes, feel free to ask the staff or consult the Tome Of Knowledge: it contains a formal user manual (a whole lot of fine print - dense, but thorough). Happy Measuring!