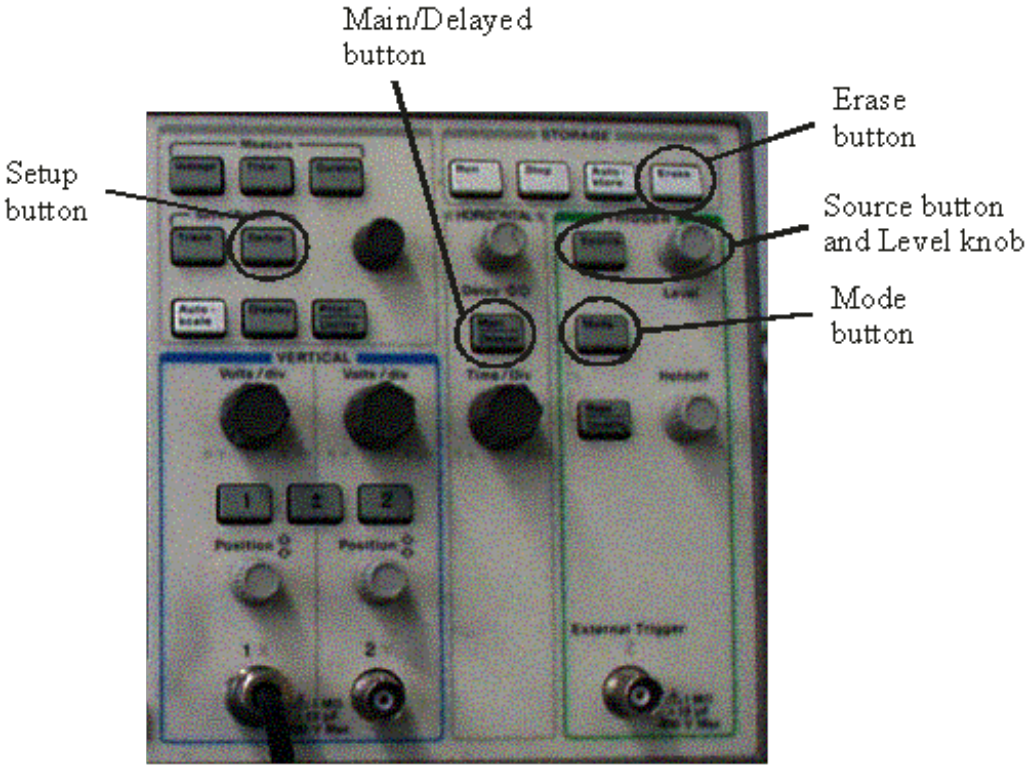
Triggering an Oscilloscope to Capture a Step Response

Triggering a scope to capture a step response is not hard as long as you are methodical in your procedure. This means primarily thinking about what knob to turn or button to push before you do it and watching the effect of your action while you do it. Let's begin from the Default Setup action. Put the scope into it's default set-up by pushing the Setup button (see panel photograph). This will cause a soft key labeled Default Setup to appear on the scope screen. Push this soft button to put the scope in its default setup.

The default setup is not the ideal point at which to begin because the scales for voltage and time are too fine. Scopes are often used for electronic work where things happen fast and voltages are small. The default setup reflects that need. For mechanical, real-world work, voltage are often larger and things happens slower. So the first thing you have to do is to get the voltage and time scales coarse enough to plot reasonable results on the screen. Before you do this, however, there is an adjustment you should make. Put the scope into Auto mode. Use the Mode button, then select Auto from a soft key that comes up.



Now connect an input signal to the scope through channel 1 or channel 2. Usually if you are capturing only the output response (not the step input), you will input it to the scope through channel 1. If you are trying to capture both the input the the output, good practice is to put the input in through channel 1 and the output in through channel 2. Turn the knob for the time scale to zoom the time scale out. A good place to start might be to get the time scale to 1 second per division. This means that each horizontal grid block on the scope represents 1 second. Note which way you are changing the scale by seeing how the scale changes as you click the knob one click clockwise or counterclockwise. Don't just randomly twist the knob back and forth without watching the affect of your twists. Note that the scope's time units run from seconds, down through ms (milliseconds, 0.001 seconds), through µs (microseconds, 0.000001 seconds), to ns (nanoseconds, 0.000000001 seconds). That's quick. Don't expect to capture a mechanical part's motion by having the time scale set on microseconds or nanoseconds.

Do the same to the voltage scale. For the types of measurements that we make in the lab,

usually you want the voltage scale up to 1 or 2 volts per division.

When you have both the time and the voltage scales zoomed out, make one more adjustment. Set the delay properly. You will notice on the screen two solid triangles, at the top center and bottom center of the screen. Where these are on the screen will affect when the trace of the input signals begins. We want the signals to begin tracing without delay. So these solid triangles need to be placed over to the left side of the screen. The way to do this is push the Main/Delayed button. In the lower right you will see the choice Left/Center. Choose the Left soft key. Notice that the triangles move over to a position one time division in from the left-hand side of the screen. This is where they should be for proper triggering.

Now you should watch the scope and make sure that the signal you are trying to capture is on the scope. It should be on the scope both before and after the step response you are doing. I.e. the voltage scale should accommodate both levels of voltage you expect to see when you trigger the response. Check that this is so. Is the pre-trigger signal sweeping across the scope? If you do not see anything, probably the voltage level that you are tracking is above or below the range tracked on the scope. You can see whether or not this is so by pushing the Erase button. Then watch the top and the bottom horizontal lines on the grid. If the voltage is above or below the maximum or minimum voltages tracked, you will see a bright trace pass across the screen on either the top or bottom grid line. If this happens, you will need to use the small Position knob for the input channel to move the screen's range up or down to include this voltage. When you have the pre-trigger input voltage tracking across the screen, trigger the step input. Now see if the post-trigger voltage (the steady state voltage) is still on the screen. Again, both the pre-trigger and post-trigger voltage need to be on the screen. If they are not, adjust the voltage scale or the voltage position so that they are.

Now try to capture the step response by timing its triggering so that it goes off while the screen scan is near the left-hand side of the screen. This may be tricky if the screen's sweep rate is fast. Just do the best you can for now. The triggering we shall do will make it perfect in the end. Check the time sweep rate to make sure that 1. you are capturing the entire response and 2. that your time scale is not so coarse that the response event is captured in just one or two time divisions and then you have a flat sweep for the rest of the time. Usually you want to study the response curve. You would like to zoom in as far as possible but still capture the entire response. You want to use as much of the screen as possible to make the response as large as possible without losing any of it.

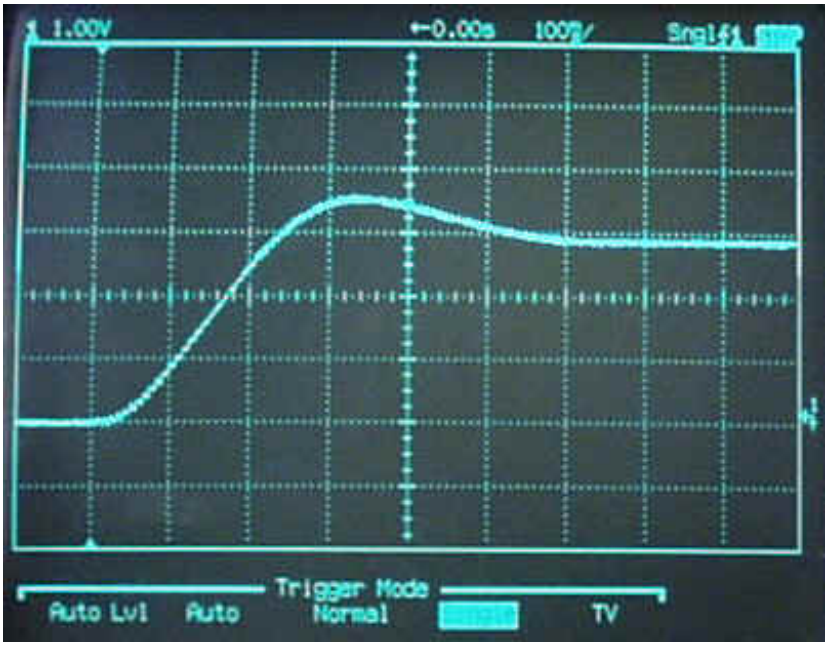
Now you are ready to set up the triggering. Set the input to the pre-trigger position. Push the Source button. Immediately after pushing it, twist the Level knob up or down. You will see a bright horizontal line rise above or below the input signal. This line represents the trigger level. In the old days of analog scopes, the scope would trigger when the input voltage crossed this line. Digital scopes use a revolving buffer. This is a memory storage area that is constantly being filled by the signal that the scope sees. When the scope sweep starts, filling this memory buffer starts. By the time the sweep reaches the right-hand side of the screen, the buffer is entirely full. As the scope sweep starts back again at the left-hand side of the screen, filling the buffer starts again. But the buffer contents are merely overwritten. That is, they are not erased before buffer filling restarts. This way, the buffer has in it a full sweep's worth of signal output. The importance of this will be explained below.

Use the Level knob to set the trigger level above the input signal. Set it close to the signal but far

enough above it so that any noise in the input signal does not reach it. Note that if you do not move the Level knob, the level line will disappear after a couple of seconds. If this does happen, just push the Source button again.

You are almost ready to trigger the scope. Use the Mode button. Push the soft key to set the scope into Single triggering mode. Now you are ready to capture the step response. Just trigger the step. The response should appear on the screen. Note that after the response is captured, the scope is automatically stopped (see STOP in the upper right-hand corner). The great thing about this set up is that you can do it over and over again. To see this, undo your step and then press Run. Redo the step. You'll see the response captured a second time on the screen.

You may want to adjust the voltage scale or position or the time scale or position. To do this you may need to return to Auto mode. Just iterate through the procedure outlined above to make readjustments. To change the time position, you need to understand the role played by the revolving buffer, the triggering level, and the little solid triangles. The scope tries to draw the response through the point of intersection of the horizontal trigger level line and the vertical line demarcated by the little triangles. If you do not like the horizontal position of the response on the screen, you can adjust the position by moving the little triangles either to the left or the right. Use the Delay knob to do this.



The photo at left shows a properly captured step response from the Motomatic positioner. Note that the response fills most of the screen but that there is not a long flat-line section after the response. You do not want wasted space. You do not want a significant portion of the screen not used to capture the curve.

Happy triggering!