



Familiarization with Agilent 54601B

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Abstract:

This document is intended to be a quick-start procedure to familiarize the user with the main features of the Agilent 54601B measurement instruments. As with any newly written procedure, there will be errors of omission and commission please let Prof. Banzhaf know of any suggestions you have for improving this document

Equipment:

- Agilent 54601B Oscilloscope

General Guidelines for Getting to Know the Instrument:

Don't be afraid to try pushing buttons and turning knobs. Much of the operation is intuitive to someone who is competent with a conventional analog oscilloscope. Anyone who is not very familiar with conventional oscilloscope use should, in my opinion, refrain from using a digitizing oscilloscope.

HARDKEY denotes a button on the front panel of the oscilloscope which has a label printed on it. **See Figure 1.**

SOFTKEY denotes one of six (6) buttons just under the CRT the function of each button depends on which **HARDKEY** you have previously pressed. **See Figure 2.**

There's a lot of information about the oscilloscope settings on the top of the display **see Figure 3.** When in doubt, touch **AUTO-SCALE**, which will give you a reasonable display of most signals present.

In-Lab Procedures:

Basic Setup and Operation:

1. Connect a 10X probe to channel 1 input BNC, and clip probe tip to calibrator output under CRT. Turn on the oscilloscope. The display depends on how the last user set up the controls (just like an analog 'scope).
2. Press **SETUP** . Then press **Default Setup**, which sets all controls to their default values. A rather unsatisfactory display of the calibrator squarewave is presented. The default values are shown at the top of the display. Starting at the top left, these default values are:



Channel 1, 100mV/div, 0.00s (zero time: to the left is pre-trigger data, to the right is post-trigger data), 100ms/div, +slope triggering on chan. 1, RUN storage mode. On the right edge of the display, ground is 4 divisions up from the screen bottom. **See Figure 4.**

3. Press **AUTO-SCALE** . The CRT should now display a "good" display of several cycles of a squarewave. Note carefully all the information provided on the top of the display, which is now different from the default settings.

Something is wrong with the display: while the calibrator puts out a 5 Vpp squarewave, the displayed squarewave is about 5 divisions p-p, or 500 mVpp. What is wrong is that a 10X probe is being used, and the oscilloscope doesn't know that! Let's fix it right now:

Press **1** in the VERTICAL section, which causes channel 1 softkeys to be displayed. Press **Probe** until the probe type is 10 (not 1 or 100). Notice that at the top of the display, the 100 mV/div is now 1.00 V/div, and the true p-p voltage (approximately 5 Vpp) is shown.

4. Notice that there is a grid present on the display grids are really not needed on digitizing oscilloscopes, and are available simply for the nostalgia, or perhaps because the folks who sign purchase orders in industry tend to be chronologically mature and are uncomfortable buying a 'scope without a grid. Whatever the reason, let's now remove the grid: press **Display**, followed by **Grid**.
5. You may note the display waveform is a bit noisy. One reason is that this 8-bit oscilloscope's Analog-to-Digital converter keeps making different decisions about the least significant bit (LSB), and this shows up as visual "noise". Try pressing **Average** under Display Mode in the Softkey legend. This will smooth the "noise" to a degree. Return to NORMAL Display Mode when done.
6. To acquaint you with storage mode, press **Stop** in the STORAGE section. This "freezes" the display (notice that at the top right of the display, RUN has changed to STOP). You can even disconnect the probe from its signal, and the squarewave will remain displayed. Also, the display can be seen to be made up of individual dots. To see a smoother display, press **Display** , followed by **Vectors** . **Vectors On** causes the dots to be connected, giving a better picture of the waveform shape. Go back to **RUN** when finished.

Automatic Measurements Of Voltage:

7. Press **Voltage** under the MEASURE section. You now have your choice of measuring Vp-p, Vavg, Vrms in the softkey region. Try them each, and notice that when each softkey is pressed lines appear on the display showing what is being measured.
8. Now let's explore Next Menu in the softkey region. Press **Next Menu**, and you can choose Vmax, Vmin, Vtop or Vbottom. To see the differences, un-compensate your probe so that it is overcompensated and there is considerable overshoot on rising and falling edges. You can see that Vmax tells you the highest voltage, while Vtop is the steady-state level of the



pulse top. Likewise, Vmin tells you the lowest voltage, while Vbase is the steady-state level of the pulse bottom. When you are done with this section, be sure to compensate the probe again!

Automatic Measurements Of Time:

9. Press **Time** under the MEASURE section. You now have your choice of measuring Freq, Period, Duty Cycle in the softkey region. Try them each, and notice that when each softkey is pressed lines appear on the display showing what is being measured.
10. Now let's explore **Next Menu** in the softkey region. Press **Next Menu** , and you can choose +Width, -Width, RiseTime or FallTime. Oops, the 'scope did fine on the first two, but not so well on the RiseTime and FallTime. This is due to the **Time/Div** being too big, so not enough of the risetime or the falltime can be sampled to give an accurate measurement.
11. One way to get an accurate measurement of risetime is to turn the **Time/Div** knob clockwise so that the risetime can be seen plainly. Notice that the 10% and 90% voltage levels are shown, and the risetime is displayed accurately. To see falltime accurately, all you need to do is change the trigger slope from positive to negative, as follows: press **Slope Coupling** in the TRIGGER section and then press **Slope** . Now the falltime can be requested and measured, as above. When you're all done with this section, press **AUTO-SCALE**.

Delayed Sweep:

12. Press **Main Delayed** under the HORIZONTAL section. You now have your choice, using softkeys, of **Main, Delayed, XY, Roll** under the **Horizontal Mode** Section, and also can select **Vernier** and **Time Ref** (sets the trigger point to **Lft** or **Ctr** of the display).
13. Press **Delayed** , and notice that now the display is split vertically the main sweep is on top, the delayed sweep is at the bottom. A second Time/Div appears at the top of the display this is the setting of the delayed sweep.

Two vertical lines appear in the upper display, which indicate the time span of the delayed sweep. Vary the Time/Div control and see the effects on the upper (main) sweep and on the lower (delayed) sweep.

14. With the shape of the risetime of the pulse clearly visible on the lower sweep, measure the risetime (that's done by using **Measure Time Next Menu Risetime**). Note the cursor lines showing the 10% and 90% points on both the upper and lower sweeps.
15. Try "walking" the two vertical lines in the upper display through the upper display, by using the **Delay** control in the HORIZONTAL section. You can speed up the walking by turning the **Time/Div** control counter-clockwise.



16. Press **Main Delayed** again. The **XY** softkey puts the 'scope into X-Y operation (e.g. looking at a Lissajous pattern). Channel 1 is the X input, channel 2 is the Y input. *(This is mentioned for reference don't use XY operation now).*
17. The **Roll** softkey sets the Time/Div to 200 ms/div, and gives a real time display where new sampled data appears on the right side, and "rolls" to the left (thus getting older as new data replaces it on the right). This is useful for observing slow-moving phenomena, like nulling an output or adjusting a low frequency generator for a particular peak-peak voltage. Connect a sinusoidal function generator at 10 Hz to channel 1, press **AUTO-SCALE**, and quickly vary the amplitude of the generator. Then, enter **Roll** mode, and do the same.

When you're not in roll mode at slow sweep speeds, one complete horizontal sweep must get digitized and placed into memory before it is displayed thus, there's a time delay before changes in the input voltage can be seen. In **Roll** mode, you see each data point as it is digitized.

C'mon already, when do we get to use the digitizing oscilloscope for storing transient non-repetitive phenomena? OK, you've paid your dues by learning everything up to here, so here comes the fun part:

Capturing Transient, Non-repetitive Waveforms:

18. Press **SETUP**. Then press **Default Setup**, which sets all controls to their default values. Connect a 10X probe to channel 1, and tell channel 1 you're using a 10X probe (see step 3). Soon we're going to take the 'scope out of automatic triggering and put it into normal triggering mode. In normal triggering mode, a sweep will occur only when an input signal, **large enough to reach the trigger threshold you set**, is present at the input.

For a signal source, let's use YOU as an antenna to pick up whatever E-field is present in the laboratory (60 Hz plus miscellaneous stuff). Put your finger on the probe tip, and press **AUTO-SCALE**. Set the time to 20 ms/div. You should see several cycles of noisy 60 Hz sinusoid. Notice that when you remove your finger, the signal disappears (after a short delay) but the trace still appears as a flat line (due to automatic triggering).

Put your finger on the probe tip again. In the **TRIGGER** section, press **MODE**, followed by **Normal**. Rotate the **Level** control, while observing the bottom of the display, and set the trigger level so that triggering is occurring (about 50 to 100 mV). Now when you remove your finger, the display stays frozen with what it had when triggering stopped.

Try contacting the probe very quickly and then removing your finger again. You should be able to capture just a few cycles of 60 Hz noise. Use the **Measure Time** feature, using T1 and T2 cursors, to see that the frequency of the frozen waveform is near 60 Hz.

Now we're going to try using some of the skills learned up to now. For the measurement situation below, it's up to you to:

- a.. decide on the appropriate settings of the oscilloscope,
- b. get the desired display on the oscilloscope screen, and

19. Gently tapping on a speaker cone is an example of transient phenomena for which a digitizing 'scope is ideally suited. Try the **AUTOSTORE** hardkey under **STORAGE** with non-periodic inputs (like speaker voltage while tapping) you'll see an envelope of the previously acquired waveforms accumulate (at half brightness), while the most recent waveform is shown in full brightness.

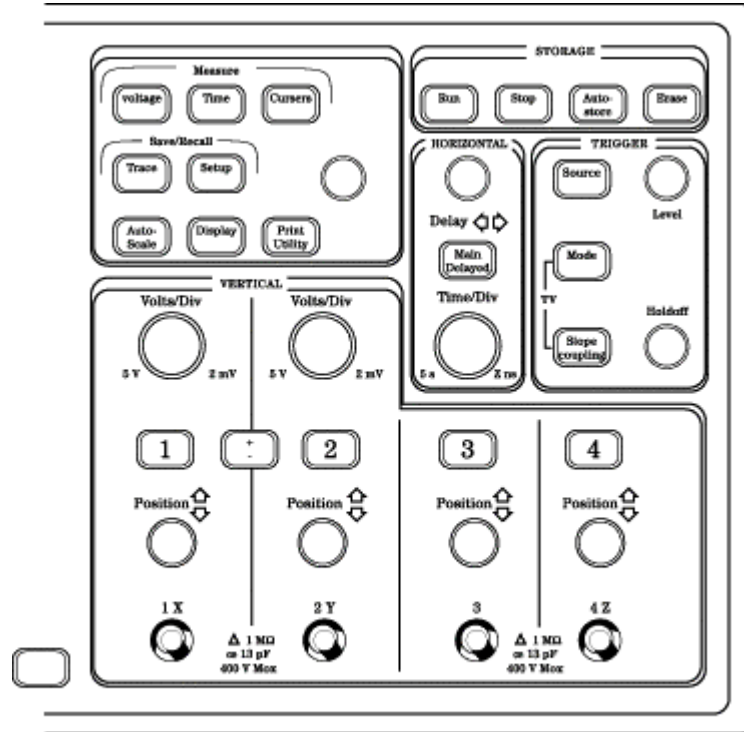


Figure 1 The Rectangles Above are "Hardkeys". They Have Permanent Labels on Them.

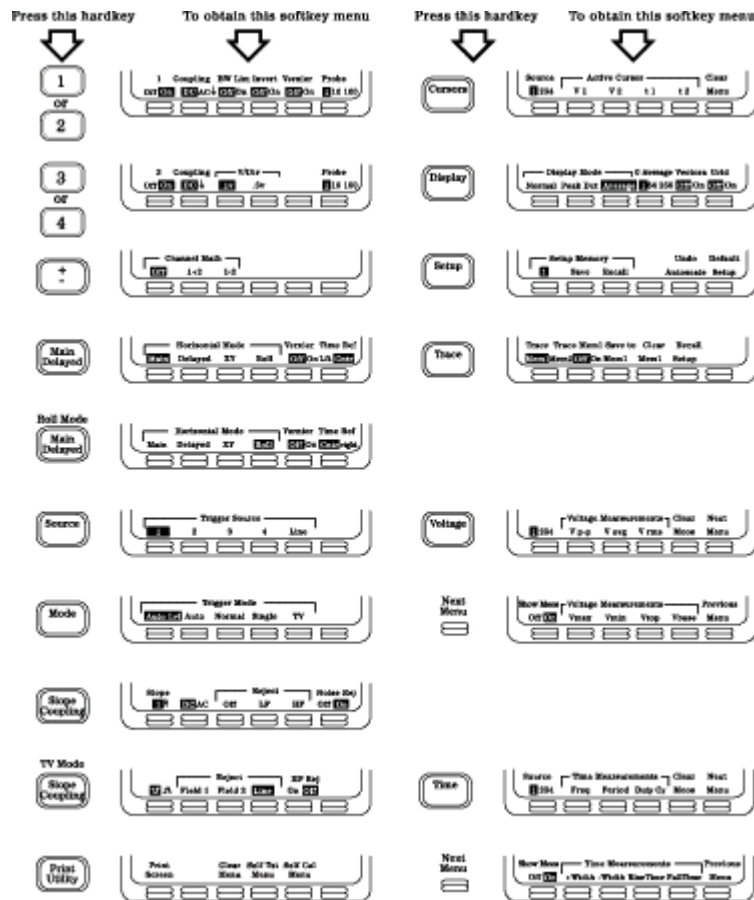


Figure 2 Hardkeys and Their Associated Softkeys

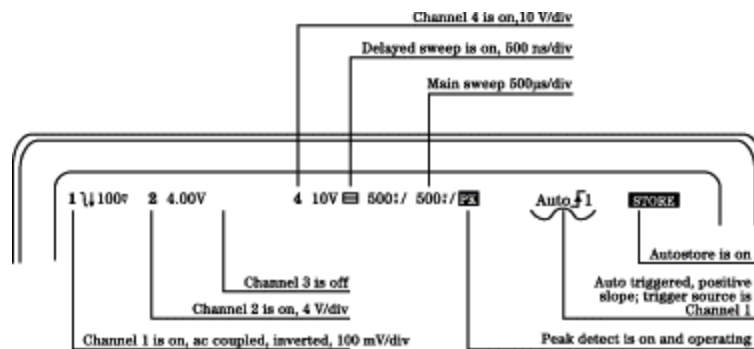


Figure 3 Information on Top of Display.

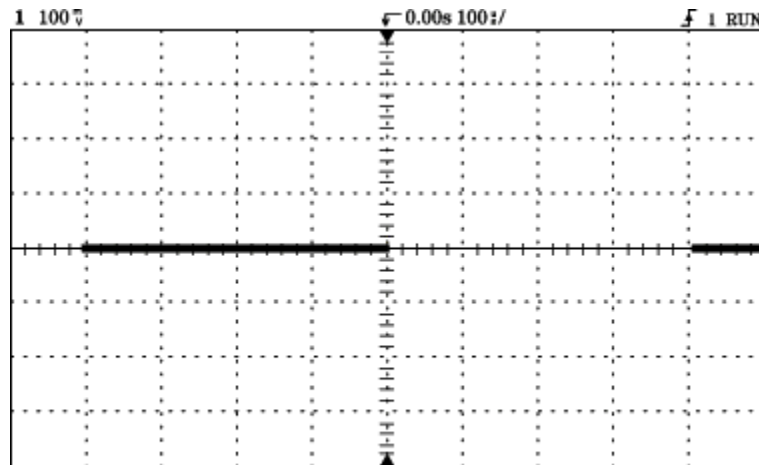


Figure 4 Display of Calibrator Signal Using the Default Settings (Notice that the top of the Squarewave is missing).