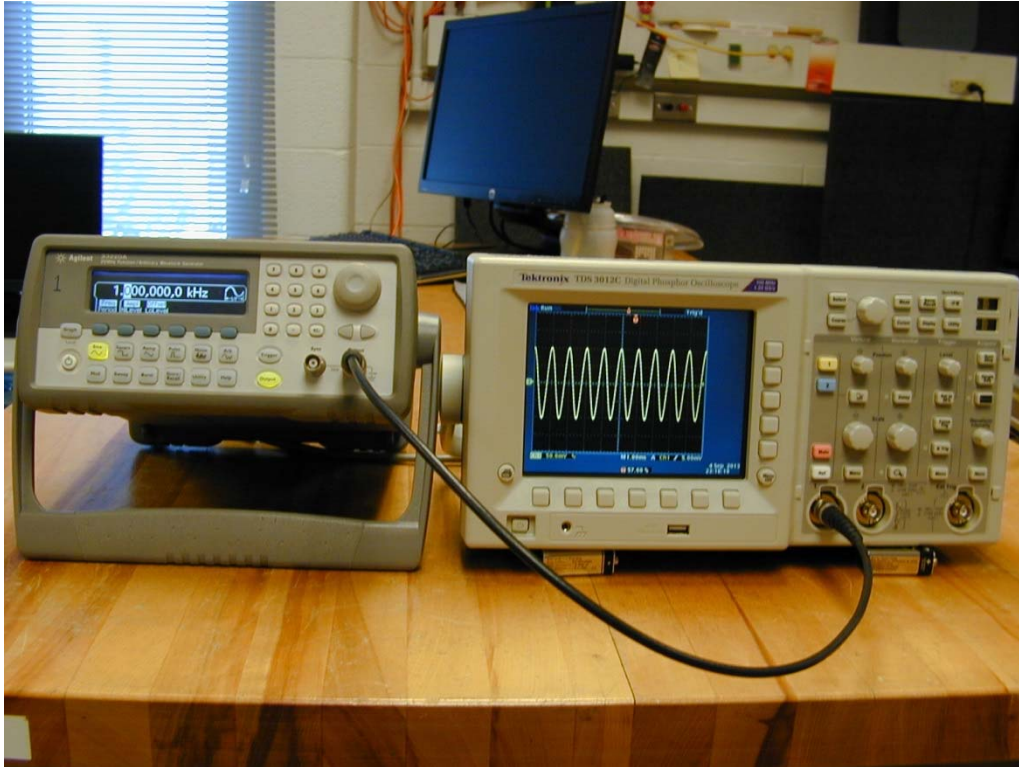# Basics of Using the Agilent 33220A Function Generator with the Tektronix 3012 Digital Oscilloscope

This document {briefly} describes how to use the Agilent 33220A Function Generator with the Tektronix 3012 Oscilloscope. Detailed information is contained in the User's Manuals for each of these two devices.



Plug in both the Agilent 33220A FG and the Tek 3012 'Scope to the 120Vac wall power, then turn them both on by pressing the AC power On/Off switches on each device. It takes a few seconds for both the FG and the 'Scope to boot up {they each have specialized processors inside them}. The power-on default settings of the FG are a $f$ = 1 KHz sine wave with a 100 mV$_{pp}$ ( = 0.100 V$_{pp}$) peak-to-peak amplitude . Note that the FG output is initially off – press the **Output** button to turn on the FG output. Select/press the Ch1 (yellow) button on the 'Scope, then *a*.) in the **Vertical** column of the 'Scope, rotate the large round knob so that the Ch1 input sensitivity is *e.g.* 20-50 mV/vertical division on the 'Scope's display screen (observe Ch1 sensitivity setting at the bottom left-hand side of display screen), then *b*.) in the **Horizontal** column of the 'Scope, rotate the large round knob so that the 'Scope's time base is 1 msec/horizontal division (observe the time base sensitivity setting at the bottom ~ center of the display screen). Then *c*.) using a 3-4 ft BNC cable, connect the output of the FG to the Ch1 input of the 'Scope. Then *d*.) depending on the previous users of the scope, you may have to setup/adjust the **Trigger** settings of the 'Scope to be able to display a stable sine wave as output from the FG – n.b. one needs to trigger the 'Scope on the Ch1 signal, since this is the only signal input to the 'Scope. Explicitly measure/verify that the period of the sine wave is $\tau$ = 1 msec (*i.e.* has a frequency $f$ = 1/$\tau$ = 1/0.001 Hz = 1 KHz, and that the peak-to-peak amplitude of the sine wave is indeed 100 mV$_{pp}$. If you have any difficulties in doing any of this, don't hesitate to ask a POM Lab TA for help!

Next, investigate the nature of the FG **Square** and **Ramp** wave signals, as shown in the figures below:
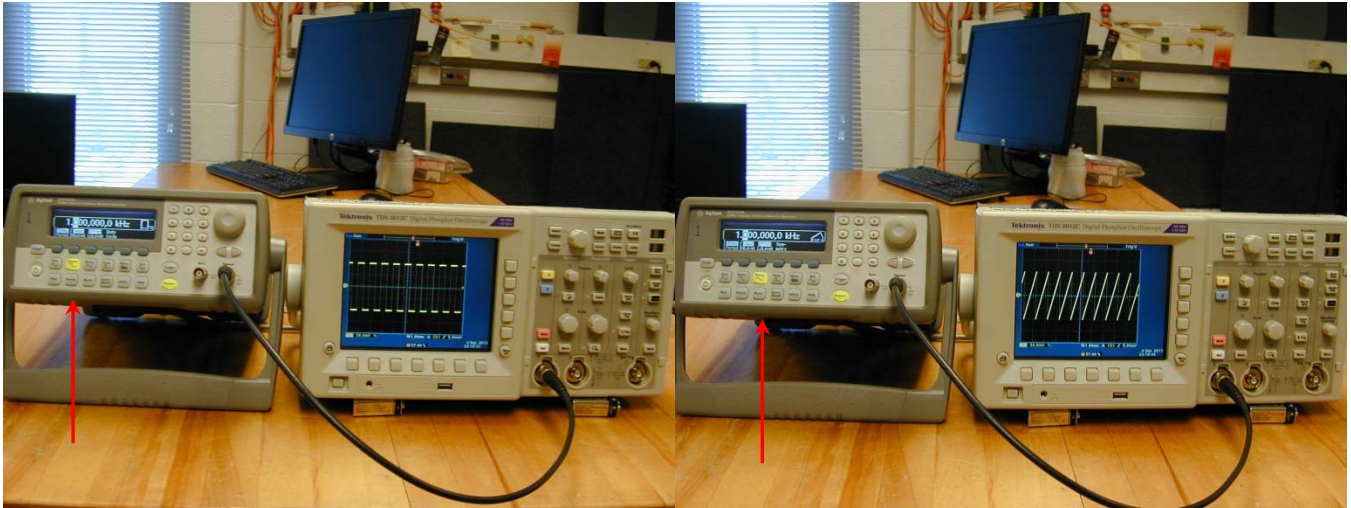
Explicitly see/investigate what happens when the **Duty Cycle** (**Symmetry**) parameter (4th blue-gray button immediately below the FG display) is varied for the **Square** (**Ramp**) wave, respectively. If the **Pulse** waveform is selected, one can examine the effect of varying the **Width** of the **Pulse**, again selecting the appropriate blue-gray button associated with the **Pulse** waveform.

It is also possible *e.g.* to use the FG **Sync** signal to **externally** trigger the 'Scope. But first, we want to investigate the nature of the FG **Sync** signal – so let's plug it into Ch2 of the scope – *a.*) press the blue Ch2 button to activate Ch2, then *b.*) in the **Vertical** column of the 'Scope, rotate the large round knob so that the Ch2 input sensitivity is 2.0 Volts/vertical division on the 'Scope's display screen (also observe Ch2 sensitivity setting at the bottom left-hand side of display screen). Then *c.*) use another 3-4 ft BNC cable, and connect the FG's **Sync** signal to the Ch2 input of the 'Scope. You should now see:
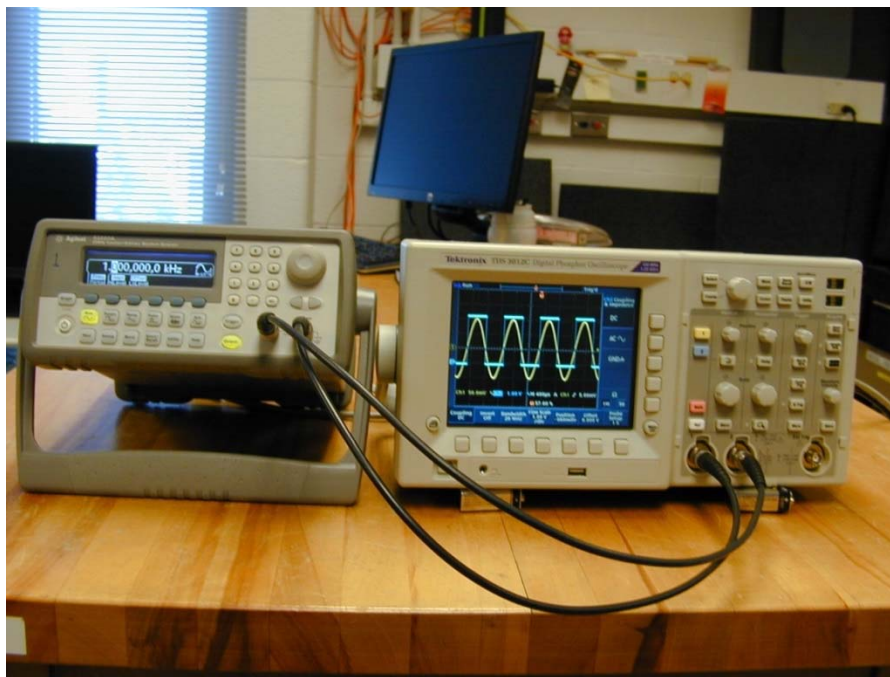


Note the phase relation between the FG's sine wave vs. the FG's Sync signal – transitions of the FG's Sync square-wave signal occur at the zero crossings of the sine wave.

So the FG's **Sync** signal is essentially a digital (TTL-type) square-wave signal, with ~ few volts amplitude. Next, remove/unplug the 2nd BNC cable from the 'Scope's Ch2 input and plug it into the **Ext. Trig.** Input (bottom right-hand side corner of the 'Scope). Then push the **Menu** button in the **Trigger** column and select **External Trigger** and e.g. **positive _|** (or **negative |_**) **slope** from the Menu buttons located at the bottom & on the right-hand side of the 'Scope's display. Likely you will also have to adjust the 'Scope's trigger Level – by rotating the **Trigger** column's **Level** button (at the top of this column) to raise/lower the voltage value at which the scope will/can trigger on the FG Sync waveform. Again, if you have difficulties in doing this, don't hesitate to ask a POM Lab TA for help!
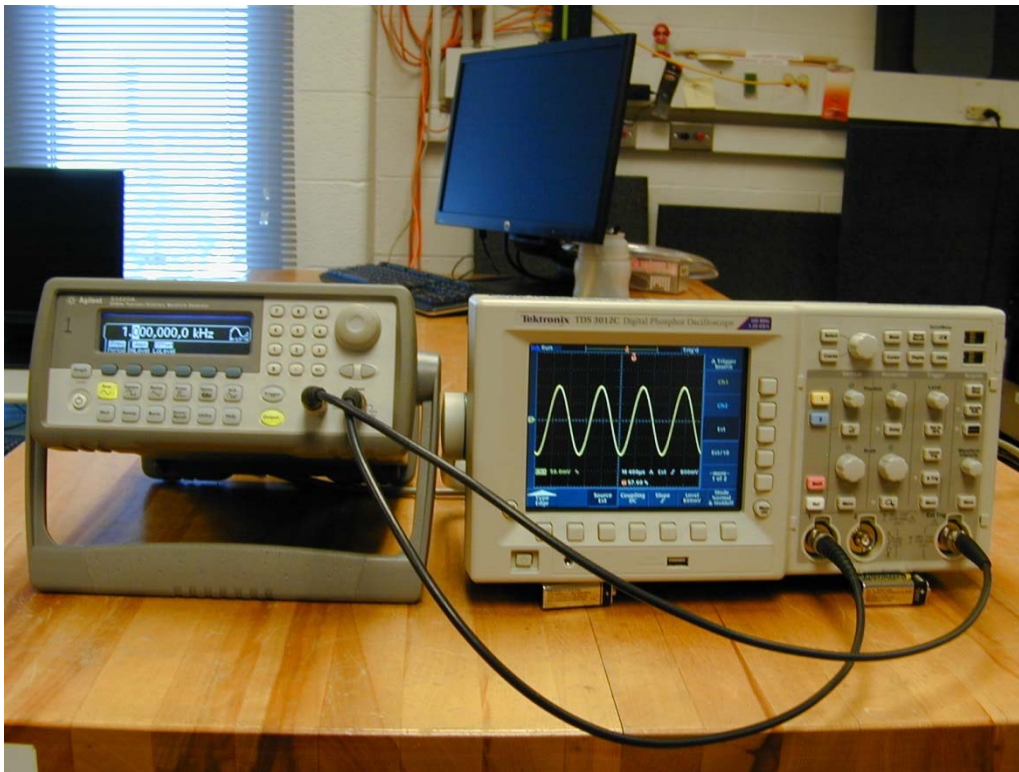


### An Additional Investigation: Different-Looking Waveforms Sound Different – Why???

Put the Agilent 33220A FG back to its **Sine** wave setting, change its frequency from $f = 1$ KHz to *e.g.* 300 Hz, and also reduce the FG's amplitude from 100 mV$_{pp}$ to 10 mV$_{pp}$. (*n.b.* this is *very* important!). Likely you will need to correspondingly change the 'Scope's Ch1 input sensitivity from 20-50 mV/vertical division to 2-5 mV/vertical division, and perhaps also need adjust the 'Scope's horizontal time base... Then, temporarily remove the BNC cable to the Ch1 input on the Tek 3012 'Scope, insert a BNC "Tee" connector on Ch1 input and then reconnect the BNC cable to one side of the BNC "Tee". Ask a POM Lab TA for one of the BNC→ 1/4" Phono cables and bring one of the small guitar amplifiers in the POM Lab over to your table. Connect the 10 mV$_{pp}$ amplitude FG **Sine** wave output to the input of the guitar amp, turn down all of the guitar amp's controls, then turn the guitar amp on, and slowly bring up the guitar amp's controls until you can {comfortably!} hear the sine wave signal. See/refer to the pix on the following page.

Having accomplished this, now switch the FG from **Sine** to **Square**, **Ramp** and/or **Pulse** waveforms, while listening to what they sound like from the guitar amp. Try varying the **Square** wave's **Duty Cycle**, the **Ramp** wave's **Symmetry**, the **Pulse** waveform's **Width**. Can you hear the difference(s) – Why???