# Using the HP 33120A Function Generator

The HP 33120A function generator is a versatile instrument capable of generating sine, square, and other waveforms with frequencies up to 15 MHz. The amplitude and offset of these waveforms may be controlled easily. Also, this instrument can supply a positive or negative dc voltage, which will be useful in many of our early labs.

<u>Setting the 33120A to HIGH-Z Mode</u>

The output resistance of the 33120A is 50 Ω, which means that we can model this device as an ideal internal voltage source with a 50-Ω resistor in series:
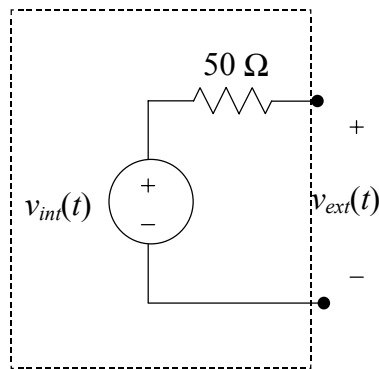
HP 33120A

where $v_{int}(t)$ is the internal voltage waveform generated by the 33120A, and $v_{ext}(t)$ is the voltage waveform observed at the output of the instrument.

Now consider the 33120A driving an external load R_L:
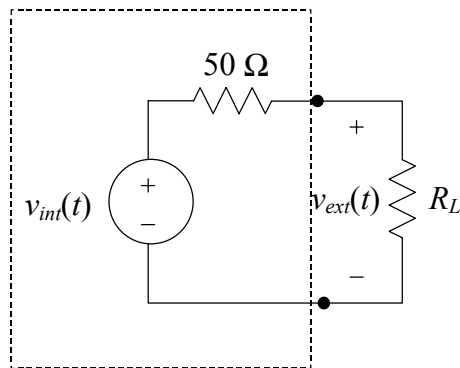
HP 33120A

Now, we have a voltage divider between the 50-Ω output resistance of the 33120A and the load R_L. Thus, the voltage seen at the output of the instrument is:

$$v_{ext}(t) = \frac{R_L}{R_L + 50\Omega} \cdot v_{int}(t).$$

Now, consider two special cases. In RF electronics, impedances of 50 Ω are very common. If $R_L = 50$ Ω, then

$$v_{ext}(t) = \frac{1}{2}v_{int}(t).$$

In this lab, you will often be driving signals into the gate of a MOSFET, which has a nearly infinite input resistance. If $R_L \gg 50$ Ω, then

$$v_{ext}(t) \cong v_{int}(t).$$

Unfortunately for us, the engineers at HP who designed this instrument assumed that most people would use it in RF applications exclusively with 50-Ω loads. Thus, the default mode of operation of the instrument is to *assume* that a 50-Ω load is connected (the machine has no way of knowing the value of R_L). As we saw, a 50-Ω load leads to a voltage divider with a gain of ½, so the instrument compensates for this by raising v_{int} to *twice* what the display shows.

In other words, if you set the instrument to produce a 5-V sine wave, it actually produces a 10-V sine wave on v_{int}, and relies on the voltage divider to reduce the signal by a factor of two. If our load is much greater than 50 Ω, as most loads in these labs will be, we get a 10-V sine wave across our load even though the display says 5 V.

What can we do about this? It turns out we can *tell* the instrument that we are using a high-impedance load (meaning $R_L \gg 50$ Ω), and then when we request a 5-V sine wave, it will produce a 5-V sine wave on v_{int}.

Here's how to set the function generator to high-impedance load ("HIGH-Z") mode:
- Press "Menu On" (Shift – Enter). You should see "A: MOD MENU" on the display.
- Press the "right arrow" key three times. You should see "D: SYS MENU" on the display.
- Press the "down arrow" key once. You should see "1: OUT TERM" on the display. This means "output termination", which is your load resistance.
- Press the "down arrow" key again. You should see "50 OHM" on the display.
- Press the "right arrow" key. You should see "HIGH Z" on the display.
- Press "Enter". The instrument is now set for correct operation with high-impedance loads. **You must go through this procedure each time you turn on the HP 33120A.**

Generating a DC Voltage

It is often useful to use the 33120A to generate a constant dc voltage. In order to set the instrument to dc output mode, press *and hold* the "offset" button down for two seconds. The display should show "DCV". You can now set the dc output voltage by changing the voltage offset.

<u>Experiment</u>

Let's try a quick experiment to verify our knowledge of 33120A operation. First turn the instrument off for a few seconds, then turn it back on. Now set the output to a dc voltage of 2.0 volts. Attach a cable to the output of the 33120A that has clips so you can attach the signal to a voltmeter. Using the handheld, battery-powered voltmeter at your lab station, measure the voltage produced by the 33120A. Is it 2.0 V? Why not?

Now go through the steps outlined above to set the 33120A to HIGH-Z mode. The display may have changed, so make sure you again set the output to a dc voltage of 2.0 volts. Measure the output voltage using the voltmeter. The voltmeter should now register 2.0 V.

Remember, *every* time you turn on the HP 33120A, you must set the output termination to HIGH-Z mode. If you fail to do this, you may accidentally produce voltages *twice* as high as you intend, and this may damage your chip.