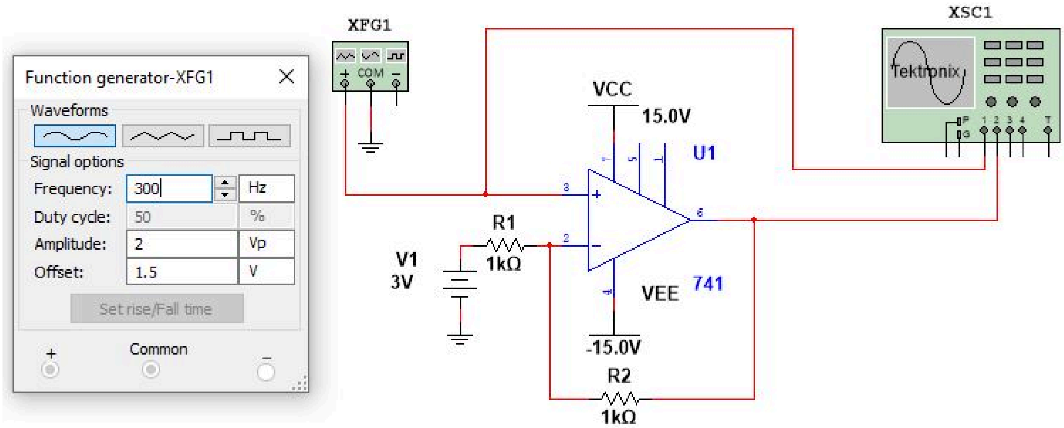
Differential Offset Compensation

So far, we've seen that having differential inputs on an op amp allow us to create either inverting or non-inverting single-input amplifiers, and to build differential amplifiers that can remove common mode signals while amplifying desired differential signals.

Somewhat related to that last topic is the addition or removal of a DC component in a complex signal, as we will investigate in this lesson. We'll start with a circuit that demonstrates the process, then we'll evaluate it to see how it works.

Build the following circuit in Multisim, and answer the questions that follow. Pay close attention to the settings of the function generator, the power supplies, and the DC offset voltage (V_1). Set up the Tektronix oscilloscope to display the input and output signals adequately.



1. What is the amplitude of the output signal? 8 $V_{p\text{-}p}$ or 4 V_p

2. What is the DC component of the output signal? 0 V_{DC}

If all went well, you should have discovered that, even though the input signal has a large DC offset, the output signal does not. Let's analyze the circuit to understand why.

3. Before you do, though, prove to yourself that the DC removal is deliberate by changing the function generator offset to 2.5 V.

   What is the DC offset in the output signal now? 2 V_{DC}

We'll use superposition. To do this, we first determine the theoretical outputs generated by the two inputs independently, then we add the results together.

4. First, let's disable the function generator by shorting it to ground. What gain does the DC voltage, V_1, see? We'll call this A_{v1}.

   -1

5. Use this gain and the value of V_1 to determine the DC component at the output generated from V_1. -3

   V_{DC}

6. Second, let's disable V_1 by shorting it to ground. Being careful to determine the op amp configuration seen by the function generator signal, determine the associated gain. We'll call this A_{v2}. 2

7. Multiply the DC offset from the function generator by the gain to determine the DC component at the output from this signal.

   3 V_{DC}

8. Add the two DC components together, to show why the DC in the output signal has been effectively removed.

   0 V_{DC}

9. Multiply the AC component by the gain seen by the function generator to determine the resulting amplitude of the signal.

   4 V_p

We can write what is called a Transfer Function for this circuit by combining the parts we analyzed using superposition, then simplifying.

$V_{out} = A_{v2} * V_{in} + A_{v1} * V_1$

$V_{out} = 2V_{in} - 3$

This fits into the equation of a line, $y = mx + b$

where

$y = V_{out}$

$m = Av$

$x = V_{in}$

$b = V_{offset}$