



EENG 385 - Electronic Devices and Circuits
Frequency Domain: Active Filters
How To: Setup the Level Shifter

The Level Shifter

Sometimes the audio signal input to your audio board will have no DC bias – it is centered around 0V. This means that the audio waveform spends $\frac{1}{2}$ its time below 0V and will be clipped because our op amp is powered with 5V and GND. Thus, I included a level shifter whose schematic is shown in Figure 1. The level-shifter removes any DC bias from the input AC signal by the capacitor C1 and then adds a DC bias to this AC input using the voltage set by 100k potentiometer R1.

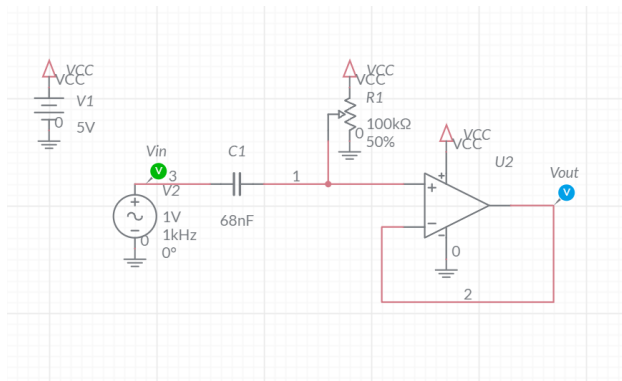


Figure 1: The level-shifter AC couples a signal onto a DC bias set by the potentiometer.

How to: Setup the Level-Shifter

The first step in tuning your level shifter is to properly setup the function generator output. A little extra time spent here will save you time later.

Step 1: Setup test and measurement equipment

The procedure to setup the function generator is given in list below. Each step is lettered A...K to correspond to letters in Figure 2.

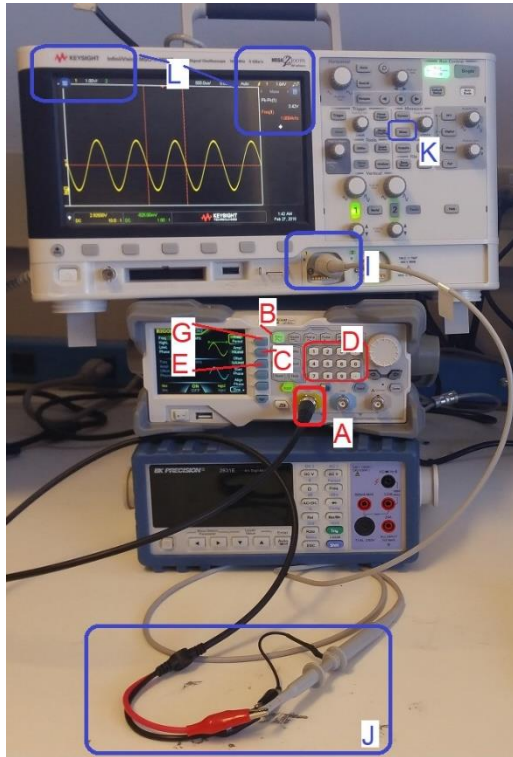


Figure 2: The test and measurement setup to check the signal input. Please DO NOT stack the equipment as pictured – this was done to fit all the equipment in one picture.

In the following procedure, dedicated keys are denoted with bold text in square brackets. Softkey are shown highlighted.

- A. Connect a proper signal generator cable to the yellow BNC connector labeled "CH1" on the Rigol DG1022Z function generator. Insert firmly and twist until you feel it click. Give it a tug to make sure the BNC connector is securely mated,
- B. If the **[Sine]** function key is not illuminated, press to illuminate it,
- C. Press the **Ampl/HiLevel** softkey to highlight "HiLevel",
- D. Enter 4.0 on the numeric keypad, and then press the **Vpp** softkey
- E. Press the **Offset/LoLevel** softkey to highlight "LoLevel",
- F. Enter 1.0 on the numeric keypad, and then press the **Vpp** softkey
- G. Press the **Freq/Period** softkey to highlight "Freq",
- H. Enter 1.0 on the numeric keypad, and then press the **kHz** softkey
- I. Connect a proper oscilloscope probe to the channel 1 input of the oscilloscope. Adjust the vertical scale to 1V/div and the horizontal scale to 500us, make sure that channel 1 is DC coupled, and that the trigger level is around 2.5V,
- J. Connect the function generator and oscilloscope cables, black clip to black clip and red clip to scope probe,
- K. Enable the function generator off by pressing the **[OUTPUT]** key,
- L. Adjust the scopes so that they display frequency and the peak-to-peak amplitude of the waveform.
 - o **[Meas]** → **Clear Meas** → **Clear All**
 - o **[Meas]** → **Source** → **1**
 - o **[Meas]** → **Type** → **Peak-Peak** → **Add Measurement**
 - o **[Meas]** → **Type** → **Freq**

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Once complete, you should see the waveform on the oscilloscope oscillating around 2.5V.

Step 2: Apply signal to the level shifter and measure input/output

You are now going to use the function generator to send a sin waves into the LEVEL input and measure the DC offset of the output waveform.

- Install female end of a male/female jumper wire onto the INPUT LEVEL pin,
- Install female end of a male/female jumper wire onto the OUTPUT LEVEL pin,
- Attach the black ground clip of the function generator to a ground loop on the Audio board,
- Attach the black ground clip of the oscilloscope probe to a ground loop on the Audio board,
- Configure your oscilloscope,

Horizontal (scale)	1ms
Ch1 probe	INPUT LEVEL (male end of jumper wire)
Ch1 (scale)	1V/div
Ch1 (coupling)	DC
Ch2 probe	OUTPUT LEVEL (male end of jumper wire)
Ch2 (scale)	1V/div
Ch2 (coupling)	DC
Trigger source	2
Trigger slope	↑
Trigger level	2.5V

- Attach the red signal clip of the function generator to male end of jumper wire attached to the INPUT LEVEL jumper wire,
- Verify that everything is setup correctly by comparing your setup to Figure 3,

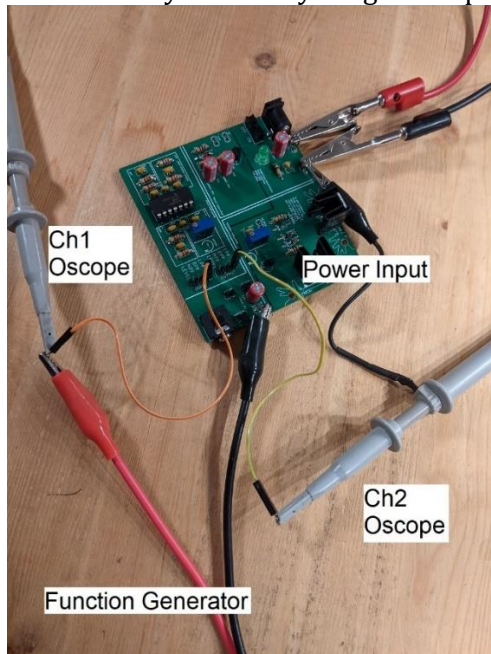


Figure 3: The setup to apply a signal to the LEVEL_IN and measure the response on the oscilloscope. Note the jumper wires are INCORRECTLY connected to the LPF header in this picture, because it's the only picture I had lying around.

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- Enable the function generator output
- Observe the oscilloscope, adjust the 100k POT until the output waveform is centered to 2.5V. As an example, the input in Figure 4 is coming in on channel 1 (yellow trace) and the level-shifted output is on channel 2 (green trace).

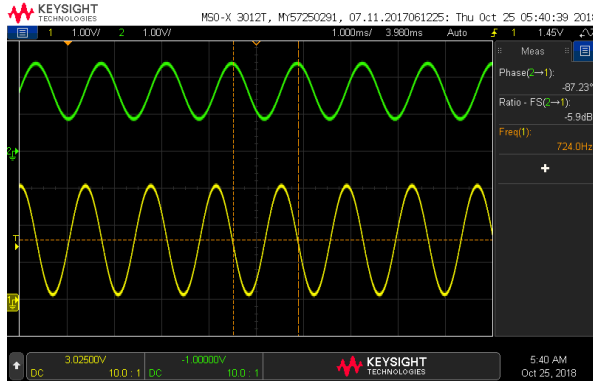


Figure 4: The input and output of the low-pass filter.

You are now ready to use the level-shifter to support Frequency Response Analysis function of the Keysight oscilloscopes.