

Low pass circuit Lab

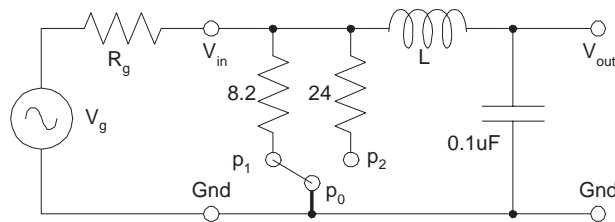
In this lab, you will investigate some properties of a second order low pass filter, the theory of which is presented in the lectures and need not be understood to perform this lab. The exercises here are intended to be performed by teams rather than individuals. A lab report for each team should be filed as a page in the team’s web site.

Special parts needed will be a magnetic core made of ferrite, a $0.1 \mu\text{F}$ ceramic capacitor, an 8.1Ω resistor and 24Ω resistor. You will also need your scopes and function generators.

Exercise 1: Adjust scope probes

Your scope probes should be checked and adjusted as necessary whenever used with different plug-ins. Once adjusted, they should be OK for any plug-in of the same kind. Refer to the probe data sheet for tuning up procedure.

Exercise 2: Construct the circuit under test (CUT):



Construct the circuit on a protoboard. Build your own inductor L by winding 10 turns of hookup wire around the ferrite core provided. The schematic is shown with a wire jumper connecting points p_0 and p_1 . Two other configurations will also be used: with the jumper between p_0 and p_2 , and with no jumper at all. These configurations will be referred to as “underdamped,” “critically damped,” and “overdamped,” respectively.

The signal generator shown as V_g with its internal source resistance R_g in the schematic represents a Wavetek Model 80 function generator, for which $R_g = 50 \text{ Ohms}$.

Exercise 3: Test the circuit:

Use the function generator as a signal source and the scope to measure voltage. Refer to the respective user manuals as needed to set them up for this exercise. *If you want to do this in a really cool way and save yourself some work, use the setup suggested in “The cool way to do it.”* In any case, be sure the Wavetek output is a sinusoidal waveform. Set and measure all signal voltages as “peak-to-peak,” (written as V_{pp} , or the voltage between the top and the bottom peaks of the sine wave).

Make the following set of measurements for each of the three configurations: first set the **Ampl** of the Wavetek so that you measure 1 volt at the output of the CUT at a

frequency of 1 KHz. Record the displayed of **Ampl**. Then record the output of the CUT at the following frequencies: 1 KHz, 10 KHz, 100 KHz, 250 KHz, f_{peak} (and note the frequency) if there is a peak in the response curve, and 500 KHz. It is a good idea to use a 10X probe to measure the output of the CUT. Your lab report should contain at minimum these data, along with any comments or observations you deem worth of recording.

The cool way to do it:

You can configure your instruments to implement a spectrum analyzer mode to show the frequency response curve directly on the scope. The idea here is to use the scope in an XY mode, and to sweep the function generator over a desired range of frequencies.

Remove the 7B53 plug-in from the right hole and substitute a 7A26. Connect one of its inputs to the **Swp Out** signal, available at a BNC connector on the back of the Wavetek. Set the Wavetek for **Op mode** of **Log S**, with a (start) **Freq** of 1 KHz, a **Stop** (freq) of 500 KHz, and a (sweep) **Time** of 50 mS. Set **Output** to a sine wave. Consult the Wavetek manual for details.

The scope horizontal should be adjusted for gain with the V/div (uncalibrated) controls and for position with the pos control so that 1 KHz lies at the left of the graticule and 500 KHz lies at the right. Then each major division quite closely represents 50 KHz.

If you do it this way, document your actual setup in detail, along with any commentary and/or observations helpful in duplicating the setup.

Extra credit: Selective Bandpass Filter

Reconfigure the circuit by wrapping an additional single turn of hook up wire around the inductor core. Disconnect the Wavetek from V_{in} and use it to drive the single turn. Connect V_{in} to Gnd with a wire jumper.

Reconfigure the Wavetek to sweep in linear mode over a range that includes the peak frequency seen above in the underdamped case, probably 200 KHz to 250 KHz is a good start. Configure the amplitude of the Wavetek and the V/div controls of the scope to normalize the voltage at the frequency f_p of the peak. Adjust the (start) **Freq** and **Stop** (freq) settings of the Wavetek so that the voltages at these extremes of the sweep are 0.71 times the voltage at the peak. Record f_p , and the frequencies f_l (start) and f_u (stop) of the sweep.

Calculate and record $Q = f_p / (f_u - f_l)$. Q is a measure of the selectivity or sharpness of the filter.