# Project 1

*Due: 12 October at 4:00 PM*

**RF Notch Filter**  
_Trap for Unwanted Frequencies_

For this project, students can work in groups of two to four (as you formed for Pre-project 1) and use the information and results from your Pre-project-1. Hand in one report for each group.

## Grading

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
<th>Grade</th>
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<tr>
<td>1. Pre-Project</td>
<td>20 pts</td>
<td>______</td>
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<tr>
<td>2. Design Information &amp; Analysis</td>
<td>15 pts</td>
<td>______</td>
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<td>3. Performance of Design</td>
<td>8 pts</td>
<td>______</td>
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<td>4. Discussion</td>
<td>5 pts</td>
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<td>5. Task Breakdown</td>
<td>2 pts</td>
<td>______</td>
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<tr>
<td><strong>Total (50 pts)</strong></td>
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**Group Members:**

1. _______________________________
2. _______________________________
3. _______________________________
4. _______________________________

**Demonstrated to:** _______________________________

(TA Names & Signature)
There are two general options shown generically below. We can either add a single open stub or a double open stub. The former is easier, but the latter generally does a better job of blocking a signal and, unfortunately, the signals from nearby channels.

Double Open Stub Tuning

Single Open Stub Tuning

**Look to the Past:** Those of you who know how this project was specified in the past will note that we have previously used either a short-circuited or an open-circuited line. The open-circuited line is easier to implement, since one only needs to cut a wire and leave it unconnected. However, even a small amount of open wire at the end of the line will act like an antenna. This is not necessarily a serious problem, so this time we will use an open stub. Pre-project 1 provides important analysis steps for the channel blocker.

**Analysis Option 1:** The traditional way to analyze stub filters is to use a Smith Chart. This is discussed in the textbook and at the following sites on the web.

Smith Chart References:
- [http://weewave.mer.utexas.edu/DPN_files/courses/363M/tuner_exmpl/dbl_tnr.html](http://weewave.mer.utexas.edu/DPN_files/courses/363M/tuner_exmpl/dbl_tnr.html)
- [http://www.ee.surrey.ac.uk/Personal/D.Jefferies/stubs.html](http://www.ee.surrey.ac.uk/Personal/D.Jefferies/stubs.html)
Analysis Option 2: Since transmission lines can be modeled using PSpice, you can do your analysis using PSpice. Please also see the PSpice analysis document linked to the Studio Session 1 on the Handouts page. Your final analysis must be done with the lossy transmission line model. This is by far the most popular choice for this project, even though it has some limitations.

Overall Goals:

You must design two systems. Preferably, one should block a TV channel below 150MHz and one should block a channel above 300MHz. However, you can choose any two channels as long as they are not too close in frequency. Your lossy transmission line model must be correct at the frequency of interest for both cases. For the PSpice option, there is no way to easily incorporate a frequency dependent resistance per unit length. Thus, you should do a complete frequency scan (covering the entire range of channel frequencies) for each of the two cases. This will help you to identify the range of validity of your two models.

Once the analysis has been done, you must build a channel blocker for the two TV channels (two F-type Tee connectors will be provided for each group and, we hope, some cable and connectors). You must test your final designs (for the two channels) and record the results (e.g. channels blocked and channels unaffected). Then, you must demonstrate its efficacy to a TA using the cable feed in the studio to the TV display and the spectrum analyzer. Remember to ask the TA to sign on your front page with a note about this demonstration.

Specific Tasks:

1. Provide all information on the parameters of the cables you are using and justify the accuracy of your numbers. Be sure that you include cable losses at the frequencies you wish to block. Fully document the sources of your information. (3 pts)

2. Qualitatively analyze the filter schemes (show your work). For example, show your hand calculations for the length of the open stub you plan to construct and predict the frequencies it will block. Check these frequencies against the list of CATV stations on campus to identify which signals will be affected. (This is what you were asked to do during the pre-project day, but you may want to update your work here.)
   a. Blocking a lower frequency cable TV station (your choice) while leaving as many other channels as possible unaffected.
      • Design (2.5 pts)
   b. Blocking a higher frequency cable TV station (your choice) while leaving as many other channels as possible unaffected.
      • Design (2.5 pts)
3. Using one of the two analysis options (Smith Charts, PSpice) do your full analysis for lossy lines, incorporating the data from item 1 above. You must clearly annotate your plots so it is completely clear what information they contain. Compare the frequency response from your analysis to the performance of a commercially available channel eliminator by incorporating both sets of information on the same plot. (7 pts)

4. Build and test the TV channel blocker which must be turned in with your report and tested in class jointly with one of the course TAs. Testing should include connecting your blocker to the spectrum analyzer and recording changes in the observed spectrum. A simple way to do this is to photograph the display of the spectrum analyzer. However, a simple sketch is also fine. You should also connect your blocker to the cable line that feeds the VCR and observe changes in the display projected on the screens at the front of the room. Describe the changes you see.
   a. Low Frequency Design (4 pts)
   b. High Frequency Design (4 pts)

5. Discuss your results. What worked as expected? What did not? How close are the predictions of your model to the actual experimental results you obtained? (5 pts)

6. Task Breakdown: You must formally divide the work up in this project and assign each task to a member of your group. (2 pts)

Suggestions: One thing that we all learn when working on projects is that everything will go better if one begins writing the report on day one. In this way, it is easy to see what yet needs to be done. Lay out the structure of the report and identify the person responsible for each section. Then the report writer will know who to bug to get things done on time. Also, the report writer needs to be sure that the report makes overall sense and does not appear to be a cut and paste job with no continuity. Be sure that you clearly identify the source of any significant information you have used. For example, you will obviously need the parameters for cables. What specification information did you use? If you used formulas from the book, lecture slides, class notes, other texts, etc. clearly indicate page numbers, etc. If you received help from anyone else (which is perfectly OK), make sure that you give them credit. You should not outsource your report, but you can really get help from anyone. Finally, do not include plots generated from PSpice, etc. without including a discussion of the information contained in the plot. The easiest way to do this is to include a figure caption with clearly label on the plots using arrows and text boxes.