RF and Digital Signal Processing

Filters Lab

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Introduction

Filters are used extensively in all fields of engineering and science. It is important to learn how to measure them and understand their performance limitations

Objective

By the end of this lab you will have measured several differing types of filters, will know their 3 dB bandwidths, their equal ripple bandwidths, return loss, insertion loss. You'll have a better feel for what happens when you try to cascade filters.

Directions and Questions

Part 1

For each filter listed below, you will need to measure:

1) Insertion loss
2) 3 dB Bandwidth
3) Equal ripple bandwidth (if applicable)
4) Minimum return loss
5) Group delay flatness
6) 20 dB rejection band
7) 40 dB rejection band
8) > 60 dB rejection band

Filters:

a) Cirqtel Lowpass
b) VLF-120

c) VLF-80

d) SHP-400

e) Bessel Bandpass (7B120-160/BT16-O/O, S/N WF165-1)

f) PCB filter

In your write-up, we expect to see two graphs of the response (one close in showing the cutoff range) and one wider band showing any anomalous or outstanding performance over a very wide band (your choice of bandwidth). In addition, all the other parameters measured above should be presented in a clean and concise manner. If you don't have a computer to make it all spiffy, try to do your best on either grid or ruled paper. Label key points on your graphs. Hand drawn graphs are completely acceptable as long as they are readable.

For each filter make a personal (honest) judgment of the quality of the filter. (i.e. "This filter is a piece of crap. It says it has a 300 MHz cut off frequency but doesn't begin rolling off until 450 MHz, thereby reducing it's effectiveness near it's band edge.) You can mention things about pass-band ripple, out of band rejection, etc.

Finally pick your favorite and make a "glossy" data sheet which talks about the good stuff of the filter but cleverly leaves out any undesirable things like spurious pass-bands or whatever.

Part 2

When trying to get ultimate rejection, the un-initiated might think that simply staggering two filters would be an excellent way to get double the rejection. This portion of the lab is meant to educate you on some of the pitfalls which may occur should you attempt this without thinking carefully about what you're doing….

Measure the two low pass Cirqtel filters. Generate a plot showing what they look like individually. Now, Put them together in series and re-measure. Make a plot and comment on what you see. Make a guess as to why this might be. What does this say about staggering filters in general?

If you were not asleep during my lecture, you may recall something I said (if I remembered to say it) about staggering of filters and potential ways you might mitigate it. If so, attempt to improve what you see in some fashion which does not involve taking things apart! Try to find the minimum loss solution to improve the rejection at the fc + 50 MHz location by 10 dB. Take a plot of your solution and draw a diagram indicating what you did.

Some random questions to answer:

1) What happens to the signals that don't go through the filter?

2) What are filters useful for?

3) What are some applications you have used them for (if you have)?

4) Why does your cell phone or your Digital TV converter box need a very sharp edged but still flat group delay filter in it?