

Tuning the Cavity Filter using a Partially Completed MSA

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The following diagram shows the configuration necessary to tune the cavity filter using the Peak Detector and a partially completed MSA. The control board, ADC, master oscillator, DDS1 and PLO1 are all connected the same as they will be in the completed MSA.

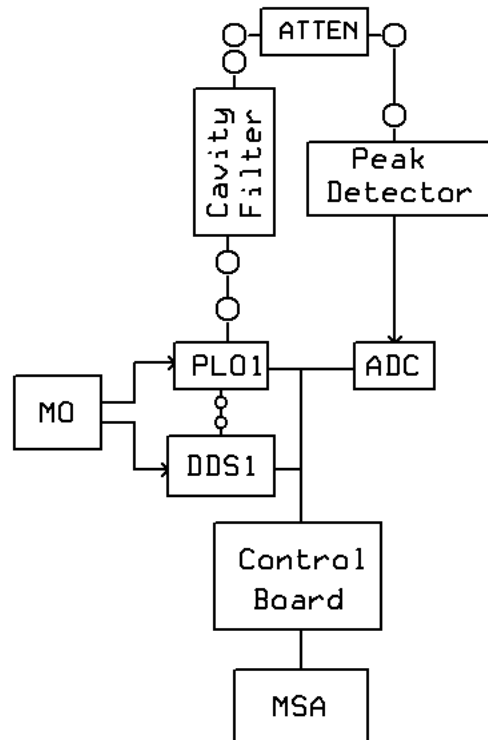


Diagram 1—Test configuration

Either PLO1 output is used as the test signal. It is run to the cavity filter, whose output runs through a 10 dB attenuator to the Peak Detector RF input. The Peak Detector output is run to the ADC, in place of the normal MagVolts. The Peak Detector is described in the Appendix A.

Note: This document was originally written with the idea of using the Peak Detector in Appendix A. However, it may be easier to get a view of the initial filter response, when it is well out of tune, by using the Log Detector shown in Appendix B, which has a larger dynamic range.

In order to get a proper reading of power levels, you need to install a path calibration file for path number 1. That is discussed in more detail below.

In Spectrum Analyzer mode, set up a scan from -20 MHz to 20 MHz, using 100 steps, zero wait time, and the widest video filter. This will cause PLO1 to vary from 20 MHz below the cavity filter center to 20 MHz above center. Select Path 1. The MSA will think you are selecting a final

IF filter. Of course, you have none installed, but this will cause the MSA to use the path calibration file for the Peak Detector.

Before connecting the cavity filter, connect a cable in its place to allow a direct scan of PLO1. Do a scan and record the signal level at the center. The graph should be very flat, at a level near 10 dBm. (The calibration table assumes a 10 dB attenuator.) If it is a few dB lower, that is OK. This verifies that your PLO1 is working, and establishes a reference level for later determining insertion loss.

Now install the cavity filter into the test setup. Click Restart. You will see a graph of the cavity filter response. You may see a large distorted hump in the middle, if the filter is just slightly out of tune, or you may see a couple small bumps if it is far out of tune.

[Note: From this point on, you could follow the procedure Scotty describes for tuning the cavity filter with it mounted inside a completed MSA. The procedure is the same, even though we are tuning the filter with a partially completed MSA.]

Start with the tuning screw at one end of the filter. Loosen its jam nut a little bit so you can turn the screw with modest effort. You don't want the nut completely loose, or you will mess up the tuning when you ultimately tighten it. Turn the screw back and forth about 1/8 turn. You should be able to see a bump moving on the screen. If not, the bump is off screen and you will have to turn the screw further. When you find the bump, move it near the center.

Repeat this process with the other screws. This should get the filter somewhat in tune. Open the Sweep Parameters window and narrow the scan range from -4 MHz to 4 MHz. Click Restart. You will now see a close-up of the response. From here on, you just play with the screws to get the center bump higher and higher, and narrower and narrower.

You can click Functions→Filter Analysis and click OK in the dialog that appears. You will get a P+ marker at the filter peak, and two markers at the -3 dB point. In the marker display area, you will see the filter bandwidth. The information for the P+ marker will show the frequency at the peak.

Adjust the screws gently until you get a reasonably symmetric response at as high a level as you can achieve. You may get a fairly rounded top, or the top may be flat. If the top is rounded, adjust the screw to see if you can flatten it a little, but without significantly increasing the bandwidth reducing the peak level. You should be able to achieve a bandwidth of 1.8-3 MHz, with insertion loss of 3-8 dB. The insertion loss is the difference between the signal level you measured for PLO1, and the level of the P+ marker. In trading off the various characteristics it is probably most important to keep the bandwidth narrow.

When you are satisfied with the response, tighten the jam nuts. You need to hold the screw in position with a screwdriver while tightening the nut, so the screw does not turn. If your tuning is very sensitive, you may have to tighten the nut a little, readjust the screw (which will start to become hard to turn), tighten the nut a little more, etc.

When you are done, you can delete the Path 1 calibration file that you created. A default file will be created next time you run the MSA software.

Installing the Calibration File

The peak detector produces a voltage that increases with power level, but not linearly. The ADC will convert the voltage to a certain bit value, but the MSA needs a calibration table to convert the ADC bit value to actual power in dBm. This table is provided as a path calibration file, and there is normally one such file per “path”, a path corresponding to a final IF filter. Here, we want to create a file for path 1, even though we don’t actually have a path 1 filter. We just want to force the MSA to use our calibration table when using the Peak Detector.

The calibration file will be a file called MSA_CalPath1.txt, which must be placed in the MSA_Cal folder, which is in the MSA_Info folder, which is located in the same folder as your MSA software. If those folders do not exist, run the MSA software and then quit; the folders will be created.

You will probably have a default MSA_CalPath1.txt file, whose contents you can change in any word processor or text editor. If not, you can create the data in a word processor text editor and then save the file with the proper name in the proper folder.

The contents of the file are very simple, and can be copied from below and pasted into the file:

```
CalVersion= 1.03
MagTable=
* ADC    dbm  in increasing order of ADC
3394    -15
3474    -10
3670     -5
4246     0
5086     5
6474    10
8506    15
```

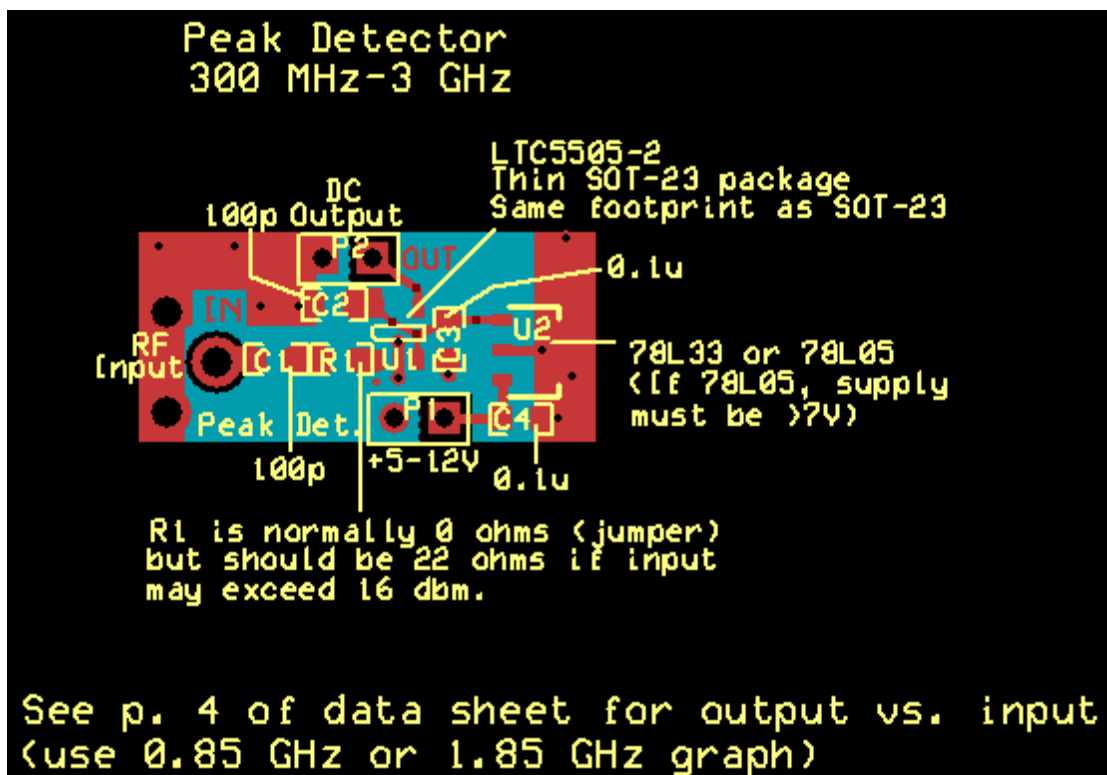
This table is based on voltage measurements provided by Paul Newman.

The above calibration file assumes that you are using a 10 dB attenuator, which may actually be built into the Peak Detector board. These values are accurate within a few dB for a typical Peak Detector board, in the neighborhood of 1013 MHz. You can create your own calibration file if you have a way to test the voltage output of the Peak Detector against known input levels. Assuming you are using the standard 16-bit ADC, the ADC value that will be generated for a given voltage is

ADC value=(Detector Voltage/5)*65535

APPENDIX A—LAYOUT OF PEAK DETECTOR

Below is a PCB layout of the Peak Detector, which also serves as the schematic.



Note the RF connection is a PCB-mount SMA connector, on which two of the legs must be broken off. It mounts on the bottom. There is no need to shield this board, unless you want to provide mechanical protection.

If you want to add an on-board attenuator, reverse C1 and R1 and add RA and RB as follows:



The board was not designed with the attenuator in mind, so it may be necessary to place one end of RA and RB on top of R1, or use size 0603 resistors for RA and RB.

For precise 10 dB attenuation, use $RA=RB=95.3$ ohms and $R1=69.8$ ohms. But that is perhaps more precision than is justified given uncertainties in the peak detector response, so it is reasonable to use $RA=RB=100$ and $R1=68$, which actually provides 9.6 dB of attenuation.

APPENDIX B—LAYOUT OF LOG DETECTOR

Below is a PCB layout of the Log Detector, which also serves as the schematic. The Log Detector provides the same function as the Peak Detector, but has an approximate range of 0 dBm to -60 dBm, and so is more suitable to measuring low level signals.

