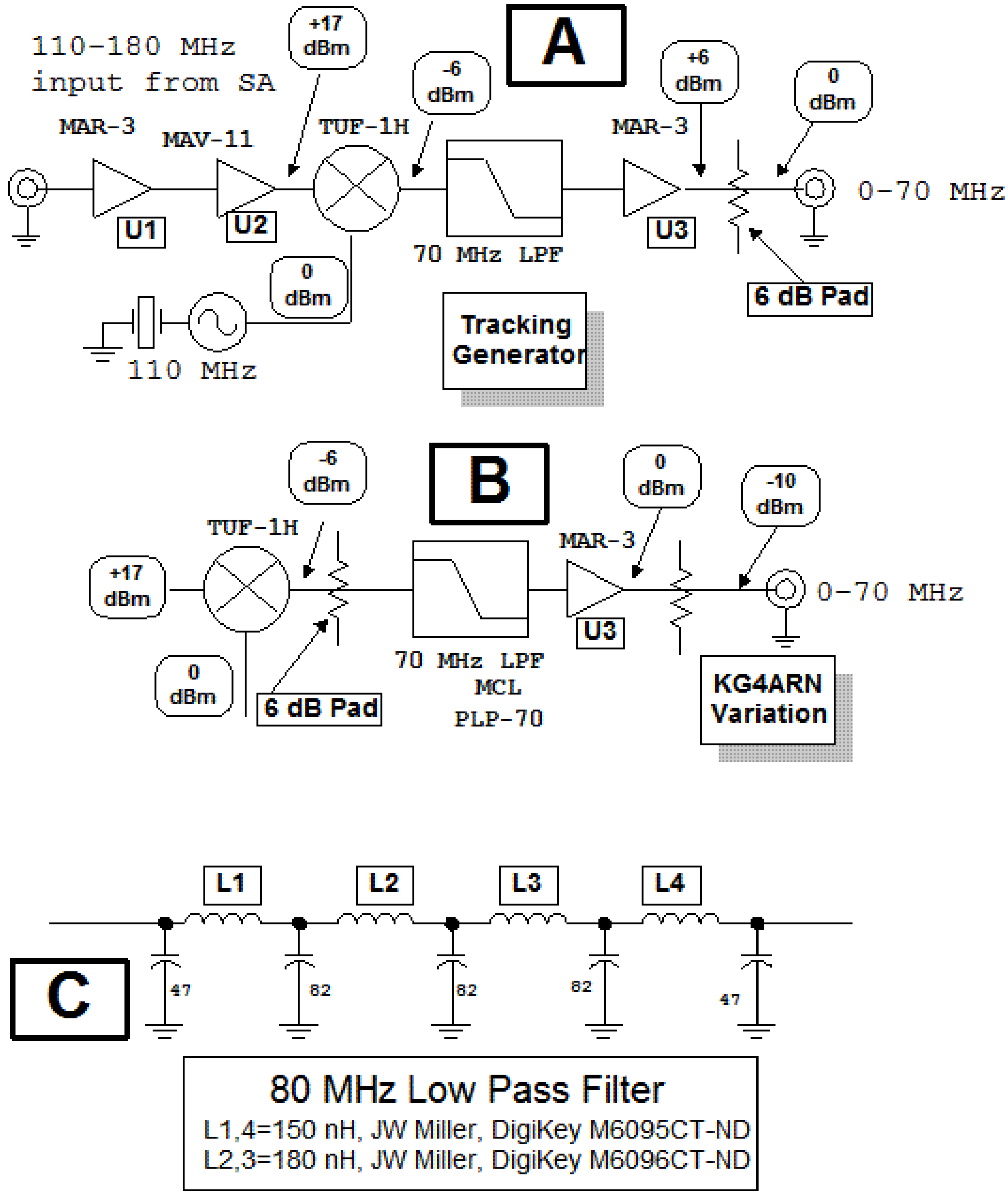
Tracking Generator Modifications (31August06, 5Jan07)

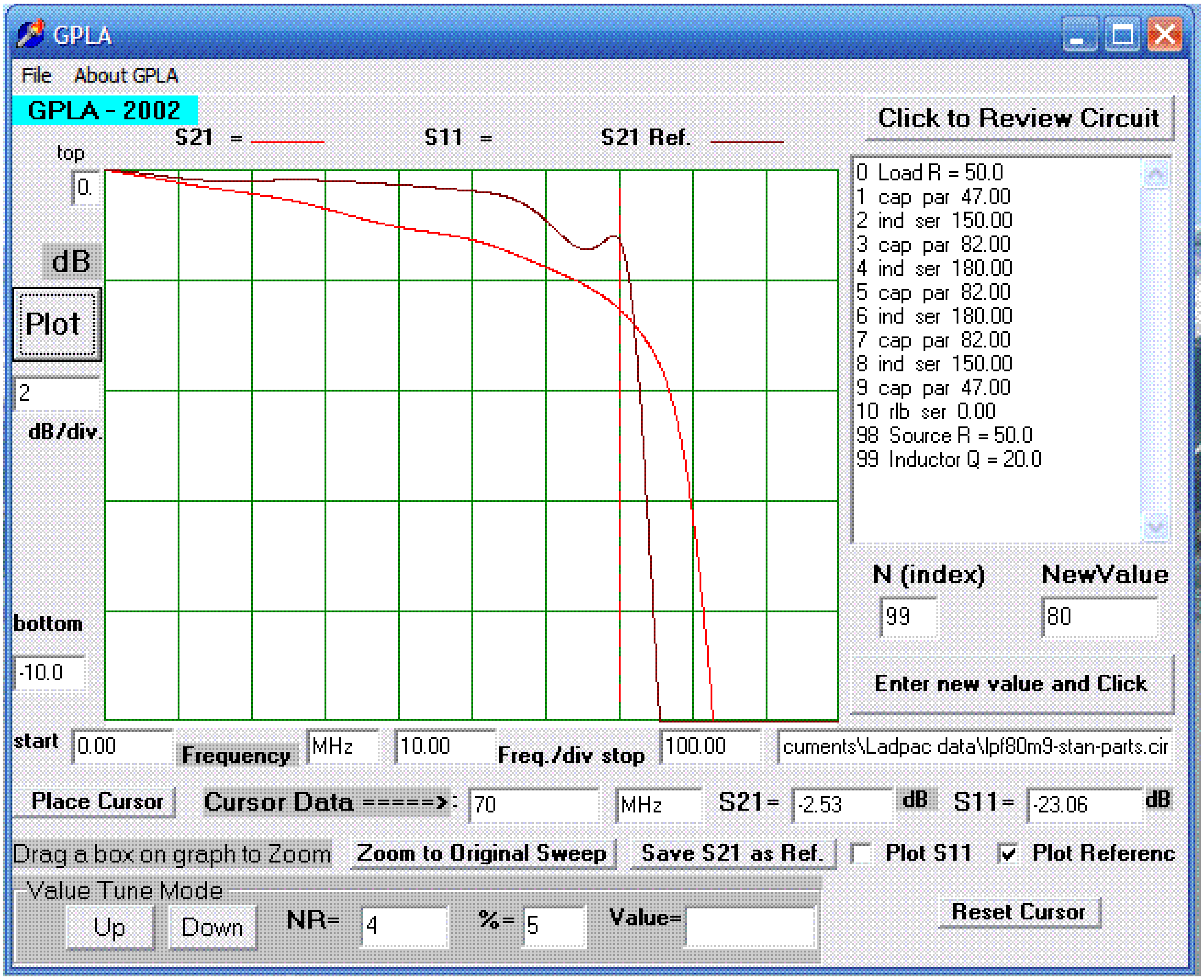
A recent email from Ed, KG4ARN, dealt with a couple of problems with the tracking generator. First, he was seeing a "*baseline rise*" when the tracking generator was powered, but disconnected. *Baseline rise* is a phenomenon where the normal noise floor at the bottom of the of the screen increases uniformly across the screen. This degrades the minimum signal that can be detected, which then compromises the dynamic range that can be achieved with the spectrum analyzer -- tracking generator combination.
The other problem that he saw was excess energy at high frequency (above 70 MHz) coming from the tracking generator output. Ed didn't say how he measured this. He speculated that there may have been problems related to a poor high frequency termination. To fix this, Ed modified the block diagram of the tracking generator.

The figure below shows the changes that Ed made. The top part of the figure **(A)** shows the original block diagram while the diagram below that in **(B)** shows the modification that Ed did. He moved the 6 dB pad to directly follow the mixer. This will then guarantee a reasonable termination for all high and low frequency mixer products. This is followed by the low pass filter. Ed elected to use a MiniCircuits PLP-70 filter in this slot. (Hey, why not. Everything else in the TG is from MiniCircuits.)



The note I got from Ed indicated that he pulled the output directly from U3 with no pad at the output. This is probably fine for most applications. The available output power should be around 0 dBm. For critical applications where it is important to have a very clean output impedance, it might be useful to include a 10 dB pad (100 Ohm parallel resistors with 68 Ohms series) in the output as I have shown the part B of the figure above. This is up to the experimenter/builder.

Part C of the figure shows a SMT filter that should be suitable for the output of the tracking generator or for the front end of the analyzer itself. The inductors are by JW Miller and are 1210 sized parts. A calculated response for this circuit is shown below.



The red curve shows the response of the filter while the brown line is the response of the original low pass circuit. The new filter is assumed to use inductors with Qu=20 while I assumed Qu=80 for the original filter. The filter used in the spectrum analyzer and then repeated for the tracking generator was designed to use identical inductors, which is the origin of the ripple. There are minor ripples in the new filter, which started as a 0.1 dB Chebyshev design. The present ripples can be observed by setting Q to a very high value instead of the present 20. The Chebyshev passband shape disappeared when the original design values were perturbed so standard values could be used. The ripple is virtually gone in the final filter shape, a result of the loss. The loss is not out of hand though -- it is 2.5 dB at 70 MHz. Note that the plots shown are obtained over a restricted 10 dB range. I have not built this circuit, but will pick up the inductors the next time I do a Digi-Key order, will build the SMT circuit, and report the results here.

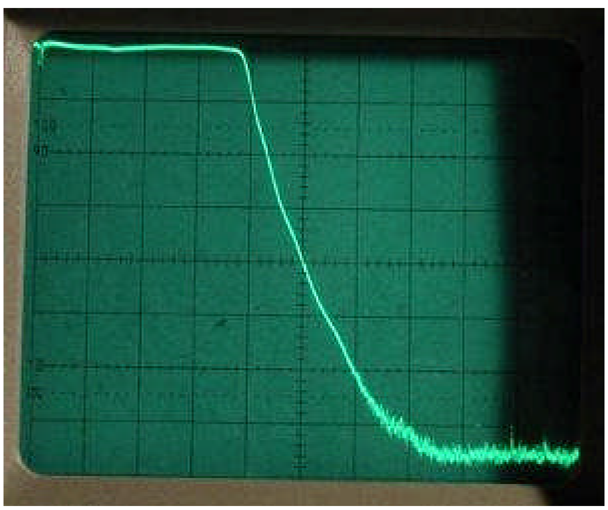
We encourage builders to give some SMT a try. This is a place where it really makes sense, for it improves the performance. SMT is not just to make things small. It is unfortunate that so many radio amateurs approach SMT with fear, for it is not that difficult once suitable optical enhancements are in place.

Many thanks to Ed, KG4ARN, for telling us about his refinements.

Update -- January, 2007.

I finally got around to building the SMT low pass filter, having included the selected coils in my last order to DigiKey or Mouser. The schematic is shown above.

This a photo of the completed photo. If doing a layout, the inductors would probably nicely fit on a 1210 footprint. The above breadboard has two wire vias for each capacitor ground. The capacitors are size 0805, 5% C0G manufactured by AVX. I used SMB coaxial connectors to facilitate measurement.



This is the measured response. The gentle loss dropoff in the simulation above is not evident, suggesting that the inductor Q may be higher than the value of 20 used with the simulation. The vertical divisions are 10 dB per division while the horizontal is 20 MHz per division (total span of 200 MHz.)

A wider span (total 500 MHz) showed two response peaks above 200 MHz, both still more than 60 dB below the peak low pass response. Modeling suggests that these come from series inductance in the chip capacitors and mutual inductance between the capacitors.