Revision of the Bandpass Filter for the LWA Analog Receiver

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Contents

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1 Introduction

In [1] we revised the design of the bandpass filter (operating in 20-80 MHz) proposed in [2] by using standard (commercially-available) components. We built a prototype of the receiver of the Long Wavelength Array (LWA) by replacing the filter sections of an existing receiver of the Eight-meter wavelength Transient Array (ETA) telescope (operating in the band 29-47 MHz) with this new revised filter. In [3] we discussed the performance of this prototype in details. In this document we present another simple revision of that filter which greatly improves the suppression in the broadcast FM band (88-108 MHz) by introducing a notch at 90 MHz.

2 Revised Design

The objective of this revision was to improve suppression of the broadcast FM band (88-108 MHz). So we added a simple notch filter to the previous filter (shown in Figure 1). Thus we arrived at the new design, shown in Figure 2. The optimal values for the components of the notch filter are listed in the following table . The response of the revised filter is shown in Figure 3.

Component	Value
L6	31.3 nH
C6	100 pF

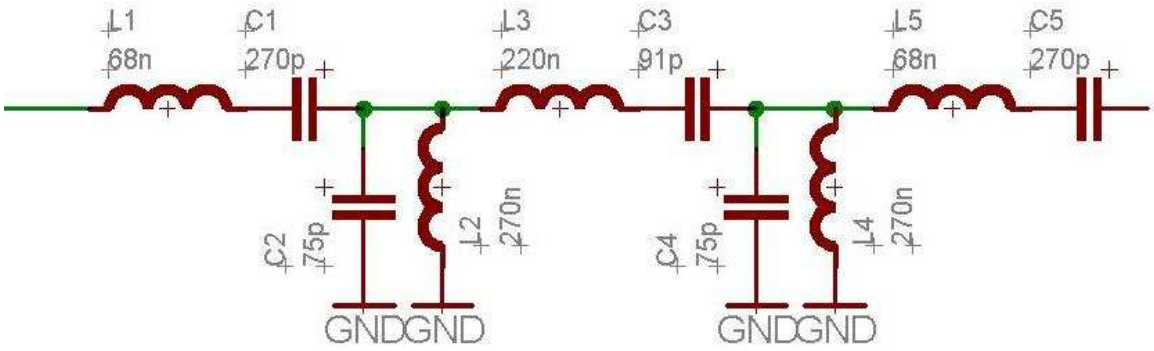

Figure 1: Filter Design proposed in [1] .

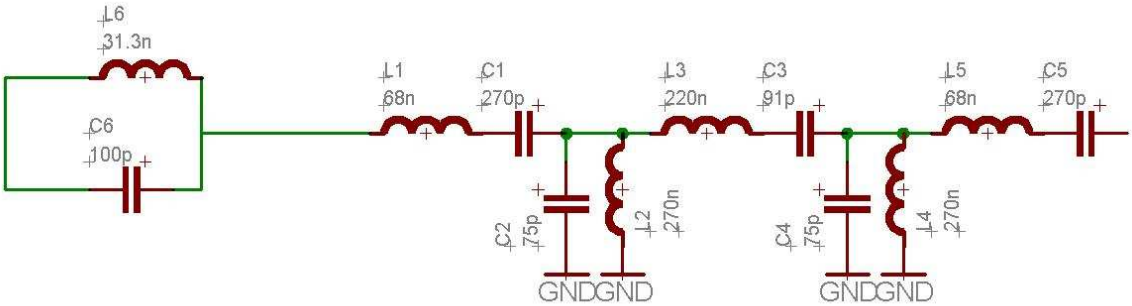

Figure 2: Revised Filter Design .

The components used in the notch filter of Figure 2 are not standard (commercially-available). So we revised it with standard values. Revised values are selected from commercially available 0603 size SMT components available from the Digikey [1] and Coilcraft [2] catalogs. The revised values are:

Component	Value
L6	33 nH
C6	100 pF

The comparison between responses with standard and design values are shown in Figure 4.

[1] www.digikey.com
[2] www.coilcraft.com

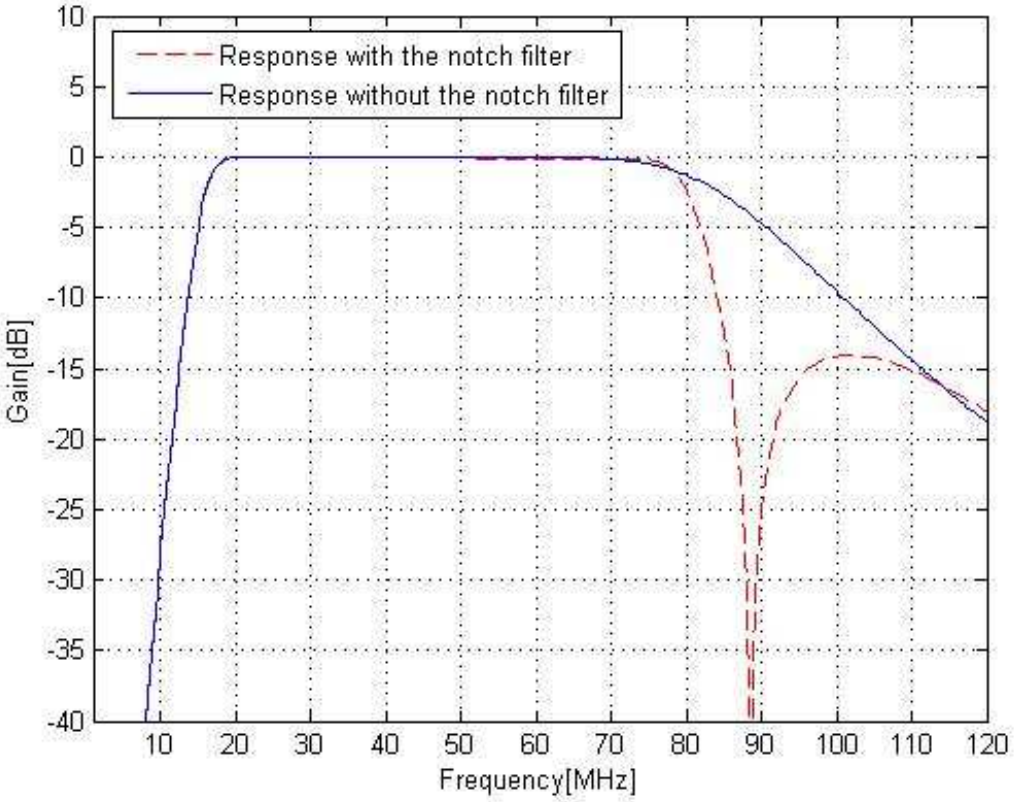

Figure 3: Illustrating frequency responses with and without the notch filter.

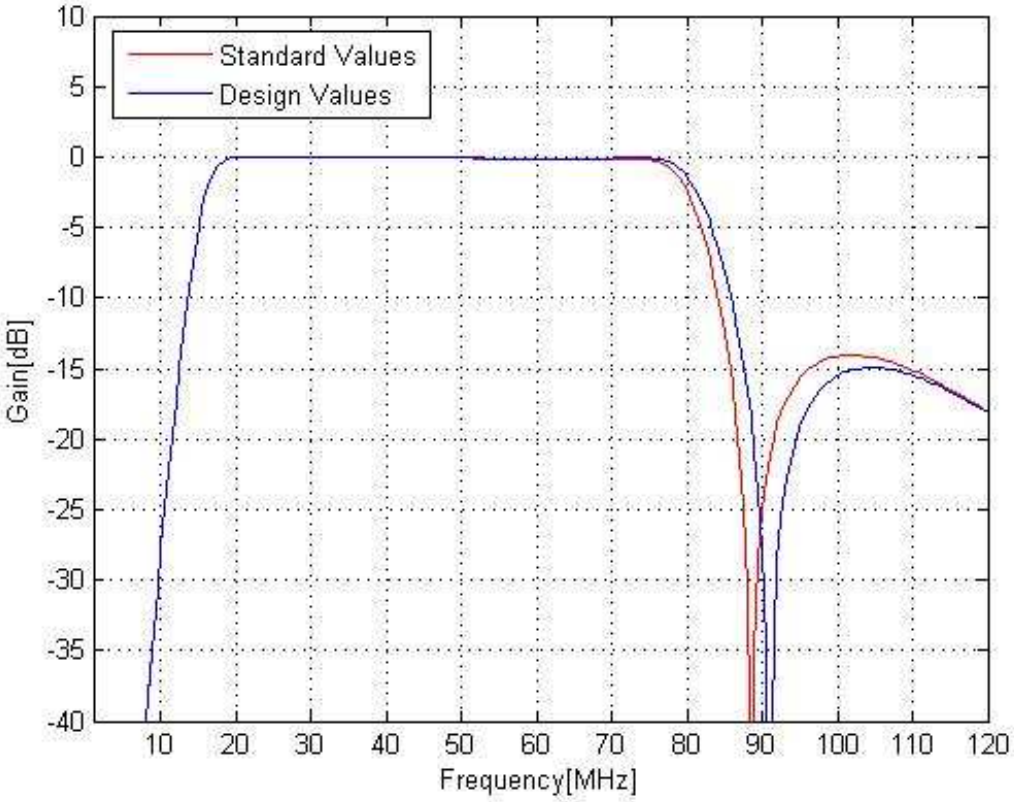

Figure 4: Comparison between responses with standard and design values.

3 Effect of Non-Zero Value Tolerances

Commercially available SMT components typically have a tolerance (i.e., maximum error in value) of 5 percent. We used monte carlo simulation to study the effect of non-zero tolerance on performance. 100 trials were run using a uniformly-distributed random distribution to generate tolerance values within the specific range. These new values were then used to plot the transfer function of the filter. In Figure 5 the response due to 5% tolerance values is shown.

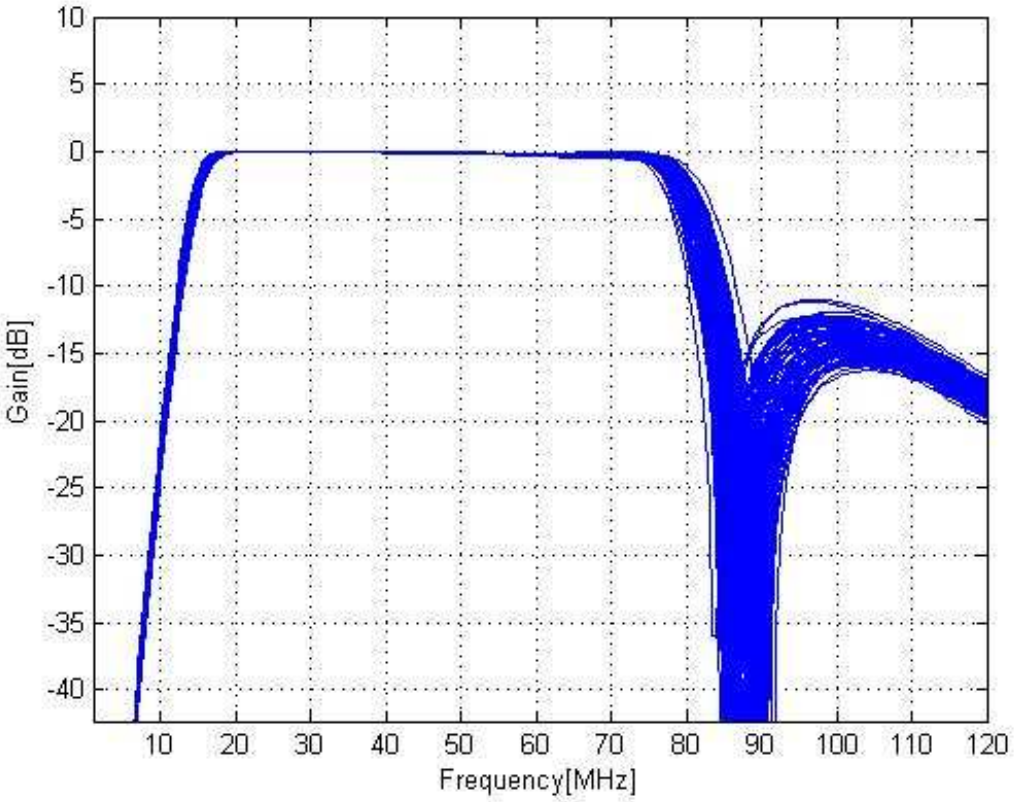

Figure 5: Frequency responses of 100 trials using components with tolerance of 5%.

4 Conclusion

Observing the results of this study we find that the use of a notch filter in front of the bandpass filter greatly improves the performance of the receiver. This is a very simple modification. We can incorporate the additional notch filter section in the receiver without altering any of the previous design.

References

[1] M. Harun and S.W. Ellingson, Practical Considerations in the Design of a Band-pass Filter for the LWA Analog Receiver, LWA Memo [63] November 14, 2006. http://www.phys.unm.edu/∼lwa/memos.

[2] D.W.A. Taylor, "Design of Ultrawideband Digitizing Receivers for the VHF Low Band," M.S. Thesis, Virginia Ploytechnic Institute & State University, 2006. http://scholar.lib.vt.edu/theses/available/etd-05162006-161217/.

[3] M. Harun and S.W. Ellingson, A Prototype Analog Receiver for LWA, LWA Memo [82] March 28, 2007. http://www.phys.unm.edu/∼lwa/memos.