# Diplexer for the Satellite User

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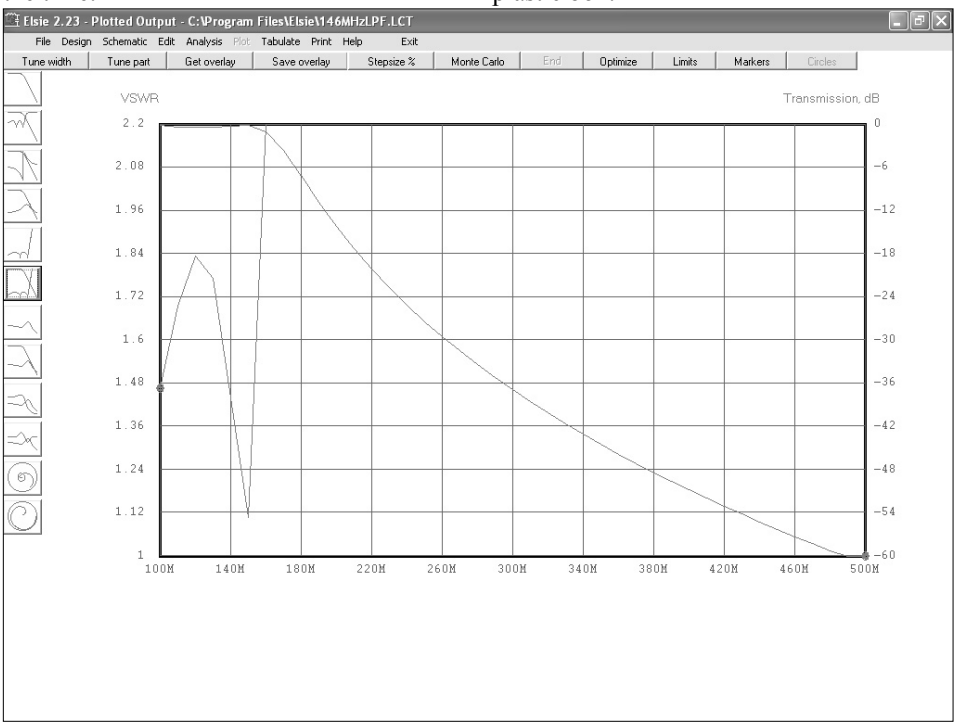
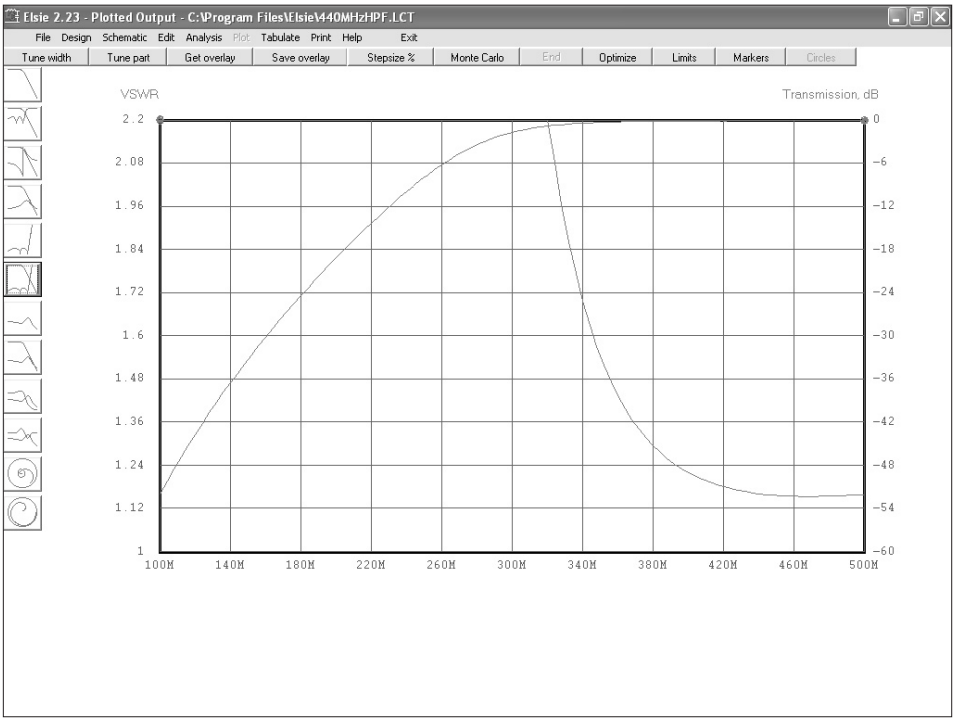
Over the past 5 years I've been working to improve the receiving and transmitting performance of my ICOM W32/Arrow antenna combo. I've actually had these two pieces of equipment for about nine years but didn't think much about how efficiently they worked with the Comet 4160 diplexer that I was using at the time.

Actually the thing that troubled me the most was the weight, a heavy diplexer and 3 additional adaptors to make all of the BNC connections. My first impression was to remove the circuit board from the Comet enclosure and make direct coax connections to the antenna and radio, which eliminates most of the weight and place it in a miniature plastic box.




***ELSIE plot for the low pass filter.***




***ELSIE plot for the high pass filter.***

During the board extraction period I noted how wide the band pass was on the low pass and high pass filters. The low pass filter bandwidth was 1.3 to 170 MHz and high pass filter bandwidth was 350 to 540 MHz. This is an area that can be improved upon to make it more efficient in the narrower satellite frequencies that I use. Now that the board is out, it's time to make some modification, but first we need to look at ELSIE for direction.

ELSIE is a software program that is on a disk that comes with *The ARRL Handbook*. I won't go into the program's full capabilities. However it will perform the mathematics to determine component values for a multitude of filter configurations and provide performance charts. This is the tool that I use for designing the diplexers that will be discussed in this article.

After opening ELSIE version 2.23, select New Design. I split up the diplexer into a inductor input low pass filter and a capacitor input high pass filter using the Butterworth family. The 3 dB bandwidth was set at 170 MHz for the low pass filter side and 280 MHz for the high pass filter. Order number is 5 and input termination 50. After inputting these parameters, details of each filter can be reviewed independently by selecting Schematic, Analysis, Plot and Tabulate on the tool bar. Adjustments to the design can be made by clicking Edit on the tool bar and changing component values as needed. Try to settle on even number values and review again using functions on the tool bar.

Another feature of the ELSIE program is a coil winding routine. Select Wind L on the tool bar and enter the inductance value or select from the "use list at left" button.

Design goals for this project are:

1. 3 dB cut off frequency at 170 MHz on the low pass side
2. 3 dB cut off frequency at 280 MHz on the high pass side
3. low insertion resistance
4. adjustable capacitors for fine tuning
5. light weight packaging

With these goals in mind I proceeded to make some changes to the Comet board and also build up a prototype on a scrap piece of copperclad board machined out with a Dremel tool. Both of the circuits worked

equally well, however I liked my proto unit better because the board was smaller and fit into a small plastic box that I had on hand.

The modifications made to the Comet board were replacing the fixed capacitors with Sprague Goodman ceramic dielectric trimmer capacitors and replacing the 4 turn coil with a 5 turn coil. Each filter was adjusted for minimum attenuation on the low pass side at 146 MHz and 436 MHz on the high pass side.

This past summer I happened to mention to Mark Spencer, WA8SME, that I had been working on a diplexer more in tune with the frequencies that we use for AO-27 and AO-51.

Mark took my ELSIE generated design and within weeks had built up and tested a prototype which proved to be close to the desired design goals. Insertion losses indicate a 1.29 dB loss on 2 meters and a .70 dB loss on 70 cm. The strong point of the design however is the variable caps and the ability to tune the diplexer for a specific duty such as the satellites as opposed to the one size fits all approach using fixed caps.

With a comfortable design in hand, a set of professionally manufactured boards were ordered, coils were wound out in my garage shop and variable caps ordered from Mouser. Within two weeks two fully tested and functional units had been completed.

These diplexers have since been tested on the air and perform as well as the first homebrew model that I have been taking with me on my trips to Hawaii.

Below is a list of recommended parts if you wish to build one for yourself.

Yellow cap, 7-40 pf, Mouser p/n 659-GKG40015

Red cap, 5-20 pf, Mouser p/n 659-GKG20015

2 turn coil, #18 wire, 6 mm ID

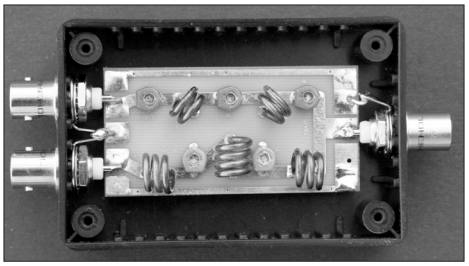
3 turn coil, #18 wire, 6 mm ID

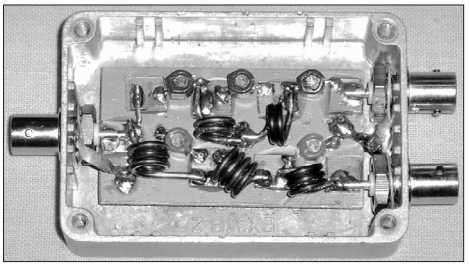
4 turn coil, #18 wire, 6 mm ID

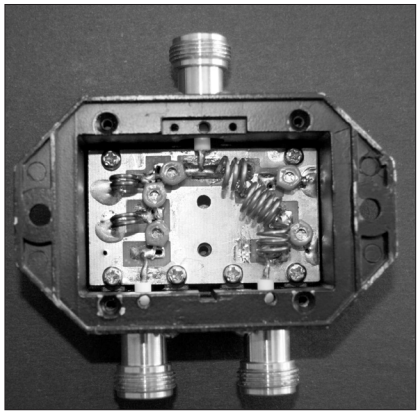
BNC connector, Mouser p/n 523-31-320-RFX

Hammond plastic box, Mouser p/n 546-1591MSBK

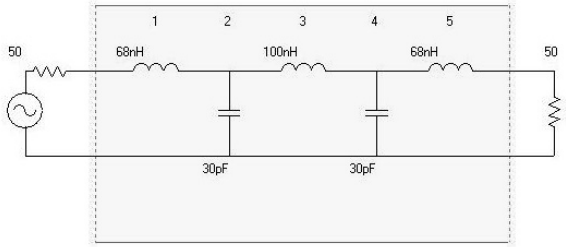
The printed circuit board is available from W6ZQ. E-mail to: ron.w6zq@gmail.com



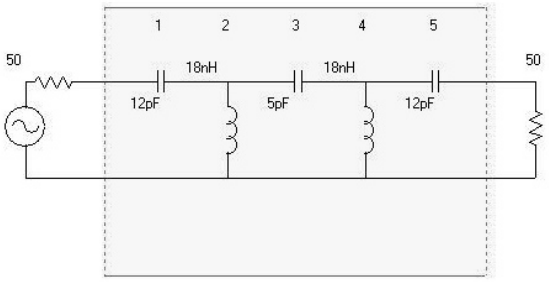




***Three different implementations of the diplexer design.***




***Low pass filter schematic.***




***High pass filter schematic.***


***W6ZQ/KH6 enjoying his diplexer while working the satellites.***