



Application Note

Reduce Filter Part Count by Strategic Constriction of Passband And Stopband Ripple

FilterSolutions[®], the filter design software by Nuhertz Technologies, is capable of designing filter circuits with severe board space constrictions, minimizing the number of components needed to achieve several contradictory objectives. This effort demands that the design program incorporates advanced design techniques targeted to minimize physical size without incurring other additional design costs. By establishing attenuation requirements for a constricted range of frequencies in the passband and stopbands, as opposed to the entire pass and stopbands, the design requirements can be somewhat relaxed. The result, using the program is a design requiring fewer parts to achieve the important response goals while reducing the number of parts and the physical size of the manufactured filter.

Designing for tight attenuation requirements within the constricted design range has typically been performed by manually positioning transmission and reflection Zeros, to shape the passband and stopband until the requirements are met. While the technique of manually manipulating poles is well known, it is unnecessarily time consuming and can be frustrating. However, using FilterSolutions, the design engineer need only enter the percentage of the passband and/or stopband to which the equi-ripple requirement should be applied. FilterSolutions will automatically synthesize passband and/or stopband attenuation requirements to the selected constricted percentage.

Filter performance outside the constricted range may be evaluated for a range of percentages of constricted ripple by slewing the constricted ripple percentage with the program's "Real Time Updates" (RTU), feature. When RTU is selected, one easily observes the filter performance outside the constricted passband and stopband as the percentage of constriction is varied.

A Design Example

Consider the following filter design requirements:

Pass band S11 attenuation <-20dB for all frequencies < 1GHz

Stop band S12 attenuation <-60dB for all frequencies > 1.2GHz

The FilterQuick™ design panel, a feature included in FilterSolutions, quickly and easily produces an Elliptic design with nine poles that meets these design requirements. (Figure 1):

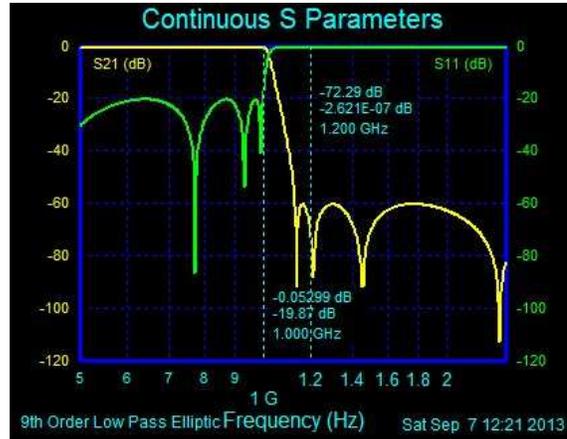


Figure 1: Nine Pole Traditional Elliptic Design

Using the FilterSolutions “Advanced” Panel Order Calculator” indicates a minimum of nine poles needed to meet the design requirements (Figure 2).

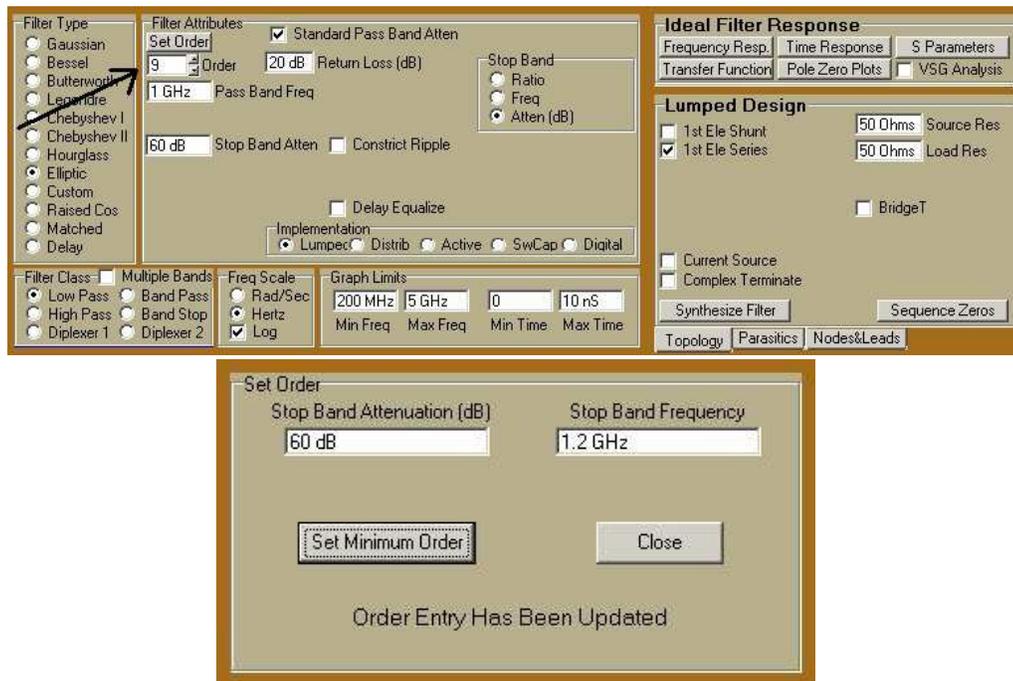


Figure 2: FilterSolutions “Order Calculator” for Traditional Elliptic Design

If it can be established that only 20 per cent of the passband and stopbands are required to meet the attenuation requirements, the Order Calculator may be set to 30% passband and stopband ripple constriction. With the constricted requirement considered, the calculated design shows that only seven poles are needed*. (Figure 3)

*(Note that the Constricted Ripple design feature is only available in the FilterSolutions “Advanced” interface, and not in the “FilterQuick” design panel).

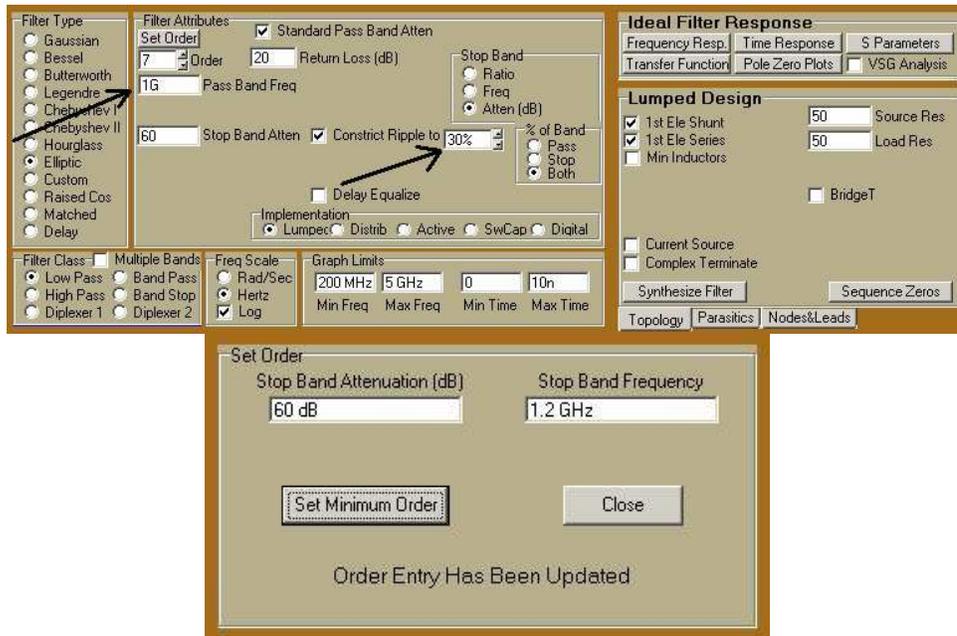


Figure 3: FilterSolutions “Order Calculator” for Constricted Ripple Elliptic Design

The S-Parameter trace is seen to easily meet the requirement with seven poles in Figure 4.

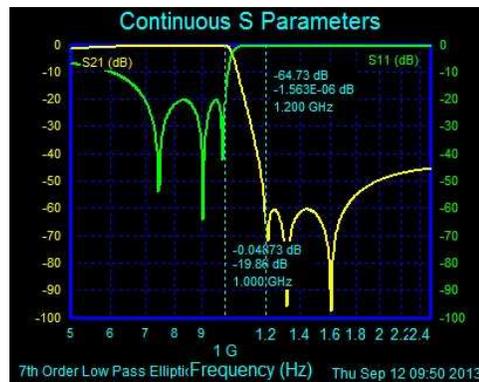


Figure 4: S-Parameters for Seven Pole Constricted Ripple Elliptic Filter Design

If it is desired in this filter design to maintain the stop band requirements for all frequencies, then one pole may be removed by eliminating stop band constricted ripple completely. Eight poles will meet this design requirement. (Figure 5):

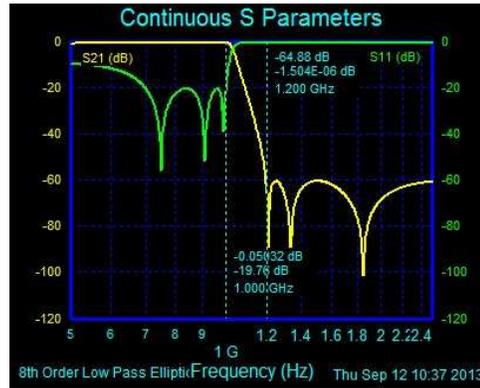


Figure 5: S-Parameters for Seven Pole, Passband Only, Constricted Ripple Elliptic Filter

Final Ideal Filter Design

By clicking on the “Synthesize Filter” button, the ideal filter design is generated. For size comparison purposes, the 9 pole traditional design is displayed first, followed by the more efficient 7 pole constricted ripple design. (Figure 6):

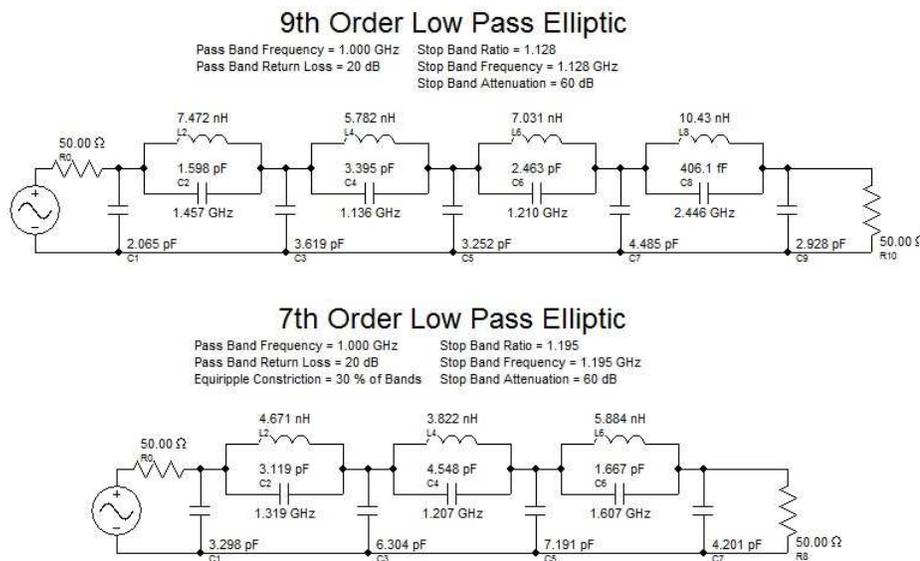


Figure 6: Ideal Elliptic Filter Designs With and Without Constricted Pass Band and Stop Band Ripple