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HARMONIC TRAP FILTER

What is an "harmonic trap filter"?

With the addition of one small component, a capacitor, we can transform a low pass filter into a filter with near infinite attenuation at a designed trap frequency. I call this an "harmonic trap filter".

Let's look at the old low pass filter in figure 1 below.

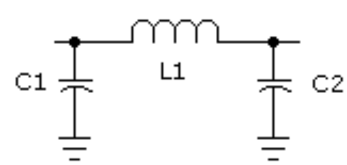

Figure 1 - schematic of a low pass filter

I presume you have already completed the tutorial on **low pass filters** and understand them fully. Now to construct an harmonic trap filter all I need to do is insert a capacitor C3 as in figure 2 below.

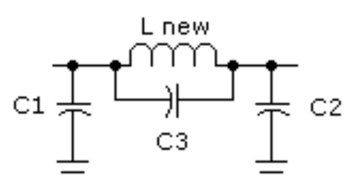

Figure 2 - schematic of an harmonic trap filter

Simple!

How do we design for an harmonic trap filter?

This gets a little tricky. Obviously you understand **reactance**, you do understand don't you?

For this exercise, in figure 1 above, XC1 = XC2 = XL = R. Here R is the circuit impedance. Therefore if we had a 50 ohm system all the reactances would be 50 ohms - splendid! This is figure 1 above remember. All we need to do is calculate L new. This is done with the following formula.

$$L\,new = L1 \times \left(1 - \frac{Fop^2}{F\,trap^2}\right)$$

Figure 3 - design formula for an harmonic trap filter

Here Fop is the original low pass frequency used in your design and of course Ftrap is the harmonic or, any frequency for that matter, at which you may want greater or infinite attenuation.

Just by way of illustration we will say we have a low pass filter with a cut off frequency of 5 Mhz. For figure 1 in a 50 ohm system, the values are C1 = C2 = 636 pF and L1 = 1.592 uH. We will assume we need further attenuation at 12 Mhz.

Using the formula in figure 3 the square of Fop = 25 and the square of Ftrap is 144, therefore:
[1 - (25 / 144)] = [1 - 0.1736] = 0.8264 which we multiply by L1 of 1.592 uH giving us Lnew = 1.32 uH.

Now all we need calculate is C3 and there are some flash formulas around for that which we will not use. Lnew and C3 in figure 2 above are simply a parallel resonant circuit which presents a high impedance to the trap frequency. How do we calculate LC values for **resonant circuits**?

Simple if you have done other LC filter tutorials you would know I love to square the frequency in Mhz and divide that into the "magic" number of **25,330.3** in this case the resonant frequency of the trap is 12 Mhz. Squaring that frequency and dividing the "magic" number by it gives us 25,330.3 / 144 = 175.9

If Lnew is 1.32 uh then C3 = 175.9 / 1.32 = 133 pF

Wasn't that dead easy? What are some of the potential problems?

Sometimes you can get into impractical values, especially at higher frequencies where you may encounter tiny values. Often it pays to re-work your problem using different impedances and then do another LPF to match those new impedances to your preferred impedance.

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