Harmonic Filters

RF amplifiers, no matter how well made, will distort their inputs. Some amplifiers are designed to distort the signal in order to increase efficiency. Class A amplifiers, like the 30 mw booster are biased on and conduct over the entire input wave form. This type of amplifier introduces a small amount of distortion. Class C amplifiers, like the PA-1 and 800mw, are not biased on and only conduct when the input signal is positive. These type of amplifiers act some what like an amplified half wave rectifier and therefore introduce a considerable amount of distortion.

Tuned circuits at the input and output of RF amplifiers act as filters to "clean up" distortion. These simple filters do a good job of converting distorted sine waves into clean sine waves but they do not block RF energy located at integer multiples of the original (fundamental) frequency. These unwanted bands of RF energy are knows as harmonics. An amplifier designed to boost a 100 MHz signal will produce unwanted RF energy at 200 MHz (2nd harmonic), 300 MHz (3rd harmonic), 400 MHz, etc. The amount of energy in the individual harmonics is a function of the type of distortion. In general, most of the energy will be in the 2nd, 3rd and 4th harmonics.

If these harmonics are not filtered they will interfere with TV and radio transmissions. An unfiltered transmitter operating at 95.9 MHz will produce a second harmonic at 191.8 MHz - the same frequency used to transmit sound for TV channel 9. Operating such a transmitter will almost certainly invite complaints and investigations by the FCC. Therefore, any transmitter that puts out more than 25mw should have some type of filtering. FCC rules require that VHF equipment reduce the second, third, and fourth harmonics by -25dB, -27dB, -30dB respectively and that no harmonic have a level of more than .7mw. The 7 element Chebyshev filter described below has been found to reduce the harmonics associated with a typical 1-watt signal to less than .1mw

Just for your information, the FM-10 puts out about 8-9mw and the second harmonic is -25dB off. The FM-4 kit by Ramsey puts out 130mw and the second harmonic is only -12dB off. This means that the second harmonic of the FM-4 is about as powerful as the FM-10!

Filter Design

Modern network theory and digital computers have made the design of filters fairly straightforward. Simple low pass filters can be designed by transforming normalized filters to frequency specific filters. This transformation is accomplished by multiplying the component values of the normalized design by the following frequency specific constants:

$C(ref) = 1/2\pi\, F(ref)\, R(ref)$
$L(ref) = R(ref) / 2\pi\, F(ref)$
$Ri = ri * R(ref)$
$Li = li * L(ref)$
$Ci = ci * C(ref)$

F(ref) = Transmitter frequency
R(ref) = Input Impedance

ri, li, and ci are taken from the "Chebyshev Low Pass Coefficient Table".