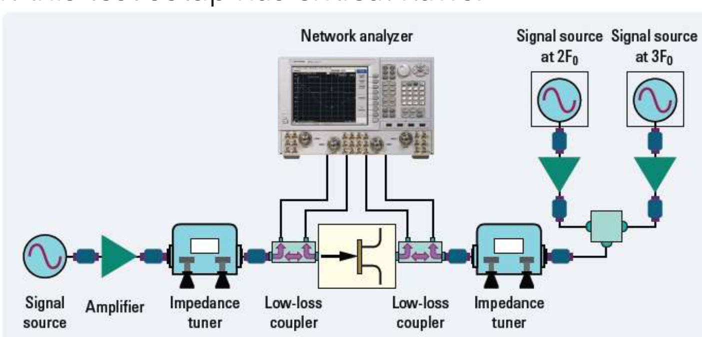
Hybrid Harmonic LP and wideband Tuners

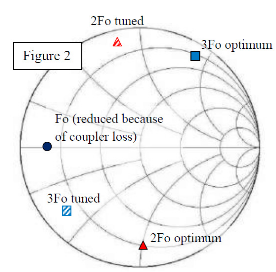
Using wideband tuners in active harmonic load pull is not a viable solution.

Figure 1 is a test setup for active harmonic load pull that has been proposed by a tuner manufacturer. It is shown here that this test setup has critical flaws:



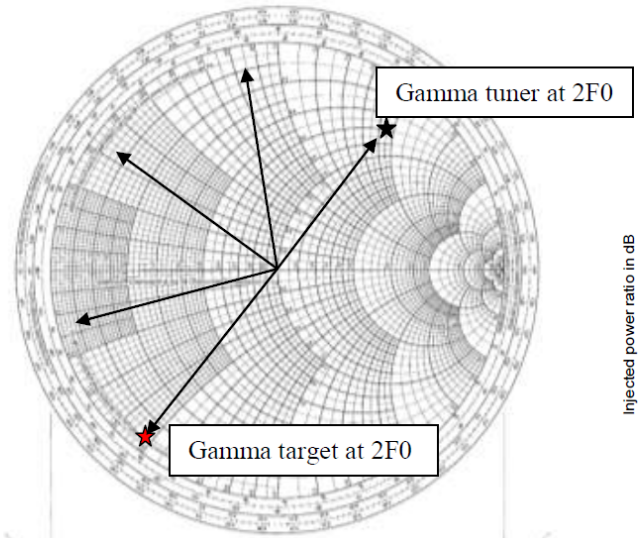
In this setup the load reflection factor Γ-load is created at Fo using the wideband tuner (1) and at 2Fo and 3Fo using additional signal injection from the sources 2Fo and 3Fo, combined with the module (2).

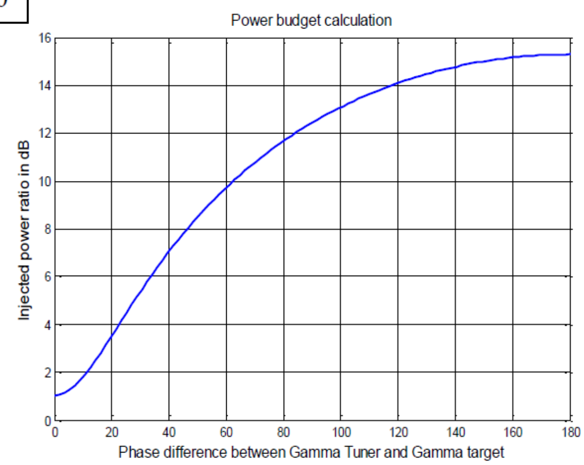
The flaws are as follows:
1.The coupler (3) introduces insertion loss, which reduces Γ T-load (Fo)
2.The tuner (1) being wideband, it will create high reflection not only at Fo but also at 2Fo and 3Fo as well as insertion loss at 2Fo and 3Fo (see figure 2).

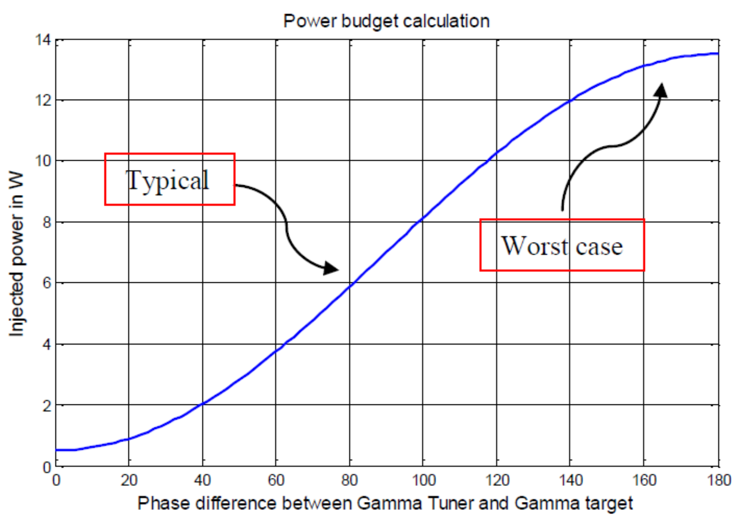


The reflection factors at 2Fo and 3Fo are not controll able by the wideband tuner (1).
As can be seen it is quite possiblethat the optimum and actually tuned impedances at 2Fo and 3Fo are anti-diametric from the optimum values. In this case the signal power needed to tune to the optimum position will be very large. This will require high power amplifiers at 2Fo and 3Fo.
This is a worst case, but readily possible,scenario. The best alternative is to replace tuner (1) with a multi-harmonic tuner MPT and inject low power also at Fo. Focus' HAILP uses an MPT, and can be upgraded to use also 2Fo and 3Fo sources.
The example below shows actual power requirements for 2Fo, in the case of a 20W FET with

P(2Fo)=0.4 W (-17 dBc) necessary in the case of the setup in figure 1:







In a typical case the harmonic power requirement will be 10dB above the FET harmonic power (at 2Fo or 3Fo) and in a worst case scenario it will be 15dB above.

In the case of the 20W (Fo)/0.4W(2Fo) FET this varies between 6 and 13 Watts.