Dual-band Feedhorn for AMSAT Phase 4

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[Preliminary – not for publication or general distribution]

The requirement, as I understand it, is for a dual-band feedhorn to be used with a common DSS offset dish, operating at 5.8 GHz uplink and 10.4 GHz downlink, full-duplex. High isolation is needed between the two ports at 5.8 GHz to keep the uplink power out of the downlink LNA.

The initial starting point was to scale up the dual-band 10 and 24 GHz feedhorn originally designed by AD6FP and AA6IW. This feed operates as a dual-mode feed at 24 GHz and as a single-mode feed at 10 GHz with a corrugated choke horn on the output to shape the beam. A few simulations on the scaled version showed that the 5.8 GHz excitation probe seriously disturbed the fields at 10.4 GHz making dual-mode operation impossible.

However, if the probes are placed orthogonally, so that the two frequencies have orthogonal polarizations, there is minimal interaction, and dual-band operation is possible. An additional advantage is significant isolation between the orthogonal polarizations. Since there is minimal interaction, it is now possible to adjust each probe for best Return Loss independently – on the original 10 and 24 GHz feed, return loss was a compromise.

The final step is to realize an output horn which provides beam shaping for high dish efficiency at both frequencies. The initial trial was to scale up the corrugated horn from an RCA DSS LNB. After adjusting the corrugation depths to work at both frequencies, this horn showed good simulated efficiency at both frequencies, but the phase centers were significantly different, so that high efficiency was not achievable at both frequencies simultaneously.

Finally, the flare angle of the corrugated horn was adjusted to move the phase centers. The best compromise is a 50° flare angle, which yields a calculated efficiency of about 75% at both frequencies at a common phase center. This holds the promise for actual dish efficiency above 60% with careful implementation.

Isolation at 5.8 GHz is provided by two factors: the orthogonal polarizations, and waveguide-beyond-cutoff in the 10.4 GHz circular waveguide section. The calculated isolation is about 80 dB, as shown in the graph below. Of course, any second harmonic output from the 5.8 GHz will see much less isolation, so a good output filter on the amplifier is essential. But this is a much easier problem than the feedhorn.

Return Loss at both frequencies is good over a reasonable bandwidth, also shown in the graphs below.