# Analysis of the W∅LMD Dual-band Patch Feed for L&S band

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Circular polarization has traditional been popular for satellite communications — since both the earth and the satellite are moving, maintaining polarization alignment is difficult with linear polarization. Where low-gain antennas are adequate, helix antennas[1,2] are ideal — simple and easy to build. For higher gain, the usual choice is a parabolic dish, which requires a feed providing good circular polarization.

One obvious choice for a circularly-polarized feed would be a short helix. However, my previous investigation into helical feeds[3] suggested that they are better suited for offset-fed dishess than for conventional prime-focus dishes. Most of the readily available dishes large enough to provide high gain at L and S bands are the "Big Ugly Dishes" recently used for C-band TVRO — deep dishes with a relatively low f/D ratio, requiring a feed with a broad illumination angle.

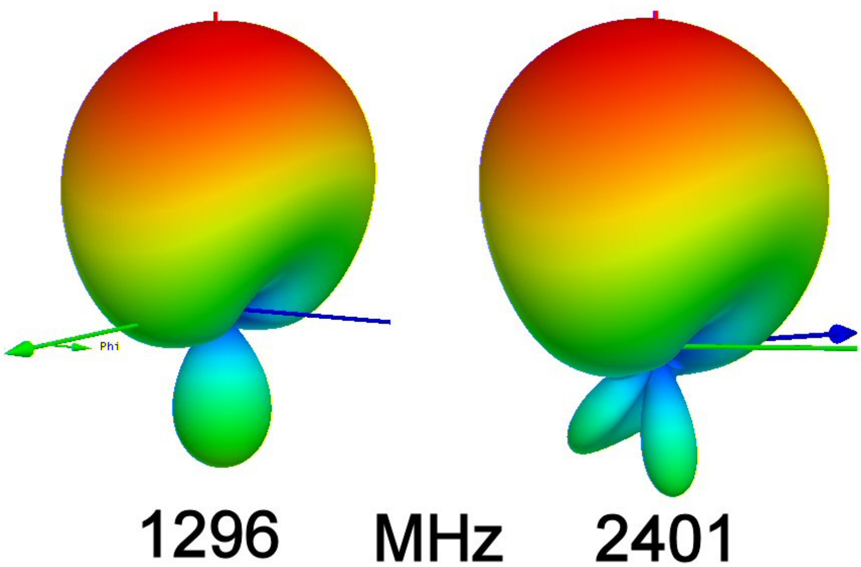
Many of the popular dish feeds are readily adapted to provide circular polarization, by adding an additional excitation probe, but only operate on one band. Since satellite operation often requires simultaneous uplink and downlink on separate bands, a multi-band feed is required. One type that seems popular is the patch feed. I have been asked occasionally how well these work; finally, KJ6HZ sent me drawings by K5MAN of a dualband patch feed by W∅LMD[4] so that I could make a computer model.

Patch antennas are popular in many consumer applications — these patches are printed on a dielectric over a ground plane, so they are cheap to mass-produce. However, the patch antenna is narrowband, and the dielectric makes it lossy and difficult to tune, so printed patch antennas are not particularly good for ham applications.

However, the W∅LMD patch feed uses air for the dielectric, eliminating dielectric loss and making the dimensions larger. It also allows easy tuning with a screw. The round patch is positioned over a slightly larger disc acting as a ground plane by a metal spacer in the middle of the discs, where the electric field should be at a minimum. Early multi-band versions apparently had the bands side-by-side, so the dish would peak in slightly different directions on different bands. The current version, shown in the photograph, stacks the two bands axially to eliminate the offset.

I used Ansoft **HFSS** software[5] to calculate radiation patterns for the patch feed; 3D patterns with linear polarization are shown in Figure 1. Then I ran my **PHASEPAT** software[6] to estimate performance as a dish feed. Figure 2 shows the performance at 1296 MHz, and Figure 3 at 2401 MHz. Calculated dish efficiency is very good on both bands for dishes with an f/D around 0.35 to 0.45, which should be right for most BUDs. Even better, the Phase Center is very similar for the two bands, about 16 mm above the largest disc on 1296 and about 19 mm on 2401 MHz, so one position is good for both bands.

Figure 1




The final check was for circular polarization, shown in Figure 4 at 1296 MHz. I arbitrarily chose LHCP, but the sense may be reversed by phasing the excitation probes. Performance is essentially identical to linear polarization, with a good polarization ratio of about 22 dB. The small XPOL (cross-polarization) loss shown in the graph is because the backlobes seen in the linear polarization patterns are cross-polarized; since they don't illuminate the reflector, the energy is lost regardless, but the loss is calculated separately.

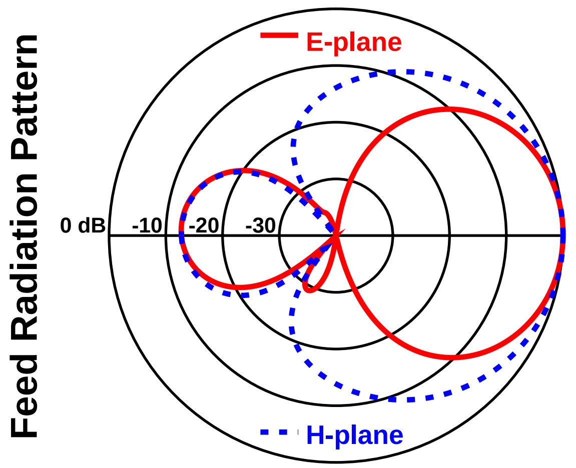
In summary, the W∅LMD dualband patch appears to be a very good feed. While it is now used predominantly for satellite work, it might also be worthy of consideration for those using a BUD for EME. However, isolation between transmit and receive ports is not very high, so a protective relay will be required.

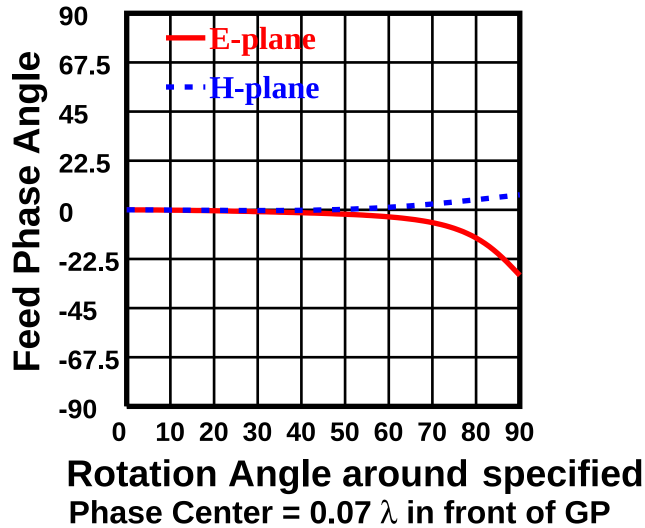
**References:**


1. Kraus, J.D., *Antennas*, McGraw-Hill, 1950.
2. Kraus, J.D. & Marhefka, R.J., *Antennas: for All Applications, third edition*, McGraw-Hill, 2002.
3. Wade, P., W1GHZ, “Helical Feed Antennas,” *Proceedings of Microwave Update 2002 and the 28th Eastern VHF/UHF Conference*, ARRL, 2002, pp. 248- 270.
4. www.ultimatecharger.com/Dish_Feed_SL.html
5. www.ansoft.com
6. www.w1ghz.org

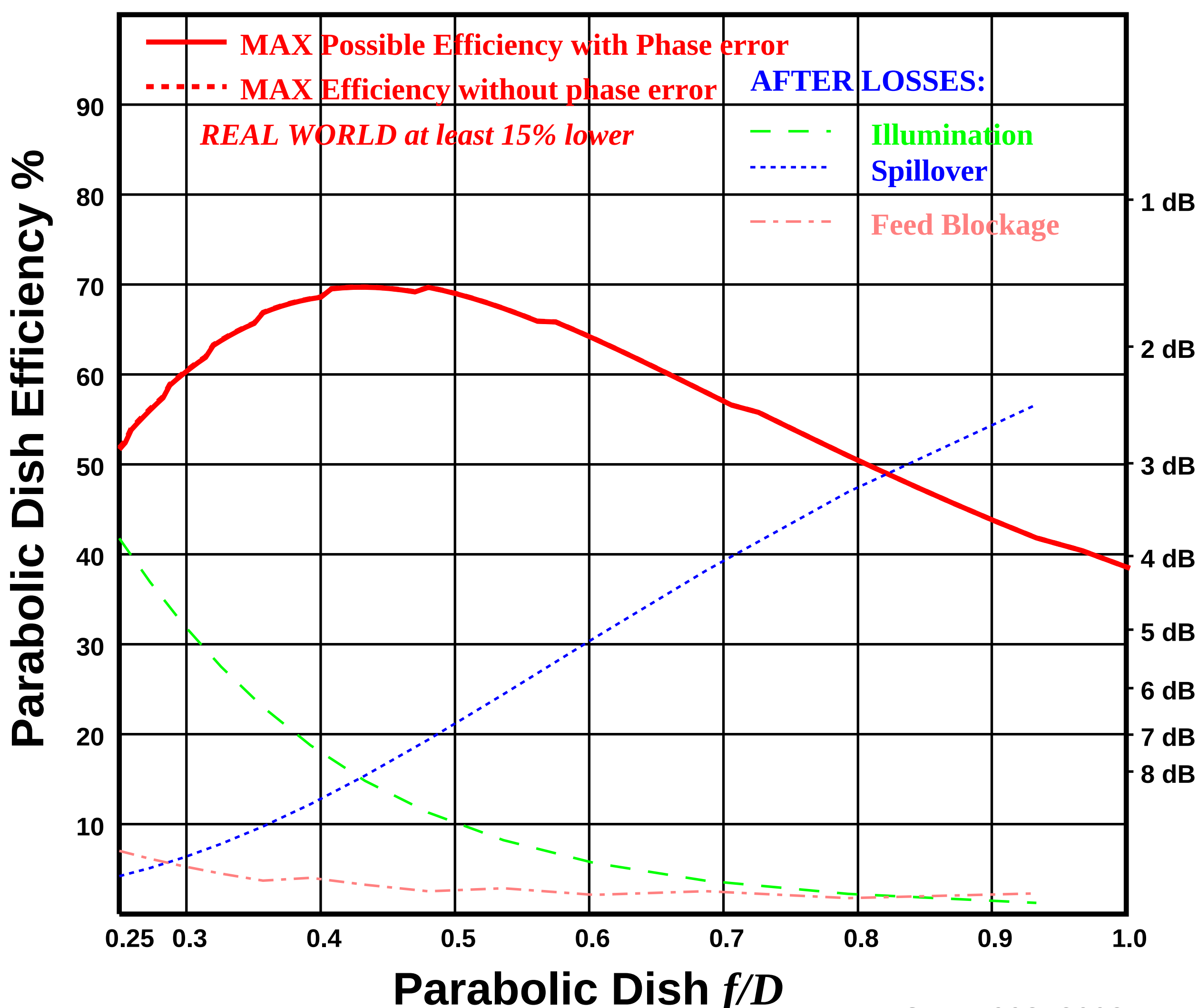
# W0LMD L&S dualband patch feed, linear pol. at 1296MHz

## Figure 2



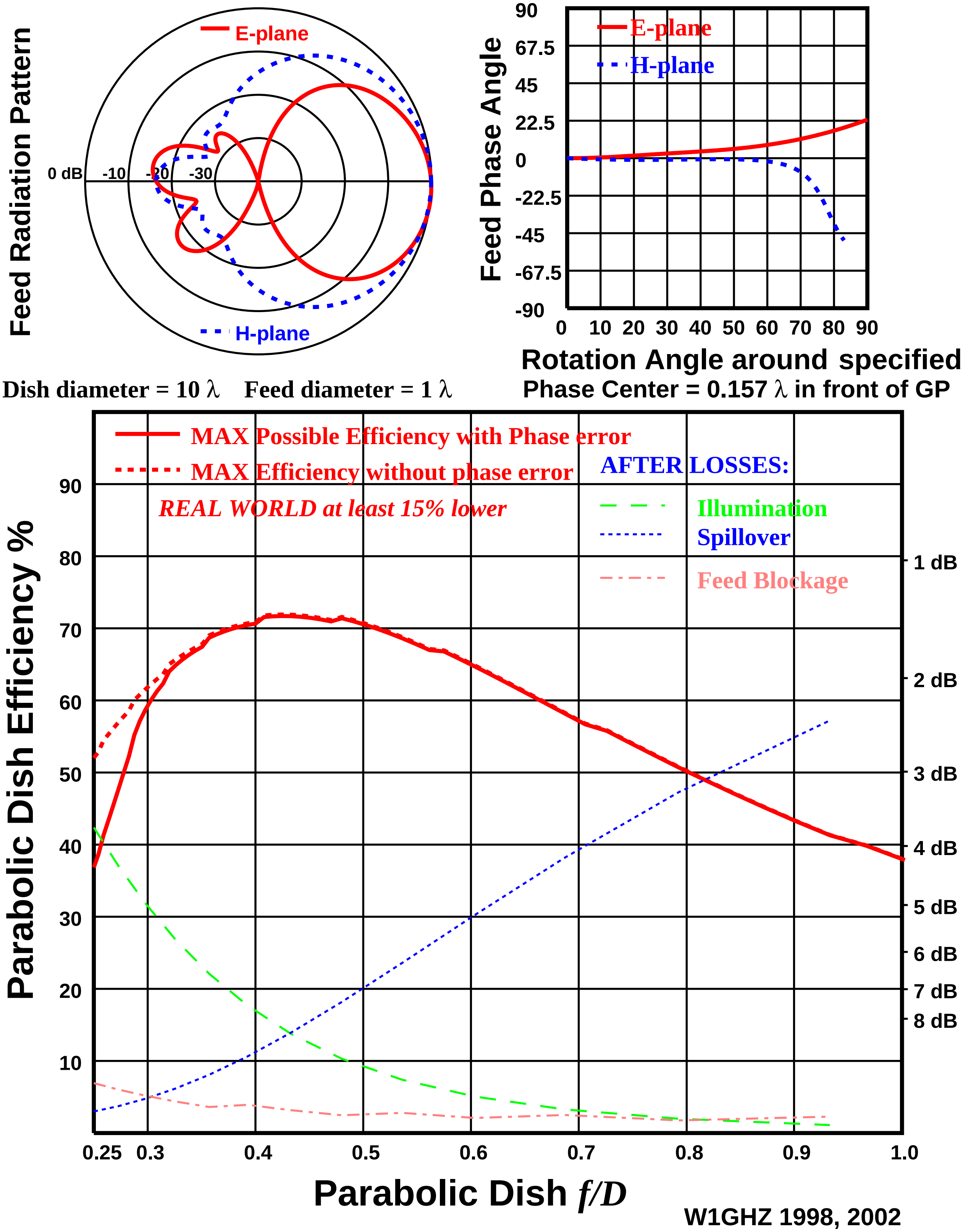

Dish diameter = 10 λ    Feed diameter = 1 λ




W1GHZ 1998, 2002

# W0LMD L&S dualband patch feed, linear pol. at 2401 MHz

## Figure 3



# W0LMD patch feed, LHCP at 1296 MHz

## Figure 4