# *Dual Band Feedhorns for 2304/3456 MHz and 5760/10368 MHz*

by

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**Background**

Numerous articles have been written by WA9HUV, VE4MA, N1BWT and others on the proper illumination of a parabolic reflector. Joel Harrison has documented most of these works in his article elsewhere in this proceedings. The proper illumination of a parabolic reflector with a given f/d (focal length to diameter ratio) requires the careful balance of both the E and H Plane beamwidths of the feedhorn. The problem on the microwave frequencies is one of putting several feedhorns for individual frequencies at the same focal point - a nearly impossible task. Attempting to put multiple feeds at the focal point of the dish generally compromises performance on all bands. The satellite industry has had reasonable success by putting a 12 GHz feed in the middle of a 4 GHz feed. This is most likely due to the significantly smaller diameter of the 12 GHz feed versus the 4 GHz feed. With the relatively closer spacing of the 2304, 3456, 5760, 10368 MHz bands this technique becomes difficult. Multiple feeds that are slightly offset are one way of obtaining multiband operation but there are some disadvantages such as pointing offsets for each band. In order to get around the offset pointing problem I began work on in-line feeds which will be the subject of this article. Any multiband feed will have compromises but I believe the techniques described here-in will still result in a high performance antenna system.

**Early Experiments on 2304 and 3456 MHz**

I first experimented with inline multiband feeds back in 1989 when I wanted a 2304 and 3456 feed that could be placed at the focal point of the dish and not require an offset in pointing between bands. I got the idea for the inline feed after analyzing the single band dual mode W2IMU feed which has been used successfully on 1296, 2304, and 10368 MHz, primarily for EME. The W2IMU feed has two different diameter circular waveguide sections which are designed to equalize the resultant E and H plane beamwidths. The equal E and H plane beamwidths with the appropriate taper contribute to a well illuminated high gain antenna. My though was, what about feeding the larger outer section on the next lower amateur band? I decided to apply this concept to a dual band feedhorn for 2304 and 3456 MHz. I used a standard 4 inch coffee can for 2304 MHz followed by a standard soup can for 3456 MHz. The results were very encouraging. This feed has been duplicated by several people over the years including K2DH, AA5C, and W5ZN with good results. The construction of this feed and performance on a 32 inch dish is covered in detail in Joel Harrison's article.

**Adding 5760 MHz to make a 3 band feed**

I wanted to add 5760 to the original 2304/3456 MHz feed so I decided what would be easier than to just add a 1.5 inch diameter copper pipe to the end of the 3456 MHz can. The results were mixed. Yes, the horn worked but as I found out , the gain was considerably lower than theoretical. This was probably due to the fact that with the large aperture of the multiband feed at 5760 MHz, the feed was under illuminating the dish.

**Separate Dual Band Feed**

I decided that the optimum combination would be to just duplicate the 2304/3456 Feed for 5760 and 10368 MHz. The result actually looks very similar to a W2IMU feed for 10368 MHz. The resultant feedhorn, shown in Figure 1, worked very well on 5760 MHz and was only slightly lower than expected on 10368 MHz. The feed was tried on several dishes with varying f/d ratios and diameters. The resultant antennas were tested during a recent North Texas Microwave Society antenna workshop hosted by Kent Britain WA5VJB. The results are documented in Table I.

**Test Results**

Starting at 5760 MHz, the dual band feed worked very well producing gains within a dB or two of theoretical 55% numbers when installed on 48 and 55 inch solid dishes and 55 and 72 inch perforated dishes. The new dual band 5760/10368 MHz feed actually had 6 dB greater gain on 5760 MHz than did the original 3 band feed as measured on the same 55 inch dish.

On 10368 MHz , the numbers were down a little but the 72 inch perforated dish ,which was the only dish rated for 12 GHz, was still measuring 40.7 dBi. I did not optimize the actual position of the feed. The feeds were placed with the focal point slightly in the mouth of the feed.

The dual 2340/3456 MHz feeds were tested in the same dishes but were slightly offset as only the dual 5760/10368 MHz feed was at the focal point. As the results show, the gain numbers were somewhat lower than expected but the antenna range was only about 125 ft long and it could be that the larger dishes were under illuminated for the tests.

**Construction**

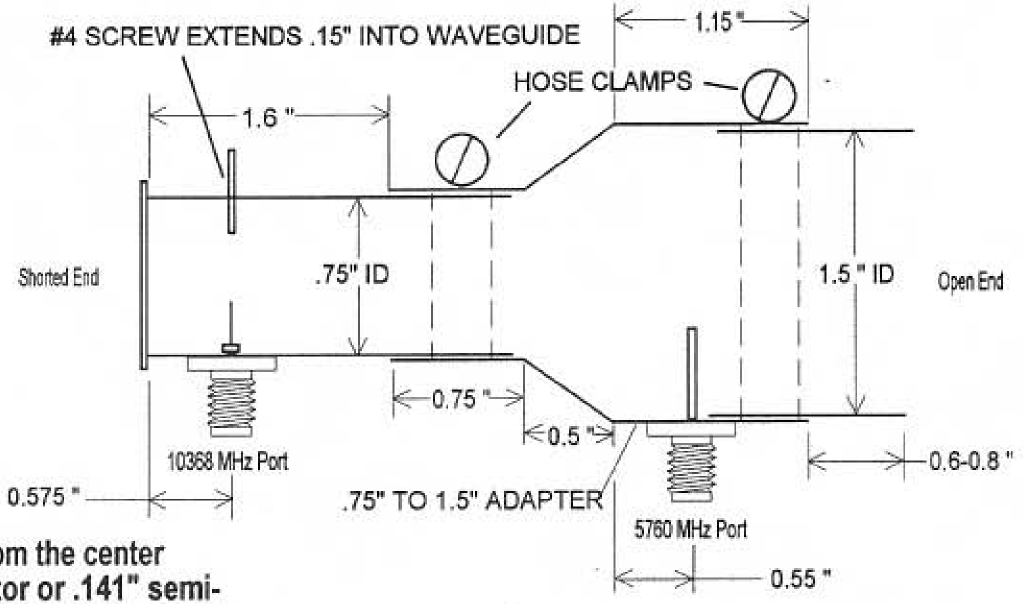
The length of both circular waveguide sections was made variable in order to improve the tunability of the feedhorn. The monopoles can be preset as shown in Figure 1 and final tuning if needed can be accomplished by tuning the length of the waveguides. The resultant isolation between bands is very good and allows each band to be individually tuned. See Figures 2 and 3. The very good isolation also minimizes the additional isolation required in order keep from destroying the front-end of the receiver for the other band. I believe part of the increased success of the 5760/10368 MHz feedhorn in regards to low frequency to high frequency isolation may, in part, be due to the smoother transition from the small section to the large section. Secondly it could be due to the 5760 MHz port having a poorer return loss at 10368 MHz. Be aware that there are several different types of .75" to 1.5" transitions available and all may tune slightly different.

**Conclusion**

I am very encouraged by the initial results of the multiband feeds. I now have one dish for 2304, 3456, 5760, and 10368 MHz. The 5760 and 10368 MHz feed is at the focal point with the 2304/3456 MHz feed slightly offset. End result is that if 5760 MHz is peaked on a particular station then 10368 MHz is also peaked. Same is true of 2304 and 3456 MHz. Good luck. Feedback is greatly appreciated.

Al Ward
WB5LUA
June 20, 1997

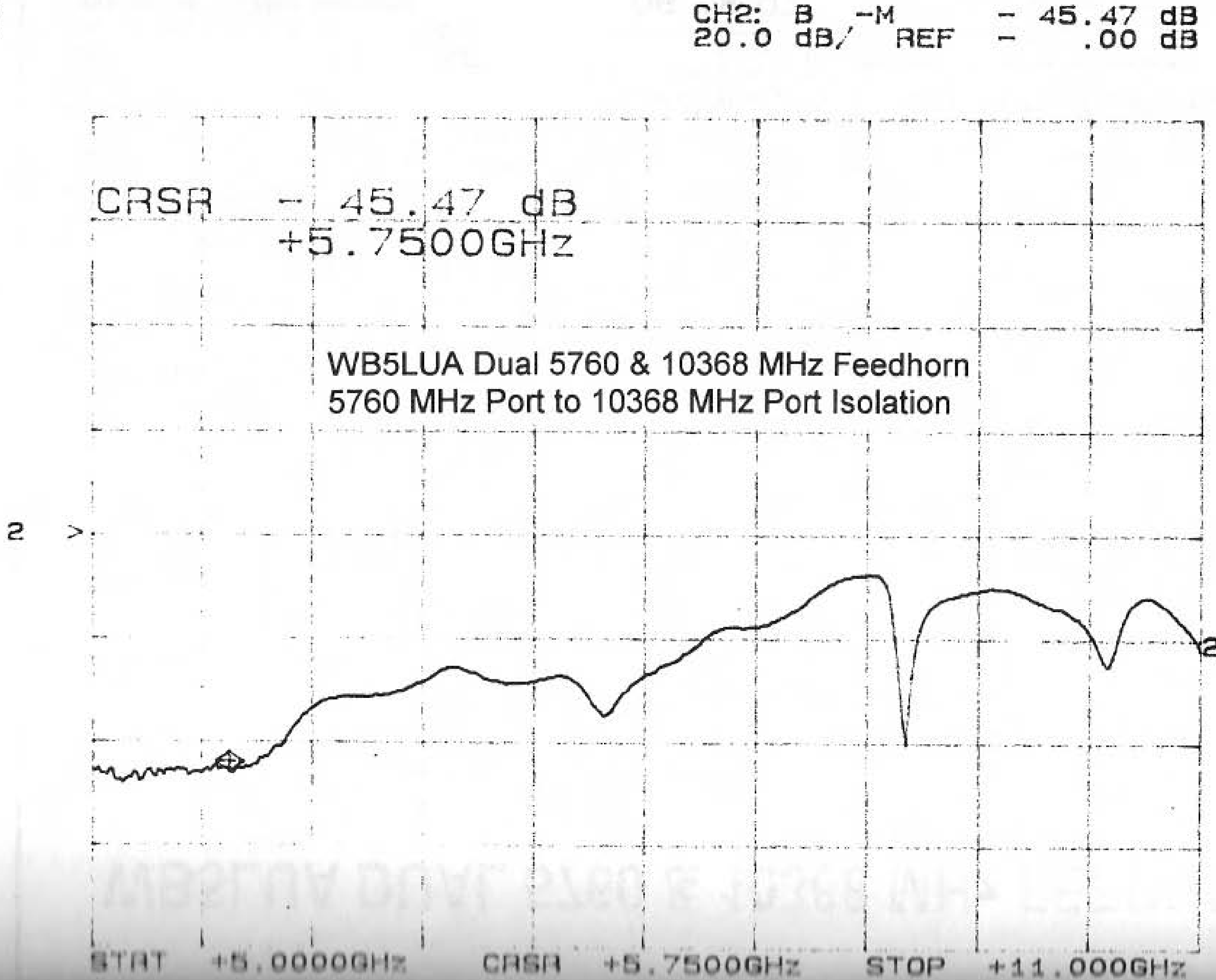
# WB5LUA DUAL 5760 & 10368 MHz FEEDHORN




NOTES

1. 10368 MHz probe is made from the center conductor of an SMA connector or .141" semi-rigid cable. .070" of the teflon dielectric extends into waveguide. Length of pin above dielectric is 0.3". Tuning screw is diametrically opposite probe and is adjustable
2. 5760 MHz probe is .6 to .7" in length and can be made from tubing .07 to .1" in diameter
3. Tuning of both frequencies can be accomplished by tuning either probe length or waveguide length.
4. Isolation
10368 MHz signal @ 5760 MHz port = -19 dB
5760 MHz signal @ 10368 MHz port = -45 dB
5. Return loss > 23 dB at both ports

| | |
|---|---|
| DRAWING NOT TO SCALE | DUAL 5760 & 10368 MHz FEEDHORN |
| 06-18-97 | Engineering Sketch by Al Ward WB5LUA |

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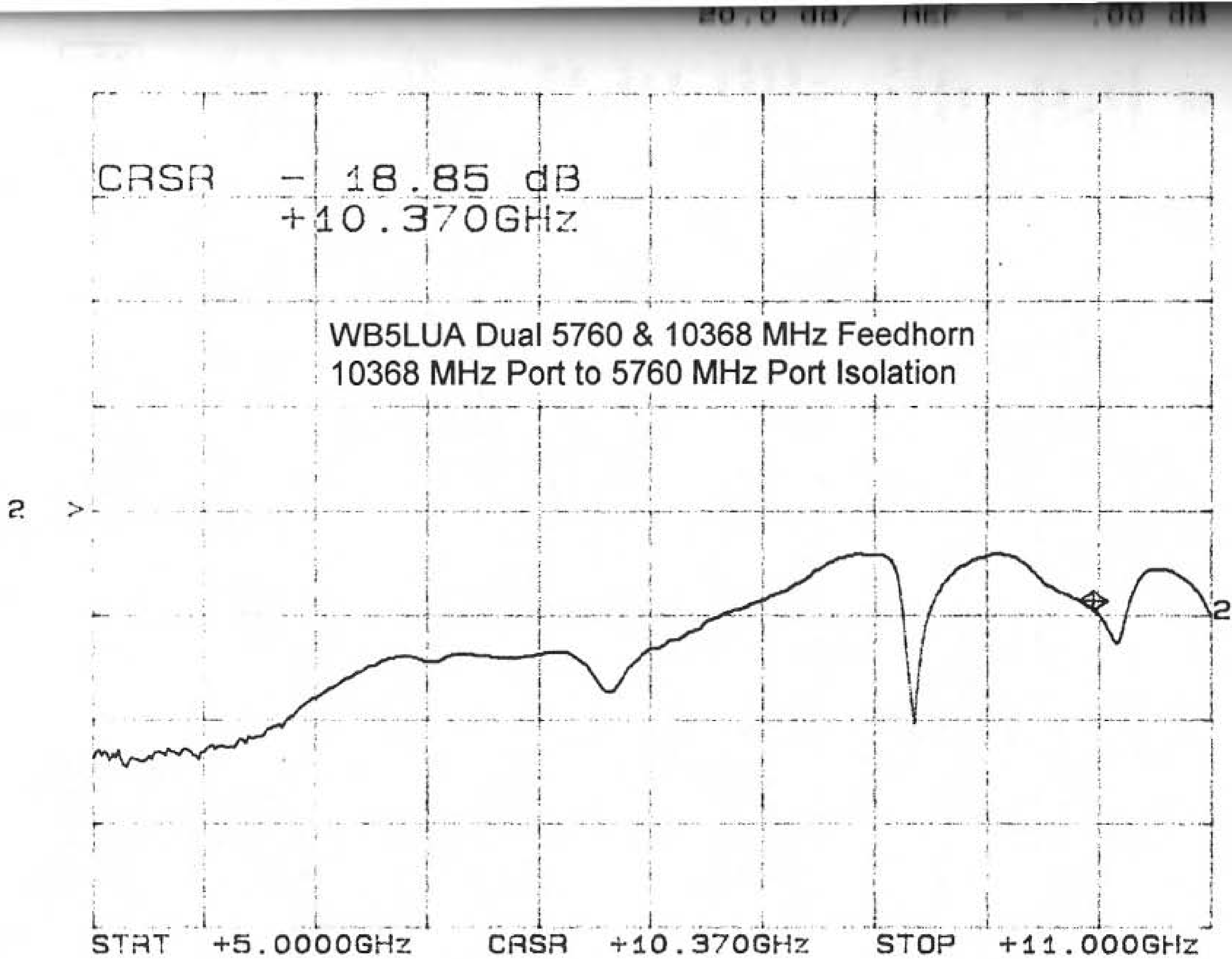


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**Figure 3**

DIRECTIVE SYSTEMS

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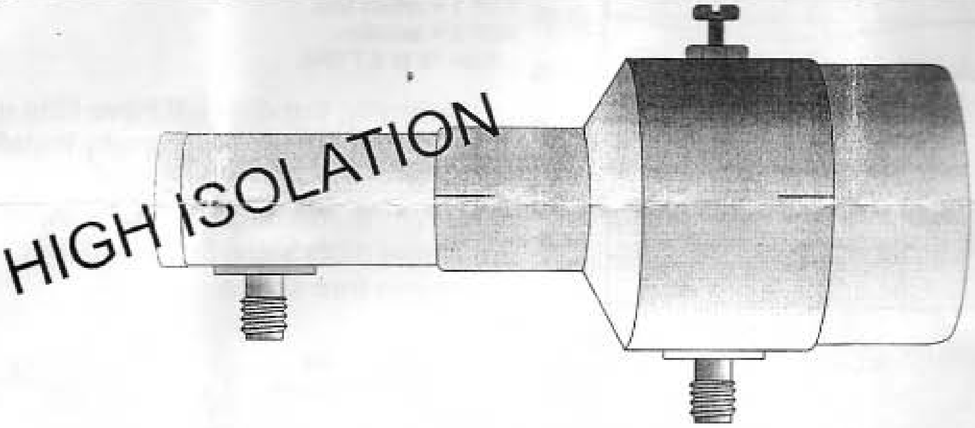
# DUAL BAND W5LUA TYPE DISH FEED, **DBFEED**

| | | | |
|---|---|---|---|
| Frequency range: | 5760 & 10.368 GHz | Return Loss: | |
| Polarization: | Linear V or H | 5.7 GHz | -16 dB minimum |
| Connector: | SMA (f) both ports | 10.368 GHz | -16 dB minimum |
| Weight: | 1 pound | Maximum Power: | 50 W CCS average |
| F/D (optimum) | .39-.45 | Isolation: | |
| | | 5.7 to 10 GHz | -70 dB |
| | | 10 to 5.7 GHz | -30 dB minimum |




This feed design is based on the work of Al Ward, W5LUA ,and represents an efficient way to use one dish on two different ham bands. Unlike earlier multi band feed designs, W5LUA's design is capable of good performance on both microwave bands in use. In addition, the higher isolation simplifies installation requirements by eliminating the need, in many cases, for a protective relay on the 5.7 Ghz port.

## INSTALLATION INSTRUCTIONS

1) Unpack antenna feed assembly and observe the location of the connectors and probe orientation. For horizontal polarization, the probes must be oriented parallel with the horizon. ( The connectors will stick out laterally on the antenna.)

2) Install the feed on your parabolic dish using the proper dimension of the focal point (supplied with the dish) to the feed. Measure this distance from about 1/8 inch inside the open mouth of the feed to the center surface of the dish.

3) The dish feed SWR has been adjusted at the factory for maximum isolation between 10 Ghz and 5.7 Ghz. Do not try to adjust the sliding joints or the 5.7 Ghz tuning slug without proper measuring equipment. All feeds are adjusted before shipment and are set for optimum isolation. If you wish to adjust your feed for best VSWR, be aware that all adjustments impact both bands to greater or lesser extents. The 1.5" open end length will tune 10 Ghz faster than 5.7 Ghz. The 3/4" tube position affects 10 Ghz primarily. The screw is for 5.7 Ghz, but can affect 10 Ghz at certain positions. Use caution when tuning!

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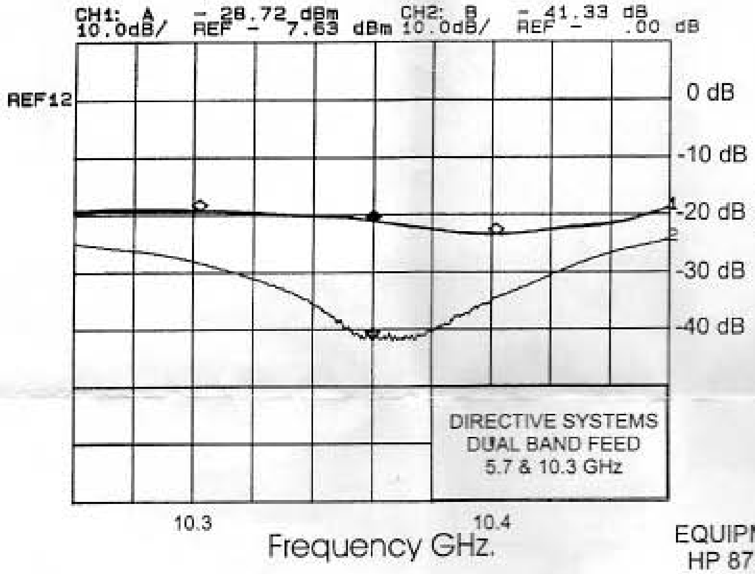
DUAL BAND W5LUA FEED FOR 5.76 & 10.368 GHz Amateur bands. Each plot displays the VSWR (return loss) and isolation between ports for the respective band. The feeds are optimized for 10 to 5.7 Ghz isolation when shipped from the factory . The VSWR on both bands can be improved at the expense of isolation. It's all a trade-off!



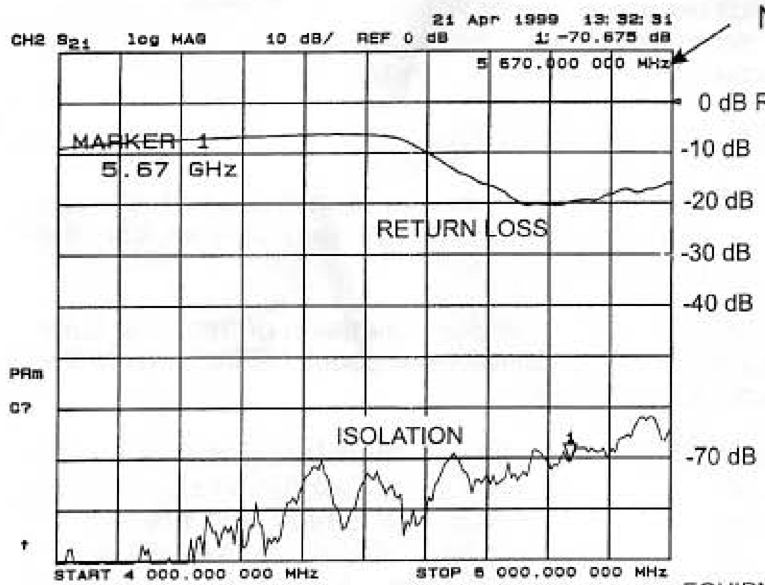

10 Ghz isolation is quite critical and can be affected by what the feed "sees". It is always a good idea to check port to port isolation whenever you adjust the feed location on your parabolic reflector.

REF 1 = return loss
REF 2 = isolation
from 10 to 5.7 Ghz.

Normally, the dish will have little effect on port isolation when properly installed, but un wanted reflections back into the feed can degrade the > 30 dB isolation value. These plots were made with the feed only in free space.

EQUIPMENT:
HP 8756A Scalar Analyzer
HP 8620C / 86290B Sweeper
Plotter

Note! Marker should be 5760 Mhz!




5760 Mhz isolation is very high and is not influenced by much, since the 10 Ghz waveguide portion of the dual band feed cannot support 5.7 Ghz propagation.

The 5760 Mhz VSWR is about -16 to20 dB when the 10 Ghz isolation is optimized. If you optimize the feed for best return loss, R.L values of close to -30 dB are possible.

EQUIPMENT:
HP 8753D Analyzer
Plotter