A NEW TECHNIQUE FOR CONSTRUCTION OF 23CM SEPTUM FEED June 18, 2010

(Revised November 15, 2017)

INTRODUCTION

1296 MHz EME popularity is growing – this band seems to be the big attraction these days. Just acquire an old TVRO dish and you are on your way. This article will hopefully at least make the feed part of the project a bit easier. My apologies up front for mixing English and Metric units. Most of the measurements are Metric due to the dimensions originating from OK1DFC. But many of the parts and pieces are measured in the English system, so it just seemed simpler to keep them in that system.

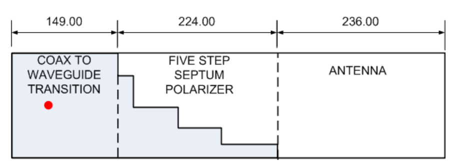
My number one rule: Take the path of least resistance; Get on the moon as quickly and easily as possible (within reason…..don't compromise safety for sure) and make refinements later. You will hear many say that the rectangular waveguide septum feed is "not the best" based on many hours of research and experimentation (I tend to disagree). But life is a compromise. Good, cheap, quick …..pick two. I believe that the OK1DFC Rectangular Feed with Septum Polarizer is the path of least resistance to implementing a very effective feed on 23cm. I believe that I have found a way to make it even easier, and my experience follows below.

COMPARISON:

1. Easier to construct than sheet metal square septum feed or VE4MA feed
2. Easy to tune by adjusting both probes for best VSWR
3. Good circularity with no adjustments (versus labor intensive polarizer screws)
4. When scalar ring is added, and the feed is compared with a VE4MA feed on a 22 ft. dish, only 0.3dB less sun noise (W5LUA & K5GW, August 2005).
5. I compared a VE4MA feed (expertly made by VE1ALQ) with my feed and get essentially no difference.
6. Material cost for the aluminum septum feed is less than $100.

A QUICK REFRESHER

A complete typical 23cm feed horn has several 'parts':



1. Excitation – Coax to waveguide transition
2. Circular polarizer – septum, screws, or other methods
3. Horn antenna of some sort

RESEARCH

1. Slightly larger than optimum size (Available 6" tubing is 5.75" inside versus 5.70" from the spreadsheet for 1296 MHz) – expected affect on performance (waveguide size less than 0.7 percent smaller, so negligible impact is expected).

2. Adjust size of septum to optimize circularity – Inside waveguide measurement = 5.75 inches, so the rest of the septum dimensions are based on this dimension which equates to 1286 MHz. So using the OK1DFC spreadsheet just enter a frequency of 1286 MHz and the spreadsheet gives you the same numbers as I have in Figure 1, below.
3. Thickness of septum - This has been shown to be a non- critical dimension, so it was increased to 0.25" for ease of drilling and tapping.
4. Be aware, if you decide to do it yourself, you have ahead of you: measuring, marking and drilling 52 holes, and tapping 34 holes. The risk of breaking a tap after cutting a septum and end plate and drilling and tapping a bunch of holes is somewhat formidable.
5. My latest method for making tuning disks is to use the ¼-20 brass flat head screw with a 3/8" brass washer. I turn the flat head screw in the lathe to fit the washer and then turn the washer outer edge down to 20mm.

PARTS

I purchased the aluminum for this project from ONLINE METALS. I have not found the 6 inch square tubing with 1/8" wall anywhere else. You can get to ONLINE METALS on my website at http://ptt-ak.com ; just scroll down and their link is on the left side.

See Appendix 1, "Bill of Materials" for a list of what is required for this project. I did not include parts for my mounting method. Dimensions for the septum are in Figure 1, below. Dimensions for the rear wall, probes and disks are in Figure 2, below. All parts are pictured in Figures 3 and 4 below.

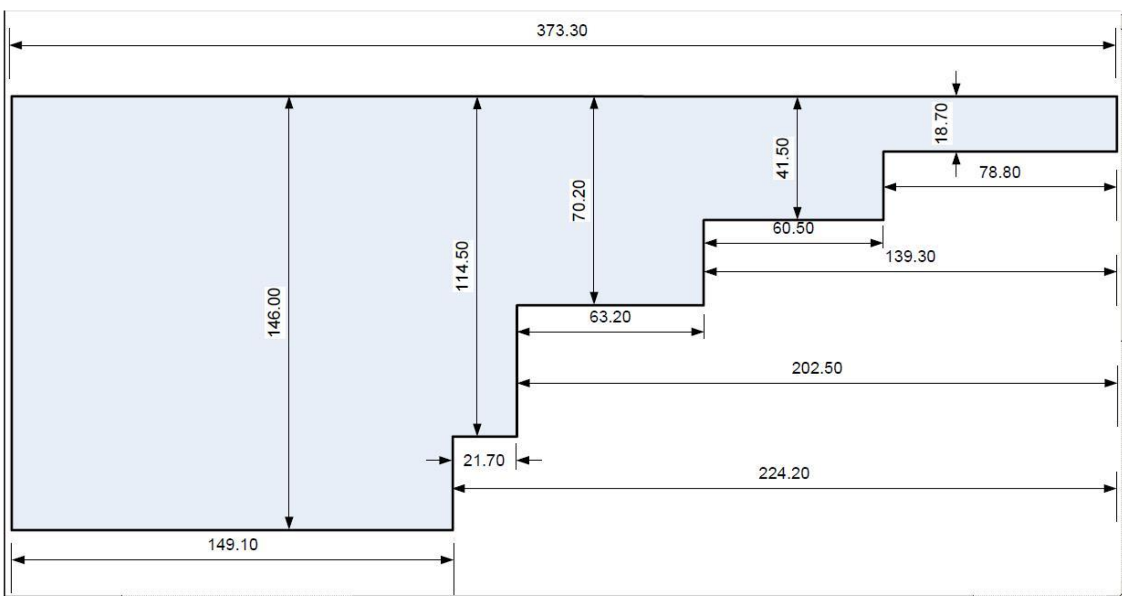


FIGURE 1. SEPTUM DIMENSIONS

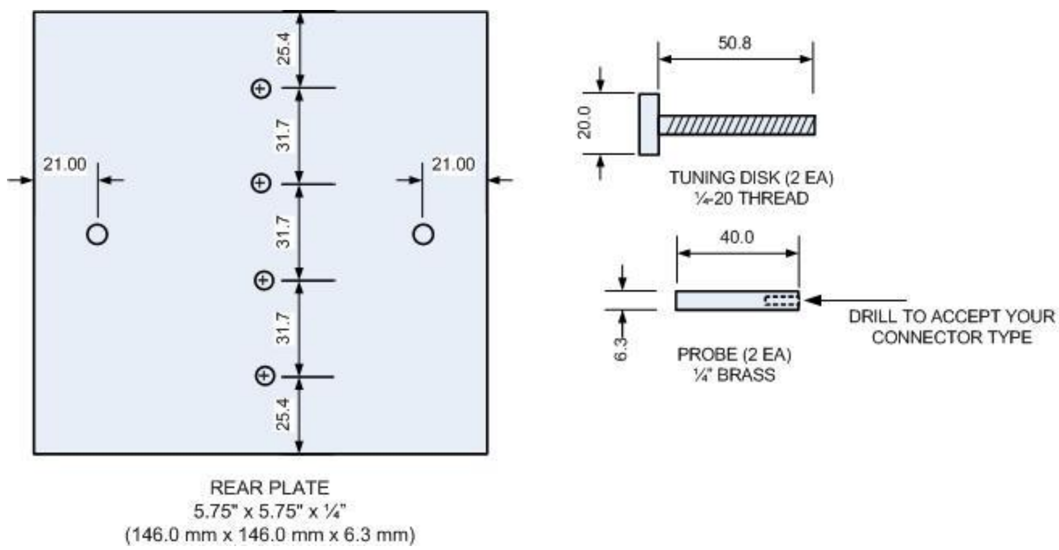


FIGURE 2. REAR PLATE, PROBES, TUNING DISK DIMENSIONS

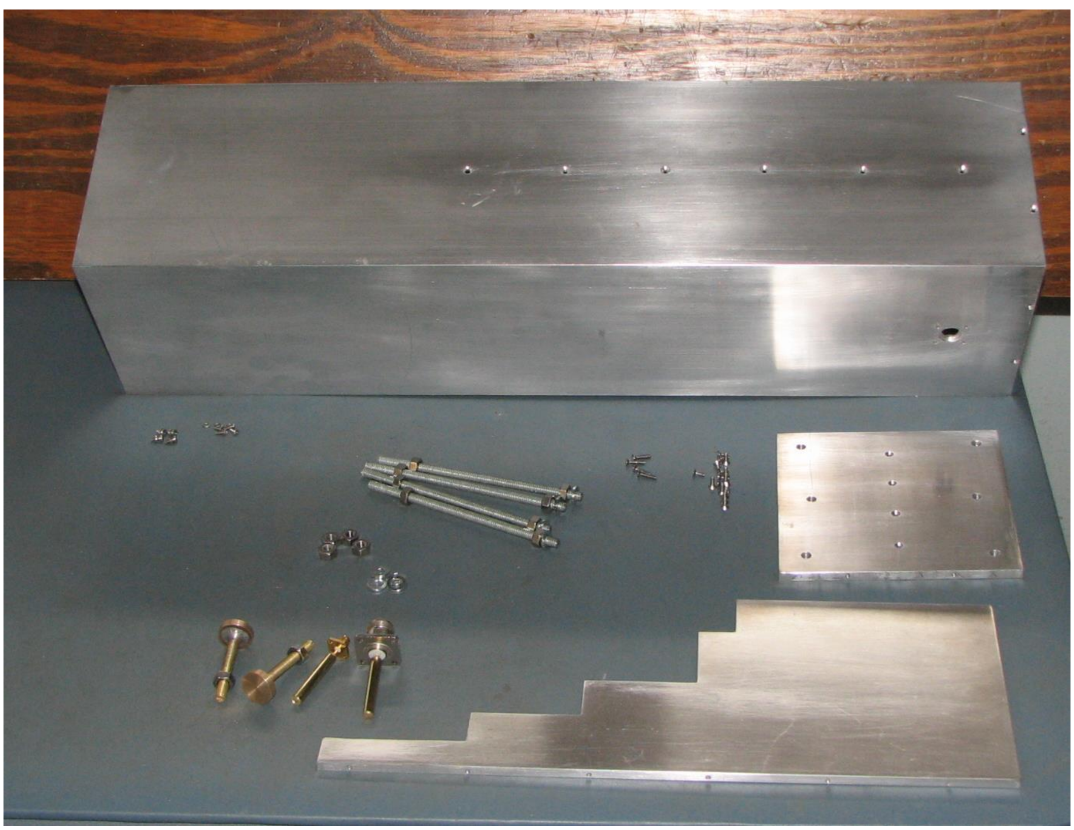


FIGURE 3. PARTS

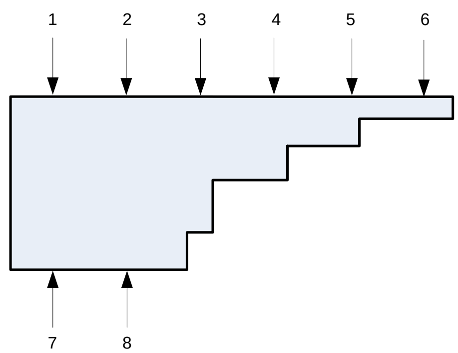
FIGURE 4. TUNING DISKS AND PROBES

TOOLS AND CONSTRUCTION MATERIALS

1. Band saw (sabre saw works, but use plenty of cutting oil)
2. Solvent (For cleaning taps)
3. Tap Lube (I use Ultra Lube – St. Paul Drill Factory)
4. Small wire brush
5. TAPS 2-56, 4-40, 1/4-20
6. BITS #50, #43, #33, #8
7. 7/16" wrench (for lock nuts on tuning disks)
8. Drill Press, and a hand drill for any drilling that cannot be done in the press
9. Awl or scribe
10. Small Hammer
11. Counter sink bit
12. Very good ruler
13. Caliper (Digital preferred)
14. Propane torch (For soldering the disks and probes)
15. Solder
16. Steel Wool
17. Compressed Air
18. Vice
19. Grinding wheel

PROCEDURES: (This is how I did it; you may have a better way!)

1. Square up the ¼” x 5.75” x 5.75” end plate with file and steel wool (saw if necessary, but OnLine Metals cuts to a pretty good tolerance).
2. Cut and file septum according to OK1DFC spreadsheet with F= 1286 MHz (See Figure 1). The straighter and smoother you get the top and bottom edges, the easier it will slide into the tube. To cut the septum it is best if you use power tools. A hand saw would be very tedious for this. A band saw is best, to get the most accurate cut to minimize filing. After very careful measuring and marking, I cut away a large piece of unnecessary material first.
3. Measure everything as accurately as possible throughout this project, and it will pay off.
4. To get the septum in the right spot, I did the following:
   a. I measured and marked 1.5” in from the end (point 1 and 7) of both the top and bottom of the large end of the septum.



   b. I set the caliper for 0.125” and scribed a line with the caliper edge right in the center at those points, and center punched them.
   c. I continued to measure and center punch in 2.5” increments for the next 5 points along the long side of the septum, for a total of 6 points.
   d. I carefully measured and marked the center lines (+/- 3”from the edges) of the square tube then measured and marked 1.75” in from the end of both the top and bottom of the square tube. I center punched these points and drilled holes with #43 bit.
   e. I measured and center punched five more points at 2.5” increments along the centerline which ends up with 6 fairly well placed fasten points.
   f. I laid the septum on top of the tube to make sure the center punched points lined up.
   g. I then drilled the remaining 5 holes in the square tube.
   h. I inserted the septum into the tube now, to see if the center punch marks are visible through the holes, especially #1 and #6, #7 and #8.
   i. If everything lines up, I drill and tap 4-40 holes in the septum at points 1, 6, 7 and 8.
   j. I then drill the tube with #33 bit at points 1 and 6, slide the septum inside, and put screws in 1 and 7. At this time you can pivot on 1 and 7 to see how the other points line up. If all is OK, then insert screws in 6 and 8.

k. Once again checking to see center punch points at points 2 through 5. If they line up OK, I use the #43 holes as guides and drill some "starter holes" through the tube into the septum.
l. Remove the screws and the septum, and finish drilling all the holes in the drill press, and tap all holes with 4-40 tap.
m. Once all the septum holes are tapped I go back and drill out the remaining holes in the tube with #33 bit, and then use the countersink bit on all septum mounting holes in the tube.
n. I followed a similar procedure to fasten the end plate to the tube.
o. I used the caliper at 0.125" and scribed a line parallel to the edge of the tube and 1-3/4" from the sides for two holes on each of the four sides for the rear plate, and center punched, etc.
p. Drill and tap holes in the rear plate for the tuning screws, and possibly for whatever method you will use to mount your feed.
q. Drill and tap the connector holes.
r. I used ¼" brass for the probes. To determine best length, I used telescoping pieces of hobby store brass and adjusted the lengths while tuning with the network analyzer. I settled on 40mm each. If my procedures are followed to the letter, the repeatability of this design should be pretty good. So just cut the ¼" solid brass to 40mm.
s. RF connectors are centered 44mm from the inside of the back wall, per OK1DFC spreadsheet.

Note: I use tap oil on each hole and after tapping a hole I rinse the tap in the solvent and use the small wire brush to clean the tap.

MOUNTING

I drilled and tapped four mounting holes and used ¼" threaded rod to mount my feed. I have a unique mount in the feed point of my dish that is designed for a one bolt connection. See Figure 5 below.

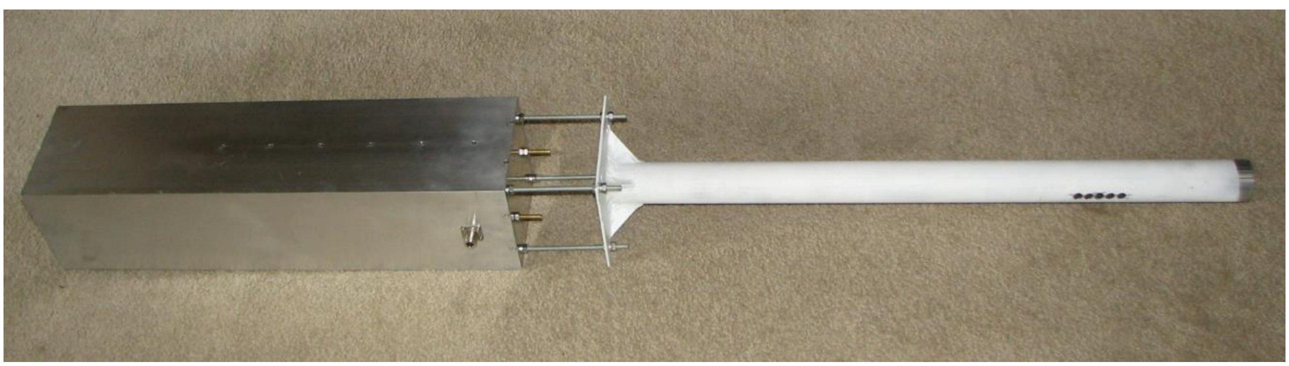


FIGURE 5. MOUNTING (KL6M STYLE)

I use the above mounting method for all my feeds. I use 2" O.D. aluminized exhaust pipe which telescopes very well into a 2" I.D. EMT on my dish feed point. One bolt holds it in place. More details on my feed mount at http://qsl.net/kl6m under "New Links" item # 5.

TUNE UP

I have the luxury of a scalar network analyzer. Test setup shown below in Figure 6. Without a network analyzer, very good results can be obtained just by tuning for best VSWR on both ports. Basically that is all I did using the network analyzer. In Figure 7 below I have screen shots of the network analyzer display of return loss for RX port and TX port respectively.

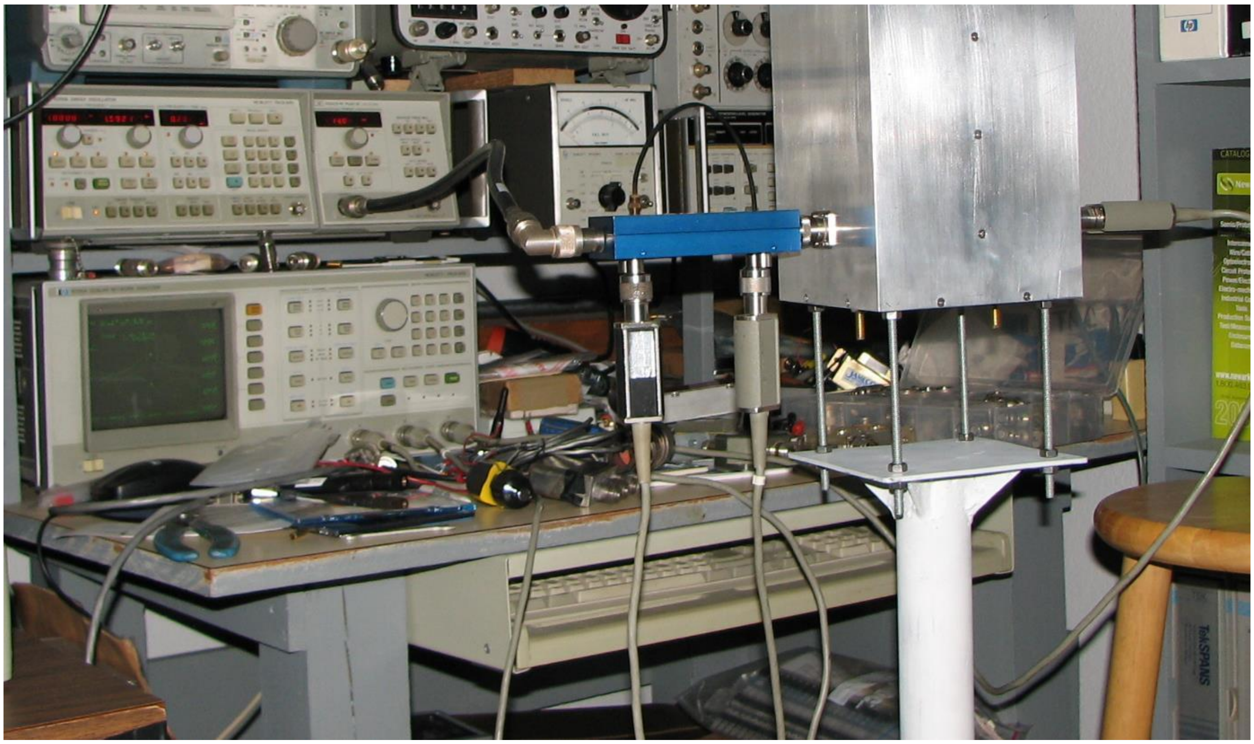


FIGURE 6. TEST SET UP

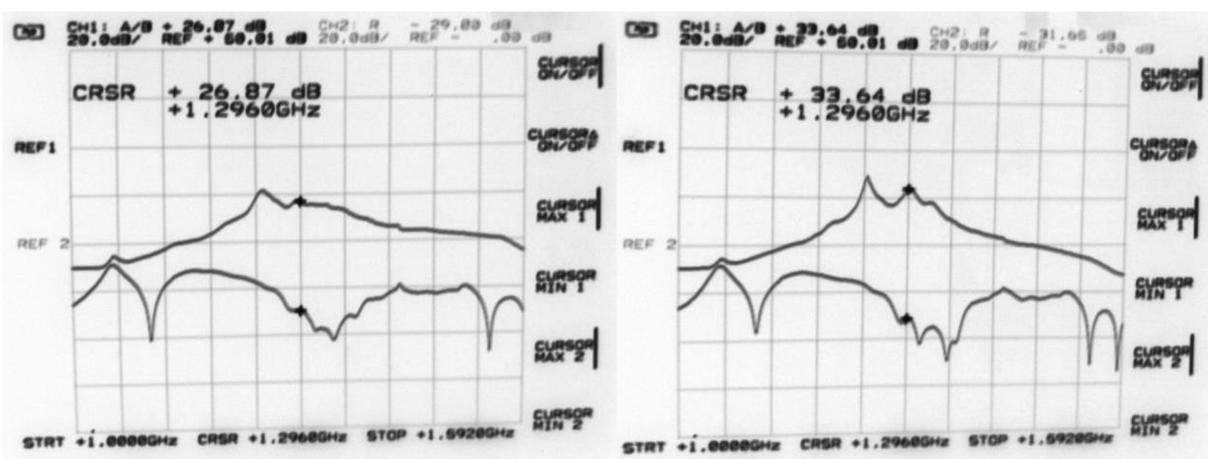
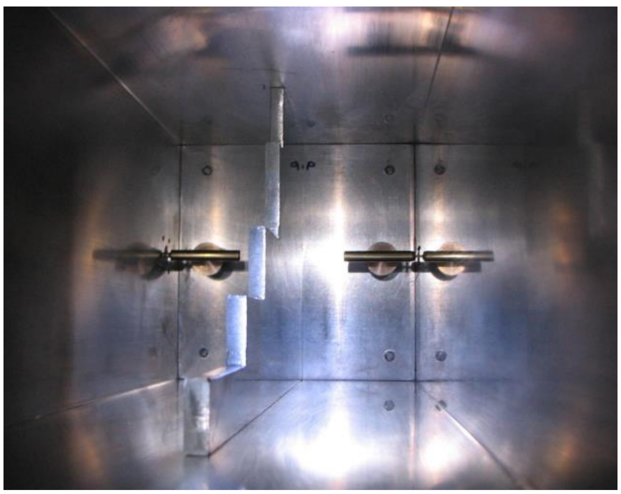


FIGURE 7. RECEIVE PORT (LEFT) AND TRANSMIT PORT (RIGHT), (ISOLATION VALUE IN UPPER RIGHT)

The final measurement values are as follows:

1. Receive port Return Loss is approximately 27 dB (1.1 : 1 VSWR)
2. Transmit port Return Loss is approximately 34 dB (1.04 :1 VSWR)
3. Isolation approximately – 32 dB (upper right reading on Transmit port display)

These values can be improved with careful adjustment in a better test environment (preferably mounted in the feed point of your dish). I believe I could have improved these values by shortening the probes slightly, and retuning the disks, but I did not have time, and these values are perfectly acceptable. Unfortunately I did not have time to compare the new feed with my VE4MA style with polarizer screws. I plan to do this later and will make the results available on my website. But there have been extensive studies performed on this subject and many reports have been published.



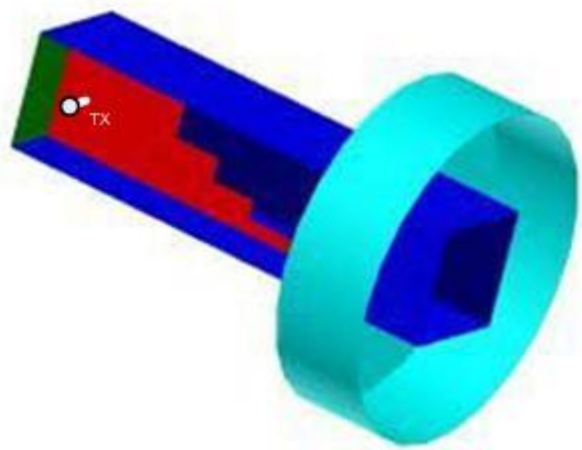


FIGURE 8. INSIDE VIEW

CONSLUSION:

I built this feed in one day. By itself it will get you on the moon, but as many of our EME researchers have reported, it will perform much better with a scalar ring (in above cartoon). But it is definitely a quick way to get going and the refinements can come later. I have some ideas on clamping the scalar ring to the square feed, and I will put these on my website later. Also since I have started on this project, ONLINE METALS has added a 6" Round Tube with 1/8" wall thickness to their inventory. This is very worthy of future experimentation and comparison with this square version.

ACKNOWLEDGEMENTS

Most importantly I would like to acknowledge Zdenek, OK1DFC, for all the work he has done with regard to the septum polarizer feed. His website is extraordinary and a valuable tool.

I also would like to acknowledge the many other folks that have contributed to the research and comparison of various feeds. I will not try to name them all, for fear that I might forget one. But I believe we know who they are, and thanks very much.

BILL OF MATERIALS

ALUMINUM (ONLINE METALS PRICES)	QTY	COST
1. 063-T52 Extruded Square Tube 6" x 0.125"		
Cut to: 24" Length	1 piece	$ 42.02
2. 6061-T6 Bare Plate 0.25"		
Cut to: 5.75" x 15"	1 piece	$ 17.25
3. 6061-T6 Bare Plate 0.25"		
Cut to: 5.75" x 5.75"	1 piece	$ 6.61
		$ 65.88

FASTENER HARDWARE (STAINLESS STEEL)

#	DESCRIPTION	QTY
1	Flat head 4-40 x 3/8" Screws	16
2	Flat head 4-40 x 1/2" Screws	4
3	Phillips Pan head 4-40 x 1/4" Screws	4
4	Phillips Pan Head 2-56 x 1/4" screws	4
5	4-40 Lock washers	4
6	2-56 Lock washers	4
7	FLAT HEAD BRASS 1/4 -20 X 2"	2
8	1/4 -20 NUT (Tuning Screw Lock Nut)	2

OTHER MATERIALS

#	DESCRIPTION	QTY
1	BRASS TUNING DISKS 20mm DIAMETER x 6mm	2
2	N FEMALE SQUARE FLANGE CONNECTOR	1
3	SMA FEMALE SQUARE FLANGE CONNECTOR	1

(Of course, other connector types can be substituted based on your personal preference)