A Coffee Can Feed for 2.4 & 3.4 GHz

Print

A "Coffee Can Feed" for 2.4 & 3.4 GHz

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Well, let's be honest from the start : I couldn't find any "coffee cans" with the correct dimensions but calling it an "asparagus tin feed" or a "milk additive tin feed" doesn't quite have the same ring to it.... but I'll come back to these matters shortly. The people behind the move to plastic packaging, and away from tin cans, will certainly have something to answer for in the future when people want to use them to construct antenna feeds - and they aren't available !!!

The master plan was to create a dual-band feed for 2.4 & 3.4 GHz to replace the original feed on the Conifer II T5120 "24dBi" gridpack antenna. The W5LUA approach seemed like a nice way out - allowing me to use the same "dish" for both bands for field days etc. That was going to make the FD requirements smaller and simpler.

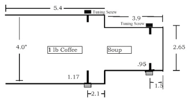


Figure 6.9-12 W5LUA Dual-band feed
For 2304 and 3456 MHz

Mouse-over any graphic for a larger view

By the way, the W5LUA feed diagram came from Paul W1GHZ's online book, particularly Chapter 6_9P1 available through the following link : **W1GHZ's Microwave Antenna Book Chap6_91** (http://www.qsl.net/n1bwt/chap6_9p1.pdf). If you are interested in a treatment of the "coffee can feed"'s use as a circular waveguide feed, the whole of the first part of the "**Feeds For Parabolic Dish Antennas** (http://www.qsl.net/n1bwt/chap6-3.pdf)" applies, also from Paul's web site.

The above dimensions are in inches so a bit of conversion makes the larger (coffee) can (for 2.4GHz) 100mm diameter by 135mm long, the smaller (soup) can (for 3.4 GHz) becomes 67mm diameter by 100 mm long. My traipsing through the supermarket with a tape measure picking up cans and measuring both diameter and lengths probably raised a few eyebrows but the web articles about dimensions indicated that they were fairly critical, particularly diameter-wise.

Let's now analyse the feed points within each "cavity" feed. The dimensions 1.17" and 2.1" become respectively 29.72mm and 53.34mm while the 0.95" and 1.5" become 24.13mm and 38.1mm (sorry, we need to work in metric so that we can accurately assess the measurements).

At 2304, the 29.72mm radiator length is 0.92 of a quarter wavelength (32.55mm). The spacing of 53.34mm is 0.82 of a half wavelength (65.1mm, so 0.41 wavelength physical spacing). I can understand the shorter radiator by taking into account "end effect" which shortens a physical radiator but the 0.41 wavelength spacing from the backplane seems a little weird for now.

At 3400, the quarter wavelength is 22.05mm making the 24.13mm radiator too long (by a factor of 1.094), the 38.1mm spacing to the backplane is 0.864 of a half wavelength (or 0.432 of a wavelength). The radiator-backplane spacing is reasonably consistent with the 2304 section (0.43 versus 0.41) but the radiator length should be 20.3mm to match. I can only wonder why.....

By the way, I concluded my supermarket survey by purchasing 3 cans to match up with the external physical dimensions required :

100mm diameter by 142.5mm high.
Coles MX11 Energy Drink, 450 gram.

68mm diameter by 112.5mm high.
Coles asparagus cuts, 340 gram.

68mm diameter by 141mm high.
Coles asparagus spears, 425 grams.

I wasn't interested in the quality of the contents - just the containers - so bought the Coles-branded products with dimensions closest in diameter and at least exceeding the length of what was required. My total purchase cost : about $8. Just a tip : feel around the cans for any dents before you buy them & avoid any with any significant damage.

Let's go back to the Conifer gridpacks for the moment. I placed the reflector on the floor without the originally supplied "feed" in place so I could make some physical measurements : 900mm long, 600mm wide, 1070mm diagonal, the height (or depth if you like) at the centre was 240mm. The measurement of the original dipole within the plastic feed housing was estimated at being at 330mm from the mounting plate so this dimension is probably close to the focal length/point for this reflector. The original shaped rectangular reflector on the feed assembly is some 40mm further out from the dipole assembly. By the way, the spacing between the grid elements is 20mm (ie the slots in the metal backplane) so that will be a limiting factor for the upper frequency use point.

This is the gridpack with the 4 screws holding the two sections of the reflector together. This was how the length and width dimensions were taken.

This is the ID label on the original Conifer II T5120 feed unit.

This was how the "depth" dimension was taken.

The original feed unit has a dipole assembly inside the octagonal shaped piece at the end closest to the shaped reflector.

The article PARABOLIC ANTENNAS AND THEIR FEEDS by N3AO at **http://www.packratvhf.com/Article_9/DISH_AOG.html** (http://www.packratvhf.com/Article_9/DISH_AOG.html) poses some interesting insights into what style of feed should be used for different reflector styles and made me start to wonder whether the "coffee can" feeds are suitable in this case. This statement : "**Most of the dishes that are available seem to be the deep type in the .25 to .35 f/D range. These are not, unfortunately, suitable for the easy coffee can feeds that you see in most articles.** If you do come across a dish that has a f/D of .45 to .5, one of those feeds will work just fine. " is from his web article (it is just under the over-proper-under illuminate graphic).

I guess that my application for the formula f = D*D/16c (in the details in the above web article) leads me to wonder : is the effective diameter actually 107cm - the diagonal measurement ??

This formula calculates out for f = 298mm for this gridpack and with a measured focal length of 330mm, that gives me a 30mm difference between calculated and actual, not much really but it means that the feed position will need to be able to be moved over at least this range to optimise it.

The various graphs (in Chap6_91) for "dish depths" use values of f/D to show the effects of the different feed styles and for this one, it appears to be 0.28 as calculated above and 0.31 by physical measurements. Let's assume some errors in the due processes and call it a round 0.3.

The outcome is therefore defined by the accuracy that we can assume for the reflector. Is it really 107cm - or something less ??? I haven't found any articles specifically referring to the cut-down form of a parabolic dish (eg the near-rectangular gridpack) and how it affects the effective diameter so this question still lingers....

From the graphs in W1GHz's PDF about this W5LUA feed (figs 6.9-13 and 6.9-14), this dish f/D ratio should give a parabolic dish efficiency in the low 60-70 percent range at 2.4 GHz (this percentage based on based on a 7 wavelength dish diameter) and in the 40-50 percent range at 3.4 GHz (also based on a 10.5 wavelength dish diameter).

The radio wavelength at 2.4GHz is about 12.5cm so 7 wavelengths = 0.88m and the gridpack is larger than that with the effective diameter above.

The radio wavelength at 3.4GHz is about 9cm so 10.5 wavelengths = 0.95m and the gridpack is larger than that with the effective diameter above.

Those values indicate to me that it **might/should** work - even if the gain/pattern/shape is not optimal. If the "coffee can feed" doesn't work well enough, I can always go back to the original implementation : a "dipole plus reflector"-style strategy. After all, at this stage it has only cost $8 plus a couple of SMA bulkhead connectors to evaluate it.

The original coffee can article makes reference to the two segments being "below cutoff" and I will just make note of a couple of important dimensions :

2400 MHz : wavelength = 12.5cm, the can we are using is 10cm diameter, ratio = 0.8.

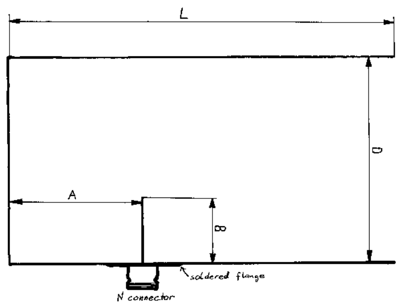
3400 MHz : wavelength = 8.8cm, the can we are using is 6.8cm diameter, ratio = 0.77.

In both cases, the physical can diameter is less than the wavelength, and it appears that the optimal size is 0.75 to 0.8 of the wavelength is being observed.
The length of the can must be >1 wavelength so that means a minimum length of 125mm at 2.4 GHz and a minimum of 88mm at 3.4GHz.
The 3 cans I purchased certainly fill both the diameter and length minimum requirements (100x 142.5mm & 68 x 112.5mm respectively).

From **OE1DMB's web page** (http://www.qth.at/oe1dmb/activity/coffecan/coffee_e.htm) titled Coffe Can Feed (though a single band arrangement) :

For everyone who wants to make his own can-feeds here is a little description for the diagram of the can:

A .. must be as good as possible 0.5 Lambda (ie wavelength) (@2400 62.5 mm)
B .. shall also be exactly 0.25 Lambda (@2400 31.25mm)
D .. The diameter shall be 0.75 Lambda, but 0.7 .. 0.8 Lambda is OK. (@2400 it's 93.75mm, my can has diameter 97mm and works perfect with SWR L .. **The length is uncritical but shall be more than Lambda** (my can has a length of 142.5mm)



The reason for the extract is the line : L .. **The length is uncritical but shall be more than Lambda** (my can has a length of 142.5mm). To me, that means that if your can is not exactly the published article/correct length, you should get away with it anyway.

Further up this page, I mentioned the radiator length and radiator to backplane spacing and the OE1DMB values are the calculated quarter and half wave values for the frequency used ie 2400 MHz. You should note that the difference is actual quarter radiator length at 2400 is about 13mm shorter than 2304 so you must determine where you want the antenna to function before you cut the radiator lengths or make holes in your "coffee" (or equivalent) cans.

The current 2.4GHz segment used in Australia for SSB use is 2403.100 calling, 2403.150 for contests working etc so my lengths will need to cornform with that section. That makes a wavelength 12.48cm (or 124.8mm) making my radiator length 31.2mm and the spacing (set as a true 0.5 wavelength value) 61.4mm. The 3400 MHz radiator (wavelength = 88.235mm) needs to be 22.06mm spaced 44.12mm. Physical measurement accuracy will come into it too but these are the target values to build to. Of course, it is almost always easier to shorten a radiator than to lengthen it. Once I get to apply RF to it to evaluate the tuning, it will be fairly obvious whether I should have shortened it to take into account "end effect".

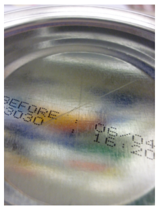
More of a problem is how to go about making a *perfect hole* in the bottom of the larger can to make it a dual band device !!!

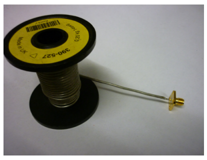
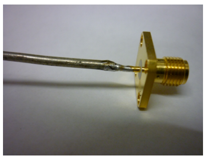
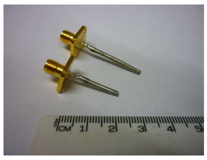
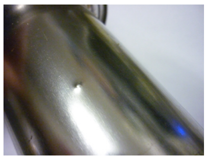
Time to push ahead and try to make the dual band feed and it's mounting for the gridpack.

Maybe your XYL/YL/partner has been to a Tupperware party at some stage and bought/won a Tupperware can opener. If there is one in the house, go grab it for this job ! (and while you are there, check to see if you have a 100mm diameter plastic can re-sealing lid - this will be needed to keep moisture/ dirt/ dust/ insects out of the feed assembly later on.)

Construction tip : if we assume that the cans are not dented before using them to construct the dual band feed, handle them carefully and keep them that way !

 This is the 67mm diameter can you saw earlier, 112.5mm long.	 Wrapper off..
 Nice clean cut edge on the can..	 The magic tool : the Tupperware can opener.

 To prove it wasn't a fluke : the 100mm diameter can	 Lid off..
 Remove the foil as completely as possible.	 Ready to clean out and use. No sharp edges and no protrusions.
 This is the ideal tool for marking the actual centre point of the larger can. I tried it out on the lid segment discarded from the 100mm can before I marked the "real" one.	 If you look closely, you will see three lines forming a very small triangle : this is the true centre of the can.
 I used a circular cutter to mark the circle although an old drawing compass (or dividers) would do the job. Once you have the circle marked, you can punch through with a screwdriver in a few spots towards the centre to get your scissors in. Curved nail scissors are recommended. A few short radial cuts were also made around the outside of the hole.	 The smaller can was then pushed through the inside of the larger can so that the bottom lip was just through the hole. The radial cuts make it easy as they tend to close up afterwards - or can be made to.
 The inner can was then pushed all of the way through. Some of the radial cuts are easy to see in this view.	 This a is the inside view. No, not a truly neat hole - but acceptable.
The two cans were aligned visually so that they lined up when the larger one was rotated on a flat table surface and then the two cans were spot-soldered together at a few spots then rechecked for alignment.	The remainder of the circumference of the cans / joint was then soldered with the soldering only requiring a 700 degree tip on a normal 60 watt Weller iron.

 The original design indicated N series coax connectors but I decided that I would use SMA bulkheads given the desired mounting on the gridpack..	 The radiator was made from 14SWG (2mm) tinned copper wire simply butt-soldered to the centre pin of the SMA socket.
 The wire was cut off at about 50mm initially so that it could be trimmed down later. The process was repeated for the 3400 MHz radiator.	 The two radiators, one at 31mm and the second at 22mm as measured from the back edge of the mounting flange.
 A 6mm diameter hole was drilled at a position 44mm in from the bottom position then a Philips screwdriver used through the hole to mark the other side. The two cans were soldered together completely by this stage but this was the first hole to be made.	 This mark was then used to drill another 6mm hole opposite the first so that the tuning screw could be fitted later. The same process was followed for the larger can at a point 61mm from the reflector plane point. I will be using 5mm screws so a slightly larger clearance hole was desirable. The main criteria is to use a fine screw thread plus locknuts, in a 3, 4 or 5mm size and about 40mm long for 3.4 GHz, 50 mm long for 2.4 GHz.
 The 3400 MHz radiator connection. The SMA socket was soldered on all 4 sides to provide good mechanical strength.	 The 2400 MHz radiator connection. Soldered on all 4 sides also. Make sure you scrape enough of the labelling off to get a good clean surface area to solder to.
 The inside view shows the top-most centre pin perfectly centred in the hole in the can.	 The two radiators are lined up axially pretty well.
Please note that the can lengths were not changed (shortened), they remained at 112.5mm and 142.5mm respectively for the 3.4 and 2.4 GHz sections, noting that the original W5LUA feed can dimensions were 100mm and 135mm respectively. The longer 141mm asparagus can was not used.	The total "finished length" of the two-can feed was 255mm.

 The two 40mm long x 5mm metric thread "tuning" screws have been mounted diagonally opposite the coaxial bulkhead connectors.	 This shows (to a degree) how well they don't line up from side-to-side on the 3.4GHz feed section. The screw is just a little further up the tube than the feed itself.
 The nuts are nickel plated (NP) and the nut to be soldered to the can must first have some of that plating removed on all 6 sides (but not top & bottom) - preferably with a file - then tinned on those surfaces before being soldered to the can. The lock-nut is left un-modified. This is the 3.4 GHz feed tuner..	 The tuning screw in it's mounting position on the 2.4GHz section.. with a locknut fitted for eventually holding the screw in position once it's length has been confirmed during testing.
 The inside view shows the screws diagonally opposite the radiator elements.	The final position of the tuning screw is set when RF is applied to the relevant feed and adjusted for best SWR (i.e. minimum reflected RF power). The feed unit will probably be painted to minimise weather exposure problems (eg tin cans do rust..) so if it appears either grey or black in subsequent photos, it's still the same unit.

That completes the construction of the dual band feed for 2.4 & 3.4 GHz. The mounting of it on the grid pack reflector has yet to be developed and chronicled here. Then after that, the testing phase.

Stay tuned...