Microwave Antennas a practical approach

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Antenna choice

- Yagi antennas/ arrays
- Dish/ Reflector type antennas
- Horn antennas

Yagi antennas

- Yagi antennas commonly used for lower microwave bands especially for 23cm and 13cm tropo-systems.
- Yagis, including loop yagis, can be stacked and bayed for more gain.
- Single long yagi antennas have typical gains around 16 to 20dBd
- Yagis are available commercially or can be home made

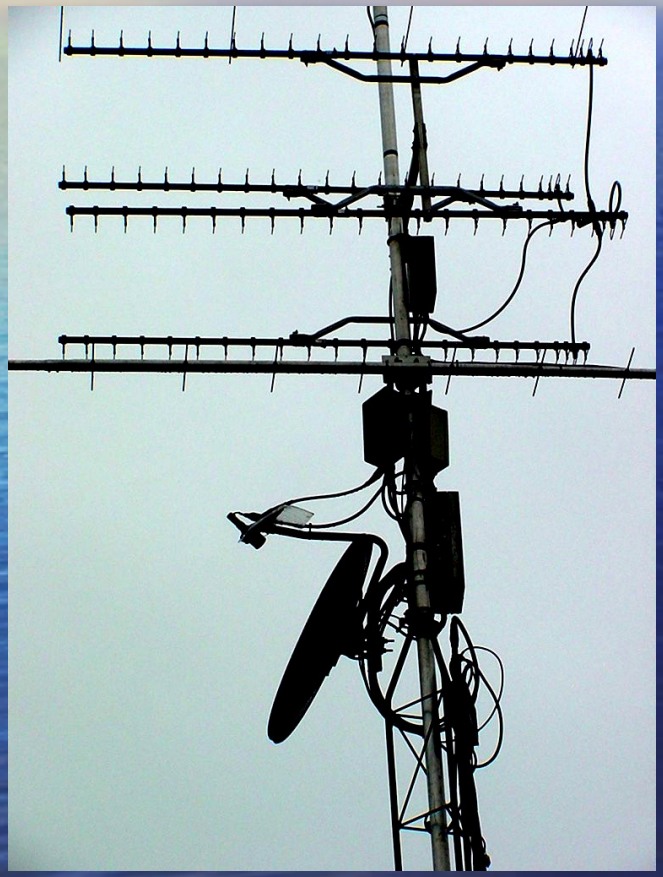
Loop Yagi

- A loop yagi is similar to a conventional yagi but with circular elements.
- Loop yagi antennas have slightly more gain for a given boom length than a conventional yagi.

Gain and the yagi antenna.

- The gain of a yagi antenna is dependant on the length of the boom in wavelengths.
- To double the gain—3dB—you would need to roughly double the boom length of the antenna.
- More gain could be had by stacking antennas vertically, baying antennas horizontally or forming a box of yagis. An antenna added in this way might give an additional 2—2.5dB gain if properly spaced and matched.

A Yagi ‘box’.



- To the left is a ‘box’ of yagis.
- This arrangement might give an additional 5dB of gain both on TX and RX.
- The downside is that the increase in gain comes at the expense of a narrower beamwidth—in the case of a box—in both the horizontal and vertical planes.
- This is sometimes referred to as a ‘sharp’ beam.

Information about Yagi design.

- For information on how to design and build a yagi antenna try 'NBS' or DL6WU designs—both are proven! (DL6WU design information is in the VHF/UHF DX Book).
- For loop yagi's try G3JVL or the Microwave Handbook, Volume 1
- Perhaps the best way to 'feed' a conventional yagi for the microwave bands is to use a folded dipole matched with a 'half wave balun'.
- Remember yagis are essentially narrow bandwidth devices. (Careful measuring required for home-made antennas.
- Antenna 'splitters' are fairly easy to construct—again design data is included in Microwave handbook, Volume 1.
- You need top quality coax at microwave frequencies plus top quality connectors. (No PL 259 or SO 239 types)
- It is often advantageous to mount power amplifiers and receive pre-amps at the mast-head; avoid long coax lengths if possible.

Dish antennas

- Dish antennas, based on paraboloidal reflectors are the most common antennas for the bands above 3.4GHz.
- They can provide large gain, operate on any frequency and are easily available.
- There is a trade-off between gain and beam-width. High gain dishes will have a narrow beam width which can make aiming difficult.
- An ex satellite offset fed dish of about 60cms can form a cheap antenna for 5.7GHz and 10GHz. *

Dishes come in all sizes!

- Not ideal for /P but a fine E.M.E. dish if you have space (no pun intended)!

Prime Focus Dishes.

- The dish pictured left is a 45cm solid prime focus dish.
- This dish is 'rear fed' with waveguide.
- The 'rf ' hits a reflector at the end of the waveguide which 'fires' it back at the dish.
- A common variation of this is the 'penny-feed', useful for short f/d dishes.
- Dishes such as this are often easier to mount. The transverter can be mounted behind the dish.

Offset dishes.

- Offset dishes are now very popular; most started life as satellite TVRO dishes. For amateur use they have to be tilted over by typically 25 degrees or so to ‘beam’ at the horizon.
- This can make mounting more difficult than a more conventional dish but offset dishes are cheap and plentiful.
- Most offset dishes have an F/D ratio of .5 to .6 which makes them relatively easy to feed with simple circular or pyramidal horns.

Dish gain

- This graph shows the relationship between dish diameter, power gain and beam-width verses frequency.

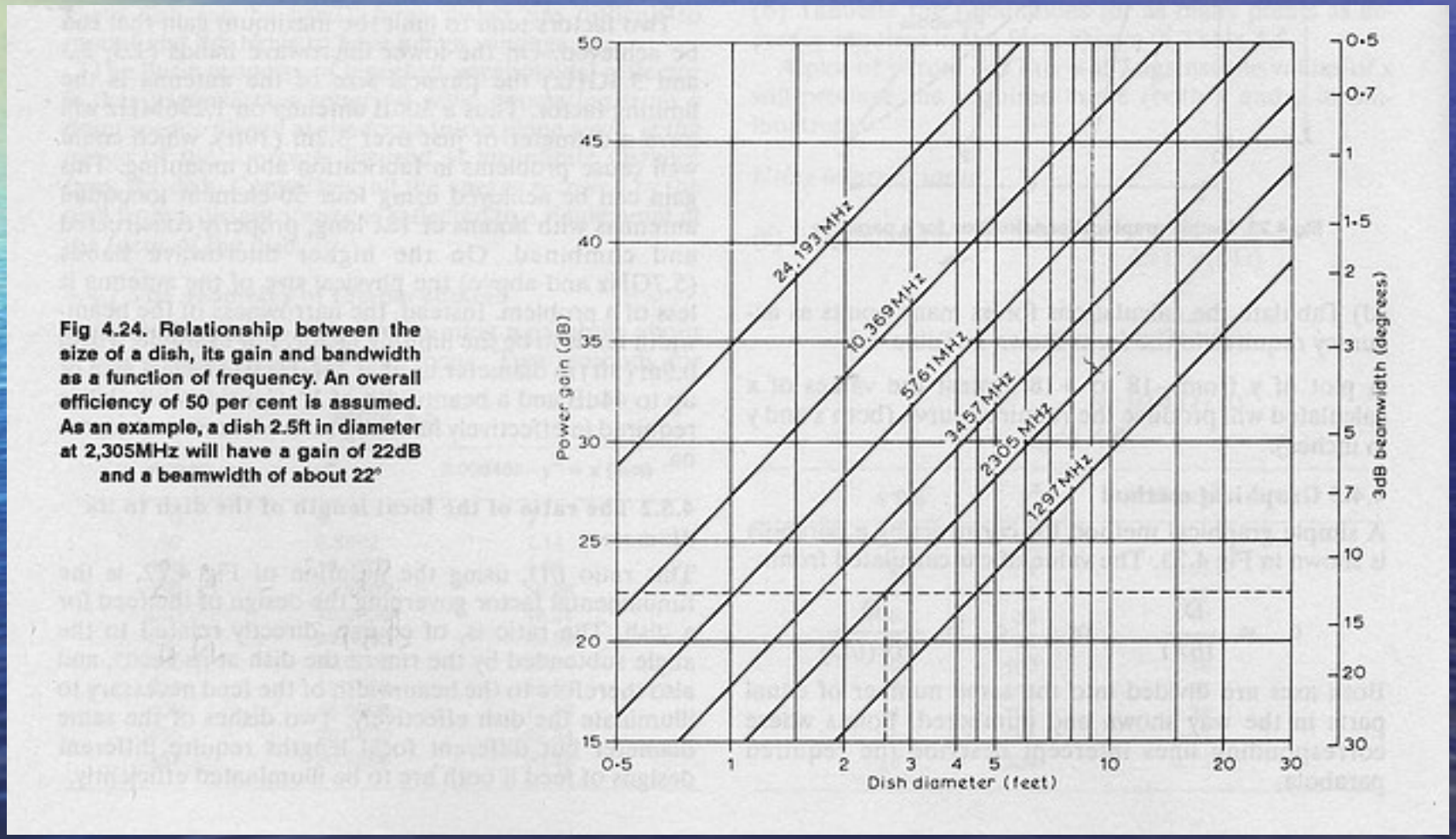


Fig 4.24. Relationship between the size of a dish, its gain and bandwidth as a function of frequency. An overall efficiency of 50 per cent is assumed. As an example, a dish 2.5ft in diameter at 2,305MHz will have a gain of 22dB and a beamwidth of about 22°

Feed systems for dish antennas

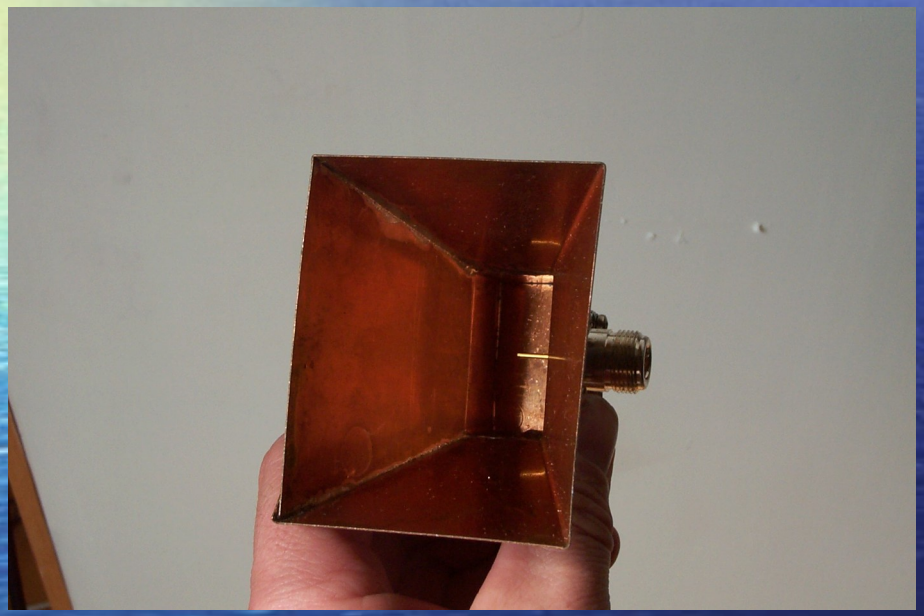
- Many types of dish feeds are possible—here are but a few of the more common.
- A wealth of information on feeds and dishes is available on W1GHZ's website (Paul Wade), Antenna Handbook.

- Conical horns.
- Pyramidal horns.
- Dipole and splash-plate.
- Log periodic feed. (Multi-band)
- 'Coffee-can feed.
- Cassegrain feed
- Penny feed
- Scalar feed

Conical horn feed

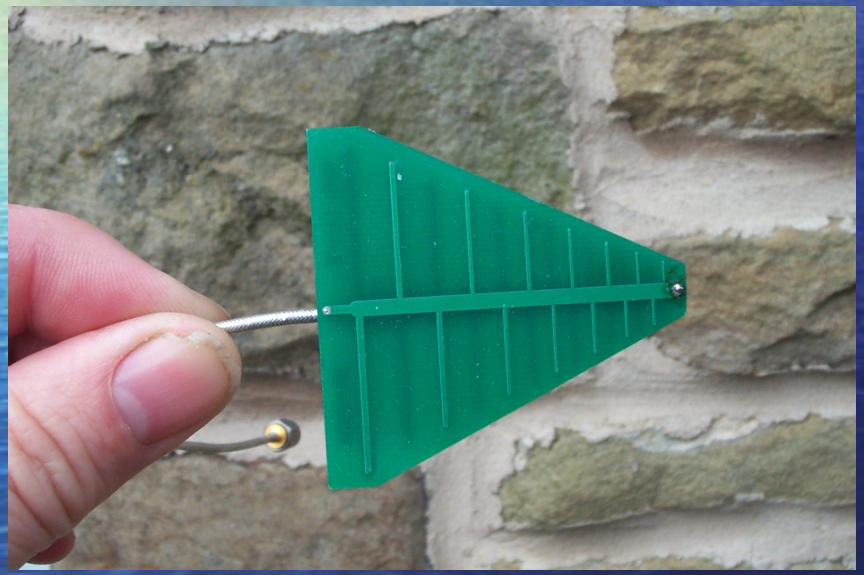
- Pictured left is an optimised conical horn feed for 10GHz.
- It was made from copper plumbing parts to a design by G3PHO.
- This feed is near ideal for offset dishes, which often have an f/D ratio of 0.6.
- Horns from satellite dishes can be easily modified.

Pyramidal horn feeds



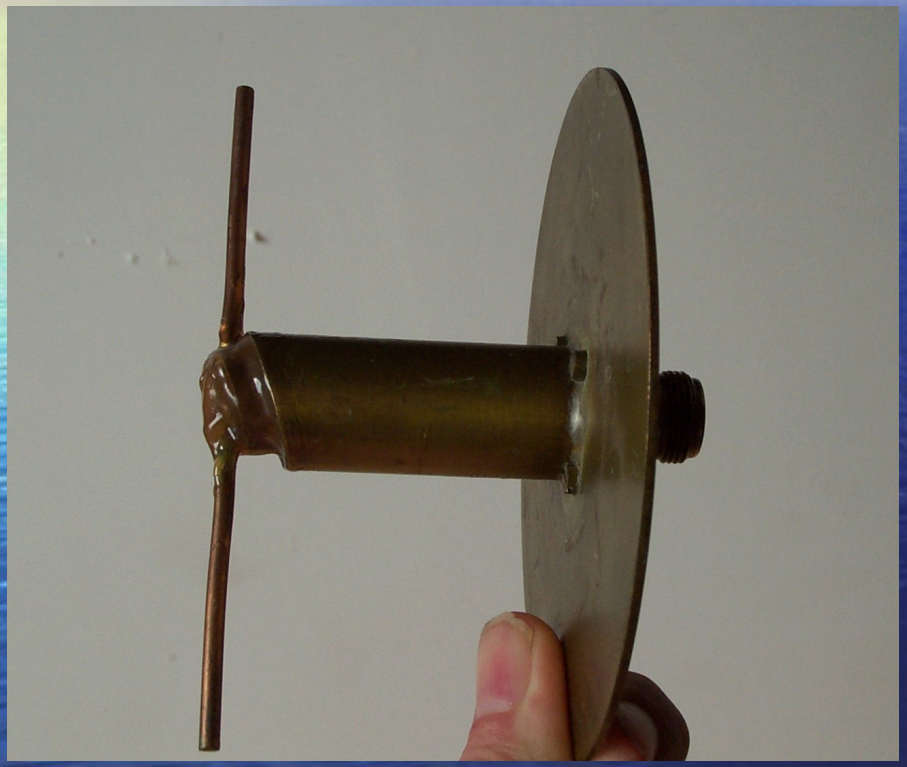
- Pictured left is a pyramidal horn feed for 5.7GHz.
- Horn feeds often incorporate a ‘waveguide transition’.
- Horns are simple to make, versatile.
- Horns generally provide a ‘good match’—that is they provide a low SWR termination without complicated matching.

Log periodic feeds



- Pictured left is a log periodic feed.
- This on is a multi-band feed covering 2 – 11GHz.
- These feeds are available for a few pounds. They are fed by semi-rigid coax.
- Being made as a ‘PCB’ they can handle up to about 10W of power.
- ‘Phase centre’ changes with band so a compromise.

Dipole with splash-plate feed



- Pictured left is a dipole with splash-plate feed for 23cm.
- The feed was made from commonly available copper and brass tubing, which incorporates a ‘balun’ to match to ‘unbalanced’ coaxial cable.

Coffee can feed.

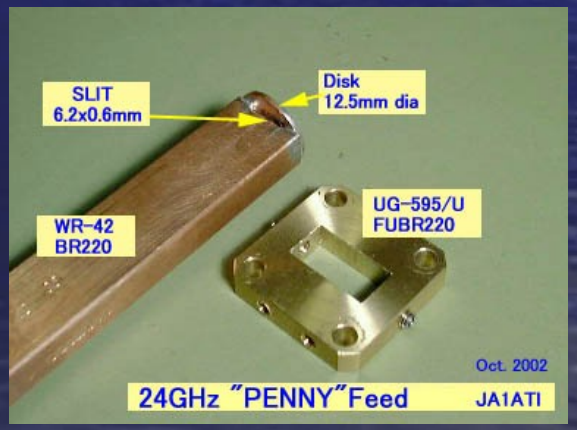
- Pictured left is a coffee can feed
- These can be very easy to construct and are often used to feed large dishes.
- Best of all they are very cheap —providing you can find a can with the right internal diameter!!

Internal details of can feed.

- Just a can fitted with an SMA connector with an extended centre pin.
- The frequency in use here is 3.4GHz but the feed can be scaled for other bands.
- A matching screw can be fitted to improve SWR—usually placed opposite the connector.

Penny feed.

- The penny feed is a simple to make feed, consisting of a disk placed at the end of the waveguide. Slots at the end of the guide allow the RF to reflect back towards the dish.
- This type of feed is useful for deeper profile dishes with F/D ratios around .3
- Typically the transverter is placed behind the dish making for an easy engineering solution.



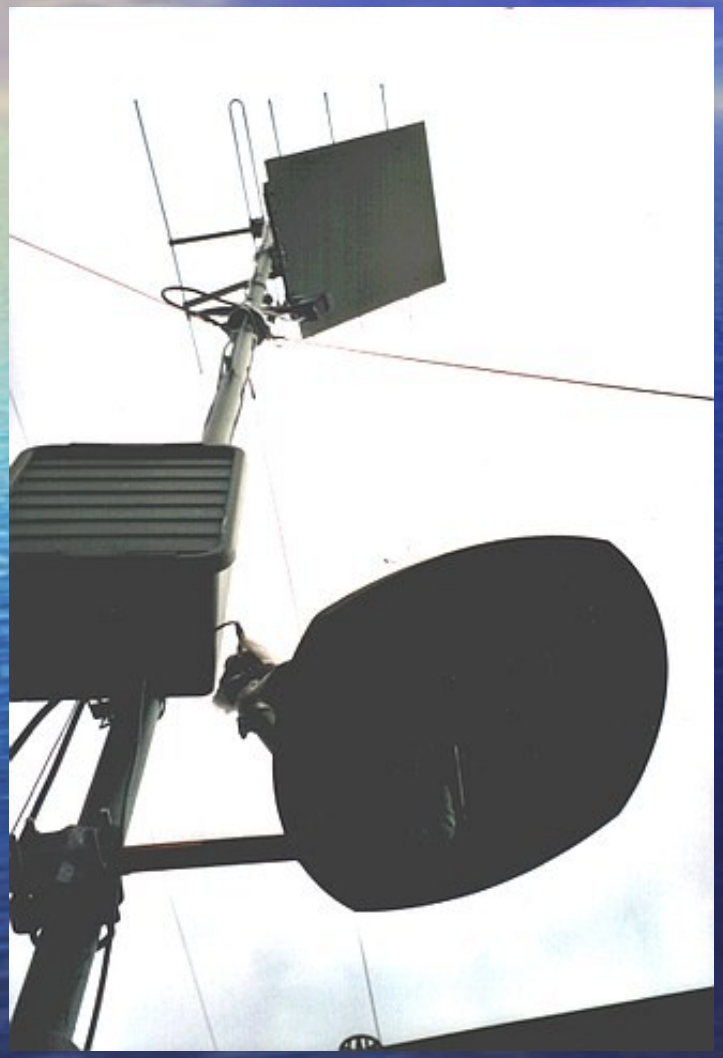
Scalar feed.

- Another type of easily made feed system.
- It consists of a circular central guide with an outer larger ring.
- The position of the outer ‘ring’ in relation to the inner can be used to tailor the feed to different F/D ratios.
- Design information can be found on the web.

Finding the focus.

- For focal plane dishes the focus can be found using the formula
  f=D*/16c
- For offset dishes a more practical approach may be easier—keep the mounting arm for the LNB with its clamp—this should give a good idea of where the focus lies.
- If there is no mounting arm—use aluminium foil taped to the dish and use a distant light source (the sun) to find the focus. Remember offset dishes designed for the UK often need around 25-27 degrees of 'tilt'.
- Check out Paul Wade W1GHz's website for more mathematical approaches to finding focus for unusual offset dishes.

Fly swatter antenna.



- This is an interesting arrangement - it allows the transverter to be mounted low down, where it can be serviced; the lower dish beams up towards a plane/ curved reflector.
- This one can change ‘elevation’ by changing the angle of the upper reflector.

Fly swatter antenna viewed from side.

- Here is a side view of the previous picture which shows the transverter low down and the reflector higher up the mast.
- The reflector angle can be altered remotely; this is useful for rain scatter.
- Another name for this arrangement is the ‘periscope’ antenna.

Horn antennas

- As well as providing suitable feeds for dish antennas, horns are useful in their own right.
- Horns are fairly easy to construct and fairly forgiving.
- Horns usually present a good match and their gain is easy to calculate, making them useful ‘reference’ antennas.
- Design data is available from a number of sources, including Microwave Handbook.
- Horns are viable antennas for the higher microwave bands, including 10GHz and upwards.

It’s up to you now—have a go!

- Microwave antennas aren’t difficult—in fact they can be cheap and easy—a number of dishes in use by G0EWN were salvaged from skips!
- Hopefully the presentation has given you some ideas.
- The microwave bands offer fantastic opportunities --- antennas shouldn’t pose too many problems — go on, have a go!