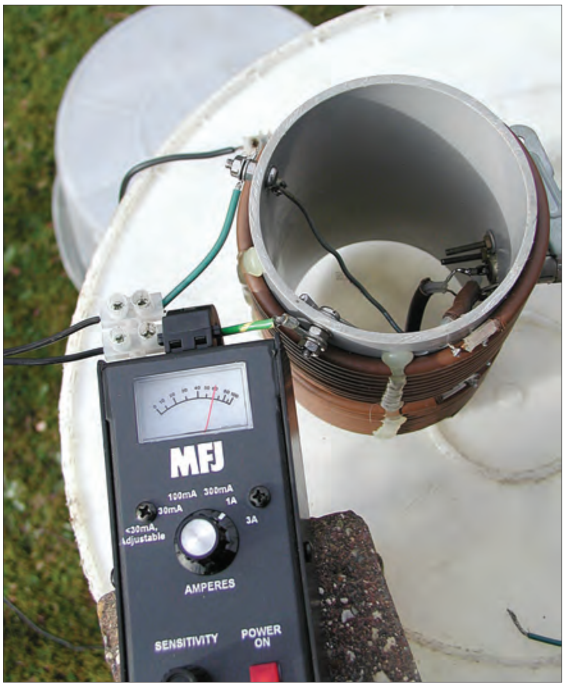
Antenna Workshop

Peter Dodd G3LDO, looks at the off-centre fed dipole and considers it could be an ideal antenna for multiple-band working.



Current measurements on the twin feeder conductors (telephone line) to OCFD. A PA0SE coaxial balun is used to match the twin feeder to the coaxial cable feeder.

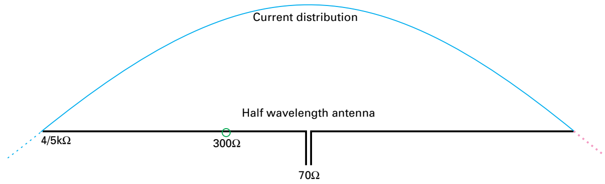


Fig. 1: The current distribution and impedance feedpoints on a half-wave dipole.

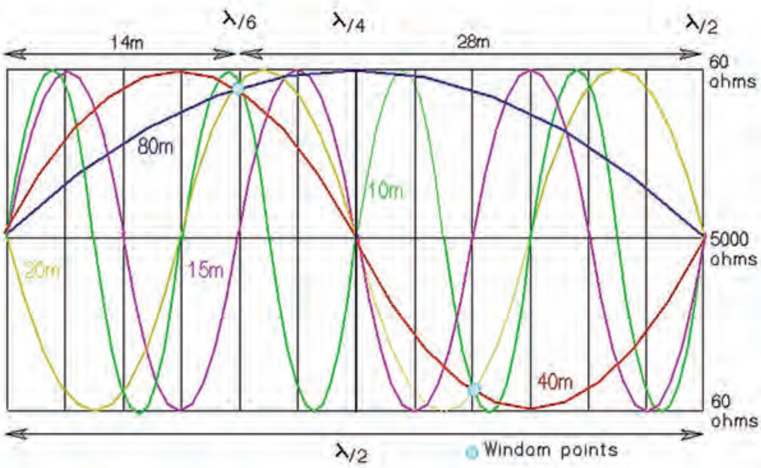


Fig. 2: The current distribution on a half-wave length of wire for 3.5MHz superimposed on the current distribution on other higher bands. Some of the bands coincide at one-sixth of a wavelength (3.5MHz) from the ends, a point that DJ2KY described as a 'Windom point'.

In the Antenna Workshop, December 2003 *PW*, I mentioned the necessity of using a balanced feeder cable in a multi-band dipole arrangement. I also stressed the importance of using twin feeder both to minimise losses and the need of having equal currents in each conductor of the twin feeder.

The reason I gave, was that with balanced feed there's little or no radiation from the feeder. Furthermore, such a feeder has less chance of picking up electrical interference on receive.

It's probable that the case for strictly balanced feeder derived from commercial practice where power output was often quite high and even a small degree of imbalance resulted in high levels of r.f. at the operating position. Feeder line imbalance could also result in power loss in long transmission line lengths.

With the relatively lower power Amateur transmissions, a degree of transmission line imbalance may not be a problem. And there's a chance that it might even be beneficial, provided that the transceiver is not located a long way from the antenna.

The feedpoint impedance of a half-wavelength (λ/2) wire is low in the centre, where the current is high. Conversely, at the ends, where the current is almost zero, the feedpoint impedance is high. Generally, the feedpoint impedance at the centre is around 60Ω and it rises to around 5kΩ at the ends.

Single-Band Antenna

A single-band antenna would enable you to select a feedpoint that would match any impedance of feeder that you might choose to use, as shown in **Fig. 1**. With the half-wave dipole it's usual to employ 50Ω coaxial cable for convenience.

However, the use of 50Ω coaxial cable isn't suitable for feeding a multi-band antenna. Feeding such an antenna needs some modification.

One arrangement of a multi-band antenna, known as the Windom or off-centre-fed dipole (OCFD) was first published by **DJ2KY**, in the German national radio society (DARC) publication *QTC* back in 1974. The diagram in **Fig. 2** is based on a diagram from DJ2KY's original article and shows the current distributions on a length of wire that's half-wavelength long at 3.5MHz (80m). Also shown (superimposed) are the current distributions for other, higher frequency bands.

The impedance levels shown may seem strange, with the highest impedance set in the centre and the lowest at top and bottom. But the impedance is related to the current amplitude – the greater the current the lower the impedance.

Look closely and you'll see that the current amplitudes of the superimposed curves coincide at a point one-sixth of a wavelength from the ends. This was the point that DJ2KY described as a 'Windom point'.

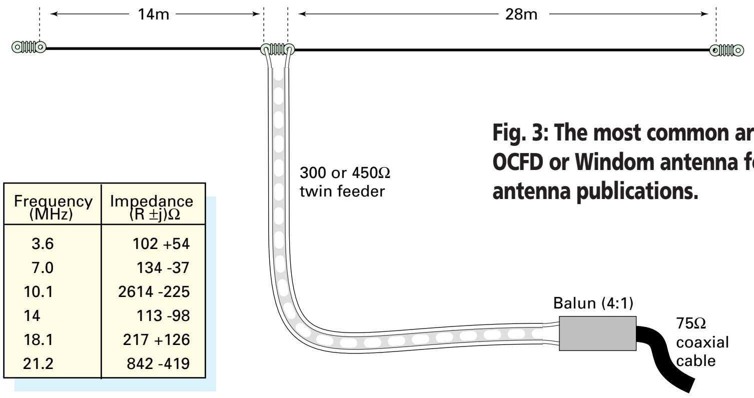


Fig. 3: The most common arrangement of the OCFD or Windom antenna found in most antenna publications.

Frequency (MHz)	Impedance (R ±j)Ω
3.6	102 +54
7.0	134 -37
10.1	2614 -225
14	113 -98
18.1	217 +126
21.2	842 -419

Table 1: Calculated impedances of the OCFD using EZNEC4.

Frequency (MHz)	Current L1 (mA)	Current L2 (mA)
3.7	320	280
7.0	90	220
10.1	450	500
14.2	330	280
18.1	430	480
21.3	90	120

Table 2: Measured currents on the OCFD twin feeder.

Current Distribution

However, the current distributions shown in Fig. 2 are idealistic, as they represent the current distributions of an antenna in free space. In practice, these currents can, and indeed will most likely, have slightly different amplitudes and phases due to the proximity of the ground.

Furthermore, the amplitudes of the current variations along the antenna element may not be constant on the higher frequencies when the antenna is fed off centre. Nevertheless, the impedances found at the λ/6 point are fairly close together on some bands and the free space impedances of a half-wave length of wire on 3.6MHz has been calculated using *EZNEC4* as shown in **Table 1**.

When the antenna is modelled close to the ground the impedances shown in Table 1 do change but, with the exception of 10 and 21MHz, are still within the range 100 to 200Ω. Such an antenna can be fed with 300Ω ladder line or with coaxial cable feeding into a 4:1 balun at the feedpoint.

The most common OCFD antenna arrangement seems the be the one shown in **Fig. 3**. Because of the layout variations that I've mentioned above, you'll find lots of variations.

I set out to construct an OCFD using a nominal 42m (138ft) length for the wire element. Because my mast is about two-thirds of the way down the garden the layout ended up being a cross between an inverted-L and an inverted-V, with the apex about 14.6m (48ft) high.

At the end of the longer section, the support point is only at an 8.5m (28ft) level, while the end of the short section is a mere 4m above ground. This asymmetric layout placed the feedpoint about 12m (40ft) above ground.

Originally, I fed the antenna with 450Ω ladder line from a balun at ground level, as shown in Fig 3. For some reason the s.w.r. measurements were all over the place, unless the outer braid of the coaxial cable feed to the shack was earthed at the point were it connected to the balun.

Twin Line

I then replaced the 450Ω ladder with twin line telephone drop wire (this is the external wire used by BT to connect house telephones to the nearest telegraph pole). The conductors of this material are made from 1mm diameter high tensile wire spaced at 3.3mm (centre-to-centre).

A local Radio Amateur, **Frank James G0LOF**, who gave me a length of this material, claims to have measured the impedance as 120Ω. The telephone wire feeder improved the s.w.r., although whether this was due to losses or a better overall match I'm unable to say.

With regard to the performance of the feeder, the relative conductor currents did not differ as much as expected. The measured values (see heading photo for the operation) are given in **Table 2**.

It would appear that, unlike the simple half-wave dipole, the configuration of the OCFD varies from constructor to constructor.

In a letter to me recently, **G3FBN** says "My version...the overall length is 139ft (42.37m) long, the short leg is 46ft 4in, (14.1m) the long leg is 92ft 8in (28.25m). I feed it with 75Ω TV coaxial cable, via a home-brew 4:1 balun at the feedpoint.

Eight Turns

"The balun at the feedpoint, comprises eight turns of 70Ω twin feeder tightly wrapped and taped to a length of 9mm ferrite rod. All of this is enclosed in a plastic 'T' electrical conduit onto which is mounted an SO-239 socket and suitable terminals for connecting the antenna wires.

"I am currently using a TS-2000 or a TS-570D both fitted with an auto a.t.u. I seldom need to use the main a.t.u., the s.w.r. is within the range acceptable to both rigs. The bands covered are 3.5, 7, 14, 18, 24 and 28MHz, but the s.w.r. is too high on 10 and 21MHz and I have to use alternative antennas for those bands."

I'm indebted to **G3GRO** for a copy of the **Crawley Amateur Radio Club** newsletter. While describing his experiments with an OCFD antenna in the newsletter, G3GRO says "...For many years I had an 80m OCFD fed with 300Ω ribbon feeder via a home-made 6:1 ferrite transformer, nominally 139ft (42.37m) long and running in a straight line up at 40ft (12.2m) above ground.

"This worked very well on 40m and bands above, but the s.w.r. at the band edges on 80m rose to around 2.5:1." The text then goes on to describe a series of tests with different feed configurations of the antenna using 300Ω twin feeder fed via a commercial 6:1 transformer mounted at ground level. To connect the transformer to the shack G3GRO used 50Ω coaxial cable.

The newsletter reads, "The s.w.r. results using this arrangement were variable and depended on the feeder length and grounding of the 50Ω coaxial outer etc. before it went into the house.

"With all these variables it proved difficult to optimise the antenna length - nominally 41.5m overall. G3GRO improved the s.w.r. compromise by changing the antenna configuration.

Ferrite Transformer

"The ferrite transformer was placed at the feedpoint of the antenna and fed with 50Ω coaxial cable more or less vertically down to ground level. At this point a current choke was inserted into the feeder.

"The choke comprised a number of turns of RG58U coaxial feeder wound on a powdered-iron toroid Type T240-15 (red). The outer of the coaxial cable was connected to the earth system as before. Other members of the Crawley club, notably **Lech G3KAU**, have also had success with this design of OCFD."

After reading the newsletter, which supported my own findings, I feel that most OCFD builders are in general agreement regarding the position of the antenna feedpoint. Many of the differences noted, relate to the feed arrangements.

I would encourage readers to experiment with this antenna. Altering the overall length is quite easy, moving the feedpoint can be achieved by making one end longer and the other a little shorter.

These changes can be made easier to adjust by making the top section longer than required and then folding back the excess length at the end insulators to lie along the elements themselves. The excess lengths can be temporarily held in place with clothes pegs while measurements are made.

PW