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The M0CVO HW-42HP

A multi-band off centre fed dipole

The starting point of the antenna is the classic off centre fed dipole.

MULTI-BAND. Nigel, M0CVO has built up a reputation over the past few years for making and selling cost-effective HF antennas. I featured his HW-20HP off-centre fed dipole in an earlier issue of *RadCom* and was quite impressed. In fact, the antenna was left up here at my QTH for an extended test and worked well on all bands from 20m to 10m, although you do need an ATU for 17m.

I think my log says it all really with contacts into ZL, VK, and VE7 on CW during the recent Commonwealth Contest, plus DX confirmations over the past year from Amsterdam Island (FT5ZM), China (BG2AUE), Burundi (9U4U) and Burkina Faso (XT2TT) among others. I have been very happy with its performance. And the antenna isn't really even in an ideal position – it is mounted as an inverted V about 8.5m high at the top of a 10m fibreglass fishing pole, hidden in a tree to keep it as stealthy as possible.

So when I was offered the chance to test M0CVO's HW-42HP off centre fed dipole I was eager to try it.

MORE BANDS. This new antenna is designed to operate on all bands from 40m (7MHz) to 6m (50MHz). M0CVO claims it will operate on 40, 30, 20, 17, 15, 12 and 10m without an ATU (SWR <3:1) plus 6m with an ATU. Nigel says it is also possible to operate on both 80m (3.5MHz) and 60m (5MHz) via a good ATU, although the performance will be down.

The antenna is designed to handle 400W key down (CW) or 500W PEP (SSB).

The starting point of the antenna is the classic off centre fed dipole. The overall length of the antenna is 20.28m or 66ft, with a feed point 1/3 of the way along. This gives two legs of 13.52m and 6.76m and a feed point impedance of around 200-300Ω.

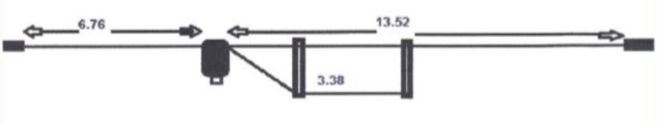
A 4:1 balun of M0CVO's design is added at the feed point to bring the impedance to something closer to the 50Ω required to match to coaxial cable, such as RG8 or RG213.

This classic OCFD design would ordinarily allow low SWR operation on 40m, 20m and 10m, but then Nigel has added a twist.

On the long side of the antenna he has added a separate element that is 3.38m long and connects to the feed point. This element is supported about 60cm under the main wire by two pieces of white 22mm PVC conduit of the type found in DIY and hardware stores. It is because of this length that the antenna has to be shipped by Parcel Force as it exceeds the length the Post Office will accept.

The antenna may be mounted horizontally, as a sloper or as an inverted V. And, if space is at a premium, M0CVO says it may also be 'bent' to fit in, with no loss in performance.

The balun is fitted inside a flame retardant ABS plastic box with a tongue and groove fitting to prevent ingress of both dust and water. It has the obligatory S0239 socket on the bottom with stainless steel screw lugs fitted to the sides whereby the grey insulated wire elements (supplied) connect to the balun inside. The wires are doubled back on themselves, secured by cable ties and then attached to the box via keyring-type retaining rings that take the weight off the connections. This is simple and effective. In the HW-20 version I have been using for the past couple of years I have had to repair one of the connections at the feed point, but this was due to the antenna whipping around in the gales that seem to hit the UK with ever-increasing regularity. The repair was a simple solder job and took less than 15 minutes.



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The far ends of the HW-42HP antenna elements are connected to two plastic dog bone insulators. Heat shrink tubing is used on all joints and the quality of workmanship is good, considering the low price of the antenna.

I tested the balun by placing a 200Ω resistor across the terminals and measuring the SWR with an MFJ-269 analyser. I measured 1.4:1/1.5:1 across the whole 3-30MHz range, which suggests that the impedance transformation is not quite 4:1. This is not uncommon and I have seen other so-called 4:1 baluns that behave in a similar fashion.

I mounted the antenna on the pole used for the HW20, with its apex at about 8.5m with the ends coming down as an inverted V – the longest element ending at about 2m high. Nigel suggests that the end of the second shorter lower element (where it is attached to the white tubing support) can be tied with nylon fishing line to the end of the antenna to keep it taut. I would agree with that idea, otherwise it can tend to fold back on itself.

SWR READINGS. Once erected (and fed with about 30m of RG213 with a 10-turn choke balun at the base of the pole) it was time to take some SWR readings. The table shows the results, but as you can see it was below 3:1 at all frequencies of interest

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and therefore within the range of internal ATUs. The actual SWR at the feed point is no doubt higher, but a length of coax (and its inherent losses) will result in an apparent lower SWR figure at the rig end. Your figures will no doubt be different with your installation.

The overall design has been designed to work on as many bands as possible and this it does remarkably well.

PERFORMANCE. So how does it perform? On back to back tests with dedicated dipoles it was usually equal to or no worse than one S-point down on just about every band. On HF it performed almost identically to the HW-20 OCFD it replaced.

In this installation it was quite a quiet antenna (especially on 21MHz and higher), no doubt helped by getting it as far away from the house as possible and feeding it with a choke balun. It certainly isn't a compromise antenna – I've seen plenty of antennas that offer a 1:1 match, but are deaf on receive and poor radiators. This one is 'lively' and each band was very accessible. A long list of countries worked isn't going to tell you much, but it offers multi-band dipole-like performance in a single antenna and could be a boon for amateurs without too much space.

But what of that design, some credit for which should go to Martin, G6VMR, who assisted in its design. A closer examination shows that the 13.52/6.76m legs gives an OFCD for 40, 20m and 10m. The addition of another leg 3.38m long appears to give a second OCFD with a total length of 10.14m and fed at the one third/two thirds point. In other words, an OCFD for 20m.

But life is not that simple – what you actually appear to get is a more complex arrangement that Nigel has obviously optimised to give the best (low) SWR results across as many bands as possible.

What the design did show (and this was backed up by my antenna model in MMANA-GAL) is that although the website suggests that the antenna could be used on 3.5MHz (80m) and 5MHz (60m), the SWR is very high on those bands, probably outside of the range of most internal ATUs. The performance is likely to be disappointing anyway as it is too short.

Overall then, the HW-42HP offers effective multi-band performance in a single package at a reasonable price. The antenna costs £56.95 from www.m0cvoantennas.com and our thanks to Nigel (07921 639 978) for supplying the review model.

SWR Results

6.298MHz – 1:1
7.000MHz – 2.4:1
7.200MHz – 2.5:1
10.100MHz – 2.2:1
10.150MHz – 2.3:1
14.000MHz – 1.8:1
14.350MHz – 1.2:1
18.068MHz – 2.3:1
18.158MHz – 2.1:1
21.000MHz – 2.0:1
21.450MHz – 1.6:1
24.890MHz – 1.7:1
24.990MHz – 1.9:1
28.000MHz – 2.2:1
29.000MHz – 1.6:1
29.700MHz – 1.4:1
50.000MHz – 2.2:1
51.000MHz – 1.7:1
52.000MHz – 2.6:1
70.000MHz – 3.6:1
70.500MHz – 3.5:1

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Antennas

The Window off-centre fed dipole

PHOTO 1: M0CVO HW-40HP off-centre-fed dipole antenna.

THE DIPOLE. The centre-fed dipole is the most fundamental of all antennas. It is the most popular antenna used by amateurs worldwide, largely because it is very simple to construct and is an effective performer. A centre-fed dipole can be any electrical length as long as it is configured in a symmetrical fashion with two equal length sides. However, in its simplest form, it is made half a wavelength long at the operating frequency because such an arrangement is easiest to feed. The current and voltage distribution on a half wave antenna is shown in **Figure 1**, with high current and low voltage in the centre. Impedance is a ratio of current and voltage, which indicates a low impedance at the centre; a suitable point to feed the antenna using low impedance 50Ω feeder.

At the ends of the antenna, the voltages are high and the current low so the impedances at these points are high. Note that the current and voltage ratios either side of the centre feed point are mirror images of each other and such an antenna is said to be balanced. Ideally, the dipole antenna should be fed with twin wire feeder where the RF power in each conductor of the transmission line is equal, thereby cancelling radiation or interference pickup on the line.

In previous Antennas, I have discussed the pros and cons of a balanced feed and balanced antennas **[1]**, noting that it is probable that the strictly balanced feeder arrangements were derived from commercial practice. These commercial installations used multiple transmitters and antennas. Furthermore, the antennas were located some distance from the transmitters and any unbalance on the feeders resulted in radiation loss and cross-talk to nearby feeders.

OFF-CENTRE-FED ANTENNAS. The half wave dipole is just fine for a single band but if used on higher frequencies the feed impedances can vary dramatically. However, if the feed point is moved part of the way from the centre of the dipole the feed impedance can be increased to any impedance; a 300Ω point is shown in Figure 1. It also has some implications for multibanding the dipole. The current distribution diagram shown in **Figure 2** is based on one by DJ2KY. It shows the current on a half-wave length of wire on 80m superimposed on the current distribution on other higher bands. It can be seen that the current amplitudes on some of the bands coincide at sixth of a wavelength from the end, described by DJ2KY as a 'Windom point' **[2]**.

The current distributions shown in Figure 2 are idealistic, showing the current distributions in free space. In practice, these currents can have slightly different amplitudes and phases due to the proximity of the ground. Furthermore, 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 sixth of a wavelength point are fairly close together on some bands.

Most off-centre-fed dipole (OCFD) antennas appear to be fed with coaxial cable (**Figure 3**). The currents on the centre core of coax cable (I_1) and the inside of the shield (I_2) are equal and opposite. The two conductors are closely coupled along their entire length, so the equal and antiphase current relationship is strongly enforced. This I_1/I_2 relationship is completely independent of the coax environment. The cable can be taped to a tower or buried, yet the equal and opposite nature of I_1 and I_2 inside the cable remain the same.

Enter the 'skin effect' **[3]**, which causes HF currents to flow only (very) close to the surfaces of conductors. This causes the inner and outer surfaces of the coaxial shield behave as two entirely independent conductors. When a coaxial feed is used, the unbalanced nature of an OCFD antenna causes a difference between the currents flowing either side of the feed point. This difference current is shown in Figure 3 as I_3, and is equal to (I_1-I_2). Current I_3 has to flow somewhere. It cannot flow down the inside of the cable because I_1 and I_2 must be equal, so instead it flows down the outside of the outer sheath. As a result, the feed line becomes part of the radiating antenna **[4]**.

A COMMERCIAL OCFD. There are many commercial OCFD antennas on the market and the M0CVO HW-40HP antenna, shown in **Photo 1**, is one of them. The centre consists of a plastic balun box with a SO239 input socket and screws with wing nuts for connection to the dipole elements. Strain relief and a support point are provided by three metal key rings attached through holes in the flange at the top of the box. The insulators at the other ends of the elements are of a very decent, heavy duty type. The antenna is supplied fully assembled as shown in Photo 1. Overall, it is 21.28m (66ft) long and described as an off centre fed dipole designed to operate on the 40m (7MHz), 20m (14MHz), 15m (21MHz) and 10m (28MHz) bands. The documentation with this antenna goes on to say "Having a feed point 1/3 of the way along instead of halfway gives an impedance of between 300 and 400Ω… a 4:1 current balun is added at the feed point to alter the impedance to something closer to the required 50Ω. This then allows the antenna to be fed using standard 50Ω coaxial cable such as RG8 or RG213".

The balun was tested and found to have a transformer action of 4:1 as claimed. It was not possible to determine if the balun was a current (as claimed) or voltage transformer because the unit was sealed. The antenna

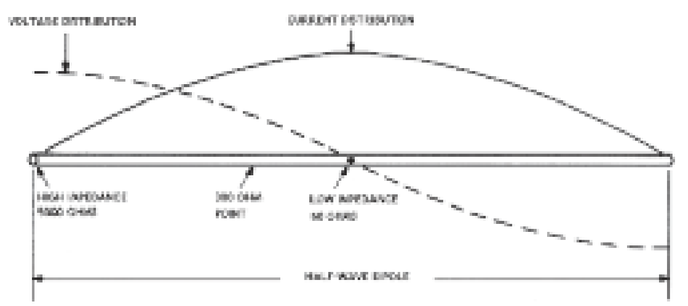

FIGURE 1: Voltage, current and impedance distribution on a half wave dipole.

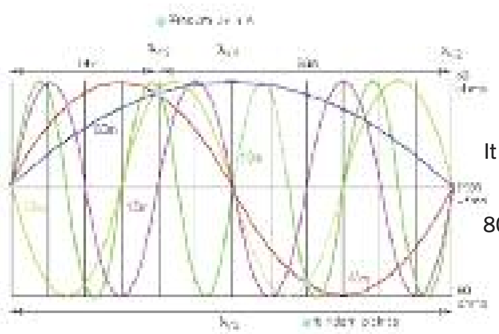

FIGURE 2: The current distribution diagram based on one by DJ2KY. It shows the current on a half-wave length of wire on 80m superimposed on the current distribution on other higher bands.

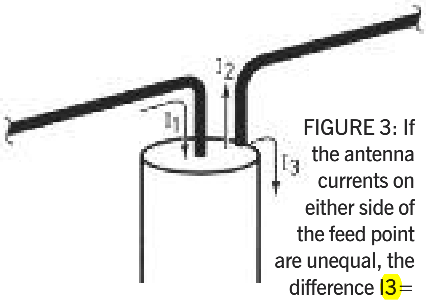

FIGURE 3: If the antenna currents on either side of the feed point are unequal, the difference I3= I1 - I2 will flow down the outside of the cable.

was fixed 10m high at one end and 7m high at the other, with the long element at the high end. (I had previously used this location for a 7MHz dipole during 501kHz/7MHz cross-band tests with VO1NA).

The results of impedance and SWR measurements, measured using the AIM 4170 via a 9m calibrated length of RG58, are shown in Figure 4. SWR is indicated with the thick red graph. Impedances Zmag and Theta are represented by the thin red and purple lines respectively. I noticed that the SWR on 7MHz varied when I touched the coax PL259 connector, indicating the presence of I_3 currents on the outer braid of the coax. Lowest SWR readings were obtained when the coax was laid on the ground. The antenna was then connected via a 25m length of coax to the shack and an MFJ-854 RF current meter was used to measure I_3 currents. With 100W of 7.02MHz RF fed to the antenna, the RF current I_3 at the bottom of the vertical section of coax to the antenna was 500mA. I measured 300mA at the shack end of the coax. These currents were less on the higher frequency bands. In spite of these currents on the outside of the coax no adverse affects such as RF in the shack, TV or audio equipment interference were experienced.

In general, the antenna performed reasonably well. Eastern USA and EU contacts were made on 7MHz without any difficulty. The antenna could be fed without an ATU on the 7, 14 and 28MHz bands (as you might expect from looking at Figure 4), in spite of the resonances being rather low in frequency. The antenna certainly would not load directly on 21MHz as claimed but this band and all the others could be loaded easily using an ATU.

Bearing in mind the asymmetrical nature of the feed, currents on the outside of the coax are inevitable. Some method of controlling them is necessary. Some OCFD builders go to a lot of trouble to eliminate common mode currents from the feed line. The arrangement shown in **Figure 5 [5]** is a multiband OCFD, which uses a 4:1 transformer plus two additional current chokes on the coax. Additionally the coax braid is connected to earth. All these precautions minimise radiation from the feeder on transmit, particularly important if one is using high power. It also reduces interference pick up on receive. I managed to reduce the current on the M0CVO antenna to 120mA in the shack by using a single W2DU current choke.

FIGURE 4: Impedance and SWR measurements of the M0CVO HW-40HP antenna, measured using the AIM 4170.

Overall, I was reasonably impressed with this antenna, although I wonder whether the metal rings would eventually wear through the flange of the plastic balun box.

THE CAROLINA WINDOM. Other antenna designs use the feeder radiation to advantage, a method described by G2HCG as 'Controlled Feeder Radiation' **[6]**. With this method, a current choke is placed some distance from the feed point so that the length of the radiating section of the feeder is preset. A commercial application of this is used with an OCFD known as the Carolina Windom. This antenna is also fed approximately 1/3 from the end using 50Ω coax and the feeder is encouraged to radiate due to the asymmetrical feed point. The physical length over which the feeder radiates is limited to 3m (10ft) by a 'line isolator', presumably a coax outer braid current choke. Radio Works who manufacture this antenna **[7]** have coined a title for the radiating section of feeder and called it VERT (Vertically Enhanced Radiation Technique). Several versions of the Carolina Windom are marketed by Radio Works.

It occurred to me that the M0CVO HW-40HP antenna could be converted to a Carolina Windom simply by adding a current choke 3m (10ft) down from the balun at the antenna feed point. While this reduced the common mode currents considerably, it had an adverse effect on the SWR – to such a degree that the ATU was necessary for all the bands. I don't know why this should be; suffice it to say there is more to the OCFD than meets the eye.

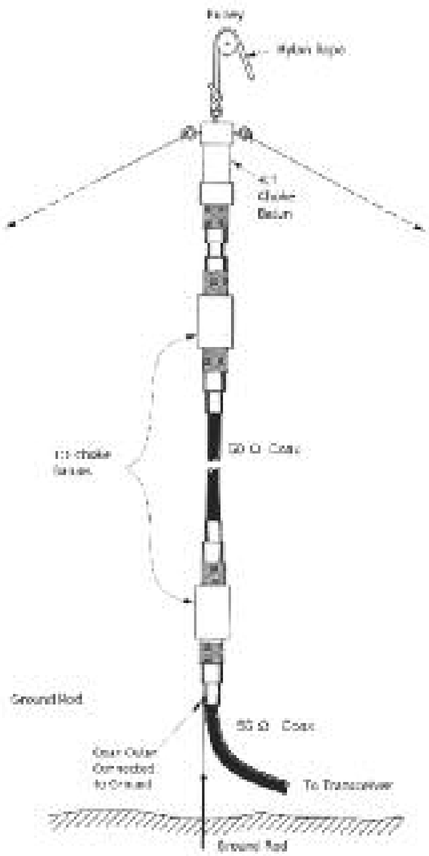

FIGURE 5: The feed system of a multiband OCFD, showing a method for eliminating antenna (I3) currents.

REFERENCES AND NOTES

[1] 'Antennas', *RadCom* January 2006 & March 2006.

[2] The original Windom antenna, popular in the 1940s, comprised a wire element fed by a single wire 'feeder' approximately 1/3 from the end. Such a configuration had to be fed against ground similar to an inverted L antenna.

[3] http://en.wikipedia.org/wiki/Skin_effect

[4] The equal and opposite currents I1 and I2 are often referred to as differential mode currents. I3 currents are often referred to as common mode currents; in some literature they are also referred to as antenna currents presumably because they cause radiation.

[5] From How to Design Off-Center-Fed Multiband Antennas Using That Invisible Transformer In The Sky, Frank Witt, AI1H, The ARRL Antenna Compendium, Volume 3.

[6] Controlled Feeder Radiation, B Sykes, G2HCG, Radio Communication May 1990.

[7] www.radioworks.com