RADCOM TECHNICAL FEATURE

A Multiband Doublet

For 10/18/24MHz

V C Lear (G3TKN/VO1XG)

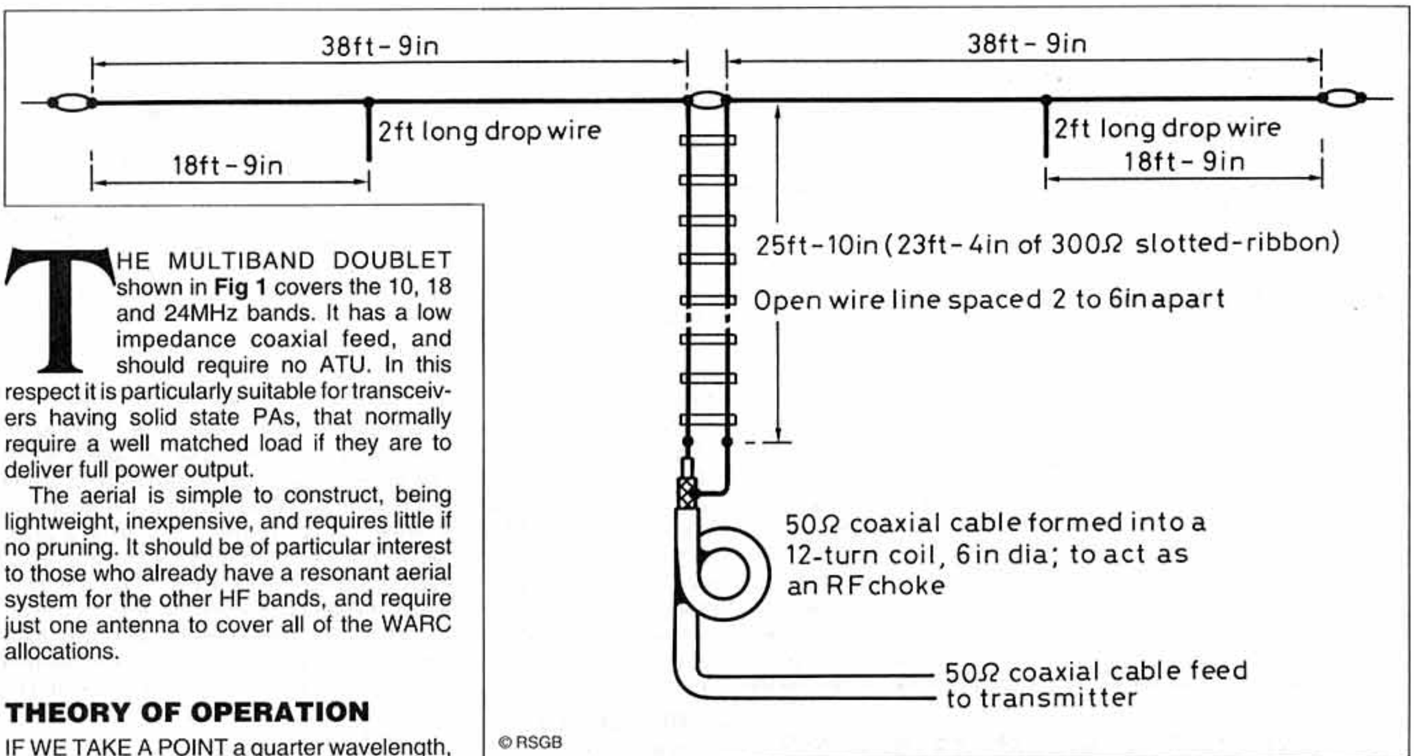

Fig 1: The Doublet is easy to build and can give excellent results.

THE MULTIBAND DOUBLET shown in **Fig 1** covers the 10, 18 and 24MHz bands. It has a low impedance coaxial feed, and should require no ATU. In this respect it is particularly suitable for transceivers having solid state PAs, that normally require a well matched load if they are to deliver full power output.

The aerial is simple to construct, being lightweight, inexpensive, and requires little if no pruning. It should be of particular interest to those who already have a resonant aerial system for the other HF bands, and require just one antenna to cover all of the WARC allocations.

THEORY OF OPERATION

IF WE TAKE A POINT a quarter wavelength, or odd number of quarter wavelengths from the end of a wire, we arrive at a point which has maximum current, and hence low impedance. By observing some odd multiples of quarter wavelengths for each of the WARC bands using the formula;

$$L = 234/f$$

where L = Length in ft of one quarter wave and f = Frequency in MHz

we find the following:

³/₄ wave on 10.125MHz = 69ft 4in

⁵/₄ wave on 18.1MHz = 64ft 7in

⁷/₄ wave on 24.9MHz = 65ft 9in

As can be seen from the above, these lengths are fairly close together. In the multiband doublet, the open wire line or 300Ω slotted ribbon stub, operates with a standing wave on it in each case, and the total length of wire from one end of the aerial to the centre, then down to the base of the stub is such that a point of low impedance is achieved on each of the three bands. The aerial is optimised for 18.1MHz, where the length from one end of the aerial to the centre then down to the base of the stub is five quarter waves. On 10.1MHz it is a little short of three quarter waves, and on 24.9MHz it is very close to seven quarter waves.

To gain a better understanding of the antenna in terms of current distribution, radiation resistance, and radiation pattern, it is easier to analyse the operation of the aerial on each of the WARC bands.

10MHZ OPERATION

THE CURRENT DISTRIBUTION on 10MHz is shown in **Fig 2**. From this we can see that each leg is 0.42 wavelength, and each half of the antenna carries in-phase currents, thus providing slight broadside gain. In other words it operates as two half waves in-phase, or two-element collinear. The theoretical gain of two half waves fed in-phase is 1.9dB. However, one could expect slightly less than this where the elements are slightly shorter, and hence where the current antinodes are closer together.

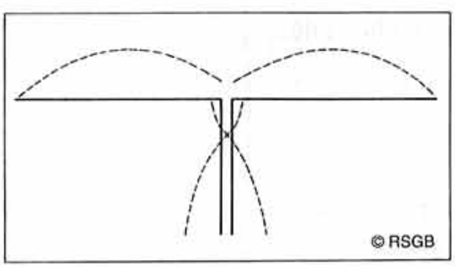

Fig 2: Current distribution at 10MHz.

Measurements with a well calibrated general coverage receiver (Eddystone EC10) and noise bridge placed at the bottom of an open wire (2in spacing) stub indicated resonance around 9.9MHz, with the aerial at about 30ft. A 300Ω slotted ribbon stub produced resonance at 9.7MHz. However, in both cases it was obvious by observation of the noise null that the antenna had a reasonably flat response between around 9.5 to 10.2MHz, and although at 10.1MHz the feedpoint could be expected to show slight inductive reactance (Ra+jX), no problems were encountered in practice. The aerial was fed with power from both a valve PA transmitter (Drake T4XC), and a TS130S with solid state PA. The latter produced its normal power output without the need for any external ATU. SWR figures across the 10MHz band were around 1.1:1 measured at the transmitter end, and different lengths of coaxial feed line produced similar results, indicating the line was operating in a flat condition.

The radiation pattern at 10MHz will be similar to a two element collinear array, maximum radiation being broadside to the wire, with a slightly narrower pattern than a dipole.

18MHZ OPERATION

ON THIS BAND the antenna is three half waves centre fed, and hence we have a low impedance point at the centre of the aerial (see **Fig 3**). The stub, which is exactly half a wavelength at 18.1MHz, acts as a 1:1 impedance transformer, and simply transfers the low impedance seen at the centre of the aerial to the feedpoint at the base of the stub. It should be noted, however, that the impedance at the centre of multiple odd half wavelength aerials increases slightly with the number of odd half waves. In practice, no problems were encountered in this latter case, and SWR figures around 1.2:1 were obtained on the 18MHz band, with the TS130S giving full output.

The theoretical radiation pattern for a three half wavelength aerial consists of four major lobes, each at 42° to the wire. The gain of each major lobe is in the region of 1dB compared to a dipole orientated to give maximum radiation in the direction of one of the main lobes.

24MHZ OPERATION

ON 24MHz, EACH LEG is approximately one wavelength, and the antenna functions as a two wavelength centre fed system. The current distribution is shown in **Fig 4**. However, when resonance was checked using the noise bridge, the aerial was found to resonate at 25.7MHz. This meant that the impedance at 24.9MHz would have a reactive component present, which would be capacitive, so that the impedance would be of the form (Ra-jX)

The SWR was in the region of 2:1, and while the T4XC transmitter with its valve PA would load into the antenna, problems were encountered with the TS130S, which would not now deliver full output at 24.9MHz.

The aerial was lengthened slightly at the ends to bring its point of resonance nearer to 24.9MHz, but this produced an unacceptable match at 18MHz, and a very slight deterioration at 10MHz. It was therefore decided to attach short loading wires a half-wavelength (at 24.9MHz) from the ends of the antenna. This meant the loading wires were at points of high impedance at 24.9MHz, but points of lower impedance at 10 and 18MHz. As a result their effect was less on these latter two bands than it was on 24MHz operation.

In practice the resonant frequency was lowered from 25.7MHz to 25.2MHz using two 2ft loading wires as shown in Fig 1. Although there was a slight lowering of resonance on the 18MHz band, it did not cause any problems, and there was certainly no noticeable difference on 10MHz. The SWR obtained at 24.9MHz was 1.4:1, and the TS130S was now delivering its full output.

The loading wires provide a means of pruning the antenna for the best compromise match on 18 and 24MHz, and depending on its height above ground, and general siting, it is probably worthwhile carrying out a little adjustment of these wires.

It is worth noting that when open wire line was used for the stub, the problem did not arise on 24MHz; the bandwidth appearing greater on each band. Therefore it is only worth fitting the loading wires if matching difficulties are encountered on the 24MHz band.

The radiation pattern at 24MHz will produce multiple lobes, tending towards the plane of the wire, but with slight gain in each of the major lobes.

RF CHOKE BALUN

TWO SIMPLE RF CHOKE type baluns were tried, and both worked well.

The first type was made by simply coiling up the coaxial feeder to make a 12 turn coil, 6in diameter at the point of connection to the base of the stub.

The second type was one described by G2HCG, [1]. It is re-

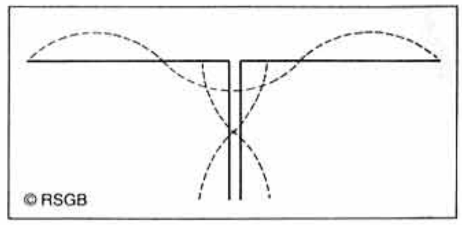

Fig 3: Current distribution at 18MHz.

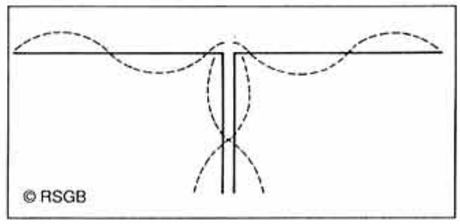

Fig 4: Current distribution at 24MHz.

produced in **Fig 5**. It was found possible to just squeeze on 10 turns of UR43, wound as shown in the diagram. If UR43 50Ω cable is used throughout, no breaks in the cable are necessary until it joins onto the stub. However, UR67 heavy duty 50Ω was used to keep losses to a minimum at 24MHz, and a well weatherproofed barrel connector was used to join the PL259 plug on the end of the balun to the PL259 on the UR67 coaxial feeder.

The simple choke balun is probably to be preferred for this antenna, as some slight reactance is present at 10 and 24MHz. Many of the commercial baluns are trifilar wound on a ferrite core, and while they work in a satisfactory manner into a resistive matched load, internal losses can increase if they are used where the load becomes reactive. However, a commercial 'W2AU' type balun was tried both with the open wire line and 300Ω slotted ribbon stubs, with no noticeable drop in performance.

CONSTRUCTION

IF THE STUB SECTION is made from open wire line, this can use 16-18SWG wire, spaced anywhere from 2 to 6in. Spreaders may be easily made from sections of plastic curtain rail, or small diameter PVC piping. If plastic curtain rail is to be used for the spreaders, it is essential to make sure it is of all plastic construction, with no metal strengthening rod running through the middle. Constructional details for the open wire line are shown in **Fig 6**.

Slotted 300Ω ribbon feeder (type GMP6) offers another alternative for the stub, and is less obtrusive than open wire line. However,

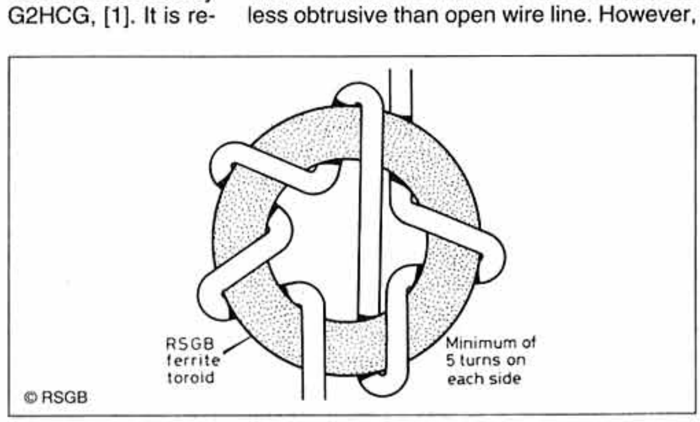

Fig 5: RF choke balun.

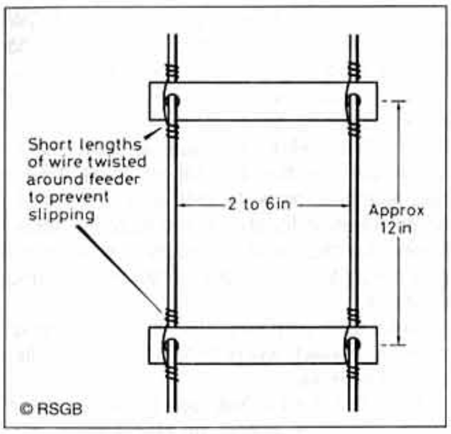

Fig 6: Detail of open wire line construction.

it can be affected more by weather than open wire line, although the differences are probably undetectable. The solid dielectric 300Ω ribbon is not to be recommended, but if it is used its lower velocity factor (normally about 0.82) must be taken into account when calculating the stub length.

The 300Ω slotted ribbon was connected to the centre of the aerial using a short length of polypropylene cord, threaded through one of the slots in the feeder, to take the weight of the cable. This relieved mechanical strain at the soldered joints.

A dipole 'T' piece was used to connect the ribbon to the coaxial cable via the RF choke balun. Again a small piece of cord was threaded through the slot in the ribbon to take the weight off the points of connection to the 'T' piece.

OPERATION ON THE OTHER BANDS

THE DOUBLET HAS ALSO been used on all bands for 7 to 28MHz inclusive, by extending the stub into the 'shack' and connecting to a balanced ATU. Although this takes away the principal advantage of the doublet using just one coaxial feed, it does offer the opportunity to extend its coverage.

It should be remembered that when used in this way, the impedance offered to the ATU will be dependent upon the length of open wire or slotted 300Ω ribbon between the aerial and the ATU. An ATU with balanced antenna connections should be used.

On 7MHz the antenna is only 11.5ft short of a double extended zepp. The double extended zepp is basically two five-eighths-wavelength sections fed in phase, and can offer 3dB gain over a dipole. Maximum radiation will be broadside to the plane of the antenna with a bi-directional lobe narrower than that expected from a dipole.

On 21 and 28MHz the doublet will offer multi-lobe radiation patterns in much the same way as it does at 24MHz.

RESULTS

THE ANTENNA HAS BEEN used mainly on the WARC bands in the form shown in Fig 1, using both open wire and 300Ω slotted ribbon stubs into coax. The apex height has been 40ft, with both ends sloping down to about 25ft.

With the antenna running N/S, particularly good results have been obtained on 18MHz on both long and short path into VK. When the antenna was first tried on 10MHz, the first report received was a S9+10dB from North America which was rather encouraging. However, it did seem rather directive on 10MHz, and as expected the best reports come from stations in an E/W direction.

On 24MHz it has given good contacts into Africa and California, but does appear quite directive as one would expect with a multi-lobe radiation pattern.

CONCLUSION

THE ANTENNA DESCRIBED offers a simple and inexpensive way to sample all three WARC bands.

It should be noted that one is more likely to have a greater degree of success with a simple wire antenna at 18 and 24MHz because the general level of QRM is less on these allocations than on the more established amateur bands.

FURTHER READING

[1] 'Controlled Feeder Radiation', B Sykes, G2HCG, *RadCom* May 1990

[2] 'The G5RV Antenna - up to date', L Varney, G5RV, *RadCom* July 1984

[3] 'ATU or ASTU', L Varney, G5RV, *RadCom* August 1983