

6 Douglas Crescent, Kelso,
Roxburghshire TD5 8BB.

A multi-band inverted-V dipole for portable operation

PART ONE

At the time of writing, the author had activated 148 islands, 136 of these in the last eight years for the SCOTIA (and IOSA) Scottish island award programmes (for further information, see his website www.gm3vlb.com). Operating time is generally limited, with most operations (many of which have been 'solo') being of 1 or 2 days' duration. The majority of Scottish islands are uninhabited, and often inhospitable. Landings may have to take place in a strong Atlantic swell, and from very small craft such as a dinghy or RIB. ('rigid inflatable'). The time-consuming assembly of complex rotary beams has heretofore never been considered. Likewise, any amplifier would necessitate both a larger and heavier generator and more fuel. Even if used in conjunction with a beam, such a setup would be unlikely to give more than a few dB gain over the Kenwood TS-50S running 100W into a well-matched inverted-V near the sea. In practice, it has been found that 50W ($1/2$ an S-point less at the receiving end!) is frequently adequate. Indeed, given reasonable conditions and 'split' operation, the use of QRP is a perfectly viable option. All Scottish island operations have used one or more of either short, loaded 'fishing-rod verticals' or inverted-V multi-band dipoles. This article looks more closely at the latter.

The principal advantage of the inverted-V dipole is that it requires only one, central, support. The main 'mast' used by the author is ex-army and comes in a convenient shoulder bag containing eight 1m long fibre-glass poles, two sets of guys (three at

Operating /P on the island of Killegray, Outer Hebrides.



In this first part of a two-part article, GM3VLB describes one of his latest designs, which has been tried and tested.

the centre and three at the top) and a simple pulley system (an ultra-light-weight version using a 'roach pole' has also been constructed). The mast is easily erected by one person, even in a howling Hebridean gale, and supports the antenna, which acts as a resonant $\lambda/2$ inverted-V dipole on each of the 20m, 40m and 80m bands. The antenna can also be used on the 15m band, where it behaves as a $3\lambda/2$ dipole ($3\lambda/2$ means 'one and a half wavelengths' – 21.150MHz is 3×7.050 MHz, so $\lambda/2$ on 40m is $3\lambda/2$ on 15m).

A second, lighter, multi-band inverted-V covering 10m, 12m, 15m, 17m (and 30m with end extensions) supported at about 7m by a roach pole, is also available. (The author has recently tested another design of the same overall length as the 20/40/80m version, but with a slightly different configuration and in which the 20m dipole is $3\lambda/2$ long, giving a small, though useful gain on this band and with two additional main lobes, giving increased global coverage - see the Appendix next month for details.

As stated above, these antennas are complemented by a variety of multi-band verticals, most of which can also be used /M on islands with vehicular access.

BASIC DESIGN CONSIDERATIONS

The multi-band dipole is set-up in inverted-V configuration, ie the central feed-point is at the apex of the Λ at the top of the mast, with the two halves sloping down to points about 60cm (2ft) above the ground. On 20m and 40m, it is designed to be resonant mid-way between the IOTA CW and SSB frequencies generally favoured by island operators and (corresponding in this case to 14.150MHz and 7.050MHz). On 80m, the design frequency is 3.772MHz. A switched linear balun transformer at the feed-point (giving a choice of two ratios, either 1:1 or 2.25:1) allows impedance matching as well as unbalanced coax-to-balanced dipole operation. The feed-line consists of a 13.6m length of 50 Ω RG-58 coax (75 Ω coax was used, unwittingly, for several years - see below). This is a velocity factor-corrected half-wavelength on 40m, two half-wavelengths on 20m and three on 15m. On these bands, the coax simply

reflects the impedance at the load end – in this case, the input to the balun. On 15m, 20m and 40m, this is reasonably close to 50 Ω , thus providing a good match to 50 Ω coax and thence to the TS-50S.

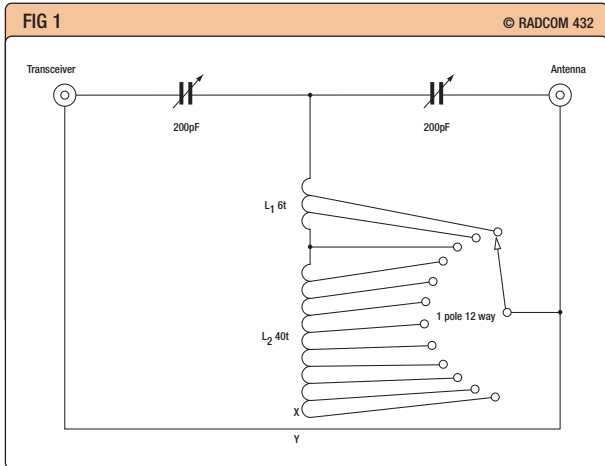
On 80m, at a height of only 8m (0.1 λ), the textbooks would suggest an input impedance of only a few ohms. In practice, it would seem to be quite a bit higher, and can approach 50 Ω . However, at the time of the early experiments, the author did not possess an antenna analyser. A lower value of around 20 Ω was therefore assumed (had the physics teacher not repeatedly said "Never assume anything boy!"). A 2.25:1 balun was designed to raise this to nearer 50 Ω to provide a better match for the coax and the TS-50S. When the system was tested using this balun, the VSWR was, indeed, as predicted. Switching over to the 1:1 balun resulted in an unusable VSWR! All worked perfectly - except the maths!

One day, some years later on the island of Rum, a coax fault occurred. The spare coax was installed. Result? High VSWR on 80m! With the help of island partner Alex, G6MDHZ, and whilst battling the most intense infestation of midges ever experienced, everything was tried and tested...to no avail.

Later, whilst repairing the faulty coax, it was noticed to be of slightly larger diameter. It had been made from a length of RG-59 salvaged from the author's 5Z4 days in the π -output 1960s! It was 75 Ω coax and not 50 Ω as originally thought!

So why did it work? Well, it's amazing how you can 'prove' something with the wrong mathematics! Now, by working backwards, and applying what was believed to be the correct quarter-wave transformer formula, but the terms of which had been inadvertently transposed, the actual antenna impedance had been 'proved' to be 33.75 Ω – this had seemed entirely reasonable!

In fact, no-one had challenged this 'proof' until a few weeks ago when Dale, WB6BYU, in Oregon e-mailed me saying (ever so diplomatically!): "You're wrong mate! The formula should be: $Z_{\text{coax}} = Z_{\text{load}} \times Z_{\text{rig}}$. If we again work 'backwards' using $Z_{\text{rig}} = 50\Omega$ and $Z_{\text{coax}} = 75\Omega$, we get



$Z_{load} = 112.5\Omega$.

Remembering our 2.25:1 balun, the antenna input impedance must in fact be $112.5/2.25 = 50\Omega$!

WB6BYU said that his own experiments indicated the input impedance was nearer this value and, if this was the case, all that was required was to use the 1:1 balun and 50Ω coax! This, in fact, is the case! This just shows that you shouldn't always believe what you read! Thanks, Dale...

ATU OR NO ATU?

Clearly, the antenna system is resonant and matched and an ATU is therefore not normally required on any of these bands (ie 15m, 20m, 40m or 80m). The author is basically 'anti-ATU', but does carry a very small homebrew T-match ATU consisting of two 200pF semi-variable capacitors, modified to have a shaft, and a switched 40-turn toroid + 6-turn fixed coil assembly – this is primarily used to tweak the GM3VLB multi-band fishing rod verticals which are also essentially resonant. See the ATU photograph.

Details of the ATU

Referring to **Fig 1**:

L1: 25mm diameter, 6t of 16SWG tapped at 2, 4 and 6 turns.

L2: T130-2 toroidal core, 40t of 18SWG, tapped at 2, 4, 7, 10, 14, 19, 25, 32 and 40 turns.

NB: Do not be tempted to connect x to y as this creates shorted turns which are not permissible when using toroidal cores.

CONSTRUCTION OF THE BALUN

Although now superfluous, the design and the construction details for the dual-ratio balun are included, as it may prove a useful accessory when attempting to match other balanced antennas. It is built into a standard 75 x 50 x 25mm ABS box (see diagrams and the photograph). Three eyes are screwed into a piece of thick (7 or 8mm) plastic in the top half of the box. One eye is for the pulley, and the other two for the dipole legs. The box contains the switched balun, con-

Fig 1: Circuit of the mini-ATU.

Details:

L1: 25mm diameter, 6 turns / 16SWG tapped at 2, 4 & 6 turns.

L2: T130-2 toroidal core, 40 turns / 18 SWG tapped at 2, 4, 7, 10, 14, 19, 25, 32 & 40 turns.

NB: Do not be tempted to connect X to Y as this creates shorted turns which are not permissible when using toroidal cores.

Fig 2: Wiring details of the quadrifilar dual-ratio balun.

Fig 3: Constructional details of the balun.

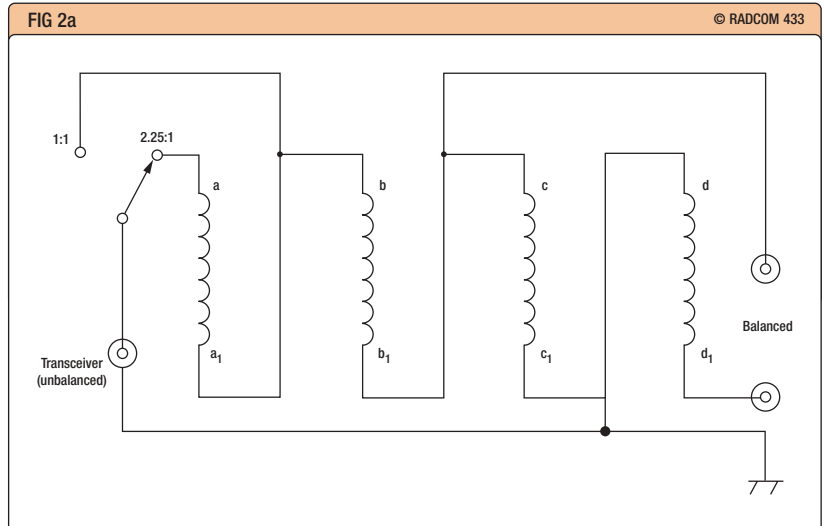
Fig 4: Details of the antenna.

Fig 5: Insulator construction.

Right, top: The mini-ATU.

Right, middle: The switched dual-ratio balun.

Right, bottom: One of the insulators.



sisting of a quadrifilar winding on a ferrite rod approximately 6cm long, a SPDT miniature toggle switch and a BNC socket with weather shield (the author uses a plastic bottle top). Brass bolts with wing nuts protrude through the back of the box to accept the 'spade' ends of the dipole. Inside the box, the connections are soldered to the heads of the bolts to reduce the risk of corrosion and/or poor contacts.

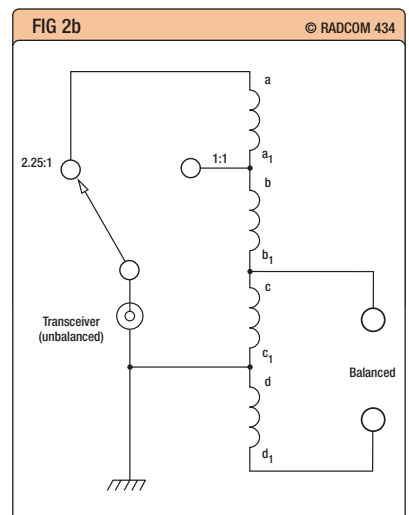
Winding the Balun

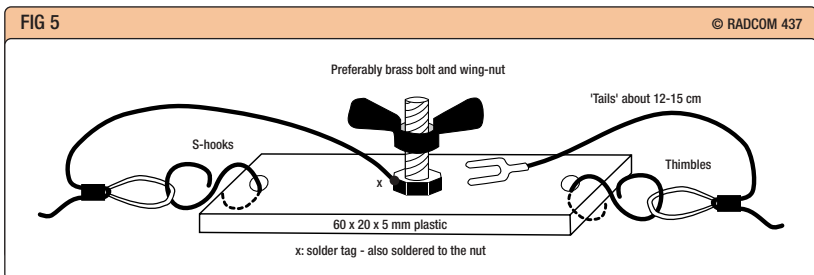
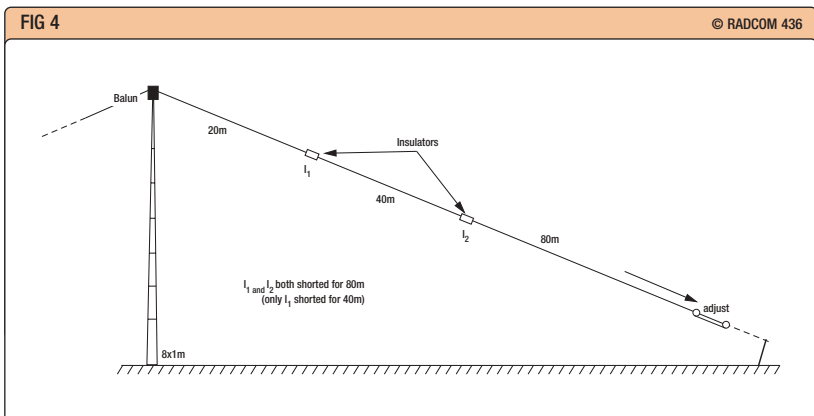
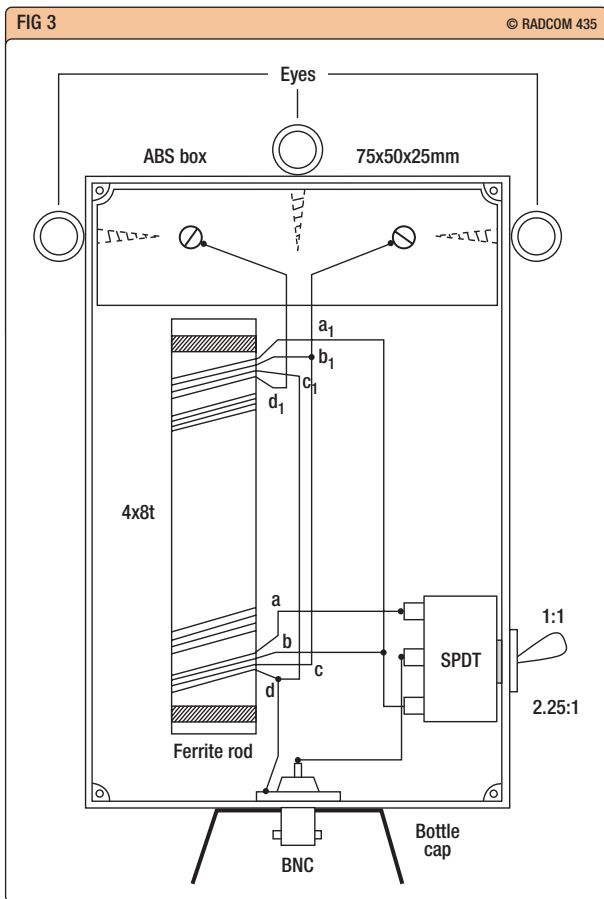
Fig 2 shows the circuit diagram of the dual-ratio balun, and **Fig 3** the constructional details. Stretch four 45cm lengths of enamelled 20 or 22SWG copper wire from a vice to remove any kinks. (different colours are ideal). Twist these together about eight times. Wind eight turns onto a 10mm diameter ferrite rod, about 6cm long (perhaps salvaged from a transistor radio?), holding the ends in place with tie-wraps (for example).

With tag-strip fixed to the ends on the windings (not shown), use further enamelled wire to make three links between a₁ and b, b₁ and c, and c₁ and d (make these links as short as possible). All links and joints should be soldered – do not rely on purely mechanical connections.

Construction of the dipole legs

There are two insulators (see the photograph and **Fig 4**) on each leg, made from suitable plastic (test in a microwave oven first!) about 60 x 20 x 5mm, each with a hole at each end to take a small S-hook attached to the small strain-relieving thimbles (**Fig 5**) at the ends of each element. A central brass bolt and wing nut allows a particular element to be connected or not (a plug and socket arrangement, or 1/4in spade connectors could also be used). The lower ends of the 20m and 40m elements are soldered to the heads of the bolts whilst the upper ends of the 40m and 80m elements have 13 – 15cm 'tails' with U-shaped tags to fit under the wing-nuts. The thimbles can be pro-





professional, metal or plastic, or can be otherwise improvised.

Band changing is simple – simply lower the dipole, disconnect the unwanted segment(s) and hoist the aerial up again – two minutes at most!

NEXT TIME...

GM3VLB looks at the numbers behind the design, the nature of the ground and the height of the antenna ends above it. Dimensions are given for the bands in use. ↕

Diode Communications

UK Stockist for the ECOFLEX® Range of cables and connectors
Aircell®7 7mmø UltraFlexi coax £1p/m or £89 100m Drum

Ecoflex®10 UltraFlexi LOW LOSS £1.40p/m/£130 100m Drum

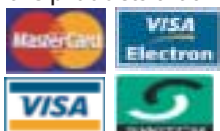
Ecoflex®15 Ultra Low Loss & Flexi
 0-25m = £2.85p/m
 1/2 inch 50R coaxial Cable 26-50m = £2.75p/m
 51-75m = £2.70p/m
 100m DRUMS = £265

RG174 Mil-C-17 spec miniature coax 50R.....30p/m
 Single core Audio cable with screen.....30p/m
 4 Core with lapped screen.....45p/m
 7 Core Heavy Duty Rotator Cable.....70p/m

CONNECTORS
 UHF/PL259 7mm Paxoline Insulator.....85p
 UHF/PL259 7mm Teflon insulator Gold Pin.....£1.75
 UHF/PL259 7mm Teflon with Gold Pin CLAMP FIT.....£2.75
 UHF/PL259 Paxoline Insulator Large cable (10mm).....80p
 UHF/PL259 Teflon/Gold Pin CLAMP FIT Eco10/W103...£4.25
 N-Plug Ecoflex10/W103/LMR400 CLAMP FIT.....£5.65
 N-Plug Aircell7 and other 7mm cables.....£4.50
 N-Plug SolderLess Ecoflex15 NO SPECIAL TOOLS!!!.....£7.50

Please go to the website or call for all the products that we sell too many to list here.

WEBSITE www.diodecomms.co.uk
 EMAIL.....sales@diodecomms.co.uk
 Tel/Fax 01226 758885



New books and CDs for worldwide radio! HF E-mail radionets and digital data decoding

2005 SUPER FREQUENCY LIST CD-ROM

all broadcast and utility radio stations worldwide!

9,300 entries with latest schedules of all clandestine, domestic and international broadcasters on shortwave. 10,100 frequencies from our 2005 Utility Radio Guide. 20,200 formerly active frequencies. All on one CD-ROM for PCs with Windows™. You can search for specific frequencies, countries, stations, languages, call signs, and times, and browse through all that data within milliseconds. It can't get faster and easier than this! · EUR 25 = £ 17 (worldwide postage included)



2005 SHORTWAVE FREQUENCY GUIDE

Simply the most up-to-date worldwide radio handbook available today. Really user-friendly and clearly arranged! Contains more than 19,000 entries with all broadcast and utility radio stations worldwide from our 2005 Super Frequency List on CD-ROM, and a unique alphabetical list of broadcast stations. Two handbooks in one - at a sensational low price! 508 pages · EUR 35 = £ 24 (worldwide postage included)

2005/2006 GUIDE TO UTILITY RADIO STATIONS

Includes many new HF email digital data radionets that we have cracked! Here are the really fascinating radio services on SW: zero, diplo, maritime, meteo, military, police, press, telecon, and terrorists. 10,200 up-to-date frequencies from 0 to 30 MHz are listed, plus hundreds of new decoding screenshots, abbreviations, call signs, codes, explanations, memo/NAVTEX/press schedules, modulation types, all Q and Z codes, and much more! 580 pages · EUR 45 = £ 31 (postage included)



Special package price: CD-ROM + Shortwave Frequency Guide = EUR 50 = £ 34. For more package deals and a full list of our products see our website and catalogue: books, CDs, frequency databases. WAVECOM Digital Data Decoders = the # 1 worldwide: ask for details. Cracks ALE, Factor-2 and its variants, plus 100+ other models! Sample pages and colour screenshots can be viewed on www.klingenfuss.org. Payment can be made by AmEx, Eurocard, Mastercard. No cheque! Please ask for our free catalogue with recommendations from all over the world. We've been leading in this business for 36 years!

Klingenfuss Publications · Hagenloher Str. 14 · D-72070 Tübingen · Germany
 Fax 0049 7071 600849 · Phone 62830 · info@klingenfuss.org · www.klingenfuss.org