IDEAS FROM ABROAD

TRANSLATED AND EDITED BY ERWIN DAVID, G4LQI

THE CONCLUSION OF DL1VU's SARDINE TIN OPENER (STO) with comments and MININEC computations by **Peter J Swallow, G8EZE**, and additional applications by **Erwin David, G4LQI**.

THE 1988 λ/8 STO is the next step. Applying the same calculations to its original symmetric form, **Fig 1d**, the uncompensated areas are: left +0.261, right -0.116; this unbalanced situation can be corrected by making the flat top lopsided, with approx. 60% of the span on the side connected to the feed point; **Fig 1e**. Now the areas are equal: left +0.192, right -0.192; the best yet.

The new top load with a span of only λ/8 permits construction of short yet very efficient radiators. The field strength on the horizon at a distance of 1km from an unloaded vertical radiator fed with a power of 1kW, neglecting all losses, is given by:

$$E=\sqrt{(3,600,000/R_r)} \times (1-\cos\beta h)$$

in which E is field strength in mV/m, R_r is radiation resistance, β is 2Π/λ and h is antenna height in λ. A T-antenna with the new low-radiation flat top delivers a surprising field strength on the horizon when compared with unloaded verticals. In **Fig 4**, the height of the radiator is marked off on the X-axis; the field strength on the horizon is read on the Y-axis. The field strengths calculated for common verticals are the broken horizontal lines marked 0.25λ (314mV/m), 0.50λ (380mV/m) and 0.64λ (444mV/m).

The field strength of unloaded verticals is plotted as a dotted curve; an infinitesimally short radiator, according to Hertz, produces 300mV/m. This is a purely theoretical value. As the antenna height increases, the field strength rises to its maximum where it touches the 0.64λ line, then goes back down.

At h = 1λ, field strength on the horizon is zero, with all radiation at high angles, ie useless for DX. *[though useful when short skip is required - Ed].*

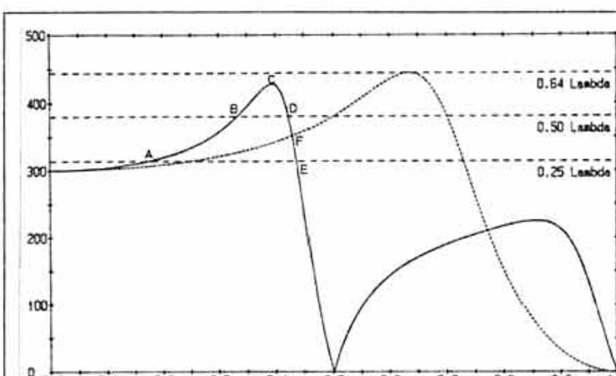


Fig 4: Field strength vs antenna height (dotted curve: unloaded vertical. Solid: new T-antenna).

The field strength of a T-antenna with non-radiating 90° flat top is shown as a solid curve. It also starts at 300mV/m, rises more steeply and at point A at a height of 0.18λ surpasses that of a λ/4 vertical. At point B, the 0.34λ high T does as well as a λ/2 vertical. Finally, at point C, the 0.39λ high T produces its maximum field strength of 428mV/m, almost as much as the 0.64λ vertical in spite of the height reduction by λ/4.

Fig 5 shows the vertical-plane patterns of 0.25, 0.5 and 0.64λ unloaded verticals, the latter often somewhat mislabeled as a five-eighth antenna, and the 0.39λ high STO T. The T's low-angle radiation approaches that of the 0.64λ vertical but its high-angle minor lobe is 1.8dB smaller.

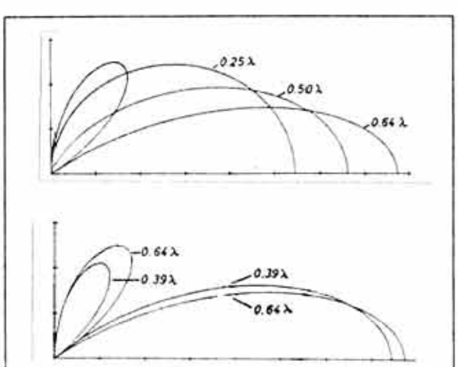


Fig 5: Vertical Radiation patterns of 0.25, 0.5 and 0.64λ verticals and new 0.39λ T over perfect earth.

CONSTRUCTION

THE NEW ANTENNA IS easy to build. The DL1VU 7MHz antenna is made of stranded hard-drawn copper wire. The 20cm end pieces are of copper pipe with steel inserts for rigidity. A good insulator should be used at the free end.

The flat top was stretched between two trees by means of 2mm polyester line. The 16.7m vertical radiator hung down from it and was terminated in an ATU at ground level. The feed point impedance was measured to be 90 - j450Ω; not what I expected but it then had a ground plane in one direction only; accordingly, this measurement may not be typical. The antenna was matched with an L-network. It and the coax were earthed to a ground mat now consisting of 48 radials, each 21.5m long.

DL1VU's article ends here but, during translation, several questions and additional applications came to mind.

DL1VU'S IMPROVEMENTS IN DX TERMS

FOR URBAN AMATEURS seeking low-band DX, a vertical with 90° top load has special advantages: maximum radiation-producing current is at the top, high and in the clear, whereas a ground mounted monopole has its maximum current at the bottom, as likely as not between the houses.

To repeat, the purpose of the top load is to place the current maximum at the top of the vertical radiator while losing a minimum of power by radiation from the top load itself. How strong, however, is the unwanted radiation off the various models of flat top? DL1VU does compare the flat tops with one another, but not with the wanted radiation off the vertical. G8EZE computed that radiation from the flat top of a T of three λ/4 legs in free space is, at 45° off the horizontal wire where it is maximum, 10dB down from the field strength due to the vertical leg: a less than 5% loss of field strength at the target, though on receive it may occasionally spoil a null towards a QRM station. Under the same conditions, maximum radiation off the original (symmetrical) STO was 30dB down, ie negligible both on transmit or receive. The effort to still further reduce radiation from the STO by making it lopsided is believed trivial as well as suspect: because the wire is folded back onto itself, the current distribution along the wire cannot be expected to be sinusoidal, a basic assumption for all of DJ1VU's calculations. Therefore, DJ1VU's method is valid as a first ap-

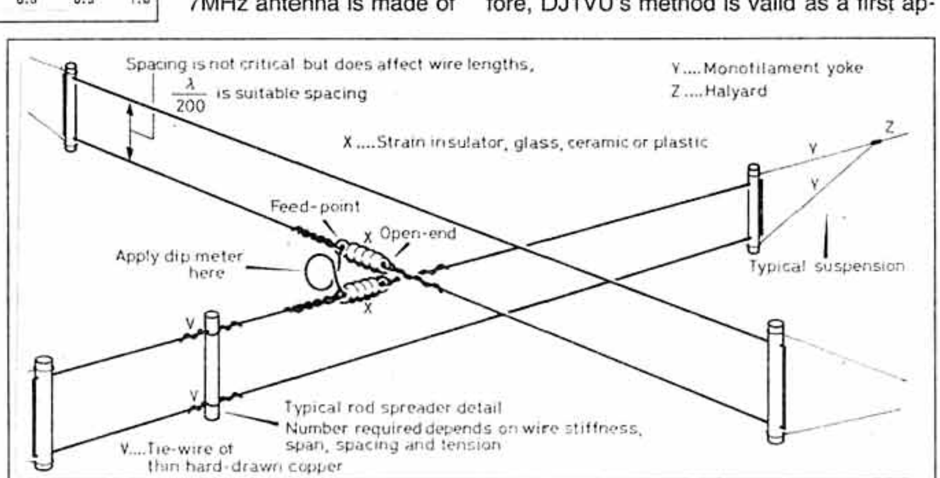


Fig 6: Checking the frequency of a pair of STOs with a dip meter.

proximation, but not when it comes to low-level details. What then is the merit of the STO? Mostly small size and hence modest demands on its supports. With it, you can buid antennas in places where one of the larger flat tops would be impossible or undesirable, with no apparent loss of performance, except possibly band width.

PHYSICAL VS ELECTRICAL LENGTHS

DIMENSIONS IN DJ1VU's article are given in terms of electrical wave lengths with no mention of physical measurements. It is well known that, for a given fraction of a wavelength, a bent (quad loop) or coiled (rubber duck) wire must be longer than a straight wire. How long then must the wire be which, when folded, makes a $\lambda/4$ STO? Wire gauge, spreader length and capacity across the insulator at the unconnected end come into it but no formula was found. Fortunately, the resonant frequency ($\lambda/2$) of a pair of identical STOs can be measured; they are temporarily suspended within easy reach from the ground at right angles to each other so that they cross, just without touching, at their feed points. A short wire, U-shaped at VHF or coiled into one or more turns at HF, interconnects the two feed points and couples to a dip meter to find resonance **Fig 6**. Dimensions can then be adjusted to move resonance to the desired frequency. At G4LQI, two 358mm lengths of Bofa 300Ω ribbon made into a pair of 342mm long STOs with an 8mm gap between feed point and open end resonated at 145MHz; 692mm of wire made 517mm of electrical length, ie a 34% lengthening factor. Similarly, using open (ladder) line with 1mm bare wire spaced 25mm with 6mm diameter

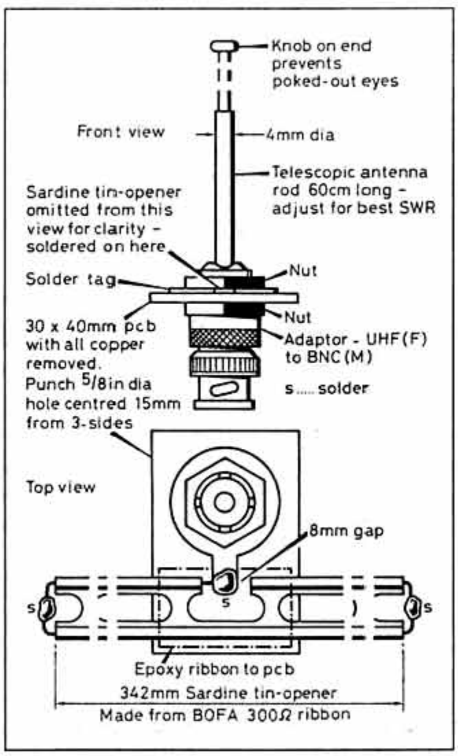
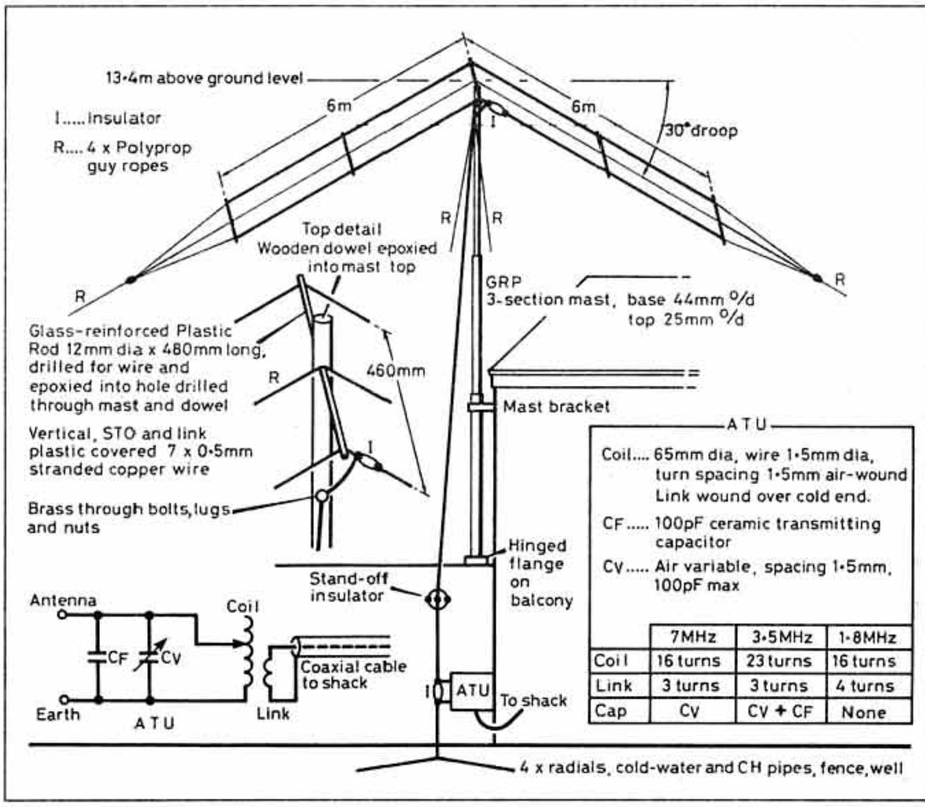


Fig 7: 145MHz ground plane vertical for use with a hand-held transceiver. During the 1990 Strathclyde Special Olympics, Raynet operators seated in packed city buses could maintain communication with this antenna where 'rubber ducks' were inadequate.



	7MHz	3·5MHz	1·8MHz
Coil	16 turns	23 turns	16 turns
Link	3 turns	3 turns	4 turns
Cap	CV	CV + CF	None

Fig 8: The STO can be hung as an inverted-V. This antenna was designed for 3.75MHz but also works well on 1.8 and 7MHz.

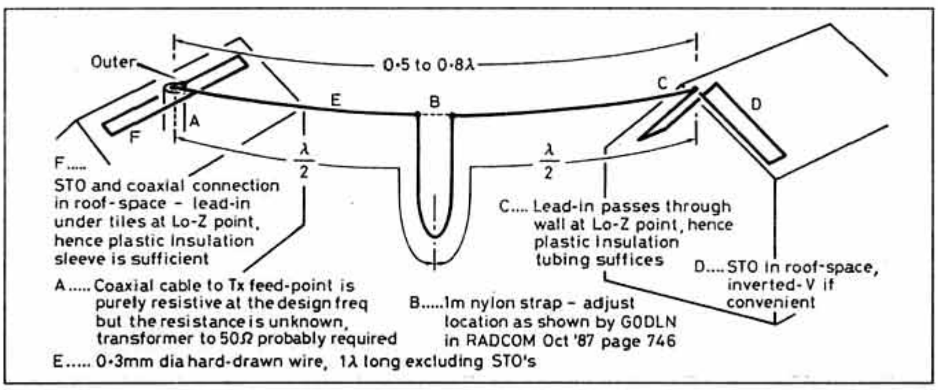


Fig 9: A collinear antenna as short as $\lambda/2$! It was designed, but is as yet untried, as a short-span alternative to the 'invisible DX antenna' described by G0DLN in *RadCom*, Oct '87.

plastic spreaders every 150mm, and a 51mm ceramic strain insulator between open end and feed point, a 29.6MHz STO had a span of 1.63m; 29% of extra wire.

The flat top must be of exact electrical length only if its feed point is to be purely resistive, eg if a coax feeder is to be connected there as in **Figs 7 & 9**. In DL1VU's own application, and in that of **Fig 8**, non-resonant antennas by nature, a shorter flat top would merely move the current loop down on the vertical wire. There would be no noticeable difference in performance though the measured feed point impedance and hence the ATU components would be different from those calculated.

An inverted-V style STO is effective atop a single vertical radiator. G8EZE has computed that a droop of 45° in the two halves of an STO on top of a 0.39λ vertical costs only a negligible 0.4dB in field strength on the horizon, a small price for saving a support. G4LQI's current 80m antenna, **Fig 8**, has a drooping STO on top of a 0.16λ vertical of which the lower 0.07λ closely skirts the salt-water drenched wall of the house. Though no objective comparison of performance can be made with an earlier $\lambda/4$ inverted-L on the same mast, raising the current loop up into the clear has considerably eased RFI to the telephones in the house.

OTHER APPLICATIONS

THE FEATURES OF THE DJ1VU flat top, ie virtual earth and current loop at its feed point together with small size and minimum radiation, are not unique to T-antennas. They also are the very requirements for counterpoises at the bottom of vertical antennas of which the ground plane vertical is but one example. Compare the STO with G6XN's linearly loaded 'best-buy' counterpoise on p165 of his book *HF Antennas For All Locations* (published by RSGB - see price list); DJ1VU's flat top is a cleverly optimised version of that counterpoise! Identical STOs could even be used as counterpoise and top load in one antenna, horizontal or vertical, eg in colinear arrays. See **Fig 9**. ❑