RADCOM TECHNICAL FEATURE

The 7f Miniloop

by Dick Bird, G4ZU

COMPACT, SURE-FIRE antennas with 50Ω feed have many attractions for those with limited garden space. Or perhaps you need an easily transportable antenna, which can be pressed into use for operation from a holiday location, or a camping site.

ASSESSING ALTERNATIVES

MANY BEGINNERS ARE hesitant about installing a rotary beam antenna, partly because of cost, and partly because even a ten metre beam is a pretty enormous and complicated structure, (at least, when you lay it out on the little patch of lawn in your back-garden). A half-wave dipole requires a couple of supporting masts, and the direction of fire cannot be changed, unless it is made of dural tubing and has some sort of rotating mechanism.

During the past few months, therefore, I have been experimenting with a variety of different antenna structures to discover just how far one can reduce the dimensions without serious loss of gain. On 80 metres, when space is at a premium, we are often obliged to use inductively loaded verticals, and put up with a performance which will certainly be quite a few decibels down on a half-wave dipole. As we go higher in frequency, things become somewhat easier, and loop type structures in particular, begin to offer quite evident attractions.

I played around for a while with the so-called 'magnetic-loop', but decided that this was not the ideal solution, because of the indifferent performance, and the need for remote-controlled tuning and gamma match capacitors. I also tried various forms of 'mini-quads', mini delta loops and so on.

Finally I finished up with such a mass of data in my various antenna files and was forced to find some means of identification, so that I could quickly lay my hands on gain and bandwidth figures for any particular design. Coding by general shape seemed the simplest solution, so I decided to use Hexadecimal graphic symbols, a square for mini-quads, a triangle for delta loops, and so on. The Mini-loop I am about to describe is of triangular shape, and the antenna gets its name from the ASCII code for a triangle (hexadecimal 7F).

SHAPES AND SIZES

MEASUREMENTS FOR the '7F Mini-loop' are only about 1.5 metres x 3 metres, so it can be fixed to any convenient chimney, or even inside the loft space. For portable work, it can quite easily be folded up, and stowed on a roof-rack, just like a pair of skis. One major attraction of the Mini-loop is that it can be directly fed with ordinary 50Ω cable – complicated matching systems are not required. In addition, the cost is very low.

Electrically, the Mini-loop can be regarded as being more or less the baby brother of a full sized delta loop. A normal delta loop is generally in the form of an equilateral triangle, the total length of wire being just a little over one wavelength (around 10.5 metres for the ten metre band). It shows a modest gain over a half-wave dipole, and has a much wider bandwidth, so no critical tuning adjustments are required.

Some might choose to feed the delta at one corner, others in the centre of one of the sides. Alternatively, the whole affair could be mounted apex up, apex down, or even lying on it's side!

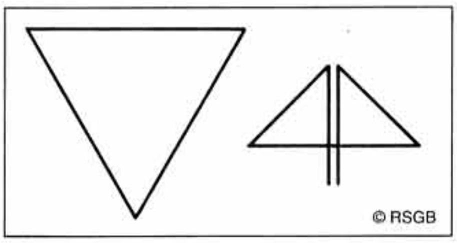

Fig 1: Delta loop (left) to the same scale as the 7f mini-loop (right).

Whatever the final configuration, the feed impedance for a full size delta loop tends to remain stubbornly around 120 to 150Ω, so some experimentation with a matching system is required to give a 50Ω feed impedance for a transceiver. You will no doubt be pleased to know that the feed impedance of the 'Mini-loop' is between 40 and 60Ω. This means that it can simply be fed with ordinary 50Ω coaxial cable via a 1:1 balun.

DESIGN PHILOSOPHY

THE PHILOSOPHY BEHIND the Mini-loop is as follows:

1) With the possible exception of business cars, swimming pools and TV sets, with size as a status symbol, the modern trend is undoubtedly towards compactness. This trend is particularly evident in the field of electronics, where transceivers, computers, etc, are packing more and more hardware into less and less space.
2) Even with antennas, (although the status symbol may still carry a certain amount of weight with the 'big boys'), most of us, (and our neighbours!), would welcome something more compact. However, we normally have a sneaking feeling, that you *must* lose *something*, when you cut down on the size of an antenna. That's the thousand dollar question! How *much* do you lose, and how far can you safely go?
3) If there are no resistive, or other losses, a modest reduction in size should not greatly reduce signal level. A drop of 1dB would normally pass completely un-noticed.
4) What else are we likely to lose? The simple answer is that radiation resistance decreases, which will make coupling to the transmitter increasingly difficult, and we will also lose out on bandwidth. In fact, if taken to extremes, only slow telegraphy would be possible, because the bandwidth would not support the 3kHz or more required for voice modulation!
5) I think it will be self-evident that, if we start off with something having more gain, more bandwidth, and more radiation resistance than a half-wave dipole, we should logically be able to effect a *moderate* size reduction, and still, at least, break even with the dipole.

It was thoughts along the above lines which led me to embarking upon the Mini-loop.

PRACTICAL POSSIBILITIES

THE DELTA LOOP HAS an exceptionally wide bandwidth *and* quite a high radiation resistance so I felt that I could safely 'scale down', until the radiation resistance fell from 130Ω to a convenient 50Ω, hoping that the bandwidth would not become excessively narrow. (I was not hoping for anything like 28 to 30MHz, but was prepared to be content with say, 28.3 to 29MHz.)

I didn't want to reduce size by means of loading coils, because of resistive and other losses plus the need for weather protection, so decided instead, to use a 'folding' technique. Thus I could retain around the same total length of wire as with a full-size delta loop. **Fig 1** shows, side by side and to the same scale, a normal delta loop, and the '7F' structure. I could have pushed the size reduction even further, but it seemed best to call a

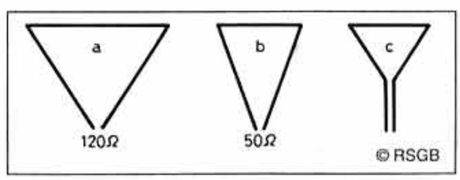

Fig 2: (a) Full size delta loop has an impedance of 120Ω. (b) Shortened top span gives 50Ω match. (c) Sloping sides pulled together at 90°.

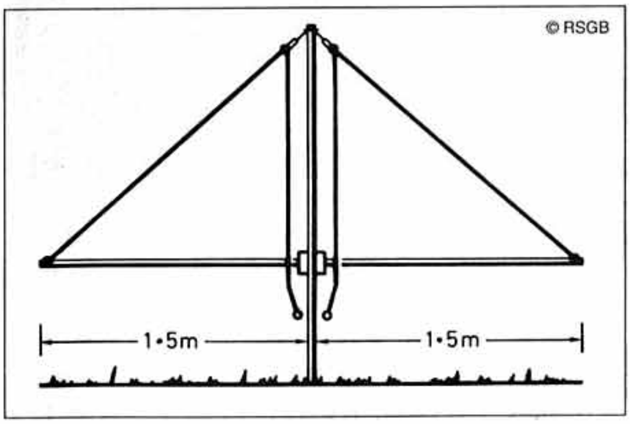

Fig 3: Practical implementation of the mini-loop for the ten metre band.

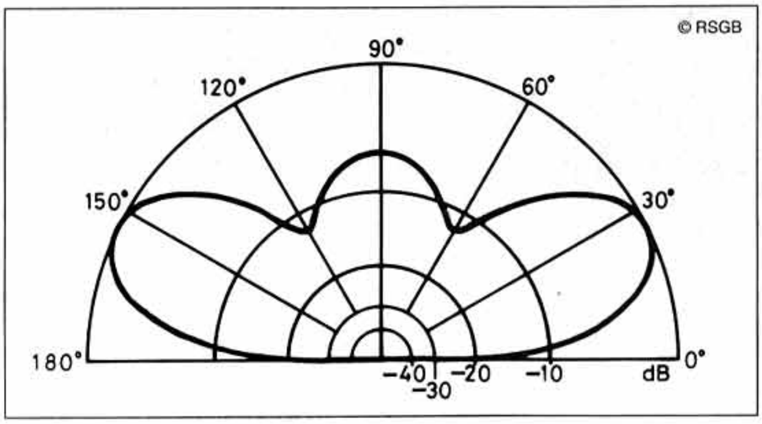

Fig 4: Polar plot of the 7f mini-loop.

halt when the radiation resistance had fallen to a convenient 50Ω.

How did I arrived at the magic 50Ω? I first strung up a full-size delta loop for ten metres, with the upper corners supported by a couple of nylon cords. Then I fed it at the bottom with 50Ω coaxial cable, via an SWR meter. As might be expected, the SWR was between 2.5 and 3:1, indicating an impedance of 120 to 150Ω. This was in complete accordance with the book. See **Fig 2(a)**

I then progressively shortened the top span down to around 3 metres, at which point, the SWR had dropped to not far off 1:1, indicating an impedance of around 50Ω. See **Fig 2(b)**. This was more or less in line with earlier experiments using a similar type of 'narrow-top' delta loop on the 20 metre band.

I next pulled together the sloping sides at a point around half-way up (**Fig 2c**), so as to form a lower apex of around 90°, with the rest of the wire hanging down like an open wire line. (There was no risk of short-circuits, as I was using plastic covered wire).

The final move was to invert the whole affair and mount it on a supporting structure as in **Fig 3**, with the 'open wire line' hanging below the the horizontal cross bar, to the point where it was terminated at the 50Ω coaxial cable feed point. Then I slightly adjusted the length of the 'open wire line' by a couple of inches or so, until I had minimum SWR around my normal operating frequency. A couple of days later, I mounted it on a five metre wooden pole and tried it out for half an hour or so during the *CQ* Contest. Running 'barefoot', I found I was kept full occupied with hardly a pause for breath. Obviously I was keeping my head above the QRM! A compute-plot (**Fig 4**) shows the theoretical polar diagram.

HINTS AND TIPS

HOPEFULLY, YOU NOW FEEL LIKE building the Mini-loop, so here are a few suggestions regarding appropriate materials. The horizontal 'spreaders' could be either a couple of bamboo canes, or two tapered fibreglass rods, butted together at the centre. The vertical strut could be in heavy duty plastic tube. For portable work, this latter item could be pushed into the top section of a tubular mast so as to permit elevation to a reasonable height (and rotation by hand, if required). The radiation pattern is bidirectional, rather like a dipole, but there are quite good 'nulls' off the side, which can be useful in suppressing QRM. It would certainly put out much more signal than a mobile whip!

Scaled down for 2 metres, it wouldn't measure much more than 30 x 50cm, and could probably be made self supporting in 16SWG enamelled copper. Construction time should be less than ten minutes, and it might be interesting to plug it in on your hand-held, in place of the 'rubber-duckie', just to see how it compares.

Some might like to try the '7F' on 15 or 20 metres. In this case I'd recommend that you mount the horizontal portion at about a half-wave above ground (if you are after real long-distance DX).

After all, the structure is so light that you needn't worry about a lattice tower! You could just throw a rope over a convenient tree branch and haul it up into place. At least, that's what I did myself, and managed to keep my usual long distance skeds. I kept mum about what I was using to avoid any psychological bias, and the only adverse comment received was a suggestion from one station that propagation seemed a bit down. However copy was 100%.

Note that the 10 metre model was constructed with *plastic-covered* wire. The plastic has a loading effect, which results in a total length of wire some 3% less than would be required with enamelled copper wire. Precise resonance in any desired part of the band can be achieved by slightly lengthening or shortening the lower end of the open-wire line. Also, for an exact 1:1 SWR, slightly increasing the size of the loop will raise the impedance, and conversely, a small reduction in size will lower the impedance. The approximate total length of wire required for any frequency, will be around 306/F in metres (allow a few centimetres extra to be on the safe side, and trim back as necessary).

FINAL THOUGHTS

FOR FIXED STATION WORK, it might be possible to install a ten metre Mini-loop in the roof-space. Alternatively, the really ambitious might like to try mounting a pair of loops on a pole with a cross-boom (**Fig 5**). This could form quite an effective, but low cost rotary beam.

No doubt interest in small antennas of this type will continue, but in the meantime I have included a computer plot to show (**Fig 6**) what might be expected, and perhaps whet your appetite!

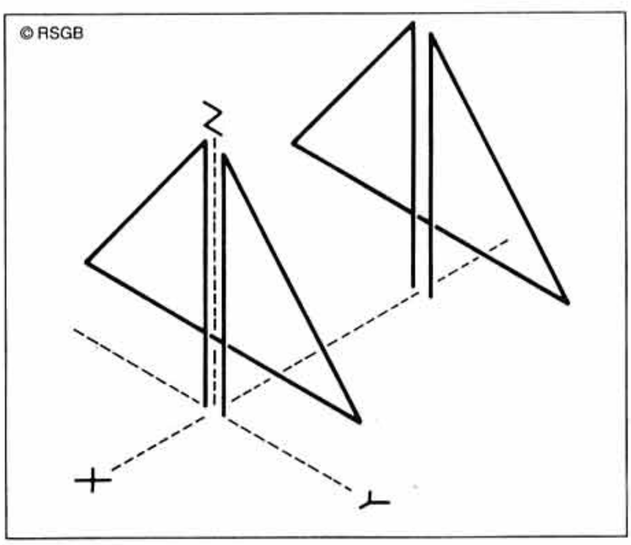

Fig 5: How about the above arrangement for a low-cost rotary beam?

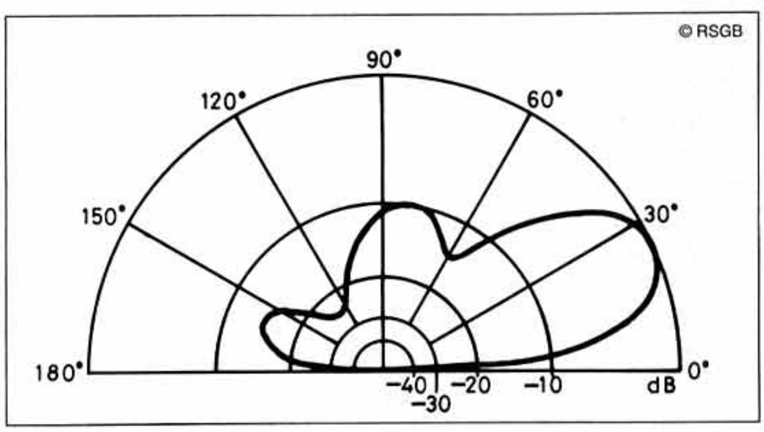

Fig 6: Polar plot of a two-element loop antenna.