Stealth Antennas

by

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Stealth antennas for the loft

THE SIMPLEST (and probably cheapest) antenna you can build is a loft-mounted half-wave dipole (**Fig 4.1**). This is simply cut for your band of choice according to the chart and fed with 50Ω coax.

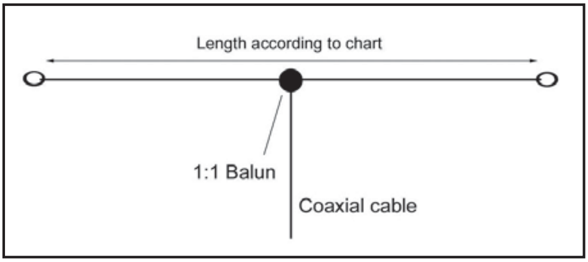


Fig 4.1: The half-wave dipole is a simple antenna, but very effective.

THE HALF-WAVE DIPOLE

A half-wave dipole is cut to length according to the formula: total length (in feet) = 468/*f*, where *f* is the centre frequency in MHz. The metric formula is total length (in metres) = 142.65/*f*. Typical dipole lengths for the bands from 40m to 6m are given in **Table 4.1**.

When I was first licensed I strung up a half-wave dipole for 10m in my attic. It worked a treat with a very low SWR across most of the band. What's more it worked stations with many contacts being made across Europe and the USA.

Just about any type of insulated wire will work and you don't need end insulators – just use a staple gun to tack the wire to the wooden rafters and let the final four inches or so dangle free away from the wood. This is a safety feature and prevents the antenna arcing to the woodwork, although that is very unlikely to happen if you keep the power levels down. I usually leave my power setting at about 25W and seldom use more than 50W. *Do not use a linear amplifier!*

A so-called 'chocolate block' electrical connector will let you connect the ends of the dipole to your 50Ω coax, which can then be led vertically away at right angles to the dipole to prevent RF pick-up and help keep the antenna balanced. If possible use a balun or choke as described earlier.

Once you have installed the antenna

Frequency (MHz)	Total length (ft in)	(metres)
7.100	65ft 11in	20.09m
10.100	46ft 4in	14.12m
14.175	33ft 0.24in	10.06m
18.100	25ft 10in	7.88m
21.225	22ft 1in	6.72m
24.940	18ft 9in	5.72m
28.500	16ft 5in	5.00m
29.500	15ft 10in	4.84m
50.200	9ft 4in	2.87m

Table 4.1: Half-wave dipole lengths.

check the SWR in the centre of the band. Now check it at the band edges too. If the SWR is better at the lower edge of the band than the top end this means it is too long. If it is better at the top end of the band it is too short. If it is too long don't cut it – just fold the ends back on themselves and either twist the wires together or use nylon cable clips. Electrically it will appear 'shorter' to your radio and have the same effect as cutting it.

Don't be surprised to find that you have to shorten the antenna slightly once you have it in position. The PVC covering of the wire and capacitative end effects will make it appear too long electrically and it is easier to shorten an antenna than lengthen it.

One you have the lowest SWR at or around the centre of the band, stop – as long as it is less than about 2:1 you will be fine. In reality you should be able to get it to 1.5:1 or better.

You may struggle to get the 30m and 40m versions in your loft – they may be too long. If that is the case see the section on the zig-zag dipole later on. Just about all of the others should fit within an average-sized loft.

It is best to mount the centre of the antenna as high as you can in the apex of the roof. This helps keep it away from electrical wiring and copper water tanks that might otherwise affect its tuning. It also helps with your radiated signal as it is the current portion of the antenna that does all the work and the current maximum on a half wave dipole is in the centre.

The dipole legs can either be tacked along the central apex with a staple gun or brought down in an inverted-V configuration - see next section.

A half-wave dipole is strictly speaking a monoband antenna, although a 40m (7MHz) version can be used on 21MHz (15m) albeit with a slightly higher SWR. You can use a dipole on something other than its design frequency, but you will need to use an ATU and the performance will not be very good. But as a 'get you going' compromise it will work. As explained in our later chapter on matched and unmatched losses using a long run of coax with a high SWR will result in high losses and is not recommended.

If you really want to use a single dipole in the loft on a band other than that of its design frequency you are better off feeding it with 300 or 450Ω ribbon cable, but this is less easy to handle than coax and must be kept away from metallic objects. Your dipole then becomes a *doublet*. If you do want to experiment with this, cut your dipole for the lowest frequency you want to use and then use it with open wire feeder on this and higher frequencies.

There are other coax-fed multi-band alternative that you can read about later.

THE INVERTED-V

The dipole doesn't have to be laid out in a straight line. You can, in fact, arrange one as an inverted-V with the centre at the apex of your roof and the legs coming down at an angle. In fact, there are a number of advantages in doing this. The first is that an inverted-V loses some of its directional characteristics. A dipole usually has its maximum radiation at right angles to the wire with little radiation off its ends, but when arranged as an inverted-V it becomes slightly more omnidirectional, as shown in **Fig 4.2**.

You will find that as an inverted-V a dipole will need to be up to about 4% shorter than if it is in a straight line. Don't worry about this. Cut it according to the chart and fold it back once installed to bring it to as close to a 1:1 SWR as you can.

Secondly, the impedance of a half wave dipole in free space is more like 70 - 75Ω, not the 50Ω our radio expects. This can result in an SWR of about 1.4:1 – 1.5:1. By narrowing the angle between the legs the impedance changes and the SWR is reduced to closer to 1:1.

But, and it is a big but, the angle between the legs of a dipole should not fall below about 70 - 80°. For best results with this type of antenna, the apex angle should be kept between 90 and 110°. Less than this and the radiators start to become parallel to each other and signal cancelling will start to occur. Above about 120° the antenna starts looking like a standard dipole, minimising any of the feed impedance and shortening effects. The optimum apex angle is 90 - 120°, but it isn't that critical.

Some pitched roofs are actually very steep and you should check to see what the angle is on yours. If you wish to fit an inverted-V you might be better off putting each leg across the side of the roof rafters to reduce the angle. That is, install it an angle with the rafters.

Inverted-V dipoles for several different bands can be connected to the same feeder, as shown in **Fig 4.3** to provide a multi-band antenna.

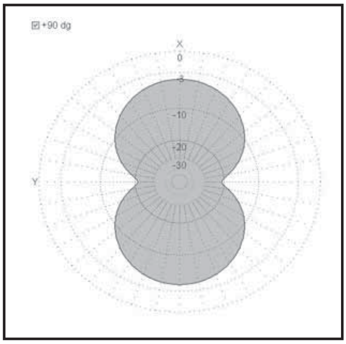


Fig 4.2(a): You can see that when erected in a straight line the dipole is quite directional.

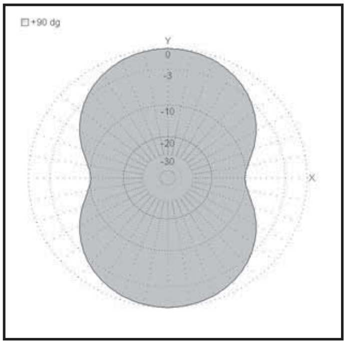


Fig 4.2(b): But when erected as an inverted-V you gain a couple of S-points (10 - 12dB) in the directions in which the dipole wires point.

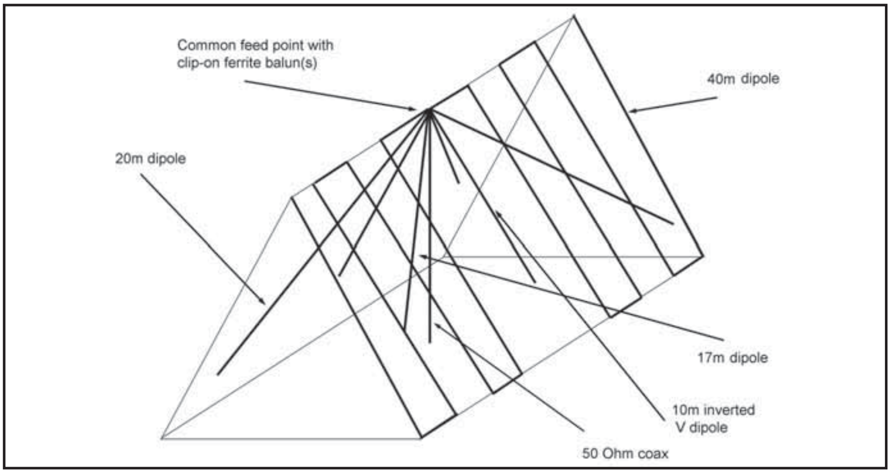


Fig 4.3: This five-band loft-mounted antenna has been used at two locations with great results.

MULTI-BAND PARALLEL-FED DIPOLES WITH ZIG-ZAG (NON-INDUCTIVE) LOADING

This antenna has nothing new about its design, but it does bring together quite a few useful ideas and characteristics. These are:

- Fully no-tune antenna system for five popular HF bands;
- Suitable for SWLs, QRP, M3 licensees and PSK31 operating plus occasional use up to 100W, but watch out for RFI at high powers. *Do not use a linear!*
- Uses non-inductive (zig-zag) loading for 40m.

Your actual mileage may vary depending on the type of loft you have, the tile type and the amount of metalwork in your attic. I have used this antenna at two different modern semi-detached and detached houses and it has always worked well. What surprises me is just how well it does work – so well, in fact, that I have yet to find another experimental indoor antenna that can beat it, including magnetic loops, crossed field loops and EH antennas.

It has been compared with the following:

- 85ft W3EDP end-fed that went up to the top of a 60ft oak tree in my garden with a 17ft counterpoise – the multi-band dipole beats it hands down on 20m and up and offers much lower noise level. On 40m they are fairly even.
- Capco and MFJ magnetic loops mounted in the loft and outdoors at a height of four metres – the multi-band dipole was consistently either equal or 1 - 2 S-points better.
- Commercial five-band, no counterpoise, vertical at 30ft – the multi-band dipoles beat the vertical on 20m by 1 - 2 S-points. But the vertical beat the dipoles on 17m on 15m by the same amount. They were very similar on 10m, although the vertical also tuned 12m. The SWR was flatter on the multi-band dipoles. While trying to read weak CW from the 3Y0X Peter 1st Island (Antarctic) DXpedition signals were inaudible on the vertical and S1 - S2 on the dipoles on 20m.

The antenna consists of separate half-wave dipoles for 40, 20, 17 and 10m (as shown in Fig 4.3), cut to a length of 468 (feet)/frequency. Only the resonant dipole will accept current at the desired frequency – the others are effectively ignored and offer a high impedance. These are fed via RG58 50Ω coax at a common feedpoint at the very apex of the centre of the loft – just buy an electrical chocolate block connector. The original version was potted in a 35mm film canister with fibreglass resin as it was going to be put up outside.

Three or four large clip-on ferrites (of the type used to get rid of RFI) are clipped on the coax at the feed point. This prevents interference flowing up the outer of the coax and makes the antenna very quiet electrically. Or you can use the choke balun described earlier.

The trick is to zig-zag the 40m dipole up and down the rafters, *but only once you have pulled the first 10ft or so of each leg out horizontally.* It is the current flowing in an antenna that does the radiating and this is concentrated towards the middle of the dipole. In fact 70% of the radiation from a half-wave dipole comes from half of the antenna's total length.

You can staple the dipoles (made out of PVC-coated wire) to the rafters with a staple gun as described earlier. Allow the ends to dangle free for about 6in to prevent end effects and RF leakage to earth via the woodwork.

The second trick is to make sure that each dipole is as far away from the other as possible. This helps bring down the SWR and improves the 10m performance dramatically. When it was originally put up all the dipoles were bundled together and although the 10m SWR was OK it was very 'deaf'. Separating the dipoles made a huge difference.

The third trick is to arrange the dipoles as inverted-Vs where possible - especially the 10m one – this gives good all-round performance and a mixture of horizontal and vertical polarisation. The vertical polarisation can work well on local contacts with amateurs using ex-CB half-wave verticals. Make sure that the included angle between any two halves of a dipole is around 90 - 120°. If it is smaller than this the antenna will start to cancel out its radiation as explained earlier.

If the lengths are calculated correctly you should find the SWR less than 1.5:1 on all bands bar 15m where the dipole acts as three-half waves and the SWR rises to about 2:1. If not, shorten the antenna by folding the ends back and twisting them together – but fold an equal amount at each end so as to maintain balance.

It isn't a beam antenna, but it is very useable and lively. It is an inexpensive antenna that your neighbours will love, as long as you keep the power levels down a bit. I would limit your power to around 50W if possible, preferably lower.

ADDING 80M TO MAKE A SIX-BAND ANTENNA

After using the antenna for a few years my biggest bug-bear was that it didn't cover 80m. Yes, with an ATU you could get the antenna to load on 80m but the performance was down somewhat. I therefore looked at adding traps at the ends of the 40m dipole and then zig-zagging extra wire horizontally across the inside ends of the house walls (**Fig 4.4**).

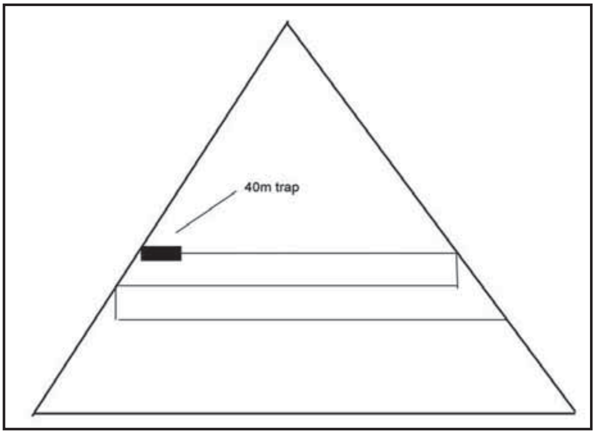


Fig 4.4: Adding a 40m trap and additional wire means that it can work on 80m as well, but the performance is not as good as an external antenna.

I had some commercial traps lying around, but you could always make your own. I calculated the amount of wire required using the fact that a W3DZZ trap dipole is usually 108ft long. Therefore, I added 54 minus 33 = 21ft to each end. A quick SWR test showed that it wasn't enough and I had to add a further three feet to each end to bring it to resonance. The length needed will depend on the inductance of the traps.

If you try this I suggest adding more wire than you need as it is easier to cut wire off once installed in the loft than it is to solder wire on – safer too!

The end result was a minimum SWR of 1.2:1 at the centre of the band, rising to 3:1 at the band ends. An ATU took care of the mismatch.

But how did it perform on 80m? Actually, not bad – at least as good as a 1.7m Capco magnetic loop mounted outdoors and a couple of S-points down on the 85ft W3EDP mentioned earlier. With signal levels around the UK on 80m being the usual S9+10 - 20dB the loss of 10dB or so wasn't a problem. It is not an effective DX antenna on 80m. When east coast US stations were just audible on the outside end-fed they are usually absent on the loft-mounted dipole. Nevertheless, it was very good for high angle NVIS-type radiation such as is required for around UK and near-European contacts.

If you have no other option for 80m then it is worth trying.

CASE STUDY: LOFT-MOUNTED FAN DIPOLE – CHARLIE IVERMEE, M0WYM

Charlie Ivermee, M0WYM, also uses a loft-mounted fan dipole to good effect. This is his story:

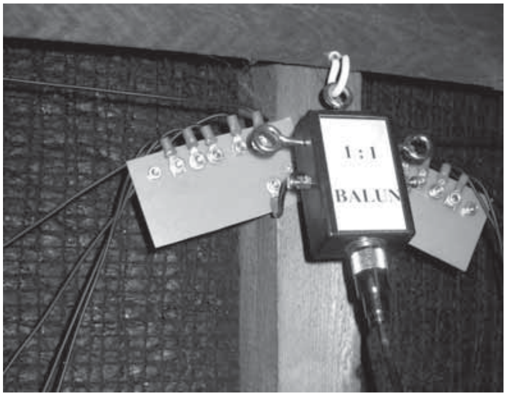
"No external antennas are permitted at my QTH, so my antennas were always going to be mounted in the attic. The object of the exercise was to produce an aerial that would allow me to operate from 40 to 10m, specifically 40, 20, 17, 15 and 10m. The attic allows the antenna to 'beam' roughly northwest / southeast and the house is some 40ft above sea level. Construction could be simplified by the fact that I intended to run a maximum of 10W, which means that the antenna wires could be simply attached to the rafters.

Charlie's, M0WYM, dipole wire pinned to the rafters.

"The attic is just about 10m long, just short of the length needed for a 20m dipole, so for that band around 250mm was bent down the rafter at each end before tuning. Obviously there is no room for a normal 40m dipole and I made full use of a design by GM4JMU that used loading coils on 40m. In my version I have made the 40m loading coils from 29 turns of 24/02 PVC covered wire tightly wound on 40mm diameter PVC pipe. Both coils should be made as identical as possible. The 40m dipole runs along the apex of the roof, below that the 20m dipole is followed by the 17m, 15m and 10m dipoles.

"Rather than make my 1:1 balun I forked out for a commercial one. In order to terminate five dipoles I used two pieces of single-sided PCB each drilled to accept six M4 bolts and a further one to connect to the balun (the sixth was added for further experimentation). Each wire making up the dipoles was crimped which made attaching to the bolts secure and simple.

"Horizontal spacing between each dipole was approximately 150mm and wires were attached to every other rafter using plastic-headed staples. The ends, fanning out dipoles after tuning, were terminated with old fashioned galvanised staples. Please remember that I am only running a maximum power of 10W and would not suggest that these mounting methods be used at higher powers.



M0WYM's 1:1 balun and PCB distribution point.

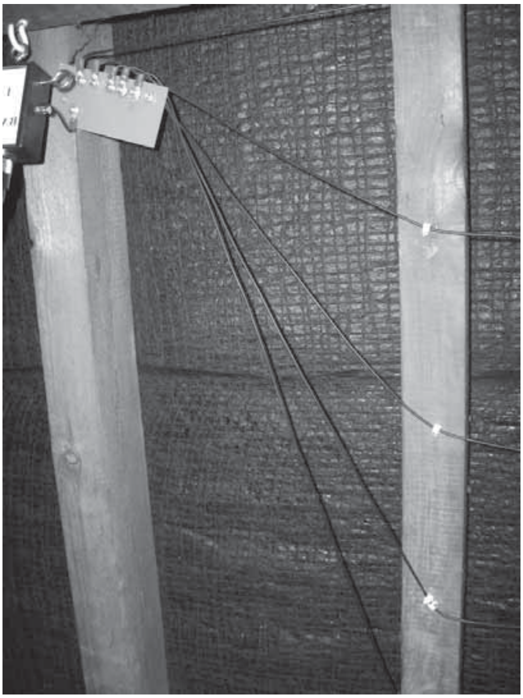
"After assembly, the antenna was tuned using an MFJ-259 SWR analyser connected to the balun by approximately 1.5m of coax. Starting from the lowest band each dipole was tuned for resonance. The results for the 40m dipole were not too good with a minimum SWR of 2:1 at resonance.

"My Icom IC-703 is very happy with the antenna and, after tuning, indicates a SWR of 1:1 on 40m, 20m, 17m and 15m. On 10m the SWR varies from 1.3:1 at 28.100MHz to 1.1:1 at 28.800MHz and 1.4:1 at 29.000MHz to 1.1:1 at 29.650MHz. In spite of the fact that the MFJ-259 puts the SWR on 80m in the red zone, the 703's ATU gets it down to 1.4:1. At 50MHz the SWR is 1:1 from 50MHz to 51.6MHz."

Results

"Reception: The antenna is lively on all the HF bands with the exception of topband, which is hardly a surprise! For example, on 17m I have heard Japan, Malta and Brazil. I have heard Costa Rica on 80m and Cyprus on 15m. 20m reception is very good and I got to hear some good DX through some pretty awful pile-ups! Overall, I'm pretty pleased with the level of reception using the fan dipole.

"Transmitting: I seem to be averaging 57 reports into Europe on 40m, 20m and 17m. Countries worked include Slovenia, San Marino, Italy, Moldova, Russia and the Netherlands.


For the best results spread the dipole wires away from each other.

"It does appear that the fan dipole works best on 20m, which ties in with the flat SWR I measured on that band. Given that we are at the bottom of the sunspot cycle I expect great things of this antenna in the next couple of years!

"On 80m the fan dipole works fine on reception and will put out a signal, but it's pretty useless with low signal reports so I will be looking at some other way of working on 80m. Given that my QTH is a first-floor flat I am not too keen on strapping the coax and loading that on 80.

"During a 6m contest in June I discovered that one of the elements of this antenna radiates pretty well on that band! I have been getting reports averaging 57 and have worked stations in Spain, Italy, Croatia (via Sporadic-E) and the UK. It looks to me as if the 17m element third harmonic resonates around 54MHz and that is near enough to put out a reasonable signal.

"I have had good reports on 10m FM from Sweden and Denmark (via Sporadic-E again). The antenna also got me a 58 report on 12m (24MHz) from France, not so far but not bad considering the aerial was never intended to work on 12m!"

USING LOADING COILS TO SHORTEN DIPOLES

So far we have looked at putting up single dipoles in the loft, and a way to parallel feed dipoles to give you multi-band operation. We have also looked at using zig-zag non-inductive loading to fit longer dipoles in the attic.

But there is another way to put dipoles in the loft for lower bands and that is to use loading coils, which is the method used by Charlie, M0WYM. These make the antenna look longer electrically, but do result in some loss of performance and reduced bandwidth.

A good rule of thumb for a shortened dipole is that its length in feet must not be less than 1.25 times the wavelength in metres. So a 40m loaded dipole shouldn't really be less than 50ft long and an 80m antenna shouldn't be less than 100ft long. Incidentally, it is interesting to note that the G5RV antenna is 102ft long and works quite well on 80m where it is only about 1 - 2dB down on a full size 80m dipole.

Other sources say that the antenna will still work reasonably well when it is only 1/3 of a wavelength long, which is 13m (42ft) on 40m or 26.6m (87ft) on 80m. Is your loft or attic 87 - 100ft long? No, I didn't think so. So from the outset we have to say that severely shortening an 80m antenna to make it fit will result in its efficiency going down, perhaps quite dramatically. My experience is that the 85ft W3EDP end-fed configuration over the roof works better on 80m than a shortened, loaded dipole in the loft. But let's look at what you could do for 40m and 80m on a suck-it-and-see basis.

Half-wave loaded dipole for 40m

A full-size half-wave dipole for 40m (7.1MHz) would be 65ft 9in long (20.09m). But let's say that we only have 30ft to play with, which is obviously much shorter than the optimum we require. Let's say that we will have two legs of 15ft each with loading coils in the middle of each leg. So we need four pieces of wire 7ft 6in long. Two of these go to the centre connection and the 50Ω coax, and then we connect our two loading coils at the ends before connecting the remaining pieces of wire.

First we need to work out what sort of loading coils we need. There are several ways of working out the inductance of the two loading coils. The first is to use an on-line calculator – Googling "dipole loading coils" will come up with a number of options. At the time of writing I used Martin Meserve's, K7MEM, site [1] to do the calculations (see **Fig 4.5**), but do bear in mind that URLs do change and websites come and go.

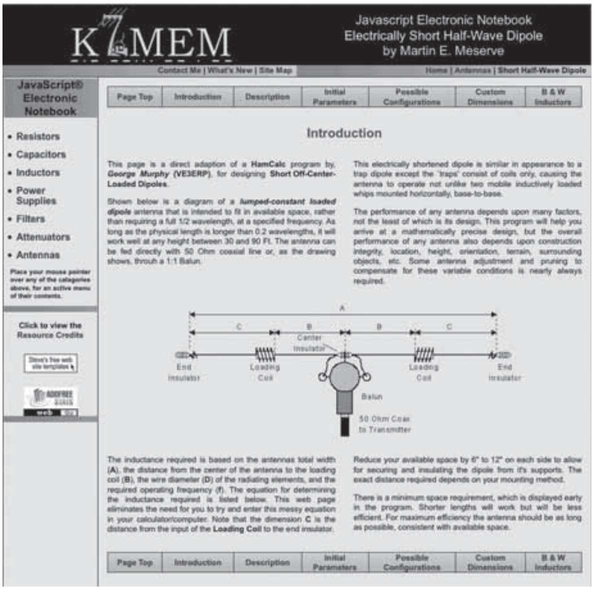


Fig 4.5: You can use an on-line calculator, like this one from K7MEM, to build a shortened dipole.

The site says that we need two loading coils of 24µH each. Using 2mm wire, Martin's site says that these can be formed by winding about 14 turns on to a former 110mm in diameter and 50mm long. Since losses occur in the loading coils a physically large coil allows a larger wire diameter, increases the Q, and improves the antenna's radiating efficiency.

I suggest that you use enamelled copper wire for the coils to reduce losses and plastic for the formers. Large plastic drinks bottles are free once you've emptied them and will support a loading coil for indoor use with no problems. You might be tempted to use white PVC waste pipe from your local hardware superstore but this is only about 40mm in diameter – we want our coils bigger. If you re-run the calculations you will find that with 40mm pipe you need around 40 turns of wire, which increases the resistance and reduces the overall efficiency – that's why you should keep your coils larger.

Any coil will end up with a self-resonant frequency (SRF) and for an optimum design you want this frequency to be well away from the frequency upon which you are trying to get the antenna to work - preferably double the operating frequency. In this worked example the SRF of the 110mm coil is about 13.7MHz which is fine.

The coils don't *have* to be half way along the wire – you can place them anywhere. Ideally, the loading coils should be as far from the centre feed point as possible. But bear in mind that as the distance from the feed point increases, the required coil size increases and the self-resonant frequency decreases until it reaches the operating frequency, at which point the coil Q decays to zero, and the antenna efficiency approaches zero.

By all means play with an online calculator like Martin's, but for a quick and easy solution place the coils half way along the dipole and you won't go wrong.

Half-wave loaded dipole for 80m

Now we have calculated how to get a 40m dipole into a space of just 30ft what happens if we try to do the same with an 80m dipole? Well, if the wavelength is 80m, our optimum lowest figure is 100ft. That is, if we don't want to lose too much efficiency then the antenna shouldn't be any shorter. But if you just have to bite the bullet and reduce the antenna size even more then go ahead. A 30ft-long 80m loaded dipole will need two inductors of 95µH .

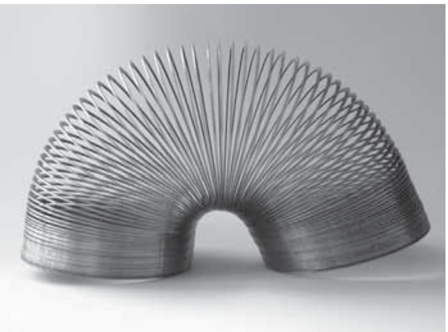
It will probably have limited bandwidth and will need an ATU to tune the whole band. Nevertheless it will let you put out a signal, but don't expect miracles.

From this argument you can see that there really isn't an effective way to build a loaded dipole for 160m (topband) that will fit in a loft. By all means try, but I think you'll be disappointed! Remember, you will get better results with stealthy antennas on the higher bands.

THE SLINKY DIPOLE

One of the biggest problems facing amateurs who want to use loft-mounted antennas is how do you put up a decent antenna for 80m (3.5MHz)? The trouble is that a half-wave dipole for 80m is going to be a around 40m or 135ft long – much longer than most attics. You can use the zig-zag loading that I mentioned earlier or you can add loading coils. But another way is to make use of a child's toy – the *Slinky* ('Slinky' is actually a trade mark, but there are other branded varieties available).

If you haven't met a Slinky before it is a coil spring that can be made to 'walk' down stairs and is used in schools to demonstrate the propagation of transverse and longitudinal waves. So its seems appropriate that we can use two Slinkies to make an HF antenna!

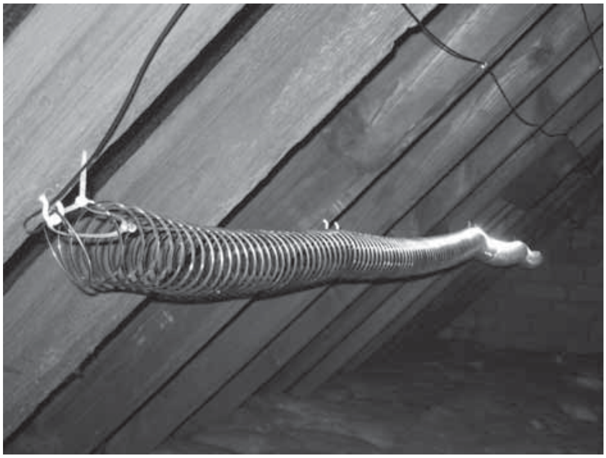


The Slinky can be used as an HF antenna – just make sure you don't buy one of the plastic versions!

If you pull a Slinky out what you effectively get is a continuously loaded helical antenna. If you then thread two Slinkies onto a piece of cord and feed it in the middle you have a continuously loaded dipole.

Slinkies can be obtained in the UK from Maplin and can also be found in most toy stores around the world. A quick search on eBay showed that you can get them for around £5 each. A quick word of warning – don't buy the plastic version for obvious reasons!

They are usually about 2.75in (70mm) in diameter and consist of about 80 - 90 turns. When a Slinky is compressed it is only 2.25in (60mm) long, but it can be stretched into a helix as long as 15ft (4.5m) in length



Charlie, M0WYM, used a Slinky dipole in his loft, but found it noisy.

without deforming. An antenna made from a Slinky is light, simple to suspend and extend, and easy to put out of sight when not in use.

They are usually made of stainless steel, which is not really ideal as an antenna material. You can get brass versions in the US, but they are expensive – more than $100 apiece. Larry Johnston, W4SAT, reports that a standard Slinky coil resonates as a quarter-wave between 7 and 8MHz when it is stretched to lengths between 5 and 15ft. To tune the Slinky within that range you extend the coil to the approximate size, then expand or contract it to reach the desired resonance. At a length close to 7.5ft (2.28m) Larry says that a standard Slinky is quarter-wave resonant on 40m. Dipoles resonant at frequencies above the 7 - 8MHz range may be created by removing turns to shorten the helices or by shorting out turns. A 20m dipole, for example, could be made by cutting a Slinky coil in half. It is certainly an area for experimentation.

Charlie, M0WYM, reports that they are easily soldered using a 25W iron. He constructed an 80m Slinky dipole for his loft and takes up the story:

"My antenna uses a total of four Slinkies with two of them soldered together. The Slinkies are supported using nylon cord and cable ties were used at the ends to make it easier to remove. Screw-in hooks spaced at approximately 1m intervals were used to support the Slinkies and the last turn at each end is looped over a hook. I only run a maximum power of 10 watts and would not suggest that these mounting methods be used at higher powers.

"The nylon cord was passed through the Slinkies before putting them into place. The cord and Slinky were attached at one end then stretched tightly and attached at the other end. The Slinkies were carefully extended and attached at the other end. Finally, the cord was hung on the remaining hooks and the wires attached with crimps to the fan dipole terminal boards.

"I had a go at making my own balun using a toroid and eight turns of RG58 coaxial cable. It performs as well as my bought one. My Icom IC-703 seems pretty happy with the 80m Slinky dipole. Signal levels on 80m have risen by about 20dB, compared with my 40m fan dipole - including the noise! The SWR on 80m varies, but is under 1.3:1 for most of the band. Daytime background noise levels have been around S5 - 6 and evening reception has been OK with signals from the UK and Europe getting through the noise," said Charlie.

Charlie has since taken the antenna down, due to the high noise levels, but it would be worth trying at your QTH. If you want to use it as a multi-band antenna I suggest feeding it with open wire or 300Ω balanced feeder.

Larry, W4SAT, says that in a test on a state-wide net, a 30ft 80m Slinky dipole at 20ft received signal reports on average 0.5 – 1.5 S-units lower than a Windom at 35ft. He say that compared with a Hustler mobile whip, its performance and bandwidth were outstanding.

One word of warning - the coils will corrode if left outdoors for more than a few weeks. This means that the Slinky is really best suited to indoor use. If you wish to put your Slinky antenna outside on a more-or-less permanent basis, you could solder all the connections and then spray paint the whole antenna.

Many Slinky users report that this 80m antenna is not the best in the world, but it will get you on the air and should cost less than £20 so is worth a try. There is even a commercial version of the Slinky antenna in the US. Called the CliffDweller II antenna [2] it is said to be the "world's most popular limited space HF antenna - indoors and outdoors" – and is used in 84 countries. It is just 10in wide and fits easily into a suitcase for portable use while traveling, or into a backpack for camping. It packs a full 130ft of pre-coiled wire (a half wavelength on 80m!) into its small footprint and covers all HF bands from 6 to 80m with any standard HF antenna tuner, and handles the full power range of QRP to 100 watts.

HORIZONTAL LOOP (SKYWIRE) ANTENNA

The horizontal loop antenna should not be confused with the magnetic loop. The one I am about to describe is usually at least one full wavelength long at its lowest frequency of operation and can be mounted horizontally by tacking the wire to the loft rafters using a staple gun – just like the dipole. Its current distribution can be seen in **Fig 4.6**.

Unlike a dipole, which is resonant on its fundamental frequency and odd multiples thereof, the loop is resonant on its fundamental and *even* multiple frequencies. Therefore, a 40m (7MHz) full-wave loop would contain about 136ft (40.23m) of wire and would also be resonant on 14MHz and 28MHz.

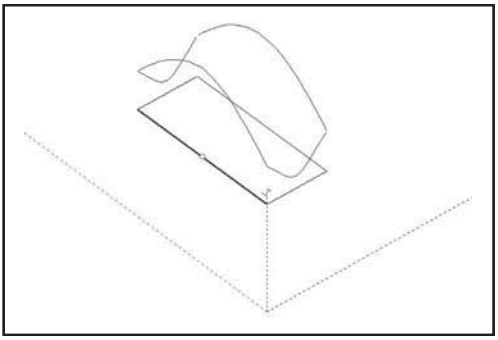


Fig 4.6: In this MMANA-GAL simulation you can see the current distribution of a 40m full-wave horizontal loop.

To make your loop use the formula: Length (in feet) = 1005 divided by frequency (in MHz). Then subtract 5% of the total full wavelength if you are using insulated wire, due to its slightly lower velocity factor. Example: For a 40m loop, 1005 divided by 7 (lowest 40-metre frequency in MHz) x 95% = 136.4 feet.

To calculate the size in metres use the formula: Length (in metres) = 306.4 divided by frequency (in MHz). Also use the 95% factor if using insulated wire.

You may struggle to fit a full-wave loop in for 40m, but the trick is to put up as big a loop as you can and not worry too much about its actual size.

6
Over-the-roof stealth antennas

THE TRADITIONAL WAY of mounting a central support for wire antennas over your roof is to fit a short pole, either to your chimney or to a bracket on the end of your house. This is fine and works well – you can either do it yourself or get a TV aerial contractor to do it for you. If you also fit a small pulley and cord you can haul different antennas up any time you wish, although it does start to look a little like a flagpole at that point.

But what if you want to remain stealthy - can you lie the antenna wires directly on to the roof? The answer is yes you can, and although it isn't ideal it does work. You will lose a decibel or two but, as you will have gathered, this book is about getting you on the air at all costs and that is a small price to pay.

I have a W3EDP 85ft end-fed wire over one side of my roof and an off-centre fed dipole (OCFD) on the other. Sometimes one works better than the other. As I am writing this I am talking to George, W4UWC, in Tennessee on 15m (21MHz) – he is actually louder on the W3EDP, which is not bad for a £5 antenna.

This 80m OCFD antenna works well, even though the antenna wire lies on the roof tiles.

Having whetted your appetite what can you do?

The first message has to be, if you have *any* electrical cables anywhere near your house forget this right away – it is just too dangerous. Either go for an internal antenna or fit a vertical in the garden.

If you are going to use this method make sure you use insulated wire. This is easier to pull over and offers a degree of insulation from the wet roof. How stealthy you want your antennas will determine the wire thickness. Most black or blue covered wire is pretty invisible at a distance, but you will need ultra thin wire if you really don't want people to see it. But then it has a habit of breaking, so it is a compromise really.

Assuming that you don't have any cabling we can go ahead. The easiest way to get a dipole or similar antenna over your roof is with a catapult. I use the same one that I described in the section on getting wires over tree branches. The yellow ball is much safer than using lead weights and will preserve your tiles and windows should your aim be off. It is also easy to find if and when it comes down in the back

Hold the catapult upside down to stop the fishing line getting tangled up. Note the tennis ball, which is a lot safer than using lead weights.

garden. The good point about using a tennis ball is that if it goes over the house but hits the roof it will usually bounce back off and end up in the back garden. You may need to have a couple of attempts at getting this right, but it usually works quite well.

I was able to get a line over my latest house on the first attempt. In fact, I was a little overzealous and managed to fire the tennis ball into the neighbour's garden, from where it was quickly recovered!

Once you have the line over the house go to the back and move it away from the house – this is so that a) you can see what you are doing and b) the line doesn't snag in the guttering.

Now attach your antenna wire. I find it best not to have insulators on at this point as they can snag in the tiles. Go back to the front of the house and pull the wire over the house.

If it snags, stop and find out why. This is a lot easier with two people but you can do it on your own if you take your time. What you don't want to do is get the line caught under a tile. This isn't fatal and can usually be recovered by pulling backwards on the antenna wire. But keep on tugging on the line over the roof and you could displace a tile.

Once you have the antenna wire over the roof you can attach the coax or whatever you have and haul the whole thing into position. If you have a typical pitched roof you can usually work out which side you want your feed point to fall. It is always better *not* to pull your feedpoint over the roof, as that is more to snag.

The important thing to remember is that if anything pulls tight just stop and find out what is wrong.

Fit insulators to the end of your antenna and tie it off to the nearest item. It is best if these are high, so as to get the antennas as far in the air as you can. If you only have a back garden and no front garden an end-fed like the W3EDP design will work well. If you have both a front and back garden a design like the G5RV, a doublet or the off centre fed dipole will work better.

If you tie the antenna off to a tree do bear in mind that these move in the wind – either leave some slack or make a movable connection, such as a weight sliding up and down a PVC tube. I use 10.4lb fishing line to tie off my antennas – it is pretty invisible under most conditions, although sunlight at some angles can make it shine.

Now let's look at the pros and cons of each antenna design.

THE G5RV REVISITED

I use a G5RV every year during the Jamboree on the Air event and it works pretty well. The only problem I have found is it is hard to tune on 10m – I burned out a switch on my ATU as I forgot to lower the power while trying to get a match.

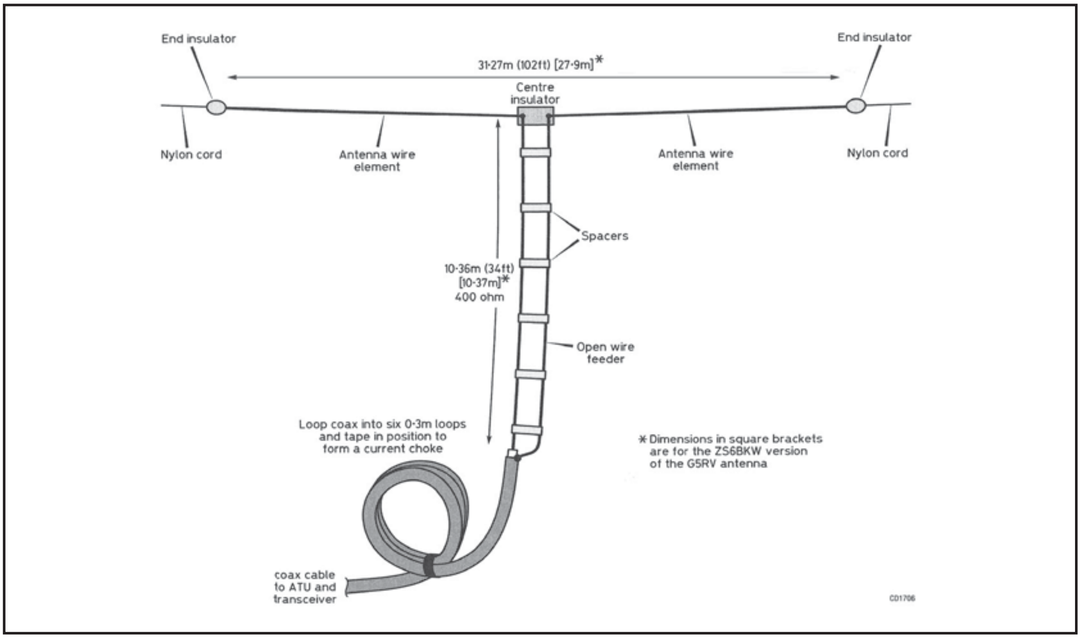


Fig 6.1: The classic G5RV may not be quite as good a multiband antenna as you think.

It was only when I moved to my present house that I started to think about whether a G5RV antenna could work here. After all, the length of 102ft would fit nicely between the garage at the front and the shed at the rear. Using insulated wire it could happily sit on the roof as well. It was at this point that I started modelling it with *MMANA* to see how it would play. The G5RV (**Fig 6.1**) would appear to be a good, cheap 'over the roof' stealthy antenna, but is it?

The G5RV has had plenty of coverage in other books so in this piece I want to concentrate on some of its characteristics that don't get mentioned very often. For those not familiar with the antenna it was designed by Louis Varney, G5RV, and consists of a 102ft (31.1m) dipole top with a 28.5ft (8.5m) centre section made out of open wire feeder or 300Ω windowed ribbon cable. You then connect your 50Ω coax to the bottom. I say 28.5ft, but in reality this depends on the velocity factor (VF) of the ribbon cable. Some designs say 34.5ft (10.36m) for the matching section, while others say that ribbon cable with 'windows' has a velocity factor that will almost be that of open-wire feeder, so its mechanical length should be 30.6ft (9.3m). The reality is that you should really select this on test or calculate the VF of the cable you intend to use and act accordingly.

You should really fit a choke or 'ugly' balun at the base of the matching section too – about 8 - 10 turns of coax in a 6in coil should do it.

The antenna was originally designed to be one and a half wavelengths long at 14MHz. I don't think Louis Varney ever really envisaged it as a multiband antenna as such, and he certainly didn't have access to the WARC bands that we now have. So let's look at just how good a G5RV is across the bands.

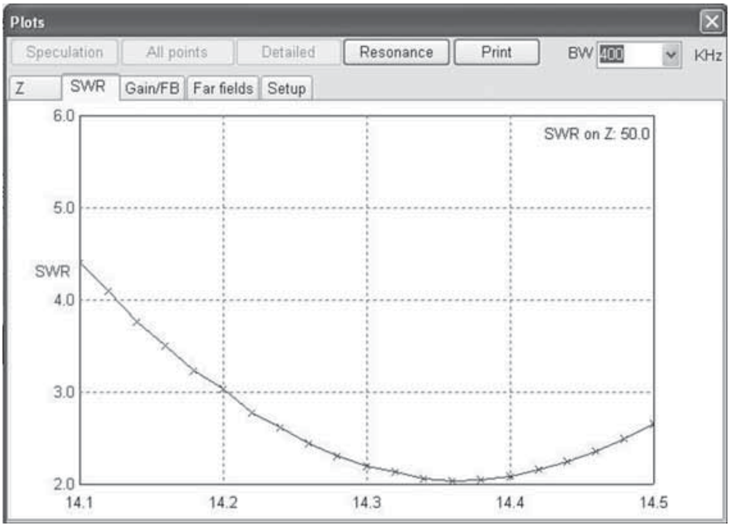


Fig 6.2: This computer simulation of a G5RV using MMANA-GAL shows that the antenna does have a SWR dip on 20m, but only to about 2:1.

The G5RV – a multiband antenna?

I started with *MMANA* and modelled the G5RV in a flat-top configuration. This is unlikely to be the way most people configure theirs as a stealthy antenna but I wanted to prove a point.

If you model the antenna with a matching section of 10.36m you find that, yes, the G5RV does have an SWR dip at around 14.350MHz so it looks like the antenna was designed for this band. Having said that, the lowest SWR is only about 2:1 (**Fig 6.2**) so you will still need an ATU.

So what about the other bands? On 80m (3.5MHz) it dips at about 2.4:1 at 3.8MHz. At the lower end of the band it is a more horrendous 7.5:1. On 40m there is no dip and the SWR is stubbornly above 7:1. It is also a terrible match on 30m (10MHz) with an SWR greater than 30:1. On 17m (18MHz), once again it offers a poor SWR – in excess of 30:1. On 15m (21MHz) it redeems itself a little bit with an SWR of under 2:1 at the low end of the band, rising to about 5:1 at the top end. On 12m (24MHz) it dips at around 2:1 near 24.950MHz and on 10m the antenna disappoints again with a very high SWR.

So the conclusions reached from this are:

1. The length of the matching section should be calculated as 10.6m x the velocity factor of the cable – don't just assume that it is any particular length.
2. If you use insulated wire I am sure that the 102ft top should be shortened accordingly – perhaps down to 97 - 98ft.
3. The antenna only offers a reasonable match on parts of the 12m, 15m, 20m and 80m bands. On others it is pretty horrendous. This means that you are going to have to use an ATU and you will get mismatched line losses on your coax due to the high SWR. If you feed it with a long enough length of coax the losses on the line will mask the high SWR (it will look better than the raw calculations).

I can't really recommend the G5RV as a multiband antenna – I think there are better alternatives. Having said that, it will work reasonably well on 80m (3.5MHz) and get you on the band with an antenna length of only 102ft instead of the full 132ft normally found with a half-wave dipole on that band. My experience at home was that it was easily beaten on HF by a dedicated dipole and the figures show why.

But what happens when you erect a G5RV as an inverted V, which is probably the way you would use one in a stealthy 'over the roof' configuration?

The G5RV as an inverted-V

I tried the G5RV as an inverted-V at this QTH and while it fitted the space quite well I was very disappointed. It performed about as well as any other antenna on 80m, but on HF DX it was pretty awful.

I have recordings of a contact with VQ9JC on the Chagos Islands. He is about S3 - S4 on my indoor dipoles and just vanishes when you switch to the G5RV. Some might say that this was not a fair test and that the station might have been in a null. But the experience was repeated over and over with other stations – so what was going wrong?

The SWR readings I obtained in real life with the inverted-V at the end of 30ft of RG213 coax are shown in **Table 6.1**.

Freq	SWR
3.5MHz:	1.7:1
3.6MHz:	2.3:1
3.8MHz:	5:1
7.0MHz:	2.1:1
7.1MHz:	2.0:1
10.1MHz:	10.2:1
14.150MHz:	5.6:1
18.150MHz:	3.3:1
21MHz:	5.4:1
21.450MHz:	5.4:1
24.9MHz:	6.7:1
28MHz:	5.6:1
29MHz:	3.6:1

Table 6.1: 'Real life' SWR readings obtained with inverted-V G5RV fed by 30ft of RG213 coax.

Given that the antenna does not offer a 50Ω impedance at the matching point, adding a length of 50Ω coax merely changes the overall impedance you see at the rig.

I don't think G5RV ever meant for his antenna to be used as an inverted-V. What you find if you model it is that on 20m those nice lobes that you get with a flat-mounted G5RV pretty much vanish when it is configured as an inverted-V – see **Fig 6.3**. Also, the low angle characteristics also vanish, so the DX capabilities of the antenna change dramatically.

It is a similar story on the other HF bands as well – the antenna's radiation pattern squashes and it becomes more omnidirectional, at the expense of the gain that the flat-top G5RV displays on bands such as 10m.

On 80m (3.5MHz) there is little difference as the antenna is very low to the ground. If anything, it is slightly better as an inverted-V as it loses some of the directional characteristics it has as a flat-top.

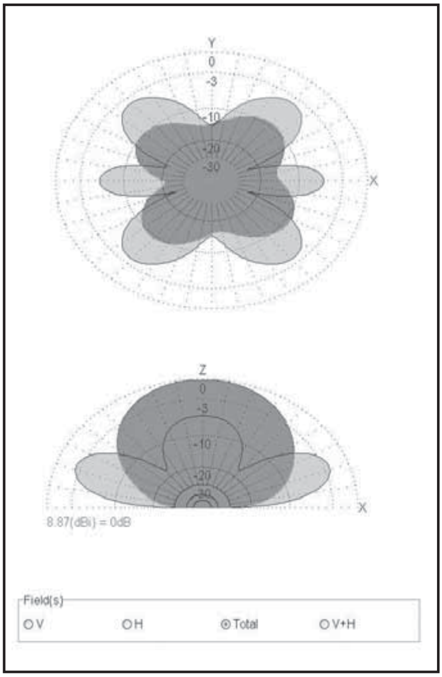
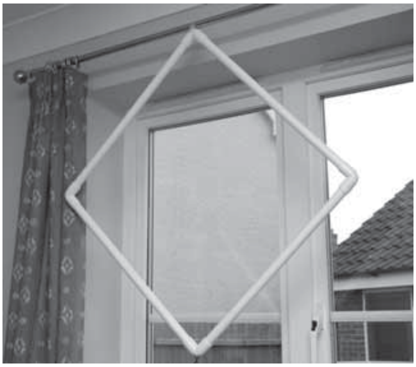


Fig 6.3: Erecting a G5RV as an inverted-V (dark grey plot) tends to kill its DX performance as this simulation shows.

8

Let's get *really* stealthy

SOMETIMES YOU JUST have to admire people's imagination and perseverance – these are the people who will get a signal out against all the odds. These antenna ideas might not be the best in terms of coupling our RF to the air, but they work.



This tiny 21in square antenna made out of PVC tubing and wire made an easy contact into the Netherlands with just 5W.

THE LOOP TUNER AND WINDOW LOOP

I'm not taking any credit for this design. It is based on the US Army loop tuner design and was inspired by an article in the G-QRP magazine *Sprat*. Jim Stirling, GM3UWX, wrote about his experience of using mini loops made out of PVC tubing and a small loop tuner that uses a couple of capacitors. I built my own just to try the design and was amazed at the results.

My loop consisted of two turns of thick insulated copper wire inserted into a diamond shape made out of 22mm white PVC tubing from the local DIY superstore. The diamond had 21in sides. The loop tuner was made from another defunct project and consisted of two variable capacitors of about 300pF each – see **Fig 8.1**. I also had a small meter in the box so I inserted a small diode and a variable resistor in series with the meter and wound the leads around one of the connections to the loop to pick up some RF. This allowed me to tune the antenna for maximum current.

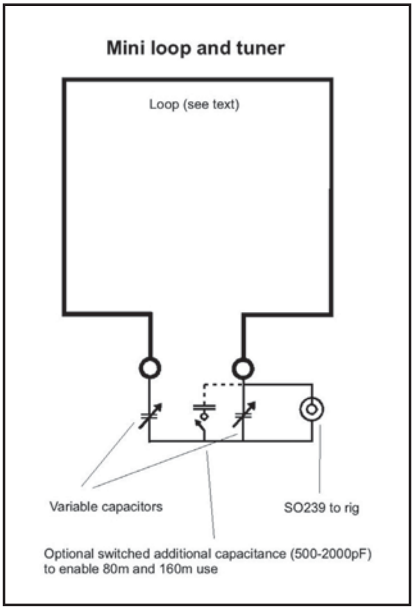


Fig 8.1: Schematic of the window loop and tuner. You can add additional switchable capacitance for 80m and 160m.

The whole thing was put together in about an hour and I taped the loop to my curtain rail just to try it. I could easily run 10W without the capacitors flashing over and found that it would tune on 40m (7MHz) easily, down to an SWR of 1.5:1. If I removed one of the turns in the loop I found that I could tune 30m (10MHz) instead.

I connected the antenna up to my radio, tuned the loop for 7.030MHz and dropped the power to 5W. I listened around and found that signals on the loop were generally down about 1 - 3 S-points compared with my 40m loft-mounted dipole and external 80m OCFD. I tentatively

The tuner consists of just two variable capacitors. The meter is optional.

put out a CQ call on CW and PA1MAX from the Netherlands came back to me. Max gave me a 579 report and we had a quick chat – all of it solid copy. He was using 100W to a dipole. Amazing! The thing actually worked.

Jim, GM3UWX, says that you can play with the size of the loop to get it to work on other bands. This will depend on having big enough capacitors or adding extra capacitance in parallel. **Table 8.1** shows Jim's suggestions.

Tuning is not as sharp as it is on a conventional magnetic loop and the antenna is quite broadband. Using a field strength meter I also found that you don't get the nulls off the sides of the loop that you would expect to find.

Band(s)	Loop size	Number of turns
1.8MHz	26in sides	5
3.5MHz	24in sides	3
7 / 10MHz	26in sides	1
7 / 10 / 14MHz	21in sides	1
7 / 10MHz	12in sides	1

Table 8.1: GM3UWX's suggestions for 'Window Loop' size and number of turns.

So there you are – an antenna for the lower bands that takes up no space at all and can be hung from a curtain rail when you want to play radio. Its performance is down on a dipole (not surprisingly), but it will make contacts, especially using CW or PSK31. Now tell me you don't have space for antennas!

K3MT'S GRASSWIRE ANTENNA

When I first read Mike Toia's, K3MT, piece on the Grasswire antenna I checked the calendar to see if it was an April fool joke – it wasn't! I'll let him take up the story. Mike says: "This antenna will not out-perform a Yagi, or a decent dipole up a half wavelength. Not in gain or signal strength, at least. But it will survive an ice storm, wind storm, and is practically immune to lightning. And it doesn't need a large tower or tall support. I deploy one from my hip pocket at times - the balun to match it is larger than the antenna!

"Put simply, it is an end-fed, long-wire antenna that is laid right on the grass, hence the name. The original Grasswire used by me in the summer of 1988 was just 204ft of #18 AWG magnet wire laid along the property line, anywhere from 1in to 6in above the ground. Either a ground rod or optional counterpoise wires are also needed - use one or the other as both are not needed." See **Fig 8.2**.

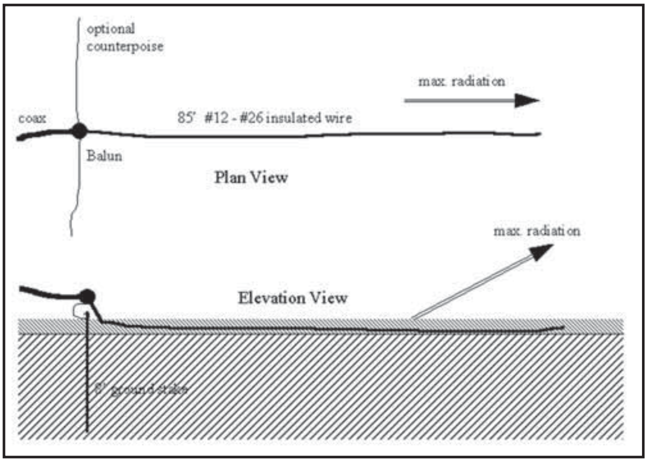


Fig 8.2: An antenna that literally lies on the ground? Mike, K3MT, says that it does radiate.

These antennas are largely resistive, with values ranging from 150 to 500Ω or so on average ground. They have been used successfully on all sorts of soil. One was used with great success by K3MT/VP9 in Southampton, Bermuda - the object of nightly pile-ups on 30m CW for four nights.

Mike says that the sceptic in you will doubt that such low antennas can work. After all, its image in the ground radiates and cancels out all radiation. True - if the ground is perfect. But nothing is perfect! The Grasswire radiates vertically-polarised signals off the end of the wire. Extensive monitoring tests have demonstrated the end-fire nature of the antenna. Mike says that launching a ray at, say, 15 - 20° take-off angle can be useful and that's what his Grasswire does. It is lossy in all directions, but least lossy when exciting the ionosphere for a long-haul DX contact. He says that signal reports are not fantastic, but contacts are made and ham radio is enjoyed! And the best part of this set-up is that his neighbours never knew that a ham station was on the air.

Mike feeds the antenna through a simple trifilar unun (an unbalanced to unbalanced impedance transformer), choosing the connections he wants for 2.5:1, 4:1 or 9:1 ratios (see **Fig 8.3**). It is basically a wide-band, three-winding autotransformer. Impedance ratios are as shown on the drawing. Generally it is necessary to connect the coax to either A2/B1 or B2/C1, and the antenna to B2/C1 or to C2. This may change from one band to another, and usually does.

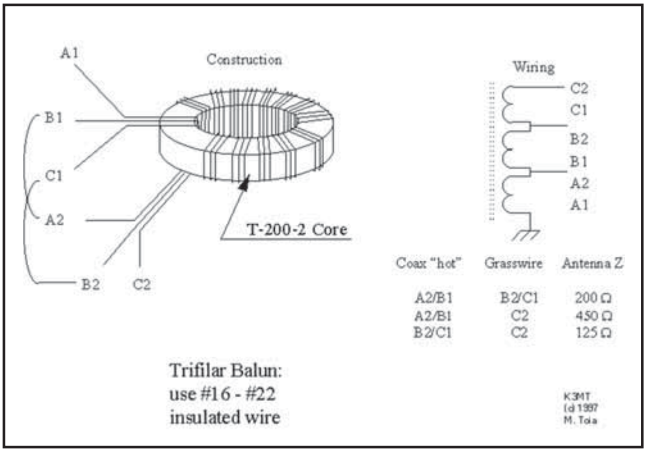


Fig 8.3: The wiring for the Grasswire matching unit.

Mike has also experimented with laying a Windom antenna on the ground. He says that it also becomes directional in the direction of the longest end. In both of these examples you will need to use an ATU.

Mike has written a book, *K3MT's HF Antenna Topics* [1], with a number of different antenna designs, including the Grasswire.

METAL FOIL ANTENNAS

You can make HF antennas out of cooking foil, but you will need quite a lot. Aluminium foil isn't very strong so this is a strictly indoor solution. It is also impossible to solder, so you are going to have to use crocodile clips or bolts and washers to get a good connection. It is relatively easy to make a foil antenna for 2m (145MHz) or 70cm (430MHz) – a half-wave dipole using foil will only take a few minutes.

You can also buy self-adhesive *copper* foil which is used to screen enclosures, such as guitar amplifiers. This is more rugged than aluminium and would work well if you wanted to create a window antenna.

Larger antennas will need more foil and more time, but you should be able to make a decent half-wave dipole for 10m with little effort.

Now, if you are really clever and handy with the kitchen scissors you can make a multi-band dipole that would work from, say, 10 - 20m: five bands in total. The secret is to cut the foil at an angle so that the lowest edge measures a half wave at 10m and the top measures a half wave at 20m, as shown in **Fig 8.4**. The RF will see a high impedance along the foil strip at anything other than its operating frequency, and will so effectively ignore the parts of the strip that it 'doesn't like'.

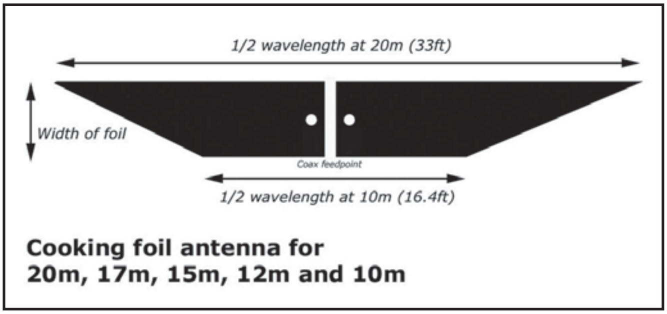
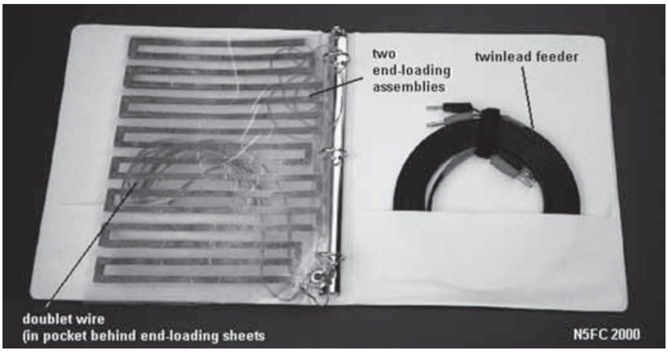


Fig 8.4: A multiband dipole made out of simple aluminium cooking foil.

Will it work? Yes, but to be honest it might be easier to create a series of five parallel-fed dipoles!

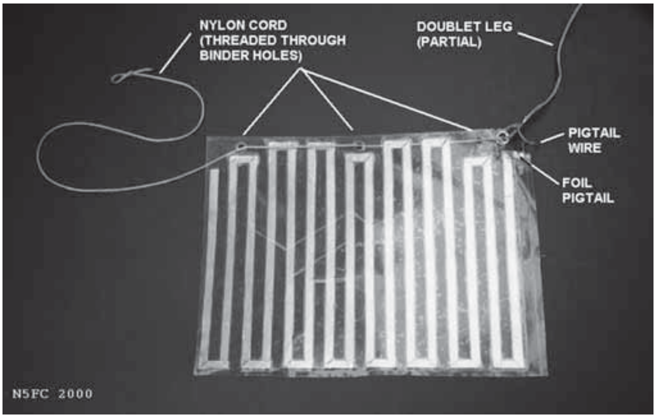
N5ESE'S NOTEBOOK ANTENNA

Monty Northrup, N5ESE, came up with a portable indoor antenna solution that is ideal for people on the move or who have no room for a permanent installation. And when it is not in use it just packs away into its own little 1in thick three-ring binder. Neat, eh?



N5ESE's Notebook antenna uses zig-zag loading.

Monty takes up the story: "In the Autumn 1990 edition of *Sprat* (Issue 64), the journal of the G-QRP Club, Gus Taylor, G8PG, expanding on material presented by G2MQ, described a 12ft, seven-band wire doublet. In the article, he suggested that one could raise the efficiency of a short antenna



The zig-zag loading elements are made from self-adhesive copper tape.

by using the entire (1/4-wave) length of wire on each leg, but forming the ends into a 'non-inductive' end-loaded assembly. [Editor's note: This is the same technique used for the zig-zag loft-mounted dipole, which was inspired by the same article!] He claimed that such a winding had been found to increase the radiation resistance of a short antenna. And that implies higher antenna efficiency. Using these thoughts as the foundation for an antenna design, I endeavoured to come up with something both practical and usable for operating QRP from a hotel room.

"Whips have been used, but are notoriously inefficient, and certainly won't fit in my suitcase. Wire loops have also been tried, and are either hard to tune or very inefficient when less than a full-wave long. Magnetic loops are very, very efficient, but are hard to fabricate, expensive commercially, and cumbersome to transport. I wanted an antenna that was very portable (i.e. fit in my briefcase), easy to set up and take down, and reasonably efficient (or at least, relatively so, compared to other equally portable antennas). The Notebook Antenna is the result of my efforts.

"Some time ago, I found that hobby stores carry adhesive-backed copper-tape. The 1/4 inch wide tape is approximately equivalent to AWG 25 wire (in cross-section), and two in parallel equal about AWG 22. This would be quite useable (and believe it or not, quite possible to solder).

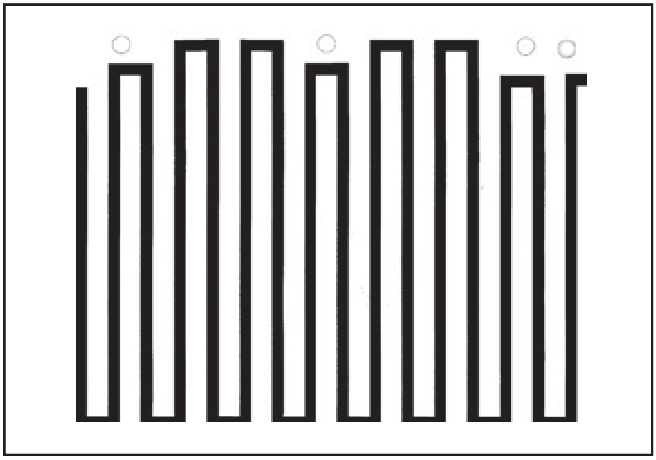


Fig 8.5: Detail of the Notebook antenna zig-zag construction.

"My idea was to use an 8.5in x 11in (US letter-sized) transparency, and lay the tape down, zig-zagging on both sides in parallel (**Fig 8.5**). I made two, of course (one for each leg of the doublet) and punched holes for a three-ring binder. The transparency would easily tear if excess force was applied, so I placed an eyelet on the top inside corner (the kind found in cloth stores) and threaded support rope and antenna wire into this eyelet.

"The support 'rope', a small diameter nylon string, passed through the transparency's three-ring binder holes, to keep it in place,

10
Avoiding interference and EMC issues

IF YOU ARE A radio amateur, sooner or later you are going to come up against EMC issues. EMC stands for Electromagnetic Compatibility, although I think it should really be called EMI (for 'Incompatibility')! EMC really breaks down into three main areas:

* **Breakthrough**
  Interference to neighbouring electronic and radio equipment caused by the relatively high field strength of the amateur transmission.

* **Interference caused by spurious emissions**
  This is where the amateur station causes interference (usually to radio or TV) by generating unwanted emissions.

* **Interference *to* amateur reception**
  This is generally called radio frequency interference or RFI.

If you use outside antennas and reasonable power levels you are unlikely to experience any more EMC problems than any other ham. But if you use indoor or loft-mounted antennas, or antennas in close proximity to your house, you are more likely to suffer problems – even with relatively low power levels.

One again, both the RSGB and ARRL have sections on their websites devoted to EMC issues and I recommend that you visit them.

Freezing, blocking or a lack of signal are all possible symptoms of RF interference to a digital TV or set-top box.

INTERFERENCE BEING CAUSED BY YOU

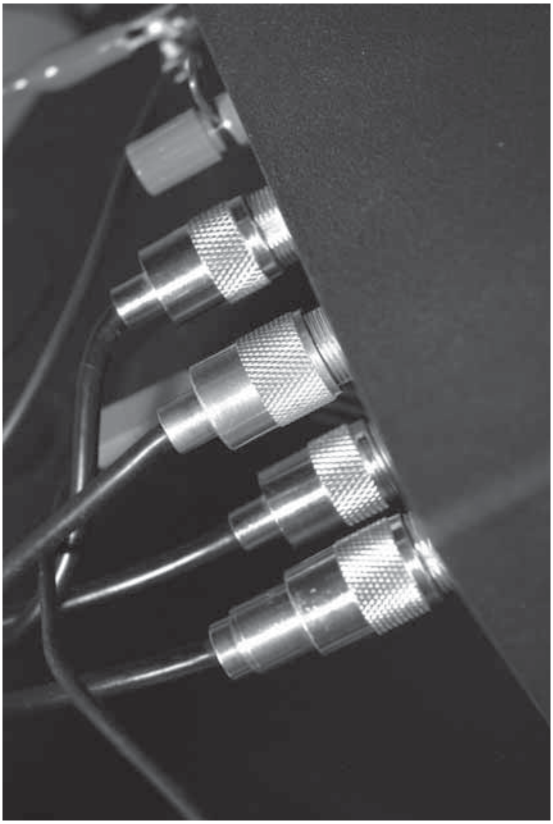
The biggest problem with stealth or hidden antennas is their relative proximity to household wiring and domestic equipment. With electromagnetic fields varying according to the inverse square law you can see that halving the distance from your antenna to a device such as a TV results in the field strength going up by a factor of four. Put another way, using 50W to an indoor loft-mounted dipole may have the same effect as someone running 400W to an outdoor antenna.

So what can you do about any potential interference problems?

Firstly, keep your antennas as far away from household wiring and domestic devices, such as TVs, hi-fi equipment, telephones etc. If possible keep them away from your neighbours too.

Secondly, if you are causing interference to you or anyone else, stop transmitting – at least until you can determine what the extent of the interference is and what is causing it.

Check your own station to make sure that it is wired correctly, that all PL259 plugs are securely tightened and that there are no breaks in your coax or other antenna cabling. I have seen loose PL259 plugs on the back of ATUs cause TVI and a break in a G5RV antenna, where the twin feeder was joined to the coax, that was arcing on transmit.



Make sure that all your antenna connections are tight. A loose PL259 can cause interference.

If possible make sure that your transmitter is working properly and not generating unwanted spurious emissions. There is usually an expert in your local club who can check this.

If the interference is caused by spurious emissions or harmonics using an ATU can help as it will attenuate out of band and unwanted signals. Certain types of antennas are better than others too – magnetic loop antennas, for example, are very good at only radiating the frequency upon which you are operating.

Wrapping your TV antenna lead through a ferrite ring might help to eliminate interference. Or try a high-pass filter.

In the UK keeping an amateur radio station log is no longer compulsory, but it is useful to have a record of when and where you have been transmitting. This helps you and your neighbours decide if you are responsible for any interference and, if you are, what band(s) and / or antenna(s) were responsible.

The first action you can take if you are found to be causing interference is to try to move the antenna away from the affected item.

I found that I was causing interference to my main television while using 2m FM, even though I was only running about 5W. The digital picture would freeze as I transmitted. I found that my moving the loft-mounted vertical antenna just six feet away did the trick. I can now run 25 - 40W with no problems, although the problem shows itself again at higher levels (which I don't run). If the problem still persists don't presume that it is your 'fault'. It could be that the TV antenna connections have deteriorated or the cable has broken. If all else fails, a high-pass TVI filter can be fitted into the back of the TV set. These are available from most good amateur radio retailers or the RSGB.

Some cheap computer speakers are notoriously bad at picking up RF.

Breakthrough on to hi-fi units can usually be cured by winding the loudspeaker wires and mains leads on to ferrite rings – as close to the device as possible.

Some cheap computer speakers are notoriously bad for breakthrough and I had one pair that resisted all attempts at silencing them. I borrowed another pair which showed no signs of breakthrough whatsoever, so replaced them with the same make.

If a telephone is sold by BT, and suffers RF breakthrough while under warranty, the customer can return it to the point of sale. In this case, BT retail outlets will, if possible, replace such a telephone with another model offering higher RF immunity. Alternatively, they may supply a 'plug-in' RFI filter free of charge if appropriate. If a telephone was sold by BT, but is out of warranty and is not covered by a maintenance contract, there is a standard charge for the sale of a 'Freelance' plug-in RFI filter, LJU 10/14A, BT Item Code 877596. These are sold by BT PhoneShops for less than £10 but may not be effective in all cases.

Some alarm PIR detectors are also prone to being triggered by stray RF.

If you find you are causing interference to more than one device in your house the chances are that you could be injecting RF into the mains wiring. If so, reduce your power or relocate your antenna. Wrapping every mains lead in the house around a ferrite may seem to make sense, but what about your neighbours?

Interference to burglar alarms is also possible, but the good news is that the RSGB's EMC Committee has never known a case of alarm RF triggering that could not be cured by fitting RF-immune PIRs or occasionally a more immune control panel. If your transmissions set off the neighbour's alarm system, it is advisable to tell them as soon as possible, otherwise that they may be charged for a visit by the installer or maintenance engineer who may find no fault. If the system is centrally monitored, the monitoring service could be withdrawn if there are too many false alarms.

Some installers have come across RF triggering before (not necessarily from amateur transmissions) and may realise the cause if they see your aerials (if visible). Others claim that it has never happened to one of their installations before and assume that it must be the radio amateur's fault - which is isn't.

If the installer does not have sufficient technical knowledge to deal with the problem, you will need to give some technical advice otherwise they may waste time trying things which are unlikely to work. Again, the RSGB has a technical document that you can download at www.rsgb.org.

If you find that you are killing your broadband Internet connection when using 80m the solution may be to reduce power and / or move the antenna further away form the telephone points. If that doesn't work it is possible to remove the ring wire from the master socket. The ring wire induces an imbalance in the phone wiring and removing mine cured the problem once and for all. It has no effect on modern telephones and the ring wire is a hang over from days of old. If you have a BT NTE5 Master socket with a removable bottom half, instructions for removing this wire can be found on the Internet, but if in doubt call in a professional.

If you cannot resolve a persistent case of interference your first stop might be another local ham with more experience.

Following a change of procedure in mid-2010, the BBC is now responsible for investigating complaints of interference to domestic radio and television. The Ofcom [1] website has more detail, but the BBC has an interactive diagnostic website [2] where you answer questions and will be presented with guidance on the possible causes of the problem you're experiencing and advice on what you could do.

This should take up to 10 minutes to complete. If the guidance and advice don't help, you are then given the option to proceed through a webform and send the BBC an e-mail. They will then investigate and, if they believe you are suffering from an interference problem, may contact you for further information to help resolve the problem. If, following the investigation by the BBC, there is evidence of interference caused by something outside your control and which is unlawful, the BBC may refer your case back to Ofcom for possible enforcement action.

Ofcom does not currently investigate problems with cable television or baby alarms, nor any equipment that is not intended to receive radio signals such as hi-fi systems, computer speakers or telephones.

INTERFERENCE BEING CAUSED *TO* YOU

Increasingly nowadays this is getting to be a major problem. Years ago, amateurs only had to worry about noisy electric motors and car ignition systems, but the rise in microcomputer-controlled circuitry and switched-mode power supplies has resulted in us living in a veritable fog of electrical noise.

Amateur Radio is an ‘unprotected service’ in the UK, which means that radio amateurs do not have a right to interference-free reception. Radio services such as emergency services, Private Business Radio (PBR, formerly PMR) and broadcasting are examples of ‘protected’ services whose users can ask Ofcom to investigate any interference. For protected services, a minimum usable signal level is defined but radio amateurs often receive weak signals which are only just detectable and may therefore suffer interference from sources which would not affect other services.

If there is interference to amateur bands, it is worth checking whether it also affects the UHF TV band or the 88 - 108MHz FM broadcast band, particularly classical music stations in stereo. If it does affect a TV or FM broadcast station, which is intended to serve your area and you are using an adequate outdoor TV or FM aerial, go to the BBC website [2], click on the “reception problems tool” link at the top of the page and complete the interactive web form. After answering a series of questions the site will offer suggestions as what could be causing the problem. Otherwise you will be invited to submit an e-mail to the BBC for further investigation.

It is worth keeping a log of exactly when the RFI occurs as this can give a clue to the possible source. Tuning across the affected band or bands can also give some clues about the source of the interference. Here are some common sources of interference:

Television line timebase harmonics

The line timebase frequency of 625-line television systems in the UK is 15.625kHz. Harmonics may be heard as narrow band signals on multiples of this frequency, for example, 3500.000kHz, 3515.625kHz, 3531.25kHz, etc. As the line frequency is 1MHz divided by 64, harmonics are found on multiples of 125kHz. If the TV is receiving an off-air programme, the harmonic will usually have a sound which changes with picture content when heard on an SSB or CW receiver.

To prove that a TV set is the source, try watching another TV set (with low RFI!) and select different channels until you find one where changes in the picture coincide with changes in the sound heard on the radio.

Sometimes a braid breaker filter fitted in the antenna lead can help reduce timebase harmonics as it prevents them being re-radiated by the TV antenna and coax. It is worth trying.

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