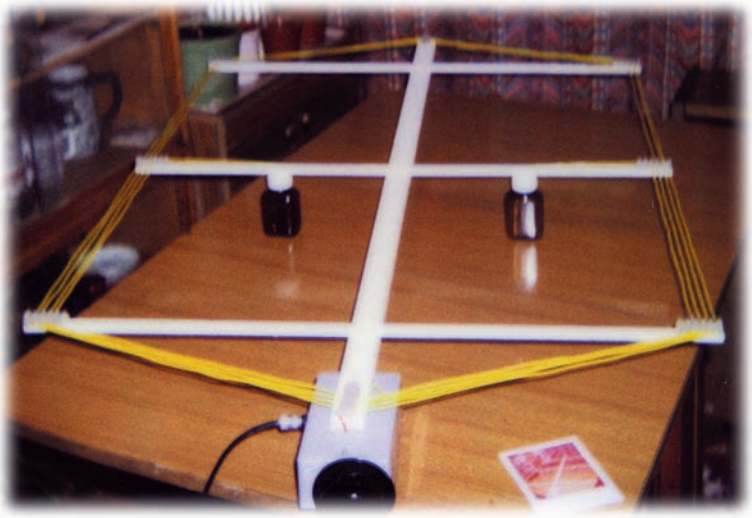
Go Loopy *Build The Tab*



Richard Marris G2BZQ is a self-confessed 'loop obsessive' and thoroughly enjoys using this form of antenna. The project described is for table-top operation on 80 metres... hence TT-80.

● Richard G2BZQ's prototype TT-80 loop antenna. Richard says that the two pill bottles makes useful stand-offs and he regularly has QSOs with a friend in Germany.

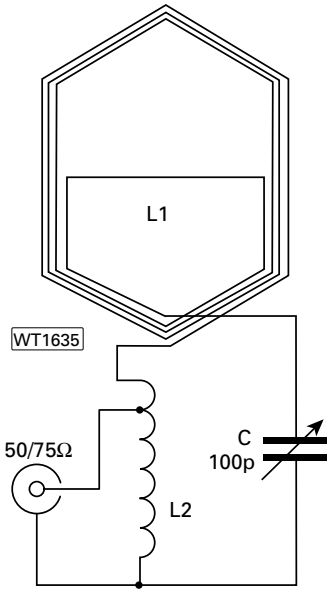
It was way back in the early 1950s when my work led to frequent changes of QTH. Inevitably this meant apartment dwelling with the equally inevitable transmitting antenna problems. Gone were the long wire antennas and dipoles...as were good earthing/grounding facilities.

In my first apartment QTH a 10W c.w. home-brew valved transmitter, and an HRO receiver were set up in the corner of quite a small room. A short end-fed antenna was slung across the room and matched with a LC (or CL) antenna tuning unit (a.t.u.), which would just about match the transmitter-receiver combination to anything on the lower h.f. bands. Results **were obtained** but needless to say they were not particularly good!

Next, a couple of wires turns were taken around the room and end-fed with the a.t.u. Results were better but not brilliant.

Another attempt led to the two wire ends being tuned with a variable capacitor. This resulted in a two turn horizontal loop with a very narrow bandwidth, which greatly reduced man-made and atmospheric QRN (noise, static, etc.) and gave much improved results on 3.5MHz c.w.

● Fig. 1: Circuit of the G2BZQ TT-80 loop antenna. The adjustment of L2 is critical for best performance (see text).



As a result of the experiments I designed a timber framed square vertical loop antenna. It had a figure of eight radiation/reception pattern; was narrow band and greatly reduced both QRM (interference from unwanted transmissions, adjacent channels, etc.) and QRN.

After trying out various low impedance coupling methods and other modifications the whole thing looked like a spider's nest! However, the results exceeded all expectations.

Since that time many transmitting and receiving loops have been designed and tested, while residing in the UK and USA (operating as G2BZQ/WO). Since then loops and other compacted antennas have become an obsession of mine!

In the past I've completed much experimental work in the field; from v.l.f. to v.h.f. frequencies using multi-turn small tuned frame loops; ferrite loops and hybrid frame and ferrite loops.

Design Considerations

Let's now take a look at some design considerations for loop antennas. In practice, dimensions of small multi-turn tuned loops are likely to range from maybe 15 x 15 inches (380 x 380mm) to over 48 x 48in (1.22 x 1.22m) - or a similar diameter - depending on the space available when mounted vertically.

The loops can be manually tuned and rotated in a room alongside the operating position. Alternatively they can be remotely controlled either indoors or out.

In use the radiation/reception pattern in usually figure-of-eight. Additionally, various methods can be used to increase the size of one lobe while decreasing the size of the other, arriving at the point where a cardioid pattern is present thus reducing reciprocal bearing QRM.

Such tuned loops will have a narrow bandwidth. They're also very directional and QRM and QRN can therefore be reduced to an absolute minimum by small rotational movements of the loop.

Harmonic radiation is very low or even non-existent, thus eliminating television inference (TVI). Another plus is that they can be fed with standard 50 or 70Ω impedance coaxial feed line.

Furthermore grounding/earthing at the loop is not necessary. In fact, a poor ground may well introduce/increase man-made noise.

However, **there is a negative side** to such a vertical loop. The radiation/reception pattern is very directional and narrow band, so that incoming CQ calls will only be heard from a small directional segment and outgoing CQ calls will only be heard in that small segment.

So, it will be seen that the chief advantage of a highly directional vertical loop can also be a disadvantage. It depends on whether you concentrate on point-to-point working as at your QTH or just send and receive CQ calls.

Horizontal Loop

The TT-80 is a horizontal, small dimension multi-turn tuned loop for the 3.5MHz band. The radiation/reception

ble-top 80 Metre Antenna

pattern is 'all round looking'.

In the prototype I found that the usable bandwidth on the is ±6kHz (a total of 12kHz). This narrow bandwidth dramatically decreased atmospheric and man-made QRN which can be simply atrocious on the 3.5MHz band.

Furthermore when the loop is carefully and correctly matched, harmonic radiation can be zero. In fact no TVI could be detected on my television with its antenna close to the loop.

Additionally, the loop can be accurately matched to either 50 or 70Ω impedance standard coaxial feed line.

Four Turns

As shown in the diagram, **Fig. 1**, the TT-80 loop consists of four wire turns. One end of the loop is connected to L2 which can be tapped for either 50 or 70Ω.

The loop is tuned to resonance by a 100pF variable capacitor C, as in Fig. 1. Loop dimensions are approximately 48in by 30in (1.22m x 762mm). This is a convenient size for lying horizontally on a table, near the operating position or even suspended below the ceiling with nylon cord.

In all cases the tuning capacitor C should be within easy reach of the operator. I've no doubt it could also be remotely controlled for indoor or outdoor use.

As an alternative the loop can also be **vertically mounted**, thus making it highly directional. A suitable hinged arrangement could be used. And in my opinion this versatility makes the TT-80 useful under all conceivable circumstances and situations.

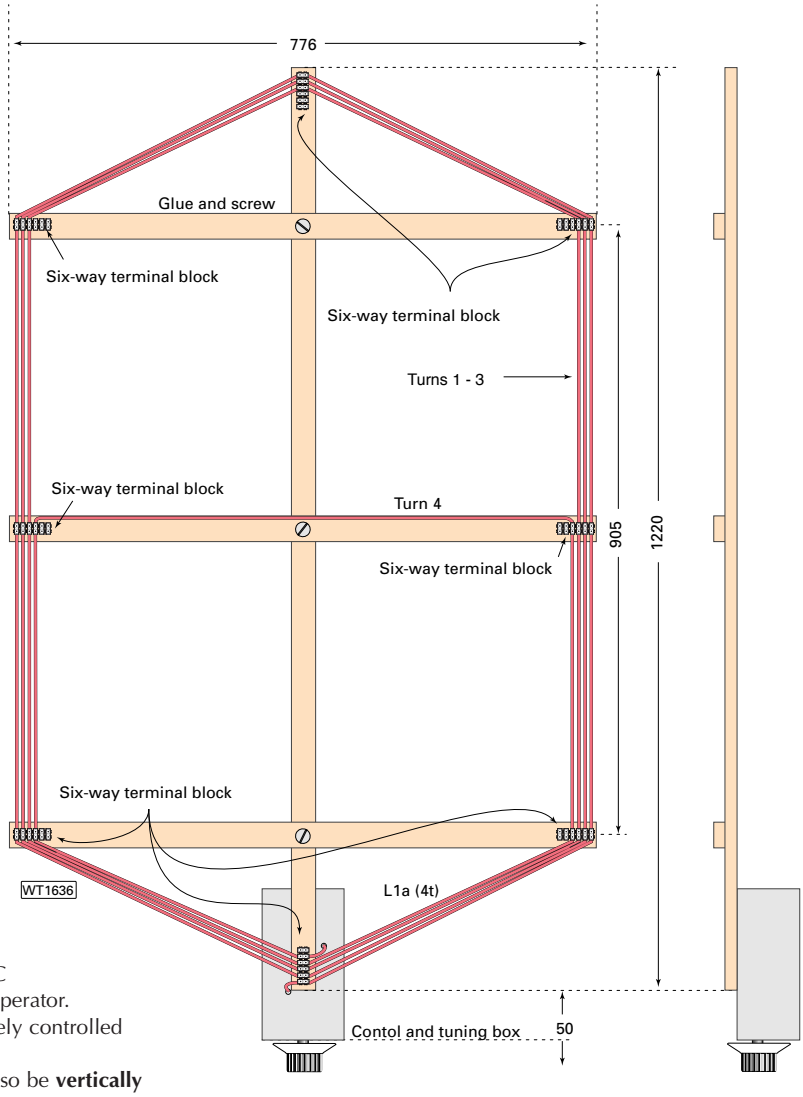


Fig. 2. Physical lay-out and dimensions of the TT-80 (a), with a side view of the complete project in (b). See text for details.

Shopping List

Timber 1.22m x 34mm x 12mm (hardwood preferred), timber 776 x 16 x 6mm. Wire For L1 = 24/0.2 pvc covered outside diameter 2.05mm and rated @ 6A. Wire For L2 - 16s.w.g. tinned copper wire. Two-way terminal blocks 6A - 8mm pitch between inserts (cut in two to form six blocks). Variable capacitor 100pF - **see text** (**note:** on the prototype a Jackson type C11 was used) ABS plastic box 90 x 14.95 x 52.5mm (Maplin PX4 or similar) 3 inch diameter instrument knob. Coaxial socket.

The Lay-out

The front view of the TT-80's lay-out is shown in **Fig. 2a**. And the associated side view on the right in **Fig. 2b**.

To build the antenna you should first obtain one piece of timber 1.22m long x 34mm wide x 12mm* thick, to form the main structural beam. Onto this are fitted the cross-struts at 90° (see diagram), each being 776 long x 16 wide x 6mm thick.

Care should be taken to select, good, straight well seasoned timber - even hardwood (if obtainable). The three cross-struts are mounted as shown in Fig. 2a. They are firmly secured with wood glue (the rapid setting carpenter's resin adhesive is recommended) and screws. The resulting frame can be given a coat of paint of any convenient colour.

A 6-way terminal block is screwed onto the end of each arm of the frame. The 6-way terminal blocks are cut from standard 12-way 6A nylon blocks (these have inserts at 8mm pitch).

Next, you should wind on the loop, L1, winding. This is done using 24/0.2 *pvc* covered wire with an outside diameter (o.d.) of 2.05mm and rated at 6A.

Start L1 at the bottom terminal block at the outer hole and winding counter-clockwise (note this end goes to L2). Pass the L1's wire through the terminal block inserts **for three full turns** plus **one half turn as shown**.

The inner end of the winding will be connected to the variable capacitor C. The terminal block grub screws should be finally tightened onto the pvc outer, of the wire, thus holding the wire turns firmly-tight in place. It will be seen that this leaves several terminal block holes unused (see later).

** No imperial equivalent measurements are provided for the wood required as timber is now mostly sold in metric sizes only, the sizes quoted are what Richard purchased.* ***Editor****.*

Plastic Box

When the antenna is assembled, the variable capacitor C and inductance L2 are housed in a readily available standard size ABS plastic box, **Fig. 3**. These are sometimes known as PX4 by some suppliers.

Go Loopy

The variable capacitor I used on the prototype was a small 100pF transmitting type Jackson type C11. But any good quality air spaced receiving type could be used for powers up to 20W or more. If it appears that the selected capacitor will not fit into the PX4 size, you only need to select a size suitable for the capacitor you've got.

Inductance L2 consists of 12 1in (25mm) diameter spaced turns of 16s.w.g. tinned copper wire. To achieve a nice tidy coil, 13 turns of wire should be close wound onto a 7/8in (22mm approximately) diameter wooden dowel (the coil will spring open to 1in diameter when released).

Next, you should then separate the turns by running a knife blade around the coil. Finally, the ends should then be shaped to fit into the plastic box.

A coaxial socket is fitted into the box side and a wire taken from the centre contact to a tap on L2. The exact position of this tap will be determined during initial testing, but start with about ten and three quarter turns from the bottom of the coil.

The complete control box assembly should be bolted to the bottom of main frame arm as shown in Fig. 2. The outer end of L1 should be taken through a hole in the box to the top end of L2. The inner end of loop L1 is taken through a hole to the moving plates of variable capacitor C.

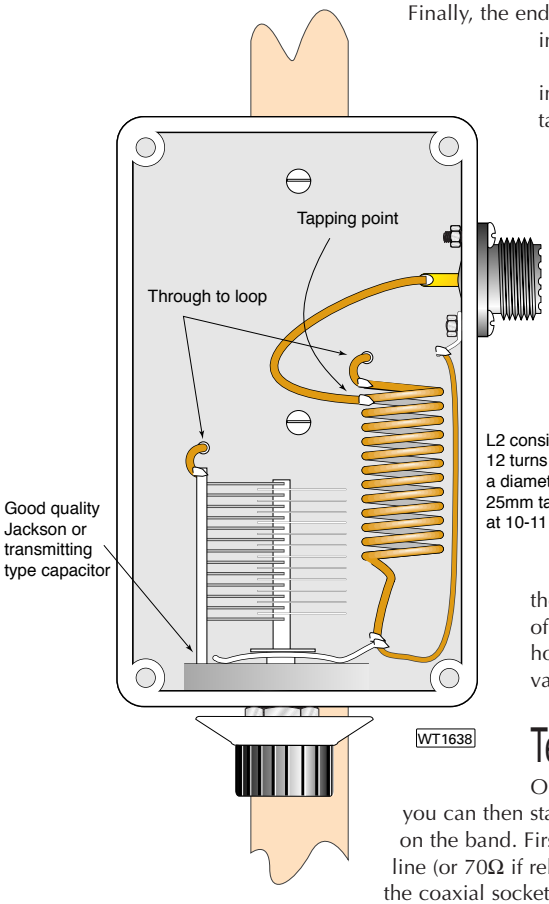


Fig. 3: The plastic control box for the TT-80, the actual size of box is chosen for the variable capacitor used, is then attached to the wooden framework by screws (see text).

Testing & Operation

Once the assembly is finished, you can then start testing ready for operating on the band. Firstly, a short length of 50Ω feed line (or 70Ω if relevant) should be taken from the coaxial socket to your receiver's antenna input socket. Next, lay the loop flat on a wood top table.

Then you should tune variable capacitor C to resonance at around 3.520-3.550MHz. When resonance of the loop is achieved, it will made obvious by a substantial increase in signal strength. As an indication and to help, I found tat the moving plates of C on the prototype were about 15/20% enmeshed. Then you should check resonance over the whole band.

Next, find a steady signal near the l.f. end of the band and adjust the tap on L2 for maximum signal. This will bring the tapping point very close to the final position for transmitting.

Finally, with a field strength meter (f.s.m.) positioned nearby, you should then feed a low power c.w. signal into the loop and make any necessary minor adjustments to C1 for maximum f.s.m. reading.

It will then be necessary to find the best position for the tap on L2. **And to obtain maximum radiation - I strongly advise that the position of this tap should be found with great care and checked, and rechecked again**.

Bear in mind that the ultimate target is **maximum radiated signal** and the tap should be moved up to maybe ±half a turn for maximum radiation as indicated on the f.s.m. Once the critical tap position has been found the s.w.r. can be checked and should be near unity; the harmonic radiation should be near zero and no TVI should be present.

The effect of the narrow bandwidth of the loop acts as a bandpass filter. This can be very useful on the crowded 80 metre band!

On The Air

In my on the air operations at G2BZQ the loop has been supported on a table by the plastic control box plus two non-metal supports. These were positioned about half-way between the centre and ends of the cross-strut C. (In my shack these supports were two plastic pill bottles with the screw-on caps being drilled and screwed to the strut).

An alternative mounting is to use a vertical short post about 2in diameter or 2 x 2in (51mm square section) screwed to a heavy base. The loop frame might well be hinged so that the loop can be used either horizontally or vertically.

In operation I recommended that a 10-15W c.w. be used although I've used up to 30W for testing purposes. In use the loop has been on a wooden table top alongside the operating position, **making certain that the periphery of the loop is not against a wall containing house wiring**. This latter point is very important as an EMC precaution, as it's possible that r.f. getting into the mains wiring could cause problems.

The antenna has been very effective in operation and has been regularly used for an early morning CQ QSO with a friend in Germany. He uses 100W and an outdoor dipole, but I'm pleased to say that there has been little to choose between the daily two-way RST reports.

Efficiency Of Loop

The efficiency of such a loop as the TT-80 will in theory be less than an outdoor antenna such as a dipole. On the other hand, it is possible of course to peak the loop to any particular frequency. Also the feed line is so short that the question of losses doesn't occur. This, plus the ability to adjust the loop to fine limits will enable every last milliwatt to be squeezed out of it.

I think that the TT-80 will move loop effectiveness some way towards equality with the outdoor antenna. The latter lives outdoors in all weathers subjected to high temperatures, sunlight, frost, snow, wind and rain.

The outside antenna will also have been made to textbook dimensions with a much wider bandwidth, feeding onto the end of a long length of somewhat lossy coaxial feed line. And everything on the system is also subject to a gradual creeping unseen loss in efficiency as general deterioration sets in. The indoor loop is spared most of this!

As I've already mentioned, low power is used with my TT-80. This is purely a personal preference, but if you do use higher power on any indoor antenna, please bear in mind it can produce nasty r.f. burns.

Finally, if the spare holes in the terminal blocks are filled with wire turns the loop will tune down to the 1.8MHz band. (for Top Band operation L2 will maybe have to be about 18 turns).

This little antenna may well be an effective answer for those transmitting Amateurs unable to use an outdoor antenna, for whatever reason. It can also be used for portable and vacation applications. So, why not give it a try? - but don't forget to select the L2 tap with care!

PW