

"Jolly Useful Hints & Tips For The New M6 Licensee" (Version 2)

JUH&T No.1: Getting Started And On-The-Air For The First Time

"Jolly Useful Hints And Tips For The New M6 Licensee"

A straightforward, practical guide for those who are new to amateur radio and who have just passed the Foundation Licence Examination. This guide should help you get on the air safely and effectively.

The best initial advice anyone can give you remains:

"Join your local amateur radio club and The RSGB and ask lots of questions!"

Introduction To Issue 2:

Introduction to Version 2 of *"Jolly Useful Hints And Tips For The New M6 Licencee"*

The first version of this CDARC *Jolly Useful Guide* first appeared some 10 years ago. Having run lots of Foundation Courses in the interim we thought we should bring this publication up-to-date.

There are lots of books on all aspects of amateur radio. So, how is this guide different?

We have written this specifically for the new M6 licencee who has just completed one of our weekend Foundation Courses and who wants to know what he or she should do next. It aims to fill the fortnight between "Well done you have passed!" and "Yippee I've just got my M6 call-sign from Ofcom!". During that period you will start to think about what your new station will be like; what type of radio equipment you will buy; what modes you will transmit; where you will put your antennas……It is at this point that you discover that there might be a bit of gap in your knowledge between the theory you so recently acquired and the challenging practicalities of setting up a station for the first time.

This guide aims to get you started in acquiring that practical approach that all radio amateurs develop over time in solving the limitations they face at their home location. It won't make you an instant expert – but it will give you the confidence to ask the right questions and start planning.

The best advice at this stage is "Join your local radio club (and the RSGB)" Within your local club will be years of accumulated knowledge and a team of people *desperate* to help you get on the air.

If your local club happens to be The Cambridge and District Amateur Radio Club then so much the better! We operate a "Buddy Scheme" for our new M6 members whereby an experienced club member living near to you can provide on-the-spot help and practical support.

So, check your bank balance, look at all the adverts in RadCom, ask us loads of questions (none of them will be thought stupid) and fill the forthcoming, never-ending fortnight with some practical planning and by reading through these ***Jolly Useful Hints and Tips!***

Peter M0DCV, Cambridge 2017

Getting Started at My QTH:

Perhaps the first problem to solve is an answer to the question:

"What do I want from amateur radio both now and in the future?"

Your answer will, of course, be unique to you. It will generally fall into one of three, broad categories with some overlaps.

1. "I just want to be able to go into the shack occasionally, turn on the radio and talk to people on different bands".

2. "I'm interested in the more technical aspects. I want to advance to the intermediate and full licence exams so that I can build and operate my own equipment".

3. "I like general operating and I fancy having a go at lots of different modes - data, atv, microwaves, etc".

None of the above is mutually exclusive. However, it could have an influence on what equipment you choose to buy first of all. Of more significance is the space you have available both for the "shack" and for the placing of your antennas. The type of dwelling in which you live is, for most amateurs, the significant factor. The nearness of your neighbours and their sensitivities are also big considerations. A bit of forward planning will pay dividends here.

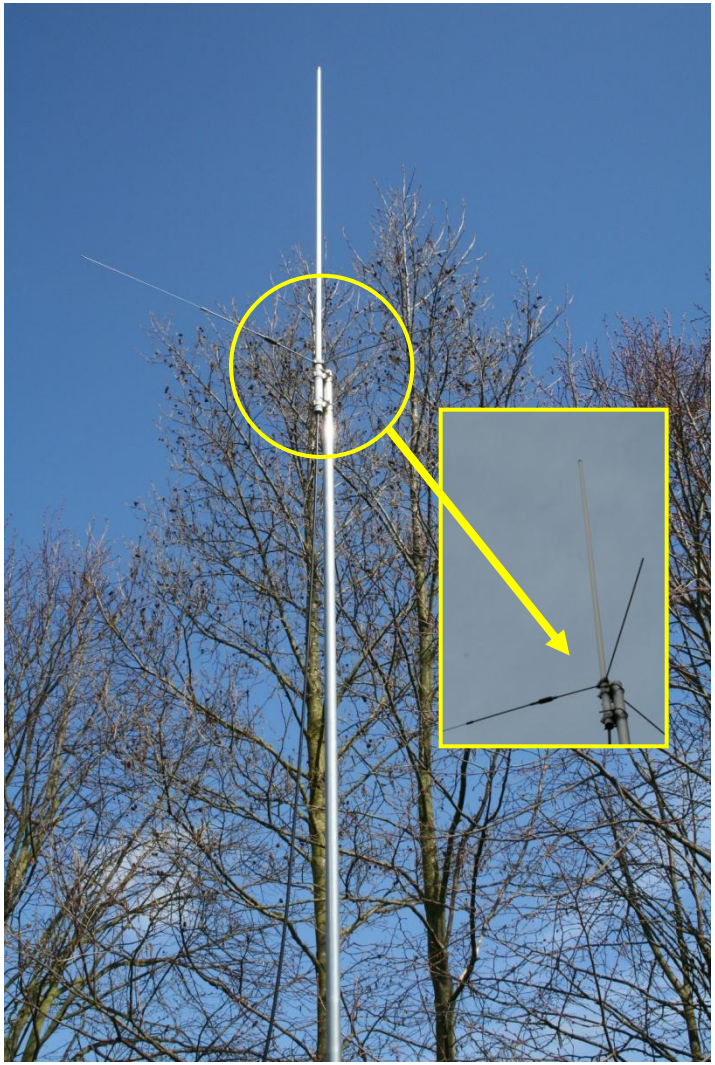
Example 1: ***Terraced house, chimney stack, small back garden, I want to be able to talk to whomever I can contact on HF and VHF.***

Antennas:

VHF and UHF (FM): The easy part is the VHF aspect. A 2-metre / 70cm co-linear antenna (the so-called "white stick") can be mounted on the chimney or at eaves height. Fed with 50Ω co-axial cable it will perform well on local FM contacts. (The CDARC Sunday net on 145.55 MHz from around 11:30hrs for example!)

VHF and UHF (ssb): For 2-metre / 70cm ssb (single side band) a yagi antenna and a rotator will be needed. This can be mounted on a short, aluminium pole attached to the chimney. (An antenna erection firm can do this if you prepare all the bits.) You can buy Yagi antennas where the 2m and 70cm elements share a common boom. A 3- or 4-element Yagi will radiate an effective signal whilst having a low visual impact.

Co-linear And Yagi Antennas:





(Above) A 2m/70cm Yagi antenna where the elements share a common boom. Directly under the antenna is the rotator and underneath that is the guying point. The mast is a 5 metre telescopic type in a weighted base. Although fixed to the same metal boom the two antennas are electrically independent and are fed with a common, coaxial feeder. A tee piece then distributes the signal to each antenna. Only the resonant antenna will radiate. Gain is about 10db.

(Above) A 6m/2m/70cm co-linear antenna. It is fixed to the top of a 3 metre pole which is itself fixed onto a 3 metre fence post. (ie. Putting the feedpoint at about 5.5m above the ground.) The pole is stiff enough not to require guying. The inset photograph shows the three, ground plane radials. The longer radial is the 6 metre radial which may be adjusted for optimum performance at 6 metres then clamped.

Horizontal or Inverted Vee HF Dipole (80m to 10m) : The HF aspect is a bit more tricky – particularly if you want to work on 80 metres. A half-wave, wire dipole for 80m will be about 40 metres long (See Fig. 3.3 Page 30) You can distort the geometry a bit by allowing the ends to drop down vertically. This may shorten the overall length by about 6 metres if you drop, say, 3 metres at each end. Too much abuse of the geometry will affect the antenna effectiveness.

A dipole with a 3/8λ (at 80m) top length will be 30 metres overall and might be a better bet. It will still function well on 80 metres. If you can do without operating on 80 metres altogether then the dipole lengths become manageable in a small garden. A vertical aluminium pole on the chimney supporting the apex of an "Inverted Vee" dipole will often fit in. You can sweep back the arms by a few degrees.

You should whenever possible feed the dipole with window or ladder line (300Ω ,450Ω or 600Ω is fine). If you really must use co-axial cable then remember to fit a balun at the dipole centre. You will need an antenna tuner (ATU) whatever feeder you use. (Ladder line is best for a multi-band dipole)

Commercial, Multiband, HF Vertical: Your other option is a vertical antenna with a few buried wire radials. Commercial verticals do offer an 80 metre section but with a very limited bandwidth. Again if you can live without the facility to operate on 80 metres the installation becomes simpler.

Feed the vertical with 50Ω co-axial. You should put line isolators (choke baluns) at each end of the feeder to stop the outer acting as a radial and affecting the vswr. (See Fig. 4 Page 38) You should have at least two, buried (25mm to 50mm deep is fine), 1/4λ radials per band. If space is a premium then make the radials as long as possible. They can have bends in them. If space is really tight then make the radials as long as the antenna is high. Try to arrange them symmetrically in a "star pattern" centred on the base of the antenna. (Insulated or bare wire is equally good.)

Home-Made Wire HF Verticals: If space is the over-riding factor in the garden and you don't want a permanent antenna installation for HF then a portable, monoband, wire vertical with elevated radials may be the answer. You will need a cheap, telescopic pole and a solid base to hold it vertically when extended. (Telescopic, fibre-glass poles of 9 metres length cost about £12. Kite shops often have them under the heading of "banner" poles).

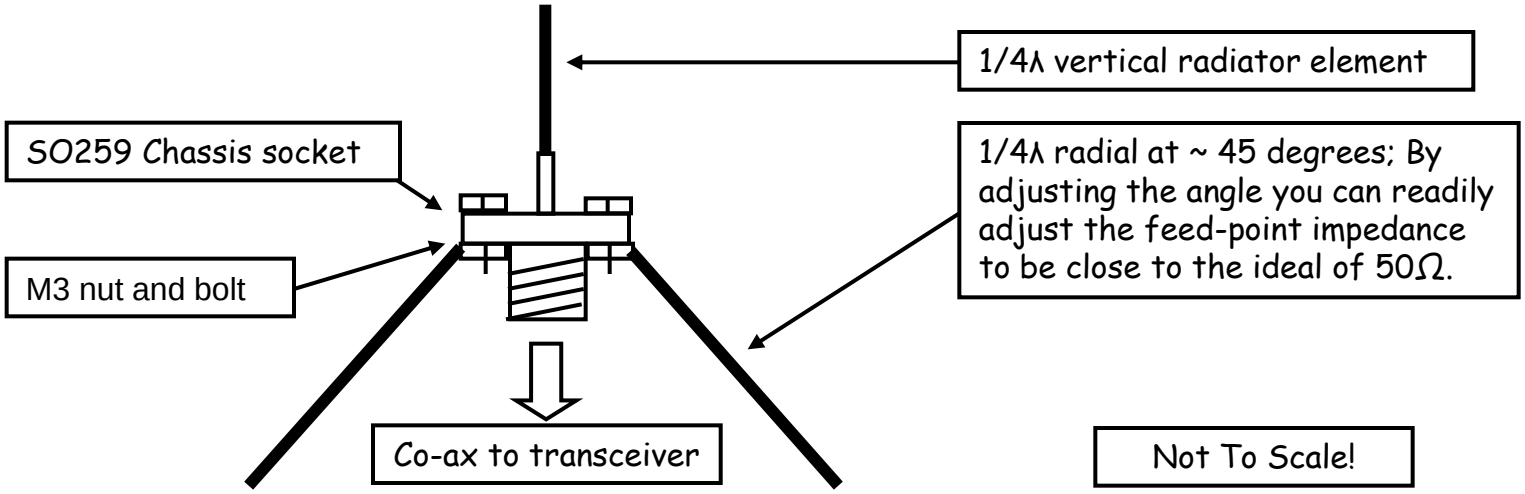
How To Make A Simple, Monoband, Wire Vertical: Cut three lengths of wire (any flexible wire will do - eg. an old 3-core mains lead.) which are a quarter of a wavelength long at the centre of the chosen band. Solder one to the centre pin of an SO259 chassis mounting socket. Attach the other two to the "earth" side of the socket. Hoist up the antenna so that it hangs as an inverted "Y". The two radials should be at an angle of about 45 degrees. Feed the antenna with co-axial. (A club member will almost certainly have an antenna analyser and will be happy to help you trim the antenna to resonance at 50Ω with the correct radial angle. Thereafter you can set the antenna up to some fixed ground marks for repeatability.)

A set of these simple, vertical, wire antennas covering 20m; 17m; 15m; 12m and 10m will only cost a few pounds in total but they work fantastically well. (This is also a good system for operating /P such as on holiday.) Below are a few hints on making an elevated ground plane, vertical antenna.

Example: A 1/4λ wire vertical for 20 metres.
We'll design the antenna for resonance at 14.200 MHz. This will put it more or less in the middle of the 20 metre band ssb sector. The free space wavelength (metres) will be about (300/14.2) or about 21.127 metres. A quarter of this is 5.282 metres.

Cut three lengths of wire about 5.290 metres long. Attach them to a SO259 chassis socket as shown below in Figure 1. You will need to trim the radiator and radials to bring it to exact resonance at 14.2 MHz.

Figure 1



Use an ATU to start with in by-pass mode (ie just the power meters in circuit) to adjust the antenna to get zero reflected power. shown on the ATU. When the antenna is correctly sized and the radials angled it will be ~50Ω at resonance and give good results across the band and an ATU shouldn't be needed. A choke balun at the antenna generally isn't necessary. These antennas are good to experiment with.

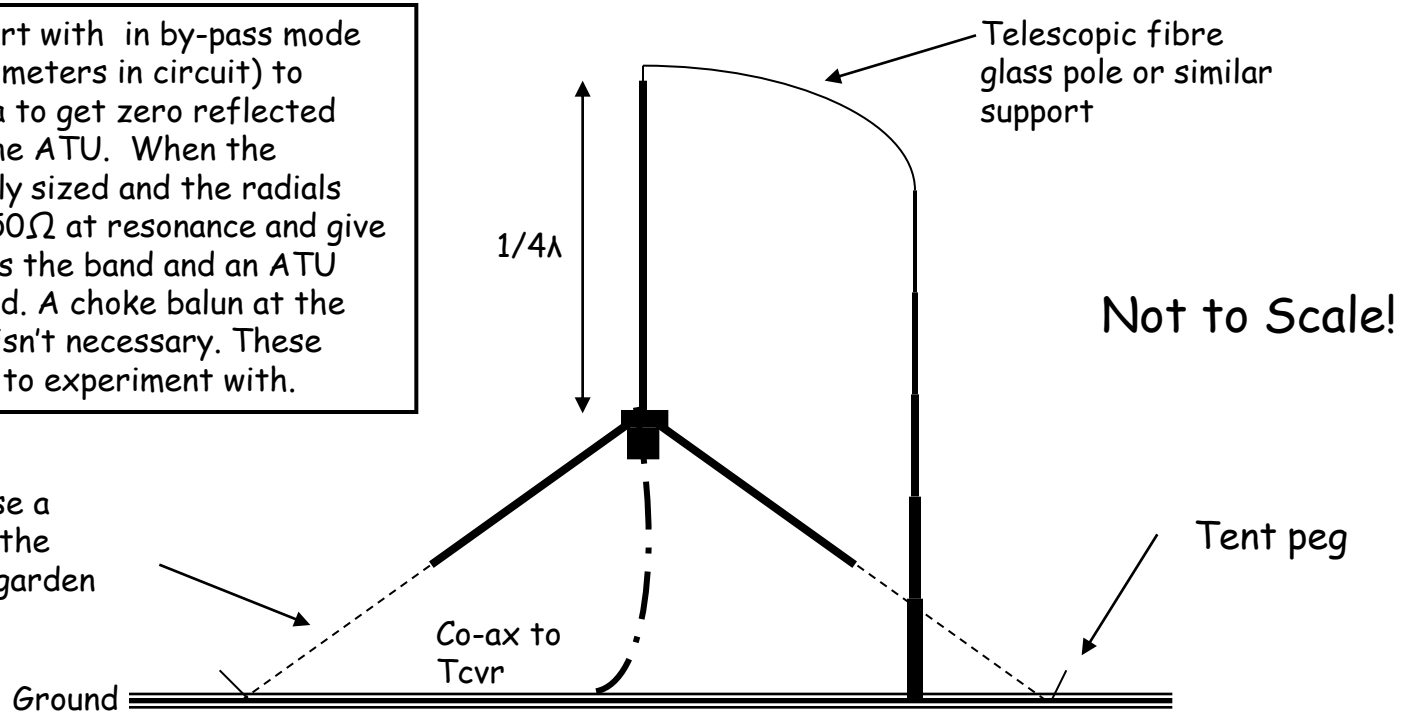
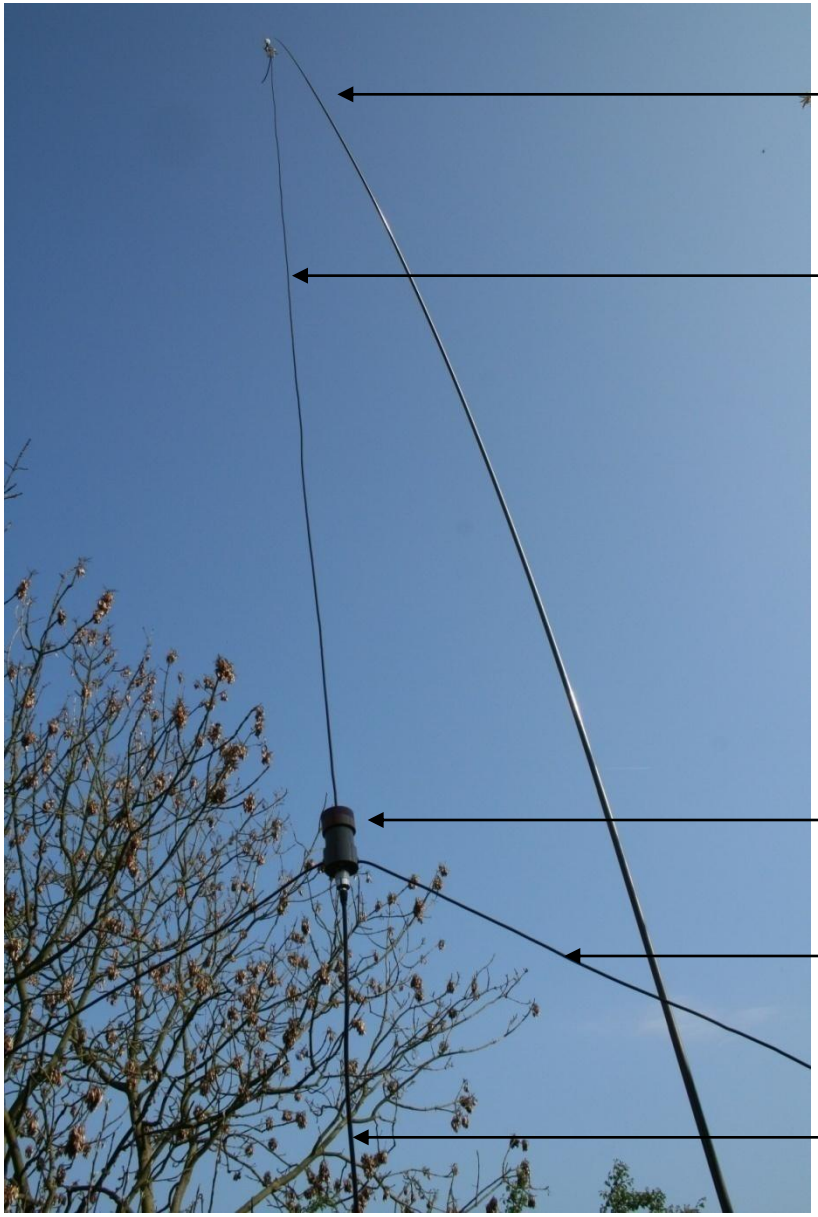


Figure 1 (Continued)

The ends of the radials can be just clear of the ground. However, like all antennas these work best when the radiating element – the vertical wire – is as high as possible. The coaxial feed should drop vertically down from the feed point and then away from the antenna along the ground. Don't leave loops of spare co-ax under the antenna.

Simple Wire Vertical With An Elevated Ground Plane



Fibre glass pole (Telescopic 9m)

1/4λ wire radiator

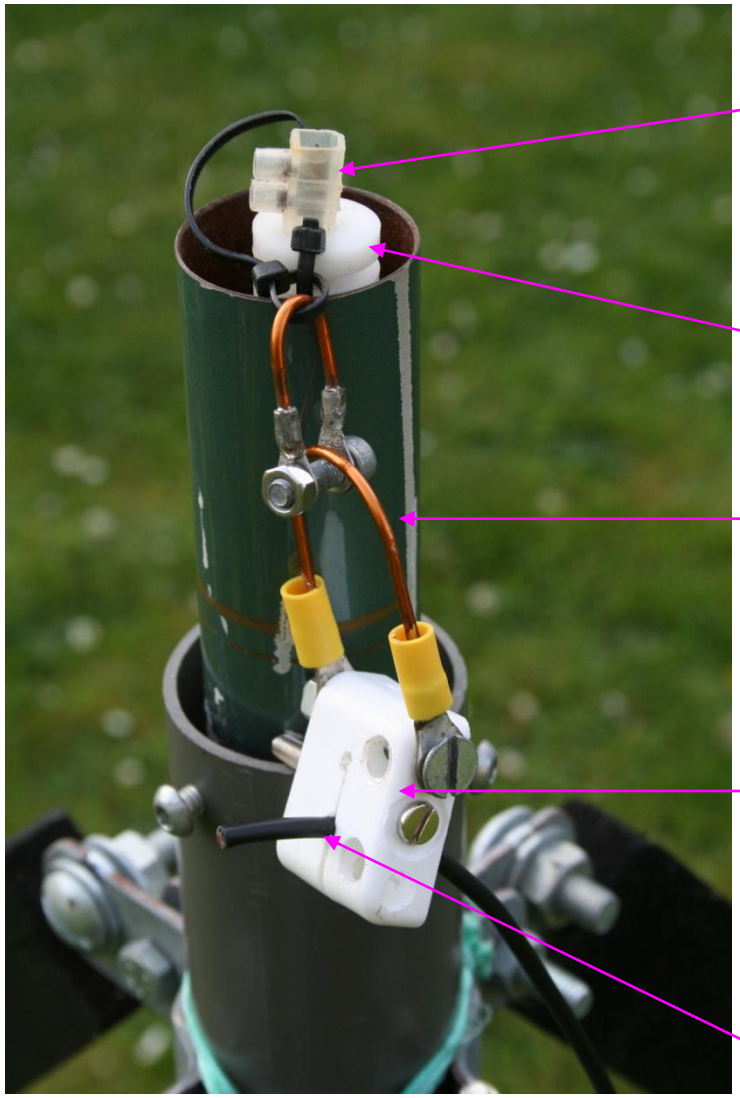
This technique lends itself well to antennas for the 20m, 17m, 15m, 12m & 10m amateur bands. You could also try this arrangement for 6 metres as well.

Plastic pipe and fittings.
(Mechanical protection)

1/4λ radial (2 off)

50Ω coaxial feeder – hang vertically

Some Ideas For Supporting And Fixing Temporary Wire Verticals



The top section of cheap telescopic poles is very fragile and brittle – it's going to break. A section of a screw-down connector strip will stop the top section disappearing into the next, hollow section

A piece of plastic or wood with an axial hole through it and hot glued onto the top section will allow you to fix some cable ties through it or around it to make some attachment loops.

A lightweight shackle is easy to make from some stiff copper wire and a couple of cable lugs which you solder onto the wire ends. Bent into a "D" with a suitable nut and bolt through the lugs they make a cheap, removable fixing. (Don't use these for anything other than the lightest of loads in non-critical situations.)

A corner block used in self-assembly furniture can be pressed into service as a wire clamp. Drill a 3mm hole through the join between the blocks and enlarge slightly with a file. Insert the top of the vertical antenna wire into this hole and tighten up the block. Provided the hole you made is small enough it will grip the cable sufficiently to allow you to hoist the antenna

Top of vertical radiator clamped in the block.

A Vertical, Wire Antenna in Use



This shows the mechanical protection given by the pipe fittings to the SO259 socket and the wire terminations. Note also the rubber grommets. Colour coding the pipe allows you to select the correct antenna from the collection.

This antenna is for 17 metres.



In use the two radials are sloped downwards at about 45 degrees. Varying this angle allows you to modify the feed point impedance to 50Ω. The bottom of the radial should be about 2m above the ground. In practice they can get quite close to the ground without grossly affecting the antenna performance.



Keep the coaxial feed vertically below the antenna until it reaches the ground. You will not need a line isolator or ATU if your system is resonant. (The 17m band antenna shown gave better than 1.3:1 across the band.



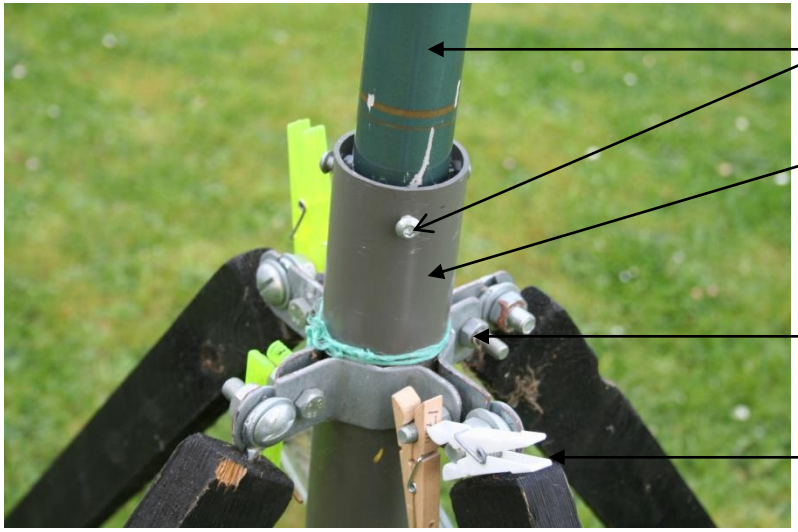
A garden chair and a clothes peg can make a reasonable anchorage for each radial. For higher frequency antennas where the radials are shorter you can tie some string to the end of the radial so that you can still anchor it to the chair in the same way. If you standardise like this then each time you erect one of your antennas you only have to move the chair to the correct position to tension the radial.

A Lightweight, Wire Dipole Antenna Support – The "Quadpod" & A Telescopic Pole.

These pictures should give you some ideas which you can adopt, adapt and improve.



The quadpod is a simple, wooden structure which supports a 9 metre long, telescopic, fibre glass pole. The pole itself fits inside a length of plastic, waste pipe. The unit can support light loads and is best suited to vertical, wire antennas. To increase the stability you can hang weights on the quadpod. The whole device can disassemble for transport and takes up the same space as a set of golf clubs. For a more permanent installation you could fix the waste pipe to a fence post.

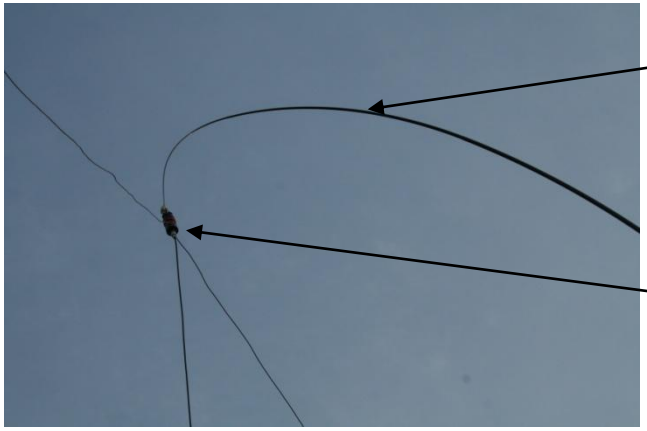


The fibre glass pole. Use small nuts and bolts to centre it in the waste pipe

Plastic waste pipe

4-way guying fixing. Each of the four, wooden legs has a "vine-eye" (from a garden centre) screwed into its top end to form the swivel for the leg at the guying fixing.

For light duty the humble clothes peg can be pressed into a variety of uses – keep a few handy.



Supporting A 20m Dipole

The top sections of the fibre glass pole are very thin. Keep the loads on the pole to a minimum.

The dipole centre for the 20 metre band dipole shown here. As for the wire vertical you can use pipe fittings for mechanical strength. Drop the coaxial feed (RG58) vertically down to the ground.

The Quadpod Continued. (A Useful Antenna Development Aid)







Frequency MHz	14.115	14.244	14.284	14.350
Radiation Resistance	65	54	50	45
SWR	1.3	1.0	1.0	1.1

The above table shows the results obtained after trimming the 20 metre band dipole. An antenna analyser is very useful (but pricey) if you think that you are going to make lots of antennas. (A club member will almost certainly have one and will be happy to help you make your antennas – just ask.)

When trimming an antenna to bring it to resonance always proceed in small steps. Start with both dipole arms being the same length and about 5 to 8% longer than the calculated length. (The 20 metre band dipole in this example was initially resonant at 13.2 MHz.)

Remove identical lengths of wire from both ends each time you trim it. As you approach the design resonant frequency only remove a few millimetres at a time.

Remember! These antennas are close to the ground. A perfect match on Monday may be difficult to repeat exactly on Tuesday. This is because of the nearness and variability of the antenna's surroundings. It will not affect its performance.



Clothes pegs and garden twine make useful quick-release devices for tensioning the dipole arms against handy garden anchorages.

If your ATU has a "by-pass" position you can use the VSWR meter in your ATU to indicate resonance instead of an antenna analyser. USE THE LOWEST POWER SETTING ON YOUR Tx

Commercial, Six-Band, Trapped Vertical Antenna:



A part view of the antenna showing some of the traps and the guying point.

This antenna covers six HF bands. They are: 80m; 40m; 30m; 20m; 15m and 10m. The 80m band has a restricted bandwidth. The traps are like "frequency operated switches" which pass or block signals onto the appropriate part of the antenna. Be sure to research the theory of vertical antennas so that you understand how to get the best out of one. (Beware of any claims about a vertical not needing radials.)



The 7 metre high antenna is fixed to a small wooden post at the base and securely guyed. At the base about 20 buried radials fan-out (radially!) to provide a ground plane. The bottom wire of a 35 metre long fence has been incorporated into the ground plane in the above installation. A line isolator is also fitted at both ends of the co-ax feeder.

The Buried Wire Ground Plane:



Final arrangement of radials at the base of the antenna



The ends of the buried radials before their final grouping. You can see the coaxial cable connection to the vertical radiator and the ground plane. The line isolator is about one metre from the connection point. The radials are buried about 25mm to 50mm under the grass. A good ground plane is essential for the efficient operation of a vertical antenna.



The line isolator (choke balun) at the feeder connection to the base.

Example 2: Average house with a medium-sized, rear garden, some mature, moderate-sized trees front and back, I want to work on both HF and VHF.

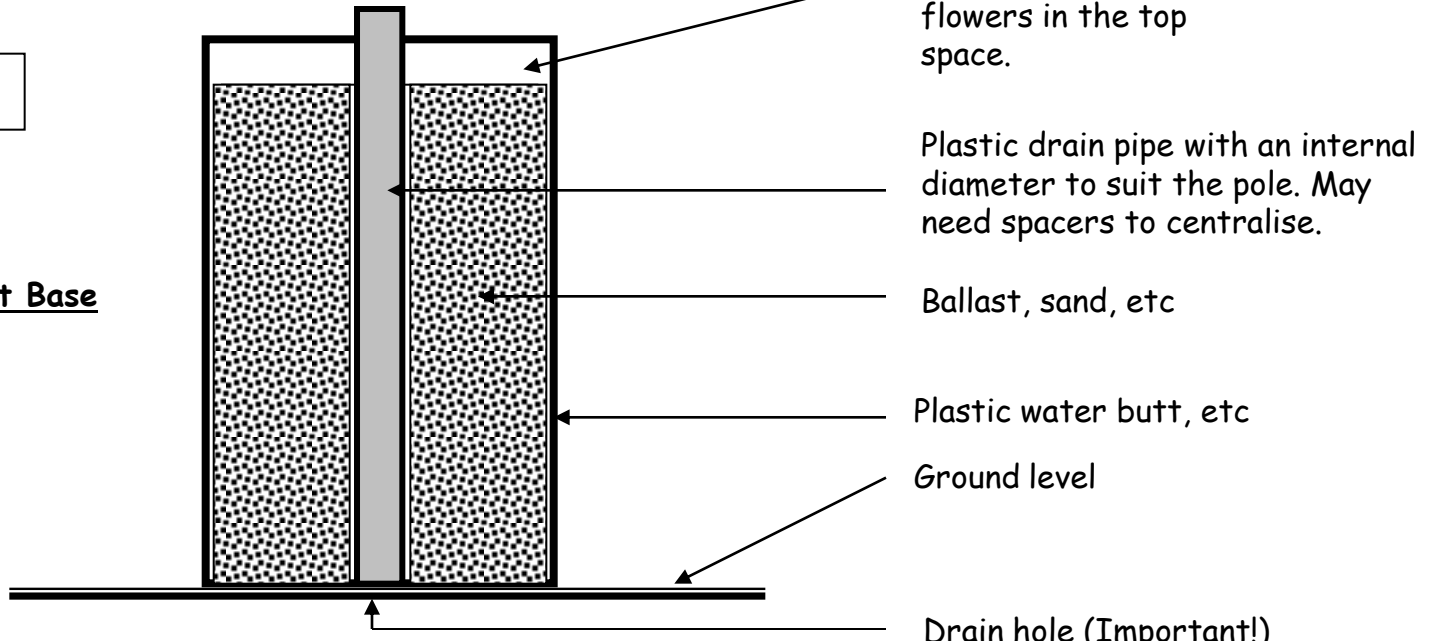
With more space, and subject to domestic harmony, you can plan the location of your antennas a bit more. Ideally a shack at ground level in a dry, heated shed will give you lots of scope for experimentation and optimisation.

If you are able you should put the shack at the centre and place your antennas around it in such a way as to minimise the feeder lengths. (Chance, of course, would be a fine thing!) The longest feeder should be the window or ladder line feeding the HF dipole as this type of feeder has the lowest losses.

The VHF antennas can be mounted as before. Alternatively you can place them on a stayed, aluminium pole about 6 to 8 metres high. You can buy aluminium poles and sleeve joints. You must guy these with 3 or 4 stays else they will buckle in any wind. A convenient way of mounting a pole is to place it within a length of plastic drain pipe which is itself positioned centrally in an empty water butt and then fill the butt with ballast around the drain pipe. See Figure 2.

Figure 2

Water Butt Mast Base



A Weighted Base for a Rotatable Yagi.



This is an example of a weighted base for a lightweight antenna.

The plastic barrel is full of ballast. A piece of plastic drain pipe passes through the centre of the lid.

The bottom section of a 5 metre high, telescopic pole just fits inside the drain pipe.

The barrel sits on top of a paving slab.

At the top of the pole is the 2m/70cm yagi and rotator which you can see in an earlier photograph.

Apart from lowering the pole once every year to inspect the rotator and coaxial connection to the antenna the installation is no different to a permanent base to a pole.

A green water butt would blend in better. However this barrel was free and is hidden behind a thick ivy trellis.

If you have the space you can take an HF dipole over the ridge of the house. The feed point is fixed to a stub mast on the chimney and the ends secured to trees in the front and rear garden. This can make an almost invisible antenna.

The VHF pole could alternatively support an Inverted Vee dipole. The dipole ends can come within about 3 metres of the ground. You need to keep them out of reach as relatively high RF voltages appear on the ends when transmitting.

Vertical, wire antennas are also a possibility. This time you have the trees for supports if they are tall enough. If you are using a commercially produced vertical you will have room to put down more buried radials. Don't skimp on radials. You should aim for at least two per band of 1/4λ each. If this isn't possible then put down as many radials as you can which are at least as long as the vertical is high. If you have any metal fencing then assimilating this into the radial system may be advantageous. (120 radials is equivalent to a perfect ground plane.)

If you have the room then wooden posts about 3 or 4 metres high in the corners of the garden can be used to support a full-sized loop antenna for 80 metres. (You should read the ARRL Antenna Book and understand the antenna feeding arrangements before rigging a full-sized loop.)

If you rig anything at roof height or atop a pole it's worth using two pulleys and two halyards. If one halyard breaks it then isn't an immediate disaster. You can thus plan the repair without having to stop transmitting.

If operating from a ground-level shack then you can place the start of an RF earth conveniently close to the transmitter. Copper-clad steel rods are available at electrical retailers. A fan-out of several, connected with heavy gauge wire, will at least help to drain static charge. Keep the lead short from the earth rods to the transmitter RF earth terminal on its chassis so that it isn't likely to be a resonant length at HF. A single earth rod is merely just a start. Ideally several square metres of copper sheet, well buried in moist, conductive soil is what you are aiming at. (If only……!)

Connect all RF earths from the equipment directly to the one earth terminal in the shack. (Don't "daisy chain" from item to item. NEVER use the mains electrical safety earth as an RF earth.)

Always try to use balanced antennas at HF and feed them with ladder or window line. Don't make any sharp bends in the line and try to keep it away from any metal objects – such as window frames.

If you are able then align your HF dipole North and South. This will put its best radiation pattern in an East-West direction. This will be good for North America and Europe. (Ideally have two dipoles one E-W and one N-S!!)

An Inverted Vee Dipole:









A number of views of an Inverted Vee HF antenna. It is supported by two , centrally-joined aluminium poles secured by a sleeve joint. The top pole has a further, short, aluminium pole inserted in it. At the top a pulley and halyard are used to raise and lower the dipole centre and attached 450Ω window line.

The dipole wires slope downwards from the top of the pole which is about 9 metres above the ground. The base of the pole is secured to the wall of an outbuilding by "T" and "K" angle iron brackets. The feeder is routed back to the shack.

The ends of the dipole wires have dog-bone, plastic isolators fitted. These are fixed to fence posts by a length of nylon rope. They are above touch height (>3m). The vertical poles are stiff enough not to need guying as the weight of the antenna is not very much.

You can use any type of wire to make an antenna. However, it will move about in the wind and break if you use wire that is too thin. Use hard-drawn antenna wire or, better still, "flexweave" (multi-stranded copper wire in a clear plastic sheath.)

Example 3: Living in a flat without access to ground level or the roof.

This is probably going to prove to be both an RF and EMC unfriendly location. There will almost certainly be a high level of electrical noise as well as a lot of adjacent wiring to act as parasitic antennas to pick-up your signals and cause RF interference. 2 metres FM will probably be ok but ssb may cause a lot of interference. (All this is apart from the problem of siting an antenna.)

There are two immediate solutions which may work.

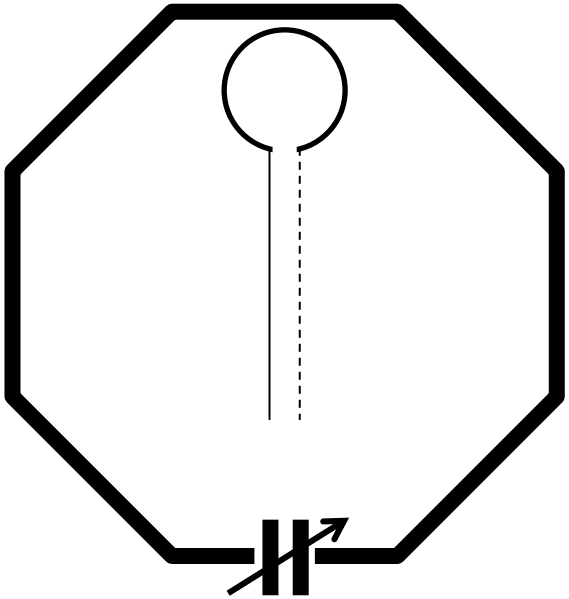
1. Accept the fact that this is not a good QTH and arrange to do all your operating as /M. If you have a car then a mobile shack could be for you. There are lots of mobile antennas for cars and which are effective from a good mobile site.

2. Use the technology available for /M – such as loaded whip antennas – and operate low power from the RF quietest part of the dwelling. People have used all sorts of ideas to overcome limitations of their QTH. Balcony railings have been pressed into service as antennas A wire around a picture rail with a counterpoise wire at floor-level will work. A stub-tuned wire loop with sides about 2.4 metres pinned to the wall may also work satisfactorily.

(Look on G0FTD's website or on the Southgate Amateur Radio Club site for details of small, stub-tuned, transmitting loops. The issues to solve will be EMC, noise and structural screening. Joining the G-QRP club will probably be worthwhile. (See the Low Power Section of this guide.))

Before making a decision ask for help from some of your fellow club members. They will have field strength meters and sensitive receivers to at least establish how bad (or good) your location is. They will also be able to advise on the antennas best suited to your QTH.

The Magnetic Loop Antenna



Mag-loops are very directional. Their maximum response is in the plane of the loop. This is useful in blocking unwanted signals at right angles to the loop.

A magnetic loop antenna is always a possibility if you have a restricted amount of space.

You can make a 20m mag-loop very easily from standard, 15mm copper pipe fittings.

There are lots of articles on the Internet telling you how to make a mag-loop and apply the RF energy to it. (There are a number of ways.)

The overall diameter of the loop for 20m will be a bit over 1m – so it's not a big device.

Take advice before building this antenna. Their "problem" is that under even moderate powers a large voltage appears across the tuning capacitor. Typically 10W will produce over a kilovolt (1000V) across the capacitor.

You must use an air-spaced capacitor, with relatively wide spacing between the plates, to avoid any problems of flashover.

See: http://www.66pacific.com/calculators/small-transmitting-loop-antenna-calculator.aspx

This is a good site for trying out design lengths for your mag-loop.

What's The Best Equipment To Buy……?

This is an impossible question given the endless variables involved. However, let's take an example which may contain elements that apply to most people starting out. We'll set these out below:

1. I have no plans to enhance my licence class over the next year or so.
2. I can put up a wire dipole at my home QTH.
3. I will operate mainly HF ssb and on 2 metres ssb and FM.
4. I have a budget of about £1100. (A later section of this guide looks at a lower-cost VHF/UHF only starting point.)

The ATU & PSU: Firstly there are two items of equipment that you will need whatever you do. These are:

- An Antenna Tuning Unit (ATU) for the HF bands;
- A DC power supply unit (PSU) to power the transceiver.

At some point you are almost certainly going to want to enhance your licence so buying with an eye to the future may be wise – particularly with these two, universal items.

A basic HF ATU usually covers 1.8 MHz to 30 MHz and will have two power handling ranges of 30 Watts and 300 Watts. It will be able to match long wire, dipole and vertical antennas. This will typically cost about £150 to buy new. It should last a lifetime.

The power supply needs to be robust enough to deal with the transmitter peaks. For 10 Watts operation you will need a minimum PSU capability of 5 Amps continuous. Again a good quality PSU will last a lifetime if treated well. If you enhance your licence class and move to 100 Watts RF you will need about 20 Amps. A switched mode PSU of 20A to 30A is a good choice either way. You can expect to pay around the following (2017):

- 30 Amp PSU (eg MyDELMP-30SWIV (PS-30))	£90
- 20 Amp PSU (eg Watson POWER-MITE-NF)	£85
- 6 Amp PSU (eg MyDEL MP-6A PSU)	£30

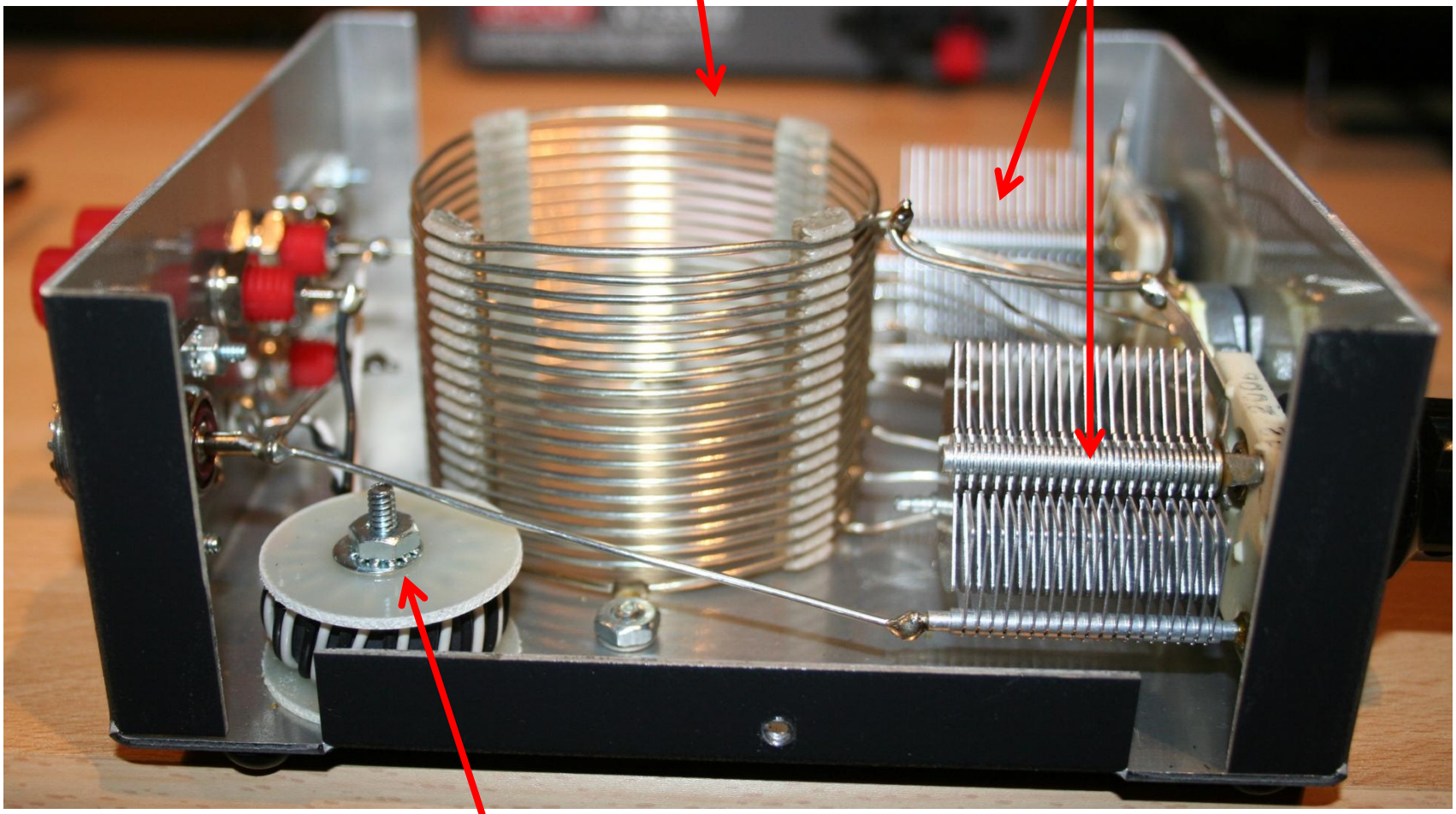
The ATU:





A typical ATU. This will handle up to 300 Watts. It can switch between two, coaxial cable-fed antennas; a balanced antenna (or a long wire) and an external, dummy load. You can bypass the unit if you wish. It has a built-in VSWR meter with facilities for illuminating the scale. The rear panel has the SO259 sockets for the two co-ax fed antennas, the dummy load and the feed from the Tx. The binding posts will accept 4mm plugs for ladder line or a long wire. There is an RF earth bonding terminal at the bottom right. A unit like this should last a lifetime if treated carefully.

What's Inside An ATU?



A Switched Mode Power Supply Unit



This unit will provide a total of 25 Amps at 13.2 Volts continuously. The rear of the unit has the terminals for the supply to the transmitter. Typically a PSU will have some auxiliary terminals from which you can take a lower current. On this unit they are located on the front panel.

The unit has an adjustable output. The "12 o'clock" position on the control has a notched position which is at 13.2 Volts. The PSU will have short circuit protection. Treated carefully a switched mode power supply should last a lifetime.

A Regulated Power Supply



As well as switched mode supplies to power your transceiver you can use a conventional static or linear power supply. This contains a large step-down transformer, rectifiers , a regulator, short-circuit protection and smoothing capacitors. It will provide up to 30 Amps at 13.2V. Generally they are slightly cheaper than switched mode supplies but are heavier to lift. Either type will be fine for a 100W transceiver.

The Transceiver: Bearing in mind that you will probably use only 20% of the radio's features for 80% of the time you can make an informed choice. You can pay a lot of money for features you will use rarely, if ever. If you like lots of menu-driven features and settings then fine. If you don't - then perhaps be a bit cautious and keep it simple.

Assuming that you want both HF and VHF capability. You can either buy:

A transceiver which combines both HF and VHF in the one base station radio;
Separate HF and VHF transceivers.

The combined transceiver is probably the easier way to do it. A hand-held, FM, 2m transceiver is nice to have but not essential. (But – see "Minimum Cost Entry Level".) At this point we have spent about £200 of our £1100 budget without the transceiver. You will need to keep some back for the antennas – even if you make the HF dipole yourself.

A transceiver such as the Yaesu FT817ND will give you 1.8 MHz to 430 MHz all modes with an output of 5 Watts and in 2017 is about £530. It is small and compact and can be easily taken on holiday or fitted in the car.
Don't be put off by the 5 Watts output. You'll easily work UK, Continental and Scandinavian stations on ssb.

Typical entry-level transceivers from Yaesu, Kenwood, Icom and Alinco and indicative prices (2017) include:

Yaesu FT-450-D £600; Yaesu FT857D £700; Kenwood TS-480HX £700; Kenwood TS-480-SATE £660;
Icom 718 HF £600; Alinco DX SR-9 £500;

You can also safely buy second hand from suppliers such as Waters and Stanton, Martin Lynch and Son, Nevada. These will usually come with a three month warranty which, as a beginner, removes the risk from buying used equipment.

The Antennas: Let's say we chose the FT857D making our total spend around £900. The last items that we need to consider are the antennas and feeders for which we have about £200 left. The antenna and its feeder are "system critical". If the antenna is ineffective then no amount of (expensive!) bells and whistles on the transceiver will compensate. Of all the items give the antenna the most thought and care.

For an HF wire dipole aim to put up **"as much wire as possible as high as possible".** Only *buy* a wire dipole if you have absolutely no practical skills and absolutely no tools at all – otherwise make it yourself. (A club member will probably have an old antenna to donate or, more likely, be delighted to make an antenna with you.)

Some Transceivers:



FT 857



Alinco DX-SR9



FT817



ICOM 718

VHF - UHF FM: For 2 metre and 70 cm FM base operation you will need a vertical, co-linear. The cheapest will cost about £60. Again it will last a lifetime. You will also need some co-axial cable with which to feed it. Expect to pay between 60p/metre (RG58) and £1/metre (RG213) for good quality co-axial. PL259 plugs to terminate onto the rig and ATU are about £1 each.

VHF - UHF ssb: 2 metre, 4-element mono-band Yagis start at about £40. (70cm Yagis are about the same price for a basic model) A light duty rotator with its control unit will be about £200. You will also need some 3-core flexible power cable, say £10. The yagi will also need a coax feed. (Say 20 metres). A dual-band 2m/70cms Yagi will cost about £120 The Yagi could sit on top of the aluminium pole which supports the HF dipole.

HF Dipole: Let's assume that you are going to make an "Inverted Vee", wire dipole and that you need an aluminium pole. You can expect to pay about £30 for a set of four, push-fit poles of 1.5 metres or two, 3-metre long aluminium poles. If you are using the house eaves or have suitable supports (trees) for a "flat top" dipole then you can ignore the cost of the pole.

At this point you have a choice. The best, general antenna wire is flexweave. This will cost about £45 for 50 metres – of which you will need about 40 metres. (Hard-drawn copper antenna antenna wire is about £25 for 50m) You will also need to buy some window line as feeder. Twenty metres of 450Ω window line will be about £20. You will also need a dipole centre at about £5.

Alternatively you can buy a 100 metre drum of 1.5mm^2 csa, multi-strand, power cable. (This is a single-core, multi-strand cable that electricians install in conduits.) A 100 metre drum will cost about £12. You can use this to make both the dipole and the ladder-line feeder. (See Figure 3 for ideas about making your dipole.) It will not last as long as either flexweave or copper antenna wire.

If you buy a ready-made, wire dipole antenna such as a full-sized G5RV the price is around £70. A "Carolina Windom" in its ready-made form is about £185. You will still need to provide the feeder. (The moral is "make your own.")

Note. Your licence allows you to make all of your antennas yourself. (It's only, active, radiating devices – such as transmitters – that your licence forbids you to make yourself.) The HF wire dipole is the easiest antenna to build with a minimum of tools. If you want to build VHF and UHF antennas you should seek some advice first about materials and the tolerances to which you must work. A club member will certainly have designs for antennas that work. Someone will have the test gear to optimise their performance. They are only slightly more difficult to make than a wire dipole.

How To Make A Full-Size, Inverted Vee, Doublet Antenna For HF

This is a really good, multi-band, simple wire antenna. It takes a lot of beating and will work extremely well.

- A 100 metre drum of 1.5mm csa of multi-strand wire. (~£12)
- 2 metres of 15mm diameter plastic pipe. (~£2)
- Several sheets of A4 paper.
- An electric drill (A hand drill is fine as well).
- A 3.0mm drill bit.
- Hot glue gun.
- A small bench vice or some similar clamping device to hold the pipe.
- A junior hacksaw or pipe cutter.
- Tape measure (20 metres ideally).

The first job is to estimate the numbers of spacers you will need to make for the 450Ω ladder line feeding the antenna from the transmitter in the shack. We will use a linear spacing of 250mm. along the ladder line. Cut as many spacers as you need from the pipe.

Each spacer is 40mm long. Allowing for wastage this will give about 23 spacers to the metre from our 15mm pipe or enough for about 5 metres of ladder line. The top spacer has to be about 200mm long. (Keep some pipe for this!.) You may need to get a bit more pipe depending upon your shack location relative to the antenna if you need a longer ladder line. The ladder line will ultimately look like this:

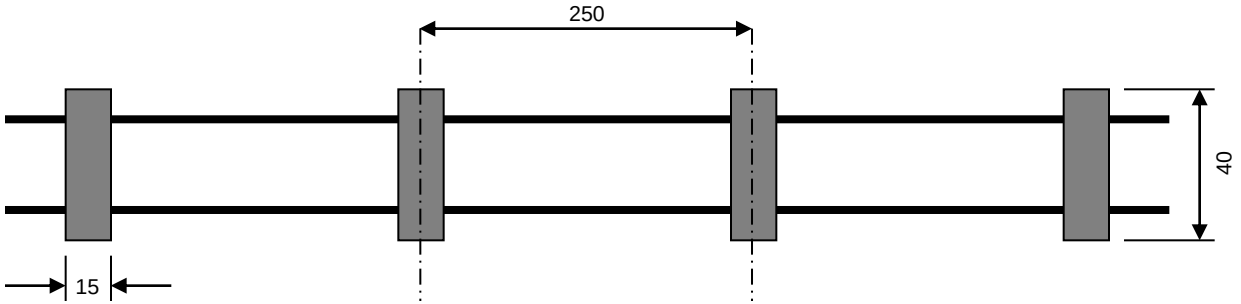
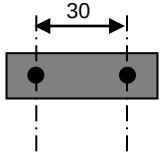


Figure 3



Drill each spacer like this. The holes are 3mm diameter and go all the way through. It's worth making a simple drilling jig for ease of manufacture. The wire should just pass through the holes and be a firm fit

A 30mm spacing will produce a characteristic feed line impedance of about 450Ω

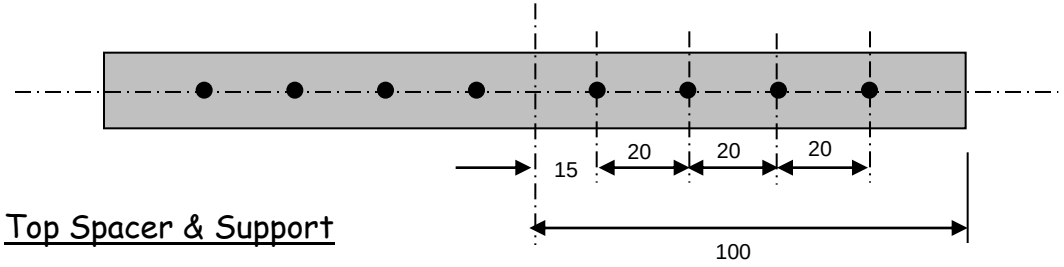
Preparing The Wire For The Antenna and Ladder Line

An advantage of this design is that there are no joins in the antenna. The feed line opens out at the top to form the dipole arms. Cut two, identical lengths of wire from the 100 metre drum. The overall length of the dipole is, of course, half a wavelength long at the lowest frequency of operation. This frequency is 3.5 MHz. Each arm of the dipole is thus a quarter wavelength (0.25λ) long from the exit of the feed line to its tip.

The sum (L=143/f) gives a quarter wavelength as 20.43 metres. Call this 21.0 metres to give ourselves a bit of a safety margin as the formula tends to underestimate a little bit at low frequency. To this you now need to add the length of the feed line which will comfortably get you into the shack and onto the ATU.

(If you want a check then hang some string from the top of the support pole and into the shack along the intended route. Add an extra metre if you are still unsure.) Let's say that this comes to 19 metres of feed line. Add the two lengths together: (21.0 + 19) = 40.0 metres.

Next cut two lengths of wire each to this length. Mark the 21.0 metre point on each. Neatly coil up ~20 metres of each length and secure the coils so that they can't unravel. Avoid any kinks or "birds nests" in the coil. You now need to make the top spacer and support. You will need a 200mm length of 15mm pipe. Drill it as shown below:



Top Spacer & Support

NB! Only thread ONE of the wires through at this stage. Do not thread the second wire yet.

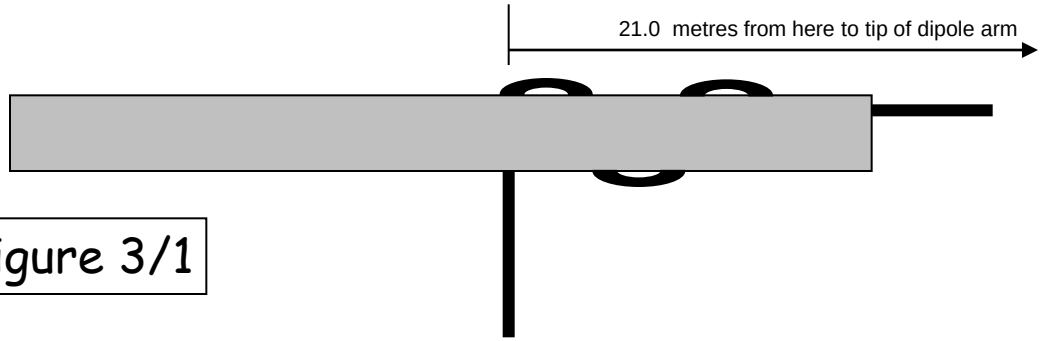


Figure 3/1

Now feed one of the wires through the holes in the top spacer so that it finishes as shown opposite with the loops pulled tight. You might find it easier to open out the holes to 3.5 or 4mm if the wire snags or scuffs excessively when you do this. A spot of liquid detergent eases the threading.

Fitting The Ladder Line Spacers

Temporarily tie the top spacer to something convenient like the fence. Holding the piece of wire which is to form one half of the ladder line walk it backwards from the top support laying it flat on the ground as you go. Make sure that there are no kinks in the wire. Next thread this wire through the spacers you have already made and position them at roughly 250mm intervals down the wire. It should now look something like this:

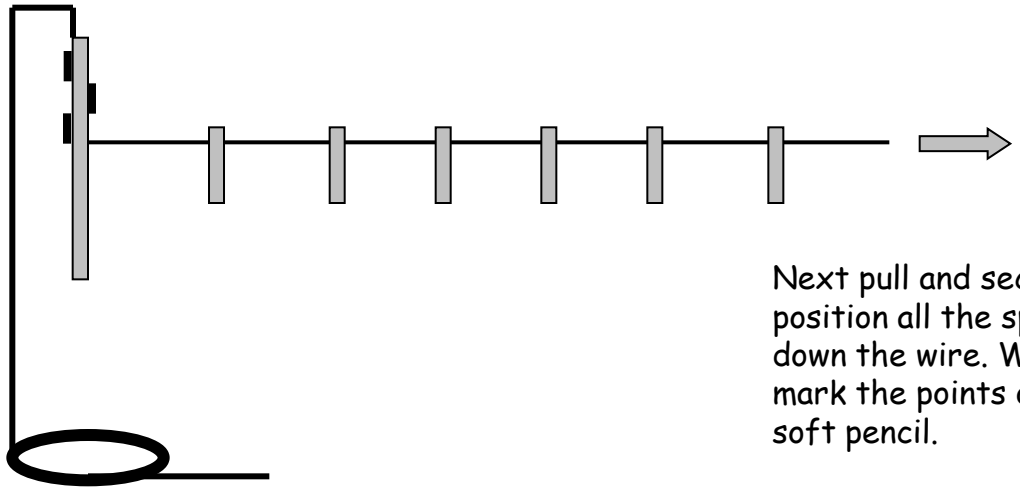
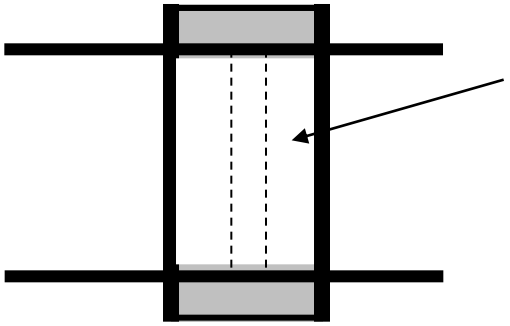


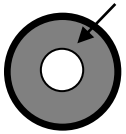
Figure 3/2

Next pull and secure the wire gently so that you can position all the spacers at 250mm centres evenly down the wire. When they are correctly arranged mark the points on the wire with a felt tip pen or soft pencil.

Taking the A4 pieces of paper cut strips about 26mm wide, roll them into tight tubes and insert one into each spacer so that it touches the wire. The idea is to just fill the space between the wires in the spacer when you insert the second wire. See below:



Paper tube inserted into spacer.



Paper tube should be a snug fit inside the spacer and have only a small hole through the middle

Now insert the second half of the ladder line through the spacers making sure that the paper tube stays in place. Ideally the paper tube should appear almost solid when viewed end-on. Fix the second wire by looping it through the top spacer as you did with the first wire.

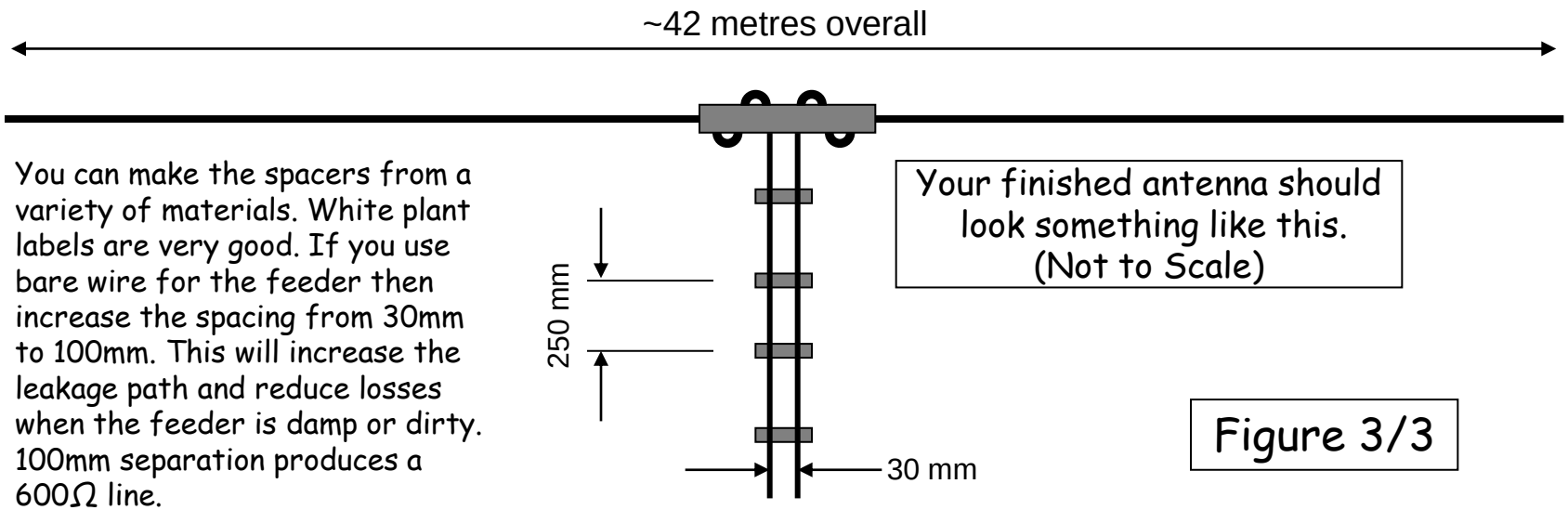
Securing The Spacers:

Finally reposition all the spacers correctly at 250mm centres and then, with the spacers hanging vertically, completely fill the upper end of each of the spacer tubes with hot glue.

When this has set turn the feeder over and fill the other end of the spacer tubes with the hot glue. The glue will bond to the plastic spacer tube, wire insulation and the internal paper tube to provide a solid mass which should not move on the feed line.

Terminate the ATU end of the feeder with two, 4mm banana plugs to connect with the ATU binding posts. Some cable ties around the top spacer pipe can be fashioned to form a secure loop with which to hoist the antenna. A bit of tuning and careful cutting back of the ends of the dipole to get it "spot-on" if you want and you are in business! (Ask someone from the radio club to help you with this. It will only take a few minutes. However, the antenna will work fine as it is with an ATU without the final trim.)

Keep the ends above "touch height" (>3 metres say) as they can develop relatively high RF voltages when you transmit. Use nylon twine or a "dog-bone" insulator to insulate and attach the ends onto some suitable fixing.



You can make the spacers from a variety of materials. White plant labels are very good. If you use bare wire for the feeder then increase the spacing from 30mm to 100mm. This will increase the leakage path and reduce losses when the feeder is damp or dirty. 100mm separation produces a 600Ω line.

Your finished antenna should look something like this. (Not to Scale)

Figure 3/3

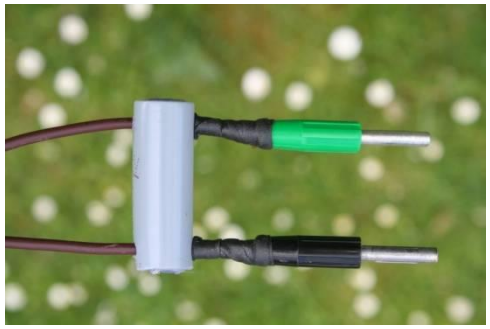
This antenna has "tuned feeders". You must use an ATU with this antenna to match it to the transmitter.

A Completed Dipole Antenna and its 450Ω Feeder. (A vertical piece of grey, pvc pipe is used at the feedpoint instead of 15mm pipe used horizontally.)



The feeder should, as far as possible, hang vertically from the dipole centre. It should not "run along the ground" to the ATU. Keep it clear of the ground. Do not allow it to "kink". A gentle spiral is OK – as long as the wire spacing of 30mm remains constant. Keep the feeder away from metal windows, downpipes etc.

The end of the feeder is terminated in two, 4mm banana plugs so that it can plug straight into the ATU.





The above shows how the end of the 15mm pipe is filled with hot glue to close the end and fix it to the feeder wire.

Resonant Dipole Lengths

This section is to give you a look-up table for the overall length of a mono-band dipole for spot frequencies. There are a number of ways that you can calculate these lengths. The commonest formula is L (metres) = 143/f(MHz) and this will give you the overall (top length). (You then halve this figure to obtain the actual wire length for each leg.)

However, this formula tends to slightly underestimate the length at the lower frequencies. The figures which appear below compensate for this. Only when you have the antenna in place can you really discover its resonant length by measuring with an analyser or vswr meter on your ATU. (Don't get too fussed about it – approximately right will work ok to start with – perfection can come later.)

Frequency (MHz)	Overall or Top Length (metres)
3.50	41.80 (Note 1)
7.02	20.76
10.125	14.40
14.20	10.24
18.10	8.03
21.20	6.86
24.94	5.82
28.40	5.10

Note 1: Use this length for the multi-band, half-wave, inverted vee dipole described earlier

Remember also that when you are cutting the wire for the dipole that about 150mm or so will be needed to connect to the dipole centre if you are making the feeder separately from the antenna.

A slight advantage of making each antenna arm and its feeder out of a single length of wire is that you can trade dipole length for feeder length and vice versa to tune the antenna. (Easier written than done – but with a bit of ingenuity you can do this.)

The key point to remember is to get **as much wire as high as possible.** In particular get the feed point as high as you (safely) can as the first third of the top length (approx) is where the antenna radiates the most.

If a multi-band antenna is difficult to match on one frequency with the ATU you may have (by coincidence) a multiple of antenna + feeder length which is adverse. A couple of meters of extra feeder length can overcome this and move you away from this multiple.

Resumé: Putting this altogether (as a worst case) looks like this:

Item	**£ Cost**	**£ Alternative(1)**	**£ Alternative(2)**
ATU	150		
Sw. Mode PSU	90		
Transceiver	500		
Co-linear VHF Ant.	50		
20 metres RG213	20		
2m Yagi	50		
20 metres RG58	12		
Rotator	150		
3-core rotator cable	10		
Plugs (x2)	2		
Aluminium Pole	30		
H. D. Copper Wire	25		
450Ω Window Line	18		
Dipole Centre	5		
Total:	**£1112**		

Without doubt the biggest, single cost will be the transceiver. You might want to do some research on the websites of various suppliers. (Or better still go and visit their shops and look at the options.) Again, ask for advice from other members of your club or group. However, everybody has their "pet" brands and models so the advice may conflict! Ultimately it will be your budget and operating profile which is important.

Always buy the best quality co-axial cable and fittings that you can.

Dipole Antenna Fed With Co-Axial Cable.

If you don't want your antenna fed by ladder-line you can use co-axial cable. You will have to put a balun of some sort at the junction of the feeder and the dipole as well as the transceiver end. If you do not then you will get unacceptably high currents down the outer of the co-ax which will cause problems of RF getting back into the shack. ("Hot" microphones with a "bite" to them! etc). The length of the dipole top will remain the same as before. The changes you need to make are listed below.

A Choke Balun: There are two ways to do this:

1. At the point where you fix the co-ax to the antenna you need to coil about six to ten turns of co-ax. These are close-wound with no overlaps. Make the diameter of the coils about 300mm or so. Similarly coil the coax at the transmitter end.

This coil forms a choke for the current flowing down the outer surface of the coaxial braid. It does not affect the wanted current on the inside of the braid. The choke "forces" all the RF current onto the inside of the braid. Depending upon the degree of imbalance you might need a few more turns. (Remember that this is only treating the symptoms. You are still feeding a balanced antenna with an unbalanced feeder.)

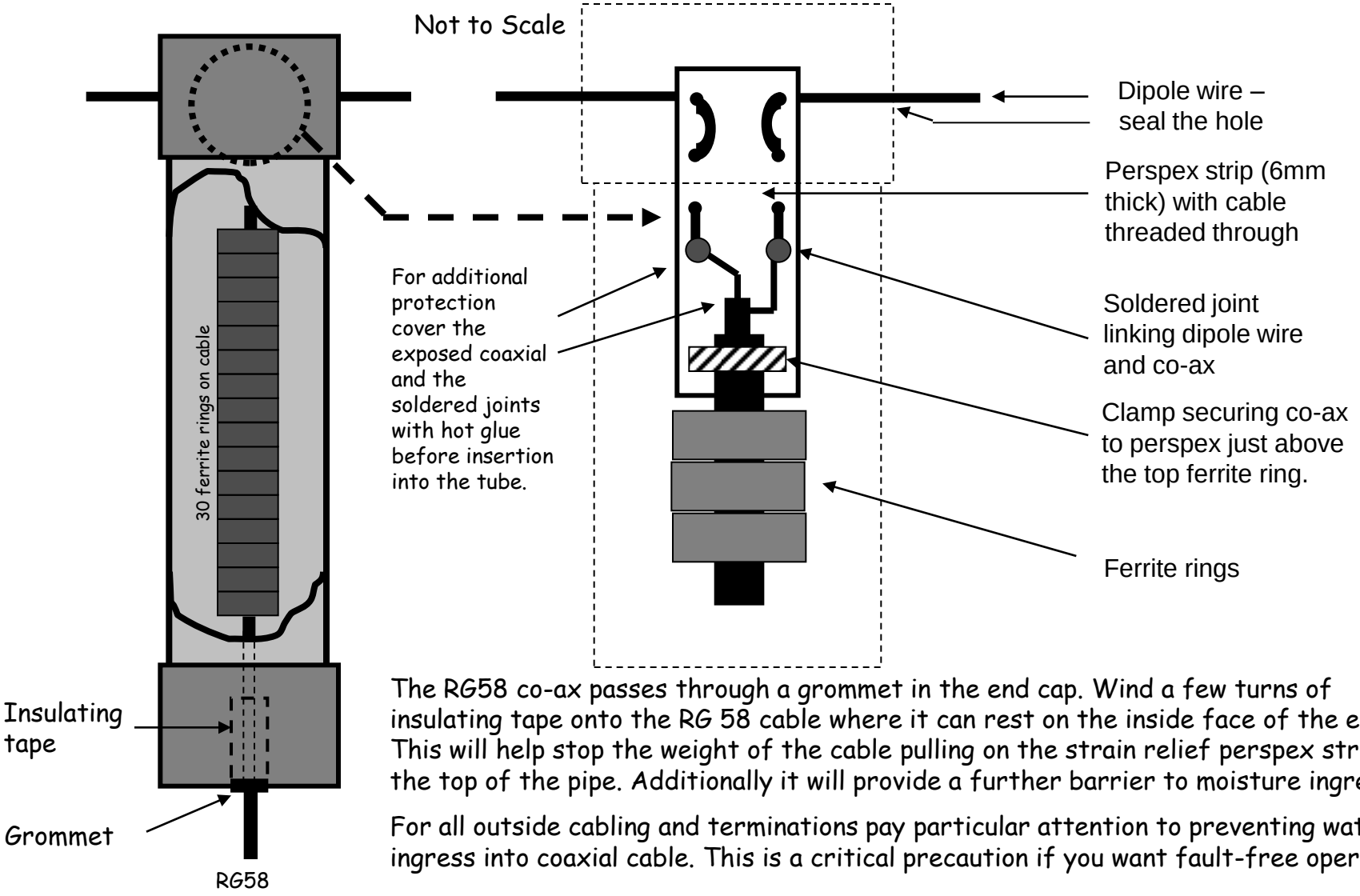
2. A better way is to make a choke balun using ferrite rings. (See Figure 4 overleaf.)

Thread ferrite rings over the outer of the co-ax. You will need about 30 or so ferrite rings. If you use RG58 co-ax then FT37-2 ferrites will fit snugly over the insulation. You can either fix them in place with self amalgamming tape, heat shrink sleeving or insulating tape. It must be waterproof.

To improve the weather proofing you can encase and seal the choke in a length of plastic waste pipe with two end caps. (37 mm diameter is ideal. This is still sold as "inch-and-a-half diameter, pvc, waste pipe" at plumbers merchants.)

The cut-away diagram which follows shows how you could do this. The perspex strip is inside the pipe and is the strain relief anchorage for the dipole wires and the coaxial cable. Make sure that all the strain is transferred to the entire cable – not the joint. In particular avoid any strain on the coaxial cable at the soldered joint with the dipole wires.

Figure 4: How To Make A Simple Choke Balun Using Ferrite Rings



The RG58 co-ax passes through a grommet in the end cap. Wind a few turns of insulating tape onto the RG 58 cable where it can rest on the inside face of the end cap. This will help stop the weight of the cable pulling on the strain relief perspex strip at the top of the pipe. Additionally it will provide a further barrier to moisture ingress.

For all outside cabling and terminations pay particular attention to preventing water ingress into coaxial cable. This is a critical precaution if you want fault-free operation.

Insertable, Choke Balun Using FT37-2 Ferrites On RG58 Coaxial & PVC Pipe







These pictures show a stand-alone choke balun during construction. Fit an SO259 socket into a blank, pipe end cap. Solder a length of RG58 to the SO259 and wrap a few turns of insulating tape around the cable at the socket end to keep the rings off the termination. Thread ~30 ferrite rings over the coaxial. Drill a hole in a second end cap and fit a rubber grommet. Cut a length of pipe sufficient to comfortably house the ferrite assembly. Pass the assembly through the length of pipe then glue the pipe to the end cap fitted with the SO259. Pass the cable through the grommet in the second end cap and glue this cap to the pipe. Terminate with a PL259 plug. (The book in the background is the ARRL Antenna Handbook. Well worth getting if you are going to make lots of antennas.)

The Finished Stand-Alone (ie Insertable) Balun In Its Housing



This view shows the finished balun. This balun has not been waterproofed – hence the "Indoor Only" label. You can weather-proof with silicone sealant. (The end caps are usually a two-part assembly - the cap and a spigot. You don't have to buy the spigot for radio work. Just position the cap carefully and concentrically on the pipe when you glue it. The gap that's left you fill with silicone sealant if it's for use outside.)

If you are using this for a dipole you can easily adapt the design in accordance with Fig. 4 by omitting the SO259 socket, lengthening the pipe and fitting the perspex strain relief strip within the pipe. Drill two holes diametrically opposite each other in the top end cap for the dipole arms. For a vertical antenna with a ground plane make two of these baluns and fit one at each end of the co-axial. (Line isolators, as these are often called, cost about £30 to buy and about £10 to make yourself. There will be no problems at 10 Watts. At higher powers check that the ferrites do not become warm or hot. If they do then change the ferrite grade.)

Where Can I Get……?

It's all very well people telling you to get so-and-so items and build it yourself. However, it can be a bit bewildering knowing where to obtain the bits. The following list carries no product or quality endorsements.

New CE-Approved Radio Equipment, Antennas and Fittings:		
Waters and Stanton:	www.wsplc.com	01702 204965
Radioworld Limited:	email sales@radioworld.co.uk	01922 414796
Martin Lynch & Sons:	www.hamradio.co.uk	0845 2300 599
LAM Communications:	www.lamcommunications.net	01226 361700
Haydon Communications:	www.haydon.info	01708 862524
Nevada Radio:	www.nevadaradio.co.uk	02392 313090
Antennas, Co-axial Cable and Antenna Bits:		
Moonraker:	www.moonraker.eu	01908 281705
SOTA Beams:	www.sotabeams.co.uk	
Amateur Radio Books:		
RSGB:	www.rsgbshop.org	01234 832700
Components & Ferrites:		
Jabdog:	www.jabdog.com	
Bowood Electronics Ltd:		01246 583777
Rapid Electronics:	www.rapidonlinecom	
Mode Components:		0121 554 5157
Electrical Wire:		
Enfield Electrical (Cambridge Area):		01763 243366
Plumbing Bits:		
Urban Plastics (Melbourn: Cambridge):	www.urbanplastics.co.uk	01763 262337
Low Power Communications (10 Watts and Under):		
GQRP Club:	www.gqrp.com	

Low-Cost Entry



You don't need to spend a lot of money to get started. A simple 2 metre / 70 centimetre hand-held transceiver will allow you to access FM stations via the local repeater. Hand-helds start from around £40 or so.

A budget priced mag-mount antenna and some adapter plugs / connectors will allow you to use the hand held in your car. (PLEASE! not while driving though!)

Similarly connecting your hand-held to a co-linear antenna at your home QTH will increase the range of your signal. If your local club has a Sunday net, for example, you can join in.

Finally if your local repeater has an Echolink capability and your hand-held is DTMF-equipped you can connect to many overseas repeaters using Echolink. Thus it is possible to work a station in New York from your garden in Cambridge via GB3PY (Node 222303) using your hand-held. Talk to someone in the repeater group about this facility and ask for a demonstration.

Nice-To-Have: A Dummy Load



A useful and inexpensive device is a dummy load.

It will last a lifetime and is invaluable in setting up some of your transmitter characteristics without radiating a signal. (eg ALC and microphone drive.)

The dummy load is a 50Ω, non-inductive resistor which presents a perfect load up to at least 500MHz. A dummy load with a continuous rating of 15W will cost about £30.

Dummy loads simply screw into the antenna socket of your transceiver.

Nice-To-Have: A Frequency Counter



You have to be able to independently check your transmit frequencies from time-to-time.

The easiest way to do this is with an RF frequency counter.

Many members of your radio club will have these and initially you can no doubt borrow one when you need to do a frequency check.

You turn it on, place it alongside your radio and transmit in the normal way. The frequency counter will display the transmit frequency.

If it has sufficient range (>1.5GHz) it is also useful for checking RF leakage from the door seals of a microwave oven.

Fitting An RF Plug to Coaxial Cable:

Eventually you will want to terminate a length of co-ax onto an RF connector. Most likely this will be a PL259 type of connector. If you know how to solder then you can follow this guide without a problem. If you have never soldered any electronic components then ask a club member to show you the proper technique before attempting this termination. The golden rule when terminating plugs onto coaxial cable is:

"If it goes wrong then stop, disassemble what you have done, clean up and start again."

Tools: You will need:

A 25 Watt soldering iron;
Solder;
Side cutters;
A pair of pliers to hold and grip the cable / plug;
A pair of wire cutters (for RG58 co-ax) or junior hacksaw (for RG213 co-ax);
A small file for cleaning up the centre pin;
A sharp knife;
A vice or similar clamp is handy but not essential.

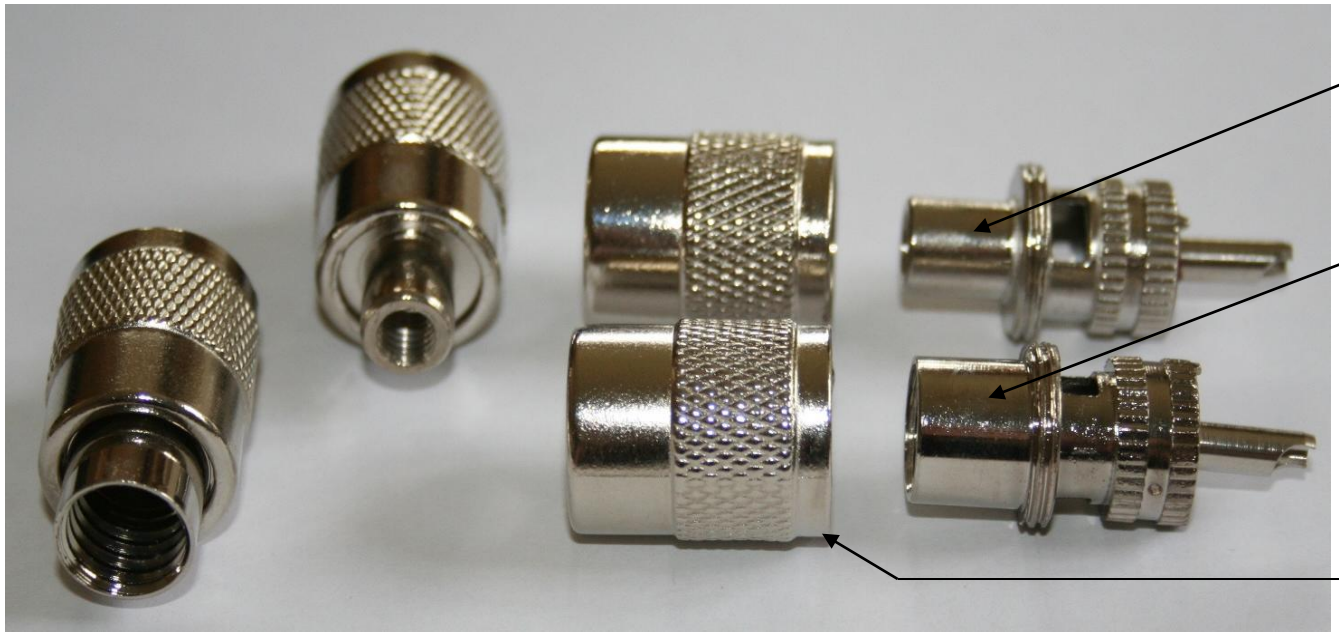
PL259 Plugs: These are sometimes (misleadingly) called VHF/UHF connectors. They are perfectly good connectors for HF (Up to 30 MHz). They are acceptable for 2 metres (144 MHz). At 2 metres and 70 centimetres, however, you are more likely to come across the better quality "N connector". (N connectors would be the best, single connector to use and avoid the PL259 altogether. However, PL259 plugs are the "industry standard" for HF.)

In amateur radio you are probably going to use two types of co-ax. These are RG58 and RG213 types. RG58 co-ax has an external diameter of about 6mm. and RG213 has an external diameter of about 10mm.

The PL259 plug comes in two sizes to suit these cables – but there are variations. The best quality plugs have a "default" size which accepts the 10mm RG213 cable. If you want to use this plug with RG58 then you must also buy a threaded reducer which screws into the plug to reduce the throat of the plug to 6mm. This reducer is essential if you use the smaller diameter cable. (See photograph)

The second type of plug comes in two, fixed sizes which suit only one size of cable each.

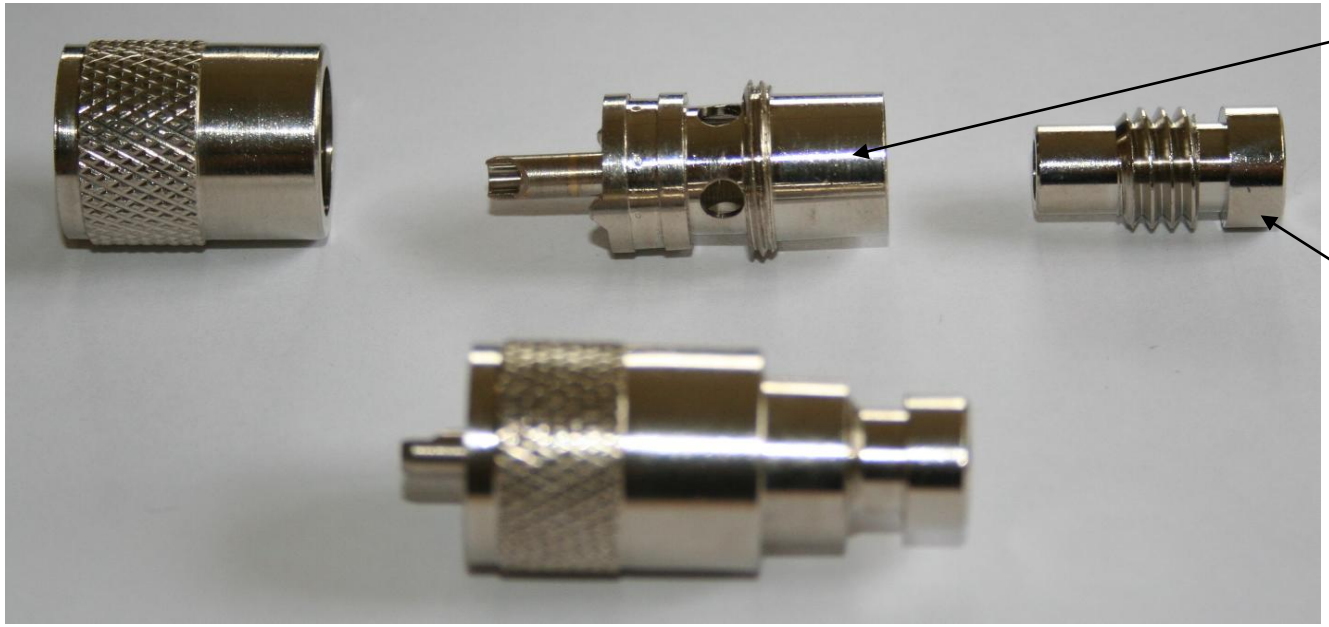
PL259 Plugs – Basic Types



6mm size (fixed)

10mm size (fixed)

Collar



10mm size (default)

Screw-in reducer for 6mm coaxial cable

N Type Plug



Screw-in gland. Make sure you buy the correct sized plug and cable gland for the coaxial you are going to use.

The photo shows a 10mm cable gland

Fully-shrouded, centre pin.

N-Plugs provide a lower insertion loss at VHF and above compared with PL259 plugs. They are a bit more complicated to attach to the co-ax.

4mm Plug (Banana Plug)

The plug will incorporate some kind of "springing" on it to increase the contact pressure in the socket. If the plug is loose in the socket then change it for a firmer one.





Multimeter cables are commonly terminated in 4mm plugs – often they are shrouded for safety.

The binding posts on the back of most ATUs will accept a 4mm plug. Power supplies also use 4mm plugs and sockets.

The cover is slipped over the cable and the conductor soldered onto the plug. The cover is then eased back over the plug to complete the job.

Use these on the end of 450Ω window or ladder line at the ATU interface.

(The name "Banana" comes from the appearance of certain plugs which have thin, strip-metal springs along the pin giving it the appearance (somewhat) of a peeled banana skin.)

How To Attach The Plug To The Cable:

The assembly process is described below as a series of fixed steps with photographs. A PL259 plug and RG213 cable are used in the illustrations. The PL259 plug is of the "fixed size" type. (ie. 10mm.)

Step 1: Cut the cable to length. For RG213 use a hacksaw. It is too tough to cut neatly with electrical pliers.

Step 2: With a sharp knife (and taking care not to cut yourself) strip back about 35mm of the sheath from the end of the cable to be attached to the plug. This will expose the braid. Be careful when you do this that you do not nick or damage the braid. If you do then cut off the damaged piece and start again. (35mm is a bit longer than you need. Trim any excess off the centre conductor when you come to solder it into the plug.)

Step 3: Remove some of the braid to leave about 12mm. This will expose the insulation around the centre conductor.

Step 4: Next remove some of this insulation to expose the copper, centre conductor and to leave an insulation collar, about 2mm long, at the free end of the braid.

You now have to lightly tin this copper, centre conductor. (If necessary tighten up the twist of any wires forming this conductor with the pliers. Don't crush the wires!). You must do the tinning relatively quickly otherwise you will start to melt the dielectric (insulation) surrounding the inner and outer cores of the cable.

At this point stop and review. If this is the second plug you are putting on the coaxial then make sure that any plug collars that need to be slid onto the cable before you solder the plug are, in fact, slid onto the cable.

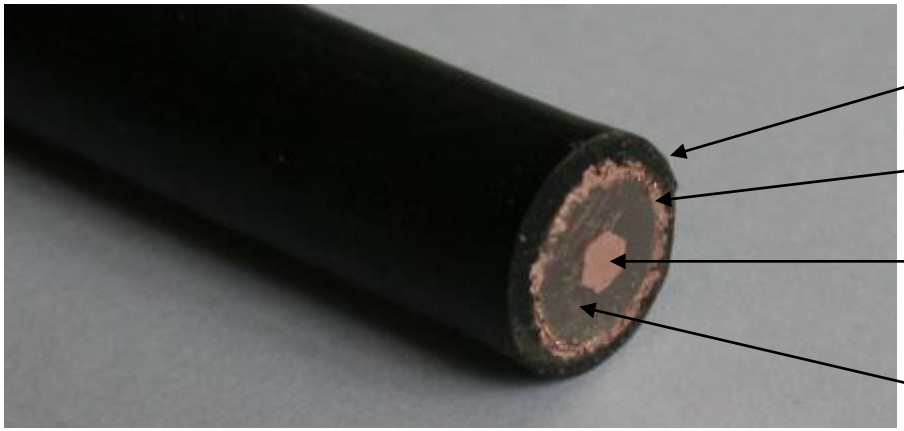
Step 5: When the cable has cooled first slide the body of the plug carefully over the braid ensuring that all the strands remain inside the plug and that the inner locates properly. When the plug meets the sheath you need to start to screw the plug onto the sheath. The plug has threads on the inside which will "self tap" into the sheath and grip it mechanically. Keep going until the end of the insulation meets the bottom of the plug. You will see the braid through the solder ports and the tinned end of the inner conductor will have appeared at the end of the centre pin.

(This is easy to write but actually doing this can be a bit of a struggle. If you have a vice to gently, but firmly, hold the cable while you grip and turn the plug with the pliers you will find this part a lot easier. Resist the temptation to apply "brute force" to the cable. A damaged or crushed cable will inevitably be a source of problems. A slight smear of silicone furniture polish to the threads will ease the "self tapping" process)

Step 6: Solder the pin to the centre conductor and the plug body to the braid. (See notes to the photograph.)

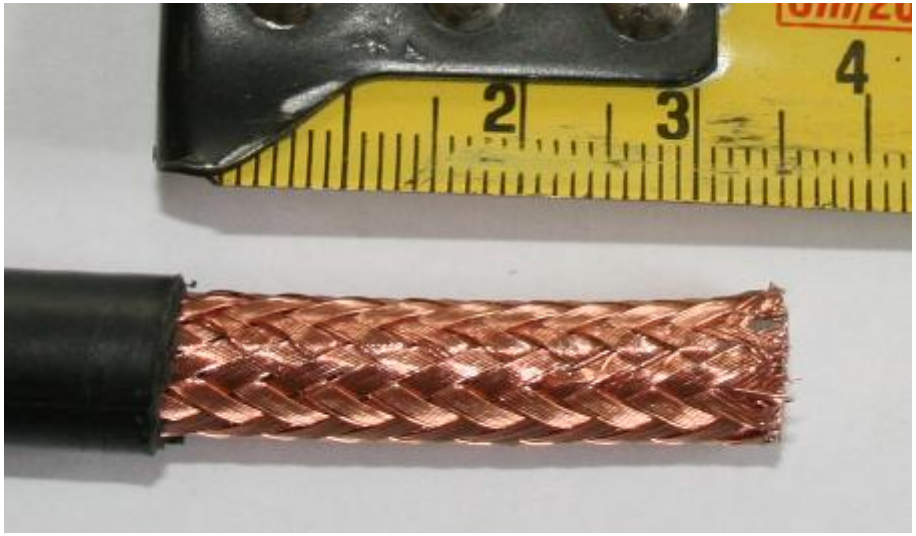
Step 7: Check for continuity and short circuits.

Step 1: Prepare And Cut The Coaxial Cable To Length.



For RG213 cable cut it to length with a junior hacksaw. Unless you have a set of cable shears for cutting large diameter cable you will damage the coaxial cable if you try to use wire cutters.

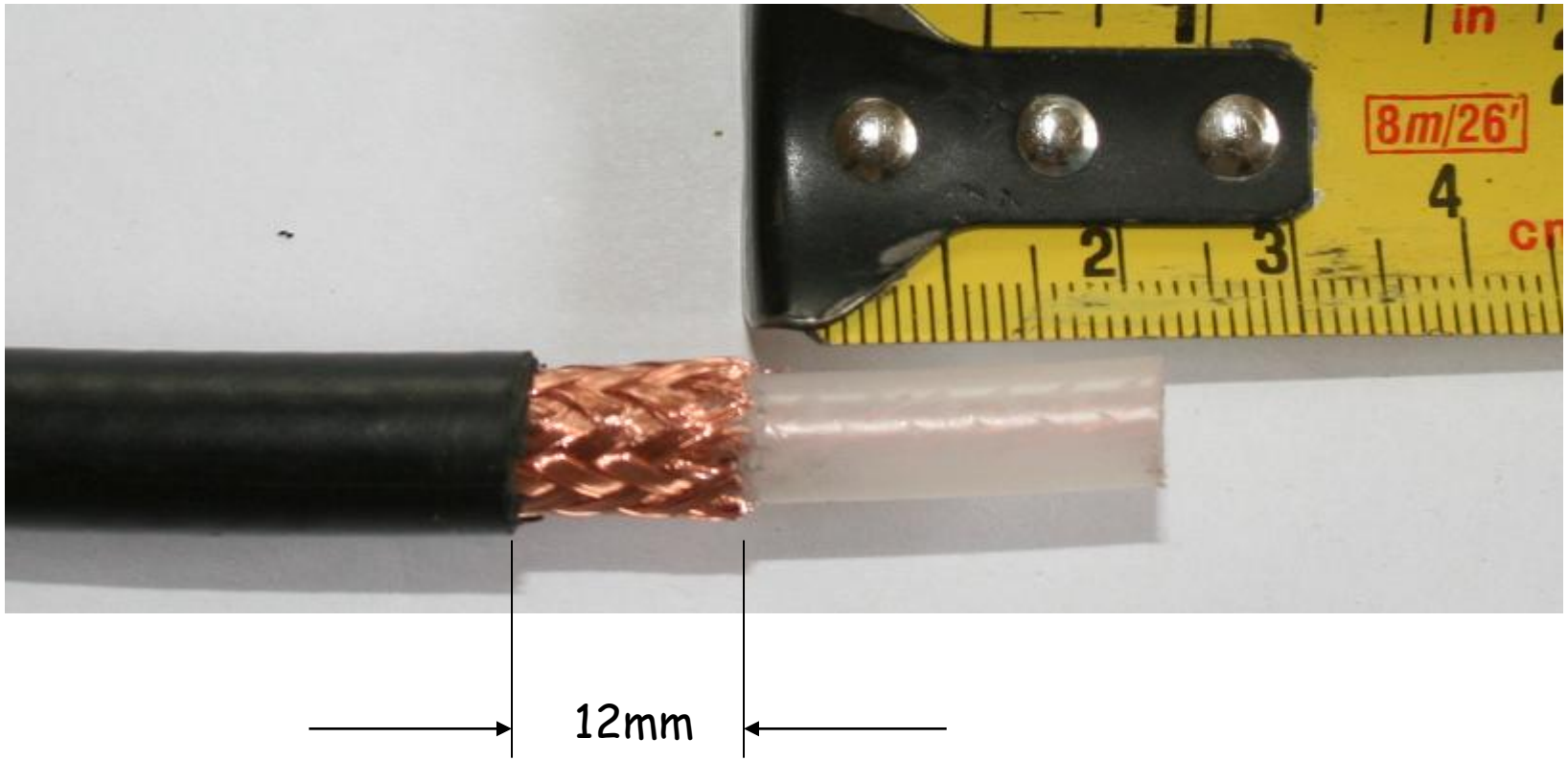
Step 2: Remove About 30 to 35 millimetres Of Sheath.



With a sharp knife or coaxial stripping tool remove about 30mm of the sheathing.

Be careful not to damage the braid.

Step 3: Trim The Braid.

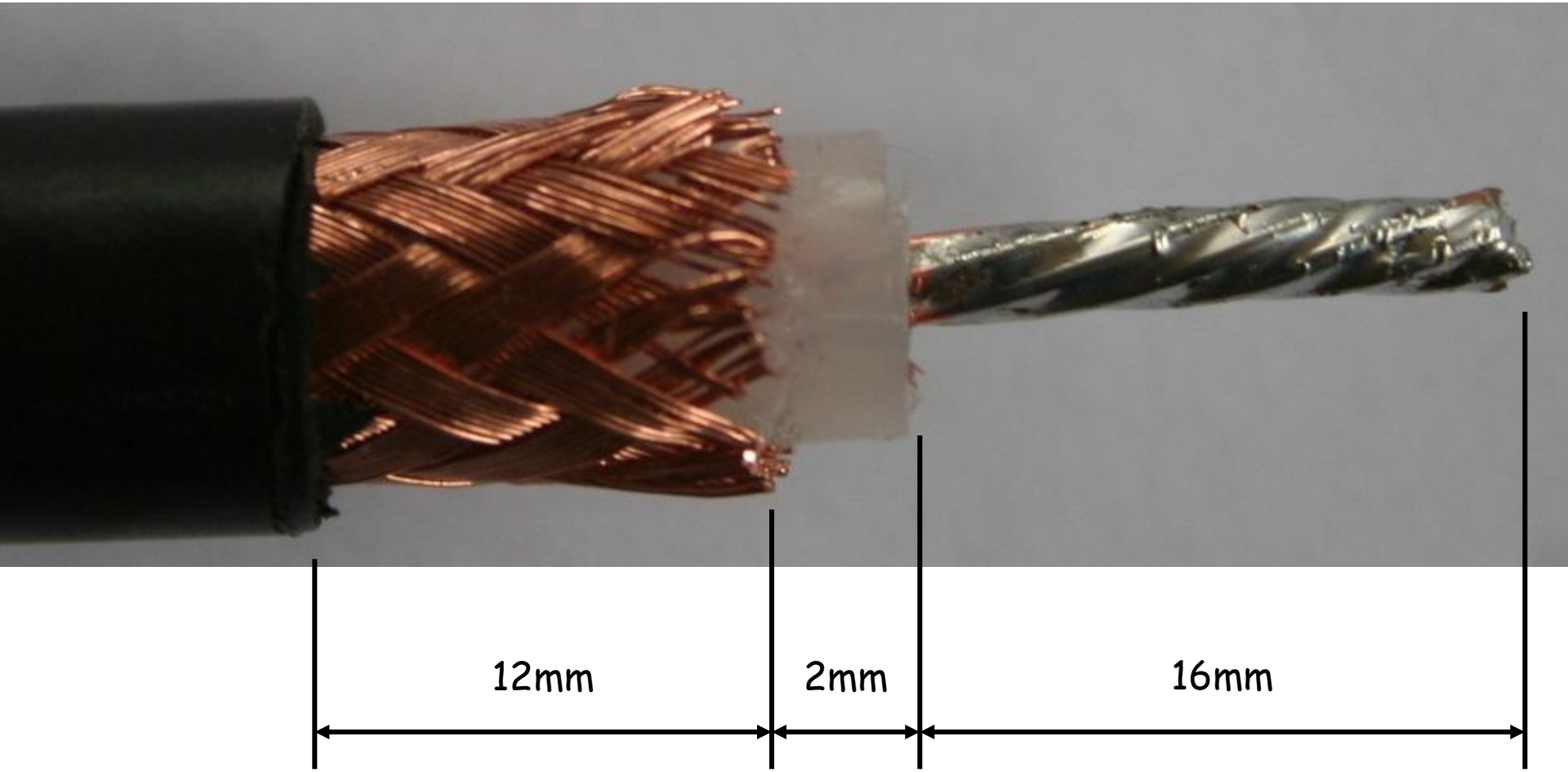


With a pair of sharp side cutters remove some of the braid.

Make sure that you leave no whiskers of copper from the braid.

You should have about 12mm of braid as shown.

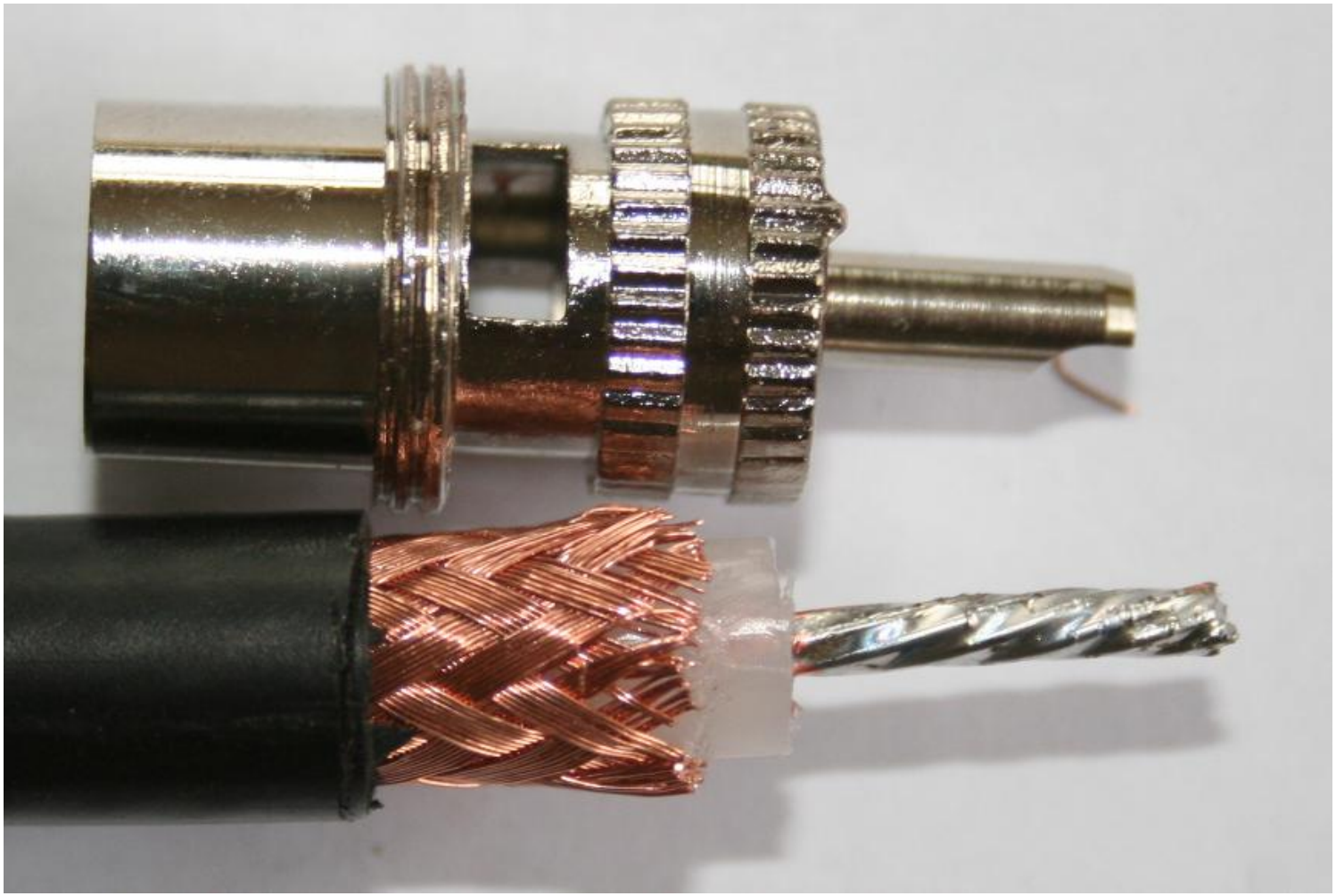
Step 4: Trim The Insulation And Tin The Centre Conductor.



Next trim back the insulation to leave a "collar" 2mm long at the end of the braid. Restore the twist to the centre conductor (gently!) if it needs it.

Lightly tin the centre conductor. Your cable should look like the photograph

Step 5: Fitting The PL259 Plug (1).



In this view the plug is placed alongside the cable to show where the cable will be relative to the plug geometry when it is inserted into the body of the plug. (Ideally there should be no collar of insulation. However, if you cut everything too fine you risk a short between the plug and the braid if whiskers of copper become detached during the construction of the plug.)

Step 5: Fitting The PL259 Plug (2).



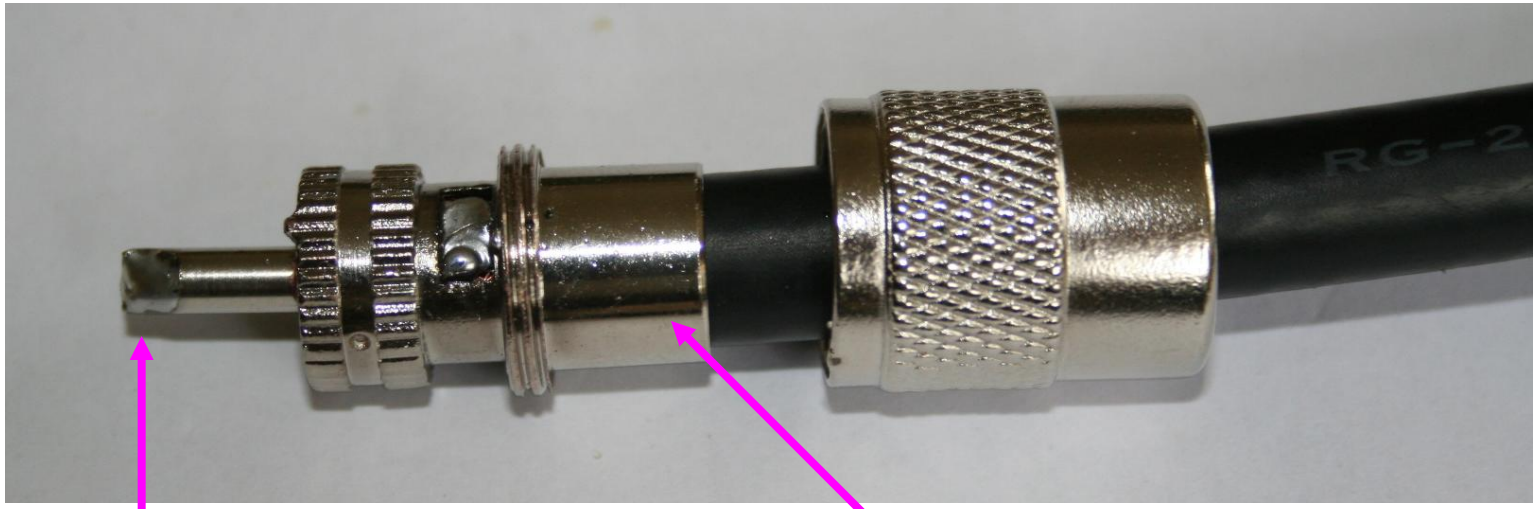
If there is already a plug on the other end of the cable, or if this is the only free end, then don't forget to slide the collar of the plug over the coaxial cable before doing anything else. Check also that the collar is oriented correctly so that it will screw up onto the plug body.

The inside of the plug body has a thread cut into it. This will "self tap" into the cable sheath as you twist the plug body onto the cable. You may need to gently hold the cable in a soft-jawed vice if you find the twisting is difficult. (A *slight* smear of furniture polish on the sheath will ease the friction a bit.)

The inner will appear through the hollow pin and you will see the braid through one of the solder ports on the plug body. Stop twisting when the insulation meets the plug end.

Do not over-tighten or damage the cable in any way.

Step 6: Solder The Pin And The Braid To The Plug.



With the soldering iron heat the braid through the solder port and apply some solder. ***This will probably not work!*** (In the sense that you will not produce a good mechanical joint between the braid and the plug.) It will probably be a dry joint as you cannot heat the plug sufficiently to cause the solder to flow. However, it will be better than nothing. Don't get too fussed about this and apply heat for a long time. All you will do is to start to melt the cable. The braid will be in contact with the inside of the plug as well.

Good quality, silver-plated plugs will solder more easily in general.

Soldering the pin will not be a problem. Make sure the liquid solder draws itself into the tube before removing the iron.

Finish off with a light filing if you need to remove any excess wire or solder. The pin should feel smooth and have no sharp protrusions to damage the socket.

Some plugs are sized so that you pull the braid back over the sheath and screw the plug over the braid rather than having to solder.

Step 7: Continuity And Insulation Check.



Use an Ohmeter to check that you have pin-to-pin continuity and outer-to-outer continuity along the length of the cable.

Check also that you do not have a short circuit between the pin and the outer.

The photo shows the pin-to-outer test with the Ohmeter on the 2000MΩ range. The "OL" on the display indicates that the dc resistance is greater than this and thus "out-of-limits". (ie. There is no short between the inner and the outer of the cable as a result of fitting the plugs.)

If the plug is to be used outside you will need to encase it in water-proofing tape to eliminate any chance of moisture from entering the coaxial cable and corroding it.

Going Solo - Safety Reminder!

Before starting to connect up your station please "Think Safety"

1. Do not climb ladders on your own - have a friend to "foot them".
2. Do not rig antennas anywhere near overhead power cables.
3. Do not work live on any item of equipment.
4. Do not interfere with the mains protective earth on any part of the supply.
5. Take account of buried services before you drive earth rods into the soil.
6. Always lift correctly – get help with heavy items.
7. Stop all activities if thunder storms threaten.
8. Stop work if you are tired or cold – that's when accidents strike.
9. Make sure someone knows what you are doing, checks regularly and knows how to isolate the supply to your equipment.
10. Don't take risks. Ask yourself: "How quickly will I get on the air after I have had the accident……?"

Going Solo!:

Your licence has arrived, some of your bank balance has been converted to shiny new bits and pieces and you have a lot of wire awaiting to be hoisted skywards. At this point you have to put it all together, check that it works and make your first QSO. The following is a suggested strategy for putting your station together and then making your first contact.

1. **Rigging The Antenna:** The first step is to rig the antenna. (Other club members will be delighted to help – usually all that is needed is a supply of tea and cake.) Assuming that you have built your own wire dipole you will already have decided where it will go and how it will be supported. If it is an Inverted Vee, held aloft by two aluminium poles in a weighted butt, then do the following:

Rigging The HF Dipole

Fix a pulley to the top of one of the poles.
Reeve the pulley with sufficient rope to be able to hoist the antenna.
Put a figure-eight knot in each end of the rope for now.
Use the sleeve joint to join both poles. Tighten the bolts evenly.
Place the weighted butt with its ballast in the chosen position.
Attach the guy rope clamp fitting to the upper pole about 300mm from the top.
Attach the guy ropes and ensure that they contain no knots.
Attach the antenna to the halyard.
Check that the feeder is secure and under no strain.
If using co-ax then check that all the joints are mechanically secure and moisture-proof.
Fit the pole into the centre support tube in the weighted butt. (NB! No overhead power cables near!)
Align the pole and pulley for best position. If necessary wedge the pole evenly in the support tube.
Carefully hoist the antenna – avoiding snagging it on the guys.
Make fast the antenna halyard. Secure the antenna ends.
Lay out the guys evenly and anchor them to the ground to be gently tensioned against the mast.
Run the feeder into the shack and terminate the end with the appropriate plug to match the ATU.
Make good any holes used for the feeder entry and mechanically check the complete antenna system.

The advantage of rigging the HF antenna first is that you now have the means of receiving signals. This will help you in setting up the station and being confident that everything is working.

Establishing An Attempt At An RF Earth

If your shack is at ground level it's worth putting in an initial RF earth – at least as a static drain. It doesn't have to be perfect only something that you can extend if you want to. If your shack is not at ground level then you can skip this section. (You can, of course, also skip this section if your shack is at ground level.)

1. Drive in an earth rod (~ 1 metre long) as close as you can to the shack. (Check for buried services.)
2. Use heavy gauge wire – at least 6 mm^2 csa - to extend the earth into the shack.
3. Terminate the earth lead onto a single, fixing point. (A length of 15mm copper pipe is good)
4. RF earth the equipment to this point. Do not common this point to the mains protective earth.
5. Extend the earth system with more rods or large metal plates as and when you want.

This will not be a perfect RF Earth by any standard. However it will be a start and at least a static drain.

Connecting The Equipment – ATU With Integral VSWR Meter

You will need a sturdy table at a comfortable working height for the station equipment. An adjustable chair is useful in getting the operating position personalised for minimum operating fatigue.

Start with all equipment in the "OFF" position

Connect the antenna to the ATU in accordance with the manufacturer's instruction. If using coaxial it will be with a PL259 plug to an SO259 socket. If using parallel feeder it will be to 4mm binding posts. You may have to insert a wire link to connect the internal ATU balun.

Connect a short, coaxial patch lead between the ATU and the transmitter HF output socket. This patch lead will be a length of coaxial cable with a PL259 plug at each end. A length of about 1 metre will be sufficient. RG58 will be flexible. RG213 will be a lot stiffer. If you have limited space then RG58 cable will allow you to place the equipment where you want without straining the coaxial.

Connect the dc cable from the PSU to the transceiver. Check that the cable is correctly fused. Be very certain that the supply polarity is correct and that the positive supply cable [+] goes to the positive terminal of the PSU.

(Red Cable to Red Terminal [+], Black Cable to Black Terminal [-].)
Double check the polarity!

Connect any RF earthing from the transceiver and the ATU to your RF earthing point. Generally there will be a wing nut terminal on the transceiver and ATU. Don't daisy-chain the earths. (This means that each item of equipment will have its own earth wire rather than inter-equipment wires with the final link completing the earth connection to the RF Earth point.)

Connecting The Equipment – Separate ATU And VSWR Meter

If you are using a separate ATU and VSWR meter you will need an extra patch lead. The VSWR meter will go between the ATU and the transceiver. Be certain that you connect the VSWR meter correctly. One of the VSWR SO259 sockets will be marked "Tx". Connect this to the transceiver. Connect the socket marked "Co-ax" to the ATU.

Matching (Tuning) Up The Antenna

This stage is to check that you have a system that can at least receive. If the receive test is ok then you can then try transmitting.

- Check all the connections once more. In particular make certain that the PL259 plugs are properly seated in their sockets. The two small "vees" on the plug must locate in two similar vee notches on the socket crown.
- If the PSU has a variable voltage output check that the voltage control is in the 13.2 Volt position. (There will often be a notched position halfway around the potentiometer travel.)
- Make sure that the transceiver is switched off.
- Turn on the PSU and check on the meter that you have 13.2 Volts.
- Check on the transmitter that any manually operated transmit controls (MOX switch) are switched off.
- Turn the AF Gain control fully counter-clockwise to its minimum position.
- Turn the RF Power control fully counter-clockwise to its minimum position.
- Turn the Mic Gain control fully counter-clockwise to its minimum position.
- Turn the RF Gain control fully clockwise
- Turn on the transceiver.

- Turn up the AF Gain control until you hear a hissing noise.
- Select an amateur band – say 80 metres around 3.7 MHz. (Or 20m during the day may yield more stations)
- Adjust the ATU controls to maximise the volume of the hiss.
- Find and resolve an lsb station on 80 metres and establish that the receiver is operating correctly.
- Adjust the ATU to maximise the signal strength.
- Make a note of the ATU settings.
- Tune in some other stations on other bands and adjust the ATU controls to maximise the signal reading. Make a note of these readings and frequencies. (This will give you a rough idea of the settings you will need to match the antenna when you transmit on these amateur bands.)

Preparing To Transmit

The next stage is to find a quiet spot on one of the permitted bands where the band plan allows you to transmit using J3E or ssb mode. Here you can match the antenna more precisely in readiness for your first QSO. For the purposes of this guide let's assume that you have found that 3.68 MHz is available in the 80 metre band. Read this guide in conjunction with the transceiver manufacturer's instructions. Where necessary you will need to translate these steps into the actual way your transceiver operates.

- Set the transceiver to the lsb mode.
- Tune to 3.68 MHz (probably displayed as 3680 kHz).
- Listen carefully to be certain that the frequency is not in use.
- Turn the Mic Gain control to about the 10 o'clock position. (Or factory default setting)
- Turn the RF Power control to its **minimum** position.
- Set the ATU controls to their position which gave the maximum hiss / signal when you were exploring the 80 metre band on receive. Fine tune these controls to maximise the background hiss.
- Select the highest sensitivity on the ATU. (Probably the 30 Watt position.)

The next step is to inject some RF into the antenna system. You will do this by pressing the push-to-talk (PTT) button on the microphone. This step will be detectable to anyone within range of your station.

If you just press the PTT button there will be no RF output in ssb mode because there will be no sidebands generated. Apart from a brief transient you will not see any forward or reflected values on the vswr meter. You need to modulate, or generate, the carrier. You can do this in a number of ways.

(a). By producing a constant tone by gently whistling into the microphone whilst pressing the PTT button.
(b). By slowly and deliberately repeating the sound "Oh-La" whilst pressing the PPT button.

(Alternatively you can generate an AM carrier and disable the microphone. (eg muffle it). Pressing the PTT switch will generate a single, unmodulated carrier. You can adjust the ATU against this signal. Be careful if you do this as you risk generating both upper and lower sidebands if any modulation appears on the signal.)

WHATEVER YOU DO ALWAYS TUNE UP THE ANTENNA AT THE LOWEST POWER LEVEL SETTING ON YOUR TRANSMITTER. LISTEN CAREFULLY BEFORE YOU TRANSMIT.

By a process of trial and error and using one of the above methods adjust the ATU controls to produce the best VSWR reading at that frequency. (1:1 is ideal but anything up to 1.3:1 will be fine.). Reselect lsb mode on completion. Make a note of the ATU settings. (The idea is to build up a table of settings at spot frequencies across the bands by repeating the above so that you can rapidly tune up in future.) Particularly at the lower frequencies you should check that a better match cannot be made by varying the inductor setting by +/- one inductor switch position and varying the antenna and transmitter controls on the ATU. (Minimum inductor setting is best.)

The first few times that you go through the above process it will seem quite complicated. However after a little while it becomes second nature and very quick to do.

First Contact!

Ideally arrange with a club member to be listening on an agreed frequency. He/she can then give you a step-by-step assessment of your signals, speech quality, etc.

The following assumes that 3.68 MHz is still available and that you have the antenna properly matched

- Get comfortable.
- Organise your writing materials and log.
- Turn the RF Gain control to maximum.
- Turn up the RF Power control to the 10 Watts position.
- LISTEN for ten or twenty seconds to be CERTAIN that the frequency seems to be UNOCCUPIED.
- Press the PTT button and ask **"Is this frequency in use please?"**
- Release the PTT button and listen.

If no-one comes back to tell you that it is then push the PTT button and say **"Nothing heard"**. (If the frequency is in use but you can't hear them – although they can hear you – at least they will know that you heard no response.) Keeping the PTT button pushed make your first CQ call. Speak SLOWLY and CLEARLY. Make your call something like this (but with your call sign of course!)

"CQ CQ CQ
CQ 80 metres from Mike Six X-Ray Yankee Zulu, Mike Six X-Ray Yankee Zulu.
CQ CQ CQ
CQ 80 metres from Mike Six X-Ray Yankee Zulu, Mike Six X-Ray Yankee Zulu.
Listening and Standing by for any calls"

Release the PTT button.
Listen for any replies.
If no-one answers then repeat the call.
If after, say, three attempts no-one answers then try another frequency and re-tune the antenna.

Don't Panic – But Someone Has Just Answered Your Call!

A bit of forward planning will make this easier. On a piece of paper have written down some bits of information about you and your station. For example.

My name is Frodo. That's Foxtrot Romeo Oscar Delta Oscar: Frodo
My QTH is Hobbiton. That's Hotel Oscar Bravo Bravo India Tango Oscar November. Hobbiton.
Hobbiton is a small village about 20 kilometres north of Mordor.
The radio is a Yaesu FT897
My antenna is a wire dipole with a feed point about 9 metres above the ground.
The antenna runs north and south.
The weather today is……
My locator square is JO 02 AC: Juliet Oscar Zero Two Alpha Charlie
My WAB square is TL44: Tango Lima Four Four.

The ensuing QSO could go something like this. You've just finished making your call with:
"……listening and standing by for any calls."

You release the PTT button and hear……..

Mike Six X-Ray Yankee Zulu from Mike Zero Delta Charlie Victor.

You take a deep breath, push the PTT switch and say:

Mike Zero Delta Charlie Victor from Mike Six X-Ray Yankee Zulu.
Thank you for answering my call.
My name is Frodo. That's Foxtrot Romeo Oscar Delta Oscar: Frodo
My QTH is Hobbiton. That's Hotel Oscar Bravo Bravo India Tango Oscar November.
Hobbiton is a small village about 20, two zero, kilometres north of Mordor.
My locator is Lima Oscar Zero Six Charlie Delta
I'll give you a signal report on the next over.
Mike Zero Delta Charlie Victor from Mike Six X-Ray Yankee Zulu.
Over to you.

Mike Six X-Ray Yankee Zulu from Mike Zero Delta Charlie Victor.
Good afternoon Frodo.
My name is Peter. That's Papa Echo Tango Echo Romeo: Peter.
The QTH is Foxton: That's Foxtrot Oscar X-Ray Tango Oscar Romeo: Foxton.
Foxton is a small village about 12, one two, kilometres south-west of Cambridge in the east of England.
Your signal is a very clear 5 by 9 with me
My locator is Juliet Oscar Zero Two Alpha Charlie. My WAB square is Tango Lima Four Four
M6XYZ from M0DCV
Back to you Frodo.

M0DCV from M6XYZ.
Thanks Peter all copied.
Your signal is also a good 5 by 9 with me
I'm running 10 Watts from a Yaesu FT 897 into a wire dipole.
Weather this end is bright and sunny with a temperature of about 18 Celsius.
M0DCV from M6XYZ Back to you.

M6XYZ from M0DCV
All copied Frodo.
Radio this end is a Yaesu FT847 and I'm running about 50 Watts into an inverted Vee dipole.
Weather with me is rain and about 14 degrees Celsius.
Back to you.

Thanks Peter.
I'll make this my final and go and have a cup of tea.
Thank you for the contact and I hope we speak again soon.
Mike Zero Delta Charlie Victor from Mike Six X-Ray Yankee Zulu.
73 Peter
Bye

Mike Six X-Ray Yankee Zulu from Mike Zero Delta Charlie Victor.
Yes thanks Frodo for a nice QSO. I look forward to the next time.
M6XYZ from M0DCV
73 Frodo
Bye.

At this point pat yourself on the back, write up the log and go and have that cup of tea!

Notes:
The Locator: This is a group of six characters such as JO 02 AC (Juliet Oscar Zero Two Alpha Charlie). It is mainly (but not exclusively) used for 2 metre contacts. The locator is calculated from the latitude and longitude of the station. It is a grid of small squares which covers the globe. Look up the word "locator" or "Maidenhead locator" on the web for a fuller explanation and how to calculate the locator code for your QTH. You can buy a locator map for Europe from the RSGB.

WAB Square: WAB stands for "Worked All Britain". It is the Ordnance Survey reference to the grid which defines the maps that the OS produce. Foxton, for example, is in square TL44. The WAB award is for anyone who has worked stations in all of the OS squares.

73: Best wishes.

Answering A CQ Call

You may prefer to listen out for (and then respond to) a CQ call for your first contact. If you hear a CQ and respond to it the opening could go like this.

……CQ 80 metres from Mike Zero Delta Charlie Victor
Listening and standing by for any calls.

Mike Zero Delta Charlie Victor from Mike Six X-Ray Yankee Zulu.

Mike Six X-Ray Yankee Zulu from Mike Zero Delta Charlie Victor
Thank you for coming back to my call
My name is Peter.
Etc.

M0DCV will then take up the conversation and pass back to you when he has finished his over.

By responding to the calling station by giving its full call sign followed by yours you alert him or her to the fact that you have heard them and are responding. Just giving your call sign can sometimes be a bit confusing. (Are you replying or has the calling station been calling over the top of a call that you are making? etc.)

Sometimes special event stations which have lots of callers may ask only for the last two letters of your call sign to produce an ordered list of callers which they will then work sequentially. Very often they will first ask if there are any M3 or M6 low power stations with whom they will talk first of all.

Calling CQ on 2 Metres and 70 cms ssb

If you call CQ on 2 metres or 70 cms ssb remember that you need to follow a slightly different process. Because Yagis are directional you have to swing the antenna several degrees between CQ calls. So there is a calling/listening frequency on which you first establish contact. The calling station will then find a free frequency if he or she receives a reply. Both parties then QSY to that free frequency for their QSO leaving the calling frequency free for someone else. It's probably a good plan to just listen a couple of times on the calling frequency (eg 144.300 MHz ssb) and QSY in tandem with the other stations to remember how this operates and feel confident for your first attempt.

Low Power Operation (QRP) And The GQRP Club

You can do a considerable amount with your 10 watts. Indeed there is a whole section of amateur radio dedicated to operation at low power.

This is called operating QRP. The GQRP Club promotes QRP operation and publishes a quarterly magazine called "Sprat" containing construction and operating articles.

In amateur radio QRP is generally taken as being 10 Watts or less for ssb and 5 Watts or less for CW. Indeed, there are lots of QRP enthusiasts who operate in the milliwatt range.

There is a GQRP web site where you can find out more and explore the possibilities. Whilst you may not build transmitting equipment under the terms of your Foundation Licence there are lots of other items which you may construct.

Operating QRP involves operating at maximum efficiency to make the most of your 10 Watts. The equipment you can build for QRP will help you optimise the performance of your station.

Many amateurs operate QRP when on holiday or staying in hotels. The equipment is compact and can be battery or even solar-powered and a complete HF station can easily be packed in a brief case – or smaller.

NB! Lots of amateurs exclusively operate at low power (QRP). They find the lure of low power a continuous and irresistible challenge. There is always the prospect of increasing their personal best "kilometres-per-watt" record.

Operating QRP is the best incentive to understanding how your station is performing and then making it increasingly efficient to maximise your radiated signals.

The intermediate examination allows you to make your own transmitters. This opens up a whole world of simple CW transmitters that you can make and fit inside matchbox-sized enclosures.

Operating Through A Repeater And Echolink

The Cambridge Repeater Group (CRG) maintains and operates a number of repeaters. These include television as well as 2 metre and 70 cms repeaters.

The idea of the repeater is to allow a low power station to access a wider area or a directional signal to be re-radiated as an omni-directional one. Two frequencies are involved namely an input frequency and an output frequency. Repeaters for 2 metres have an offset between their input and output frequencies of 600 kHz. and 70cms typically use an offser of 1.6MHz They operate as follows.

An amateur has, say, a low power, hand-held, 70cms FM transceiver. The transceiver can generate a tone at the start of each transmission or a continuous, nearly sub-audible tone. This tone serves to open the repeater to receive the incoming transmission from the hand-held.

The amateur puts out a short CQ call through the repeater. (ie "M0DCV listening PY" if using the Cambridge 70cm repeater GB3PY) The repeater shifts and retransmits this signal onto a different frequency and at a much higher power. The radiated signal will also be omni-directional. Anyone hearing the signal can reply via the repeater in the same way.

Repeaters are particularly useful for people who are operating mobile from a car. Two mobile operators can conduct a QSO even though they may be many kilometres apart and constantly changing their relative bearings.

For amateur tv a number of stations can conduct a QSO via the repeater. All stations point their antennas at the repeater. The transmitting station can then re-radiate his or her picture over a wide area to anyone who can "see" the repeater. Again the repeater will use two frequencies.

This short description omits lots of detail about the actual process of operation. You should contact the Cambridge Repeater Group via their website if you want to be a repeater user. When travelling around the UK you may freely use the various repeaters maintained by other groups. However, the accepted protocol is to help maintain your local repeaters by joining or making a contribution to the repeater group.

The repeater site is often donated by a communications company on one of their towers. The repeater group pays for the installation, the electricity and possibly a nominal rental. Costs are not always insignificant.

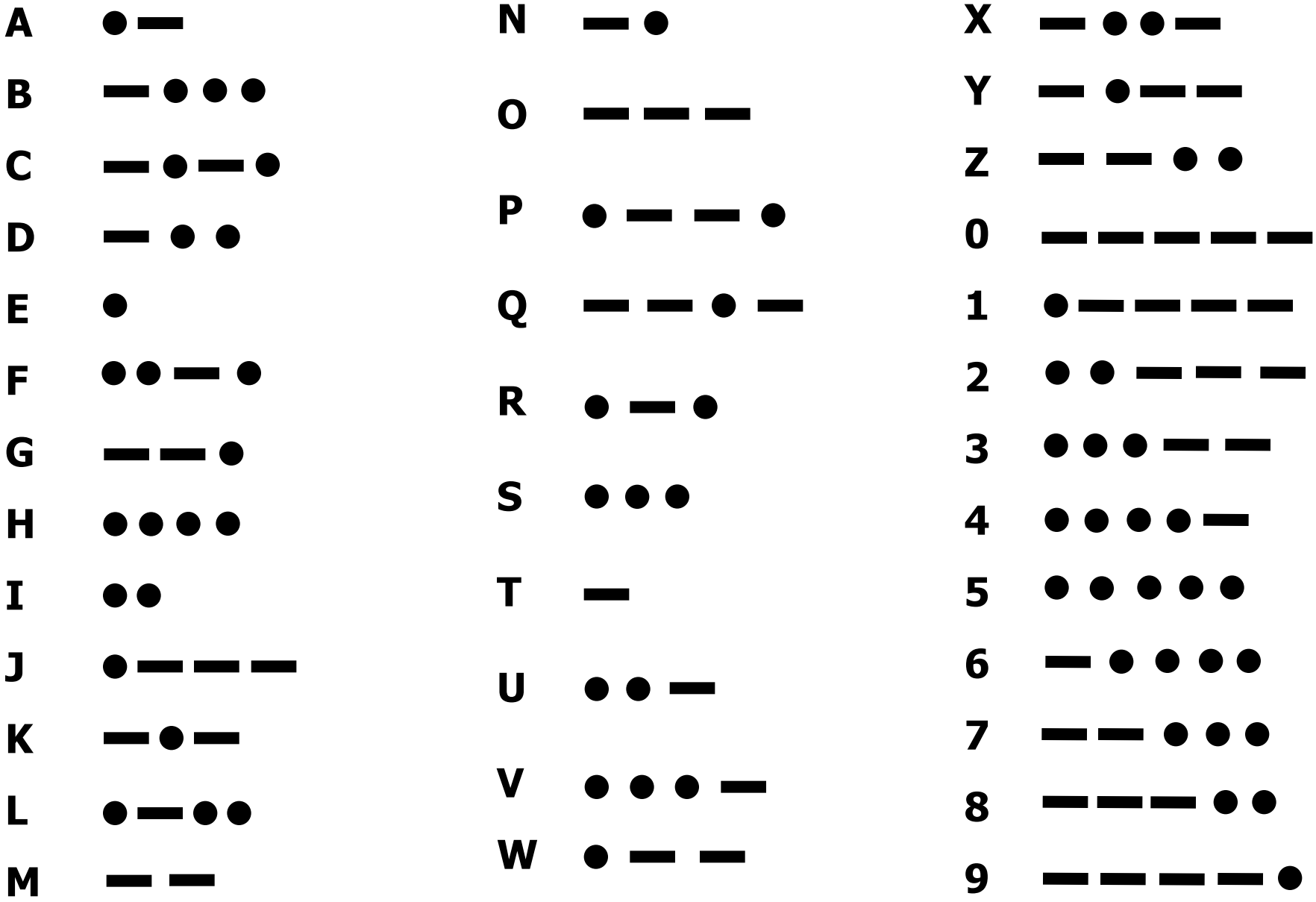
A variant on the repeater is "Echolink". Here signals are steered via an internet gateway station to a chosen destination and retransmitted by a similar radio gateway station. It is thus possible to use a hand-held, 2 metre FM transceiver in Cambridge and put out a CQ call in, say, Boston USA, or Perth Western Australia. Again look on the internet for a fuller description of Echolink and how to use it.

NATO Phonetic Alphabet

Alpha	**K**ilo	**T**ango
Bravo	**L**ima	**U**niform
Charlie	**M**ike	**V**ictor
Delta	**N**ovember	**W**hiskey
Echo	**O**scar	**X**-Ray
Foxtrot	**P**apa	**Y**ankee
Golf	**Q**uebec	**Z**ulu
Hotel	**R**omeo	
India	**S**ierra	

Use this standardised phonetic alphabet in preference to other (personalised) phonetic words.

Morse (Look-Up Sheet)



The Most Common Q Codes:

Here are a few of the commonest Q codes that you are likely to hear. It's not an exhaustive list and you can find many more by a search on the Internet. Lots of Q codes are now obsolete.

QTH	Home station location
QRP	Low Power
QRO	High Power
QSY	Change frequency
QSB	Fading
QRN	Natural (Atmospheric) Noise
QRM	Man-made noise or interference
QSO	A radio contact
QSL	Agreed, affirmative, received
QRZ	Who is calling me?
QRT	Closing down, going quiet

End

We hope that you have found this little guide helpful in planning, building and operating your first amateur radio station.

Do come along to the next CDARC meeting, (or your local club), meet the members and further your knowledge and enjoyment of operating your equipment.

CDARC Training Team. Cambridge - Spring 2017

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