A compact and easily reproduced Sleeve Dipole for 435MHz **By G8MCD**

Sleeve Dipoles are often seen in professional radio communication systems but far less so in Amateur usage. For UHF use, their 40 MHz bandwidth and compact size is very attractive though…. This design avoids the machined parts and complex modelling of professional designs.

Theory

Many will be familiar with the Simple Vertical Dipole in **Fig 1**, with the feeder sticking out 90° sidewise from the centre - a feed and mounting arrangement that doesn't always suit the situation and frequently adds a 'notch' to the radiation pattern.

Fig 1

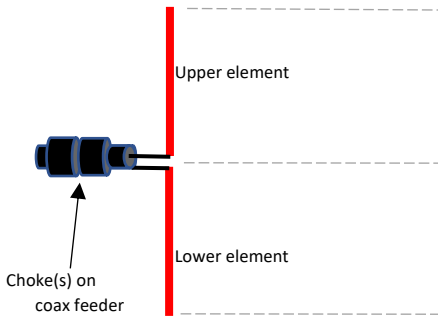


Fig 2

Fig 2 is one form of a **Sleeve Dipole.**

There are several interesting things going on here.

- Mechanically, the feeder comes up inside the lower element, leaving a clean radiation pattern (and mounting only needs one hook or string making life easier).
- As with the simple dipole, no radials are needed; and it can be hung 'upside down'.
- The radiating sleeve (see w8ji here) **provides both the lower element and a (imperfect) choke/balun** that interacts with the coax braid via the internal air-gap and outer insulation
- The Sleeve and off-centre feed can provide a better, unbalanced, match to 50 ohm coax and increase the bandwidth to 10% or more of centre frequency (vs 5% for a simple dipole)
- The entire antenna can be covered in heatshrink or plastic pipe (before final tuning).

Sleeve dipoles have gained a reputation as difficult to model and build, as :

- The sleeve size is hard to calculate via modelling and its multiple role as lower element ***and*** a coax balun/choke depends on several dimensions, materials and velocity factors lining up.
- Shorter wider sleeve dimensions (under 40% of total length) seem to optimise matching / bandwidth but tilt the maximum radiation angle up, reducing useful gain at the horizon level

After some attempted modelling and then reverting to much experimentation, I found a workable solution for 435MHz that should be reproduceable without too much frustration.

These instructions are for a '45% sleeve' compact / portable antenna centred on 435MHz

The usable frequency range is better than 420-450MHz with an acceptable SWR

The length of the sections **can** be adjusted pro-rata to move the centre frequency by 20 MHz or so; beyond that additional experimentation with pipe diameters will also be needed.

Construction

To assist with reproduction, I will be quite detailed about parts and techniques.
The UK plumbing pipe may be a problem for overseas readers but hopefully the right size can be found or produced from rolled copper sheet!

Parts

BNC plug	Amphenol 31-320 RFX & suitable crimping tool (or any RG58 BNC or N plug)
RG58 C/U, 2 -5metres	e.g. Farnell 1219357 All wires tinned copper. 4.95mm PVC outer.
15mm copper pipe	15x0.7 mm (Toolstation 78209) Outside dia 15.0 mm, Inside dia 13.6 mm
Heat-shrink tube	Adhesive-lined, 5mm, 8 and 19mm initial diameters. 3 to 1 shrink ratio.
Wiring grommets	2 'For 10 mm hole' size grommets (O/D 13.7mm) for the pipe and cut end.
Clip on ferrite chokes	1x Fair-rite 0461164281 (Farnell 2113046) and 2x generic 8 mm (amazon etc)
Polypropylene Rope	Between 2.5 and 3 mm diameter to hang /support the antenna (waterproof)

Tools

Standard tools including a craft knife, wire cutters, Large 'mole grips' or vice , wooden packing etc.
Tough wireman scissors (or ones that you don't mind blunting)
90 – 100 watt soldering Iron, ideally temperature controlled. That little 25W one won't do it !
Solder with medium active flux resin (Or pre tin the tube end before soldering the braid on.)
Plumber's pipe cutter to leave a nicely rounded finished end (or a hacksaw and files)
Hot air gun, or small blowtorch
Hot melt glue stick / gun. **Superglue** (waterproof)
Electronic Antenna SWR or Network Analyser, calibrated and rated for UHF

Assembled Dimensions (for 435 MHz centre)

Pipe section cut to 134mm (the braid and soldering process will increase this to effectively 135mm)
Exposed coax centre . Cut to start trimming at 170mm, probably nearer to 160 mm once 'on-tune'

Coax I used 5metres but somewhere 2 – 5 metres is good.

Assembly

Cut The Pipe to 134mm size.
This does need to be done accurately; ideally within +/- 0.5mm.

I used a plumber's cutter which rounds the cut ends too.

Smooth any sharp edges and clear out any copper dust from inside

Fit the plug
I used RG58 coax (5m has 1.8dB loss so a lot more is not advisable) and a plug with a solderable centre and a crimped outer. Whatever you use, follow the manufacturer's instructions.

If you have a multi-meter, check the cable end to end now for continuity / no shorts then finish the plug off with suitable heat-shrink tubing.

Prepare the Coax.

Slide **2 grommets** and then **the pipe** over the coax. Then, using a sharp knife, cut a 'groove line' around the outer insulation **170mm from the end. Don't cut down to the braid** !
Then from that line, score an increasingly deep line back towards the end of the cable. It's ok to cut right down **to** the braid after the first 20mm of the line. Then 'unzip' and remove the outer PVC.
Next carefully 'balloon' the braid to separate, cut, and remove all but 15-20 mm of the braid leaving, hopefully, undamaged centre insulation.

Bring the pipe up to the level of the end of the black outer cable insulation and wrap the remaining braid over the edge of the pipe keeping it level with the start of the (now exposed) centre insulation

(Solder with 'No clean' flux may require pre-cleaning or tinning of the pipe end or adding more active flux e.g. ROM1 level - but if so remember to clean any excess off with a suitable safe solvent)

Arrange a way to keep the coax / pipe steady that will survive them being at 350°C ! (e.g. Wood packing in vice or mole-grip jaws)

Use the soldering iron to heat the very end lip of the pipe and once it is at temperature, start soldering the braid to the lip /side of the pipe

Once the outside is completely done, re-check the braid is flat on top of the pipe then solder and 'fill in' the braid strands around the centre insulation as much as practical to stop the feed point moving up and down due to pressure or tension in the coax or support cord! Again, try not to damage the centre insulation !

At the bottom end, push one grommet up into the middle of the pipe. Drip down superglue between the grommet and inner pipe. Then insert the second grommet into the bottom end and apply superglue to both the grommet/pipe and cable/grommet areas (don't block them completely at this stage). Leave it all to set.

Now fit the chokes into place. The Fair-Rite one goes next to the pipe end, followed by two of the Generic Amazon /Chinese ones. Hold the lower one in place with packing or tape as required.

Cut enough 19mm Heatshrink tube to cover the pipe bottom and extend 5- 10 mm at the top.
Cut enough 5mm heatshrink tube to fully cover the exposed coax-centre insulation.
Put the tubing loosely over the elements as it affects tuning - Don't heat it yet !

Ensure the antenna is away from any large, solid or metal objects, (hanging from suspended string can help). Ensure the heat-shrink remains in place when measuring during 'trimming to tune'.

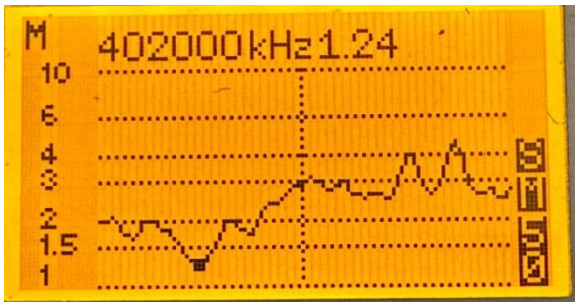
Take it very slowly; Cutting just 1mm off the Centre insulation/conductor part can change the tuned frequency by several MHz !

n.b. You can cover the chokes with tape or heatshrink if required and/or install the whole thing in a piece of plastic pipe. **(If so, the pipe should be in place before final frequency checks/trims)**

Trimming to frequency

Using a calibrated Antenna SWR /VNA analyser, see where the (currently too long) antenna is tuned

Here using my FA-VA5 Analyser the curve initially looks bad, with too low a frequency at the SWR Dip (measured as 402MHz in the pic below – but the 1.24 SWR there already looks promising).

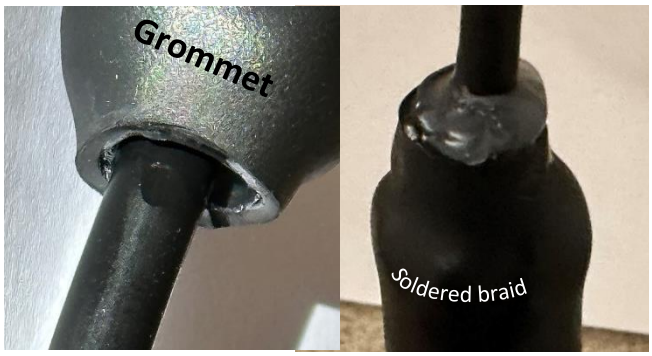


Trim 0.5 to 1mm off the coax centre length each time before replacing heatshrink and re-measuring

You should approach the 435MHz frequency with a good match (<1.3:1) as you trim.
(If you cut too far, firmly solder some new coax centre to the end of the existing, and try again)

When it looks close (perhaps somewhere about 160-165 mm of centre conductor left ?) and **If** you are quite sure the antenna is in 'free space' (or where it will be installed), with chokes on and the heat-shrink loosely fitted around the elements etc. you can now trim to a 435MHz 'dip'.
(You might wish to try out a few other locations to see/learn how the SWR varies before proceeding)

Next, temporarily remove the chokes and shrink the inner conductor heat-shrink onto the centre conductor insulation. Next, cut / shrink the large heatshrink into place on the pipe so as to wrap around the grommet at the base and leave 10mm above the soldered braid at the top.

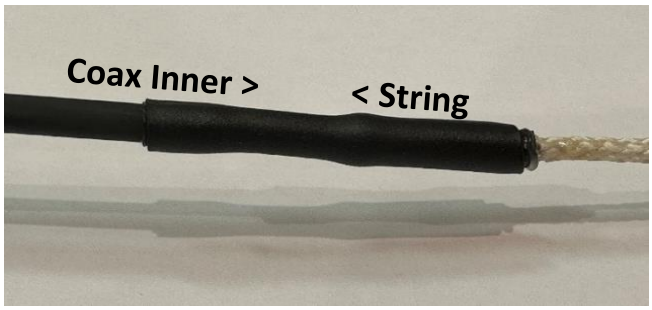


Insert hot melt glue into the upper opening with glue gun and/or re melt with the heat gun.

At his stage finalise all parts of the top and sleeve element to avoid further centre frequency changes

RE-FIT THE CHOKES
Re-check the tuning.

It has probably gone down in frequency a little (1 – 2 MHz)?
If so, cut the 'heat-shrink and inner insulation/conductor' section down another fraction to reach your tune point again and then go a fraction (0.5 to 1.5 MHz) beyond.

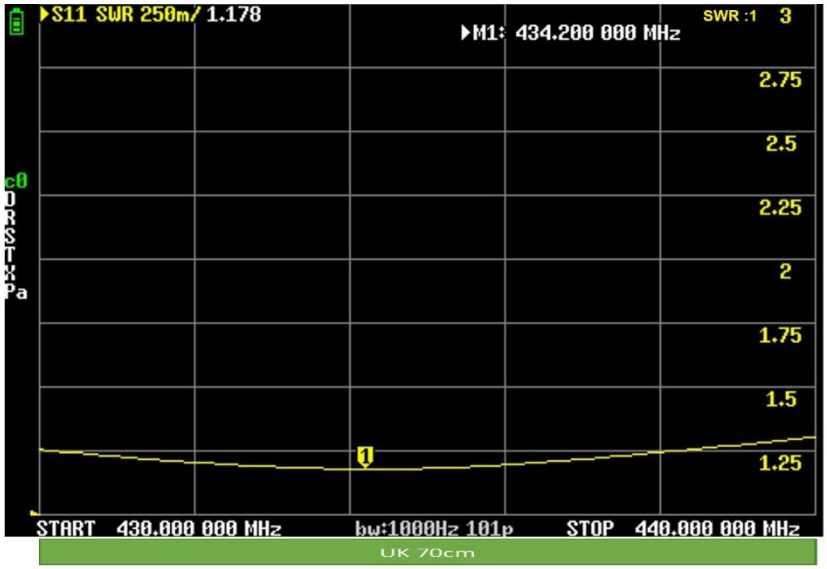


Burn the ends of the Polypropylene 'support string' a little to make a mushroom shape then apply another piece of adhesive lined heatshrink, long enough to overlap the inner conductor by 5 or 10 mm and the rope by 20mm with a 5mm gap between the end of the inner conductor and the rope. (If one layer feels too flimsy add another on top)
The centre frequency will likely drop another bit after doing this; hopefully right onto target.

If the ferrites move down the cable over time this too could change the tuning slightly, so I now added some hot melt glue inside the grooves of the last clip-on before quickly closing it on the cable.

A 'final trimmed' antenna's SWR sweep on my other VNA (always get a second opinion !)

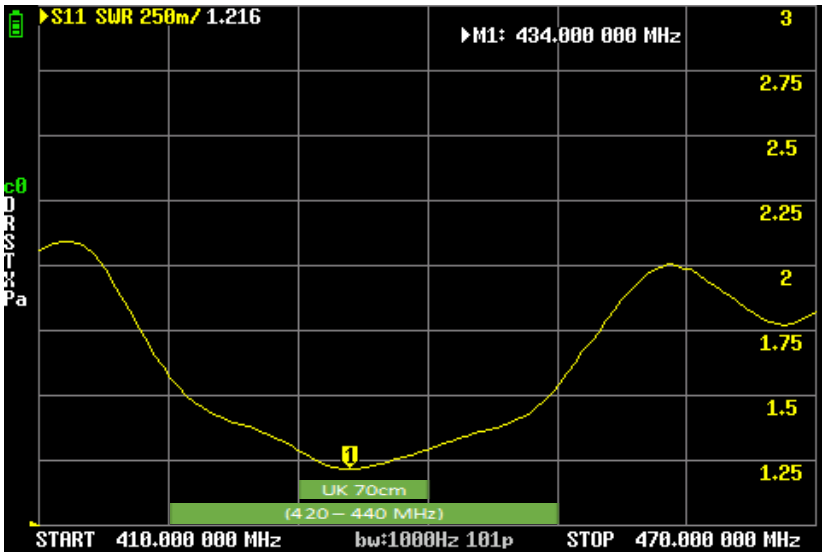
NanoVNA H4: 430 – 440MHz sweep, SWR :1 on the right hand vertical axis



SWR at Marker (434.2) 1.2 :1 (45 +j7) **(**Confirmed with the FA-VA5)

So with 5m of RG58 the final trim delivered a < 1.3 :1 match across the band at the BNC plug, (so <1.5 at the antenna) a great radiation pattern, low visual impact and estimated power handling of 200 W (RG58 limited).

NanoVNA H4: 410 to 470 MHz sweep. SWR :1 on right hand vertical axis.
SWR at Marker (434.2) 1.2 :1



Over the 420 – 440 band it's <1.6:1 at the BNC (so <2:1 at the antenna).

For practical purposes with 5m of RG58 cable the <**2:1 SWR points span (415 -458 MHz or more) i.e. 43MHz+ wide** (10%) as measured at the BNC connector.

With this design, sleeve and chokes, the coax outer is now well matched and isolated from the antenna feed-point and there are no signs of significant common mode current or coax length fussiness. Different locations /nearby objects will of course affect the SWR level and curve but only rarely took it over 1.5 : 1 between 430 and 440MHz

It works equally well suspended upside down by the coax if that is more convenient.
Just hung off a bedroom door frame it almost matched the range/ receive performance of a loft mounted 5.5dBi antenna that was using much lower loss coax! Results compared to a rubber-duck handheld helical were significantly (5 – 10dB ?) better.

73's and Enjoy !