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QST Issue: May 2011
Title: A Folded Skeleton Sleeve Dipole for 40 and 20 Meters
Author: Joel R. Hallas, W1ZR

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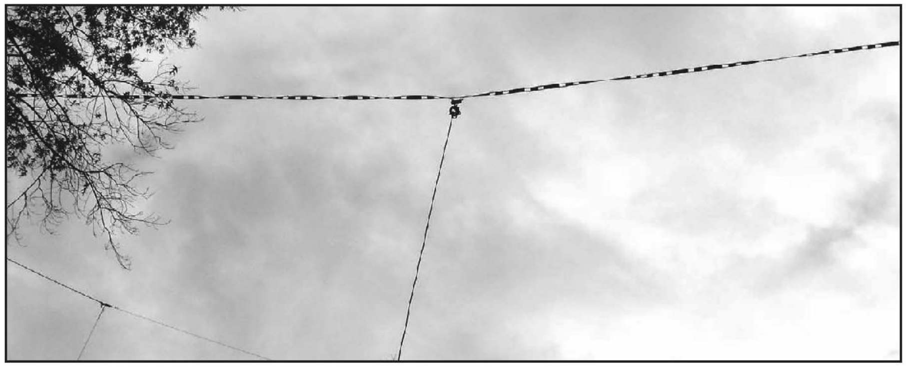
W1ZR

A Folded Skeleton Sleeve Dipole for 40 and 20 Meters

This design features a matched coax fed antenna with performance similar to a full size dipole on two bands, 40 and 20 meters. The mechanical and electrical design is such that it can be fabricated from a single piece of nominal 450 Ω window line. It offers a wider bandwidth and improved performance on the higher band, compared to the more commonly encountered parallel-fed dipoles made of window line.



The Design Concept

There have been many approaches to multiband operation — traps, parallel dipoles and others. This antenna is somewhat different in two regards:

- It uses the parasitic *skeleton sleeve* coupling from a single driven 40 meter dipole to a single higher frequency element to provide the second band — rather than the more common parallel connection.
- The ends of the lower frequency dipole are bent back to almost reach the higher frequency one. This results in an antenna about 10 feet shorter than the usual 40 meter dipole. This is independent of the sleeve coupling method.

The first change eliminates the narrow bandwidth usually encountered in closely spaced parallel wired dipoles. The close spacing employed allows the whole antenna to be constructed from a single piece of nominal 450 Ω window line. Additional structural integrity is provided because the 20 meter section is continuous across the center feed point, as shown in Figure 1.

Construction

Any of the usual antenna construction techniques can be used. To provide strength at the ends and the connection point, I suggest the use of standard antenna insulators or other mechanically sturdy fixtures. For my prototype, as shown in the lead photo, I just tied the halyards through "windows" near the ends and it has held up so far — but for long term use, I'd do something better. The connection of the coax to the driven dipole should be reinforced so that the hanging coax is not supported by the connections. The open end of the coax must be sealed so that water can not penetrate into the cable structure.

While good practice and to insure accurate SWR readings, but not essential in some installations, I formed a common mode choke by temporarily wrapping eight turns of the coax feed line through an FT-240-43 ferrite toroid. A better approach, particularly if foam coax is used, would be to use five 43 mix ferrite beads, with inner diameter selected to fit snugly on your coax just below the feed point.

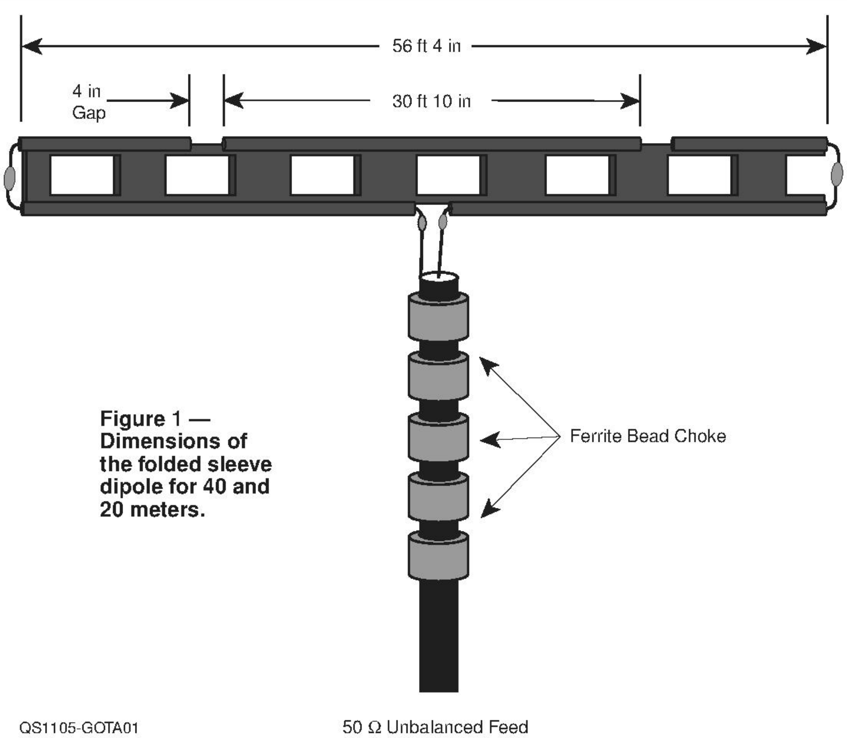


Figure 1 — Dimensions of the folded sleeve dipole for 40 and 20 meters.

Joel R. Hallas, W1ZR ♦ *QST* Technical Editor ♦ jhallas@arrl.org

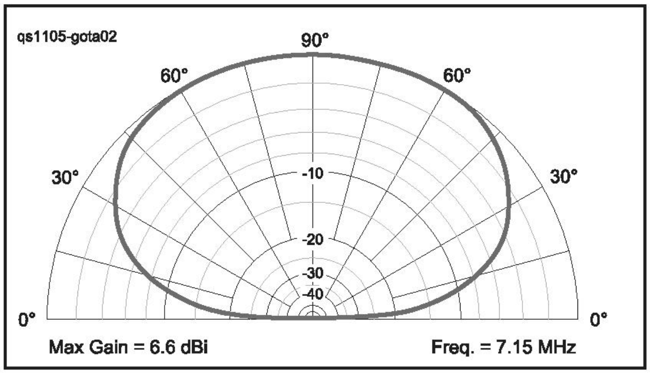


Figure 2 — *EZNEC* predicted elevation pattern of two-band dipole on 40 meters at a height of 30 feet.

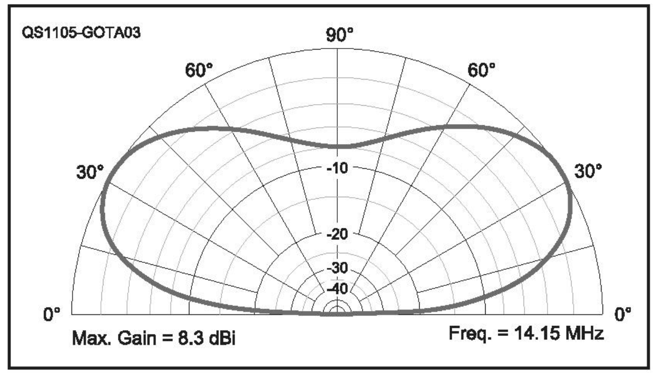


Figure 3 — *EZNEC* predicted elevation pattern of two-band dipole on 20 meters at a height of 30 feet.

They could be secured with shrink tubing or PVC pipe, if desired. A *QST* author described the use of five Palomar FB 56-43 beads over RG-58C coax. His measured results should prove satisfactory here.[1,2]

This design should be adaptable to any of the various parallel window lines. The line I used was marked "JSC WIRE & CABLE #1317 18 AWG 19 STRAND MADE IN USA."[3] The conductors were stranded copper plated steel — a good choice for both flexibility and strength. If a different type of cable is selected, I would expect that differences in wire dimensions and dielectric properties would necessitate some changes in the lengths shown in order to achieve resonance on each band.

One assembly caution should be noted. It is critical that the coax feed line be connected to the longer 40 meter wire. There is a mode in which it can be made to work the other way, feeding the shorter dipole instead. The dimensions will be different, however, and the system will not match 50 Ω.

I performed some sensitivity analysis using *EZNEC,* in case your antenna needs trimming to make it resonant within the band or desired segment. The good news is that unlike the case with close spaced parallel dipoles, there is almost no interaction between the bands. Changing the overall length of the antenna by 1 inch moves the 40 meter resonance about 130 kHz — keep in mind that, because it is folded on 40, it changes more rapidly than might be expected. The same adjustment in overall length makes a change to the 20 meter resonance by only about 10 kHz. Changing the length of the 20 meter dipole by 1 inch (by making a change to the inner edge of the 4 inch gap) results in a change of about 50 kHz with virtually no change to the 40 meter resonance — so start with the 40 meter adjustment, if needed. As expected, making either portion shorter results in a higher resonant frequency.

Performance

This antenna provides gain and directivity comparable to a full size dipole on both 40 and 20 meters. See Figures 2 and 3 for the *EZNEC* elevation patterns.[4] Note that on 20 meters, *EZNEC* predicts about a 1.5 dB gain over a half-wave dipole, as a result of narrowing the main beams by 4-5°. This is likely the effect of radiation from each side of the 40 meter antenna acting as 20 meter half waves in phase — a small bonus at no extra cost.

At its design height of 30 feet, the SWR across both bands is 2:1 or less to 50 Ω coax as shown in Figures 4 and 5. There is a small variation in resonance predicted at heights from 20 through 50 feet. At the end of 100 feet of RG-8X coax, however, it is still within a 2:1 SWR across both bands at any height within the range.

[1]L. Burke, W7JI, "An Easy to Build 500 W Mini Balun," *QST*, Mar 2009, p 74.

[2]Available from Palomar Engineers, PO Box 462222, Escondido, CA 92046, tel 760-747-3343, part number FB 56-43.

[3]Mine came from Davis RF, their part number LL450-553. See **www.davisrf.com/ladder.php**.

[4]Several versions of *EZNEC* antenna modeling software are available from developer Roy Lewallen, W7EL, at **www.eznec.com**.

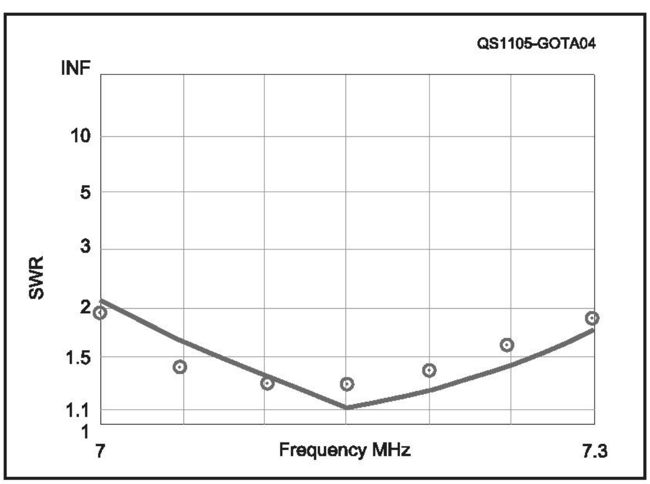


Figure 4 — *EZNEC* predicted SWR sweep of the two-band dipole on 40 meters. The Os indicate measured SWR at the end of 45 feet of RG-8X with a height of 25 feet.

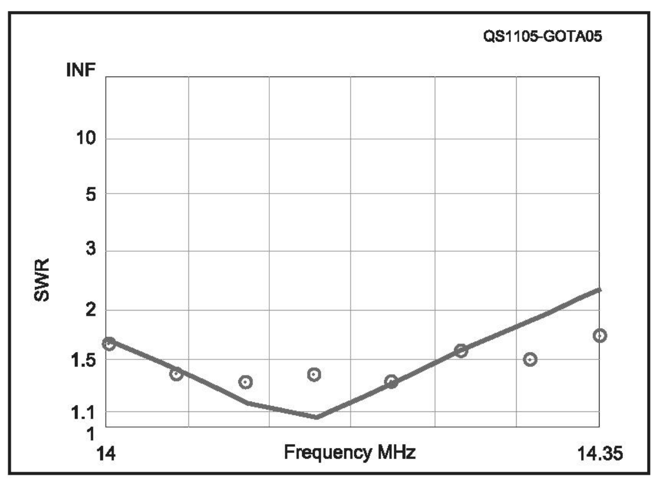


Figure 5 — *EZNEC* predicted SWR sweep of the two-band dipole on 20 meters. The Os indicate measured SWR at the end of 45 feet of RG-8X with a height of 25 feet.

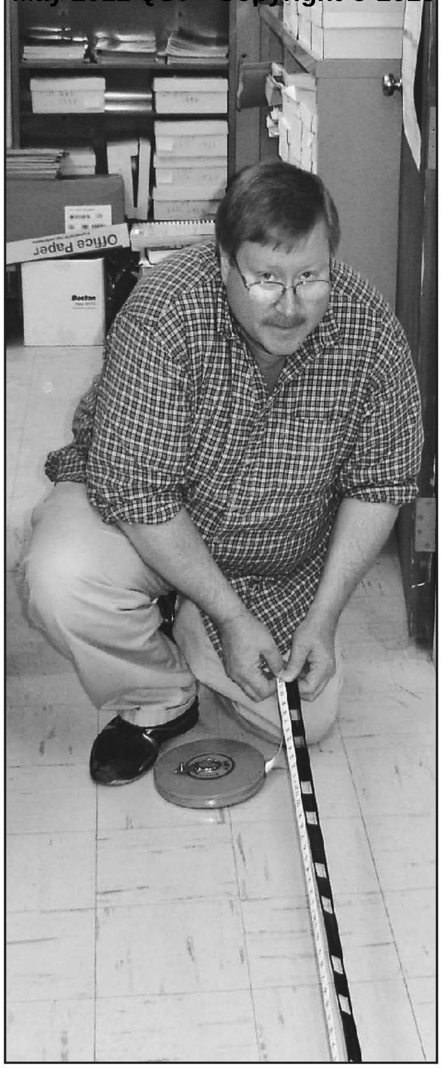


Figure 6 — ARRL Test Engineer Bob Allison, WB1GCM, measuring twice and cutting once to make his own folded skeleton sleeve.

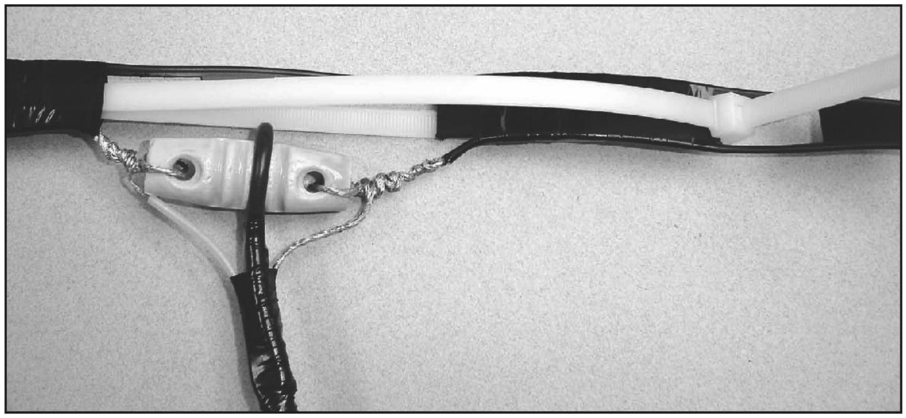


Figure 7 — Center insulator and common mode choke as built by ARRL Test Engineer Bob Allison, WB1GCM. Bob wrapped the RG-58 coax around the center insulator and taped it to provide strain relief and seal the end. The tape also holds the fertrite beads prior to application of heat shrink tubing.

On the Air

I used the antenna to make multiple contacts on each band with good results compared to my other antennas. With the antenna just below my second story roofline, I was surprised to find that my first contact on 20 meters in a late afternoon was from Connecticut to Australia with 100 W on 20 meter CW. The station was stronger on this dipole than on a one element rotary about 10 feet higher, in the clear and pointed at VK. On 40 meters, stations were just a bit lower in level than on my 100 foot center fed dipole fed with window line. This was expected since my 100 foot dipole is about twice as high, and it also provides some gain over a full size half wave dipole on 40.

ARRL Test Engineer Bob Allison, WB1GCM, tried the antenna from his house, just to keep me honest. He found that it was more effective on 40 than his inverted L, with much less noise pickup. It was also quieter on 20 meters, with similar signal levels from most directions compared to his ground plane at the same height. His first contact on 20 meter SSB was with Perth, Australia — not sure if VK contacts can be guaranteed, but it certainly seems to work well! Bob has made one of his own. See Figures 6 and 7.

Other Sleeve Dipole Possibilities

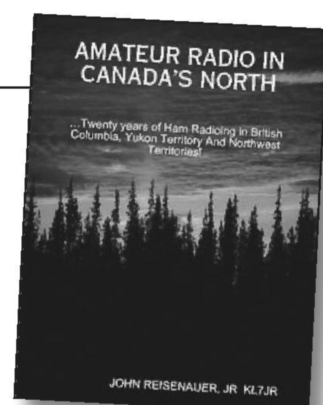
I have not made the antenna for any other bands, but I have tried some other band combinations successfully on *EZNEC*. There is nothing magic about the 2:1 frequency relationship. For example, a model for 20 and 17 meters seems to work fine, although the extra bit of gain on the higher band is not predicted for this case.

The folding of the lower band dipole is not fundamental to the design, and it will provide just a bit better performance on the lower band if it is unfolded and made full size. My objective was to have a *compact* two band antenna, hence the folded design, although it also makes nice use of the length of window line and avoids a pair of mid span connections.

If the full size dipole is used for 40 meters, it opens the possibility to also use it on 15 meters. Unfortunately, as with any 40 meter dipole, a single length doesn't provide a good match across both bands. If it is trimmed for 3/2 wavelength resonance at the top of 15 meters, it will also provide a reasonable match at the low end of 40. The SWR will be in the 3:1 range over a portion of both bands, so losses won't be very high with low loss coax. Both bands should be usable with most 3:1 range internal antenna tuners. QST

New Book

AMATEUR RADIO IN CANADA'S NORTH



◊*Amateur Radio in Canada's North* by *QST* author John Reisenauer Jr, KL7JR, chronicles 20 years of Amateur Radio adventuring in Canada's British Columbia, Yukon and Northwest Territories. *QST* readers have enjoyed occasional articles about KL7JR's exploits, and this book offers more detail about contesting, antenna homebrewing, mobile and portable operating including special event operations under the Northern Lights with all the challenges of Mother Nature in VE7, VY1 and VE8 (with some KL7 for spice)! Price: $10.75. Available from **www.lulu.com/product/paperback/amateur-radio-in-canadas-north/15055805**.