**MY BIFILAR COMMON MODE CHOKES**

 **WØLEV 25 Jan, 2021**

 **MATERIAL and CONSTRUCTION**

 **31 31(GRN) 31 43 (GRN) 73 43 (BRN) 31 31 43 31 31**

 **2x2.4” 2x2.4” 5x2.4” 2x2.4” 2x2.4” 2x3” 1x2.4” 2x2.4” 2x3.0” 2x4.0” 2x2.4”**

 **15t 13t 14 t 13t 13t 10 t 12 t 18t 10t 22t 12t**

 **#14strd #14strd #14strd #12 strd #14 strd #10 strd #14 sstrd #12 solid #12 solid #12 solid #12 solid**

 **Spaced Spaced**

 **Windings Windings**

**BAND DM LOSS (dB) / CM Res (Ω)**

**160 -0.07 dB -0.06 dB -0.12 dB -0.06 dB -0.07 dB -0.07 dB -0.03dB -0.04 dB -0.05 dB -0.08 dB -0.03 dB**

 **13.5 k 6.10 k 9.7k 1.5 k 7.0k 2.6 k 3.0k 15.0k 2.2 k 6.0 k 8.2 k**

**75 -0.14 dB -0.12 dB -0.2 dB -0.13 dB -0.15 dB -0.16 dB -0.07 dB -0.05 dB -0.09 dB -0.12 dB -0.06 dB**

 **7.45 k 7.5 k 4.3 k 3.8 k 11.6 k 4.7 k 4.2 k 6.7 k 4.2 k 3.1 k 7.4 k**

**40 -0.38 dB -0.36 dB -0.6 dB -0.37 dB -0.43 dB -0.48 dB -0.15 dB -0.11 dB -0.26 dB -0.25 dB -0.17 dB**

 **3.98 k 4.60 k 2.4 k 11.1 k 5.2 k 7.1 k 4.5 k 4.1 k 7.6 k 1.7 k 4.5 k**

**30 -1.0 dB -0.98 dB -1.2 dB -1.0 dB -1.0dB -1.3 dB -0.57 dB -0.29 dB -0.76 dB -0.50 dB -0.58 dB**

 **3.00 k 4.30 k 1.8 k 13.4 k 3.7 k 5.1 k 4.4 k 3.5 k 8.0 k 1.8 k 3.6 k**

**20 -1.5 dB -1.5 dB -1.6 dB -1.4 dB -1.5 dB -1.8 dB -1.0 dB -0.33 dB -1.1 dB -0.49 dB -0.85 dB**

 **2.30 k 3.7 k 1.4 k 8.1k 2.7 k 3.4 k 4.1 k 2.9k 7.9 k 1.1 k 2.8k**

**17 -1.9 dB -2.1dB -1.7 dB -2.1 dB -1.9 dB -2.4 dB -1.4 dB -0.36 dB -1.5 dB -0.51 dB -1.1 dB**

 **1.9 k 4.3 k 1.2 k 5.7 l 2.2 k 2.7 k 3.8 k 2.7 k 7.1 k 980 2.4 k**

**15 -2.2 dB -2.4 dB -1.4 dB -2.5 dB -2.1 dB -2.8 dB -1.8 dB -0.32 dB -1.7 dB -0.79 dB -1.3 dB**

 **1.70 k 3.3 k 1.1 k 3.2 k 2.0 k 2.3 k 3.5 k 2.6 k 4.8 k 856 2.2 k**

**10 -2.1 dB -2.7 dB -0.64 dB -2.8 dB -1.8 dB -2.9 dB -2.5 dB -0.57 dB -1.6 dB -2.6 dB -1.2 dB**

 **1.31 k 1.3 k 845 3.4 k 1.6 k 1.4 k 3.0 k 1.9 k 1.3 k 1.0 k 1.5 k**

**50 -1.5 dB -0.9 dB -3.4 dB -0.18 dB -2.3 dB -0.81 dB -2.5 dB -1.0 dB @ 31.4 M -1.33 dB -1.8 dB**

 **538 792 322 796 605 495 954 -2.0 dB @ 35.2 MHz 487 Ω 685 Ω**

 **-3 .0 dB @ 38.3 MHz**

 **635 Ω**

 **NOTE 1 NOTE 2 NOTE 3 NOTE 4 NOTE 5 NOTE 6 NOTE 7 NOTE 8 NOTE 9**

**NOTES: Frequencies of measured data: 1.90, 3.75, 7.15, 10.10, 14.20, 18.10, 21.30, 28.40 MHz**

 **The following address amplitude equality and phasing (should be 180-degrees out of phase) on DM side of the CMCs:**

1. **Phase skew of on DM side ≤ 20-degrees ≥ 21 MHz**
2. **Extremely minor phase skew on 1.9 MHz only**
3. **Amplitude unbalance and extremely bad phase skew on 1.9 MHz**
4. **Roughly 20-degree phase skew on 1.9 and 3.75 MHz**
5. **Very minor phase skew on 1.9 MHz only**
6. **Excellent in all respects 1.9 through 30 MHz**
7. **Major phase skew on 1.9 MHz, somewhat less on 3.75 MHz**
8. **Very slight phase skew only on 14.2 MHz – Very slight**
9. **Excellent in all respects 1.9 through 30 MHz**

**POINTER:**

 **It’s recommended that the CM impedance of the choke be at least 10X the presented measured complex impedance of the**

 **feedline in the shack at the point where it enters either the transceiver or the matching network (a.k.a.: antenna “tuner”).**

**Lessons Learned:**

1. **Lowest DM loss with tight bifilar pair windings. No spacing between each member of each bifilar wind. Keep it clean even if you have to go back with nylon ties to snug things up.**
2. **31 material is definitely better than 43 materia for HF coverage with a single CMC choke.**
3. **It is difficult to cover 160 through 30 MHz with a single CMC. Consider at least two chokes to properly cover all of HF.**
4. **The adage (conventional knowledge or whatever) of spacing bifilar pairs is not born out in my construction and measurements. This is supposed to reduce distributed capacitance between bifilar pairs. My best results were with crammed together bifilar windings, except for the 4” core where they were spaced about one pair apart.**
5. **If you desire coverage from 7 MHz upward, 43 material is a good choice.**
6. **If you desire coverage from 7 MHz downward, 31 material is a good choice.**
7. **However, a good single CMC can be made using 31 material with the slight compromise of lower DM impedance.**
8. **Solid conductor, even though harder to wind, is preferred to stranded conductor (possibly due to the lower Z of the transmission line once on the core due to closer spacing of the bifilar pairs – no ‘thick’ insulation as with stranded conductor)**

**FINAL THOUGHT: I have finally zeroed in on my choices of a CMC for my system addressing measured complex impedance of in-the-shack side of my 450-foot doublet fed with parallel wire transmission line. Those noted with 3, 6, and 8 are my all-around choices for my specific application.**

**I hope this will help others in digging into CMC construction, measurement, and choice of a ferrite material for HF.**

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**Example of winding technique:**

**#14 strd: DavisRF #14 Stranded ‘antenna” wire**

**GRN: #14 stranded, green insulation unknown insulation composition**

**All measurements are made in a calibrated 50-ohm system using the HP 8753C.**

**All cals were done with HP provided cal standards**