Shield current chokes: some measurements

Eric Scace K3NA

Contents

Executive summary

Purpose:

Examine impedance vs. frequency for three styles of shield current chokes:

- Spiral-wound on toroids (Amidon FT-240-77 = FairRite 5978003801).
- Circle-wound through toroids.
- Circle-wound through clip-on ferrite (Amidon 2x31-3551P2).

RG-142 50 Ω coax used: 0.195 OD, min bend radius 1.0 in, max at 30 MHz.

Results:

1. For a given amount of ferrite toroids, a spiral-wound shield current choke provides much higher rejection than a circle-wound choke.
2. Even the circle-wound choke with clip-on ferrite did not approach the spiral-wound choke.
3. Sprial-wound chokes of minimum bending radius, using 2 stacked toroids, provides higher rejection <30 MHz than a larger bending radius choke on 3 stacked toroids.

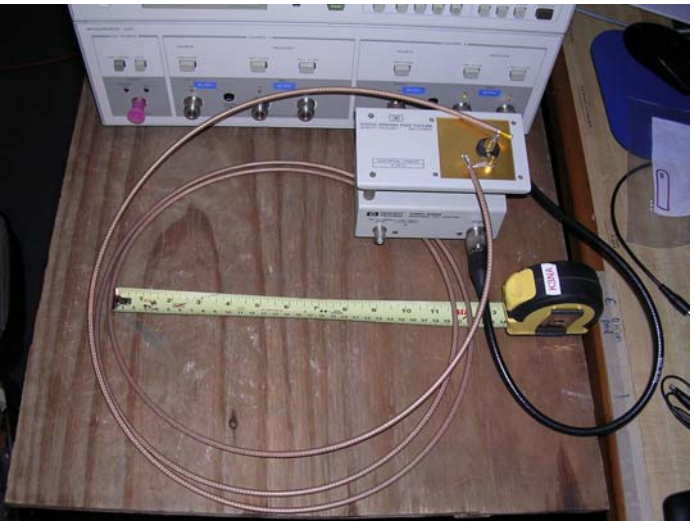
Further thoughts:

- For receive-level signals, 12-15 passes of smaller-diameter coax spiral-wound on toroids of equivalent A_L seem likely to provide at least 1000 Ω $|\mathbf{Z}|$ across the LF/HF spectrum.
- For 1.5 kW transmit level signals:
  - Some suggest RG-142 may be slightly marginal.
    - Other cables of equivalent diameter with better loss and power handling characteristics are available: e.g., Semflex Corp SW150 (0.153in OD, 0.9 in bend radius) or HP106s or RG+142.
    - In short lengths needed for choke, increased per-foot cable costs seem acceptable.
  - No tests were done for heat tolerance at transmit power levels.
    - A threshold for reasonable shield current power absorption has not been established.
  - Larger toroid size may be useful for cables with larger bending radius.
    - Higher A_L permits fewer passes; e.g., FairRite 5978011101 2.9 in OD, 1.53 in ID: A_L19% higher.

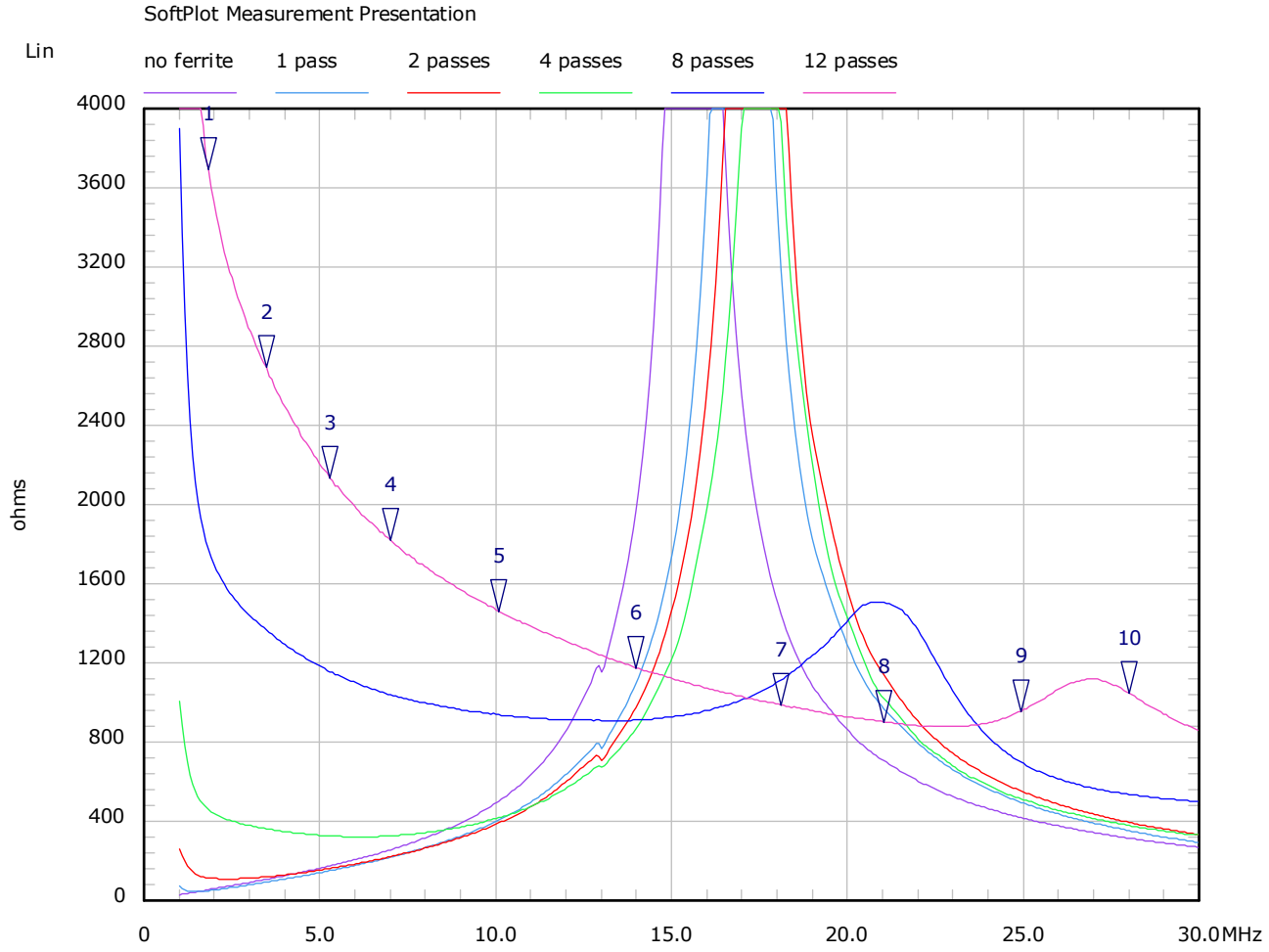
Spiral wound toroid

- Max capacity for this size toroid: 12 passes.
- Test a stack of two toroids (1 in deep) and three toroids (1.5 in deep).
- "No ferrite" case shows natural self-resonance of the coil of RG-142 used to make the toroid; see below.
- At 8 passes, the coil of surplus RG-142 past the choke begins to disappear from the view of the generator.
- 12 passes provides >900 Ω impedance on all bands.
- Real component of **Z** dominates across MF/HF spectrum.

(Use PageUp/PageDown to flip between adjacent slides to see trends.)

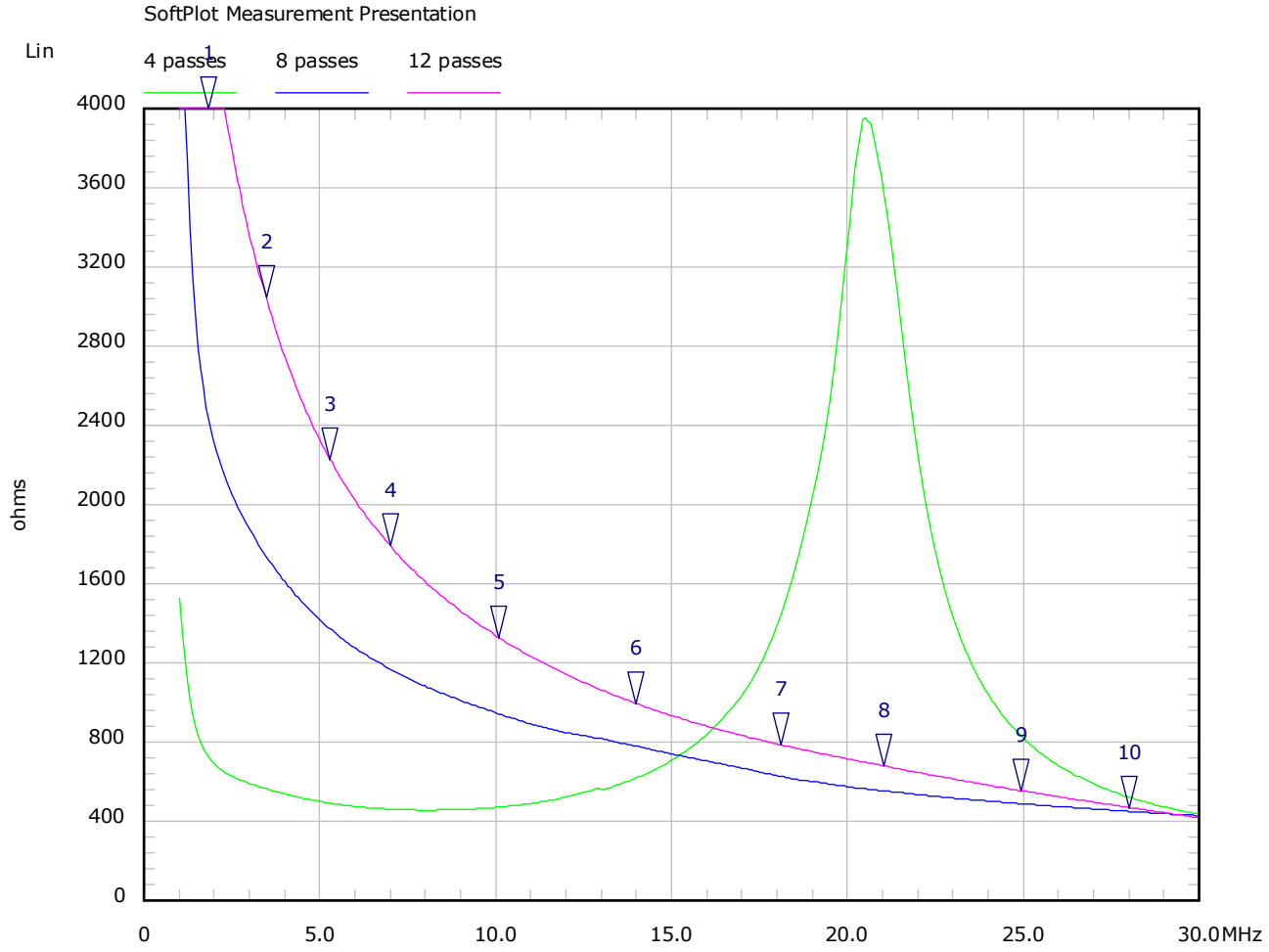


Spiral wound toroid: |**Z**|
RG-142 on two Amidon FT-240-77 cores



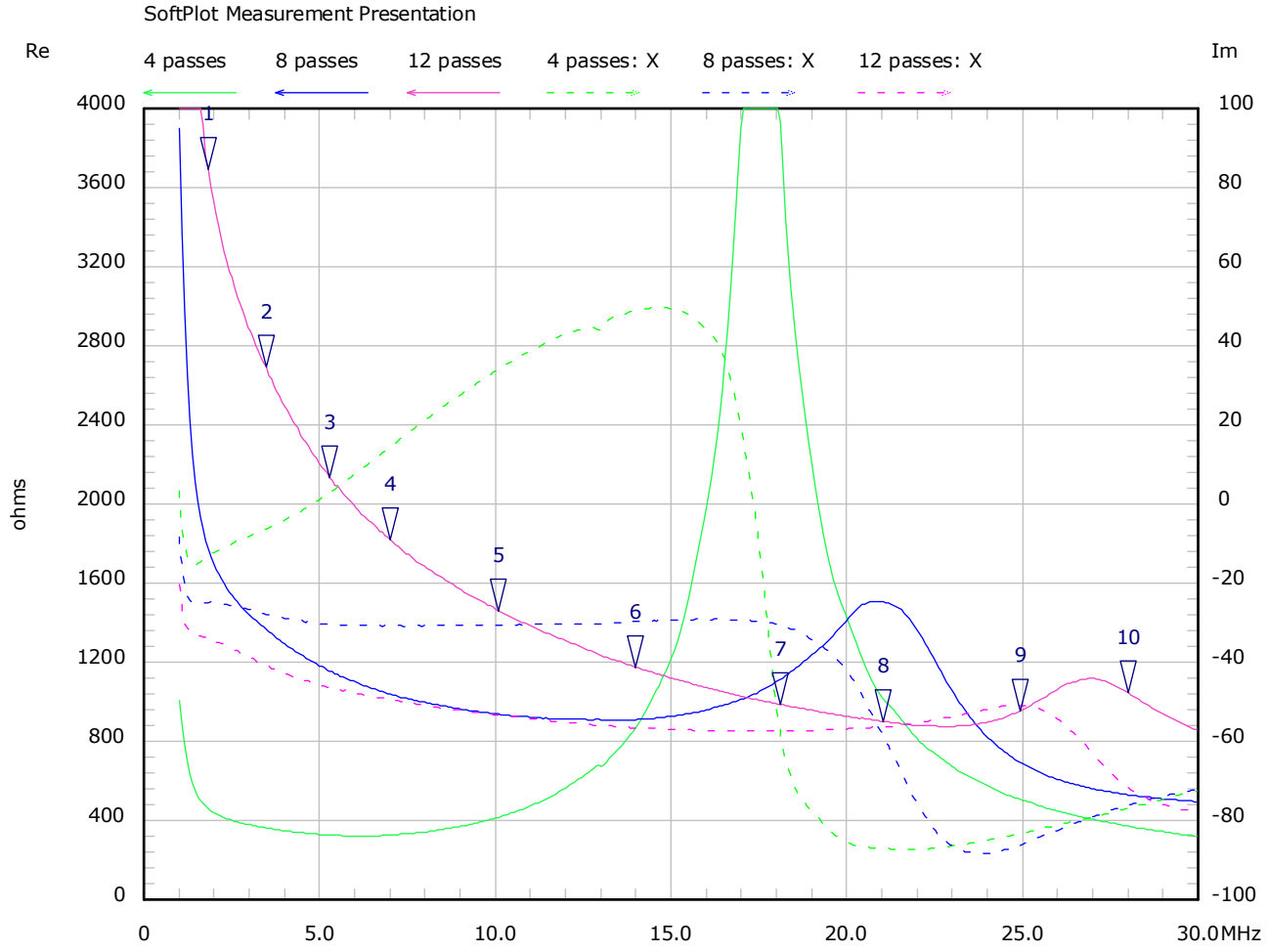
Mkr	Trace	X-Axis	Value
1	12 passes	1.8 MHz	3.69 kLin
2	12 passes	3.5 MHz	2.70 kLin
3	12 passes	5.3 MHz	2.13 kLin
4	12 passes	7.0 MHz	1.82 kLin
5	12 passes	10.1 MHz	1.46 kLin
6	12 passes	14.0 MHz	1.18 kLin
7	12 passes	18.1 MHz	988.24 Lin
8	12 passes	21.0 MHz	902.77 Lin
9	12 passes	24.9 MHz	956.54 Lin
10	12 passes	28.0 MHz	1.05 kLin

Spiral wound toroid: |**Z**|
RG-142 on three Amidon FT-240-77 cores



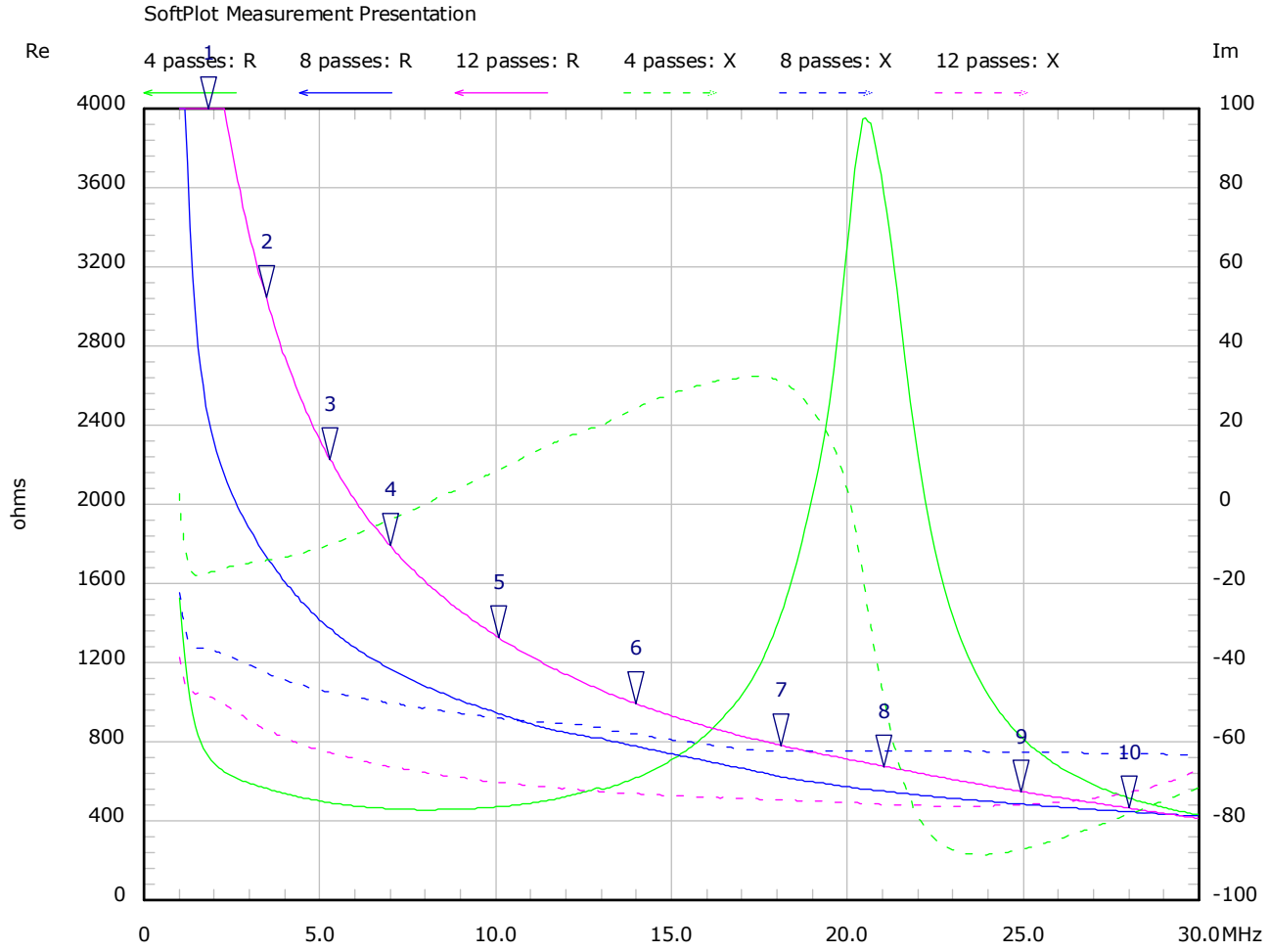
Mkr	Trace	X-Axis	Value
1	12 passes	1.8 MHz	4.61 kLin
2	12 passes	3.5 MHz	3.04 kLin
3	12 passes	5.3 MHz	2.23 kLin
4	12 passes	7.0 MHz	1.79 kLin
5	12 passes	10.1 MHz	1.33 kLin
6	12 passes	14.0 MHz	995.31 Lin
7	12 passes	18.1 MHz	785.86 Lin
8	12 passes	21.0 MHz	680.01 Lin
9	12 passes	24.9 MHz	554.23 Lin
10	12 passes	28.0 MHz	469.63 Lin

Spiral wound toroid: R+X
RG-142 on two Amidon FT-240-77 cores



Mkr	Trace	X-Axis	Value
1	12 passes	1.8 MHz	3.69 kRe
2	12 passes	3.5 MHz	2.69 kRe
3	12 passes	5.3 MHz	2.13 kRe
4	12 passes	7.0 MHz	1.82 kRe
5	12 passes	10.1 MHz	1.46 kRe
6	12 passes	14.0 MHz	1.17 kRe
7	12 passes	18.1 MHz	986.58 Re
8	12 passes	21.0 MHz	901.01 Re
9	12 passes	24.9 MHz	955.18 Re
10	12 passes	28.0 MHz	1.04 kRe

Spiral wound toroid: R+X
RG-142 on three Amidon FT-240-77 cores



Mkr	Trace	X-Axis	Value
1	12 passes: R	1.8 MHz	4.61 kRe
2	12 passes: R	3.5 MHz	3.04 kRe
3	12 passes: R	5.3 MHz	2.23 kRe
4	12 passes: R	7.0 MHz	1.79 kRe
5	12 passes: R	10.1 MHz	1.33 kRe
6	12 passes: R	14.0 MHz	992.61 Re
7	12 passes: R	18.1 MHz	782.29 Re
8	12 passes: R	21.0 MHz	675.77 Re
9	12 passes: R	24.9 MHz	549.01 Re
10	12 passes: R	28.0 MHz	463.96 Re

Circle-wound shield current chokes

- Uses much more coax than spiral wound for equivalent performance.
- "No ferrite" case shows natural self-resonance of a different coil of RG-142 used to make the choke.
- Even at 8 turns, this configuration did not seem to be developing strong shield current choking impedance. More ferrite or more turns required; both raise costs.
- 8 turns through 3 snap-on ferrite beads also tried:
  - 8 turns maximum capacity.
  - 4 in diameter coil: smallest practical.
  - While somewhat larger Z at most frequencies, still not sufficient. A larger coil diameter with more snap-on beads would be required.*

* Tests on RG-213 suggest a coil that makes 64 passes through snapon beads (e.g., 4 turns through 16 beads) develops at least 1000 Ω. Passes add linearly.

Circle-wound shield current chokes