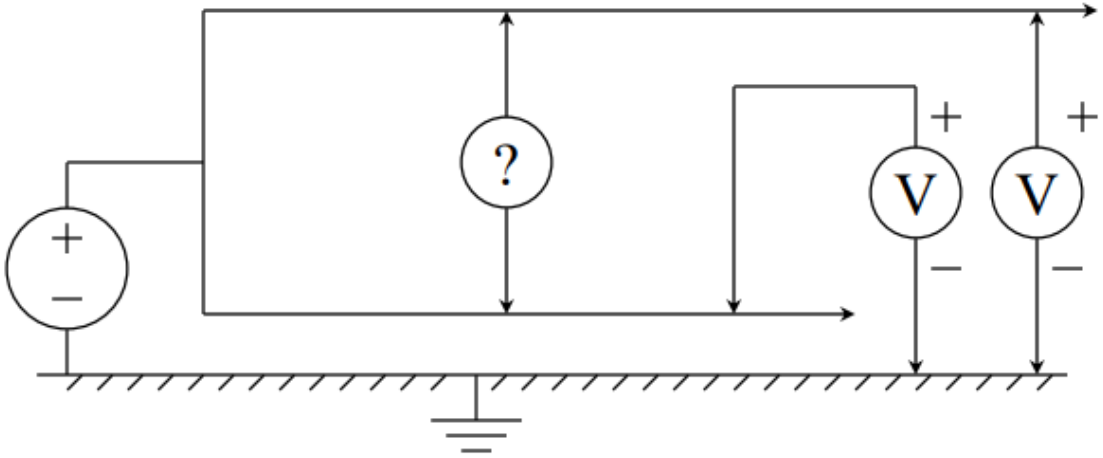
Overview of Specifying a Common Mode Choke For Improved Performance

MINNTRONIX
Wind Up the Best

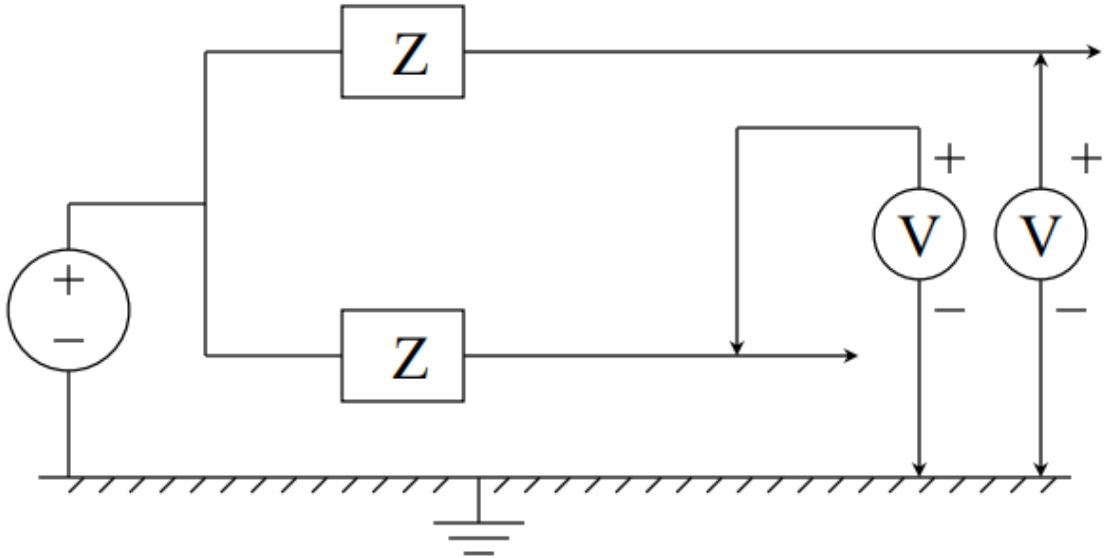
Common Mode Noise

Common-mode Signal: A signal which appears as a voltage on a pair of conductors having the same phase and polarity on each conductor with respect to ground.

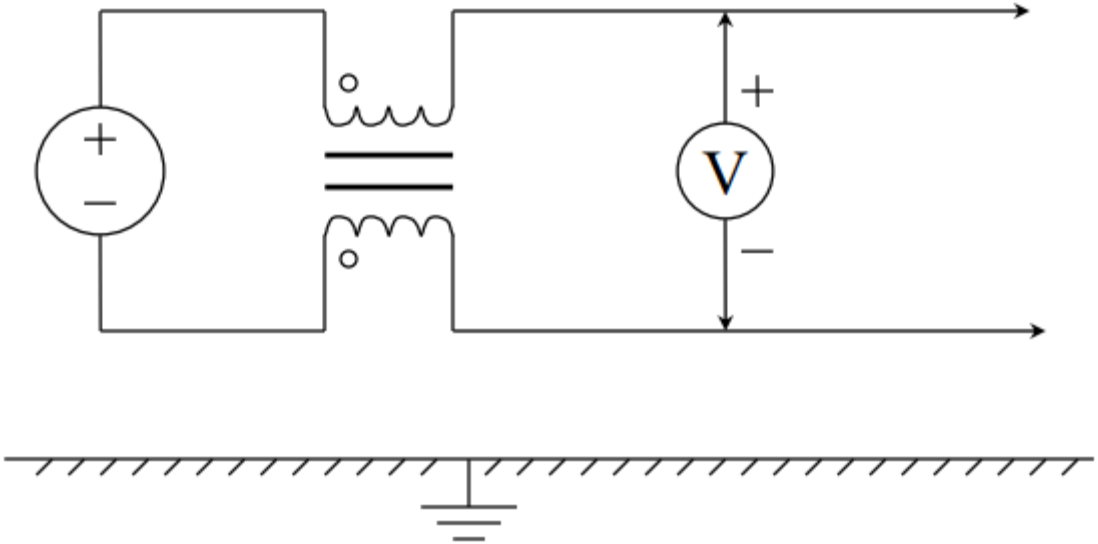


Common-Mode Choke

We need a special device: one that opposes common-mode signals:

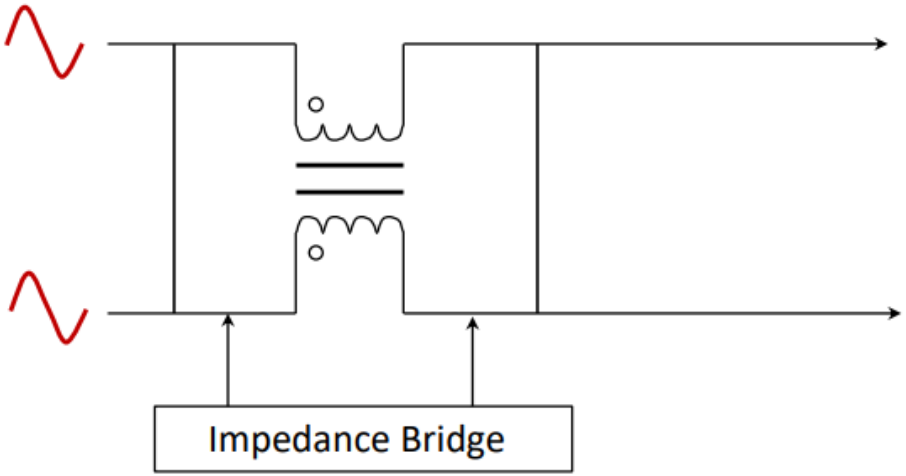


The Common Mode Choke is the Solution



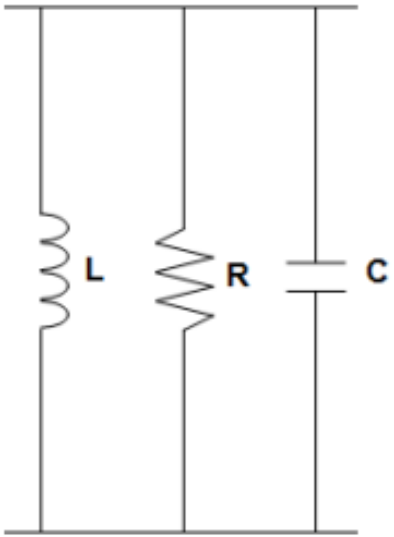
Testing Common Mode Chokes

Proper Testing of a common mode choke is done with all windings connected in parallel as shown below:

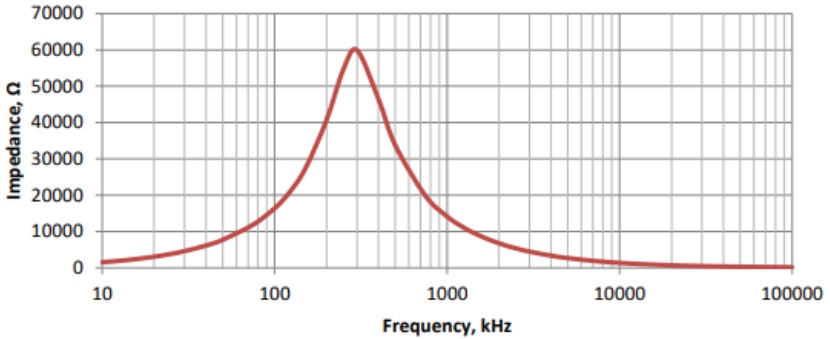


Common Mode Choke Equivalent Circuit

Here is the equivalent circuit for a ferrite common-mode choke (again with both windings in parallel).

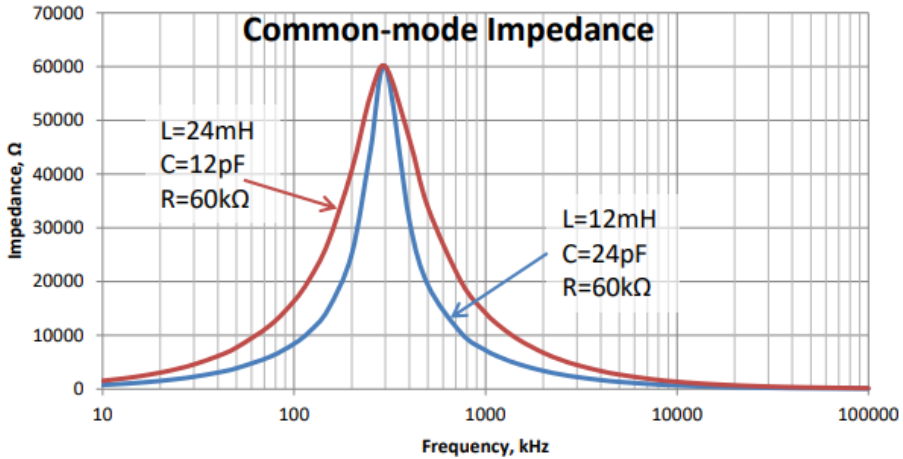


$$Z = \frac{1}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{j\omega L} - j\omega C\right)^2}}$$



Common Mode Choke Equivalent Circuit

The width of the impedance peak is a function of the ratio L/C. Here we see two CMC with the same resonant frequency, but one has twice the inductance and half the capacitance.



Common Mode Choke Performance

For best performance, we need to offset the capacitance that comes with high turn counts. Two ways to accomplish this are using multi-section bobbins or special winding technique called “sector winding”

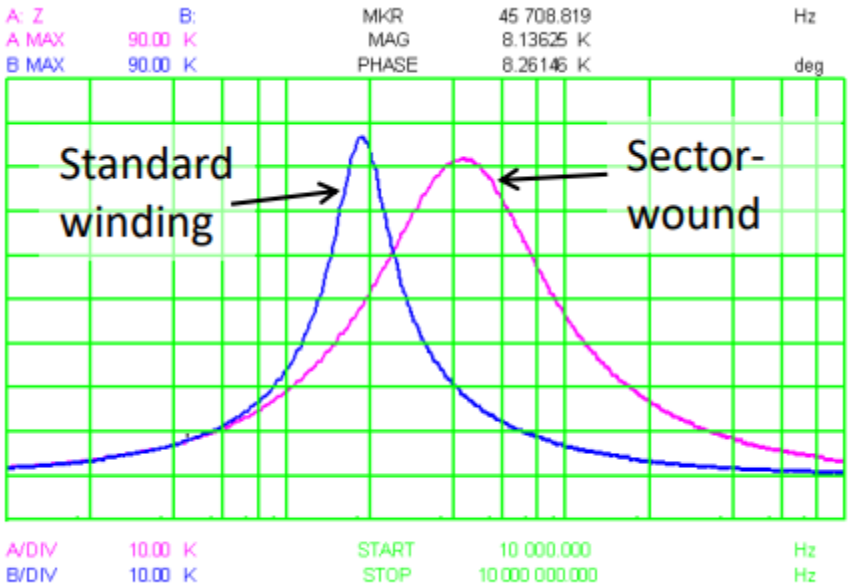
Two-section bobbin

Four-section bobbin

Standard winding

Sector-wound CMC

Common Mode Choke Performance



Common Mode Choke Performance

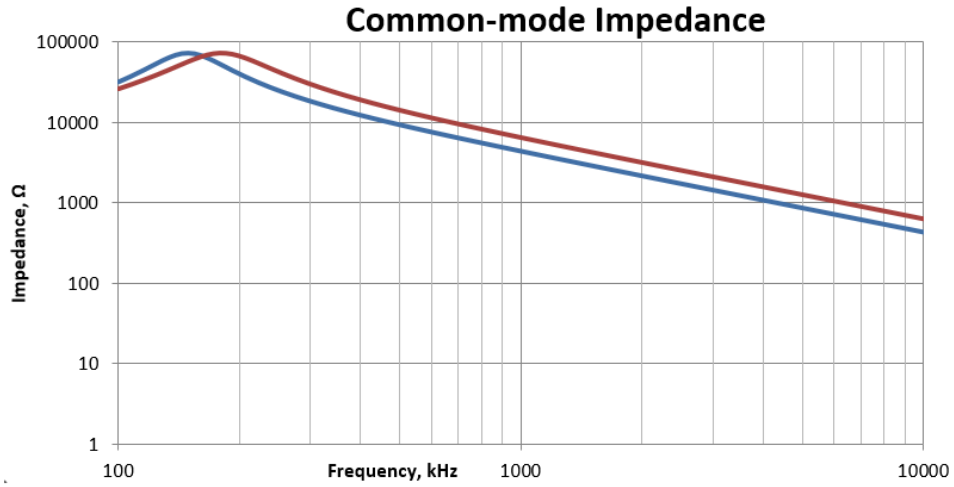
Using data from all the CMC a magnetics company has produced allows for dialing into a quick solution

L (mH	Rp (kohm	C (pf)	SRF (kHz)
0.761	4.69	6.47	2537.31
0.7124	2.42	10.75	2019.8
31.27	74.02	36.7	147.6
41.97	4.98	5.41	1054.6
3.48	31.76	27.82	514.01
10.82	15.54	3.7	945.7
1.53	3.55	19.6	881.27
15.3	106.3	22.99	264.7
0.335	2.02	25.08	1721
23.17	49.13	10.99	319.05
11.59	7.4	19.3	396.7
4.64	13.1	6.84	877.4
1.136	0.92875	5.496	912.36
42.357	50.374	34.452	112.81

Common Mode Choke Performance

Using data from all the CMC available allows for dialing into a quick solution

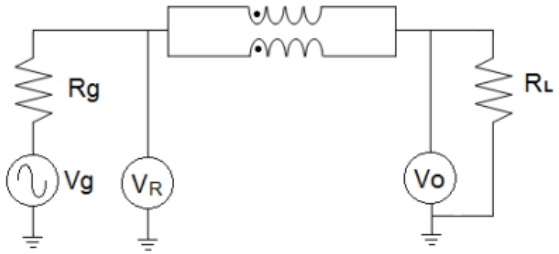
	A	B	C
1	Common-mode choke analysis		
2	Equivalent circuit models		
3		Model #1 (Z1)	Model #2 (Z2)
4	L (mH)	31.27	31.27
5	R (kohms)	74.02	74.02
6	C (pF)	36.72	25
7	fo	148.527	180.006
8	fstart	100	kHz
9	Rg, RL	50	Ω
10			

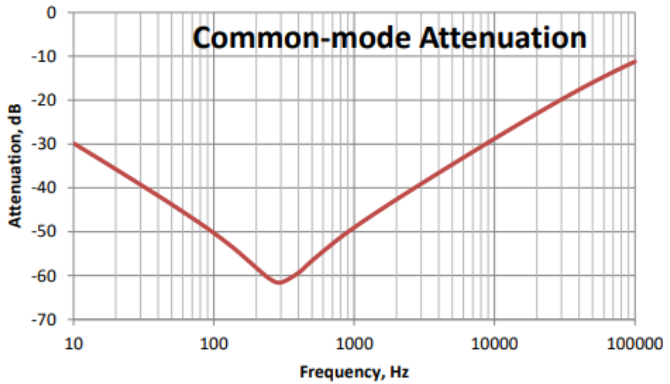


Common Mode Choke Performance

Impedance is the property that allows these devices to attenuate unwanted CMC noise. The amount of attenuation in dBs can be predicted if the impedances on either side of the CMC are known. We can assume 50ohms.

$$A = 20 \cdot \log_{10}\left(\frac{\kappa_g}{R_L + Z_{CMC}}\right)$$





Common Mode Choke Summary

By using reduced capacitance winding techniques, increased impedance can be provided.

By using the modeling techniques in this paper, design cycles can be shortened with improved attenuation.

Common Mode Choke Resources

www.minntronix.com/resources – A spreadsheet tool is available for download that helps predict impedance based on the equivalent circuit model. The spreadsheet was used to create some of the plots used in this presentation.