

COMMON MODE CHOKE / BALUN

And how to Measure the Choking Impedance

Choke / Balun built from info from Ian White, GM3SEK
“Cost-effective ferrite chokes and baluns”

<http://www.nonstopsystems.com/radio/pdf-ant/article-cost-effective-chokes.pdf>

Jacques Audet
VE2AZX
Web: ve2azx.net

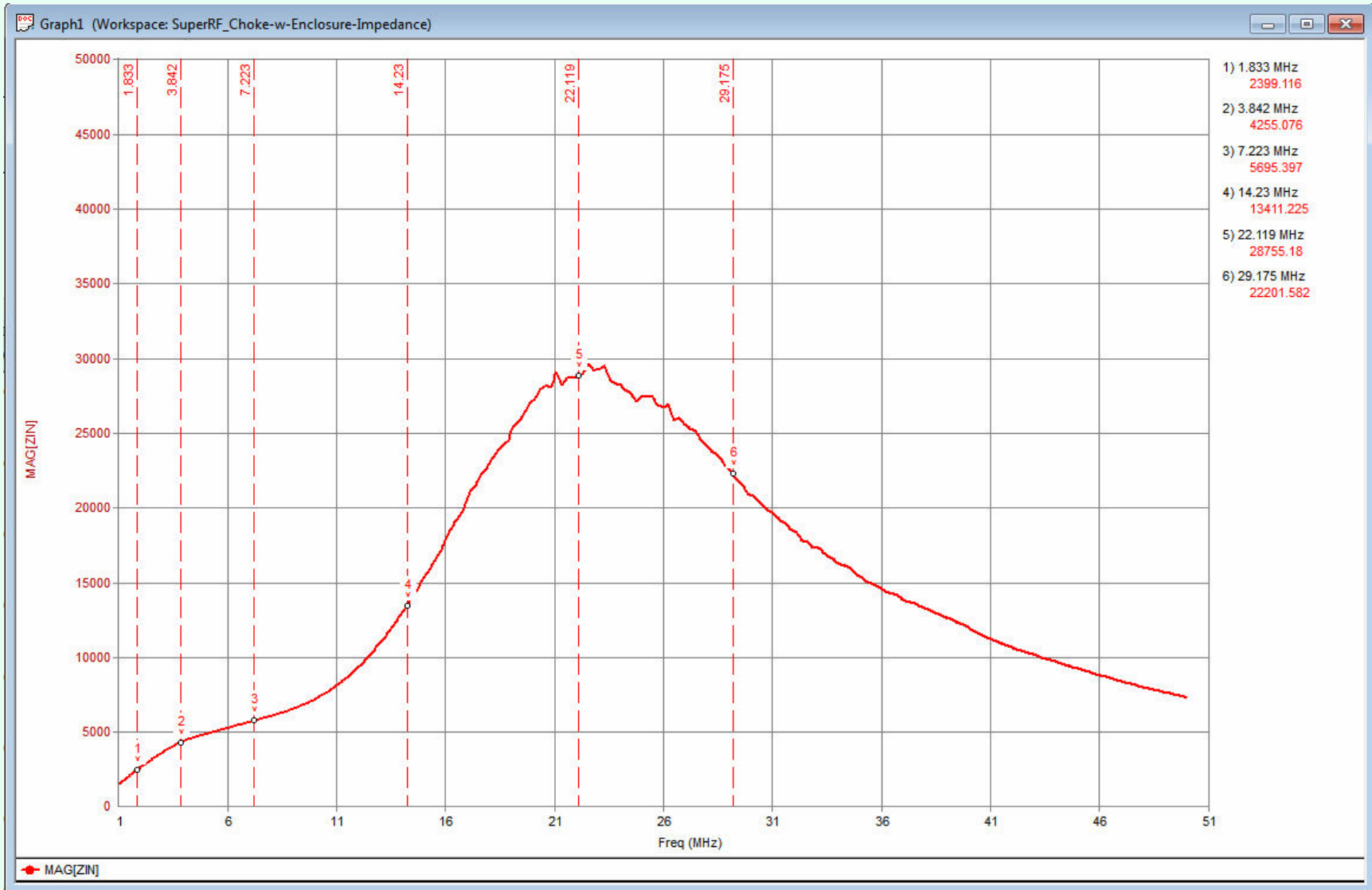
Rev. 1.1 July 2017



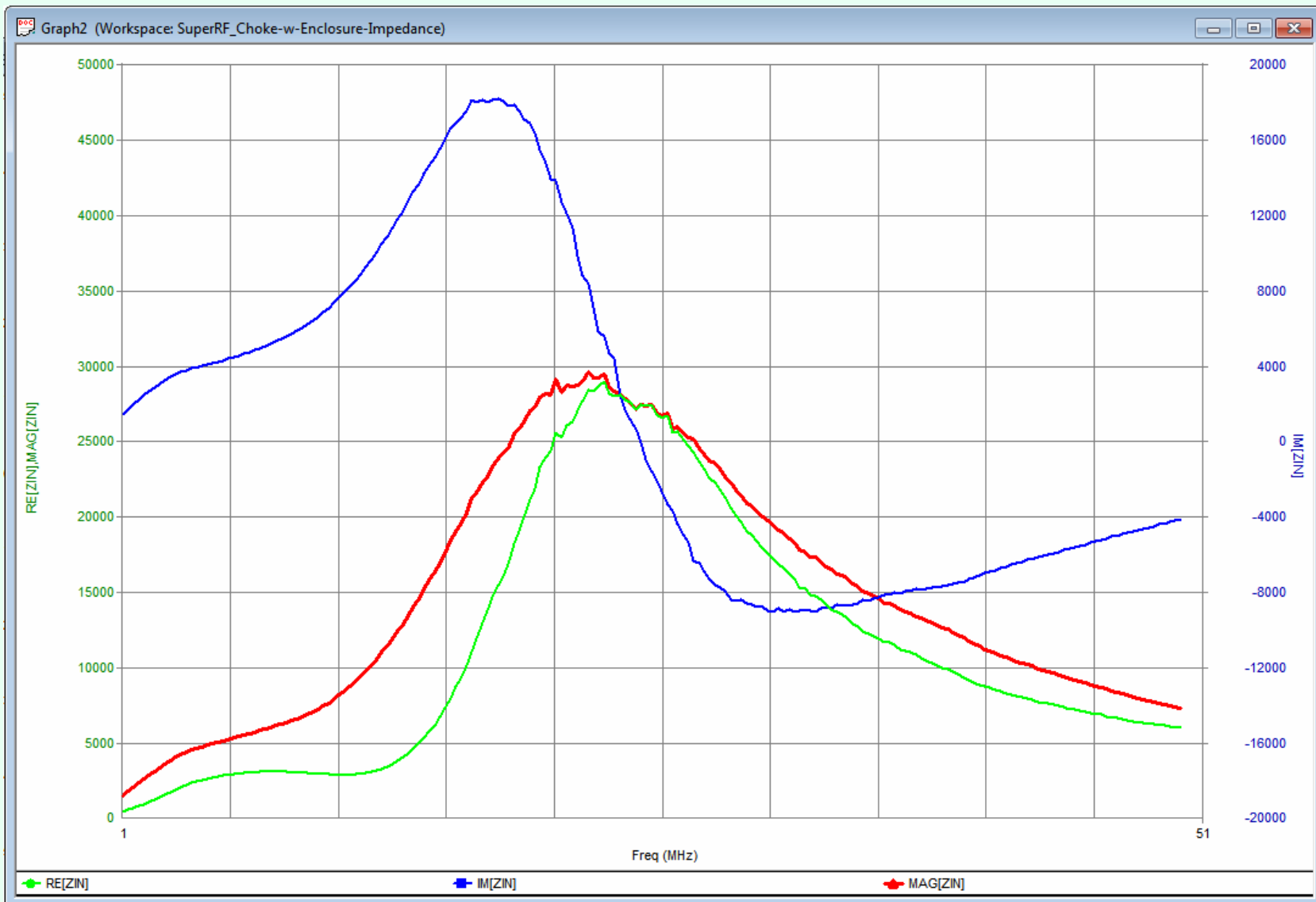
The balun is built in a plastic case (Hammond 1598JSGYPBK)



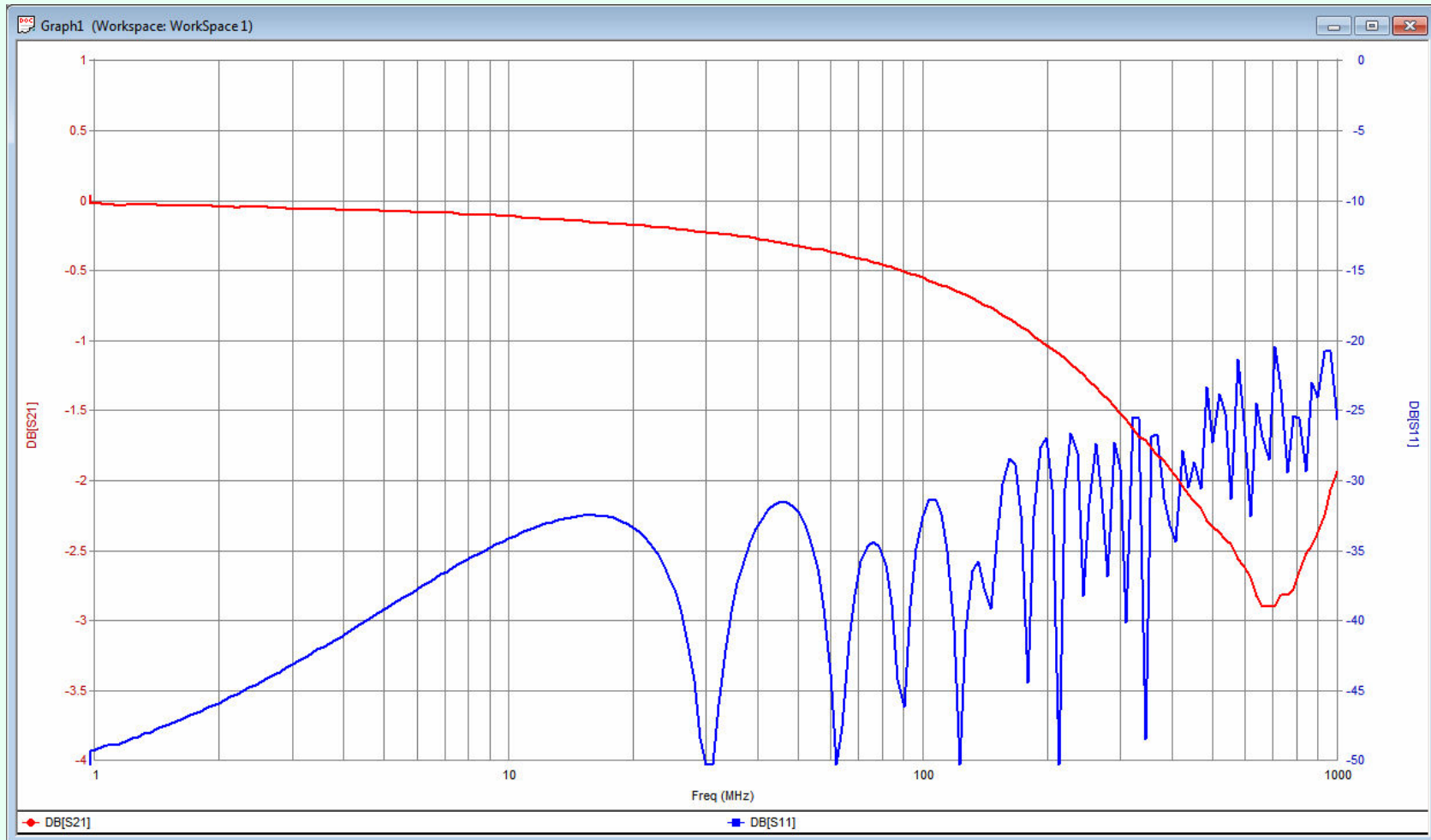
Layout of the three coils. This arrangement minimizes coupling between the coils. The coax cable is RG-8X. The ferrites are held in place by foam tape. On the two smaller coils, a small piece of heavy cardboard holds the coax in place.



Measured Isolation Impedance (ohms) vs frequency (MHz)



Measured Isolation Impedance (ohms) vs frequency (MHz)
Left scale: Red = Mag (Z), Green = Re(Z), Right scale: Blue = Im(Z)



Choke / Balun Coax Measured Frequency Response (red) and Return Loss (blue)

Note: The rise in the frequency response above 700 MHz seems to be a property of the Tandy RG-8X cable that I used !

Of course the ferrites have nothing to do with this behaviour.

The attenuation above 100 MHz seems to be higher than the published data and its attenuation falls too rapidly. It does not follow the square root (F)

Calculating the Balun Equivalent L and C around resonance

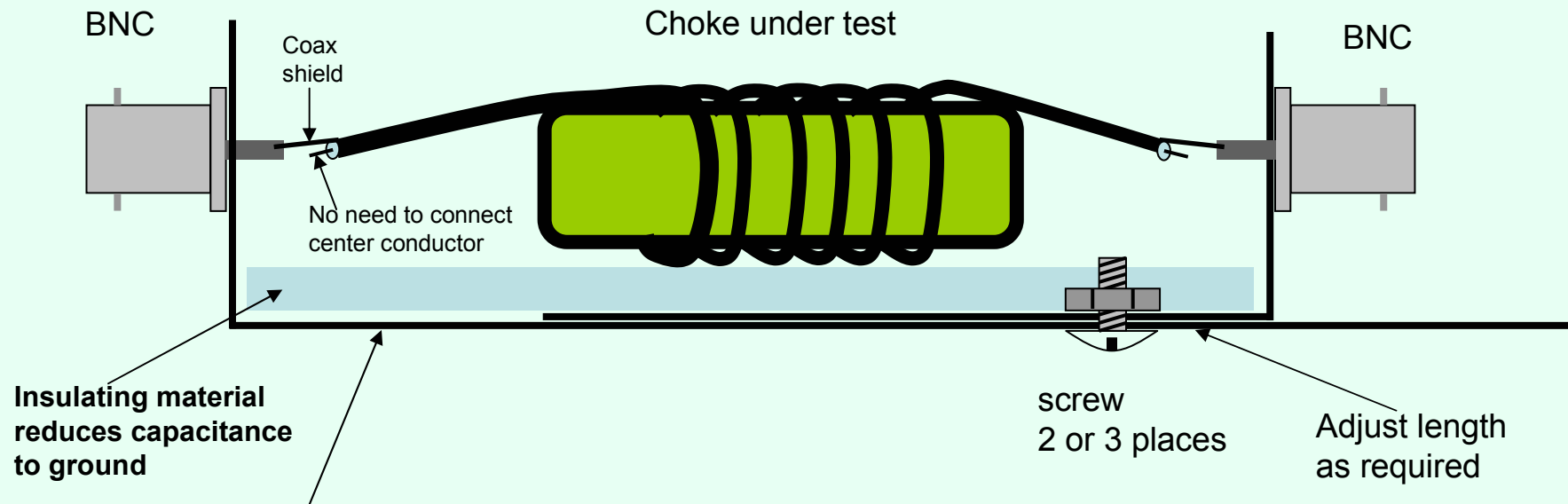
A small value cap (C1) is added in parallel with the measured Balun Complex Impedance
 From the initial resonant frequency and the frequency with the cap added, we can calculate the
 Balun Equivalent L and C around resonance. This is best done by simulation.

$F0 := 25.01 \cdot 10^6$	Resonant frequency No capacitor	The resonant frequency is found where the reactance goes to $\sim 0 \Omega$
$F1 := 18.15 \cdot 10^6$	Cap added	
$C1 := 0.296 \cdot 10^{-12}$	Cap value	
$C := \frac{10^{12} \cdot C1 \cdot F1^2}{F0^2 - F1^2}$	C = 0.329 in pF	F is in Hz
$L := \frac{10^6 \cdot (F0^2 - F1^2)}{4 \cdot \pi^2 \cdot C1 \cdot F0^2 \cdot F1^2}$	L = 122.963 in uH	

Note that the value of C is very small.
 This indicates low coupling between the balun IN/OUT
 The value of L is rather high which helps to get high isolation and low Q.

Ref.: SolveForLnC.xmcd

Measuring the Choking Impedance with an S21 Transmission Measurement



Aluminium sheet 30 to 62 mil thick

The width should be 2 or 3 inches larger than the choke under test.

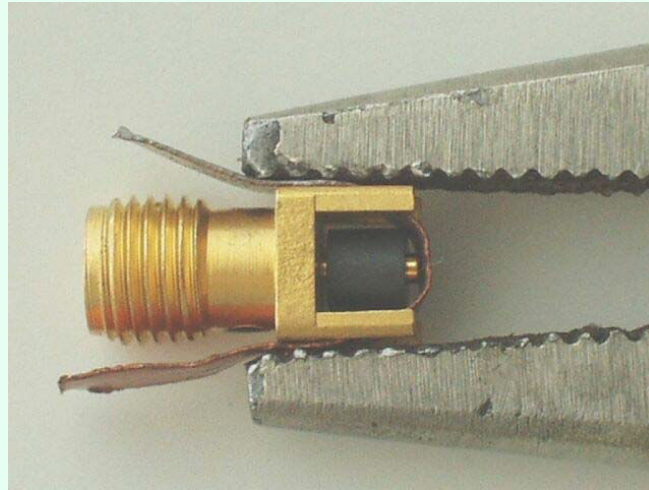
Using Al baking foil is a good substitute. Use alligator clips to make contact with the BNC's.

Set **S21 mode** and calibrate the VNA with a THRU adapter.

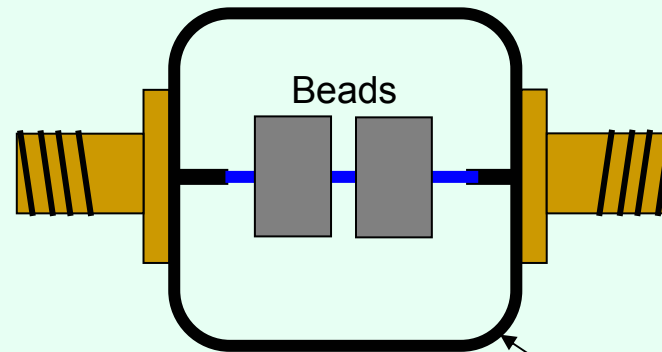
Use 6 dB pads at in / out, before calibration, if you don't trust the VNA impedance.

Testing Ferrite Beads

Using S11 mode

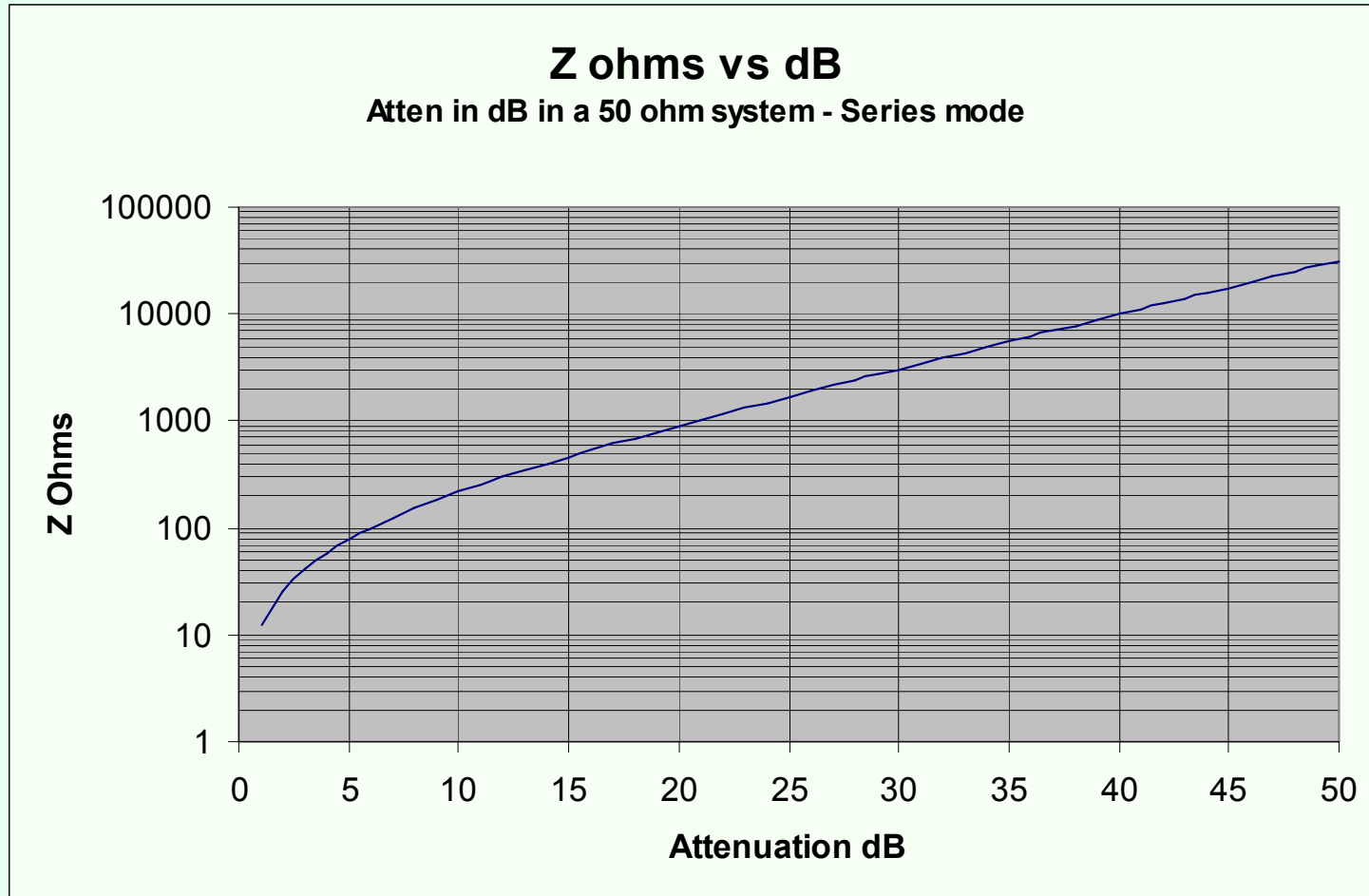


Using S21 mode



Al extrusion bar
0.75 x 0.75 in.

Measuring the Choking Impedance Z_x



$$Z_x = \left(10^{\frac{\text{dB}}{20}} - 1 \right) \cdot (R_L + R_S)$$

R_L and R_S are the load and source resistances. Normally 50 ohms.
See: <http://ve2azx.net/technical/MeasuringSeries-Z-FromdB.pdf>