

MEASUREMENTS ON FERRITE

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Reverse engineering formulas

To derive permeability parameters from a ferrite, it is necessary to obtain the dimensional data of the ferrite. In particular, the area through which the magnetic flux passes (A_e) and the length of the magnetic path in the ferrite (l_e) must be determined. These two values can be found in the datasheets of ferrites available on manufacturers' websites, such as <https://fair-rite.com/> or <https://www.amidoncorp.com/>.

Alternatively, they can be obtained using calipers, but the result is only approximate because, for example, in a toroid, the flux does not distribute evenly over the entire area. Therefore, the area traveled by the flux is different from the physical area measured with calipers. The same applies to the path (l_e). However, in the absence of certain data, measurements with calipers can still be acceptable.

Once A_e [cm²] and l_e [cm] are determined, the series impedance of a coil wound around the ferrite in terms of resistance R_1 and reactance X_1 at the frequency of interest f should be measured using a VNA.

Given A_e [cm²], l_e [cm], R_1 [Ω], X_1 [Ω], f [kHz], and the number of turns N , the following formulas can be applied:

$$\mu' = \frac{l_e 10^6}{8\pi^2 f A_e N^2} X_s$$

$$\mu'' = \frac{l_e 10^6}{8\pi^2 f A_e N^2} R_s$$

From these, permeability can be calculated and the inductance factor A_L :

$$\mu = \sqrt{\mu'^2 + \mu''^2}$$

$$A_L = 4\pi\mu \frac{A_e}{l_e} \text{ nH/sp}_2.$$

The formulas, taken from https://ia803405.us.archive.org/1/items/SNELLING_SOFT-FERRITES_1969/SNELLING_SOFT-FERRITES_1969.pdf, are complex, but I have summarized them in a convenient Excel spreadsheet.

61 Material Permeability vs Frequency

Image taken from the Fair-Rite website.

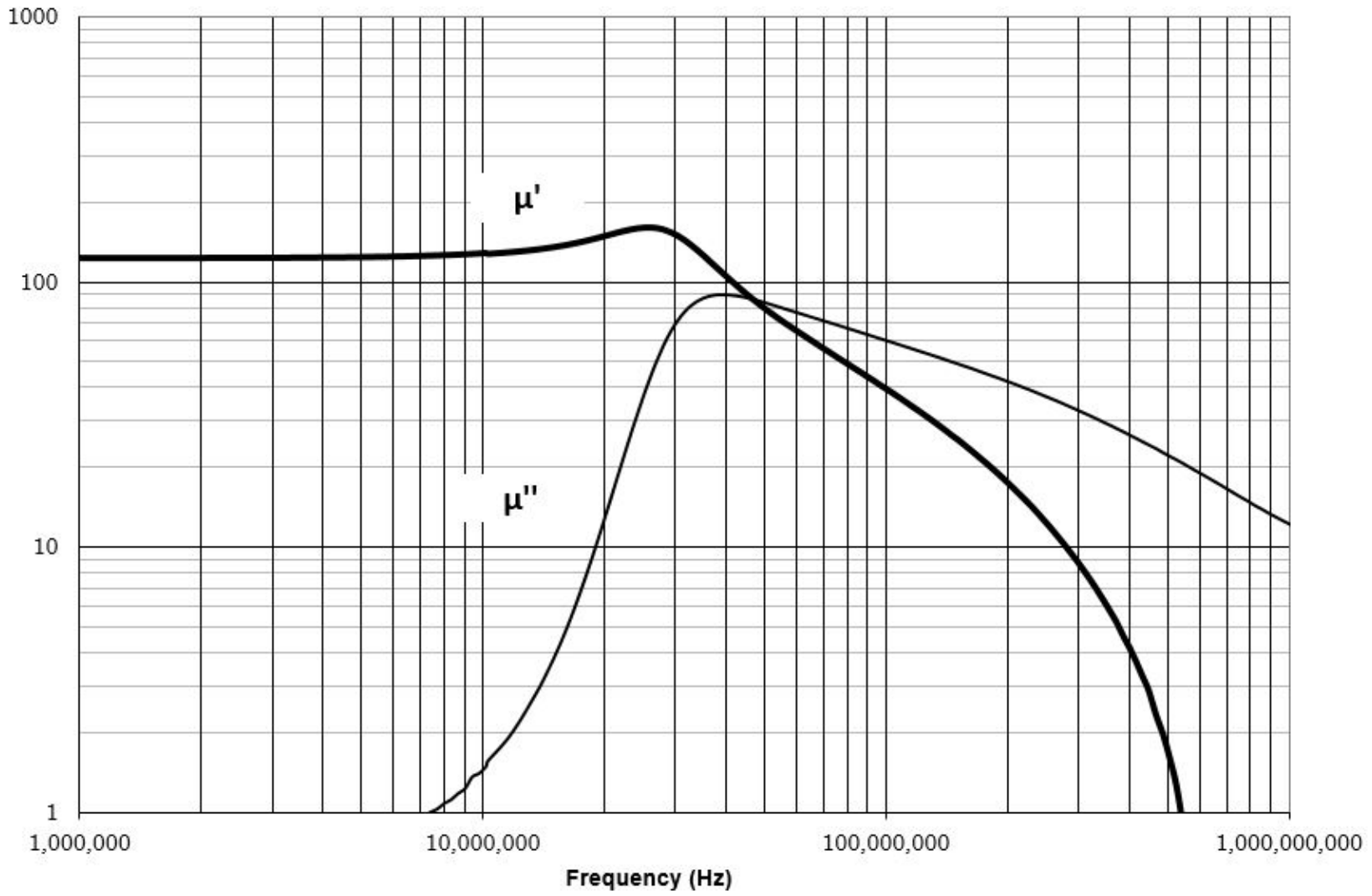


Image taken from the Fair-Rite website.

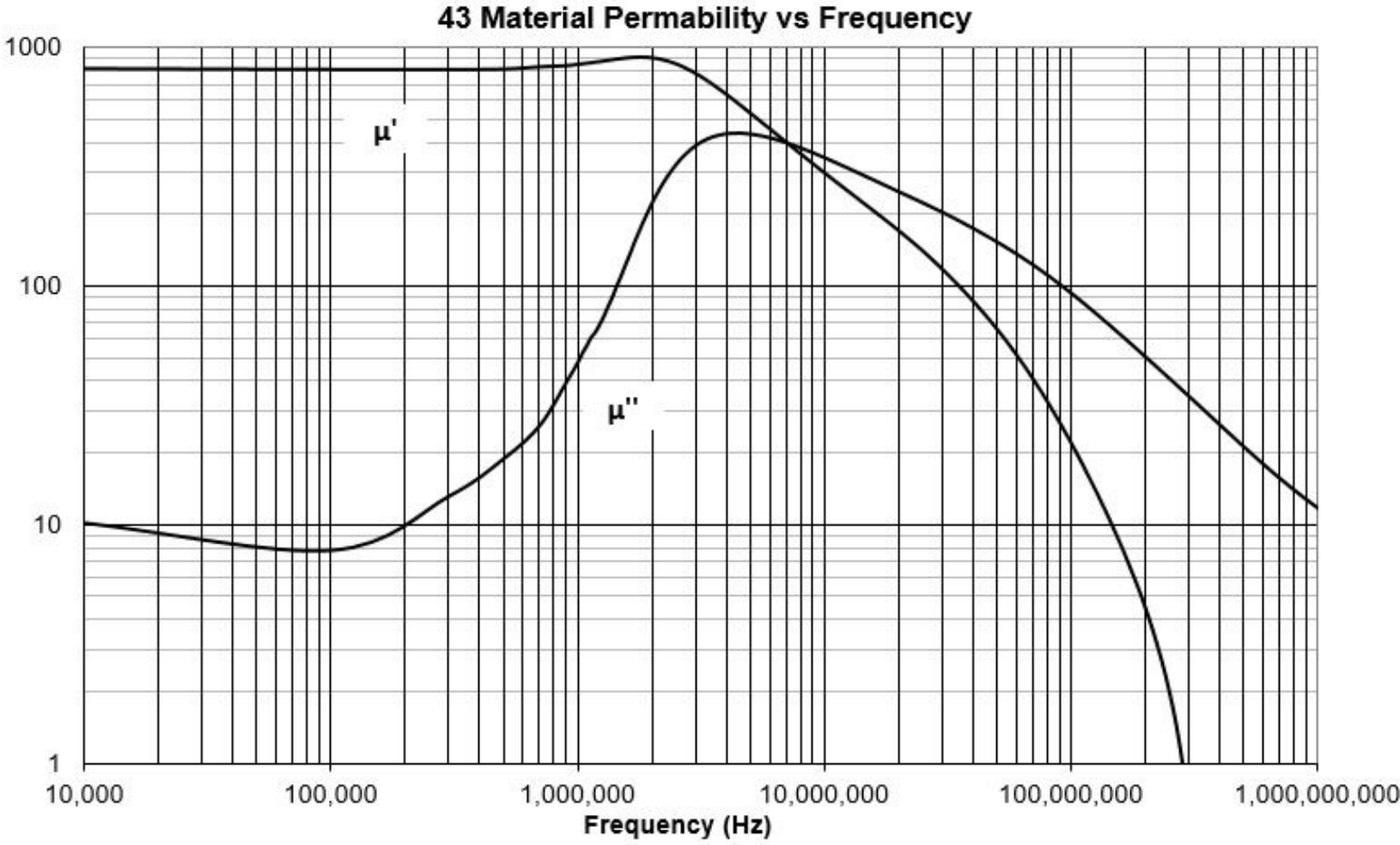


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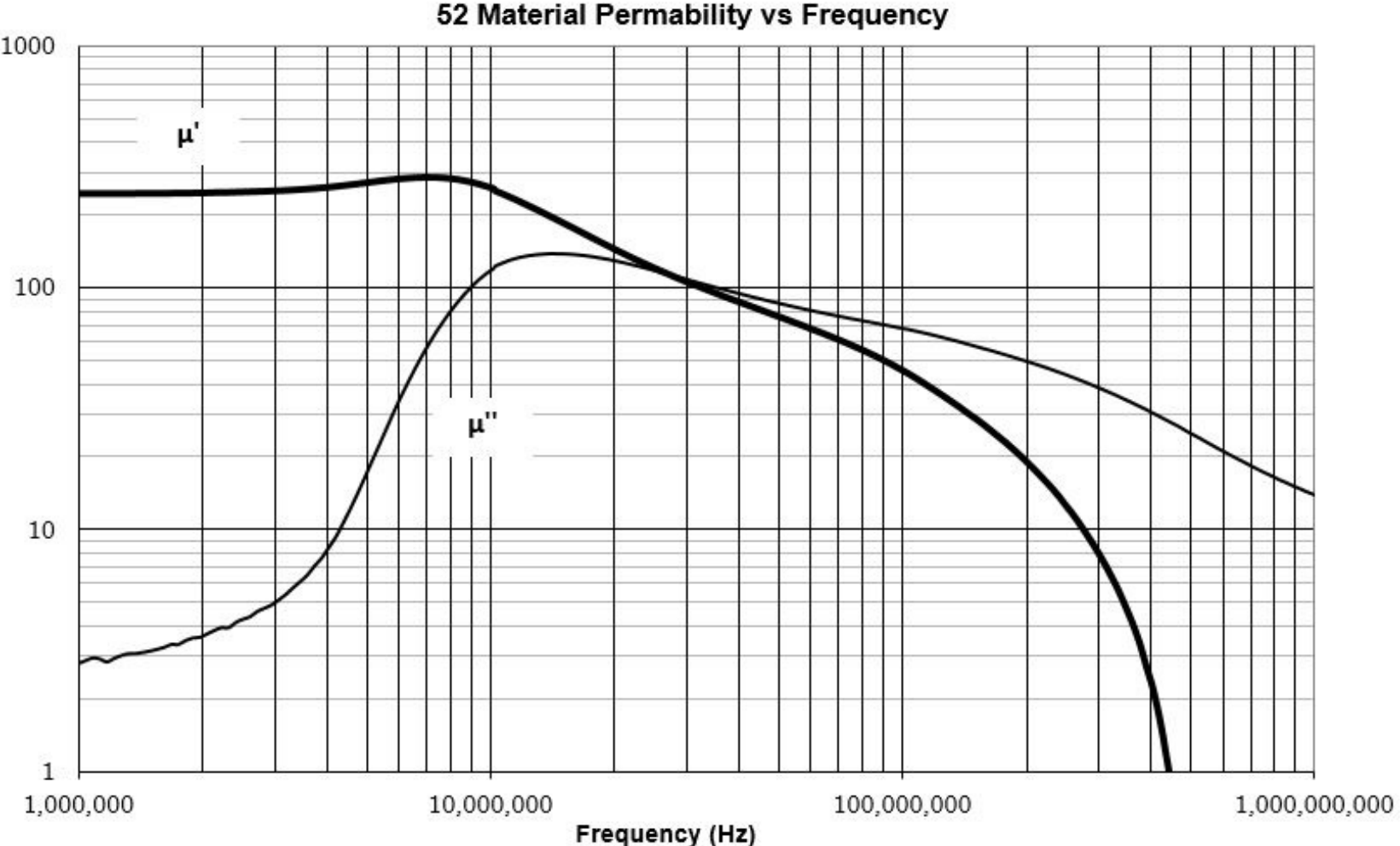


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