THE CHOICE OF FERRITE.

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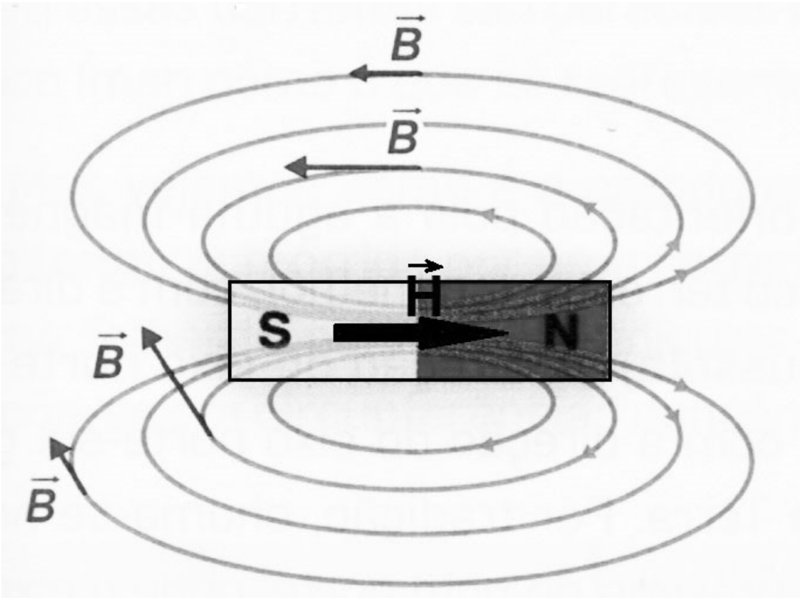
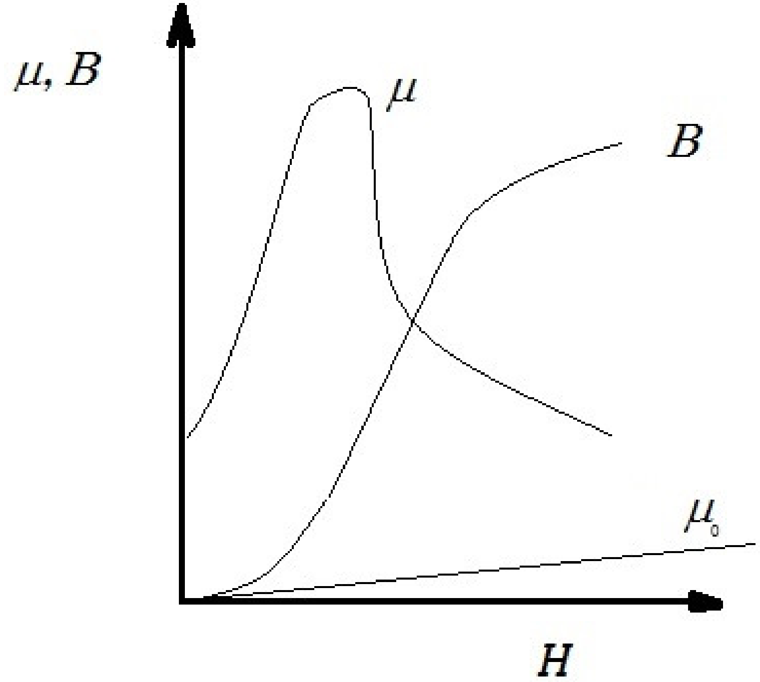
Fundamental relationship of magnetism.





B = μ H $\left[\frac{T}{m^2}\right]$ *Fundamental relationship between the magnetic field H and the flux density B.*

Magnetic permeability.

$\mu = \mu_0 \mu_r \left[\frac{H}{m}\right]$ *Magnetic permeability.*

$\mu_0 = 4\pi\ 10^{-7} = 1{,}256\ 10^{-6} \left[\frac{H}{m}\right]$ *Magnetic permeability of vacuum.*

μ_r [dimensionless] *Relative magnetic permeability with respect to vacuum.*

$\mu_r = \mu' + j\mu''$ *Relative magnetic permeability of a homogeneous anisotropic material.*

μ' *Real part, which stores magnetic energy and gives rise to inductance L.*

μ'' *Imaginary part, which gives rise to dissipative components and generates heat.*

TYPES OF FERRITES USED BY OM.

- Iron powder ferrites have a relatively low magnetic permeability (mr), with a maximum of 70.

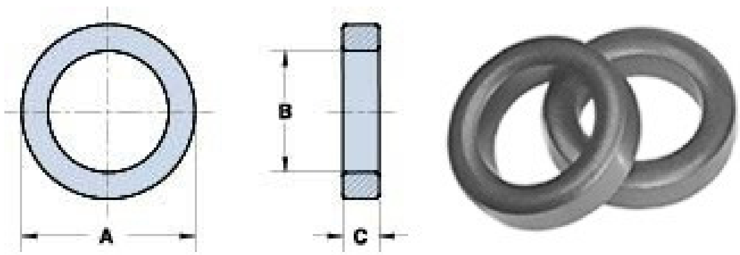
- Ni-Zn ferrites have a higher relative magnetic permeability, with a maximum of 800.

- Mn-Zn ferrites have a very high relative magnetic permeability, up to 10,000.

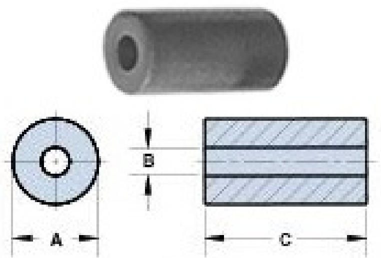
REAL FERRITES

Immagine presa da ARI Caserta

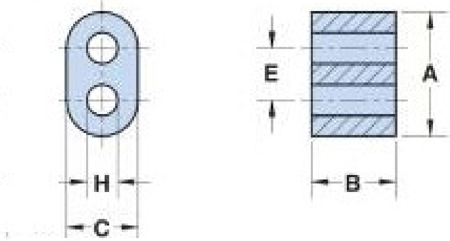
MODELS USED BY HAM RADIO



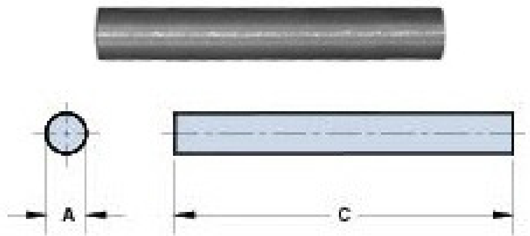
Toroide



Manicotto



Binoculare



Bacchetta

The images are taken from www.fair-rite.com

TOROIDS

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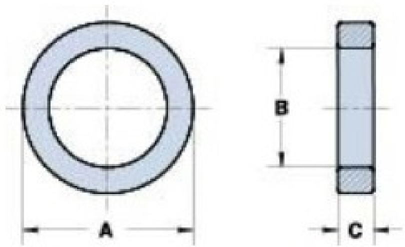
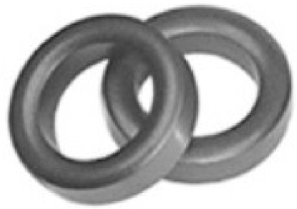




Low-Medium Permeability, 43 (ui=800) material

Dimensions: Top numbers are in millimeters, bottom numbers are in nor

Part Number	Frequency Range	A	B	C	Wt. (g)	A_L (nH)	Ae(cm^2)	l_e(cm)	V_e(cm^3)
5943011121	43 Material	75.85 Max (2.978" Max)	37.60 Min (1.480" Min)	13.60 Max (0.535" Max)	189.70	1300+25%, -30%	2.15	16.7	35.9
5943017501	43 Material	102.60 ±2.10 (4.039")	63.50 ±1.30 (2.500")	15.85 ±0.35 (0.624")	360	1225 ±25%	3	25.1	76.5
5943015901	43 Material	100.00 ±2.00 (3.937")	55.00 ±1.20 (2.165")	12.70 ±0.30 (0.500")	320	1215 ±25%	2.77	23	63.7
5943011101	43 Material	073.65 ±1.50 (2.900")	38.85 ±0.75 (1.530")	12.70 ±0.40 (0.500")	188	1300 ±25%	2.14	16.5	35.3
5943003821	43 Material	062.80 Max (2.472" Max)	34.20 Min (1.347" Min)	13.70 Max (0.539" Max)	106	1075+20%, -25%	1.58	14.5	22.8
5943003801	43 Material	061.00 ±1.30 (2.400")	35.55 ±0.85 (1.400")	12.70 ±0.50 (0.500")	120	1075 ±20%	1.58	14.5	22.8
5943017301	43 Material	047.50 ±1.20 (1.902")	31.50 ±0.80 (1.252")	19.05 ±0.35 (0.750")	94	1275 ±25%	1.55	12.2	18.9

Usage in the amateur context.

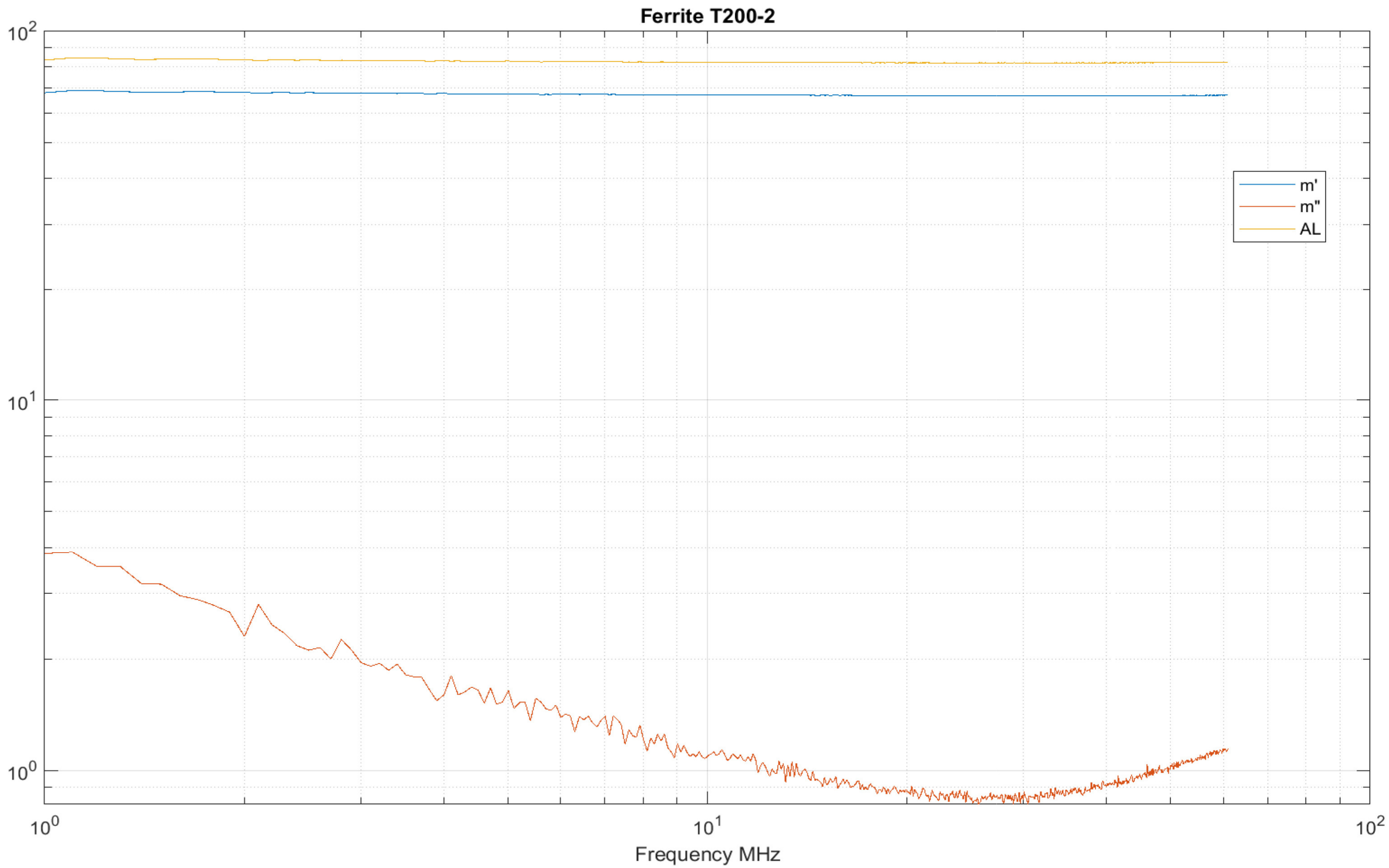
Building an inductance with a relatively large fixed value, which cannot be achieved with an air-core winding. The ferrite to be used should be one that does not change its permeability within the operating range; otherwise, the inductance would vary with frequency. Additionally, we would like the losses in the magnetic material to be extremely low to achieve the highest possible quality factor (Q).

Constructing a wideband impedance transformer (UnUn). The choice of ferrite falls on one that ensures a magnetization impedance, always present in parallel with the primary winding, at least 5 times the impedance of the primary (i.e., 250 ohms if the primary is 50 ohms). Furthermore, we would like the losses in the magnetic material to be at most equal to those in the conductors.

Building a choke (BalUn). In this case, the ferrite to be chosen must be able to resist common-mode currents, with the largest possible impedance. Therefore, the contributions of μ' and μ'' will both be useful. Of course, the larger the contribution of μ'', the more heat will be generated, which will need to be dissipated, but the choke will still benefit from it.

Complex permeability of a #2

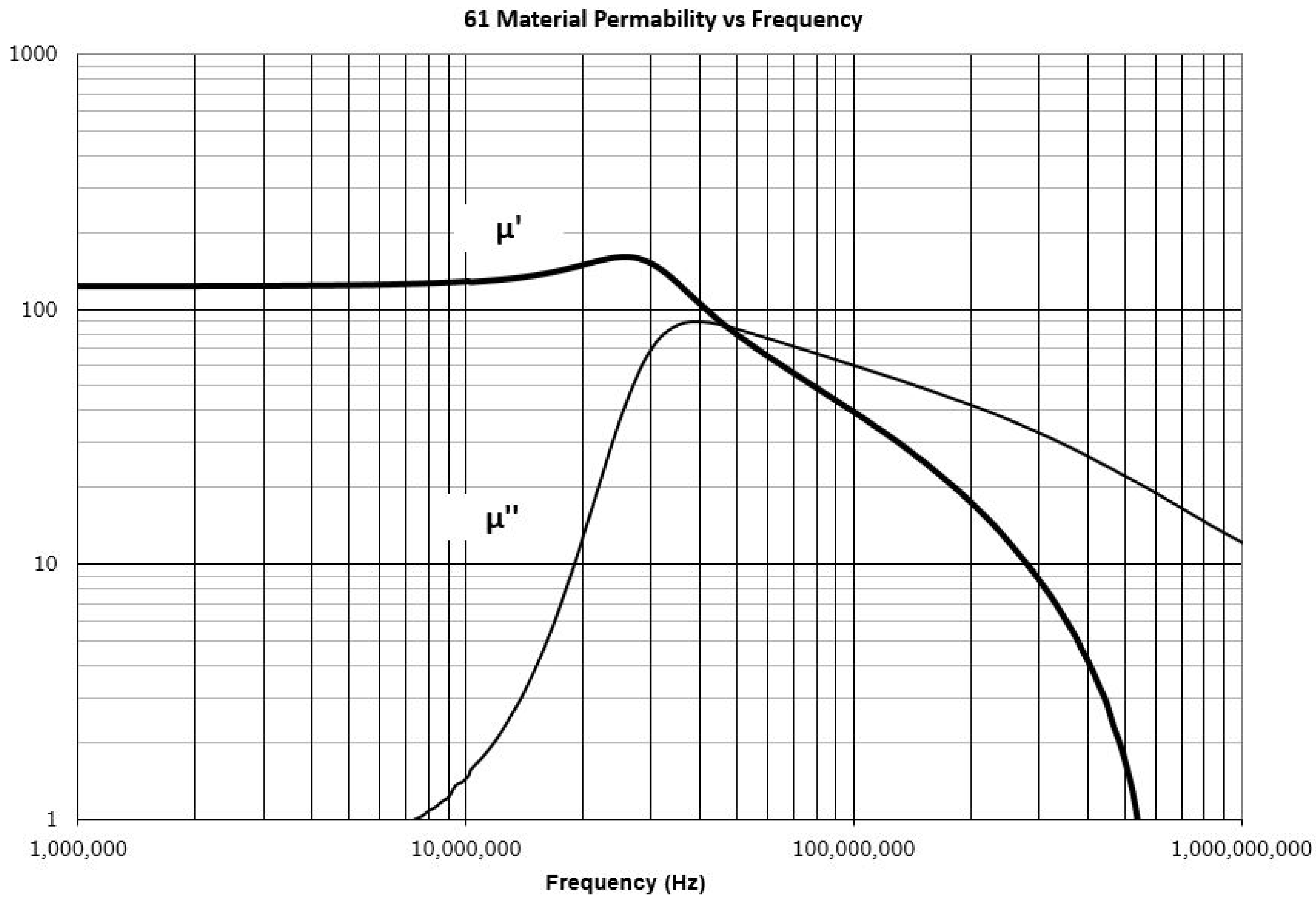
$\mu_r = \mu' + j\mu''$



T200-2 measured with VNWA

Complex permeability of a #61

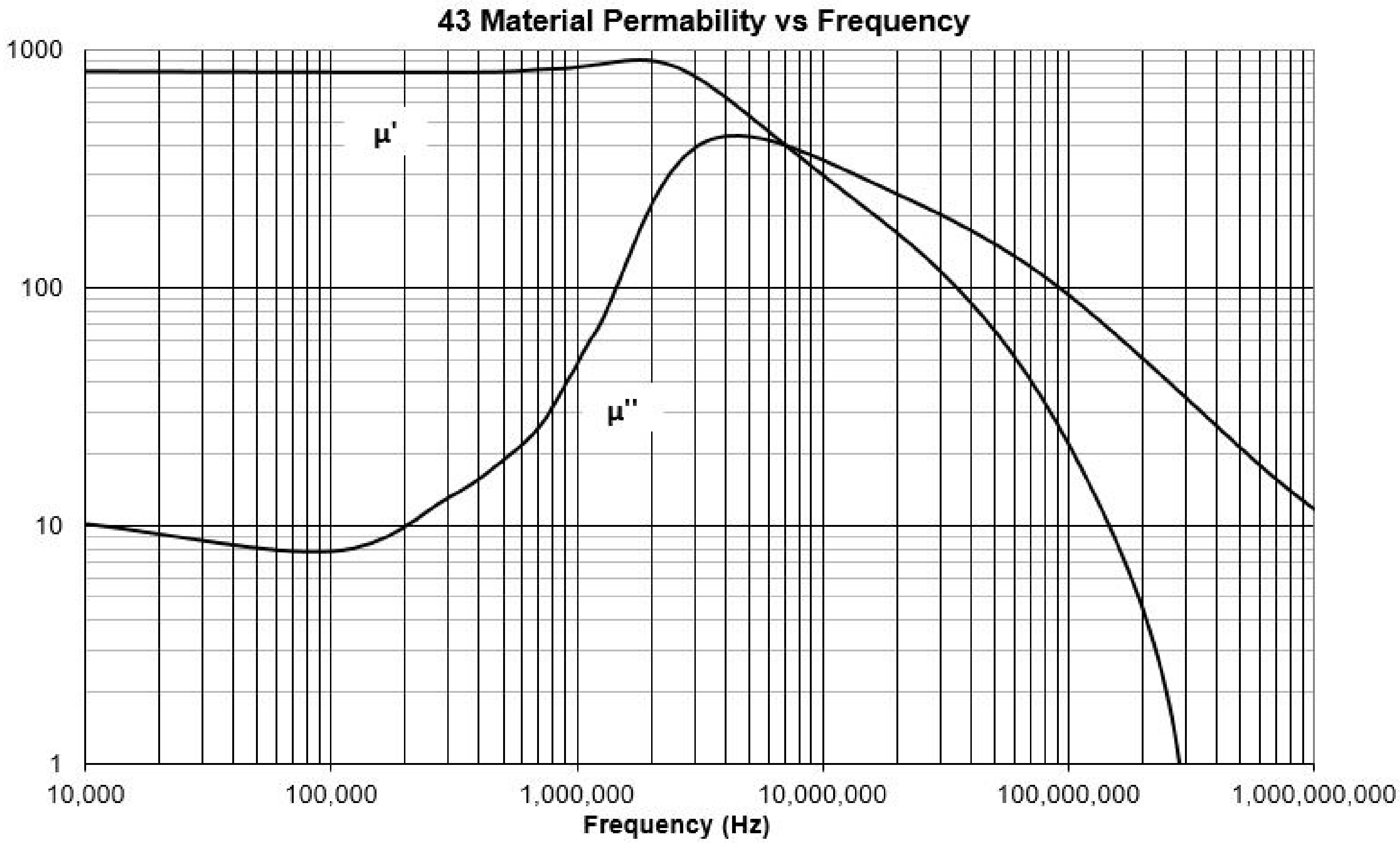
$\mu_r = \mu' + j\mu''$



The images are taken from www.fair-rite.com

Complex permeability of a #43

$\mu_r = \mu' + j\mu''$



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MEASUREMENT METHOD

Regardless of the purpose of our project, we need to know the type of material to determine the relative permeability of the magnetic material at our disposal, both the real part μ' and the imaginary part μ''. Additionally, we must know its maximum induction B_{Max} and its Curie temperature TC.

The measurements to be performed are as follows:

1. If the ferrite is bulk, use an ohmmeter to measure the resistance of the material to identify the type: high resistance indicates Ni-Zn, otherwise, it's Mn-Zn. If it is coated with colored epoxy paint, it is a Powder ferrite (refer to the colors on the Amidon website: https://www.amidoncorp.com/iron-powder-toroids/).
2. Measure the physical dimensions D_e, D_i, and thickness h [in mm], and wind 10 turns of wire around the toroid. Measure the inductance of the winding with a low-frequency LCR meter (1 – 10 KHz). Use the online calculator on the website https://fair-rite.com/toroid-permeability-calculator/ to input the data and calculate the initial permeability. Finally, refer to the table on https://fair-rite.com/materials/ to find the material that best matches the calculated values.
3. If the above research does not identify a specific material, we won't be able to determine the ferrite type, and we will need to rely on the VNA (Vector Network Analyzer). However, this will be addressed in another video.