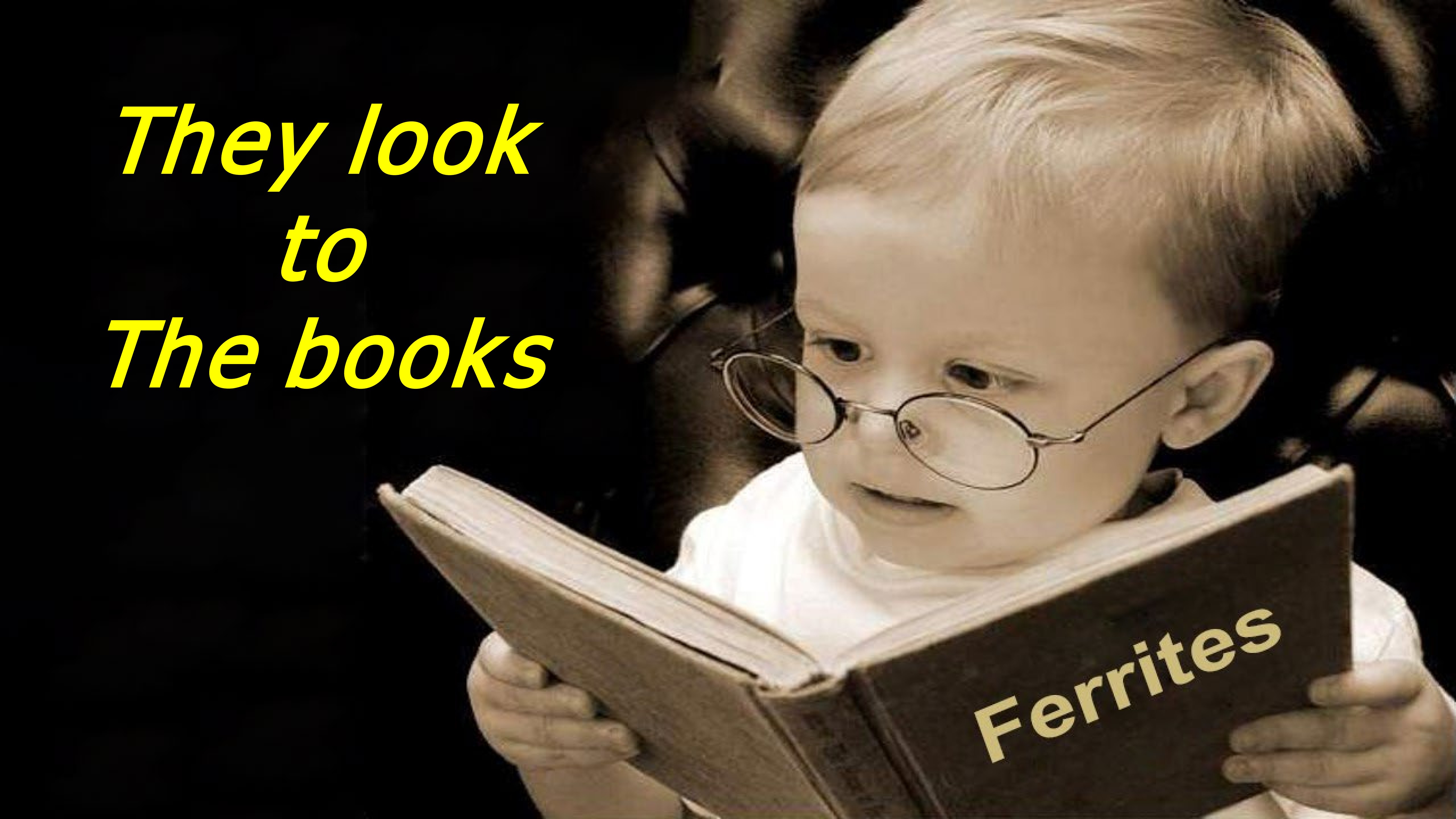
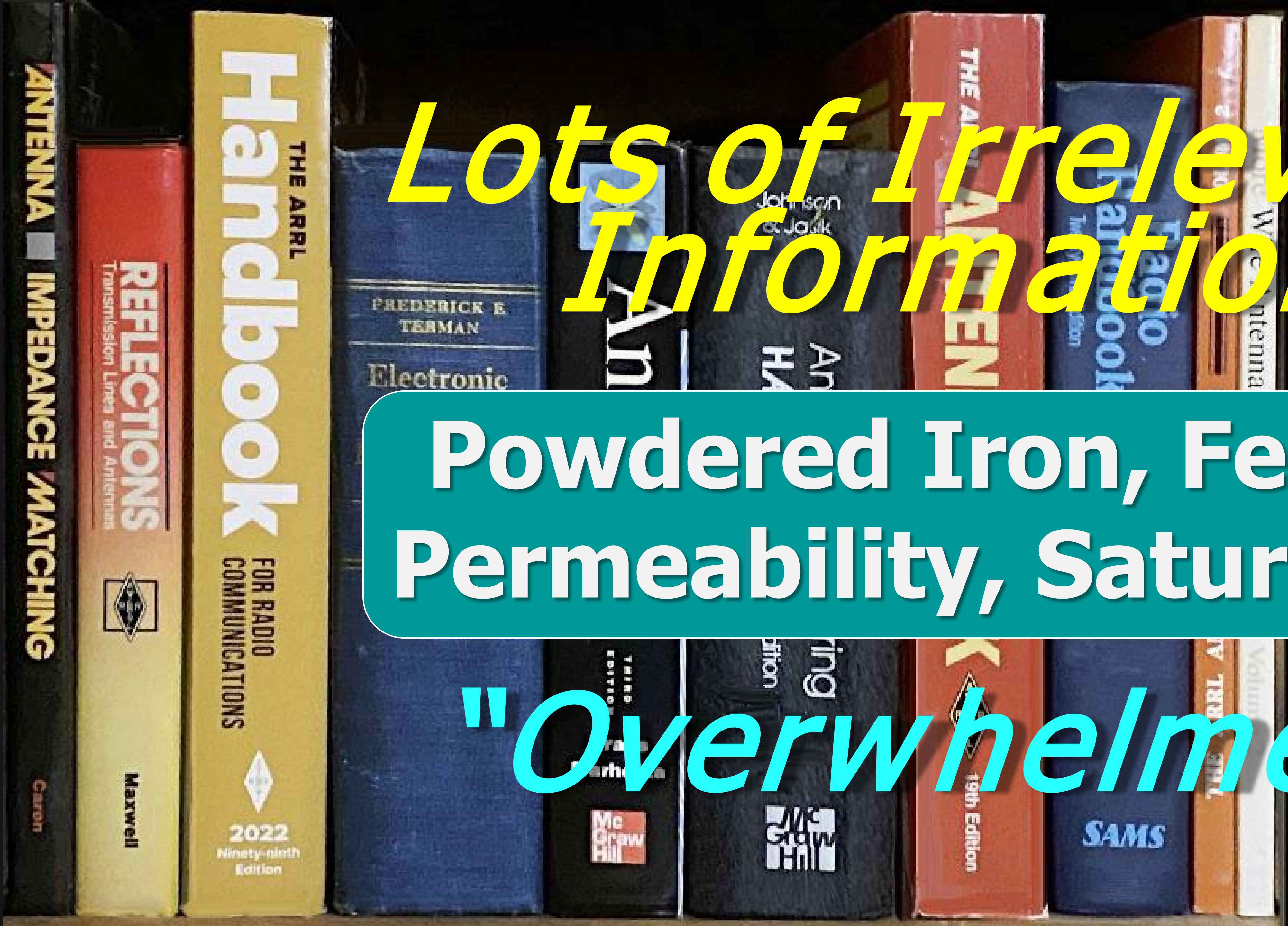
Ferrite Toroid Baluns

Most hams haven't a clue

How to build a ferrite toroid 1:1, 4:1, 49:1 balun


They look
to
The books
Ferrites

Lots of Irrelevant Information



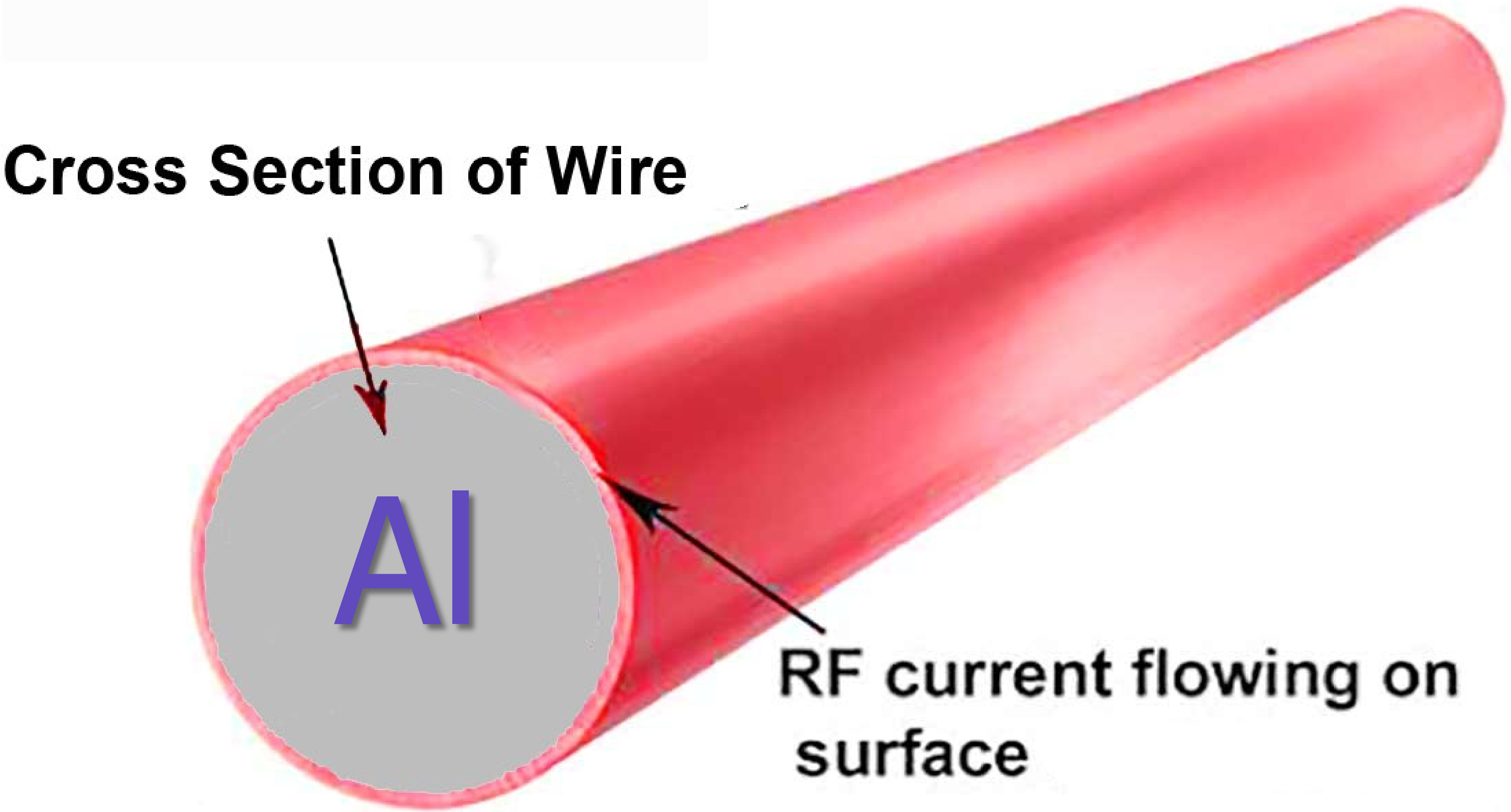
Powdered Iron, Ferrite
Permeability, Saturation

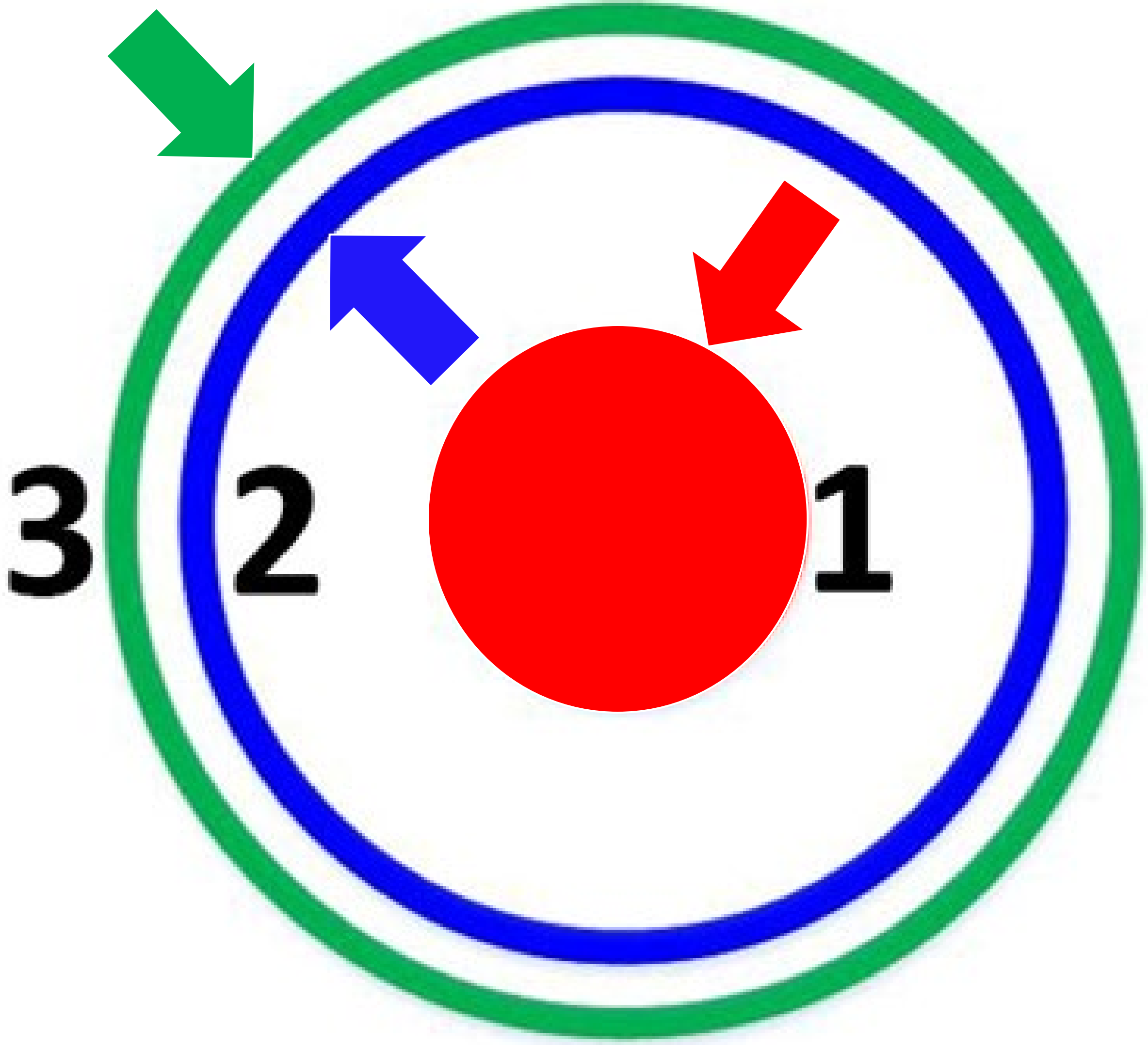
"Overwhelmed"

Ferrite Toroids are Not a Mystery if you Begin with

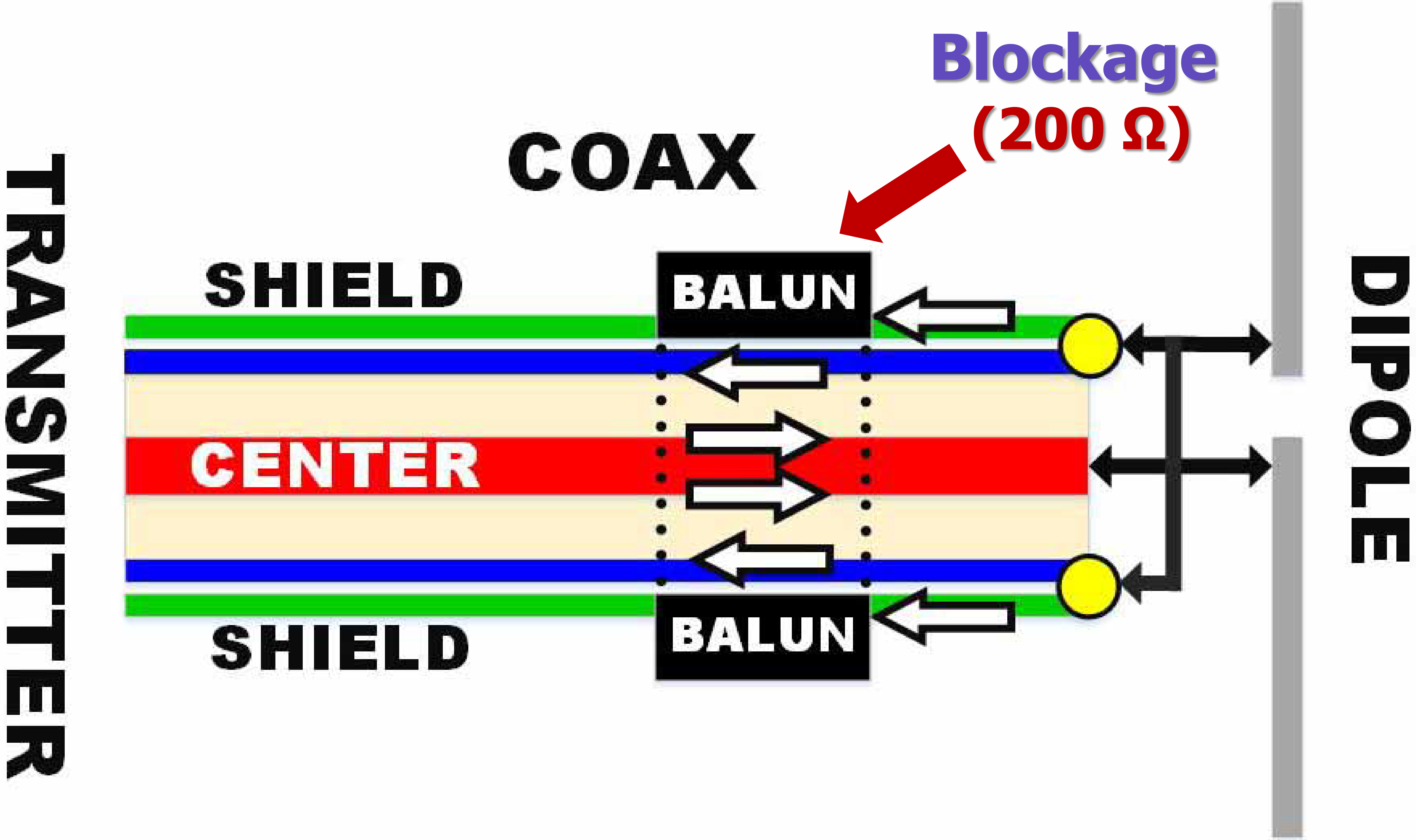
The Primary Job a Balun

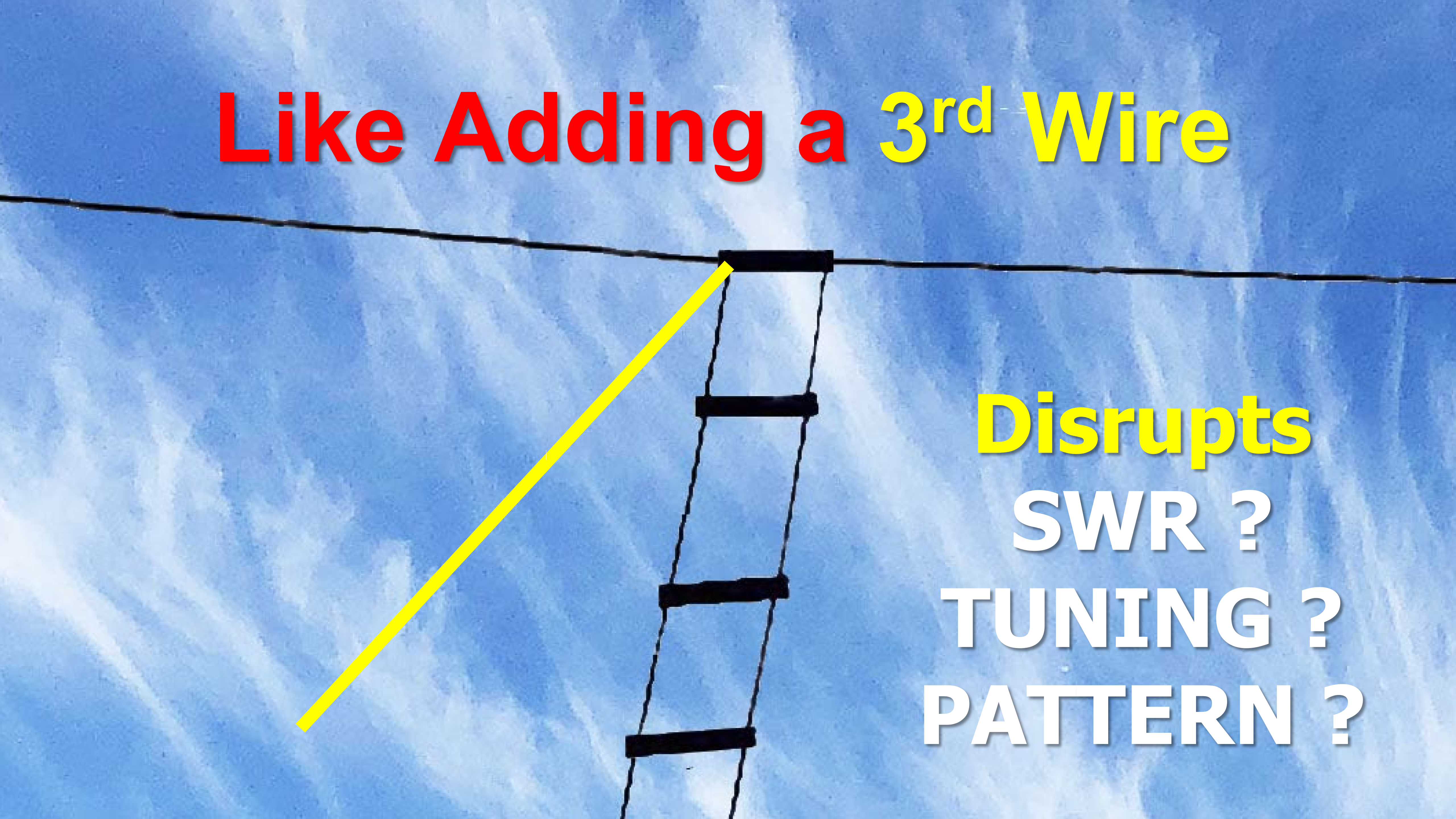
Baluns are the Consequence of Skin Effect

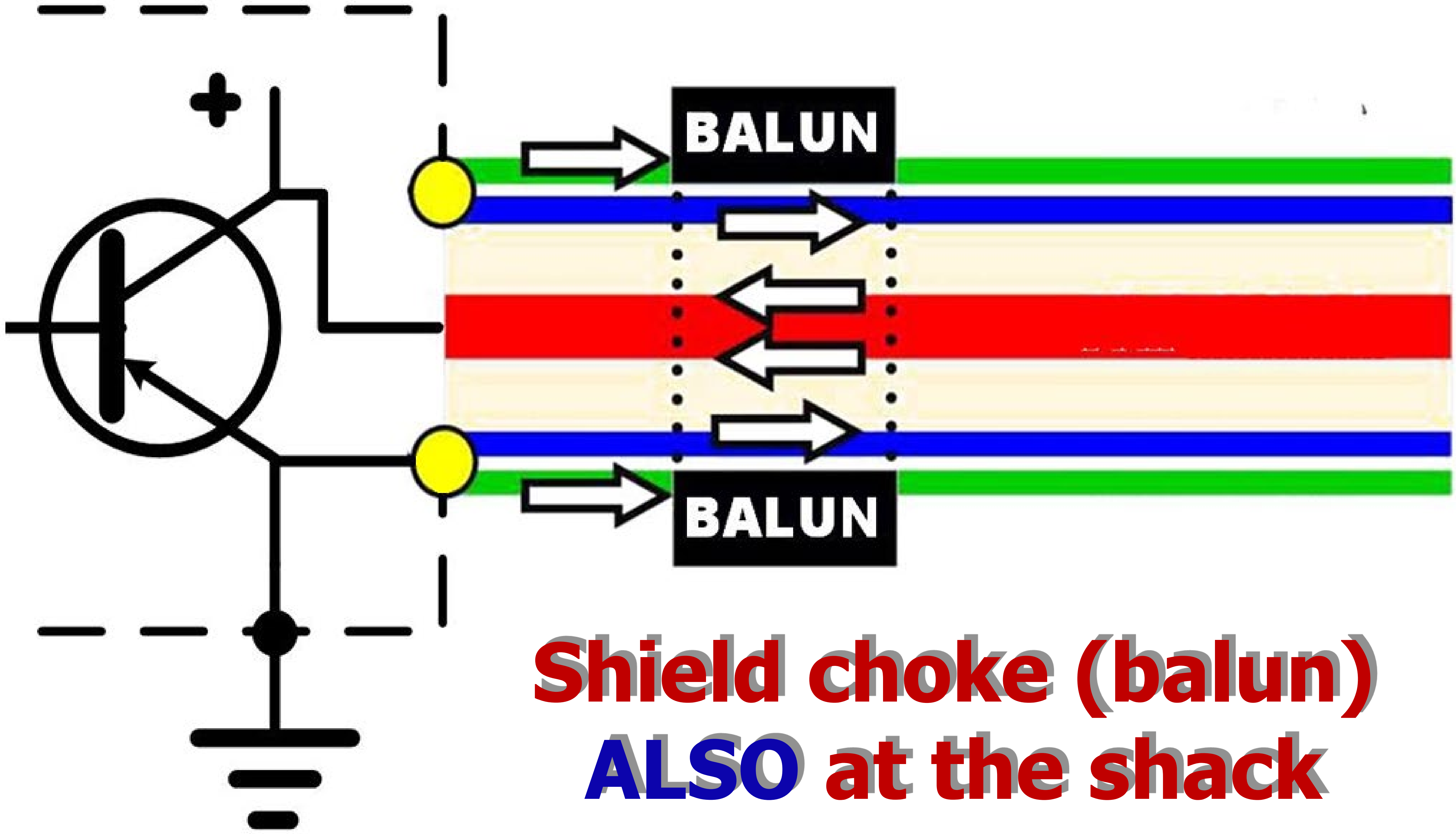




Skin Effect Causes Coax To Have 3 Conductors


Blockage
(200 Ω)
COAX
TRANSMITTER
SHIELD
BALUN
CENTER
BALUN
SHIELD
DIPOLE


Like Adding a 3rd Wire
Disrupts
SWR ?
TUNING ?
PATTERN ?



Shield choke (balun)
ALSO at the shack

The PRIMARY job of all baluns is to choke off outside shield current

A secondary job may also to be an impedance transformer 4:1, 7:1

But it is ALWAYS an Outside Coax Shield Current Choke

A **MUST HAVE**
Free On-Line Calculator

https://coil32.net/online-calculators/amidon-ferrite-torroid-calculator.html

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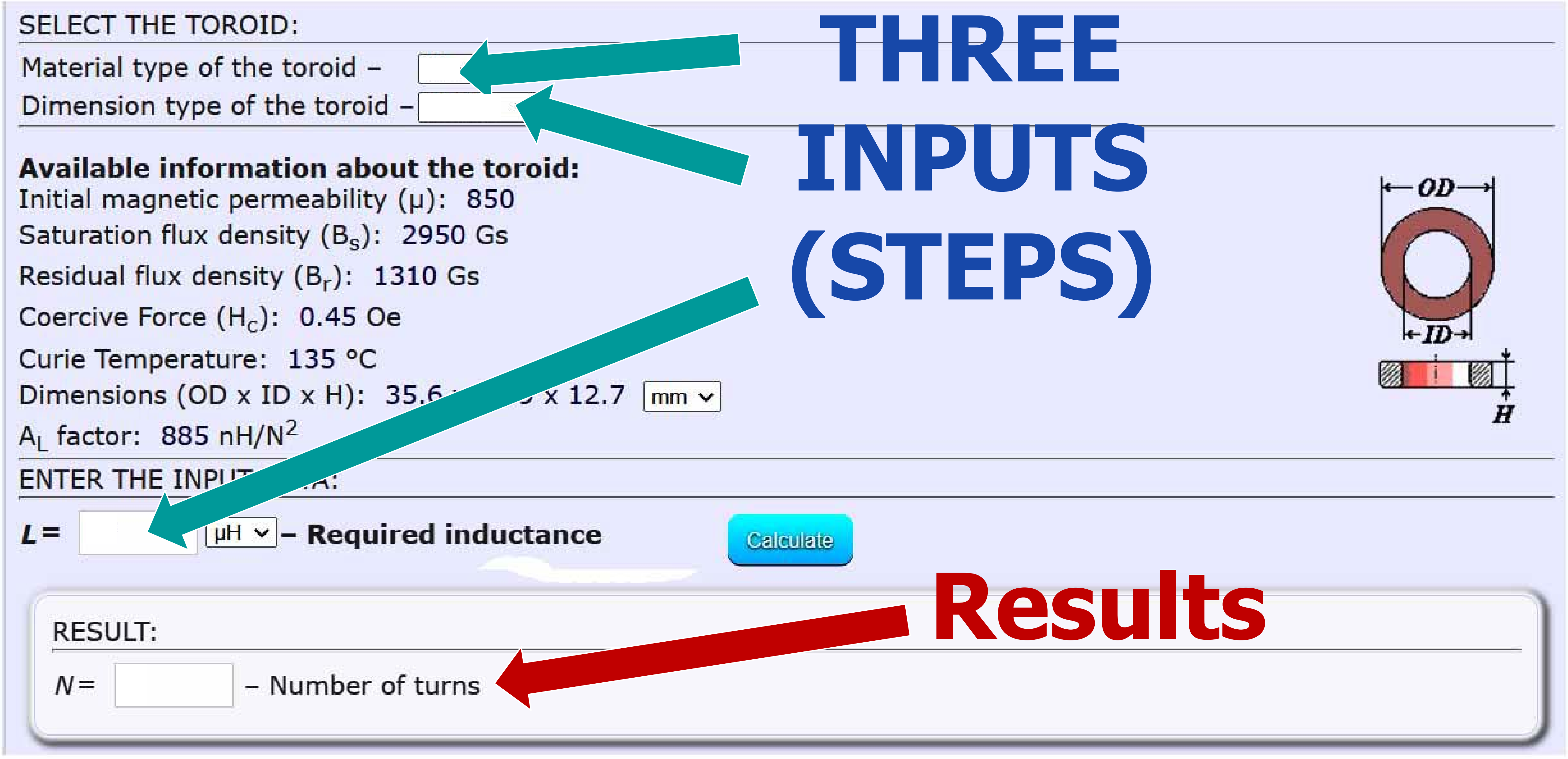


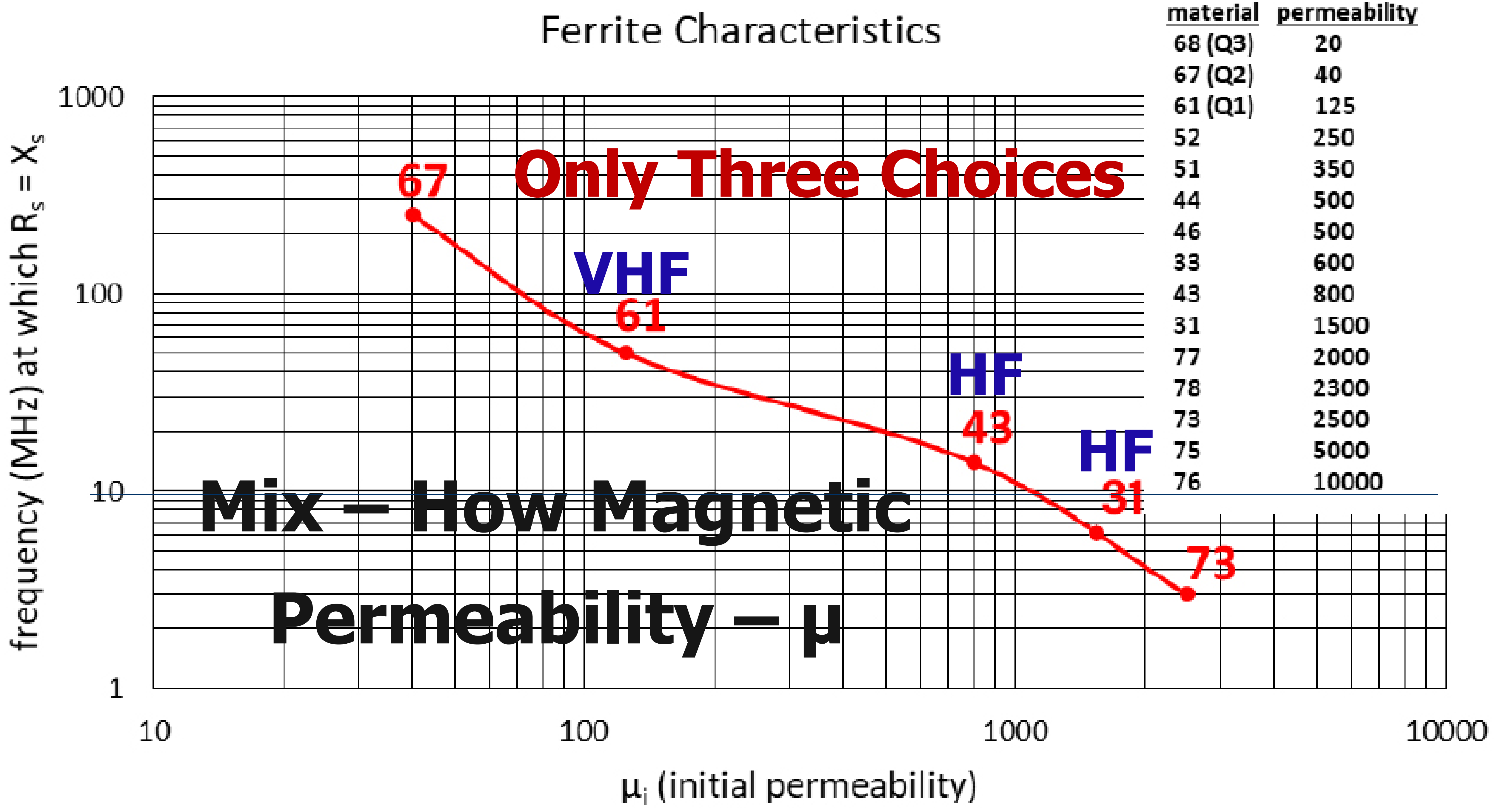
1. **Pick a toroid**
   Frequency – by MIX
   Power – by SIZE

2. **Find the INDUCTANCE (µH)**
   for an AC resistance of 200Ω

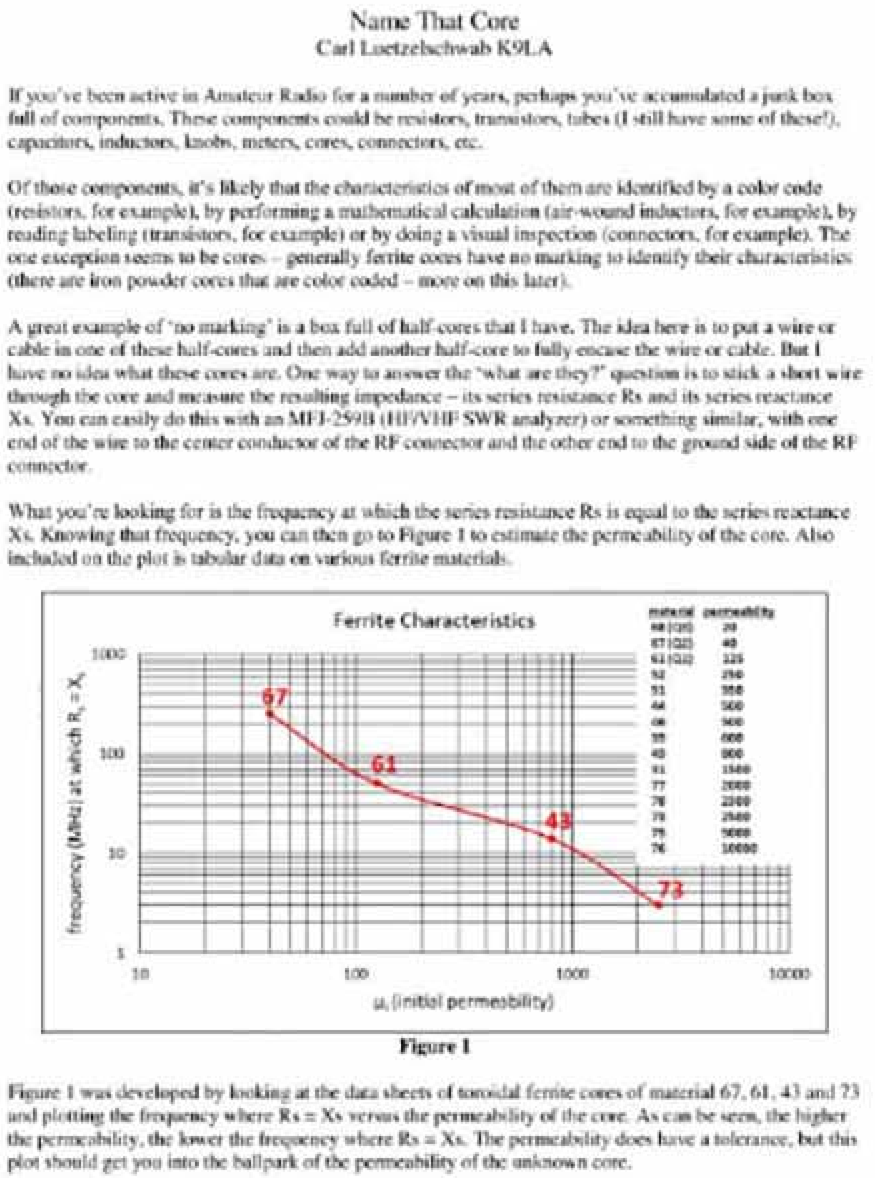
3. **Use the calculator → *<u>TURNS</u>***

Step (input) One

Pick a Toroid by Frequency and Power



material	permeability
68 (Q3)	20
67 (Q2)	40
61 (Q1)	125
52	250
51	350
44	500
46	500
33	600
43	800
31	1500
77	2000
78	2300
73	2500
75	5000
76	10000



Name That Core
Carl Luetzelschwab K9LA

If you've been active in Amateur Radio for a number of years, perhaps you've accumulated a junk box full of components. These components could be resistors, transistors, tubes (I still have some of these!), capacitors, inductors, knobs, meters, cores, connectors, etc.

Of those components, it's likely that the characteristics of most of them are identified by a color code (resistors, for example), by performing a mathematical calculation (air-wound inductors, for example), by reading labeling (transistors, for example) or by doing a visual inspection (connectors, for example). The one exception seems to be cores – generally ferrite cores have no marking to identify their characteristics (there are iron powder cores that are color coded – more on this later).

A great example of 'no marking' is a box full of half-cores that I have. The idea here is to put a wire or cable in one of these half-cores and then add another half-core to fully encase the wire or cable. But I have no idea what these cores are. One way to answer the "what are they?" question is to stick a short wire through the core and measure the resulting impedance – its series resistance Rs and its series reactance Xs. You can easily do this with an MFJ-259B (HF/VHF SWR analyzer) or something similar, with one end of the wire to the center conductor of the RF connector and the other end to the ground side of the RF connector.

What you're looking for is the frequency at which the series resistance Rs is equal to the series reactance Xs. Knowing that frequency, you can then go to Figure 1 to estimate the permeability of the core. Also included on the plot is tabular data on various ferrite materials.

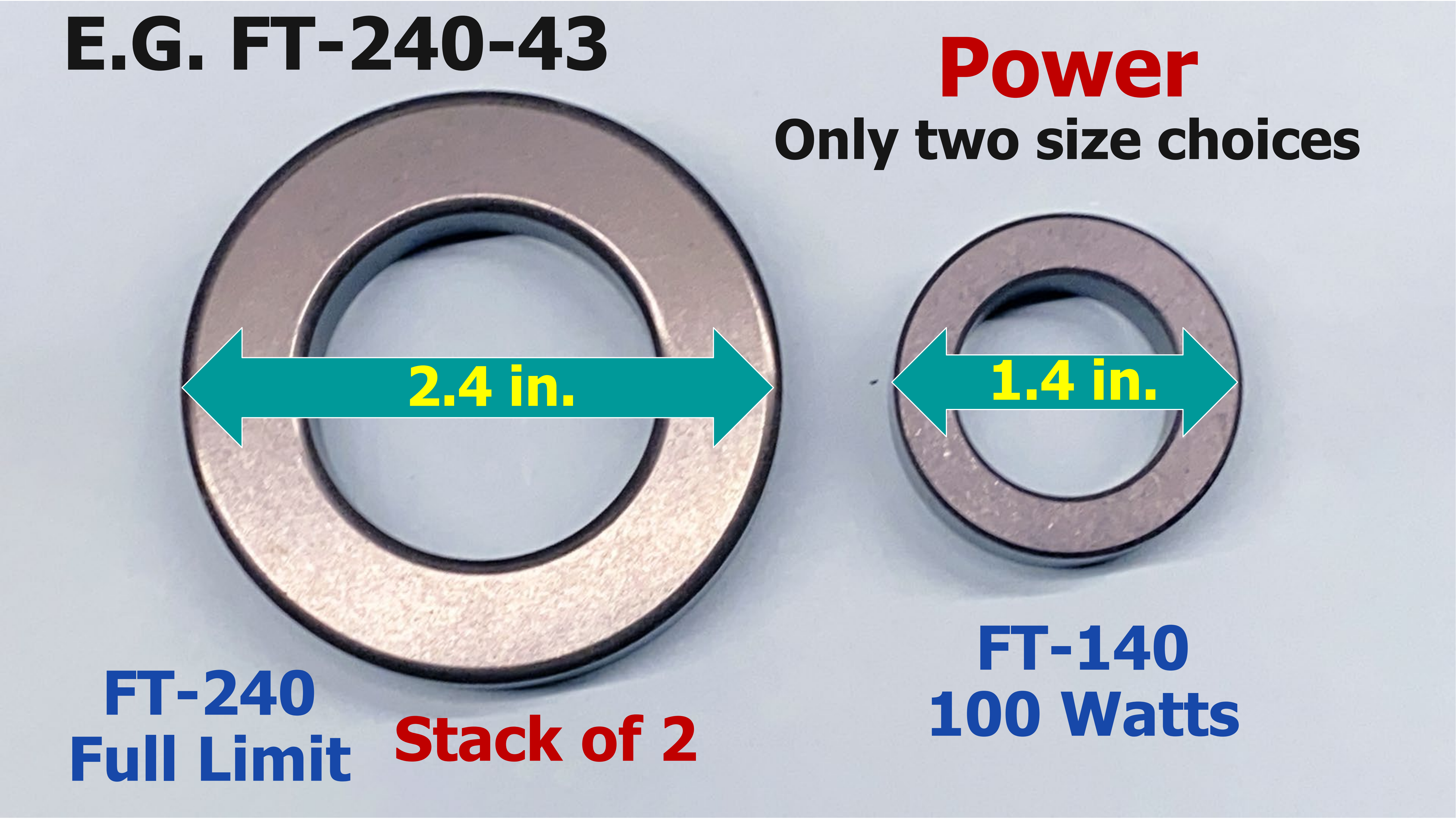
Figure 1

Figure 1 was developed by looking at the data sheets of toroidal ferrite cores of material 67, 61, 43 and 73 and plotting the frequency where Rs = Xs versus the permeability of the core. As can be seen, the higher the permeability, the lower the frequency where Rs = Xs. The permeability does have a tolerance, but this plot should get you into the ballpark of the permeability of the unknown core.

Carl Luetzelschwab K9LA

https://archive.org/details/Name_That_Core

How to identify unknown ferrite cores with an MFJ-259B or similar e.g Nano VNA


E.G. FT-240-43
Power
Only two size choices
2.4 in.
1.4 in.
FT-140
100 Watts
FT-240
Full Limit
Stack of 2

Toroid Core FT140-43 Ferrite

Brand: FAIR-RITE

$7.35

prime

FREE Returns

Report incorrect product information.

https://coil32.net/online-calculators/amidon-ferrite-torroid-calculator.html

Mix 43

100 Watts – FT-140

SELECT THE TOROID:

Material type of the toroid – 43

Dimension type of the toroid – FT-140

Available information about the toroid:

Initial magnetic permeability (μ): 850

Saturation flux density (B_S): 2950 Gs

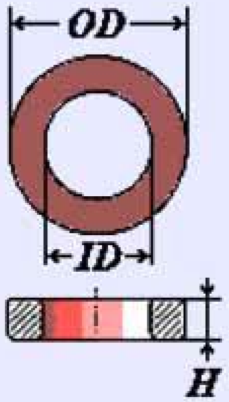
Residual flux density (B_r): 1310 Gs

Coercive Force (H_C): 0.45 Oe

Curie Temperature: 135 °C

Dimensions (OD x ID x H): 35.6 x 22.9 x 12.7 mm

A_L factor: 885 nH/N^2



ENTER THE INPUT DATA:

L = μH – **Required inductance**

Calculate

RESULT:

N = – Number of turns

Step (input) Two

Find the inductance for minimum choking

RF resistance = 200 Ω min.

4 times coax impedance 50 Ω

$RF_{Resistance}$ $X_L = 2\pi f L$

$L_{\mu H} = 200\ \Omega\ /\ 6.28\ x\ f_{MHz}$

Freq. MHz	Band m	LuH
1.8	160	17.7
3.5	80	9.1
5	60	6.4
7	40	4.5
10	30	3.2
14	20	2.3
18	17	1.8
25	12	1.3
28	10	1.1

Minimum RF Choking Resistance of 200 Ω By Ham Band

More is OKAY

https://coil32.net/online-calculators/amidon-ferrite-torroid-calculator.html

SELECT THE TOROID:

Material type of the toroid – 43

Dimension type of the toroid – FT-140

Available information about the toroid:

Initial magnetic permeability (μ): 850

Saturation flux density (B_s): 2950 Gs

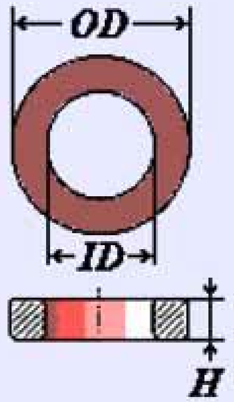
Residual flux density (B_r): 1310 Gs

Coercive Force (H_c): 0.45 Oe

Curie Temperature: 135 °C

Dimensions (OD x ID x H): 35.6 x 22.9 x 12.7 mm

A_L factor: 885 nH/N^2



160-meters or higher – 17uH

ENTER THE INP… A:

L = 17 μH – **Required inductance**

Calculate

RESULT:

N = – Number of turns

Step (input) Three

Calculator → μH to turns

Smallest winding (4:1, 7:1)
The one connected to coax

https://coil32.net/online-calculators/amidon-ferrite-torroid-calculator.html

SELECT THE TOROID:

Mix 43

Material type of the toroid – 43

Dimension type of the toroid – FT-140

100 Watts – FT-140

Available information about the toroid:

Initial magnetic permeability (μ): 850

Saturation flux density (B_S): 2950 Gs

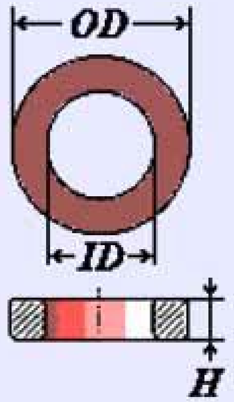
Residual flux density (B_r): 1310 Gs

Coercive Force (H_C): 0.45 Oe

160-meters or higher – 17uH

Curie Temperature: 135 °C

Dimensions (OD x ID x [illegible] 35.6 x 22.9 x 12.7 mm



A_L factor: 885 nH[illegible]

ENTER THE IN[illegible] DATA:

L = 17 μH – **Required inductance**

Calculate

PUSH

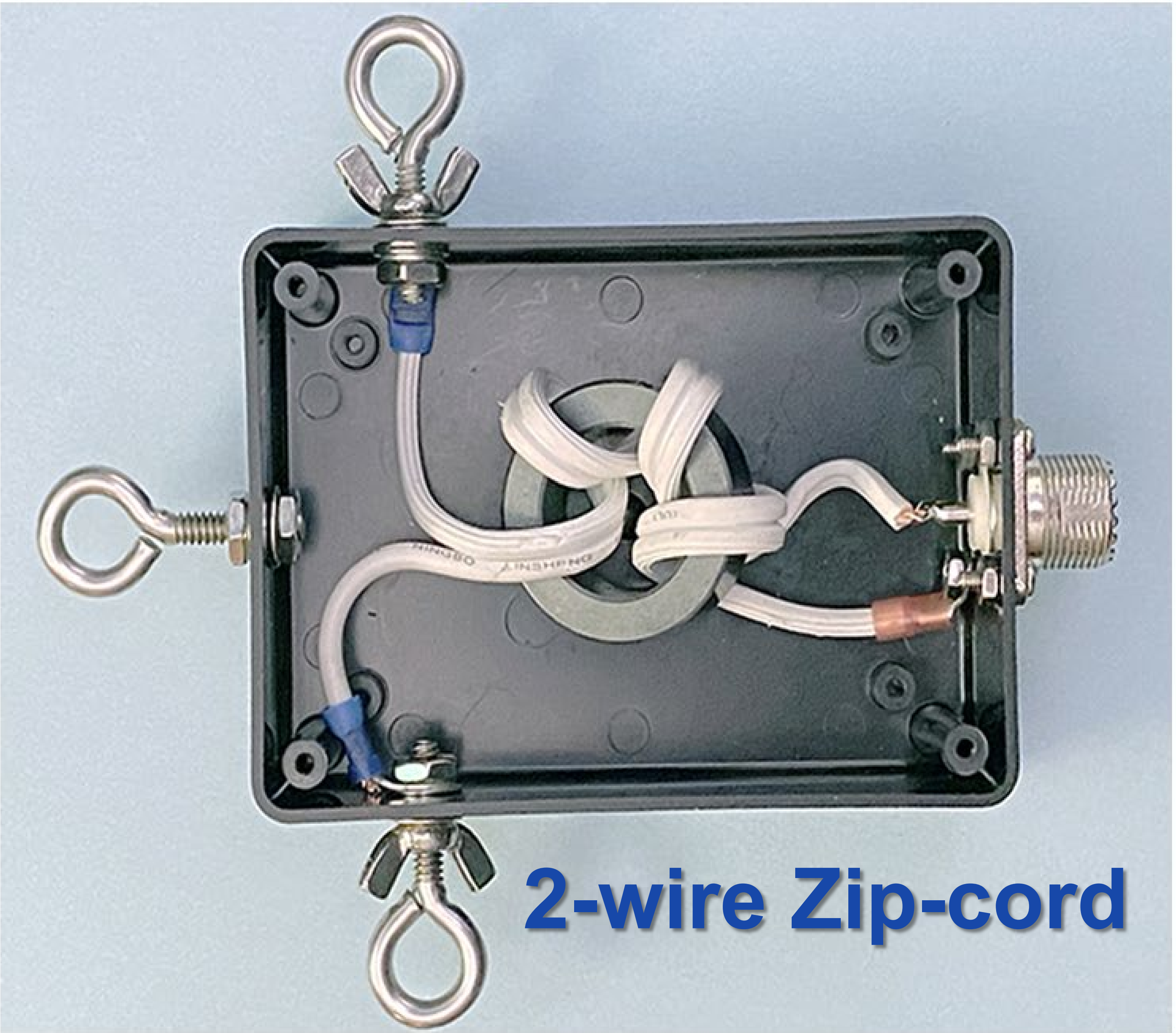
RESULT:

N = 4 – Number of turns

4 Turns

Let’s Build One

On the Air Magazine Jan-Feb 2023



PROJECT BUILD

Build a Balun

John Portune, W6NBC

Baluns are basic to ham radio, an essential piece of gear for the new and experienced ham alike. The May/June 2022 On the Air article "About Baluns" discussed the use of baluns as a way to have the best of both worlds, the ease of use that coaxial cable — an unbalanced feed line — offers, along with the low-loss benefits offered by the use of balanced feed line such as window line. In this article you will learn how to build the most useful type, a 1:1 ferrite choke balun. The basic meaning of the 1:1 ratio is that the balun makes no changes to the signal as it passes through the balun. A 1:1 balun affects an antenna system little more than a very short extension of the coax.

Power wise, this balun is rated for 100 watts maximum, ideal with a Technician license and a basic wire dipole for 10 meters. Eventually, when you upgrade your license, you can use this balun on any ham band 160 through 6 meters.

Other types of baluns, such as voltage baluns, phased coax baluns, and multi-ratio baluns (4:1 or 7:1) perform additional functions in specific situations. But for most applications, a 1:1 current choke balun of this simple design is satisfactory. Its operation is transparent to the antenna, as it is electrically only a small extension of the coax. It does, however, efficiently perform the basic job of all baluns, which is to prevent the negative consequences of unwanted RF current flowing on the outside of the shield of the coax. Use 1:1 choke baluns liberally on any antenna system that uses coax.

Combatting Skin Effect

One of the downsides of coaxial cable is that it has a tendency to let power from the transmitter get onto the outside of the coax's shield and cause undesirable consequences. Transmitter power that's traveling on the outside of the coax isn't getting to the antenna, and therefore the power of the signal is reduced — we call this loss.

Because of what electrical engineers call *skin effect*, radio frequency current (RF) flows only on the surface of conductors. Figure 1 shows the cross section of a coax cable coming from a transmitter (bottom), and connecting it to a dipole antenna (top). Note specifically that the shield of the coax has two surfaces — inner and outer.

Skin effect effectively divides the two surfaces of the shield into two separate conductors (shown here in blue and green), each capable of simultaneously conducting current in either direction. The arrows represent the flow of current on the surfaces of the coax — the inside and outside of the shield and the outside of the center conductor.

Materials and Tools

- (1) Plastic enclosure, approx. 3 ×4 ×1 inches
- (1) SO-239 chassis mount jack
- (4) 4-40 × ½ inch stainless screws and nuts
- (15 inches) Light-duty 120 V ac AWG 16 or 18 two-wire extension cord or clear two-wire vinyl speaker wire
- (1) FT-140-43 ferrite toroid
- (3) 10-24 × 1½ (1⁄16 inch) stainless eye bolts, nuts
- (9) 10-24 stainless washers
- (2) Solder or crimp-on ring terminal lugs for #10 screw
- (1) Solder or crimp-on ring terminal lug for #4 lug screw
- Clear silicone sealant
- Black electrical tape
- Wire cutter and stripper
- Electric drill and bits
- Needle nose pliers
- Screwdrivers
- Soldering iron (and solder) or terminal lug crimper
- Hot glue gun (Optional)

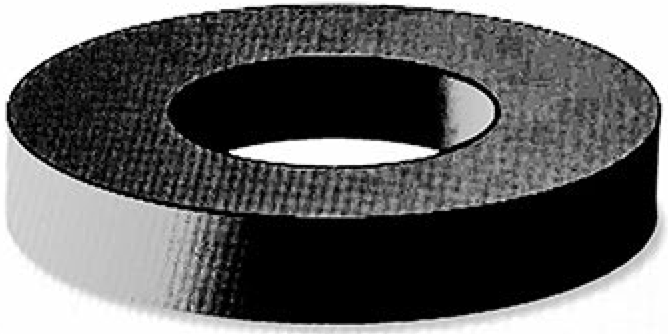
The finished balun in a small plastic box, with eye bolts on the sides for attaching antenna wire and a bolt on the top for suspending the balun.

Material type of the toroid – 61 **MIX 61 VHF**

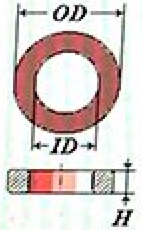
Dimension type of the toroid – FT-140 **1.4 in. Toroid 100 Watts**

Joe Ferrante K2TEK

FT-140-61



Available information about the toroid:
Initial magnetic permeability (μ): 125
Saturation flux density (B_s): 2400 Gs
Residual flux density (B_r): 1000 Gs
Coercive Force (H_c): 1.9 Oe
Curie Temperature: 350 °C
Dimensions (OD x ID x H): 35.6 x 22.9 x 12.7 mm
A_L factor: 140 nH/N²



ENTER THE INPUT DATA:

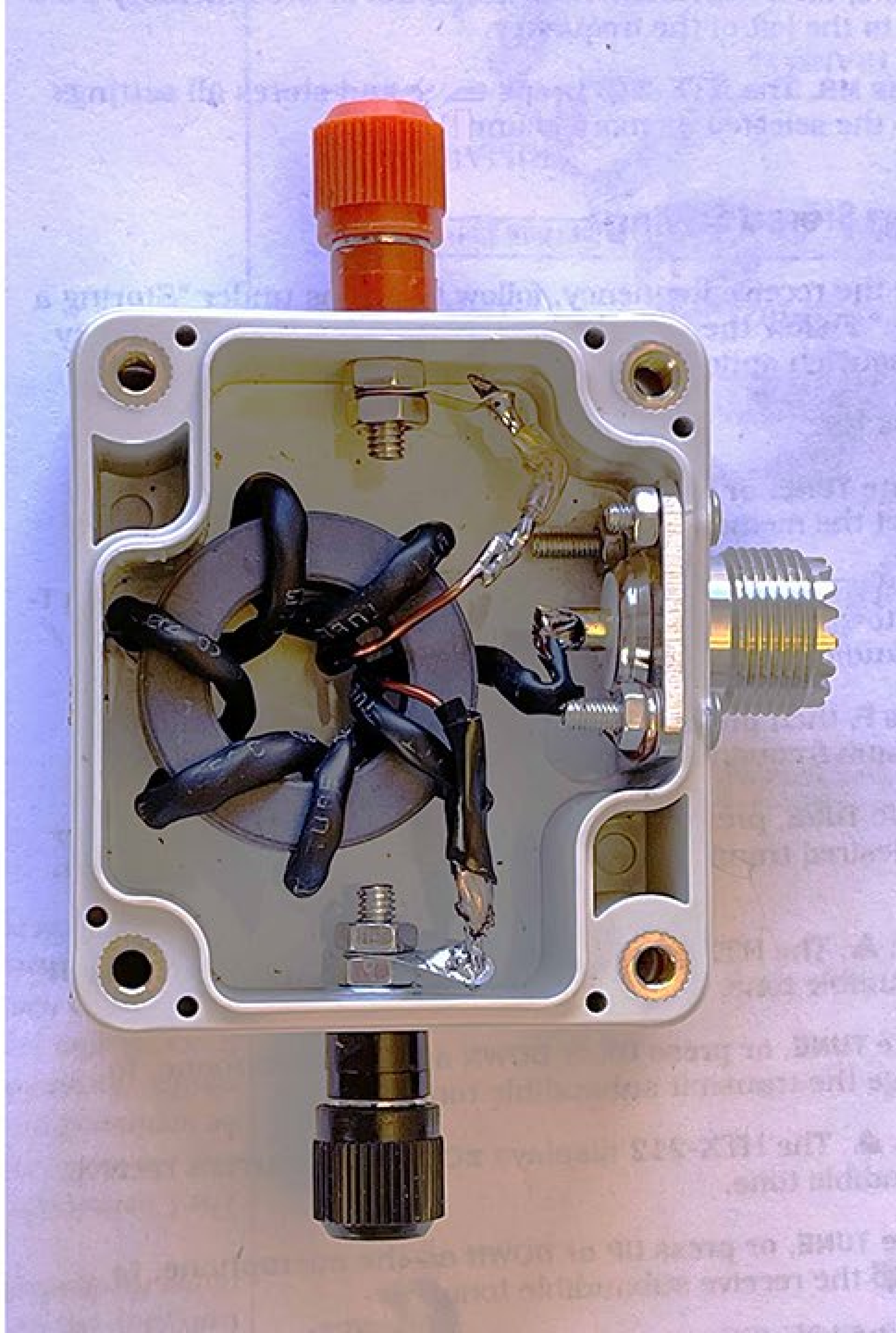
L = 4.5 μH – **Required inductance**

4.5 micro Henries

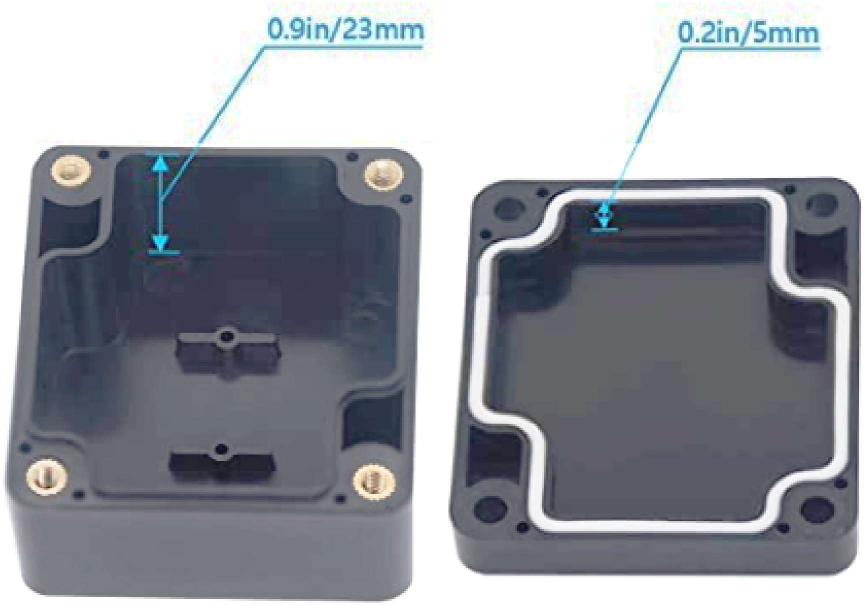
Calculate

RESULT:

N = 6 – Number of turns **6 Turns**



https://www.amazon.com/Zulkit-Waterproof-Electronic-Junction-Enclosure/dp/B07SBWQL18?th=1



Zulkit Waterproof Plastic Project Box ABS IP65 Electrical Junction Box Enclosure Black 2.48 x 2.28 x 1.38 inch (63 x 58 x 35mm)

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$6.99

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Size: **2.48" x 2.28" x 1.38"(Pack of 1)**

2.48" x 2.28" x 1.38"(Pack of 1) | 2.48" x 2.28" x 1.38"(Pack of 2) | 3.27" x 3.19" x 2.20"(Pack of 1)

3.27" x 3.19" x 2.20"(Pack of 2) | 3.94" x 2.68" x 1.97"(Pack of 1) | 3.94" x 2.68" x 1.97"(Pack of 2)

4.5" x 3.5" x 2.2"(Pack of 1) | 4.5" x 3.5" x 2.2"(Pack of 2) | 4.7" x 4.7" x 3.5"(Pack of 1)

4.7" x 4.7" x 3.5"(Pack of 2) | 6.22" x 3.54" x 2.36"(Pack of 1) | 6.22" x 3.54" x 2.36"(Pack of 2)

7.87" x 4.72" x 2.95"(Pack of 1) | 10.4" x 7.2" x 3.7" | 11.42" x 8.27" x 3.94"(Pack of 1)

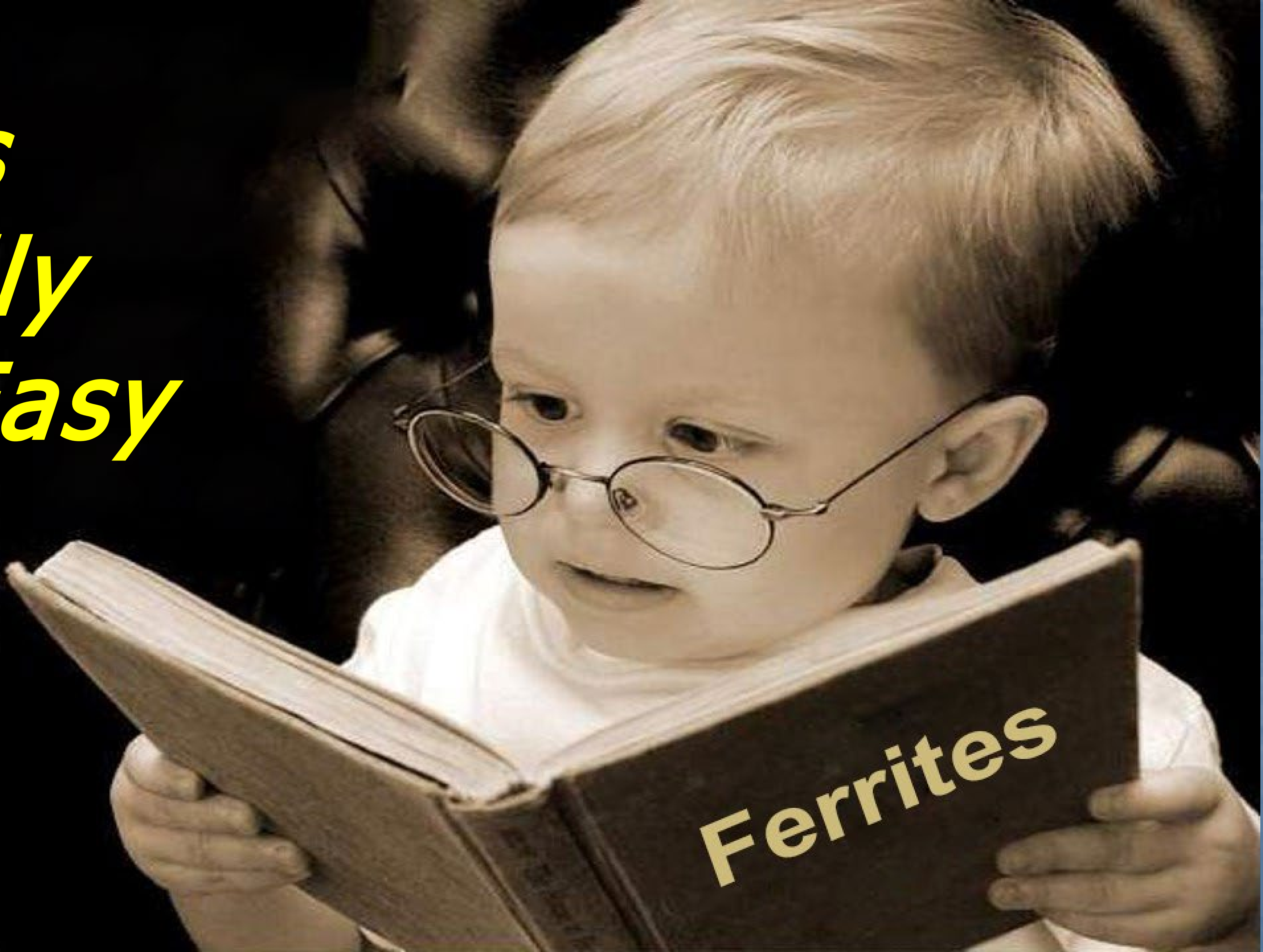
Only the smallest winding matters

1. Pick a toroid
   - Frequency – MIX 31, 43, 61
   - Power – SIZE FT-140, 240

2. Calaculate INDUCTANCE (µH)
   - AC resistance of 200Ω+

3. Convert µH to TURNS (calc.)

It's Really That Easy



https://coil32.net/online-calculators/amidon-ferrite-torroid-calculator.html

Input

Required inductance

L [ ] microhenry (μH)

Coil former diameter

D [ ] inch (in)

Diameter of wire without insulation

d [ ] inch (in)

Diameter of insulated wire

d_i [ ] inch (in)

Calculate Reset | Share

Output

Winding length

l [ ] cm

Number of turns

L [ ]

translatorscafe.com/unit-converter/en-US/calculator/coil-inductance/

For Coax "Ugly" Baluns

DØGGY

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