Identify the AL value of Ferrite/Iron core material by: ON7DY

The AL value is commonly used in the design of electronic transformers based on ferrite cores, for which the value is often given in nanoHenry.

The AL value is used widely with relation to magnetic cores made of soft ferrite. The name permeance is physically and mathematically synonymous with AL value, but is a more general term referring to a property of a given magnetic circuit.

Mathematically, the AL has the SI unit henry (H), but the the relationship to inductance is non-linear and the practical unit is nanohenry per square turn or nH/turn.

Therefore, to calculate inductance the AL value must be multiplied by the square of the number of turns N, because it is defined as:

Units and equations

$$A_L = \frac{L}{N^2} \quad (\text{H/turn}^2) = (\text{H})$$

So the AL value for a given core can be calculated if the number of turns is known and the inductance can be measured.

Practical use

In the design of transformers and inductors for switch mode power supplies the switching parameters and power level dictate the values of inductance required for such component.

Therefore, the value of inductance is known for the next design step. Using the AL value allows for a quick calculation of the required number of turns for a given core size.

It should be noted that the AL value is often given in the units of (nH) or similar, with the “per square turn” implied. It is important to remember that the relationship between the AL value and inductance is not proportional, due to the squared turns.

The AL value is especially useful when designing with gapped cores, for instance for gapped inductors or flyback transformers. Under normal conditions the air gap stores all the energy and dictates the effective permeability of the magnetic core.

For a simplified case of a uniform magnetic circuit the inductance can be calculated from the following equation:

$$L = \frac{N^2 \cdot \mu_0 \cdot \mu_r \cdot A}{l} \quad (\text{H})$$

where: N - number of turns, μ0 - magnetic permeability of free space (H/m), μr - relative permeability of the material (unitless), A - cross-section area (m2), l - magnetic path length (m).

The above equation can be rewritten as:

$$L = N^2 \cdot C_x$$ where: $$C_x = \frac{\mu_0 \cdot \mu_r \cdot A}{l}$$

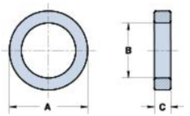
And by comparing the equations it can be seen that the value Cx=AL and it is a constant for a given magnetic core of fixed parameters, as long as the effective magnetic permeability is not affected (e.g. saturation is avoided).

Therefore, if the manufacturer provides the AL this simplifies the calculations.

<u>Referenties of FT240 AL values:</u>

FT240-31 AL=3180   FT240-43 AL=1075   FT240-52 AL=330   FT240-62 AL=170

Physical Dimensions



OD(A) = 2.40 in / 61.0 mm +/- 1.30 mm
ID(B) = 1.40 in / 35.55 mm +/- 0.85 mm
Ht(C) = 0.50 in / 12.7 mm +/- 0.50 mm

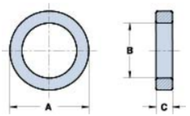
A_L=3180 +/- 20 %   uH=(A_L*Turns^2)/1000
Actual measured AL using 10 turns #28 wire

Temperature Stability (ppm /°C) = 16000

Color Code = black

Application Freq Range
Wideband Transformers 1 - 300 MHz
Power Transformers 0.5 - 30 MHz
RFI Suppression 1 - 500 MHz

Physical Dimensions



OD(A) = 2.40 in / 61.0 mm +/- 1.30 mm
ID(B) = 1.40 in / 35.55 mm +/- 0.85 mm
Ht(C) = 0.50 in / 12.7 mm +/- 0.50 mm

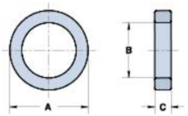
A_L=1075 +/- 20 %   uH=(A_L*Turns^2)/1000
Actual measured AL using 10 turns #28 wire

Temperature Stability (ppm /°C) = 12500

Color Code = shiny black

Application Freq Range
Wideband Transformers 5 - 400 MHz
Power Transformers 0.5 - 30 MHz
RFI Suppression 5 - 500 MHz

Physical Dimensions



OD(A) = 2.40 in / 61.0 mm +/- 1.30 mm
ID(B) = 1.40 in / 35.55 mm +/- 0.85 mm
Ht(C) = 0.50 in / 12.7 mm +/- 0.50 mm

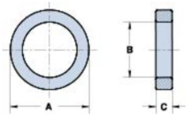
A_L=330 +/- 20 %   uH=(A_L*Turns^2)/1000
Actual measured AL using 10 turns #28 wire

Temperature Stability (ppm /°C) = 2000

Color Code = dull black

Application Freq Range
Wideband Transformers 10 - 500 MHz
High-Q Inductor 0.1 - 5 MHz
RFI Suppression - above 10 MHz

Physical Dimensions



OD(A) = 2.40 in / 61.0 mm +/- 1.30 mm
ID(B) = 1.40 in / 35.55 mm +/- 0.85 mm
Ht(C) = 0.50 in / 12.7 mm +/- 0.50 mm

A_L=170 +/- 20 %   uH=(A_L*Turns^2)/1000
Actual measured AL using 10 turns #28 wire

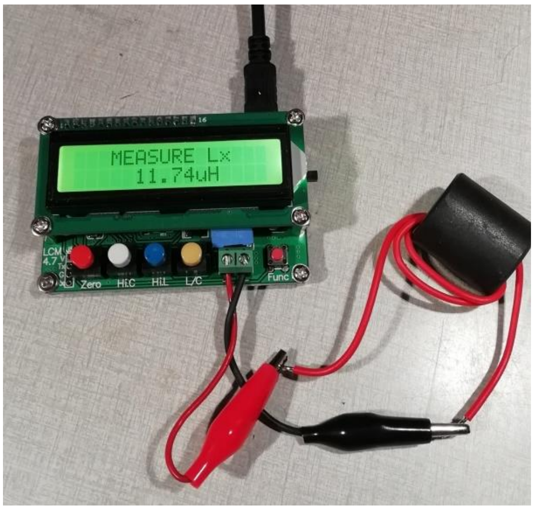
Temperature Stability (ppm /°C) = 1000

Color Code = dull black

Application Freq Range
Wideband Transformers 20 - 500 MHz
High-Q Inductor 0.2 - 10 MHz
RFI Suppression - above 20 MHz

<u>Example:</u>

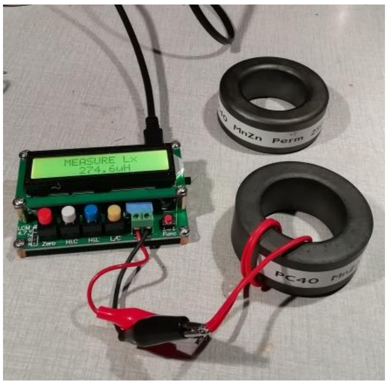
We have an unknown Ferrite – wind 3 turns wire – measure the L value – see picture

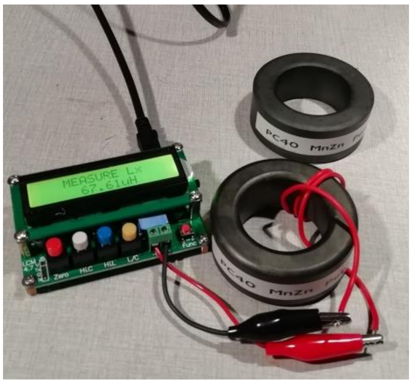


The L value =11.74 microHenry <u>we have to convert alway's to nanoHenry</u> so its 11740 nanoHenry

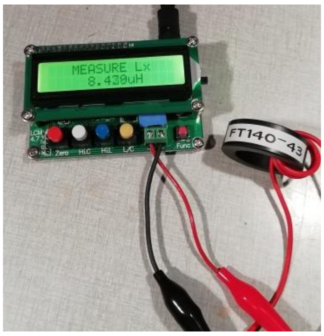
Using the formula AL= L/Turns² AL= 11740 /9 = 1304 so looking the AL references its close to 43

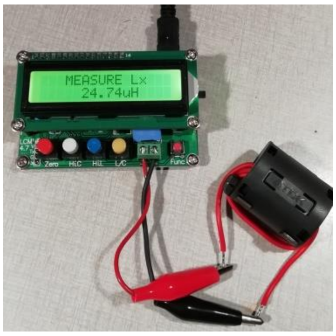
On hand of this method we can compare different Ferrite's from different suppliers/brands



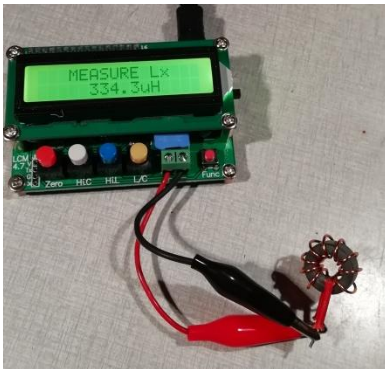


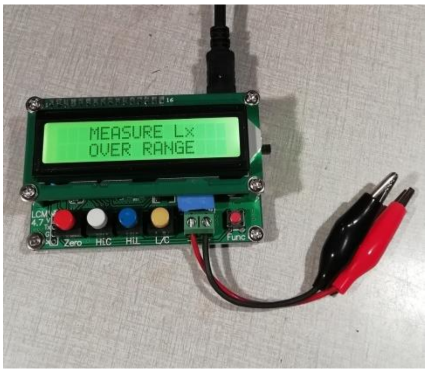
Examples:





L= 8.430 AL= 930 L= 3.904 AL= 437 L= 24.74 AL= 2740 TDK L=11.64 AL= 1295 Chinees





L= 334.3 LA= 4127 (number turns 9) L= 13.44 LA = 1493

Testing Iron cores: the number of turns must be high e.g. 10

L = 2.411 AL = 267

A general thumb: For choke construction the AL value must be high, for transformer build low

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