

## WAIRL \* AIR WOUND SINGLE LAYER INDUCTORS

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The inductors in every L-C filter design must be given serious attention in order to ensure good performance. The inductors are the weakest link with respect to "Q" and insertion loss.

As a general rule, the bigger the physical size of an air wound single layer coil is made, the higher the "Q". The "Q" is also related to the winding pitch (turns per inch) and aspect ratio (length to diameter).

The WAIRL.EXE program have been developed to design air wound inductors in such a way as to allow full control of these parameters. It is screen formatted to allow the effects on all other parameters to be seen when any one is changed.

A double iteration scheme is used. The first will find the exact number of turns required to give the required inductance with the winding data you suggest. Then, the number of turns is changed to the nearest integer number and the length is adjusted to compensate in a second iteration. All results are then presented along with any warnings.

NOTE: The inductors designed by this program should be closewound and installed in your filter still closewound. This will cause your filter to be low in frequency when first tested. The very act of tuning the filter up to the correct frequency by spreading the turns will yield the correct winding pitch that your have design for. Do not spread the coil in advance unless it is not possible to do otherwise.

To install the program simply create a desktop shortcut icon from Windows explorer. Simply double-click the icon to run the program.

As a sample design, let's design an inductor for use at 150 MHz to yield .1 uH (100 nHy).

Required inductance (nHy.)?  
[ 100 \_\_\_\_\_ ] [OK]

Select the [OK] button or press the <Enter> key.

American Wire Gauge number (AWG)  
or wire diameter (In.)  
(A number less than 1.0 is wire diameter)  
[ 24 \_\_\_\_\_ ] [OK]

Frequency (MHz.)  
Frequency at which Q information is desired.  
[ 150 \_\_\_\_\_ ] [OK]

The window will open and present:

eXit   winding Pitch   form Dia.   wire Gauge   Frequency   Start over   Value  
  
> Air Wound Single Layer Inductor <

-> Wire dia. <-  
[Down]      [Up]

-> Form dia. <-  
[Down] [Auto] [Up]

Winding pitch :    Default setting  
Wire gauge =       24  
Closewound =    46.2669 turns / In.  
Range set =      0.75 - 0.85  
Frequency =    150.0 MHz.  
Diameter =      0.1360    (Auto)

ALK Engineering                      Turns =       7.0000  
Version 4.0                      Turns / In. =    33.3856 <--(0.72)--> Stretched !  
   Length =      0.2097  
   Approximate Qu = 239.5540  
   Length / Form dia. =    1.5411  
Self resonance (GHz.) =    1.1730  
Inductance (nHy.) =    99.9999

The top menu may be used by your mouse but the key letters for each item are activated a hot-keys. You need only to press the capitalized key letter to bring up the prompt for that item. To change the diameter of the coil form to .125 in. for example, you would respond:

-> D.125 <Cr>

Simply entering the command alone brings up a dialog box prompt

## **The menu items**

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### **winding Pitch**

Lower and Upper - Change Upper or Lower winding pitch limits

Allows the winding pitch range to be changed. The first iteration will calculate the number of turns for a turn spacing midway between the extremes you specify. A good starting place is a range that, midway between them, will be about 80% of closewound, or a winding pitch of .8 (This is provided automatically by the automatic winding pitch mode). Closewound is the tightest winding possible, that is, each turn touches the one next to it. The turns per inch value for a closewound coil is shown for the wire gauge you request.

Default limit range

This sets the pitch range to 0.75 to 0.85 of closewound

Threaded form

The minimum and maximum winding pitch limits you specify may be the same. In this case, the exact number of turns may be calculated for an inductor to be wound on a threaded form. This causes the second iteration (the one that forces the integer number for turns) to be bypassed. If you specify 0, or <Enter> after the U, L or D, the program to the "Auto" mode.

**form Dia** - Change the coil form Diameter

Coil form diameter is specified in inches. The "form" can be a removable winding mandrel such as a drill bit. The form diameter is adjusted internally to give the inductance formulas used the wire center-to-center diameter needed. You can press the Form dia [Auto] button at any time to return to the automatic diameter mode. Auto diameter mode is turned off when you manually specify a form diameter. Auto mode will adjust the length to diameter of the inductor to get a 1.5 to 1 ratio before the second iteration is done to force an integer number of turns. This means that some manual adjustment to the diameter may be necessary. Three mouse buttons are provided to control the form diameter. [Down], [Auto] and [Up]. These will adjust the form diameter to standard drill bit sizes from numbered drill #60 through #1. Above that, drill sizes increase in 1/32 Inch increments to 1 Inch diameter.

**wire Gauge** - Wire Gauge or diameter

This command allows the wire diameter to be changed. Any number specified that is 1 or greater is taken to be a AWG number and the wire diameter is calculated internally. If a number is specified that is less than 1 it is assumed to be a wire diameter. For example, if .125 is keyed in, the program will design for 1/8 inch

diameter wire. A coil wound of 1/8 inch O.D. copper tubing could be designed like this. The maximum turns per inch possible (closewound) is calculated and presented. This closewound number is adjusted for the insulation thickness normally found on enamel or "poly" wire. Wire gauge may be adjusted up or down using the [Down] and [Up] mouse buttons also provided.

### **Start over**

Allows a re-run from start for an entirely new problem.

### **Frequency**

This is the frequency at which the coil is to be used. It is necessary to estimate the unloaded "Qu" of the coil.

### **inductance Value**

Use this to design a different inductor using nearly the same wire and form size.

### **Warning messages**

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There are several warning messages that will appear to help in the event a design is not reasonable. These are:

The LOWER limit on winding pitch has been exceeded, The coil has been stretched beyond the lower limit THAT YOU HAVE SET when the second iteration rounded the number of turns UP. The actual pitch is displayed.

**<--(##)--> Stretched !**

The UPPER limit on winding pitch has been exceeded, The coil has been compressed beyond the upper limit THAT YOU HAVE SET when the second iteration rounded the number of turns DOWN. The actual pitch is displayed.

**-->(##)<-- Squashed !**

If the iterations compress the winding pitch tighter than closewound, (which is impossible) this message will appear:

**Tighter than closewound !**

In the event the coil length is suspicious, these warnings may appear. These two should be considered less important than the unloaded Q.

**<-- Short ?**

Coil is short and "fat":

**<-- Long ?**

Coil is too long relative to its diameter:

In the event you have entered parameters that are so unreasonable that the iterations are totally stumped the program will simply terminate.