

# FERRITE CORE ROUND WIRE COIL INDUCTOR TAKES THE LEAD

## Introduction

Iron powder (IP) core flat coil inductors have become the default choice of design engineers that need to meet low inductance (0.4uH – 10uH) requirements at high current (10A – 40A). However, these inductors are commonly designed into applications which do not require the very low profile offered by the flat coil inductor at a price premium. Indeed, the flat coil inductor was originally developed for mobile computing applications where the critical requirements differ from that of data communications applications.

The IP flat coil inductor's characteristics do not yield an optimum inductor design for the modern high frequency Switch Mode Power Supply (SMPS). An alternative winding technology and material choice is presented to reduce the cost and increases the performance while using the additional available height. Finally a direct comparison between the IP flat coil inductor and the new inductor validates this performance enhancement in a real application.

## The Optimized Inductor

The optimum inductor design can be best derived by considering the features, benefits and limitations of the present IP flat coil solution. This solution is constructed from a helical coil, wound from rectangular cross section wire, and surrounded by IP material. The rectangular cross section wire provides an excellent core fill factor. With the low inductance achieved by a few turns, the winding has low DC resistance ( $R_{dc}$ ) in a very low profile.

In applications where this is not a requirement, the same  $R_{dc}$  per turn can be achieved in a coil using standard round wire of the same cross section. The height of the round wire coil (RWC) is greater, but with the immediate benefit of a much reduced coil cost.

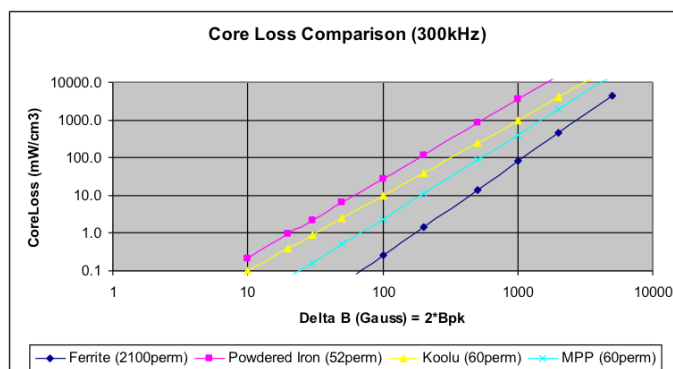
The IP material can support large currents without saturation. The saturation current of an IP flat coil inductor can be significantly higher than the rated heating current. This is an advantage for computing applications where the power supply may need to provide high currents for a short duration. However, in data communications SMPS applications, this feature is not useful as the peak (or ripple) current is typically a fixed percentage of the RMS current. A better solution is one where the saturation current is just a little larger than the heating current.

The IP material has relatively high core losses. A comparison of available magnetic materials shows that there are superior options, especially when considered that inductors in data communications applications typically have higher Volt-Time drops, which generate a larger core excitation when compared to the low voltage drops in computing applications. The increased magnetic excitation (Delta B) generates significantly higher core losses, particular at higher switching frequencies (*see Fig. 1*).

Finally, the IP material has an inherent tendency to degrade when continuously subjected to elevated temperature in excess of 100°C over a long period of time. While this not a concern for mobile computing applications which need to operate at a lower ambient temperature, the feature of thermal aging is a real issue for applications where components are required to have an operating temperature range up to 125°C. Higher grade IP materials are available, but this further increases the cost of the component.

In comparison, ferrite material does not suffer thermal aging, is low in cost and offers 10% of the core losses of IP material. Significant performance enhancement arises from selecting this material.

**Fig. 1 Core Loss Vs Delta B for different core materials**

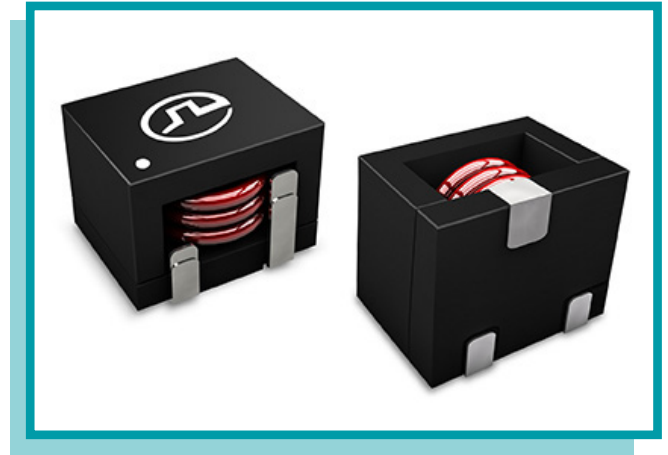


## The Ferrite Round Wire Coil Inductor

The optimization process is incorporated into the ferrite round wire coil inductor demonstrated in *Fig 2*.

Some additional attractive features include

- Flattening and self terminating of the coil ends for increased reliability
- Dummy third pin for increased mechanical stability
- Less turns compared to IP equivalent, lower  $R_{dc}$
- Tighter  $R_{dc}$  tolerance
- Optimized core design based on coil dimensions further reduces core losses
- Possible to increase number of winding turns/larger inductance range



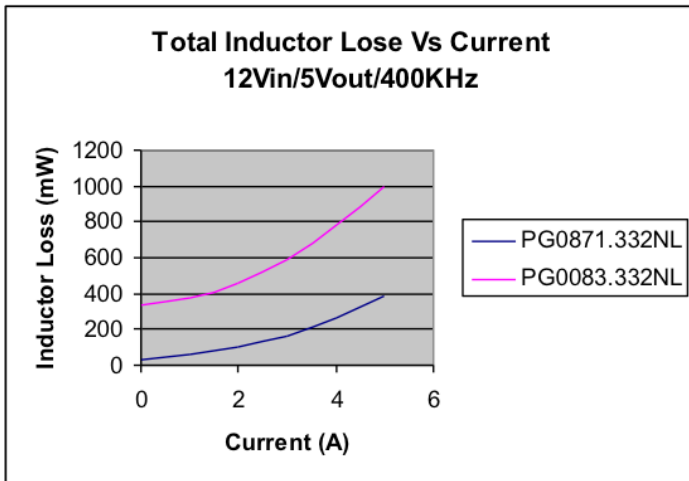
**Fig. 2 The Ferrite Round Wire Coil Inductor**

## Ferrite RWC Vs IP Flat Coil Performance Comparison

**Table 1 RWC Vs Flat Coil Electrical Comparison**

Pulse Part Number	Type	$R_{dc}/m\Omega$	$L @ I_{rated} (\mu H)$	$I_{RMS} (A)$	$I_{SAT} (A)$
<b>PG0083.332NL</b>	Flat Coil	26.6	2.6	5.8	9.5
<b>PG0871.332NL</b>	Ferrite RWC	7.1	3.0	7.1	9.5

*Table 1* shows the electrical specification of two inductors of comparable size (7.5mm x 7.5mm). The height of the RWC is 6.4mm, while the flat coil equivalent is 3.2mm.



**Fig. 3 Total Inductor Losses Vs Current comparison for RWC and Flat Coil**

The RWC features a significantly lower  $R_{dc}$  and the saturation current is optimized to 30% greater than the heating current. Considering a typical end application as outlined in *Fig. 3*, this and the reduced core losses significantly reduce the total inductor losses.

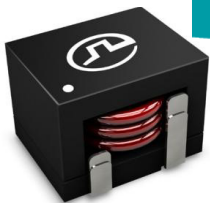
## Conclusion

The development of a new type of wound inductor was motivated by the need to offer a lower cost solution for low-inductance, high-current requirements to the data communications market compared to currently available product offerings. The RWC inductor achieves this by reducing the cost of the winding technology. The selection of a ferrite core material brings the additional benefit of improved performance and an increased operating temperature range.

The following is an overview of the available Pulse RWC inductors.

Written By: Gerard Healy

# Round Wire Coil SMT Power Inductor



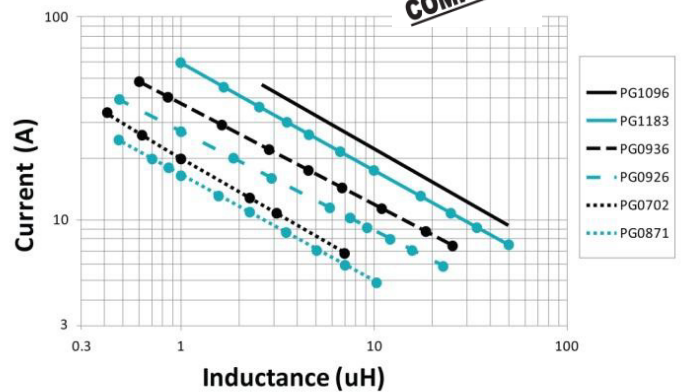
## Application

SMPS for:  
DATACOM / TELECOM  
Home Automation  
Smart Grid  
Computing  
Industrial Controls



## Features and Benefits

- Inductance range: 0.30uH to 50uH
- High efficiency inductors with low loss ferrite material
- Lower cost alternative to Flat Coil inductors
- Sizes: 8X7X6.4mm to 26x26x14.8mm
- No thermal aging effects



Pulse P/N	PG0871	PG0702	PG0926	PG0936	PG1083	PG1096
Size (mm)	8 x 7 x 6.4	11 x 9 x 8	13 x 13 x 8	18 x 17 x 10	22 x 22 x 12.5	26 x 26 x 14.5
PAN Size	700	500	300	200	100/120	60

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