



Ferrite core round wire coil inductor takes the lead

by Gerard Healy, Pulse (<http://pulseelectronics.com>)

Introduction

Iron powder (IP) core flat coil inductors have become the default choice of design engineers that need to meet low inductance (0.4uH – 22uH) 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).

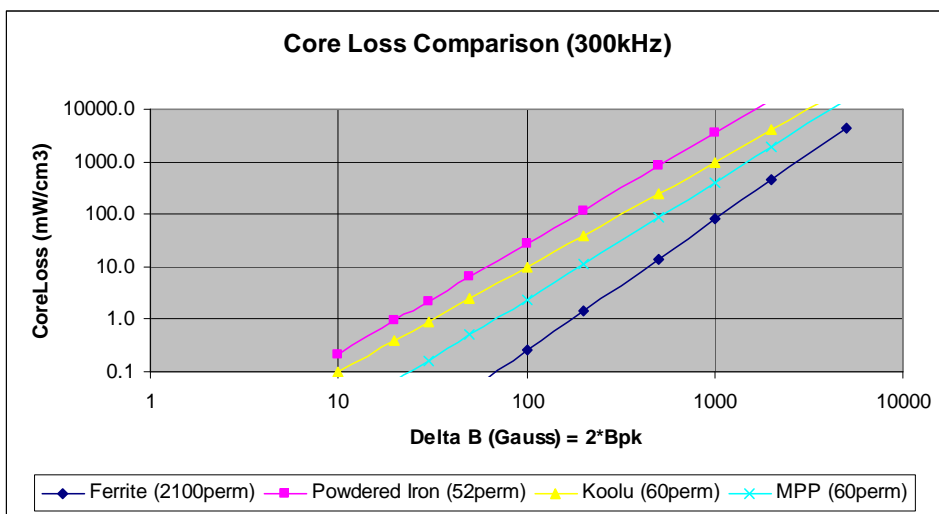


Fig. 1 Core Loss Vs Delta B for different core materials

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.

The Ferrite Round Wire Coil Inductor

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

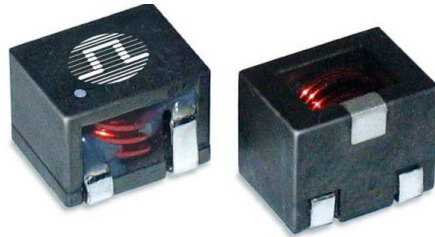


Fig. 2 The Ferrite Round Wire Coil Inductor

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

Ferrite RWC Vs IP Flat Coil Performance Comparison

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.

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

Table 1 RWC Vs Flat Coil Electrical Comparison

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.

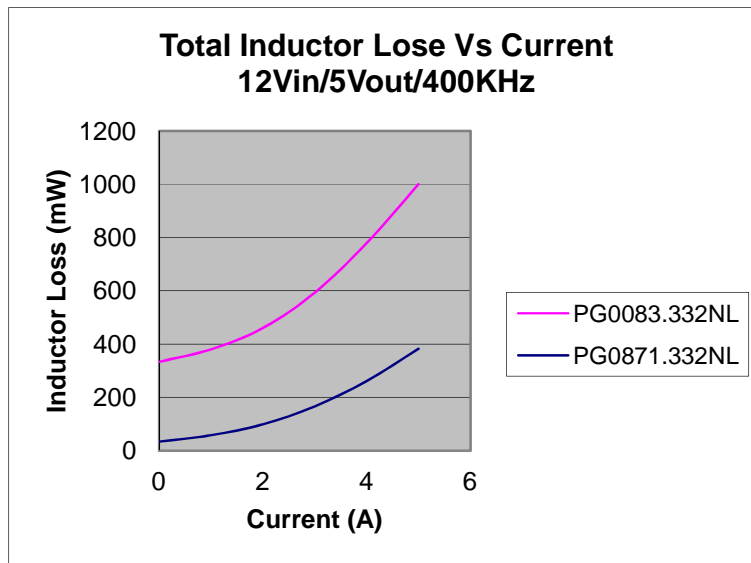


Fig. 3 Total Inductor Losses Vs Current comparison for RWC and Flat Coil

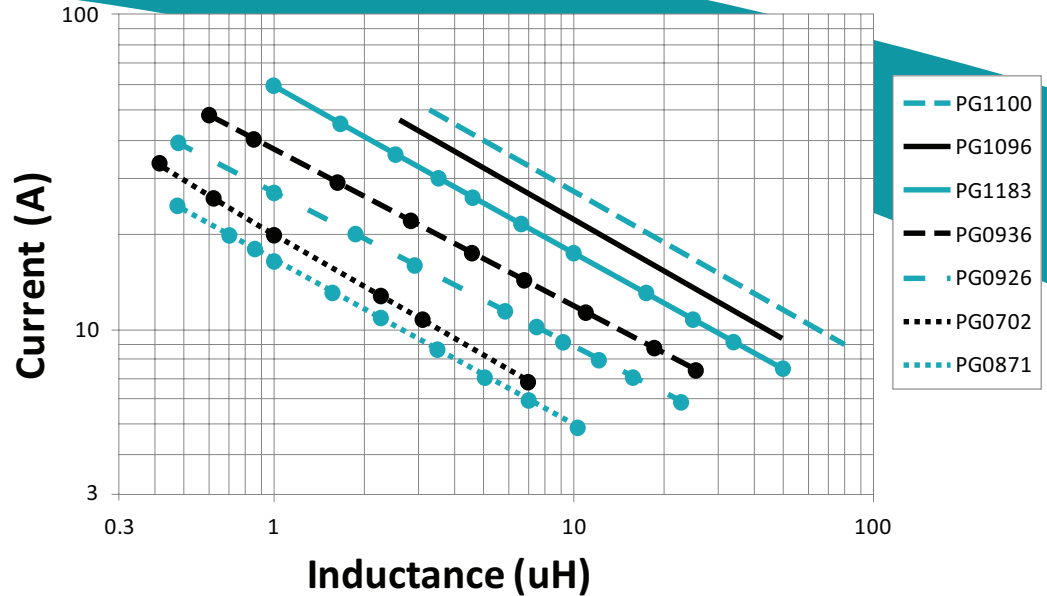
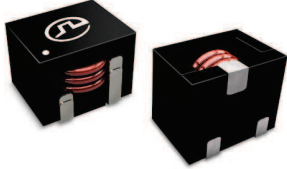
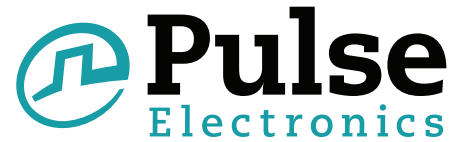
Conclusion

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

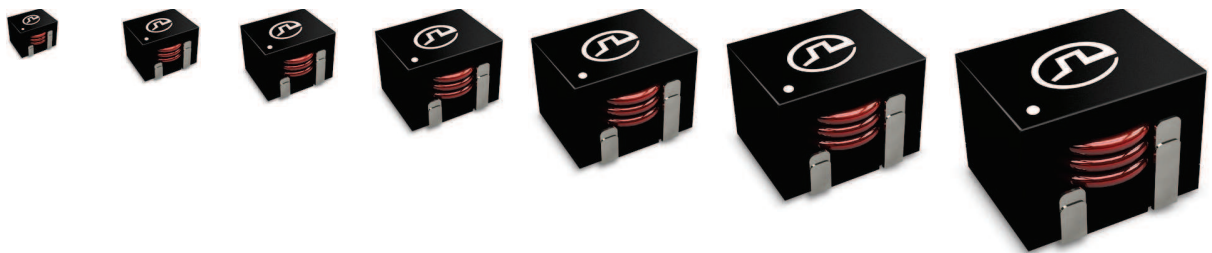
Product Overview

Round Wire Coils



- High efficiency for datacom, computing, industrial applications
- Inductance Range: 0.47uH to 80uH
- Sizes 8x7x6.4mm - 32x31x15.5mm
- Low DCR
- Low loss ferrite material
- No thermal ageing

Pulse P/N	PG0871	PG0702	PG0926	PG0936	PG1083	PG1096	PG1100
Size (mm)	8x7x6.4	11x9x8	13x13x8	18x17x10	22x22x12.5	26x26x14.5	32x31x15.5



For More Information

Pulse Worldwide Headquarters
12220 World Trade Drive
San Diego, CA 92128
U.S.A.

Pulse Europe
Zeppelinstrasse 15
71083 Herrenberg
Germany

Pulse China Headquarters
B402, Shenzhen Academy of
Aerospace Technology Bldg.
10th Kejian Road
High-Tech Zone
Nanshan District
Shenzen, PR China 518057
Tel: 86 755 33966678
Fax: 86 755 33966700

Pulse North China
Room 2704/2705
Super Ocean Finance Ctr.
2067 Yan An Road West
Shanghai 200336
China
Tel: 86 21 62787060
Fax: 86 2162786973

<http://www.PulseElectronics.com/download/3789/g044>

Pulse South Asia
135 Joo Seng Road
#03-02
PM Industrial Bldg.
Singapore 368363

Pulse North Asia
3F, No. 198
Zhongyuan Road
Zhongli City
Taoyuan County 320
Taiwan R. O. C.
Tel: 886 3 4356768
Fax: 886 3 4356823 (Pulse)
Fax: 886 3 4356820 (FRE)

Tel: 858 674 8100
Fax: 858 674 8262

Tel: 49 7032 7806 0
Fax: 49 7032 7806 12

Tel: 65 6287 8998
Fax: 65 6287 8998

Performance warranty of products offered on this data sheet is limited to the parameters specified. Data is subject to change without notice. Other brand and product names mentioned herein may be trademarks or registered trademarks of their respective owners. © Copyright, 2013. Pulse Electronics, Inc. All rights reserved.