



Application Note

Advantages of Flat Wire Inductors for High Frequency, High Current Designs



SRP4020



SRP7030F

As electronics become faster and smaller it is important that the components scale appropriately, and inductors are no exception. Because the inductors are wirewound, the solution to providing a highly conductive wire in the most compact package possible for high frequency applications is to change the shape of the wire. Bourns has found that if the shape of the inductor wire is altered from the standard round shape, which is classified by larger packages, to the flat wire shape, then more efficient current conduction at high frequencies is possible. The extensive portfolio of the SRP inductor series offered by Bourns has been expanded with flat wire inductors that have powdered iron cores directly molded to the wire. These inductors are available in a vast range of inductance values and provide an optimal solution for designs that require high frequencies and high current.

Introduction to Inductors

Inductors have been used as energy storage devices in DC-DC conversion circuits for decades. Buck, boost, and buck-boost converters each require one inductor and other types, like SEPIC, require a pair of inductors. An inductor works in two ways depending on the position of the switch in the DC-DC conversion circuit. When the switch is turned on, the inductor charges while current is turned into magnetic flux stored in the inductor. When the switch is turned off, the magnetic flux collapses and is transformed back to electrical current to provide power to the load. Therefore, the wire conductor in the inductor is in use at all times. Thus, having an efficient wire is essential in high power and high frequency designs.



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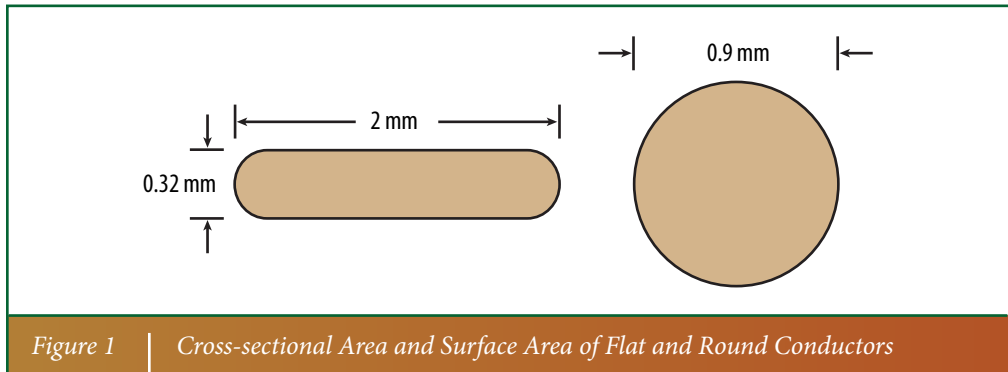


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Round versus Flat

Typically, round wire conductors are used in low frequency inductor designs. However, the conductor is subject to the “skin” effect at high frequencies, where electrons travel along the surface area of the conductor rather than through the entire cross section. This means there is larger AC resistance in round wire working in high frequency applications. For DC-DC converters with higher current and frequency requirements it may be necessary to move to a high current shielded flat wire inductor solution.

The Bourns® SRP line of shielded inductors offers several flat wire alternatives for high current, high frequency designs. While the cross-sectional area is the same for the flat and round wire as shown in figure 1 below, the surface area of the flat wire is approximately 60 % greater.



This provides a larger area for the current to flow to combat the skin effect at frequencies up to 5 MHz and reach higher inductance values. Higher current values also are possible with flat wire construction. For example, a Bourns® SRP7030F flat wire inductor has a 7 mm footprint and 3 mm height, which is the same footprint as the conventional Bourns® SRP7030 round wire inductor, though the Bourns® SRP7030F maintains a higher level of inductance as the current increases.



SRP4020



SRP7030F

Designed for Efficiency

The compact flat wire inductor is designed for efficiency. Flat wire has a high winding factor of 95 %, so only 5 % is unused space in the gap between each winding compared to 30 % unused space in round wire. Figure 2 illustrates the space savings achieved by the high winding factor with minimal wasted space in the flat wire cross-section.

The powdered iron core of the Bourns® SRP flat wire is molded to the flat wire directly, which provides a double benefit. In addition to the conductivity of the conductor being increased at high-frequency operation, there is no wasted space as may be the case in round wire designs. Figure 3 shows the cross-section of two inductors and the advantage of saved space around the flat wire design with its powdered iron core.

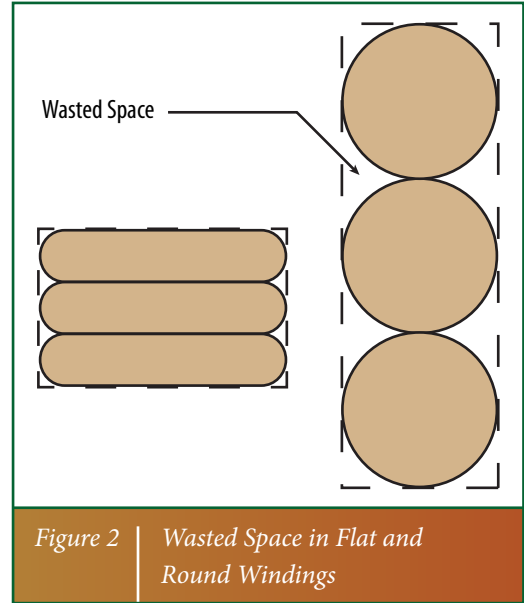


Figure 2 | Wasted Space in Flat and Round Windings

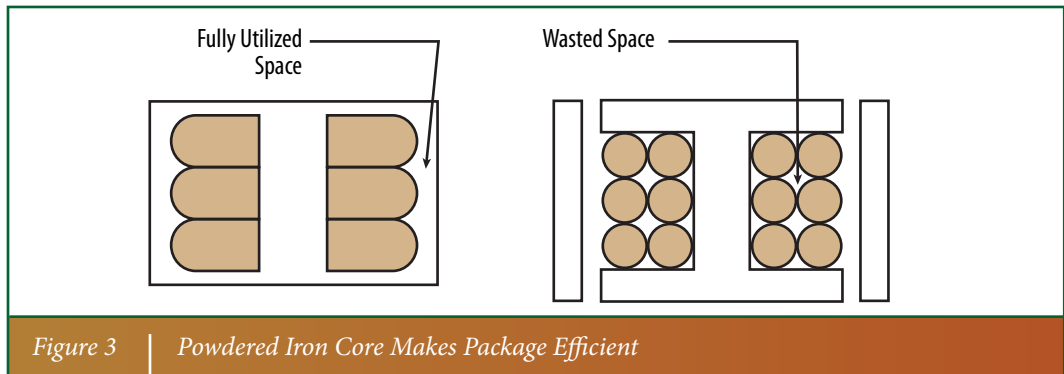


Figure 3 | Powdered Iron Core Makes Package Efficient

This technology allows for a smaller package and greater efficiency, with inductance values currently available to 47 μ H. Bourns® SRP inductors have high saturation currents to 60 A, the values of which are related to the inductance drop. The compact packages are available in footprints as small as 4.8 mm square to 14.8 mm square, and heights from 2 mm to 7 mm. Rated current values, which are based on temperature, are available up to 46 A.

Bourns continues to add to Bourns® SRP inductor product families. The recently released Bourns® SRP4020 inductor measures 4 mm square by 2 mm tall and provides 0.22 - 2.2 μ H inductance up to 10 A. Also released recently, Bourns® SRP7030F inductor has a 7 mm footprint and 3 mm height, providing 0.1 - 10 μ H at current levels up to 32 A. The roadmap for Bourns® SRP inductors will offer customers larger components for higher current such as one with a 20 mm footprint that provides a 150 A saturation current. Similarly, smaller inductors are also planned that will provide down to a 3 mm footprint with a 10 A saturation current.

Design Resources

Implementing an inductor that features a flat wire conductor is no different than designing with an inductor featuring a round wire conductor. It is still an inductor, though the difference is evident with smaller package sizes and higher possible rated currents. Selecting the right flat wire inductor will depend on the specification requirements of a particular application, and several resources are available to assist in determining the appropriate part. An example of a DC-DC buck converter circuit is shown below, where L is the inductor.



SRP4020



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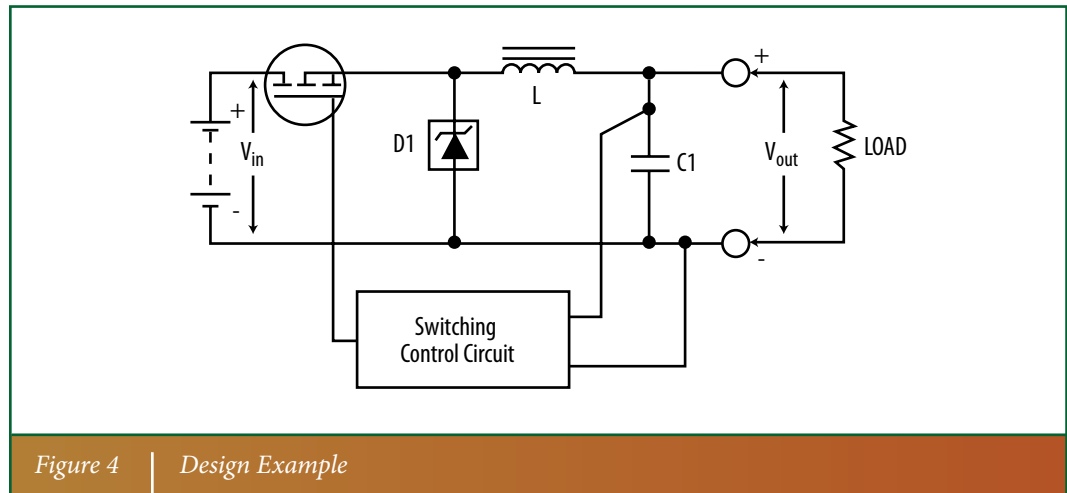


Figure 4 | Design Example

An online program for DC-DC converter designs can be found on many switching controller manufacturers' websites, such as Webench[®] by National Semiconductor Corporation (NS). The designer is prompted for details of the design including the power supply input and output voltages, output current, and efficiency. The program then suggests which NS chipset to use and provides a database from which to select auxiliary components. Bourns[®] inductors are built into the Webench[®] database, allowing the designer to choose an inductor for the converter design before navigating away from the design page. Similarly, Texas Instruments (TI) offers SwitcherPro[™], a program that includes a database of all Bourns[®] surface mount inductors to support TI's chipsets in converter designs.

In addition, Bourns has its own parametric search tool on its website. The designer is prompted for the inductance and rated current, and the program then suggests a series of components that will match the requirements. Examining the datasheets for that series will allow the designer to fine tune the selection of the inductor.

Finally, seven types of designers' kits are ready to ship from Bourns to support new designs, and additional types are pending release. Designers can contact a Bourns representative to obtain a kit for use with a new design.



SRP4020



SRP7030F

Conclusion

Since applications continually are demanding higher current and lower DC resistance, Bourns® SRP family of inductors offers customers an optimal solution with its flat wire technology and powdered iron core construction. The flat wire technology at high frequencies is able to take advantage of its large surface area to create low resistance paths for electrons to flow. These inductors are smaller, more efficient in terms of inductance as current rises, and allow higher inductance values. With larger and smaller series planned, the right inductor for a given design is likely among the Bourns' portfolio.

Benefits of Bourns Inductors

Bourns has been a leader in inductive products consistently for decades, remaining competitive with trends and advancements in electronics. Thus, Bourns is a trusted name to be considered in new DC-DC converter designs or any other design requiring a surface mount inductor. With over 2,000 standard parts alone to choose from and more on the way, it is highly probable that a Bourns® component is available to meet or exceed your design specifications. Resources are plentiful for part selection, although computing the core loss for a given application may depend on factors such as flux density, core unit loss, and temperature change. With its wealth of experience in inductive components, Bourns is available to assist in calculations and in selecting the right part.

Suggested References

Additional information regarding selection of a component from Bourns® inductive portfolio can be found in the following two selection guides:

- http://www.bourns.com/data/global/pdfs/bourns_inductors_chokes_selection_guide.pdf
- http://www.bourns.com/data/global/pdfs/Choke_SelGuide.pdf

Bourns inductor parametric search can be accessed at:

- <http://www.bourns.com/ParametricSearch.aspx>

For further technical support and for complete inductor and magnetics solutions, please visit

www.bourns.com

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