

Application Note

Understanding SMD Power Inductors

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Power inductors play an important role in voltage conversion applications by yielding lower core losses. They are also used to store energy, filter EMI noise, and provide lower signal loss in system designs. The increased utilization of battery powered miniaturized portable electronics such as mobile phones, notebook PCs, and handheld game devices has led to the added use of these popular, small-sized SMD power inductors into system designs.

As a precondition to constructing an outstanding product that is also competitive, electronic product designers must deeply understand the characteristics of each component being considered for the system design and select the appropriate parts based on that understanding. Even further, proper power consumption design is the most vital aspect in battery powered systems. Accurate comprehension of the energy storage feature of power inductors is essential for system designers.

The addition of power inductors frees up limited board space while filtering noise and providing a stored energy source.

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Understanding SMD Power Inductors

Surface mount power inductors are used to store energy while also filtering EMI currents with a low-loss inductance for voltage conversion applications. They are also used in DC-to-DC converters for a wide range of products in a variety of applications. Requiring minimal printed circuit board (PCB) space, power inductors provide a high-performance, multiphase design that significantly reduces the overall system cost.

Power Inductor Parameters

The key parameters of a power inductor are as follows:

L-Inductance

The primary functional parameter of an inductor. Inductance is the property in an electrical circuit where a change in the electric current through that circuit induces an electromotive force that opposes the change in the current. The unit of inductance is the henry (H). This parameter determines the current output and ripple noise level.

DCR-DC Resistance

The resistance in the power inductor due to the length and diameter of the winding wire that is used. DCR is the key parameter for power efficiency. The power consumption will increase if a larger DCR power inductor is used.

Rated Current

Rated current is the maximum allowable operational current of the inductor. If the applied current exceeds the rated current, the self-temperature rise and the drop of the inductance value will exceed specification, and the performance and reliability will be decreased.

For power inductors, there are two different definitions to describe the rated current, which is based on self-temperature rise or on inductance change.

Laird Technologies defines the maximum rated current as the maximum amount of current by which inductance will drop by a typical value of 10% of initial inductance.

SRF (Self-Resonant Frequency)

The inductor's self-resonant frequency (SRF) is the frequency where the inductor and parasitic capacitor among coil windings resonates, as shown in Figure 1 below. At a higher frequency than SRF, the inductor appears as capacitive rather than inductive, and is defined as a minimum value in megahertz (MHz). The higher the SRF, the higher the inductor's effective operational frequency range. So, the operational frequency selected for the inductor should be lower than the SRF.

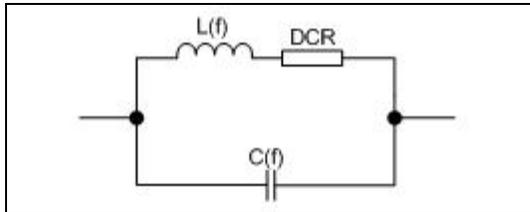


Figure 1: Equivalent Circuit

Shielded and Unshielded SMD Power Inductors

First, the magnetic field generated by the shielded power inductor keeps the magnetic field within the inductor. It emits few magnetic fields outside the package and has a less negative effect on other parts that are in close proximity to it, therefore minimizing the coupling to other components or modules. In an unshielded inductor, some of the magnetic flux field is radiated outside. If a sensitive component or module is in close proximity to it, its normal functionality may be affected.

Since the entire magnetic flux field is contained within the inductor, the power efficiency is higher. The inductor also contains less wire turns if it has equal inductance with the unshielded inductor. This results in the DCR being smaller for a shielded inductor, as compared to that of an unshielded one.

If the DCR is the same for both the shielded and unshielded inductors, then this implies that the inductors utilize the same wire and winding turns. The shielded inductor should have a higher inductance value than the unshielded one. However, the inductance change versus the current curve will drop earlier because of saturation characteristics. This determines that the unshielded power inductor is easier to work with in a larger current.



Figure 2:Laird Technologies Power Inductors

Power Inductor Applications

Power inductors mainly have three applications:

- Low pass frequency noise filter
- Conducted EMI noise filter
- Energy storage in DC-to-DC converter.

Low pass frequency filter applications are mostly used in DC power lines in order to filter the low frequency ripple current noise. Larger inductors also can be used in AC inputs as conducted EMI noise filters in order to meet the regulatory requirements.

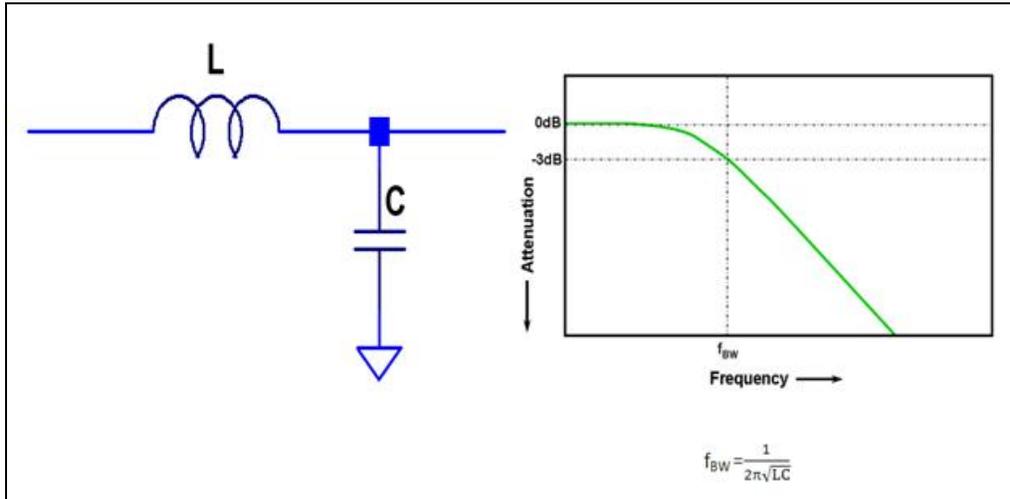
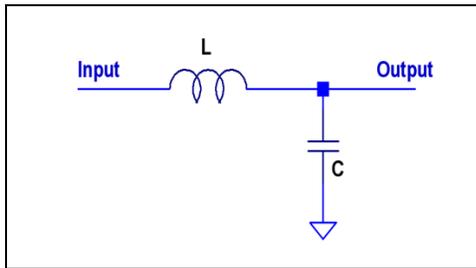


Figure 3: Low Pass LC Filter

DC-to-DC Power Converter: Buck and Boost DC-DC Converter

SMD power inductors are widely used in DC-to-DC converters as energy storage parts in the circuit. There are typically buck, boost, and buck-boost converters which convert the DC input voltage from high to low or low to high in order to provide the DC power to various circuits in an electronic system.

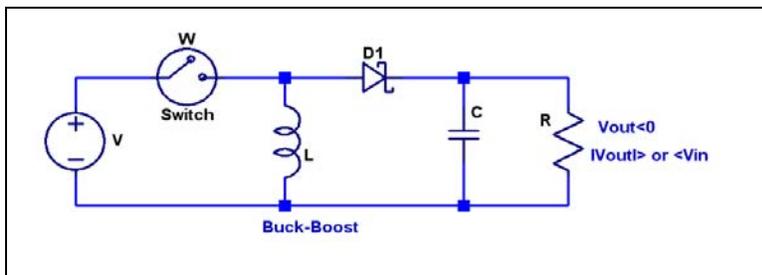
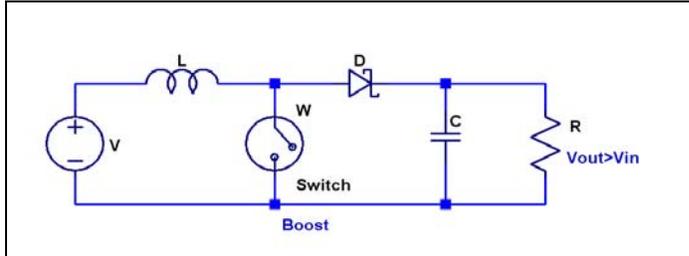
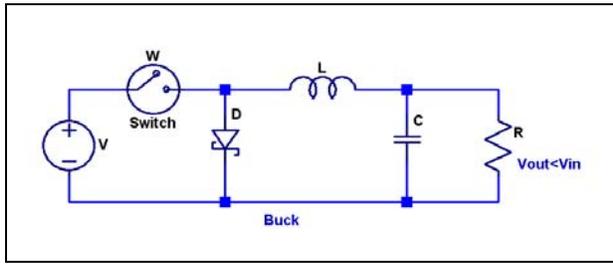


Figure 4: Buck, Boost, Buck-Boost

Summary

As battery devices continue to be designed and produced with slimmer profiles, implementation of convergence components that perform a variety of functions is more important than ever. Power inductors play an important role in voltage conversion applications by yielding lower core losses and are used to store energy, filter EMI noise, and provide lower signal loss and handle higher power capability in system designs. The result is a high-performance, rugged constructed design with a small footprint that requires significantly less total pc board space and a lowered overall system cost.

Laird Technologies can provide a series of SMD power inductors, including shielded and unshielded, which are widely utilized in the electronics market. The inductors cover from 1uH to 10uH, and have a current from 20mA to a larger current of 30A with a constraint size to save space in portable electronic systems.

About Laird Technologies, Inc.

Laird Technologies designs and manufactures customized, performance-critical products for wireless and other advanced electronics applications.

The company is a global market leader in the design and supply of electromagnetic interference (EMI) shielding, thermal management products, specialty metal products, signal integrity components, and antenna solutions, as well as radio frequency (RF) modules and wireless remote controls and systems.

Custom products are supplied to all sectors of the electronics industry including the handset, telecommunications, data transfer and information technology, automotive, aerospace, defense, consumer, medical, mining, railroad and industrial markets.

Laird Technologies, a unit of Laird PLC, employs over 12,000 employees in more than 49 facilities located in 16 countries.

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