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Application Notes of Power Inductors

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Application Notes

Selecting the Optimum Inductor Technology to Best Match the Performance Requirements

How to Select the Right Inductor for DC-DC Converter

1. Current Rating

Current through a DC-DC converter inductor is always changing throughout the switching cycle and may change from cycle to cycle depending on converter operation, including temporary transients or spikes due to abrupt load or line changes. This peak-to-average ratio makes specification of current ratio difficult. If one takes the highest possible instantaneous peak current as "current rating" for an inductor, the inductor is likely to be spoiled for the application. If one takes the average current as "current rating", the inductor may not perform well when passing the peak current. The way to solve this problem is to look for an inductor that has two current rating factors.

- The first factor is Isat which to deal with possible core saturation from the peak current.
- The second factor is Irms which to deal with possible heating that can occur due to the average current.

2. L (Inductance)

In most design procedures, inductance is the first and main parameter to be calculated the desired circuit function. Inductance is calculated to reduce output current ripple and to provide a certain minimum amount of energy storage (or volt-microsecond capacity). Using much greater or much less inductance may force the converter to change between continuous and discontinuous modes of operation. Using less than the calculated inductance causes increased AC ripple on the DC output. Most DC-DC converter applications do not require extremely tight tolerance of inductance which ±20% is suitable for most converter applications.

3. DCR (DC Resistance)

DCR is simply a measure of the characteristic wire used in the inductor and is based strictly on the wire diameter and length. Normally this is specified as a “max” in the catalog but can also be specified as a nominal with a tolerance. Typically to reduce the DCR means having to use larger wire and probably a larger overall size. So optimizing the DCR selection means a trade-off of power efficiency, component size and allowable voltage drop across the component.

4. SRF (Self Resonant Frequency)

The frequency at which the winding self-capacitance resonates with the inductance. For most converters, it is best to operate the inductors at frequencies well below the SRF. This is usually shown in the inductor data as a "typical" value.

5. Isat (Saturation Current)

The amount of current flowing through an inductor that causes the inductance to drop due to core saturation.

6. Irms (RMS Current)

In physical meaning, the RMS (Root-Mean-Square) is often called the effective value or DC-equivalent value of a current is an equivalent of a DC current, which has the same heat dissipation as the real current on any resistor. Irms is the amount of continuous current flowing through an inductor that causes the maximum allowable temperature rise. In this case the data sheets almost always provide a rating based on application of DC or low frequency AC current.

Conclusion

It can be seen that inductors for dc-dc converters can be described by a small number of parameters. However each rating may be thought of as a "5th element" based on one set of operating conditions which may need to be augmented to completely describe expected performance in application conditions.