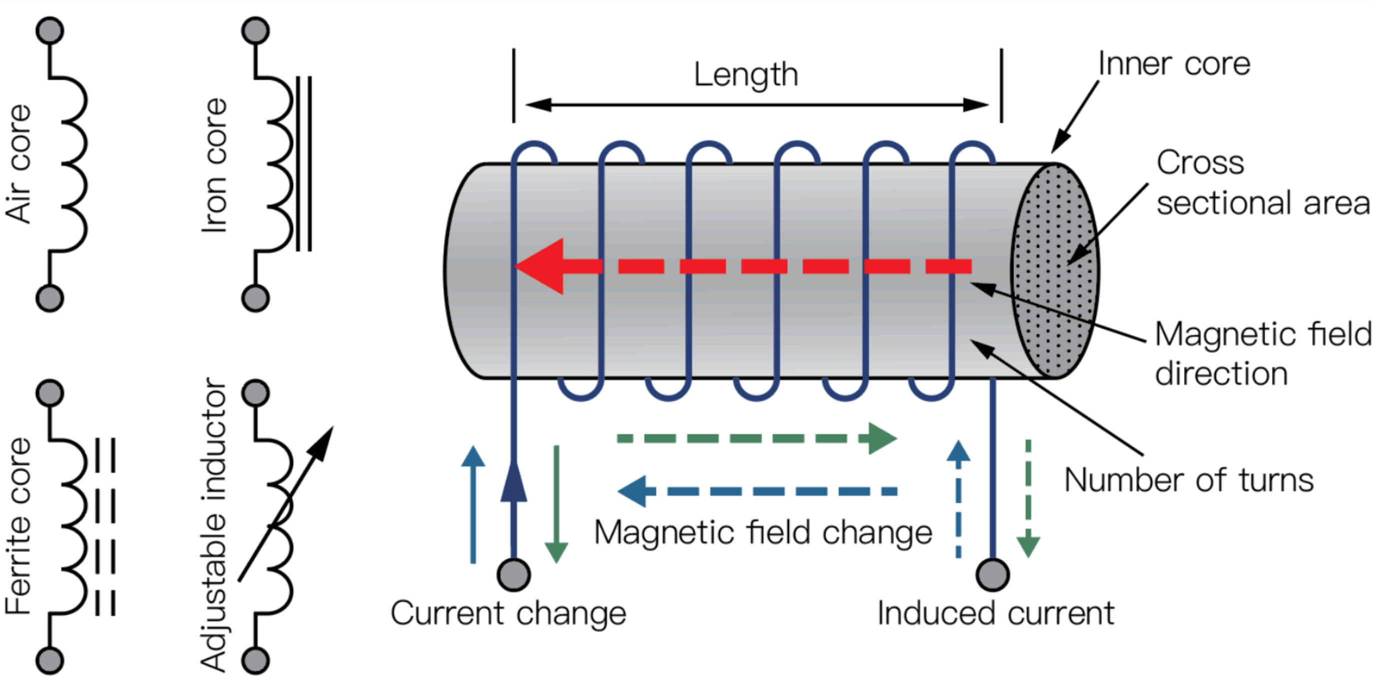
HOW TO SELECT INDUCTORS AND TYPES OF INDUCTORS

Inductor symbols



In electronic circuits, inductors serve a wide range of purposes, which has led to the existence of numerous types. This article briefly presents the methods for selecting inductors.

Common - Mode Inductors

Common - mode inductors are utilized for common - mode filtering in circuits. They are mainly categorized into ferrite common - mode inductors and amorphous common - mode inductors.

Ferrite Common - Mode Inductors

Advantages: They exhibit excellent high - frequency filtering characteristics.

Disadvantages: They are relatively large and have poor temperature stability.

Amorphous Common - Mode Inductors

Advantages: They are small in size, require fewer winding turns, and have good temperature stability.

Disadvantages: Their high - frequency attenuation characteristics are not as good.

Common-mode inductor design focuses on two core factors:

- Copper wire cross-section:

  Select a proper size to avoid overheating, e.g., thicker wires for high-power, high-current circuits.

- Core size:

  Match winding turns and wire thickness; undersized cores limit winding capacity, while oversized ones waste circuit space.

Differential - Mode Inductors

Selection of differential-mode inductors hinges on two key factors: magnetic saturation and temperature rise, with design requirements of zero saturation and reasonable temperature rise.

Magnetic Saturation

Governed by core material's saturation flux density (B_s); high-B_s materials fit high-current/high-magnetic-field scenarios.

Temperature Rise

Related to copper wire thickness and core loss—thicker wires (lower resistance) and low-loss cores reduce heat generation.

Key Formulas (Sinusoidal AC)

$$U = 4.44NBSF$$

$$U = 2I\pi FL = X_L \times I$$

(Where U=voltage, N=winding turns, B=magnetic induction, S=core cross-sectional area, F=frequency, I=current, L=inductance, X_L=inductive reactance)

B selection is critical:

B_s defines its upper limit; for high-frequency currents, B must be far lower than B_s to account for core loss.

Our Advantages

Our company's iron - silicon series inductors have a Bs value reaching 1.6T, and they also have low high - frequency losses. They are excellent choices for applications such as differential - mode inductors, filter inductors, BOOST inductors, and PFC inductors. The high Bs value provides the conditions for product miniaturization. At the same time, the low high - frequency losses enable the inductor to perform better under high - frequency conditions.

Applications of Different Inductors in Various Scenarios

Applications of Common - Mode Inductors

Power Supply Circuits

Common-mode inductors in computer power supplies filter common-mode interference, ensuring clean, stable power for motherboards and components and minimizing electromagnetic interference risks.

Communication Circuits

In high-speed data lines (e.g., Ethernet), common-mode inductors suppress common-mode noise, boosting data signal-to-noise ratio and ensuring reliable communication.

Applications of Differential - Mode Inductors

Switching Power Supplies

In buck switching power supplies, differential-mode inductors store/release energy during switching, smoothing output current/voltage and reducing power supply ripple.

Motor Drive Circuits

In motor drives, differential-mode inductors limit motor startup inrush current and suppress operational voltage spikes, protecting the motor and drive circuit.

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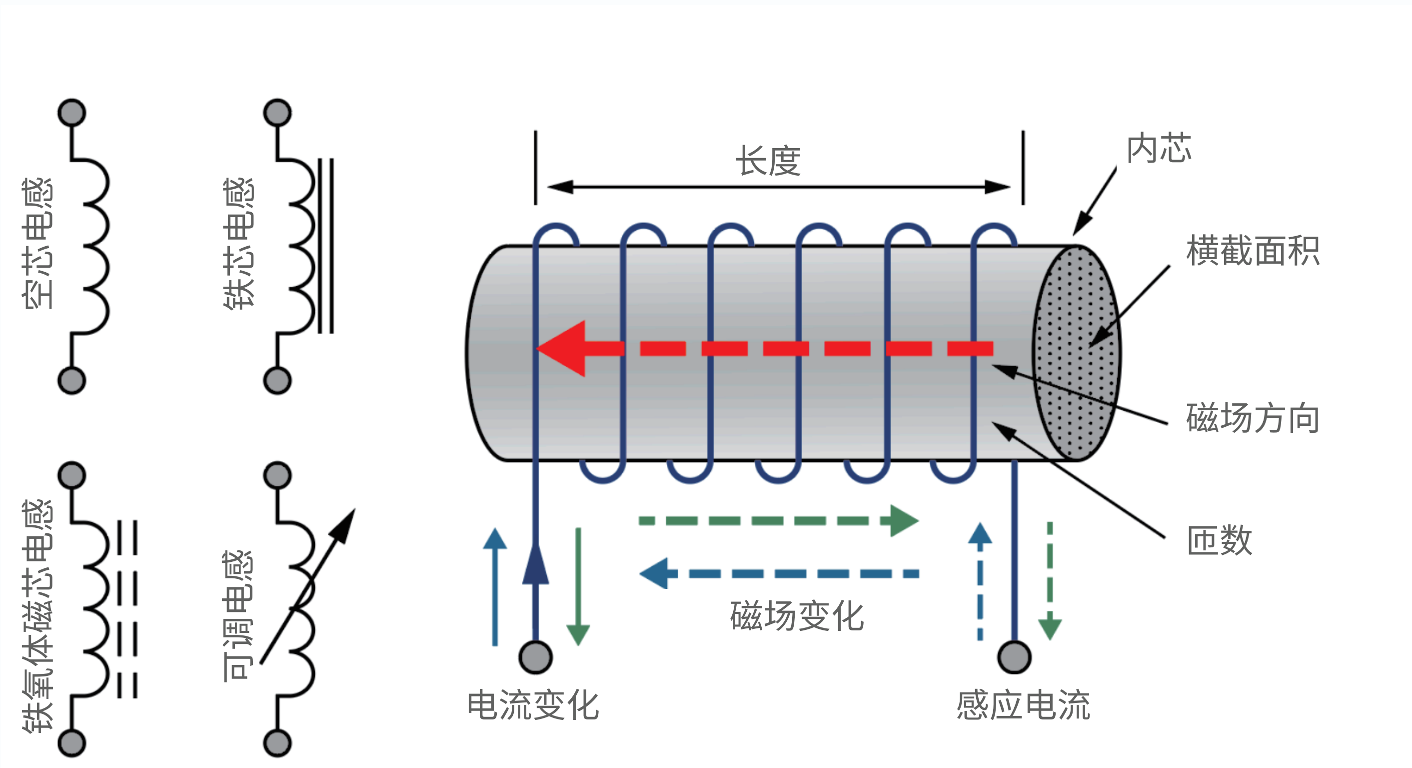
电感符号



在电子电路中，电感用途广泛，因此类型丰富多样。本文将简要介绍电感的选型方法。

共模电感

共模电感用于电路中的共模滤波，主要分为铁氧体共模电感与非晶共模电感两类。

铁氧体共模电感

优势：具备优异的高频滤波特性。

劣势：体积相对较大，且温度稳定性较差。

非晶共模电感

优势：体积小、所需绕线匝数少，且温度稳定性良好。

劣势：高频衰减特性欠佳。

共模电感的设计需重点考虑两点

- **选择铜线的横截面积：**

  避免导线过热。例如，在大电流的大功率电路中，应选用横截面积更大的粗铜线，确保导线能承受电流而不发热。

- **选择尺寸合适的磁芯：**

  以便绕制铜线。磁芯尺寸需与绕线匝数、导线粗细相匹配——磁芯过小可能无法绕制足够匝数；磁芯过大则会占用电路过多空间。

差模电感

差模电感的选型相对复杂，主要受两大因素影响：磁饱和与温升。
设计过程中，需满足电感不饱和、温升保持在合理范围的要求。

磁饱和

电感的饱和状态主要由磁芯材料的饱和磁通密度决定，不同磁芯材料的饱和磁通密度存在差异。例如，高饱和磁通密度的材料更适用于大电流、强磁场的应用场景。

温升

温升与铜线线径的选择、磁芯损耗特性相关。线径更粗的铜线通常电阻更低，可减少电流通过时产生的热量；此外，低损耗的磁芯材料也有助于降低温升。

正弦交流电下的差模电感计算公式

$$U = 4.44NBSF$$

$$U = 2I\pi FL = X_L \times I$$

式中：X_L为感抗，U为电压，N为绕组匝数，B为磁感应强度，S为磁芯截面积，F为频率，I为电流，L为电感值。

由公式可知，电感设计的核心关键在于选取合适的磁感应强度B值。对于不同材料而言，饱和磁通密度B_S决定了B值的选取上限。此外，在高频电流工况下，需考虑磁芯损耗的影响，选取的B值应远低于B_S。

我司铁硅系列电感的饱和磁通密度（B_s）高达 1.6 特斯拉，同时具备低高频损耗的特性，是差模电感、滤波电感、升压（BOOST）电感及功率因数校正（PFC）电感等应用场景的理想之选。

高B_s值为产品小型化提供了有利条件，而低高频损耗的优势，则能保障电感在高频工况下保持优良的运行性能。

各类电感的多场景应用

共模电感的应用

电源电路

在计算机电源中，共模电感可滤除共模干扰信号，保障供给计算机主板及其他元器件的电源洁净稳定，降低电磁干扰影响计算机正常运行的风险。

通信电路

在以太网等高速数据传输线路中，共模电感能够抑制共模噪声，提升传输数据的信噪比，保障数据通信稳定可靠。

差模电感的应用

开关电源

在降压型开关电源中，差模电感可在开关过程中存储与释放能量，平滑输出电流与电压，减小电源输出纹波。

电机驱动电路

在电机驱动电路中，差模电感可以限制电机启动时的浪涌电流，同时抑制电机运行过程中产生的电压尖峰，保护电机及驱动电路免受损坏。