

## OBJECTIVES

- Discuss the construction of a Inductor
- Describe the way Inductors react differently in AC and DC circuits
- Define the calculations for connecting Inductors in Series and parallel

## INTRODUCTION

Inductors are used for their ability to filter high frequencies out of the audio in a sound system. As an introduction to Inductors the focus of this lesson will be to discuss the different types of Inductors and the way they are used. Inductors are used for their “ability to oppose a change in Current.” This property is called INDUCTANCE.

### Inductors

Inductors are electronic components that oppose a change in current.

Of all electronic components, inductors are perhaps the simplest in their design. Inductors are simply windings or coils of wire. The number of windings and the type of material around which they are wound, along with the gauge of wire, are the only elements that differentiate inductors.



Air Core Inductor Symbol

### *How Do They Work?*

As with capacitors, inductors react differently to both DC (direct current) and AC (alternating current) circuits.

### Inductors and DC

A DC signal passing through an inductor simply creates a magnetic field around the inductor. This magnetic field can be used for several functions. Probably the most common to installers is that of the coil inside an automotive relay. As the coil of the relay is energized by a DC signal the magnetic field generated by the inductor changes the state of the relay from an Open to a Closed state. This is the fundamental principle behind most electromagnetic switches (relays).

### Inductors and AC

An AC signal when introduced to an inductor also tries to create a magnetic field. However, as AC signals are changing from positive (+) to negative (-), the magnetic field around the inductors also changes in state. This change in magnetism, or Magnetic Flux creates an effect called INDUCTANCE. The inductive property of an inductor is determined by the gauge of wire and number of windings in the inductor.

The inductive property of an inductor when in an AC circuit has the ability to actually block high frequency AC signals. Remember, an inductor resists changes in current. The higher the AC frequency the more rapid the change in current from positive to negative. The inductor effectively blocks signals that represent a rapid change in current. The frequency at which this starts to happen is dependent on the amount of inductance of an inductor.

As mentioned earlier, inductors are primarily used as a crossover components. The inductors ability to BLOCK high frequencies is ideal for low frequency applications where you want high frequencies to be BLOCKED and low frequencies to PASS through to the speaker.

### Iron Core Inductor

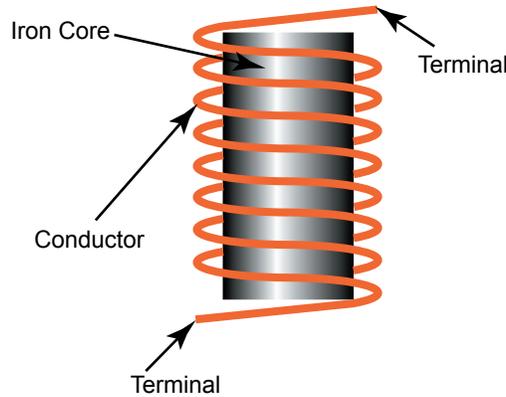


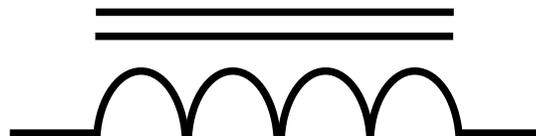
Figure 1

In Figure 1 we see the basic construction of most inductors. As discussed earlier, the inductor is made up of a conductor (wire) winding. In this case the inductor also involves a center core. These cores are typically made of iron or ferrite. Note the two (2) terminals. Inductors are not polarized, in other words there are no positive (+) or negative (-) terminal.

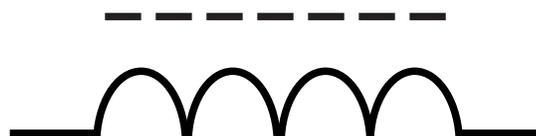
### Inductor Symbols



Air Core Inductor Symbol



Iron Core Inductor Symbol



Ferrite Core Inductor Symbol

## Unit of Measure

Inductors are measured by the amount of inductance they possess. The unit of measurement is the HENRY (H). A Henry of inductance is a large amount of inductance and most inductors are measured in millihenries (mH).

1000 millihenries = 1 Henry

# H, mH

## Four physical factors that determine inductor inductance:

- 1) Number of windings or turns – The inductance of a coil is proportional to the square of the number of turns.
- 2) Permeability of the core – The inductance of a coil increases as the permeability of the core material increases. Coils with iron cores have higher permeability caused by the core material.
- 3) Cross-sectional area – The inductance of a coil increases as the cross-sectional area of the core increases.
- 4) Length – The inductance of a coil increases as its length increases.

## Inductor Types

While there are several types of inductors the most common to the mobile electronics installer is the fixed inductor. Variable inductors are also used in some industries, however, these devices are not typically used in mobile electronics. Fixed inductors come in many shapes and sizes. One of the main differences in inductor types is that of the core material around which the conductor is wound. While some inductors use a center core material others do not and are simply windings of wire.

### Iron Core Fixed Inductors

One of the most common inductor types, iron core inductors, utilize a core material made of iron around which the conductor wire is wound. The iron material reacts with the magnetic field or magnetic flux created by the current passing through the wire. The iron core plays an integral part in the amount of inductance which the inductor possesses.

### Ferrite Core Fixed Inductors

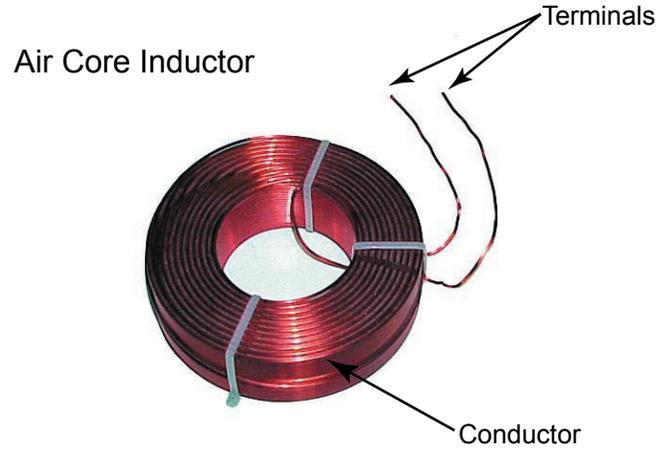
Similar to Iron Core Inductors, the ferrite core inductor incorporates a center core made of a ferrite material. Ferrite is a material consisting of molded metal particles.



Ferrite Core Inductor

## Air Core Fixed Inductors

Air core inductors do not incorporate a core material. The air core inductor is simply a winding of conductor material (wire). Often considered the inductor of choice for crossover applications, air core inductors are known for their accuracy and performance. With this increased performance comes a higher price tag. Air core inductors are typically the most expensive. This price increase is due to the fact that air core inductors utilize more copper wire in lieu of the iron or ferrite core materials.

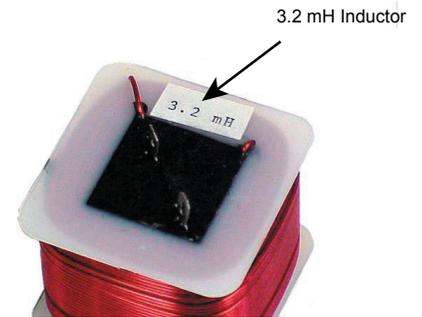


## Fixed Inductor Value Calculation

As with resistors and capacitors, inductors are most often simply labeled for their value.

In most cases the value will be in the millihenry (mH) range. While the unit of measure for inductance is the Henry (H) most inductors in the mobile electronics industry are of a value much smaller than a Henry.

Note that in the illustration to the right this particular inductor has a value of 3.2mH or 3.2 millihenries.



## Fixed Inductor Applications

The most common application for an inductor in the mobile electronics industry is that of a crossover component. This has already been discussed throughout this section. Inductors are used in a broad scope of audio signal filtering (crossover) applications. Whether custom installed or part of a component system's passive crossover network, inductors are used to block high frequencies from passing to the speaker. Typically these are woofers or midrange drivers.

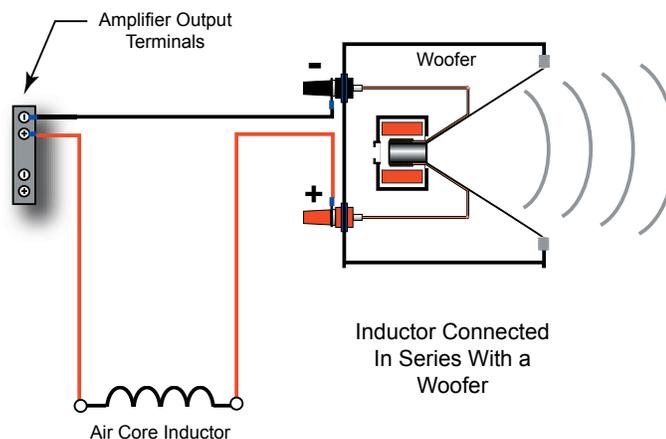


Figure 2

In Figure 2 we see an inductor installed in series with a woofer. This is the most typical use for an inductor by installers. Note that only the positive (+) speaker terminal is interrupted by the inductor. This is sufficient to filter high frequencies from reaching the woofer. You need NOT install an inductor on the negative (-) terminal of the speaker.

Figure 3 is a photo of a popular passive crossover as included with a pair of component speakers. Note the use of both Air and Iron core inductors.

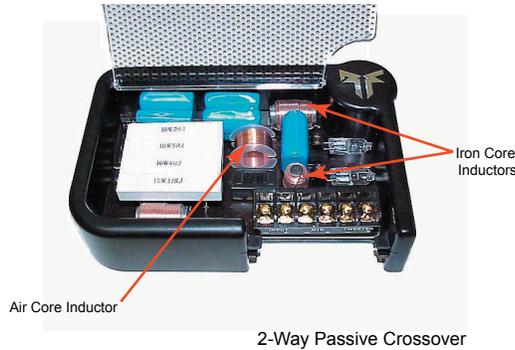


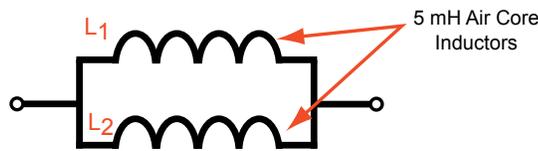
Figure 3

### Series And Parallel Inductor Connection

When inductors are connected to a circuit in series or parallel, the inductance of the circuit reacts differently. This fact is useful when trying to attain a certain amount of inductance. It is possible to combine inductor values to derive the desired amount of inductance.

Note in the illustration below how the same two (2) coils react differently when connected in parallel and series. Following each illustration note the formula used to determine total inductance ( $L_t$ ).

#### Inductors in Parallel



Total Inductance ( $L_t$ ) = 2.5 mH

Calculation

$$L_t = \frac{L_1 \times L_2}{L_1 + L_2}$$

Or

$$L_t = 25/10$$

#### Inductors in Series



Total Inductance ( $L_t$ ) = 10 mH

Calculation

$$L_t = L_1 + L_2$$

Or

$$L_t = 5 + 5$$