Inductors & Phasing

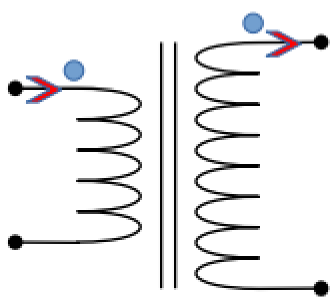
Examine the phase and dot conventions of the bifiler chokes and the VIC5 transformer.

In & Out Of Phase Inductors

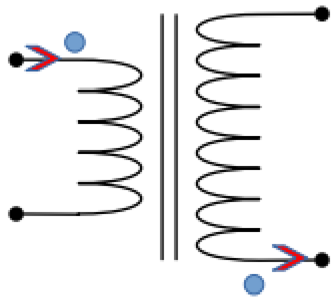
By: Christophe Campain

Introduction To Inductor Phasing

> With the traditional way of representing a transformer, it's pretty easy to figure out the dot convention meaning.



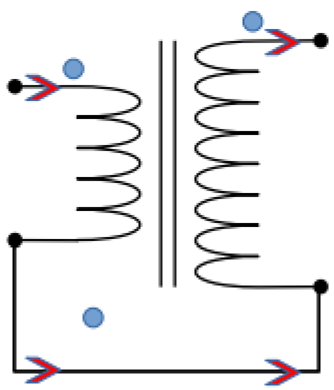
In phase



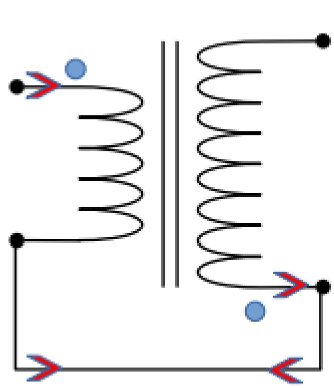
180° out ofphase

In the case of inductors **in series** AND **magnetically coupled**, it is not always easy to figure out if the inductors are in phase or out of phase because they are not always represented side by side in the traditional way of transformers.

> To help us, simply "connect" the bottom of a usual transformer to follow the current and figure out what would mean in series.



In phase

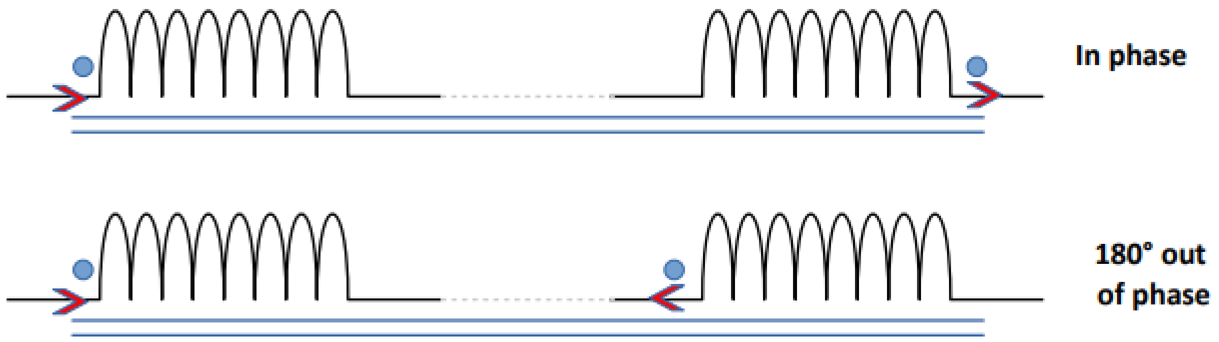


180° out of phase

In phase : Current flows in the same direction.

Out of phase: Current flows in an opposing direction.

So for 2 inductors **that are magnetically coupled** to each other and **in series**, if their input or output
currents goes in the same direction, they are **in phase** and if their currents oppose to each other, they are 180° **out of phase**.

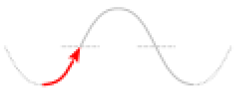
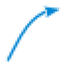
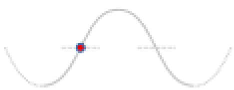
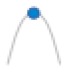
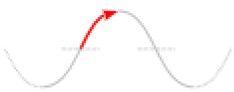
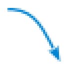
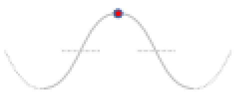
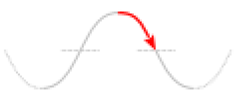
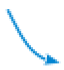


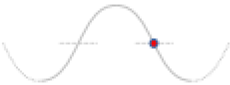
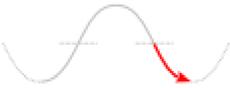
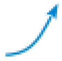
PDF Version: In phase or out of phase.pdf

Inductor EMF Vs. Current Flow

By: Christophe Campain

Interpreting Voltage & Current Waveforms

Current	Inductor voltage	Comments
		The current increase and its rate of change $\frac{di}{dt}$ increase too (acceleration). The emf voltage of the inductor increases, but its rate of change $\frac{dv}{dt}$ slow down (deceleration).
		Inflection point[i] of the increasing current curve: The current rate of change $\frac{di}{dt}$ is at its maximum[ii] and emf voltage of the inductor reach a maximum positive voltage. $\frac{dv}{dt}=0$
		The current increase but its rate of change $\frac{di}{dt}$ now slow down (deceleration). The emf voltage of the inductor start to decreases, but its rate of change $\frac{dv}{dt}$ increases (acceleration).
		The current value reach a maximum amplitude, but the rate of change of the current $\frac{di}{dt}=0$ The emf voltage of the inductor = 0 (The waveform have a zero crossing)
		The current start to decrease and its rate of change $\frac{di}{dt}$ increase (acceleration). The emf voltage of the inductor decreases, and its rate of change $\frac{dv}{dt}$ slow down (deceleration).

		Inflection point of the decreasing current curve: The current rate of change $\frac{di}{dt}$ is at its maximum and emf voltage of the inductor reach a maximum <u>negative</u> voltage.
		The current decrease and its rate of change $\frac{di}{dt}$ now slow down (deceleration). The emf voltage of the inductor start to increases, and its rate of change $\frac{dv}{dt}$ increases too (acceleration).
		The current value reach a minimum value (but maximum amplitude), the rate of change of the current $\frac{di}{dt}$ = 0. The emf voltage of the inductor = 0 (The waveform have a zero crossing)

Fleming's Right Hand Rule

[NOT to be confused with Maxwell's right-hand grip rule]

https://www.youtube.com/embed/LAnRTNwrFMo

Fleming's

Image not fo

Fleming's right hand rule is applicable for electrical generators. As per Faraday's law of electromagnetic induction, whenever a conductor is forcefully moved in an electromagnetic field, an emf gets induced across the conductor. If the conductor is provided a closed path, then the induced emf causes a current to flow. According to the **Fleming's right hand rule**, the thumb, fore finger and middle finger of the right hand are stretched to be perpendicular to each other as shown in the illustration at right, and if the thumb represents the direction of the movement of conductor, fore-finger represents direction of the magnetic field, then the middle finger represents direction of the induced current.

How to remember Fleming's right hand rule?

You can follow the same methods mentioned above for Fleming's left hand rule. In this case, you just have to consider your right hand instead of the left hand.

Fleming's Left Hand Rule

by Kiran Daware - Electrical laws

https://www.youtube.com/embed/qvB1mmfo7MQ

If a current carrying conductor placed in a magnetic field, it experiences a force due to the magnetic field. On the other hand, if a conductor moved in a magnetic field, an emf gets induced across the conductor (Faraday's law of electromagnetic induction).

John Ambrose Fleming introduced two rules to determine the direction of motion (in motors) or the direction of induced current (in generators). The rules are called as **Fleming's left hand rule** (for motors) and **Fleming's right hand rule** (for generators).

Fleming's left hand rule

Fleming's left hand rule

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Whenever a current carrying conductor is placed in a magnetic field, the conductor experiences a force which is perpendicular to both the magnetic field and the direction of current. According to **Fleming's left hand rule**, if the thumb, fore-finger and middle finger of the left hand are stretched to be perpendicular to each other as shown in the illustration at left, and if the fore finger represents the direction of magnetic field, the middle finger represents the direction of current, then the thumb represents the direction of force. Fleming's left hand rule is applicable for motors.

How to remember Fleming's left hand rule?

Method 1: Relate the thumb with thrust, fore finger with field and center-finger with current as explained below.

- The **Th**umb represents the direction of **Th**rust on the conductor (force on the conductor).
- The **F**ore finger represents the direction of the magnetic **F**ield.
- The **C**enter finger (middle finger) the direction of the **C**urrent.

Method 2: Relate the **Fleming's left-hand rule** with **FBI** (wait! NOT with the Federal Bureau of Investigation). Here, F for Force, B is the symbol of magnetic flux density and I is the symbol of Current. Attribute these letters F,B,I to the thumb, first finger and middle finger respectively.

Magnification

Transformers are critical components in many electrical systems, as they allow for efficient power transfer between different voltage levels. A transformer operates on the principle of electromagnetic induction, where a changing magnetic field induces a voltage in a nearby conductor. In this article, we will explore how transformers can magnify voltage and current, and examine the factors that influence this magnification.

Voltage Magnification in a Transformer

In an ideal transformer, the voltage on the secondary winding is directly proportional to the voltage on the primary winding, and there is no voltage magnification. However, in a real transformer, there are losses due to the resistance of the windings and core, which can affect the voltage on the secondary side.

One way in which voltage magnification can occur is when the load impedance on the secondary side is higher than the load impedance on the primary side. This can happen, for example, when a transformer is used to step up voltage to a high voltage transmission line. In this case, the voltage on the secondary side of the transformer can be higher than the voltage on the primary side, as the transformer compensates for the increased load impedance.

Another way in which voltage magnification can occur is when the transformer operates at a frequency that is different from its rated frequency. This can happen, for example, when a transformer is used in a system with a high frequency, such as in a switch-mode power supply. In this case, the transformer's core can saturate, which reduces the transformer's inductance and causes the voltage on the secondary side to increase.

Current Magnification in a Transformer

Current magnification in a transformer occurs when the current on the secondary side is higher than the current on the primary side. This can happen when the load impedance on the secondary side is lower than the load impedance on the primary side. In this case, the transformer compensates for the increased load current by increasing the current on the secondary side.

One application where current magnification is commonly used is in audio amplifiers. In an audio amplifier, a small current from a pre-amplifier is used to drive a larger current to the speakers. The transformer in the audio amplifier is designed to provide current magnification, so that the small current from the pre-amplifier can be amplified to the required level to drive the speakers.

Factors That Influence Magnification in a Transformer

The amount of voltage and current magnification in a transformer depends on a variety of factors, including the turns ratio, the load impedance, and the frequency of the input signal.

The turns ratio is the ratio of the number of turns in the primary winding to the number of turns in the secondary winding. In an ideal transformer, the turns ratio is equal to the voltage ratio. For example, a transformer with a turns ratio of 2:1 will step up the voltage by a factor of two. However, in a real transformer, the turns ratio can be affected by the geometry of the windings and the magnetic properties of the core.

The load impedance on the primary and secondary sides of the transformer also plays a role in determining the amount of magnification. If the load impedance on the secondary side is higher than the load impedance on the primary side, the transformer will step up the voltage and decrease the current. Conversely, if the load impedance on the secondary side is lower than the load impedance on the primary side, the transformer will step up the current and decrease the voltage.

The frequency of the input signal also affects the amount of magnification in a transformer. Transformers are designed to operate at a specific frequency, and if the frequency deviates from this value, the transformer's performance can be affected. In particular, the transformer's core can saturate at high frequencies, which can cause voltage magnification.

Magnification in a 1:1 Ratio Transformer

A 1:1 ratio transformer is also known as an isolation transformer because it provides electrical isolation between the primary and secondary windings. It is designed to match the impedance of the primary circuit to that of the secondary circuit, which means that the voltage and current in the primary and secondary windings are equal.

In an ideal 1:1 transformer, there is no voltage or current magnification. The voltage and current on the primary side of the transformer are equal to the voltage and current on the secondary side. However, in a real transformer, there are losses due to the resistance of the windings and core, which can affect the voltage and current on the secondary side.

In some cases, a 1:1 transformer can exhibit voltage or current magnification if the load on the secondary side has a different impedance than the load on the primary side. This can cause a voltage or current imbalance, which can result in a magnified voltage or current on the secondary side.

For example, if the load on the primary side of the transformer has a low impedance, and the load on the secondary side has a high impedance, the transformer can exhibit voltage magnification. This is because the transformer is designed to match the impedance of the primary and secondary circuits, and if the impedance of the secondary circuit is higher than that of the primary circuit, the voltage on the secondary side can be magnified.

Similarly, if the load on the primary side of the transformer has a high impedance, and the load on the secondary side has a low impedance, the transformer can exhibit current magnification. This is because the transformer is designed to match the impedance of the primary and secondary circuits, and if the impedance of the secondary circuit is lower than that of the primary circuit, the current on the secondary side can be magnified.

> In summary, while a 1:1 transformer is designed to provide electrical isolation and match the impedance of the primary and secondary circuits, it can exhibit voltage or current magnification if the impedance of the loads on the two sides are different. However, it's worth noting that this magnification is typically small and is limited by the losses in the transformer.