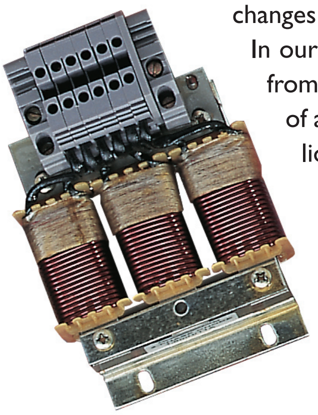
Reactors / Chokes

Reactors

A reactor (choke) is an inductive component which is generally used to suppress AC voltages. It is a characteristic of a reactor that it presents inductive resistance to electrical current changes. It stores energy when the current in the windings increases by presenting a negative field voltage and gives off energy when the current decreases by supplying an additional voltage. It is therefore the electrical counterpart of the mechanical flywheel. The large mass of the flywheel ensures a virtually constant speed even if the force driving the flywheel varies for short periods (single-cylinder, slow-running diesel engine).
The efficiency of the reactor depends on how large the current changes are and how quickly they happen. Reactors for 400 Hz, for example, can be made substantially smaller because the current changes happen eight times as quickly as in the case of reactors for 50 Hz.
The unit of measurement for inductance is the henry (H). A reactor has an inductance of 1 henry when it presents a voltage of 1 volt for a current change of 1 amp for a period of 1 second. In practice this unit of measurement is much too big because current changes happen much faster in electronics. In our power system the current increases from nought to max. in five thousandths of a second. A thousandth (1mH) or millionth (1mH) of a henry is therefore normally used. The practical design of the reactor is relatively similar to that of the transformer: an electric coil around a core made up of transformer laminations. What makes it different is that the reactor has one or more air gaps in the iron core. Without this air gap the core would become saturated at a low current strength. In the rest of the current change process the reactor will operate with an inductance which is approximately the same as an air-core reactor and then present a very small resistance to further current change. The size of the air gap is determined by the current strength x the number of turns of the coil and the saturation of the iron. In the case of large reactors and high amperages/numbers of turns, several small air gaps may be necessary owing to the increasing leakage field around a large air gap. This makes the practical design of the reactor more difficult. Powerful magnetic fields produce losses in nearby magnetic components and eddy currents in parts of the copper winding. In the case of large reactors, exposed parts should therefore be protected against the effects of such fields. The square of the desired current times the desired inductance is an indication of how large the reactor will be. The size is half that of a transformer because one winding is used instead of two.



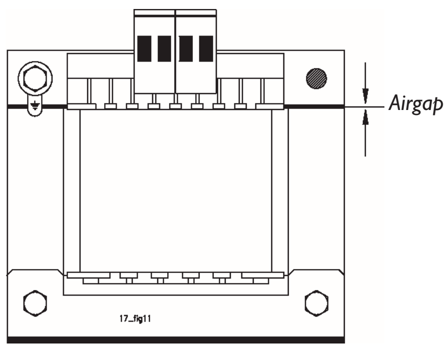
If a reactor of L=10mH with a current of I=20A is wanted, the equivalent transformer size will be P at 50Hz.

$\mathbf{P = \frac{1}{2} I^2 \times RL}$,
where RL = 0.314 x L when L is specified in mH.

This produces:
$P = \frac{1}{2} \times 20^2 \times 0.314 \times 10 = 628$ VA.
It can be in a single or three-phase design.

Examples of reactor use:

- Smoothing reactors are used in rectifiers to reduce the ripple voltage on the DC side. The voltage from a single-phase rectifier bridge has a ripple voltage of 48% unfiltered and that from a three-phase bridge 4.32% unfiltered. The reactor can be used on its own or in combination with electrolytic capacitors. Without capacitors filtering is equal to L/R, where R is the load. With capacitors the effect of filtering is proportional to LxC, where C is the capacitor size. Complete smoothing is not economical because the necessary reactor would be large.
- In AC circuits reactors can be used to reduce short-circuit currents. In this case straight-forward air coils are often used to avoid satu-ration in the event of high currents in the coil.
- With increasing requirements for damping of electromagnetic interference from power electronics, reactors can be used on the AC side of a thyristor bridge. In this case the aim is to increase the current rise time for thyristor commutation.
- Reactors are also used for filtering in AC circuits to obtain the best possible sinusoidal voltage from inverters and magnetic stabilisers.
- In the case of thyristor inverters a reactor is needed together with a capacitor to cut off the current in the thyristors during commutation. Since the thyristors used in inverters have a short cut-off time, air coils can be used to advantage.
- Small reactors on a ferrite core have become widely used in high-frequency switching. The same applies for noise protection in relation to the system and user equipment.



Typical single-phase reactor