Dry-type transformers

Dry-type reactors, inductors and chokes For power electronics, transmission and distribution applications

Power and productivity
for a better world™

ABB reactors for simple and complex technical requirements

Electricity was not created by men, but certainly men have gone far in using principles available in nature and adapting them to their needs.

One of the most important achievements in this field is the possibility of generating electricity and, most of all, of distributing and controlling it. In this respect, the need to control electricity increases constantly and requires a high degree of sophistication.

An important role in the above scenario is carried out by reactors, known also as inductors or chokes, depending on their duty in the electrical circuit. The presence and the utilization of such components is often neglected and they are considered minor components, however, their role is fundamental in order to achieve maximum functionality and efficiency of an electrical system.

The basic inductor is a simple wound conductor in which current flows, but in today's industry it can reach considerable dimensions and complexity. It is a passive component and its main features are to give reluctance to changes in current or to modify phase shifts between voltage and current. Its characteristic (inductance) is measured in Henry (H), mostly as mH or uH.

Utilization of reactors

There are different applications in the electrical field where reactors improve the performance of a system or contribute to protecting it. The majority of cases are found in systems with presence of harmonics, but not only for those. Some applications are listed hereafter.

Power Electronics

Power Electronics is a large umbrella covering a vast range of industrial solutions provided by rectifiers and inverters. The use of Variable Speed Drives (VSD), a combination of both, allows to control the rotation speed of electric motors, from small pumps to the largest of the compressors. Rectifiers are used where conversion from AC to DC systems is required, ie, railroad supply, static excitation, electrochemical processes, just to name few, while inverters do the opposite conversion, eg, photovoltaic inverters.

An important role in the power electronic circuits is carried out by the electrical inductors, which are used in different typologies, with the main objective to reduce the effects of the harmonics generated.

In addition to those, two particular applications can be identified:

- DC reactors: reactors are also present in DC circuits, where they are mostly used to limit the ripple on DC currents.
- Common mode reactors: modern power electronics circuits require such reactors to reduce the amount of common-mode current flowing through the system and capacitances to earth.

Reactive power compensation

Capacitive or inductive loads cause reactive power flow which can be compensated by adding inductors or capacitors to the power system. Heavy industries require randomly and frequently large amounts of energy for their manufacturing cycles. Typically, a steel melting process requires stable, steady voltage support for equipment that consumes large amounts of power, such as the electric arc furnace, but also causes important disturbances to the supply network.

The effects of such processes are efficiently mitigated by compensating the reactive power absorbed during operation. Damping and filtering reactors, used in Var Compensations Systems, have an important role in obtaining quality results.

Harmonic filters

International standards impose stringent limitations to the amount of harmonics present in a network, since a “clean” network imposes much less strain on the equipment and increases its life span. This translates to lower maintenance costs and lower costs for replacing worn-out equipment.

Harmonic filters are often intentionally designed to meet the required characteristics and are built using an array of capacitors, inductors, and resistors that contain and often eliminate harmonics.

Short-circuit limiting

Large networks involve large amounts of power that is not easy to control. The breakers’ nominal fault current interruption capacity can often be reduced by the use of short circuit limiting inductors which, depending on their location in the circuit, can be used to protect other important equipment from high current levels.

The inductors to be used for this applications are large air-cored chokes as this is the optimum solution to have inductors with linear behaviour.

Motor starting

The starting current of an AC motor can vary from three to seven times the nominal current. This is because a large amount of energy is required to magnetize the motor enough to overcome the inertia the system has at standstill. The high current drawn from the network can cause problems such as voltage drop, high transients and, in some cases, uncontrolled shutdown.

By connecting a reactor in series with the motor during the start, the starting current is limited in proportion with the voltage. However, this also means a substantial (quadratic) reduction in the available starting torque. The advantage of this method is its low cost in comparison with other methods.

Neutral grounding

The connection of earth ground to the neutral points of current carrying conductors such as the neutral point of a circuit, a transformer, rotating machinery, or a system, may result in excessive current for the circuit breaker and excessive forces in the generator during a single line-to-ground fault.

The presence of a neutral grounding reactor increases the impedance in the neutral point connections and limits the fault current.

ABB recognizes these specific requirements and, thanks to its high technical and personnel competence, is able to offer optimized solutions, tailored for different application segments.

ABB reactors for the evolving industry

With factories and engineers located around the globe, ABB takes full advantage of its global presence by manufacturing to different electrical standards including IEC, IEEE and most national standards.

A wide range of products and technologies available

The continuous evolution of the electrical systems, led by the need to improve performances while reducing dimensions, has posed demanding challenges to the design and execution of the associated inductors. The inductors have evolved from simple coils to quite complex components, designed specifically for the perfect integration into the circuit they are meant for. ABB is one of the major players and at the forefront in improving technologies and products.

Different winding materials, different conductor composition as well as different insulation and cooling techniques are offered by ABB to meet the needs of various industries for these demanding products.

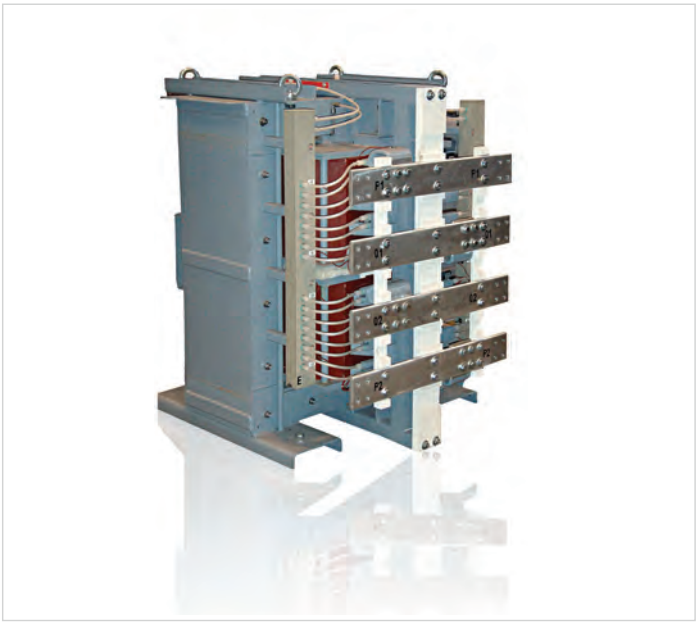

ABB offers a variety of dry-type reactors. To make the right selection, consider the following four most important characteristics.

Iron-cored or air-cored

The discriminating factor between these two alternatives is the linearity of the inductance. While air-cored reactors are fully linear, for iron-core reactors this is only the case over a certain current range. In addition, iron-core inductors allow a better control of the stray flux and are generally smaller than the air-cored ones. Depending also on the electrical performance required, the designer may opt for one or the other but it has to be considered that the air-cored solution will require also more surrounding free space, due to the stray flux.

Air-cooled or water-cooled

Historically, dry-type inductors and also transformers, have always been air-cooled, either by natural convection or by forced ventilation. Recent evolution of Power Electronics and increase of currents have paved the way to the introduction of water-cooling also for the magnetics. Specific know-how has been developed by ABB which allows to propose solutions with direct water-cooling through the conductor or indirect water cooling via heat-sinks.

Aluminium or copper windings

Depending on the final preformance requirements the choice for the conductor can fall on copper or aluminium. There is no clear technical preference between the two; an aluminium wound inductor will be lighter tha and equivalent copper one, but slightly larger.

ABB can use many different conductor shapes to wind the inductors: foil, round wire, flat wire, hollow conductor or a purpose-made composition of conductors meant to satisfy the electrical design.

Vacuum pressure impregnated (VPI) or cast resin

The circuit topology, electrical parameters and the application environment play an important role in the choice of the insulation system to be used for the inductors. Based on the final operating insulation levels required, the choice may fall on a high temperature class VPI or with cast epoxy resing with high insulation performance.

A high expertise is necessary to blend above described solutions so to offer the best performance to the customer.

The one shown on the above picture is an iron-cored inductor, wound with hollow, water-cooled copper conductors and being vacuum casted within epoxy resin.

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