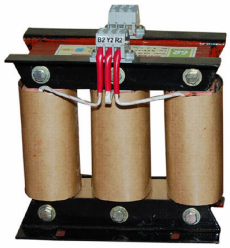
De-Tuned / In-Rush Current Limiting Reactors



In-Rush Current Limiting Reactors

Shunt capacitor banks are installed for variety of reasons in industrial, distribution and transmission systems. A common thread to all installation is the question of what, if any series reactor should be installed with capacitor banks.
Series reactors are used with capacitor banks for two main reasons:

- To dampen the effect of transients during capacitor switching, and to
- Control the natural frequency of the capacitor bank and system impendence to avoid resonance or sink harmonic currents.

Need For Current Limiting Reactors:

When a capacitor bank is energized, the bank and the network are subjected to transients voltage and current. The severity of the effect is determined by the size of the capacitor and the network impendence.

The worst case occurs when a capacitor bank is energized close to a bank that is already connected. The inrush current into the newly connected bank is determined by the size of capacitor bank and the inductance between two banks. The larger the banks, and smaller the inductance between banks, the higher will be the inrush current.

The frequency of the inrush current is determined by the inrush current is determined by the ratio of capacitor bank reactance and the impedance between the banks. The smaller the impedance, the higher will be the frequency.

In most of the installations, the inductance between the banks will be only few micro-Henry, a peak current of more than 150 times nominal current, at a frequency of more than 8 khz can be expected.

Capacitor standards such as IEC 60871 state that capacitors should be able to withstand inrush currents up to 100 times nominal. The standards suggest a lower value if banks are switched frequently.

Large and high frequency inrush current can damage capacitors, circuit breakers and contactors. All connected equipments are subject to voltage transients and may result in sporadic malfunction or failure.

To avoid this problem, it is common practice to insert inrush limiting reactors in series with the capacitors.

De-tuned Reactors:

When PFC capacitors are connected, the inductance of the transformer together with capacitors form a resonant circuit that could be excited by a harmonic current generated by the load. The resonant circuit has a resonance frequency, and if harmonic current of this frequency (or close to it) exists, it will lead the circuit into a resonance condition where high current will flow through the branches (L: the transformer, and C: the capacitor bank), overloading them and raising the voltage across them and across the whole electrical system that is connected in parallel.

PFC detuned filtering is a technique to correct the power factor avoiding the risk of resonance condition performed by shifting the resonance frequency to lower values where no harmonic currents are present.
This is achieved by modifying the basic LC circuit formed by the transformer and the capacitor banks, introducing a filter reactor in series with the capacitors, making this way a more complex resonant circuit but with

desired feature of having a resonance frequency below the first existing harmonic. This way it is not possible to have a real resonance condition.

Besides this main objective, the reactor connected in series with the capacitors form a series resonant circuit with a certain tuning frequency at which the branch will offer a low impedance path. Filtering of harmonic currents and "cleaning" of the gird will be achieved.

Components for PFC detuned filters must be carefully selected according to the desired PFC purpose, to the harmonic present in the system, to some features of the system like short circuit power and impedances, to the desired filtering effect and to the characteristics of the resonant circuit configured.

For example, the voltage across the capacitors will be higher than the nominal grid voltage when they have a reactor connected in series.

The reactors must be selected in line with the inductance value to obtain the desired tuning frequency and the current capability high enough for the harmonic current absorption that can be expected. Tuning frequency is usually indirectly referred to as the detuning factor p and expressed as a percentage. (Value will be in 5.67or 7 or 14)

If De-tuned reactor is described as 7%, infers that the reactor reactance is 7% of the capacitor reactance at the fundamental frequency.

De-tuned reactor technical data:

Voltage harmonics : U3 = 0.5% UR
: U5 = 6% UR
: U7 = 5% UR
: U11 = 3.5%UR
:U13 = 3% UR

Effective current : $\sqrt{I1^2 + I3^2 + \ldots\ldots I13^2}$

Fundamental Current = 1.06 X IR (50Hz Current of capacitor)

Voltage : 400, 415, 440, 480V
Capacity : 5…….. 100KVAR

De-tuning Factor : 5.67%, 7%, 14%
Cooling : Natural
Class of Insulation : F 155 Deg.

Reactor Installation:

GR Reactors are available in open construction and with enclosure. Open Reactors are designed for mounting within appropriate electrical equipment enclosure. Reactors rated 80A and under are designed for mounting in both vertical and horizontal position. Larger reactors must be mounted in horizontal position typically on the floor of the enclosure. Allow side clearances of 100mm and vertical clearances of 150mm for proper heat dissipation and access.

The part of the enclosure containing Line Reactors must be forced ventilated according the dissipated power. Minimum Air flow must be: F= 0.4 X Ps in m^3/h (Ps = power dissipated by the Line reactor)

Limited Warranty:

- GR Electronics warrants to the original purchaser only that the reactors will be free from defects in material and workmanship for period of one year from the date of shipment.
- Our liability is limited only to the repair or replacement of product defective in materials or workmanships. GR shall not in any event, be liable for incidental damages or consequential damage or economic loss.
- This warranty shall not apply to the defects that occur to improper storage / handling or misuse.

Tests conducted at our works

- Visual inspection for general workmanship, Quality and finish.
- Measurement of impedance value @ rated current.
- Measurement of Insulation resistance with Insulation tester.
- High Voltage test at 3KV for one minute between live parts to earth