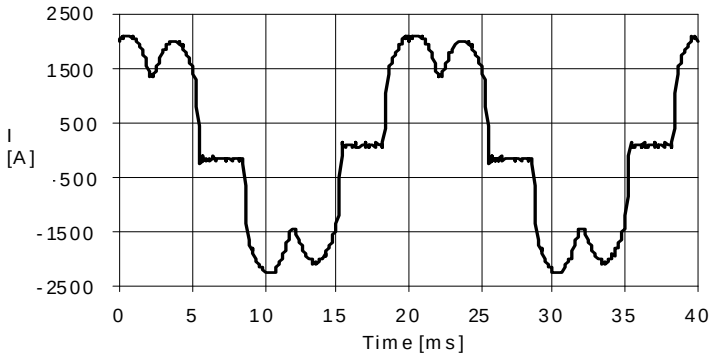
Thyristorised Automatic Power Factor Correction with 7% D-Tune Harmonics Suppression (Reactor/Filtering) System

Power quality?

In the present Low voltage (LV) industrial distribution system the power factor maintenance and harmonics control are the most critical issues to ensure acceptable power quality, and hence demands at most concern at consumers end to maintain a stable power system

Harmonics

In recent years, with increased usage of AC/DC Drives, UPS, Computers, Arc Furnaces & Welders etc, Power harmonics (both Voltage & Current) have become a serious problem in industries and commercial installation. The harmonics generated by these Non-Linear loads are the biggest obstruction in maintaining the power quality and have been a major reason for equipment failure & many other problems like..



- Voltage Harmonics can **cause additional heating** in induction and synchronous motors and generators.
- Voltage Harmonics with high peak values can **weaken insulation in cables, windings, and capacitors.**

- Voltage Harmonics can cause **malfunction of different electronic components and circuits** that utilize the voltage waveform for synchronization or timing.
- Current Harmonics in motor windings can **create Electromagnetic Interference (EMI).**
- Current Harmonics flowing through cables can cause **higher heating over** and above the heating that is created from the fundamental component.
- Current Harmonics **flowing through a transformer** can cause higher heating over and above the heating that is created by the fundamental component.
- Current Harmonics flowing through circuit breakers and switch-gear can increase their heating losses.
- **RESONANT CURRENTS which are created** by current harmonics and the different filtering topologies of the power system can cause capacitor failures and/or fuse failures in the capacitor or other electrical equipment.
- **False tripping of circuit breakers ad protective relays**.

Resonance is the most series consequence when connecting a power capacitor in the LV distribution system. The capacitance of the capacitor forms a resonant circuit in conjunction with the feeding transformers and cables. **The self-resonant frequency of this circuit lies typically between 250 and 600Hz** i.e. in the region of the 5 and 11 harmonics and leads to the following effects

- Overloading of capacitors, transformers and transmission equipment's
- Interference with metering, control system, computers and electrical gear.

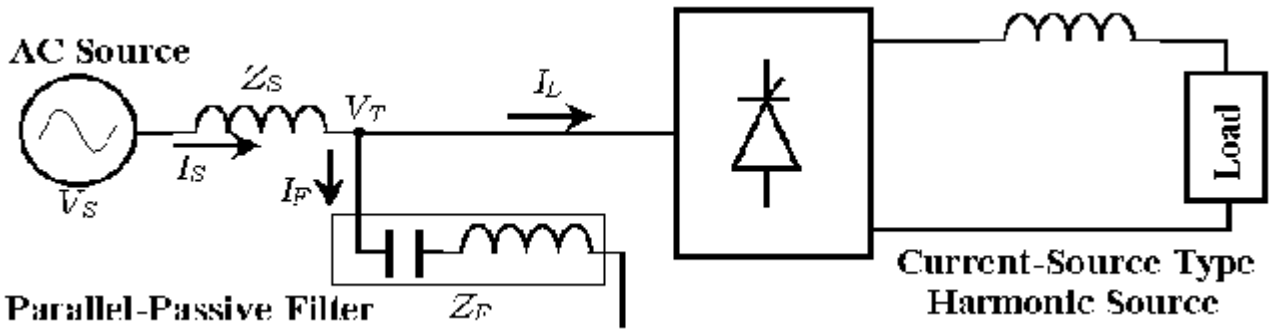
Why use a 7% harmonic filter reactor in a power factor correction capacitor bank?

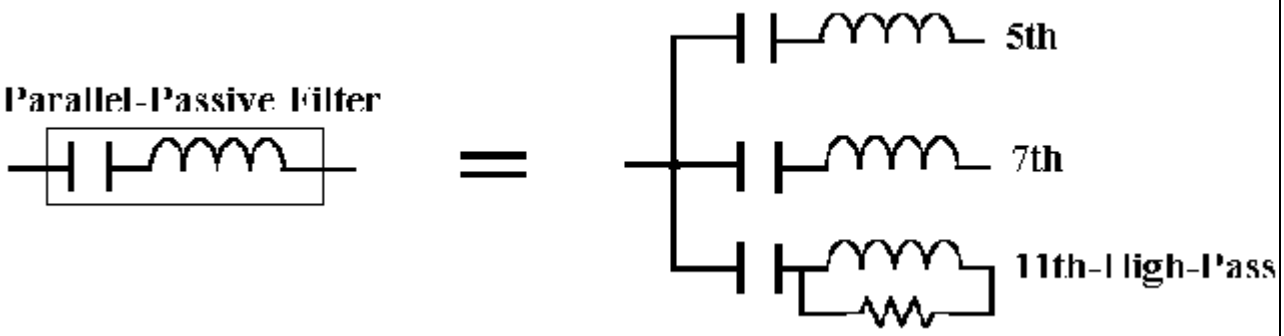
1. Capacitor are required to improve power factor, and possible system interaction may occur with the installation of a plain capacitor bank.

2. Permissible distortion limits of the local utility or IEEE-519 are exceeded, and filters are required to reduced them.

3. A combination of 1 & 2 above, whereby capacitor are required to improve power factor and with the addition of the capacitors, permissible distortion limits are exceeded.

To overcome the resonance effect detuned filter reactor is connected in series with the capacitor and its self-resonant frequency is tuned below the lowest line harmonics by varying the choking factor of the reactor





Benefit of using De-tuned reactor

1. Pro-long the life of power factor capacitor by reducing overheating, or fuse failure.

2. Prevent nuisance input fuse blowing or circuit breaker tripping.

3. Reduce over heating of transformer.

4. Reduce the harmonic current in the electrical supply system.

5. Addressing the harmonic problems created by non-linear load such as AFD's, AC-DC converter, DC drives, welding m/c etc

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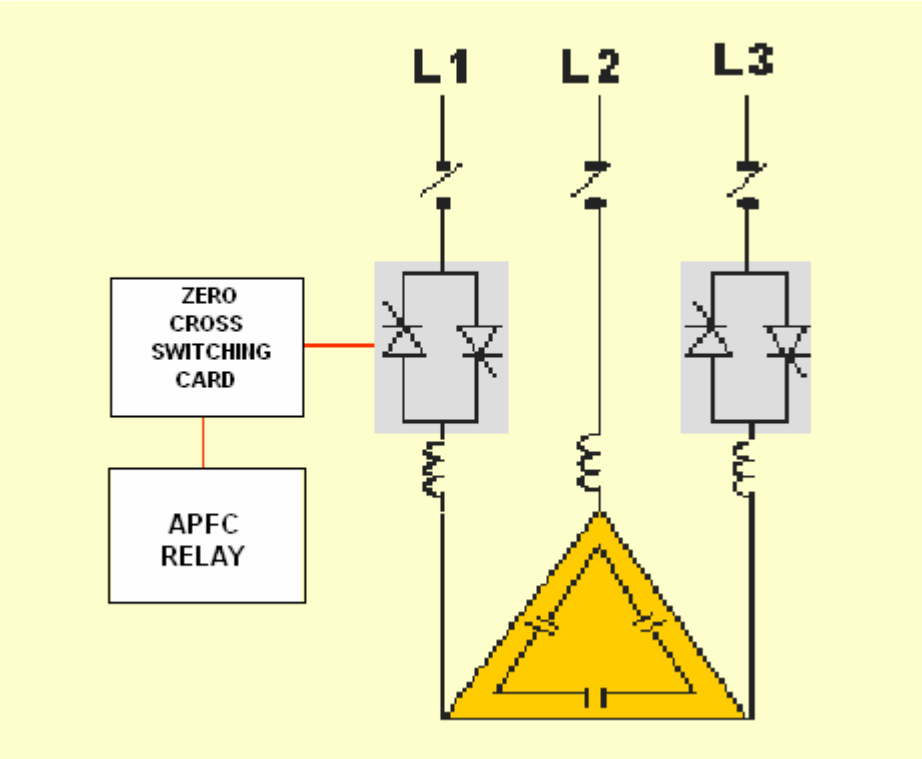
High Speed Real Time Automatic Power Factor Correction System with 7% D-Tune Passive Harmonics Filters

State-of-the art electronic switching device designed to replacement of electro-mechanically switched equipment in power factor correction systems

High Speed power factor correcting systems are designed to compensate the Reactive power of any load or equipment requiring P.F correction within a very short time.



There is no contactor switching causing high voltage transient. Harmonics and other disturbances. Prevents voltage flickring. Reduces failures in highly sophisticated electronic equipments like PLCs. Computer and other control systems.

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BENEFITS OF REAL TIME HIGH SPEED APFC AGAINST CONVENTIONAL APFC:

- Power Factor will maintain almost near to unity so guaranteed P.F. bonus of 4 % to 5 % every month.
- Reduction in KVA demand by 15% to 20%.Result in saving in Demand charges.
- Substantial saving in the electricity bill for HTP-1 & HTP-2 consumers in MOST of the state in India.
- Enhance the capacity of distribution transformer, switchgear and HT cable.
- Eliminate high voltage condition during no load. [i.e. vacation, recess, shift change, strikes, off load etc.]
- Saving in manpower for switching on & off the capacitors.
- Eliminate fixed losses of the capacitor during no load & less load condition.
- The system is maintenance free because it does not use contactors for switching the capacitors.
- Capacitors life is enhance minimum 3 to 4 times. Due to electronics switching & rectors available in the system. The reactors will filter the harmonics & prevents the possibility of resonance by shifting resonance frequency below 5^{th} harmonics.

- The load current will be approximately reduced by 15% to 20% which in turn will reduce fluctuation in voltage and improve voltage quality and prevents damaged to sensitive electronics equipment.
- If used with D.G. sets, It can be additionally loaded by 15% to 20% & Corresponding increase in fuel efficiency. When running on D.G. set the fluctuation in voltage is substantially reduce.
- Capacitor connection is through Thyristor and at zero current Crossing, this doesn't generate transient.
- Due to fast correction of P.F. Large H.P. motor can be started on generators already running near full load capacity. Large HP motors Do not require soft start starters if connected through FRPFC.
- Renders the distribution network stable & helps in improving system PF to 0.99 plus, without causing any problem to sophisticated electronics equipment & other loads of variable nature.
- Cost is comparable with conventional contactors switching APFC Systems.

DISADVANTAGE OF CONTACTOR SWITHCHING APFC

- Slow response time. Typically 30 to 120seconds.
- Generate electrical noise & spikes, which can be damaging computers, CNC Machines or other digital equipments.
- Due to large inrush current, life of capacitor is very less say, 2-3 years.
- The contactors get welded based on the frequency of operation and needs replacement.
- Not suitable for use on D.G.SETS.
- Takes much longer time to correct voltage sag. Hence, starting current is much higher for longer period, requires Higher capacity of switch gears/cables to cope up with high starting current.
- Due to high starting current, starting torque is much lower. Drives need to be of higher rating to compensate for the low starting torque. Set up will incur more losses because of lower load efficiency.
- Adds wide range of harmonics because of random switching operation.
- Does not incorporate inductor (REACTOR). Hence resonance may occur at times, which can damage the switchgears as well as generating sets without visible notice.
- Requires regular maintenance.

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DISADVANTAGES OF DIRECTLY CONNECTED CAPACITORS TO THE SYSTEM

- Fix capacitors make the power factor in leading condition, during no load and less load condition. These over correction leads to over voltages, which can damage electrical equipments. This over voltage appears across the terminals of the capacitor itself and can affect its life too.

- With increase in voltage a demand increases proposal to the square of the voltages in certain cases and it depends on the characteristic of the load. As a rule of thumb, the maximum demands of load increase by 1.6 times the increase in voltage. i.e. for every 1% increase in voltage the maximum demand will increase 1.6 percent. The average demand will increase one third to one percent voltage rise.

- Watt loss of capacitors varies from.5w to 2.5w per KVAR. So if capacitors are connected directly to the system, there is a watt loss during no load & less load conditions.

- Directly connected capacitors are remain permanently in the system in charged condition all the time, which will leads to temp. Rise and affect the life span of the capacitors.

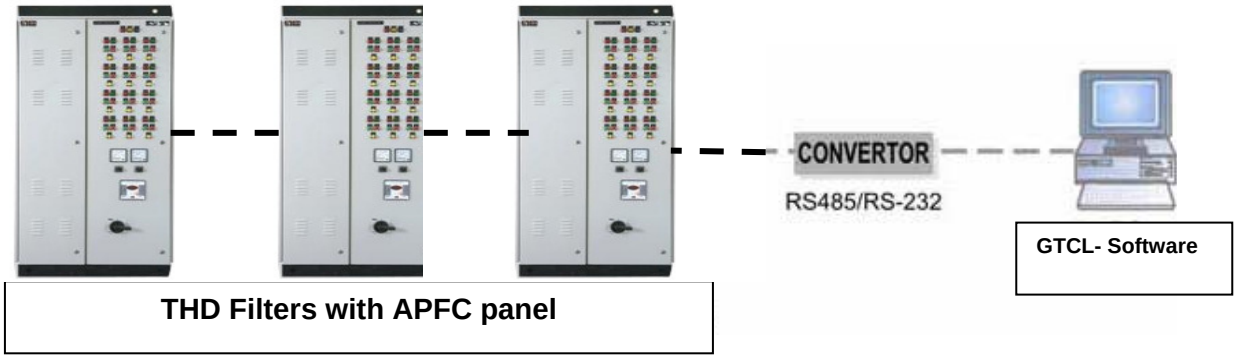
- Directly connected capacitors required periodic checking for verifying capacitor rating.

- If fixed capacitors are directly connected across the motor terminal exceeds 85% of the no load magnetizing KVA of the motor, then there are chances of resonance, which is undesirable.

- If fixed capacitors is connected across the motor employing star delta starters, care should be taken that there should be no

  disconnection of the motor capacitor group from the supply changeover from star to delta, otherwise these may damage motor winding, because fully changes capacitor tends to discharge suddenly when the starter changes from star to delta.

Centralized Monitoring System for APFC:



THD Filters with APFC panel

All or single APFC System over plant network can be interconnected through communication wire to transfer the following data from system to Gloabtel Software. Where it can be viewed & recorded in graphical & tabular format. It offers complete control and power quality management of the plant.

Parameters:

- Frequency
- Phase Current
- Neutral Current
- Phase to Phase Current*
- Phase Voltage
- Neutral Voltage
- Phase to Phase Voltage
- Active Power (kW)
- Reactive Power (kVAr)
- Apparent Power (kVA)
- Power Factor
- Time of use (TOU) - in, out, net, total:
- Active Energy (kWh)
- Reactive Energy (kVARh)
- THD at Phase Current
- THD at Neutral Current
- THD at Phase to Phase Current
- THD at Phase Voltage
- THD at Neutral Voltage
- THD at Phase to Phase Voltage
- Harmonics of Phase Current
- Harmonics of Neutral Current
- Harmonics of Phase to Phase Current
- Harmonics of Phase Voltage
- Harmonics of Neutral Voltage
- Harmonics of Phase to Phase Voltage

Questioners for HFID

- Power Consumption in KVA
- Power Consumption in KW
- Existing Power Factor Correction panel in KVAR
- Existing Power Factor with Capacitor ON
- Existing Power Factor with Capacitor OFF
- % THD for Current with Capacitor ON
- %THD for Current with Capacitor OFF
- Transformer Rating in KVA
- Transformer Impedance in % (normally specified on the name plate of transformer)