GE
Grid Solutions

HV Compensation & Filtering Products

Providing Power Quality and Energy Efficiency

High Voltage (HV) reactive power compensation and harmonic filtering solutions help customers to improve the performance of installations through energy savings and better power quality, enabling end users to save money and reduce the environmental impact of their operations.

Applications	Products	Customer Types
Reactive power compensation and harmonic filtering in distorted networks	Tuned harmonic filter capacitor banks (automatic or fixed)	• Electric utilities for generation, T&D • Heavy industries like steel or aluminium • MV/HV systems integrators • Electrical contractors
Reactive power compensation and harmonic filtering in distorted networks	Detuned harmonic filter capacitor banks (automatic or fixed)	• Electric utilities for generation, T&D • Heavy industries like steel or aluminium • MV/HV systems integrators • Electrical contractors
Reactive power compensation and harmonic filtering in distorted networks	Capacitor banks without reactors or with damping reactors (automatic or fixed)	• Electric utilities for generation,T&D • Light industries of all kinds • MV/HV systems integrators • Electrical contractors
Reactive power compensation in networks without harmonics	Capacitor banks without reactors or with damping reactors (automatic or fixed)	• MV panel builders • Electric utilities • MV/HV systems integrators • Maintenance companies

Key Benefits

- Energy savings
- Improved power quality
- Pay-back period 0.5-2 years
- Reduction of losses in the electrical network
- Improved transmission capacity

Broad Range of Solutions

- High voltage capacitor units
- High voltage reactors
- Electronic products for high voltage applications
- High voltage shunt capacitor banks
- High voltage filter capacitor banks

Imagination at work

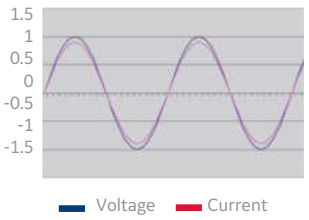
Why do we need reactive power compensation and harmonic filtering?

Reactive Power Compensation

Connected equipment (transformers, motors, air-conditioning, refrigerators, etc.) cause a phase angle between current and voltage. When the current is phase-shifted, it takes more current to deliver the same amount of active power.

Voltage and current
▶ **should be like this...**

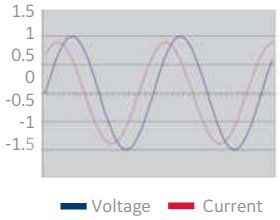
(maximum active power)

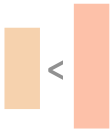


Active Power
=
Apparent Power

▶ **but are like that.**

(deteriorated active power)





Active Power
<
Apparent Power

Power factor = Active power / Apparent power

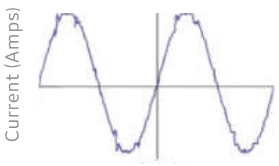
Dephasing between current and voltage decreases the active power (only the active power is converted into useful mechanical power)

IMPACT OF REACTIVE POWER
• Transmission equipment has to be sized for the apparent power, yet only active power is useful • Increased losses in the network • You pay for apparent power but use active power (higher electricity bill) • Reactive power energy fees to customers with a low power factor installation (example < 0.95)
WHO
• Power consumers, network operators, electric utilities, power industry, hospitals, offices, public and commercial buildings, factories
SOLUTION
• The power factor of a facility can be improved by installing capacitor banks

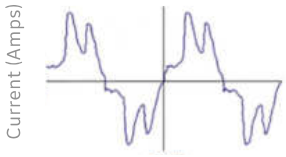
Harmonic Filtering

Variable speed drives (process industries, lifts, air conditioning pumps, etc.), uninterruptible power supplies for computers, electronic equipment, etc. distort the current (introduce harmonics).

Current
▶ should be like this...



▶ but is like that.



Current oscillogram before filtration

WHO

- Power consumers, network operators, electric utilities, power industry, public and commercial buildings

SOLUTION

- Harmonics can be filtered through a combination of reactors and capacitors (passive filtering) or by injecting the exact opposite of the harmonics detected (active filter) into the network

IMPACT OF HARMONICS ON TRANSMISSION / DISTRIBUTION EQUIPMENT

- Additional losses (paid for by the end user)
- Heating in power cables
- Audible noise (transformers)
- Metering errors

IMPACT OF HARMONICS ON EQUIPMENT CONNECTED

- Decreased machinery efficiency
- Costly process shutdowns
- Disturbed electronic equipment (computers, telephones)

Reactive Power Compensation and Harmonic Filtering Bring:

ECONOMIC BENEFITS

- Saving the costs of reactive power
- Additional savings through reduced active power losses
- Reduction in investment cost
  - increase of machinery lifetime
  - decrease of maintenance requirements and downtime of equipment

Return on investment is generally below 18 months..

ENVIRONMENTAL BENEFITS

- Reduced CO_2 emissions
  Customers see environmental benefits through energy savings and more efficient power systems.

  By saving millions of tons of CO_2, power compensation makes an active contribution to protecting the environment.

High Voltage Reactors

Product Features

GE's' high voltage reactors offering is divided in:

HV Air-Core Reactors

- HV air-core shunt reactors
- HV air-core current-limiting reactors
- HV air-core neutral-earthling reactors
- HV air-core power flow control reactors
- HV air-core motor starting reactors
- HV air-core arc-furnace series reactors
- HV air-core damping reactors
- HV air-core harmonic filter reactors
  - HV air-core detuned filter reactors
  - HV air-core tuned filter reactors
- HV air-core discharge reactors
- HV air-core smoothing reactors
- HV air-core reactors for special applications
  - HV air-core SVC reactors (TS R and TCR)
  - HV air-core test lab reactors

HV Iron-Core Reactors

- HV iron-core harmonic filter reactors
  - HV iron-core detuned filter reactors
  - HV iron-core tuned filter reactors

HV Encapsulated Reactors

- HV encapsulated damping reactors

HV Encapsulated Damping Reactors

When capacitor banks are switched on, this connection causes voltage transients and very high inrush currents. Damping reactors installed in capacitor banks limit the current transients to acceptable values for the capacitor units and reduce surge currents to acceptable values for the corresponding switching devices.

Advantages

- Increase of switching equipment life
- Increase of capacitor units life

Applications

- Capacitor banks formed by several steps
- Several capacitor banks connected in the same busbar
- Installations with very high network short-circuit power in relation to the power of the capacitor bank to be connected

HV Iron-Core Reactors

The filter reactors are connected in series with the capacitor units to form a series resonant circuit with a very low impedance.

Advantages

- Reactive power compensation (power factor correction) in networks with harmonics
- Reduction of inrush currents that flow from step to step of the capacitor banks when switched
- Avoiding the risk of resonance as the LC circuit is having a resonance frequency below the first existing harmonic
- Decrease the level of harmonic distortion as the circuit is also having a certain tuning frequency at which the branch will offer a low impedance path for harmonic currents

Applications

- Capacitor banks formed by several steps
- Several capacitor banks connected in the same busbar
- Capacitor bank installations with risk of resonance or with presence of harmonics

HV Air-Core Reactors

Air-core dry-type reactors provide a linear response of impedance versus current that is essential to numerous applications. They are mainly employed in electric power transmission and distribution systems as well as in electric power systems of electrical plants. They are installed to protect these systems and to increase their efficiency. These reactors are also used in electrical test laboratories and research institutions.

Advantages

- No ferromagnetic saturation
- Good linearity degree
- Minimum maintenance
- Safe operation
- Environmentally friendly
- Dry-type construction

Applications

- Power generation
- T&D networks
- Industrial sites
- Electrical test laboratories

From the arctic to the tropics

Grid Solutions' capacitor banks are already giving excellent service in all parts of the world. Our know-how covers the design of capacitor banks for use in extreme climatic conditions, ranging from the freezing arctic of northern Canada and Scandinavia to the tropical heat of Africa and the Far East. Grid Solutions' shunt capacitor banks are built up from high voltage, all-film dielectric capacitor units. The impregnation liquid is both non-PCB and nonchlorine, and the individual units are fully sealed in welded weather resistant stainless steel cases (AISI 409).
The cases are given a protective coating of paint selected according to conditions at the installation site.

Installation work minimised

Grid Solutions' capacitor banks are designed for maximum possible ease of installation, and allowance is also made for the special requirements imposed by transportation. The capacitor units are mounted in the frames or enclosures and ready wired up before dispatch from the factory. At the installation site it is only necessary to fix the frames or enclosure in position and complete the connections.

High quality standards

Grid Solutions put itself well ahead of its competitors when it was the first manufacturer to connect a 735 kV capacitor bank to the network. This pioneering installation has proved itself over the years, and has subsequently helped to bring Grid Solutions a number of commissions for other major projects. With a wealth of know-how and expertise that is second to none, our Research and Development team continues to produce innovative applications to improve the quality of electrical supplies. Grid Solutions' capacitor factory in Tampere is one of the most modern in Europe and provides all the facilities required for the development and production of reliable, high technology equipment.

Installation

Installation of capacitor banks can be made to any point of the network. When measurements are done and harmonic distortion is known, the selection of the compensation method can be made (figure 1):

a) Individual compensation: bank connected directly to the terminals of the consumer
b) Group compensation: bank connected to a distribution system that feeds a number of individual loads
c) Central compensation: bank connected to the main busbar in large installations where many individual loads operated

Data required for design

- Schematic diagram of the system to be compensated
- Rated voltage and frequency
- Reactive power needed
- Data of harmonic loads if any
- Permitted level of harmonic currents and voltages
- Insulation level
- Short circuit level of the system
- Installation and environmental requirements
- Protection systems needed
- Extra accessories needed

Advantages

- Reduced power system losses
- Reduced reactive energy costs
- Capital investments postponement
- Improved voltage profile of the system
- Released power system capacity
- Harmonic distortion removal

Applications

- Windfarms
- Electric utilities
- Heavy manufacturing plants
- Large commercial institutions
- Mines
- Petrochemical industries
- Pulp and paper factories
- Steel processing plants

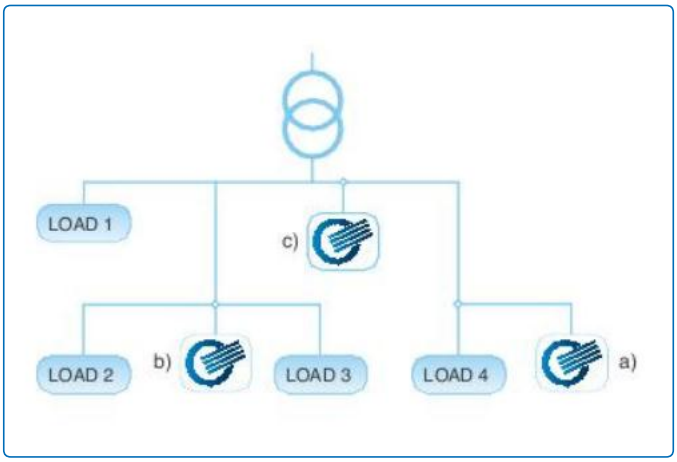


Figure 1: Installation of shunt capacitor banks