2. Capacitor Bank

① General Capacitor Bank

► Application
Capacitor Bank is an economical method of reducing High reactance of high and extra high voltage lines. And it controls the voltage level supplied by reducing or eliminating the voltage drop and increase power transfer Power system. Capacitor Bank is relatively inexpensive and can be easily installed with all accessories anywhere on the network.

► Capacitor Bank benefits to
• Increase power transmission capability
• Improve system stability
• Reduce system losses
• Improve voltage profile on the lines
• Optimize power flow between parallel lines

(Capacitor Bank 150kV 25Mvar – Gl Duri substation in Indonesia)
2-1 Capacitor Bank

② Harmonic Filter Capacitor Bank

▶ Application

Most type of equipment in electrical systems generate harmonics. Harmonics is not only found in industrial networks, it can spread into the distribution system and cause problems for other customers. Each plant is unique and needs its own special technical solution to prevent it. Harmonic Filter Bank usually consists of a capacitor which is connected in series with a reactor. The components are dimensioned to create a series resonance circuit for a required frequency. We can help you to calculate and design filters which will reduce interference and interruption on your network.

▶ Harmonic Filter Bank benefits to

- Improve power factor, voltage stability
- Reduce line loss
- Filter harmonics in the system
- Avoid resonance problems and amplification of electrical disturbances

{(Harmonic Filter Bank 22.9kV 63Mvar – Doosan Heavy Industrial, Korea)}
2-2 Capacitor Bank Type

① Cubicle Capacitor Bank

➤ Application & Construction

This is a fixed reactive compensation system for individual motor compensation. There is a range of metal enclosed capacitor banks for a variety of medium voltage applications. The product range consists of indoor and outdoor solutions, which can be single step fixed or multi-step switched. According to the requirement, it is possible to include also inrush current reactors or other protections and measuring elements. It will automatically compensate the network to maintain a preset level of power factor.

➤ Available options

- Circuit Breaker
- Disconnect Switch
- Earthing Switch
- Inrush or Detuning reactor
- Discharge Coil
- Unbalance Protection
- Automatic Power Factor Controller

<<3.3kV 3P 50Hz 300kvar>> <<10kV 3P 50Hz 700kvar>> <<APFCR with Dry Type Capacitor>>
2-2 Capacitor Bank Type

② Open-rack Capacitor Bank

> Application & Construction

The Samwha Open-rack Capacitor Banks are primarily used to improve the power factor in the network. Improving the power factor also means a higher power transmission capability and increased control of the power flow. They will also improve the voltage stability and reduce network losses. The installation of capacitors in a transmission or distribution network.

> Open-rack Capacitor Bank benefits to

- Reduce network losses
- Increase voltage stability
- Improve power quality
- Limit or reduce charges for excess reactive power consumption,
- Increase load possibility on existing transmission lines and transformers

The Samwha Open-rack Capacitor Bank type is the most common capacitor bank and available with internally fused capacitor units.

<table>
<thead>
<tr>
<th>Range</th>
<th>Internal Fuse Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>Up to 250kV</td>
</tr>
<tr>
<td>Location</td>
<td>Outdoor</td>
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</tbody>
</table>

<<110kV 3P 50Hz 50Mvar Open-rack Capacitor Bank>>
2-2 Capacitor Bank Type

The Samwha Pole Mounted Capacitor Bank provide voltage support, reduce system losses, improve power factor in the distribution systems. The installation is in distribution systems.

**Composition equipments**
- Cut-off Switch
- Capacitor Switch
- Surge Arrester
- Voltage Transformer
- Controller
- Capacitors

<table>
<thead>
<tr>
<th>System Voltage [kV]</th>
<th>Frequency [Hz]</th>
<th>Capacity [kvar]</th>
<th>Number of Capacitor unit</th>
<th>Dimension [mm]</th>
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<td></td>
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<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>12</td>
<td>50 / 60</td>
<td>1000</td>
<td>334 kvar x 3EA</td>
<td>575</td>
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<tr>
<td></td>
<td></td>
<td>1500</td>
<td>300 kvar x 3EA</td>
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<tr>
<td></td>
<td></td>
<td>2500</td>
<td>417 kvar x 6EA</td>
<td>575</td>
</tr>
</tbody>
</table>

* Approximate Dimensions and Capacities are given above. Please contact factory for your projects.
2-3 Capacitor Bank Protection

① NVS [Neutral Voltage Sensor]

➢ General
Capacitor Bank is needed to set proper protection systems to protect capacitor bank against faults occurring within the bank including those inside the capacitor units, and to protect capacitor bank against system disturbances and faults.
Generally, the method of detecting neutral value [voltage or current] is selected as the protection for capacitor bank system.

➢ Application
NVS is the protection system using voltage unbalance signals to alarm or shut down the capacitor bank in case of faults that may lead to significant damages.
To measure the unbalance of voltage, the neutral voltage-sensing device [NVS] is used.

• Ungrounded Single Wye Banks
It detects the unbalance voltage between capacitor neutral and resistance which is connected with capacitor.
NVS of deflecting voltage is changeable according to the number of internal series in capacitor.

• Ungrounded Double Wye Banks
It is the same protection method as ungrounded single Wye Bank.
The difference is that it detects the unbalanced voltage between the two neutrals and it needs to use overvoltage relay.
2-3 Capacitor Bank Protection

② NCT [Neutral Current Transformer]

Application

NCT is the protection system using unbalanced current on neutrals composed in Double Wye Capacitor Banks signals to alarm or shut down the banks.

To measure the unbalance of current, the current transformer with low current value is used.

The current transformer ratio and relay rating are selected for the desired sensitivity.

NCT protection system is normally used on wide range of level from high to extra voltage capacitor banks, and can detect faults in all kinds of capacitor units.

Current Transformer with rated current value 1 is manufactured, therefore it is useful to protect Capacitor Bank with internal fuse which has low fault current on neutral.

• 36kV CAPACITOR BANK with NCT Protection System

<table>
<thead>
<tr>
<th>System voltage [Max] [kV]</th>
<th>Frequency [Hz]</th>
<th>Capacity [kvar]</th>
<th>Number of Capacitor unit</th>
<th>Dimension [mm]</th>
</tr>
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<tr>
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<td>50 / 60</td>
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<td>A</td>
</tr>
<tr>
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<td>7500 8000 7500</td>
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<td>556kvar x 18EA</td>
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<td>10000 10500 10000</td>
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<td>30000</td>
<td>500kvar x 60EA</td>
<td>1340 7000 4000</td>
<td>30000 30500 30000</td>
</tr>
</tbody>
</table>

* Approximate Dimensions and Capacities are given above. Please contact factory for your projects.