PQC-STATCON
Instantaneous and stepless compensation for dynamic reactive power and unbalanced loads
ABB (www.abb.com) is a leader in power and automation technologies that enable utility and industry customers to improve their performance while lowering environmental impact. The ABB Group of companies operates in around 100 countries and employs about 145,000 people.

ABB delivers the full value chain in low, medium and high voltage technologies for electrical power transmission, distribution and usage. ABB has been driving development in the field of Power Quality for over 70 years and is responsible for several important developments in reactive power and filtering technologies.

Today, ABB is recognized as a leader in Power Quality, partnering our customers to define the optimal solution for their systems.
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Applications and key benefits

PQC-STATCON technology is used for dynamic reactive power compensation, unbalanced load compensation and voltage stability improvement. It can provide compensation in grid supply. Apart from the grid supply network, it can support dynamic loads fed from generator. PQC-STATCON has a good steady state performance with ultra fast response and superior control characteristics. It can be operated dynamically to compensate to fast varying capacitive, inductive and unbalanced loads.

Applications
Instantaneous stepless power electronics based dynamic compensator for dynamic reactive power (power factor) and unbalanced loads (<1 cycle response time)

- For inductive and capacitive loads
- For highly fluctuating loads
- For industrial loads fed by weak networks
- For three phase and single phase applications
- For LV networks and MV networks with step-up transformer

Key benefits
- Improved power quality
- Enhanced energy efficiency by reducing system losses
- Reduced carbon foot print
- Improved reliability of existing capacitor banks under dynamic condition
- Reduced maintenance needs and enhances life of electrical installations
- Easy installation and commissioning
- Easy and convenient operation with touch screen interface
- No risk for harmonic amplification

Typical installations include
- Automotive, welding plant
- Steel plants, rolling mills, furnace applications
- Railway traction substations
- Airports, shipyards, ships
- Off-shore drilling
- Process industries
- Sky lifts, compressor loads
- Pulp and paper industries
- Chemical plants
- Rubber industries
- Hydro power plants
- Cement factories
- Water treatment plants
- Wind mills
The PQC-STATCON is based on Voltage Source Converter (VSC) technology. VSC consists of Insulated Gate Bipolar Transistor (IGBT) as fully controlled power semiconductor devices.

VSC produces single or three phase AC voltage from a DC input voltage. The VSC generated voltage is coupled to the source voltage through a Pulse Width Modulation (PWM) reactor. By varying the magnitude of AC terminal voltage of VSC, reactive power exchange takes place between the VSC and the AC source. If the magnitude of VSC voltage is more than the AC source voltage, capacitive current flows from supply voltage to VSC and the PQC-STATCON generates capacitive reactive power. If the magnitude of VSC voltage is less than the AC source voltage, inductive current flows from supply voltage to VSC and the PQC-STATCON generates inductive reactive power. If the amplitude of VSC voltage is equal to the AC source voltage, no current flow happens between supply voltage and VSC; PQC-STATCON does not generate reactive power.

Further, PQC-STATCON generates appropriate magnitude of voltages at the AC terminal of VSC to compensate for negative sequence current caused due to unbalanced loads.

Hence, the source will be totally relieved from reactive current and negative sequence current (due to unbalanced loads). This results in flow of balanced real current in all three phases in the source.

PQC-STATCON provides excellent steady state performance, instantaneous response (<1 power cycle) and has superior control characteristics, thanks to high speed Digital Signal Processor (DSP) technology.

PQCT / PQCL nullifies the reactive & unbalance currents at the source. Note: PQCT / PQCL is a three wire device. It compensates the phase to phase unbalance currents.
Improved power quality and energy efficiency - Graphical representation of typical applications

Case 1: Typical resistive loads

\[ I_R = 0 \; A; \; \text{I}_{Y} = 173 \; A; \; I_B = 173 \; A; \; S = 83 \; \text{kva}; \]
\[ \text{PF} = 1; \; I_{UB} = 100 \% \]

Case 2: Typical welding loads

\[ I_R = 283 \; A; \; \text{I}_{Y} = 124 \; A; \; I_B = 291 \; A; \; S = 167 \; \text{kva}; \]
\[ \text{PF} = 0.45; \; I_{UB} = 45 \% \]

Case 3: Typical process industries

\[ I_R = 168 \; A; \; \text{I}_{Y} = 81 \; A; \; I_B = 140 \; A; \; S = 93 \; \text{kva}; \]
\[ \text{PF} = 0.80; \; I_{UB} = 40 \% \]

Note: x-axis = Time; y-axis = Ampere
I_R = 100 A; I_Y = 100 A; I_B = 100 A; I_Q = 0 A; I_{Neg} = 100 A

I_R = 224 A; I_Y = 124 A; I_B = 291 A; I_Q = 200 A; I_{Neg} = 100 A

I_R = 90 A; I_Y = 40 A; I_B = 121 A; I_Q = 75 A; I_{Neg} = 50 A

Note: I_R - R phase current; I_Y - Y phase current; I_B - B phase current; I_Q - Reactive current; I_{Neg} - Negative sequence current; I_{ub} - % Current unbalance; S - kva; PF - Power Factor; kva reduction = 13\%
Key product features

**PQC-STATCON is available for single phase and three phase applications**
PQC-STATCON performs fast reactive power compensation for a single phase network.

PQCT-STATCON performs fast reactive power and unbalanced load compensation for a three phase network.

**Versatile configuration options allow for variety of applications**
PQCS-STATCON can be configured with main and auxiliary target PF settings. This option enables the system to work at unity PF (or any other Main PF setting), when supplied from utility source and to work at 0.8 lag PF (or any other Auxiliary PF setting), when supplied from generator.

PQCT-STATCON has priority option to allocate the converter resources between reactive power and unbalance compensation requirements, in addition to the dual PF target option as in PQCS-STATCON. The priority compensation can be selected to be reactive power or unbalance. If reactive power is selected as priority, PQC-STATCON will compensate for reactive power to the specified target PF and use the remaining resources for unbalance compensation. If unbalance is selected as priority, PQC-STATCON will nullify the unbalance current components in the load and use the available remaining resources for reactive power compensation. In addition to priority setting, the dual PF target option enables the system to work at unity PF (or any other main PF setting), when supplied from utility source and to work at 0.8 lag PF (or any other auxiliary PF setting), when supplied from generator.

**Energy efficient operation**
Energy save mode is a feature available in PQCS and PQCT range of PQC-STATCON. If the PQC-STATCON is operating at near zero current levels for 30 seconds, IGBT converter is switched off and successively the blowers are switched off in 2 minutes. The system enters a sleep mode and the stress on power components is minimized. The power consumption of PQC-STATCON in sleep mode is almost zero, but the system is available in hot standby. As the load demand rises, the system can supply the rated kVAR within 5-8 power cycles.

**Operation with parallel fixed capacitor bank for better economics**
PQC-STATCON has the capability to operate in inductive and capacitive dynamic range of \(-X\) to \(+X\) kVAR. In order to achieve higher kVAR, PQC-STATCON may be operated in parallel with a fixed capacitor bank/ de-tuned filter bank of fixed size X kVAR. The dynamic range will be modified as 0 to 2X kVAR, increasing compensation capability for inductive loads.

PQC-STATCON may also control the parallel filter banks through a potential free contact, by which energy efficient operation is achieved more efficiently and the system will achieve a dynamic range of -X to +2X kVAR.

**PQC-STATCON is designed with customers in mind**
PQC-STATCON is an advanced, reliable and user friendly solution for power quality problems.

It uses robust control and protection techniques implemented on a high speed digital control system. It is a modular non-overloadable technology, which can be upgraded in the future.

PQC-STATCON has advanced fault diagnostic features to provide a maximum protection level. This feature monitors the performance of the system and its components. The observed abnormal conditions are recorded with time stamping. The logged history is accessible through the graphical user interface (GUI).

User friendly backlit touch-screen graphical user interface allows easy programming, monitoring of the system. Works with standard class CT’s.

PQC-STATCON is a compact solution usable in both new and retrofit applications.
The different modes of PQC-STATCON operation are:

**Fixed compensation mode**
In this mode PQC-STATCON supplies a fixed lagging / leading reactive current. It functions as a fixed inductive / capacitive reactive current source. The current to be supplied can be set through the user interface.

**Dynamic modes**
In dynamic modes PQC-STATCON supplies a dynamic current based on the feedback from CT. It can take feedback from CT located on the source side or load side.

**Dynamic, load CT mode**
This mode can be selected through the user interface. PQC-STATCON measures the reactive/unbalance component in load current and injects an anti-phase component of the same. Since both the currents are flowing on the same bus, the reactive/unbalance currents drawn by the load are locally compensated. This mode operates in an open loop fashion. When more than one STATCON is used in parallel, all of them use the same CT feedback and share the load demand equally.

This mode is useful, when only the loads in a specific feeder are to be compensated and STATCON is located on a different feeder of the same bus.

**Dynamic, grid CT mode**
This mode can be selected through the user interface. In this mode PQC-STATCON measures and regulates the reactive/unbalance currents at the source side to zero. This is performed in a closed loop fashion. This is the most widely used, accurate and recommended method, by which the capabilities of PQC-STATCON can be utilized to the maximum.

In most cases more than one STATCON is used to meet the reactive power requirement. All the PQC-STATCON systems can share the same CT feedback and regulate the source power factor.

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**Operating boundaries of PQCT-STATCON**
(Refer technical specifications for current details)

Note: \( I_r \) = Real current; \( I_q \) = Reactive current; \( I_L \) = Load current, \( I_{STAT} \) = PQC-STATCON current; \( I_s \) = Source current; \( I_R \) = Rated PQC-STATCON current
Sizing of PQC-STATCON for reactive power compensation

To quickly calculate the size of a PQC-STATCON based reactive power compensation system.

Calculate the required capacity for dynamic compensation through PQC STATCON, which is half of the total dynamic compensation requirement.

\[ Q_{\text{PQC-STATCON}}^\text{dyn} = \frac{Q_{\text{max}} - Q_{\text{min}}}{2} \]

Calculate the required capacity for fixed capacitor based compensation, which is the sum of base compensation requirement and half of the total dynamic compensation requirement.

\[ Q_{\text{capacitor}} = Q_{\text{base}} + \frac{Q_{\text{dyn}}}{2} = Q_{\text{base}} + \frac{(Q_{\text{max}} - Q_{\text{min}})}{2} \]

Note:

*To perform load balancing, add the negative sequence demand of load.*

---

S. No | Type No. | Application | Voltage | kvar | Current (I) |
--- | --- | --- | --- | --- | ---
1 | PQCS-50-V240 | 1-Ph | 240 | 50 | 210 |
2 | PQCS-100-V240 | 1-Ph | 240 | 100 | 420 |
3 | PQCS-100-V415 | 1-Ph | 415 | 100 | 240 |
4 | PQCS-150-V415 | 1-Ph | 415 | 150 | 360 |
5 | PQCS-250-V415 | 1-Ph | 415 | 250 | 600 |

S. No | Type No. | Application | Voltage | kvar | Current (I) |
--- | --- | --- | --- | --- | ---
1 | PQCT-100-V415 | 3-Ph | 415 | 100 | 140 |
2 | PQCT-150-V415 | 3-Ph | 415 | 150 | 210 |
3 | PQCT-250-V415 | 3-Ph | 415 | 250 | 350 |
4 | PQCT-300-V415 | 3-Ph | 415 | 300 | 420 |

Type no. Nomenclature : 
For example.

Refer PQCT (S.No. 3) (PQCT - 250 - V 415)

Refer PQCS (S.No. 2) (PQCS - 100 - V 240)
**Technical specifications**

<table>
<thead>
<tr>
<th>Detail</th>
<th>Unit</th>
<th>POCT</th>
<th>POCL</th>
<th>POCs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection method</td>
<td></td>
<td>3 phase, 3 wire system</td>
<td>3 phase, 3 wire system</td>
<td>1 phase, 2 wire system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V415: 380V - 440V</td>
<td>V240: 210, 420, 240, 360, 600</td>
<td></td>
</tr>
<tr>
<td>Permissible voltage variation</td>
<td>%</td>
<td>±10%</td>
<td>±10%</td>
<td>±10%</td>
</tr>
<tr>
<td>Current ratings</td>
<td>Ampere</td>
<td>140, 210, 350, 420</td>
<td>100</td>
<td>V240: 210, 420, 240, 360, 600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V415: 240, 360, 600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>kvar ratings(1)</td>
<td>kvar</td>
<td>±100, ±150, ±250, ±300</td>
<td>±70</td>
<td>V240: ±50, ±100, ±150, ±250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V415: ±100, ±150, ±250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System frequency</td>
<td>Hz</td>
<td>50 Hz, 60 Hz (±5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment loss</td>
<td>%</td>
<td>3% of the equipment power typically</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compensation method</td>
<td></td>
<td>Closed loop / Open loop / Fixed mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaction time</td>
<td>ms</td>
<td>&lt; 2ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response time</td>
<td>ms</td>
<td>Less than one power cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Completion of Compensation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load balancing modes</td>
<td></td>
<td>Between line to line</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Modularity</td>
<td>Nos</td>
<td>Maximum 32 units can be combined</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal protection</td>
<td></td>
<td>Main breaker</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Programming / Communication characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communications</td>
<td></td>
<td></td>
<td>Modbus(2)</td>
<td></td>
</tr>
<tr>
<td>Programming interface</td>
<td></td>
<td>Using PQC-Manager (Touch screen Graphical User Interface - GUI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redundancy</td>
<td></td>
<td>Master/master arrangement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive power range</td>
<td>kvar</td>
<td>100% inductive to 100% capacitive, stepless</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary PF setting</td>
<td>Programmable as per the site conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target cos φ</td>
<td>Programmable from 0.6 (inductive) to 0.6 (capacitive)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Physical aspects (per base unit)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximate dimension (unpacked) (W x D x H) mm</td>
<td>1000 x 900 x 2200</td>
<td>585 x 315 x 700</td>
<td>1000 x 900 x 2000</td>
<td></td>
</tr>
<tr>
<td>Approximate weight (unpacked) kg</td>
<td>800kg</td>
<td>125kg</td>
<td>800kg</td>
<td></td>
</tr>
<tr>
<td>Mounting</td>
<td>Free standing</td>
<td>Wall mounting</td>
<td>Free standing</td>
<td></td>
</tr>
<tr>
<td>Colour</td>
<td></td>
<td>RAL 7035 (Other colours on request)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Installation Aspects (Per base unit)</strong></td>
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</tr>
<tr>
<td>Ingress Protection (IP)(3)</td>
<td>IP-31</td>
<td>IP-30</td>
<td>IP-31</td>
<td></td>
</tr>
<tr>
<td>Altitude Protection (IP)(3)</td>
<td>Upto 1000m (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature °C</td>
<td>-5°C to (+) 45°C(6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humidity %RH</td>
<td>Maximum 95% RH, Non-condensing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable Entry</td>
<td>Bottom entry (for others please consult factory)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT Requirements</td>
<td>- 3 CT’s are required (class 1.0 or better)</td>
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</tr>
<tr>
<td></td>
<td>- Burden: 5VA for upto 8 units with 25m distance</td>
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<tr>
<td></td>
<td>- Secondary rating: 5 A</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>- CT’s must be installed in closed loop configuration</td>
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</tr>
</tbody>
</table>

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1) kvar rating calculated based on nominal voltages of 415V for V415 group and 240V for V240 group and 415V for PQCL
2) Modbus connection can be used either to STATCON GUI or custom modbus RTU connection
3) For other IP ratings please consult factory
4) For higher altitudes (up to 2000m / 6600ft max.) and for higher temperature please consult factory