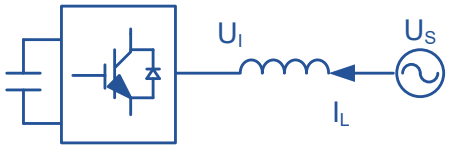
PCS-9583

Static Synchronous Compensator (STATCOM)

The Static Synchronous Compensator is a voltage regulating device based on voltage source converters. It acts as a source or a sink of reactive power which is independent of AC system voltage. The STATCOM can adjust reactive power of power grid, improve power quality, and reduce grid losses and the impact on electrical equipment. It is extensively applied to power grid, renewable energy generation, steel mill, chemical plant, electrified railway, city subway, mine and so on.

Operating Principle

PCS-9583 STATCOM system adopts voltage source converter and the most advanced reactive power compensation technology, not needing large-capacity capacitors and inductors. The H-bridge circuit is connected to the grid via connection transformer or reactor, by suitably adjusting the phase angle and amplitude of output voltage at AC side of the bridged circuit or directly controlling its AC current, this circuit can absorb or generate reactive current as required and realize dynamic adjustment of voltage or reactive power.



STATCOM

Figure 1 STATCOM Operating Principle

The cascading scheme of multi-level topology is used in the PCS-9583 STATCOM system. This topology consists of several H-bridge power units with monopole multiplier modulation to achieve three-level output on the AC side. Each phase adopts the carrier phase modulation method to obtain better voltage output waveform with much more level numbers. The cascading scheme can output phase voltage with 2N +1 levels if each phase comprises N +1 links (i.e. the H-bridge power unit).

Functions

- Power Transmission Substation
  - Compensate line reactive power and stabilize system voltage
  - Reduce transmission losses
  - Increase line transmission capacity through the dynamic support of line terminal voltage
  - Improve transient stability to prevent against transient voltage collapse
  - Provide power oscillation damping
- Mining Hoists and Industrial Mills
  - Improve power factor, reduce reactive power loss and energy-saving
  - Solve serious harmonic pollution problems, and improve power quality by active power filtering
  - Enhance line terminal voltage, improve voltage stability and power supply security
  - Reduce voltage fluctuation and flickers caused by heavy load during startup
- Electrified Railway
  - Provide power factor control to reduce power loss
  - Supply voltage regulation to weak grid
  - Compensate negative sequence/unbalance current or voltage
  - Provide harmonic filtering
- Wind Farm and Solar Energy
  - Correct system power factor
  - Reduce voltage fluctuation and flicker
  - Filter harmonic current
  - Balance three phase power
  - Enhance voltage stability and improve low-voltage ride through (LVRT) capability
- Steel Plant and Rolling Mill
  - Provide harmonic filtering

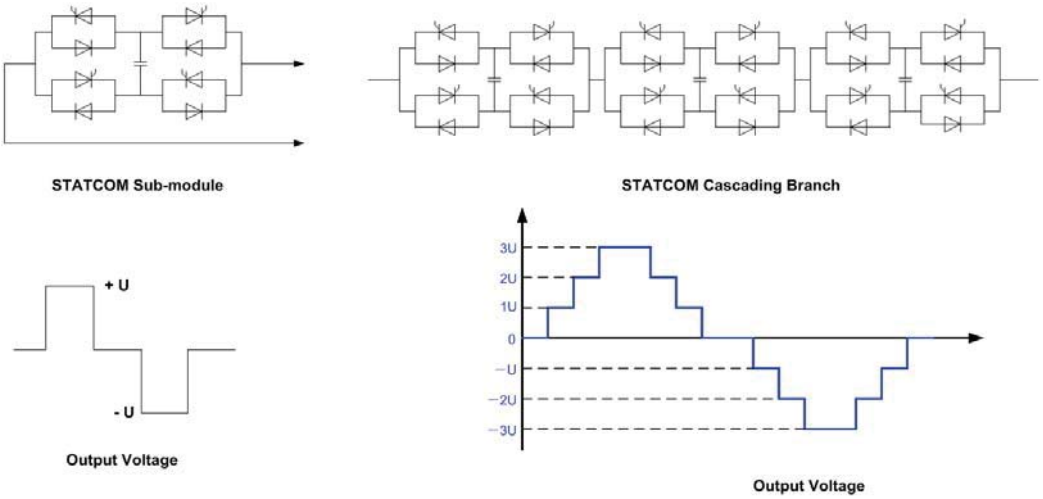


Figure 2 Chain Circuit STATCOM

- Compensate unbalanced voltage
- Significantly reduce voltage fluctuation and flicker
- Improve productivity
- Reduce reactive power impact
- Control power factor

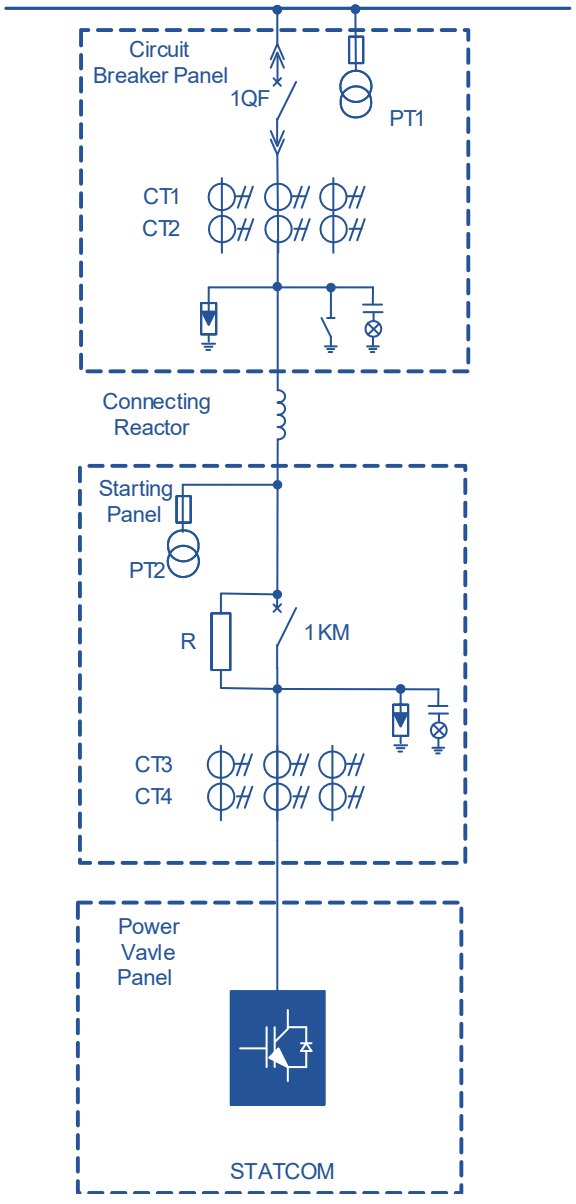


Figure 3 STATCOM System Configuration

System Configuration

This complete set of STATCOM system mainly includes the following main equipments:

- Interface Reactor/Converter Transformer
  The interface reactor/converter transformer is used to connect the converter with the AC power networks, realizing the active power and reactive power exchange between the converter and the AC power networks.

Figure 4 Startup Equipment

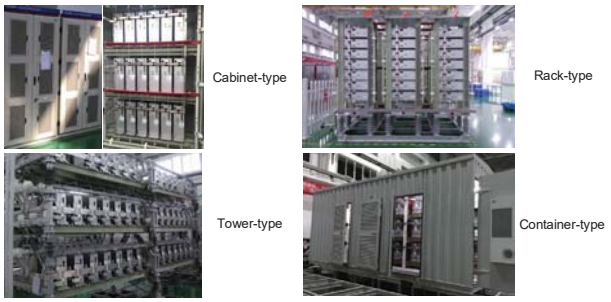


Figure 5 Power Valve

- Startup Equipment
  To start the STATCOM system, the capacitor at DC side needs to be charged firstly. And for reducing the charging current and the impact on the system, the startup equipment is adopted in STATCOM system.

- Power Valve
  Power module, as the basic unit of STATCOM system, consists of IGBT and its drive circuit, supporting capacitor, radiator, equalizing resistance and so on. The power valves adopt H-bridge cascaded structure. Each phase consists of a number of power modules, adopting redundant design and satisfying “N-1” or “N-2” operational requirements.

- Cooling System
  Formation of enormous heat during operation may damage the components if it is not dissipated well. During low system capacity, PCS-9583 STATCOM adopts forced air cooling whereas during large system capacity, it adopts closed-loop water cooling with specialized control system.

- STATCOM Control and Protection System
  The STATCOM control and protection system consists of PCS-9583 PCP (Pole Control and Protection), PCS-9589 VBC (Valve base Control) unit, SMC (Sub-module controller), interposing relay set, network switch and other protection devices.

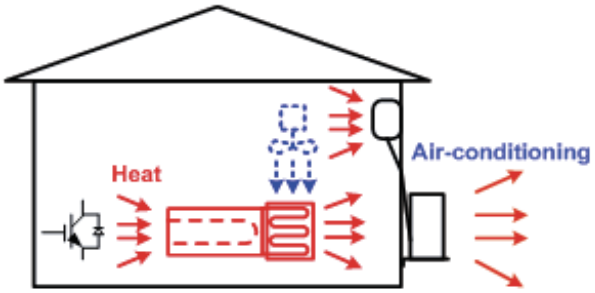


Figure 6 Forced Air Cooling

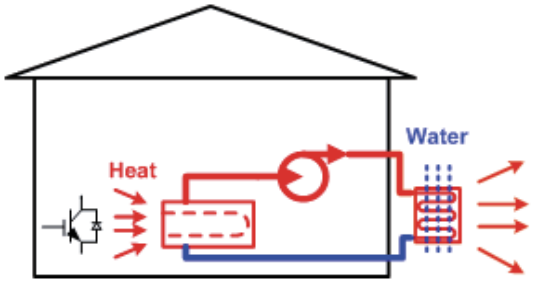


Figure 7 Enclosed Water Cooling

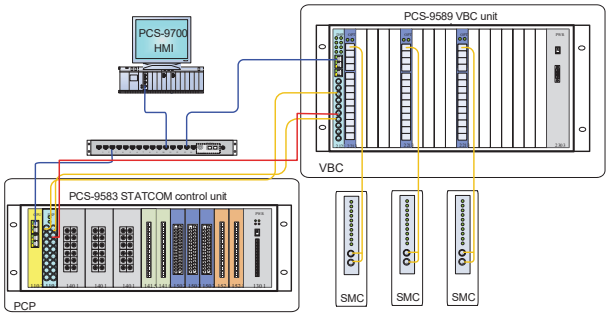


Figure 8 STATCOM Control and Protection System

Features

- Modular design
  Modular power modules with professional design, compact structure, high reliability, and easy to product and maintain. The hot standby redundancy of unique design can ensure operation of redundant unit with zero impulse in case of fault in an operating power module.

- High performance, high reliability of control and protection system
  The UAPC platform of NR is adopted to constitute the control and protection system. Framework is high-performance and high-reliability, and with mature hardware and software. The kernel controller adopts the latest floating controller in the industry, which has high main frequency, large memory, and high operation and control precision. Integral panel and fully enclosed chassis are used so that ingress of dust can be effectively prevented, thus guaranteeing safe and reliable operation of the control system.

- Advanced DC side voltage balance technique
  Adopt advanced DC side voltage balance technique in the industry. Unique innovative balance algorithm between chains and inter-phase balance algorithm have been proposed, effectively control capacitive voltage equalizing between chains, reduce power module complexity, and reduce power loss of the whole system without use of any additional auxiliary hardware equipment.

- Advanced HMI system
  PCS-9700 HMI system is a new generation HMI system developed by NR based on years of SAS research achievements and site operation experiences. This system adopts advanced distributed network technology, object-oriented database technology, cross-platform visualization technology, and latest standards in the industry. It is the achievement of elaborate design and devoted in-depth development. International standards such as IEC60870-5-103 and IEC61850 are fully supported. PCS-9700 can satisfy the demands on HMI system in conventional substations, digital substations, as well as the NCS system in power plants.

- Integrated fault recording function
  This system integrates fault recording function, which can record the whole dynamic process in STATCOM system, including the change process of relevant system electrical parameters after large disturbance and operation behavior of protection modules. Recorded fault data includes data in transient state and steady state. Transient fault recording can record transient disturbance process at a rate of 9.6kHz at highest, without use of triggering conditions. Steady state fault recording continuously records power system status process at a rate 1Hz~1.2kHz. The equipment has a large capacity and high-speed FLASH memory card to ensure safety of dynamic data recording and storage. COMTRADE format of IEEE is adopted to facilitate later acquisition and analysis.

- Complete protection functions
  NR is dedicated to the power system protection, and has obtained a series of patented technologies and proprietary technologies in protection and control of power system. PCS-9583 STATCOM system provides multiple protections, including component level protection, valve unit level protection, and system level protection. The complete set of protection function are provided for power modules, valve banks, lines, and filter capacitor (FC). This hierarchical comprehensive protection strategy greatly improves product reliability.

- Powerful communication functions
  Flexible communication mode is provided and seamless connection with NR PCS-9700 series protection and supervisory control platform can be realized. Power industry communication standard IEC60870-5-103, Modbus protocol and new generation substation communication standard IEC61850 are supported.