# STATCOM: future-proofing reactive power compensation

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FACTS POWER QUALITY SVC – STATCOM

*Demand for transmission system voltage support is increasing along with growing input from renewables. At the same time, weak and aging grids, the retirement of thermal and nuclear plants, as well as little space for building new installations are limiting transmission system development. Next-generation STATCOM is the answer.*

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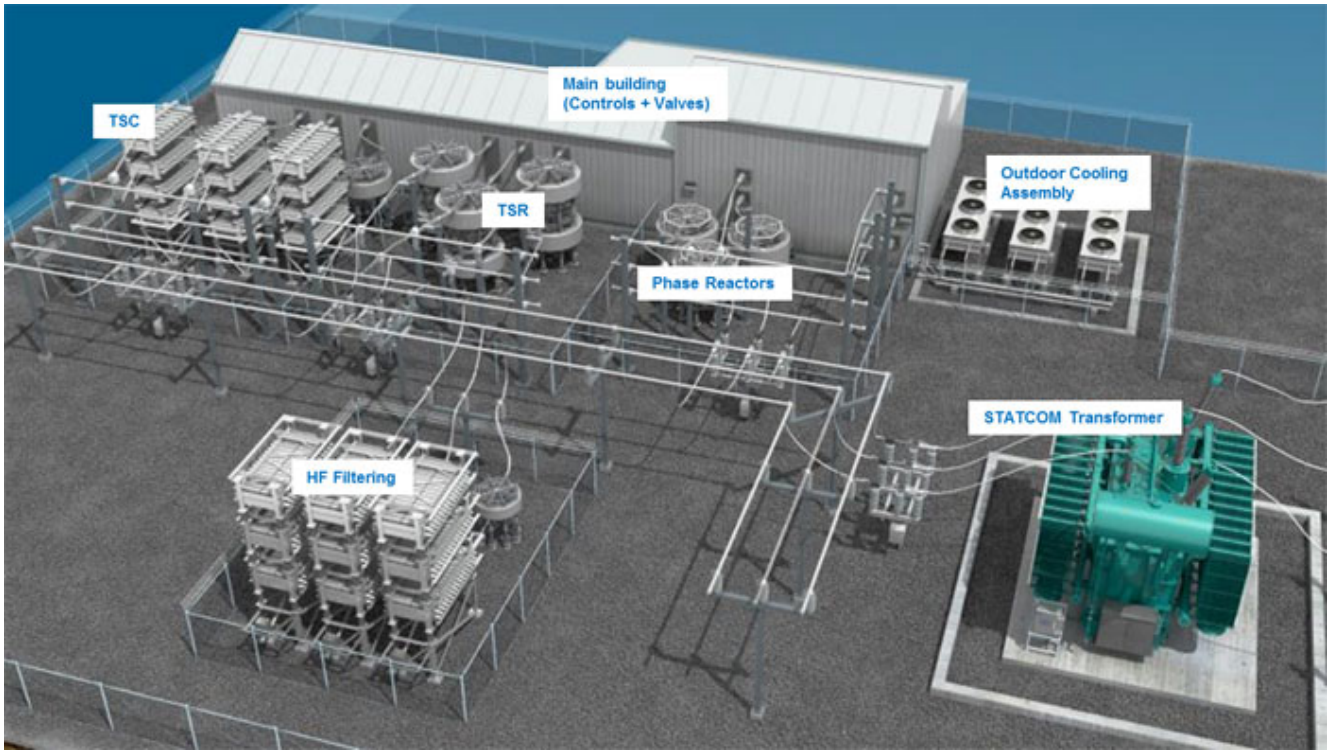
The integration of distributed generation into existing networks poses a number of challenges. The predictability of renewable energy sources is limited and the amount of power they produce fluctuates. Furthermore, wind farms require support from reactive power sources during recovery from line faults. GE helps TSOs to maintain power quality and power transfer capability using active network management based on future-proof smart technologies.

GE's utility-grade static synchronous compensator (STATCOM) solution is a custom-designed system to be installed on transmission grids to provide reactive power compensation and voltage control. GE's design is based on a leading-edge modular multilevel converter (MMC) architecture with HVDC MaxSine® full-bridge power submodules. STATCOM operation characteristics differ from a classical SVC (static VAR compensator): STATCOM undervoltage performance is superior, while SVC masters overvoltages.




System Layout (shown with optional equipment)
Thyristor Switched Reactor (TSR) + Thyristor Switched Capacitors (TSC)
for extended output power rating

## STATCOM basics

The development of insulated gate bipolar transistor (IGBT) technology enables high power shunt compensation systems with voltage source (VSC), the next-generation STATCOM to complete GE's FACTS offering. The shunt-connected STATCOM can generate capacitive or inductive output current independent of the AC system voltage. Jussi Pöyhönen, Grid Solutions Senior Lead Design Engineer, describes STATCOM advantages in shunt compensation. "The shunt compensation market is turning to STATCOMs thanks to their harmonic and undervoltage performance. Moreover, stringent harmonic performance requirements are more easily met, even in weak networks."
Each phase of the VSC valve consists of a string of series-connected full-bridge valve submodules, each of them having its own DC-link capacitor. The STATCOM VSC valve current is controlled by switching valve submodules to its positive or negative DC-link voltage or zero voltage for voltage difference over the coupling impedance of a step-down transformer or a series reactor. AC voltage is controlled with capacitive reactive power, when the converter voltage is greater than the system voltage. If the converter voltage is less than the system voltage, the

STATCOM produces inductive reactive power. VSC valve reactive current capability is symmetrical for inductive and capacitive operation.
The core of the STATCOM controller is a modulator in charge of valve submodule switching, applying novel algorithms including DC-link balancing and valve submodule sorting. STATCOM VSC valve submodules utilize proven HVDC design standards sharing the same design and manufacturing facilities. GE's STATCOM VSC valve has inherent transient performance thanks to the strongest DC-capacitor rating on the market. Extensive self-diagnostic capabilities maximize reliability. Performance degradation and component faults are pinpointed in real time. High availability is ensured by a dual-lane redundancy control system configuration. A built-in event logger with automatic time stamping of 1 millisecond resolution and a synchronized transient fault recorder with up to 10 microsecond sampling allow for detailed analysis post event.
The control system can be remotely accessed using a secure protocol. It allows remote monitoring using the built-in real-time monitor function and fault detection including diagnostics. To fulfill modern remote control interfacing requirements, the control platform supports an extensive set of industry protocols and custom protocols can be integrated as an option.

## STATCOM advantages for utilities

STATCOM helps utilities in three different domains. First, to increase system stability and power quality by providing voltage control and support, reactive power control, power oscillation damping, and increased power transfer capacity. Next, it enables electro-intensive industrial processes to obtain a grid connection by controlling flicker level, harmonic voltage distortion, and voltage unbalance. Finally, it allows renewables to be connected to the grid in compliance with grid code requirements by providing fault ride through support and voltage control.
Jussi Pöyhönen sums up the advantages: “GE’s utility-grade STATCOM solution provides grid operators with reactive power to support grid stability in difficult network conditions and weak grids in a more compact package compared to traditional SVC solutions.”

## The industry’s only model-based design control system

The advanced digital control (ADC) system from GE represents state-of-the art technology for shunt and series compensation to control and

protect any connected equipment at over 10 times better performance ratings than previous designs. Thanks to hybrid processing technology (microprocessor plus field-programmable gate array, or FPGA) and high-speed serial connectivity, ADC provides top performance when running complex utility and industrial compensation algorithms. Such real-time performance allows control of modern insulated gate bipolar transistor (IGBT)-based voltage source converters, requiring sub-microsecond reaction time.

Advanced digital control (ADC) System

ADC incorporates model-based software design to provide fast, automatic and error-free code generation from control models, ensuring a greater level of confidence for the users. Software quality is greatly increased by eliminating errors during earlier stages of development using simulations of control software together with power electronics. Model-based design methodology also reduces time for control software design, testing and verification by up to 50% compared to traditional coding approaches, by automatically generating code from control models. This allows for very fast customer-specific software development and testing, which reduces project costs even for highly customized applications. The resulting control software is fully hardware-independent, giving engineers the freedom to

define hardware connections.
In addition ADC introduces built-in observation and diagnostic features, such as the internal transient fault recorder, event logger, and engineering interface tools, which allow fast troubleshooting onsite and support commissioning. Ease of integration into control system software with power system modeling tools such as PSCAD provide the most accurate representation of system performance for planning and troubleshooting analysis.
ADC's fully modular control system platform hardware is based on rugged, modern military-based VPX technology and state-of-the art commercial off-the-shelf components for better reliability and longer lifetime. VPX technology offers future-proof, higher control execution speed with higher controller-internal (backplane) data rates, and scale-up without sacrificing speed, while using established technologies from commercial and industrial markets, thus giving access to a wide knowledge community, support, and documentation
Dual-lane redundancy with hot-swap capability and no changeover unit increases the availability of the system, while a distributed signal acquisition system provides hundreds of analogue and digital channels with microsecond latency and large bandwidth.
ADC is type-tested according to IEC substation standards. It is an essential part of GE SVC, STATCOM and hybrid (STATCOM + SVC) solutions, and is scalable to any project size and power.

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