BEGEL ENERGY
SYSTEMS POWER
QUALITY DIVISION

SVC

STATIC VAR COMPENSATOR

Static VAR Compensator (SVC)

The quality of delivered electricity is increasingly important to industrial processes that are reliant on seamless power supply. The challenge is to decrease operation disturbances caused by reactive power changes and voltage fluctuations.

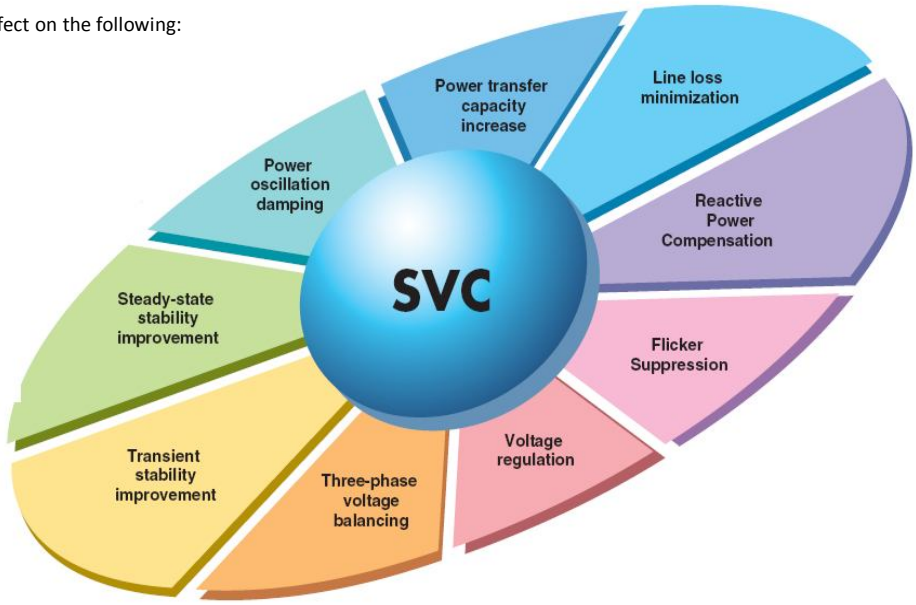
Disturbances can be caused by line switching, line faults, non-linear components such as tyhristor controls and rapidly varying active or reactive loads, or industrial disturbance sources such as electric arc furnaces and rolling mills. These result in harmonics that load the supply network and cause voltage fluctuations. Varying loads can also create disturbances in the form of phase and voltage flicker phenomenon requiring additional reactive power.

BEGEL SVC SOLUTIONS FOR INDUSTRIAL APPLICATIONS

The SVC system can keep a steel plant bus voltage at a practically constant level. This decreases steel processing time and increases productivity. The SVC system also reduces production breaks and expensive restart procedures. The benefits of an SVC can be seen within a steel plant as a stable power factor in spite of varying loads at the plant.

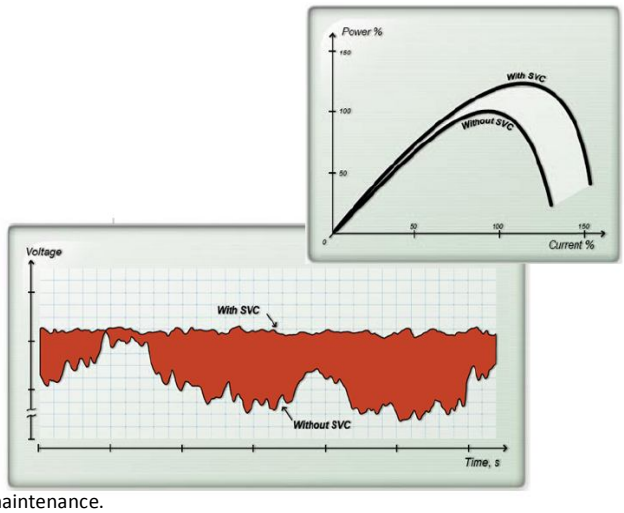
In short, the Static VAR Compensator has a positive effect on the following:

✓Flicker reduction
✓Voltage stabilization
✓Reactive power compensation
✓Improved power factor
✓Increased voltage on the load bus
✓Reduction of harmonics



SVC Technical Features

✓Adopting full digital control system based on DSP.
✓Responce time olf controller is less than 10ms.
✓Control accuracy of controller is less than %1.
✓The control system provides with local and remote operator workstation to supervise all components in a real time.
✓Adopting dual redundant protection.
✓The control system is fast, flexible main protection and the microcomputer
✓protection is safe, reliable back-up protection, to ensure safe and reliable operation of the SVC by its extent.
✓The thyristor valve adopts the valve components manufactured by **ABB,** photoelectric triggering mode,
✓high voltage energy storage with high potential board, thyristor BOD protection and compact structure,
✓which can ensure the SVC safe and reliable operation, efficient and convenient maintenance,
✓Adopting the closed-loop water-cooling system, or high efficient air-cooling system with heat pipe technology.



✓Effective heat pipe natural cooling or water cooling TCR with simple structure and non-maintenance.
✓Adopting photoelectric triggering mode, which can ensure powerful anti-jamming ability.
✓Providing several control modes, such as synchronous three-phase control, split control, three phase equilibrium, reactive power control, voltage control and united control of reactive power and voltage.
✓Adopting a variant of communication protocol to facilitate communication with the substation
✓automation system which can truly realize the unattended operation or centralized control.

Device Component

SVC system of thyristor controller reactor (TCR) type is mainşy composed of filter capacitor brancjh and TCR branch, including thyristor valves, control and protection system, cooling system, TCR reactor and other equipments.

Overall Performance

Item	Specification					
Grid voltage (kV)	6	10	20	27.5	35	69
TCR rated capacity (MVar)	6.3~80		10~300			
Cooling method	Self-cooled; water cooled					
Control	Digital					
Fault diagnosis	Self-diagnosis system					
Compensation range	-100% ~ +100%					
Regulating mode	Separate phase control					
Response time	<10ms					
Triggering mode	Photoelectric; Light triggered					
Noise level	Quiet					
Longevity	>20 years					

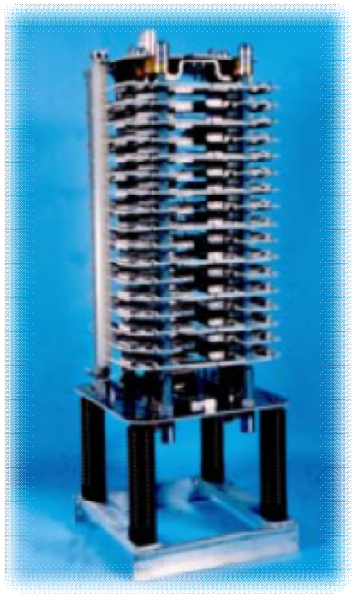
Control and Protection System

✓Layered and distributed control system can simply the system design and strengthen the reliability and expansibility of the SVC.
✓Digital signal parallel processing based on the DSP can realize the calculation of the real time control signal, and the response time of the controller is less than 10ms.
✓The control system provides with local and remote operator workstation to supervise all components in real time and favorable human-machine interface (HMI)
✓Adopting dual redundant digital redundant digital protection.
✓Providing several control modes, such as synchronous three-phase control, split control, reactive power control, voltage control or unified control of reactive power and voltage
✓Adopting a variety of communication protocol to facilitate communication with the substation
✓Automation system, which meets the requirement of the high-speed data transfer, fast control and remote communication
✓Open loop/closed loop feedback control mode not only guarantees the system voltage fluctuating and flicker accord with national standard, but also ensures the stabilize the power factor of the system.

We know how to deal with it…

Thyristor Valves

The thyristor valve adopts the compact structure with multilayer form, and the frame adopts the special metallic material. The thyristor valve is built up of thyristors which are from **ABB** and can withstand the system maximum overcurrent/overvoltage and higher dv/dt, di/dt. Cooperated with the reactor, the thyristor valve can achieve the dynamic response, high potential taken from the potential panel, triggering and BOD protection function. It adopts photoelectric triggering mode, which ensure the SVC safe and reliable operation, efficient and convenient maintenance.



Cooling System

✓Precision design of the regulation and control system multiple early warningg and protection function make sure the cooler running under

✓Safe temperature

✓All parameters are displayed in real time, such as cooling water pressure, cooling water flux, cooling water temperature, cooling water resistivity, valve hall temperature, the water level in the vessel.

✓Having the function of water leakage detection, the water-cooling control system shall send alarm signal to the SVC control system, when the leakage is higher that setting value.

✓Having the function of controlling the occurrence of dew. When the water temperature is below point temperature, the water may be heated to prevent the occurrence of dew.

✓Having the unique function of the anti-freeze, which can guarantee the circulating water not to freeze in the cold regions.

✓Remote communication function

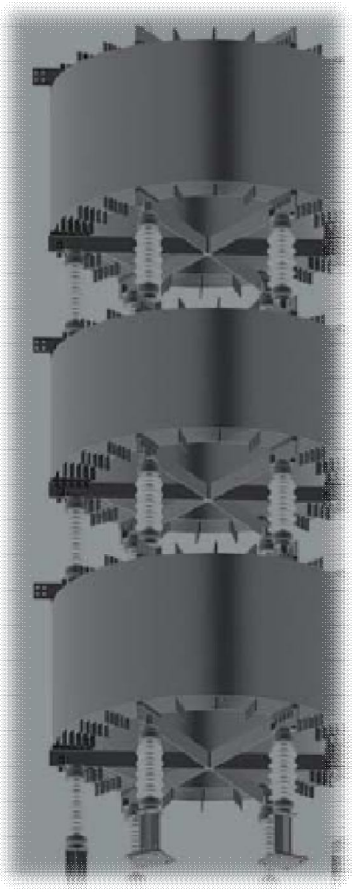
✓Annual availability is more that %99.5

Filter Banks

Filter banks are made up of several filterbranches. On the one hand, they provide capacitive reactive power on the other hand, they are needed for the filtering of harmonics generated by the load and the TCR

TCR Reactors

✓Dry, air-core, epoxy resin curing
✓Each phase reactor may be divided into two reactors
✓Manufacturing error: ±%2 (each phase) ±%1(three phase)
✓Adopting a structure of multiple conductors wound in parallel and
✓Multiple enclosures, and adopting small round section aluminum wires as
✓Coil conductor, which can ensure low eddy current and stray current, low interturn capacitance, and equal voltage distributing along height of coils
✓Adopting lots of effective precautions to avoid tree discharge
✓Simple convenient installation and maintenance, no tinder, and running safely and reliably
✓Natural cooling



TRENCH

Solutions for better power quality by using a Utility SVC

Nowadays the quality of electricity is becoming more and more important due to the increasing usage of electricity in our everyday life. Our electrical equipment, such as computers, are becoming more sophisticated and at the same time more vulnerable to disturbances.

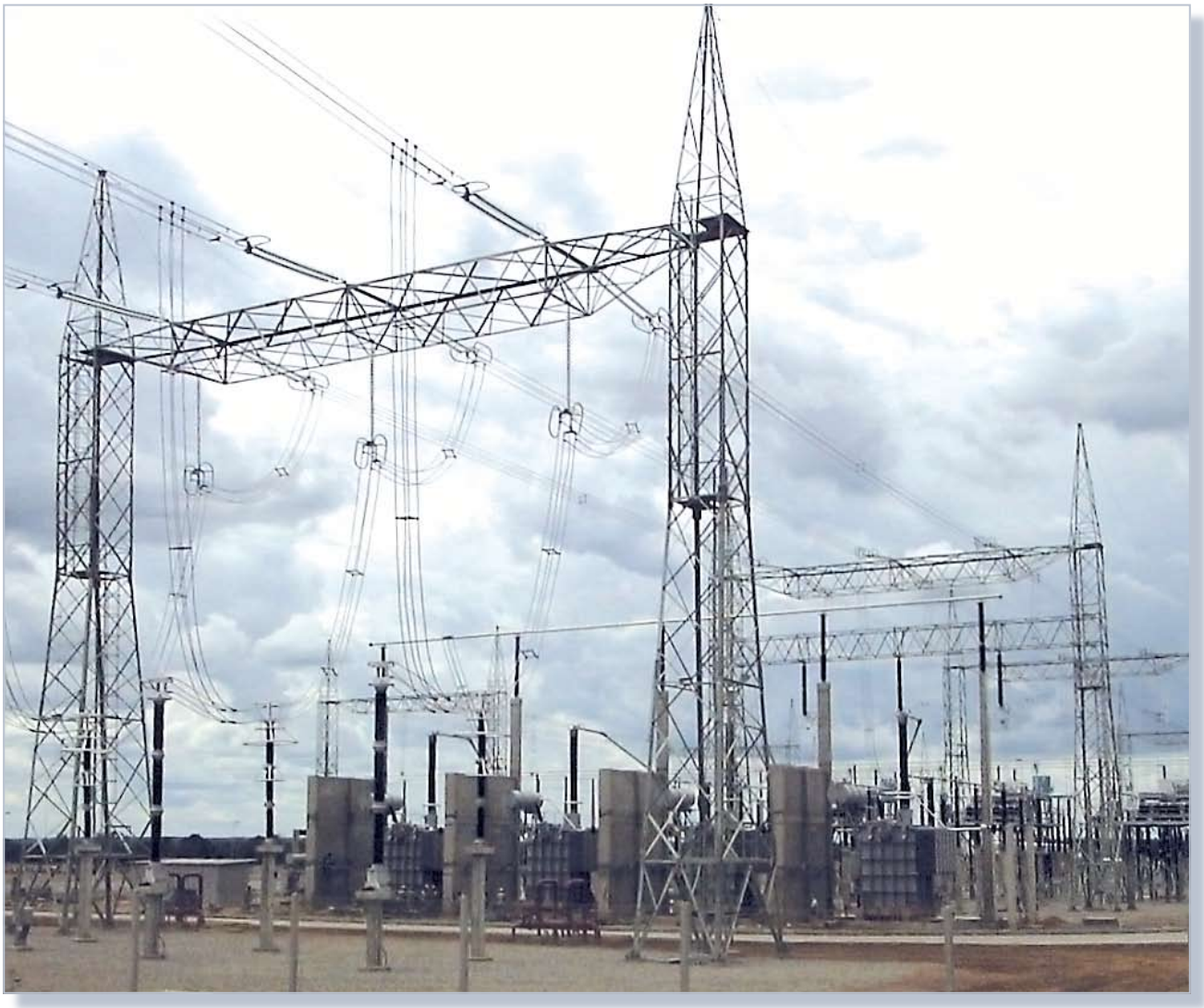
Less energy is produced by the use of fossil fuels and more renewable energy sources are being taken into use around the world, for example wind farm usage is increasing especially rapidly.

Disturbances in the normal operation of transmission lines and industrial distribution systems may be caused by line switching, line faults and non-linear components, such as thyristor controls, rapidly varying active or reactive loads, unbalanced phase voltages, of the network or loads.

The problems solved with SVC :

- Harmonics
- The need for additional reactive power
- Voltage fluctuation
- Flicker phenomena
- Unbalanced loads
- Rapid changes in reactive power
- Power oscillation

Electricity makes our everyday life much easier and we want the best out of our electricity. The disadvantages mentioned above can be reduced by the use of a Utility SVC.



Functional benefits of the Utility SVC

The Static Var Compensator for utilities increases the quality of power in many respects. The benefits of stabilised voltage levels and reactive power compensation improves the system stability and increases the power transfer capability of a transmission line.

Reduction of harmonics
Non-linear loads generate harmonic currents. The harmonic currents load the network and lead to voltage distortions. Distorted voltage may cause malfunctions in sensitive computerised devices and other process control equipment.

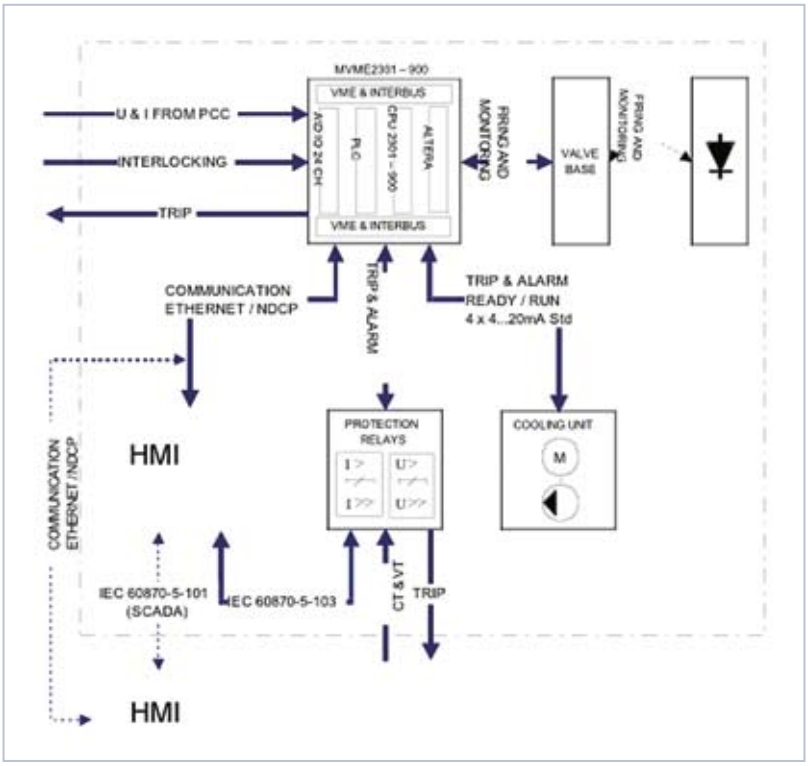
The filter circuit of the Utility SVC system is designed to absorb harmonics generated by loads as well as by Thyristor Controlled Reactors (TCR). The total harmonic distortion (THD) and individual harmonic voltages are limited to below specified levels.

Power transfer capacity increases
Transmission of reactive power leads to significant voltage drops and current increases in the network, which limits the transmission capacity of active power. Utilities can maximise their transmission line capacities by compensating reactive power. The Static Var Compensator maintains the demand of reactive power within the limits set by utilities.

Voltage stabilisation, unbalance loads
Loaded non-transposed lines will create voltage unbalance. The unbalanced voltage causes reduced efficiency, overheating, noise, torque pulses and speed pulses to motor operations.

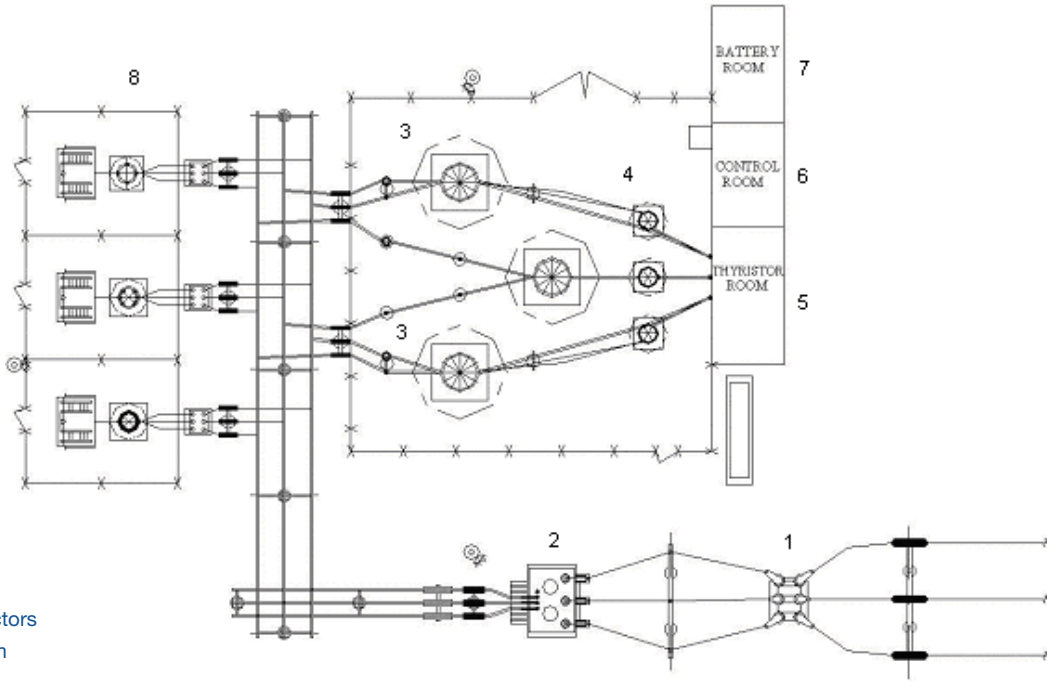
The Utility SVC operates in single-phase control mode, thus balancing the voltage.

Flicker reduction
Rapidly varying reactive power causes voltage fluctuations at the point of the common coupling. The human eye perceives this frequency of voltage fluctuations as flickering lights. The SVC will reduce flicker.



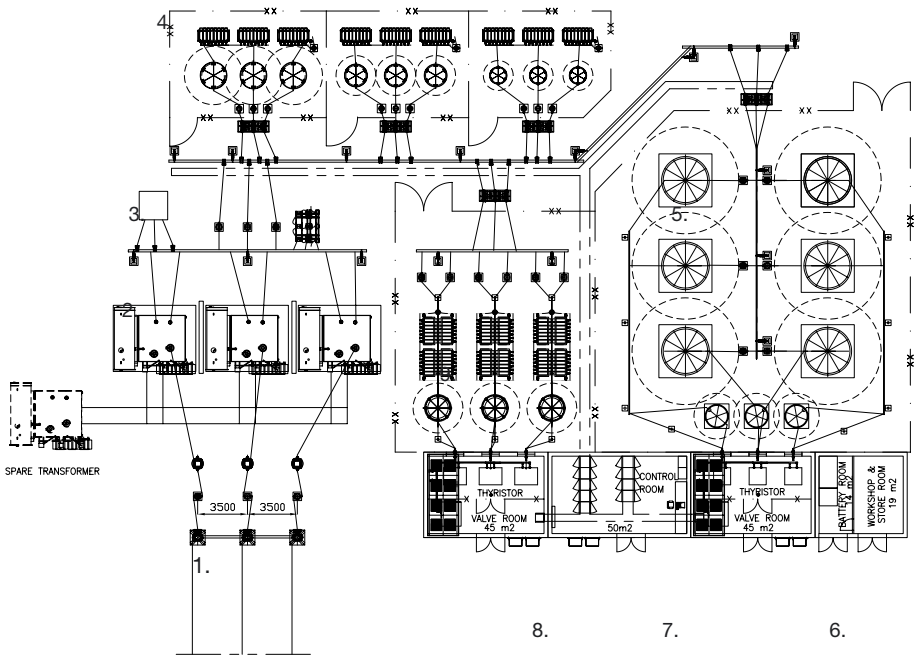
Control block diagram

Utility SVC layout example



1. HV switches
2. Transformer
3. TCR reactors
4. Damping reactors
5. Thyristor room
6. Control room
7. Battery room
8. Harmonic filters

Utility SVC with Thyristor Switched Capacitors layout example



1. HV switches
2. Transformer
3. Auxiliary transformer
4. Harmonic filters
5. TCR reactors
6. TCR thyristor room
7. Control room
8. TSC thyristor room
9. TSC capacitors

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AZİZİYE MAH.KIRKPINAR SOKAK 14-8 ÇANKAYA ANKARA TURKEY TEL : (90) 312 428 76 70 (pbx) FAX : (90) 312 428 76 80 info@begelenergy.com ; sales@begelenergy.com