SVC Light: for flexibility in power systems

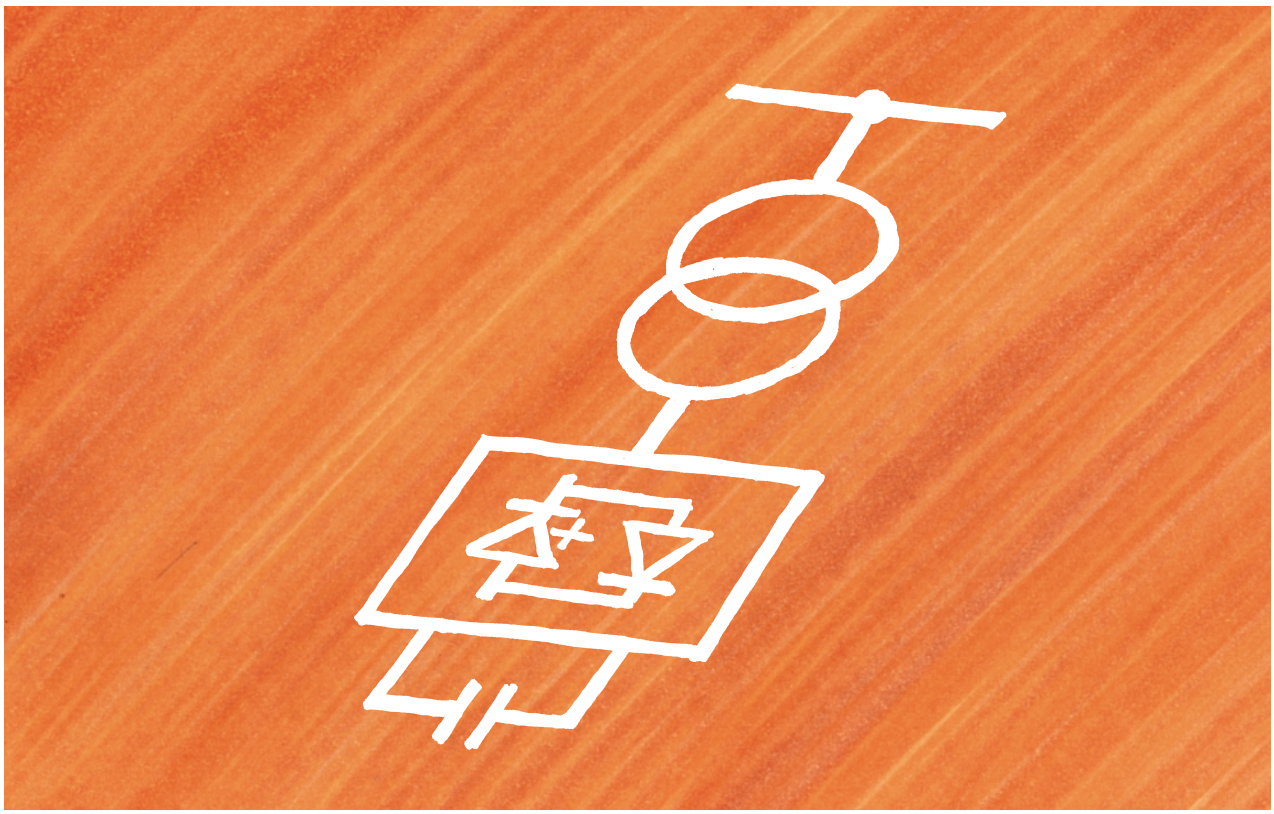


ABB Power Transmission

Introduction

The electricity industry is changing fast. Deregulation, privatization and dispersed generation, together with the rapid rise in inter supplier power transfers, pose immense challenges for users of high voltage transmission systems. At a time when rising costs and growing environmental concerns make the process of building new transmission lines ever more complicated and timeconsuming. And yet all these market factors offer golden opportunities for the actors involved.

Similarly, power quality is becoming a major issue for transmission and distribution. When consumers can choose their supplier freely, contracts can stipulate minimum standards of power quality. Which means voltage and current distortions, surges and sags must be eliminated. Likewise, lamp flicker and energy and production outages caused by poor power quality in grids are no longer acceptable.

Based on our innovative concept using Voltage Source Converter (VSC) technology equipped with IGBT (Insulated Gate Bipolar Transistors), SVC Light delivers dynamic stability and flexibility to power systems, plus superior power quality when and wherever needed.

SVC Light: the flexible solution for dynamic power environments

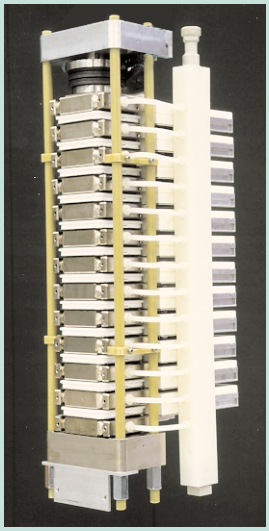
SVC Light is a device of the STATCOM type, i.e. a Static Compensator. Static by name thanks to its integral static semiconductors, but assuredly not by nature. When connected to the grid, its highly dynamic performance makes SVC Light the ideal tool for improving system behavior in a dynamic power environment.

Applied to power systems, SVC Light delivers benefits such as:

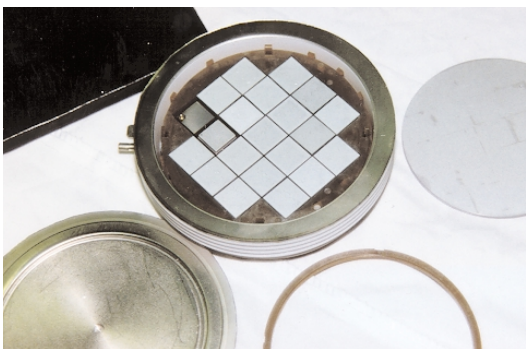
- Dynamic and steady-state voltage control in transmission and distribution
- Greater transient stability
- Power oscillation damping
- Superior power quality

By enabling more active power to be transmitted under stable conditions, with higher availability and reliability, SVC Light improves the economic performance of both new and existing power systems. It also secures power quality in line with current requirements.

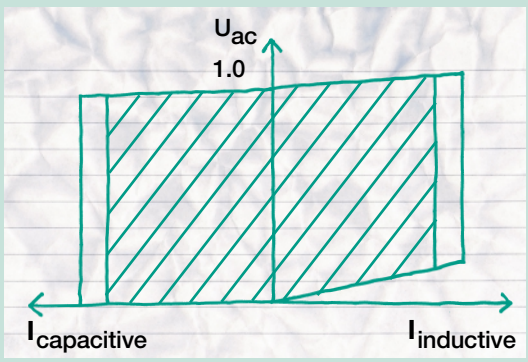
What's more, SVC Light delivers full current output virtually independently of the system voltage (constant current output at low voltage). This is particularly beneficial where SVC Light is used to support system stability during and after faults, when stability could be a limiting factor on the power transmission capacity of the system.



IGBT stack.

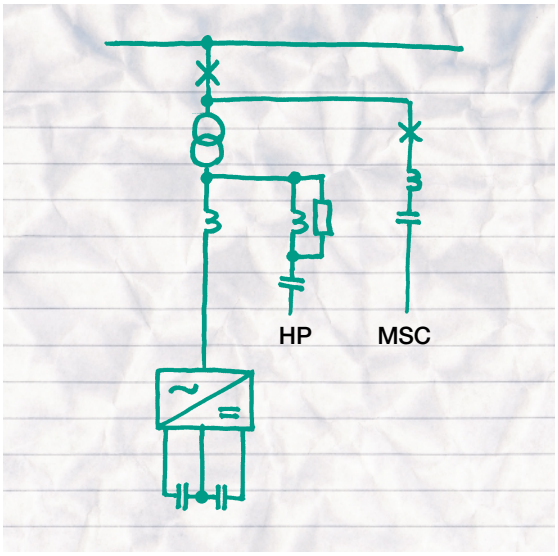


IGBT close-up.

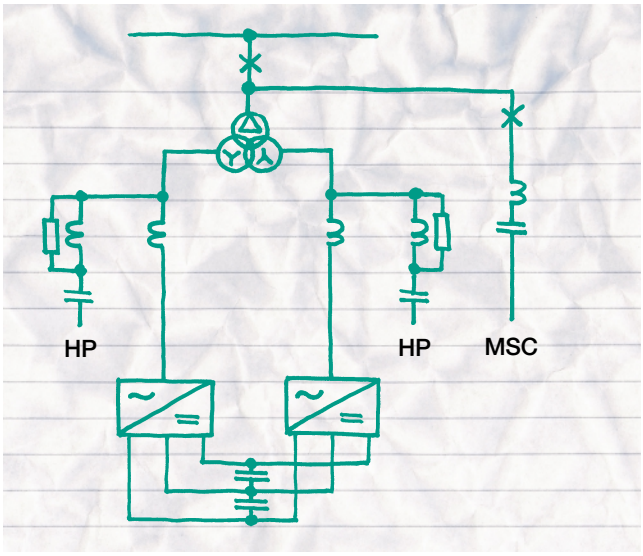


STATCOM voltage/current characteristic.

Main schemes



Single Converter scheme.



Dual Converter scheme.

HP = High Pass Filter

MSC = Mechanically Switched Capacitor

Configured back-to-back, Light can be used to control both the active and reactive power in a grid. This Dual Purpose Light adds up to supreme flexibility for a host of applications.

In practice, SVC Light brings other important benefits such as:

- A small foot print. Compact electronic converters makes SVC Light far more space efficient than conventional passive reactive components.
- Quicker and cheaper to install. Modular, pre-assembled units, reduce on-site installation and commissioning time and costs.
- Readily relocatable. The compact modular design and low harmonic interaction with the grid make SVC Light easy to move.

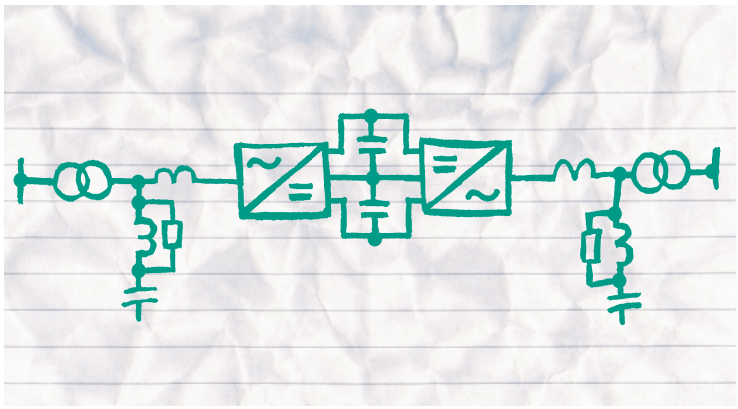
Depending on the desired rating and application, we recommend three main circuit configurations of SVC Light. Each has specific advantages:

1. Single Converter scheme
The single VSC converter scheme is simple and robust, suitable for medium size dynamic ranges, typically tens of Mvar up to a hundred Mvar. The converter is connected to the power system via its phase reactors directly, or through a step-down transformer, depending on the system voltage. If the operational range is unsymmetrical, an offsetting capacitor bank is added in parallel.

2. Dual Converter scheme
This scheme is particularly suited for large dynamic ranges, typically above 100 Mvar. For optimum performance, two converters are utilized via a three-winding transformer with its down side windings arranged in a dual inverted wye connection. An offsetting capacitor bank can be added in parallel, for an unsymmetrical range of operation.

3. Dual Purpose scheme
Combining two converters in a back-to-back connection on the DC side, enables active power to be transmitted. This Dual Purpose Light, (or Back to Back Light), offers active power transfer and dynamic compensation of reactive power to each connected AC system simultaneously and independently.

Applications



Dual Purpose scheme.

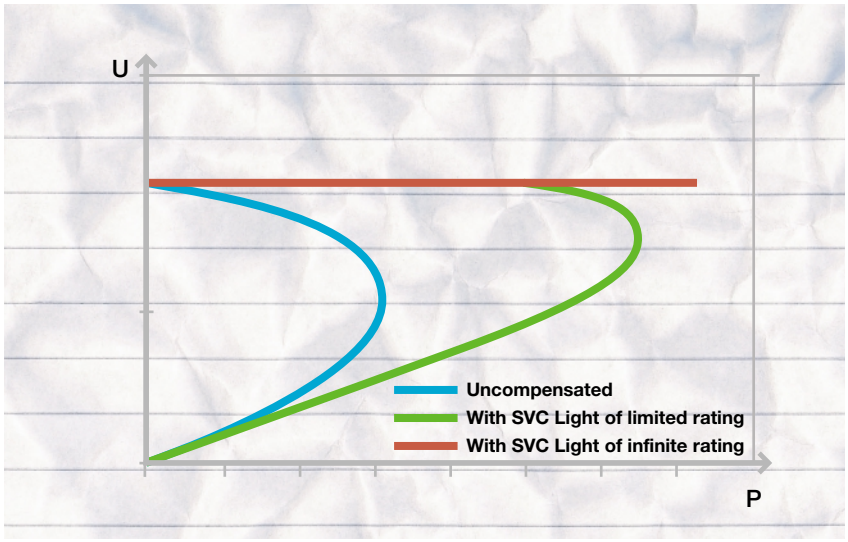
SVC Light valve.

Dynamic voltage control/ Increases system availability and transmission capability...
The very high dynamic response of SVC Light makes it the perfect tool for voltage control in demanding situations, enabling uninterrupted operation of power systems in situations where, without SVC Light, the system performance would be degraded or lost altogether. This can prevent voltage collapse and so save the power transmission system in the event of sudden overload and/or sudden loss of generation or line.

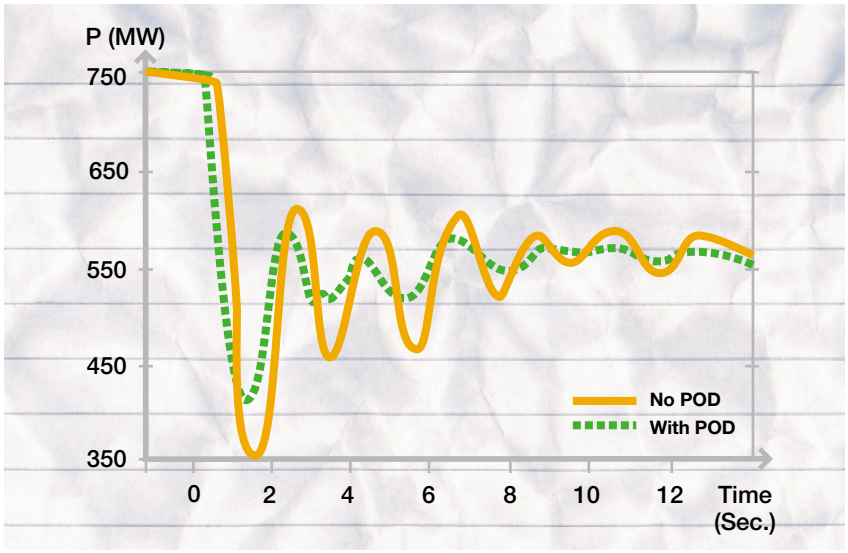
...and maintains system stability
Just as important, SVC Light is an extremely efficient tool for mitigating active power oscillations between interconnected power systems or areas of a power system. SVC Light makes an efficient tool for mitigation of the same, thereby maintaining system stability.

Which all adds up to extremely stable power transmission, increased availability, and the potential to raise transmission capability over both new and existing power circuits and lines.

Making existing lines more efficient can be a compelling choice, compared with the expensive and time consuming process of building new lines. Especially in environmentally sensitive areas, where planning permission may not be granted.

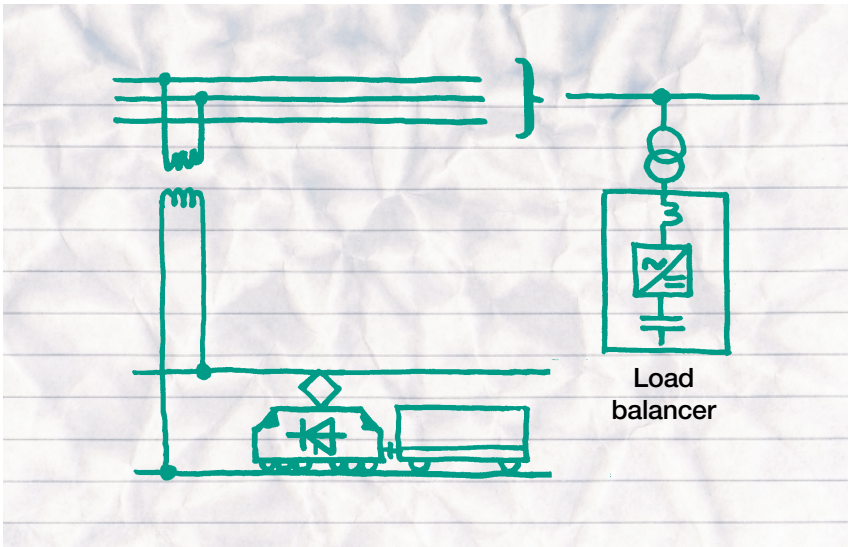


Voltage stabilization.



Example of power oscillation damping (POD) in 400 kV intertie.

Applications



SVC Light Load balancer and active filter for traction.

Eagle Pass BtB Light.

Dynamic load balancing/
improving the power quality of rail feeders

Modern electric rail systems designed for heavy-duty service, such as high speed passenger trains and heavy freight haulage, are generally fed directly from national transmission or sub-transmission grids at 50 Hz or 60 Hz. These loads are, by nature, large, unsymmetrical (single-phase connected between feeder phases) and highly time dependent. Unless properly addressed, these loads will result in derated power quality in the feeder grid. This will manifest itself in voltage and current un-balance, voltage fluctuations, and harmonics. These disturbances will spread through the grid and become a nuisance to many other users. Unbalance in particular can cause extensive damage through the increased and uneven heating of generators, transmission line phase conductors, motors, and similar plant and equipment. Such risks are increasingly unacceptable on deregulated markets.

SVC Light is an excellent tool for restoring voltage and current balance in the grid, and to mitigate voltage fluctuations generated by variations in loads. It does so by the simple expedient of injecting corrective voltages into each phase of the network, thereby restoring balance and achieving three-phase symmetry in the grid. Voltage fluctuations are remedied by fast dynamic compensation of the reactive power absorbed by the traction loads.

And as SVC Light can perform as an active electronic filter, it also eliminates harmonics injected into the grid by locomotives, without the need for expensive, complicated and cumbersome filter arrangements.

Dual-purpose applications/
Power conditioning

Dual Purpose Light or BtB Light, twin VSCs in a back-to-back combined scheme, enables the economic and robust implementation of asynchronous AC ties. Thanks to the versatility of the Light concept, active power flow and system voltages at either ends of the tie are controlled independently of each other.

By enabling bi-directional flow of power, the interconnection can be exploited in the most economic and advantageous way. Depending on power demands and current market prices, power can be imported or exported to where it is most needed, or most profitable at that time.

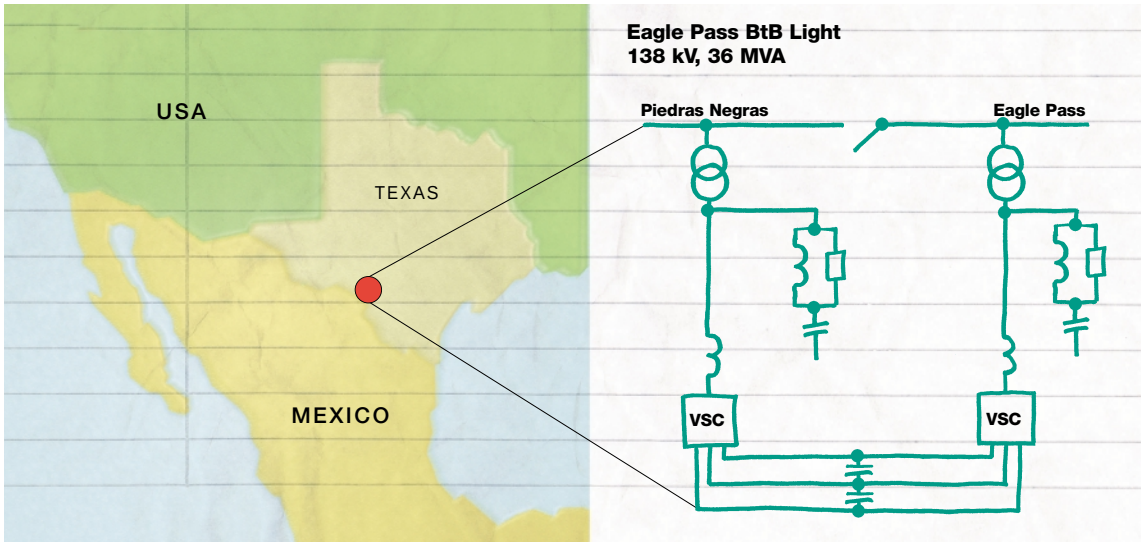
A typical example is the Eagle Pass cross-border electrical intertie between Mexico and USA, commissioned in 2000.

Loading of prefabricated module.

The Eagle Pass interconnection, rated at 138 kV, 36 MVA, links the power transmission systems of the Texas based Central Power and Light Company (CPL) with the Mexican state power transmission system CFE. This dual purpose installation is based on the ABB Light platform, simultaneously performing as an HVDC tie and two Static Var Compensators, for dynamic voltage control of the Texas and Mexican grids on either side. This combination protects power exchange even if the AC systems are severely weakened.

Due to the relative weakness of the Texas grid, a conventional BtB intertie would not have been feasible from a performance point of view.

The intertie enables CPL and CFE to provide emergency power supply services to each other on a mutual basis.



Single-line diagram, Eagle Pass.

ABB Power Systems is your power transmission and distribution partner.

Partnering ABB Power Systems as your FACTS and Power Quality supplier ensures you always access the very best expertise and technology.

We offer a complete range of equipment and services, including SVC, Series Capacitors and FACTS (Flexible AC Transmission Systems).

Please contact us to discuss how we can best meet your power transmission and/or distribution needs.

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