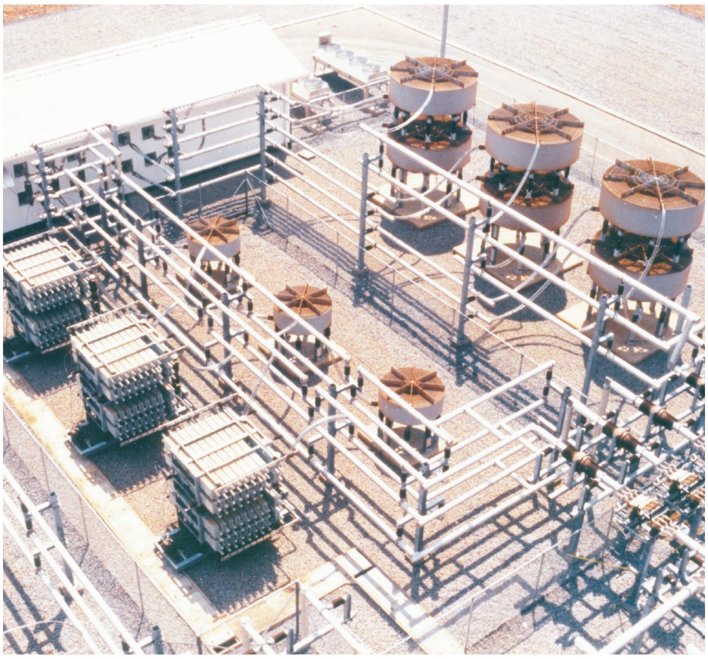
Increase of power transmission capacity in South Africa-Zimbabwe interconnection by means of SVC



Since 1995, a Static Var Compensator (SVC) rated at 100 Mvar inductive to 200 Mvar capacitive at 330 kV supplied by ABB has been operating in the Matimba-Insukamini 600 MW power interconnecting corridor between South Africa and Zimbabwe. It is located at the ZESA Insukamini 330 kV substation in Zimbabwe, close to the coupling point for the 400 kV interconnection to South Africa.This 405 km long line forms part of an AC connection running in parallel with the Cahora Bassa HVDC link. In 2014 an upgrade of the SVC was performed.

The purpose of the compensator is to provide high speed dynamic voltage control during certain system loading and outage conditions. The single 400 kV interconnection between Matimba and Insukamini is relatively weak, and unless proper measures are taken, poorly damped, low frequency (<0,5 Hz) active power oscillations tend to appear between South Africa and Zimbabwe. The SVC is equipped with a Power Oscillation Damper (POD) in order to mitigate these power oscillations.

With the SVC in operation, stability and power transfer margins have been increased by approximately 150 MW in the existing power corridor.

Main building blocks

The SVC consists of a TCR (Thyristor-controlled reactor) rated at 150 Mvar, a TSC (Thyristor-switched capacitor) rated at 150 Mvar and Harmonic filters rated together at 50 Mvar. By control of these branches, the -100/+200 Mvar operating range of the SVC is achieved.

The SVC control system is built up by micro-processor based computer functions that constantly monitor the status of the SVC reactive output and status of switching devices. It comprises a voltage regulator based on closed-loop three-phase symmetrical voltage control.
The gain of the closed control loop is supervised by a gain supervisor and a gain optimizer, to ensure optimum and stable control during varying system conditions.

The var control has two main operating modes:
In the **automatic** mode the SVC output is continuously controlled by the automatic voltage regulator. A slow susceptance control function is provided, resetting the susceptance during steady-state conditions to a pre-set value.
In the **manual** mode the SVC susceptance is controlled manually by the operator.

Power Oscillation Damper

To obtain a damping effect on power oscillations over the 400 kV interconnection, active power is measured and used as an input to a Power Oscillation Damper function within the SVC control system. The Input signals to the POD are supplied from measuring transformers in the main substation. These signals are evaluated in a special program sequence. The output, the POD reference, is superimposed on the normal voltage control, to counteract the power oscillations of the system.

The POD control is activated if large power oscillations or a large power derivative appear in the transmission system.

The SVC can be operated from three different locations: the local SVC control room, the ZESA control house at Insukamini and remotely via a SCADA system in the ZESA control centre. To assist operating and service personnel, monitoring and recording systems are provided.

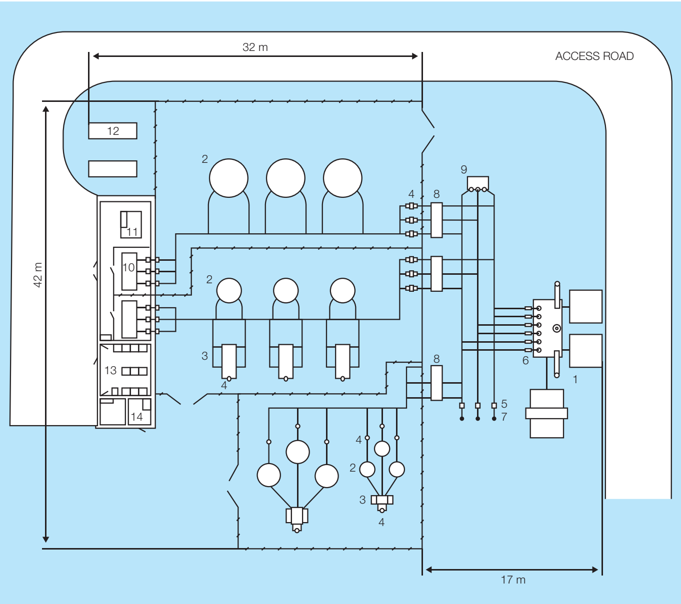
SVC upgrade

After many years of successful operation, it was decided to upgrade the SVC by replacing vintage key components by the latest technology, thereby extending the life span of the SVC additionally. Thus, the two thyristor valves including cooling plant were exchanged. New protective equipment was installed. The control system was upgraded into ABB's latest generation, MACH 2, a micro-processor based system built around an industrial PC with add-in circuit boards and I/O racks connected via standard type field buses. Facilities for remote operation and supervision are integrated in the system. The upgrade was completed in 2014.

Technical data

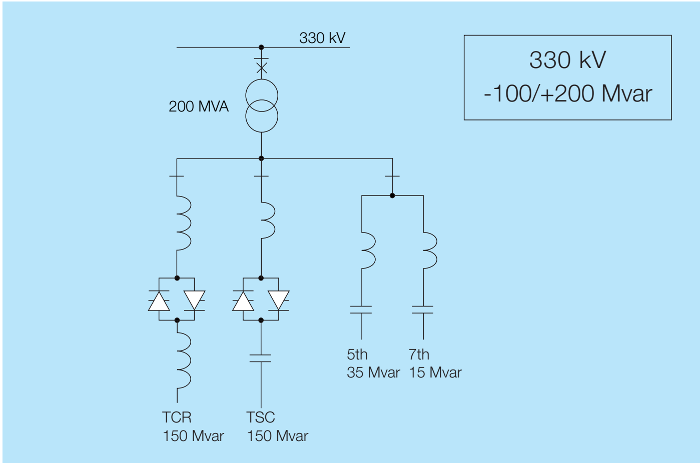
Controlled voltage	330 kV
SVC rating	100 Mvar inductive to 200 Mvar capacitive.
Control system	Three-phase voltage control by means of a closed-looped voltage regulator. Strategy selection includes Power Oscillation Damping.
Thyristor valves	Water-cooled three-phase valves with indirect light triggering.

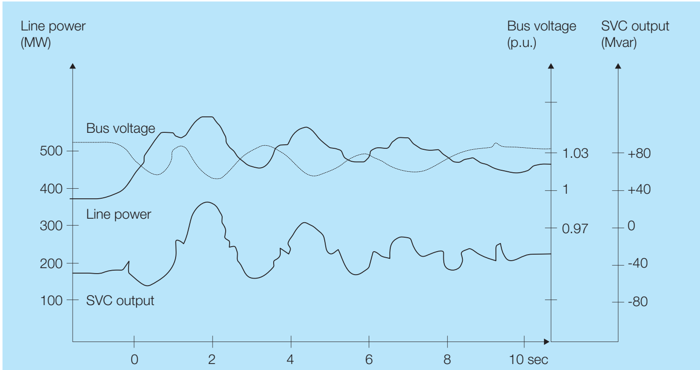
layout



1 Power transformer
2 Reactor
3 Capacitor
4 Current transformer
5 Voltage transformer
6 Surge capacitor
7 Surge arrester
8 Disconnector
9 Grounding transformer
10 Thyristor valve
11 Pump station
12 Cooler
13 Control room
14 Battery room

Single-line diagram





Damping of power oscillation upon trip of a 100 MW generator unit. Oscillation damped out after 9 seconds.
Maximum 330 kV voltage deviation during POD: 2,7%

POD diagram

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