DIGSILENT

POWERFACTORY

PowerFactory 2021

Technical Reference

Static Var System (SVS)

ElmSvs, ElmSvsctrl

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

PF2021

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Contents

1 General Description

The static var compensator system is a combination of a shunt capacitor bank and a thyristor controlled shunt reactance. The capacitors in the capacitor bank can be switched on and off individually. It includes two types of configurations: A thyristor switched capacitor (TSC) and a mechanically switched capacitor (MSC) (Figure 1.1) [1].

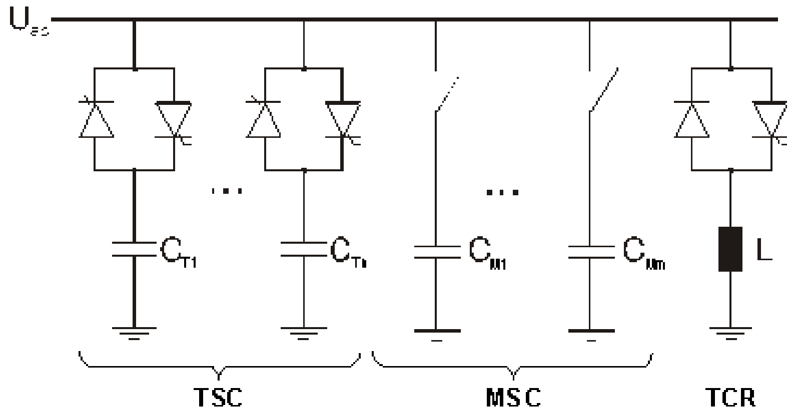

Figure 1.1: Static var system model

The static var system is important for controlling the voltage at the directly connected busbars or at a remote busbar. The capacitors may be switched on and off, depending on the load situation, in response to changes in reactive power demands. In addition, a thyristor controlled reactor (TCR) fine-tunes the reactive power delivered by the static var system.

A SVS can produce a part or all of the reactive power demand of nearby loads. This reduces the line currents necessary to supply the loads, which in turn reduces the voltage drop in the line as the power factor is improved. Because the static var systems lower the reactive requirements from generators, more real power output will become available.

The capacitor banks and reactors are connected in delta configuration.

1.1 Basic Data

The SVS element does not need any type. The Basic Data page contains the input data for the reactor and the capacitor banks:

- ***TCR*** Reactance and limit of the thyristor controlled reactance
  - *Q Reactance (>0)* in $Mvar$ (parameter name: $qmax$)
  - *Maximum Limit* in $Mvar$ (parameter name: $tcrmax$)
- ***TSC*** Number and reactance of thyristor switched capacitors.
  - *Max. Number of Capacitors* (parameter name: $nxcap$)
  - *Q per Capacitor (<0)* in $Mvar$ (parameter name: $qmin$)
- ***MSC*** Number and reactance of mechanically switched capacitors
  - *Number of Capacitors* (parameter name: $nfixcap$)

- *Q per Capacitor (<0)* in $Mvar$ (parameter name: $Qfixcap$)

* ***Balanced/Unbalanced Control*** Defines the kind of control desired.

2 Load-Flow Analysis

In the following section, the different control combinations specify how the internal admittance of the SVS (y_{svs}) is calculated. For balanced load flow, only one admittance value is calculated. For unbalanced load flow all three admittances are calculated. The current for balanced operation is then calculated according to the following equation:

$$\underline{i}_1 = j \cdot y_{svs} \cdot \underline{u}_1 \tag{1}$$

When the option *Balanced Control* on the basic data page is enabled, all three admittances are equal. If the control is set to *Unbalanced Control* instead, then all admittances are calculated separately according to the selected control mode on the load flow page and the general settings of the load flow command.

If the current of the SVS is displayed in per unit values, then the admittance values are based on $1Mvar$ and the voltage of the connected bus.

2.1 Balanced Operation

If a balanced load flow is executed one of the following control options could be used:

- No control (Section 2.1.1).
- Reactive power control (Section 2.1.2).
- Voltage control (Section 2.1.3).

2.1.1 No control

If this control option is selected, the SVS will have a fixed admittance, which is defined by the input parameters *Act. Value of Tcr* $tcrqact$ and the number of switched capacitor n_{tsc}. The total admittance of the SVS is calculated as follows:

$$y_{svs} = q_{tsc} \cdot n_{tsc} + tcrqact + q_{fixcap} \cdot n_{fixcap} \tag{2}$$

2.1.2 Reactive power control

Reactive power control can be done locally, i.e. the reactive power output of the SVS is controlled to a constant value. It is also possible to control the reactive power flow on a remote branch to the desired Q setpoint.

Note that capacitive reactive power hast to be inserted as a negative value. A warning will be displayed in the output window if the setpoint for Q is out of range (Section 2.3) and if the option *Consider Reactive Power Limits* is not used in the load flow command.

2.1.3 Voltage control

The SVS can be set to control the local voltage at its terminal or the voltage on a remote busbar to a specified setpoint.

Droop Control Within the voltage control method, droop control can also be enabled. The voltage at local or remote busbar is then controlled according Equation 3. The droop control is also depicted in Figure 2.1. With droop control the setpoint is not reached in any case because the setpoint is moved as more reactive power is needed to reach the original voltage setpoint of the SVS. The advantage of the droop control is that more than one SVS at one busbar can control the voltage.

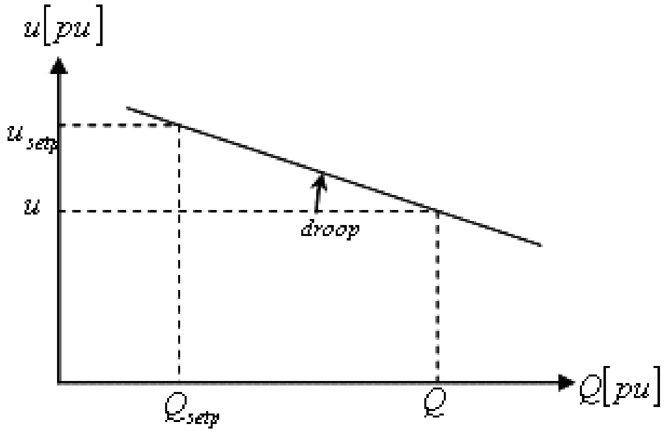

Figure 2.1: Droop control

$$u_{bus} = u_{setpoint} + \frac{Q_{meas}}{Q_{droop}} \tag{3}$$

Where:

- u_{bus} is the voltage in p.u. at measurement point.
- $u_{setpoint}$ is the reference voltage in p.u.
- Q_{meas} is the reactive power flow at Q-Measurement point. If no Q-Measurement point is select then Q is the reactive power output of the SVS.
- Q_{droop} is an input parameter the unit is Mvar/p.u.

Alternatively also the rated apparent power (S_{rated}) and the droop (ddroop) in % could be entered instead of Q_{droop}. Q_{droop} is then calculated as follows:

$$Q_{droop} = \frac{S_{rated}}{ddroop} \cdot 100\% \tag{4}$$

If no Q-Measurement Point is selected, then the local reactive power flow in Mvar is used. If a Q-Measurement Point is selected (cubicle) the reactive power flow in Mvar of the Q-Measurement

Point is used. The Q-flow direction of the Q-Measurement Point should be equal to the Q-flow direction of the SVS. This is depicted in Figure 2.2.

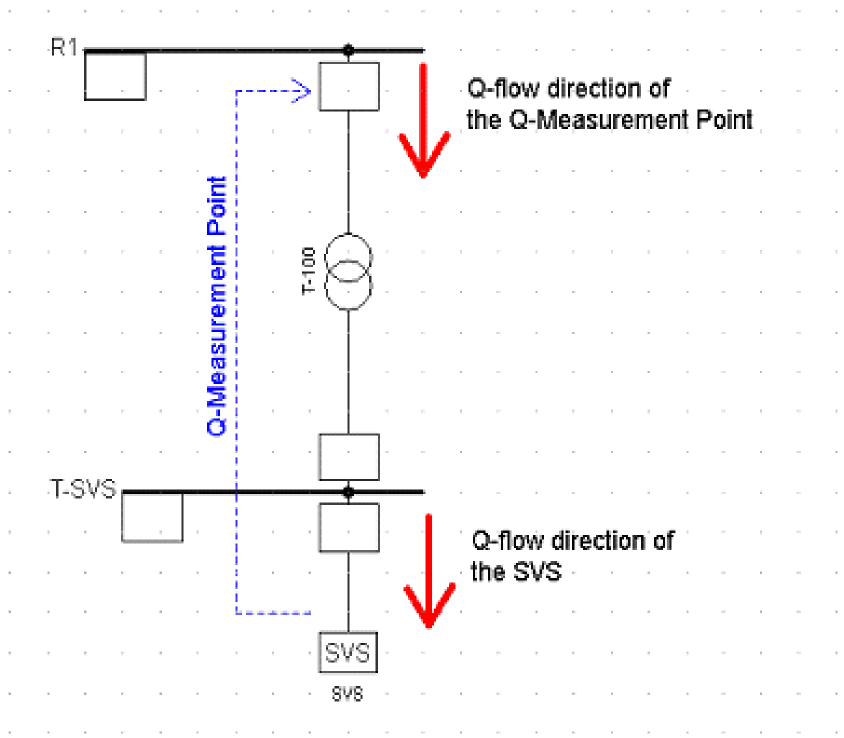

Figure 2.2: Q-Measurement Point flow direction

Voltage Dead Band An additional feature of the voltage control method, is the voltage dead band control, which can be seen in Figure 2.3.

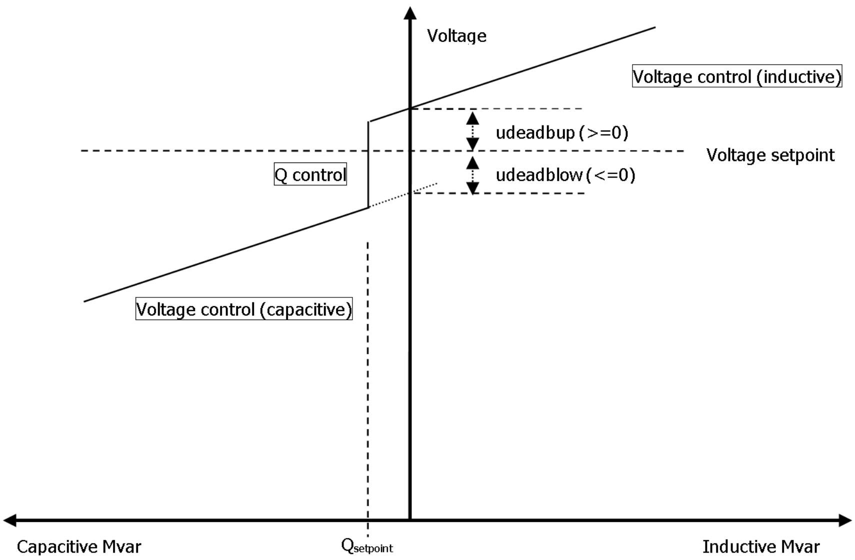

Figure 2.3: Voltage Dead Band

Where:

- $udeadbup$ is the upper limit in %
- $udeadblow$ is the lower limit in %

There are three internal control modes:

- Voltage control (capacitive): The voltage setpoint is the following:

$$u_{bus} = u_{setpoint} + \frac{udeadblow}{100\%} + \frac{Q_{mea}}{Q_{droop}} \tag{5}$$

- Voltage control (inductive): The voltage setpoint is calculated as:

$$u_{bus} = u_{setpoint} + \frac{udeadbup}{100\%} + \frac{Q_{mea}}{Q_{droop}} \tag{6}$$

- Q control: The reactive power flow of the measurement point is controlled to the reactive power setpoint, using a constant reactive power control (const. Q).

- u_{bus} is the voltage in p.u. at measurement point.
- $u_{setpoint}$ is the reference voltage in p.u.
- $udeadbup$ is the upper limit in %
- $udeadblow$ is the lower limit in %
- Q_{meas} is the reactive power flow at Q-Measurement point. If no Q-Measurement point is select then Q is the reactive power output of the SVS.
- Q_{droop} is an input parameter the unit is Mvar/p.u.

2.1.4 Station controller

The SVS can also be part of a station controller. The admittance will then be calculated according to the following equation:

$$y_{svs} = K_q \cdot q_{stationctrl} \tag{7}$$

where:

- K_q is the distribution factor in p.u. of the station controller.
- $q_{stationctrl}$ is the reactive power input signal (from station controller).

2.2 Unbalanced Operation

For unbalanced load flow it is possible to choose between *balanced* and *unbalanced* control on the Basic Data page. If an unbalanced load flow with *unbalanced control* is calculated three different susceptances are calculated. With the option *balanced control* all three susceptances are identical:

$$y_{svs\_AB} = y_{svs\_BC} = y_{svs\_CA} = y_{svs} \tag{8}$$

If a balanced load flow is executed one of the following control options could be used:

- No control (Section 2.2.1).
- Reactive power control (Section 2.2.2).
- Voltage control (Section 2.2.3).

2.2.1 No Control

$$y_{svs\_AB} = y_{svs\_BC} = y_{svs\_CA} = y_{svs} \tag{9}$$

The option *balanced/unbalanced* control has no influence.

2.2.2 Reactive Power Control

If an unbalanced load flow is calculated with the options *reactive power control* and *balanced*, then the susceptances are calculated as follows:

$$q_{ctrl} = q_{ctrl\_AB} + q_{ctrl\_BC} + q_{ctrl\_CA} \tag{10}$$

$$y_{svs\_AB} = y_{svs\_BC} = y_{svs\_CA} = y_{svs} \tag{11}$$

With the option *unbalanced* on the basic data page selected *PowerFactory* calculates each susceptance in the way that each phase delivers 1/3 of the selected reactive power. The resulting susceptance depend then also on the phase voltages and currents. The control conditions from equation (12) are used:

$$q_{ctrl\_AB} = q_{ctrl\_BC} = q_{ctrl\_CA} = \frac{Q_{setpoint}}{3} \tag{12}$$

2.2.3 Voltage Control

If an unbalanced load flow is calculated with the option *voltage control* the controlled voltage is set according to the selection in the drop down menu *Controlled Phase*:

- If 'a-b' is selected: $u_{ctrl} = u_{AB}$
- If 'b-c' is selected: $u_{ctrl} = u_{BC}$
- If 'c-a' is selected: $u_{ctrl} = u_{CA}$
- If 'average' is selected: $u_{ctrl} = (u_{AB} + u_{BC} + u_{CA})/3$
- If 'positive sequence' is selected: $u_{ctrl} = u_1$

With the option *balanced* selected on the basic data page the following is calculated:

- Without droop: $u_{ctrl} = u_{setpoint}$
- With the option 'droop' enabled: $|u_{ctrl}| = u_{setpoint} + Q_{dmeas}/Q_{droop}$

The susceptance are then calculated that either the voltage u_{ctrl} or a reactive power limit are reached (2.3).

With the option *unbalanced* selected on the basic data page the following is calculated:

- Without droop: $u_{ctrl\_AB} = u_{ctrl\_BC} = u_{ctrl\_CA} = u_{setpoint}$
- With the option 'droop' enabled: $u_{ctrl\_AB} = u_{ctrl\_BC} = u_{ctrl\_CA} = u_{setpoint} + Q_{meas}/Q_{droop}$

where Q_{meas} = total reactive power at measurement point.

Alternatively also the rated apparent power (S_{rated}) and the droop (ddroop) in % could be entered instead of Q_{droop}. Q_{droop} is then calculated as follows:

$$Q_{droop} = S_{rated} \cdot 100\%/ddroop \tag{13}$$

The susceptances are then calculated that either the voltage u_{ctrl_phase} or a reactive power limit are reached (refer to 2.3). With *unbalanced control* the three susceptances have not to be equal.

2.2.4 Station controller

If a SVS is used with a station controller for unbalanced load flow the same equations are used as for balanced load flow (Section 2.1.4). The susceptances are calculated as follows:

$$y_{svs\_AB} = y_{svs\_BC} = y_{svs\_CA} = y_{svs} \tag{14}$$

2.3 SVS Range

The SVS can only operate in the given range. If the SVS is running into the lower or upper range, the admittance is set to the minimum or to the maximum value.

The minimum range is defined using the parameters from the TCR and MSC as:

$$y_{min} = -(tcrmax + Qfixcap \cdot nfixcap) \tag{15}$$

and the maximum range is defined using the parameters from the TSC and MSC as:

$$y_{max} = -(qmin \cdot nxcap + Qfixcap \cdot nfixcap) \tag{16}$$

where:

- y_{min} is the minimum admittance.

- y_{max} is the maximum admittance.
- $tcrmax$ is the maximum reactive power limit of the TCR.
- $Qfixcap$ is the reactive power per capacitor of the MSC.
- $nfixcap$ is the number of capacitors of the MSC.
- $qmin$ is the reactive power per thyristor switched capacitorof the TSC.
- $nxcap$ is the maximum number of thyristor switched capacitors of the TSC.

3 Short-Circuit Calculations

3.1 VDE 0102 - IEC 60909 - IEC 62363- ANSI

The SVS-element is ignored for short circuit calculations according to the standards VDE 0102, IEC 60909, IEC 61363 (std. method) and ANSI. The current is zero.

3.2 Complete Short Circuit

With load flow initialization

The complete short circuit can be calculated with or without load flow initialization. If load flow initialization is used the SVS susceptance (y_{svs}) is calculated according to the control settings described in section 2. The short circuit contribution of the SVS is then for 'balanced' control settings calculated as follows:

$$\underline{i}_{svs\_shc} = j \cdot y_{svs} \cdot \underline{u}_{shc} \tag{17}$$

For *unbalanced* control settings depends then the short circuit current on the faulted phases because susceptance is calculated differently per phase as described in Section 2.

The SVS is not considered for X/R calculation.

Without load flow initialization

If the complete short circuit is calculated without load flow initialization (advanced options page of the short circuit command) then the short circuit current of the SVS is calculated as follows:

$$\underline{i}_{svs\_shc} = j \cdot y_{msc} \cdot \underline{u}_{shc} \tag{18}$$

This means that the thyristor switched capacitors and the thyristor controlled reactor are not activated.

4 Harmonics

The harmonics generated by the SVS are dominated by the TCR. If the option 'Ideal SVS' is selected, a maximum order can be entered. *PowerFactory* calculates only harmonics up to that order according to Equation (20). The firing angle α ' is defined according to Equation (19). The definition of the original firing angle α is shown in Figure 5.1.

$$\alpha' = \alpha - \frac{\pi}{2} \tag{19}$$

$$i_{abc} = \frac{4}{\pi \cdot f_{fund}} \frac{sin(\alpha')cos(n\alpha') - ncos(\alpha')sin(n\alpha')}{n(n^2-1)} \tag{20}$$

where: $n = 2k+1, k = 1,2,3\dots$

If the option 'Ideal SVS' is not selected then the harmonic current will be calculated according to the definition of a harmonic current source (TCR). Further information about harmonic current source can be found in the corresponding chapter of the manual.

5 RMS Simulation

For time domain simulation the needed reactive power can change over time. For that the thyristor-switched capacitors and the thyristor-controlled reactor has to be controlled.

If there is no control implemented for the SVS (i.e. no signals are connected) then it will be kept to the initial settings as calculated by the load flow command for the initial conditions prior to a simulation. To make the SVS into an active var controller during simulations, a composite model has to be used. The values for starting the simulation (initial load flow) are obtained from a load flow using the settings from the load flow page of the SVS (see Section 2).

There are two ways of controlling the SVS element:

- By controlling the susceptance
- By controlling the firing angle and switched capacitors

When controlling the firing angle and switched capacitors, the SVS-Interface (*ElmSvsctrl*) can also be used for balanced models (see Section 7).

5.1 Balanced RMS Simulation

5.1.1 Controlling the susceptance

The model can be controlled by varying the input signal $bsvs$. The total susceptance of the model is the sum of the susceptance $bsvs$ and the fix portion due to the manually switched capacitors:

$$y_{svs} = bsvs + Qfixcap \cdot nfixcap \tag{21}$$

where $Qfixcap$ and $nfixcap$ are the input parameters of the MSC.

The value of y_{svs} is limited between $ymin$ and $ymax$ as defined in Section 2.3.

5.1.2 Controlling the firing angle and the number of switched capacitors

The SVS element can aslo be controlled by using the two input signals:

- $gatea$: Firing angle in degree
- $nncap$: Number of switched on capacitors.

The firing angle is defined as shown in Figure 5.1. It may vary between 90° and 180°. The 90° correspond to full conduction of the thyristor controlled reactor and the 180° correspond to no conduction.

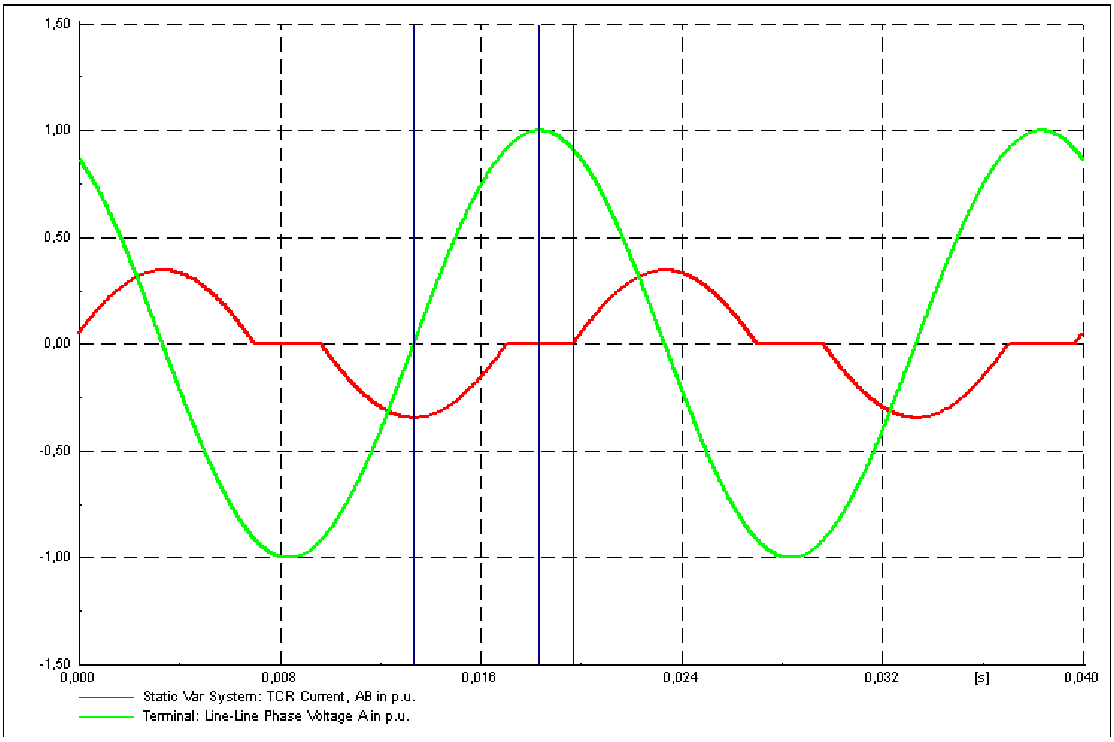

Figure 5.1: Definition of the Firing Angle α (EMT plot)

The input signals are both calculated from the initial load flow. The *gatea* signal is the firing angle derived from alpha (in radian). Alpha is calculated from the ratio:

$$\alpha = -q_{tcr}/qmax \tag{22}$$

where:

- q_{tcr} is a result from the load flow.
- $qmax$ is element parameter *Q Reactance (>0)* of the TCR.

The susceptance of the thyristors controlled reactor is calculated as follows:

$$y_{tcr} = -qmax \cdot \left(2 - \frac{2}{\pi} \cdot \alpha + \frac{1}{\pi} \cdot sin(2 \cdot \alpha)\right) \tag{23}$$

where $\alpha = gatea/180° \cdot \pi$

The susceptance of the TSC calculated as follows:

$$y_{tsc} = -qmin \cdot nncap \tag{24}$$

where $qmin$ is element parameter *Q per Capacitor (<0)* of the TSC.

The susceptance of the SVS is then calculated as follows:

$$y_{svs} = y_{tsc} + y_{tcr} + Qfixcap \cdot nfixcap \tag{25}$$

where $Qfixcap$ and $nfixcap$ are the input parameters of the MSC.

5.2 Unbalanced RMS Simulation

For an unbalanced simulation, one input signal for all phases (balanced model) or a signal for each phase (unbalanced model) could be used.

5.2.1 Controlling the susceptance

The balanced model uses the input signal $bsvs$ same as for the balanced simulation.

For the unbalanced model the following input signals need to be used:

- $bsvs\_AB$: susceptance AB
- $bsvs\_BC$: susceptance BC
- $bsvs\_CA$: susceptance CA

The calculation of the susceptance is then done with the same scheme as the balanced simulation but for all phases separately.

5.2.2 Controlling the firing angle and the number of switched capacitors

The balanced model uses the input signals ($gatea$ and $nncap$ same as for the balanced simulation.

For the unbalanced model the following input signals need to be used:

- $gatea\_AB$: Firing angle AB in degree
- $gatea\_BC$: Firing angle BC in degree
- $gatea\_CA$: Firing angle CA in degree
- $nncap\_AB$: Number of switched on capacitors, AB
- $nncap\_BC$: Number of switched on capacitors, BC
- $nncap\_CA$: Number of switched on capacitors, CA

The calculation of the susceptance is then done with the same scheme as the balanced simulation but for all phases separately.

6 EMT Simulation

For EMT simulation it is possible to choose between a TCR model as variable inductance or more detailed modelled with thyristors. If *Variable Inductance* is selected the TCR is treated as an ideally variable inductance. If the option *Thyristors* is used the phase control is simulated in detail. Thus the current shape will be influenced from the thyristor firing.

For the EMT simulation, the firing angle and the number of switched capacitors can be controlled. For balanced models the SVS-Interface (*ElmSvsctrl*) can be used (see Section 7).

With the option *Thyristors*, the thyristors are modelled as an inductance in a row with a switch (Figure 6.1).

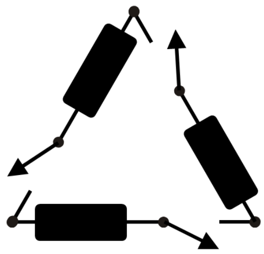

Figure 6.1: 'Thyristor' valve representation for EMT simulations (delta connection)

The SVS model includes an inbuilt frequency measurement, based on which the angles necessary to perform the firing of thyristors are calculated. The inbuilt frequency measurement is based on voltage zero crossing and may not be accurate during fast transients in the grid, with high frequency harmonics in the line-line voltages. In such cases, it is recommended to connect an external frequency measurement, *Fmeas*, from a PLL.

The line-line voltage zero crossing detection is used by the model to insert a new capacitor step (TSC model) and to properly perform firing of thyristors (TCR model). The line-line voltage zero crossing detection is by default performed internally in the model. Alternatively, the cosinus of phase "a" (signal *cosphiref*) can be measured with a PLL and connected to the SVS model. In the last case, the zero crossings of the line-line voltage are found internally under the assumption of balanced voltages. This last option is not indicated for studies with unbalances in the grid.

7 SVS-Interface

In order to control a SVS, the SVS-Interface object (*ElmSvsctrl*) can be used in a composite SVS model to translate the output signal $usvs$ of a SVS controller into a signal for the firing angle of the thyristor controlled reactor and into a signal which equals the number of capacitors which are to be connected. The SVS interface has two additional input signals from the SVS controller for the minimum and maximum reactive power limits ($qmin$ and $qmax$).

A composite model frame for the SVS control can be found in the global library. A number of standard controls are also available.

The option *Rating of SVS-controller output* sets the base value of the controller output (usvs):

- Reactor: The output of the controller (input to the SVS interface $usvs$) is interpreted as admittance in per unit of a base equal to $Rtd = |qmax|$ where $qmax$ is the input signal connected to the output of the Reactive Power in the SVS under *TCR/Q Reactance*.
- Nominal voltage: The output of the controller (input to the SVS interface $usvs$) is interpreted as admittance in per unit of a base equal to the nominal voltage of the SVS $Rtd = Uknom$.
- Enter value: The output of the controller (input to the SVS interface $usvs$) is interpreted as admittance in per unit of a base equal to the admittance of the entered Reactive Power Rating $Rtd = Rating$.

The susceptance is equal to:

$$y_{tcr} = y_{isvs} + y_{0svs} = usvs \cdot Rtd + y_{0svs} \tag{26}$$

and limited between 0 and $qmax$. The offset y_{0svs} is kept constant throughout the simulation. It is initialised to 0 if the option *Neglect Offset* is used. If the offset is considered, y_{0svs} is initialised to:

$$y_{0svs} = qmax \cdot \left(2 - \frac{2}{\pi} \cdot \alpha + \frac{1}{\pi} \cdot sin(2 \cdot \alpha)\right) \tag{27}$$

The firing angle $gatea$ is calculated iteratively from y_{tcr}. This output signal can be used to control the *ElmSvs* element.

The number of switched-on capacitors (output signal $nncap$) will increase or decrease depending on the value of the y_{tcr}:

- Increase: if $y_{tcr} \leq 0$ and $nncap < nxcap$.

  The parameter $nxcap$ is the maximum number of capacitors of the TSC (taken automatically from the controlled *ElmSvs*).
- Decrease: if $y_{tcr} \geq qmax$ and $nncap > 0$.

The *Capacitor switching Time Constant* $Tvcap$ delays the time point when the number of switched-on capacitors is decreased or increased.

8 Input/Output Definition of Dynamic Models

8.1 Stability Model (RMS)

The input combinations are shown in descending priority order. So the first found input combination is used. The highest priority is for the *bsvs* input:

Figure 8.1: Input/Output Definition of the SVS model for balanced RMS with admittance input

Figure 8.2: Input/Output Definition of the SVS model for unbalanced RMS with admittance input

Figure 8.3: Input/Output Definition of the SVS model for balanced stability analysis (RMS-simulation)

Figure 8.4: Input/Output Definition of the SVS model for unbalanced stability analysis

Table 8.1: Input Definition of the RMS-Model

Parameter	**Description**	**Unit**
bsvs	Admittance input (for all three phases)	Mvar
gatea	Firing Angle (for all three phases)	deg
nncap	Current Tap-Position (number of connected capacitors)	int
bsvs_AB	Admittance input (phase AB)	Mvar
bsvs_BC	Admittance input (phase BC)	Mvar
bsvs_CA	Admittance input (phase CA)	Mvar
gatea_AB	Firing Angle (phase AB)	deg
gatea_BC	Firing Angle (phase BC)	deg
gatea_CA	Firing Angle (phase CA)	deg
nncap_AB	Current Tap-Position (number of connected capacitors) AB	int
nncap_BC	Current Tap-Position (number of connected capacitors) BC	int
nncap_CA	Current Tap-Position (number of connected capacitors) CA	int

Table 8.2: Output Definition of the RMS-Model

Parameter	**Description**	**Unit**
cur1	Positive-Sequence Current, Magnitude	p.u.
cur1r	Positive-Sequence Current, Real Part	p.u.
cur1r	Positive-Sequence Current, Real Part	p.u.
Q1	Positive-Sequence Current, Reactive Power	Mvar

8.2 EMT-Model

Table 8.3: Input Definition of the RMS-Model

Parameter	Description	Unit
gatea	Firing angle (for all three phases)	deg
nncap	Current tap-position (number of connected capacitors)	int
gatea_AB	Firing angle phase AB	deg
gatea_BC	Firing angle phase BC	deg
gatea_CA	Firing angle phase CA	deg
nncap_AB	Current tap-position (number of connected capacitors) AB	int
nncap_BC	Current tap-position (number of connected capacitors) BC	int
nncap_CA	Current tap-position (number of connected capacitors) CA	int
Fmeas	Frequency	Hz
cosphiref	Reference angle (cos)	

Table 8.4: Output Definition of the RMS-Model

Parameter	Description	Unit
cur1	Positive-sequence current, magnitude	p.u.
cur1r	Positive-sequence current, real part	p.u.
cur1r	Positive-sequence current, real part	p.u.
Q1	Positive-sequence current, reactive power	Mvar
iL_AB	TCR current, phase AB	p.u.
iL_BC	TCR current, phase BC	p.u.
iL_CA	TCR current, phase CA	p.u.
iC_AB	TSC current, phase AB	p.u.
iC_BC	TSC current, phase BC	p.u.
iC_CA	TSC current, phase CA	p.u.
iQ_AB	MSC current, phase AB	p.u.
iQ_BC	MSC current, phase BC	p.u.
iQ_CA	MSC current, phase CA	p.u.
Phi_AB	Voltage angle, phase AB	rad
Phi_BC	Voltage angle, phase BC	rad
Phi_CA	Voltage angle, phase CA	rad

9 References

[1] L. Gyugyi N. G. Hingorani. *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*. IEEE Press, 2000.

List of Figures

List of Tables