

Modeling the AMSC D-VAR[®] VVO STATCOM in the Synergi Electric Distribution Software

February 24, 2021



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Document Revision History

Revision #	Date	Description	By	Reviewed
01	1/23/17	Initial Release	JDDL	MG
02	07/10/19	Updated for Synergi 6.3.0	RR	BD
03	07/15/19	Clarified Synergi Droop Parameter	RR	BD
04	10/22/20	Revised for Synergi update allowing piecewise droop	RR	TF
05	2/24/21	Revised for Synergi 6.7.0 update allowing per phase Volt/VAR	RR	TF

Introduction

The Synergi Electric distribution software, produced by DNV GL, is used by many utilities to study their distribution systems. The software allows the user to conduct load flow analysis – the study of the power system’s voltage and current flows under steady state conditions. For example, utility facilities can be placed out-of-service, and load flow analysis will show what the new steady state voltages and currents will be.

AMSC manufactures a STATCOM device for use on the distribution system - the **D-VAR® VVO**. The D-VAR VVO is a STATCOM which can be directly connected to 15 kV class feeders and is available in a 1 MVAR three-phase rating. A single-phase version, one-third the size of the three-phase, is also available. The device, capable of supplying both inductive and capacitive reactive power, is used to regulate voltage or power factor on the distribution system.

The benefits of the D-VAR VVO can be studied using the Synergi software. This document provides a description of how the AMSC D-VAR VVO can be modeled in the Synergi Electric software package version 6.7.0 and above, using the STATCOM model available in the standard library.

VVO Operating Modes & Synergi Modeling Equivalent

VVO Mode #1: Volt/VAR (Positive Sequence) (Synergi Equivalent: STATCOM with inverter profile)

This mode in Synergi applies the Volt/VAR profile to the RMS average of the three phase voltages. The STATCOM will then inject or absorb an equal number of VARs per phase based on where the average RMS voltage aligns with the Volt/VAR profile. This is like the AMSC VVO’s positive sequence Volt/VAR mode which injects or absorbs an equal number of VARs per phase based on the positive sequence voltage.

A STATCOM is represented by selecting device kind “**STATCOM**” within the **flexi-type** component available in the Warehouse (see Figure 1).

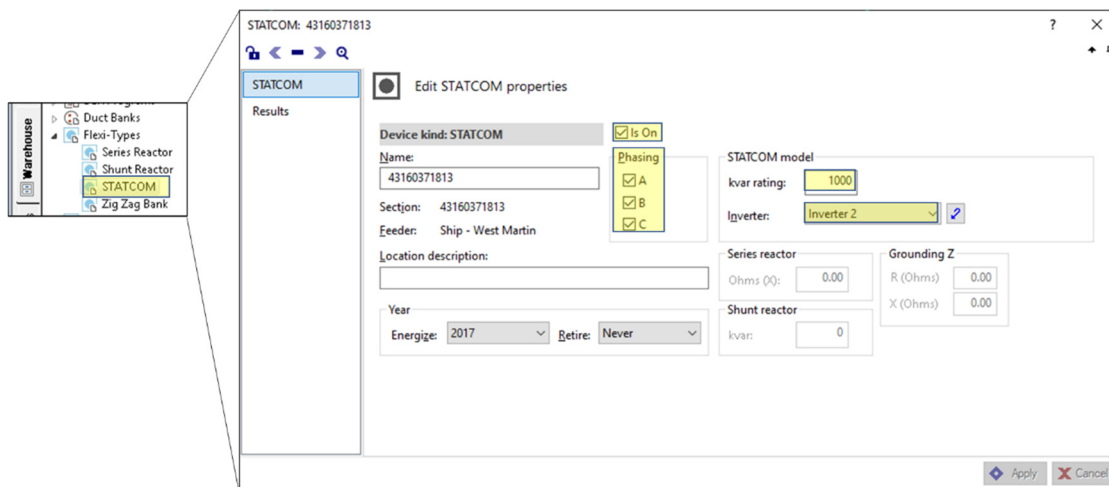


Figure 1: Flexi-type Component Properties for Balanced Volt/VAR

Confirm “Is On” is checked, along with A, B, and C phasing. Enter 1000 kVAR for STATCOM kVAR rating for most use cases. Note, however, the VVO STATCOM also has a short-term capability of 1300 kVAR for 60 second durations up to 5 instances per hour. The kVAR rating in Synergi can be entered as 1300 kVAR for use cases that require that capacity infrequently and for 1-minute periods.

The key STATCOM parameters are input in the “Inverter” page under the STATCOM model (see Figure 2).

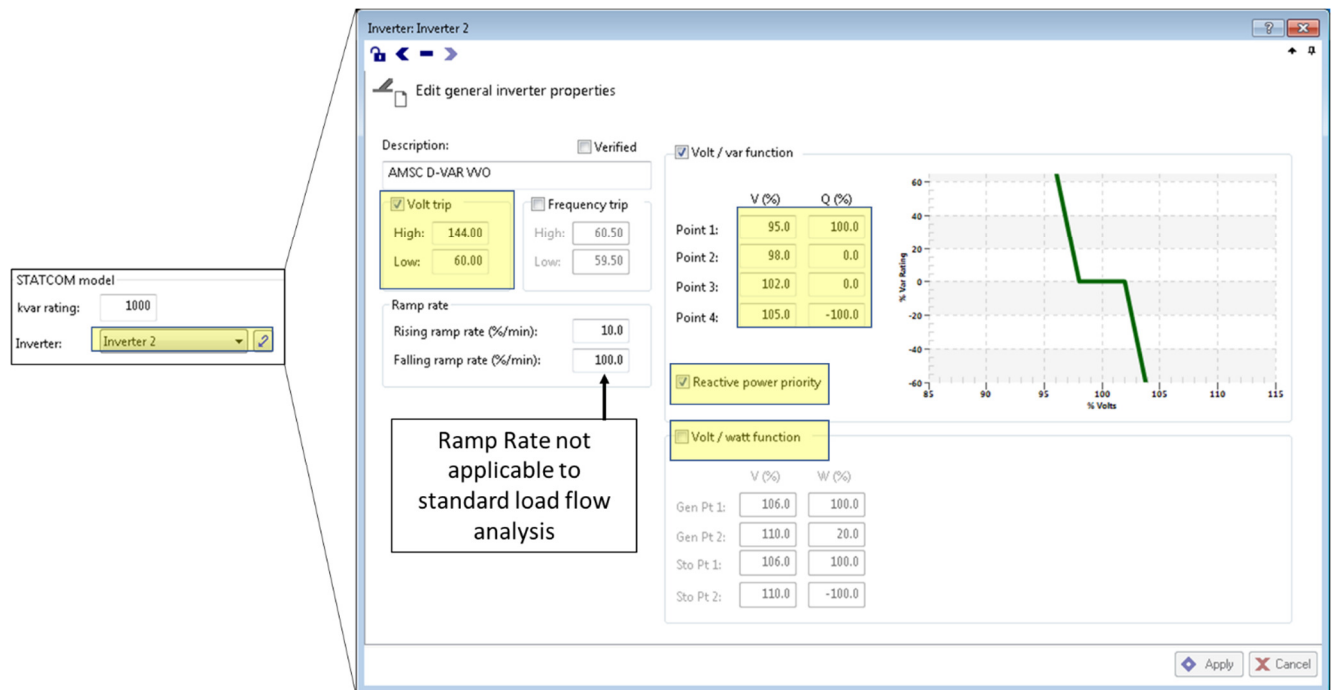


Figure 2: STATCOM Inverter Properties

Be sure to uncheck “Volt/watt function” and check “Volt/var function” and “Reactive power priority”. The Volt/VAR droop profile can then be configured using the four points. The Q(%) column should remain 100%, 0%, 0%, 100% but the V(%) values can be updated based on the operating voltage objectives of the use case.

The V(%) difference between Point 1 & Point 2 defines the capacitive droop and the V(%) difference between Point 3 & Point 4 defines the inductive droop. For example, the profile set in Figure 2 has both a capacitive and inductive droop equal to 3%. The 3% droop means that the STATCOM will swing from 0% of its kVAR rating to 100% of its kVAR rating (inductive or capacitive) for the applicable 3% change in voltage. A droop between 1% and 5% is suitable for most distribution applications.

The V(%) difference between Point 2 and Point 3 defines the deadband where the VVO STATCOM will remain idle at 0 kVAR output. A wide deadband reserves the VVO dynamic VARs for only the most outlier operating voltages and typically reduces total kVAR supplied or absorbed by the VVO over a given time. A narrow deadband ensures the VVO is almost always providing some voltage management and it is likely to take regulation precedence over series

voltage regulators. A deadband between 0.5% and 5% is suitable for most distribution applications.

VVO Mode #2: Volt/VAR (Per Phase)

(Synergi Equivalent: three 1-PH STATCOMs on separate sections)

The AMSC VVO can also apply the Volt-VAR profile to each individual phase voltage. This results in the VVO injecting dissimilar amounts of VARs per phase in response to existing unbalance in the circuit's phase voltages. Existing unbalance in the circuit's phase voltages may be caused by unevenly distributed single-phase loads or residential PV installations that result in unbalanced current flows. The per phase Volt/VAR control model will help reduce the voltage unbalance between phases to produce a tighter average operating voltage range.

Synergi only allows one STATCOM per line section and a single STATCOM with phase A/B/C will operate in balanced mode. To simulate per-phase Volt/VAR control, instead begin by creating three single-phase dummy sections at a node. Make each single-phase section only one foot long with large conductor and assign them to phases A, B, and C respectively. On each single-phase section, install a STATCOM as shown in Figure 3.

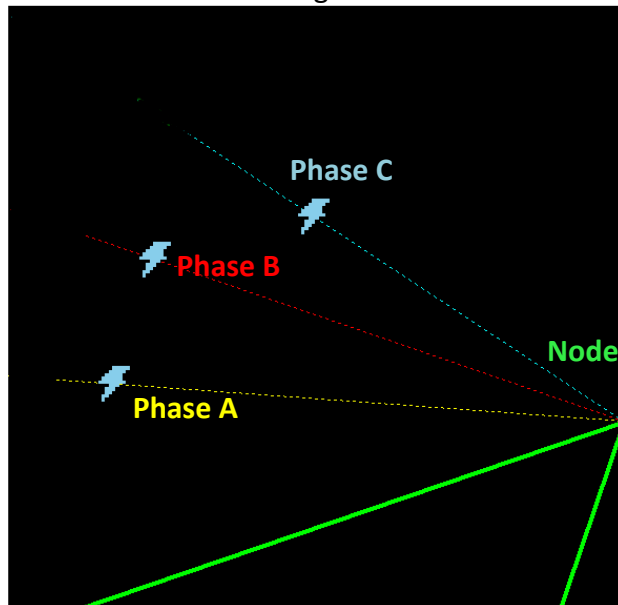


Figure 3: single-phase STATCOMs modeled on single-phase tap lines

Update the properties for each single-phase STATCOM as shown in Figure 4. The phasing should automatically be assigned to match the single-phase section. The kVAR rating should be set for the single-phase capacity of 333 kVAR (1/3rd of 1000 kVA three-phase rating).

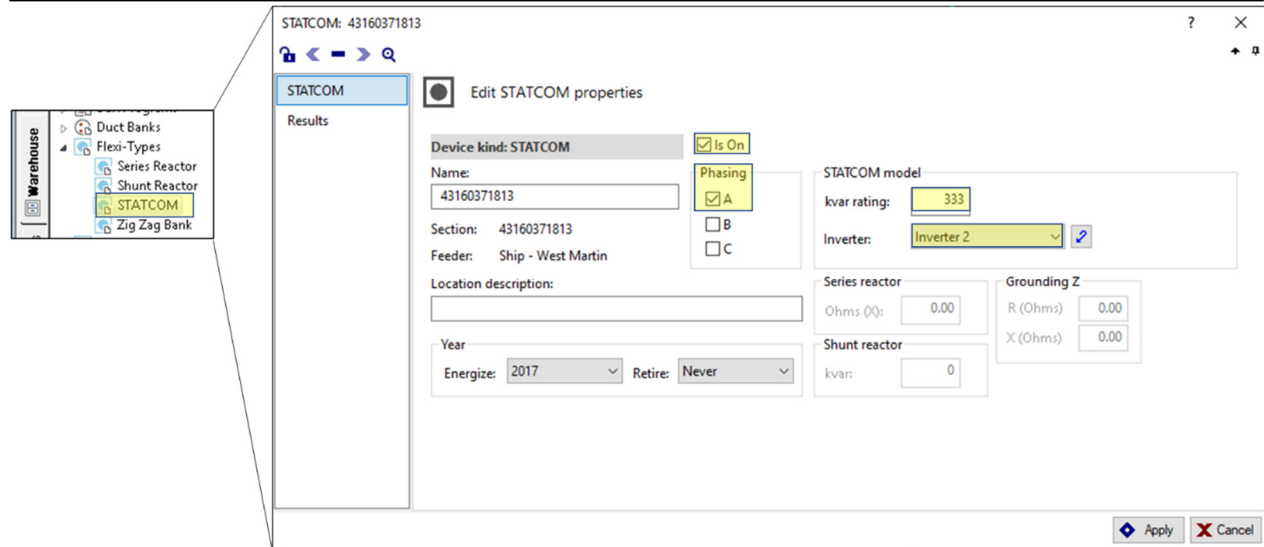


Figure 4: Flexi-type Component Properties for Unbalanced Volt/VAR

Refer to the previous instructions for VVO Mode #1 to set the key STATCOM parameters (Volt/VAR function, droop, etc.).

VVO Mode #3: Feeder VAR (Synergi Equivalent: Offsetting Constant Power Load)

The VVO Feeder VAR mode is a current-based control where the VVO measures reactive current flow on the line to which it is connected and injects or absorbs VARs to achieve a specific net VAR target. Typically, the VAR target is set to 0 kVAR so that the VVO optimizes the net power factor to unity when possible.

This can be simulated manually in individual Synergi load flows using a constant current load. First, run a load flow and double click the section on which the VVO is planning to be installed. Under the results tab, look at the *kVAR Into* value. Next, on the *Load Spot* tab, create spot load in the center of the section with the negative value of *kVAR Into* from the preceding step. Note, if the measured *kVAR Into* value exceeded +/-1000 kVAR, then only enter -/+1000 kVAR into the spot load since that is the capability limit of the VVO.

Re-run the load flow and confirm on the section's results tab that *kVAR Into* has reduced to near zero or reduced by 1000kVAR as applicable.

QUESTIONS?

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