Wide Area Oscillation Damping Control Using SVC As Actuator- Terna Case Study

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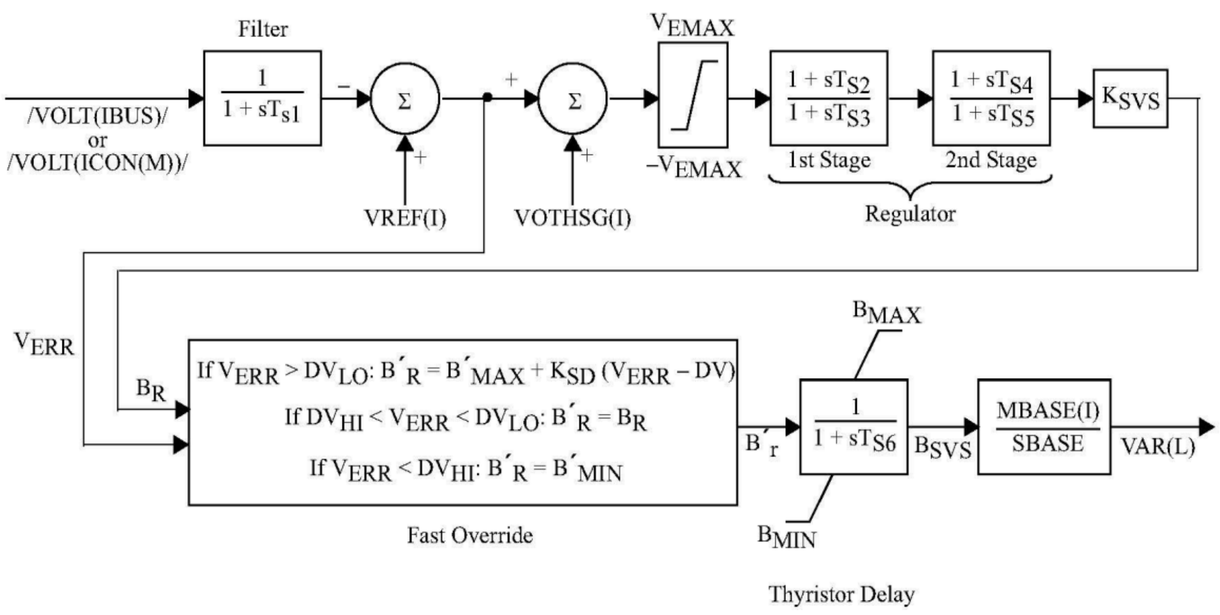
Background & Introduction

- Low-frequency oscillations are significant issues that threaten power system security.
- To avoid the need for detailed dynamic models and parameters, researchers in the University of Tennessee, Knoxville developed a measurement-driven wide-area damping control (WADC) approach, in which data from Phasor Measurement Units (PMUs) are adopts for controller design.
- Widely used worldwide, Static var compensators (SVCs) have the potential to serve as an oscillation damping actuator.
- In this research, the design methodology of the WADC controller is transferred and applied to the scenario of SVCs to validate its feasibility, with the Terna grid serving as a case study.

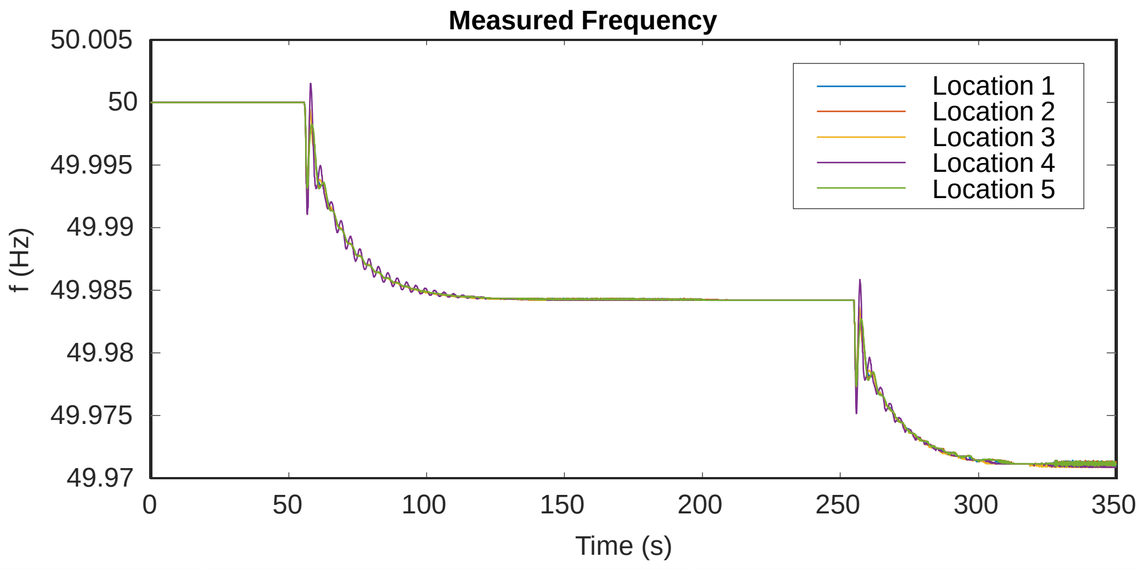
SVC Short-term Dynamic Model with Fast-Override

- The model includes a filter block to model the measurement delay, a voltage regulator with a gain block to model the slope of the V-I characteristics of SVC, and a thyristor delay block.
- A fast override module is added to prevent the system from serious failure and voltage deviation exceeding the controllable limit value.
- Fast Override logic:
  If DV = 0, $DV_{LO} = B'_{MAX} / K_{SVS}$, $DV_{HI} = B'_{MIN} / KSVS$
  If DV > 0, $DV_{LO} = DV$, $DV_{HI} = -DV$



Terna Case Study —— SVCs at different locations

- In all locations, SVCs demonstrate a positive effect on oscillation damping.



SVC Location	Gen1 Trip		Gen2 Trip	
	Freq (Hz)	DR (%)	Freq (Hz)	DR (%)
None	0.291	-0.267	0.292	-0.288
Location 1	0.203	40.9	0.247	30.0
Location 2	0.220	33.0	0.232	26.3
Location 3	0.231	44.7	0.264	23.2
Location 4	0.324	15.7	0.341	15.2
Location 5	0.230	27.7	0.247	20.5

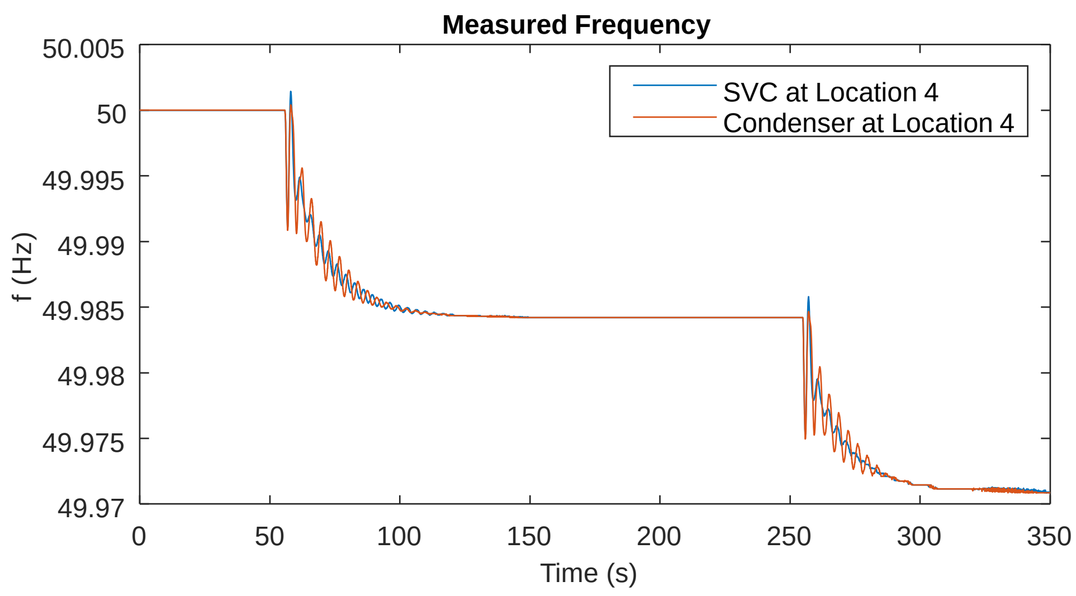
Terna Case Study —— Single SVC vs Multiple SVCs

- Multiple SVCs show better performance compared to a single SVC.
- System's oscillation frequency varies with SVC. This phenomenon is more pronounced in scenarios involving multiple SVCs.

SVC Location	Gen1 Trip		Gen2 Trip	
	Freq (Hz)	DR (%)	Freq (Hz)	DR (%)
None	0.291	-0.267	0.292	-0.288
Location 2	0.220	33.0	0.232	26.3
Location 1 & 2	0.166	33.7	0.166	54.8
Location 2 & 3	0.176	35.4	0.110	61.4
Location 2 & 4	0.197	35.3	0.109	81.3
All 5 Locations	0.148	29.2	0.086	63.2

Terna Case Study —— Comparison Between SVCs And Condensers As Actuators

- The durations of oscillation are almost same, with condenser case slightly shorter.
- During oscillation, SVC case has a smaller amplitude, while condenser case has a smaller overshoot.



Conclusion & Future Works

- SVCs with WADC can effectively suppress the oscillations in the power grid caused by disturbances.
- The control effects of SVCs vary with different locations and quantities. A more detailed analysis is needed.
- In addition to simulations, this study also plans to conduct hardware-in-the-loop (HIL) testing and field experiments.