CONTROLLING VOLTAGE SUPPORT FOR STATIC SYNCHRONOUS COMPENSATORS IN UNBALANCED VOLTAGE SAG SCENARIOS

[#1]DR.ARRAMARAJU PRASAD RAJU, ***Professor & Principal,***
[#2]Mr.ALABOTHARAM VINOD KUMAR, ***Assistant. Professor,***
Department of Electrical and Electronics Engineering,
SREE CHAITANYA INSTITUTE OF TECHNOLOGICAL SCIENCES, KARIMNAGAR, TS.

ABSTRACT:

Voltage regulation, network balancing, and stability enhancement are just few of the many uses for static synchronous compensators in alternating current electrical networks. These compensators, which boost the performance of ac networks by smoothing out voltage fluctuations, have been the subject of extensive study. In this paper, we provide a complete method of control for synchronous compensators operating in deviant network environments. This control method is novel because it incorporates both a novel reactive current reference generator and a novel voltage support control loop. The present reference generator's standout characteristic is its precision in producing reactive current, even when the voltage amplitude drops as in a voltage sag. The system's reliability is ensured by setting the minimum current demand at the maximum rated current. By altering the two voltage set points, the voltage control loop can implement a wide variety of control systems. This study presents three different voltage support control systems and compares and contrasts their features and shortcomings. Two theoretical contributions made in this investigation have been verified by experimental evidence. Clearly, there is a need for more research on the topic of voltage support, and the control system demonstrated in this dissertation can be seen as an intriguing arrangement for the development of different control systems in future investigations.

Index Terms: Power quality, reactive power control,staticsynchronouscompensator(STATCOM),voltagesag.
DOINumber: 10.48047/nq.2022.20.2.NQ22363 **NeuroQuantology2022;20(2):665-668**

1. INTRODUCTION:

The standard layout of the alternating current (AC) power grid is presently being updated. The use of renewable energy sources that are geographically close to where electricity is needed has increased dramatically in recent years. Due to the short transmission and distribution distances, power losses are drastically cut down on. In addition, the current state of decentralized power generation offers numerous advantages, such as reduced network congestion, enhanced local power reliability, and the provision of new services. An additional function that distributed renewable energy sources offer the alternating current (AC) network is reactive power exchange. By increasing the margin against voltage breakdown, this service improves the dependability of the power grid. Reactive power serves multiple purposes, including voltage regulation, network balancing, and voltage support in the event of transient abnormalities.

Reactive power control is typically used by low-rated distributed renewable energy sources to instantly modify the power factor of the installation. The ability of high-power sources to change terminal voltage rises as generation capacity rises, making voltage control the preferred method. The evolution of grid codes for wind power plants is a great example of this idea in action. Wind generation installations are considered peripheral energy sources by many existing and historical grid protocols, requiring the injection of reactive power. Voltage control on the grid is a relatively new concept, necessitated by the rising popularity of wind power.

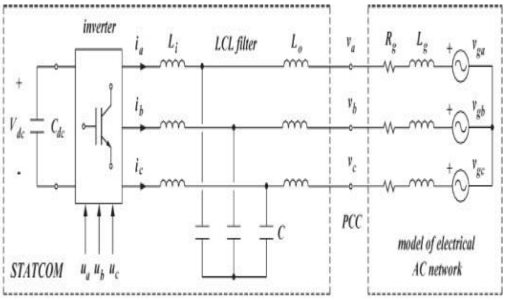


Diagram of the power system, including the STATCOM and the model of the electrical ac network.

2. EXISTING SYSTEM:

The STATCOM's power circuit topology and control mechanism are outlined in the next section. It also provides an overview of the system's underlying ideas. Figure 1 depicts the STATCOM used in this study. The DC-side capacitor, LCL output filter, and 3-phase Voltage Source Converter (VSC) make up the power circuit architecture. The point of common coupling (PCC) is typically used to connect the STATCOM to the transmission and distribution networks. Leakage inductance, distinct from magnetizing inductance, is depicted in Figure 1 by the Lo inductor. An alternating current voltage source is shown in series with a grid impedance (Rg and Lg) representing the electrical grid. Like the line impedance, the grid impedance provides a quantifiable description of extra transformers in the power system. Reflected amounts Rg, Lg, and vg are those that are returned to the STATCOM transformer's primary winding.

3. PROPOSED SYSTEM:

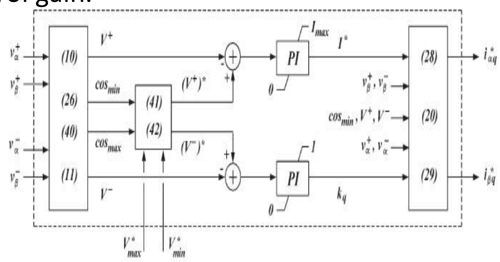
The main contribution of this research is a generator that can produce a reference current in response to various inputs. The development of the generator is the focus of this subsection. You'll find the equations you need to calculate the reference signals that fix the maximum amplitude of the phase currents (called the set point I) in this subsection. This goal should be met even if the phase currents are not perfectly uniform. Additionally, the examination of both positive and negative series reactive power at the end of this section reveals the way of injecting reactive power via the current reference generator. Importantly, by integrating a standard reactive power control with a current limiting module, the injected current may be easily limited to a set maximum magnitude. Total harmonic distortion occurs when the injected current is suddenly cut off during an overcurrent situation. The proposed current generator keeps the current waveforms intact while successfully limiting the maximum amplitude to a fixed value. Since active power is predominantly used to compensate for power losses, reactive current significantly dominates active current. As a result, we will only consider reactive current references in this subsection.

4. VOLTAGE SUPPORT CONTROL STRATEGIES

The paper's second contribution is a method of voltage support regulation for STATCOMs that can be used when there are voltage drops in an imbalanced fashion. Instructions for making the voltage regulator are provided here. In addition, three mechanisms for controlling the supply voltage are presented and thoroughly examined.

Control Objectives

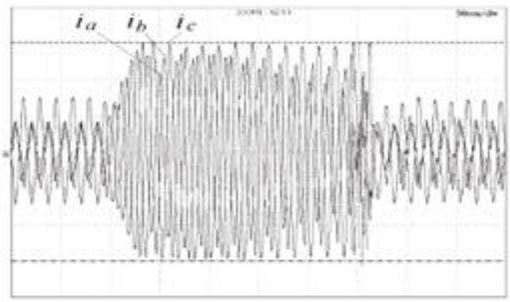
This section's goal is to build a voltage control loop that uses the PCC voltage maximum and minimum set points to establish the appropriate set point I and control gain kq. Different voltage support control strategies can be developed based on the values that are chosen for these voltage set points. As shown by Equations (33) and (34), the quantity of reactive power sent to the AC network is controlled directly by the current set point I. The positive sequence voltage at the PCC rises as a result of an increase in the current set point, which in turn increases the reactive power injection [29]. This reference voltage (V+) is then utilized to calibrate the positive-sequence voltage (V+) to the desired level. Equal amounts of reactive current can be introduced in positive and negative sequences, thanks to the control gain kq. Reduces the negative-sequence voltage at the point of common coupling (PCC) when gain kq is small. Therefore, the voltage V of the negative sequence is modified in relation to the reference voltage (V) via the control gain.



. Diagram of the proposed reactive current reference generator with voltage support auxiliary service.

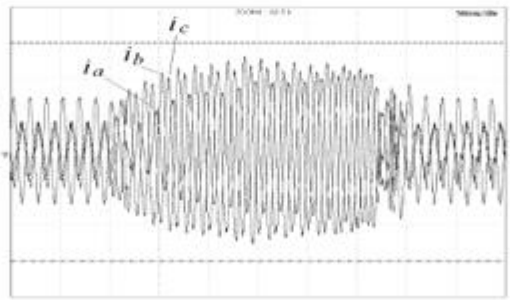
EXPERIMENTAL VALIDATION

The experimental findings in this section validate the theoretical advances made in this work. The reactive current reference generator and the voltage support control method are both verified by two sets of experiments.



EXPERIMENT 1: steady state: CS1, voltage sag: CS1

(a)

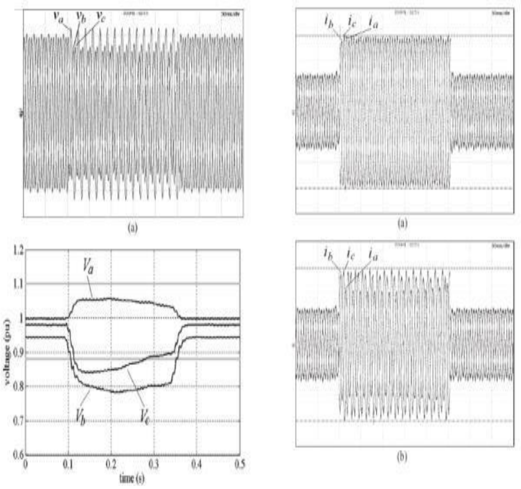


EXPERIMENT 2: steady state: CS1, voltage sag: CS2

(b)

Experimental Setup

A Semikron three-phase insulated-gate bipolar transistor inverter and a programmable Pacific Power ac power supply were used to create a working prototype of the power system depicted in Figure 1. In Table I, we can see the power system's typical settings. The use of a Texas Instruments TMS320F28335 floating-point digital signal processor in a control system is shown in Figures 2 and 4. The internal and exterior control circuits' bandwidths were suitably separated at 1.2 kHz and 60 Hz, respectively, to reduce the likelihood of interference. The Table II control parameters are suitable for this purpose.



5. CONCLUSION

In order to keep STATCOMs operational when faced with unbalanced voltage drops, this paper proposes a comprehensive method of control. The first departure from convention is the use of a current set point rather than the more common reactive power set point in a reactive current reference generator. By limiting the amplitude of the alternating current in the network, this generator ensures the STATCOM can operate safely. The proposed method improves upon previous reference generators by providing stable output limitations regardless of variations in grid voltage. As a result, there is no longer a need for an online maximum reactive power calculation. The second advancement is a voltage control loop that allows for various voltage support control schemes to be implemented with only two voltage set points requiring adjustment. It is recommended to test the control system's ability to deal with significant voltage imbalances using one of three possible control strategies. Under normal network settings, the CS1 performs admirably, but when there is a substantial voltage imbalance, it struggles to keep up. Indeed, a STATCOM with a greater power rating is required to generate the required reactive current in order to satisfy the CS1 criteria. By modifying voltage set points, the CS3 and CS3 enhance performance during uneven voltage sag and alleviate the burden on the CS1.

REFERENCES

1. J.M.Carrasco,L.G.Franquelo,J.T.Bialasiewicz,E.Galván,R.C.Guisado,M.A.Prats,J.I.León,andN. Moreno-Alfonso, “Powerelectronic systems for thegridintegrationofrenewableenergysources:A survey,” IEEE Trans. Ind. Electron., vol. 53, no. 4, pp.1002–1016,Jun.2006.
2. F. Blaabjerg, R. Teodorescu, M. Liserre, and A. V.Timbus,“Overviewofcontrolandgridsynchronizationfordistributedpowergenerationsystems,” IEEETrans.Ind.Electron.,vol.53,no.5,pp.1398–1409, Oct. 2006.
3. P. Rodrıacute;guez, A. Timbus, R. Teodorescu, M.Liserre, and F. Blaabjerg, “Independent PQ control fordistributedpowergenerationsystemsundergridfaults,”inProc.IEEEIECON,2006, pp. 5185–5190.
4. Luna, P. Rodrıacute;guez, R. Teodorescu, and F.Blaabjerg,“Lowvoltageridethroughstrategiesf orSCIG wind turbines in distributed powergenerationsystems,”in Proc.IEEEPESC, 2008,pp.2333–2339.
5. P.Rodriguez,A.Timbus,R.Teodorescu,M.Liserre, and F. Blaabjerg, “Reactive power control forimproving windturbinesystem behaviorundergridfaults,” IEEE Trans. Power Electron., vol. 24, no. 7,pp. 1798–1801,Jul.2009.
6. Wang, J. L. Duarte, and M. A. Hendrix,

"Pliantactive and reactive power control for grid-interactiveconvertersunderunbalancedvoltage dips,"IEEETrans.Power.Electron.,vol.26,no.5,pp.1511–1521, May2011.

7. Junyent-Ferré, O. Gomis-Bellmunt, T. C. Green,andD.E. Soto-Sánchez, "Currentcontrolreferencecalculationissuesfortheoperationofrenewablesourcegridinterface VSCsunderunbalancedvoltagesags," IEEE Trans. Power. Electron., vol. 26, no. 12,pp. 3744–3753, Dec. 2011.
8. Camacho,M.Castilla,J.Miret,J.Vasquez,andE. Alarcon-Gallo, "Flexible voltage support control forthree phase distributed generation inverters under gridfault," IEEE Trans. Ind. Electron., vol. 60, no. 4, pp.1429–1441,Apr. 2013.
9. MartinezandP.C.Kjaer,"Fastvoltagecontrolin wind power plants," in Proc. IEEE Power EnergySoc. Gen.Meet., 2011, pp.1–7.
10. Grid Code-High and Extra High Voltage, E. ONNetzGmbH, Bayreuth,Germany, 2006.