



# VOLTAGE SUPPORT CONTROL STRATEGIES FOR STATIC SYNCHRONOUS COMPENSATORS UNDER UNBALANCED VOLTAGE SAGS

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## ABSTRACT

This project presents a complete control scheme intended for synchronous compensators operating under these abnormal network conditions. In particular, this control scheme introduces two contributions: a novel reactive current reference generator and a new voltage support control loop. The current reference generator has as a main feature the capacity to supply the required reactive current even when the voltage drops in amplitude during the voltage sag. Thus, a safe system operation is easily guaranteed by fixing the limit required current to the maximum rated current. The voltage control loop is able to implement several control strategies by setting two voltage set points. The two theoretical contributions of this paper have been validated by experimental results. Certainly, the topic of voltage

support is open for further research, and the control scheme proposed in this paper can be viewed as an interesting configuration to devise other control strategies in future works.

Key words-Voltage,Network, kalman filters,AC Bus,DC Bus, static synchronous compensator

## I INTRODUCTION

The centralized traditional large power

supply mode has some defects such as low reliability, environmental pollution and poor flexibility. In order to solve the above problems, the distributed generation installed near the users becomes an alternative choice. However, due to the shortcomings of DG, such as randomness and intermittency DGs will have a great impact on the

large power grid when transmitted to the grid directly. Therefore, the concept of micro grid is proposed. The micro grid can make full use of these new energy sources and interconnect the DGs with the loads, which can work independently as a reliable and stable power supply and also used as a generation transmitting power to the large power grid. STATCOM is a shunt reactive compensation device based on inverter technology. It is equivalent to an adjustable voltage or current source that can be controlled by its amplitude and phase to change the reactive power delivered to the grid[7].

## II LITERATURE SURVEY:

Today power quality is the most essential variable in both levels of transmission and distribution. It's very much essential to take care of the acceptable limits of power quality.

**N.G hingorani**[1], 1995, has given the basic concept of custom power. It gives the reliability of power flow. Solid state circuit breakers, static compensators, static condensers provide the basis of the custom power.

**ChellaliBenachaiba** et al. [2], 2008, describes DVR, a compelling custom power gadget for moderating voltage swell and sag. Also gave the method of voltage restoration at the PCC i.e. the point of common coupling, DVR principles and also described about the different methods of voltage injection. DVR can handle both unbalanced and balanced situations effectively.

**Mehmet Ucare** et al. [3], 2008, proposed the p-q theory which is also called instantaneous reactive power theory, another control calculation has been suggested for three-phase four-wire and four-leg parallel active power filter (APF), based on this proposal, for remuneration of reactive power, harmonic currents suppressions, and balancing of the load currents under non-perfect mains voltage conditions and unbalanced non-linear load.

**Kamran and Habetler**[4],1998,has proposed a new method taking into account the deadbeat control, that treats UPQC inverter association as a solitary unit. The whole concept has been exhibited utilizing a 3-phase series-shunt active filter. It also uses a full-order predictive state observer.

Modelling the system as a solitary multi-input, multi-output framework has many advantages. It showed faster dynamic response and steady state precision and thereby giving enhanced control execution over the independently controlled converters.

**K.H Kwan** et al. [5], 2007, propose a model predictive control design for the UPQC. Use of kalman filters makes it easy for the extraction of principal and harmonic parts of the given load current and the supplied voltage. The model predictive controller had been designed based on the state space model of the UPQC. The MPC controller proved beneficial in regulating the error in supplied voltage and the load current thereby regulating both supply voltage and load current. It is helpful in mitigating load variation, sag and swell.

## III. METHODOLOGY:

### PI CONTROL ALGORITHM:

A proportional-Integral (PI) controller is a generic control loop feedback mechanism (controller) widely used in industrial control systems . A PI is the most commonly used controller and it calculates an "error" value as the difference between a measured process variable and a desired set point. The controller attempts to minimize the error by adjusting the process control inputs. The Proportional and Integral values are denoted as P and I. Heuristically, these values can be interpreted in terms of time such as P depends on the present error and I depends on the accumulation of past errors.

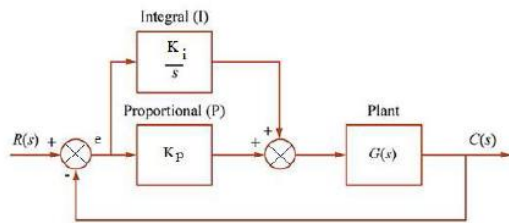
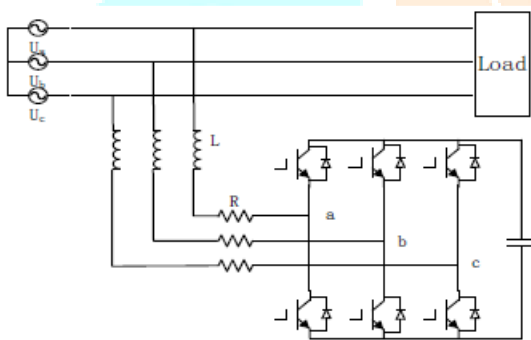


Figure 3.1 Block diagram of system with PI Controller

## STATCOM:

STATCOM is a three-phase and shunt connected power electronics based device. It is connected near the load at the distribution systems.

## CIRCUIT DIAGRAM



## POWER QUALITY

Power Quality is a term that mean different to different people. Institute of Electrical and Electrical Engineers (IEEE) standard IEEE 1100 defines power quality as “the concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment.”

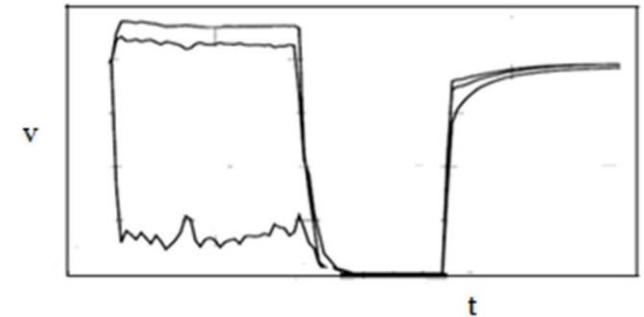
## PROBLEMS REGARDING POWER QUALITY

### Voltage Sag (Or Dip)



**Description:** A decrease of the normal voltage level between 10 and 90% of the nominal rms Voltage at the power frequency, for durations of 0.5 cycle to 1 minute.

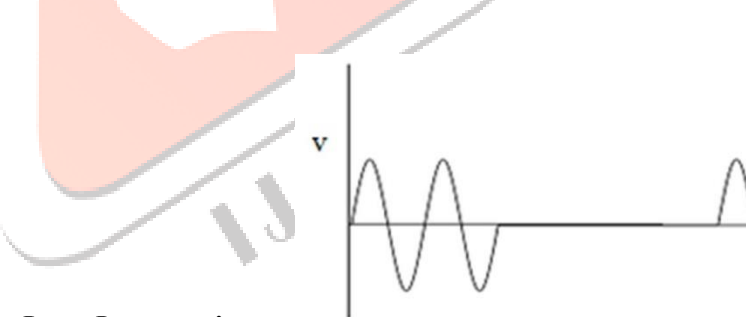
### Very Short Interruptions



### Very Short Interruption

**Description:** Total interruption of electrical supply for duration from few milliseconds to one or two seconds.

### Long Interruptions



### Long Interruptions

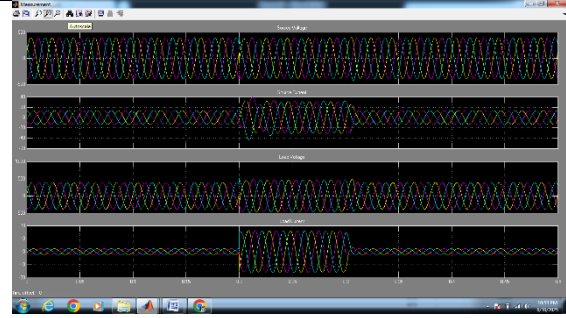
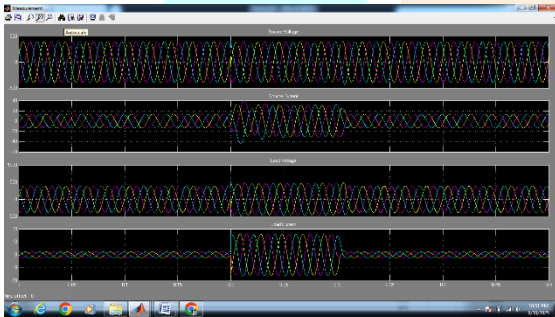
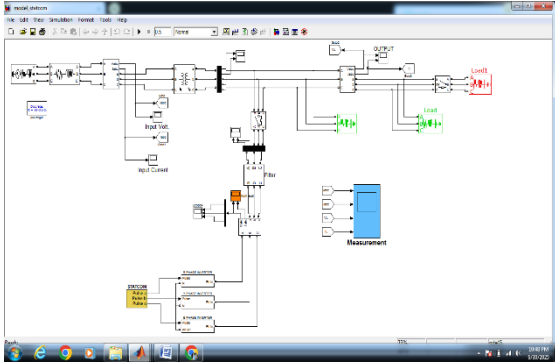
**Description:** Total interruption of electrical supply for duration greater than 1 to 2 seconds.

## SIMULATION

Simulation (left figure) and measurement (right figure) results (Time/div = 5ms) and (Voltage/div = 10V): (a) output voltage of the first basic unit; (b) output voltage of the second basic unit; (c) output voltage of the first sub multilevel converter; (d) output voltage of the second sub multilevel converter; and (e) top and bottom: converter output voltage and current.

Static inverters have no moving parts and are used in a wide range of applications, from small switching

power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries.



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