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# SEIG based Facts Device for the Three phase Non-Linear Loads

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## ABSTRACT

***This paper deals with the performance analysis of unified power quality conditioner(UPQC) based voltage regulator for self- excited induction generators (SEIGs) feeding non-linear single phase loads. The presence of non-linear loads in some applications injects harmonics into the generating system. Because an SEIG is a weak isolated system, these harmonics have a great effect on its performance. Additionally, SEIG's offer poor voltage regulation and require an adjustable reactive power source to maintain a constant terminal voltage under a varying load. A three-phase insulated gate bipolar transistor (IGBT) based current controlled voltage source inverter (CC-VSI) known as STATCOM & DVR is used for harmonic elimination. It also provides the required reactive power an SEIG needs to maintain a constant terminal voltage under varying loads. A dynamic model of an SEIG-UPQC system with the ability to compensate the unbalanced current caused by single-phase loads that are connected across the two terminals of the three-phase SEIG under varying loads has been analyzed by using D-Q frame theory algorithm. This enables us to predict the behavior of the system under transient conditions. The simulated results shows that by using a UPQC based voltage regulator the SEIG can balance the current; in addition to that the STATCOM is able to regulate the terminal voltage of the generator and suppresses the harmonic currents injected by non- linear loads.***

***Index Terms—Self-excited induction generator (SEIG), single- phase synchronous D-Q frame theory, static synchronous compensator (STATCOM).DVR,UPQC.***

## I. INTRODUCTION

Distributed power generation has become a topic of interest in recent years to supply power to remote, rural and isolated regions. Need for standby power is also increasing rapidly due to unreliable utility supplies. Heavy distribution losses and investment in transmission lines compel one to seek autonomous power generation. Depletion of fossil fuels has turned our attention towards renewable energy sources. For power generation wind, small hydro and biomass are attractive options. Since they are exceptionally to be located in isolated regions, the technology must be simple, rugged and easy to maintain and operate. Suitable energy conversion system has to be developed for such applications. On the electrical side the generator and controller have to be appropriately chosen to meet the customer needs. Self-excited induction generator (SEIG) has been shown advantages for such applications. Such three-phase generators would often feed unbalanced loads due to the very nature of distributed load arrangement dictated by location of consumers. Engine and hydro turbine driven SEIG needs to have suitable controllers to satisfy proper power quality at consumer end. At varying loads, reactive power requirement has to change to provide the required voltage at the given prime mover speed and load pf. The unbalanced loads would pose additional problem on the design of controller that should not only provide needed VAR but also maintain the generator

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output voltage and current under balance in spite of unbalanced load. This paper addresses this issue and suggests a viable STATCOM based controller. The other suggested controllers in literature like switched capacitor, thyristor controlled inductor , saturable core reactor , and series capacitor do not meet such requirements. With rapid advances in power electronics and signal processing, static compensator (STATCOM) can be an attractive reactive power controller. While use of STATCOM for power systems and for self excited induction generator has been already reported under balanced condition, its applicability to SEIG under unbalanced conditions has not been explored.

Fig. 1 shows the schematic diagram of the STATCOM-compensated three-phase SEIG feeding single-phase loads. The system consists of an SEIG driven by renewable energy-based prime mover. The single-phase consumer loads are connected across ―a‖ and ―c‖ phases of the SEIG. A two-level, three-leg insulated-gate bipolar transistor (IGBT)-based VSI with a self-sustaining dc-bus capacitor is used as a STATCOM. The STAT- COM is connected at point of common coupling (PCC) through filter inductors as shown in Fig. 1. The STATCOM regulates the system voltage by maintaining equilibrium among the reactive power circulations within the system. Moreover, STATCOM suppresses harmonics injected by nonlinear loads and provides load balancing while feeding single-phase loads.

The unbalanced load currents in a three-phase system can be divided into two sets of balanced currents known as positive sequence components and negative sequence components. In order to achieve balanced source currents, the source should be free from the negative sequence components of load currents. Therefore, when the STATCOM is connected across PCC, it sup- plies the negative sequence currents needed by the unbalanced load or it draws another set of negative sequence currents which are exactly 180◦ out of phase to those drawn by unbalanced load so as to nullify the effect of negative sequence currents of unbalanced loads.

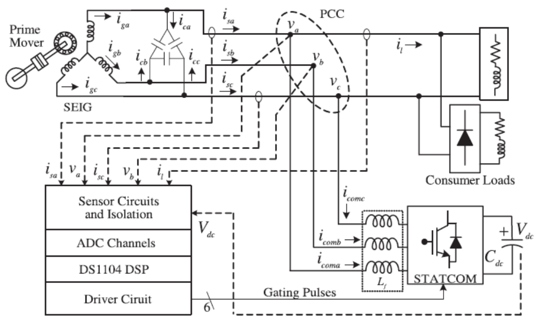


Fig. 1. Schematic diagram of the SEIG–STATCOM system feeding single-phase loads

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### Dynamic Voltage Restorer (DVR)

A DVR is composed of a Voltage Source Converter (VSC) that has an energy storage connected to the DC link. The VSC is connected in series with the power network by means of a series-connected injection transformer and coupling filters.

A DVR may be formed by three VSCs where each one is connected to the network through an LC filter (Lf, Cf) and a transformer. The capacitor filter I connected across the secondary winding of the coupling transformer .

The DVR is normally used to protect critical loads or sensitive installations from the effects of faults at the point of common coupling. During a voltage dip the DVR is able to inject the required voltage to reestablish the load supply voltages.

The typical DVR is based on IGBT solid-state power electronic switching devices in a PWM converter structure and it is capable of independently generating or absorbing controllable real and reactive power at its AC output terminals. For line currents exceeding the inverter rating a bypass scheme can be incorporated to protect the power electronic converter.

### BASIC CONFIGURATION OF UPQC

UPQC is the integration of series (APFse) and shunt (APFsh) active power filters,connected back-to-back on the dc ide, sharing a common DC capacitor [8],shown in Figure 5. The series component of the UPQC is responsible formitigation of the supply side disturbances: voltage sags/swells, flicker, voltageunbalance and harmonics. It inserts voltages so as

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to maintain the load voltages ata desired level; balanced and distortion free. The shunt component is responsiblefor mitigating the current quality problems caused by the consumer: poor powerfactor, load harmonic currents, load unbalance etc. It injects currents in the acsystem such that the source currents become balanced sinusoids and in phase withthe source voltages. The overall function of UPQC mainly depends on the seriesand shunt APF controller. A basic functional block diagram of a UPQC controlleris shown in Figure 4. Here, the shunt APF injects the compensating reactive andharmonic current using hysteresis current controller and where as the series APFuses PWM voltage controller to minimize the voltage disturbances. Mainly three significant control approaches for UPQC can be found to control the sag on the system: 1) active power control approach in which an in-phase voltage is injected through series inverter , popularly known as UPQC-P; 2) reactive power control approach in which a quadrature voltage is injected, known as UPQC-Q; and 3) a minimum VA loading approach in which a series voltage is injected at a certain angle, which is known as VAmin. The VA loading in UPQC-VAmin is determined on the basis of voltage sag, may not be at optimal value. The voltage sag/swell on the system is one of the most important power quality problems in distribution

## III. CONTROL STRATEGY

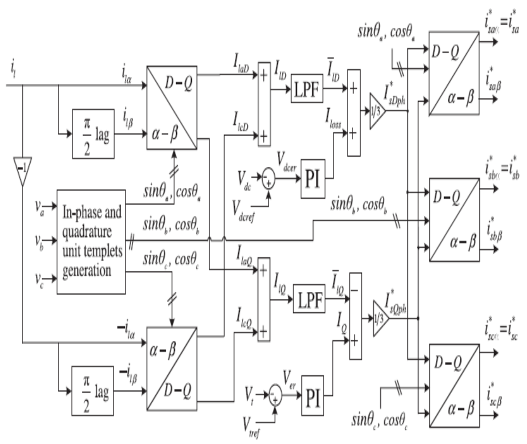


Fig. 2. Block diagram of the single-phase synchronous D-Q theory control algorithm for the STATCOM.

Fig. 2 shows the block diagram of the proposed single-phasesynchronous D-Q frame theory-based control algorithm for thethree-phase STATCOM. The referencesource currents ($i*sa$ , $i*sb$ ,$i*sc$ ) for regulating the terminal voltage and current balancing arecomputed using a single-phase synchronous D-Q frame theoryapplied to the three-phase SEIG system.

## IV.SIMULATION RESULTS

Extension is dvr added in series so it will become upqc device

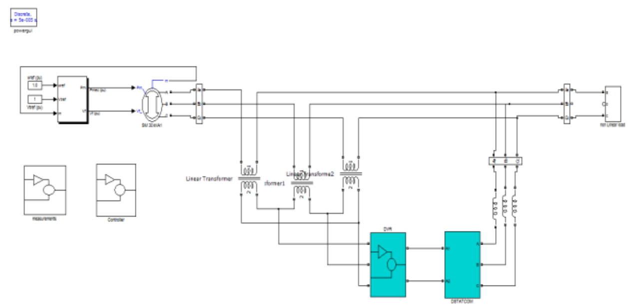

Fig.4 simulation circuit

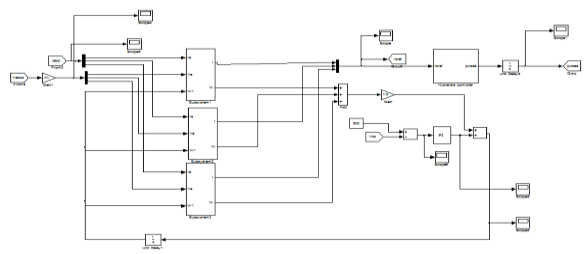

Fig.5 Control circuit block

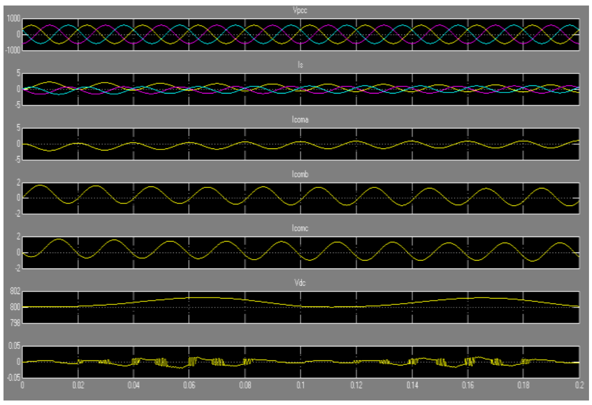


Fig.6 Vpcc,Isabc,upqc converter output current(Icomabc),Vdc,1ph Load Current(ILa)

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## V. CONCLUSION

The proposed method of feeding single-phase loads from a three-phase SEIG and VSI based STATCOM combination has been simulated and it has been proved that the SEIG is able to feed single- phase loads up to its rated capacity. A single-phase synchronous D-Q frame theory-based control of a three-phase STATCOM has been proposed, discussed and implemented for current balancing of the SEIG system. Simulation results have demonstrated effective current balancing capability of the proposed single-phase synchronous D-Q frame-based control using the VSI based STATCOM. In addition to current balancing, the STATCOM is able to regulate the terminal voltage of the generator and suppresses the harmonic currents injected by non- linear loads. The performance of the SEIG at different voltages has been simulated to identify the terminal voltage corresponding the maximum power output. It has been observed that when the SEIG is operated at lower instead of the rated voltage, the generator is able to deliver rated power without exceeding the rated winding current. The satisfactory performance demonstrated by the developed VSI based STATCOM–SEIG combination promises a potential application for isolated power generation using renewable energy sources in remote areas with improved power quality.

## REFERENCES

[1] E. D. Bassett and F. M. Potter, ―Capacitive excitation for induction gen- erators,‖ *Trans. Amer. Inst. Elect. Eng.*, vol. 54, no. 5, pp. 540–545, May 1935.

[2] J. E. Barkle and R. W. Ferguson, ―Induction generator theory and appli- cation,‖ *Trans. Amer. Inst. Elect. Eng.*, vol. 73, no. 1, pp. 12–19, Jan. 1954.

[3] http://www.picohydro.org.uk

[4] N. Smith, *Motors as Generators for Micro-Hydro Power*. London, U.K.: ITDG Publishing, 1994.

[5] S. Khennas and A. Barnett, ―Best practices for sustainable Development of micro hydro power in developing countries,‖ World Bank, Washington, DC, USA, ESMAP Tech. Rep. 21640, no. 6, 2000.

[6] H. Rai, A. Tandan, S. Murthy, B. Singh, and B. Singh, ―Voltage regulation of self excited induction generator using passive elements,‖ in *Proc. IEEE Int. Conf. Elect. Mach. Drives*, Sep. 1993, pp. 240–245.

[7] L. Shridhar, B. Singh, and C. Jha, ―Transient performance of the self reg- ulated short shunt self excited induction generator,‖ *IEEE Trans. Energy Convers.*, vol. 10, no. 2, pp. 261–267, Jun. 1995.

[8] E. Bim, J. Szajner, and Y. Burian, ―Voltage compensation of an induction generator with long-shunt connection,‖ *IEEE Trans. Energy Convers.*, vol. 4, no. 3, pp. 526–530, Sep. 1989.

[9] L. Shridhar, B. Singh, C. Jha, B. Singh, and S. Murthy, ―Selection of ca- pacitors for the self regulated short shunt self excited induction generator,‖ *IEEE Trans. Energy Convers.*, vol. 10, no. 1, pp. 10–17, Mar. 1995.

[10] L. Wang and C.-H. Lee, ―Long-shunt and short-shunt connections on dynamic performance of a SEIG feeding an induction motor load,‖ *IEEE Trans. Energy Convers.*, vol. 15, no. 1, pp. 1–7, Mar. 2000.

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