6.1. INTRODUCTION

The steady-state analysis of six-phase and three-phase self-excited induction generators has been presented in the earlier chapters. To extend the validity of the proposed model, this chapter analyzes the steady-state performance of single-phase single winding and two winding self-excited induction generators.

The performance of the single-phase SEIG was obtained by Chan [14] without considering the core loss component using nodal admittance technique. A nodal equation is formed and then manually the equation is separated into real and imaginary parts so as to solve them first for $F$ (ninth degree polynomial) and then for $X_M$ by substituting the value of $F$. Also, capacitance requirement is computed by increasing the value of excitation capacitance in steps from a minimum value until desired terminal voltage is achieved, keeping $X_C$ and $F$ as unknown quantities.

A single-phase static VAR compensator was proposed by Ahmed et al. [105] to regulate the output voltage of the single-phase SEIG. Two non-linear simultaneous equations are obtained by manually separating the real and imaginary parts of the equivalent loop impedance. These equations are further reduced to a $12^{th}$ degree polynomial which is solved first for $F$ and then for $X_M$ using Newton-Raphson method. An analysis of a constant voltage single-phase SEIG without considering the
core loss component was presented by Mohd Ali et al. [83]. Two non-linear equations are obtained by manually separating the real and imaginary parts of the equivalent loop impedance and arranging the term with $X_C$ and $F$ as unknown quantities. The two equations are simplified as single quadratic equation. The steady-state value of $F$ is obtained using the root nearest to the rotor per unit speed and then $X_C$ is computed using the value of $F$. A methodology of selection of capacitors for optimum excitation of single-phase SEIG was presented by Singh et al. [95] with the core loss component. A sequential unconstrained minimization technique in conjunction with a direct search method namely Rosenbrock’s method of rotating co-ordinate have been used to compute the unknown quantities such as magnetizing reactance $X_M$ or capacitive reactance $X_C$ and frequency $F$.

It is observed that, the disadvantage of the SEIG is its poor voltage regulation characteristics under varying load conditions. Rai et al. [82] presented the analysis of single-phase single winding as well as two winding SEIGs. It is found that the voltage regulation is unsatisfactory without a series capacitor. But, it is shown that the performance considerably improves with the inclusion of series capacitor. Separation

Fig. 6.1. Schematic diagram of single-phase single winding SEIG with series compensation.
of the real and imaginary parts of the complex impedance manually yields two nonlinear simultaneous equations with $X_M$ and $F$ as unknown quantities. These two equations are solved by Newton Raphson method. Therefore improvements in the performance of a single-phase single winding SEIG through short shunt and long shunt compensation (Fig.6.1) are also investigated in this Chapter.

In single-phase two winding induction generator, the excitation circuit is made up of the auxiliary winding which supplies the field by connecting a shunt capacitor across its terminals. The main winding on the other hand supplies the load. The output voltage may be controlled by varying the capacitance in the auxiliary winding or in the main winding (Fig.6.2). It is found that the better mode of operation is the case when auxiliary winding is excited by capacitance and main winding is used for the loading purpose.

![Schematic diagram of single-phase two winding SEIG with series compensation.](image_url)

Fig. 6.2. Schematic diagram of single-phase two winding SEIG with series compensation.

The performance of single-phase two winding SEIG was described by Rahim et al. [78]. Two nonlinear simultaneous equations are formed from the equivalent circuit by manually separating the equivalent loop impedance into real and imaginary components. The equations are manually arranged for unknown quantities.
such as magnetising reactance ($X_M$) and frequency ($F$), taking rest of the operating variables and machine parameters as constants and the two equations are then solved using Newton Raphson method. The theoretical [79] and experimental investigation [80] of single-phase SEIG was presented by Murthy et al. Two equations are obtained by manually separating the real and imaginary parts and they are solved for magnetizing reactance $X_M$ and generated frequency $F$ by Newton-Raphson method. To improve the voltage regulation, several voltage regulating schemes [77, 104] have been suggested. An algorithm was given by Singh et al. [31] for calculating the number of capacitor steps to load the machine to its rated capacity while maintaining the load voltage within the specified upper and lower limit.

These voltage regulators need relay/semiconductor switches involving a lot of cost, complexity, harmonics and transients. The voltage regulators using thyristor-controlled inductor with fixed value of capacitors are advantageous over the voltage regulators using switched capacitors, because large inductor protects the commutated thyristors. However, the operation of voltage regulators using thyristor-controlled inductor involves large switching transients and harmonics, which consequently required large filter that results in a costlier operation. The voltage regulation is unsatisfactory without a series capacitor. But, the performance considerably improves with the inclusion of series capacitor. Therefore improvements in the performance of a single-phase two winding SEIG through short shunt and long shunt compensation (Fig. 6.2) are also investigated in this Chapter.

The steady-state and dynamic performance of a single-phase two winding SEIG was described by Olorunfemi Ojo [74] with different excitation capacitor
topologies based on the d-q model in stationary reference frame using fluxes as state variables.

Most of the papers in literature [14, 74, 78, 79, 82, 83, 95, 105] on steady-state performance evaluation of a single-phase SEIG need manual separation of real and imaginary components of complex impedance/admittance of the equivalent circuit. These equations are solved by either Newton-Raphson method or unconstrained nonlinear optimization method. It is also observed that, the mathematical model differs for each type of load and capacitor configurations. Also, the coefficients of mathematical model vary with change in load and capacitance configuration. This requires repetition of the manual work of separation of real and imaginary component of complex impedance/admittance and consequently a lot of time is wasted. Also for different unknown variables (X_M and F or X_C and F), rearrangement of the terms has to be done manually to obtain the two non linear equations for the chosen variables and these two non linear equations have to be solved using Newton-Raphson method.

Velusami et al. [117,118] suggested a steady-state model of single-phase SEIG using graph theory approach. This mathematical model reduces the manual separation of real and imaginary parts of equivalent loop impedance or nodal admittance. But the graph theory based approach also involved the formation of graph, tree, co-tree, tie-set or cut-set, etc. which makes the modeling complicated.

Therefore, in this chapter a generalized mathematical model [146] is developed using nodal admittance method based on inspection. The mathematical model developed using inspection completely avoids the tedious manual work involved in separating the real and imaginary components of the complex
impedance/admittance of the equivalent circuit. The proposed model is a simplified approach in which the nodal admittance matrix can be formed directly from the equivalent circuit rather than deriving it using graph theory approach. Moreover, the proposed model is more flexible such that it can be used for both uncompensated and compensated single-phase single winding as well as two winding SEIGs.

To predict the steady-state performance of single-phase SEIG, a genetic algorithm based approach is used as discussed in section 2.3 of Chapter 2. The experimental and theoretical results are found to be in close agreement which validates the proposed method and solution technique.

6.2. PROPOSED MATHEMATICAL MODELING

A mathematical model based on inspection is proposed for the steady-state analysis of single-phase SEIG from the equivalent circuit of generator. The developed model results in matrix form which is convenient for computer solution irrespective of any combinations of unknown quantities.


Fig. 6.3. Steady-state equivalent circuit of single-phase single winding SEIG.
Fig. 6.3 shows the per phase equivalent circuit of the single-phase single winding SEIG (Fig. 6.1). The various elements of equivalent circuit are given below.

\[
Y_1 = \frac{1}{[R_L/ F + j X_L - j X_{csh} / F^2]}; \quad Y_2 = \frac{1}{[- j X_C / F^2]};
\]

\[
Y_3 = \frac{1}{[R_M / F + j X_{IM} - j X_{clo} / F^2]}; \quad Y_4 = \frac{1}{[j X_M / 2]};
\]

\[
Y_5 = \frac{1}{[j X_M / 2]}; \quad Y_6 = \frac{1}{[R_r / 2(F - u) + j X_{ir} / 2]};
\]

\[
Y_7 = \frac{1}{[R_r / 2(F + u) + j X_{ir} / 2]}. 
\]

The matrix equation based on nodal admittance method for the equivalent circuit can be expressed as

\[
[Y] \ [V] = [I_S] \quad (6.1)
\]

Where \([V]\) is the node voltage matrix, \([I_S]\) is the source current matrix, and \([Y]\) is the nodal admittance matrix.

The \([Y]\) matrix can be formulated directly from the equivalent circuit (Fig.6.3) by inspection \([147]\) as

\[
[Y] = \begin{pmatrix}
Y_1 + Y_2 + Y_3 & - Y_3 & 0 \\
- Y_3 & Y_3 + Y_4 + Y_6 & -(Y_4 + Y_6) \\
0 & -(Y_4 + Y_6) & Y_4 + Y_5 + Y_6 + Y_7
\end{pmatrix} \quad (6.2)
\]

where

\[
Y_{ii} = \sum \text{Admittance of the branches connected to } i^{th} \text{ node}
\]

\[
Y_{ij} = -\sum \text{Admittance of the branches connected between } i^{th} \text{ node and } j^{th} \text{ node}
\]

Since \([Y]\) is symmetric, \(Y_{ji} = Y_{ij}\). If there is no branch between any two nodes, then the corresponding element in the matrix is zero. Since, the equivalent circuit does not contain any current sources, \([I_S] = [0]\) and hence Eq. (6.1) is reduced as

\[
[Y] \ [V] = 0 \quad (6.3)
\]
For successful voltage build up, \([V] \neq 0\) and therefore from Eq. (6.3), \([Y]\) should be a singular matrix i.e., \(\det [Y] = 0\). It implies that both the real and the imaginary components of \(\det [Y]\) should be independently zero. Therefore to obtain required parameter which results \(\det [Y] = 0\), genetic algorithm based approach which is discussed in section 2.3 of Chapter 2 is implemented.

### 6.2.2. Mathematical Modeling of Single-phase Two Winding SEIG

Fig. 6.4 shows the per phase equivalent circuit of the single-phase two winding SEIG. The various elements of equivalent circuit are given below.

\[
\begin{align*}
Y_1 &= 1 / [R_L + j F X_L - j (X_{sh} / F)], \\
Y_2 &= -1 / [j X_{CL} / F], \\
Y_3 &= 1 / [- (R_L / 2) - j (F X_L / 2) + j (X_{sh} / 2 F)], \\
Y_4 &= 1 / [j X_{CL} / 2 F], \\
Y_5 &= 1 / [R_L + j F X_L - j (X_{sh} / F)], \\
Y_6 &= -1 / [j X_{CL} / F], \\
Y_7 &= 1 / [j F X_M], \\
Y_8 &= 1 / [(R_L F / (F - u)) + j F X_{ir}], \\
Y_9 &= 1 / [j F X_M], \\
Y_{10} &= 1 / [(R_L F / (F + u)) + j F X_{ir}], \\
Y_{11} &= 1 / [R_{IM} + j F X_{IM} - j (X_{elo} / F)], \\
Y_{12} &= 1 / [R_{IM} + j F X_{IM} - j (X_{elo} / F)], \\
Y_{13} &= 1 / [(R_{IA} / 2a^2) + j (F X_{IM} / 2a^2) + j (X_{elo} / 2 F) - j (X_{C} / 2Fa^2) - (R_{IM} / 2) - j (F X_{IM} / 2)].
\end{align*}
\]
The matrix equation based on nodal admittance method for the equivalent circuit can be expressed as

\[ [Y] [V] = [I_s] \]  \hspace{1cm} (6.4)

where \([V]\) is the node voltage matrix, \([I_s]\) is the source current matrix, and \([Y]\) is the nodal admittance matrix.

The \([Y]\) matrix can be formulated directly from the equivalent circuit (Fig.6.4) by inspection \([147]\) as

\[
[Y] = \begin{bmatrix}
(Y_1+Y_2+Y_{11}) & -Y_{11} & 0 & 0 & 0 & 0 \\
-Y_{11} & (Y_7+Y_8+Y_{11}) & 0 & - (Y_7+Y_8) & 0 & 0 \\
0 & 0 & (Y_3+Y_4+Y_{13}) & -Y_{13} & 0 & 0 \\
0 & - (Y_7+Y_8) & -Y_{13} & (Y_7+Y_8+Y_9+Y_{10}+Y_{13}) & 0 & - (Y_9+Y_{10}) \\
0 & 0 & 0 & 0 & (Y_5+Y_6+Y_{12}) & -Y_{12} \\
0 & 0 & 0 & - (Y_9+Y_{10}) & -Y_{12} & (Y_9+Y_{10}+Y_{12})
\end{bmatrix}
\]  \hspace{1cm} (6.5)

where

\[ Y_{ii} = \sum \text{Admittance of the branches connected to } i^{th} \text{ node} \]

\[ Y_{ij} = - \sum \text{Admittance of the branches connected between } i^{th} \text{ node and } j^{th} \text{ node} \]

Since \([Y]\) is symmetric, \(Y_{ij} = Y_{ji}\). If there is no branch between any two nodes, then the corresponding element in the matrix is zero. Since, the equivalent circuit does not contain any current sources, \([I_s] = [0]\) and hence Eq. (6.4) is reduced as
\[ [Y] [V] = 0 \quad (6.6) \]

For successful voltage build up, \([V] \neq 0\) and therefore from Eq. (6.6), \([Y]\) should be a singular matrix i.e., \(\det [Y] = 0\). It implies that both the real and the imaginary components of \(\det [Y]\) should be independently zero. Therefore to obtain required parameter which results \(\det [Y] = 0\), genetic algorithm based approach which is discussed in section 2.3 of Chapter 2 is implemented.

6.3. EXPERIMENTAL SETUP AND MACHINE PARAMETERS

A single-phase induction machine is selected for the test. The view of experimental setup is shown in Fig. 6.5.

The machine used for the test is a single-phase induction generator rated as follows: 0.75 kW, 225V, 6A, 50Hz, 1500 rpm. The parameters obtained from the results of the standard test and referred to respective stator windings are \(R_{lm}=2.813\Omega\), \(R_{1A}=5.2\Omega\), \(X_{lm}=6.42\Omega\), \(X_{1A}=11.783\Omega\), \(R_f=3.972\Omega\), \(X_{il}=6.42\Omega\) and turns ratio a=1.25.

The variation of air gap voltage with magnetizing reactance is expressed (in p.u) in the form of equation as shown below.

\[
\frac{V_g}{F} = 1.6893 - 0.2014 X_M, \quad \text{for } X_M \leq 3.2 \quad (6.7)
\]

\[
\frac{V_g}{F} = 2.8445 - 0.5551 X_M, \quad \text{for } X_M > 3.2 \quad (6.8)
\]

Fig. 6.5. View of the laboratory experimental setup.
6.4. STEADY-STATE PERFORMANCE ANALYSIS OF SINGLE-PHASE SINGLE WINDING SEIG WITHOUT SERIES COMPENSATION

To obtain the steady-state performance (keeping \(X_M\) and \(F\) as unknown quantities) of single-phase single winding SEIG without series compensation, the \([Y]\) matrix is computed in the same manner as section 6.2.1 with the series capacitive components \(-X_{cis}/F^2\) and \(-X_{clo}/F^2\) are made zero in the terms \(Y_1\) and \(Y_3\) respectively. Then Eq. (6.3) is solved by genetic algorithm approach to find the unknown parameters \(X_M\) and \(F\).
Fig. 6.6 shows the load characteristics of single-phase single winding SEIG with different fixed shunt capacitances and constant speed under pure resistive load.

The variation of load voltage with output power for two different values of shunt capacitances (C=51 µF and C=56 µF) is shown in Fig. 6.6(a). It is observed that the load voltage drops as load increases. Also, higher value of shunt capacitance provides better loading. Figs. 6.6(b) and 6.6(c) show respectively the variations of stator current and load current with output power when the generator is excited by shunt capacitances of two different values while supplying resistive load at rated speed. The characteristics closely resemble those obtained for three-phase SEIG, but the voltage drop with load is aggravated by the presence of the negative sequence circuit.

6.5. STEADY-STATE PERFORMANCE ANALYSIS OF SINGLE-PHASE SINGLE WINDING SEIG WITH SERIES COMPENSATION

The steady-state analysis of single-phase single winding SEIG without series compensation has been presented in the previous section. It is observed that the
disadvantage of the SEIG is its poor voltage regulation characteristics under varying load conditions. Therefore, this section presents the steady-state performance of single-phase single winding SEIG with series compensation using the mathematical model proposed in section 6.2.1 by including the series capacitive components. Both short shunt and long shunt configurations of series compensation are presented in this section.

6.5.1. Steady-State Performance Analysis of Single-phase Single Winding SEIG with Short Shunt Configuration

For steady-state performance analysis of a single-phase single winding SEIG for short shunt compensation the following modifications are made in the [Y] matrix (section 6.2.1).

(a) The term \( Y_5 \) is removed from the [Y] matrix in order to remove the magnetizing reactance of negative sequence rotor circuit.

(b) The term \( -j \frac{X_{cl}}{F^2} \) is removed from \( Y_3 \) in order to remove the long shunt compensation element.

\[ V_T/V_L \]

\[ C=42 \mu F, \quad C_{sh}=65 \mu F \]

\[ \text{Speed}=1 \text{ p.u}, \quad pf=1 \]
Solution is obtained by genetic algorithm process presented in section 2.3 using matrix [Y] to predict the unknown quantities $X_M$ and $F$ of the equivalent circuit.

Fig. 6.7 shows the characteristics of the short shunt SEIG for supplying power to a resistive load. It is observed that the variation of the load voltage with output power is
marginal. Further, higher overload capability of the system is possible by the inclusion of series capacitance.

Characteristics of the short shunt SEIG for feeding power to a resistive-reactive load at constant speed is shown in Fig. 6.8. It can be seen that, voltage droops to a considerably low value during a certain power range like a V-curve. The voltage drooping is more pronounced in this case than in the case of UPF load (Fig. 6.7).

6.5.2. Steady-State Performance Analysis of Single-phase Single Winding SEIG with Long Shunt Configuration

For steady-state performance analysis of a single-phase single winding SEIG for long shunt compensation the following modifications are made in the $[Y]$ matrix (section 6.2.1).

(a) The term $Y_S$ is removed from the $[Y]$ matrix in order to remove the magnetizing reactance of negative sequence rotor circuit.
(b) The term \( -j \frac{X_{csh}}{F^2} \) is removed from \( Y_1 \) in order to remove the short shunt compensation element.

Fig. 6.9. Variation of: (a) Terminal voltage and Load voltage (b) Stator current and Load current of single-phase single winding SEIG with long shunt configuration under unity power factor load.
The unknown quantities $X_M$ and $F$ are computed by genetic algorithm process presented in section 2.3 of Chapter 2. Fig. 6.9 shows the characteristics of the long shunt SEIG when supplying power to a resistive load. It is seen that the variation of the load voltage with output power is marginal. Further the inclusion of series capacitance results in higher overload capability of the system.

Fig. 6.10. Variation of: (a) Terminal voltage and Load voltage (b) Stator current and Load current of single-phase single winding SEIG with long shunt configuration under resistive-reactive load.
Characteristics of the long shunt SEIG under resistive-reactive load is shown in Fig.6.10. It is seen that the droop of the load voltage is more compared to pure resistive load. Further the inclusion of series capacitance results in higher overload capability of the system.

6.6. STEADY-STATE PERFORMANCE ANALYSIS OF SINGLE-PHASE TWO WINDING SEIG WITHOUT SERIES COMPENSATION

To obtain the steady-state performance (keeping $X_M$ and $F$ as unknown quantities) of single-phase two winding SEIG without series compensation, the $[Y]$ matrix is computed in the same manner as section 6.2.2 with the following modifications.

(i) The short shunt component $X_{csh}$ in the terms $Y_1$, $Y_3$ and $Y_5$ is made zero.

(ii) The long shunt component $X_{clo}$ in the terms $Y_{11}$, $Y_{12}$ and $Y_{13}$ is made zero.

(iii) The reactive load component $X_L$ in the terms $Y_1$, $Y_3$ and $Y_5$ is made zero in order to consider pure resistive load.

Then Eq. (6.6) is solved by genetic algorithm approach to predict the unknown quantities $X_M$ and $F$. Fig. 6.11 shows the load characteristics of single-phase two winding SEIG with different fixed shunt capacitances and constant speed under pure resistive load. Three different values of shunt capacitances ($C=35 \mu F$, $C=37 \mu F$ and $C=39 \mu F$) are used. The variation of load voltage and auxiliary winding voltage with output power for three different values of shunt capacitances is shown in Fig. 6.11(a) and Fig. 6.11(b) respectively. It is observed that the load voltage drops as load increases. It is evident that, an increase in the value of shunt capacitance leads to an increase in the power output. The system faces voltage collapse when the generator is
loaded beyond the attainable maximum steady-state output power. Figs. 6.11(c) and 6.11(d) show respectively the variations of load current and auxiliary winding current with output power when the generator is excited by shunt capacitances of three different values while supplying resistive load at rated speed. Since the currents in both main and auxiliary windings are less than rated current, it does not affect the safe operation of the machine so far as loading is concerned.
6.7. STEADY-STATE PERFORMANCE ANALYSIS OF SINGLE-PHASE TWO WINDING SEIG WITH SERIES COMPENSATION

The steady-state analysis of single-phase two winding SEIG without series compensation has been presented in the previous section. It is observed that the disadvantage of the SEIG is its poor voltage regulation characteristics under varying
load conditions. Therefore, this section presents the steady-state performance of single-phase two winding SEIG with series compensation using the mathematical model proposed in section 6.2.2 by including the series capacitive components. Both short shunt and long shunt configurations of series compensation are presented in this section.

6.7.1. Steady-State Performance Analysis of Single-phase Two Winding SEIG with Short Shunt Configuration

For the steady-state performance analysis of a single-phase two winding SEIG with short shunt compensation, the following modifications are made in the \([Y]\) matrix (section 6.2.2).

(a) The term \(Y_9\) is removed from the \([Y]\) matrix in order to remove the magnetizing reactance of negative sequence rotor circuit.

(b) The long shunt components (- j \(X_{cl}\)/F and j \(X_{cl}/2F\)) are removed from \(Y_{11}, Y_{12}\) and \(Y_{13}\) of \([Y]\) matrix.
Solution is obtained by genetic algorithm process presented in section 2.3 using matrix \([Y]\) to predict the unknown quantities \(X_M\) and \(F\) of the equivalent circuit.

Fig. 6.12 shows the characteristics of the short shunt SEIG for supplying power to a resistive load. It is observed that the variation of the load voltage with output power is

![Graph](image-url)
Characteristics of the short shunt SEIG for feeding power to a resistive-reactive load at constant speed is shown in Fig. 6.13. It can be seen that, voltage droops to a considerably low value during a certain power range like a V-curve. The voltage drooping is more pronounced in this case than in the case of UPF load (Fig.6.12).

6.7.2. Steady-State Performance Analysis of Single-phase Two Winding SEIG with Long Shunt Configuration

For steady-state performance analysis of a single-phase two winding SEIG for long shunt compensation, the following modifications are made in the [Y] matrix (section 6.2.2).

(a) The term $Y_0$ is removed from the [Y] matrix in order to remove the magnetizing reactance of negative sequence rotor circuit.
(b) The short shunt components (- j X_{ch}/F and j X_{ch}/2F) are removed from Y_1, Y_5 and Y_3 of [Y] matrix.

Fig. 6.14. Variation of: (a) Load voltage, Main and Auxiliary winding voltages and (b) Load current, Main and Auxiliary winding currents of single-phase two winding SEIG with long shunt configuration under unity power factor load.
The unknown quantities $X_M$ and $F$ are computed by genetic algorithm process presented in section 2.3 of Chapter 2. Characteristics of the long shunt SEIG for feeding power to a resistive load is shown in Fig. 6.14. It is seen that the variation of the load voltage with output power is marginal. Further the inclusion of series capacitance results in higher overload capability of the system. The currents are within rated value.

![Graph showing the variation of load voltage, main and auxiliary winding voltages and load current, main and auxiliary winding currents of single-phase two winding SEIG with long shunt configuration under resistive-reactive load.](image)

Fig. 6.15. Variation of: (a) Load voltage, Main and Auxiliary winding voltages and (b) Load current, Main and Auxiliary winding currents of single-phase two winding SEIG with long shunt configuration under resistive-reactive load.
Characteristics of the long shunt SEIG for feeding power to a reactive load is shown in Fig. 6.15. It is seen that the variation of the load voltage with output power is marginal. Further the inclusion of series capacitance results in higher overload capability of the system. The currents are within rated value.

6.8. CONCLUSION

Generalized mathematical model using nodal admittance method based on inspection and genetic algorithm based computation are proposed for finding the steady-state performance of a single-phase single winding and two winding self-excited induction generator. Experimental and predicted performances agree closely which validates the proposed method. The proposed mathematical model is flexible so that the same model which is used for uncompensated single-phase SEIG can be extended for compensated single-phase SEIG. Both short shunt and long shunt configurations are considered to improve the performance of SEIG.

It is observed that the value of total capacitance, i.e. sum of series and shunt capacitances and VAr requirement to achieve the desired performance, is much higher in the case of long shunt configuration. The excellent performance of the short shunt SEIG system demonstrates the usefulness of the series capacitance in improving the performance of the single-phase self-excited induction generator.

With its good voltage regulation characteristics and high overload capability, the inherent drawbacks of the simple shunt SEIG are taken care of, which suggests its suitability as a simple, rugged and self regulated stand alone generator. Since fixed series and shunt capacitances are used, the terminal voltage is free from harmonics and switching transients compare to shunt capacitance switching.