Voltage Controlled Induction Generator by Using Arduino

Jamadar Asif, Aparadh Pooja, Attar Saniya, Kamble Pooja, Salunkhe Varsha, Mane Priyanka

Department of Electrical Engineering, SITCOE, Yadrav, India

E-mail: asif.jamadar007@gmail.com, poojaaparadh28@gmail.com, saniyaattar24@gmail.com, varshasalunkhe30@gamil.com, priyankamanesit95@gmail.com

Abstract

The phenomenon of self excitation in an induction generator which is of practical interest. For the induction generator using terminal capacitor across generator terminals it can generate electrical power. The capacitance value to the terminal is not constant but it is varying with many system parameters like shaft speed, load power and its power factor. If the proper value of capacitance is selected, the generator will operate in self excited mode. Hence the main drawback of induction generator in wind energy conversion system applications is its need for leading reactive power to build up the terminal voltage and to generate electrical power. Critical values of speed, below which the machine fails to self excite irrespective of the capacitance used, are found to exist.

Keywords: Arduino, capacitor, generator, induction motor, switching, relay, voltage

INTRODUCTION

Now a days the rate of use of conventional energy is increasing rapidly so because of this the impact on renewable energy sources is takes rate place such as wind, mini/micro-hydro power plant etc. The generation of electrical energy has been from thermal, nuclear, and hydro plants. They have continuously degraded the environmental conditions. It has given rise to an increased impact on renewable energy sources, particularly after the increase in fuel prices [1, 2]. The self excited induction generators are cheap in cost, robust, do not have separate DC excitation system and it can be operated trouble free for many years. Therefore, self excited induction generators are also considered to suited for generating electrical energy from non-conventional energy sources like biogas, wind, small hydro power plant etc. In isolated and remote locations, it is known for the operation of induction generator in standalone mode, the capacitive excitation is necessary to maintain the voltage across the machine terminals. If the speed of the machine is kept constant, the terminal voltage range of machine depends on the value of capacitance and load connected

across its terminals [3, 4]. The voltage range of the machine decreases with increase in load for a fixed value of capacitance. The reactive power consumption & the poor voltage regulation under varying speed are the major drawbacks of the induction generators, but the development of controller facilitated the control of the output voltage of induction generators.

DESIGN OF SELF EXCITED INDUCTION GENERATOR

The Experimental set up of a SEIG is as shown in Figure 1. It can be observed that the generator is made of three main components which are DC motor used as prime mover.
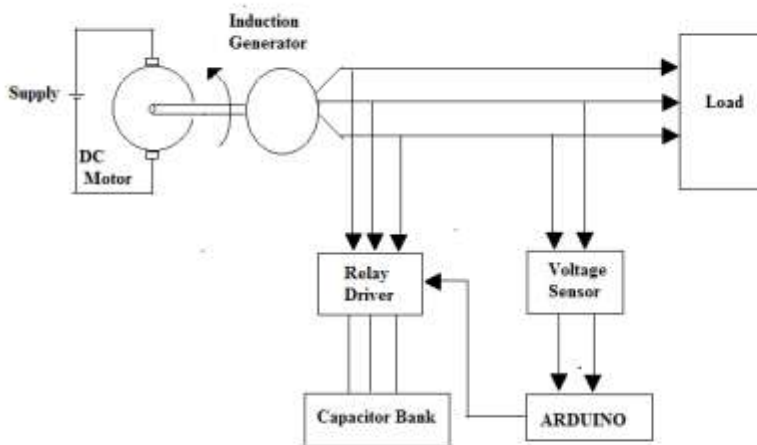
Fig. 1: Experimental Set up of Self Excited Induction Generator.

This is a block diagram of voltage controlled induction generator by using Arduino. Here the dc motor is coupled with the 3 phase induction motor. The 3 phase induction motor which further will acts as a generator by providing external reactive power. The output of Induction generator is given to the load. The voltage is measured across the two phases of Induction machine through the

Arduino. The voltage range is set to the Arduino and the set value of voltage compared with the measured value of the voltage by using Arduino. As per the comparison Arduino drives the relay through the relay driver circuit and capacitor is switch according to the measured values and speed of coupled drives.

The major parts used for the designing SEIG are based on the ratings of the induction machine and dc machine i.e. induction motor is of 3.7kw is coupled to the dc motor of 5 HP as a prime mover, determination of the equivalent circuit parameters of the three phase induction motor and the determination of the excitation capacitor value to be placed across the terminals of the induction machine.

DC Motor

The speed of a DC motor can be controlled by varying the supply voltage is given by the Following equation,

$$\omega = \frac{V_a - i_a R_a}{K\phi}$$

Where,

V_a= armature supply voltage

I_a= armature current

R_a= armature resistance

K_ϕ= field flux constant

The DC motor used for this particular application is of the shunt motor. The variable armature winding supply was derived from the combination of a three phase rectifier bridge with a variable AC supply as shown in figure1. The rectifier bridge is chosen so as to withstand for the rated conditions of the DC motor. The field voltage of the motor was supplied directly from a 220 V DC external supply.

Induction Motor

The specifications of the induction motor used are as follows: 415 V, 3.7 kW, 4 pole and power factor of 0.83. The analysis of the induction motor can be simplified by representing the machine by a per phase equivalent circuit diagram as shown in Figure 2. The determination of the equivalent circuit parameters of the machine was carried out by the well known methods which involve direct current, no load and block rotor tests.
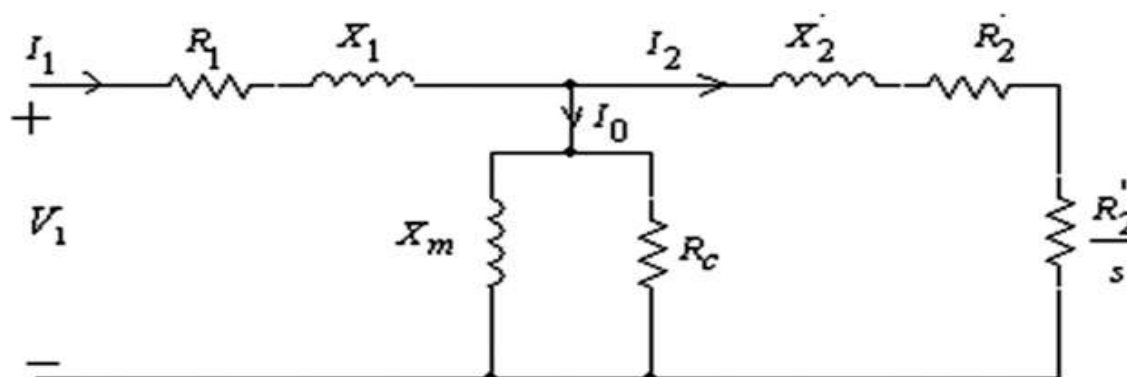

Fig. 2: Equivalent Circuit Diagram of Induction Motor.

Calculation of Capacitor

$$P = \sqrt{3} \, V \, I \, \cos\varnothing$$

$$\varnothing = \cos^{-1}\left(\frac{P}{\sqrt{3}\,V\,I}\right)$$

$$\text{Reactive Power} = \sqrt{3} \, V \, I \, \sin\varnothing$$

$$\text{Reactive Power per phase} = \frac{\sqrt{3}\,V\,I\,\sin\varnothing}{3}$$

$$\text{Capacitor Current} = \frac{\text{Reactive Power per phase}}{V}$$

$$\text{Capacitive Reactance} = \frac{V}{\text{Capacitive Current}}$$

$$\text{Capacitor(C)} = \frac{1}{2\,\pi\,f\,X_c}$$

ARDUINO

The Arduino is simpler than the microcontroller. It is ireally easy to use. There are many examples are ready in the software of Arduino which you just have to click and they will serve your purpose. There are many functions present in the software of Arduino which makes the coding so easy and fast. Nowadays everyone is using Arduino that is why we can get help anytime from anywhere whenever you will stuck somewhere.

SIMULATION
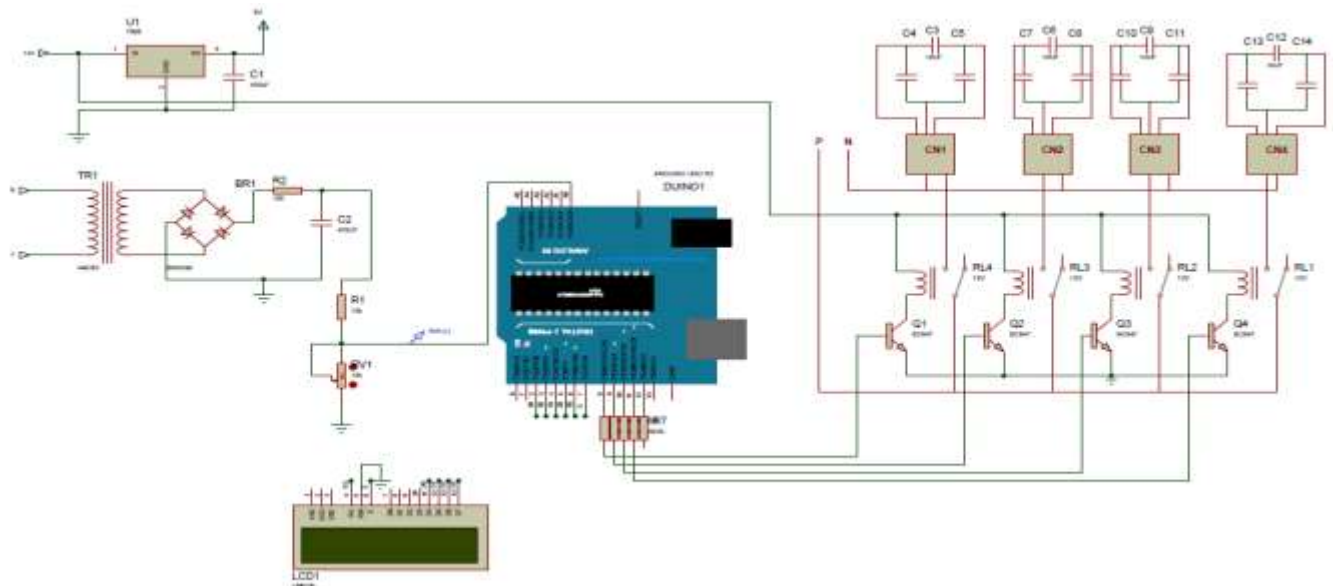
Fig. 3: Simulation.

In Arduino kit 4 I/O ports are placed named as A, B, C, D. for voltage measurement analog pins are connected. Port B is 6 bits and it is used for relay switching. Port D has 2 bits and is used for LCD interface. 12 V input is given from the adapter and 7809 regulator is used for power providing. In this kit 2 capacitors are provided one is 470 µf and other 220 µf for filtration purpose. For the AC to DC conversion bridge rectifier is used and for measuring pure DC resistance connected across it. The 12 V relay coil is provided in kit. Across the relay transistor is connected for amplification .To limit base bias current the resistor are used for each relay. Contactors are connected in parallel manner and capacitors are connected in delta manner.

Table 1: Result.

Voltage (v)	Speed (rpm)	Capacitor	Load (watt)
205	1229	90	400
206	1075	120	400
202	970	150	400
207	897	180	400
200	875	210	400

CONCLUSION

This paper concludes that, the constant output voltage is given by the induction machine at variable speed of the prime mover. The effectiveness of the proposed method is then evaluated on a 5HP induction generator driven by a regulate prime mover for variable speed. In normal operation the stator current is found to be insensitive to the output power of the generator but sensitive to the excitation capacitor.

REFERENCES

1. General study of self excited induction generator used in isolated renewable energy conversion source. Mohamed. Barara, Ahmed. Abbou. International Journal on Electrical Engineering and Informatics - Volume 5, Number 2, June 2013

2. Voltage and Frequency Control of Self Excited Induction Generator Feeding Stand-Alone AC Loads.

Kripa Nandakumar M , Praveesh V V
International Journal of Innovative Research
in Science , Engineering & Technology

An ISO 3297: 2007 Certified Organization
Volume 5, Special Issue 5, April 2016

3. SEIG for variable speed wind turbine
generator E. Muljadi, B. Gregory, D. Broad

National Renewable Energy Laboratory
POWERSYSTEMS WORLD '96
Conference Ventura, California September
7-13, 1996 .

4. R.C. Bansal.”Three-Phase Self-Excited
Induction Generators: An Overview” (IEEE
Transaction on Energy Conservation)
Vol.20, no. 2 (June 2005)