

7. WIRELESS CONTROL OF IRRIGATION SYSTEM OPERATING FROM 3 ϕ INDUCTION MOTOR FED BY 1 ϕ SUPPLY

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INTRODUCTION

There have not been any significant technological advancements being made in agricultural sector as compared to other sectors. Irrigation system needs to be monitored on a regular basis. The first aim of the project is to reduce the wastage by automating the entire irrigation system. The three-phase supply system is now available worldwide, except perhaps in some rural areas where only a single phase supply is available. The second aim of our project is to tackle this issue, thereby enabling the operation of these pumps even in the absence of three phase supply.

PROBLEM DEFINITION

The moisture content of the field is not monitored and it is manually observed by the farmers which are prone to errors.

DESIGN AND IMPLEMENTATION

The technical details of the project contain block diagram, circuit connections and detailed explanation of various components used. The analysis is split into two parts

- Automation of irrigation system using wireless communication.

- Operation of a three phase motor pump using single phase supply

Automation of irrigation system using wireless communication

The water or moisture sensor is placed in the field which continuously senses the moisture content in the field. The output of the sensor is transmitted wirelessly using a zigbee module. Another zigbee module at the receiving end receives these transmitted signals and gives it as an input to the main micro-controller which is the control unit. This main micro-controller is programmed to perform the various functions. First, the opening/closing of the shutters is controlled by the main micro-controller depending on the sensor output. Secondly, once all the fields are irrigated to the optimum level a signal is sent to switch off the motor thereby stopping the water supply. Thirdly, the main micro-controller sends all the details of the operations being performed in the field to the farmer's mobile using GSM. The farmer can operate the field either in manual mode or in automatic mode. In the manual mode the farmer will wirelessly control the on/off of the motor and the shutters irrespective of the sensor output. In automated mode, the operation is based on the sensor output as explained above. The picture of the hardware model of irrigation part is given below:



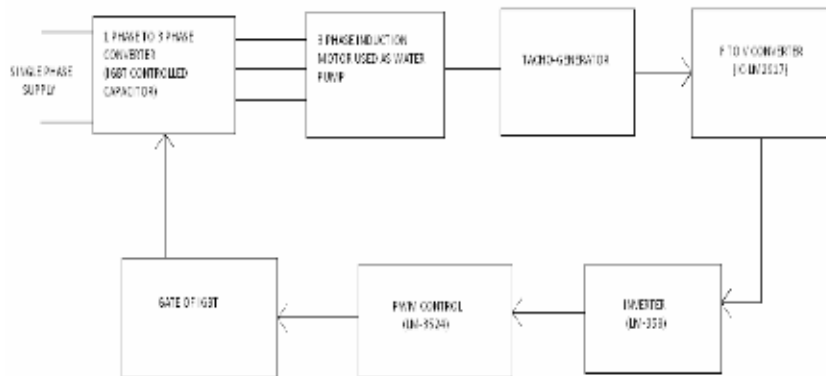
Field 1



Main control unit and GSM module

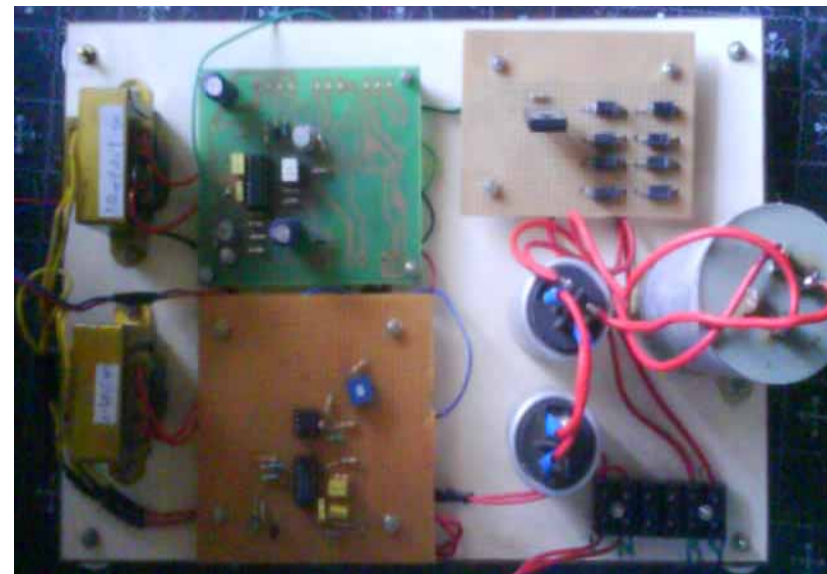
OPERATION:

Single-phase motors are the most common form in the lower horse-power ranges, but they become uneconomical for ratings above about 0.5kW and therefore an increasing tendency to use standard three-phase motors supplied from single-phase supply if the three-phase supply is not available.



The phase and neutral of the single phase supply are given to the two windings of the three phase induction motor. The

third winding is connected to the line through a fixed and variable capacitor, both being parallel to each other. The capacitance of the variable capacitor is varied electronically with the help of an IGBT connected in series with the capacitor. The duty cycle of the IGBT is varied continuously with respect to motor speed as follows. The speed of the motor is obtained using a tachometer. The frequency pulses are tapped out from the tachometer and given to a frequency to voltage converter. The voltage level which is proportional to the frequency is given as the reference input to the comparator whose other input is the saw tooth waveform. The pwm pulse obtained is given as the gate pulse to the IGBT. Hence as the speed varies the voltage level and hence the duty cycle of the IGBT varies thereby varying the net capacitor value. This continuous variation of capacitance with respect to speed maintains minimum unbalance between the three phases of the induction motor. An opto-coupler is used in order to isolate the low voltage electronic circuit from power circuit.



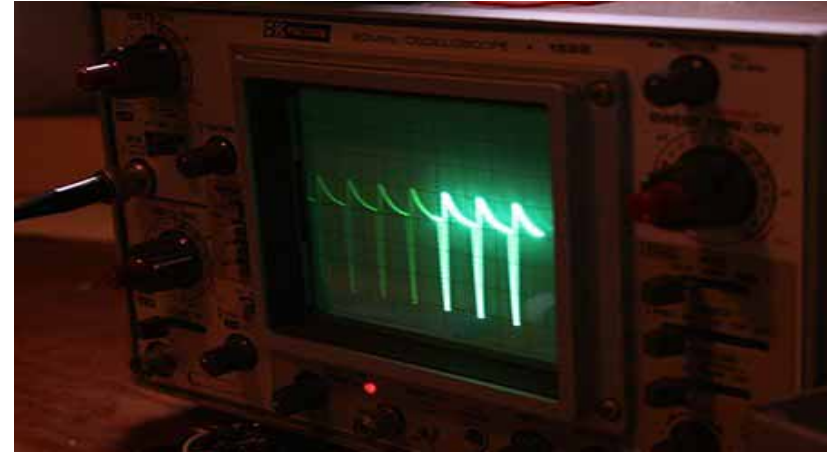
TESTING

In the automation part the reference of the comparator of the moisture sensor is set to 4.54V. When the field is dry, the sensor produces an voltage of 4.81V and hence the comparator output will be high. The sensor gives an output voltage of 3.2V during wet condition and the comparator output will be at zero volts. This output is converted to serial data with the microcontroller for Zigbee transmission. After Zigbee transmission, the GSM module either transmits or receives messages as per the mode of operation. The tacho generator is coupled with the motor to get the desired speed. This gives the frequency pulses as output. There is a digital tachometer connected to this which reads the motor speed. These frequency pulses obtained are spike waveforms. This output from the tacho generator is amplified and fed to the frequency to voltage converter to get appropriate voltage for the corresponding speed of motor. As the pulses obtained are very less in magnitude, an amplifier circuit is used and then it is converted to voltage pulses. The output voltage thus obtained is about 2V. The output obtained from the F to V converter is fed to the inverter LM 358 so that the voltage varies in direct proportion to frequency. The magnitude remains same (2V). The DC voltage output got from the F to V converter and inverter circuit acts as the reference and cuts the saw tooth waveform to get the PWM output. These PWM pulses are fed to the base of the IGBT and hence switching of the IGBT is controlled by the PWM output. This in turn controls the net capacitance of the circuit.

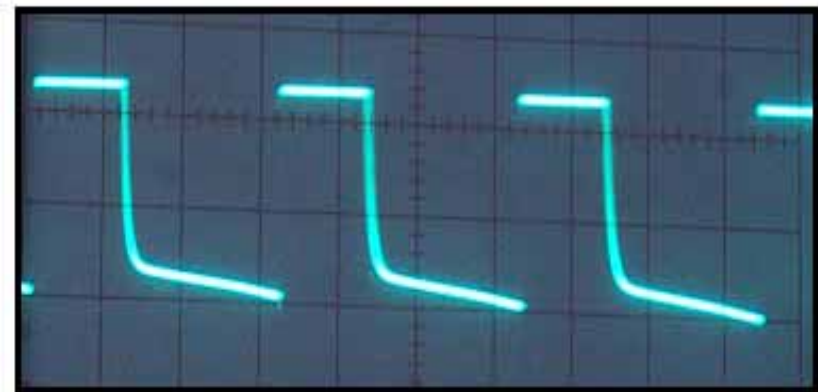
ADVANTAGES

- No centrifugal switch
- Less harmonics
- No zero current switching

- Steady state current minimized
- Less maintenance cost
- More economical
- Better efficiency



Frequency pulses



Input to IGBT gate

APPLICATIONS

- Woodworking machines

- Ice cream mixture and compressor
- Agricultural
- Horticulture

LIKELY PROBLEMS THAT MAY BE ENCOUNTERED

- Water level sensors should be placed in appropriate place such that there is uniform distribution of water all over the area, else the water level sensors might give a wrong output.
- The ratings of the capacitors are decided based on the impedance of the circuit: - If the capacitors are not designed properly the capacitors may even burst.
- As high voltage capacitors are used the switch should be capable of withstanding the high voltage surges produced hence care should be taken while deciding the rating of the IGBT.

CONCLUSION

The design and implementation of a controlled capacitor for a three-phase induction motor operating from single phase supply has been presented by using a fixed capacitor in series with an electronic switch. The proposed system eliminates the use of mechanical or centrifugal switches which is located inside the motor. This avoids the possibility of the switch failure and leads to less operational and maintenance cost and improves the system reliability. The optimum effective capacitor value can be on-line adjusted at any operating speed by periodically changing the duty cycle of the controlled switch to achieve minimum unbalance in phase voltages or any other optimization criteria to improve the motor performance at different speeds. With the output obtained from the hardware module, it can be inferred that

the automation of the irrigation system is highly feasible so that the irrigation can be done even without the presence of farmer.

REFERENCES

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