LOW COST AUTOMATIC WATER LEVEL CONTROLLER WITH PROTECTION FOR ENERGY AND WATER SAVING

[1]K.V.KISHORE. [2] U. NARESH BABU, [3] Dr.G. Sreenivasulu
[1]Asst.Professor EEE-Dept, Narayana Engineering College, Nellore
[2]Associate Professors, EEE-Dept, Narayana Engineering College, Nellore.
[3]Professor, EEE-Dept, Narayana Engineering College, Nellore.

ABSTRACT

In present days, most of the equipment's are automated. So, the present system is designed in such a way that the automatic water filling as well as protection is provided for 3- ø Induction motor. The proposed system trips the total circuit when the water level in the tank is maximum. The motor is turned on when the water level in the tank is minimum or low level. Due to this water filling and protection of the motor will be operated automatically. Also, indicators are used to indicate water level in the tank. It can be operated easily, safely and it is a cost effective. This project helps in protecting the motor and reduces the wastage of power and water. It can also be further extended as per one's requirement. The main advantage of this water level controller circuit is that it can automatically control the water pump without any user interaction. The pump is not allowed to start when the water in the sump tank is low. Whenever the water level decrease below or exceed the prescribed level the motor will be switched ON/OFF, thereby controlling the water level efficiently. The induction motor is protected from the faults like over voltage or under voltages, any unbalanced voltage from the supply.

LITERATURE REVIEW

This product is designed to automatic control of motor, which ensures constant reserve of water in storage tanks. Automatic water level controller is used to automatically fill the overhead tank as and when it gets empty and monitor the water level initially. Automatic water level controller switches ON the motor when the water level in the overhead tank drops below pre-fixed low level (on point) and puts off the motor when water level rises up to pre-fixed high level (off point) motor also switches off when the sump water is exhausted before filling overhead tank, pump running dry, Mains voltage fluctuations. State of the art, digital technology, advanced microcontroller-based products. The system is very versatile, A number of tailor made variations like control of multiple tanks, or multiple pumps are possible.

When the water level in the overhead tank exceeds the required level, the pump automatically turns off and stops the pumping process thus preventing the over flow of water. It uses a relay to cut off the power supply to the water pump.

The ultrasonic sensor senses the level of water in the tank by transmitting ultrasonic signals towards the tank. The water in the tank reflects back the ultrasonic signals, which are received by the receiver. The ultrasonic or the sound signal received is converted to electric signal pulses which are applied to the Microcontroller. These pulses denote the level of water in the tank. As the water level decreases below certain level, the ultrasonic module gives an indication through the electric signal and the Microcontroller accordingly drives the transistor to off condition, which in turn causes the MOSFET to be switched on and accordingly the relay gets energized and the pump is switched on. In case the water level is above the threshold level, the Microcontroller accordingly switches off the relay through the transistor and MOSFET arrangement, so as to switch off the pump.

When the input unit is placed in the water tank, current flows through the wires immersed in water and accordingly the corresponding number of inputs is in high logic state. The Encoder receives this input and based on the priority level of the inputs, gives a digital output code corresponding to the input with highest priority.

INTRODUCTION

OVERVIEW

Many a time, we forget to switch off the motor pushing water into the overhead tank in our households. As a result, water keeps over flowing until we notice the overflow and switch off the pump. As the overhead tank is usually kept on the top most floor, it is cumbersome to go up frequently to check water level in the overhead tank.

The premier intension behind this project is minimizing work hazards, improving the use of irrigation, maintaining optimal usage of electricity and to provide flexibility to farmers.90% of total burn out of the motors are mainly due to overloading caused by unbalanced voltage conditions or phase failure. Phase failure occurs in case of fuse blown-off, loose connections or loss of phase from supply itself. Hence it is of paramount importance to monitor the availability of the three-phase supply and switch off the appliance in the event of failure of one or two phases. This fault remains undetected by conventional bimetallic overload relays. Single phase preventer offers protection up to motor terminals and does not allow motor to start under unfavourable supply conditions.

Normal fusing and overload protection may not adequately protect a poly-phase motor from damaging single-phase operation. Without this protection, the motor will continue to operate if one phase is lost. Large currents can be developed in the remaining stator circuits which eventually burn out.

What we are aiming at to provide the options to farmer through our system

1. Automatic starting

2.Three phase induction motor protection

THREE PHASE INDUCTION MOTOR

An electrical motor is such an electromechanical device which converts electrical energy into a mechanical energy. In case of three phase AC operation, most widely used motor is **Three phase induction motor** as this type of motor does not require any starting device or we can say they are self-starting induction motors. For better understanding, the **principle of three phase induction motor**, the essential constructional feature of this motor must be known to us. This Motor consists of two major parts:

AUTOMATIC STARTING

The device will check availability of three phase supply and switch ON the contactor only when the three-phase supply is present. The power to the motor will resume with the availability of all phases of the supply with certain time delay in order to avoid surges and momentary fluctuations.

CIRCUIT ELEMENTS

RELAYS

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays found extensive use in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly drive an electric motor is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protection relays".

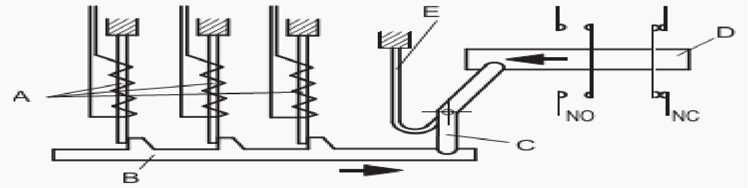


Fig 2.1(e) Principle of operation of a three pole thermally delayed bimetal motor protection relay with temperature compensation.

CONTACTOR

A contactor is an electrically controlled switch used for switching a power circuit, similar to relay except with higher amperage ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit. Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contractor is not intended to interrupt a short circuit current.

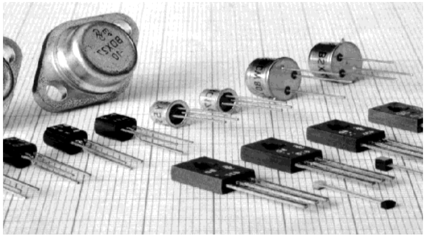
Contactors range from those having a breaking current of several amps and 24V DC to thousands of amps and many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter(yard) on a side. Contactors are used to control electric motors, lighting, heating, capacitor banks, and other electrical loads.

LIGHT-EMITTING DIODE

The LED is based on the semiconductor diode. When a diode is forward biased (switched on), electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the colour of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor.

TRANSISTOR

A transistor is a semiconductor device used to amplify and switch electronic signals. It is made of a solid piece of semiconductor material, with at least three terminals for connection to an external circuit.



A voltage or current applied to one pair of the transistor's terminals changes the current flowing through another pair of terminals. Because the controlled (output) power can be much more than the controlling (input) power, the transistor provides amplification of a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.

CAPACITORS

A capacitor (formerly known as condenser) is a passive electronic component consisting of a pair of conductors separated by a dielectric (insulator). When a potential difference (voltage) exists across the conductors, an electric field is present in the dielectric. This field stores energy and produces a mechanical force between the conductors. The effect is greatest when there is a narrow separation between large areas of conductors; hence capacitor conductors are often called plates.

RESISTOR

A resistor is a two-terminal electronic component that produces a voltage across its terminals that is proportional to the electric current passing through it in accordance with Ohm's law:$V = IR$

TRANSFORMER

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors-the transformer's coils. A varying current in the first or primary winding creates a varying magnetic field flux in the transformer's core and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force(EMF) or "voltage" in the secondary winding. this effect is called mutual induction.

If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will be transformer from the primary circuit through the transformer to the load. In a transformer, the induced voltage in the secondary winding (V_s) is in proportion to the primary voltage (V_p), and is given by the ratio of the number of turns in the secondary (N_s) to the number of turns in the primary (N_p) as follows:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

OPERATION AND WORKING

OPERATION

In three phase supply, first R-phase and Y-phase are connected to primary winding of the Scott connection transformer of which R phase is connected through a switch SW. This transformer reduces the 440V AC to 12V AC. We get 12V AC at secondary winding of the transformer. An isolation rectifier circuit is connected to the secondary winding of transformer.

This rectifier circuit rectifies the 12V AC to 12V DC. A LED is connected to rectifier circuit in series with resistor to indicate the presences of R and Y phases. This output is connected to the transistor base. Transistor emitter is connected to the ground and collector is connected to the anode of free-wheeling diode. Across the free-wheeling diode operational relay RL is connected. The NO of operational relay RL is connected to Y phase. The pole of operational relay RL is connected to coil of 3 pole contactor RL_1 through the NC terminals of thermal overload relay, the B phase is directly connected to the second terminal of the contactor RL1 coil.

For input side of 3 pole contactor RL_1, three phase supply is connected. And for output side, a thermal overload relay is connected to which the load is connected. The contactor RL_1 acts as switch depending upon the presence of all the three phases.

In the first case by using the output of rectified voltage the availability of water level is checked which mentioned as the sump circuit. If the water available the relay coil is operated and then the water tank circuit is operated otherwise the circuit is not operated.

All these conditions are check by using sump operation which is based on the availability of water in the sump. In this mode relay is in ON condition and motor is in OFF condition.

<u>CIRCUIT DIAGRAM</u>

Circuit diagram of automatic water level motor controller with protection

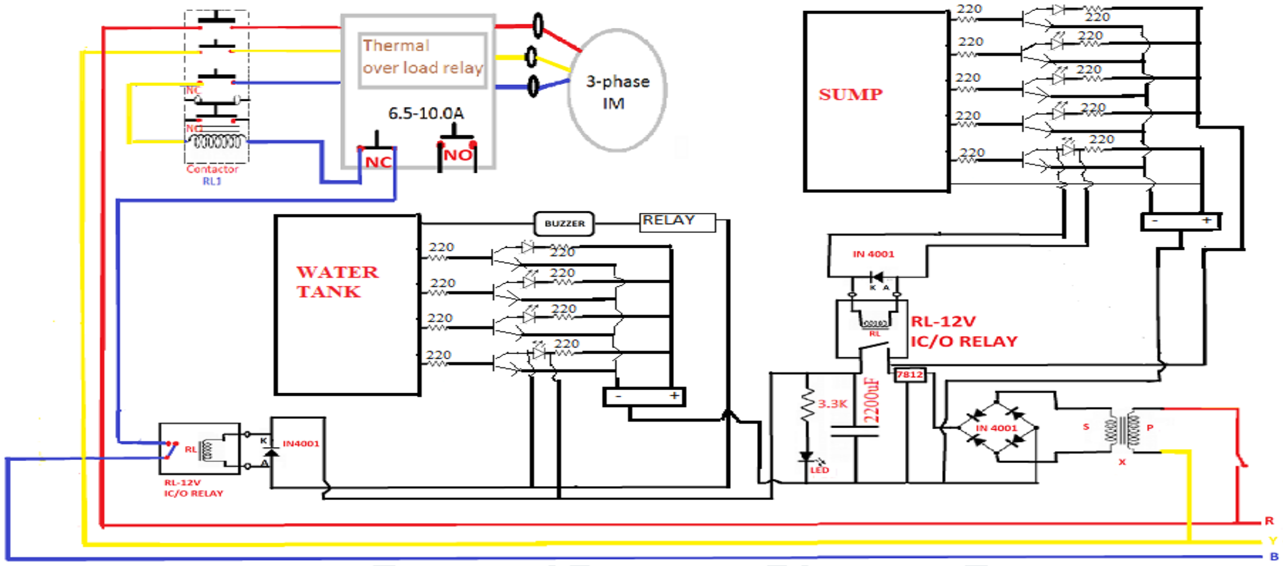
If R-phase or Y-phase supply was not present then the operational relay will not operate and the Y-phase will not connect to the coil of 3 pole contactor RL1 and the contactor will not trigger thus the supply will not connect to the load.

If B-phase supply was not present then the contactor RL1 will not trigger thus the supply will not connect to the load.

When switch SW is OFF: The operational relay RL will not operate and the Y-phase will not connect to the coil of 3 pole contactor RL1 and the contactor will not trigger thus the supply will not connect to the load.

A simple but very reliable and effective water level controller circuit diagram is shown here. The circuit uses 6 transistors, BC547 IC, a relay and few passive components. The circuit is completely automatic which starts the pump motor when the water level in the overhead tank goes below a present level and switches OFF the pump when the water level in the overhead tank goes above the full level. Probe D is positioned at the bottom level of the tank while probes A, B and C are placed at full, half and medium levels of the tank respectively. The level sensing part of the circuit is built around transistors Q1, Q2 and Q3. When water level is below the quarter level probes A, B and C are open and the transistor Q1, Q2 and Q3 remains OFF. When the water level rises and touches the probes the corresponding transistors gets biased and switches ON. Resistors R1, R2, R3 limit the bases current of corresponding transistors while resistors R4, R5, R6 limit their collector current.

LEDs D1, D2 and D3 provide a visible indication of the current water level. Probe D is positioned at the bottom level of the tank while probes A, B and C are placed at full, half and medium levels of the tank respectively. The level sensing part of the circuit is built around transistors Q1, Q2 and Q3. When water level is below the quarter level probes A, B and C are open and the transistor Q1, Q2 and Q3 remains OFF. When the water level rises and touches the probes the corresponding transistors gets biased and switches ON. Resistors R1, R2, R3 limit the bases current of corresponding transistors while resistors R4, R5, R6 limit their collector current.



LEDs D1, D2 and D3 provide a visible indication of the current water level. When the water level goes below medium, transistor Q2 gets switches OFF and its collector goes positive. Collector of Q2 is connected to the base of transistor Q6 and as result transistor Q6 gets switched ON. Transistor Q5 will be also ON because its base in connected to the collector of Q4 which presently OFF. As a result, when the water level goes below medium relay K1 gets energized and the pump is driven. The relay is wired in the latching mode so that even if the water level goes above medium level the pump remains ON so that the tank gets completely filled.

For wiring the relay in latching mode one set of N/O contacts is used. When relay is activated these contacts close which forms a short across collector and emitter of Q6. This makes the state of Q6 irrelevant to the operation of the relay and the relay remains ON as long as the transistor Q5 is ON.

The only way to make the relay OFF is by switching OFF Q5 and it is done automatically when the water level reaches the full level. Collector of transistor Q1 is connected to the trigger pin (pin2) of IC1. When the water level reaches full level the transistor Q1 gets switched ON. As a result, its collector goes to ground level which triggers the IC1 which is wired as a monostable. The output of IC1 goes high for about 1S. This makes the transistor Q4 ON for the same time and transistor Q5 whose base is connected to the collector of Q4 is switched OFF cutting the supply to the relay. This makes the motor OFF and it remains OFF until the water level again goes below the medium level.

Resistor R8 is a pull up resistor for the trigger pin of the BC547. Capacitor C3 couples the collector of Q1 to the trigger pin of BC547 and facilitates edge triggering whenever the transistor Q1 goes ON. A monostable circuit can be made edge triggered by connecting the trigger signal to the trigger input pin through a capacitor. The capacitor blocks DC and passes sudden changes. The circuit used here is termed as negative edge triggered because the monostable is triggered whenever the trigger input signal falls. R10 and R12 limits the collector current of Q4 and Q5 respectively while R9 and R11 limits their base current. R13 limits the base current of Q6 while D4 is a freewheeling diode which protects the switching transistors from voltage transients.

The probes can be arranged as shown in the diagram above. Insulated Aluminium wires can be used as the probes. The probes can be binded on a plastic rod and should be erected vertically inside the tank. The length of the probes wires and the supporting plastic rod must be chosen according to the depth of the tank. Since DC is used in the level sensing section electrolysis will occur in the probes and so the probes require small maintenances in 1 or 2-month intervals. Using AC in the sensingsection will completely eliminates the chance of electrolysis

PROTECTION SYSTEM:

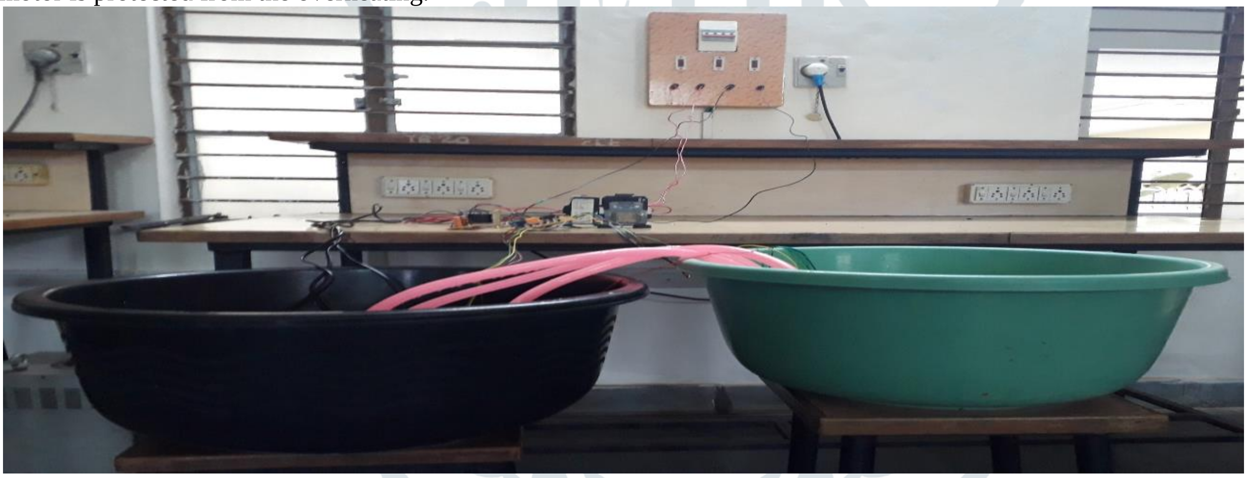
The motor is a most crucial electrical device in the current period of automation. These are used in various industrial applications. But can be protected from the various faults like mechanical, electrical faults to help their purposes. This article discusses an induction motor protection system from emerging faults by employing a microcontroller. This motor experiences different types of electrical faults like over voltage, under voltage, overload, unbalanced voltage, phase reversing earth fault, and single phasing. Due to these electrical faults, the motor's windings will get heated which lead to decrease the life of the motor. The degree of the induction motor depends on the costs and functions of the motor.

The basic idea of this project is to give safety to the Induction Motor. If any of the phases, out of the 3-phases is misplaced and also if the motor's temperature during process surpasses the set value, the supply to the induction motor is cut-off instantly. This project is supplied with a 3-phase power i.e., the 3-transformers are connected to the 3-phases supplyThe hardware requirements of this project include op-amps, resistors, capacitors, diodes, transformers, regulator and relays. This system protects the 3-phase AC motor from single phasing and overheating. When any of the phases is out, then this system recognizes it and immediately turns off the motor, which is powered by the mains. All the three phases are rectified, filtered and regulated and given to operationalamplifier where this supply voltage is compared with certain voltage. If any of the phases is missed, then it gives zero voltage at the Op-amp input, and therefore, it gives low logic to the transistor which further de-energizes the relay. Hence, the main relay gets turned offand the power to the motor is interrupted.

PRACTICAL WORKING OF THE CIRCUIT

In this practical setup the three-phase supply is used for the whole operation of the circuit. The step down transformer is used to step down the three-phase voltage to 12V for operating the relays and control circuit. The LED's are used as water level indicators. There are five level indicators are used in the circuit. The resistors are used for the operation of LED's. The transistors are used to operate the whole circuit. The submergible pumps are used to pump the water from the sump to water tank when the water is present in the sump. The probes are inserted in the tank such that to indicate the different water levels in the sump as well as in the water tank.

Three relays are used in the circuit, two relays are used to ON or OFF the motor when water level in the tank reaches minimum level or maximum level. Another relay is used to OFF the when the tank is completely filled or water reaches to the top level of the tank. The alarm circuit is used in the setup to control the overflow of the water from the tank which is connected to fifth level indicator. In this setup, the protection is provided to protect the motor from over voltages, over currents, under voltages and under currents also to trip the motor when there is no requirement of pumping the water to the tank and also the motor will not be in ON condition when the water level in the sump is minimum or low. The thermal overload relay and contactor are used for protection purposes, whenever the over voltages and under voltages occurs the relay will trip then automatically the motor will go to OFF condition so that the motor is protected from the overheating.



OPERATION:

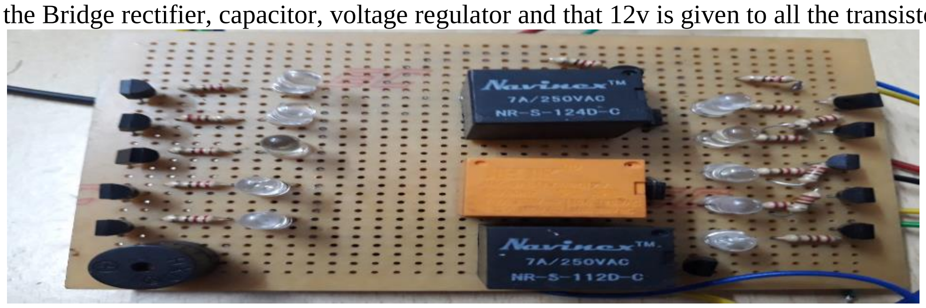
Step-1:

The Three phase supply is taken from the three phase terminals. These terminals are connected to relay and contactor. The thermal overload relay NC is connected to relay output to control the motor ON and OFF condition. The Nc from the overload relay is connected to one end of the contactor coil NO.

The contactor NO and NC are shorted. The motor relay input terminals are connected to the diode which is connected to IC IN4001.

Step-2:

Any two phases are given to the Scott connected transformer for stepping down the voltage from 440v to 12v which is required for the circuit. But, in output we'll get harmonics and ripples. To eliminate these the output is given to the Bridge rectifier, capacitor, voltage regulator and that 12v is given to all the transistor emitters.



Sump and Motor Circuit

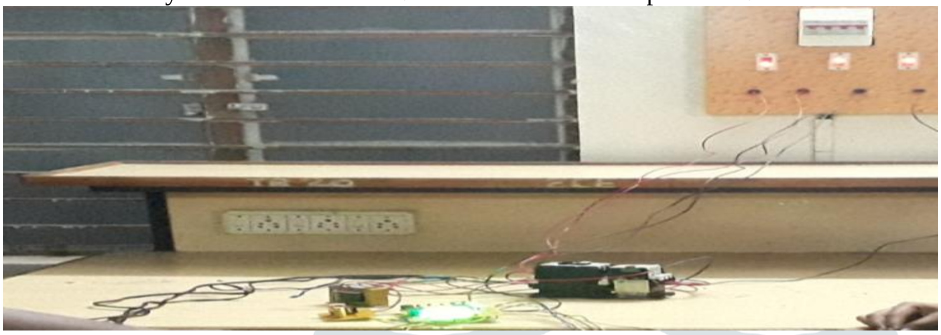
Step-3:

When the water level in the sump circuit is low, the Red LED will glow motor and the motor relay will be in OFF condition. When the water level in the sump is medium, high then the water level will be indicated by LED's i.e., lower level to higher level. Sump relay and motor relay will be in ON condition then water is pumped to the water tank until the water level in the tank reaches to maximum position. When it reaches to maximum the motor is automatically turn OFF through relays.

Step-4:

Water tank circuit is connected similarly as sump circuit i.e., all transistor emitters are connected to negative terminal of the supply and all the transistor collector terminals are connected to positive terminal. The lower and higher-level transistors are connected through relay.

The water will be filled in the tank whenever the water in the tank is minimum and water level will be indicated by LED's by level wise i.e., lower to higher. When the water level reaches to maximum the buzzer will give alarm and automatically motor will turn OFF. So that motor will be protected.



Circuit under operating condition

CONCLUSION

The test system considered in this paper is worked out for the best operation and protection of a 3-phase induction motor.

Using this device, we can prevent the mishaps like single phasing and can protect the costly motor; the motor will not run unless all the three phases are present.

It is flexible to farmers with automatic starting which is very less expensive; the device is in active state it will automatically trigger when there is a three-phase supply.

FUTURE SCOPE

In future, this paper can be improved more by making it a complete remote-control system, which is possible using GSM technology.

But the challenge lies behind making it feasible, economical and user friendly for farmers with basic features

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