

**REMOTE MONITORING OF INDUCTION MOTOR THROUGH INTERNET**

**A PROJECT REPORT**

***Submitted by***

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**BONAFIDE CERTIFICATE**

Certified that this project entitled **“REMOTE MONITORING OF INDUCTION MOTOR THROUGH INTERNET”** is the bonafide work of **“ARANGANATHAN R, PAVITHRAN J U, SAKTHIVEL M P”** who carried out the project work under my supervision.

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**INTERNAL EXAMINER EXTERNAL EXAMINER**

**ABSTRACT**

An integrated motor monitoring system which collects, analyzes, and stores data in database through on-line and coordinated real-time graph of 3-phase Induction motors. On-line coordinated real-time motor data from remote sensors at a motor control center are collected simultaneously and processed. Off-line sensor data can be visualized with integrated Liquid Crystal Display (LCD). Monitoring units at the motor control center collects load voltage, load current, speed and temperature of the motor. The Real-time graph provides load current and historical data on the motor for analyses conducted at the motor or at the motor control center. Additionally the motor monitoring system has the capability of controlling the motor and shutdown of motor at abnormal condition.

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**LIST OF ABBREVIATIONS**

|  |  |
| --- | --- |
| **ABBREVIATION** | **DESCRIPTION** |
| MCU  GPR  SPR  RAM  LCD  PC | Microcontroller Control Unit  General Purpose Register  Special Purpose Register  Random Access Memory  Liquid Crystal Display  Program Counter |

**CHAPTER 1**

**INTRODUCTION**

Induction Motors are generally utilized as a part of industry due to their rigidity and speed control flexibility. In this manner, the issue of induction motor protection attracted many researchers. This Project aim is the protection and monitoring of three phase Induction Motor. There are different techniques for fault identification and protection of Induction motor. Some of fault detection using Artificial Neutral Network, Stator fault checking strategies, Microcontrollers based protection system and Programmable Logic Controller (PLC) based protection system.

In this task, the technique utilized is Microcontroller based protection system and monitoring via internet. The circuit will take the full control of the motor and it will protect the motor from several faults, for example, over voltage and under voltage and the circuit will switch on the motor under safety conditions. This additionally protects induction motor from single phasing which is also a major fault. The circuit is completely controlled by the microcontroller and the microcontroller will consistently monitors the voltages of the three phases and if the voltage goes abnormal then it will switch off the motor until they are typical. With the help of current transformer which senses the current and if it exceeds some particular level then comparator sends this signal to microcontroller to stop the motor. All the conditions are shown by it over the LCD display.

In this project we are utilizing the 8 bit microcontroller ATmega328. It is a 28 pin microcontroller. The protection of induction motor with microcontroller has adaptability to switch off at required time, monitors phase of motor at each time furthermore every motoring activity is known through LCD display and simultaneously uploading the measured value to the website. Nowadays with the emergence of Internet of Things(IOT),the Monitoring and controlling of machines have become much simpler and can be manipulated from any part of the world. The proposed idea will focus on monitoring of induction motor through a Web App powered by NodeJS as backend and using Arduino.

* 1. **MONITORING MODULE**

This project is designed with induction motor, contactor, Microcontroller and sensor circuits.

* + 1. **INDUCTION MOTOR**

An induction or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor therefore does not require mechanical commutation, separate-excitation or self-excitation for all or part of the energy transferred from stator to rotor, as in universal, DC and large synchronous motors. An induction motor's rotor can be either wound type or squirrel-cage type.

* + 1. **CONTACTOR**

When a relay is used to switch a large amount of electrical power through its contacts, it is designated by a special name: contactor. Contactors typically have multiple contacts, and those contacts are usually (but not always) normally-open, so that power to the load is shut off when the coil is de-energized.

* + 1. **MICROCONTROLLER**

The ATmega328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328P achieves through puts approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

* + 1. **LCD**

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle

**1.2 SENSORS AND DRIVER CIRCUITS**

This project is Composed of various sensors and driver circuits. They are listed below:

* + 1. **PROXIMTY SENSOR**

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target.

The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance.Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.

* + 1. **TEMPERATURE SENSOR**

A thermistor is a type of resistor whose resistance is dependent on temperature, more so than in standard resistors. The word is a portmanteau of thermal and resistor. Thermistors are widely used as inrush current limiter, temperature sensors (NTC type typically), self-resetting over-current protectors, and self-regulating heating elements.

* + 1. **RELAY**

Relays are electromechanical switches. They have very high current rating and both AC and DC motors can be controlled through them because motor will be completely isolated from the remaining circuit

Relays consist of a electromagnet, armature, spring and electrical contacts. The spring holds the armature at one electrical contact and as soon as a voltage is applied across the electromagnet, it coils the armature, changes its contact and moves to another electrical contact.

**CHAPTER 2**

**BLOCK DIAGRAM**

CURRENT MMT

MICRO-CONTROLLER

ARDUINO UNO

TEMPERATURE SENSOR

DATAS TO CLOUD

ESP 8266-WIFI MODULE

PROXIMITY SENSOR

LCD

VOLTAGE MMT

DRIVER CIRCUIT

RELAY

3 PHASE UNIT

CONTACTOR

3 PHASE IM

Fig 2.1 Overall Block Diagram

**2.1 BLOCK DIAGRAM EXPLANATION**

Block diagram consist of so many blocks they are 3-Phase induction motor, 3-Phase Contactor, Temperature sensor(LM235), Microcontroller, Proximity sensor, Relay,LCD.

**2.1.1 3-PHASE INDUCTION MOTOR**

An induction or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor therefore does not require mechanical commutation, separate-excitation or self-excitation for all or part of the energy transferred from stator to rotor, as in universal, DC and large synchronous motors. An induction motor's rotor can be either wound type or squirrel-cage type.

Three-phase squirrel-cage induction motors are widely used in industrial drives because they are rugged, reliable and economical. Single-phase induction motors are used extensively for smaller loads, such as household appliances like fans. Although traditionally used in fixed-speed service, induction motors are increasingly being used with variable-frequency drives (VFDs) in variable-speed service. VFDs offer especially important energy savings opportunities for existing and prospective induction motors in variable-torque centrifugal fan, pump and compressor load applications. Squirrel cage induction motors are very widely used in both fixed-speed and variable-frequency drive (VFD) applications. Variable voltage and variable frequency drives are also used in variable-speed service.

**2.1.2 INDUTION MOTOR CONSTRUCTION**

A 3 phase induction motor also consists of a stator and a rotor. Basically there are two types of 3 phase IM - 1. Squirrel cage induction motor and 2. Phase Wound induction motor (slip-ring induction motor). Both types have similar constructed rotor, but they differ in construction of rotor. This is explained further:

* **STATOR**

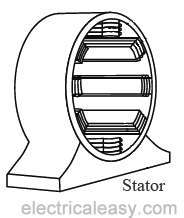


Fig 2.2 stator

The stator of a 3 phase IM (Induction Motor) is made up with number of stampings, and these stampings are slotted to receive the stator winding. The stator is wound with a 3 phase winding which is fed from a 3 phase supply. It is wound for a defined number of poles, and the number of poles is determined from the required speed. For greater speed, lesser number of poles is used and vice versa. When stator windings are supplied with 3 phase ac supply, they produce alternating flux which revolves with synchronous speed. The synchronous speed is inversely proportional to number of poles (Ns = 120f / P). This revolving or rotating magnetic flux induces current in rotor windings according to Faraday's law of mutual induction.

* **ROTOR**

Rotor of a 3 phase induction motor can be of either two types, squirrel cage rotor and phase wound rotor (or simply - wound rotor).

* **SQUIREL CAGE ROTOR**

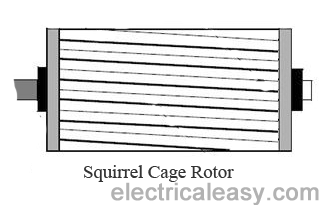


Fig 2.3 Squirrel Cage Rotor

Most of the induction motors (upto 90%) are of squirrel cage type. Squirrel cage type rotor has very simple and almost indestructible construction. This type of rotor consist of a cylindrical laminated core, having parallel slots on it. These parallel slots carry rotor conductors. In this type of rotor, heavy bars of copper, aluminum or alloys are used as rotor conductors instead of wires.

Rotor slots are slightly skewed to achieve following advantages -

1. it reduces locking tendency of the rotor, i.e. the tendency of rotor teeth to remain under stator teeth due to magnetic attraction.

2. increases the effective transformation ratio between stator and rotor

3. increases rotor resistance due to increased length of the rotor conductor

The rotor bars are brazed or electrically welded to short circuiting end rings at both ends. Thus this rotor construction looks like a squirrel cage and hence we call it. The rotor bars are permanently short circuited, hence it is not possible to add any external resistance to armature circuit.

* **PHASE WOUND ROTOR**

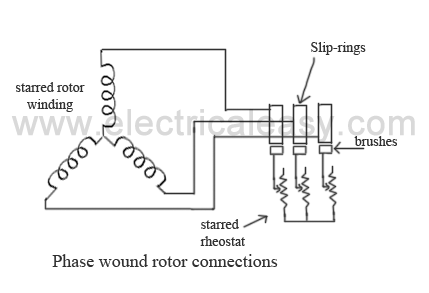


Fig 2.4 Phase Wound Rotor

Phase wound rotor is wound with 3 phase, double layer, distributed winding. The number of poles of rotor are kept same to the number of poles of the stator. The rotor is always wound 3 phase even if the stator is wound two phase.

The three phase rotor winding is internally star connected. The other three terminals of the winding are taken out via three insulated sleep rings mounted on the shaft and the brushes resting on them. These three brushes are connected to an external star connected rheostat. This arrangement is done to introduce an external resistance in rotor circuit for starting purposes and for changing the speed / torque characteristics.

**2.1.3 OPERATION OF INDUCTION MOTOR**

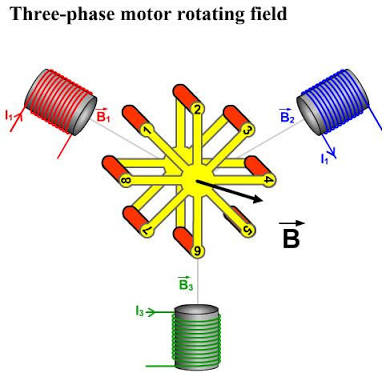


Fig 2.5 3-Phase Motor Rotating Field

In a DC motor, supply is needed to be given for the stator winding as well as the rotor winding. But in an induction motor only the stator winding is fed with an AC supply.

* Alternating flux is produced around the stator winding due to AC supply. This alternating flux revolves with synchronous speed. The revolving flux is called as "Rotating Magnetic Field" (RMF).
* The relative speed between stator RMF and rotor conductors causes an induced emf in the rotor conductors, according to the Faraday's law of electromagnetic induction. The rotor conductors are short circuited, and hence rotor current is produced due to induced emf. That is why such motors are called as induction motors. (This action is same as that occurs in transformers, hence induction motors can be called as rotating transformers.)
* Now, induced current in rotor will also produce alternating flux around it. This rotor flux lags behind the stator flux. The direction of induced rotor current, according to Lenz's law, is such that it will tend to oppose the cause of its production.
* As the cause of production of rotor current is the relative velocity between rotating stator flux and the rotor, the rotor will try to catch up with the stator RMF. Thus the rotor rotates in the same direction as that of stator flux to minimize the relative velocity. However, the rotor never succeeds in catching up the synchronous speed. This is the basic working principle of induction motor of either type, single phase of 3 phase.

**2.2 CONTACTOR**

**2.2.1 INTRODUCTION**

* A contactor is a relay that is used for switching power.
* They usually handle very heavy loads like an electric motor, lighting and heating equipments and so on.
* Though their output is used for switching very high loads, they are controlled by a circuit with very less power.
* According to the loads they handle, they vary in sizes from a small device to as huge as a yard.
* Though they are used for switching purposes, they do not interrupt a short-circuit current like a circuit breaker.
* They have ratings ranging from a breaking current of a few amperes and 24 DC volts to thousands of amperes with many kilo volts.

**2.2.2 Working of Contactor**

As contactors are used for high-current load applications they are designed to control and reduce the arc produced when the heavy motor currents are interrupted. Other than the low current contacts, they are also setup with Normally Open contacts. These are devices which handle more than 20 Amperes current and over 100 Kilo Watts power.

The contactor has an AC/DC supply driven coil input. This will depend on the requirement. This coil will mostly be controlled by a lower voltage PLC. They can also be controlled by the motor voltage. The motor may have series of coils connected to either control the acceleration or even the resistance.

When current is passed through the contactor, the electromagnet starts to build up, producing a magnetic field. Thus the core of the contactor starts to wind up. This process helps in energizing the moving contact. Thus the moving and fixed contacts make a short circuit. Thus the current is passed through them to the next circuit. The armature coil brings in high current in the initial position. This reduces as soon as the metal core enters the coil. When the current is stopped, the coil gets de-energized and thus the contacts get open circuited.

**2.2.3 Contactor Ratings**

Ratings of a contactor are given according to the pole of the contactor. It also depends on factors like fault withstand current, coil voltage and so on. According to their rating, contactors are classified into the following.

AC1 – Non-inductive rows

AC2 – Contactors for starting of slip-ring motors

AC3 – Starting of squirrel-cage motors and switching off only after the motor is up to speed.

AC4 – Starting of squirrel-cage motors with inching and plugging duty.

AC11 – Auxiliary control circuits.



Fig 2.6 Contactor

**2.3 POWER SUPPLY**

**2.3.1 Block diagram:**



Fig 2.7 Block diagram (Power supply)

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

**2.3.2 SCHEMATIC DIAGRAM:**

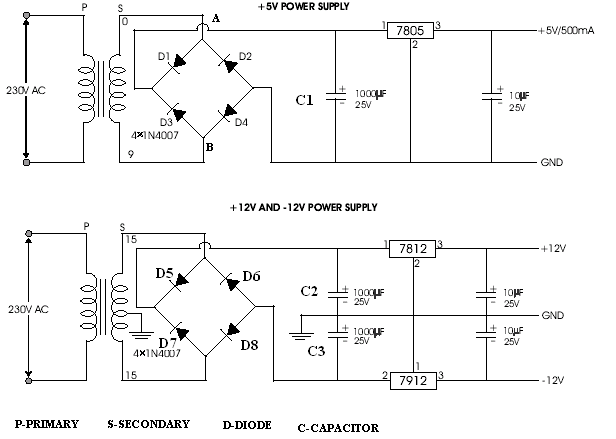


Fig 2.8 Power Supply Circuit

**2.3.3 WORKING PRINCIPLE**

**2.3.4 TRANSFORMER**

The potential transformer will step down the power supply voltage (0-230V) to (0-9Vand 15-0-15) level. If the secondary has less turns in the coil then the primary, the secondary coil's voltage will decrease and the current or AMPS will increase or decreased depend upon the wire gauge.  **This is called a STEP-DOWN transformer.** Then the secondary of the potential transformer will be connected to the rectifier.

**2.3.5 Bridge rectifier**

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

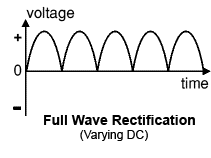


Fig 2.9 Waveform(volts VS time)

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flow is from point B through D1, up through Load, through D3, through the secondary of the transformer back to point B.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through Load, through D2, through the secondary of transformer, and back to point A. Across D2 and D4. The current flow through Load is always in the same direction. In flowing through Load this current develops a voltage corresponding to that. Since current flows through the load during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional half-wave circuit.

This bridge rectifier always drops 1.4Volt of the input voltage because of the diode. We are using 1N4007 PN junction diode, its cut off region is 0.7Volt.

So any two diodes are always conducting, total drop voltage is 1.4 volt.

**2.3.6 Positive 12 and Negative 12 Volt circuit:**

The unregulated AC/DC power supply part of the circuit consists of a transformer that steps down 230VAC to 15 volts across a center tapped secondary winding 15V AC individually across the two halves of the secondary winding with opposite polarities, diodes (D5) to (D8) that rectify the AC appearing across the secondary with (D5) and (D7) providing ‘full wave rectification to produce a positive output, (D6) and (D8), providing full wave rectification to produce a negative output, capacitors (C2) and (C3) providing the filtering action.. 7812 is a fixed output positive three terminal regulator whereas 7912 is a fixed output negative three terminal regulator.

**2.3.7 FILTER**

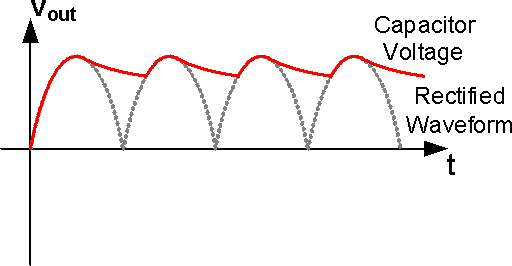


Fig 2.10 Filter Waveform

If a Capacitor is added in parallel with the load resistor of a Rectifier to form a simple Filter Circuit, the output of the Rectifier will be transformed into a more stable DC Voltage. At first, the capacitor is charged to the peak value of the rectified Waveform. Beyond the peak, the capacitor is discharged through the load resistor until the time at which the rectified voltage exceeds the capacitor voltage. Then the capacitor is charged again and the process repeats itself.

**2.3.8**  **IC VOLTAGE REGULATOR**

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

A fixed three-terminal voltage regulator has an unregulated dc input voltage , applied to one input terminal, a regulated dc output voltage, from a second terminal, with the third terminal connected to ground.

The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

This is a regulated power supply circuit using the 78xx IC series. These regulators can deliver current around 1A to 1.5A at a fix voltage levels. The common regulated voltages are 5V, 6V, 8V, 9V, 10V, 12V, 15V, 18V, and 24V. It is important to add capacitors across the input and output of the regulator IC to improve the regulation. In this power supply circuit we get 5, 12 and -12Volt output.

**2.4 TEMPERATURE SENSOR**

**2.4.1 THERMISTOR :**

A **thermistor** is a type of resistor used to measure temperature changes, relying on the change in its resistance with changing temperature. Thermistor is a combination of the words thermal and resistor. If we assume that the relationship between resistance and temperature is linear (i.e. we make a first-order approximation), then we can say that:

Δ*R* = *k*Δ*T*

Where

Δ*R* = change in resistance

Δ*T* = change in temperature

*k* = first-order temperature coefficient of resistance

Thermistors can be classified into two types depending on the sign of *k*. If *k* is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (**PTC**) thermistor, **Posistor**. If *k* is negative, the resistance decreases with increasing temperature, and the device is called a negative temperature coefficient (**NTC**) thermistor. Resistors that are not thermistors are designed to have the smallest possible *k*, so that their resistance remains almost constant over a wide temperature range.



Fig 2.11 Thermistor

**2.4.2 SPECIFICATION**

* Rated zero-power resistance R25 : 2.252 KΩ NOMINAL
* B value. B25/85 : 3,977 K ± 1 %
* The B value is calculated using the zero-power resistance values measured at 25 °C and 85°C.
* Temperature coefficient @25°C : -4.4 %/°C
* Dissipation factor. : Approx. 0.5 mW/°C (in air)
* Thermal time constant. : Approx. 0.4 s (in air)
* Tolerance range (tolerance) : 0°C to 70°C (±0.1°C)
* Maximum operating temperature : 150 °C

**2.4.3 SYMBOL:**



Fig 2.12 Thermistor Symbol\

**2.5 PROXIMITY SENSOR**

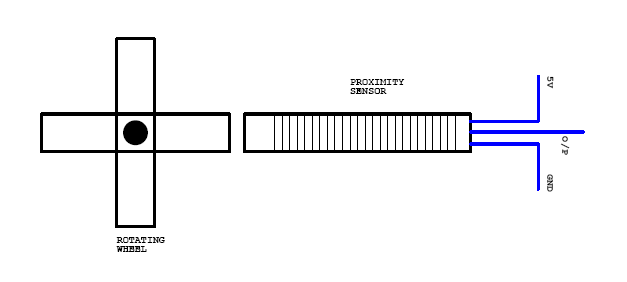


Fig 2.13 Proximity Sensor

**2.5.1 WORKING PRINCIPLE**

Inductive proximity sensors are widely used in various applications to detect metal devices. They can be used in various environments (industry, workshop, lift shaft...) and need high reliability.

Inductive proximity sensors generate an electromagnetic field and detect the eddy current losses induced when the metal target enters the field. The field is generated by a coil, wrapped round a ferrite core, which is used by a transistorized circuit to produce oscillations. The target, while entering the electromagnetic field produced by the coil, will decrease the oscillations due to eddy currents developed in the target. If the target approaches the sensor within the so-called "sensing range", the oscillations cannot be produced anymore: the detector circuit generates then an output signal controlling a relay or a switch.

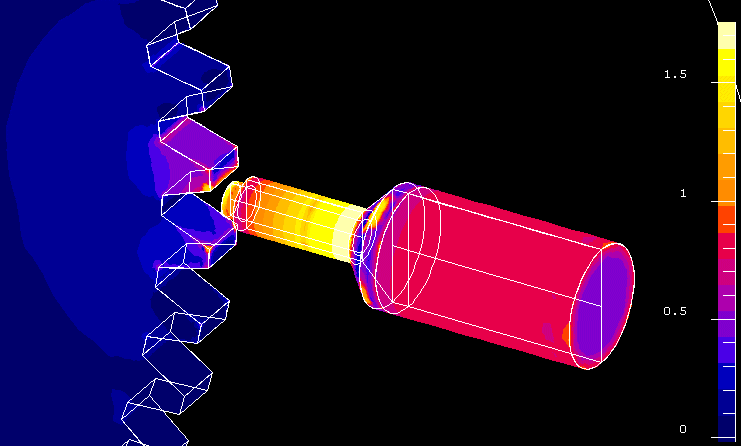


Fig 2.14 Proximity sensor

**2.5.2 MICROCONTROLLER(ARDUINO)**

**2.5.3 INTRODUCTION**

* High-performance and RISC Architecture
* 130 Powerful Instructions – Most Single-clock Cycle Execution
* 32 x 8 General Purpose Working Registers
* Fully Static Operation and Up to 16 MIPS Throughput at 16 MHz
* On-chip 2-cycle Multiplier
* Operating Speed is 0 - 16 MHz (ATmega8)
* Low Power Consumption
  + 1. **PERIPHERAL FEATURES**
* Two 8-bit Timer/Counters with Separate Pre scalar, one Compare Mode
* One 16-bit Timer/Counter with Separate Pre scalar, Compare Mode, and Capture Mode and Three PWM Channels
* Real Time Counter with Separate Oscillator and
* 8-channel ADC in TQFP and QFN/MLF package
* Eight Channels 10-bit Accuracy
* 6-channel ADC in PDIP package and 10-bit Accuracy
* Byte-oriented Two-wire Serial Interface
  + 1. **SPECIAL MICROCONTROLLER FEATURES**
* Power-on Reset and Programmable Brown-out Detection
* Internal Calibrated RC Oscillator
* 1024 Bytes EEPROM
* 32K Bytes of In-System Self-programmable Flash program memory
* 2K Byte Internal SRAM
* Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
* External and Internal Interrupt Sources
* Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby and 23 Programmable I/O Lines
* 28-lead PDIP, 32-lead TQFP, and 32-pad QFN/MLF

**2.5.6 PIN DIAGRAM**

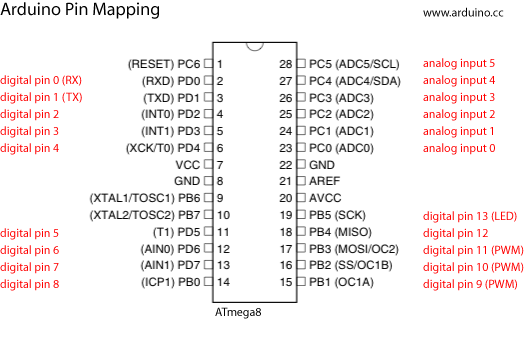


Fig 2.15 Microcontroller Pin Diagram

* + 1. **I/O PORTS**

Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

Additional Information on I/O ports may be found in the IC microcontroller Mid-Range Reference Manual

* + 1. **MICRO CONTROLLER ARCHITECTURE**

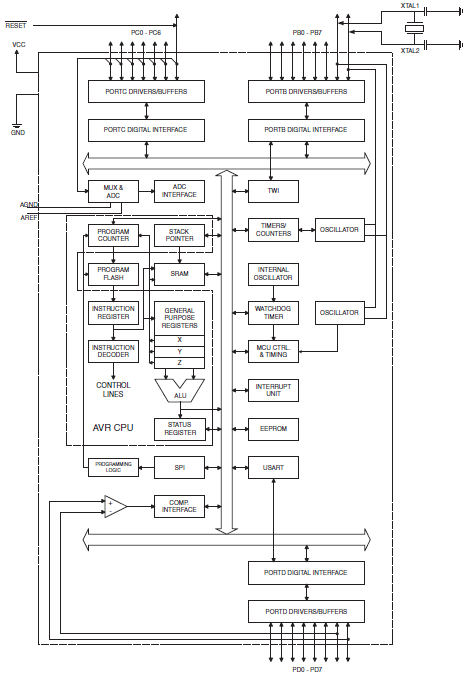


Fig 2.16 Architecture of Microcontroller

* + 1. **PORT B (PB7.PB0)**

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit. Depending on the clock selection fuse settings, PB7 can be used as output from the inverting Oscillator amplifier. If the Internal Calibrated RC Oscillator is used as chip clock source, PB7.6 is used as TOSC2.1input for the Asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

* + 1. **PORT C**

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.

* + 1. **PC6/RESET**

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is programmed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a Reset.

**2.5.11 PORT D**

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

* + 1. **PROGRAM MEMORY MAP**

The Flash memory has an endurance of at least 10,000 write/erase cycles. The ATmega8 Program Counter (PC) is 12 bits wide, thus addressing the 4K Program memory locations. The operation of Boot Program section and associated Boot Lock Bits for software protection are described in detail in “Boot Loader Support – Read-While-Write Self-Programming”. “Memory Programming” on page 215 contains a detailed description on Flash Programming in SPI- or Parallel Programming mode.

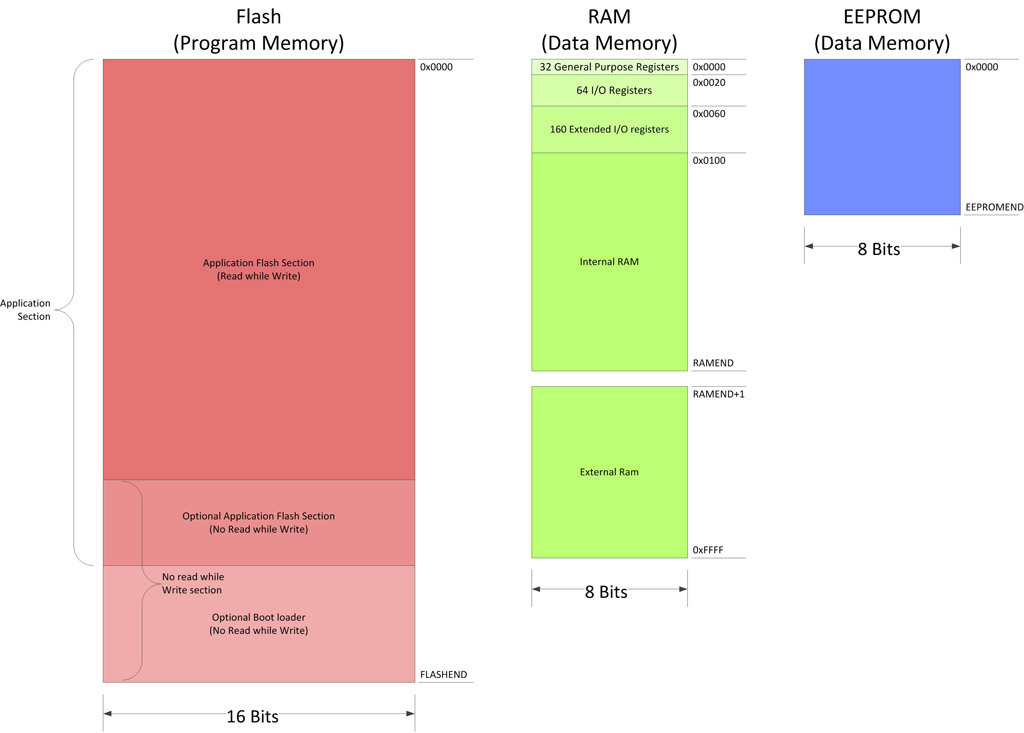


Fig 2.17 Program Memory Map

* + 1. **DATA MEMORY ACCESS TIMES**

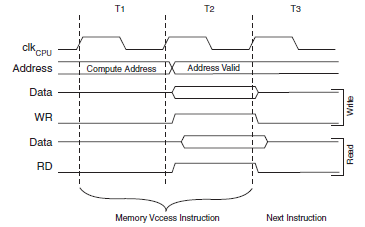


Fig 2.18 on-Chip Data SRAM Access Cycles

The ATmega328 contains 1024bytes of data EEPROM memory. It is organized as a separate data space, in which single bytes can be read and written. The EEPROM has an endurance of at least 100,000 write/erase cycles.

The access between the EEPROM and the CPU is described below, specifying the EEPROM Address Registers, the EEPROM Data Register, and the EEPROM Control Register. “Memory Programming” on page 215 contains a detailed description on EEPROM Programming in SPI- or Parallel Programming mode.

* + 1. **CLOCK SYSTEMS AND THEIR DISTRIBUTION**

Presents the principal clock systems in the Atmel®AVR® and their distribution. All of the clocks need not be active at a given time. In order to reduce power consumption, the clocks to modules not being used can be halted by using different sleep modes, as described in “Power Management and Sleep Modes”. The clock systems are detailed

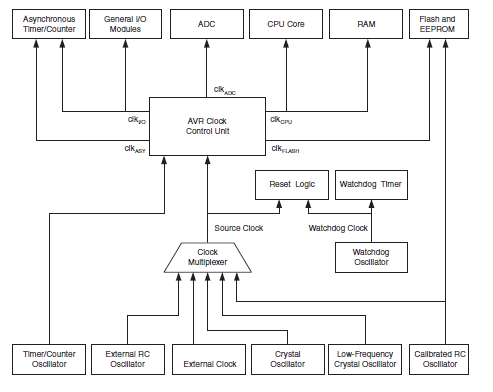


Fig2.19 Clock Distribution

* + 1. **CRYSTAL OSCILLATOR**

XTAL1 and XTAL2 are input and output, respectively, of an inverting amplifier which can be configured for use as an On-chip Oscillator, as shown in Figure 5.9 Either a quartz crystal or a ceramic resonator may be used. The CKOPT Fuse selects between two different Oscillator amplifier modes. When CKOPT is programmed, the Oscillator output will oscillate a full rail-trail swing on the output. This mode is suitable when operating in a very noisy environment or when the output from XTAL2 drives a second clock buffer. This mode has a wide frequency range.

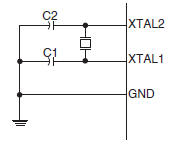


Fig2.20 Crystal Oscillator Connections

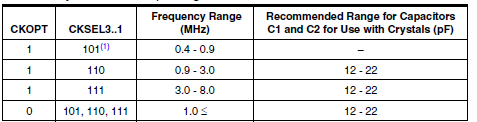


Table 2.1 Crystal Oscillator Operating Modes

When CKOPT is unprogrammed, the Oscillator has a smaller output swing. This reduces power consumption considerably. This mode has a limited frequency range and it cannot be used to drive other clock buffers. For resonators, the maximum frequency is 8MHz with CKOPT unprogrammed and 16MHz with CKOPT programmed. C1 and C2 should always be equal for both crystals and resonators. The optimal value of the capacitors depends on the crystal or resonator in use, the amount of stray capacitance, and the electromagnetic noise of the environment. Some initial guidelines for choosing capacitors for use with crystals are given in Table 2.1. For ceramic resonators, the capacitor values given by the manufacturer should be used.

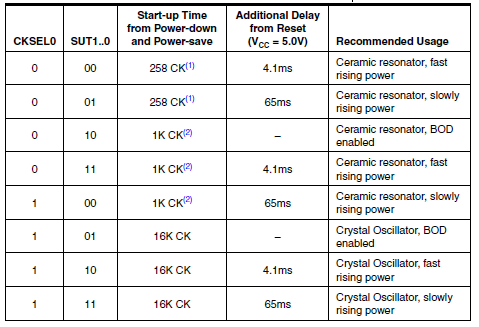


Table 2.2 Start-Up Times For The Crystal Oscillator Clock Selection

1. These options should only be used when not operating close to the maximum frequency of the device, and only if frequency stability at start-up is not important for the application. These options are not suitable for crystals
2. These options are intended for use with ceramic resonators and will ensure frequency stability at start-up. They can also be used with crystals when not operating close to the maximum frequency of the device, and if frequency stability at start-up is not important for the application.

**2.7 RELAY**

Relays are switching device. It is the heart of industrial electronic system. Every industrial electronic system required some type of switching device (or) relay. Depending on the basic force available for relay contact closing and opening there is several types of relays. Some of them are listed below:



Fig 2.21 Relays

* Electromagnetic or electrodynamics relays
* Gas or compressed air operated pneumatic relays
* Heat sensitive bimetallic.

Electromagnetic relays is form of electromagnets in which the coil current produces a magnetic effect to pull or push flat soft iron armatures of strips carrying relay contacts. Several relay contacts can be operated to get several possible ON/OFF combinations.

When an [electric current](http://en.wikipedia.org/wiki/Electric_current) is passed through the coil it generates a [magnetic field](http://en.wikipedia.org/wiki/Magnetic_field) that attracts the armature and the consequent movement of the movable contact either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces [arcing](http://en.wikipedia.org/wiki/Arcing).

When the coil is energized with [direct current](http://en.wikipedia.org/wiki/Direct_current), a [diode](http://en.wikipedia.org/wiki/Diode) is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a [voltage spike](http://en.wikipedia.org/wiki/Voltage_spike) dangerous to [semiconductor](http://en.wikipedia.org/wiki/Semiconductor) circuit components. Some automotive relays include a diode inside the relay case. Alternatively, a contact protection network consisting of a capacitor and resistor in series ([snubber](http://en.wikipedia.org/wiki/Snubber) circuit) may absorb the surge. If the coil is designed to be energized with [alternating current](http://en.wikipedia.org/wiki/Alternating_current) (AC), a small copper "shading ring" can be crimped to the end of the solenoid, creating a small out-of-phase current which increases the minimum pull on the armature during the AC cycle.

A solid-state relay uses a [thyristor](http://en.wikipedia.org/wiki/Thyristor) or other solid-state switching device, activated by the control signal, to switch the controlled load, instead of a solenoid. An [optocoupler](http://en.wikipedia.org/wiki/Optocoupler) (a [light-emitting diode](http://en.wikipedia.org/wiki/Light-emitting_diode) (LED) coupled with a [photo transistor](http://en.wikipedia.org/wiki/Photo_transistor)) can be used to isolate control and controlled circuits.

**2.8 LIQUID CRYSTAL DISPLAY (LCD)**

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.



Fig 2.22 Liquid Crystal Display (LCD)

One each polarizes are pasted outside the two glass panels. These polarizes would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarizes and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent.

When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by polarizes, which would result in activating highlighting the desired characters. The LCD’s are lightweight with only a few

RS-232C specifies 25 signal pins and it specifies that the DTE connector should be a male, and the DCE connector should be a female. A specific connector is not given, but the most commonly used connectors are the DB-25P male and the DB-25 signals pins female. The voltage levels for all RS-232C signals are as follows.

A logic high, or mark, is a voltage between –3V and –15 V under load (-25 V no-Load). A logic low or space is a voltage between +3 V and +15 under load (+25 V no load). Voltages such are ±12 V are commonly used. It contains 25 pins only.

**2.9 WIFI MODULE –ESP8266**

**2.9.1 FEATURES**

* 802.11 b/g/n
* Wi-Fi Direct (P2P), soft-AP
* Integrated TCP/IP protocol stack
* Integrated PLLs, regulators, DCXO and power management units

+19.5dBm output power in 802.11b mode

* Power down leakage current of <10uA
* 1MB Flash Memory
* Integrated low power 32-bit CPU could be used as application processor
* STBC, 1×1 MIMO, 2×1 MIMO
* A-MPDU & A-MSDU aggregation & 0.4ms guard interval
* Wake up and transmit packets in < 2ms
* Standby power consumption of < 1.0mW (DTIM3)

**2.9.2 DESCRIPTION**

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network.The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that’s just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

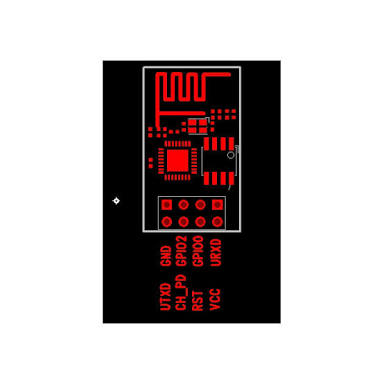


Fig 2.23 Wifi Module

**CHAPTER 3**

**CIRCUIT DIAGRAM**

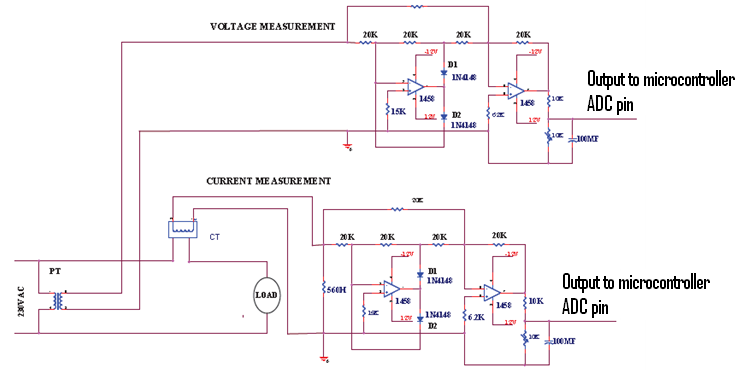


Fig 3.1 Circuit Diagram

**3.1 CIRCUIT EXPLAINATION**

**Voltage measurement:**

This circuit is designed to monitor the supply voltage. The supply voltage that has to monitor is step down by the potential transformer. Usually we are using the 0-6v potential transformer. The step down voltage is rectified by the precision rectifier. The precision rectifier is a configuration obtained with an operational amplifier in order to have a circuit behaving like an ideal diode or rectifier.

The full wave rectifier is the combination of half wave precision rectifier and summing amplifier. When the input voltage is negative, there is a negative voltage on the diode, too, so it works like an open circuit, there is no current in the load and the output voltage is zero. When the input is positive, it is amplified by the operational amplifier and it turns the diode on. There is current in the load and, because of the feedback, the output voltage is equal to the input.

In this case, when the input is greater than zero, D2 is ON and D1 is OFF, so the output is zero. When the input is less than zero, D2 is OFF and D1 is ON, and the output is like the input with an amplification of − *R*2 / *R*1. The full-wave rectifier depends on the fact that both the half-wave rectifier and the summing amplifier are precision circuits. It operates by producing an inverted half-wave-rectified signal and then adding that signalat double amplitude to the original signal in the summing amplifier. The result is a reversal of the selected polarity of the input signal.

Then the output of the rectified voltage is adjusted to 0-5v with the help of variable resistor VR1. Then given to ripples are filtered by the C1 capacitor. After the filtration the corresponding DC voltage is given to ADC or other related circuit.

**Current Measurement:**

This circuit is designed to monitor the supply current. The supply current that has to monitor is step down by the current transformer. The step down current is converted by the voltage with the help of shunt resistor. Then the converted voltage is rectified by the precision rectifier. The precision rectifier is a configuration obtained with an operational amplifier in order to have a circuit behaving like an ideal diode or rectifier.

The full wave rectifier is the combination of half wave precision rectifier and summing amplifier. When the input voltage is negative, there is a negative voltage on the diode, too, so it works like an open circuit, there is no current in the load and the output voltage is zero. When the input is positive, it is amplified by the operational amplifier and it turns the diode on. There is current in the load and, because of the feedback, the output voltage is equal to the input.

In this case, when the input is greater than zero, D2 is ON and D1 is OFF, so the output is zero. When the input is less than zero, D2 is OFF and D1 is ON, and the output is like the input with an amplification of − *R*2 / *R*1. The full-wave rectifier depends on the fact that both the half-wave rectifier and the summing amplifier are precision circuits. It operates by producing an inverted half-wave-rectified signal and then adding that signalat double amplitude to the original signal in the summing amplifier. The result is a reversal of the selected polarity of the input signal.

Then the output of the rectified voltage is adjusted to 0-5v with the help of variable resistor VR1. Then given to ripples are filtered by the C1 capacitor. After the filtration the corresponding DC voltage is given to ADC or other related circuit.

**Speed Measurement:**

An inductive proximity sensor has four components; The coil, oscillator, detection circuit and output circuit. The oscillator generates a fluctuating magnetic field the shape of a doughnut around the winding of the coil that locates in the device’s sensing face.

When a metal object moves into the inductive proximity sensor’s field of detection, Eddy circuits build up in the metallic object, magnetically push back, and finally reduce the Inductive sensor’s own oscillation field. The sensor’s detection circuit monitors the oscillator’s strength and triggers an output from the output circuitry when the oscillator becomes reduced to a sufficient level.

**CHAPTER-4**

**MICROCONTROLLER PROGRAM**

#include <SoftwareSerial.h>

#include <stdlib.h>

#include <LiquidCrystal.h>

LiquidCrystal lcd(12, 11, 10, 9, 8, 7);

int sensorPin0 = A0;// R -voltage

int sensorPin1 = A1;// Y -voltage

int sensorPin2 = A2;// B -voltage

int sensorPin3 = A3;// R -current

int sensorPin4 = A4;// Y -current

int sensorPin5 = A5;// B -current

int speed; //speed

int temperature; //temperature

const int ledPin = 5; // speedsensor?

const int rlyPin = 6;

int sensorState = 0; // tempsensor ?

String apiKey = "ETWI0YZCDOHZA6BN"; //Thingspeak api

// connect 2 to TX of Serial USB [GREEN]

// connect 4 to RX of serial USB [ORANGE]

SoftwareSerial ser(3,4); // RX, TX any digital pin

int k=0,motoff;

int r\_volt,y\_volt,b\_volt,sec,msec;

int r\_amp,y\_amp,b\_amp,interruptt,sped;

void decimal3(unsigned int col,unsigned int row,unsigned int value);

void decimal3c(unsigned int col,unsigned int row,unsigned int value);

void Lcd8\_Decimal4(unsigned int col,unsigned int row,unsigned int val);

//unsigned int current\_measure(char channel);

unsigned int calibrate(unsigned int adc\_val);

void timer\_init();

void setup()

{

pinMode(ledPin, INPUT);

pinMode(rlyPin, OUTPUT);

//esp setup

Serial.begin(9600);// enable debug serial

ser.begin(115200);// enable software serial

ser.println("AT+RST");// restart ESP8266

attachInterrupt(0, blink1, RISING);

digitalWrite(rlyPin, LOW);

// Serial.begin(9600);

lcd.begin(20, 4);lcd.setCursor(0, 1);

lcd.print("MONITORING&CNTRLLING");

lcd.setCursor(0, 2);

lcd.print("OF 3 PHASE INDUCTION");

lcd.setCursor(0, 3);

lcd.print(" MOTOR ");

delay(3000);delay(3000);

lcd.setCursor(0, 1);

lcd.print(" ");

lcd.setCursor(0, 2);

lcd.print(" ");

lcd.setCursor(0, 3);

lcd.print(" ");

//delay(3000);

lcd.setCursor(0, 1);

lcd.print("V");

lcd.setCursor(3, 0);

lcd.print("R:");

lcd.setCursor(7, 0);

lcd.print("Y:");

lcd.setCursor(11, 0);

lcd.print("B:");

lcd.setCursor(0, 2);

lcd.print("A");

lcd.setCursor(0, 3);

lcd.print("S:");

timer\_init();

}

void loop()

{

r\_volt = analogRead(sensorPin0);

y\_volt = analogRead(sensorPin1);

b\_volt = analogRead(sensorPin2);

// speed and temperature

speed = random(1100,1200);

temperature = random(30,35);

//decimal3(3,1,msec);

/\*decimal3(3,3,msec);

decimal3(7,3,interruptt);\*/

Lcd8\_Decimal4(3,3,sped);

r\_volt=r\_volt>>2;

decimal3(3,1,r\_volt);

y\_volt=y\_volt>>2;

decimal3(8,1,y\_volt);

b\_volt=b\_volt>>2;

decimal3(12,1 ,b\_volt);

r\_amp=1.732\*analogRead(sensorPin3);

y\_amp=1.732\*analogRead(sensorPin4);

b\_amp=1.732\*analogRead(sensorPin5);

r\_amp=r\_amp>>2;

//decimal3c(3,3,r\_amp);

y\_amp=y\_amp>>2;

//decimal3c(8,3,y\_amp);

b\_amp=b\_amp>>2;

//decimal3c(13,3,b\_amp);

/\*r\_amp=calibrate(r\_amp);

y\_amp=calibrate(y\_amp);

b\_amp=calibrate(b\_amp);\*/

decimal3c(3,2,r\_amp);

decimal3c(8,2,y\_amp);

decimal3c(13,2,b\_amp);

if (r\_volt<180 || r\_volt>240){motoff=0;}

else if (y\_volt<180 || y\_volt>240){motoff=0;}

else if (b\_volt<180 || b\_volt>240){motoff=0;}

else if (r\_amp>70){motoff=0;}

else if (y\_amp>70){motoff=0;}

else if (b\_amp>70){motoff=0;}

else {motoff=1;}

sensorState = digitalRead(ledPin);

// relay section

if(sensorState==1)

{

lcd.setCursor(7, 3);

lcd.print("OVER TEMP ");

}

else

{

lcd.setCursor(7, 3);

lcd.print("NORMAL TEMP");

}

if(sensorState==0 && motoff==1)

{

digitalWrite(rlyPin, LOW);

}

else

{

digitalWrite(rlyPin, HIGH);

}

// THINGSPEAK SECTION

// TCP connection

String cmd = "AT+CIPSTART=\"TCP\",\"";

cmd += "184.106.153.149"; // api.thingspeak.com

cmd += "\",80";

ser.println(cmd);

if(ser.find("Error")){

Serial.println("AT+CIPSTART error");

return;

}

// prepare GET string

String getStr = "GET /update?api\_key=";

getStr += apiKey;

// field1 - R volt

getStr +="&field1=";

getStr += String(r\_volt);

// field2 - Y volt

getStr +="&field2=";

getStr += String(y\_volt);

// field3 - B volt

getStr +="&field3=";

getStr += String(b\_volt);

// field4 - R Amp

getStr +="&field4=";

getStr += String(r\_amp);

// field5 - Y Amp

getStr +="&field5=";

getStr += String(y\_amp);

// field6 - B Amp

getStr +="&field6=";

getStr += String(b\_amp);

// field7 - speed

getStr +="&field7=";

getStr += String(speed);

// field8 - temperature

getStr +="&field8=";

getStr += String(temperature);

getStr += "\r\n\r\n";

// send data length

cmd = "AT+CIPSEND=";

cmd += String(getStr.length());

ser.println(cmd);

if(ser.find(">")){

ser.print(getStr);

}

else{

ser.println("AT+CIPCLOSE");

// alert user

Serial.println("AT+CIPCLOSE");

}

delay(1000); // delay for function execution

}

unsigned int calibrate(unsigned int adc\_val)

{

int temp=0;

temp=((0.7407407407407407\*adc\_val) -71.11111111111111);

// else temp=0;

return temp;

}

ISR(TIMER1\_COMPA\_vect)

{

// cli();

msec++;

//if(msec>2){msec=0;sec++;}

//TCCR1A = 0xff; // set entire TCCR1A register to 0

//TCCR1B = 0x00; // same for TCCR1B

// sei();

if(msec>2)

{msec=0;sped=interruptt;interruptt=0;}

}

void timer\_init()

{

cli(); // disable global interrupts

TCCR1A = 0; // set entire TCCR1A register to 0

TCCR1B = 0; // same for TCCR1B

// set compare match register to desired timer count:

OCR1A=20000;

//OCR1A = 1;

// turn on CTC mode:

TCCR1B |= (1 << WGM12);

// Set CS10 and CS12 bits for 1024 prescaler:

TCCR1B |= (1 << CS10);

TCCR1B |= (1 << CS12);

// enable timer compare interrupt:

TIMSK1 |= (1 << OCIE1A);

sei();

}

/\*

unsigned int current\_measure(char channel)

{

unsigned int k,last\_val,temp\_val;

for(k=0;k<=50;k++)

{

if(channel==3)temp\_val=analogRead(sensorPin3);

if(channel==4)temp\_val=analogRead(sensorPin4);

if(channel==5)temp\_val=analogRead(sensorPin5);

if(temp\_val>=last\_val)

{

last\_val=temp\_val;

}

}

return(last\_val;)

}

\*/

void decimal3(unsigned int col,unsigned int row,unsigned int value)

{

lcd.setCursor(col+0, row);

lcd.print(value/100);

lcd.setCursor(col+1, row);

lcd.print((value%100)/10);

lcd.setCursor(col+2, row);

value=(value%100);

lcd.print(value%10);

}

void decimal3c(unsigned int col,unsigned int row,unsigned int value)

{

lcd.setCursor(col+0, row);

lcd.print(value/100);

lcd.setCursor(col+1, row);

lcd.print((value%100)/10);

lcd.setCursor(col+2, row);

lcd.print('.');

lcd.setCursor(col+3, row);

value=(value%100);

lcd.print(value%10);

}

void Lcd8\_Decimal4(unsigned int col,unsigned int row,unsigned int val)

{

unsigned int Lcd\_th,Lcd\_thr,Lcd\_h,Lcd\_hr,Lcd\_t,Lcd\_o;

val = val%10000;

Lcd\_th=val/1000;

Lcd\_thr=val%1000;

Lcd\_h=Lcd\_thr/100;

Lcd\_hr=Lcd\_thr%100;

Lcd\_t=Lcd\_hr/10;

Lcd\_o=Lcd\_hr%10;

lcd.setCursor(col+0, row);

lcd.print(Lcd\_th);

lcd.setCursor(col+1, row);

lcd.print(Lcd\_h);

lcd.setCursor(col+2, row);

lcd.print(Lcd\_t);

lcd.setCursor(col+3, row);

lcd.print(Lcd\_o);

}

void blink1() //External Interrupt service routine

{

interruptt++;

}

**CHAPTER-5**

**APPLICATIONS**

Capturing motor data from remote locations and storage of this data in a comprehensive database provides time correlated motor performance,and the motor's condition. In addition, displaying historical operational data of a motor would show to maintenance personnel the trends in operating parameters that would help predict motor operation and greatly enhance plant service maintenance also flexibilizing the accessibility of collected data through a website with a comprehensive dashboard and Real-time Graphs.

**CHAPTER 6**

**CONCLUSION AND FUTURE SCOPE**

Protection of three phase induction motor from under voltage, single phasing, over current and phase reversal provide the smooth running of motor improves its lifetime and efficiency. Generally these faults generated when supply system is violating its rating. In three phase induction motor when running at rated voltage, current and load these faults are not generated. For smooth running of motor generally concentration on supply voltage under the prescribe limit and load which is driven by the motor should also be under the specified limit.

Thus the the induction motor vital parameters such as Load voltage,Load current,Speed and temperature can be monitored off-site from remote locations through a communication link between the on-site motor monitoring unit(Arduino) and the off-site computer, wherein the communications link is internet.These values are uploaded into a web based server automatically. Also, in the event of abnormal motor performance such as under-voltage,over-current and over-temperature a notification is sent to the maintenance personnel off-site in order to initiate the fault detection and diagnosis of motor.

**CHAPTER-7**

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