Government Polytechnic, Kolhapur

An Autonomous Institute of Government of Maharashtra

A

PROJECT REPORT ON

"Electronic Clutch for single phase induction motor"

SUBMITTED BY

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Under valuable Guidance of

Prof C.S.Prabhu

DEPARTMENT OF INDUSTRIAL ELECTRONICS

Year 2013-2014

Government Polytechnic, Kolhapur

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CERTIFICATE

THIS IS TO CERTIFY THAT

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SUDENT OF THIRD YEAR INDUSTRIAL ELECTRONICS HAVE SATISFACTORILY COMPLETED THE PROJECT REPORT ON

"**Electronic Clutch for single phase induction motor**" UNDER MY SUPERVISION & GUIDANCE IN ACADAMIC YEAR 2013-2014

PLACE: Kolhapur

DATE:

GUIDE **EXT. EXAMINER** **H.O.D.**

(Prof.C.S.Prabhu) **(Mr. R.K. Sawant)**

ACKNOWLEDGEMENT

"A few words to place record emotions heart full thanks are no doubt necessary however incapable they doing on."

We express our deep respect and gratitude from bottom of our hearts to our guide Prof.C.S.Prabhu for a valuable guidance, inspiration and encouragement. Her valuable guidance in this project work helped us to reach our destination.

We also express sincere thanks to Prof (Principal), Prof (H.O.D.) and all concerned staff members of Industrial Electronics Department for providing a valuable guidance and all required facilities for carrying out this project work.

We also take opportunity to thanks to college for providing us library and internet facilities for carrying out this project work.

We also give our gratitude to our parents to support us and to provide all guidance.

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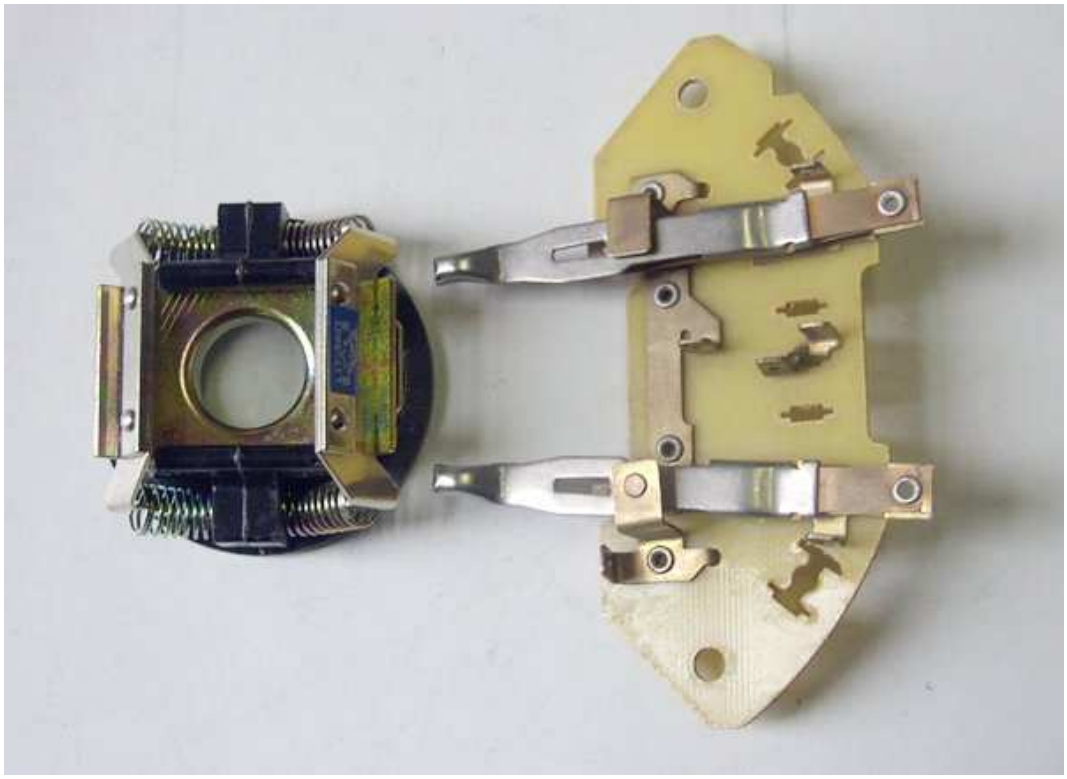
Introduction

We are presenting here a project named Electronic Clutch for Single phase induction motor. Instead of using centrifugal clutch for changeover from starting winding to running winding we are going to use electronic clutch for single phase induction motor. This electronic clutch will be made up of contactless tachometer, arduino board as a control circuit and SSR. Arduino board will be used to check RPM of motor at a given time and to switch the motor winding at appropriate speed. Normal changeover speed is around 75-80 % of the motor running speed.

Earlier Mechanical system using Centrifugal Clutch



A centrifugal switch is an electric switch that operates using the centrifugal force created from a rotating shaft, most commonly that of an electric motor or gasoline engine. The switch is designed to activate or de-activate as a function of the rotational speed of the shaft.

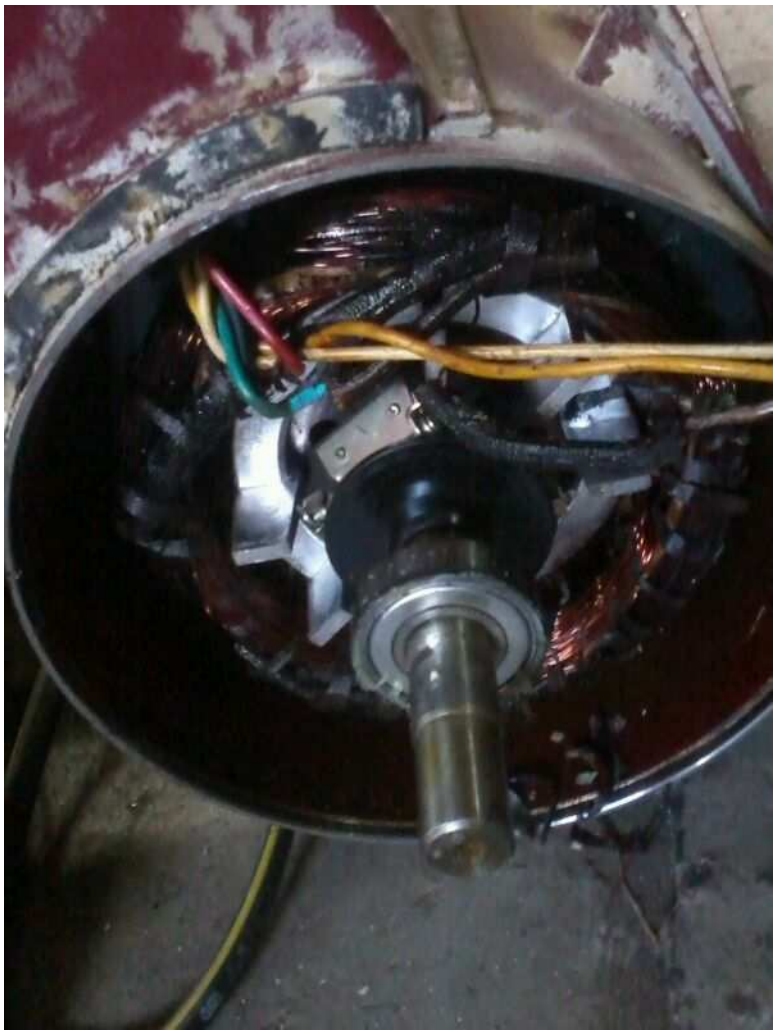
Perhaps the most common use of centrifugal switches is within single-phase, split-phase induction motors. Here, the switch is used to disconnect the starting winding of the motor once the motor approaches its normal operating speed.

In this case, the centrifugal switch consists of weights mounted to the shaft of the motor and held near the shaft by spring force. At rest, levers attached to the weights press a low-friction, non-conductive plate against a set of electrical contacts mounted to the motor housing, closing the contacts and connecting the starting winding to the power source.

When the motor approaches its normal operating speed, centrifugal force overcomes the spring force and the weights swing out, raising the plate away from the electrical contacts. This allows the contacts to open and disconnects the starting winding from the power source; the motor then continues operating solely using its running winding. Motors using such a centrifugal switch make a distinct clicking noise when starting and stopping as the centrifugal switch opens and closes.

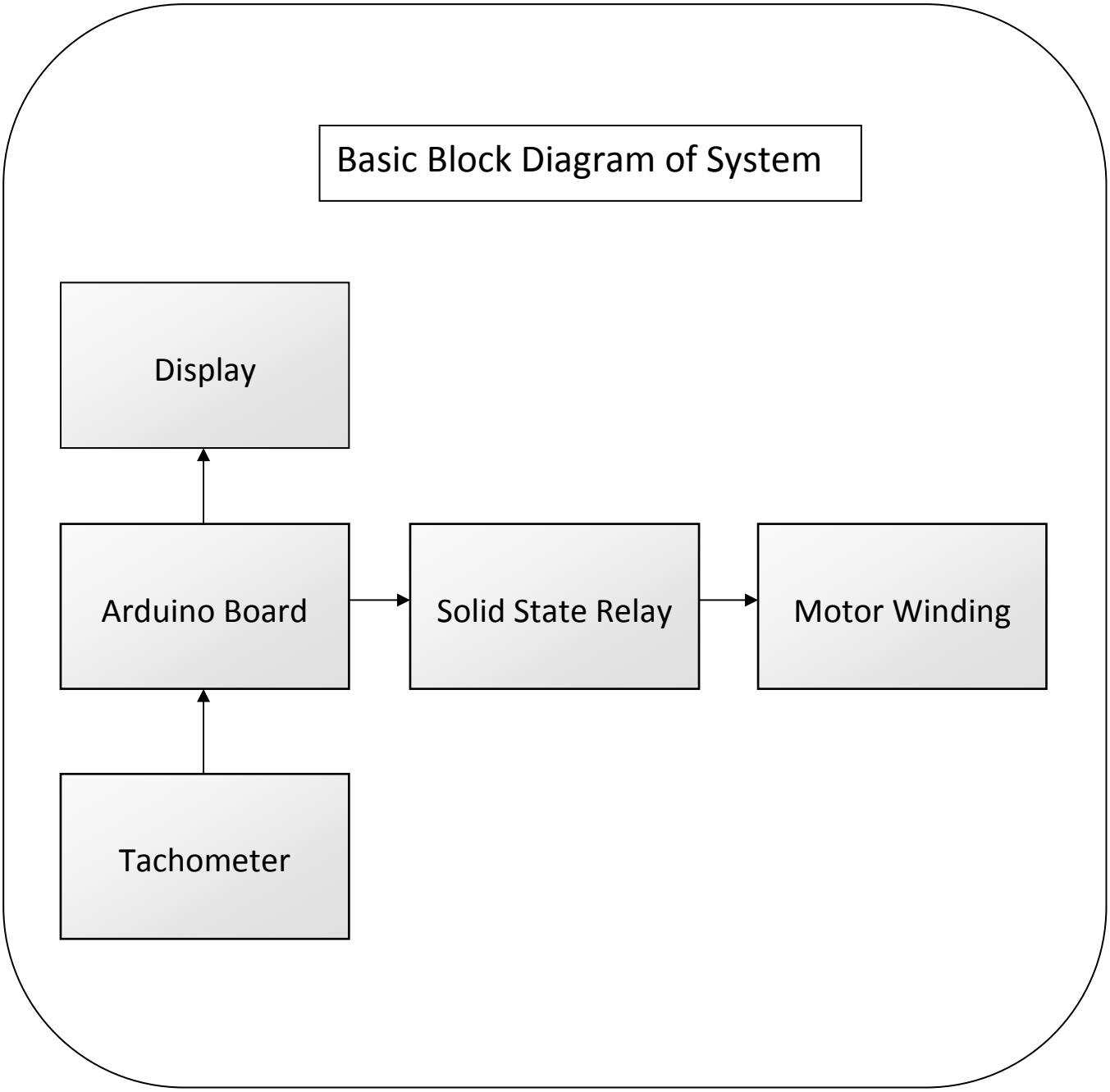
A variation of the centrifugal switch used a changeover contact to ensure that the auxiliary windings remain in the circuit through a running capacitor. These motors are called two-value or capacitor start capacitor run motors.

Recent problems



- Burning of motor winding due to over current during start conditions.
- In the varying load conditions the mechanical clutch was unable to switch the motor winding at appropriate speed which may lead to increase in starting current thereby increasing the chances of burning motor winding.

- Heating of motor winding which leads to loss of energy in motor winding.
- Mechanical action of centrifugal clutch is less accurate as compared to electronic systems.
- Frequent reverse-forward motion of single phase induction motor was not possible with the use of mechanical clutch systems.
- There is chance of improper functioning of mechanical clutch in the motor due to hammering to the shaft during fitting of pulley on the shaft.
- Chance of failure due to improper function of spring in the mechanical clutch.

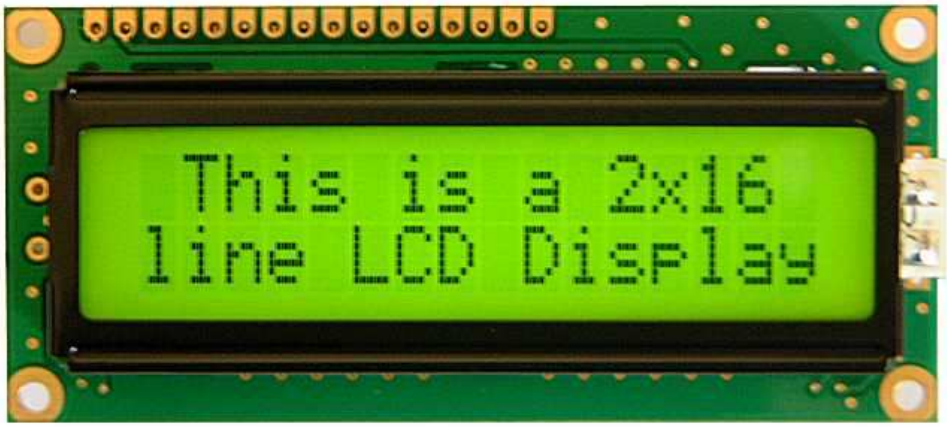

Basic Block Diagram of System
Display
Arduino Board
Solid State Relay
Motor Winding
Tachometer

Parts of the system

- Arduino UNO R3 w/ ATmega328
- LCD 16*2 Display
- IR LED
- IR Phototransistor
- 5V DC Relay
- Solid State Relay
- Transistor BC547

Functional Description

LCD Interfacing



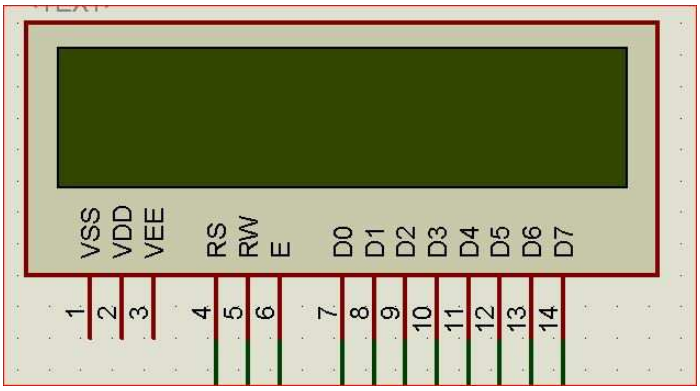
LCD'S are widely used nowadays since they consume less power as compared to LED's. This allows the display to be battery operated for example mobile phones or calculators. LCD's are also more flexible in terms of size, shape and permits combination of numbers, letters, words and graphics with simple interfaces.

By using refreshing controllers into LCD, the burden on CPU can be reduced. Also they are easy to program. An LCD consists of a liquid-crystal material that behaves electrically as a capacitor and uses alternately current voltage to change the light reflectivity. The ability to display numbers, characters, and graphics of LCD display.

The LCD that we will study in this section is of two lines and 16 characters per line. (2x16 char.) It has 14 pins. The functions of each pin is given in the below table

Pin	Symbol	I/O	Description
1	V_{SS}	–	Ground
2	V_{CC}	–	+ 5V supply.
3	V_{EE}	–	Power supply to control contrast
4	RS	I	RS = 0 selects command register RS = 1 selects data register
5	R/W	I	R/W = 0 for write R/W = 1 for read
6	E	I/O	Enable
7	DB0	I/O	8 bit data bus
8	DB1	I/O	8 bit data bus
9	DB2	I/O	8 bit data bus
10	DB3	I/O	8 bit data bus
11	DB4	I/O	8 bit data bus
12	DB5	I/O	8 bit data bus
13	DB6	I/O	8 bit data bus
14	DB7	I/O	8 bit data bus

The 2x16 character LCD display has 14 pins. The function of each pin as follow Vcc, Vss, and VEE.



VCC and VSS :- It provide +5V and ground, respectively,.

VEE:- It is used for controlling LCD contrast.

RS (Register Select):- There two very important registers inside the LCD. The RS pin is used for their selection as follows.

If RS = 0, the instruction command code register is selected, allowing the user to send a command such as clear display, cursor at home, etc.

If RS = I the data register is selected, allowing the user to send data to be displayed on the LCD.

R/W (Read/ Write):- R/W input allows the user to write information to the LCD or read information from it.

R/W = 1 when reading operation done; R/W =0 when writing operation occurs.

EN (Enable) :- The enable pin is used by the LCD to latch information presented to its data pins. When data is supplied to data pins, a high-to-low pulse must be applied to this pin in order for the LCD to latch in the data present at the data pins. This pulse must be a minimum of 450 ns wide,

Relays

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. It was invented by Joseph Henry in 1835. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be broad sense, a form of an electrical amplifier.

Despite the speed of technological developments, some products prove so popular that their key parameters and design features remain virtually unchanged for years. One such product is the ‘sugar cube’ relay, shown in the figure above, which has proved useful to many designers who needed to switch up to 10A, whilst using relatively little PCB are since relays are switches, the terminology applied to switches is also applied to relays. A relay will switch one or more poles, each of whose contacts can be thrown by energizing the coil in one of three ways:

1) **Normally-open (NO)** contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a FORM A contact or “make” contact.

2)**Normally-closed (NC)**contacts disconnect the circuit when the relay is activated; the circuit is connected when relay is inactive. It is also called FORM B contact or “break” contact.

3)**Change-over or double-throw** contacts control two circuit; one normally open contact and one normally closed contact with a common terminal. It is also called a FORM C or "transfer" contact.

The following types of relays are commonly encountered:-

- **SPST-** Single Pole Single Throw: These have two terminals which can be connected or disconnected. Including two for the coil, such a relay has four terminals in total. It is ambiguous whether the pole is normally open or closed. The terminology "SPNO" and "SPNC" is sometimes used to resolve the ambiguity.
- **SPDT-** Single Pole Double Throw: A common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.
- **DPST-** Double Pole Single Throw: These have two pairs of terminals. Equivalent to two SPST switches or relays actuated by a single coil. Including two for the coil, such a relay has six terminals in total. It is ambiguous whether the poles are normally open or closed, or one of each.
- **DPDT-** Double Pole Double Throw: These have two rows of change-over terminals. Equivalent to two SPDT switches or relays actuated by a single coil. Such a relay has eight terminals, including the coil.
- **QPDT-** Quadruple Pole Double Throw: Often referred to as Quad Pole Double Throw, or 4PDT. These have four rows of change-over terminals. Equivalent to four SPDT switches or relays actuated by a single coil, or two DPDT relays. In total, fourteen terminals including the coil.

Infrared LED

An IR LED, also known as IR transmitter, is a special purpose LED that transmits infrared rays in the range of 760 nm wavelength. Such LEDs are usually made of gallium arsenide or aluminium gallium arsenide. They, along with IR receivers, are commonly used as sensors.

The appearance is same as a common LED. Since the human eye cannot see the infrared radiations, it is not possible for a person to identify whether the IR LED is working or not, unlike a common LED. To overcome this problem, the camera on a cellphone can be used. The camera can show us the IR rays being emanated from the IR LED in a circuit.

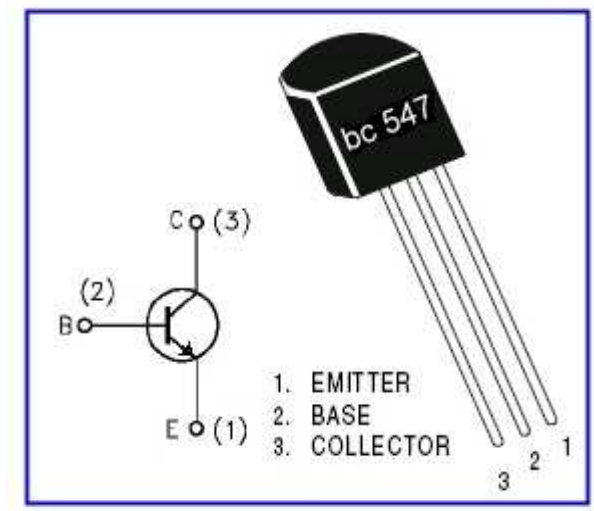
IR Phototransistor

There are several ways to detect infrared light in an electronic circuit, but the most common is with a device called a **phototransistor**.

In a phototransistor, the base isn't a separate terminal that's connected to a voltage source in your circuit. Instead, the base is exposed to light. When infrared light hits the base, the energy in the light is converted to voltage, and the emitter-collector path conducts.

Thus, infrared light hitting the base has the same effect as voltage on the base of a traditional transistor: The infrared light turns the transistor on. The brighter the infrared light, the better the emitter-collector path conducts.

BC 547



BC547 is an NPN bi-polar junction transistor. A transistor, stands for transfer of resistance, is commonly used to amplify current. A small current at its base controls a larger current at collector & emitter terminals.

BC547 is mainly used for amplification and switching purposes. It has a maximum current gain of 800. Its equivalent transistors are BC548 and BC549.

The transistor terminals require a fixed DC voltage to operate in the desired region of its characteristic curves. This is known as the biasing. For amplification applications, the transistor is biased such that it is partly on for all input conditions. The input signal at base is amplified and taken at the emitter. BC547 is used in common emitter configuration for amplifiers. The voltage divider is the commonly used biasing mode. For switching applications, transistor is biased so that it remains fully on if there is a signal at its base. In the absence of base signal, it gets completely off.

Absolute Maximum Ratings T_a=25°C unless otherwise noted

Symbol	Parameter		Value	Units
V_{CBO}	Collector-Base Voltage	: BC546	80	V
		: BC547/550	50	V
		: BC548/549	30	V
V_{CEO}	Collector-Emitter Voltage	: BC546	65	V
		: BC547/550	45	V
		: BC548/549	30	V
V_{EBO}	Emitter-Base Voltage	: BC546/547	6	V
		: BC548/549/550	5	V
I_C	Collector Current (DC)		100	mA
P_C	Collector Power Dissipation		500	mW
T_J	Junction Temperature		150	°C
T_{STG}	Storage Temperature		-65 ~ 150	°C

Arduino Uno R3 (Atmega328)

Arduino is a microcontroller platform that can be used to control almost any electronic device/equipment. Imagine yourself controlling the lights and any appliances inside your house by using sensors or texting them using mobile phone or controlling them via internet and the like. And you don't need to pay anyone to do it because doing it is so easy that even kids can make. That's what Arduino can bring us – making complicated things in a very simple and easy way. Having its Input and Output pins exposed, we can connect input and output devices into it such as switch, sensors, keypad, led, motors, relays, LCD, 7 segment display, etc. Simply program the Arduino to react to any inputs and control whatever output device that is connected to it and we already have a special purpose computer that can control whatever we want it to control.

Now that we already know its capabilities, it's time to know our controller board more. It's gonna be a little bit techy but don't worry I'll try to explain it the easiest way possible.

Arduino is using ATmega microcontroller as its main chip. It is an open-source hardware and software which allows anyone to use it without paying for costly compilers. It is using C programming language but it has a lot of available libraries that makes the programming very easy. It also has its own IDE (Integrated Development Environment) and compiler that is free. There is no need for an external programmer to program the Arduino (such as pickit3 for PIC microcontrollers). Just connect the Arduino board to the USB port of the computer, install its USB driver and you should be able to program it right away.


RST
AREF
GND
DIGITAL
ARDUINO
UNO
PWR
SUNROM.COM
RESET-EN
POWER
ANALOG IN

The new Uno R3 is the latest version after the Duemilanove, with an improved USB interface chip. Like the Duemilanove, it not only has an expanded shield header with a 3.3V reference and a RESET pin (which solves the problem of how to get to the RESET pin in a shield) AND a 500mA fuse to protect your computer's USB port, but ALSO an automatic circuit to select USB or DC power without a jumper!

The Uno is pin and code-compatible with the Duemilanove, Diecimilla and older Arduinos so all your shields, libraries, code will still work. The new R3 (3rd revision) of the UNO has a few minor updates, with an upgrade to the USB interface chip and additional breakouts for the i2c pins and an IO Ref pin.

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, Max/MSP).

The Arduino Uno R3 requires the Arduino 1.0 drivers folder in order to install properly on some computers. We have tested and confirmed that the R3 can be programmed in older versions of the IDE. However, the first time using the R3 on a new computer, you will need to have Arduino 1.0 installed on that machine. If you are interested in reading more about the changes to the IDE, check out the official

Features

- ATmega328 microcontroller
- Input voltage - 7-12V
- 14 Digital I/O Pins (6 PWM outputs)
- 6 Analog Inputs
- 32k Flash Memory
- 16Mhz Clock Speed

Advantages

- **Price** – being one of the cheapest development board,
- **Cross Platform** – it can run in Windows, Mac and Linux operating systems,
- **Simple and easy to use programming environment** – it has a user friendly easy to use programming environment making it pleasing for the beginners but flexible enough for the advanced users.
- **Open source hardware and software** – as I mentioned, it is free which allows anyone to use it without paying for the costly compilers.

Solid State Relay

A **solid-state relay (SSR)** is an electronic switching device that switches states when an external voltage is applied along its n-type and p-type junctions. SSR has a small control signal that controls a larger load current or voltage. It consists of a sensor which responds to an appropriate input (control signal), a solid-state electronic switching device which switches power to the load circuitry, and some coupling mechanism to enable the control signal to activate this switch without mechanical parts. The relay may be designed to switch either AC or DC to the load. It serves the same function as an electromechanical relay, but has no moving parts.

Solid-state relays are composed of semiconductor materials, including thyristors and transistors. Solid-state relays have current ratings that extend from a few microamps for low-power packages up to around a hundred amps for high-power packages. Solid-state relays have extremely fast switching speeds usually ranging between 1 to 100 nanoseconds. Solid-state relays are not easily affected by contact wear.

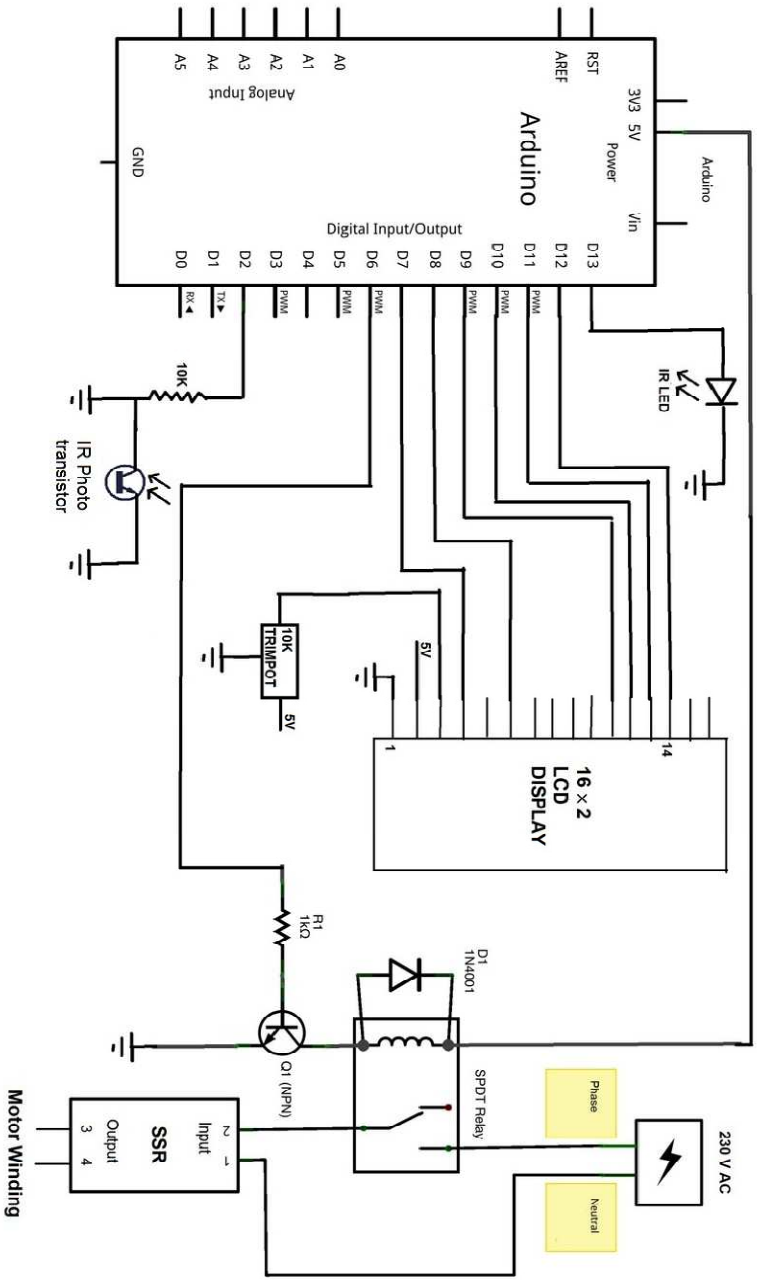
Advantages over mechanical relays

Most of the relative advantages of solid state and electromechanical relays are common to all solid-state as against electromechanical devices.

- SSRs are faster than electromechanical relays; their switching time is dependent on the time needed to power the LED on and off, of the order of microseconds to milliseconds
- Increased lifetime, particularly if activated many times, as there are no moving parts to wear and no contacts to pit or build up carbon
- Output resistance remains constant regardless of amount of use
- Clean, bounceless operation
- No sparking, allowing use in explosive environments where it is critical that no spark is generated during switching
- Totally silent operation
- Inherently smaller than a mechanical relay of similar specification (if desired may have the same "casing" form factor for interchangeability).
- Much less sensitive to storage and operating environment factors such as mechanical shock, vibration, humidity, and external magnetic fields.

Specifications			
Sr. No.	**Electrical Parameter**	**Value**	**Units**
1.	Input voltage range	230 or 04-32	V.AC. V.DC.
2.	Max input current	20 or 30	MA. AC. MA.DC
3.	Zero cross voltage	15	V. AC.
4.	RMS on state current	10, 16, 25, 40, 50, 60	A. AC.
5.	RMS on state voltage	1.8 or 3.0	V. AC.
6.	Peak rep. off state voltage	600, 800, 1200	V. PK.
7.	Half cycle surge current For 10m. sec.	100, 150, 250,300	AMPS.
8.	Critical rate of rise of off state voltage	200	V / usec.
9.	Isolation voltage	1500	V. AC.
10.	Response time(max)	10 or 1	m. sec.

Circuit Diagram



Programming

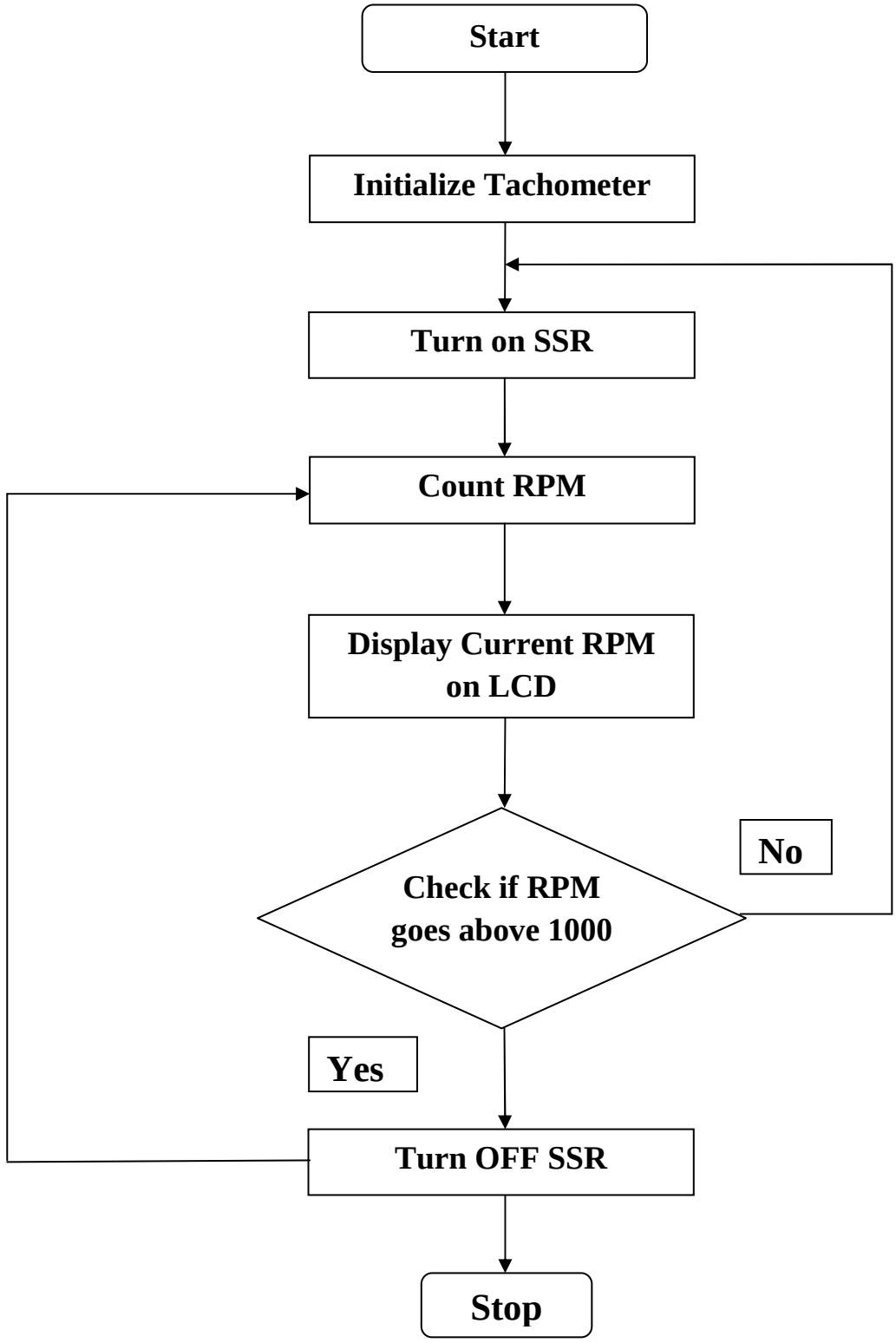
```
int ledPin = 13;
int outpin = 6;
volatile byte rpmcount;
unsigned int rpm;
unsigned long timeold;
#include <LiquidCrystal.h>
LiquidCrystal lcd(7, 8, 9, 10, 11, 12);
void rpm_fun()
{
rpmcount++;
}
void setup()
{
lcd.begin(16, 2);
attachInterrupt(0, rpm_fun, FALLING);
pinMode(ledPin, OUTPUT);
digitalWrite(ledPin, HIGH);
pinMode(outpin, OUTPUT);
digitalWrite(outpin, HIGH);
rpmcount = 0;
rpm = 0;
timeold = 0;
}
void loop()
{
delay(1000);
detachInterrupt(0);
rpm = 60*1000/(millis() - timeold)*rpmcount;
timeold = millis();
rpmcount = 0;
```

```
lcd.clear();
lcd.print("RPM=");
lcd.print(rpm);
if(rpm > 1000)
digitalWrite (outpin, LOW);
else
digitalWrite (outpin, HIGH);
attachInterrupt(0, rpm_fun, FALLING);
}
```

Working

It is microcontroller based system. In this system the contactless tachometer is formed using IR led and IR phototransistor. During starting condition the starting winding of motor is considered in circuit. So first of all the SSR is turned on so that the starting winding is now in parallel with running winding and fully operational. The real time speed of the induction motor is checked continuously and displayed on LCD with the help of contactless tachometer. The normal changeover speed is around 75-80% of the normal speed of motor. Here we are going to use single phase induction motor with 1400 RPM for demonstration purpose. So the changeover speed will be around 1000 RPM. When the motor RPM will be greater than 1000 RPM the SSR will be made turned OFF and starting winding will be cut off from the circuit. The controller continues to check RPM of motor at runtime. Whenever the RPM falls below 1000 RPM it again turns ON the SSR to increase speed of the motor to normal speed.

Flowchart


Start
Initialize Tachometer
Turn on SSR
Count RPM
Display Current RPM on LCD
Check if RPM goes above 1000
No
Yes
Turn OFF SSR
Stop

Advantages & Limitations

Advantages

- High accuracy as compared to previous mechanical systems.
- We can adjust the changeover speed of winding according to the load condition.
- We can avoid chances of burning of motor.

Limitations

This system costs more than the earlier mechanical system.

Applications & Future Scope

Applications

This circuit is made for the single phase induction motor.

Future Scope

- We can use current sensing along with RPM sensing to improve accuracy further.
- We can add power monitoring to the circuit for monitoring motor power consumption.
- We can add soft starting circuit to improve motor starting torque and to avoid starting kick.
- We can reduce size of this circuit by using SMD components and make this fitted in motor terminal box.

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