# "Electronic starter for DC motors"

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***Abstract*** *The objective of our project is to use the automatic starter for the starting of the dc motor. Commonly 3-point or 4-point starters are used for starting of dc motors. In our project, the device based on the triggering of the thyristors is used. This reduces the mechanical stress on the motor and thus increases the life of the motor.*

*At the time of starting, the value of armature current is very high and in order to limit the high starting current a resistor is connected in between the supply and dc motor. Resistor is divided in several parts and across each part thyristors are connected parallel to it. When dc supply is connected to motor, due to presence of resistor in between supply and motor, motor will get less voltage and current than the rated voltage and rated current. So, at start motor will start slowly. In order to cut out the resistors thyristors have to be fired after specific intervals.*

***Keywords:*** *Triac, DC motor, Arduino UNO*

## [I] Introduction

The need of starters for DC motors is to reduce the armature current at starting. At standstill, the back emf is zero and resistance of the armature circuit is very small. So, a large amount of armature current flows at starting. This large armature current may damage the armature winding. In order to limit that current different methods of starting are employed. Commonly, 3-point and 4-point starters are used.

3-point and 4-point starters are variable resistance, integrated into number of sections. At the time of starting, the entire resistance comes in series with the armature circuit and high stating armature current gets limited. As the handle is moved over the different sections of resistance, it gradually cut off the series resistances from the armature circuit as motor gathers speed. This results in incearsed machine wear as rapid acceleration causes damaging torque transients and high peak currents.

Electronic starters solve the problem through controlling the application of current during acceleration. These are static starters that use semiconductor devices such as SCRs, TRIAC, IGBT etc for controlling the starting armature current. Here are few objectives of the electronic starter:-

- Reduced starting current and torque.
- Elimination of mechanical stress and electrical transients.
- Increase the life of the motor.

## [II] Block Diagram

The block diagram consists of power supply block, microcontroller circuitry and trigger circuitry.

The 220 volt AC supply is stepped down, rectified by diode rectifier and regulated to 5 volt dc by filter and regulator circuitry. This supply is provided to Arduino Uno board. The output of board is applied to trigger circuitry which in turn provides pulses to triacs.

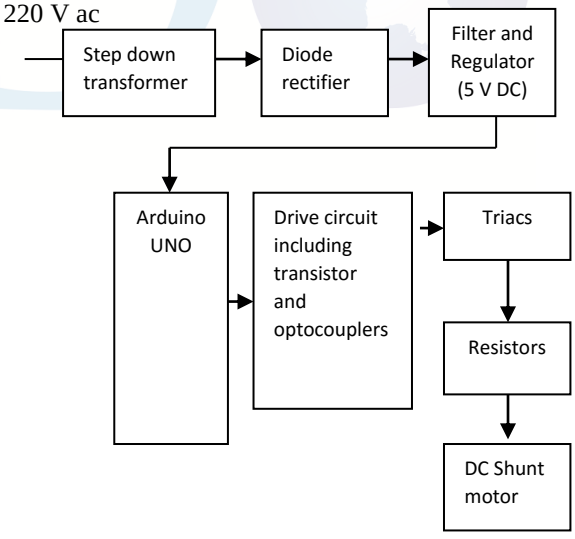


**Fig.1: Block diagram**

## [II]Hardware Description

### DC shunt motor

The DC shunt motor used here has following ratings:
H.P rating: 0.5 hp
Voltage rating: 220 V
Current rating: 2 Amp

R.P.M: 1500


**Fig.2: DC Shunt motor**

## Power Supply

The AC supply is applied to 12V step down transformer. The transformer output is 12 V AC which is rectified by using diode and filter circuit and converted into the 12/5 V DC supply.

## Arduino UNO

Arduino UNO is a microcontroller board. It has 14 digital input/ output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack and a reset button. The board can operate on external supply of 7 to 12 volts. It has 32 KB of flash memory for storing code. It has also 2 KB of SRAM and 1 KB of EEPROM.


**Fig.3: Arduino UNO**

## Triac and Resistor

Triacs BTA12 are used here for providing a control over the starting current of motor. Traics are connected in parallel with resistors.

## Triggering Circuit

Triggering circuit provides triggering pulses to the triac. The output pulses of microcontroller are amplified by using the combination of npn and pnp transistors- D1351, TIP127. This forms the Darlington circuit. The output pulses are applied to triac through optocoupler MOC3021.

- **Darlington Circuit**

This is two transistors connected together so that the current amplified by the first is amplified further by the second transistor. The overall current gain is equal to the two individual gains multiplied together:
Darlington pair current gain, hFE = hFE1*hFE2
(hFE1 and hFE2 are the gains of the individual transistors).
This gives the Darlington pair a very high current gain, such as 10000, so that only a tiny base current is required to make the pair switch on.

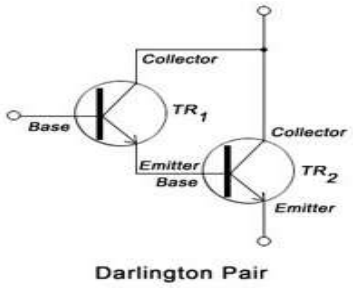


**Fig.4: Darlington Circuit**

- **Optocouplers**

Opto-couplers are made up of a light emitting device, and a light sensitive device, all wrapped up in one package, but with no electrical connection between the two, just a beam of light. The light emitter is nearly always an LED. The light sensitive device may be a photodiode, or a phototransistor.

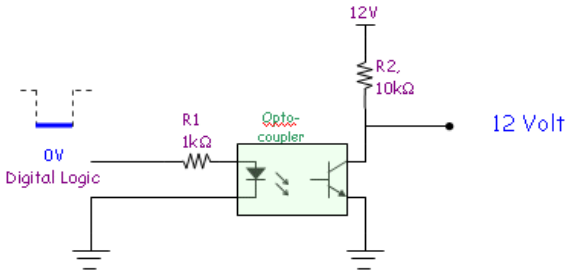


**Fig.5: Opto-coupler**

## LCD Display

Liquid Crystal Display has the ability to display numbers, characters & graphics. The display is fused to I/O port of microcontroller. The display is in multiplexed mode i.e. only 1 display remains on at a time. Within 1/10th of a second the next display switches on.

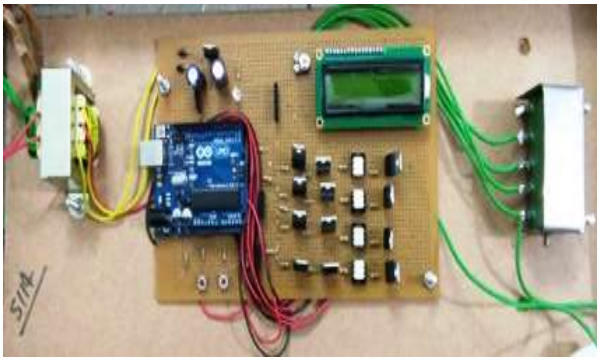

**Fig.6: DC motor starter**

## [III] Working

In order to protect the motor during starting, the starting current is limit to twice of the rated current. To limit the high starting current a resistor is connected in between supply & DC shunt motor. In our project the rated current of motor is 2 Amp so 10ohm resistor is used in circuit. Resistor is divided in several parts & across each part triacs are connected parallel to it. Here resistor has been divided in four parts & four triacs connected across it. At the time of starting, twice the rated current flows through the motor. So, triacs should be of rating of twice the motor current to handle this large current without heating. Here, triacs of 10A are used. When DC supply is connected to motor, due to presence of resistor in between supply & motor, motor will get less voltage & current than the rated voltage & rated current. So, during starting, motor will start slowly. In order to cut out the resistors connected across it triacs have to be fired after specific intervals. For firing of triacs microcontroller Arduino Uno is used.

The firing pulses provided by microcontroller are amplified by using npn and pnp transistor circuitry. These amplified pulses are applied to the gate of triac through optocoupler. Optocoupler is used to isolate the microcontroller circuitry to the triac and motor assembly.

As soon as triac receives gate pulse it turns ON & start conducting. As triac starts conducting it will create parallel path for current to flow eliminating resistor connected across it. As resistor is cut out from circuit supply voltage to motor increase & motor will run at slightly higher speed. In this way after specific intervals all four triacs are fired by micro- controller & full supply voltage is applied to motor. As triacs are fired, motor voltage & motor speed will increase gradually & motor will start smoothly.

The circuit effectively reduces the inrush current at start-up moment. The circuit can be modified for the speed adjustment and can be further implemented with the speed regulation and the over-current protection.

## Advantages of Electronic Starter

- Electronic starter are durable because of no moving parts.
- Sparking does not take place.
- Less maintenance is required due to less sparking
- Efficiency of motor does not get affected due to use of electronic starter.
- Performance is fast & stepwise.
- There are voltage and current transients associated with the electromechanical starters. In this, voltage or current is applied gradually, without the voltage and current transients.
- Smooth acceleration without the torque transients.
- Starting current of motor is reduced to twice of its rated value.
- Easy adjustment of start performance i.e. the starting time can be adjusted to suit the specific motor and load.
- Reliable performance even if load characteristics vary during starting.
- Consistent performance even with frequent starts.

## Comparison between electronic and conventional starter

Over the conventional starters, electronic starters provide the following features:

1. Soft starters effectively reduce the inrush current at start-up moment.
2. No sparking problem is associated with electronic starter.
3. It also provides the speed adjustment and can be further implemented with the speed regulation and the over-current protection.
4. It provides smoother control over speed.
5. The power loss with electronic starter is very less as compared to conventional starter.
6. Reliability is high.
7. The starting current is limited to about 45% of its original value.

## [IV] Results and Conclusion

- The electronic starter provides the smooth starting of DC motor reducing voltage and current transients.
- This starter eliminates the need of manual starter and thus increases the life and efficiency of the motor.
- This starter gradually cut off the resistors in four steps with a time delay of five seconds.

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