Implementation Of An Automatic Induction Motor Starter With Delay Using Microcontroller

Agbo D. O., Kureve D. T, Shittu D. H

Abstract: It is well understood that induction motors draw higher currents during their starting operations than is the case under full load running conditions. Since the early days of induction motor availability, starting methods other than Direct-on-Line have been used, and in some cases mandated by Utilities, to reduce the effect of these high starting currents on the electrical distribution network. What is generally not recognized is the existence of short duration inrush currents, which greatly exceed these starting currents. Furthermore, the introduction of complex starting methods to reduce starting currents is often compromised by other unanticipated inrush currents introduced by the starting system itself, unless special precautions are taken. This paper implements a device that protects three phase induction motor from inrush currents on the distribution system, as well as on the motor protection components using PIC16F84A Microcontroller.

Keywords: Induction Motor, Microcontroller, motor protection, currents, MPLAB, Direct on line, distribution system.

1. INTRODUCTION

Induction motors are popular due to their low-cost, sturdy construction, fast pick-up, low maintenance expenditure and good efficiency. The DOL (direct-on-line) starters and star/delta starters used for starting and running of induction motors provide coarse type of protections against voltage fluctuations and single phasing. Induction motors are very sensitive to low voltage and single phasing during which they draw a heavy current and can burn out unless switched of within few seconds of occurrence of such conditions. This makes the requirement of a sensitive protective device essential to avoid burning of induction motors under such conditions. The circuit of an automatic starter, incorporating the important features given below, is described here. It is meant to be used in conjunction with a DOL starter. Automatic start on resumption of proper conditions Single phasing prevention 24-hour programmable off timer (on completion of actual runtime of the motor). An induction or asynchronous motor is a type of AC motor where power is supplied to the rotor by means of electromagnetic induction, rather than a commutator or slip rings as in other types of motor. These motors are widely used in industrial drives, particularly poly-phase induction motors, because they are rugged and have no brushes. Single-phase versions are used in small appliances. Their speed is determined by the frequency of the supply current, so they are most widely used in constant-speed applications, although variable speed versions, using variable frequency drives are becoming more common. The most common type is the squirrel cage motor.

2. METHOD

The block diagram of the system is depicted in Fig. 1.0. The embedment of a microcontroller into the system makes it a standalone system that is capable of taking decisions to keep the system functioning properly. The microcontroller receives inputs signals from the three phase mains which is been step down by step-down transformers, depending on the input the microcontroller receives, it either takes decision to switch on the relays or switch off the relays.

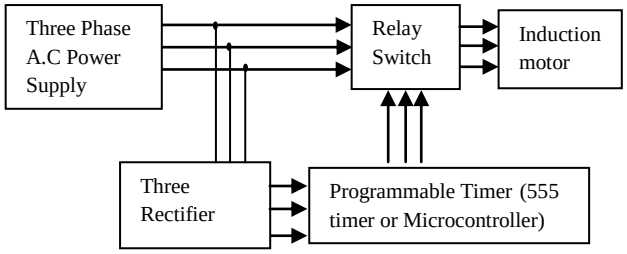

Fig.1.0: The automatic induction motor starter with programmable timer

When the system is first switched on, it waits for 30 seconds to make sure the power source is stable and starts monitoring. By switching ON or OFF of the relays, the microcontroller also turn on LEDs and the color of LED, being lit ON, indicates which the three phases is ON or OFF. The schematic diagram of the automatic three phase direct starter controller system is given in Fig. 2.0. The microcontroller used for the project is the PIC16F84A [5]. The microcontroller takes inputs from the three mains continuously via step-down transformer. Under the control of the program written in the microcontroller's memory, the microcontroller turns either Red or Green LEDs and turns the three relays ON or OFF.

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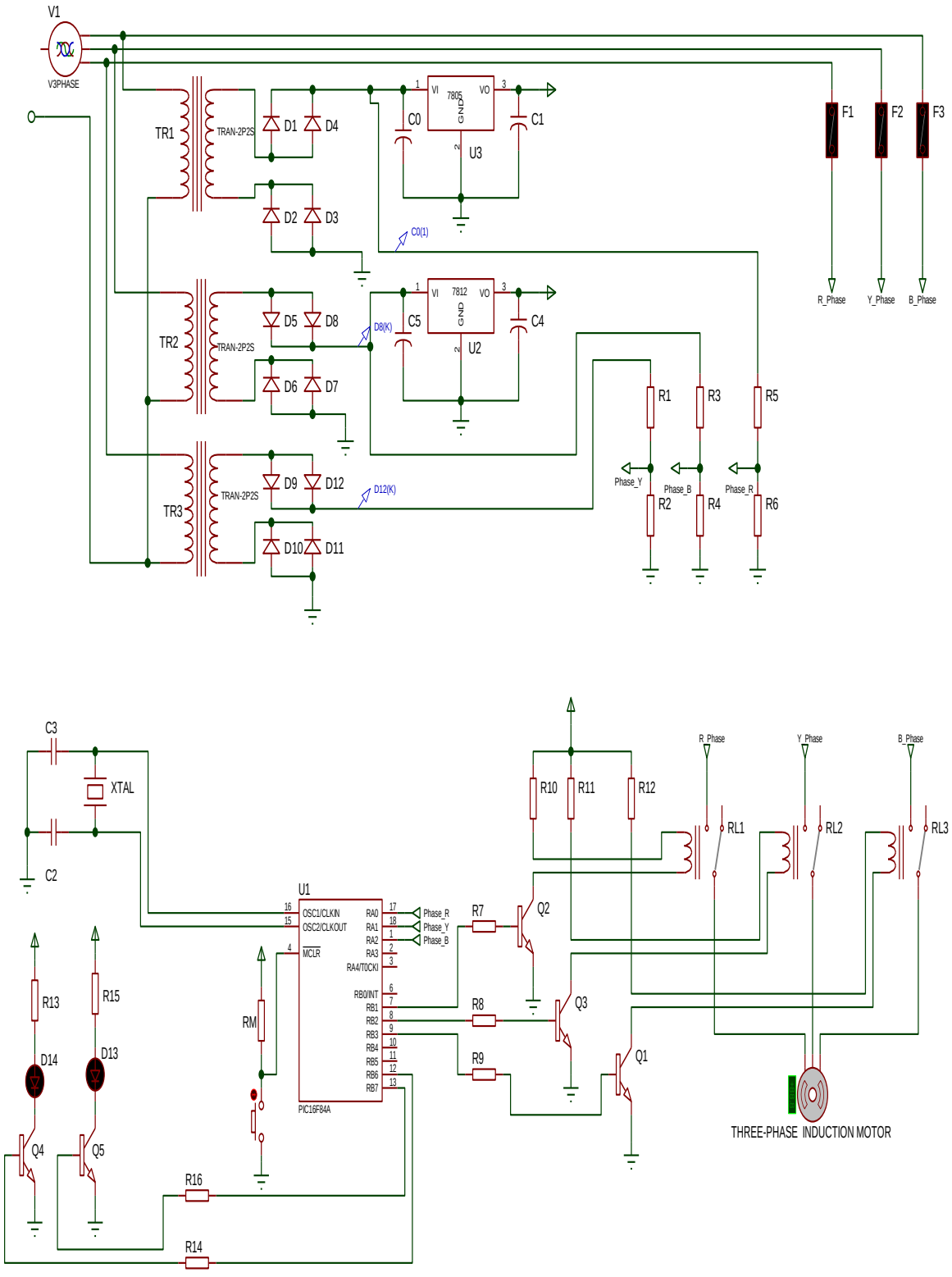

Fig. 2.0: Complete Circuit diagram of a Three phase Induction Motor

The transistors are turned on depending on the state of each AC supply phase. The voltage at each phase determines which of the transistor will trigger on. Using the requirements for the saturation of the BJT expressed as

$$\beta_F I_B > I_C \text{.....(1)}$$

Under the condition in equation 1, the transistors (Q1, Q2, Q3, Q4, Q5, Q6, Q7) will turn on.

The transistor (Q) will turn on when

$$R_g + R_b < \frac{\beta_F R_1 (V_{CC} - V_{BEsat})}{V_{CC} - V_{CEsat}} \text{.....(2)}$$

Since we are using transformer of 240/12 volts and need a voltage of 5volts (nominal input voltage of microcontroller) Figure 3.0 gives the flow chart of the program executed by the microcontroller. As indicated in the flow chart the microcontroller polls the input.

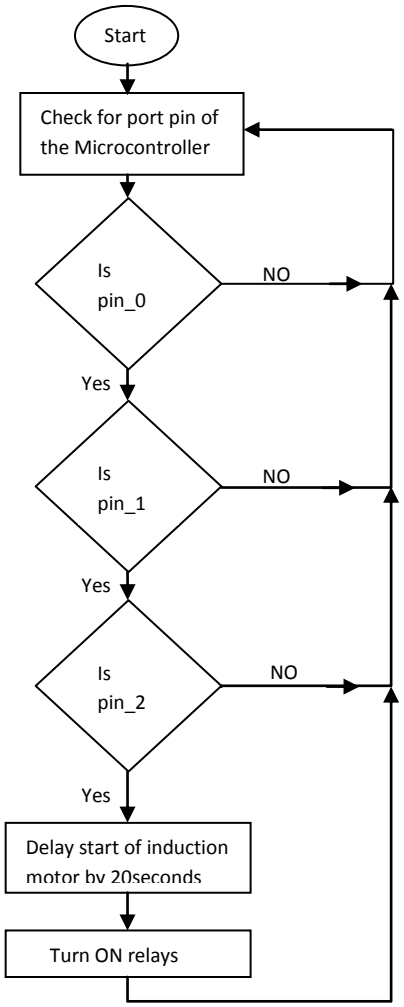

Fig.3.0: Flow chart of the three induction motor starter with automatic programmable timer

3. RESULTS AND DISCUSSIONS

The program for the microcontroller was written in Assembly Language which is attached as Appendix 1 and was then built into an executable **Hex** file using the MPLAB IDE Version 8.50 and the embedded MPASM assembler [6], [7]. A software simulation was carried out with the simulator built into the MPLAD IDE to ensure that the program variables and registers changed as desired. The program required few registers but the output ports (PORTA and PORTB) were observed to have the correct values. The circuit shown in Fig. 2.0 was then built in Vero board, which was tested using three phase ac mains and the output was connected to 220 V, 100 Watts bulb. The microcontroller program was observed and it gave the required outputs.

Table 1: Sensor Conditions and Microcontroller Decisions

Phase Conditions			**Indication**	**Output**
P1	P2	P3		
H	L	L	Only one phase is on	Red LED ON and the relays are turned off
H	H	L	Two phases are on	Red LED ON and the relays are turned off
H	H	H	All the three phases are on	Green LED ON and the relays are turned off

Note that in Table 1, L = Low Logic Level Signal and H = High Logic Level Signal, P1 = Phase 1, P2 = Phase 2, P3 = Phase 3

4. CONCLUSION

An automatic over and under voltage protector system has been implemented using induction motor starter which is neccessitated by the need to monitor the voltage supply to equipments and appliances and consequently protect them from the danger of being damaged due to voltage fluctuation. Based on the theoretical analysis, design and testing of this work, the following conclusions are made:

1. Since switching is automatic, the device is no doubt being used as an automatic voltage protector.
2. The display of the monitored voltage is indicated simply by LEDs, which can be easily seen and understood by all.
3. The assembly unit is very compact and portable and can be easily incorporated into appliancies or equipments.
4. The cost of constructing this project is relatively low as compared to the important function it performs. It can therefore be easily commercialised.

5. REFERENCES

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6. APPENDIX 1

Assembly Programming Language

```
;Author          :  AGBO
;File Name       :  A_IM_STARTER.asm
;TITLE           : "INDUCTION MOTOR STARTER WITH AUTOMATIC TIME DELAY "
;Date            :  3RD NOV. 2012
;Version         :  1.0
;Debugged        :  29 NOV. 2012
;***********************************************************
;********Processor Declaration and Configuration*************

PROCESSOR PIC16F84A
        #Include "p16f84A.inc"

  __CONFIG _CP_OFF & _WDT_OFF & _PWRTE_ON & _XT_OSC

 ORG 0x00
        BCF STATUS, RP0         ;
        CLRF PORTA              ; Initialize PORTA by clearing output data latches

        BSF STATUS, RP0         ; Select Bank 1
        MOVLW B'11111111'       ; Value used to initialize data direction

        MOVWF TRISA             ; Set RA<5:0> as inputs.

        BCF STATUS, RP0         ;
        CLRF PORTB              ; Initialize PORTB by clearing output data latches

        BSF STATUS, RP0         ; Select Bank 1
        MOVLW B'00000000'       ; Value used to initialize data direction

        MOVWF TRISB             ; Set RB<7:0> as outputs

START
        BSF     STATUS,5        ;Turn to Bank 1
        MOVLW0x00               ;
        MOVWF       PORTB       ;
        BCF     STATUS,5        ;Return to Bank 0

MAIN
        NOP

SWITCH1
        BTFSC PORTA, 0
        GOTO SWITCH2
        GOTO OUTPUT1

SWITCH2
        CALL DELAY      ; CALLING DEBOUNCE
        BTFSC PORTA, 1
        GOTO SWITCH3
        GOTO OUTPUT1

SWITCH3
        CALL DELAY      ; CALLING DEBOUNCE
        BTFSC PORTA, 2
        GOTO OUTPUT
        GOTO OUTPUT1

OUTPUT
        CALL DELAY20MSEC        ;               CALLING DEBOUNCE
        BSF PORTB, 1            ;       LED     GREEN ON(UNRESET)
        BSF PORTB, 2            ;   ENGAGING    CAR ENGINE
        BSF PORTB, 3            ;   ENGAGING    CAR ENGINE
        BSF PORTB, 6            ;   ENGAGING    CAR ENGINE
```

```
        BCF PORTB, 7        ; LED GREEN IS
OFF(UNRESET)
        GOTO START          ; if it is 1 skip this
instruction

OUTPUT1
        CALL DELAY20MSEC    ;
        BSF PORTB, 7        ; LED GREEN IS
OFF(UNRESET)
        BCF PORTB, 1        ; LED GREEN
ON(UNRESET)
        BCF PORTB, 2        ; ENGAGING CAR
ENGINE
        BCF PORTB, 3        ; ENGAGING CAR
ENGINE
        BCF PORTB, 6        ; ENGAGING CAR
ENGINE
        GOTO START

DELAY
        MOVLW.2     ;Make deld repeat two times
        MOVWF       0x1A    ;

deld
        DECFSZ      0x1B,1  ;Decrement file 1B till
zero
        GOTO deld   ;
        DECFSZ      0x1C,1  ;Decrment file 1C till
zero
        GOTO deld   ;
        DECFSZ      0x1A,1  ;Decrement file 1A till
zero
        GOTO deld   ;

DELAY20MSEC
        MOVLW0x02           ;Make deld repeat two
times
        MOVWF       0x1A    ;
deld1
        DECFSZ      0x1B,1  ;Decrement file
1B till zero
        GOTO deld1  ;
        DECFSZ      0x1C,1  ;Decrment file
1C till zero
        GOTO deld1  ;
        DECFSZ      0x1A,1  ;Decrement file
1A till zero
        GOTO deld1  ;
        RETURN

        END
```

The Automatic Induction Motor Starter With With Programmable Timer