DC Motor Control System By Using PIC Microcontroller

Mar Mar Cho[*] , Aung Naing Oo [**]

Abstract

DC motor can be designed to rotate in clockwise direction, counter clockwise direction and bidirectional rotation. The PIC microcontroller receives the instruction and processing is made. Then it sends signals to clock wise rotation unit, counter clock wise rotation unit, bidirectional rotation unit and display unit. The direction of rotation is shown simultaneously by both light emitting diode and liquid crystal display. The required programs are written in Pic BASIC Pro language in MicroCode Studio software. The programs are complied and downloaded into PIC 16F877A microcontroller and PIC16F84A microcontroller via GTP USB Lite programmer.

Key words: PIC16F84A and PIC16F877A microcontrollers, Pic Basic Pro language.

Introduction

DC motors consist of one set of coils, called armature winding, inside another set of coils or a set of permanent magnets, called the stator. Applying a voltage to the coils produces a torque in the armature, resulting in motion. The stator is the stationary which is outside part of a motor. The stator of a permanent magnet dc motor is composed of two or more permanent magnet pole pieces. The magnetic field can alternatively be created by an electromagnet. In this case, a DC coil (field winding) is wound around a magnetic material that forms part of the stator. The rotor is the inner part which rotates. The rotor is composed of windings (called armature windings) which are connected to the external circuit through a mechanical commutator. Both stator and rotor are ferromagnetic materials. The two are separated by air-gap. A winding is made up of series or parallel connection of coils. Armature winding is the winding through which the voltage is applied or induced. Field winding is the winding through which a current is passed to produce flux (for the electromagnet). Windings are usually made of copper.

PIC Microcontroller

A microcontroller is a single chip computer. Micro suggests that the device is small, and controller suggests that the device can be used in control applications. A microcontroller differs from a microprocessor in many ways. The main difference is that a microprocessor requires several other components for its operation, such as program memory and data memory, I/O devices and external clock circuit. A microcontroller on the other hand has all the supported chips that are incorporated inside the same chip. All microcontrollers operate on a set of instructions (or the user program) stored in their memory. A microcontroller fetches the instructions from its program memory one by one, decodes these instructions, and then carries out the required operations. In this work, three dc motor control units are designed and constructed. They are clock wise rotation unit, counter clock wise rotation unit and bidirectional rotation unit. These control units are also shown by liquid crystal display unit.

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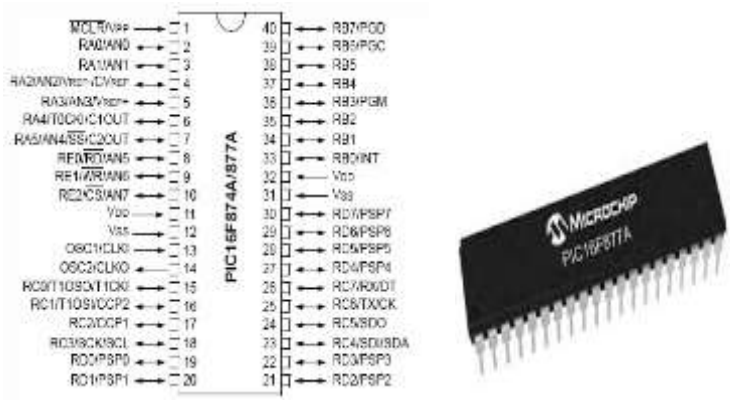

Fig.1 Pin diagram and photograph of PIC16F877A microcontroller

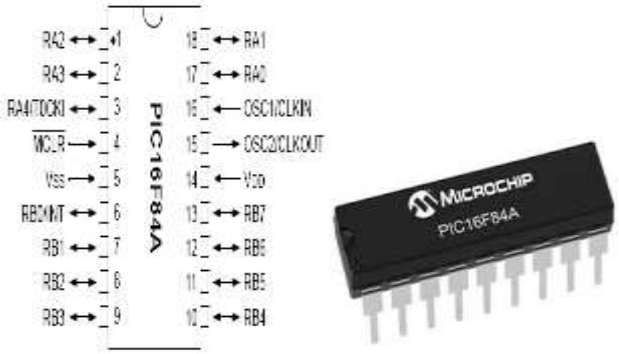

Fig.2 Photograph and pin configuration of PIC16F84A

Design and Construction

There are five main parts of "DC Motor Control System By Using PIC Microcontroller". They are

(i) Regulated Power Supply Unit
(ii) Liquid Crystal Display Unit
(iii) Clock Wise Rotation Unit
(iv) Counter Clock Wise Rotation Unit
(v) Bidirectional Rotation Unit

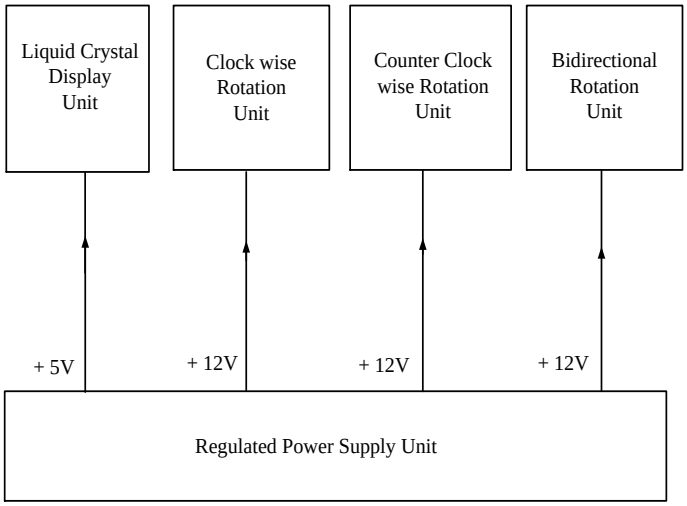

Fig.3 The block diagram of the constructed system

Regulated Power Supply Unit

The PIC16F84A and PIC16F877A microcontroller work at DC +5V well. The required DC voltage is taken from voltage regulator (LM7805). For liquid crystal display unit, DC +9V battery is used and for DC motor rotation unit, DC +12V battery is used separately The pin 1 (input pin) of LM7805 is connected to positive terminal of the battery and they are also ground. The output voltage of DC +5V is taken from pin 3 (output) of LM7805.

Liquid Crystal Display Unit

This unit shows about the construction of the whole system. The 20 characters x 4 lines liquid crystal display (2004A) is used. The pin 2 (V_{DD}) is powered by DC +5V. The pin 3 (V_{EE}) is also connected to middle pin of 20 kΩ variable resistor. The pin 1 (V_{SS}) and pin 5 ($R/\overline{W}$) are tied to ground. The pin 11 (DB4), pin 12 (DB5), pin 13 (DB6), pin 14 (DB7), pin 6 (E) and pin 4 (RS) of (2004A) are connected to pin 33 (RB0), pin 34 (RB1), pin 35 (RB2), pin 36 (RB3), pin 37 (RB4) and pin 38 (RB5) of PIC16F877A microcontroller respectively. For back light emitting diode, the anode pin 15 is connected to DC +5V through 100Ω and cathode pin 16 is grounded.

Clock Wise Rotation Unit

This unit is designed to rotate the DC motor in clock wise direction. The one end of microswitch is connected to DC +5V and the other end is connected to pin 4 ($\overline{MCLR}$) of PIC 16F84A and this end is also grounded through 10 kΩ resistor. So, the PIC microcontroller is in reset mode for initial condition. Pin 6 (RB0) is connected to anode pin of green light emitting diode. The cathode pin of LED is connected to Pin 1 of photocoupler (PC817). Pin 2 of PC817 is connected to ground. Pin 3 of PC817 and collector pin of TIP122 are tied to DC +12V. Pin 4 of PC817 is connected to base pin of TIP122. The emitter pin of TIP122 is connected to one end of DC motor and the other end is grounded.

Counter Clock Wise Rotation Unit

This unit is designed to rotate the DC motor in counter clock wise direction. The one end of microswitch is connected to DC +5V and the other end is connected to pin 4 ($\overline{MCLR}$) of PIC 16F84A and this end is also grounded through 10 kΩ resistor. So, the PIC microcontroller is in reset mode for initial condition. Pin 6 (RB0) is connected to anode pin of red light emitting diode. The cathode pin of LED is connected to Pin 1 of photocoupler (PC817). Pin 2 of PC817 is connected to ground. Pin 3 of PC817 and collector pin of TIP122 are tied to DC +12V. Pin 4 of PC817 is connected to base pin of TIP122. The emitter pin of TIP122 is connected to one end of DC motor and the other end is grounded.

Bidirectional Rotation Unit

This unit is designed to rotate the DC motor in clock wise and counter clock wise directions. One end of the clock wise switch is connected to DC +5V and the other end is connected to pin 4 ($\overline{MCLR}$) of PIC16F84A microcontroller. This end is also grounded through 10 kΩ resistor. The microcontroller is in reset mode for initial condition. For counter clock wise rotation, one end of the counter clock wise switch is connected to DC +5V and the other end is connected to pin 17 (RA0) of PIC16F84A microcontroller. This end is also grounded through 10 kΩ resistor. So, the pin 17(RA0) is at LOW state for initial condition. Pin6 (RB0), pin 7 (RB1) and pin 8 (RB2) of PIC16F84A microcontroller are connected to pin 2 (1A), pin 7 (2A) and pin 1 (1,2 EN) of quadruple half-H drivers (L293D) respectively. Pin8 (V_{CC2}) and pin 16 (V_{CC1}) of L293D are connected to DC +12V and pin 4 (GND) and pin 5

(GND) of L293D are connected to ground. Pin 3 (1Y) of L293D is connected to one end of DC motor and pin 6 (2Y) of L293D is also connected to other end of DC motor respectively.

Result and Discussion

The required program for liquid crystal display unit is written in Pic BASIC Pro language. It is compiled and downloaded into PIC16F877A microcontroller. The pin 33 (RB0), pin 34 (RB1), pin 35 (RB2), pin 36 (RB3), pin 37 (RB4) and pin 38 (RB5) are defined as output pins. When the circuit is powered, "DC MOTOR CONTROL" in the first line, "(I)CW ROTATION" in the second line, "(II)CCW ROTATION" in the third line and "(III)BI DIRECTION" in the fourth line are shown in liquid crystal display.

For clock wise rotation unit, the required program is written in Pic BASIC Pro Language. It is compiled and downloaded into PIC16F84A microcontroller. The pin 6 (RB0) is defined as output pin and CW SWITCH is fixed at pin 4 ($\overline{\text{MCLR}}$). The DC motor makes clock wise rotation as long as the switch is pressed.

For counter clock wise rotation unit, the required program is written in Pic BASIC Pro Language. It is complied and downloaded into PIC16F84A microcontroller. The pin 6 (RB0) is defined as output pin and CCW SWITCH is fixed at pin 4 ($\overline{\text{MCLR}}$). The DC motor makes counter clock wise rotation as long as the switch is pressed.

For bidirectional rotation unit, the required program is written in Pic BASIC Pro Language. It is complied and downloaded into PIC16F84A microcontroller. The pin 6 (RB0), pin 7 (RB1), pin 8 (RB2) are defined as output pin and pin 17 (RA0) is defined as input pin. BCW SWITCH is fixed at pin 4 ($\overline{\text{MCLR}}$) and BCCW SWITCH is fixed at pin 17 (RA0). The DC motor makes counter clock wise rotation as long as BCW SWITCH is pressed. If both BCW SWITCH and BCCW SWITCH are pressed simultaneously, the DC motor makes counter clock wise rotation.

Conclusion

DC motor is widely used in many areas. It can be found in many places such as small machines to large machines. The basic theory and operation of dc motor can be enhanced by carrying out this work. The application and control of dc motor are also suggested to be carried out as further works by using other electronic devices.

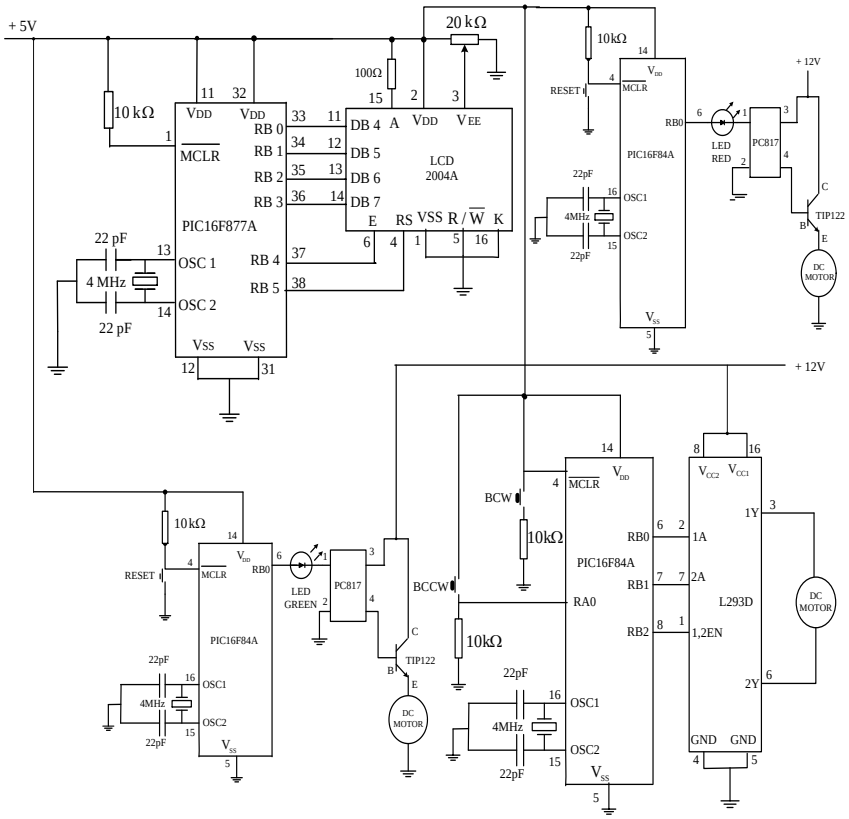

Fig.4 Complete circuit diagram of "DC Motor Control System By Using PIC Microcontroller"

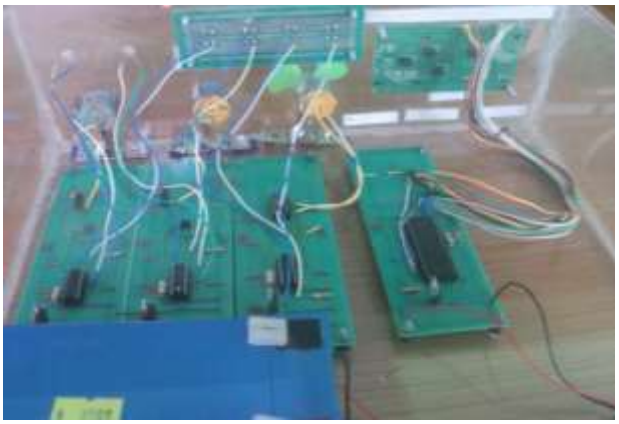

Fig.5 The photograph of constructed circuit

Fig.6 The display of operation

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