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Speed Control of DC Motor Using PSOC 4

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Abstract- The speed control of a DC motor using a PSOC 4 is represented in this paper. The aim of this project is providing speed control to dc motor towards providing simple method using PWM technique. The speed of DC motor is directly proportional to the applied voltage to its terminals. if voltage across motor terminal is increases , then speed can also be increases. This project uses the above principle to control the speed of the motor by varying the duty cycle of the pulse applied to it (popularly known as PWM control). The project uses two input buttons interfaced to the PSOC 4, which are used to control the speed of motor. PWM (Pulse Width Modulation) is generated at the output by the PSOC 4 as per the program. Under that condition, conducted a research on a DC motor speed control with pulse width modulation (PWM) method of the infrared remote control. The program can be written in Embedded C language in the PSOC creator software. The average value of voltage given or the average value current flowing through the motor these changes depends on the duty cycle ON and OFF time of the pulses so the speed of the motor will change. A motor driver IC L293D is interfaced to the PSOC 4 for receiving PWM signals and gives desired output for speed control of a DC motor.

1. INTRODUCTION

The task that will be done by speed controller of dc motor is controlling of various robotic motion and automation system in various industries. In this paper controller presented uses the pulse width modulation (PWM) technique for speed control of DC motor. Using PSOC 4 microcontroller generate the PWM wave for speed control of DC motor, we need a variable-voltage DC power source to control the speed of the DC motor. When the DC motor is on, it takes certain time to reach at full speed. As soon as the power source is on, the DC motor starts gaining speed and if we switch off the power source before it reaches at rated speed, it starts to goes down. In quick succession of switching on and switching off are done, the motor rotate at a lower speed between zero and rated speed. In this paper we used PWM method so it switches the motor „on" and „off" with a pulse wave. The main objective of this paper is to become easy with the implementation of hardware of PSOC 4 microcontroller based speed control of DC motor, L293D IC is used to provide to motor and infrared it give senses of occurring overload to the operator at overload condition and speed display on LCD screen. For the required speed the speed controller takes signal represent and to drive a motor at required speed. Direct current (DC) motors have variable characteristics and are used extensively in variable-speed drives. DC motor can provide a high starting torque and it is also possible to obtain speed control over wide range. It is important to make a controller to control the speed of DC motor in desired speed. DC motor plays a significant role in modern industrial. These are several types of applications where the load on the DC motor varies over a speed range. These applications may demand high-speed control accuracy and good dynamic responses. DC motors are suitable for belt-driven applications and the applications where great amount of torque is required. In train and automotive traction, fuel pump control, electronic steering control, engine control and electric vehicle control are good examples of these. In aerospace, there are a number of applications, like centrifuges, pumps, robotic arm controls, gyroscope controls and so on. For precise speed control of servo system, closed-loop control is normally used. Basically, the block diagram of the speed control of DC motor using PSCO 4 is as shown in Figure 1.

The usb mounted PSOC4 which is used to insert the program in the PSOC 4 by using computer. Speed control of dc motor could be achieved using mechanical or electrical techniques. In the past, speed controls of dc drives are mostly mechanical and requiring large size hardware to implement. The development has launched these drives back to a position of formidable relevance, which were hitherto predicted to give way to ac drives. Some important applications are: rolling mills, paper mills mine winders, hoists, machine tools, traction, printing presses, textile mills, excavators and cranes. Fractional horsepower dc drives are widely employed -as servo means for positioning and tracking. Controlled rectifiers provide a variable dc voltage from a fixed dc voltage. Due to their ability to supply a continuously variable dc voltage, controlled rectifier and dc choppers made a revolution in modern industrial equipment and variable speed drives. Adjustable speed drives may be operated over a wide range by controlling armature or field excitation. Transistor and thyristor along with various analog digital chips used in firing or controlling circuits have made dc drives more accessible for control in innumerable areas of applications . Recent developments in the area of semiconductor technology have made smaller, faster microprocessors and microcontrollers available at reduced cost. The potential use of microprocessors to control some or all electronic functions justifies their use. The main objective of this work is to become familiar with the design and implementation of both software and hardware of a microcontroller based closed loop speed control of DC motor and to give senses of occurring overload condition to the operator at overload condition. The purpose of a motor speed controller is to take a signal representing the required speed, and to drive a motor at that speed.

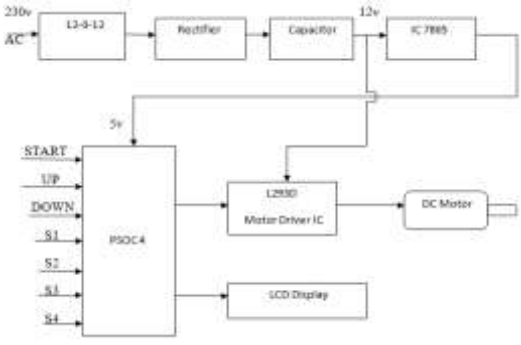

Fig.no.1 Block Diagram of speed control

2. Methodology

2.1. PSOC 4

PSoC 4 (Programmable System on chip) is a family of microcontroller integrated circuit by cypress Semiconductor. These chips include a CPU core and mixed-signal arrays of configurable integrated analog and digital peripherals. In 2002, Cypress began shipping commercial quantities of the PSoC 1. To promote the PSoC, Cypress sponsored a "PSoC Design Challenge" in Circuit Cellar magazine in 2002 and 2004.In April 2013, Cypress released the fourth generation, PSoC 4. The PSoC 4 features a 32-bit ARM Cortex-M0 CPU, with programmable analog blocks (operational amplifiers and comparators), programmable digital blocks (PLD-based UDBs), programmable routing and flexible GPIO (route any function to any pin), a serial communication block (for SPI, UART, and I²C), a timer/counter/PWM block and more. PSoC is used in devices as simple as Sonic are toothbrushes and Adidas sneakers, and as complex as the TiVo set-top box. One PSoC, using Cap Sense, controls the touch-sensitive scroll wheel on the Apple iPod click wheel. In 2014, Cypress extended the PSoC 4 family by integrating a Bluetooth Low Energy radio along with a PSoC 4 Cortex-M0-based psoc in a single, monolithic die.

Fig.no.2 PSOC4

2.2 OVERVIEW

A PSoC integrated circuit is composed of a core, configurable analog and digital blocks, and programmable routing and interconnects. The configurable blocks in a PSoC are the biggest difference from other microcontrollers. PSoC has three separate memory spaces: paged SRAM for data, Flash memory for instructions and fixed data,

and I/O Registers for controlling and accessing the configurable logic blocks and functions. The device is created using SONOS technology. PSoC resembles an ASIC: blocks can be assigned a wide range of functions and interconnected on-chip. Unlike an ASIC, there is no special manufacturing process required to create the PSoC resembles an FPGA in that at power up it must be configured, but this configuration occurs by loading instructions from the built-in Flash memory .PSoC most closely resemblesa microcontroller combined with a PLD and programmable analog. Code is executed to interact with the user-specified peripheral functions (called "Components"), using automatically generated APIs and interrupt routines. PSoC Designer or PSoC Creator generates the startup configuration code. Both integrate APIs that initialize the user selected components upon the user's needs in a Visual Studio-like GUI.

2.3. PULSE WIDTH MODULATION

Pulse width modulation (PWM) is a fancy term for describing a type of digital signal. Pulse width modulation is used in a variety of applications including sophisticated control circuitry. The width of each pulse varies between 0 and the period (T). The main principle is control of power by varying the duty cycle. Here the conduction time to the load is control of power by varying the duty cycle. Here the conduction time to the load is controlled. Let for a time t1, the input voltage appears across the load i.e. ON state and for t2 time the voltage across the load is zero. The duty cycle can be varied from 0 to 1 by varying t1, T or f. Therefore, the output voltage V0 can be varied from 0 to Vs by controlling k, and the power flow can be controlled. As the time t1 changes the width of pulse is varied and this type of control is called pulse width modulation (PWM) control. A simple method to control the speed of a DC motor is to control driving voltage, when the voltage is high the speed would be high. In many applications normal voltage control would cause lot of power loss on control system, so PWM method is mostly used in DC motor speed control application. When applying PWM controlling method, keep in mind that using a motor is as low pass system. PWM method is the high frequency avoided and we know that large motor is mainly inductive so avoid high frequency, hence will not perform well using high frequencies. This method work on low frequency so lower frequency is better than higher frequency. .We can easily understand by example. On an Off time is referred to as "duty cycle". The figure 2 shows the waveforms of 10%, 50% and 90% duty cycle signal. As we can see in figure 2, for 10% waveform 10% duty cycle signal in on and 90% off while a for 90% waveform 90% duty cycle signal is on and 10% off. These signals are send to motor. The end result of the PWM is that power is send to the motor and it can adjust from 0% to 100% duty cycle with stable control and high efficiency.

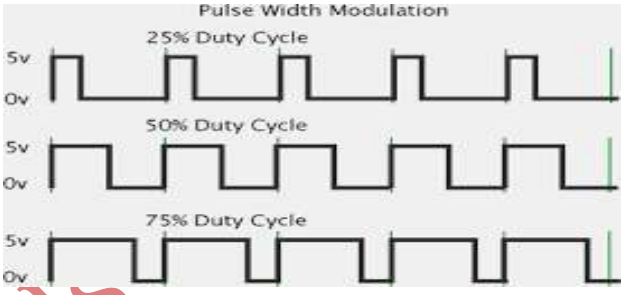

Fig.no.3 PWM

2.3. POWER SUPPLY

Power supply is the important section of the system. The electronics system requires the direct current for switching. In this project for power supply using step down transformer 230v ac to 12v ac then using rectifier circuit to convert this 12volt ac supply in to 12volt dc supply. Rectifier is device that coverts the ac supply in to the dc. Conversion process of rectifier is follows. During the positive half cycle of voltage, diodes D2 and D4 are conducting and diodes D1 and D3 are reverse bias. Therefore, current flows through the winding, diode D2, load and diode D4. During negative half-cycles of voltage, diodes D1 and D3 conduct, and diodes D2 and D4 are reverse bias, therefore current flow through diode D3, D1 and load.

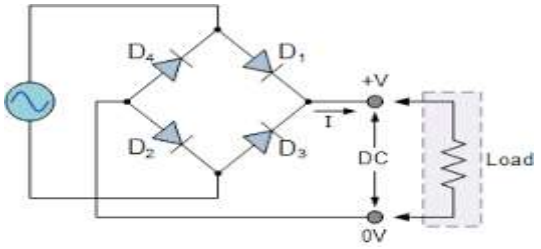

Fig.no.4 rectifier

2.4. MOTOR DRIVER IC L293D

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. L293D is a dual H-bridge motor driver integrated circuit (IC). L293D is a dual H-Bridge motor driver, so with one IC we can interface two DC motors which can be controlled in both clockwise and counter clockwise direction and if you have motor with fix direction of motion. You can make use of all the four I/Os to connect up to four DC motors. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supplyhas a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor drive.

Fig.no.5 L293D

2.5. LCD (Liquid Crystal Display)

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. We will discuss how a 16×2 LCD is interface with PSOC 4. LCD 16×2 is used as output by the controller to display data to user. The 16×2 LCD display have 16 number of data can be written on 2 lines.

Fig.no.6 LCD

3. HARDWARE

The connection of power supply used diode bridge rectifier with capacitor is used. Power supply converts the AC supply into the pure form of DC supply. In above LCD is interfaced with PSOC4.

Fig.no.7 Connection of power supply on PCB

Separate step down transformer 230/12 volt which is used here for driving the motor.

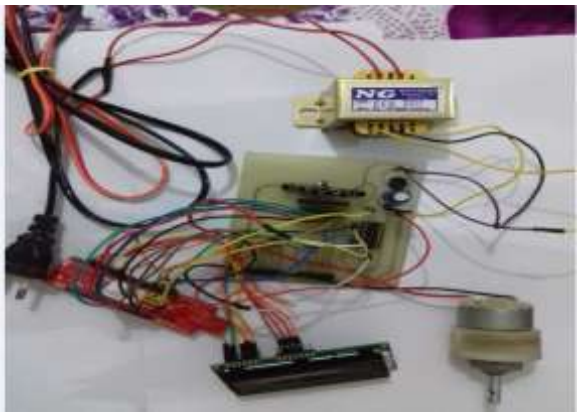

Fig.no.8 Final schematic circuit with motor and all component combination

3. RESULTS

In figure no. 5 graph shows the speed control of Dc motor using PWM technique.

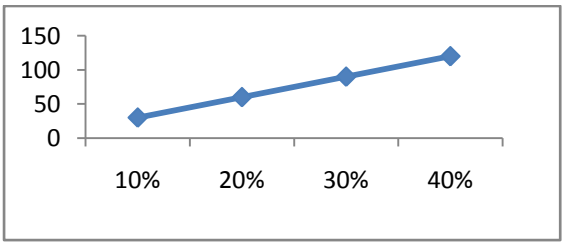

Fig.no.9 speed v/s PWM

4. CONCLUSION

The PSOC 4 based speed control of dc motor has been introduced. Controlling of dc motor using a PSOC 4 with help of PWM technique. This system controls the speed of motor by giving information by the PSOC 4 module.

Finally conclude speed control of dc motor using PSOC4 is the best method.

5. Future scope

1. Speed control of DC motor by using PSOC 4 can deal with robotics while moving their arms and joints. We can move their arms in whatever directions we want to move it.

2. Speed control of dc motor plays a importance in the industrial area by using this technique with changes in the circuit diagram.

3. DC motors are widely used in industry because of its low cost, wide range of speed and torque, less complex control structure so better future of this project.

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