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RESEARCH ARTICLE

MICROCONTROLLER (TMS 320 F 28027) BASED PWM SIGNAL GENERATION FOR SPEED CONTROL OF DC MOTOR

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ABSTRACT

In any modern factory all types of DC motors, AC motors, power amplifiers are used. Therefore there is need of intelligent devices capable of controlling and driving a wide range of electromechanical devices. Series architecture of variable resistors is not good for controlling the speed of DC motor because it drops excess of energy and flux control is affected by commutation and armature control methods cannot provide speed control in the desirable range. Therefore Voltage control method is used to control the DC motor in which PWM signal is used to control electromechanical devices. PWM signal obtained from analog or digital IC contains harmonics; therefore mostly PWM signals are generated from (TMS 320 F 28027) Microcontroller. It reduces the hardware complexity and it consumes less power. By modifying CCP register of TMS controller PWM signal is generated. DC motor is connected with TMS through Motor driver. PWM signal is generated at four duty cycle for controlling speed of motor.

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INTRODUCTION

Due to increasing industrialization and automation, the need of intelligent devices capable of driving and controlling a wide range of electrical and electromechanical devices becomes a big challenge. Rapid progress in microcontrollers and microelectronics has made it possible to apply modern control technology to control efficient and reliable operation of many applications such as the engine, cruise, steering, vehicle traction and anti-lock braking system (ABS). Many operations including DC motor and therefore the need of implementing effective control strategies with digital control of these motors. The speed of DC motor is inversely proportional to field flux and directly proportional to armature voltage andadjustable speed drives can be operated over a wide range by controlling armature or field excitation (Bakibillah *et al*., 2014).In any modern factory all types of electromechanical devices are used and they are controlled by PWM signal which is generated from microcontroller and such intelligent device contain one or more microcontrollers/microprocessors. In this technique, the regulation of motor's speed is examined by changing the voltage of motor which is adjusted by the duty ratio of PWM.

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In order to reduce the steady-state error of the rotational speed of motor and to improve the performance of motor's speed regulation, a high- performance microcontroller can be used. The 8-bit microcontroller is not effective when the problem is very complex. Therefore some advanced PWM techniques and additional processing functions for much more complex automation process control, the use of 16/32 bit microcontroller is good choice (Bogdancroitoru *et al*., 2014). In this work (TMS 320 F 28027) microcontroller is used for implementation. The great advances of microcontroller based control system are due to microcontroller versatility and flexibility. This is because all the control algorithms can be implemented in the software (Bakibillah *et al*., 2014). It causes the PWM voltage control with high accuracy. PWM signal will be generated at four duty cycles with values 25%, 50%, 75% and 100%. A motor driver used to control the speed of motor. The rest of the paper is organized as follows- Section II describes Framework of proposed system. Section III describes working of the proposed system and section IV concludes the paper.

SYSTEM ARCHITECTURE

Advantages of PWM is that the pulses reach the full supply voltage and will produce more torque in motor it is help to

overcome the internal resistances of motor more easily. The block diagram of system is shown in Figure1. This system compromises both hardware and software elements. Main system elements are (TMS 320 F 28027) microcontroller, DC motor, H-bridge driver and power supply.PWM can be easily generated using the inbuilt CCP module of a (TMS 320 F 28027) Microcontroller. CCP stands for Capture/Compare/ PWM. A microcontroller is used to feed PWM signals to the motor driver. Generated PWM pulses applied to the enable pin of the motor driver IC L293D to control the applied voltage of the motor. The variation of pulses is done by the TMS microcontroller, with the input signal from the push buttons.

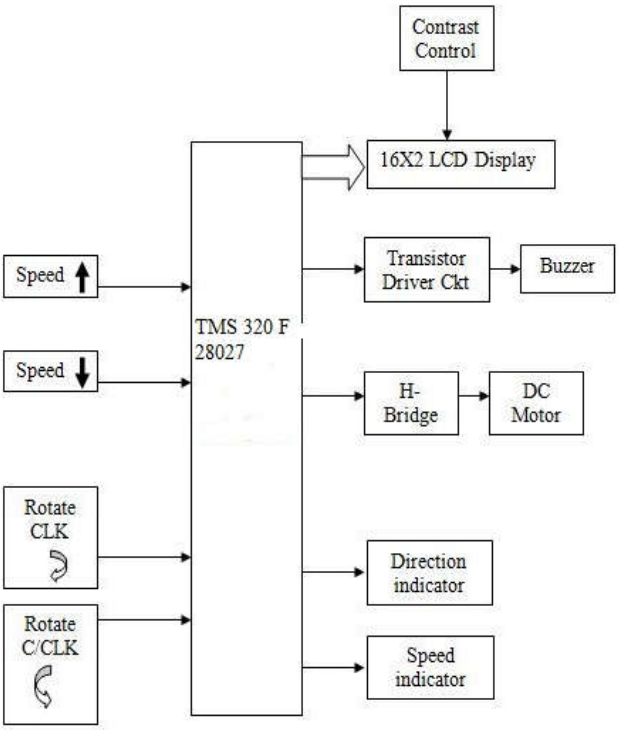

Figure 1. Block Diagram of Speed Control of DC Motor

Here, two push buttons are used, each for decreasing and increasing the duty cycle of PWM pulses and another two push buttons are used to control the direction of motor. Desktop is serially interfaced to display the speed level of the motor and the direction and for visual indication LED used.

Hardware Specification

Microcontroller TMS 320 F 28027

The TMS320F28027 is highly integrated, high-performance solutions for demanding control applications. The TMS320F28027 is designed to work with Code Composer Studio. Code Composer communicates with the board through an On Board JTAG emulator (Mekala and Muniraj, 2015; Texas Instruments, 2012).

Features of TMS 320 F 28027

- High-Efficiency 32-Bit CPU (TMS320C28x™)
- Code-Efficient (in C/C++ and Assembly)
- Single 3.3-V Supply
- Up to 22 pins are Individually Programmable
- Three 32-Bit CPU Timers
- Independent 16-Bit Timer in Each ePWM module
- Code-Security Module.

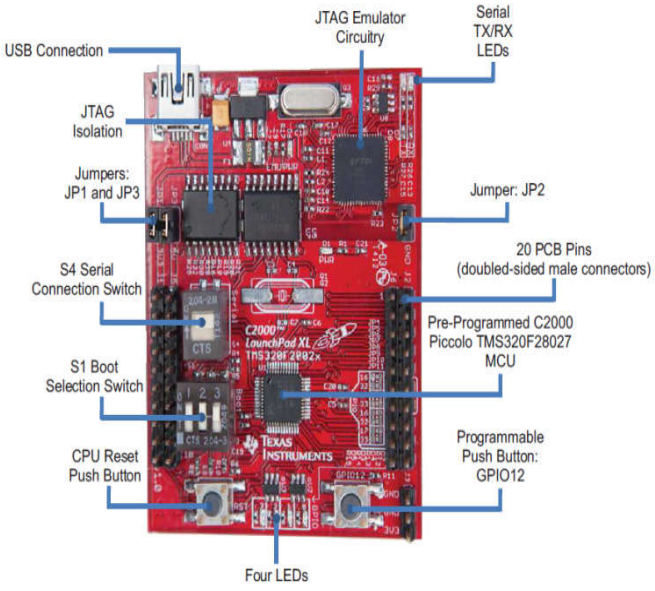

Figure 2. TMS 320 F 28027 Board

H-Bridge Driver

An H bridge is an electronic circuit is used to control the motion of motor. These drivers are regularly used in robotics, paper mills and many other applications to allow DC motors to run backwards and forwards.

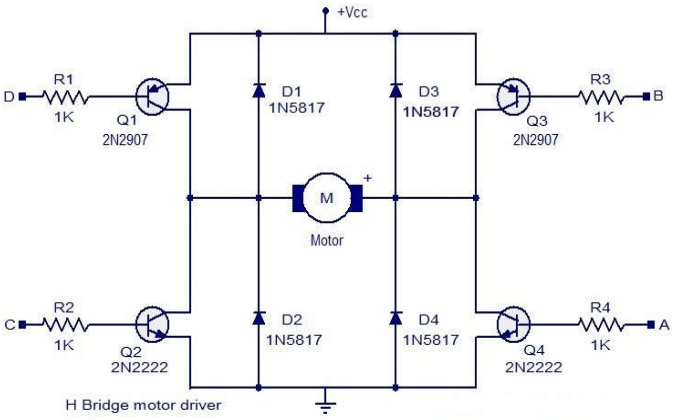

Figure 3. H-Bridge Driver

12V DC Geared Motor (10-400rpm)

12V DC Geared Motor can be used in robotics, paper mills, elevators applications and is available with wide range of RPM and Torque. Hence, in this system DC motor with following specification is used:

- Length: 80 mm
- Torque: 1.5 kg.cm
- Shaft Diameter: 6mm
- Weight: 130g

Software Specification

Code Composer Studio (CCS) enhances and speeds the development process for programmers who create and test real-time, embedded signal processing applications. CCS extends the capabilities of the Code Composer Integrated Development Environment (IDE) to include full awareness of the DSP target by the host and real-time analysis tools.

WORKING METHODOLOGY

TMS 320 F 28027 is special purpose DSP microcontroller hence there is no need to modify the timer for generation of PWM signal. PWM can be generated by modifying the CCP register (capture/compare/PWM) and ePWM (enhanced PWM) register. It can support Independent 16-Bit Timer in Each ePWM module. The operational algorithm can be implemented by using CCS (code composer studio) software and it is Code-Efficient (in C/C++ and Assembly).

#include "DSP28x_Project.h" // The device header file contain Macros, Externs and Prototypes.#include "Hal.h" // it can initialize all the register such as Timers, ADC, ePWM, Global interrupt etc.PWM signal generated at four duty cycle 25%, 50%, 75% and 100%.

The PWM Duty cycle for clockwise direction is
PwmDuty= (1875*2*AppDutyCycle).
The PWM Duty cycle for anticlockwise direction is PwmDuty= 15000 - (1875*2*AppDutyCycle).

This is initial Duty cycle and it can be incremented or decremented by using AppDutyCycle. The incrementing or decrementing of Applied Duty cycle can be based on pressing of Up/Down switches and by using the directional switches the Direction of device can be changed. These four switches are connected to GPIO pins which are programmable. By pressing the Up switch PWM Duty cycle can be incrementing from 0% to 100%. As the PWM Duty cycle is incrementing speed of DC motor is increases.

By pressing the Down switch PWM Duty cycle can be decrementing from 100%to 0%. As the PWM Duty cycle is decrementing speed of DC motor is decreases. Two switches are provided to control the speed of the motor. Here we are using 12V DC Motor and average DC value delivered to motor can be varied by varying the duty cycle ratio of the PWM. The average DC Voltage of 0% duty cycle is 0V, 25% duty cycle is 3V, 50% duty cycle is 6V, 75% duty cycle is 9V and for 100% duty cycle 12V.

Conclusion

For controlling of DC motor Flux and armature control methods cannot provide speed control in the desirable range. DC motor is also controlled by series architecture of variable resistor, but it has alarge power dissipation. Therefore DC motor is controlled by Voltage control method in which PWM signal is generating from microcontroller. PWM signal obtained from analog or digital IC contains harmonics, therefore mostly PWM signals are generated from Microcontroller. It reduces the hardware complexity and it consumes less power. Advances of microcontroller based control system are due to microcontroller versatility and flexibility. This is because all the control algorithms can be implemented in the software. It causes the PWM voltage control with high accuracy.

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