

CONTROLLING DC MOTOR SPEED USING PWM FROM C# WINDOWS APPLICATION

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ABSTRACT

It is very important task to control the speed of DC motor for various applications. Also the shorter settling time is desired for practical applications. In this paper it is presented the realization of the speed control by using Pulse Width Modulation. For setting the desired speed of the motor, it is designed a windows application programmed with C# language. This application communicates with 8051 microcontroller through standard PC serial port. Connection of DC motor with hardware is also explained.

Keywords: DC motor, speed control, Pulse Width Modulation, C#, 8051 microcontroller, serial port

1. INTRODUCTION

Direct current (DC) motors have been widely used in many industrial applications such as electric vehicles, steel rolling mills, electric cranes, and robotic manipulators due to precise, wide, simple, and continuous control characteristics [1].

DC motor drives are used for many speed and position control systems where their excellent performance, ease of control and high efficiency are desirable characteristics. Pulse-width modulation (PWM) is the technique of using switching devices to produce the effect of a continuously varying analogue signal; this PWM conversion generally has very high electrical efficiency. In controlling either a three-phase synchronous motor or a three-phase induction motor it is desirable to create three perfectly sinusoidal current waveforms in the motor windings, with relative phase displacements of 120°. The production of sinewave power via a linear amplifier system would have low efficiency, at best 64%. If instead of the linear circuitry, fast electronic switching devices are used, then the efficiency can be greater than 95%, depending on the characteristics of the semiconductor power switch [2].

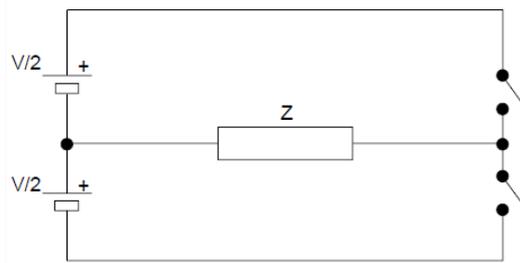


Figure 1. Half Bridge Switching Circuit

The half-bridge switching circuit in Figure1 is given as an example: the switches can be any suitable switching semiconductors. If these two switches are turned on alternately for equal times, then the

voltage waveform across the load is as shown in Fig.2a. The mean value of this waveform, averaged over one switching cycle is 0. This square wave with a constant 50% duty ratio is known as the 'carrier' frequency. The waveform in Fig.2b shows the effect of a slow variation or 'modulation' of the duty ratio; the mean voltage varies with the duty ratio. The waveform of the resultant load current depends on the impedance of the load Z. If Z is mainly resistive, then the waveform of the current will closely follow that of the modulated square wave. If, however, Z is largely inductive, as with a motor winding or a filter choke, then the switching square wave will be integrated by the inductor. The result is a load current waveform that depends mainly on the modulation of the duty ratio.

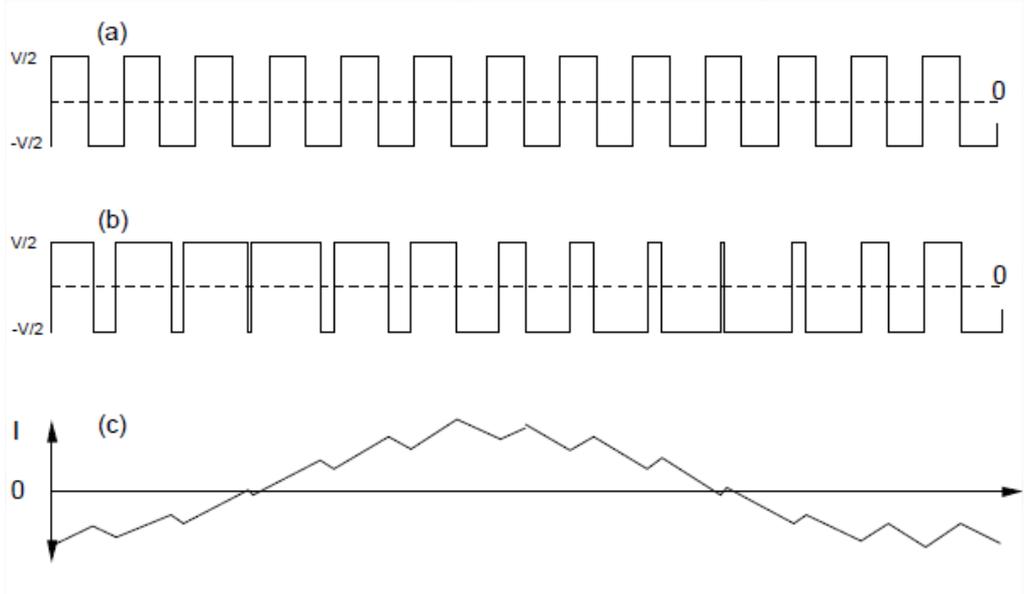


Figure 2. Waveforms in PWM inverter: (a) Unmodulated carrier; (b) Modulated carrier; (c) Current in inductive load

If the duty ratio is varied sinusoidally in time, then the current in an inductive load has the form of a sinewave at the modulation frequency, lagging in phase, and carrying ripple at the switching frequency as shown in Fig.2c. The amplitude of the current can be adjusted by controlling the depth of modulation, that is, the deviation of the duty ratio from 50%. For example, a sinewave PWM signal which varies from 5% to 95%, giving 90% modulation, will produce a current nine times greater than that produced by a signal which varies only from 45% to 55%, giving only 10% modulation [2].

2. CONTROL SCHEME

In Figure 3 it is presented the control scheme that is designed for controlling DC motor speed. First block represents PC serial port RS232 through which the computer communicates with microcontroller. In the second block it represented MX 232 circuit. This circuit enables the adaption of voltage levels between serial port and TTL and CMOS electronics technologies. In TTL/CMOS, logical levels are "1" = +5V and "0" = 0V. In other hand serial port RS 232 has levels of "1" = -10V and "0" = +10V. So the MAX 232 circuit enables that these two sides communicate with each other. Third block in the scheme represents simplified microcontroller.

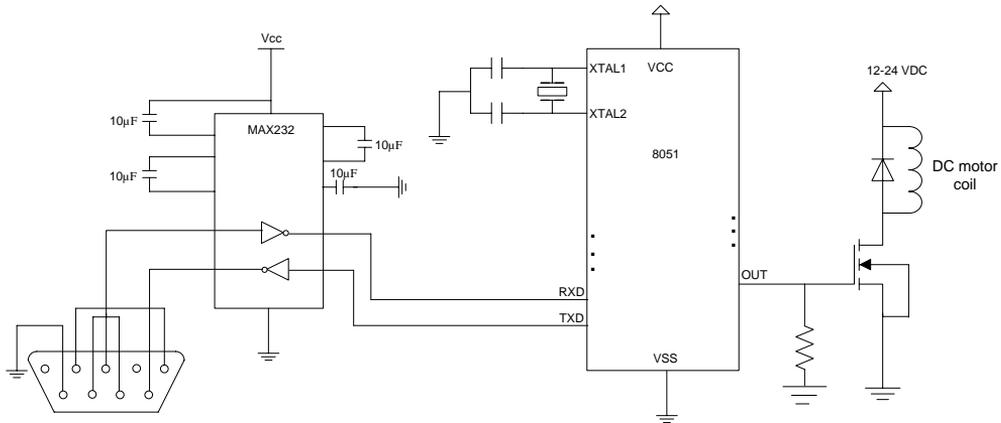


Figure 3. Control scheme

3. DESIGNING INTERFACE

Visual Studio IDE offers a set of tools that can help to write and modify the code for programs, and also detect and correct errors in your programs. These tools enable developers to build simple but very useful interface for various applications. In our case we used following controls:

- One ComboBox, where the user chooses the speed that will motor have
- Three buttons: One for starting motor, one for stopping motor and one for closing application
- One serialPort control to enable code writing to the serial port

The interface is presented in the Figure 4.

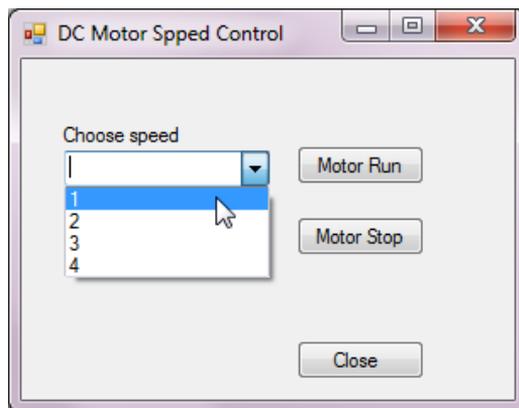


Figure 4. Interface created with Visual Studio C#

The user chooses values from 1 to 4, and then the chosen number goes to computer serial port. The chosen number then is read by Microcontroller that has a programmed procedure to scan serial port to see what number has arrived from the interface. For example if we have chosen number 1, microcontroller generates a signal in the output with specific frequency and duty cycle by modulating the signal. In this case the motor will move with lowest programmed speed. If we choose the value 2 in the ComboBox control, the microcontroller goes into second procedure and generates another signal with different frequency and duty cycle. While coding, it is necessary to add the System.IO.Ports namespace into the project to enable writing to and reading from serial port.

The System.IO.Ports namespace contains classes for controlling serial ports. The most important class, SerialPort, provides a framework for synchronous and event-driven I/O, access to pin and break states,

and access to serial driver properties. It can be used to wrap a Stream objects, allowing the serial port to be accessed by classes that use streams [3].

4. CONCLUSION

Pulse width modulation is a power technique which has found its use in numerous industrial applications. Having this in mind, our projects initial idea was to help it improve in a certain aspect – its flexibility. In motors as well as in Variable Voltage Power Supply, always there is little space to move from producers given parameters. Our idea was to introduce computer software applications to help it increase flexibility, meaning controlling and changing the output performance. Additionally, in many production lines, when there is needed to increase production volume, often engineers go machine by machine in production line, changing/increasing Motor Invertors frequency. Instead the motors could be controlled from a software applications where collectively or individually can be accessed and parameters could be adjusted.

6. REFERENCES

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