Application of Microcontroller SAB80C537 to Control DC Servo Motor

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Abstract

The DC servo system is known as a feedback control system. This system has the full function that a feedback control system must have and they based on the operating state of the system and the desired state to operate. DC servo transmission systems are widely used in the industry because of the outstanding advantages of speed adjustment easily and accurately. Since the introduction of high-speed microcontrollers, servo systems have real-time responsiveness and give very high controllable quality. Derived from the actual needs of modern transmission, the article introduces the solution application of SAB80C537 microcontroller to control the DC servo motor.

Keywords - *DC servo system, feedback control system, easy speed control, microcontroller, pulse width modulation, fast response.*

I. INTRODUCTION

With easy adjustable speed ability, high adjustable quality in wide ranges, servo motors are increasingly used in driver systems in industry such as controlling pressure, flow, level, temperature, oil refining, chemical processing, remote control valve, contour alignment, dies of machine tools, etc. As we know that servo motor operate at a normal speed when it is supplied with rated voltages and rated loads. However, in practical applications the motors usually do not work at constant speed. For applications when motor speed has to vary with load characteristics, it is important to actively regulate motor speed. One of the solutions today is to use a pulse converter based on pulse width modulation (PWM) principle using the SAB80C537 microcontroller to adjust the motor speed.

II. PWM CONVERTER

The use of DC-DC converter based on PWM principle makes the electromotive force Eb of the converter change continuously in order to control the motor speed. The PWM technique generates series of rectangular pulses to control semiconductor switches. By controlling the pairs of valves to work with certain rules, the motor speed as well as the working states of the system will be controlled. The DC-DC converter based on PWM technique has many advantages such as: simple control structure, reliable operation. The converter in this paper is designed to be able to change the current direction and to implement regenerative braking. The IGBT is chosen due to small power of the motor. The force circuit diagram is shown in figure 1.

According to the above diagram, 4 force valves T1, T2, T3, T4 are arranged to form the bridge diagram. Valve control method is asymmetric control method.

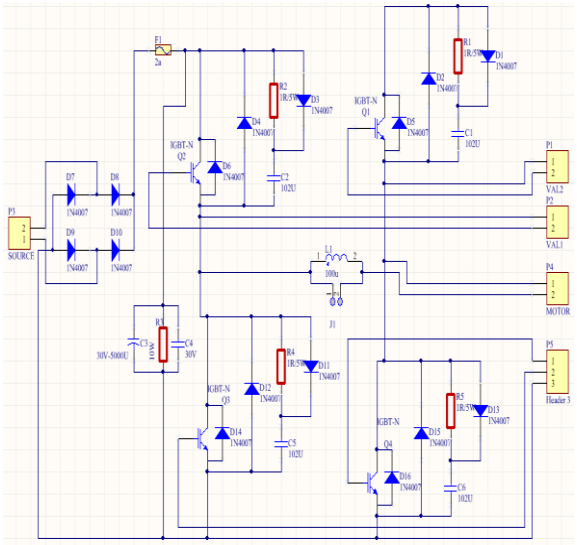

Fig 1: The diagram of the force circuit

The working pairs of valves give the voltage to the motor can change polarity and so the motor can reverse rotation.

III. SAB80C537 MICROCONTROLLER AND DC MOTOR CONTROL BOARD DESIGN

A. SAB80C537 Microcontroller

The SAB80C537 microcontroller is a fully compatible microcontroller for the 8051 family. It consists entirely of SAB 80C515, providing 100% compatibility up. On the other hand, the amount of peripheral integration increases dramatically.

The SAB80C537 is a highly integrated microcontroller of siemens for control applications. Several on-chip peripherals have been added to provide the ability to respond time to the 8-bit processor core. The 32-bit/16-bit arithmetic unit improves the interrupt structure with 4 priority levels

and increases 8 pointers with 16-bit data for a more meaningful CPU.

Furthermore, the SAB80C537 incorporates three 8-bit input / output ports and 12 analog inputs and outputs. There are serial channels suitable for the 8051-UART and provide independent programmable and general baud rates. An A/D converter with preset voltage can be programmed with built-in software to handle analog signals. The SAB80C537 also includes a powerful CAP/COM with two 16-bit timers for all types of digital signal processing. The controller is perfect for fail-safe response in unsafe applications and it has all the features of CMOS such as minimizing power when not in use, low power and slow running mode.

B. Control Card (CPU Board):

The control card uses the following components:

The chip is a SAB80C537 microprocessor with no internal ROM, external data memory is 32Kbyte RAM.

Microchip generates pulses with frequency 16MHz (Quartz)

The external memory is an EPROM 32 Kbyte chip that can be erased with ultraviolet rays and recharged by electrical impulses.

Data memory is EEPROM that can be loaded and erased by electrical impulses and has high data protection.

The IC74HC86 serve for PWM modulation based on the spatial vector modulation principle.

1) Buffer circuit model*

+ Delayed signal circuit:

The principle diagram is shown in figure 2.

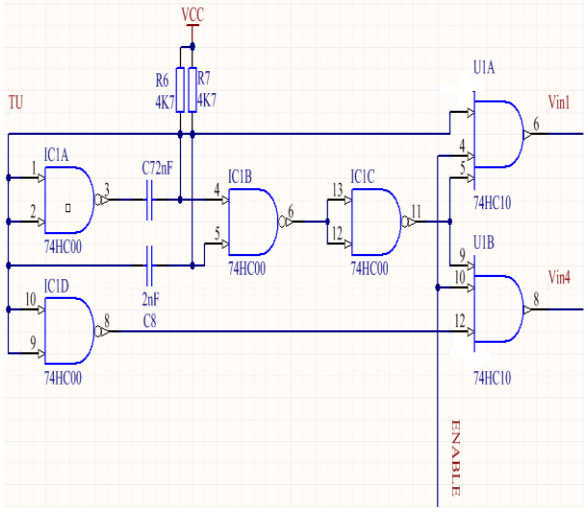

Fig 2: The diagram of the delayed signal circuit

This circuit is designed so that the control signal from the microprocessor will be delayed to the required quantity calculated for supplying the valves, in addition to ensuring the isolation between the control circuit and the circuit force.

+ Device decoding circuit:

The principle diagram is shown in figure 3.

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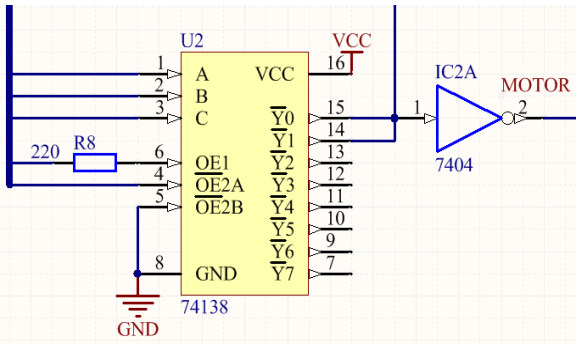


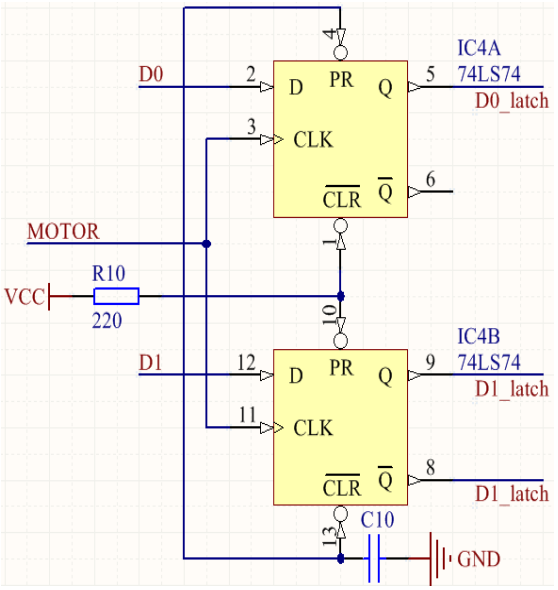
Fig 3: The diagram of the device decoding circuit

The IC74LS138 has three input terminals (A, B, C) and three decoded outputs (from Y0 to Y7). Address lines A2, A3 and A4 are put in IC74LS138 to allow the control circuit or feedback circuit to operate.

2) The circuit provides the signal for switching and reversing the motor:*

This circuit uses an Flip-Flop IC74HC74 to lock the control signal. This IC is used to lock the output signal which means that when there is no next control signal (closed, cut or reversed), the old control signal will remain. The diagram is shown in figure 4 and figure 5.

Fig 4



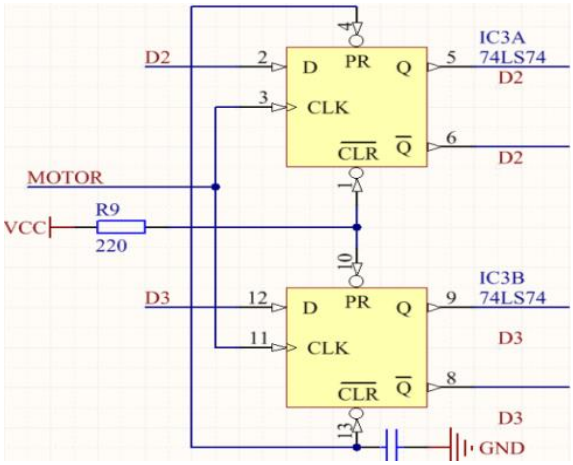


Fig 5

*3) *Circuit part provides signal to control motor:*

The diagram is shown in figure 6.

Control signal from two output Tu, Tv of the SAB 80C537 is combined with IC74HC08, IC74HC00, IC4ABT332 to give control signal controlling motor by the reverse width.

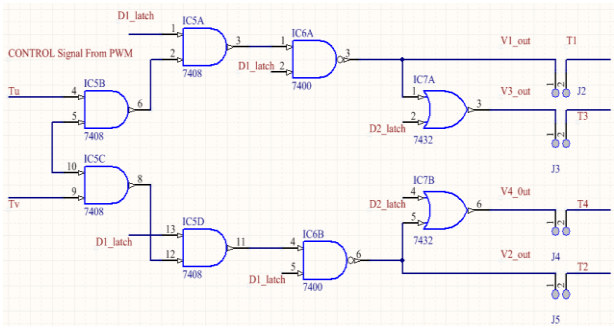


Fig 6: The diagram of the circuit provides signal to control motor

*4)*Control circuit open the force valve T1*:

The diagram is shown in figure 7.

This circuit uses IC 6N135 to isolate the control and the power amplifier. IC MC33153 is designed to generate positive and negative pulse, just to amplify the power.

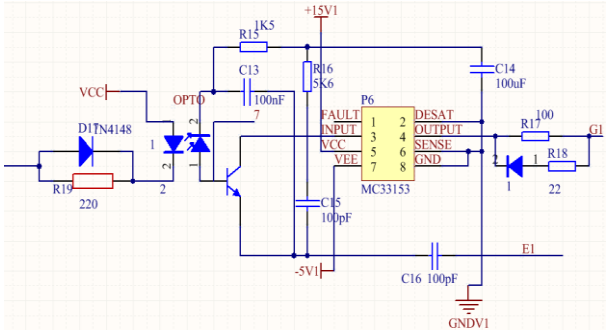


Fig 7: The diagram of the control circuit open the valve T1

*5)*Control circuit open the force valve T2:*

The diagram is shown in figure 8. Similar to control circuit open the force valve T1.

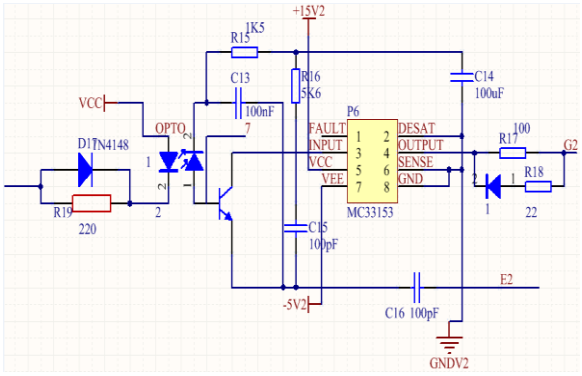
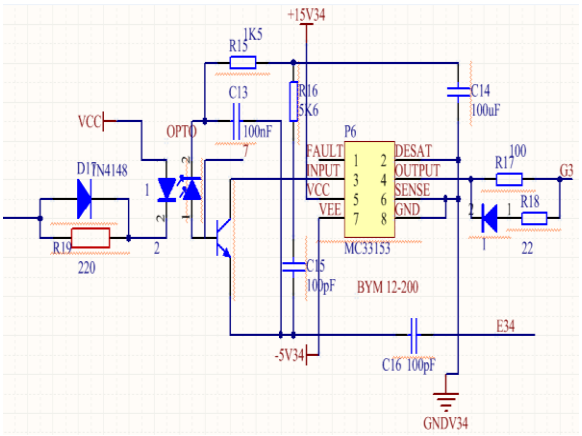


Fig 8: The diagram of the control circuit open the valve T2

*6)*Control circuit open the force valve T3:*



The diagram is shown in figure 9.

Fig 9: The diagram of the control circuit open the valve T3

*7)*Control circuit open the force valve T4:*

The diagram is shown in figure 10.

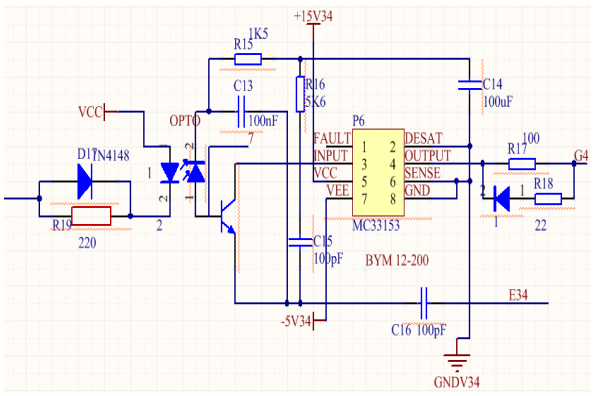


Fig 10: The diagram of the control circuit open the valve T4

*8)**Feedback circuit:***

The feedback circuit receives the signal from the encoder and transfers it to the microcontroller processor and stores it in the external RAM. The diagram is shown in figure 11.

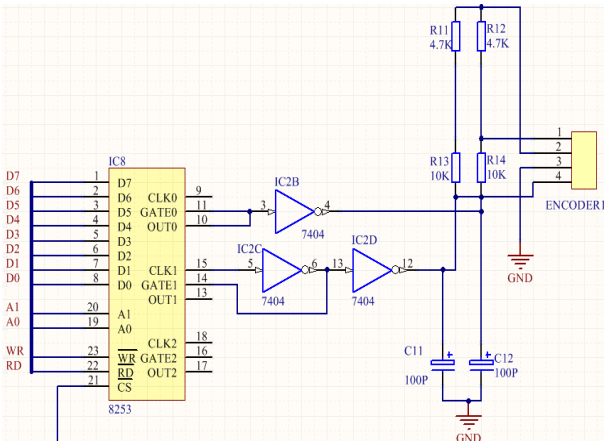


Fig 11: The diagram of the feedback circuit

*9)*** Installation diagram of the DC motor control board***

The Installation diagram of the DC motor control board is shown in Figure 12 and Figure 13.

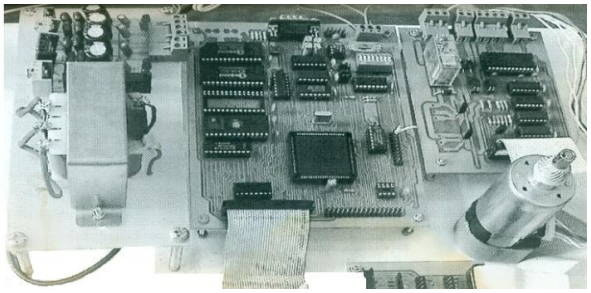


Fig 12

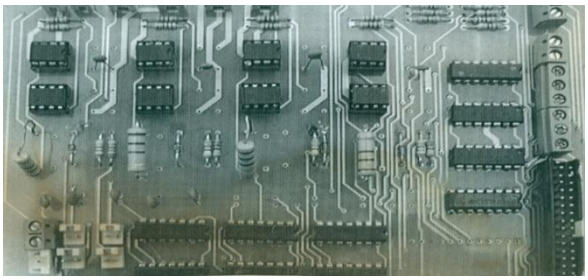


Fig 13

IV. EXPERIMENTAL RESULT

Based on the SAB80C537 microcontroller to build a servo motor control program. The program is written with Visual C ++ programming tools and is capable of running on Windows operating systems. Pulse width modulation PWM thanks to microcontrollers using the Compare Timer, built-in digital PID controller based on the Keil C51-Compiler software. The user interface includes the main interface in the program, the communication setting window allowing the user to select the communication mode between the computer and the microcontroller card, Set point window to set parameters for DC motor control system, PID setting window to set the PID controller for the system, The DC motor block parameters window specifies the maximum speed of the motor, window encoder block parameters to declare number of pulses on a rotation of encoder.

*10) ***Test result control DC servo motor with control board***

The circuit running test drive a DC servo motor has the following parameters:

Rated power: P_{dm}=42W
Nominal voltage: U_{dm}=30V
Rated current: I_{dm}=2A
Inductance armature: L_u=10mH
Armature resistor: R_u=2Ω
Nominal speed: n_{dm}=2750v/ph
Inertia equation: J=0.0002Kgm^2

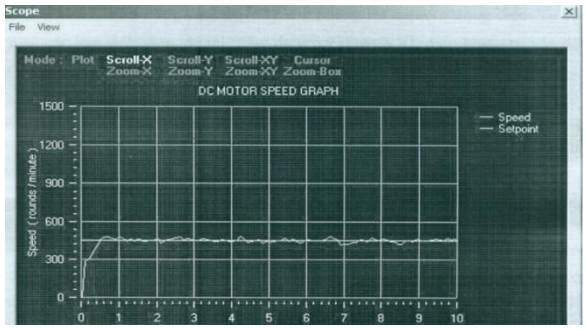


Fig 14: Experimental result

V. CONCLUSIONS

This paper proposes a model for controlling a DC servo motor using microcontroller with feedback. The test circuit uses a feedback signal from the encoder with 200 pulses/ cycle, at a motor speed of about 1200v/ph, the minimum time required for the encoder to operate (motor full rotation) is 100ms. With the current cycle of 20ms, in which the speed read time is only 5ms, meaning the error can be up to 20%. However, the characteristic of the motor (Figure 14) show the control capability is quite stable of the PID controller and enables to improve control quality in transmission systems in industry.

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