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DC Drives: Microcontroller Based Control

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Abstract— This paper is to present a microcontroller based control for DC drives to effectively control the output when there is sudden change in the input parameters. An assembly language program has been built for the programmable microcontroller which controls the various functions of DC drive. The main objective of control is to get the desired output and keep the motor or drive safe in case of any fault occurred. An eight bit microcontroller has been used for the controller purpose. Introducing a microcontroller based scheme facilitates the new DC drive system to deal with the various changes in the system and helps in maintaining the safe operation of the system.

Keywords— Assembly Language, DC drive, Microcontroller, Speed Control.

I. INTRODUCTION

A. Background

In modern electrical drive system, about 50% of the total energy is consumed by the drives which may be either constant speed drives or variable speed drives [1]. The 75% of the system has application with constant speed drives in which energy is wasted across the throttling valve to adjust flow rate or any other parameter of interest. Using solid state control of drives, machine speed is adjusted in such a way that it delivers the required flow rate or any other parameter of interest efficiently [2] [3]. The conventional electric motor drive system with variable speed is depicted in figure 1. The demerits associated in the system for implementing other performance requirements.

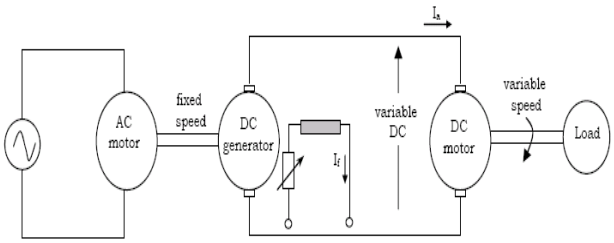

Fig. 1 Classical Electrical Drive for variable speed operation

With such system are: the system becomes bulky, inefficient and inflexible to the change parameters. It is clearly shown in the figures 2 and figure 3 that the losses are much more in constant speed drives as compared to the variable speed drives. In conventionally analog control scheme, implementation is done by the hardwired electronics. The non-linearity of speed sensors poses the problem in efficient control of speed of dc drives [4]. The demerits further associated with such control are its temperature dependency and requirement of major changes on contrary to this; the microcomputer based control has the merits of software implementation which in turn makes the system reliable and flexible in nature. The control is precise and faster in operation as it depends on the programming for the microcontroller.

In this paper, we present a flexible and reliable control scheme for controlling the dc drive in different situations such as forward and reverse motoring and braking, speed control, torque regulation, overvoltage and current protection, speed and error code display which can be used by the industries for efficient and sophisticated control of the dc drives [5] [6]. The dc drives has the advantage over the ac drives of easy and sophisticated control. An assembly program based on the control requirements is developed to simulate various operating condition of a dc drive. The cost of overall control scheme is reduced and also the size of the system is much smaller than that with the conventional analog control scheme. The microcontroller used is the eight bit PIC series microcontroller. The applications for such control scheme range from large industrial drives to small dc drives, servomotors such as in robotics, printers and plotters, start and stop of drives, speed and current control, monitoring control variables, initialisation of protection and trip circuit and diagnostics for built in fault finding [7]. The theory development of microcontroller based control of dc drive is given followed by implementation of the control scheme for various operating conditions and discussed in the results section. Results obtained are found in good agreement with the available in literature [8]. Finally and the most important section is the conclusion which concludes the purpose of this paper.

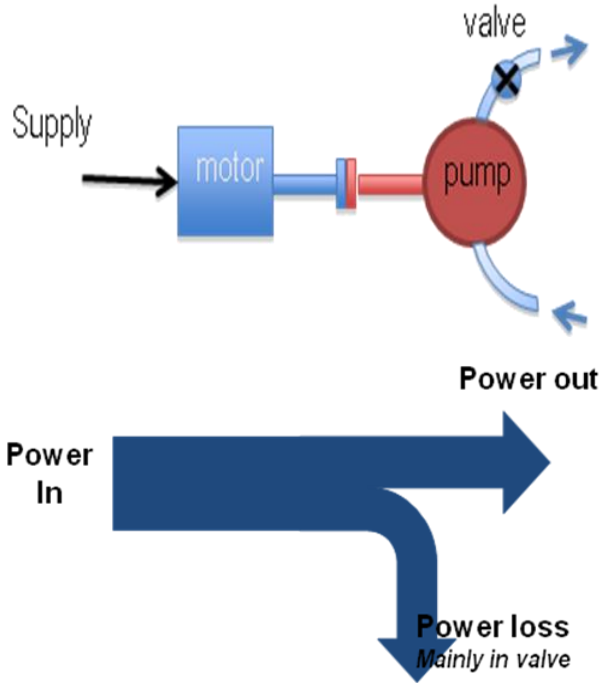

Fig. 2 Constant speed operation

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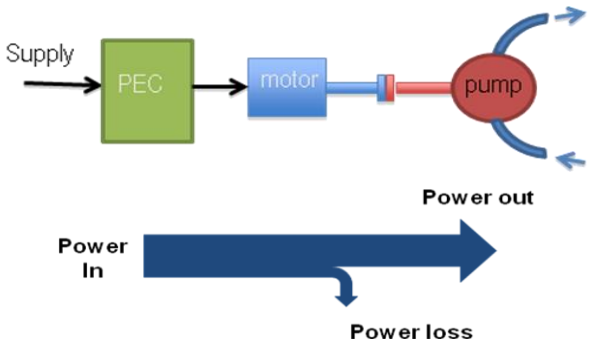

Fig. 3 Variable Speed Operation

II. DESIGN METHODOLOGY

The hardware and software design of the microcontroller based control scheme is presented in this section.

A. Hardware Design

The figure 4 shows the block diagram of the speed control system for the dc motor drive. Figure 5 shows the dc motor control hardware block. The microcontroller unit (MCU) controls the dc motor by processing its controlling parameters that are speed and current signals.

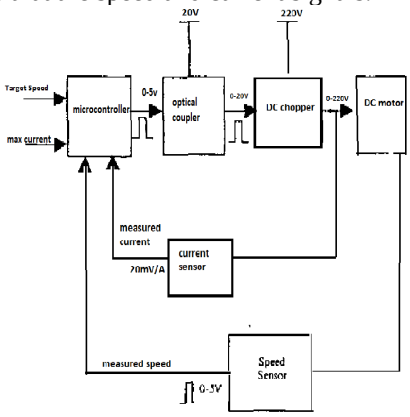

Fig. 4 Block diagram of speed control system

The keypad is used to enter the reference speed signal. The optocouplers are used to isolate the high voltage circuit from the low voltage controlling signals. The assembly program developed for the control purpose includes checking the parameters time to time and act accordingly to protect the motor from any type of damage due to overvoltage or current.

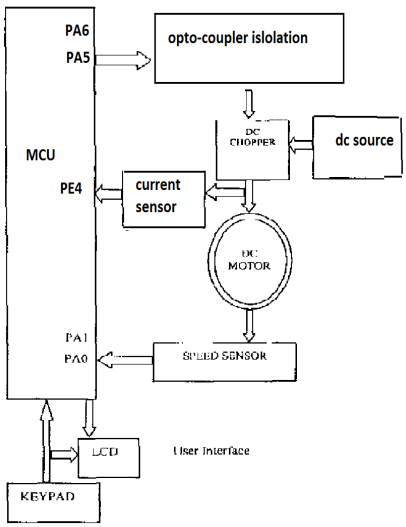

Fig. 5 DC motor control hardware block

B. Software Design

The complete flowchart for the system software design is given in figure 6.

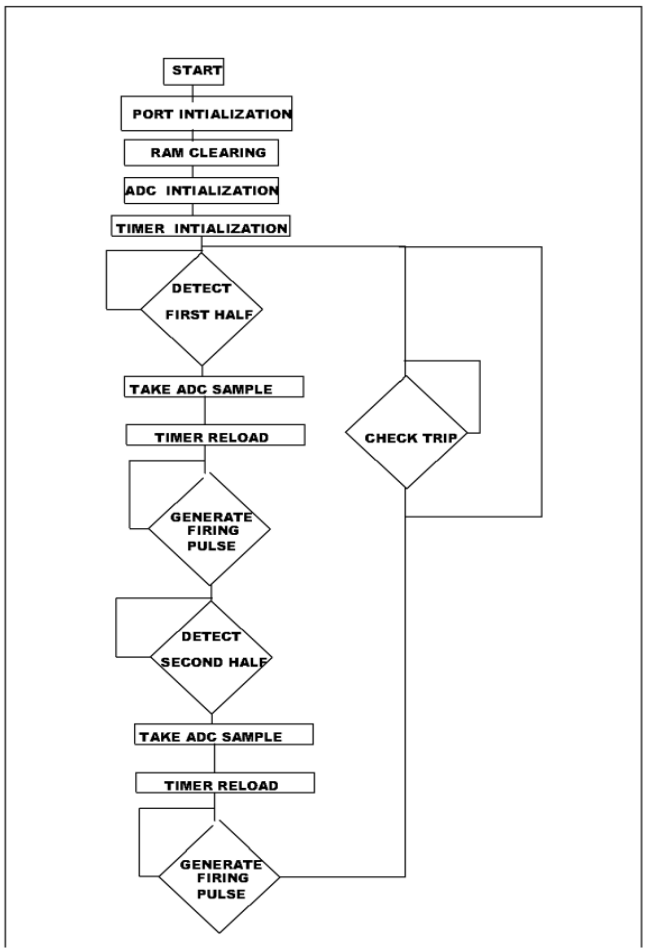

Fig. 6 Flowchart for microcontroller programming

The gate pulses of the dc chopper are generated using the pulse width modulation technique (PWM). The block diagram for PWM pulse generation is shown in figure 7.

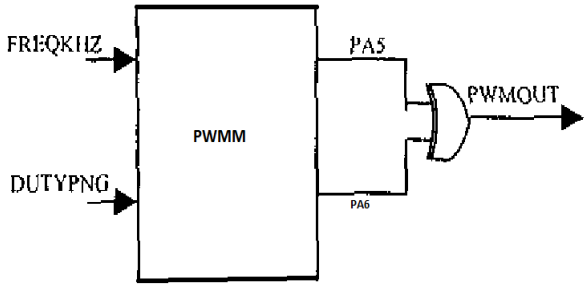

Fig. 7 PWM generation block

III. RESULTS AND DISCUSSION

The hardware and software has been developed for the closed loop control of dc shunt motor and the results are obtained in accordance with the expectations which are discussed in this section. The outputs of the motor and speed responses are observed when input to the microcontroller is fed by the keypad. The speed response of the motor is shown in figure 8 where the motor achieves the preset 1000rpm value which is steady after sometime and there is also very less overshoot before achieving the steady value of the speed.

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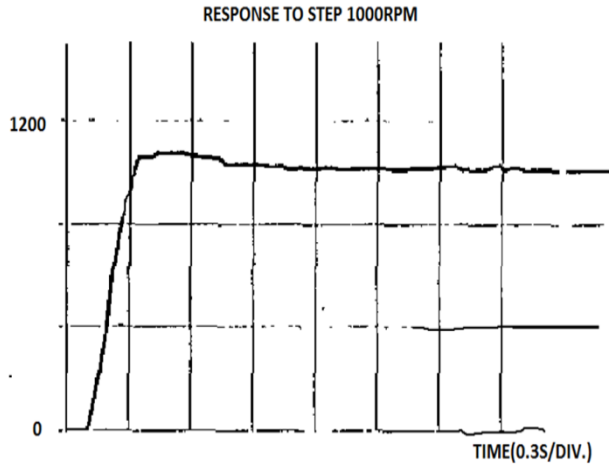

Fig. 8 Speed response of motor to step 1000rpm

Figure 9 shows the speed response when suddenly load is applied at the load end of the motor. The motor regain its steady state speed value and does not enter the instability mode.

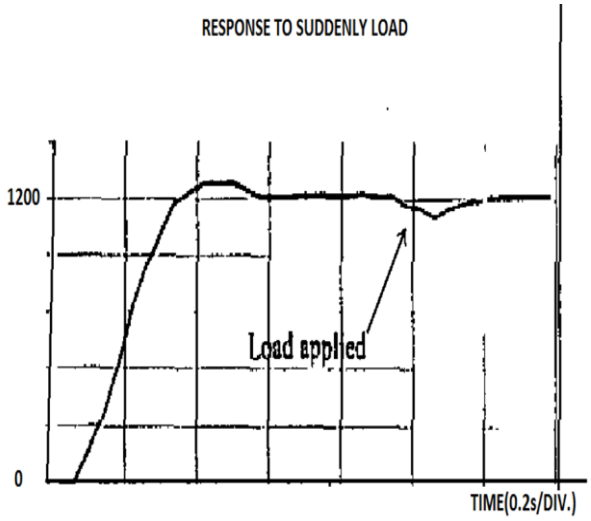

Fig. 9 Speed response of motor to suddenly load

The figure 10 and 11shows the response to overload and emergency stop operating conditions. It is clear that the motor acts accordingly and stops so as to avoid any damage to the system and thus protects the system.

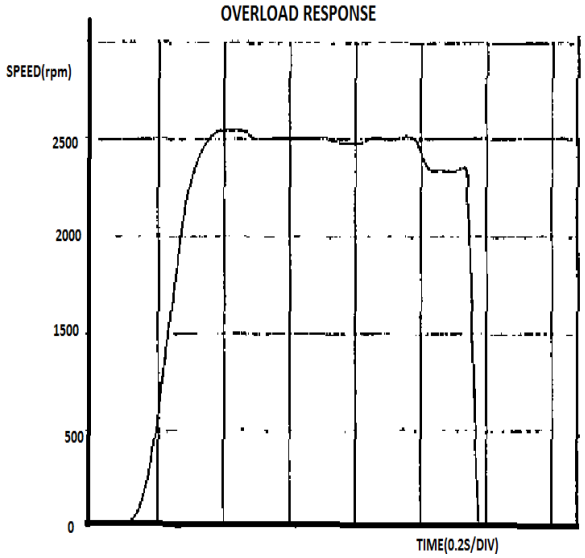

Fig. 10 Overload response

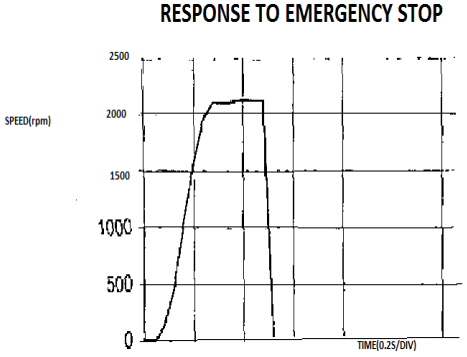

Fig. 11 Response to emergency stop

IV. CONCLUSION

The microcontroller based control scheme has been developed for the control of dc drives. Experimental results have been obtained and discussed in the result section.

It can be concluded that the present control scheme is reliable, flexible and easy to use for any size and type of motor. Thus, it can also be used for protection and power cut off system.

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