CLOSED LOOP SPEED CONTROL OF DC MOTOR USING PID CONTROLLER

INTRODUCTION

- The development of high performance motor drives is very important in industrial as well as other purpose applications.
- Generally, a high performance motor drive system must have good dynamic speed command tracking and load regulating response.
- The dc motors are used in various applications such as defense, industries, Robotics etc.
- DC drives, because of their simplicity, ease of application, reliability and favorable cost have long been a backbone of industrial applications.

INTRODUCTION

- DC drives are less complex with a single power conversion from AC to DC. DC drives are normally less expensive for most horsepower ratings.
- DC motors have a long tradition of use as adjustable speed machines and a wide range of options have evolved for this purpose.
- In these applications, the motor should be precisely controlled to give the desired performance. Many varieties of control schemes such as P, proportional integral (PI), PID, adaptive, and FLCs, have been developed for speed control of dc motors.
- The proposed controller systems consist of PID controller and DC drive for the speed control.

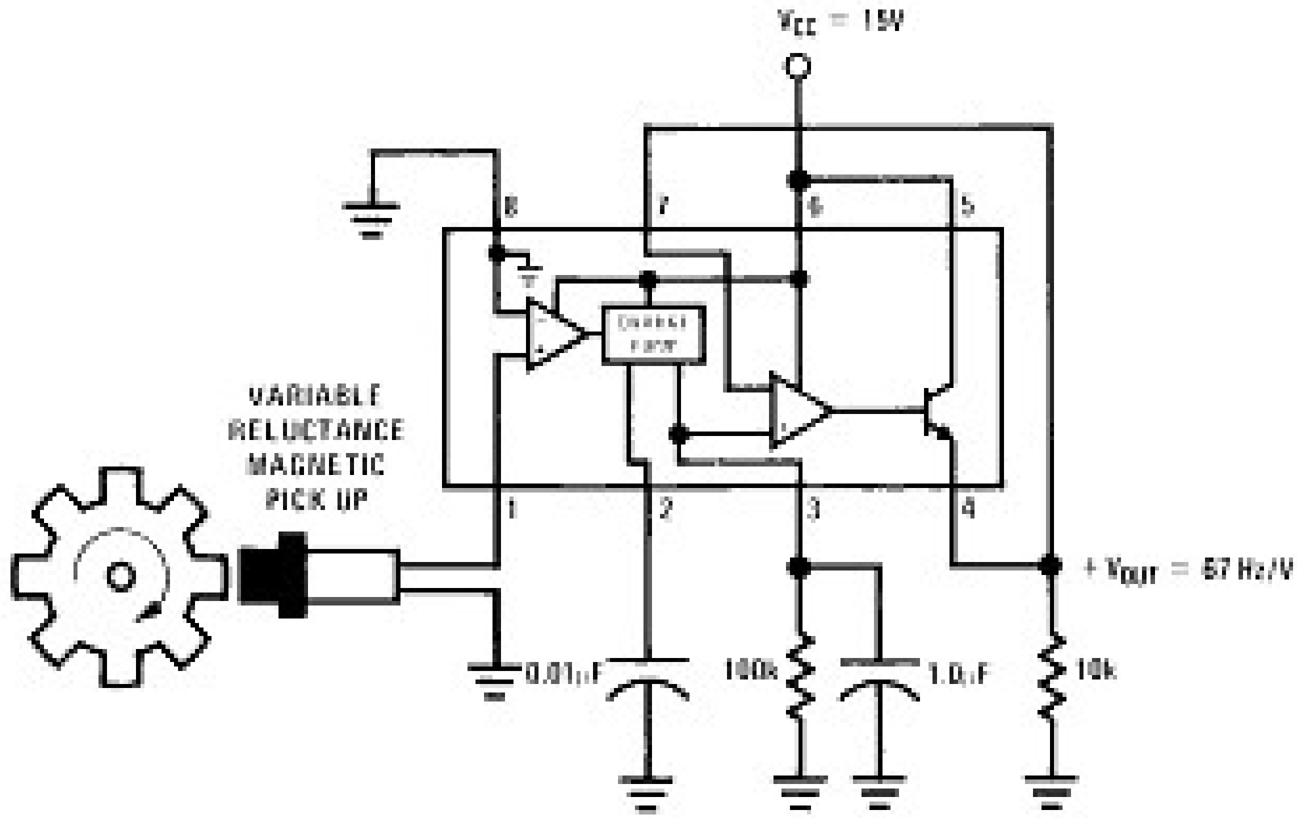
TACHOMETER

- The LM2907, LM2917 series are monolithic frequency to voltage converters with a high gain op amp/comparator designed to operate a relay, lamp, or other load when the input frequency reaches or exceeds a selected rate.
- The tachometer uses a charge pump technique and offers frequency doubling for low ripple, full input protection in two versions (LM29078, LM2917-8) and its output swings to ground for a zero frequency input.
- The op amp or comparator is fully compatible with the tachometer and has a floating transistor as its output. This feature allows either a ground or supply referred load of up to 50 mA.

TACHOMETER

- The two basic configurations offered include an 8-pin device with a ground referenced tachometer input and an internal connection between the tachometer output and the op amp non-inverting input.
- This version is well suited for single speed or frequency switching or fully buffered frequency to voltage conversion applications. The more versatile configurations provide differential tachometer input and uncommitted op amp inputs.
- With this version the tachometer input may be floated and the op amp becomes suitable for active filter conditioning of the tachometer output. Both of these configurations are available with an active shunt regulator connected across the power leads.

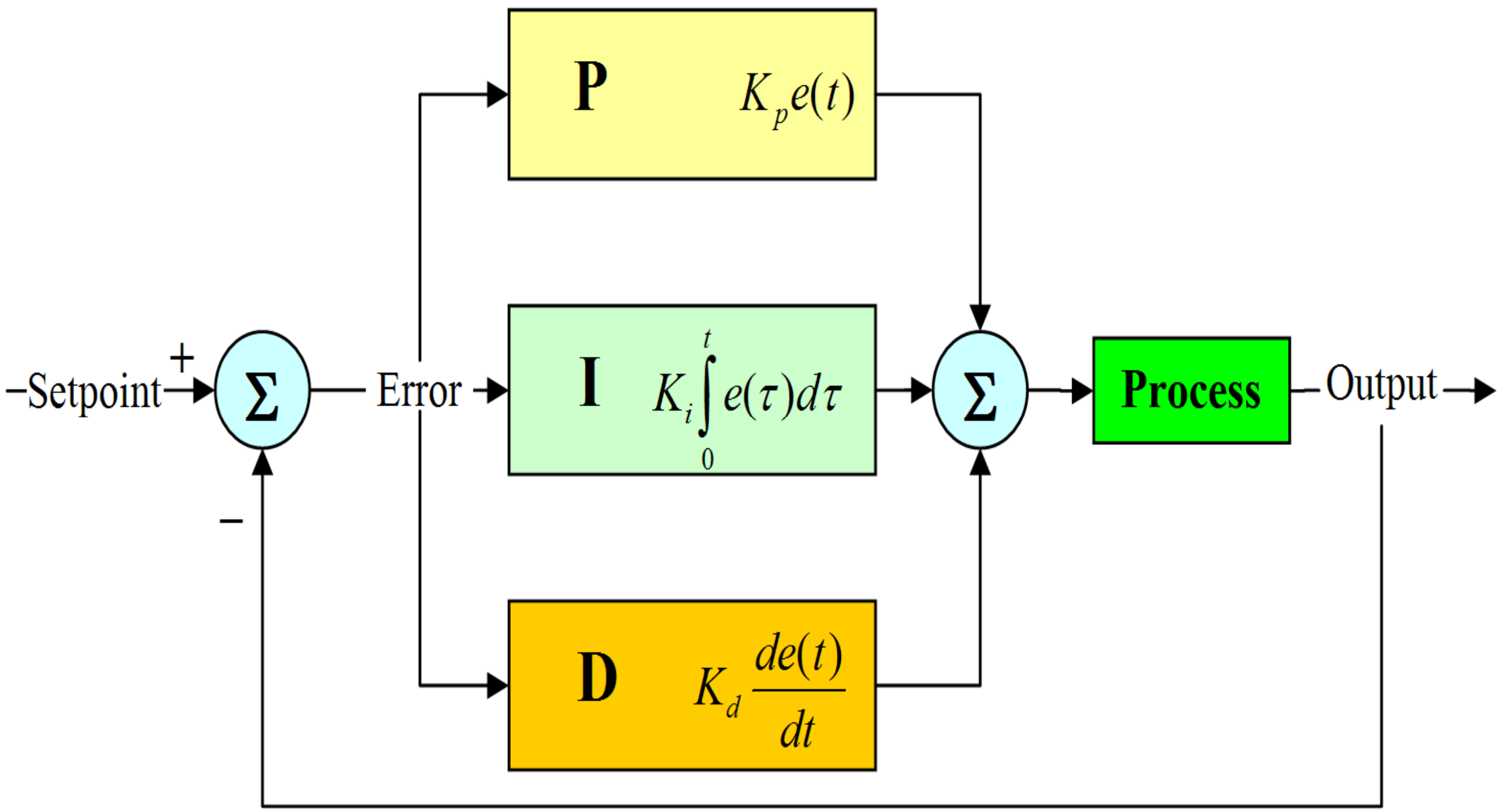
APPLICATIONS IN TACHOMETER (FREQUENCY TO VOLTAGE CONTROLLER)



PID CONTROLLER

- PID control is used to control and maintain processes. It can be used to control physical variables such as temperature, pressure, flow rate, and tank level. The technique is widely used in today's process industry to achieve accurate control under different process conditions.
- PID is simply an equation that the controller uses to evaluate the controlled variables. A controlled variable temperature, for example, is measured and feedback to the controller.
- The controller then compares the feedback to the set-point and generates an error value. The value is examined with one or more of the three proportional, integral, and derivative methodology.

PID CONTROLLER



DC DRIVE

- The thyristor DC drive remains an important speed-controlled industrial drive, especially where the higher maintenance cost associated with the DC motor brushes (c.f. induction motor) is tolerable. The controlled (thyristor) rectifier provides a low-impedance adjustable 'DC' voltage for the motor armature, thereby providing speed control.
- DC supply needed for speed control of an industrial DC motor was to generate it with a DC generator. The generator was driven at fixed speed by an induction motor, and the field of the generator was varied in order to vary the generated voltage.

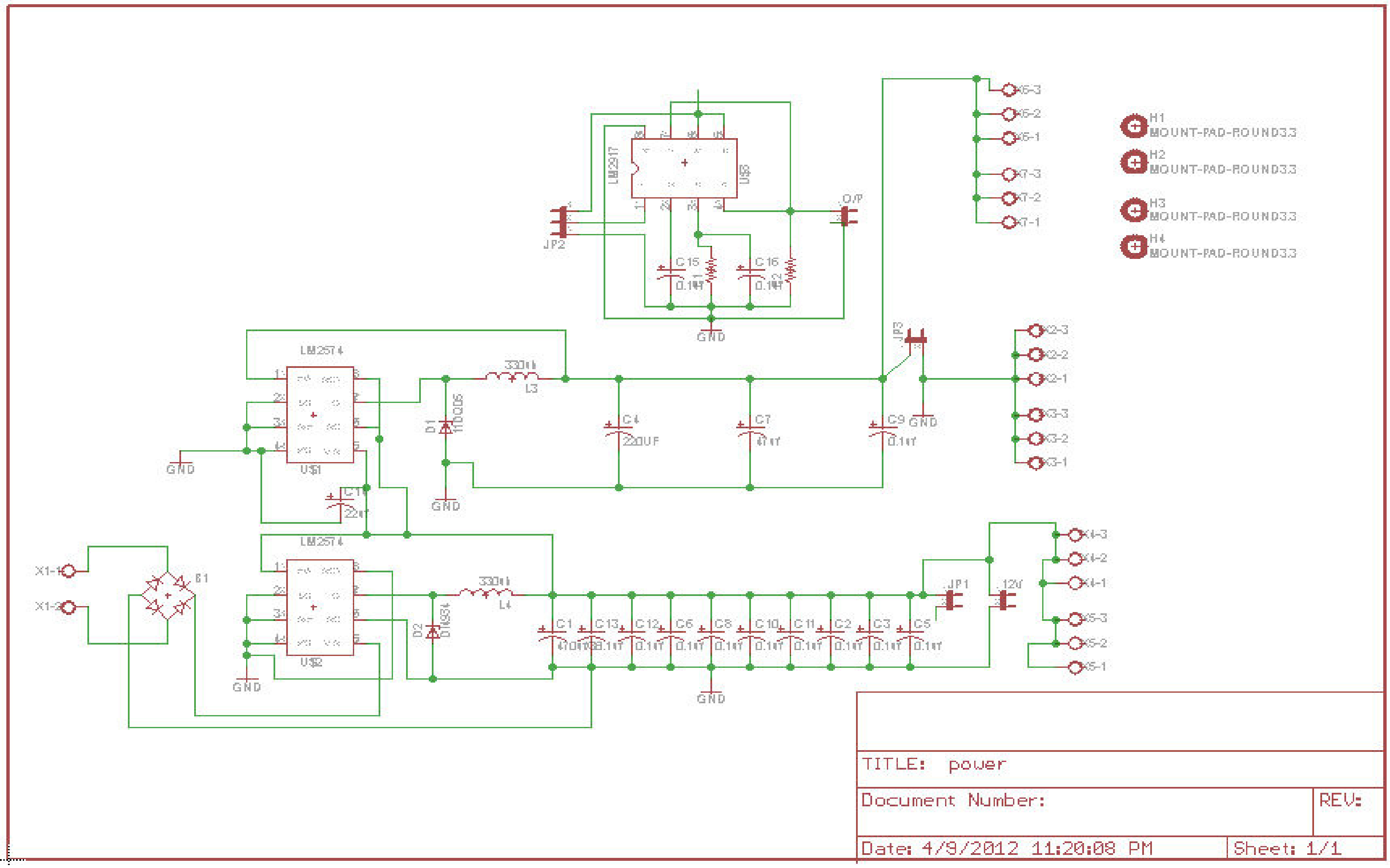
HARDWARE IMPLEMENTATION

- The controller used in a closed loop provides a very easy and common technique of keeping motor speed at any desired set-point speed under changing load conditions.
- This controller can also be used to keep the speed at the set-point value when, the set-point is ramping up or down at a defined rate. The essential addition required for this condition to the previous system is a means for the present speed to be measured.
- In this closed loop speed controller, a voltage signal obtained from a Tachometer attached to the rotor which is proportional to the motor speed is fed back to the input where signal is subtracted from the set-point speed to produce an error signal.

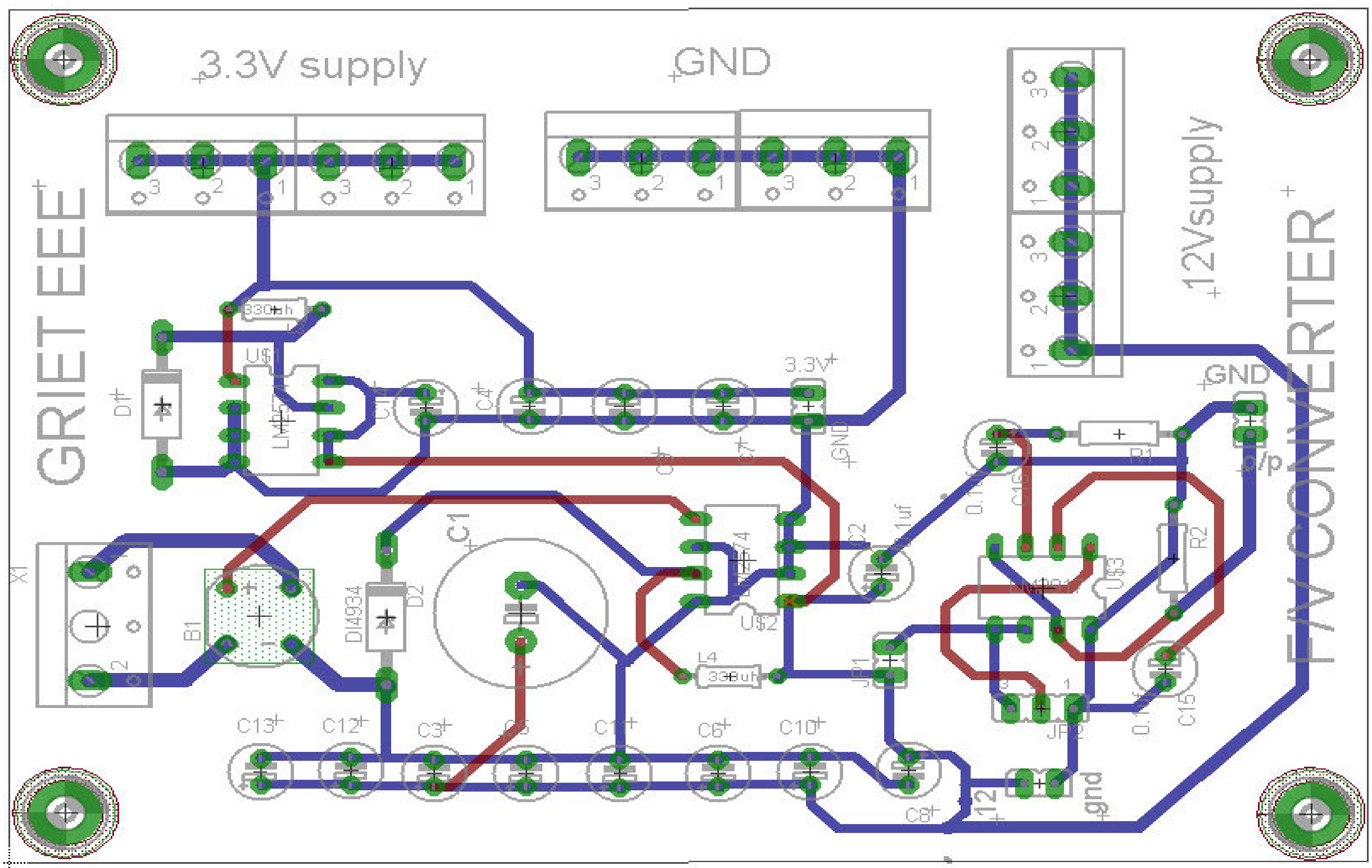
HARDWARE IMPLEMENTATION

- This error signal is then fed to work out what the magnitude of controller output will be to make the motor run at the desired set-point speed. For example, if the error speed is negative, this means the motor is running slow so that the controller output should be increased and vice-versa.
- This section covers a various circuits present in the hardware of the speed control of DC motor using PID controller
- Tachometer,Error Amplifier,PID controller,DC Drive

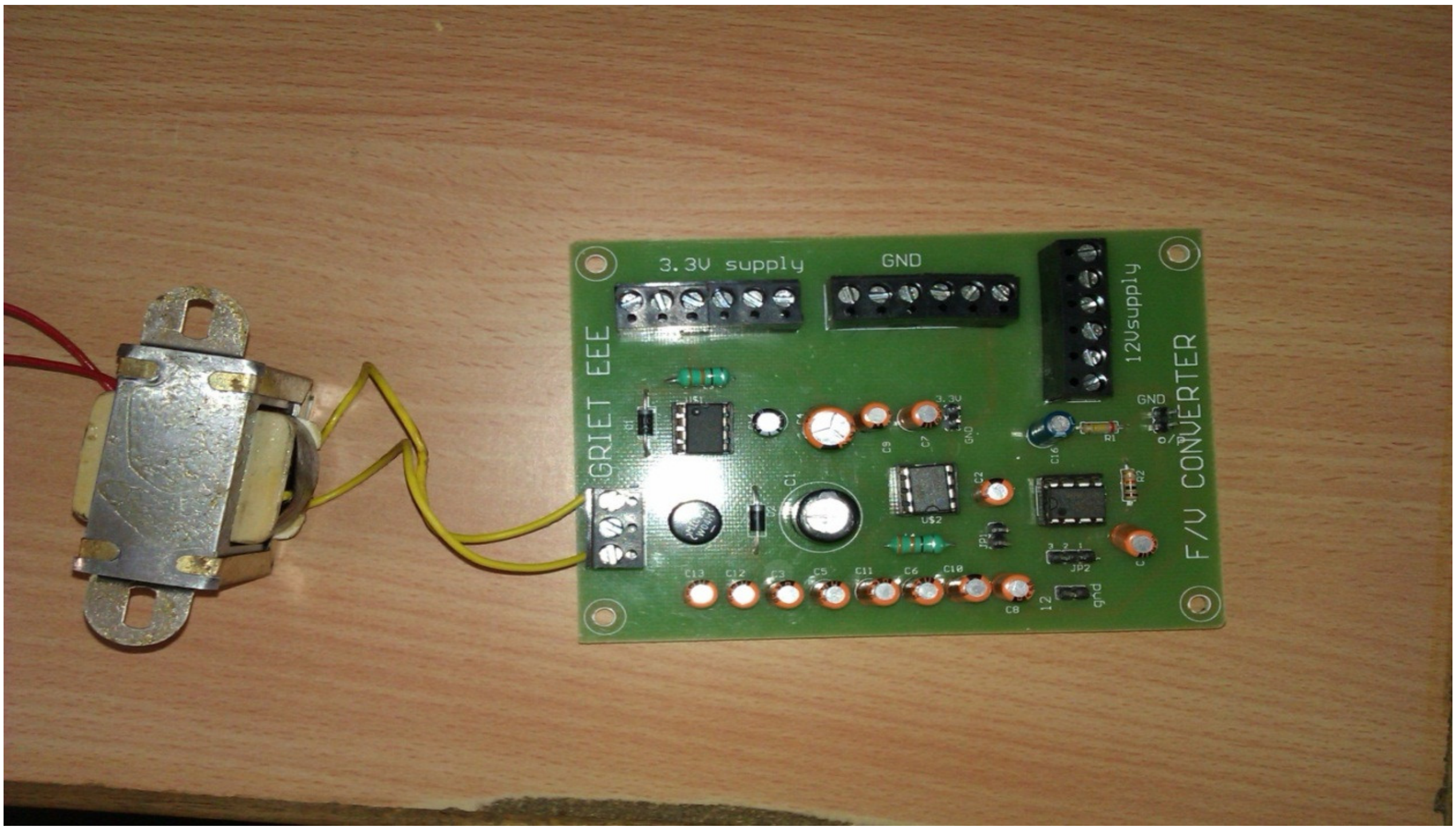
Schematic Diagram of Voltage regulator and tachometer



Layout of Voltage regulator and tachometer



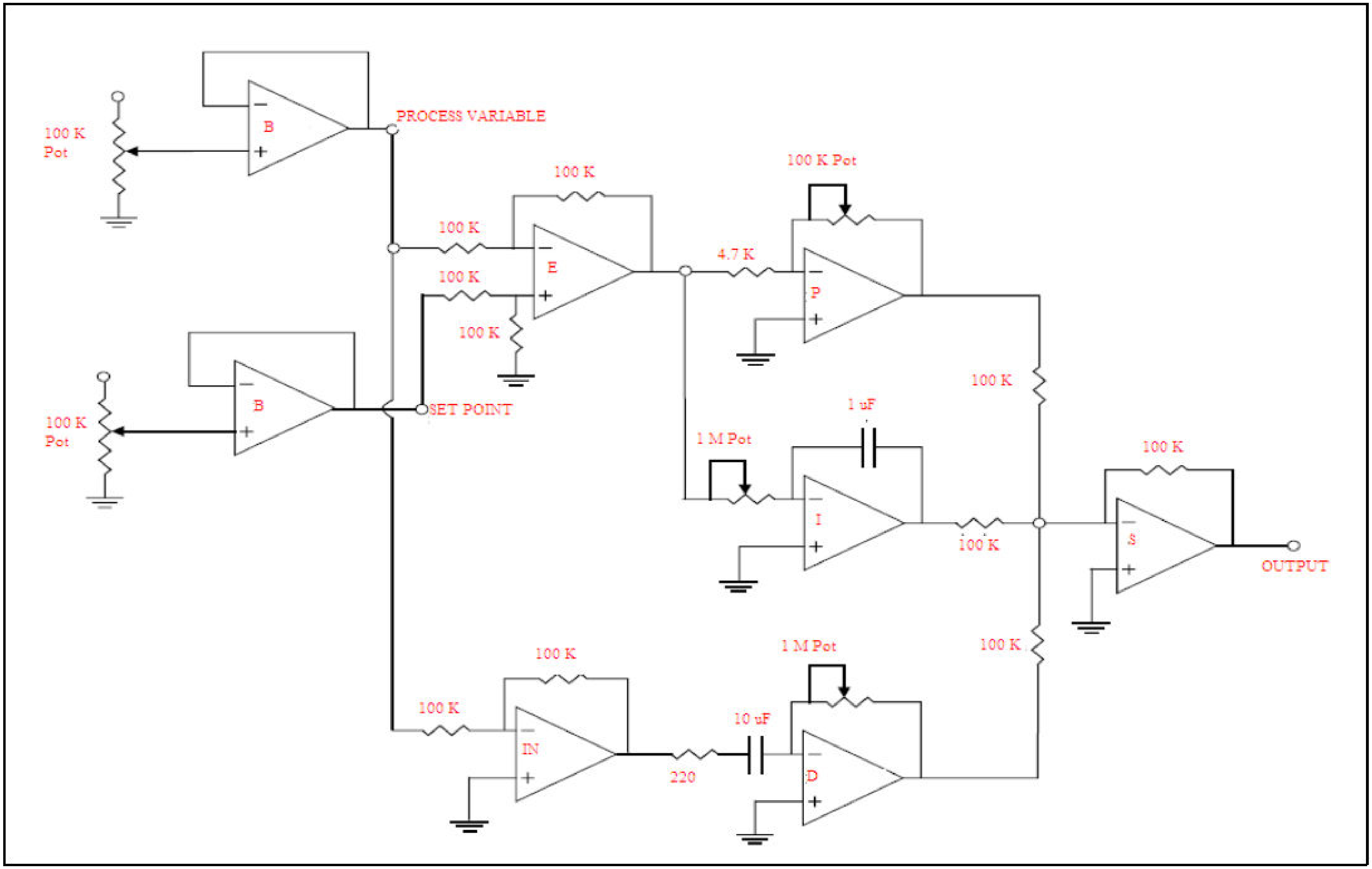
Voltage regulator and Tachometer circuit



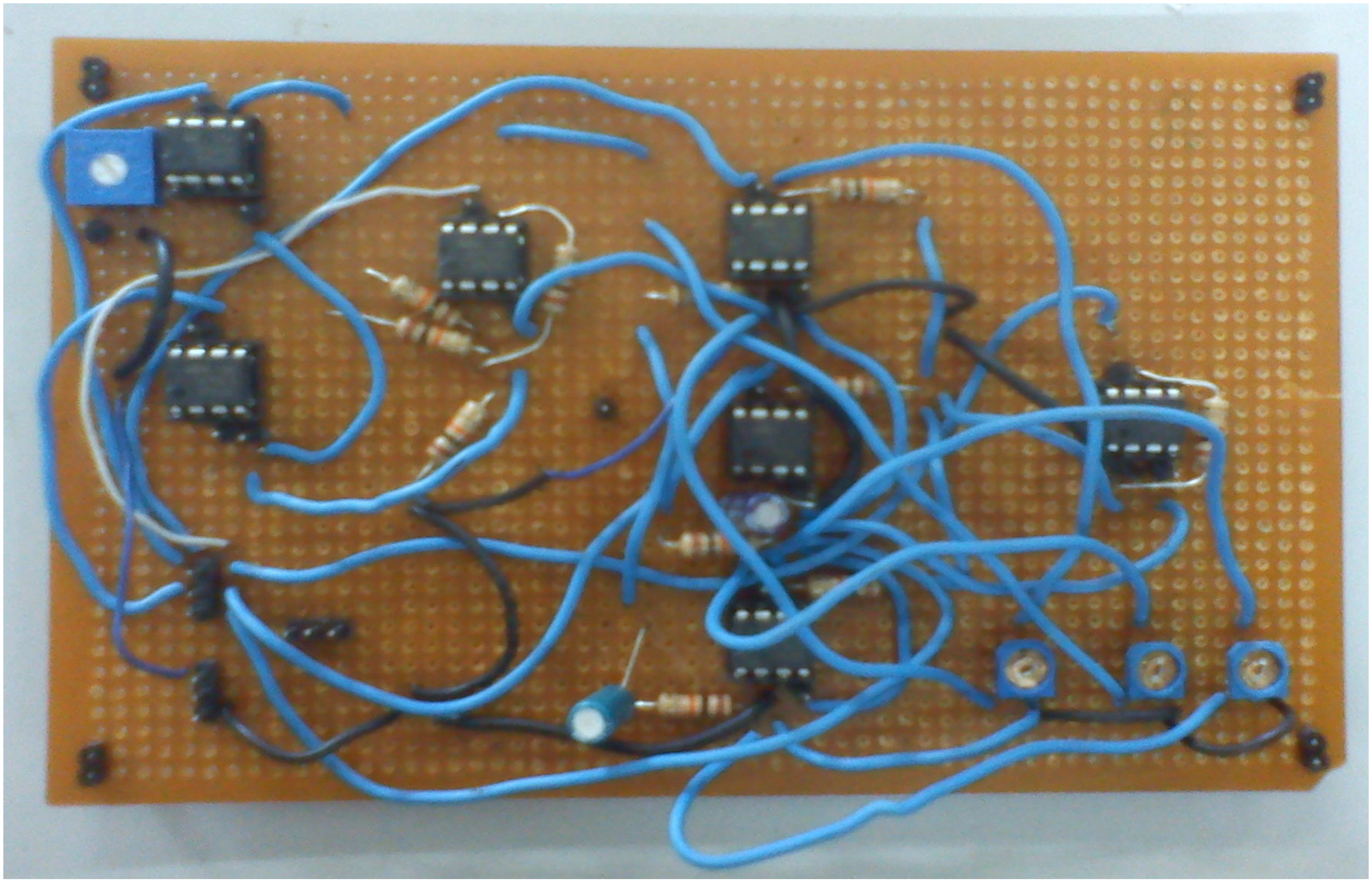
ERROR AMPLIFIER AND PID CONTROLLER

- An error amplifier is most commonly encountered in feedback unidirectional voltage control circuits where the sampled output voltage of the circuit under control is fed back and compared to a stable reference voltage.
- Any difference between the two generates a compensating error voltage which tends to move the output voltage towards the design specification.
- The signal from the tachometer is given to the inverting terminal. The reference voltage is given to the non-inverting terminal.
- The sensor signal given to the inverting terminal.

Error amplifier and PID Controller layout



Error amplifier and PID Controller circuit



CONCLUSION AND SCOPE FOR FUTURE WORK

- We obtained a variable speed by varying the voltage applied to the non-inverting terminal of the error amplifier which gives error that is made zero by the PID controller thus controlling the speed of the DC Motor by varying the voltage supplied from the DC drive to the armature of the motor.
- Our project closed loop DC motor speed control using PID controller is mainly intended to control and maintain constant speed of a DC Motor even at variable loads. The speed of DC Motor can be varied by varying the input reference voltage. The two voltages, reference and signal voltage are continuously compared and the difference of these voltages is fed to PID controller which is made zero and armature supply from DC drive is varied.

- If the reference voltage is greater than the feedback voltage, then the voltage input to the motor is increased till both the voltages are equal. If the reference voltage is less than the motor feedback voltage then the voltage input to the DC motor is reduced so as to match with reference voltage. In this way the speed of a DC motor can be controlled based on input voltage
- The project can be extended to use frequency from the proximity sensor near the rotor directly instead of converting it to voltage by comparing it with the required user frequency and converting the error frequency into voltage which is used as the reference for DC drive.