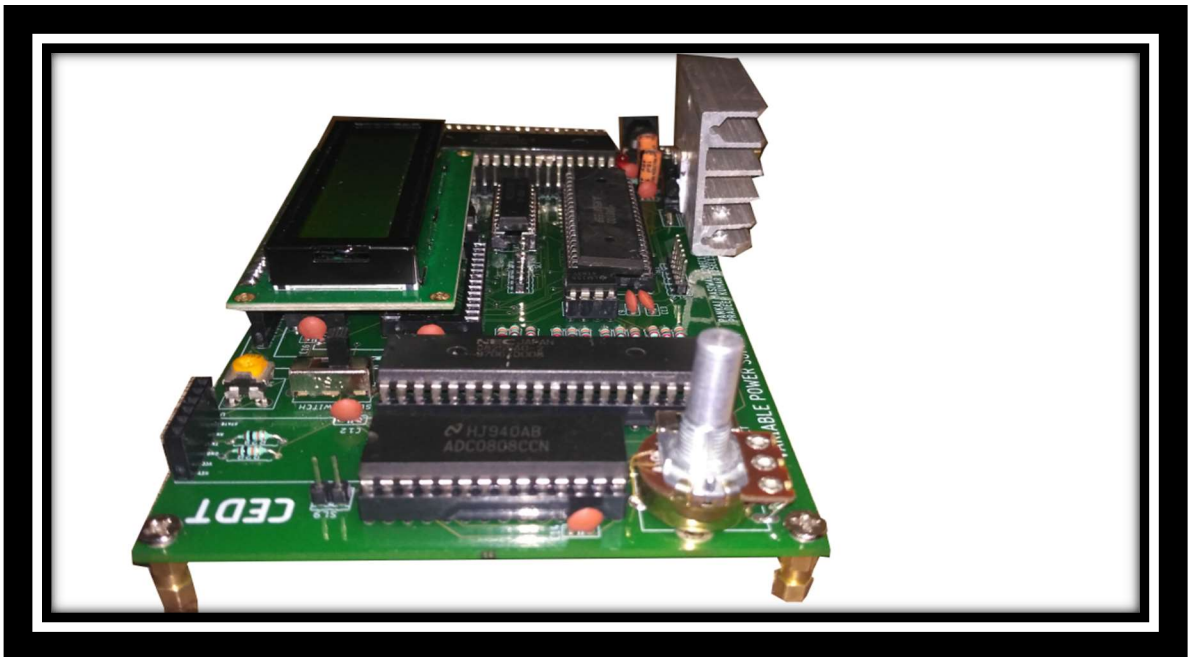
8085 based Variable Power Supply

EC-316
MICROPROCESSORS



Pankaj Masiwal- 120EC15

Pradeep Kumar- 125EC15

ACKNOWLEDGEMENT

We are highly grateful to Prof. Dhananjay V. Gadre for his guidance and constant supervision as well as for providing necessary information regarding the project & also for his support in completing the project

Our thanks and appreciations also go to our colleagues who helped us in developing the project and people who have willingly helped us out with their abilities.

Table of Contents

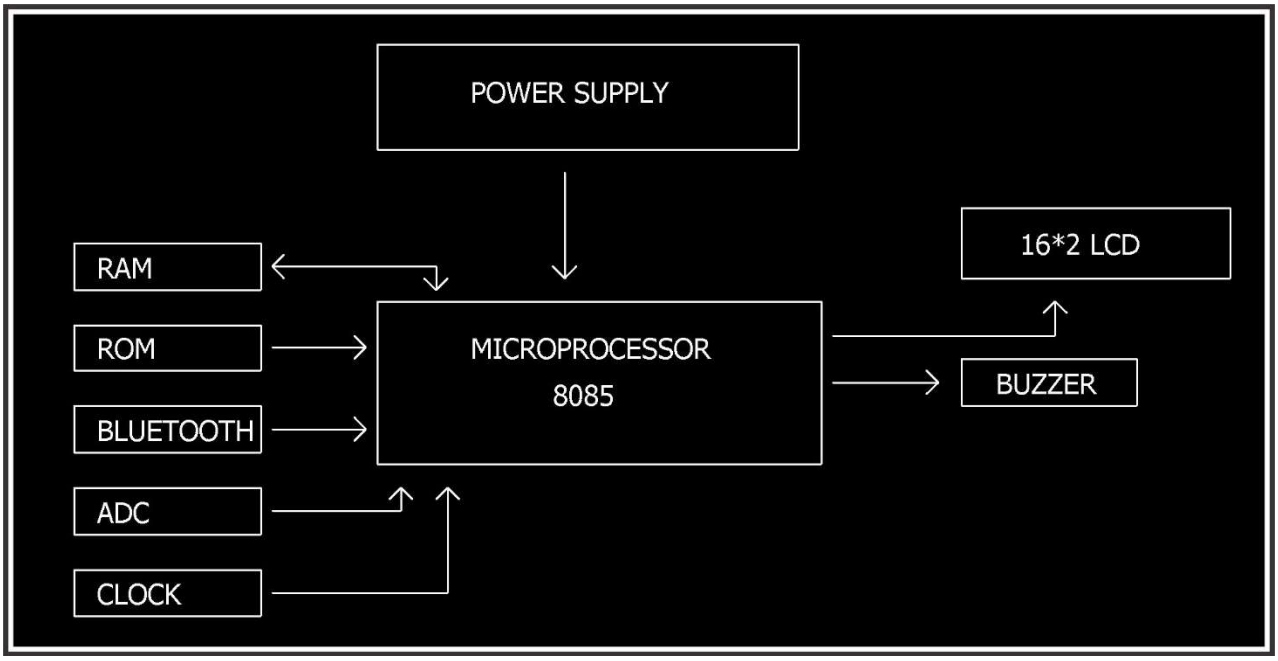
Introduction

Electricity is the most versatile and easily controlled form of energy. It is practically loss-free and essentially non-polluting. Every electronic gadget in this world needs power in one form or another to perform the desired operations. A D.C power supply which can provide a desired voltage and current, proves to be very useful for the same as different electronic gadgets require different operating voltage and current. This happened to be the motivation for this project. It is a LM723 based variable power supply capable of supplying 1 amps with an output voltage ranging from around 0-25V. The output can be controlled in either of the two under mentioned ways-

- Remote control (Using Bluetooth)
- Manual control (Using Potentiometer)

If Bluetooth control is chosen then the value of the desired output voltage can be sent to the microcontroller (in this case, Arduino) using a self-designed android application. If potentiometer control is chosen by the user then the coarse and fine adjustments of the output voltage can be made using two on-board potentiometers. A temperature monitoring circuit has been included which senses the temperature of the power supply and displays on the LCD.

Block Diagram



Description:

1. **Source:** This supply takes 30 V DC as its input and hence needs a 220V A.C - 30V D.C converter to work with 220V A.C. This supply requirement is fulfilled with the help of an adapter whose output is of 30V DC and with maximum current as 2 Amperes.
2. **Input Control:** There are two modes of input control.
    a. Manual Control: The output voltage of power supply can be controlled with the help of coarse and fine adjustment pots available on the board. The output voltage to be set can be adjusted by observing the value on the LCD display.
    b. Bluetooth Control: This supply can also be controlled remotely by connecting the phone bluetooth with the bluetooth of supply. Through bluetooth control, the value of the desired output voltage can be sent to the microcontroller (in this case, Arduino) using a self-designed android application.

3. **Output:** It provides output voltage, range from 0 V to 25 V with a maximum current of 1 Amp. The output is available at the XLR02 connector.
4. **Microcontroller(8085) :** 8085 is working here as a bridge between the user controls and supply circuitry to get desired value of output voltage. It takes input from user through coarse and fine adjustments or with the help of the app via bluetooth and produce the

required PWM signal to give the desired value of voltage at the output of the linear supply. It also displays the output value and temperature on the LCD.

5. **Digital to Analog Convertor:** 8085 PWM with second order RC low pass filter makes a digital to analog converter and thus helps in converting the arduino produced digital value into analog signal which is then converted and mapped to produce the desired output voltage.
6. **Linear Power Supply:** LM723 based linear power supply is used in this circuit. LM723 is responsible for stable and amplified output voltage corresponding to the variable input voltage at Vref pin generated by DAC. Thus in this circuit LM723 takes variable input at Vref pin and produces the desired amplified output at Vout pin with the help of negative feedback at error amplifier of LM723.
7. **Temperature monitor:**Temperature monitoring is available to automatically shut off the power supply when it's temperature goes beyond the maximum permissible value.
8. **LCD display:** 16*2 alphanumeric display is used to show the mode, either the manual or remote control in which the supply is working. Besides this, it shows output voltage value and the current temperature of power supply.
9. **Switching Power Supply:** Two MC34063 based switching power supply is used in this circuit. Buck converter is made using one MC34063 to provide 5V output from 30V input. This 5V output is used to power up Arduino,LCD and other digital circuitry available on this board. Other MC34063 based circuit is providing negative output from 30V input to provide negative supply voltage at negative supply terminals of Op-Amp available in LM723 IC.

Basic Concepts of power supply:

A power supply can be classified into two categories depending on the regulation used, they are:

Linear Power Supply

A linear power supply operates on the principle of a voltage divider i.e. it constantly changes resistance to regulate the output voltage. In an ideal case, the current that goes into it is the same as the current that goes out of it. The transistor is operated in active region. It has high power wastage and is thus comparatively less efficient though it has excellent noise immunity. It also has a faster transient response. These are relatively simple and easy to design. Its disadvantage is that it only reduces the voltage that is it acts like a step down type of transformer.

Applications where Linear Regulators are preferable:

1. Simple/Low cost Solution
2. Low Noise/low ripple applications
3. Fast Transient Applications
4. Low Dropout Applications

Switched Power Supply

The transistor operates in the cut off and saturated region. The voltage of a switched mode power supply constantly oscillates and the circuitry uses this to decide when to connect and disconnect from the source. As it stays in the cut off and saturated region, the static power dissipation is minimal, though dynamic power dissipation is significant. It has a higher efficiency than linear power supply but is considerably more complex. It suffers from low noise immunity. This type of power supply is used in most electronic gadgets like Laptops, mobile phones etc.

It is of 3 types-

- ***Buck-Buck*** converter is a voltage step down and current step up converter. The basic operation of the buck converter has the current in an inductor controlled by two switches (usually a transistor and a diode).

- ***Boost-Boost*** increases the input (battery) voltage to a level required to drive a load at the desired current level. If a DC source, an inductor, a switch and the corresponding electrical ground are places in series and the switch is driven by a square wave, the peak to peak voltage of the waveform measured across the switch can exceed the input voltage from the DC source. Thus, boost converter acts like a step up transformer for the DC signals.

- ***Buck-Boost*** converter is a type of switched mode power supply that combines the principles of the Buck Converter and the Boost converter in a single circuit. Like other SMPS designs, it provides a regulated DC output voltage from either an AC or a DC input. It has output voltage magnitude either greater than or less than the input voltage magnitude.

Summarising Linear V/S Switching Regulator

REGULATOR TYPE	ADVANTAGES	DISADVANTAGES
LINEAR	● LOW LEVEL OF NOISE ● STRAIGHT FORWARD TECHNOLOGY	● LOW LEVEL OF EFFICIENCY ● LARGE AMOUNT OF HEAT IS REQUIRED TO BE DISSIPATED ● LARGE IN SIZE
SWITCHING MODE	● HIGHLY EFFICIENT ● COMPACT ● LESS AMOUNT OF HEAT IS REQUIRED TO BE DISSIPATED	● RIPPLE AND NOISE IS HIGHER ● SWITCHING SPIKES CAN CAUSE INTERFERENCE

Working

This variable power supply can be controlled manually or remotely with the help of coarse and fine potentiometers or Bluetooth APP. By default supply remains in manual control. In Bluetooth App control input value from 0-25V is sent directly to the microcontroller where as in case of manual control, output value is set with potentiometer and checking the output value shown in LCD. Input data send by Bluetooth or potentiometer control is first mapped to 12 bit PWM output by Arduino, then it generate this 12 bit PWM output on its digital pin. Now this 12 bit PWM is feed as input in second order RC low pass filter of cut off frequency 1/1000 of PWM frequency. The output at low pass filter is averaged out with the voltage level directly proportional to duty cycle of PWM input. Thus output at low pass filter can be controlled in 4096 steps from 0 to 5 volt.

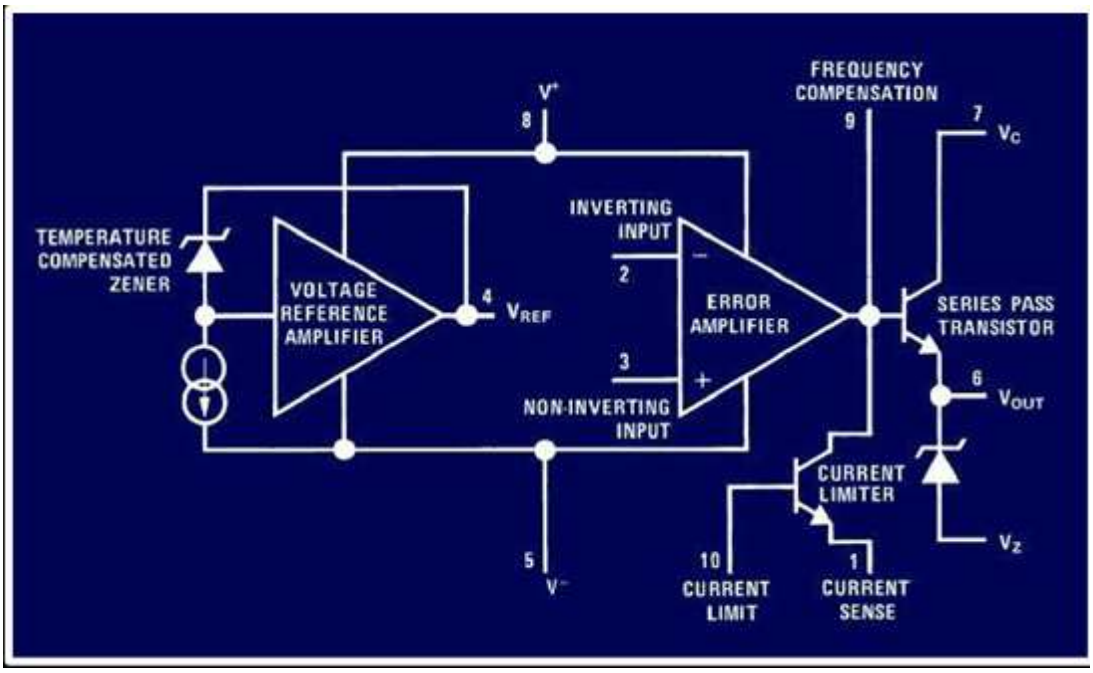
This input voltage is sent to Vref pin of LM723 IC which finally mapped this 0-5V to 0-25V constant voltage with a very low ripple. Finally you can change this 0 to 25 volt in 4096 steps and thus a maximum resolution of 6mV is achieved. Maximum current of 1 amp is achieved by putting MJE3055, a power transistor in series with series pass transistor of LM723 IC. Short circuit protection is also available in LM723.

One MC34063 based buck converter is used to provide 5V from 30V to power Arduino and other digital circuitry whereas another MC30463 based invertor circuit is used to provide -5V for negative supply pin of LM723 so that it can provide a full range of 0 to 25V without any offset at zero volt.

Working of LM723 (linear power supply)

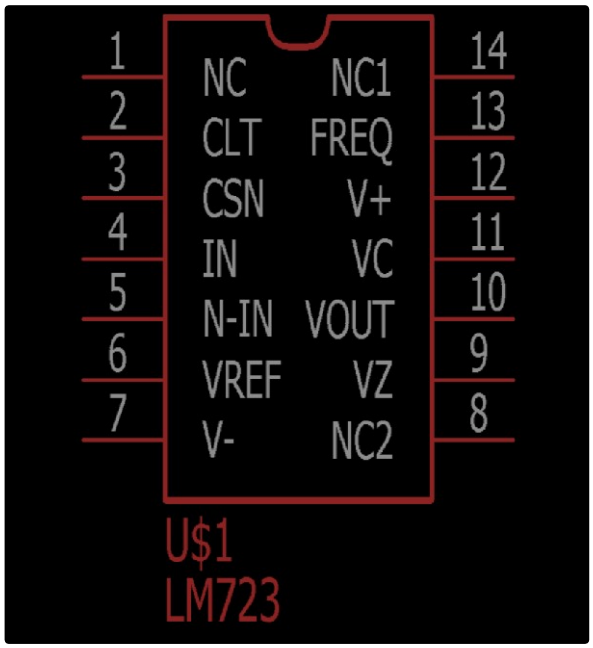
Basic description: IC 723 is a voltage regulator designed primarily for series

regulator applications. It is a flexible, easy-to use regulator with excellent performance. By itself, it will supply output currents up to 150 mA; but external transistors can be added to provide any desired load current.



The Zener Input configuration, Op-amp, and Short Circuit Protection is bundled in itself, thereby reducing the size and labour and also increasing the reliability of the circuit. The device can be connected to operate as a positive or negative voltage regulator with an output voltage ranging from 2 V to 37 V, and output current levels up to 150 mA. The maximum supply voltage is 40 V, and the line and load regulations are each specified as 0.01%. The internal working can be explained by dividing it into two blocks, **the reference voltage generator** and **the error amplifier**. In the reference voltage generator, a zener diode is being compelled to operate at fixed point (so that zener output voltage is a fixed voltage) by a constant current Source which comes along with an amplifier to generate a constant voltage of 7.15V at the Vref pin of the IC. The error amplifier section, consists of an error amplifier, a series pass transistor Q1 and a current limiting transistor. The error amplifier can be used to compare the output voltage applied at Inverting input terminal through a feedback to the reference voltage Vref applied at the Non-Inverting input terminal. These connections are not provided internally and so has to be externally provided in accordance with the required output voltage. The

conduction of the transistor Q1 is controlled by the error signal. It is this transistor that controls the output voltage.



V+ and V- : These are the supply voltage terminals of the IC. V+ is the positive terminal and V- is the negative terminal. The voltage difference between these terminals should be between 9.5V to 40V.

Non Inverting Input: This is the non inverting input of the error amplifier whose output is connected to the series pass transistor. We usually give reference voltage or a portion of it to the non inverting input.

Inverting Input: This is the inverting input of the error amplifier whose output is connected to the series pass transistor. We usually give output voltage or a portion of it to the inverting input. This makes the output voltage constant.

Vref: It is the reference voltage output of the IC. It is the output of voltage reference amplifier. Its output voltage is about 7.15V.

Vout: It is the output terminal of the IC. Usually output voltage ranges from 2 to 37V. This pin can provide up to 150mA current.

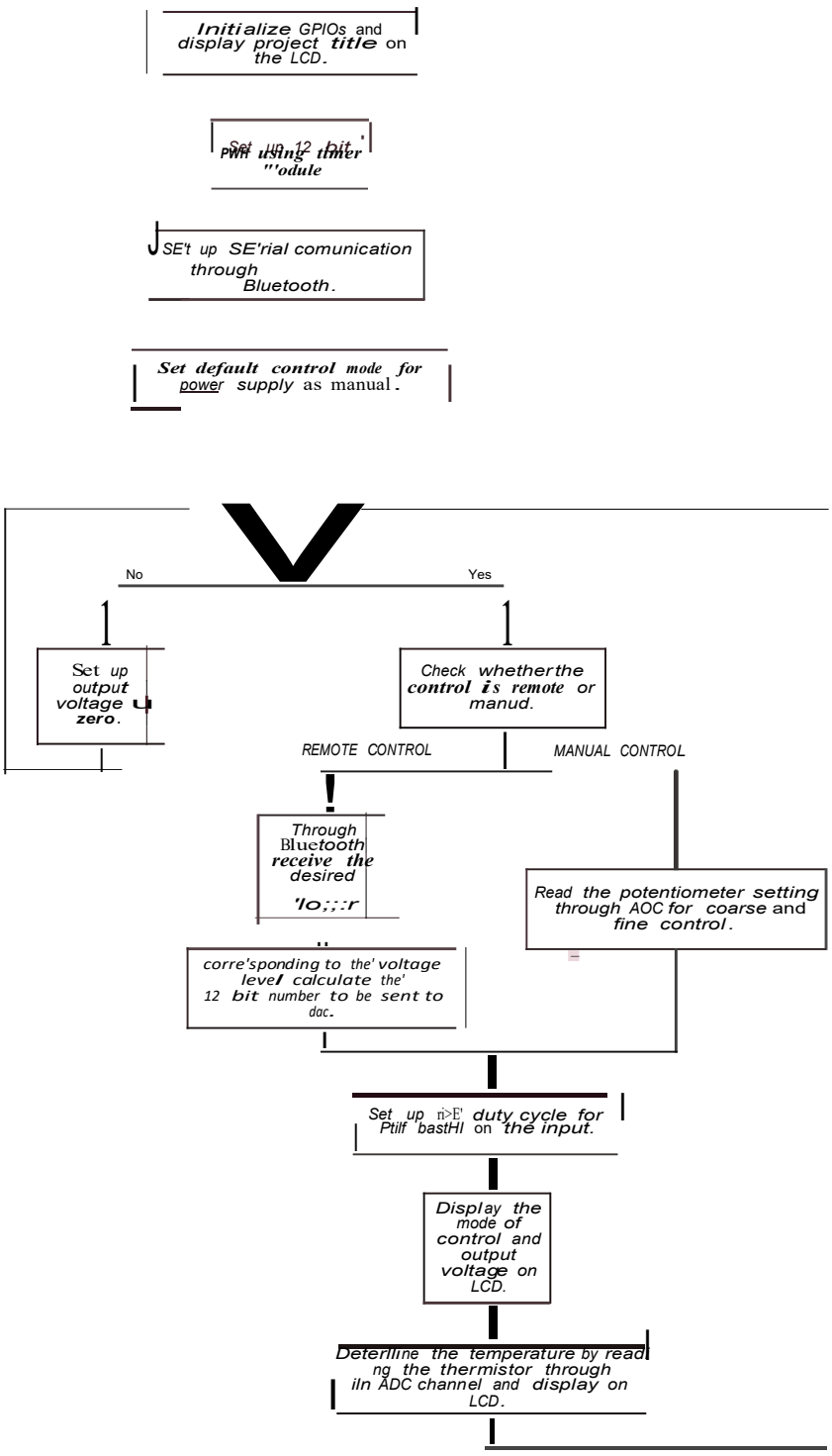
Current Limit: It is the base input of the current limiter transistor. This pin is used for current limiting or current fold back applications.

Current Sense: This is the emitter of current limiting transistor. This terminal is used with current limiting and current fold-back applications.

Vc: This is the collector input of the series pass transistor. It is usually directly connected to the positive supply voltage if an external transistor is not used.

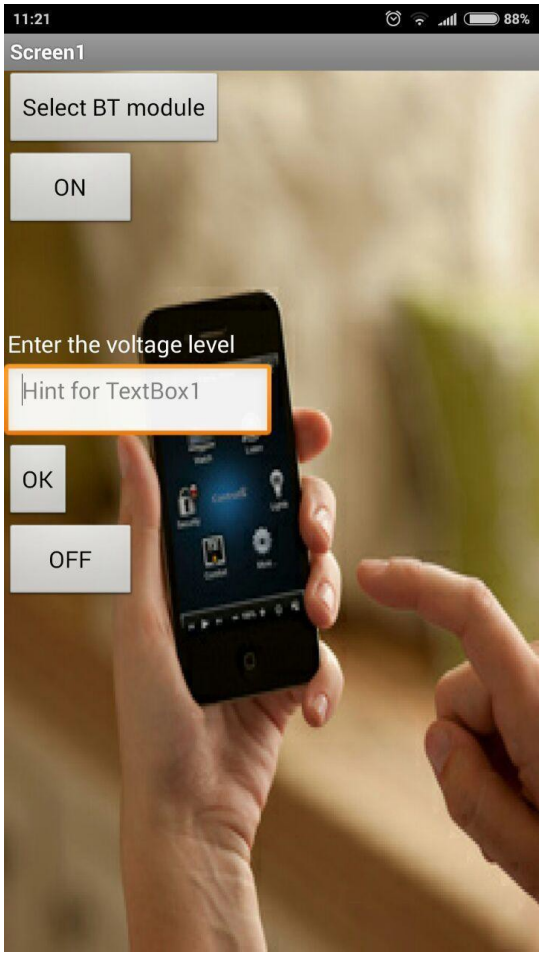
Working: In the variable power supply the Vref pin and the Vz pin remain unconnected. The supply voltage terminals of the IC V+ and V- are kept at 30V and -2.7V (to nullify the effect of the offset voltage of the Op-Amp) respectively. The output of the second order RC filter is applied to the Non Inverting Input pin of the IC. The Inverting Input pin is connected to a resistor divider network (composed of resistors and preset) which forms a feedback network and provides gain to the circuit. Value of the presets is so adjusted so as to provide an overall gain of 5. The transistor MJE3055 (power transistor) has been connected in conjunction with the series pass transistor of the IC LM723 so as to increase the current rating of the power supply to 1 amp. Such a configuration is called a Darlington Pair. The darlington pair configuration has a high current gain and can be driven by the low output current of the Op-Amp. The resistor (R3=0.68 ohms) connected between the current limiting pin and the current sense pin of the Op-Amp provides short circuit protection to the circuit. In case the power supply faces a short circuit, a short circuit current flows through the resistor making the voltage drop across it greater than 0.7 V. This drives the current limiter transistor of the IC LM723 in active mode which thereby pushes the series pass transistor of the IC in cutoff region and protects it from getting burnt by the excess short circuit current. The output voltage from the IC is filtered using a parallel combination of an electrolytic and a ceramic capacitor and taken for use from the XLR02 connector provided in the power supply board.

8085 Code Flow:



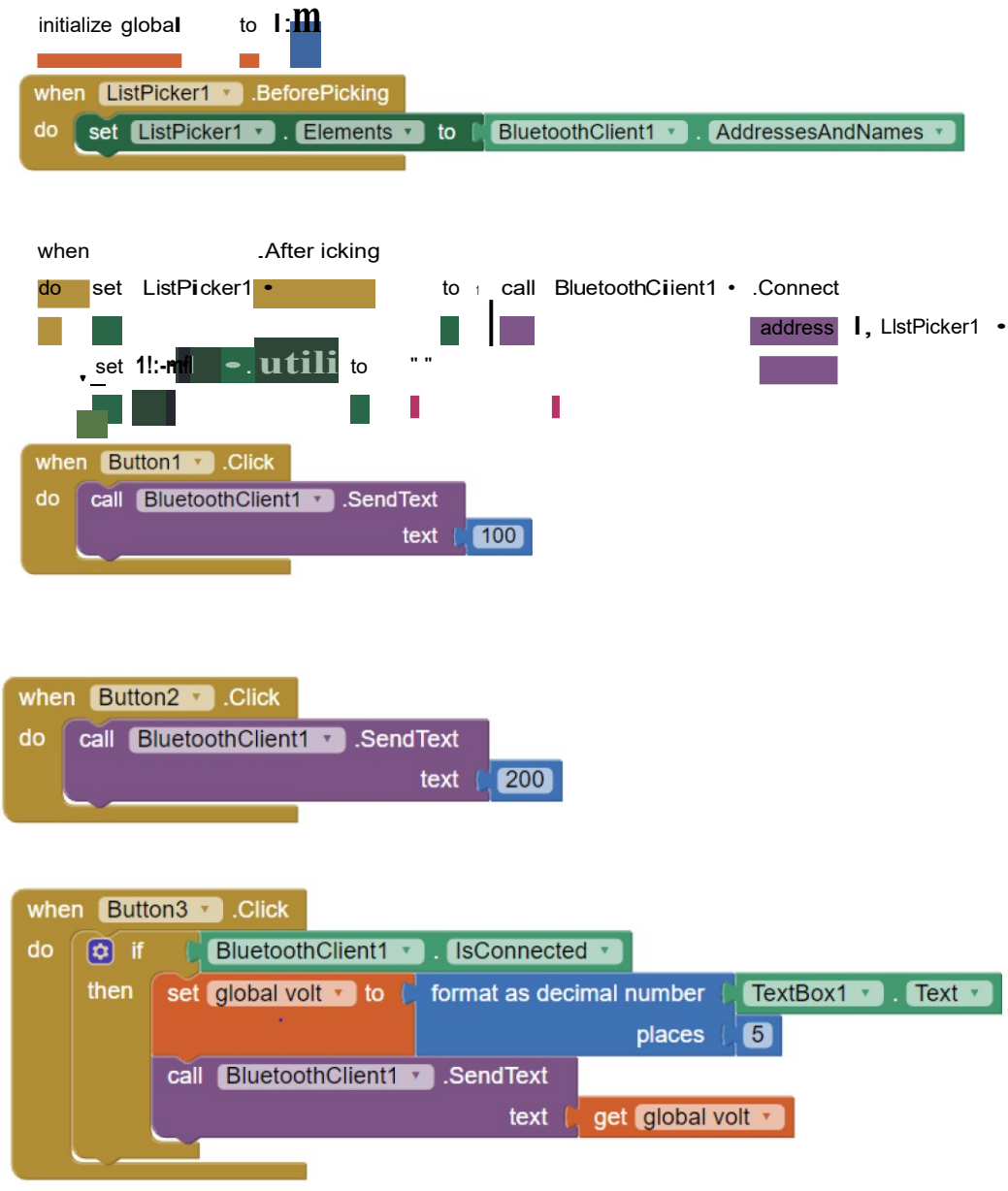
Mobile Application

The android application for interacting with the power supply has been developed using MIT APP Inventor-2 which is a free software for creating fully functional apps.

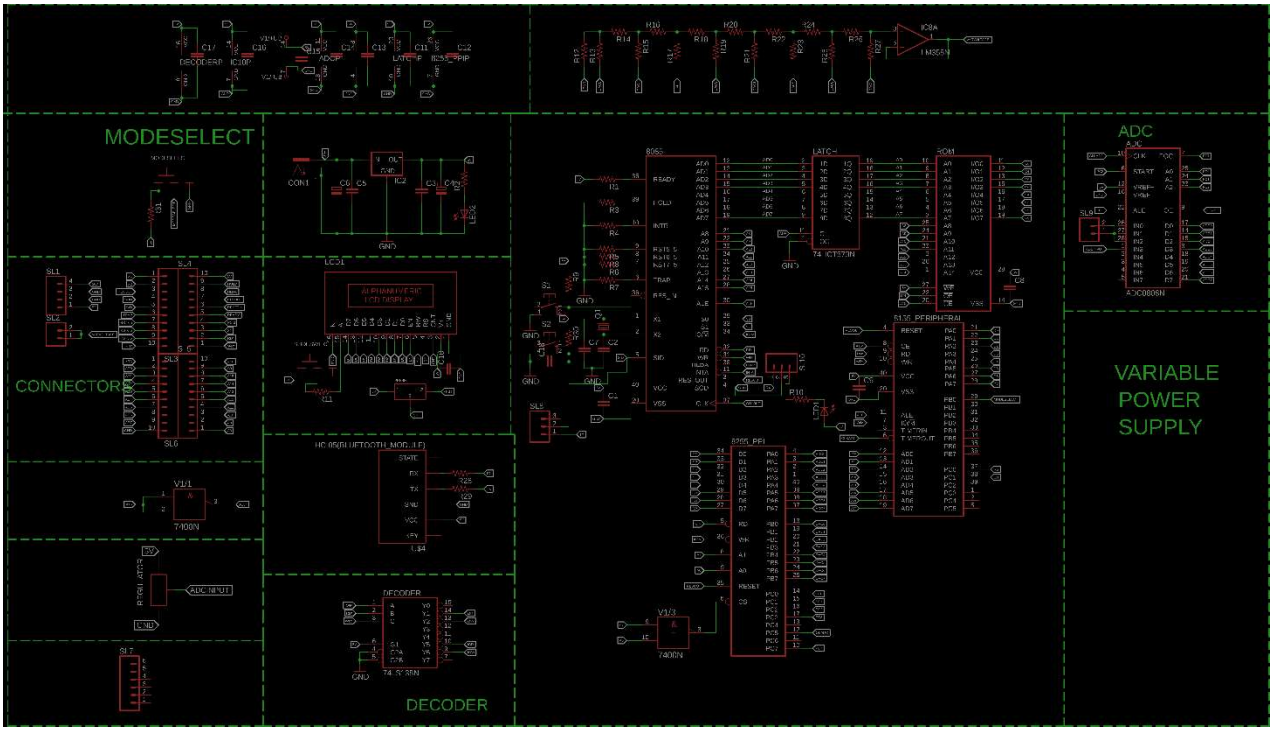


The application first connects the mobile Bluetooth with the HC-05 bluetooth module present on the variable power supply. When the button for ‘On’ is pressed, a code - 100 is sent to the Bluetooth module directing to make the shift manual control of power supply to Bluetooth control. On the other hand, if code - 200 is sent it indicates shifting back to manual control. When the voltage level is entered in the text box and ’OK’ is pressed, the application sends the value of the desired voltage level upto 6 decimal places.

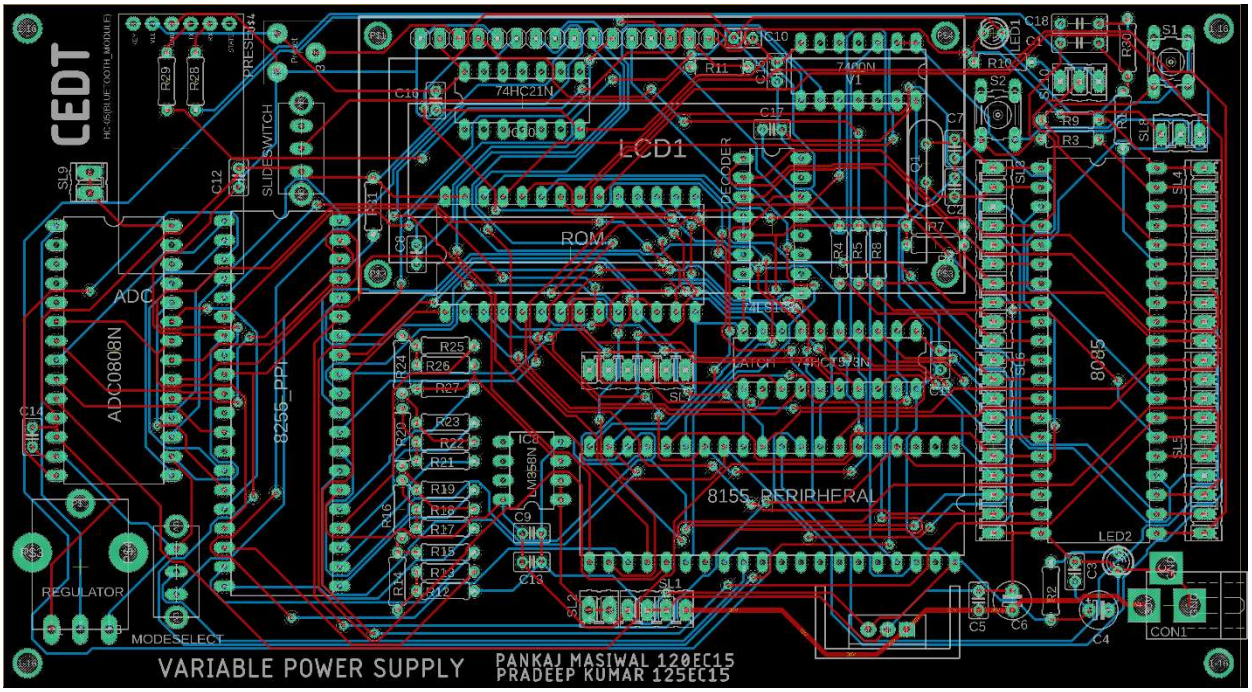
Application Code

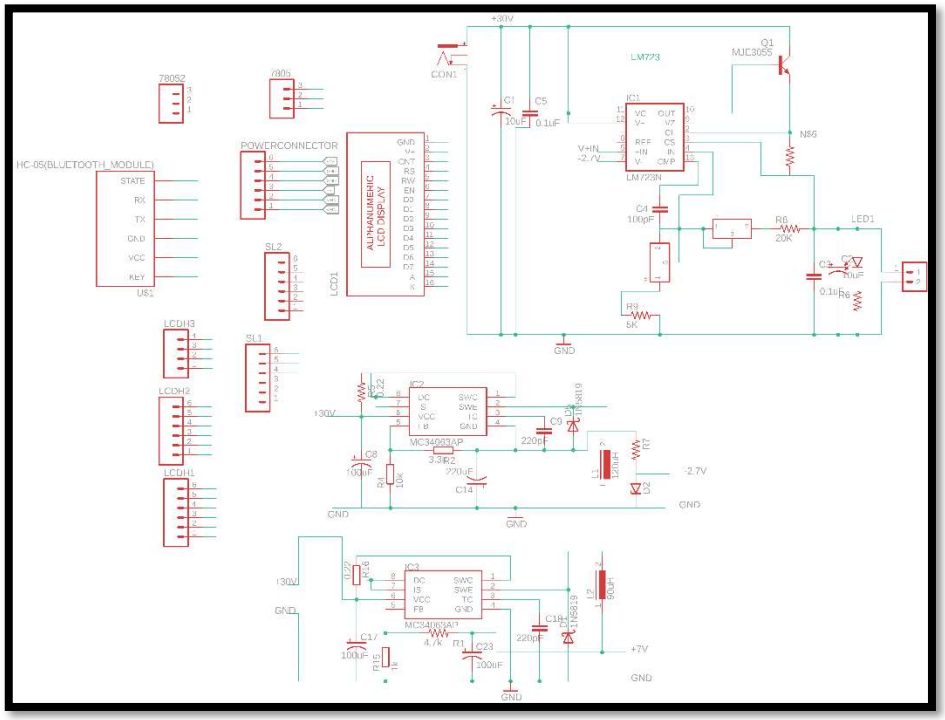


Schematic and Board File

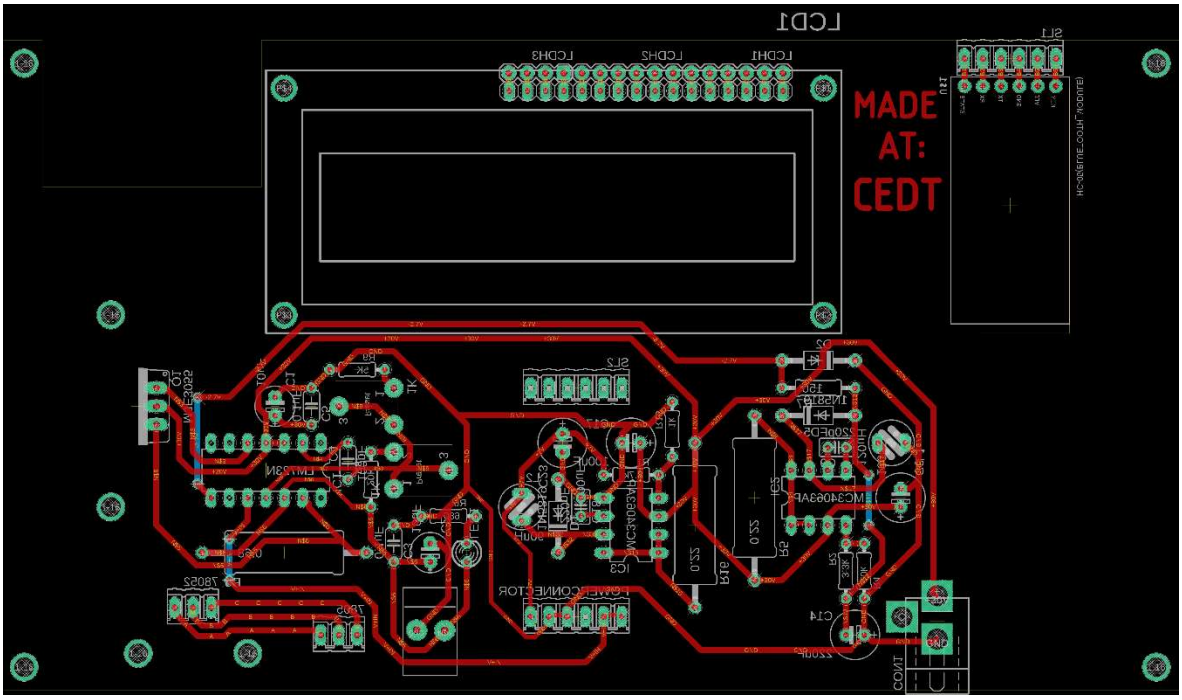


Digital Interfacing Schematic



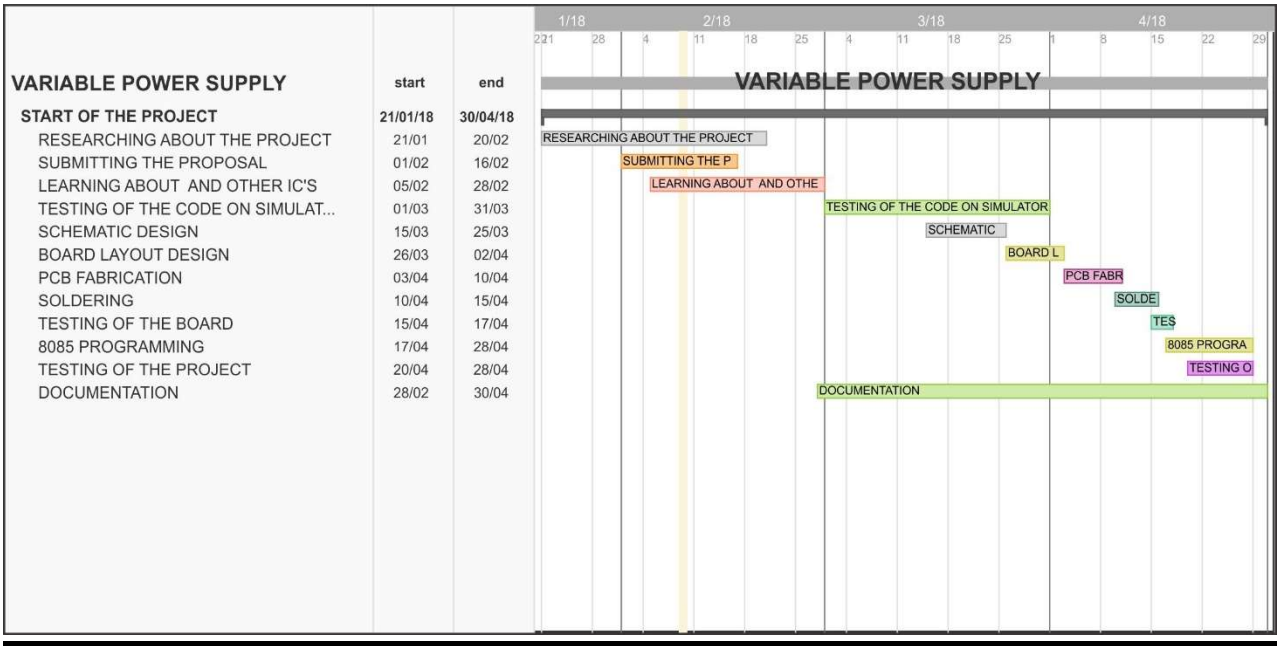


Linear and switching Power Supply Schematic



Board File

Gantt Chart


1/18
2/18
3/18
4/18
21
28
4
11
18
25
4
11
18
25
1
8
15
22
29
VARIABLE POWER SUPPLY
start
end
VARIABLE POWER SUPPLY
START OF THE PROJECT 21/01/18 30/04/18
RESEARCHING ABOUT THE PROJECT 21/01 20/02
SUBMITTING THE PROPOSAL 01/02 16/02
LEARNING ABOUT AND OTHER IC'S 05/02 28/02
TESTING OF THE CODE ON SIMULAT... 01/03 31/03
SCHEMATIC DESIGN 15/03 25/03
BOARD LAYOUT DESIGN 26/03 02/04
PCB FABRICATION 03/04 10/04
SOLDERING 10/04 15/04
TESTING OF THE BOARD 15/04 17/04
8085 PROGRAMMING 17/04 28/04
TESTING OF THE PROJECT 20/04 28/04
DOCUMENTATION 28/02 30/04
RESEARCHING ABOUT THE PROJECT
SUBMITTING THE P
LEARNING ABOUT AND OTHE
TESTING OF THE CODE ON SIMULATOR
SCHEMATIC
BOARD L
PCB FABR
SOLDE
TES
8085 PROGRA
TESTING O
DOCUMENTATION

References:

1. RAMESH S GAONKAR, Microprocessors architecture, programming and applications with 8085.
2. www.8085projects.in
3. https://www.sparkfun.com/datasheets/IC/MC34063A.pdf