Linear Power Supply

Introduction

Power supplies are used to drive a load under constant voltage/current conditions. Handling power supplies in a safer method is very crucial as the equipment attached or any human being handling it may get affected or electrocuted by excessive current or improper wiring methods. When designing power supplies several factors should be taken into consideration including efficiency, load and line regulation, short circuit protection etc. We are in need of creating a voltage regulator design from scratch to drive a high-power load (50 W) from 230 V input voltage. The circuit should give an output of 10V linear voltage with a maximum current rating of 5A.

Procedure (Proposing Method)

The main idea is quite simple. The input voltage of 230V from the main power supply should be step down using a 230V rms -15V rms transformer and the stepped down alternating current should be rectified first using diodes or bridge and then the direct current should be regulated to provide 10V. But the problem here is that the simple voltage regulator circuit using a zener diode as shown in the figure, will not be appropriate to produce 5A current and drive heavy loads. Further we will have to keep the voltage constant at 10V and limit the current at 5A maximum.

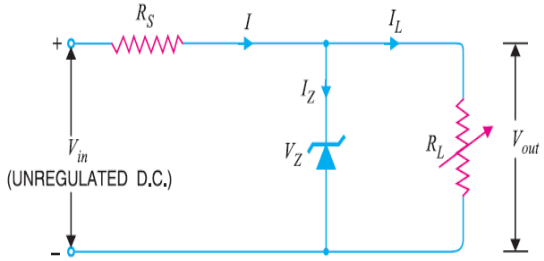

Figure 1 Normal regulator

Therefore we thought of coming up with a circuit that includes the following peripheral circuits.

1. Regulator
2. Current divider
3. Feedback
4. Foldback Current

The regulator circuit will provide us a voltage regulation using a zenor diode of 5.9V. The regulated voltage will be further increased by a series of transistors (the base emitter voltage will be added). This takes care of the voltage regulation part. And the rest would take care of the current limiting part.

Since current divider circuit consists of three transistors in series which is also called the Darlington Pair , we can amplify a small current of 5µA to the maximum current of 5A.

The Foldback current circuit which consists of one transistor and a couple of resistors will ensure that the maximum current is set to 5A. This is an alternative for the current limiting circuit, which performs as the same but limits the short circuit current further and the base voltage of the transistor will be set to a higher value through the voltage divider circuit which consequently reduces the power dissipation at the short circuit condition.

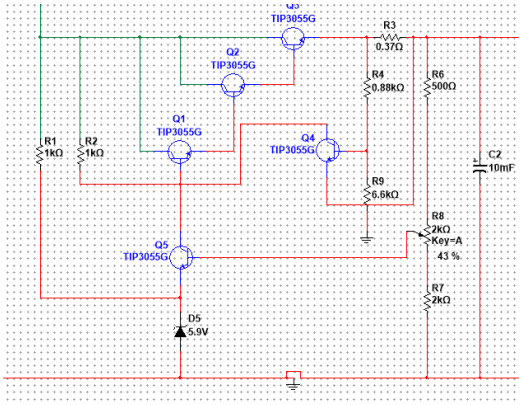

Figure 2 Main regulator circuit

The feed back circuit consisting another transistor will ensure that any excessive current is handled properly and it is routed to the right place.(surge limiting transistor) This also provides Overload protection to the circuit.

Further to ensure the the heat dissipated in the circuit is cooled down a small fan will be used. And another simple regulating circuit using zenor diode would be enough to drive this fan.

Circuit Protections

1. Short circuit protection

   A bistable multivibrator circuit is used here to provide the short circuit protection. The circuit will quickly recognize the short circuit condition and quickly change its state so that there won't be power supplied to the main regulator circuit part and the output current will be 0. Through switch this circuit is needed to be reset to its original stage, as soon as the short circuiting problem is identified and corrected. In short, this performs as the electronic fuse.

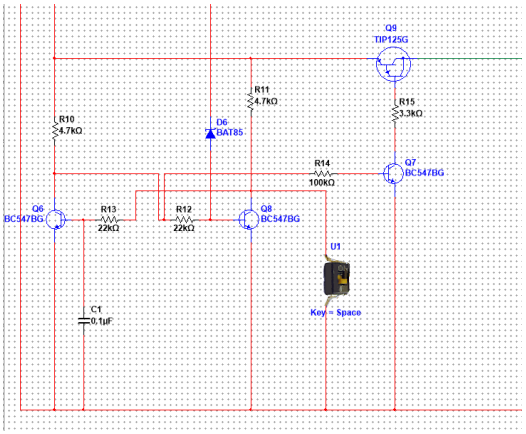

Figure 3 Short Circuit Protection

2. Over Voltage Protection
   The crowbar circuit shown in the figure is used to provide overvoltage protection to the main regulator circuit. Whenever the threshold voltage of 11V is reached at the the crowbar circuit, thyristor gets activated and it will shortcuit the circuit through the thyristor, thereby moving the circuit into short circuit condition and the bistble multivibrator circuit will change state.
3. Negative voltage Protection
   A simple diode as shown in figure 4 across the output will change the direction of the current in the circuit when the input voltage suddenly turns out to be negative.

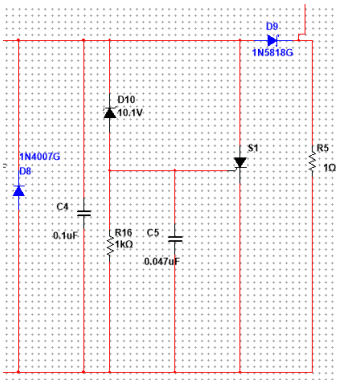

Figure 4 Overvoltage protection and negative voltage protection

4. Overload Protection
   The feed back pheripheral circuit mentioned above will provide the Overload protection to the circuit.

Preliminary Design (Block Diagram)

1. Main regulator Circuit

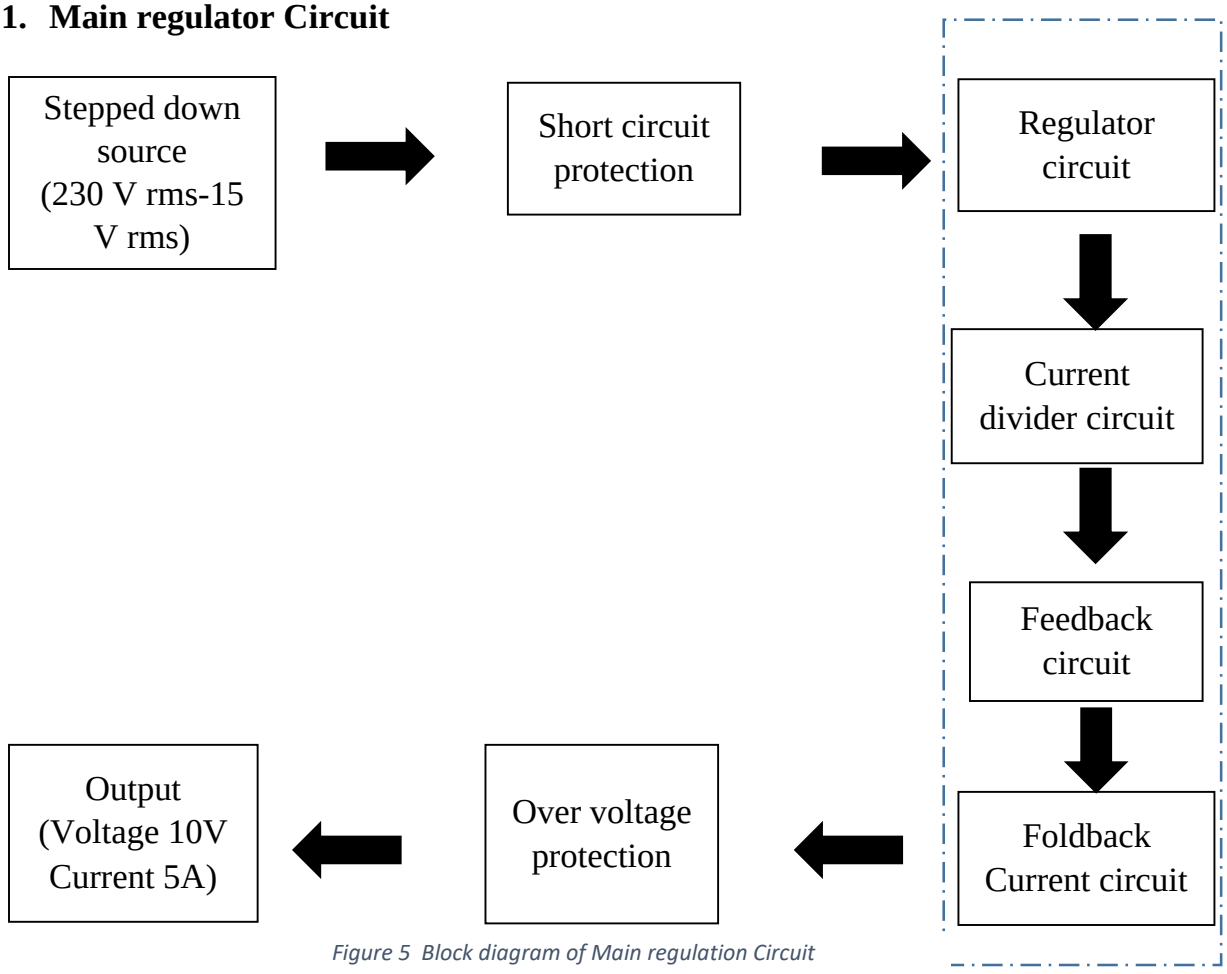

Figure 5 Block diagram of Main regulation Circuit

2. Fan Regulating Circuit

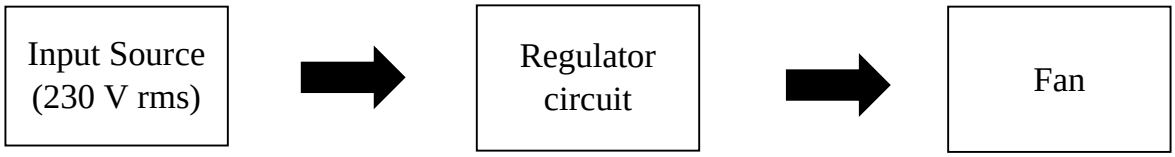

Figure 6 Block Diagram for Fan Regulation

Component selection and discussion

1. 230 V rms – 15V rms transformer – to step down the input voltage
2. Tip3055G – Has a current gain of 70, output current can go upto 15A annd 60V, has an excellent safe operating area considering power disspation, heat and other factors. So this could be used in peripheral circuits such as Current limiting, current divider and feedback.
3. MBR1045 Diodes – has the capability to withstand 10A and 90V, less power dissipation and it is readily available at shops.
4. BC547BG, TIP125G – To facilitate the bistable multivibrator circuit
5. Potentiometer – to control the feedback circuit
6. Zener diode – 5.8V for main regulator circuit and 12 V for Fan regulation circuit
7. 1N5818G, BAT85 – This is a Schotkky Diode which would perform the function as diode but have minimal voltage drop across it.
8. Fan (12V, 0.14A) – to control the heat dissipated in the main circuit
9. Other miscellaneous components such as resistors and capacitors. Values are mentioned in the conceptual design provided below.

Conceptual design

Fan Regulation Circuit

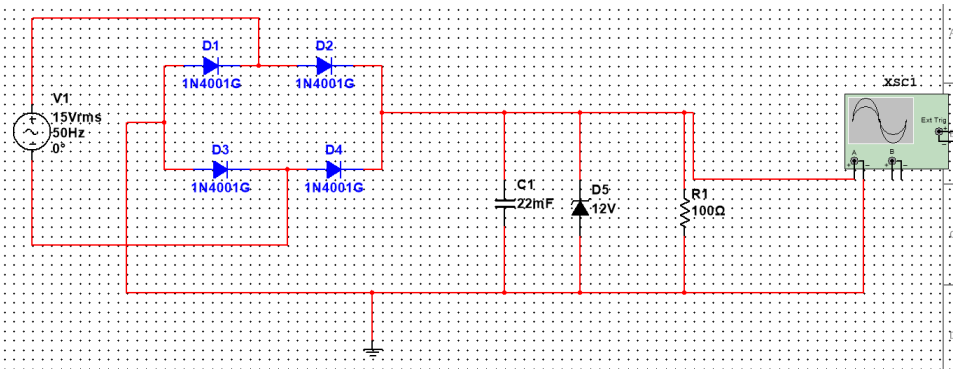

Figure 7 Fan Regulation Circuit

Main Regulation Circuit

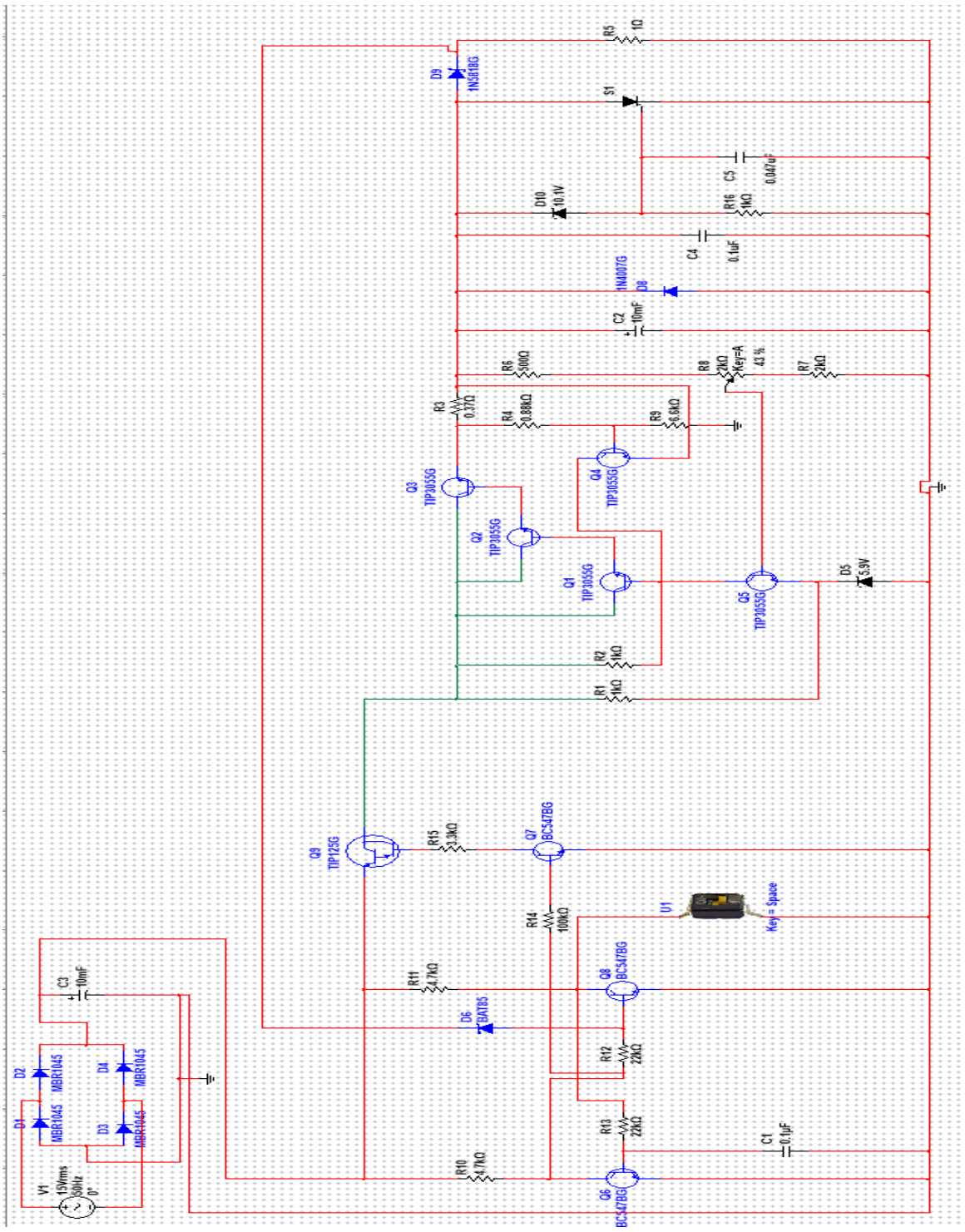

Figure 8 Main Regulation Circuit

Some Graphs to indicate Circuit Performance

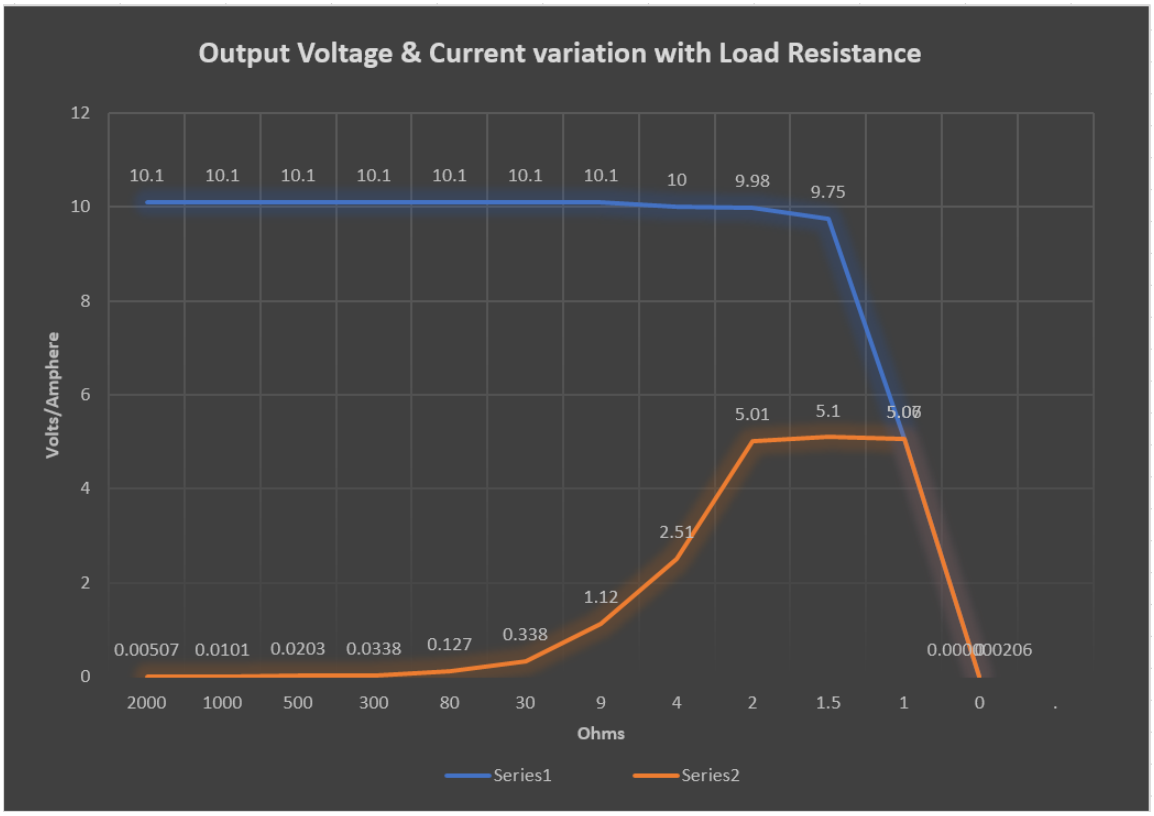

Figure 9 Output Voltage & Current Variation with Load Resistance Chart

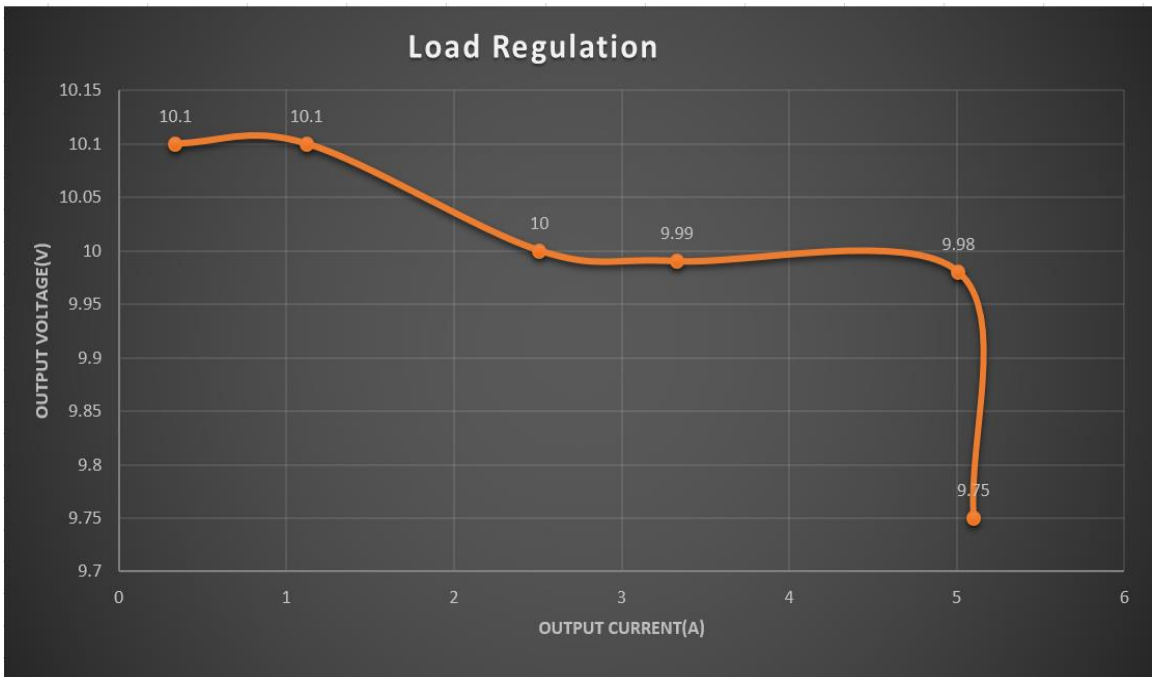

Figure 10 Load Regulation Chart

Work Load Allocation

Group No. 5

Name	Index No.	Work allocated
Nirhoshan S.	180428T	Designing the Main regulation Circuit
Nayanajith T.M.S	180417J	Designing the Fan regulation Circuit and enclosure , drawing the charts
Bandara H.M.A.M.	180060G	Designing the Over voltage protection
Jayapala P.S.C	180265N	Designing the short circuit protection