Design Project:DC Power Supply

ELG2136: Electronics I

Professor: Sawsan Abdul-majid;

By:

Khyber Lahori (8018423);
Mohammed Alijehny(7608494);
Iwuagwu Emmanuel (8395970);
Jainil Gandhi (8269134);
Dhruv Iyengar(7571674)

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Current limiting is the practice in electrical circuits of imposing an upper limit on the current that may be delivered to a load with the purpose of protecting the circuit generating or transmitting the current from harmful effects due to a short-circuit or similar problem in the load. There are three major types of current limiters and they are the foldback current limiters, fold forward current limiters and the constant current limiters.

The foldback current limiter is a feature that helps prevents overload of power supplies or power amplifiers. When the load attempts to draw excess current, the foldback reduces the output voltage and the output current to well below the normal operating limits. When there is a short circuit, with output voltage reduced to zero, the current reduces to just a little fraction of the maximum current. This technique is employed in linear power supplies because it reduces the strain on the supply's internal power devices to minimum. Depending upon the design, recovery from a fold-back current limit condition can be automatic, or after a built-in time delay when the overload condition is removed.

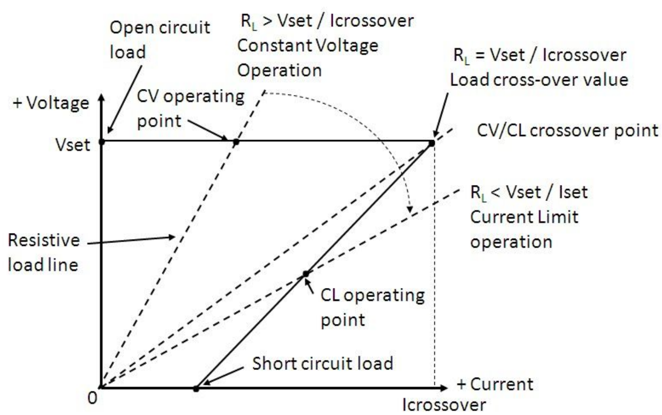

Figure 1: Output characteristic of a CV power supply with fold-back current limiting

A variety of loading devices, such as electric motors, DC-DC converters, and large capacitive loads can draw large peak currents at startup. Because of this they can often be better suited for being powered by a DC power supply that has a fold-forward current limit characteristic, as depicted in Figure 2. With fold-forward current limiting after exceeding the crossover current limit the current level instead continues to increase while the voltage drops while the loading increases. Recovery from a fold-forward current limiting situation is usually automatic when the overload is removed.

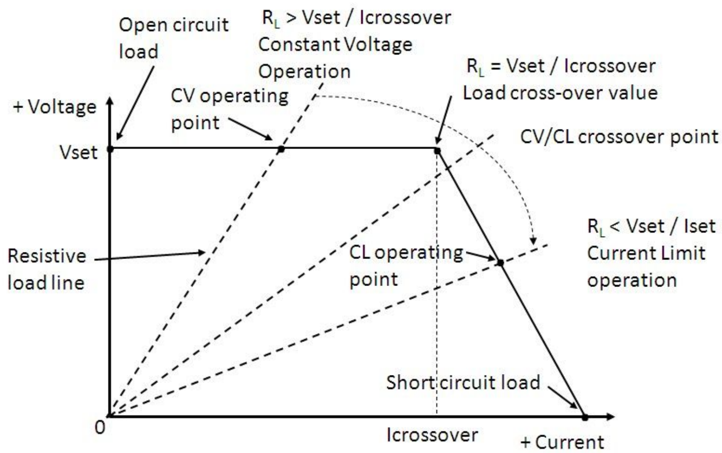

Figure 2: Output characteristic of a CV power supply with fold-forward current limiting

With a constant current limiter, should an overload occur, the output current stays at its limit point and the output voltage reduces towards zero in a somewhat linear fashion. This technique is used in many switchmode power supply designs. Typically, the supply will automatically return to its normal output voltage when the overload condition is no longer present.

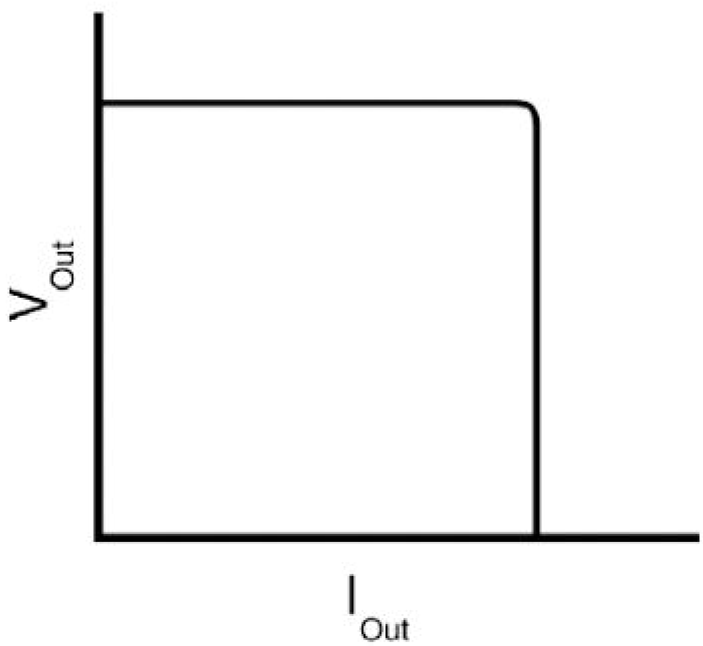

Figure 3 : Output characteristic of a constant current limiter

In some power supply designs, when an overload occurs the power supply will begin to go into a constant-current limit mode, but when the output reaches a preset reduced voltage, the supply will shutdown. Recovery from this condition can be automatic or may require recycling of the input power, for this reason we decided not to use the constant current limiter.
We decided to go with the fold-back current limiter as, it will increase the protection for the load as well as its own circuit.So in a scenario where the load reaches its current limit (20mA in our case) the current limiter will reduce the current and voltage linearly to avoid causing damage to the circuits. In the case of a short circuit the current limiter will make the voltage almost 0V and nothing will get damaged since the current is so low which would not be the case with a constant or fold-forward current limiter in those cases current would either stay the same or increase which would increase the chances of the power supply circuit getting damaged over time.

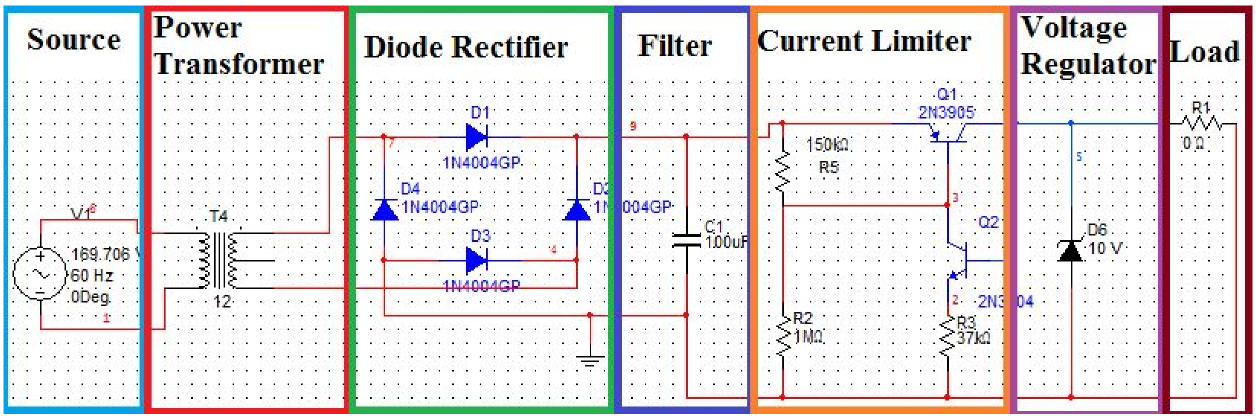

Figure 4: Our Design broken down

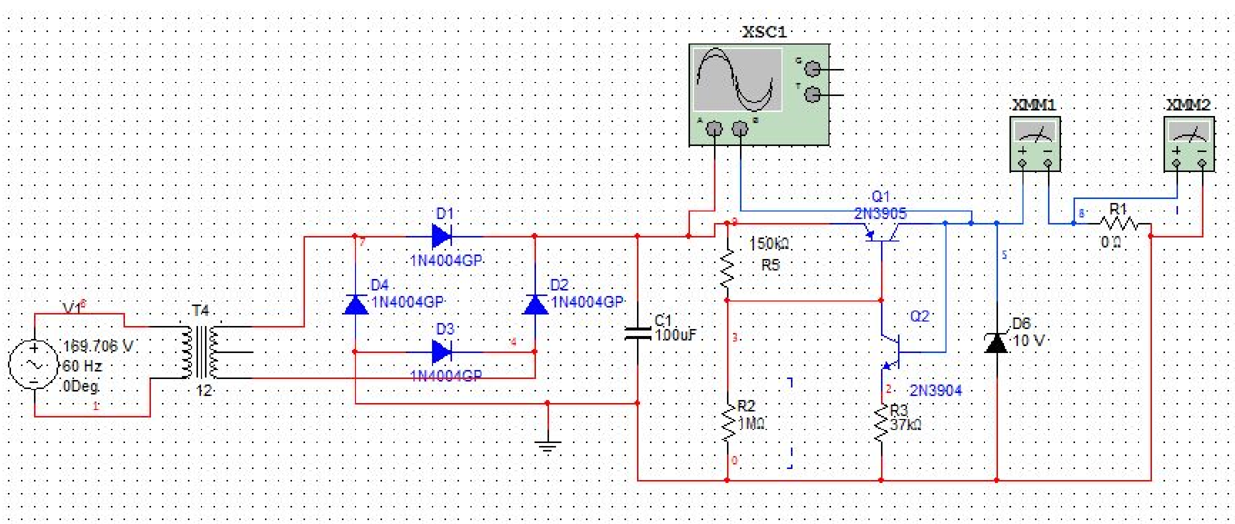

Figure 5: How we got the measurements for our circuits

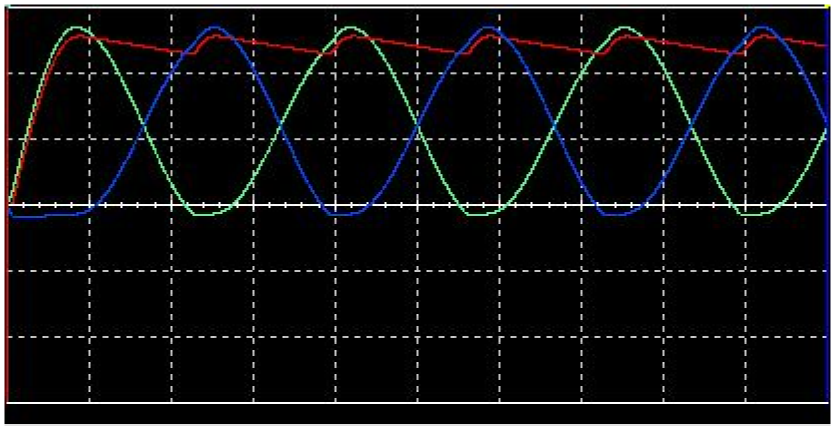

Figure 6: Oscilloscope reading of filtering and bridge rectification

Just as we expecting the filtering (red line)has an almost straight line as it increases when the voltage from bridge rectifier increases and decreases as the capacitor discharges

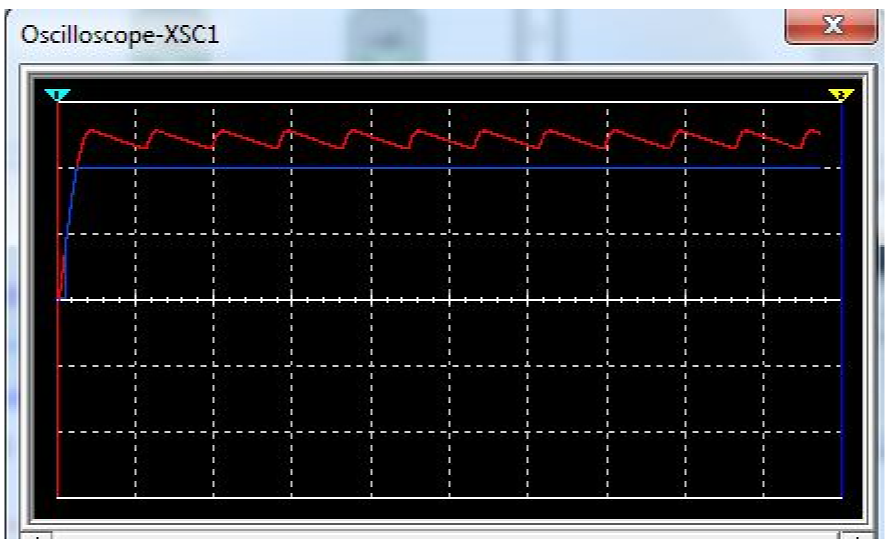

Figure 7: Oscilloscope reading of filtering and output voltage

Here we have the oscilloscope reading as we can see as soon as we run the circuit the output(blue line) increases to 10V very quickly and the voltage stays at 10V thus meaning that the output is 10V DC which is what we were aiming to have and as you see the DC line is very smooth for the output especially compared to the red line which is the voltage at the end of filtering phase. The reason as to why the output is so smooth would be because we had a voltage regulator of a 10V zener diode placed right before the output the reason we placed the zener diode there instead of placing it after the filtering was because we knew that if we placed if right after filtering we would get noise from the limiting current circuit so in order to reduce the amount of bumps in our output voltage as much as possible we placed it near the end of the circuit.

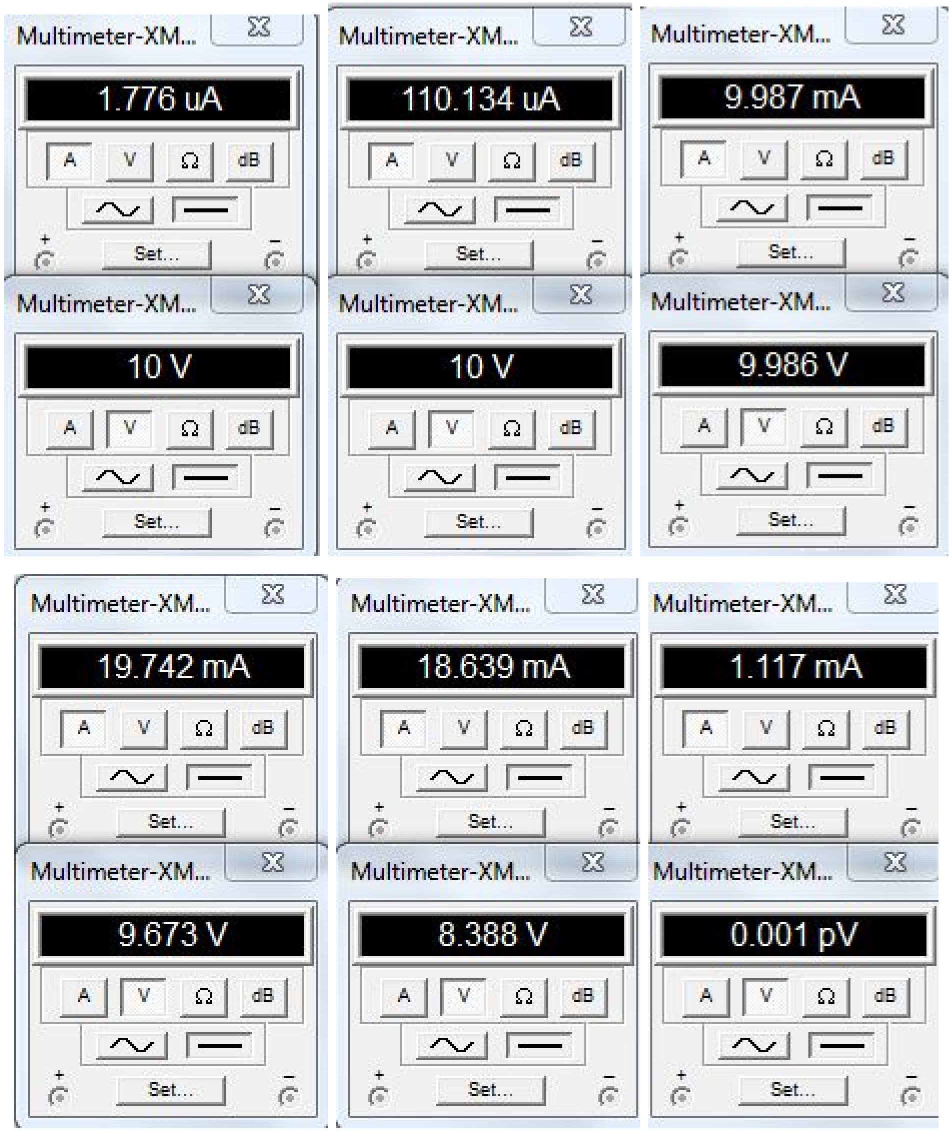

Figure 8: Results using multimeter

On the top left we see the results from the output when we have a high load as you can see we have 10V and a relatively low current as the load decreases (top middle) the voltage stays the same even though the current increases as we expected however as wee keep decreasing the load(top right) we see voltage start to decrease by a small amount as the current increases. Once the load reaches its cross over value(bottom left) we see the current is very close to 20mA and the voltage still close to 10V.Once we decrease the load after it already passes its cross over value (bottom middle)we see the voltage starts decreasing a lot as the current begins to decrease. As we short the circuit (bottom left)by setting resistance to 0 ohms we see the current is very low as the voltage is almost negligible. Therefore from these results we can say we have designed the circuit to do exactly what we wanted which was to have a 10V DC output and a 20mA current limit.

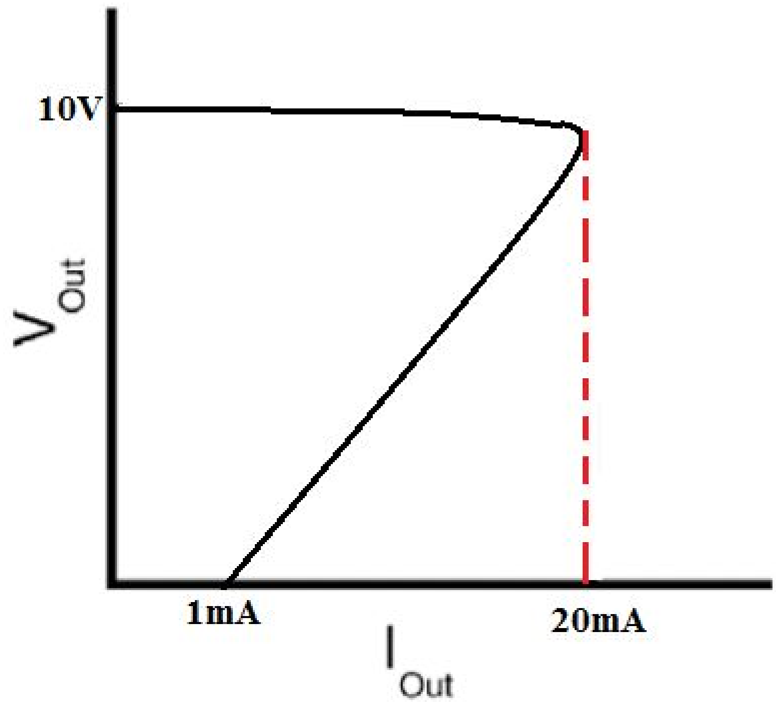

Figure 9: Output Characteristic of our power supply with its current limiter

References

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- **http://powersupply.blogs.keysight.com/2013/01/types-of-current-limits-for-over.html**

- **Agilent Technologies DC Power Supply Handbook, application note AN-90B, part number 5952-4020 “**

- **https://de.tdk-lambda.com/faq/section.aspx?cat=4**