Bangladesh University of Engineering and Technology

A Project Report on Adjustable DC Power Supply Generation

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ABSTRACT

Here we make a variable DC power supply and the main working principle of this project is full wave rectification which is done by bridge configuration. Where we are using 4 diodes and those rectifies the output of the step-down transformer, that step down the 220 AC volts to 12 AC volts.

In this circuit we use a capacitor to reduce ripple and the sharp peaks in the output. and a Zener diode are used to get constant input to the regulator

Here we also use SG3524 as controller circuit and buck boost regulator to vary the voltage from 0V-40V.

Content List

OBJECTIVE

- To design the circuit for variable dc power supply that varies 0V to 40V.
- To observe the output to meet the requirement.

MATERIAL REQUIRED

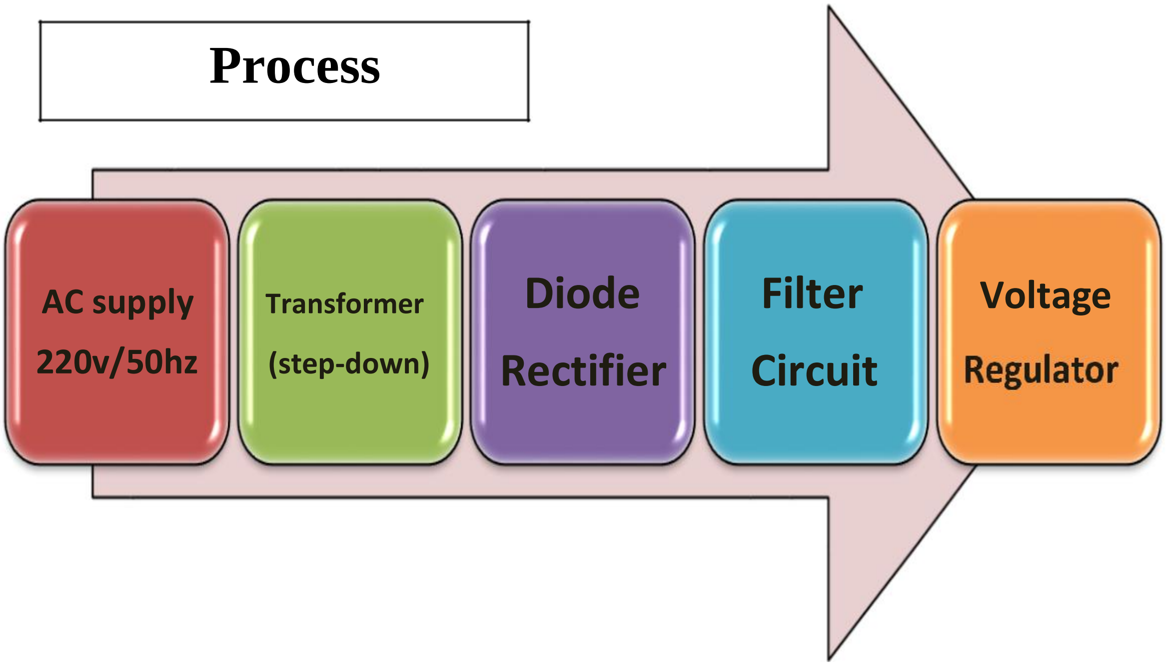
Components

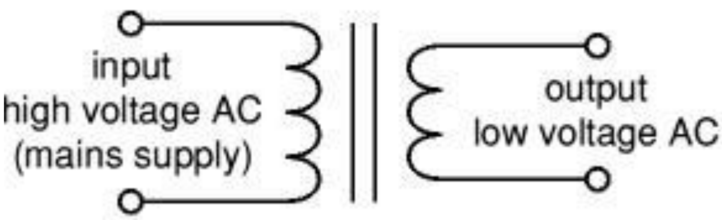
1. Transformer 240v 50 HZ (24v-2A)
2. 4 diode 1N4001
3. 1000µF capacitor
4. 13.1 V Zener diode
5. 47µF capacitor
6. 0.1µF capacitor
7. MOSFET
8. Inductor
9. Power resistor 6.8 kΩ
10. 1 KΩ , 10 KΩ, 4.7 KΩ,220 Ω resistor

Apparatus

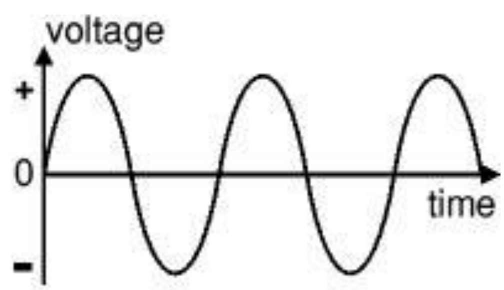
1. Power supply
2. Multimeter
3. Connection wires
4. Wire cuter

<u>**THEORY & WORKING Principle:**</u>

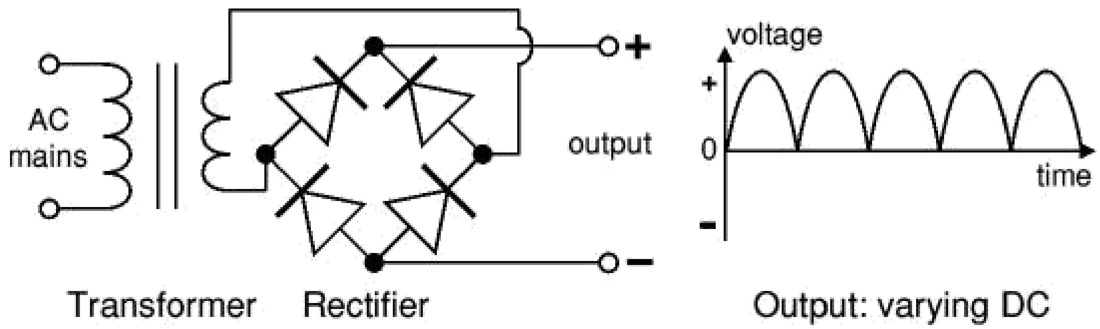




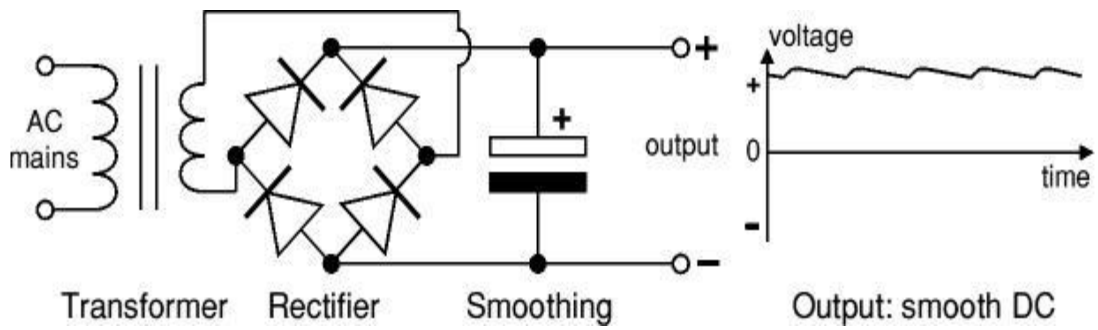
Transformer



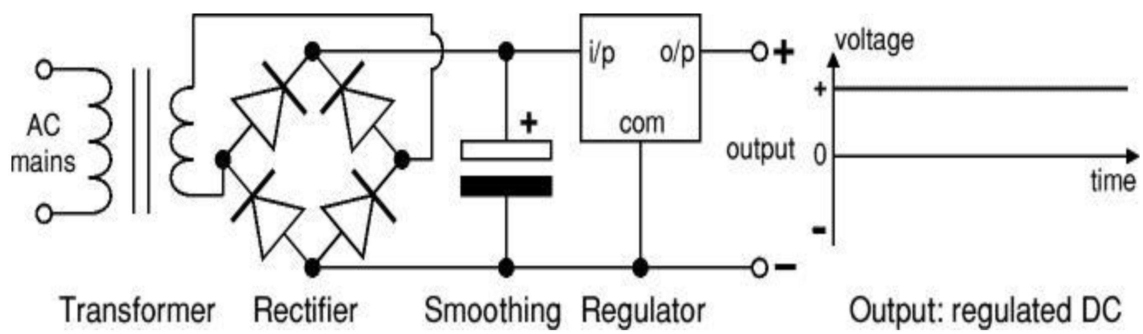
Output: low voltage AC



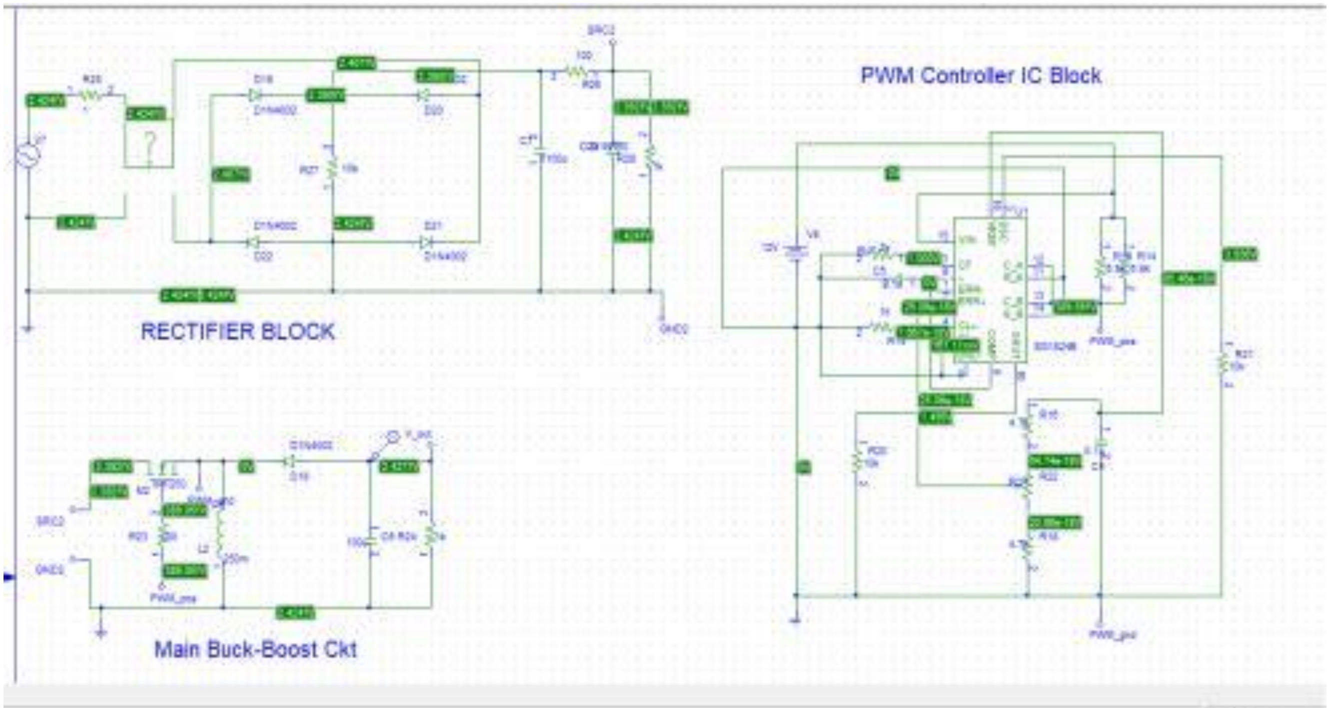
Transformer + Rectifier + Smoothing: - The smooth DC output has a small ripple.



Transformer + Rectifier + Smoothing + Regulator: - The regulated DC output is very smooth with no ripple. It is suitable for all electronic circuits.



Circuit Simulation:



Transformer

A Transformer is an equipment used either for raising or lowering the voltage of an ac supply with a corresponding decrease and increase in current. It essentially consist of two windings primary and secondary

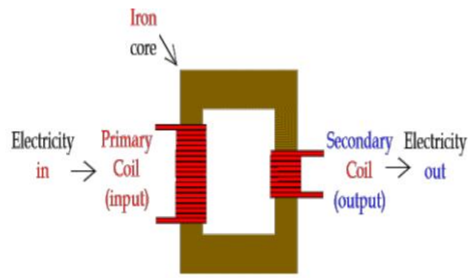
N1: no. of turns in primary coil

N2: no. of turns in secondary coil

N1< N2 :- Step-up transformer
N1> N2 :- Step-down transformer

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.

Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230v) to safer low voltage.



Transformers and their symbol

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils, instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core.

Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

$$\text{Turns ratio} = \frac{V_p}{V_s} = \frac{N_p}{N_s} \quad \text{and}$$

power out = power in

$$V_s \times I_s = V_p \times I_p$$

Vp = primary (input) voltage
Np = number of turns on primary
coil Ip = primary (input) current

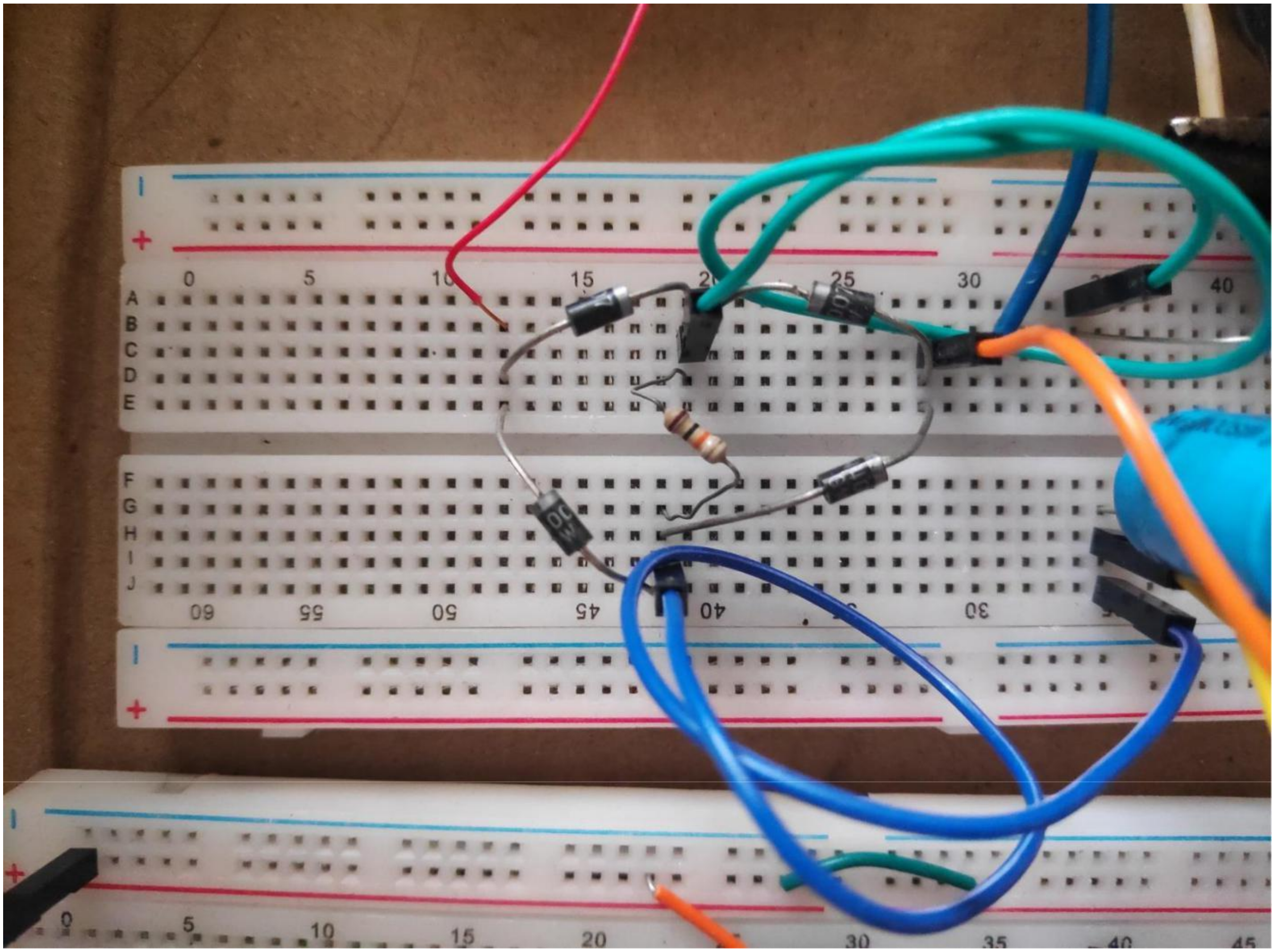
Vs = secondary (output) voltage
Ns = number of turns on secondary
coil Is = secondary (output) current

Rectifier

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a center-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC.

Bridge Rectifier

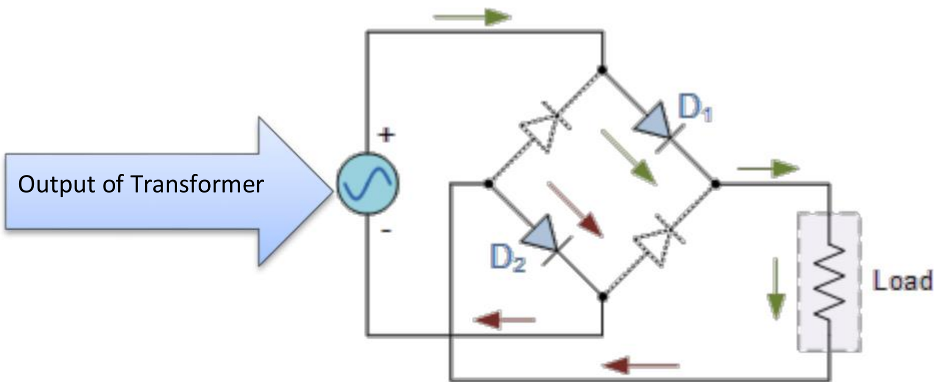
A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses all the AC wave (both positive and negative sections).



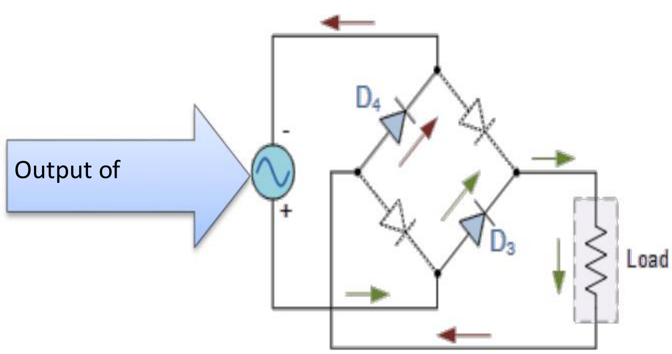
Working of Full Wave Bridge Rectifier:-

The Positive Half-cycle. During the positive half cycle of the supply,

diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.



The Negative Half-cycle During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch “OFF” as they are now reverse biased. The current flowing through the load is the same direction as before.



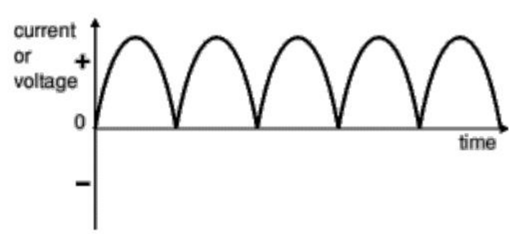
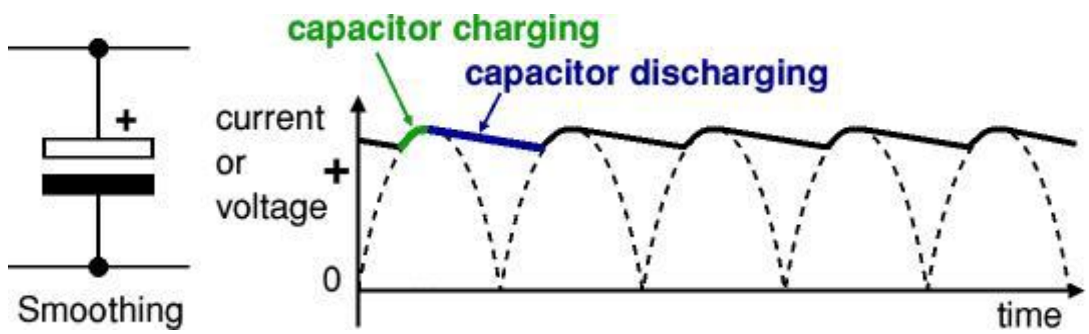


Fig: Resultant wave form

Hence, we can say that the bridge wave rectifier gives the pulsating DC voltage which are not suitable for electronics circuit.

Smoothing (Filter): -

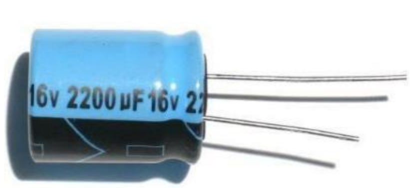
Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.



Smoothing is not perfect due to the capacitor voltage falling a little as it discharges, giving a small ripple voltage. For many circuits a ripple which is 10% of the supply voltage is satisfactory and the equation below gives the required value for the smoothing capacitor. A larger capacitor will give less ripple. The capacitor value must be doubled when smoothing half-wave DC

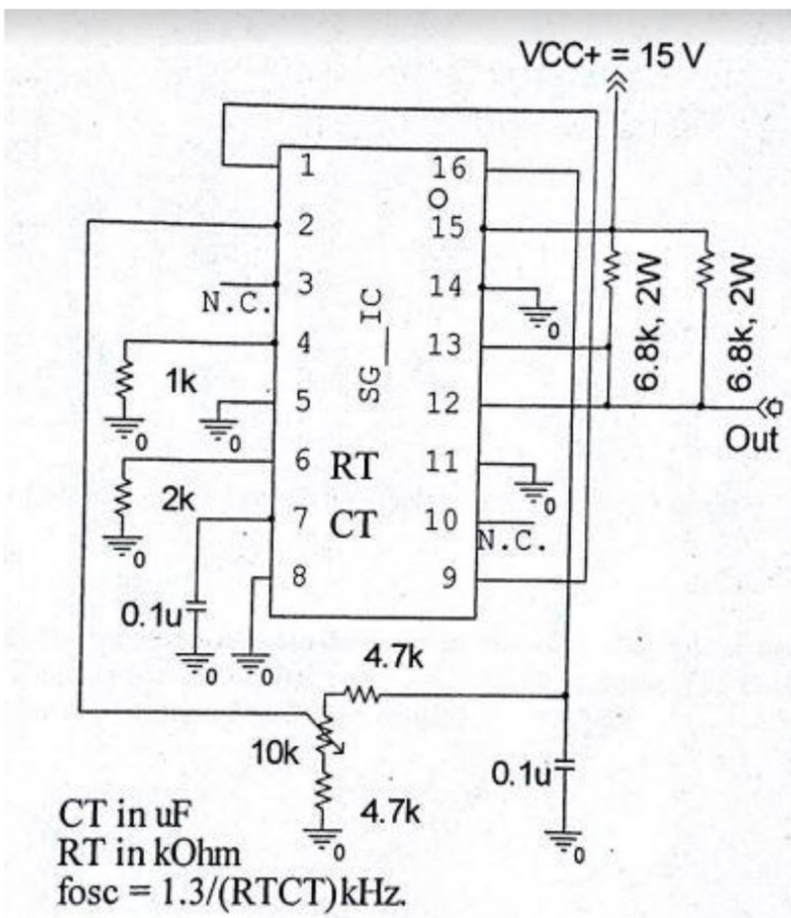
So, in this we concluded that the pulsating DC voltage is applied to the smoothing capacitor. This smoothing capacitor reduces the pulsations in the rectifier DC output voltage.

The smooth DC output has a small ripple. It is suitable for most electronics circuits.



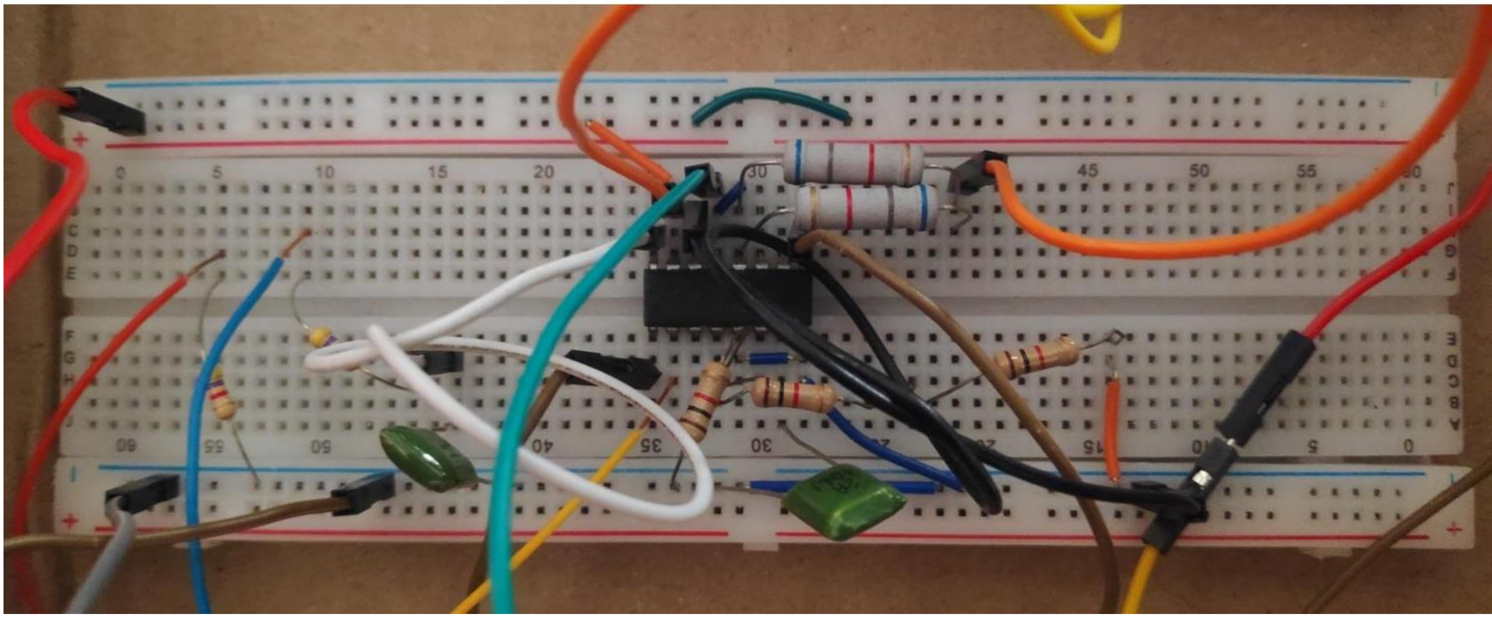
Controller Circuit:

SG3524 is an integrated circuit having all the desired functions which are required to design dual polarity converters. It can also be used to design transformer coupled DC to DC converters as well as transformer less voltage doublers, it has a complete power control circuitry for PWM, which is its unique and special feature. It provides uncommitted output for single ended and push pull applications. Its major application area includes switching regulators having any polarity and transformer coupled DC-DC converters.



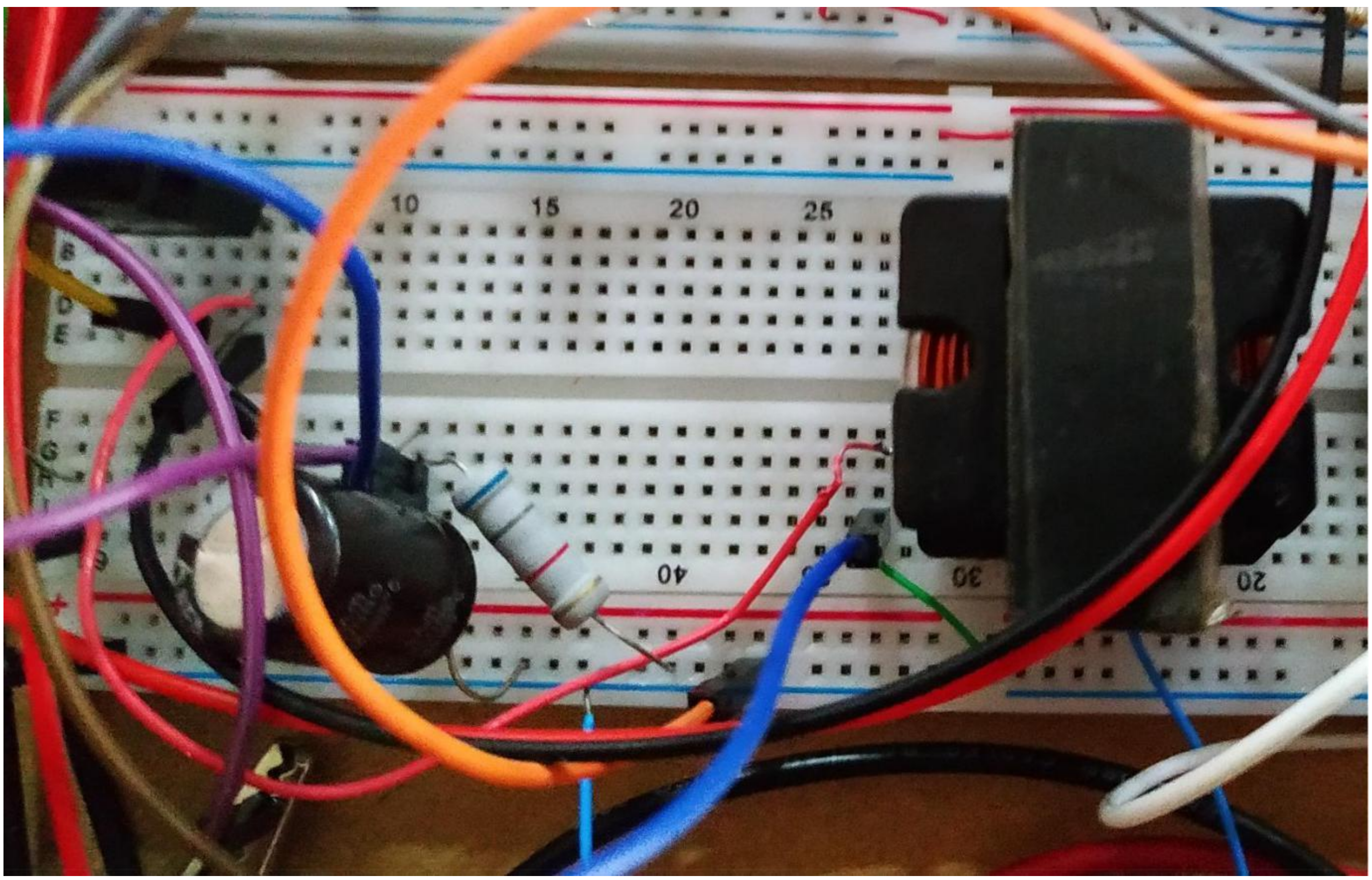
SG3524 Pins Description	
Pin Name	**Pin Description**
IN-	Inverting input
IN+	Non-inverting input
OSC OUT	Oscillator output
CURR LIM+	Positive current limiting amplifier input
CURR LIM-	Negative current limiting amplifier input
RT	Resistor terminal for adjusting oscillator frequency
CT	Capacitor terminal for adjusting oscillator frequency
GND	Ground (0V)
COMP	Error amplifier compensation pin
SHUT	Device shutdown
EMIT1	Emitter terminal of BJT output 1
COL1	Collector terminal of BJT output 1
COL2	Collector terminal of BJT output 2
EMIT2	Emitter terminal of BJT output 2
Vcc	Voltage supply
REF OUT	Reference regulator output

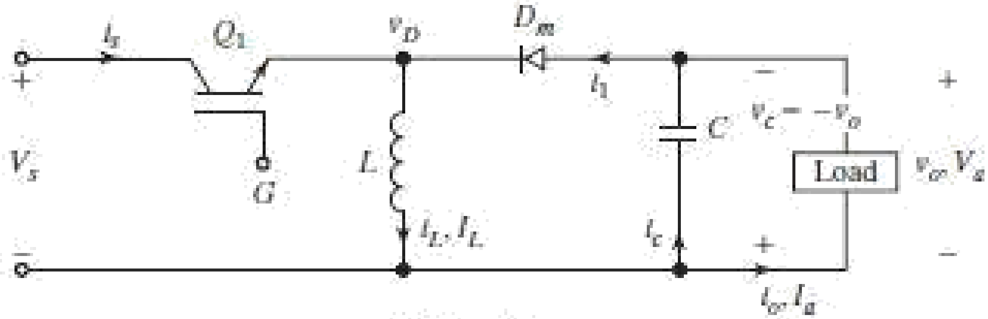
SG3524 Pins	
Sr. No	Pin Name
1	IN-
2	IN+
3	OSC OUT
4	CURR LIM+
5	CURR LIM-
6	RT
7	CT
8	GND
9	COMP
10	SHUT
11	EMIT1
12	COL1
13	COL2
14	EMIT2
15	Vcc
16	REF OUT



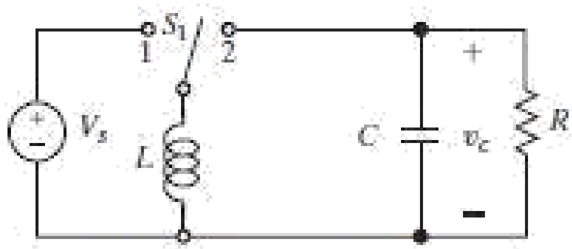
Buck Boost Circuit:

A buck–boost regulator provides an output voltage that may be less than or greater than the input voltage—hence the name “buck–boost”; the output voltage polarity is opposite to that of the input voltage. This regulator is also known as an inverting regulator.

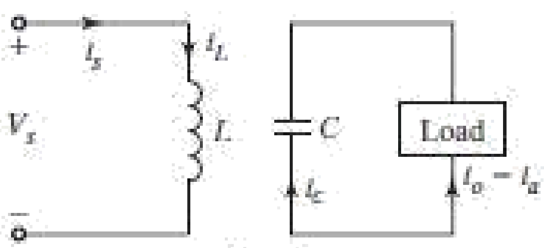




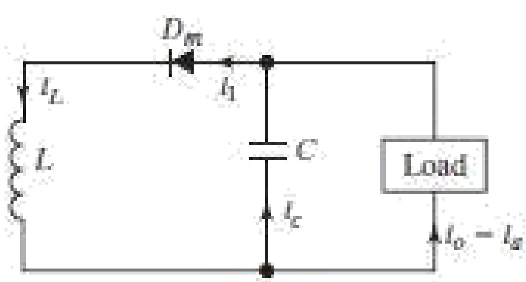
(a) Circuit diagram



(b) Switch representation

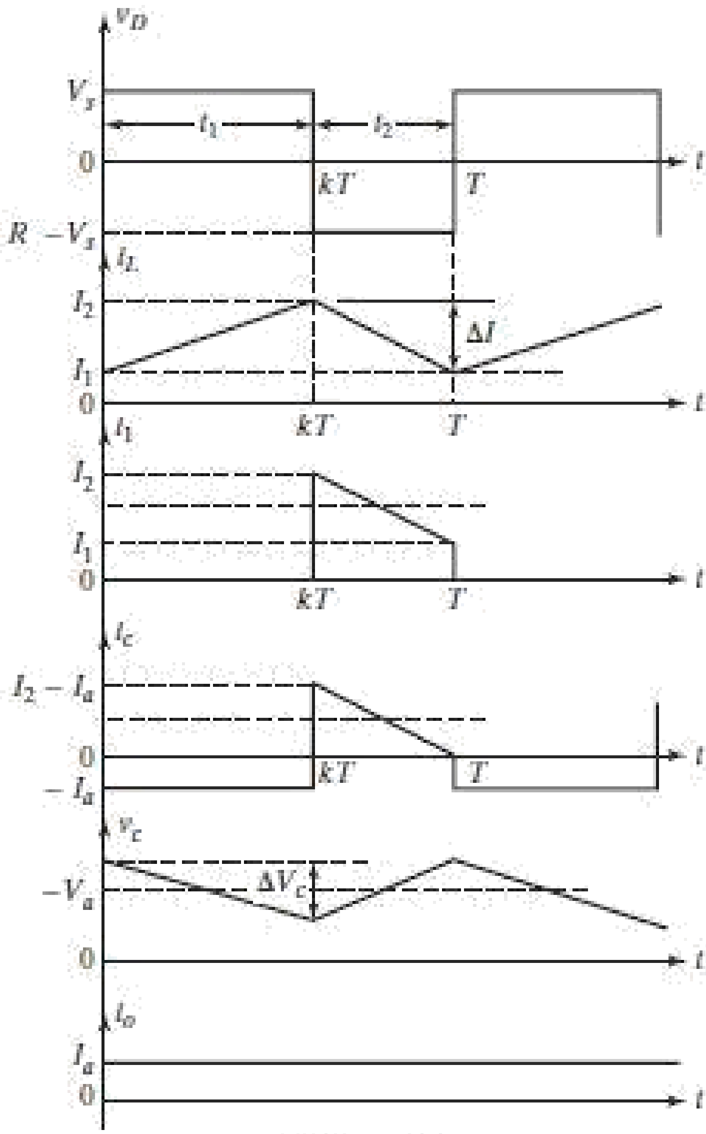


Mode 1



Mode 2

(c) Equivalent circuits



(d) Waveforms

Mode I : Switch is ON, Diode is OFF :

The inductor stores charge during the time the switch is ON and when the solid state switch is OFF the polarity of the Inductor reverses so that current flows through the load and through the diode and back to the inductor. So the direction of current through the inductor remains the same.

Let us say the switch is on for a time T_{ON} and is off for a time T_{OFF}. We define the time period, T, as and the switching frequency,

Since the switch is closed for a time T_{ON} = DT we can say that Δt = DT.

$$f_{switching} = \frac{1}{T}$$

Let us now define another term, the duty cycle,

$$D = \frac{T_{ON}}{T}$$

Let us analyse the **Buck Boost converter** in steady state operation for this mode using KVL.

$$\therefore V_{in} = V_L$$

$$\therefore V_L = L\frac{di_L}{dt} = V_{in}$$

$$\frac{di_L}{dt} = \frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{DT} = \frac{V_{in}}{L}$$

Since the switch is closed for a time T_{ON} = DT we can say that Δt = DT.

$$(\Delta i_L)_{closed} = \left(\frac{V_{in}}{L}\right) DT$$

Mode II : Switch is OFF, Diode is ON :

In this mode the polarity of the inductor is reversed and the energy stored in the inductor is released and is ultimately dissipated in the load resistance and this helps to maintain the flow of current in the same direction through the load and also step-up the output voltage as the inductor is now also acting as a source in conjunction with the input source. But for analysis we keep the original conventions to analyze the circuit using KVL.

.

$$\therefore V_L = V_o$$

$$\therefore V_L = L\frac{di_L}{dt} = V_o$$

$$\frac{di_L}{dt} = \frac{\Delta i_L}{\Delta t} = \frac{\Delta i_L}{(1-D)T} = \frac{V_o}{L}$$

Since the switch is open for a time
$T_{OFF} = T - T_{ON} = T - DT = (1-D)T$
we can say that
$\Delta t = (1-D)T$
.

$$(\Delta i_L)_{open} = \left(\frac{V_o}{L}\right)(1-D)T$$

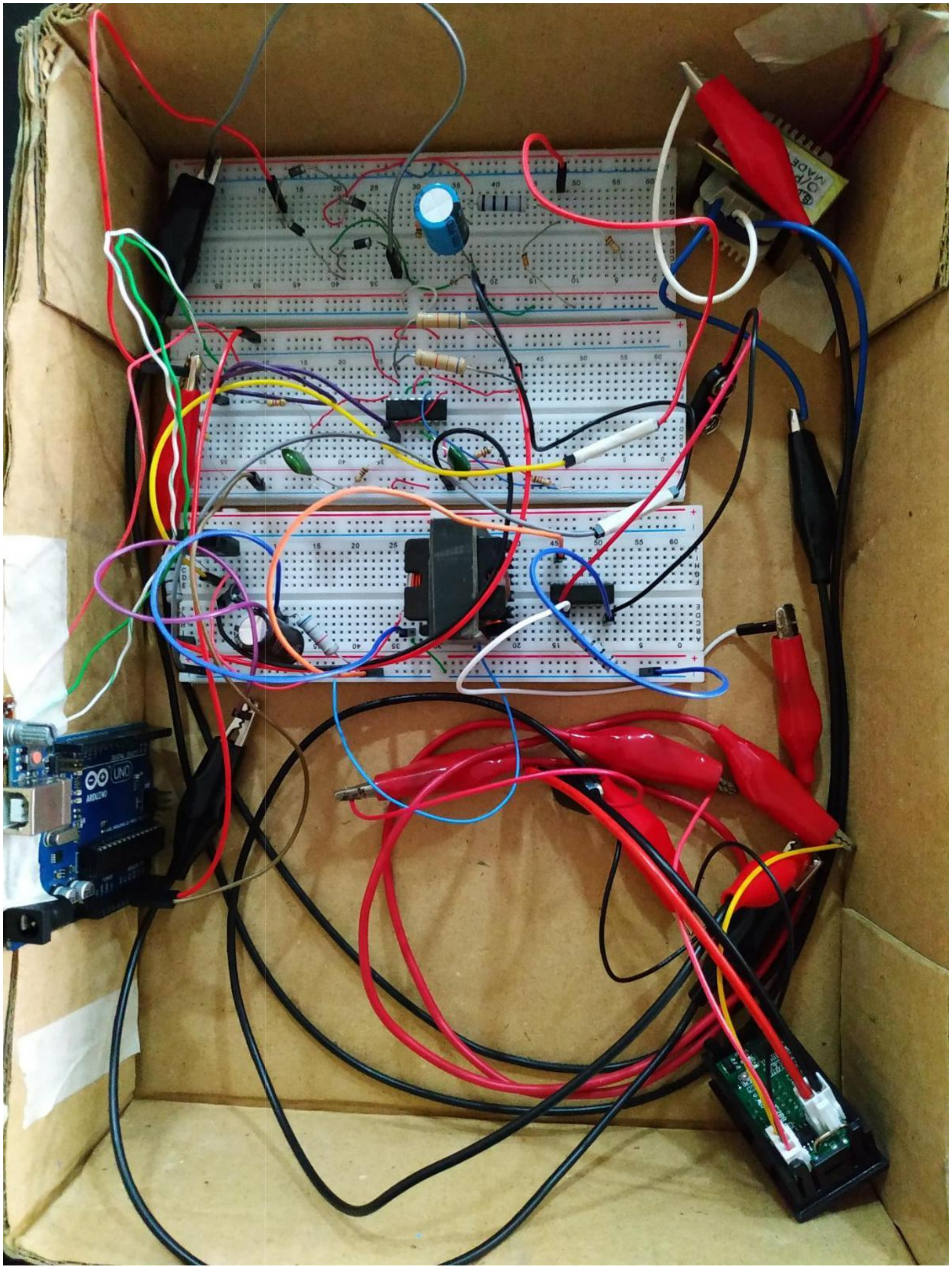
It is already established that the net change of the inductor current over any one complete cycle is zero.

$$\therefore (\Delta i_L)_{closed} + (\Delta i_L)_{open} = 0$$

$$\left(\frac{V_o}{L}\right)(1-D)T + \left(\frac{V_{in}}{L}\right)DT = 0$$

$$\frac{V_o}{V_{in}} = \frac{-D}{1-D}$$

Final Project:



Result:

We get DC Regulated power supply which can varies through variable DC output from 0 V to 40V

Limitation:

In our project we couldn’t apply current limiter because our voltage was dropping really fast after using current limiter. Thus, with current limiter, it was impossible to use the buck-boost circuit.

REFERENCES

[1] Book ‘Encyclopedia of Electronic Components’ by Charles Platt
[2] Book ‘Practical Electronics for Inventors’ by Paul Scherz and Simon Monk
[3] Book ‘Circuit Theory and Analysis’ by Abhijit Chakrabarti
[4] https://en.wikipedia.org/wiki/Diode
[5] http://en.wikipedia.org/wiki/Capacitor
[6]http://en.wikipedia.org/wiki/Rectifier
[7] http://www.electronics-hub.com
[8] http://electronics.stackexchange.com
[9] http://www.electronics-tutorials.ws/diode/diode_6.html
[10] https://www.eleccircuit.com/lm317-power-supply/

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