Design of Flyback Converter

Project Report submitted for

POWER ELECTRONICS DEVICES AND CIRCUITS

(EET 3113)

Submitted by

Sub group-3

DEBANSH RAY **1641014035**
G. SHUBHAM SREE **1641014038**
SATYAJIT PATRA **1641014039**

(EEE-C, 6th Semester)

Department of Electrical and Electronics Engineering

Institute of Technical Education and Research
(Faculty of Engineering)

SIKSHA 'O' ANUSANDHAN
DEEMED TO BE UNIVERSITY
Bhubaneswar, Odisha, India

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Declaration

We the undersigned students of B. Tech. of Electrical and Electronics Engineering Department hereby declare that we own the full responsibility for the information, results etc. provided in this PROJECT titled “**Design a flyback converter**” submitted to **Siksha ‘O’ Anusandhan University, Bhubaneswar** for the partial fulfillment of the subject **Power Electronics Devices And Circuits (EET 3113)**. We have taken care in all respect to honor the intellectual property right and have acknowledged the contribution of others for using them in academic purpose and further declare that in case of any violation of intellectual property right or copyright we, as the candidates, will be fully responsible for the same.

Debansh Ray

Registration No.: 1641014035

G. Shubham Sree

Registration No.: 1641014038

Satyajit Patra

Registration No.: 1641014039

DATE: 10^{th} April , 2019

PLACE: ITER , Bhubaneswar

ABSTRACT: -

The purpose of this project is to design a fly back converter that has an input voltage of 6V to 15V DC and the output voltage is 12V DC. Fly back converter is one of the switching DC power supplies applications with electrical isolation. The transformation of DC voltage from 6V – 15V to 12V DC is accomplished by using DC to DC converter circuits. The switching element used in this fly back converter is MOSFET (metal oxide semiconductor field effect transistor), which is operating completely off or completely on this is because MOSFET has high power rating and high switching speed. The output of the MOSFET is fed to high frequency transformer. The snubbed circuit is connected parallel to the MOSFET for protection. A high speed isolation transformer provides the electrical isolation in fly back converter. The speed transformers were used due to the small size and small weight. Consequently, the design circuit will deliver accurate value with low power losses on the whole, the under taken task would provide to understand the operation of fly back converter circuit practically.

INTRODUCTION: -

Fly back converter is the most commonly used SMPS circuit for low output power applications where the output voltage needs to be isolated from the input main supply. The output power of fly back type SMPS circuit may vary from few watts to less than 100 watts. The overall circuit topology of this converter is considerably simpler than other SMPS circuits. Input to the circuit is regulated DC obtained by rectifying the utility AC voltage followed by a simple capacitor filter. The circuit can offer single or multiple isolated output voltages and can operate over wide range of input voltage variation. In respect of energy-efficiency, fly back power supplies are inferior to many other SMPS circuits but its simple topology and low cost makes it popular in low output power range. The commonly used fly back converter is in the range of 100kHz. A two switch topology exists that offer better energy efficiency and less voltage stress across the switches but costs more and the circuit complexity also increases slightly. The project here is only limited to the study of the fly back converter.

PROBLEM STATEMENT: - Design a fly back converter which will provide an output voltage of 12V for the source variation of 6V – 15V.

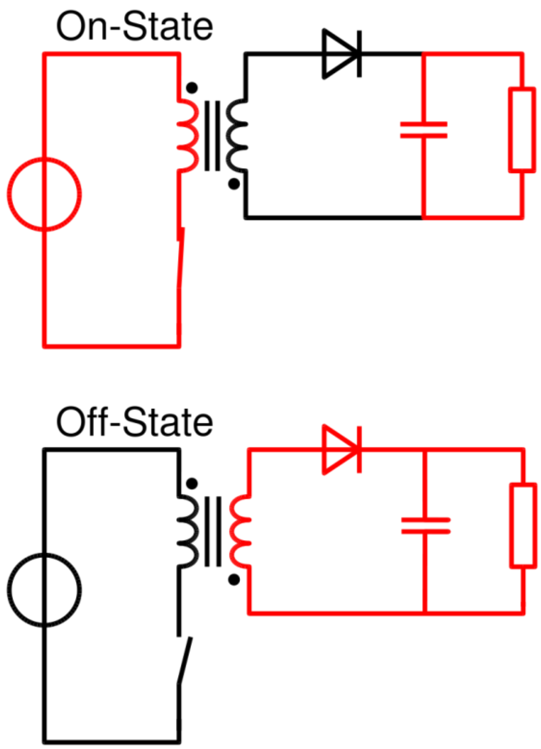
THEORY: -

The fly back converter is an isolated power converter. The two prevailing control schemes are voltage mode control and current mode control (in the majority of cases current mode control needs to be dominant for stability during operation). Both require a signal related to the output voltage. There are three common ways to generate this voltage. The first is to use an optocoupler on the secondary circuitry to send a signal to the controller. The second is to wind a separate winding on the coil and rely on the cross regulation of the design. The third consists of sampling the voltage amplitude on the primary side, during the discharge, referenced to the standing primary DC voltage.

A variation in primary-side sensing technology is where the output voltage and current are regulated by monitoring the waveforms in the auxiliary winding used to power the control IC itself, which have improved the accuracy of both voltage and current regulation. The auxiliary primary winding is used in the same discharge phase as the remaining secondary's, but it builds a rectified voltage referenced commonly with the primary DC, hence considered on the primary side.

Previously, a measurement was taken across the whole of the fly back waveform which led to error, but it was realized that measurements at the so-called knee point (when the secondary current is zero) allow for a much more accurate measurement of what is happening on the secondary side. This topology is now replacing ringing choke converters (RCCs) in applications such as mobile phone chargers.

OPERATION: -



When the switch is closed (T_{on}): -

When the switch is closed, the primary of the transformer is directly connected to the input voltage source. The primary current and magnetic flux in the transformer increases, storing energy in the transformer. The voltage induced in the secondary winding is negative, so the diode is reverse-biased (i.e., blocked). The output capacitor supplies energy to the output load.

$$V_L - V_1 = V_s$$

$$i_c = -\frac{V_0}{R}$$

When the switch is open (T_{off}): -

When the switch is opened (bottom of Fig. 2), the primary current and magnetic flux drops. The secondary voltage is positive, forward-biasing the diode, allowing current to flow from the transformer. The energy from the transformer core recharges the capacitor and supplies the load.

$$V_c = -\frac{V_0}{n} \; and \; i_c = \frac{i_1}{n} - I_0$$

$$V_s D T_s + \left(\frac{-V_0}{n}\right) D' T_s = 0$$

$$V_s D T_s - \left(\frac{V_0}{n}\right) D' T_s = 0$$

$$V_s D T_s - \frac{V_0}{n}(1-D) T_s = 0$$

$$V_s D T_s - \frac{V_0 T_s}{n} + \frac{V_0 D T_s}{n} = 0$$

$$V_s D T_s n - V_0 T_s + V_0 D T_s = 0$$

$$V_s D T_s n - V_0 (1-D) T_s = 0$$

$$V_s D T_s n = V_0 (1-D) T_s$$

$$\frac{V_s}{V_0} = \frac{(1-D) T_s}{D T_s n}$$

$$\frac{V_s}{V_0} = \frac{1-D}{Dn}$$

$$\frac{V_0}{V_s} = \frac{D}{D'} n - - - - - - Equation\ (1)$$

CALCULATION OF THE PARAMETERS: -

1) Duty cycle: -

$$from\ Equation(1),\ \ \frac{V_0}{V_s} = \frac{D}{D'}n$$

$$\frac{12}{13} = \frac{D}{D'}n$$

$$n = \frac{N_1}{N_2} = \frac{1}{1}$$

Since it is 1:1 transformer.

$$12(1 - D) = 13D$$

$$12 - 12D = 13D$$

$$12 = 25D$$

$$D = \frac{12}{25}$$

$$D = 0.48$$

2) Resistor: -

Assuming the value of the resistor i.e. the load is $100\ \Omega$.

3) Capacitor: -

$$C = \frac{D}{R \times 2f}$$

$$= \frac{0.48}{100 \times 2 \times 10000}$$

$$= 2.4 \times 10^{-7}$$

$$C = 24 \times 10^{-7} \mu F$$

4) Magnetizing Inductance (L_m): -

$$I = \frac{V_0 T_{on}}{L_m}$$

$$L_m = \frac{V_0 T_{on}}{I}$$

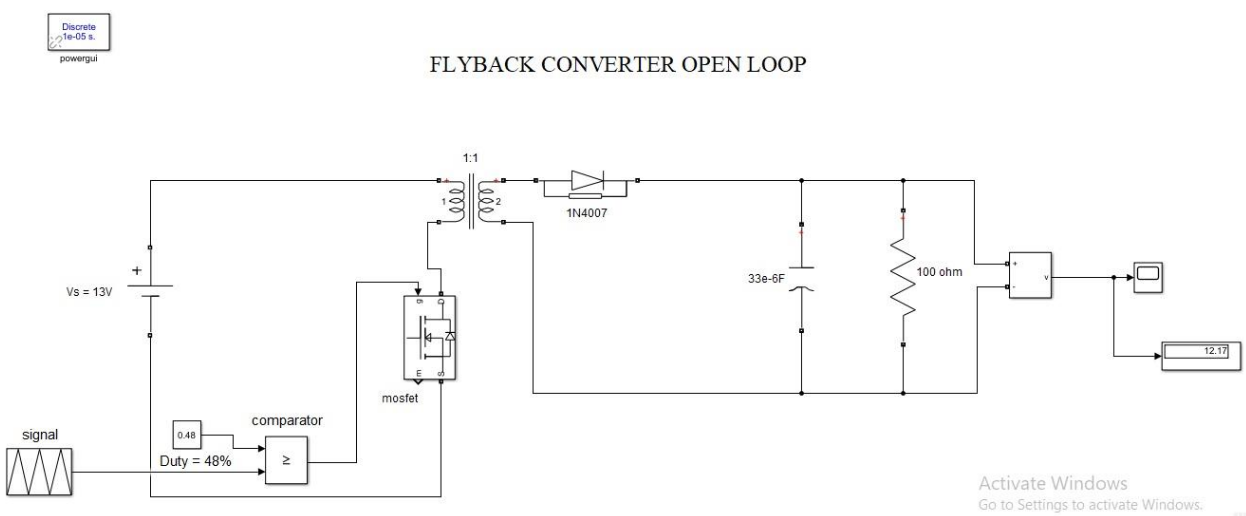
Assuming that the output current is 1A.

$$= \frac{12 \times 0.48}{1}$$

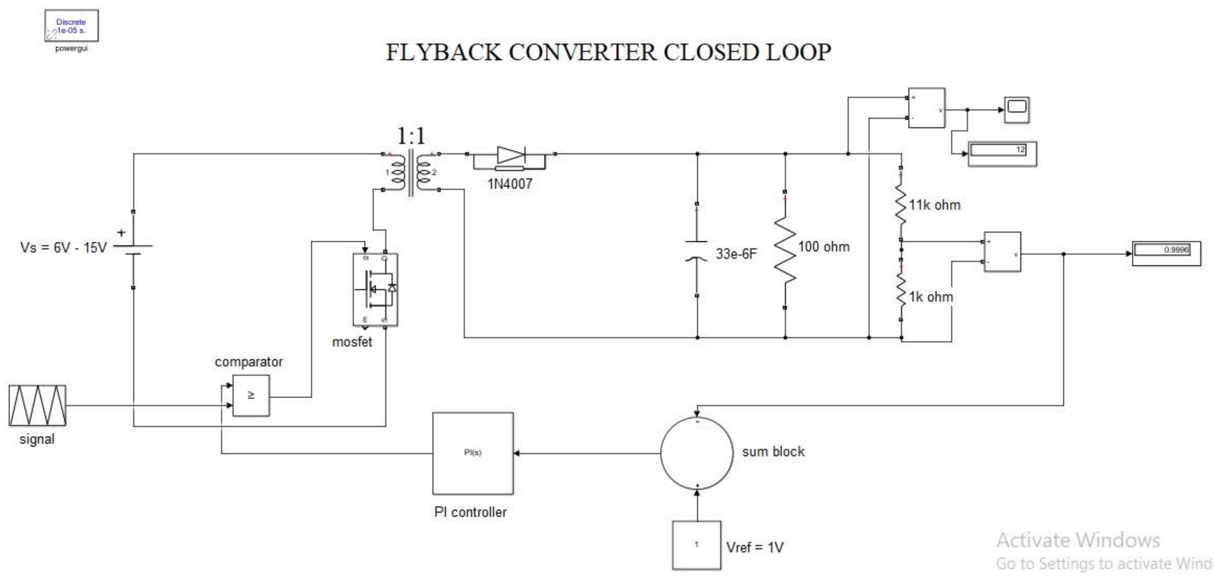
$$L_m = 5.76H.$$

Simulation of the open loop and closed loop: -

MATLAB simulation using Simulink of open loop:

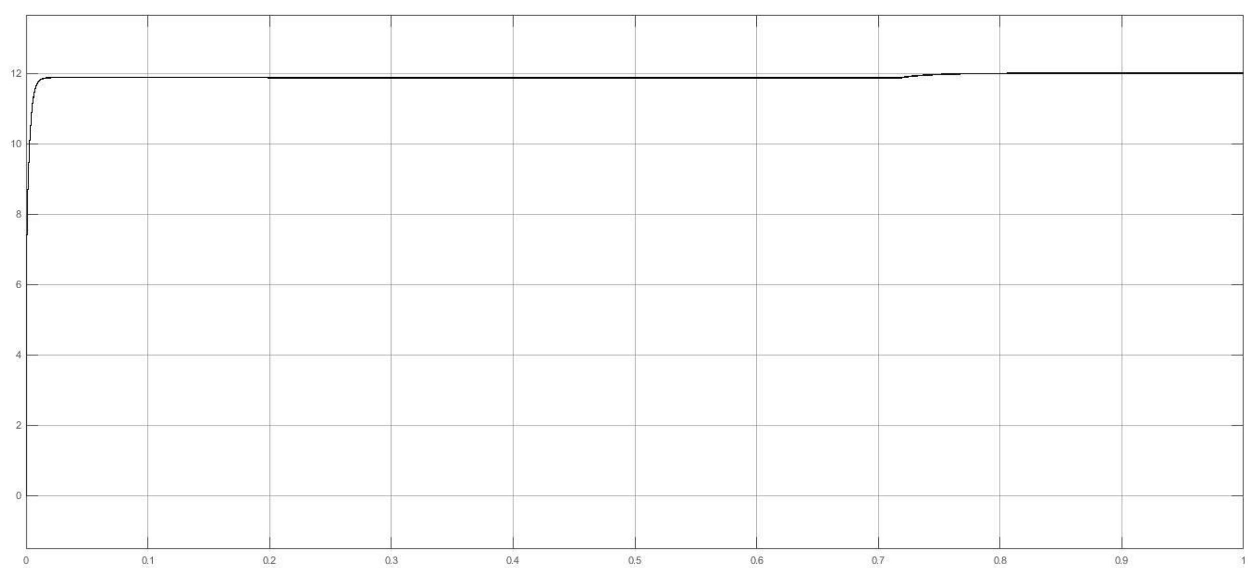


MATLAB simulation using Simulink of closed loop:



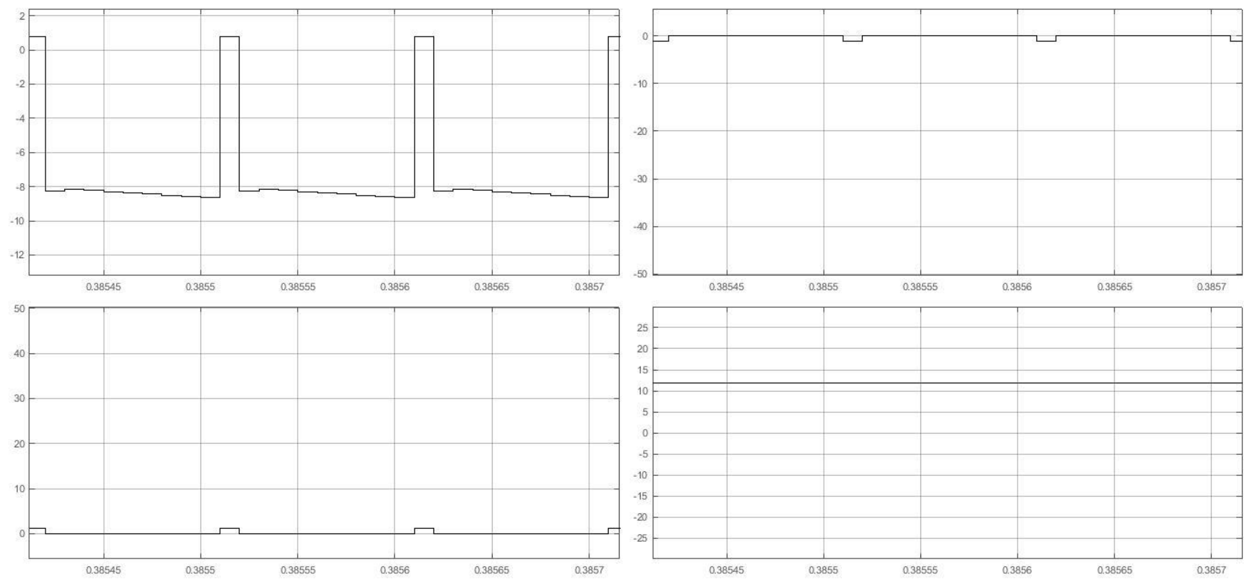
Result and result analysis: -

OPEN LOOP:



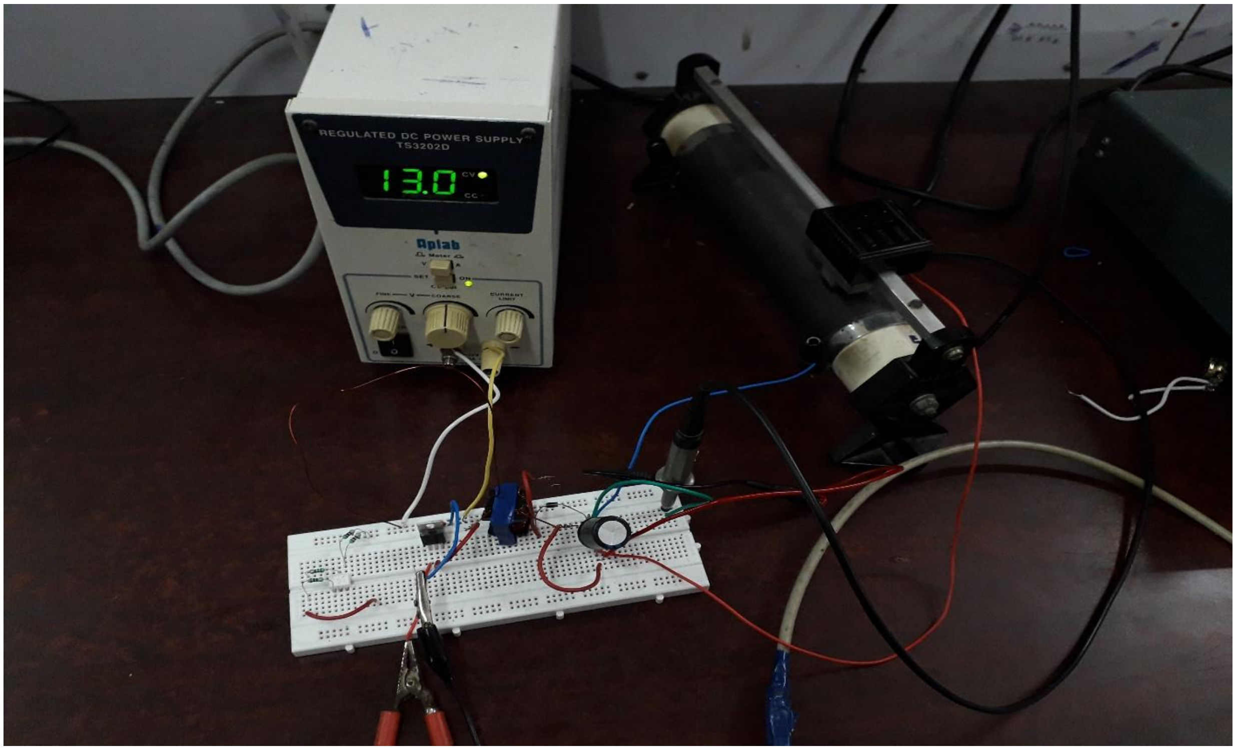
The above open loop simulation shows the output voltage of the open loop circuit i.e. 12V.

CLOSED LOOP:

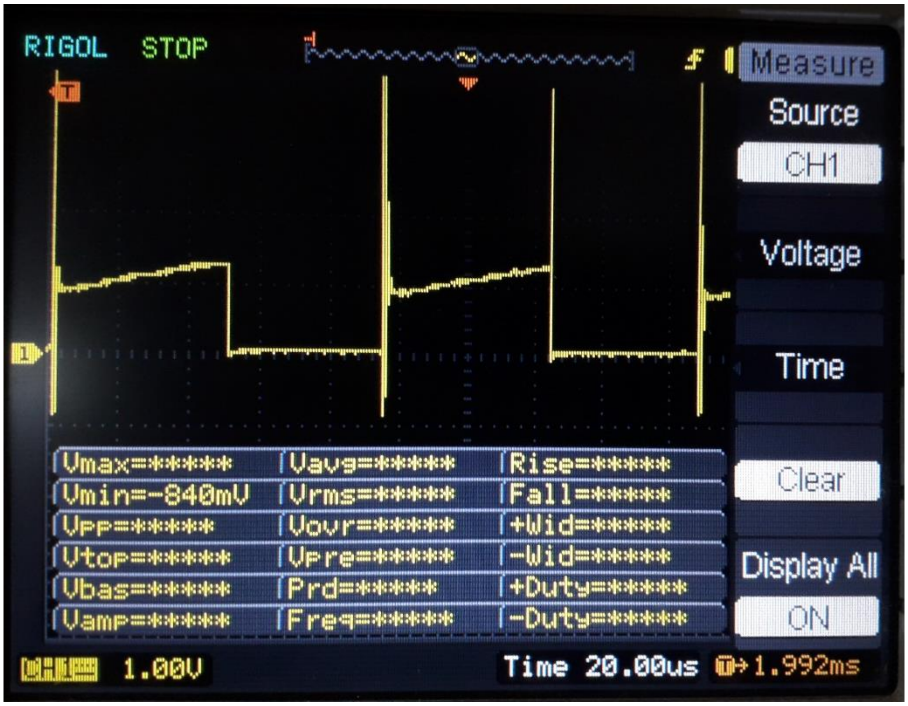


The above closed loop simulation output shows the diode voltage, diode current, capacitor current and the output voltage i.e. 12V.

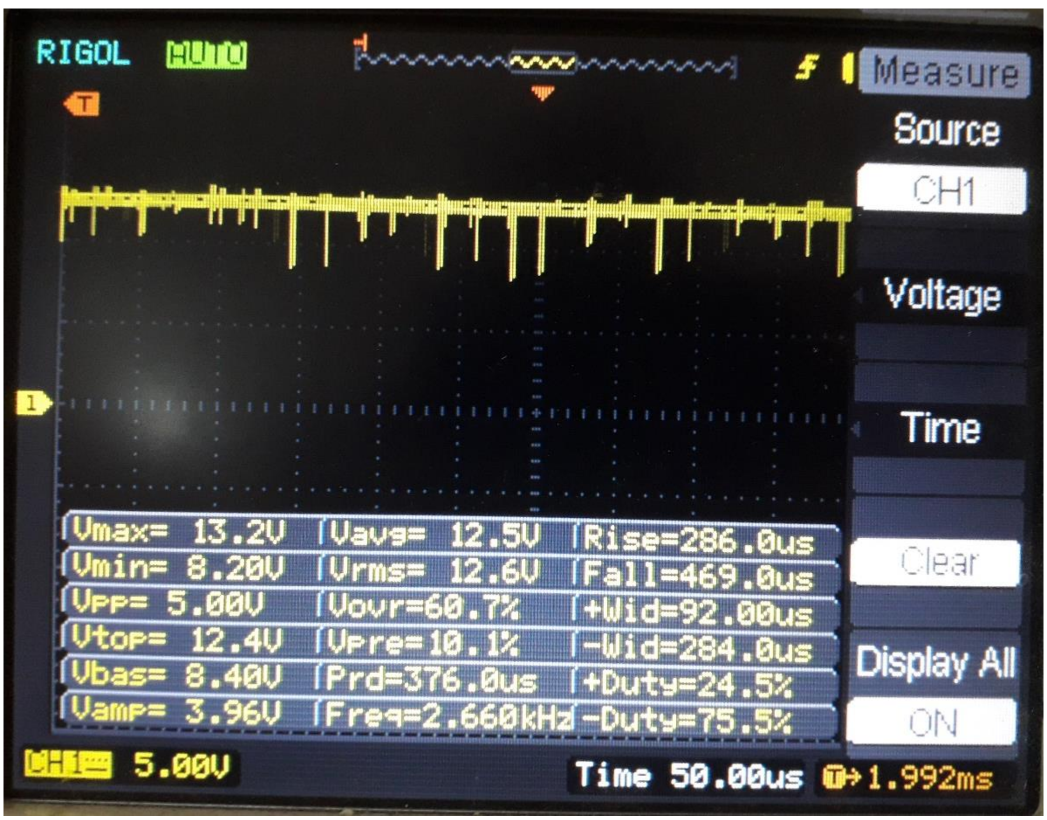
Hardware implementation: -



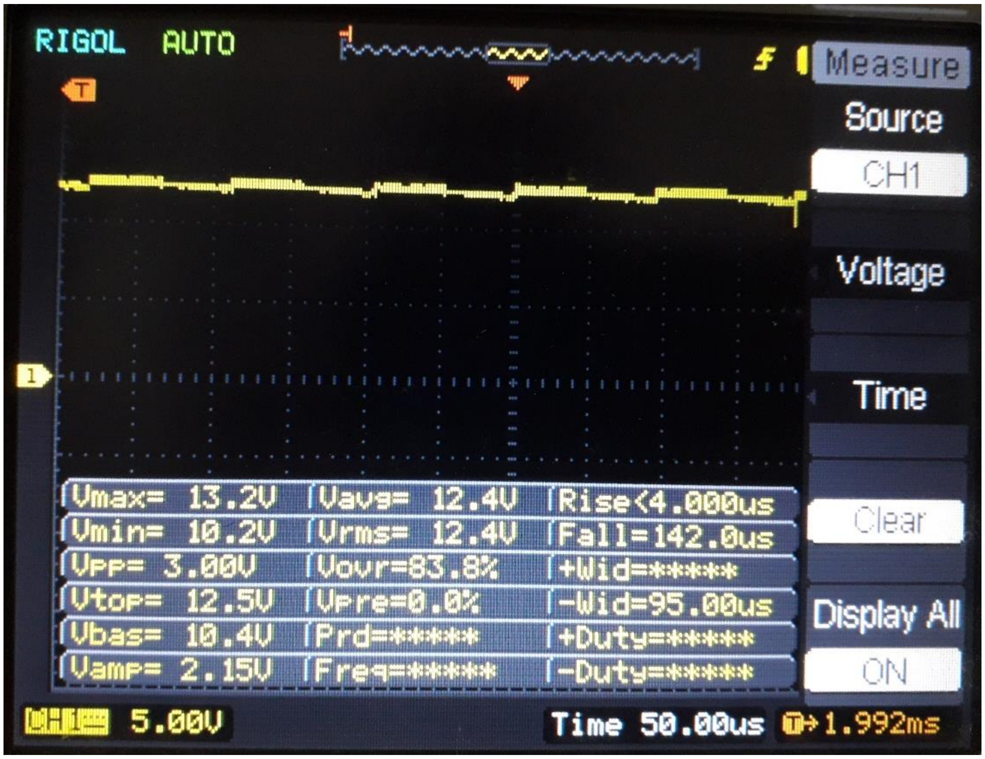
Hardware implementation of the open loop circuit.



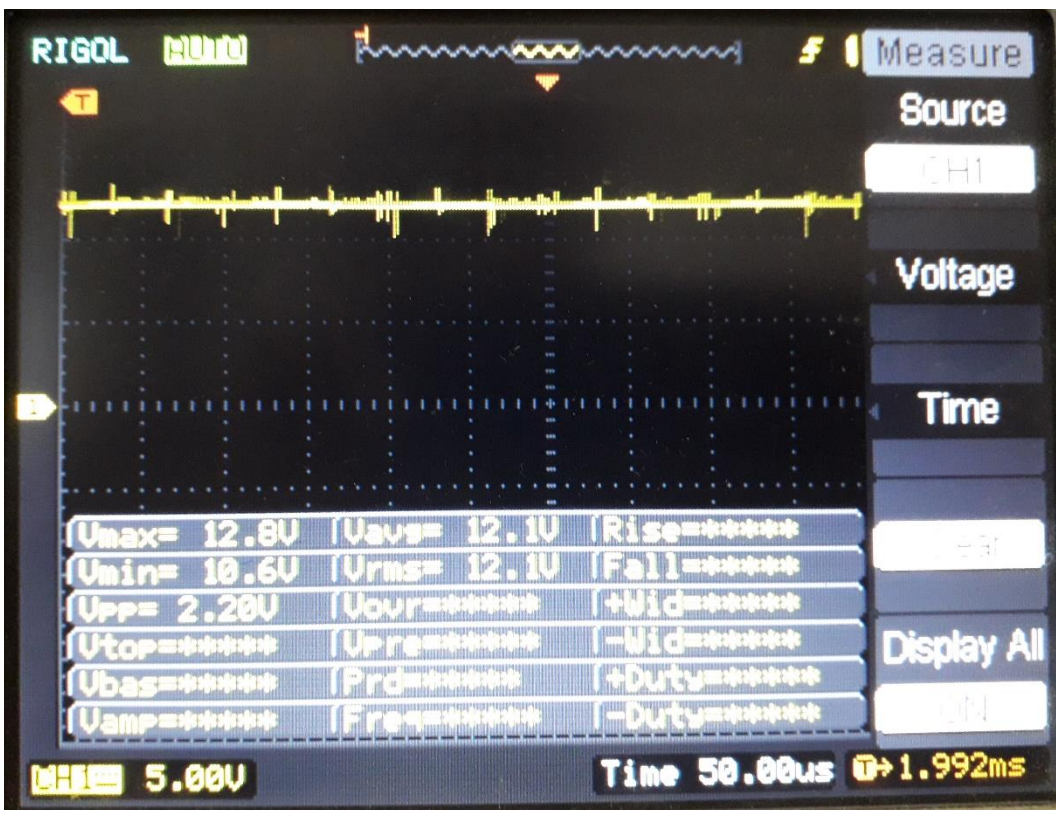
Drain to Source voltage of the MOSFET.



Transformer primary voltage.



Transformer secondary voltage.



Output voltage of the fly back converter

The simplified and idealized fly back converter circuit high voltage drop and losses. The coupling between the primary and secondary winding will not be ideal. Due to the non-ideal coupling between the primary and secondary winding when the primary side switch is turned off some energy is trapped in the leakage inductance of the winding the flux associated with the primary winding leakage inductance of the secondary winding the flux associated with the primary winding leakage inductance will not link the secondary winding and hence the energy associated with the leakage flux need to dissipated in an external circuit. The switching element used in fly back converter is MOSFET which is operating completely OFF completely ON this is because MOSFET has high rating and high switching speed. The output of the MOSFET is fed to high frequency transformer. And all the waveforms are studied as shown in the above figures.

The output obtained is 12V by providing 17.6V in the input

Bill of materials: -

Sl.no	Components	Specifications	Quantity	Price
1	MOSFET	1RF540N	1	30
2	Diode	1N4007	1	1
3	Capacitor	1000µF	1	15
4	Transformer bobbin	5mH	1	40
5	Connecting wire	23SWG	As required	10

CONCLUSION:

Here we successfully completed our project i.e. fly back converter, the expected output was 12V by input of 15V, but we got it at 17.6V.

REFERENCE:

[1] Power Electronics , Converters ,Applications and Designs by John Wilesy and Sons

[2] Power Electronics by Daniel W. Hart

[3] Amir Faizy, Shailendra Kumar, design of fly back coverter, NIT Rourkela 2011.

FUTURE PROGRESS/FURTHER IMPROVEMENT:

1) In order to get the accurate output, the transformer turns ratio should be taken care off and the windings should be done properly.
2) Calculating the capacitor value taking resistor value constant.
3) The transformer should be constructed as per the calculated values of the magnetizing inductance and resistance.