

# Design and Simulation of Flyback Converter (Two Output, 8 W)

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## Abstract

DC-DC converter is the essential part of any satellite for providing power to high definition cameras and sensitive sensors and other small devices. These devices require constant low dc voltage and varying load current which can be provided by isolated DC-DC topologies. Some ICs are also available which can provide the required constant low voltage but they are cost effective. So the project includes the design and Simulation of Flyback converter (Two Output, 8W). Design calculations of Flyback converter presented in this project. Design is also simulated in PSPICE simulator with a switching frequency of 150KHz. Simulation results are also presented and discussed.

## 1. Introduction

Power electronics use has increased a lot over the past few decades. One of the major applications of power electronics is the dc-dc conversion. We can differentiate this application into two different types.

- I. DC-DC converter with an input of direct source
- II. Use of DC-DC converter when the input is alternating source

Switched mode power supplies with PWM techniques become an essential component of many industrial, military, communication, automobile, computer, space applications and also in consumer products where good efficiency, light weight, low cost and small size are of major concern. In addition to these, some switched mode power supplies requires electrical isolation between source and load.

The Flyback converter is used in both AC to DC and DC to DC conversion with galvanic isolation between the input and any outputs. The Flyback converter is a buck-boost converter with the inductor split to form a transformer, so that the voltage ratios are multiplied with an additional advantage of isolation. When driving for example a plasma lamp or a voltage multiplier the rectifying diode of the boost converter is left out and the device is called a Flyback transformer.

Flyback 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 circuits 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 generally unregulated dc voltage obtained by rectifying the utility ac voltage followed by a simple capacitor filter.

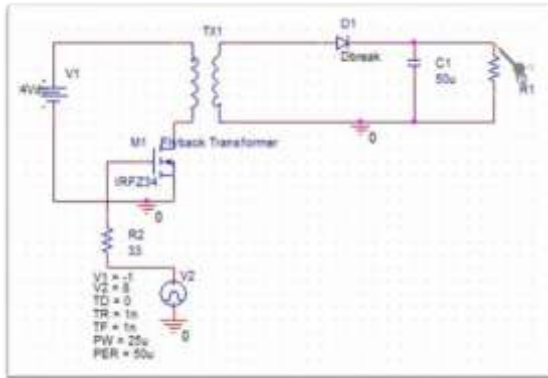
The circuit can offer single or multiple isolated output voltages and can operate over wide range of input voltage variation. In respect of energy-efficiency, Flyback power supplies are inferior to many other SMPS circuits but it's simple topology and low cost makes it popular in low output power. [2] [4]

## 2. Flyback Converter Circuit

Circuit shown in figure 2.1 operates in similar manner to the buck-boost converter, but here inductor has a secondary winding. An isolation transformer is used which acts like a coupled inductor. An ideal

transformer directly couples' energy between the

Figure 2.1 Circuit diagram of Flyback converter

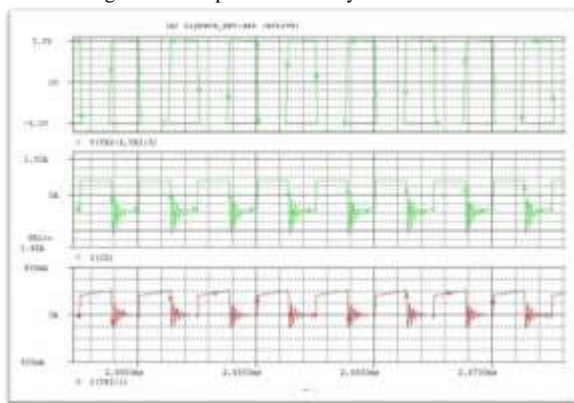


Primary and secondary circuit and does not store energy. In this circuit an air gap is required, as energy is primary stored in the device.

During on period, current builds up in the primary winding, storing energy in the inductor. Since secondary has opposite polarity so diode is reversed biased during on period.

During off period, volt-ampere is transferred to secondary which forward bias the diode and hence energy is released to the load. [3]

Figure 2.2: Output results of Flyback converter



Here above figure 2.2 is indicate the ideal output waveforms of the Ideal Flyback converter in the Pspice simulator.

The Flyback converter is mostly used in discontinuous mode due to

- Smaller inductor required
- Better closed loop response

The disadvantages of discontinuous mode operation are:

- High peak transistor current

- Large filter capacitor

### 3. Design Calculation

#### Specifications:

- Input voltage range ( $V_g$ ) = 28-42Volts
- Nominal value of input voltage = 35
- Auxiliary voltage ( $V_{aux}$ ) = 12 volts at 0.16 A
- Maximum duty cycle ( $D_{max}$ ) = 0.45
- Output voltage ( $V_{O1}$ ) = 14 volts at 0.25 A
- Output voltage ( $V_{O2}$ ) = 5 volts at 0.5 A
- Switching frequency ( $F_s$ ) = 150 KHZ
- Time Period (TP) = 6.66 us
- Time On ( $T_{On}$ ) = 2.99 us
- Efficiency = 75% (Estimated)

Here in this converter we use mpp toroid core.

- Dc transfers function of Flyback Converter:

$$V_o = (N \cdot D / (1 - D)) \cdot T_P$$

- Output Power:

$$P_{out} = 14(0.25) + 5(0.5) + 12(0.160) = 7.92W$$

- Primary inductions :

$$L_{Pri} = (V_{In(Low)} \cdot D \cdot T_P) / I_{Pk} = 54 \mu H$$

- Primary Turns [1]

$$N_{Pri} = ((L \cdot 10^3) / A_L)^{1/2}$$

- Secondary turns

$$N_{Sec} = (N_{Pri} \cdot (V_o + V_D) \cdot (1 - D)) / (V_{In} \cdot D)$$

- $N_{Sec(5V)} = 6$  Turns
- $N_{Sec(14V)} = 15$  Turns
- $N_{Sec(12V)} = 13$  Turns

- Secondary Inductance

$$L_{Sec} = (L_{Pri} / (N_{Pri} / N_{Sec})^2)$$

- $L_{Sec(5V)} = 4 \mu H$
- $L_{Sec(14V)} = 25 \mu H$
- $L_{Sec(12V)} = 18.85 \mu H$

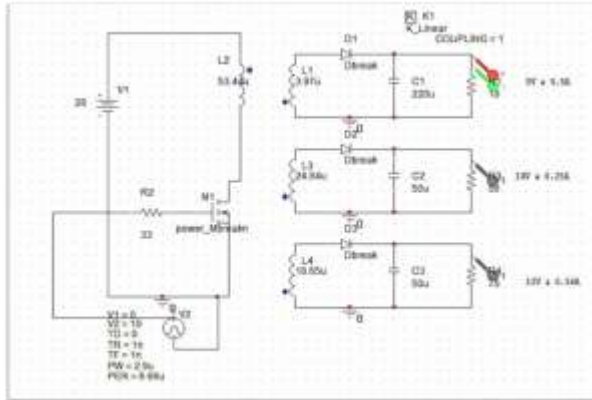
### 4. Open loop circuit simulation of Flyback converter

Pspice technology offers mixed-signal simulation and system-level analysis capabilities across different levels of abstraction across low- to high-power applications, including electric vehicles to data centers, to wearables, renewables, and the power grid. Known for its accuracy and high performance in power supply simulation technology as well as the ability to integrate with OrCAD

capture and Allegro solution, PSpice simulation program makes power supply analysis simple.

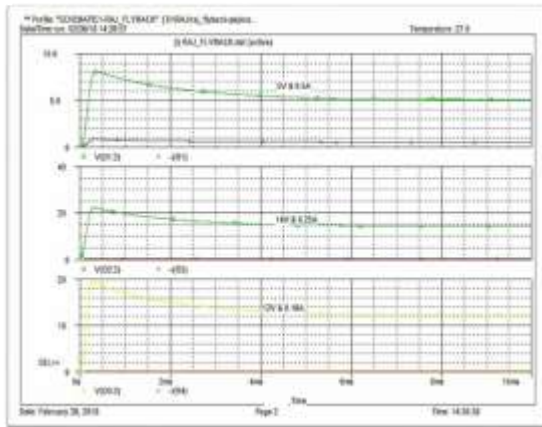
To Design, simulate and analyze the circuit we have used PSpice software. PSpice have made simulating switching regulators extremely fast, allowing the user to view waveforms for most switching regulators in just a few minutes.

Figure 3.1 Open loop simulations



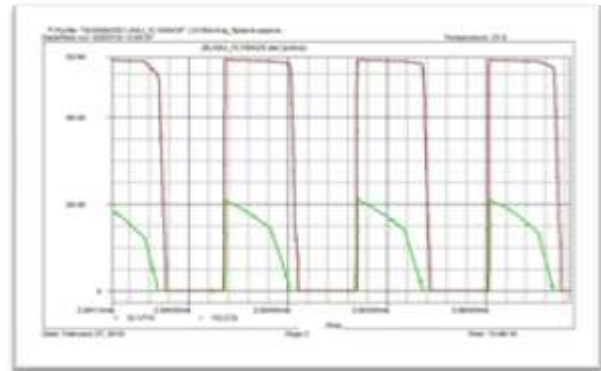
Here in above figure 3.1 the design of Flyback converter in the simulator is shown with multiple outputs as required in design specification.

Figure 3.2 Output waveform of Flyback converter for open loop



In the above figure 3.2 shown the output waveform of the designed Flyback converter at the input voltage level of 28 v.

Figure 3.3 Inductor current and duty cycle waveform



Our aim is that the Converter should work in discontinuous conduction mode. So, the above figure 3.3 indicates the inductor current and duty cycle waveform that the designed converter is work under DCM mode.

## 5. Results and Discussion

Line regulation table 5.1 shows at different input voltage and fixed load at both outputs.

Flyback converter circuit is simulated in software. The line regulation found was poor, so in order to improve the regulation, a post regulator is used which may be a UC-1846 or UC-1834.[5]

Table 5.1 Line regulation

Vin (v)	Vo1 (v)	Io1 (A)	Vo2 (v)	Io2 (A)	Vo3 (v)	Io3 (A)
28	14	0.245	5	0.49	12	0.158
35	15.37	0.292	6.97	0.515	14.9	0.161
42	18.7	0.326	7.93	0.57	16.22	0.172

## 6. Conclusions

The isolated Buck - Boost Converter also known as Flyback converter is simulated in open loop condition but there is poorer regulation is obtained so in order to improve the regulation we have to simulate the converter in closed loop condition with post regulator.

### Abbreviations

- PWM = Pulse width modulation
- SMPS = Switch Mode Power Supply
- MPP = Molly-perm alloy Powder core
- R = Ripple Ratio

### Acknowledgement

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I express my gratitude to my HOD for giving this project. I also extend my gratitude to my Project Guide who assisted me in compiling the project.

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