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Simulation Analysis Of Fly back Converter Using Psim

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Abstract:

Flyback converters have been used for DC-DC conversion and electrical isolation since they are simple to operate, minimum component count and small size. Flyback converter like any other switch mode power supply (SMPS) has two modes of conduction. The best mode for the design is selected and implemented. Due to its operation in relatively high frequency range of 1 KHz compared to 50 Hz transformer with hard switching with 72 watt output. Some noise appeared from parasitic and leakage elements in the converter. The sources of noise have been tracked to minimize its effect on performance. This paper shows PFC based flyback converter.

Keywords **—DC-DC converter, PSIM Simulation, SMPS, Microcontroller.**

I. INTRODUCTION

Flyback converter is the commonly used for SMPS circuit. It is use for low output power application where the output voltage needs to be isolated from the input main supply. This is mostly used for less than 100 watts. The overall circuit of this converter is simpler than other SMPS circuit. Input of the circuit is generally unregulated DC obtain by rectifying the AC voltage followed by a simpler capacitor filter. The circuit can offer single or multiple isolated output voltage and operate over wide range of input voltage variation. It is simple topology and low cost makes it popular in low output power range. The PFC booster circuit is connected between rectifier and flyback circuit.

The boost circuit is boost up the output of rectifier voltage. The generally used flyback converter required high switching like MOSFET. Due to switching input power factor isdecrease and with the help of PFC the input power factor is improve. This device efficiency is good and it is also reliable.

Types of power factor correction techniques

Here active PFC is used, it is mostly used in industries. Active PFC circuit is operate at high frequency range and because of this size and cost of passive filter element is reduce.[2].

Basic of flyback converter

Here, first 230volt, 50 Hz AC supply is given to the primary side of step down transformer. Which converts the 230volt, 50 Hz AC supply in to 24volt, 50 Hz AC supply. This 24volt supply is directly given to the rectifier circuit. This rectifier circuit is unregulated. It convert AC into DC supply.

PFC booster circuit is boost the output of rectifier. This is a close loop circuit. Output of this circuit is given to flyback transformer. The flyback transformer output is single or multiple.

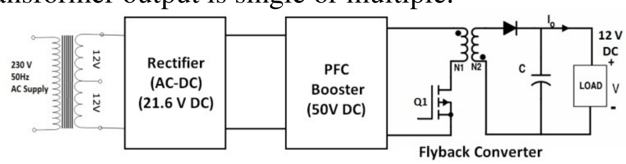

Fig.1 Block diagram of Flyback Converter

TABLE I
Design Parameters

Parameters	Ratings
RMS input voltages	24 V AC
Dc output voltage	75.25 V DC
Dc output current	0.07 A DC
Dc output power	5.26 W DC
Output efficiency	>0.85
Switching frequency	1 kHz

DESIGN AND CALCULATION OF PFC BOOST CONVERTER

The input power of PFC Boost Converter is,

Input Power:- $P_{in} = \frac{P_{out}}{\eta}$

RMS Input Current:- $I_{in(RMS)} = \frac{P_{in}}{V_{in(RMS)}}$

Maximum Input Current:-

$$I_{in(\max)} = \sqrt{2} \times I_{in(RMS)}$$

Therefore the current Δi passing through inductor is to be,

$$I_L = 0.2 \times I_{in(\max)}$$

$$I_{in(avg.)} = \frac{2 \times I_{in(\max)}}{\pi}$$

$$I_{out(\max)} = \frac{P_{out}}{V_{out(\max)}}$$

Duty cycle:- $$D = \frac{V_{out(\max)} - V_{in(\max)}}{V_{out(\max)}} \times 100$$

Where; P_{out} = DC output power, P_{in} = AC input power, η = Input efficiency, $V_{in(rms)}$ = AC input RMS current , $I_{in(max)}$ = AC input maximum current ,$I_{in(avg)}$ = Average AC input current , I_L = Inductor current , Δi = Inductor Current ripple, I_o = Maximum DC output Current.

The selection of inductor aand the capacitor in the boost topology plays a major role in the output response,

$$L = \frac{V_{in(\min)} \times D}{F_{s/w} \times \Delta i}$$

L = Inductance , $F_{s/w}$ = Switching Frequency, $V_{in(min)}$ = Minimum input Voltage , D = Duty Cycle

The value of the output capacitor is,

$$C_{out} = \frac{I_{out(\max)} \times D}{F_{s/w} \times \Delta V_{out}}$$

ΔV_{out} = Output Voltage ripple, C_{out} = Output Capacitance

DESIGN OF HIGH FREQUENCY TRANSFORMER:-

Secondary Output power $P_o = (V_o + V_{rl} + V_d) \times I_o$

Where ; V_{r1} = Resistive Drop in the Inductor, V_d = Output Diode drop

Area of Product:- $$A_p = \frac{\sqrt{D_{\max}} \times P_o \times (1 + \frac{1}{\eta})}{K_w \times J \times B_m \times F_{s/w}}$$

Where; Kw= Window Utilization Factor,
Bm = Max. Allowable flux density,
J= Current Density,
Ac = Area of core

Window area:- $$A_w = \frac{A_p}{A_c}$$

Primary turns:- $$N_1 = \frac{V_{i(\max)} \times D_{\min}}{A_c \times B_m \times F_{s/w}}$$

Turns ratio:- $$n = \frac{V_o \times V_{rl} \times V_d}{V_{i(\min)} \times D_{\max}}$$

Secondary turns:- $N_2 = n \times N_1$

Where ;RMS secondary current:- $I_2 = I_o \times \sqrt{D_{\max}}$

RMS secondary current:- $I_1 = n \times I_2$

Primary inductance:- $$L_1 = \frac{\mu_o \times \mu_r \times A_c \times N_1^2}{1m}$$

Magnetizing current:- $$I_{mag} = \frac{D_{\max} \times V_{i(\min)}}{F_{s/w} \times L_1}$$

Area of primary conductor:- $$a_p = \frac{I_1}{J}$$

Area of secondary conductor:- $$a_s = \frac{I_2}{J}$$

DESIGN OF OUTPUT INDUCTOR

Output inductance:- $L = \frac{V_o \times (1 - D_{\max})}{\Delta i \times F_{s/w}}$

Area of Product :- $A_p = \frac{2E}{K_w \times K_c \times J \times B_m}$

Where; E= Energy dissipation in inductor

II. SIMULATION RESULTS OF FLYBACK CONVERTER

TABLE II
Simulation Parameters

Parameters	Values
Booster Inductor	800u
Output Capacitance	900u
AC input voltage	24V
Load resistance	1000
PWM switching	1000Kz

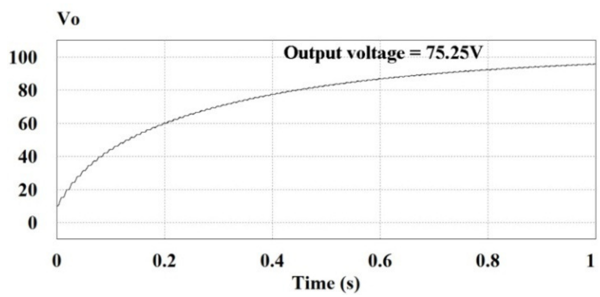

Fig.1[V_o($_{avg}$):75.25V][Scale:X axis: 0.2s/div., Y axis: 20V/div.]

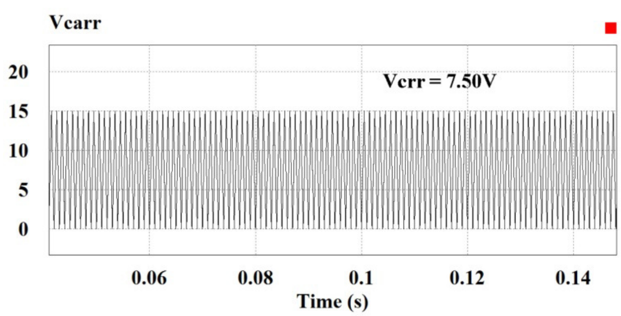

Fig.2[V_{carr} : 7.50V] [Scale: X axis: 0.06s/div., Y axis:5V/div.]

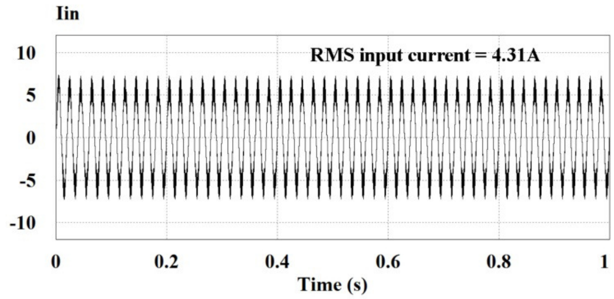

Fig.3[$I_{in(rms)}$: 4.31A][Scale: X axis: 0.2s/div., Y axis: 5A/div.]

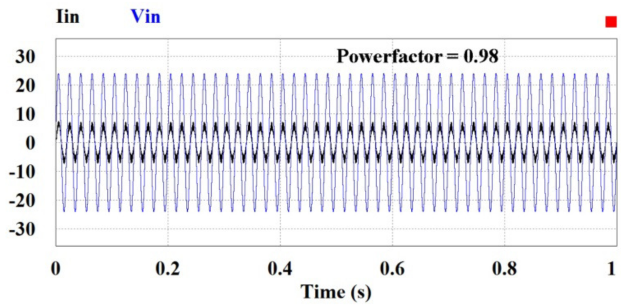

Fig.4[Power factor : 0.98]

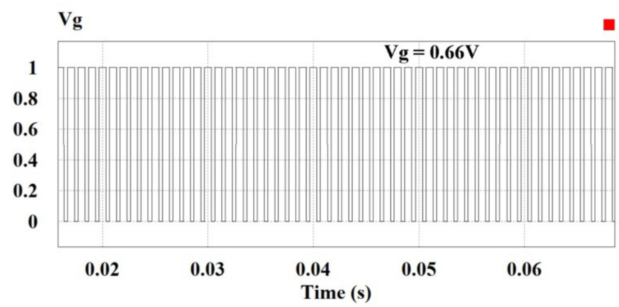

Fig.5[Gate voltage: 0.66V][Scale: X axis: 0.02s/div., Y axis: 0.2V/div.]

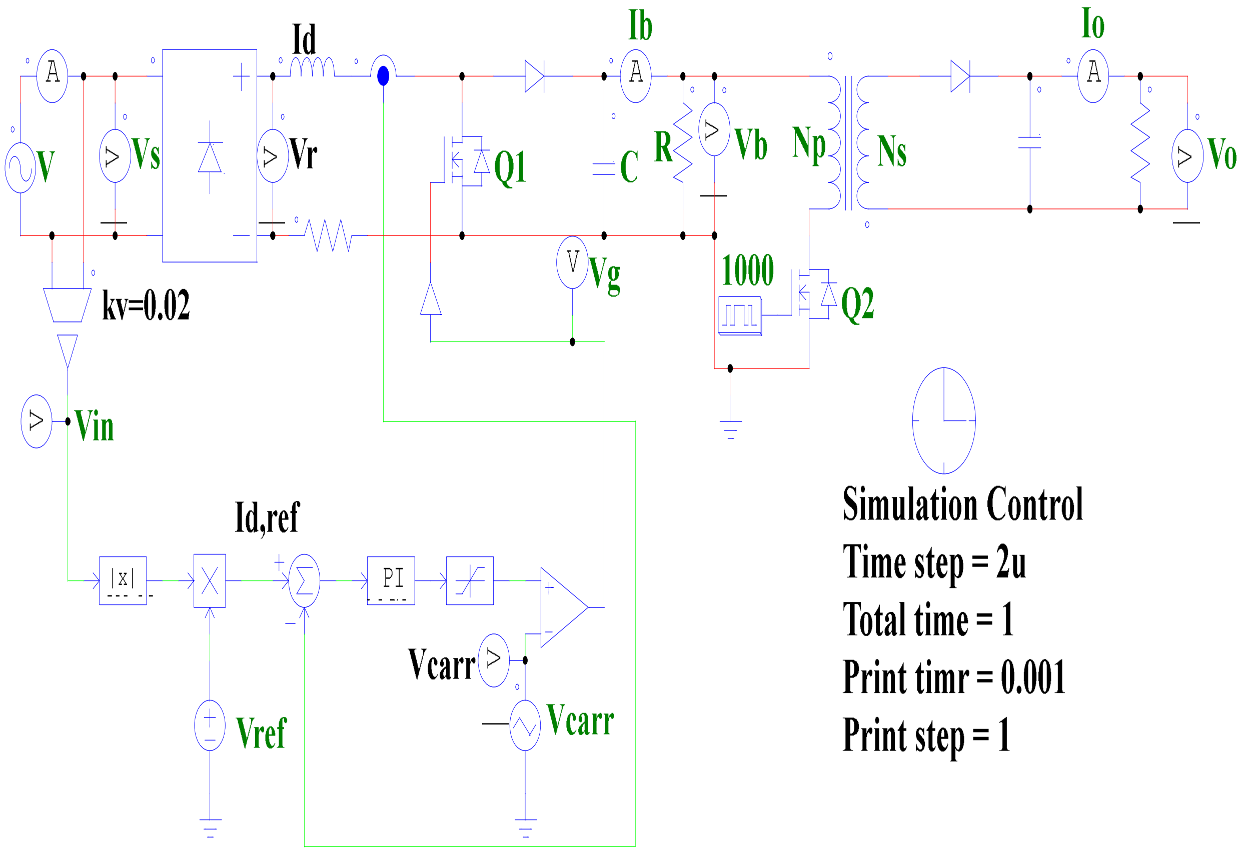

Fig.8 Simulation of flyback converter

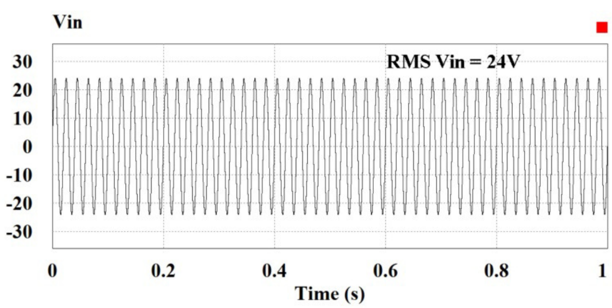

Fig.6[V_s : 24V][Scale: X axis: 0.2s/div., Y axis: 10 V/div.]

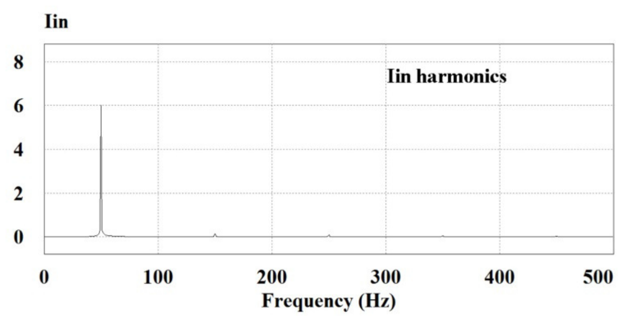

Fig.8[Scale: X axis: 100Hz./div., Y axis: 2A/div.]

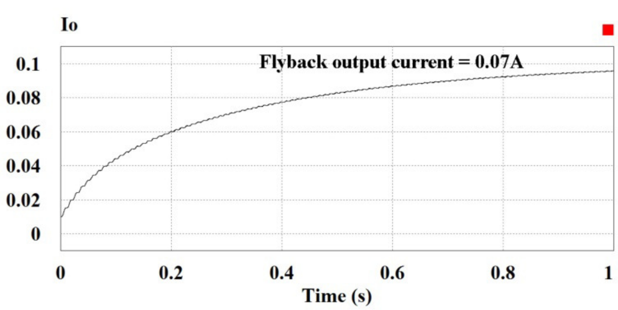

Fig.4[I_o: 0.07 A][Scale: X axis: 0.2s/div., Y axis: 0.02A/div.]

III. CONCLUSIONS

We have improved power factor with the help of PFC based flyback converter and increase efficiency (70-90%). Some noise appeared from parasitic or leakage elements in the converter so we tracked the source of noise to reduce its effect on performance.

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