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Design of a LED Driver Power Supply Based on IW3620

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Abstract: The IW3620 is a high performance, low cost LED driver which uses the Primary-side feedback control technology to simplify the circuit structure and reduce the circuit size. Based on IW3620, a flyback LED constant current driver circuit is designed. The circuit operates within the range of AC input 85V~265V.The output current is 400mA, and efficiency is up to 85%. The features of the chip is introduced and Circuit element parameters are calculated in the paper. In the end, the electric circuit is tested. The results show that the design of the circuit achieve the desired effect.

Keywords: IW3620, Primary-side feedback, Flyback, Constant current

I. INTRODUCTION

In order to reduce energy waste and consumption, new energy-saving products will inevitably produce, so the rise of LED lighting is not accidental. Because of LED lighting's low energy consumption, less environmental pollution, less heat and other advantages, it has been widely used in many aspects of life [1]. In life we found that street lamps, home lighting, their brightness is different, it is because they have different current, that is to say, the brightness depends on the size of the current. And the current fluctuations will cause the effect which can not be ignored, the too large current will affect its life, too small current will hinder the brightness, so the design of the power supply is mostly constant current mode [2]. Based on the above reasons, after the full study on features and typical circuit of the IW3620 chip,the new power supply is designed, output constant current is 400mA. The biggest highlight of the chip is the use of primary feedback, simplifying the circuit, reducing the size and reducing costs. Test data shows that the circuit can well ensure the output of constant current output to meet the requirements, to achieve the desired results.

II. OVERALL CIRCUIT DESIGN

Input voltage is AC85V~264V, output is 400mA/28V. Within the voltage range of rated input , the efficiency is 85% and the power factor is up to 0.9. The overall block diagram of the circuit is shown in Figure 1.

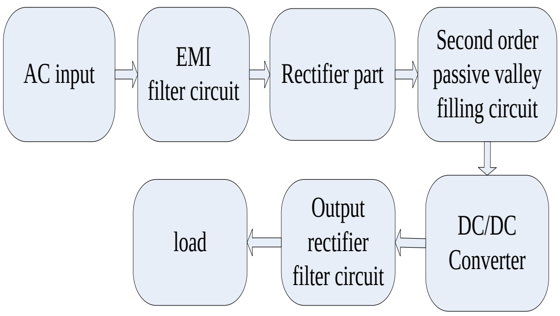


Figure 1 Block diagram of the circuit

The overall design circuit shown in Figure 2.

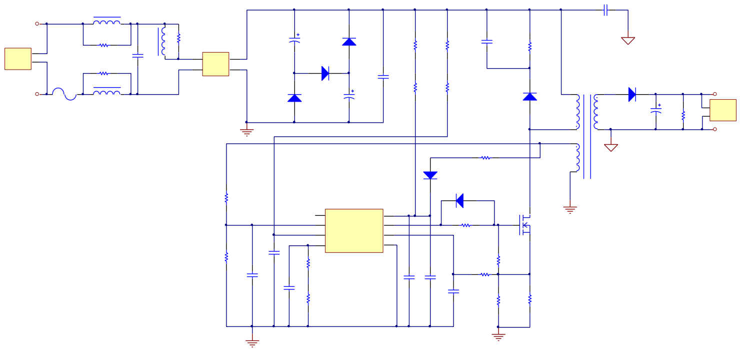


Figure 2 The LED driver circuit Based on IW3620

Figure F1 is the insurance tube, protection circuit. The front part of the rectifier bridge is a EMI filter, which is used to eliminate the interference of the external power network. RCD composed of D4, C4, R8 clamp can protect circuit to prevent the switch tube from being damaged. D7, C11 output form rectifier filter circuit to ensure that the output voltage is stable value. C1, C2, D1, D2, D3 form passive second order valley fill circuit, to increase the conduction time of rectifier, to achieve the purpose of correcting power factor [4]. C3 is used to filter high frequency interference. R12, R13 are current sampling resistor. R17, R18 is a voltage feedback resistor. By detecting resistance R18 voltage gives a feedback to both ends of the V_{SENSE} pin to adjust the output voltage.Circuit work process: after simple sinusoidal alternating voltage passes through the rectifier bridge,it will become the bread wave with doubled frequency, loop voltage passes by R4, R5, and charges for C7. When Vcc reaches the start voltage, the chip will start working.

III. CALCULATION OF PERIPHERAL CIRCUIT PARAMETERS

Transformer design is the key to flyback converter, in the calculation we should consider a number of factors: core model, air gap size, turns requirements and so on.For design of the transformer first we should select the appropriate core, there are three ways: empirical formula to select the core, the output formula to select the core, the use of AP (area product method) to select the core. Here, the design is the most simple, that is the output formula to select the core. By comparing the corresponding relationship of the core model and the output power , this design will select transformer core EE19.When the auxiliary side is turned on, it will induce a voltage in the original side. For the flyback circuit, the direction of induction is opposite to that of the secondary side voltage. The voltage is the reflected voltage, which is represented by V_{or}. The expression relationship with turns ratio is:

$$n = \frac{V_{or}}{V_{or} + V_d} \tag{1}$$

In the formula, V_{or} is the output voltage V_d is the output diode voltage drops, n is turns ratio.
According to the EE series core parameters, the maximum magnetic flux density B_{max} of EE19 and the core area A_e are obtained. The number of the original turns is obtained by the following formula:

$$N_p \geq \frac{(U_{in} \times T_{on})_{max}}{B_{max} \times A_e} \tag{2}$$

The secondary winding is calculated by formula (3):

$$N_s = \frac{N_p}{n} \tag{3}$$

The number of secondary turns is calculated by formula (4):

$$N_b = \frac{N_s \times (V_{cc} + U_d)}{U_{out}} \tag{4}$$

Among them, V_{cc} takes 0.5V.
The inductance of the original side is obtained by formula (5):

$$L_p = \frac{P_0[Z(1-\eta)+\eta] \times 10^6}{\frac{1}{2} I_{PK}^2 f_s \eta} \tag{5}$$

Among them, Z is the loss allocation factor, where Z=0.5. And ηtakes 0.8 for convenient calculation.

According to the above formula, combined with the actual test results, the final selection of the design is the EE19 skeleton ferrite core, the original side is 64 turns, secondary side is 31 turns, auxiliary side is 10 turns, the original inductance is 650μH.

The voltage on the auxiliary winding of the transformer passes by a resistor R_{17}, R_{18} sampling and feedback to the V_{SENSE} pin of the chip , so as to regulate the output voltage. R_{17}, R_{18} satisfy relation:

$$V_{sense} = \frac{R_{18}}{R_{18} + R_{17}} \bullet \frac{N_b}{N_s} \bullet U_{out} \tag{6}$$

If you choose R_{17}=33K, by the above formula, it is R_{18}=4.3K.
R_{12}, R_{13} are current sampling resistor, the formula is as follows:

$$R_{sense} = N_{tr(\max)} K_c \eta \big/ 2 I_0 \tag{7}$$

By calculating, R_{sense}=1.16R, further R_{12}=1.8R, R_{13}=3.3R are obtained.

IV. CIRCUIT DIAGRAM AND TEST RESULTS

The actual circuit based on IW3620, it is shown in figure 3.

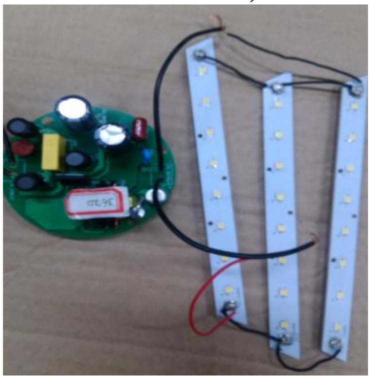


Figure 3 the actual circuit diagram Based on IW3620

When the input voltage changes, the test results of output current are shown in Figure 4.

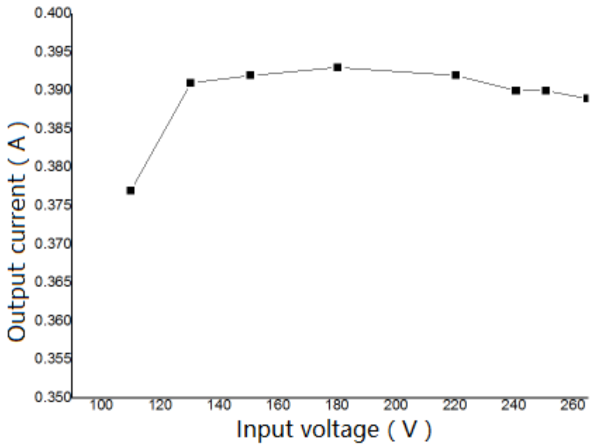


Figure 4 Diagram of voltage input and the output current

From the map we can see, with changes of the input voltage , the current maintained at about 400mA, which can run up to the design requirements.When the input voltage changes in the range of 85V ~ 264V, the efficiency curve is shown in Figure 5.

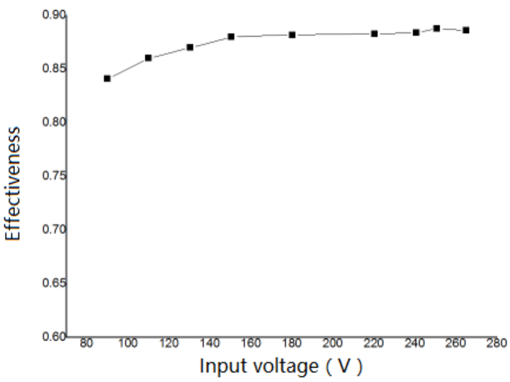
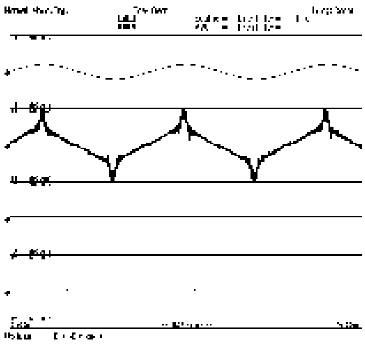


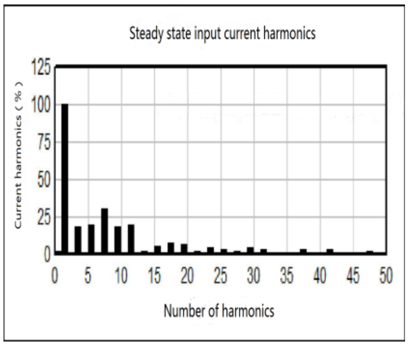
Figure 5 The relationship between the input voltage and efficiency

We can see from the figure, within the variation range of the input voltage, the efficiency of the power supply increases with increasing voltage, and above 0.8, which can meet the design requirements.

In order to test the impact the power factor on the introduction of passive second order valley fill circuit, here, the voltage waveform of input current , current harmonics were tested, the test chart is shown in Figure 6.



(a) voltage and current wave forms



(b) Harmonic test chart

Figure 6 Input voltage and current wave forms and input current harmonic waveform

As it can be seen from Figure 6(a), the conduction angle of the input current is significantly increased. And the current waveform can follow the change of the voltage waveform. As it can be seen from Figure 6(b), the total harmonic of the power input current is 52.7%, and the content of the odd harmonics of the current is also significantly reduced. Test results show that， for the design of passive second order valley fill circuit， its effect is good.

V. CONCLUSION

This paper designs a flyback LED driver circuit based on IW3620. After continuous debugging, the design indicators were verified. The results show that the output current is 400mA in the range of 85V ~ 264V, and has good constant current characteristics， the efficiency is 85%. Circuit can simplify circuit at the same time, it can achieve the desired results, with the feasibility.

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