National conference on Engineering Innovations and Solutions (NCEIS – 2018)
International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2018 IJSRCSEIT | Volume 4 | Issue 6 | ISSN : 2456-3307

Universal High Frequency Multiple Output Forward/ Isolated Buck Converter For Gate Drive Application Using Digital Proportional Integral Controller.

Bhoomika M U[1], Neethisaraswathi M V[1], Sushma C M[1], Dhanalaxmi H R[2], Madhu. B[3], Pratheek Poovaiah[3]

[1]Students of 8th semester EEE Depatment, VTU,GSSSIETW, Mysuru,Karnataka, India

[2]Assistant Professor, Department of EEE,VTU, GSSSIETW, Mysuru,Karnataka, India

[3]External guide, Manager at engneering Department, SKANRAY TECHNOLOGIES, Mysuru,Karnataka, India

ABSTRACT

This paper presents design and implementation of DC-DC Buck converter by using ATmega32 microcontroller. The forward DC-DC converter is most widely used electronic circuits for its high conversion efficiency and flexible output voltage. These converters are designed to regulate the output voltage against the changes in the input voltage. Many existing and developing electrical and electronic technologies require the voltage of different levels that are supplied from an available source voltage. To control the output voltage of the converter, the controller is designed to change the duty cycle of the converter. In this converter, MOSFET switch is digitally controlled by ATmega32 microcontroller. The circuit is verified with hardware implementation. This paper focuses on the hardware design and implementation of forward converter using pulse width modulation with digital proportional integral controller. Generating multiple outputs for gate drive applications.

Keywords. Buck Converter, forward converter, isolated converter, microcontroller, high frequency,
Pulse width modulation and PI control.

I. INTRODUCTION

The forward converter is a DC/DC converter that uses a transformer to increase or decrease the output voltage (depending on the transformer ratio) and provide galvanic isolation for the load. With multiple output windings, it is possible to provide both higher and lower voltage outputs simultaneously. [1]

The DC converter is a device, which transforms AC to DC. This device is also known as an AC to DC converter. A Chopper can be considered as a DC equivalent of an AC transformer with a convertible constant convertible in a continuous form. Like a transformer, the converter can be employed for stepwise increase or reduction of DC source Voltage. [2]

The name Buck Converter most probably evolves from the fact that the input voltage is bucked/chopped or attenuated, in amplitude and a lower amplitude voltage appears at the output. [3]

MOSFET switch produces a flow of current in the drain when a voltage is applied between the gate and source terminals. The gate of a MOSFET is composed of a silicon oxide layer. Since the gate is insulated from the source, an application of a DC voltage to the gate terminal does not theoretically cause a current to flow in the gate, except in transient periods during which the gate is charged and discharged. In practice, the gate has a tiny current on the order of a few nano amperes. When there is no voltage between the gate and source terminals, no current flows in the drain except leakage current, because of a very high drain-source impedance. [4][11]

The output voltage is sensed Vout and compared with the input voltage Vref then an error signal is produced which is processed through PI controller to generate a control voltage. The control voltage is used to feed to the PWM generator for control of switch. The PI controller has two parameters namely Kp and Ki. PI controller has transfer function. C(s) = Kp+ (Ki/S)

Where, KP=Proportional gain and Ki= Integral gain. [5]

The voltage mode control strategy is proposed by using pulse width modulation (PWM) with a proportional-integral (PI).[12]

The PWM signals are generated by comparing the voltage of the output with the ADC value of ATmeg32 AVR microcontroller. [6]

II. OPERATION CIRCUIT MODEL FOR FORWARD BUCK CONVERTER.

The forward converter with multiple output windings is the simplest implementation for multi output power supply. Typical application area for this solution is the low power, low current, and multi-output power conversion where semi-regulated output voltages are acceptable and noise requirements are significantly relaxed. [7]

The primary side of the transformer is connected to the 24 volts DC supply. As the forward converter with multiple outputs is obtained because of the isolation of the transformer. The output is controlled by the primary side of the transformer of MOSFET switch. The MOSFET has to be switched at certain rate to get the output voltage of 10 volts this is done by taking a feedback. Based on the feedback voltage the output voltage of 10v is down converted (buck) for 2.5volts using voltage divider.

The figure 1 shows the circuit diagram of the forward converter using digital PI controller by the ATmega32 microcontroller.

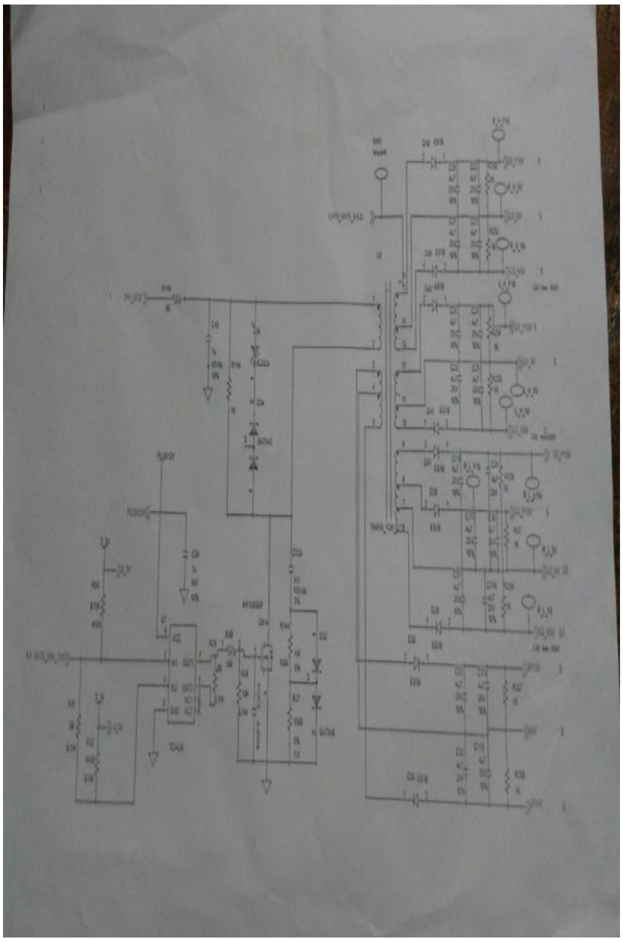

Figure 1. schematic circuit diagram of a isolated forward buck converter with digital PI control.

If the output voltage is to be of 10v, the microcontroller should have 2.5 volts of feedback. Taking that feedback from the output and giving it to a microcontroller. By comparing the feedback voltage with the reference voltage based on the error is given by,

Error =Vref-Feedback

Where, Vref is the reference voltage, feedback is from the output.

Where the input is operating at a switching frequency of 65 kHz. The pulse width is varying based on the error. If the error is positive the pulse width is decreased. If the error is negative the pulse width is increased to maintain the output voltage of 10 volts dc as constant.

As earlier discussed, the forward converter is having multiple outputs where one of the output is controlled but the other output will be automatically generated. Based on the PWM technique the pulse width is changing through gate drive and it is giving it to MOSFET. When the PWM is changed automatically MOSFET ON time and OFF time will be changing to give the supply voltage to the required voltage as the output.

III. SCOPE

- ✓ Design and modeling dc-dc converter (buck) using PWM to generate the pulse.[8]
- ✓ Design of the PID controller and the system will operates in close loop or in other word has feedback to stabilize the system and the system is linear.[9]
- ✓ Form stability analysis of the system.[10]

IV. RESULT AND DISCUSSION

The output of the isolated forward buck converter is obtained by varying the PWM in the controller. For the multiple output of the buck converter the MOSFET switch is turned ON and OFF by changing the PWM using ATmega32 AVR microcontroller.
The output will be 10 volts DC (positive) and -5 volts DC (negative) is obtained because of the isolation of the transformer. The multiple outputs are obtained.

V. CONCLUSION

The designing of forward converters has been carried out for constant voltage applications. The design concepts are validated and results are obtained.

Forward converter will be highly stable with high efficiency. Better efficiency due to moderate duty cycles, lower voltage MOSFETs and reduced switching losses due to reduced peak-to-peak voltage swing.

VI. REFERENCES

1. Sanjeev Singh and Bhim Singh, “An adjustable speed PMBLDCM drive for air conditioner using PFC Zeta converter,” Int. J. Power Electron. (IJPElec), vol. 3, no. 2, pp. 171–188, Apr. 2011.
2. Sanjeev Singh and Bhim Singh, “Power Electronics, Drives and Energy Systems (PEDES),” in Proc. IEEE PEDES’2010.
3. Sanjeev Singh and Bhim Singh, “Single-phase power factor controller topologies for permanent magnet brushless DC motor drives,” in IET Power Electron., 2010, Vol. 3, Iss. 2, pp. 147–175.
4. Sanjeev Singh and Bhim Singh, “A voltage controlled adjustable speed PMBLDCM drive using a single-stage PFC half-bridge converter,” in Proc. IEEE APEC’10, 2010, pp. 1976–1983.
5. Sanjeev Singh and Bhim Singh, “Comprehensive study of single phase AC-DC power factor corrected converters with high frequency isolation” IEEE Trans. on Industrial Informatics, vol. 7,no. 4, Nov. 2011, , pp. 540-556.
6. Altamir Ronsani and Ivo Barbi, “Three-phase single stage AC-DC buck-boost converter operating in buck and boost modes” in Proc. IEEE, 2011, pp.176-182.
7. Boopathy.K and Dr.Bhoopathy Bagan .K, “Buck Boost converter with improved transient response for low power applications” in Proc. IEEE SIEA, Sep 2011, pp. 155-160.
8. Marcos Orellana, Stephane Petibon and Bruno Estibals, “Four switch buck-boost converter for

photovoltaic DC-DC ower applications” in proc. IEEE, ISGE, 2010, pp.469-474.

9. S C. Ravi raj and P. C. Sen, “Comparative study of proportional integral, sliding mode, and flay logic controllers for power converters,” IEEE Transactions on Industrial Applications, vol 33, no.2, pp.518— 524, MariApr. 1997.
10. Sanjeev Singh and Bhim Singh, “Power quality improved PMBLDCM drive for adjustable speed application with reduced sensor buck-boost PFC converter” in proc. IEEE 11th ICETET, 2011, pp.180-184.
11. M. Namnabat, M. Baysti Poodeh, S. Eshlehardiha, “Comparison the Control Methods in Improvement the Performance of the DC-DC Converter”, The 7’ international conference on power electronics, 22- 26, EXCO, Daegu, Korea, 2007.
12. Venkstarsmanan, A. Sabanoivc, and S. Culç “Sliding mode control of dc-to-dc converters,” in Proc. IEEE ConE Industrial Electronics, Control Instrumentations (IECON), pp. 25 1-258, 1985.