SYNCHRONOUS BUCK CONVERTER

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***Abstract*— The main objective of the project is to implement the synchronous rectifier to improve the existing buck converter. It improves the circuit efficiency by reducing the conduction losses and switching losses by using of zero voltage switching technique. A low DC power supply is provided, by a single phase step down transformer which is given to a bridge rectifier circuit and to a filter circuit. The output realize on MATLAB simulation.**

***Index Terms*–Micro controller, Filter, synchronous buck regulator, MATLAB**

I. INTRODUCTION

The main objective of the project is to implement the synchronous rectifier to improve the existing buck converter circuit with a switch instead of diode to increase the efficiency of the converter even in the light loaded condition. It improves the circuit efficiency by reducing the conduction losses and switching losses by using of zero voltage switching technique [1].

This project proposes a new control technology that enables a synchronous rectifier (SR) buck converter to realize zero voltage switching (ZVS) in light load condition .The SR control technique is applied to dc low voltage outputs because of the replacement of output rectifier diode by MOSFET which can minimize conduction losses and increase the efficiency of the whole circuits . However the technique cannot achieve good efficiency in light load condition in the conventional buck circuit. The control method present in this paper to enable an SR buck converter to carry out ZVS in light load condition to increase the efficiency .It is low cost and easy to control.

The pulses are generated using a microcontroller circuit. The pulse is given to the driver circuit and that driver drives the MOSFET switches from Fig.1 [2].A low DC power supply is provided, by a single phase step down transformer which is given to a bridge rectifier circuit and to a filter circuit. The proposed system is economic and easy to implement so it can be used for various DC power supply units and also used for the battery charging circuits.

II. SYNCHRONOUS BUCK CONVERTER BLOCK DIAGRAM

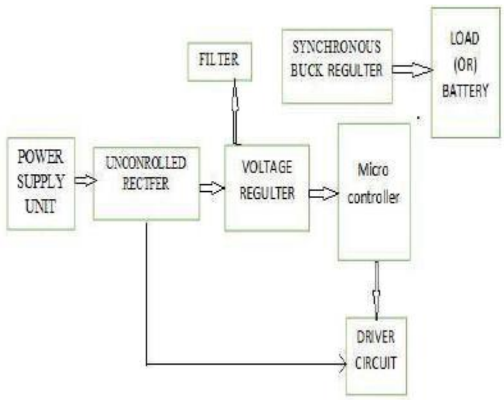


Fig. 1 Block Diagram of Synchronous buck converter

III. HARDWARE DESCRIPTION

A. Power Supply

A power supply provides a constant output regardless of voltage variations. “Fixed” three-terminal linear regulator are commonly available to generate fixed voltage of plus 3 V, and plus or minus 5 V, 9 V, 12 V, 15 V when the load is less than about 7 amperes [3 & 4].

The “78xx” series (7805, 7812, etc.) regulate positive voltages while the “79xx” series (7905, 7912, etc.) regulate negative voltages.

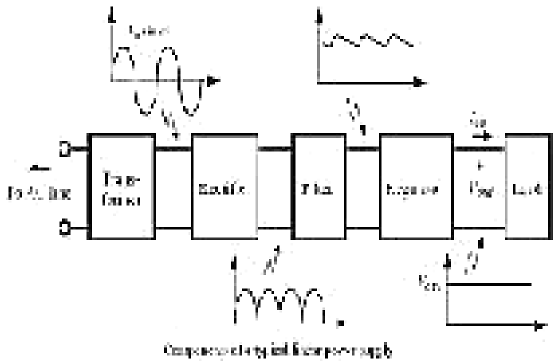


Fig. 2 Arrangement of Power supply

Some times, the last two digits of the device number are the output voltage; e.g. a 7805is a +5 V regulator, while a 7915 is a -15 V regulator. The 78xx series ICs can supply up to 1.5 Amperes depending on the model.

Features:

- Output Current up to 1A
- Output Voltages of 5,6,8,9,10,12,15,18,24
- Thermal Over Load Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

When you have a requirement for a project of say 12V, or even 5V if it's a digital project, then these are the type you use. 7805 or 7812 are the types. There are of course negative voltage regulator with the numbers 79XX with are substantially the same as those discussed here excepting they are negative. We will not consider them further. Assume your project calls for a basic fixed 12V
D.C. to operate. Looking back to our earlier tutorial we apply all the same principles. Look at the original schematic in Fig.2.

In a typical linear power supply, AC line voltage is first down-converter to a small peak voltage using a transformer which is then rectifier using a full wave bridge rectifier circuit. A capacitor filter is then used to smoothen the obtained sinusoidal signal. The residual periodic variation or ripple in this filtered signal is eliminated using an active regulator.

B. Circuit Description

This circuit is a small +5V power supply, which is useful when experimenting with digital electronics. Small in expensive wall transforms with variable output voltages are available from any electronics. Those transforms are easily available, but usually it's voltage regulation is very poor, which makes then not very usable for digital circuit experiment unless a better regulation can be achieved in some way.

The following circuit is the answer to that problem. This circuit can give +5V output at about 150 mA current, but it can increased to 1A when good cooling is added to 7805 regulator chip. The circuit has overload and terminal protection. The capacitor must have enough high voltage rating to safely handle input voltage feed to circuit. The circuit is very easy to build for example into a piece of Vero board.

C. Driver Circuit

As an independent discipline for decades, power electronics is concerned with the conversion and control of electrical power for various application, such as heating and lightning control, electrochemical processes, DC (Direct Current) and AC (Alternating Current) regulated power supplies, inductions heating, DC and AC electrical machines drives, electrical welding, active power line filtering, and static VAR (Voltage-Ampere Reactive) compensation. It included the use of electronic components, the application of circuit theory and design technique, and the development of analytical tools toward efficient electronic conversion, control and conditioning of electrical power [5].

The core power electronic apparatus consists of a converter built on a matrix of power semiconductor switching devices that works under the guidance of control electronics. As the fundamental design elements, power semiconductor switching devices are the MOSFET important components in a power electronic apparatus [6]. Like values in vein, they control the direction of electrical power which flow within the apparatus. Through intense technological evolution, various types of power semiconductor switching devices have been developed: power MOSFETs (Metal- Oxide-Semiconductor Field-Effect Transistor).

Hence MOSFET is used to drive the synchronous buck convertor circuit. In ON condition, the resistance of MOSFET is less than that of the diode [8]. So the conduction losses decrease.

IV. MICROCONTROLLER SOFTWARE DESIGNING

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include: Math and computation, Algorithm development.8

Modelling the switching devices as MOSFETs witch rather than ideal switches sure that device on-resistances are correctly represented. The model also captures the switch-on/switch-off timing of the devices, this depending primarily on the gate capacitance values and the PWM driver output resistance

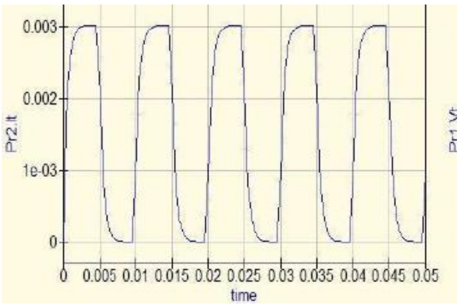


Fig. 4 Input value 1

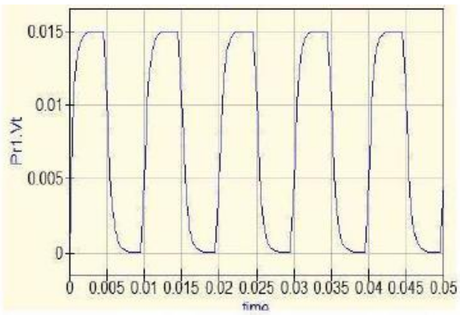


Fig. 5 Input value 2

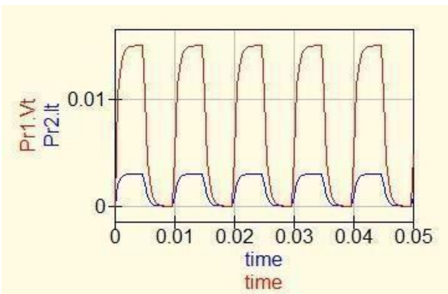
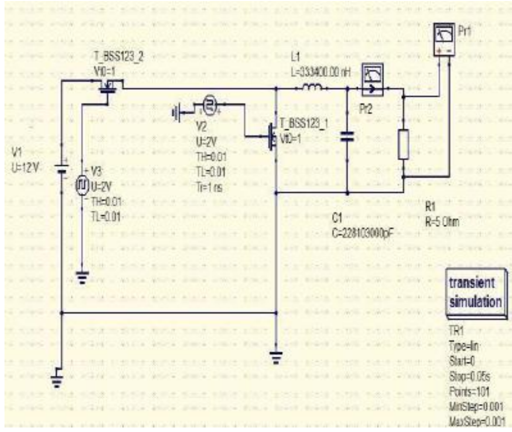


Fig. 6 Output

V. CONCLUSION

"Synchronous buck convertor" is used to constant output voltage even in light loaded



condition. In this project, and the analysis of its operating principles is discussed. The control technique for the synchronous buck convertor is developed, and satisfactory results are achieved in the experiment. The control method proposed here has two advantages.

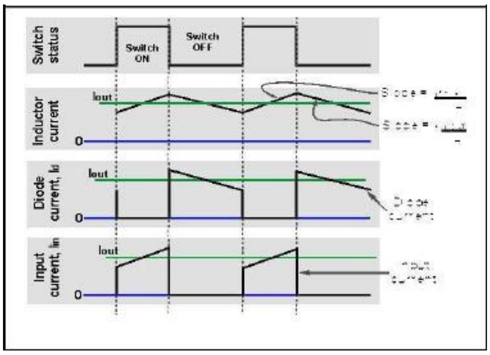


Fig. 8 switching of currents

1. Due to the synchronous technique proposed in this project, the diode of output rectifier can be replaced by a MOSFET. This will help to reduce conduction losses and increase the conventional efficiency of the convertor.

2. When the converter is working in light load condition, ZVS it will be achieved successfully without any auxiliary switch or passive component (R, L, and C). In other words, there is no need to add extra cost in the convertor, and convention efficiency of the convertor can be also increased in light load condition.

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