A Synchronous Buck DC-DC Converter using Novel Dual mode Control Scheme to Improve Efficiency

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Abstract: One of the most popular converters for the consumer electronics industry is the Dc to Dc step-down converter, also known as the buck converter the synchronous buck can converter is used to step a voltage down from a higher level to a lower level, with industry moving to higher performance platforms, efficiency of the power converter is critical. This synchronous buck converter is work at heavy load conditions in the continuous conduction and light load conditions in the discontinuous conditions in this switched mode converters can be found in power supplies & battery charging circuitry for computers, electric and electronic devices.

***Index Terms—quasi-resonant valley switching, ZVS, auxiliary circuit*.**

I. INTRODUCTION

This chapter consists of insight into the design and development of the most commonly Used DC-DC converters. The following sections contain DC-DC converter basics, a summary of converter control information, common topologies with necessary design equations including isolated converters, supplemental circuits such as gate drivers and protection circuits, practical considerations in converter design, and other essential converter development details.

A DC-DC converter in this chapter is defined as any power electronics system with a a primary function of taking, as an input, DC power from a source with a given volts-amps characteristic, and producing as an output DC power with a specified volts-amps characteristic. The volts-amps characteristics may be as simple as maximum and minimum voltages and currents, or more complex characteristic curves that may be dependent on other outside parameters, such as current control requirements, or photovoltaic or fuel cell Power output characteristics. Other converter requirements may include voltage regulation requirements; input and output impedance specifications to better match filters, loads, and sources; ambient operating temperature range; and requirements concerning vibration, efficiency, lastingness, reliability, protection, weight, volume, manubrium, Cost, and applicable standards.

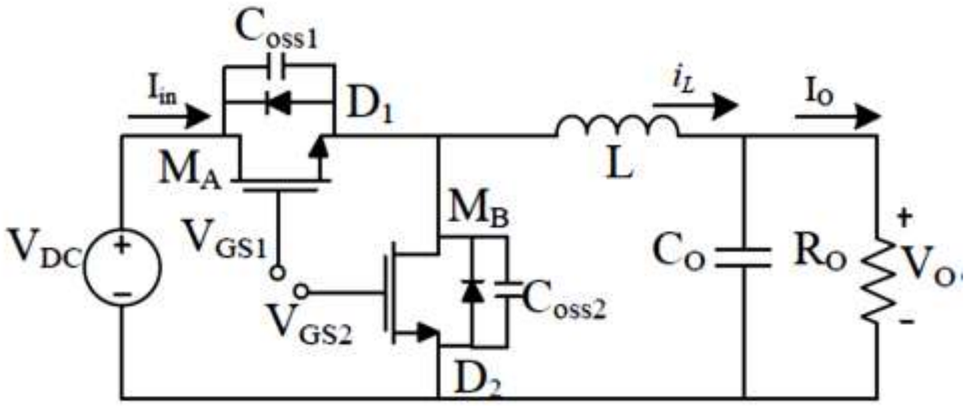
Typically, a first step in the development or procurement of a DC-DC converter is to create a specification addressing each of these areas in detail utilizing technical criteria of the IEEE, UL, SAE, NEC, ANSI, and CENELEC as sources of reference. On commercial-grade vehicle coatings the most crucial aspects of the design are enduringness, reliability, and cost. Vehicle applications ask special attention be given to thermal and oscillation conditions in the design and boxing, as vehicles can be exposed to harsh environments, and engine spaces and other parts of a vehicle tend to be extremely hot or cold in certain climates. DC-DC converters are typically used for power supplies for other circuits: battery charging, welders, heaters, up converters that transfer power from a lower DC voltage bus to a higher DC voltage bus, and downconverters that transfer energy from a more top DC voltage bus to a smaller DC voltage bus. DC-DC converters are also used in DC motor drives, AC machine field control circuits, and power factor correction circuits. DC-DC converters are often combined with other types of power converters such as inverters and rectifiers to form more complex power converters such as DC-to-AC and AC-to-DC converters. The inverter-driven DC-DC converters, i.e., the push-pull, half-bridge, and full bridge, consist of a DC-AC stage followed by an AC-DC stage: an inverter-rectifier two-stage system. All of the other types discussed in this chapter are purely DC-DC converters.

II. DC-DC CONVERTER TYPES

There are many types of DC-DC converters including buck or step-down, boost or step up, buck-boost (step-up or -down), flyback, Cúk, Sepic, resonant types, and inverter-driven Types: push-pull, half-bridge, and full-bridge. The highest power levels that need DC-DC conversion use paralleled DC-DC converter units that operate with "phasing" that requires the switching pulses of each of the paralleled units be staggered or "phased" through 360 degrees, such that a higher frequency current ripple is present in the combined converter, reducing the filtering requirements, increasing the volume of similar parts used, and thus reducing costs. Alternatively, for higher power systems, an inverter-rectifier System or DC-AC/AC-DC two-stage system is used with a step-up or step-down transformer to provide the DC-DC conversion. In the presentations of the converter types that follow, only the continuous current mode of operation covered for converters without parasitic. The constant current process means that the inductor current in the converter is ongoing, never staying at zero flow. At the boundary of continuous and discontinuous conduction, the current in the inductor will reach zero at the lowest peak of the current waveform once each cycle. The discontinuous mode of operation is typically. The buck, boost, and buck-boost converters each consist of a power switch, a diode, and an inductor, and are often accompanied by an output filter capacitor and input filter. The arrangement of the components varies slightly from one topology to the next, as will be discussed in the sections to follow; however, some similarities will first be presented.

III. SYNCHRONOUS BUCK CONVERTER

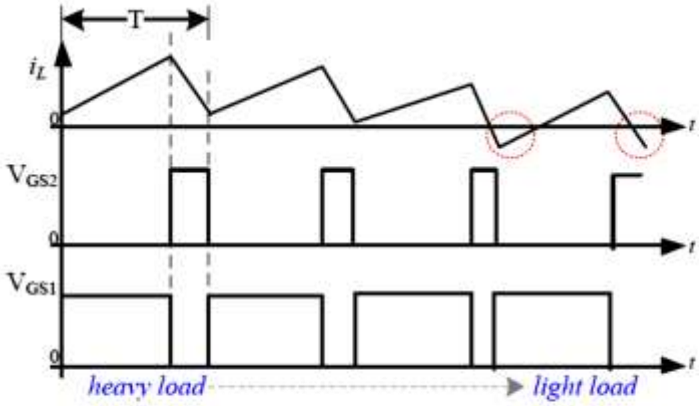
The design of the power converter must be optimized to maximize performance and to meet customer requirements. The synchronous buck converter is used in consumer electronics. This converter produces a regulated voltage that is lower than its input voltage, and can deliver high current while minimizing the power loss. As shown in fig.1(a)



(a)

fig. 1(a) Synchronous buck converter

The synchronous buck converter is comprised of two power MOSFET'S, an output inductor and capacitor. MA, the high side MOSFET, is connected directly to the input voltage of the circuit. When MA is turn on and allow the current and supplied to the load through the high side MOSFET. In this time, MB is off and the supply current flows through the inductor and capacitor and this will be changing the LC filter. When MA is turn off, automatically MB is turn on and the supply current flows through the load and low side MOSFET. In this time current in the inductor and capacitor will be discharging the LC filter.



(b)

Fig.1 (b) shows the synchronous buck converter wave forms

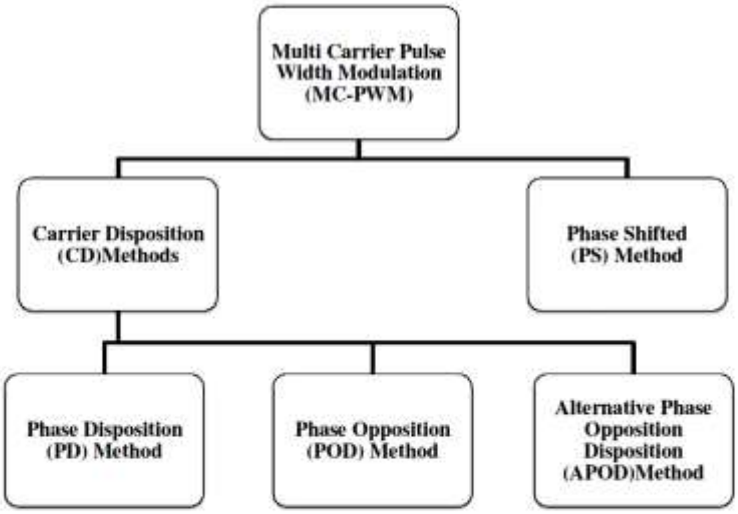


Fig.2 Key switching waveforms

Fig.1 (b) shows the synchronous buck converter wave forms. In continuous condition mode the total change in current in the inductor is maximum rated value of inductor current the switch node voltage is smoothed out by the LC output stage in order to produce the low condition loss inherent and increasing the conversion efficiency. In the boundary conduction mode, the current flow in an inductor is reverse and produce excess loss as shown in the dotted lines in fig 1(b)

3.1 In operations can be classified into two frequency modes

i) Fixed frequency mode

ii) Variable frequency mode

According to the variable frequency, mode is pulse width modulation is based on the turn ON and OFF and find out output voltage, in this output power and frequency will decreases. And another way is detecting the valley of the inductor current and triggering & the main switch ON the converter will be operated range between the continuous and discontinuous conduction mode.

The main draw backs of the variable frequency control mode are minimized for fixed frequency PWM methods. In this methods to the value of inductor current is zero. This will be to turn OFF to prevent an inverse inductor current. Increases the synchronous buck converter efficiency using zero voltage switching method under light load conditions. The main control strategy is the turn ON twice the synchronous switch in a switching cycle. This will be to synchronous switch generates extra losses at an instant of switch turn ON. This drawback minimized by the paper proposes a novel control strategy.

The two switching methods (zero voltage & zero current)to increase the efficiency of buck converters. The zero voltage switching is used in the communication and consumer electronics products, and it will eliminate the capacitive loss to turn ON the switch. A digital control method is used for mathematical solutions and digital signal processors. This all ways to increase the cost. Zero voltage switching controller controls the switching frequency under light load conditions in the novel limit frequency. This method is to does not use external passive devices for the SBC main switch. The main advantages of the technique are cheap in cost and efficiently manufacture of the integrated circuits Vin=12v, Vout=5v, Pout=25w, switching frequency is 40kHz.

IV. EXISTING SYSTEM

The literature survey focuses its attention towards synchronous buck converters (SBC) to operate in a continuous conduction mode under heavy-load conditions and in a discontinuous conduction mode under light-load conditions. The dc-dc switching converters are the widely used circuits in electronics systems. They are usually used to obtain a stabilized output voltage from a given input DC voltage which is lower (buck) from that input voltage, or higher (boost) or generic (buck–boost) [1]. Most used technique to control switching power supplies is Pulse-width Modulation (PWM) [2]. The conventional PWM controlled power electronics circuits are modeled based on averaging technique and the system being controlled operates optimally only for a specific condition [3]-[4]. The linear controllers like P, PI, and PID do not offer a good large-signal transient (i.e. large-signal operating conditions) [4]-[5].

Therefore, research has been performed for investigating non-linear controllers. The main advantages of these controllers are their ability to react immediately to a transient condition. The different types of non-linear analog controllers are: (a) hysteretic current mode controllers, (b) hysteretic voltage-mode/V2 controllers, (c) sliding-mode/boundary controllers. Advantages of hysteretic control approach include simplicity in design and do not require feedback loop compensation circuit. M. Castilla [6]-[8] proposed voltage mode hysteretic controllers for synchronous buck converter used for many applications. The analysis and design of a hysteretic PWM controller with improved transient response have been proposed for buck converter in 2004[9].

The use of SM control techniques in variable structure systems (VSS) makes these systems robust to parameter variations and external disturbances [10]-[11]. Sliding mode control has a high degree of design flexibility and it is comparatively easy to implement. This explains its wide utilization in various industrial applications, e.g. automotive control, furnace control, etc. [10]-[12]. Switched mode dc-dc converters represent a particular class of the VSS, since there structure is periodically changed by the action of controlled switches and diodes. So it is appropriate to use sliding mode controllers in dcdc converters [13]. It is known that the use of SM (nonlinear) controllers can maintain a good regulation for a wide operating range. So, a lot of interest is developed in the use of SM controllers for dc-dc converters [14]-[63]. Siew-Chong Tan presented a detail discussion on the use of SM control for dc-dc power converters [15]

V. PROPOSED PV-STORAGE SYSTEM ARCHITECTURE

Fig. 1 shows the block diagram of the proposed dual-mode control scheme with a fixed frequency pulse width modulation controller and an LZC. This type converter can be working into two modes they are discontinuous conduction, and continuous conduction mode refers to the feedback voltage Vfb and compensation amplifiers with a reference voltage to give error signal Veao. The error signal gives to calculate the value of the duty cycle of the main switch. In other auxiliary winding and Vzco is mainly supplied to detect the drain voltage of Mb and Vpulse signals can be generated by giving negative –edge of V22-0 triggers switching of the main switch Ma. Here Vref1 is close to V0/2.

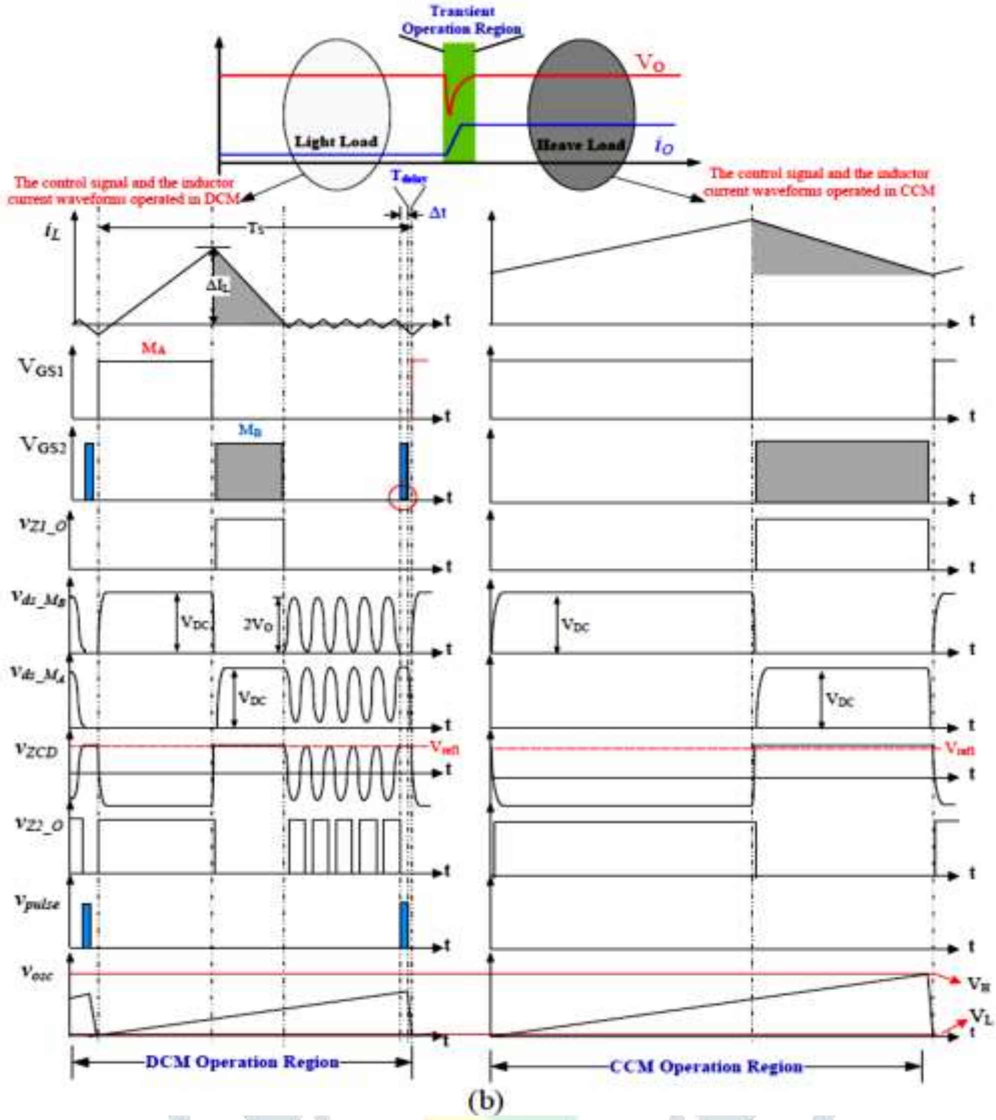


Fig.3 Key waveforms of the proposed controller

Fig 3 shows the critical waveforms of the proposed controller. In this waveforms are both discontinuous conduction and continuous conduction regions follows. When turning OFF the Mb by using decreasing the inductance current drop to zero, the Vz10 signal changes fro high level to a low level. And give the backward induction current valley voltages can be determined by the inductance and parasitic capacitance (Coss) resource. In this the frequency of switching can be reaching to the higher frequency, Lzc gives the control signal, V-pulse, for valley switching of Mb based on the rate of Vosc. The PWM controller starts to reach the ZVS of Ma for the next switching cycle to turn ON of the Mb after delta t.

In the waveforms, the continuous conduction mode the Lzc enters a conventional synchronous rectification control mode. The wave forms of the continuous conduction mode increase the output power; this constant conduction mode can be changed to the discontinuous conduction mode the SBC can be operated under the light-load conditions. In extra added, the Ma ZVS operation becomes feasible following the Mb valley conduction.

The main drawback is highest switching frequency can be solved by limited, and adding the switching cycle and minimum OFF-time and addition to the blanking time circuits and time delay circuits, rendering the overall control circuit design more complicated. This typing method is used for increasing the frequency. LZC contains other one pulse generator circuit is used for limiting the maximum frequency of the QR mode (fig3). Ma has characteristics of ZVS.

VI. RESULTS AND DISCUSSION

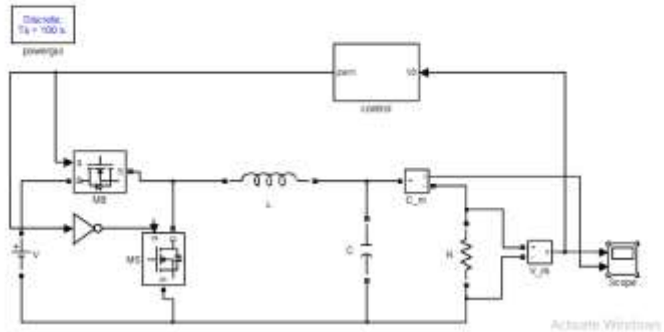


Fig. 4 Proposed dual mode control scheme

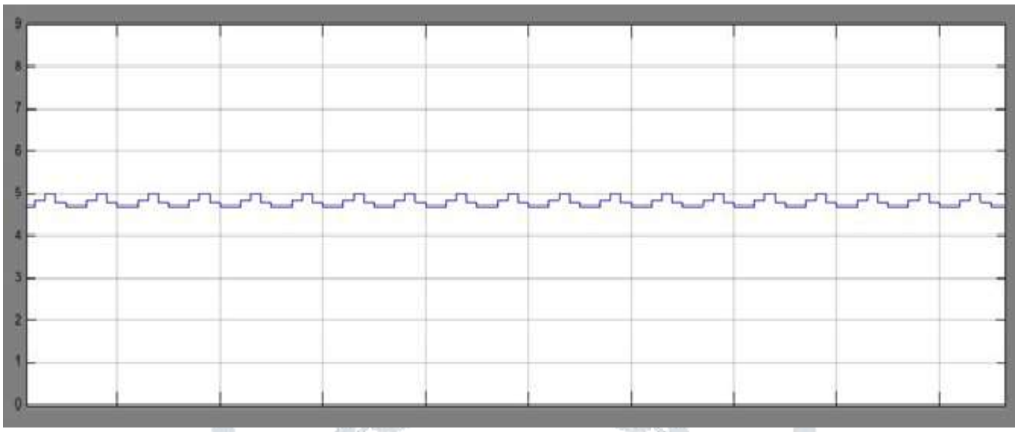


Fig:5. Output Voltage Wave Form

Fig: 6. Output Current Wave Form

VII. CONCLUSION

In this study, a novel dual-mode control scheme suitable for synchronous buck converters (SBC) was developed, and the operating principle of this strategy was explained. It was then analyzed to demonstrate its efficiency. The novel control scheme mainly integrates a continuous conduction mode and a discontinuous conduction mode (DCM). In particular, when the SBC was operated in the DCM, the second synchronous switch conduction that occurred before the main switch conduction contributed to the zero-voltage switching (ZVS) of the main switch. In addition, composing the pulse and saw tooth waveform signals prompted the synchronous switch to achieve valley switching under limited frequency conditions. This scheme possesses the following advantages. First, it is integrated with a synchronous rectification technique to reduce the conduction losses of the converter and improve the efficiency of the overall circuit. Second, operating an SBC in the DCM can achieve ZVS in the main switch without requiring additional auxiliary switches or passive devices comprising a Resistor, an inductor, and a capacitor. The simple pulse generators are employed to limit the highest switching frequency of the quasi-resonant mode.

VIII. REFERENCES

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