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Digital Synthetic Ripple Modulator (SRM) for DC-DC Converter

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ABSTRACT: SRM (Synthetic Ripple Modulator) allows voltage-hysteretic modulation to be realized in low-voltage buck converters where the natural voltage ripple is too small for reliable hysteretic operation. It involves the generation of an artificial ripple me of carrier signal generation for Pulse-width modulation (PWM) control enables voltage-hysteretic modulation to be achieved in the low-voltage voltage regulator module (VRM) modules for microprocessors. This paper provides the literature survey on Digital Synthetic Ripple Modulator (SRM) for DC-DC Converter as well as Architecture of Digital Synthetic Ripple Modulator

KEYWORDS: Synthetic Ripple Modulator, Pulse-width modulation (PWM), voltage regulator module (VRM), Converter, artificial ripple.

I. INTRODUCTION

Now days, renewable energy sources have become the fastest growing power sector, whereas the fossil-fuels has limited reserve capacity and costs for high price and hence the renewable energy sources like photovoltaic cells and fuel cell stacks have received developers attention towards it [1]. Converter is nothing but the power electronic devices which is used to transform an input voltage level into another level, and high power dc-dc converter is strongly required in the latest systems like aerospace, electric vehicle (EV), portable electronic device like mobile, tablets, pagers etc. [2].

II. DC - DC BUCK CONVERTER PRINCIPLES

To convert one level of electrical voltage into another level by a switching action, a DC-DC Converters are used, these are power electronic systems. These type of converter has two mode of operation Continuous conduction mode (CCM: the inductor current in the energy transfer never reaches zero value) and discontinuous conduction mode (DCM: inductor current is not persistent throughout the complete cycle and reaches zero level earlier even before the end of the period) [3, 4].figure 1 shows dc-dc Buck converter circuit. When the switch (d) is ON for a time duration (d*T), where, 'd' is a switching status (0 or 1)and 'T' is a duration of operation of switching device. Here the switches conduct the inductor current and diodes becomes reverse biased, this will gives the positive voltage (VL) across the inductor.

$$V_L = V_g - V_o$$

Where, V_L = inductor voltage, V_g = dc input voltage and V_o = output voltage.

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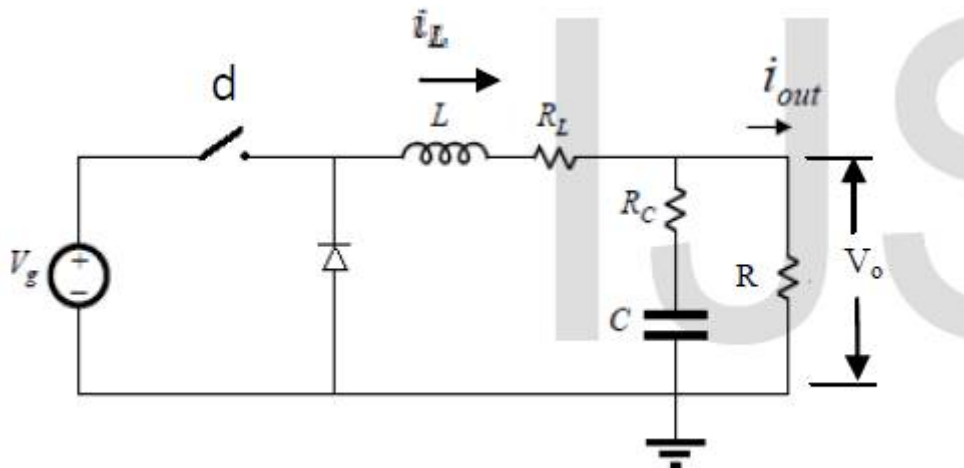


Figure 1 DC-DC Buck converter circuit [3]

III. LITERATURE SURVEY

There are several Boost Converters several control techniques have been proposed like Artificial Neural Network (ANN), PID controller, PI controller and Fuzz Logic controller.

3.1 ARTIFICIAL NEURAL NETWORK (ANN)

Hussain K. Sayed [3] developed the Artificial Neural network (ANN) methodology to control the output voltage of a dc- dc buck converters and also the Artificial Neural network (ANN) methodology to control the output voltage of a dc- dc buck converters. this proposed work is compared with the conventional PID controller under different operating conditions like no-load and full load condition by using MATLAB Simulink software. and it is found that the response for output voltage and output current of the system with PID controller that the overshoot of the terminal voltage is (12.5%), the rise time is $(1.5 \times 10^{-5}$ sec) and the settling time is (0.2 sec), where as the ANN, response for the terminal voltage and output current, we note that the overshoot is (0 volt), the rise time and the settling time is $(9.5 \times 10^{-5}$ sec).

W.M.Utomo et al [5] proposes a neural network control scheme of a DC-DC Buck-Boost converter, in this a back propagation learning algorithm is derived, which will track the output voltage of the DC-DC converter and to improve performance of the Buck-Boost converter during transient operations.

3.2 PID CONTROLLER

Ankita Pandey1 and Dr. Dharmendra Singh [6], present a pulse width modulation non-isolated buck converter based on PID controller, the buck converter connected to the PID controller and it will calculate an error value, it is nothing the difference between a measured process variable and a desired set point. In the final result it is found that PID controller achieve the better performance of buck converter. Mirza Fuad Adnan et al. [7] proposes the design and simulation of a DC-DC Boost converter employing PID controller and it maintain a constant output voltage despite variations in input/source voltage, components and load current. Proportional, Integral and Derivative (PID) controller has been applied to a conventional Boost converter and tested in MATLAB-Simulink.

3.3 PI CONTROLLER

Bakar et al [8] presents design of Proportional Integral (PI) controller with Real Time Interface (RTI). This will the dynamic response of digitally control dc to dc boost converter, in which DS1103 dSPACE RTI has been used as an interface controller between hardware and software through the MATLAB/Simulink model. D.Sivamani et al [9] design a system for tuning Genetic Algorithm based PI (proportional Integral) feedback controller for DCDC converter.

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In this proposed system controller uses the GA based tuning of PI controller to contract the existence and effect of high amplitude disturbances. GA based PI controller for PWM pulses is successful to minimize the effect of noise even when noises several folds higher than the normal buck boost generated output signal.

IV. ARCHITECTURE OF DIGITAL SYNTHETIC RIPPLE MODULATOR

The carrier signal utilized in the comparison process is derived from a system parameter unlike the traditional approach of using external oscillators and the modulation strategy is nothing but the bonding the error between the controlled variable and a command variable to a synthetic ripple. As shown in the Figure 1 the system parameter are sampled and given as input to the digital timing generator, where it scales the sampled input and generates the step value. These step values are successively accumulated between the hysteretic limits and the required duty ratio is generated. In this architecture PWM output is set to logic high or "1" (the modulator output exceeds the upper hysteretic threshold (2^{N-1})) otherwise set to logic low or "0" (the modulator output is lesser than the lower hysteretic threshold (-2^{N-1})).

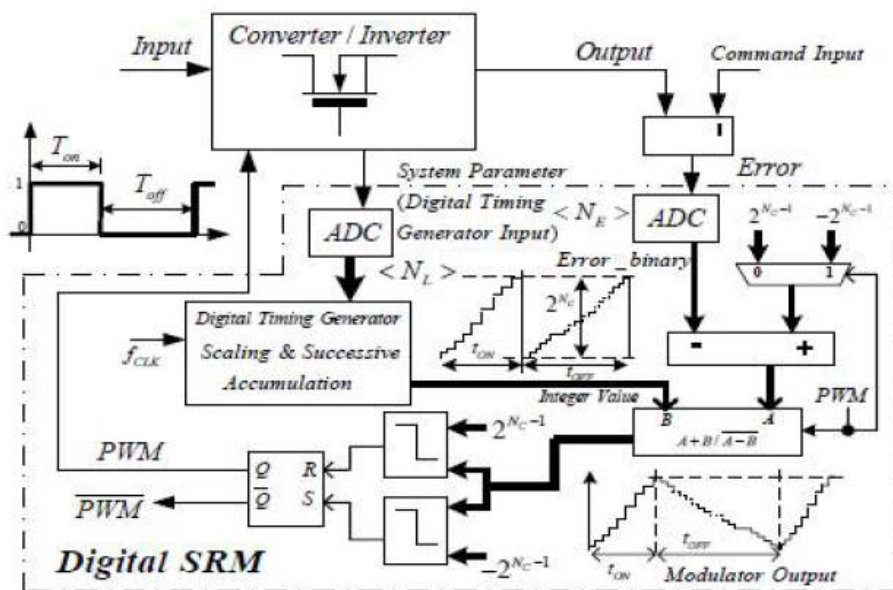


Figure 2 architecture of a proposed system controlled by digital synthetic ripple modulator

V. RESULT AND DISCUSSION

To generate the on-time/off-time & adjusting duty ratio it uses sampled inductor voltage, to the timing generator block accumulated value, integer value, the current step value, and the carry output are fed back as inputs. Figure 3 a and b shows the Simulation outputs of the synchronous buck converter using MATLAB and Comparison between on-time/off-time generated respectively.

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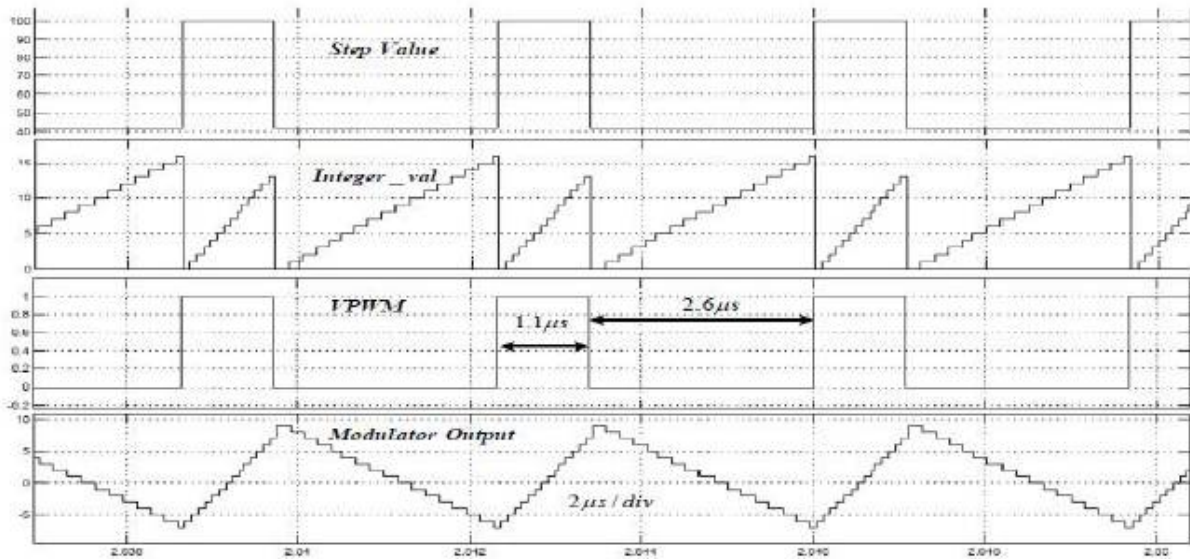


Figure 3a Simulation outputs of the synchronous buck converter using MATLAB

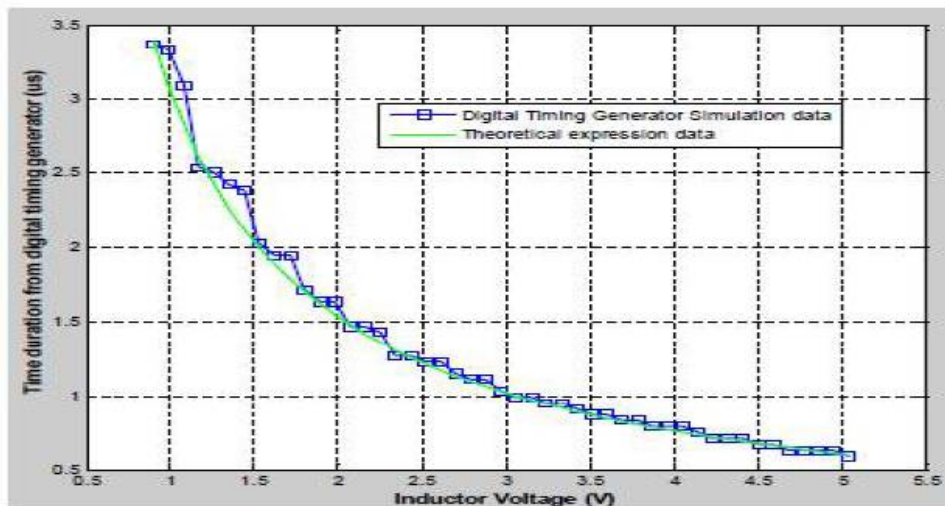


Figure 3b Comparison between on-time/off-time generated

VI. CONCLUSION

This paper will provided the theoretical review on various control techniques of Interleaved DC-DC Boost Converters. Also provides the Different control techniques like Techniques like Artificial Neural Network (ANN), PID controller, PI controller and Fuzz Logic controller. The Synthetic ripple modulation (SRM) facilitates the controlled variable to be regulated with a tight tolerance as well as give the significant advantage of linear control of the output variable with a command signal even under open-loop conditions. The synthetic ripple modulations derive its principle from hysteretic mode of control, superior dynamic performance and are achieved without the need for current sensing or a fast resolution PWM comparator.

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