ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 9, September 2019

Modified Interleaved Buck Dc-Dc Converter with Reduced Number of Switches and Input Current

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ABSTRACT: Now a days there are many applications that needs a very low voltage DC source in the method of control. It contains several electronic ICs, microcontrollers, laptops, electric vehicles, traction signalling etc. So this DC-DC converter with interleaved method can step down high voltage to very low DC voltage with low value of inductor and capacitor and lesser voltage ripple. The system will be of reduced size because of inductor and capacitor is having low value. The conventional DC-DC buck chopper is used to convert high value of voltage to low voltage, small duty cycle is essential which additional adds many limits on different components. And also it requires high values of capacitor and inductor. So that the size of the system will be very large. Compare to interleaved method voltage ripple and the current ripple will be more. The proposed DC-DC converter decreases the difficulty of the circuit and it reduces the input current also. And here Simulations have been accomplished using MATLAB / SIMULINK. All the simulation results clearly show that very low voltage can be attained using this method. Additionally, the desired output voltages can be mathematically calculated which completely match with the simulation results. And also analysis is conceded out by plotting the variance of voltage ripple with different frequencies.

KEYWORDS:DC-DC converter, interleaved buck converter, Interleaved switches.

I.INTRODUCTION

The electronic apparatus is consisting of the digital and analog, mixed-signal structures. They are more difficult to meet the challenges of better demand for altered features and due to continuous stress on size decrease. In present the trend in decreasing the price and power consumption of electronic devices are compelling to implement altered scheme in a single IC. But these schemes need independent of low power supplies and very low input voltage. DC-DC converters be able to work as power source unit for dissimilar systems with isolation from each other. By this the scheme of converter is dependent on application. Recent electronic systems typically have a sum of different controlled DC source voltages providing power to several purposeful blocks. The common development for these supply voltages is to convert lower affecting into 0.6 V to 3.3 V range. In such tenders synchronous DC-DC buck converters have become desirable resolution generating low voltages from high voltage dc input [4]. But in these the ripple amount may be very large. For DC voltage with decreased ripple content we choice interleaved converter. In Applications wherever step-down conversion ratio, non isolation, and high output current with the low ripples are necessary, an IBC (interleaved buck converter) has expected a lot of consideration due to its very simple construction and low control difficulty. Interleaved Buck Converter (IBC) Have Better Step-Down Conversion Ratio and Low Switching Harms compared with the traditional buck converter, interleaved converter offers smaller size of device, lesser peak-to-peak ripple amplitude, stress-free maintenance, lower stress on mechanisms, greater fault acceptance and reliability [10].

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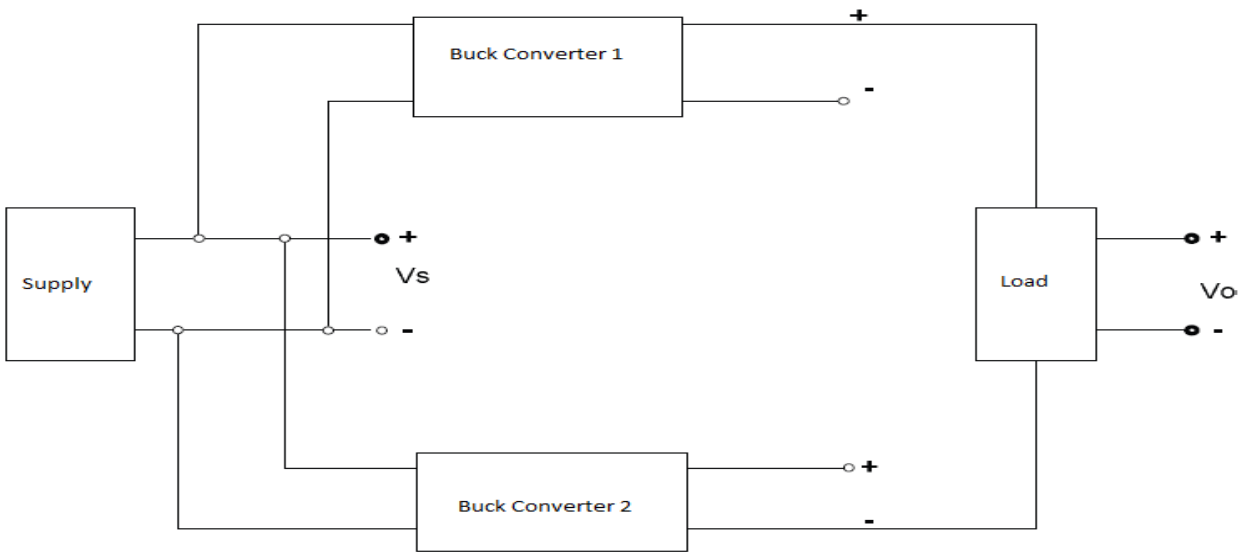
In the buck converter the size of the passive elements can be reduced by increasing the switching frequency, but it also chance to increased switching losses. Thus, to reduce the size of the passive device used, the converter can be interleaved. Interleaved method also offer the benefit of lower ripples in the output current [11].
Nowadays the response of electrical energy is developing at a fast rate. To come across this demand, more effective systems are required. For satisfying this quicker and more efficient scheme such as microcontrollers, data processors etc are required. These plan works under very small voltages. This interleaved DC-DC converter provides high current and low voltage at its output. Meanwhile interleaving approach is used here because the voltage ripples at the output terminals is reduced with the improvement of the ICs and the size of the devices is compact day by day. Here for attaining low dc voltage at the output terminals the essential duty ratio is big nearly 50%. So that the value of capacitor and inductor is reduced and also compact in size. In conventional DC-DC buck converter, particularly low duty cycle is essential for attaining low output voltage which rises the value of capacitor and inductor used [1].In this paper the proposed DC-DC converter reduces the input current and difficulty also reduced. In-stead of four switches only two switches are there. Thus the control difficulty is reduced. Finally, the difference of output voltage ripple with dissimilar frequencies are evaluated.

II.SYSTEM MODEL AND DESCRIPTION

The below Fig .1 shows the block diagram of the system It is mainly two DC-DC buck converters connected in parallel. And the duty cycle of both the buck converters can be different or same. In these paper, the duty cycle of both DC-DC buck converters is kept same. By varying the duty cycle of two converters and any one of the converter, the preferred output voltage can be attained. And also here the duty cycle is relatively high, it gives output voltage very small.
In conventional buck DC-DC converter 6.25% duty cycle is essential to develop 1.5V with 24V of voltage input but here two buck choppers are operated at duty cycle near 50% to get same 1.5V for the output voltage with 24V of input. Because the benefit of increasing the duty cycle is that the value of capacitor and inductor needs for continuous conduction gets compact but both current ripple and voltage ripple gets improved.



(Fig 1: System block diagram)

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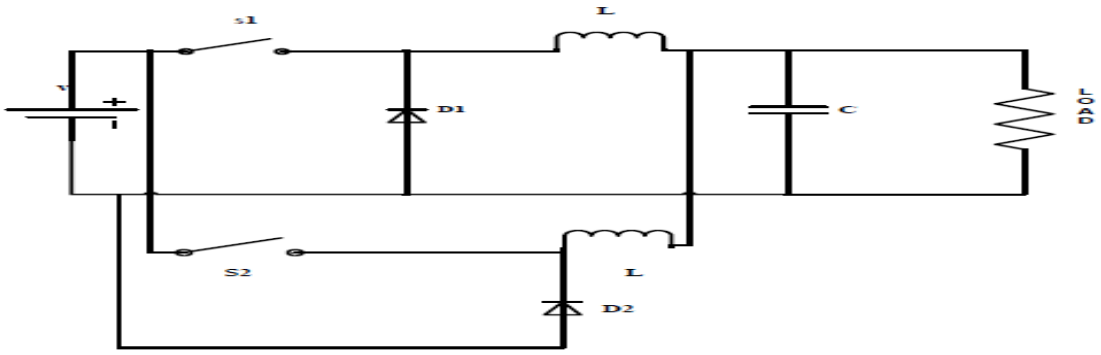
A.Circuit Diagram

The below Fig 2 shows the circuit diagram of the system. Here the two buck DC-DC converters are cascaded. In this technique, they involved two methods. First is interleaved method and another one is synchronous buck method. Both buck DC-DC chopper are interleaved from one another by 180 degree as activating pulse in S1, S3. And they are having the time lag equivalent to 180 degree so S3 is on after some time i.e. t=1/(2*fc) when S1 is ON.

Second method is synchronous buck DC-DC converter system. There will be two switches first is a main switch and another one is a complementary switch. S2 switch which is complementary with S1 and likewise S4 is complementary with S3. The advantage of using the synchronous buck converter process is that it decreases power loss in diode during operation period that is equal to the product of the current owing and the forward voltage drop during conduction period.



(Fig 2: Circuit diagram of the system)

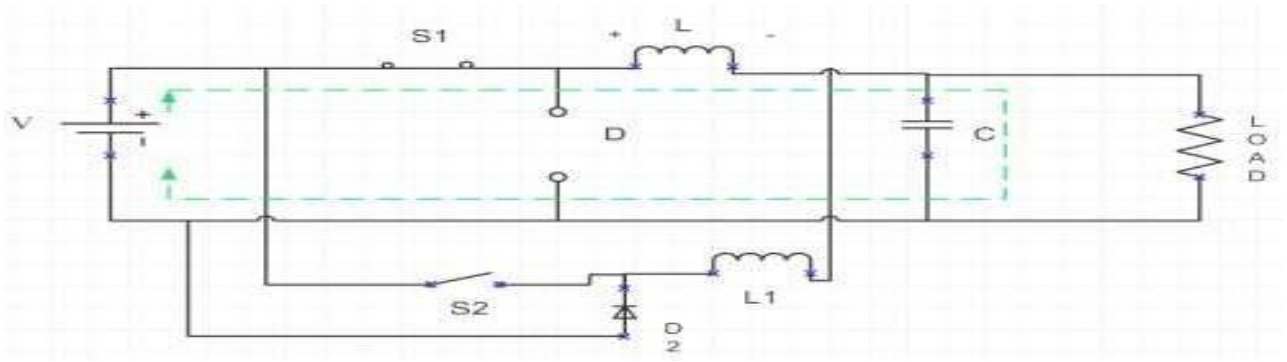
But in the above interleaved DC-DC buck converter the input current is very high. So its real implementation is tough. And also there are four switches the control circuit board is difficult. So this interleaved DC-DC buck converter is modified.

B. Modes of Operation

Modes of operation can be described in two methods.

1) Mode 1

In mode 1 switch S1 is ON. Switch S2 is OFF. Diode D2 conducts. Here they are two tank circuit. Then inductance (L) and capacitance (C) values of both the tank circuit is equal and also the frequency is same. The tank circuit voltages are opposite in sign but equal in magnitude. So that this will cancel each other. The output voltage will be in DC.



(Fig 2.1: Mode 1 operation of the system)

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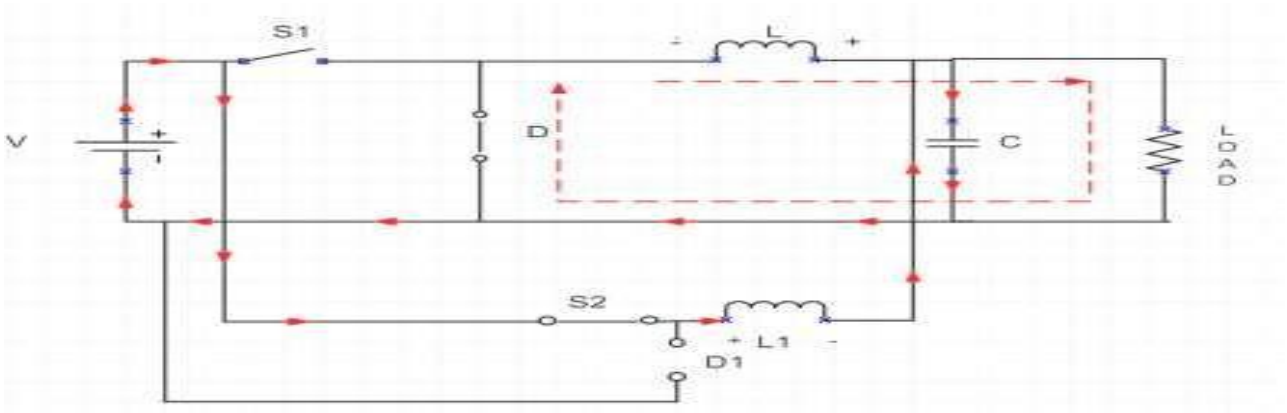
2) Mode 2

In mode 2 switch S2 is ON means conducting. Switch S1 is OFF. Diode D1 conducts. Now here also two tank circuits are existing. Operation is similar to mode 1 operation.



(Fig 2.2: Mode 2 operation of the system)

III.SIMULATION MODELS AND RESULTS

Present in this segment it can be observed that how DC-DC buck converter method can obtain small output voltage at high duty cycle that is the major advantages compare to conventional buck DC-DC converter and it operates at small duty cycle that is less than 10% in imperative to attain similar output voltage. The comprehensive MATLAB/SIMULINK model of interleaved DC-DC buck converter is prepared.The MATLAB simulation parameters are specified by the table1.

Parameters	Specifications
Supply voltage	24V
Inductance	3.6mH
Capacitance	1000µF
Voltage ripple	0.2V
Current ripple	0.1A

(Table 1: Simulation parameters)

The simulation model is designed on the base of the parameters shown in table 1. The MATLAB/Simulink model is given in figure 6. Then here we will attain low voltage at the output level and output power is also low value. And also it can be used for the low power applications. Current ripples and voltage ripples is reduced. And we are attaining low voltage at moderately greater duty ratio near equivalent to 50% and output current is huge. And also here the capacitors and inductor values very low.

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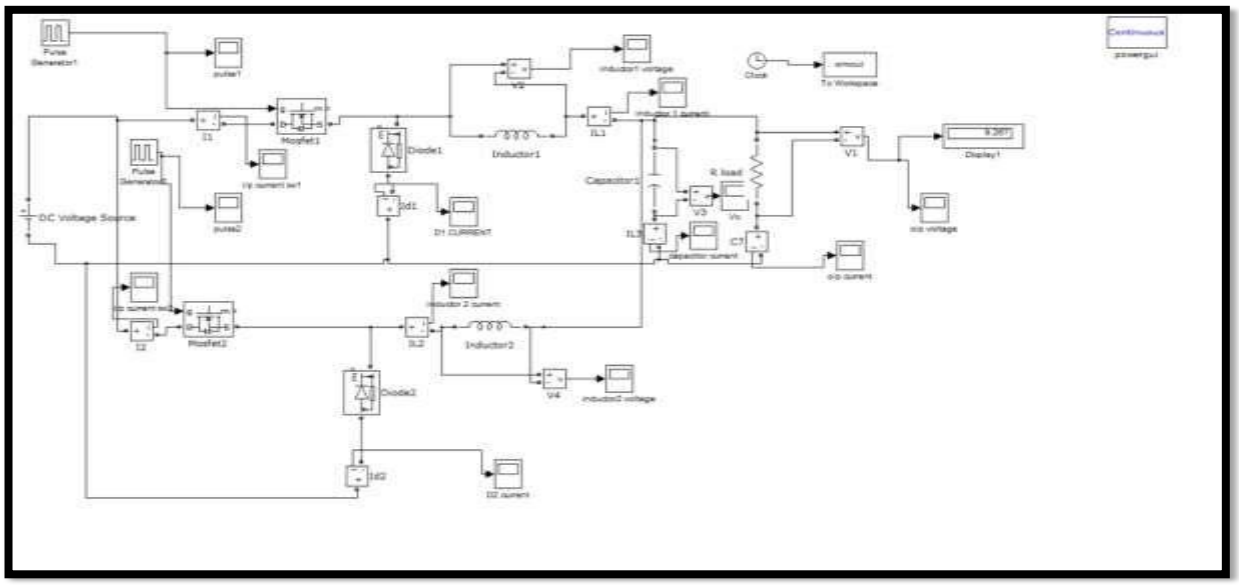
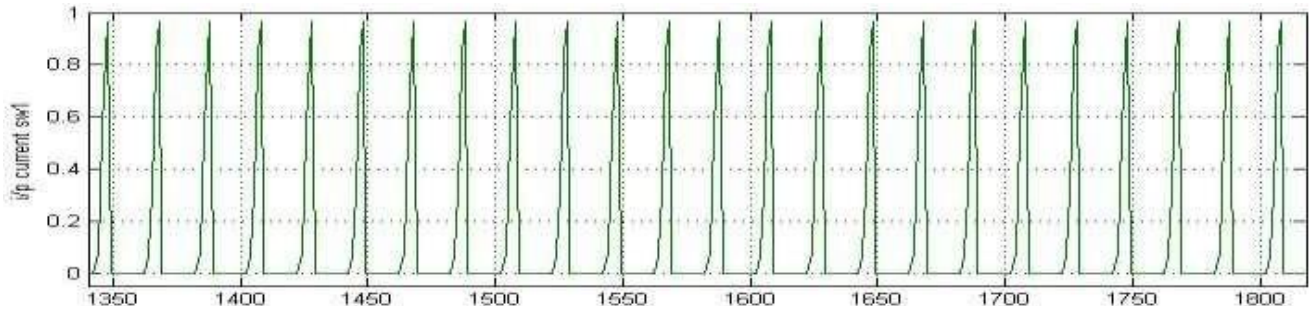
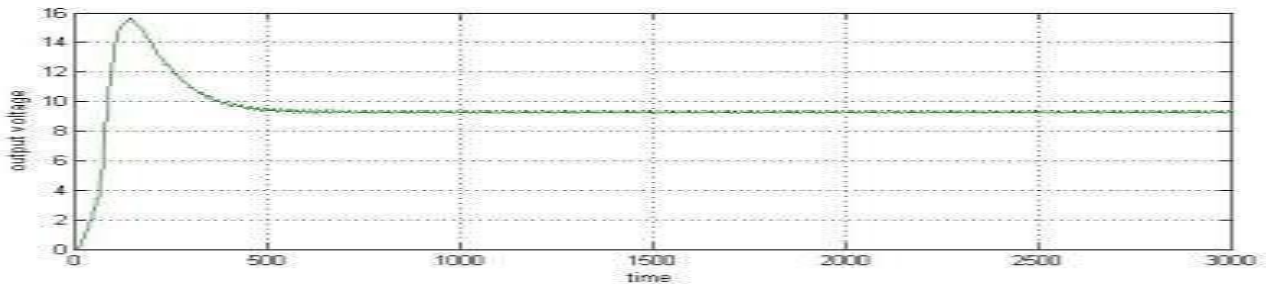


(Fig 3: MATLAB/Simulink Model of Interleaved Buck DC-DC Converter)

Then here voltage pulse is given to first switch S1 and this voltage pulse is shifted by 180 degree and given to second switch S2. The below figures shows the switch current and output voltage and output current.



(Fig 3.1 Switch current)



(Fig 3.2 Output voltage)

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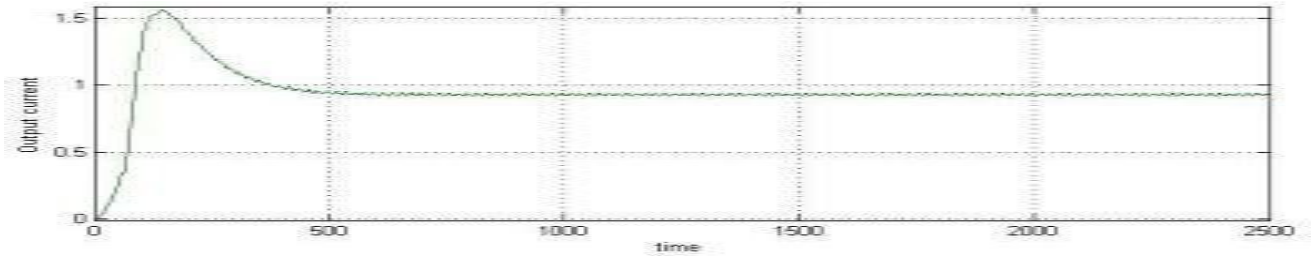
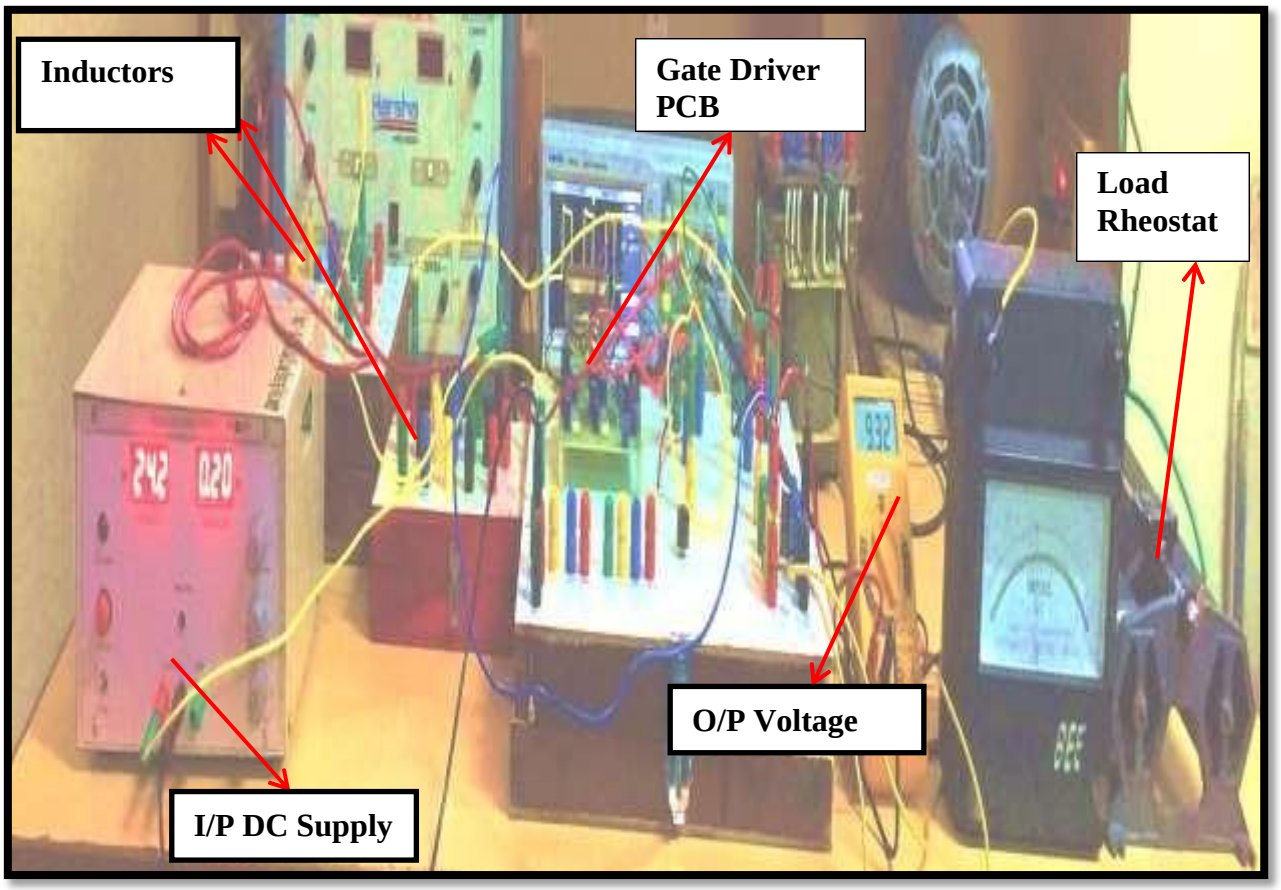


(Fig 3.3 Output current)

IV.EXPERIMENTAL SETUP AND RESULT



(Fig 4: Hardware Kit)

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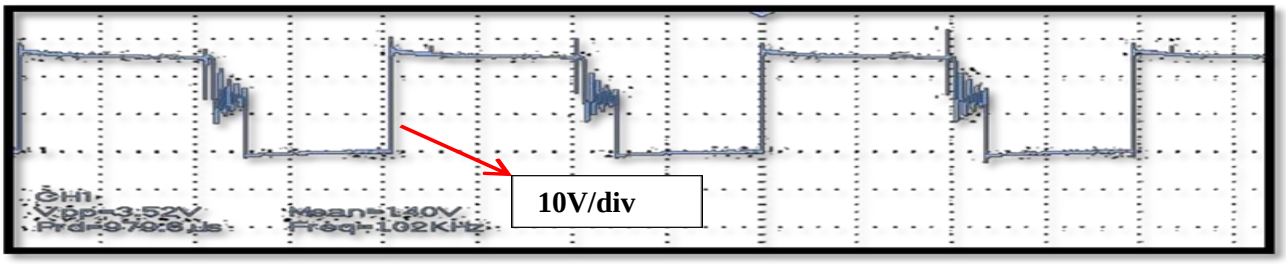
A.Components Used in hardware system

Components used	Specifications
Controller	PIC16F877A
MOSFET	IRFP460
Driver IC	MCP1407
Inductance	3.6mH
Capacitance	1000µF
Power diode	INF5822

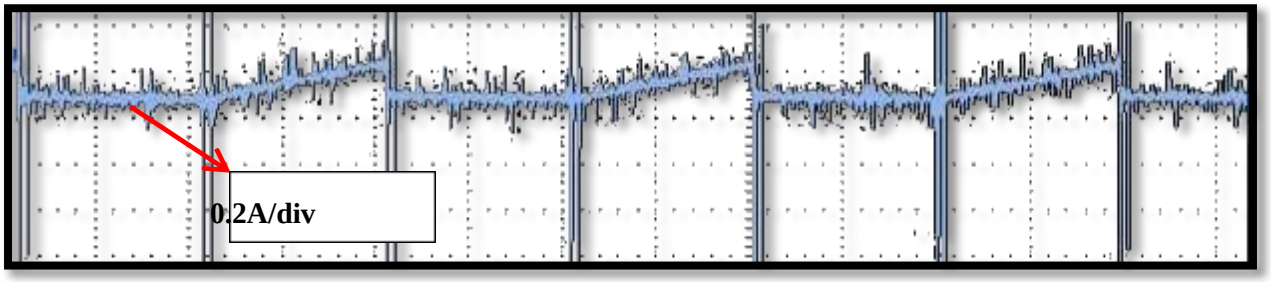
(Table 2: Hardware components)

B.Switching Pulses

Switching pulses of first switch S1 and switch S2 is obtained by experimentally. Both these switches have 180-degree phase shift. The below figure shows the switch voltage current and output voltage and output current.



(Fig 4.1: Switch Voltage (24V))



(Fig 4.2: Switch current (1A))

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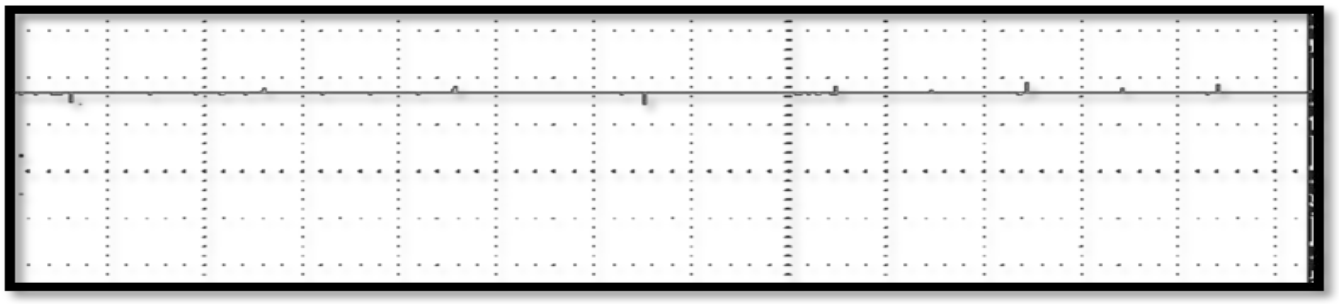

(Fig 4.3: Output Voltage (9.3V))

VI. CONCLUSION

In this paper proposed interleaved Buck DC to DC Converter, we attain compact voltage ripples at the output. The control electric circuit is very simple because only two switches are present and it is inexpensive. Capacitor and inductor values required is also very low. So the device size is also reduced. In the present system the continuous inserting the high number of devices on single one chip may growth the size. So that the size becomesvery major problem. The use of this proposed system we can improve the system with compact in size. The Interleaving approach is used to decrease the voltage ripples. In our system it has been found that the voltage ripples is very small 0.2V. Voltage ripple obtained is 0.5% of thevoltage output. Current ripples also compact and also the power output attained is short. Therefore the proposed Interleaved DC to DC buck converter is highly important in low power applications.

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