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A Novel Convertor and PWM Method Used to Control Voltage Stress for Fuel Cell Power System

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Abstract:

This project investigates a novel pulse width modulation (PWM) scheme for two-phase interleaved boost converter with voltage multiplier for fuel cell power system by combining alternating phase shift (APS) control and traditional interleaving PWM control. The dc/dc converter will generate high frequency input current ripple, which will reduce the life time of the fuel cell stack. The voltage stress on switches in light load will reduces by the APS control while the traditional interleaving control is used to keep better performance in heavy load. The boundary condition for PWM control is derived. Based on the aforementioned analysis, a full power range control combining APS and traditional interleaving control is proposed. To explore the efficiency of the converter loss breakdown analysis is given. Finally, it is verified by experimental results.

INTRODUCTION:

With expanding worry about vitality and environment, it is important to investigate the renewable vitality including wind power, sun based, energy component, and so forth. Energy component is one of promising decisions because of its focal points of zero emanation, low clamor, higher force thickness, and being effectively modularized for convenient power sources, electric vehicles, circulated era frameworks, and so forth. The framework associated power framework in light of energy unit is appeared in Fig. 1. For an average 10-kW proton trade layer power module, the yield voltage is from 65 to 107 V. Be that as it may, the info voltage of the three-stage dc/ac converter should be around 700 V, the voltage increase of the dc/dc converter between energy unit and the dc/air conditioning converter will be from 6 to 11 V.

An interleaved support converter with voltage multiplier was proposed. Its voltage addition was expanded up to (M +1) times (M is the quantity of the voltage multiplier) of the traditional help converter with the same duty cycle D and lower voltage stress. Furthermore, it has lower information current swells and yield voltage swells in examination to the traditional help converter. The interleaving help converter with voltage multipliers is appeared in Fig. 2.

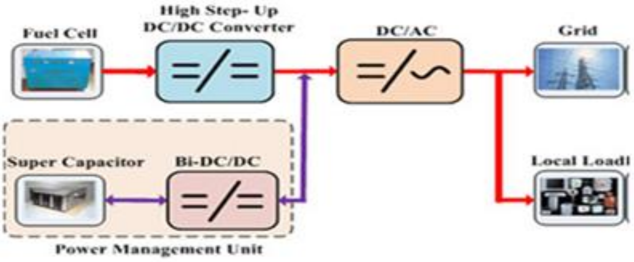

Figure 1 Grid-connected power system based on fuel cell

The converter appeared in Fig. 2 can accomplish low-voltage stress in the force gadgets, which expands the transformation efficiency. However, this is just valid in overwhelming burden when the voltage anxiety of the force gadgets may increment when it works in intermittent conduction mode (DCM), which occurs when power module just supplies a light neighborhood load as appeared in Fig. 1. In this case, higher voltage power gadgets should be utilized, and in this way its expense and power misfortune will be expanded.

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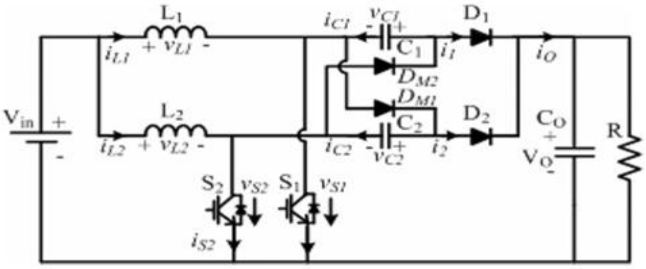

Figure 2: Two phase interleaved boost converter with voltage multiplier

OVERVIEW OF FC:

Over View of Fuel Cell:

A power module is a gadget that changes over the compound vitality from a fuel into power through a synthetic response with oxygen or other oxidizing specialists. Hydrogen created from the steam methane improving of normal gas is the most well-known fuel, however for more noteworthy effectiveness hydrocarbons can be utilized straightforwardly, for example, regular gas and alcohols like methanol. Energy components are not the same as batteries in that they require a constant wellspring of fuel and oxygen/air to manage the compound response while in a battery the chemicals present in the battery respond with one another to produce an electromotive power (emf). Power modules can deliver power persistently for whatever length of time that these inputs are supplied.

Operating Principles and Modeling of System Boundary Condition Analysis with Traditional Inter Leaving Control for Low Power Operation

1) First Stage (t0, t1):

right now of t0, both switch S1 and S2 are off, the vitality put away in the inductor L2 and capacitor C2 in past stage are exchanged to the yield capacitor CO through D2 as appeared in Fig. 3(a). The voltage weight on switch S1 is the info voltage VIN, and the voltage weight on switch S2 is (VO −VC2), where VO is the yield voltage and VC2 is the voltage of capacitor C2.

2) Second Stage (t1, t2):

right now of t1, the switch S1 is turned ON, the inductor L1 begins to store vitality from zero as appeared in Fig. 3(b). Meanwhile, if (VC1 + VC2) < VO , where VC1 is the capacitor C1 voltage, the diode D2 will be killed and the diode DM2 will be turned ON; in this way, the vitality in the inductor L2 will be exchanged to the capacitor C1 .

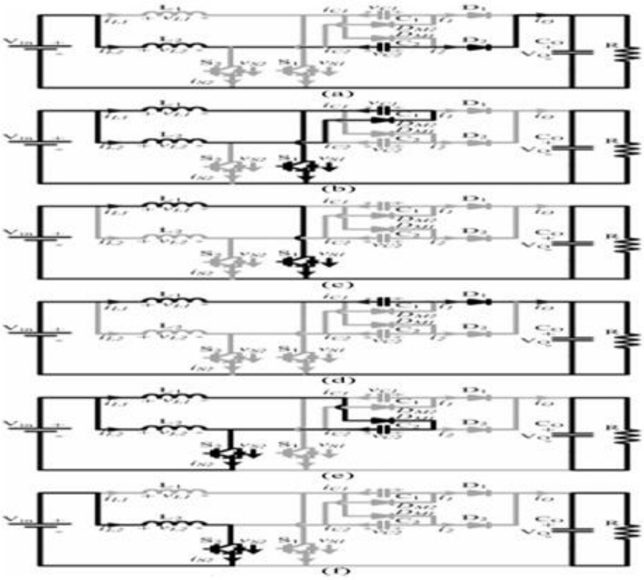

Figure 3 Stages at boundary condition. (a) First stage (t0 , t1), (b) second stage (t1 , t2), (c) third stage (t2 , t3), (d) fourth stage (t3 , t4), (e) fifth stage (t4 , t5), (f) sixth stage (t5 , t6).

3) Third Stage (t2, t3):

right now of t2 , the current in the inductor L2 just tumbles to zero, every one of the diodes are in off state and the inductor L1 is in charging state until the switch S1 is killed right now of t3 . The voltage weight on switch S2 is VIN. Toward the end of this stage, the current in the inductor L1 goes to the crest esteem

$$I_{L1P} = \frac{V_{in} D_m T_S}{L} \quad (1)$$

IL1P, and

Where VIN is the information voltage, L is the inductance of L1 and L2, Dm is the obligation cycle at limit condition, and TS is the exchanging period.

4) Fourth Stage (t3, t4):

right now of t3, switch S1 and S2 are in off state, the vitality in the inductor L1 and the capacitor C1 will be exchanged to the yield capacitor CO through the diode D1, which is like First Stage. In this stage, the voltage weight on switch S1 is (VO − VC1),

$$I_{L1M} = I_{L1P} - \frac{V_O - V_{C1} - V_{\text{in}}}{L}(0.5 - D_m)T_S. \quad (2)$$

5) Fifth Stage (t4, t5):

right now of t4, the switch S2 is turned ON and the inductor L2 begins to store vitality. This stage is like the Second Stage. In this stage, the voltage weight on switch S1 is VC2. Toward the end of this stage, the current in the inductor L1 reductions to zero from IL1M. What's more, subsequently?

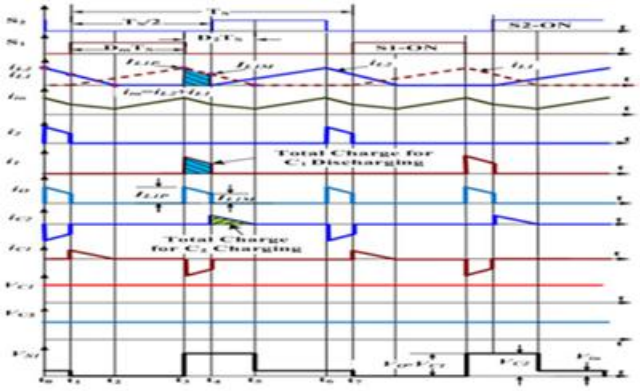

Figure 4: Main theoretical waveforms at boundary condition

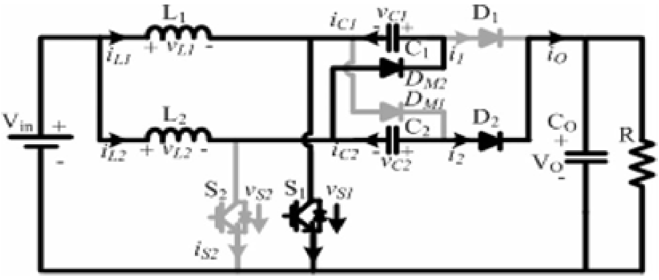

Figure 5 One stage above boundary condition

6) Sixth Stage (t5, t6):

right now of t5, the current in the inductor L1 abatements to zero. Every one of the diodes are in off state and the inductor L2 is in charging state until the stage arrives at the end right now t6.

Another exchanging period will start with the following First Stage.

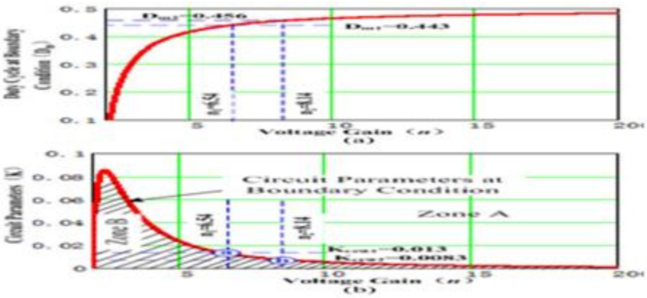

Figure 6: Boundary constraint varies with voltage gain. (A) Duty cycle at boundary condition varies with voltage gain, (b) circuit parameters at boundary condition varies with voltage gain.

At that point, the APS control ought to be utilized to accomplish divided voltage weight on switches in Zone B. In our 1-kW model outline, the information voltage of the converter is 86–107 V, and the yield voltage of the converter is 700 V. The voltage increase will fluctuate from n1 = 6.54 to n2 = 8.14, and after that the circuit parameters at limit conditions Kcrit will shift from Kcrit1 = 0.013 to Kcrit2 = 0.0083 as appeared in Fig. 6(b), the obligation cycle will shift from Dm1 = 0.443 to Dm2 = 0.456 keeping in mind the end goal to keep up the steady yield voltage.

At the point when the circuit parameters K = 2L/(R × TS) are beneath the strong red line from point to point at distinctive voltage pick up as appeared in Fig. 6(b), the obligation cycle will be diminished further to be not exactly the strong red line from Dm1 = 0.443 to Dm2 = 0.456 as appeared in Fig. 6(a), and afterward the voltage weight on switches will be expanded at this heap. Keeping in mind the end goal to accomplish the divided voltage weight on switches at this heap, APS control is required.

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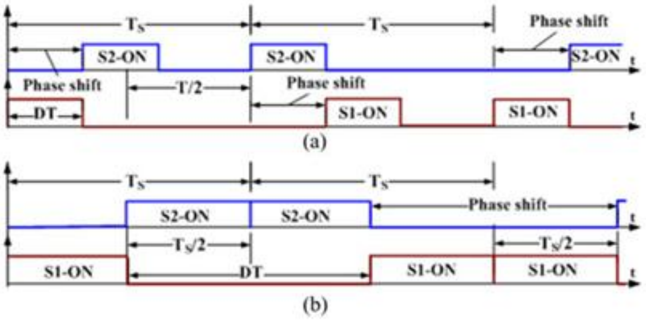


Figure 7: PWM waveform of APS with D < 0.5 and D = 0.5. (a) D < 0.5, (b) D = 0.5.

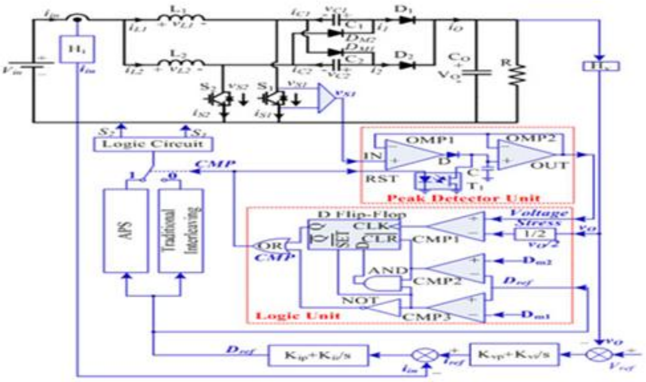
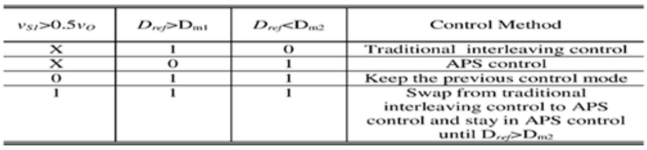


Figure 8: Block diagram of the converter with the control scheme of all power range.

Control Scheme of All Power Range with APS and Traditional Interleaving Control

As per the standard of APS, APS control is proposed to take care of the light load issue with obligation cycle under 0.5 as appeared in Fig. 7(a). With the heap expanding, the obligation cycle will be expanded too. At the point when the obligation cycle is expanded to 0.5, the APS control will be adjusted to be customary interleaving control with split exchanging recurrence as appeared in Fig. 7(b). As indicated by past examination as appeared in Fig. 6, the base obligation cycle to accomplish low-voltage weight on switches with customary interleaving control is under 0.5.



$v_{S1} > 0.5 v_O$	$D_{ref} > D_{m1}$	$D_{ref} < D_{m2}$	Control Method
X	1	0	Traditional interleaving control
X	0	1	APS control
0	1	1	Keep the previous control mode
1	1	1	Swap from traditional interleaving control to APS control and stay in APS control until $D_{ref} > D_{m2}$

Table I Operational Principle of the Logic Unit in Fig. 8

Hence, it is conceivable to join both APS control and conventional interleaving control to control the converter for full power range operation. Considering the variety of the data voltage from 86 to 107 V for 1-kW energy unit operation and the yield voltage of the converter 700 V, the base obligation cycle of conventional interleaving control changes from Dm1 = 0.443 to Dm2 = 0.456.

CONTROL STRATEGY:

For a dynamic EM vitality collector framework, if the outer excitation recurrence is not quite the same as the inherent reverberation recurrence, the PEI ought to have the capacity to match its data impedance with the inward impedance of the reaper so most extreme force point (MPP) could be followed. This paper proposed once more topology, which has the greatest force point following (MPPT) ability.

Pulse width Modulation Techniques:

Pulse Width Modulation:

Pulse Width Modulation (PWM) is the best intends to accomplish consistent voltage battery switching so as to charge the nearby planetary group controller's energy gadgets.

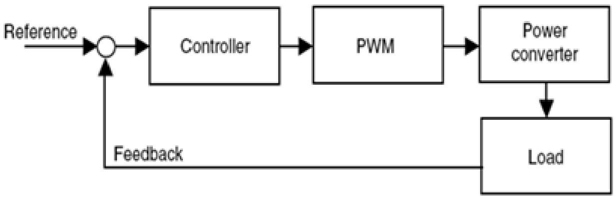


Figure 9: Block diagram of pwm

At the point when in PWM regulation, the current from the sunlight based cluster decreases as per the battery's condition and reviving needs Consider a waveform, for example, this: it is a voltage exchanging somewhere around 0v and 12v. It is genuinely clear that, since the voltage is at 12v for precisely the length of it is at 0v, then a 'suitable gadget' associated with its yield will see the normal voltage and think it is being encouraged 6v - precisely 50% of 12v. So by shifting the positive's width beat - we can fluctuate the "normal" voltage.

By shifting - or "tweaking" - the time that the yield is at 12v (i.e. the positive's width beat) we can modify the normal voltage. So we are doing 'heartbeat width balance'. I said before that the yield needed to nourish 'a suitable gadget'. A radio would not work from this: the radio would see 12v then 0v, and would likely not work legitimately. However a gadget, for example, an engine will react to the normal, so PWM is a characteristic for engine control.

Pulse Width modulator:

Things being what they are, how would we produce a PWM waveform? It's very simple; there are circuits accessible in the TEC site. Initially you create a triangle waveform as appeared in the outline underneath. You contrast this and a d.c voltage, which you change in accordance with control the proportion of on to off time that you require. At the point when the triangle is over the "interest" voltage, the yield goes high. At the point when the triangle is underneath the interest voltage.

At the point when the interest speed it in the center (A) you get a 50:50 yield, as in dark. A fraction of the time the yield is high and a fraction of the time it is low. Luckily, there is an IC (Integrated circuit) called a comparator: these come more often than not 4 segments in a solitary bundle. One can be utilized as the oscillator to create the triangular waveform and another to do the contrasting, so a complete oscillator and modulator should be possible with a large portion of an IC and perhaps 7 different bits.

The triangle waveform, which has around equivalent ascent and fall inclines, is one of the commonest utilized, yet you can utilize a saw tooth (where the voltage falls rapidly and washes gradually). You could utilize different waveforms and the definite linearity (how great the ascent and fall are) is not very critical. Conventional solenoid driver gadgets depend on straight control, which is the utilization of a consistent voltage over an imperviousness to create a yield flow that is straightforwardly corresponding to the voltage. Criticism can be utilized to accomplish a yield that matches precisely the control signal. In any case, this plan disseminates a great deal of force as warmth, and it is hence extremely wasteful. A more effective method utilizes beat width adjustment (PWM) to deliver the steady current through the loop. A PWM sign is not consistent. Maybe, the sign is on for some portion of its period, and off for the rest. The obligation cycle, D, alludes to the period's rate for which the sign is on. The obligation cycle can be anywhere in the range of 0, the sign is constantly off, to 1, where the sign is continually on. A half D results in an impeccable square wave.

In this we are clarified the ideas of

- Explain the idea of sine-balanced PWM inverter
- Design a straightforward controller for the sine-PWM inverter
- Calculate yield voltage size from the inverter working parameters
- Compare sine-balanced PWM inverter with square wave inverter

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SIMULATION RESULTS

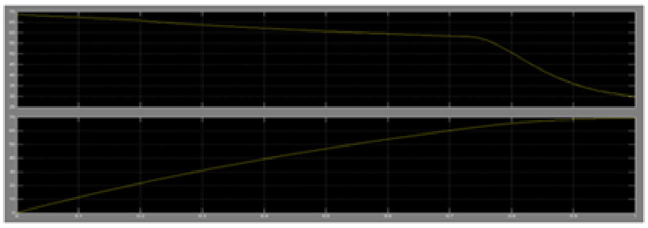

Figure 10: wave forms of V in, I in (t=0.4sec)

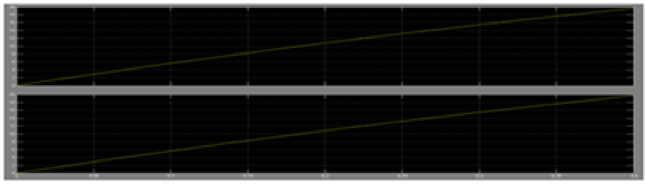

Figure 11: wave forms of I1, I2 (t=0.4sec)

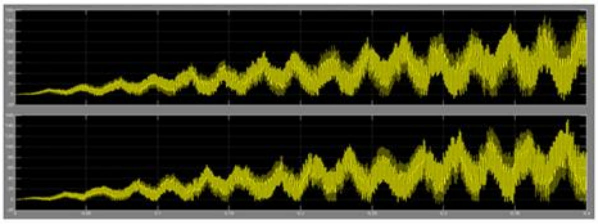

Figure 12: wave forms of Vc1, Ic1 (t=0.4)

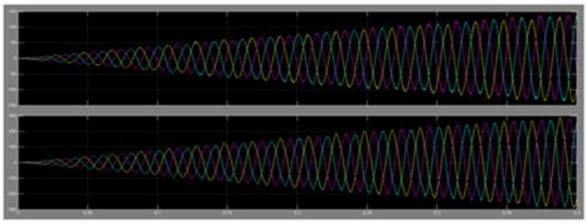

Figure 13:3 wave forms of Vabc, Iabc (t=0.4sec)

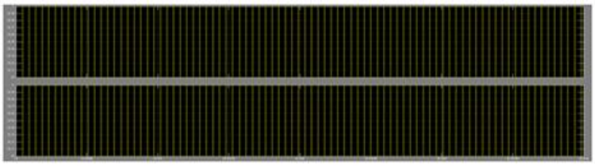

Figure 14 wave forms of switches S1, S2 (t=0.4sec)

CONCLUSION:

The boundary condition is derived after stage analysis in this paper. The boundary condition classifies the operating states into two zones, i.e., Zone A and Zone B. The traditional interleaving control is used in Zone A while APS control is used in Zone B. And the swapping function is achieved by a logic unit. With the proposed control scheme, the converter can achieve low voltage stress on switches in all power range of the load, which is verified by experimental results.

EXPECTATIONS OF FUTURE:

The available of natural fuel may be difficult in future so we are choose the alternative methods. so, we take the Fuel cell because it is a Renewable energy source and these energy will be directly used to the dc operators and it is noise less and pollution free. But the cost will be high and its life time is less.

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