International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Design and Implementation of an Isolated Interleaved Buck-Boost Converter with Phase Shifted Control

S. Senthilmurugan, Viswanathan Ganesh, Akash Prabhu, Ajay Krishna V.M, Ajit Ram R. R

Abstract**:** *This paper focuses on developing a novel method for the design of discrete buck booster converter with single phase power consumption. In this method, it uses converters based on high frequency frequency bridge-less interlaced width rectifiers. The merit of this method is that by incorporating interleaved boost converters into complete bridge diode rectifiers, switching and conduction losses can be significantly reduced. Here, we analyze the whole bridge in detail with the discrete buck-booster converter voltage coefficient. Voltage coefficient correction helps increase the voltage gain in the circuit. We use an optimized phase shift modulation strategy on a complete bridge discrete buck boost converter for improved performance and increase overall efficiency. Transformers with low ratios and low voltage MOSFETs and diodes can be implemented to improve efficiency. Based on a variety of interlaced booster converters, including traditional booster converters and high step-up booster converters with voltage multipliers. From the point of view of conversion efficiency, the discrete buck-boost (IBB) converter is a good approach. Unfortunately, the fly-back converter is a typical IBB converter, but the efficiency is still very low due to the high voltage pressure on the components and rectangles. In this paper we give an input DC supply of 12V and an output voltage of 140V. The output prototype was designed to validate the effectiveness of the proposed IBB converters and its control strategies.*

Keywords: Interleaved Buck-Boost (IBB), Pulse Width Modulation (PWM), Matrix Laboratory (MATLAB), Continuous Conduction Mode (CCM).

I. INTRODUCTION

In various industrial applications, we need to convert a constant DC voltage source into a variable DC voltage chamber. The dc-dc converter is used to convert dc directly to dc and is also known as dc converter [1]. A DC transformer with a constant variable turning ratio is equivalent to an AC transformer. Similar to a transformer, it can be used to move the DC voltage source up or down. The input of this converter is uncontrolled DC voltage, which is obtained by adjusting the line voltage and fluctuations due to variation in line voltage magnitude. Switch mode DC-DC converters are used to convert uncontrolled DC input to controlled DC output at the desired DC level. DC converters are commonly used for electric automobiles, marine hoists, forklift trucks, trolley cars, and mine hackers for traction motor control. They are beneficial because they provide smooth acceleration, high efficiency, fast dynamic response and control. DC-DC converters are also used in the regenerative braking of DC motors, and they come back to power, contributing to energy savings in transit. They are also used in DC voltage regulators along with the inductor to produce the DC current source used in CSI (current source inverter).

Revised Manuscript Received on March 30, 2020.

***** Correspondence Author
S. Senthilmurugan*, Assistant Professor (Sr.G) in the Department of Electrical and Electronics Engineering in SRM Institute of Science and Technology (SRMIST) , Kattankulathur, India
Viswanathan Ganesh, B. Tech EEE in SRM Institute of Science and Technology, Kattankulathur, India
Akash Prabhu, B. Tech EEE in SRM Institute of Science and Technology, Kattankulathur, India.
Ajay Krishna V.M, B. Tech EEE in SRM Institute of Science and Technology, Kattankulathur, India
Ajit Ram R. R, B. Tech EEE, SRM Institute of Science and Technology, Kattankulathur, India

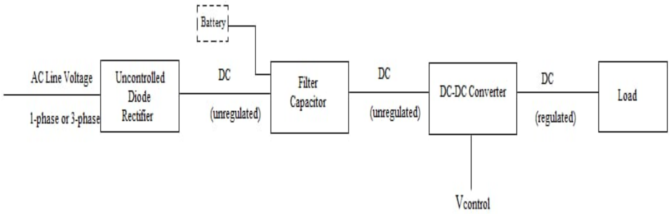

Fig. 1. Block Diagram of Converter

The methods for controlling the DC-DC converter are as follows:

1. Constant Frequency Operation - The switching frequency of the converter is kept constant and T1 is varied over time. The pulse width is changed and this control operation is called Pulse Width Modulation (PWM) control.
2. The variable frequency operation-chopping or switching frequency ch is changed and the time t1 or off-time t2 is kept constant. This is called frequency modulation. Frequencies must be varied over a wide range to achieve full output voltage range.

II. TYPES OF CONVERTERS

A. BUCK CONVERTER

A step down converter gives the average output voltage at DC voltage VD.

This applies mainly to controlled power supply and DC motor speed control. The basic circuit of the buck converter includes a step-down converter for pure resistive load. While the ideal switch is constant instantaneous input voltage VD and fully resistive loading,

this instantaneous output voltage waveform is a function of the waveform switch position. The average output voltage can be calculated in terms of the switch duty ratio.

V_o= 1/Ts$\int_0^{Ts} Vo(t)\,dt$ = 1/Ts($\int_0^{Ts} 0dt$) = (ton / Ts) V_d =

DV_d.

Substitute for D in the above equation gives

V_o= (V_d/V_{st}) Vcontrol= kVcontrol

K=V_d/V_{st} = constant.

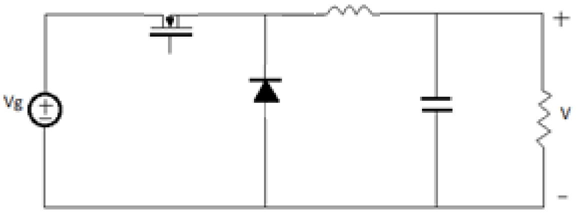

Fig. 2. Buck Converter

By changing the duty ratio ton / ts of the switch, the VO can be controlled. Another consideration is that the average output voltage VO varies with the same control voltage as the linear voltage. In practical applications, this circuit has certain impulses, such as load impulse, and some impulse impulses, also with resistance load, meaning the inductance of the switch must be absorbed or dispersed and thus destroyed. Can. Is. In addition, the output voltage fluctuates between 0 and Vd, which is not possible in most applications. The problem of stored inductive energy can be overcome by using diodes to reduce output voltage fluctuations and by using low-pass filters with the inductor and capacitor. The corner frequency of the low-pass filter is selected with a value less than the frequency of the FC switching frequency, thereby eliminating the waveform of the switching frequency at the output voltage. When its position is turned on during the interval, the diode is reverse biased and supplied to the inductor with input load. When the switch is closed, the inductor current flows through the diode, allowing some of the stored energy to be transferred to the load..

During steady-state analysis, the output end filter capacitor is considered too large, requiring almost constant instantaneous output voltage Voice (T) OVO in case of applications. The waveform at the output voltage is then calculated. Also, in the step-down converter, the average capacitor current and steady-state are zero, so that the average inductor current is equal to the average output current.

B. BOOST CONVERTER

The main applications of the Boost Converter are DC power supply and regenerative braking of DC motors. As the name suggests, the output voltage is definitely higher than the input voltage. When the switch is on, the diode reverse bias so that the output phase is different. The input supplies power to the inductor and when the switch is in position, the output phase receives power from both the inductor and the input. In steady-state analysis, the output filter capacitor is assumed to be large enough to ensure a constant output voltage voice (T) TiVo.

The steady-state waves for this conductor mode where the inductor current is constantly increasing are shown below. For some time, the integral constant of the inductor voltage must be zero,

$V_d$ton+(Vd-Vo)toff=0

Dividing both sides by Ts, and rearranging terms,

Vo/Vd=Ts/toff=1/(1-D)

Assuming a lossless, Pd=Po,

Vd*Id=Vo*Io

Io/Id=(1-D)

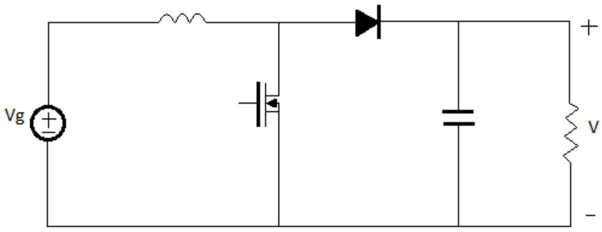

Fig. 3. Boost Converter

C. BUCK-BOOST CONVERTER

In this case, the main application of a step-down / step-up or buck-booster converter is in a controlled DC power supply, where the normal terminal and negative polarity of the input voltage are considered relative to the output output voltage. The input voltage is more or less equal. The buck-booster converter is obtained by cascading the connections of two basic converters, the step-down converter and the step-up converter. Features of Buck Boost Converter:

1) Pulsed input current, input filter required.
2) The pulsed output current increases the output voltage waveform
3) The output voltage is greater or smaller than the input voltage

In steady state, the output-to-input voltage conversion ratio is the product of the conversion ratio of two cascade converters (assuming that the switches used in both converters have the same duty ratio):

Vo/Vd=D× $1/(1-D)$.

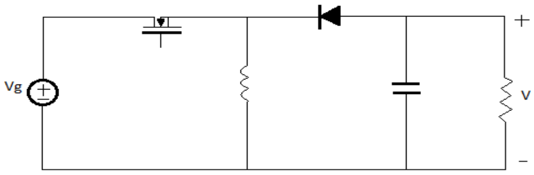

Fig. 4.Buck Boost Converter

This allows output voltage to be higher or lower than the input voltage depending on the duty voltage. When the switch is closed, power is supplied from the input to the impeller and the diode is reverse biased. When the switch is opened, the energy stored in the inductor is transferred to the output. Energy is not supplied by the input at this interval. In steady-state analysis, the output capacitor is assumed to be too large, resulting in a constant output voltage. For a continuous conduction mode of low conduction where the inductor current is constant. The integrity of the inductor voltage is coupled to zero yield.

$$V_dDT_s+(-V_o)(1-D)T_s=0$$

Therefore, $V_o/V_d=D/(1-D)$

And $I_o/I_d=(1-D)/D$ (assuming $P_d=P_o$)

This equation implies that depending on the duty ratio, the output voltage can be greater or lesser than the input.

D. CUK CONVERTER

The circuit arrangement of the cuk regulator using power bipolar junction transistors is shown in the figure. Similar to the buck-boost regulator. The cook regulator provides output voltage greater than or equal to the input voltage, but the output voltage polarity is the opposite of the input voltage and is named after its inventor. When the input voltage is turned on and the transistor Q1 is turned off, the diode DM is more biased and the capacitor C1L1, the DM and the input supply Vs

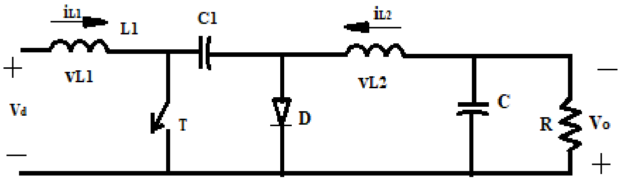

Fig. 5.CUK Converter

E. SEPIC CONVERTER

All dc-dc converters operate on and off the MOSFET, usually with a high frequency frequency pulse. This is what the converter does, making the SEPIC converter perfect. For SEPIC, when the pulse is high / MOSFET is on, the inductor 1 is charged through the input voltage and the inductor 2 capacitor. The diode is closed and operated by the output capacitor. 2. When the pulse is low / MOSFET is off, the outputs and capacitors are loaded by the diode. The higher the pulse (duty cycle), the higher the output. Because the longer the impulses are charged, the higher their voltage. However, if the pulse is long enough, the capacitors will not charge and the converter will fail.

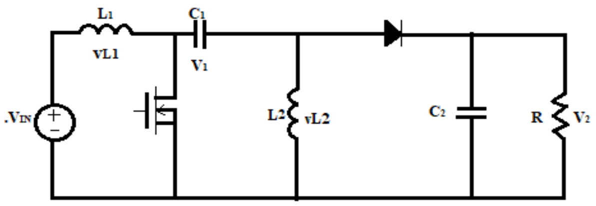

Fig. 6.Sepic Converter

III. EXISTING TOPOLOGY

The voltage can be moved up and down using a buck-booster converter. Shown in the discrete non-buck cell image with a two-switch buck-boost converter. It should be noted that although a wide range of voltage gains can be achieved with flexible control, the conversion efficiency is significantly reduced by the cascade two-phase conversion structure due to additional conduction and switching losses. Therefore, discrete non-buck-booster converters are not suitable in terms of conversion efficiency and voltage range. Therefore, achieving high-frequency frequency conversion at wide voltages is an important research topic. From the point of view of conversion efficiency, a dedicated buck-booster converter is a good approach. By adding booster converters to full bridge diode rectifiers, the semiconductor's conduction losses and switching losses are greatly reduced. The full bridge IBB converter with voltage coefficient appears in detail. The voltage multiplier helps to increase the voltage gain. Therefore a transformer and diode with low conversion and low voltage can be used for improved conversion and conduction performance.

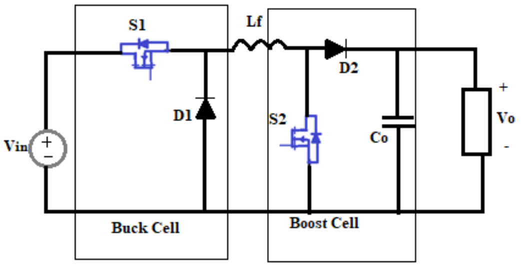

Fig. 7. Non-isolated two switch Buck-Boost Converter.

The ID is turned on / off, and in this the output of the circuit is the transformation of the primary coil, similar to the secondary coil of the transformer, which is initially characteristic of the secondary coil. The diode is connected to the diode transformer, while the cathode transformer is connected to the diode anode between the secondary coil and the node connected to the load resistor capacitor.

IV. REVIEW CRITERIA

Based on the proposed BridgeStyle boost rectifiers, new IBB converters can be obtained using the input phase of the dedicated Buick converter as the primary side circuit of the IBB converters.

Daily-side circuits can be shown as full-bridge, half-bridge. Or a three-tiered half bridge.

Since the focus of this paper is to promote rectifiers, only the IBB converter topology with the full-bridge input phase is shown. Clearly, the input phase of the IBB converter is the buck-cell, the output phase is the bridge boost cell, and the two cells are connected by a high-frequency inductor and transformer.

This architecture resembles an unprocessed two-switch buck-boost converter. The bridgeless interlaced boost rectifier can be built by merging the interleaved boost converter and the high frequency full bridge diode rectifier. Compared to the traditional cascade topology, four diodes are removed and the inductor current flows through only two semiconductors, resulting in a decrease in conductivity. Additionally, the bridgeless unlisted boost rectifier can be minimized with the loss of switching. It should be noted that both Lf1 and Lf2 are high frequency frequency pulses. Two high-frequency frequency encoders are integrated into an inductor because they are always in series. The final version of the Bridgeless Interleaved Boost Rectifier is then summarized. The original full bridge diode rectifier of output voltage, rectification and control, and the Boost Converter are integrated with the integrated bridgeless interlaced boost rectifier. All interleaved boost type converters and high frequency full bridge diode rectifiers can be connected to a high frequency interleaved boost type rectifier. The bridgeless boost rectifiers shown are suitable for high output voltage applications because the output voltage ratio can be increased with the help of voltage multiplier and coupled inductor. Based on the proposed bridal boost rectifier, new IBB converters can be obtained using the input step. Buck converter dedicated to the primary side circuit of IBB converters. The primary side circuit can be a full bridge, a half bridge, or a three-level half bridge. Since the focus of this paper is promoting rectifiers, only the IBB converter topology with full bridge input phase is performed. Clearly, the input phase of the IBB converter is the buck cell, The output phase is the bridge boost cell, and the two cells are connected by a high-frequency frequency inductor and transformer. This architecture resembles an unproven two-switch buck-booster converter. However, the concept of a high-frequency bridgeless boost rectifier was introduced in this project, using only the second-hand phase-shift control. Full-operation-range soft-switching is not possible. Converters are one Nicotines are equal. The full-bridge IBB converter is analyzed with voltage coefficient.

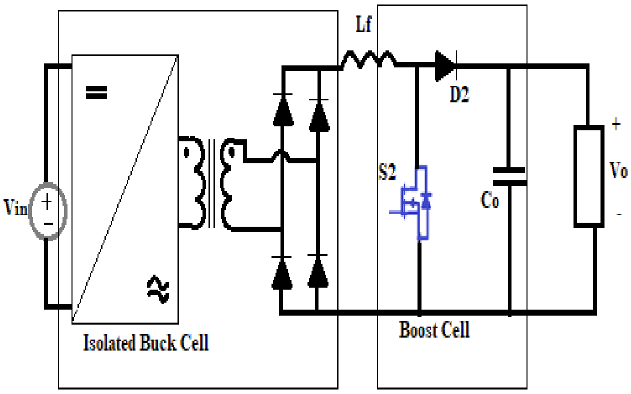

Fig. 8. Isolated Buck-Boost Converter

To increase conversion efficiency, a special buck booster converter is a good practice. The fly-back converter is a typical IBB converter, but the efficiency is still low due to the high voltage / current pressure on the components and the hard-switching of the active switches and hard diodes. In fact, the IBB converter is now a separate version of the corresponding discrete non-buck booster converter. Therefore, placing the transformer in a non-discrete buck booster converter can simplify the IBB converter, for example the Quake, Sepic and Zeta converters. As with fly-back converters, the specialized Cooke, Zepic and Zeta converters still suffer from problems such as high pressure, hard-switching and low efficiency. Additionally, these single-switch IBB converters can only be used in small power applications. Non-Discrete Buck Booster Converter, Buck Cell Inductor, Boost Cell and Two-Buck Buck Booster Converter is an easy and popular solution due to its flexible control and high efficiency.

V. BLOCK DIAGRAM

The input supply is fed to a separate buck-booster converter. Currently, fast converters mainly operate at high switching frequency and die to reduce the weight and size of filter components. As a result, the tendency to bend the deficit is now increasing, which increases the temperature of the junction.Special techniques are used to clean and disable the switch. And the converter operates on a load basis. The converter is controlled by the driver circuit and operates using the PIC controller. The 140 V output prototype is designed to validate the effectiveness of the proposed discrete buck-booster converters and its control strategies, i.e. phase-shift control. The DC input of 12V is fed to the DC-source battery and inverter circuit. The DC voltage is converted to AC voltage and given to the converter circuit, where it multiplies. Pulse width modulation (PWM) technology is used to control the switch. Driver circuits are used to control the current flow for the switch. The driver closes the circuit current to close a particular switch. The Proportional Integral Controller (PIC) is then coded to control the operation of the driver circuit to close and close.

The output voltage obtained after the converter circuit increases to a large amount. Also, switching loss and circulation loss are reduced.

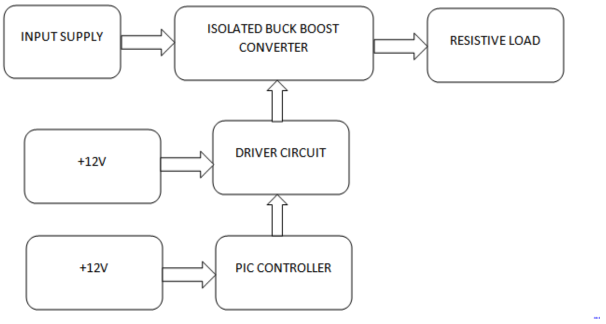

Fig. 9. Block Diagram of Proposed System

VI. WORKING

The original full bridge rectifier and boost converter with integrated bridgeless interlaced boost rectifier can detect the performance of the correction and output voltage / power. A novel high frequency interleaved boost rectifier with voltage coefficient can be obtained and shown in the figure given. These bridgeless boost rectifiers are more suitable for high output voltage applications as the output voltage ratio can be increased with the help of a voltage hipliner. In addition, the voltage pressure of the semiconductor and the turning ratio of the transformer can also be significantly reduced. Since the principle of operation and the performance of these IBB converters are identical to each other, the voltage of the complete bridge IBB converter is evaluated with a voltage bridge that has an optimized phase-shift control strategy.

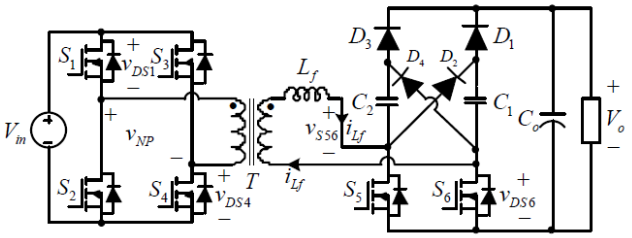

Fig. 10. Proposed full bridge Isolated Buck-Boost Converter

The full-bridge IBB converter shown above is taken as an example to analyze. VDS1, VDS2 and VDS6 flow into the source voltages of S1, S4 and S6 respectively. Primary and secondary side voltages of VNP and VS56 transformers. Current ILF flows through inductive Lf. To simplify the analysis, the capacitance of the mosque is ignored. The normalized voltage gain is defined as G = NVo / 2Vin where Vin, Vo and N are the input voltage, output voltage and transformer ratio np / ns. The phase-shift angle of the secondary is defined as the difference between the 'O' S6 and S4 gate signals. We define the duty cycle Ds = O / pi. The phase-shift angle of the secondary side is defined as the phase difference between the gate signals of S1 and S3. Therefore, the duty cycle is DP = A / PI.

VII. MODES OF OPERATION

A. Boost Continuous Conduction Mode (CCM) Operation

In boost mode, the primary side S1and operates S4 and S2 and S3 simultaneously, ie Dp = 1. Now, the secondary side phase-shift angle is used to control the output power. If the primary side switch is turned on before it is reduced to zero, the converter boost will work in CCM mode. The switching period consists of eight phases, but due to the symmetry of the circuit, we are analyzing only four phases here and the corresponding equivalent circuit for each operation phase is shown below.

Mode 1 [TO, TI] - On the front, S2, S3, S5 and D2 are on. On the secondary side S5, D1 and C1 are one of the current ends. Similarly, D4 and C2 form one another. Turn on S2 and S3. Both the S1 and S4 diodes begin to operate due to the energy stored in the L1. Due to the negative voltage across the Lf, the current ilf decreases rapidly,

if (t) = ilf (to) + (Vo / 2) / Lf (1 / G + 1) (t-to).

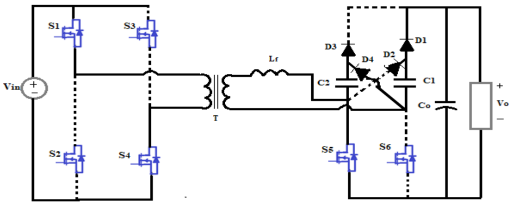

Fig. 11. Mode 1 of Boost CCM operation

Mode 2[t1, t2]: At t1, S1 and S4 are turned ON. This stage ends when ilf returns to zero and D2 is OFF naturally without reverse recovery.

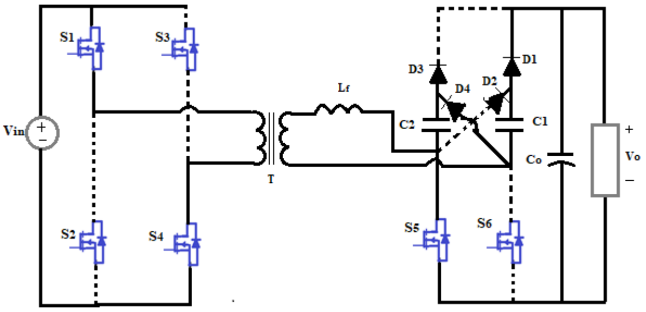

Fig. 12. Mode 2 of Boost CCM operation

Mode 3[t2,t3]- at t2, ilf returns to zero. S6 begins to conduct and Lf is charged by the input voltage.

ilf (t1) = ilf(t2)+ (Vo/2)/GLf(t-t2).

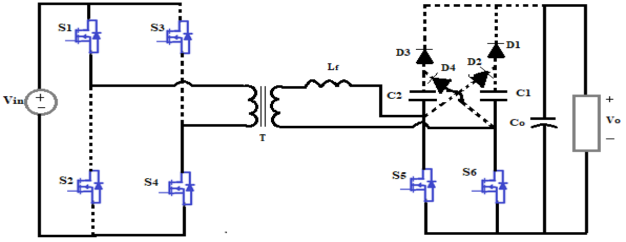

Fig. 13. Mode 3 of Boost CCM operation

Mode 4[t3,t4]- at t3,S5 turns OFF and S6 turns ON. D2 and D3 are ON and the power is transferred to the load during this stage.

$ilf\ (t)= ilf(t3)+ (Vo/2)/Lf(1/G-1)(t-t3)$

At the end of the stage ilf has the same absolute value but the direction is reversed as compared to the beginning of mode 1 which is expressed as

$ilf\ (t4)= -\ ilf\ (to).$

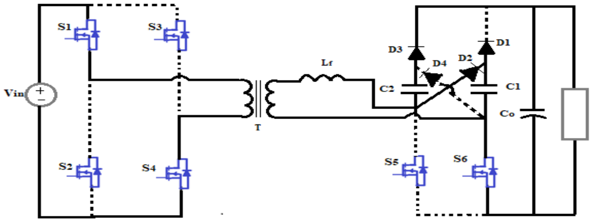

Fig. 14. Mode 4 of Boost CCM operation

A similar operation works in the rest stages of a switching period.

B. Buck Continuous Conduction Mode (CCM) Operation

In this mode of operation, a dual phase-shift control scheme is used. The primary phase-shift angle is fixed and the phase-shift angle between the primary and secondary side is used to control the output power and voltage. The switching period consists of twelve stages, but due to the symmetry of the circuit, only six stages are analyzed here and the corresponding equivalent circuits are shown for each operation phase.

Mode 1 [TO, T1] - On the front, S2, S3, S5 and D2 are on. In addition, S2 turns off S2.

Due to the energy stored in the L1 the body diode of the S1 begins to function.

$ilf(t)=ilf(t2)+(Vo/2)/Lf$

$(t-in)$

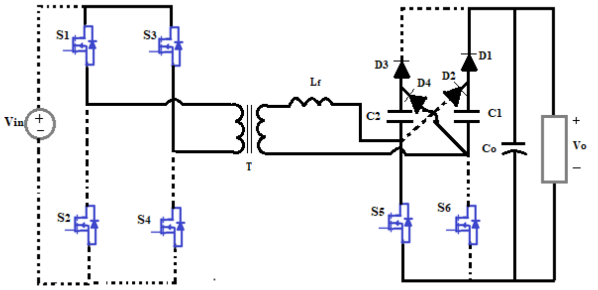

Fig. 15. Mode 1 of Buck CCM Operation

Mode 2[t1, t2]- At t1, S1 is turned ON. This stage ends when S3 turns OFF.

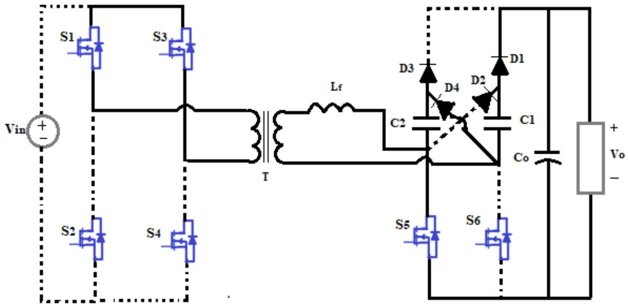

Fig. 16. Mode 2 of Buck CCM Operation

Mode 3[t2, t3] - At t2, S3 turns OFF. Body diode of S4 now starts conducting. The current ilf decreases rapidly due to the negative voltage across the inductor.

$ilf\ (t) = ilf(t2)+ (Vo/2)/(1/G+1)(t-t2).$

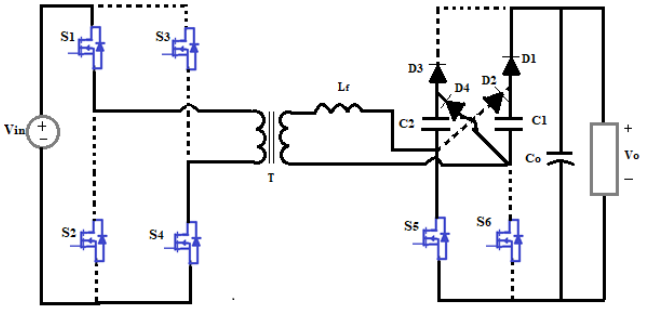

Fig. 17. Mode 3 of Buck CCM Operation

Mode 4 [t3,t4], Mode 5 [t4,t5], Mode 6 [t5,t6]- At t3, S5 turns OFF and S6 is turned ON. The operating principle of this state is same as that of Mode 2. At the end of this stage ilf has the same absolute value but the direction is reversed as compared to that of stage 1. A similar operation is carried out in the rest of the stages.

VIII. SIMULATION RESULT

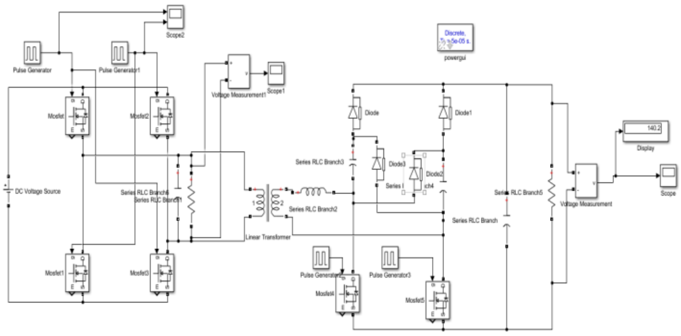

Fig. 18. Simulation Diagram

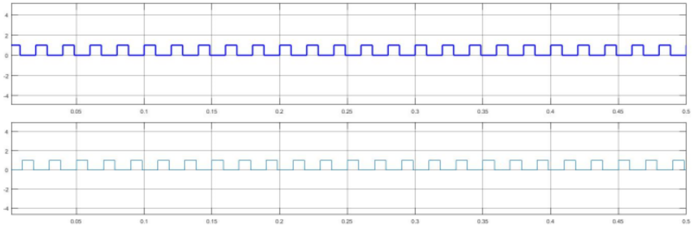

Fig. 19. Input Pulse

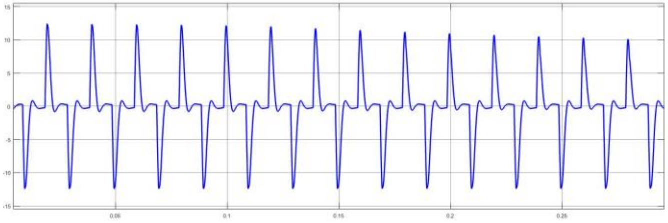

Fig. 20. Output at the inverter

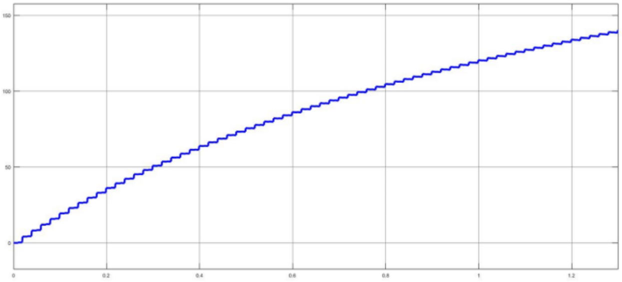

Fig. 21. Final Output Voltage

IX. RESULTS AND DISCUSSION

The DC input of 12V is delivered using a DC-source battery and fed to the inverter circuit. DC voltage is converted to AC voltage and given to the converter circuit, where it multiplies. Pulse width modulation (PWM) technology is used to control the switch. Driver circuits are used to control current flow. The driver circuit turns off the current to shut off a specific switch. The proportional integral controller (PIC) is subsequently coded to control the operation of the driver circuit to turn on the proportional switch.An output voltage of approximately 10V is obtained at the end of the inverter circuit, which is converted to a DC voltage and a final output voltage of 140V.

X. HARDWARE SETUP

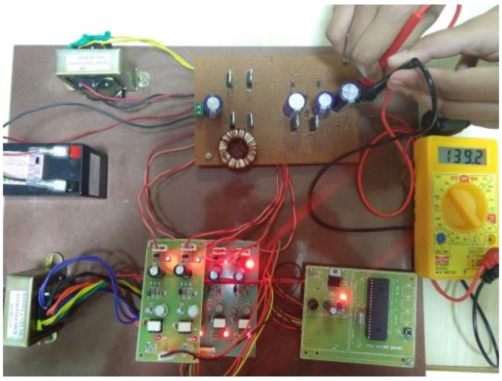

Fig. 22. Hardware Setup

XI. CONCLUSION

In this paper, different buck-booster converters based on high frequency bridgeless interlaced boost rectifiers with single phase power conversion have been proposed and investigated. The Bridgeless Interlaced Boost Rectifier built by integrating a full-bridge diode rectifier is located on this bridgeless AC-DC power factor character circuit. A fully discrete buck-boost converter with voltage coefficient is used for improved conduction and conversion performance.The analysis and performance on the 60V input in MATLAB Simulink, which delivers 420V output, are fully validated. Additionally, soft switching in hardware can be achieved across the entire operating range by adopting an optimized phase-shift control.

REFERENCES

1. Mojtaba Forouzesh, Yam P. Siwakoti, Saman A Gorji, “Step-Up DC–DC Converters: A Comprehensive Review of Voltage-Boosting Techniques, Topologies, and Applications”. IEEE Trans, on Power Electronics, vol. 32, no. 12, pp. 9143-9178, December 2017.
2. Yangfeng Shen, Huai Wang, Ahmed Al-Durra, “. High gain efficient DC-DC converter for low-voltage power generation application”. IEEE Trans. on Electrical Electronics and Computer Science, vol 24, no. 11, pp. 3287-3296, March 2016.
3. Synthesis and Analysis of Double-Input Single-Output DC/DC Converters, BY Ping Yang, Chi K. Tse, Fellow, IEEE, Jianping Xu, Member, IEEE, and Guohua Zhou, Senior Member, IEEE, IEEE Trans on Industrial Electronics, Vol. 62, no. 10, october,2015.
4. Mona Marodkar, Sarala Adhau, Manisha Sabley, “Design and simulation of DC-DC converters for Photovoltaic system based on MATLAB”. IEEE Trans. on Industrial Instrumentation and Control, 30th May, 2015.
5. G. Di Capua, S.A. Shirasavar, M.A. Hallworth, N. Femia, “An enhanced model for small-signal analysis of the phase-shifted full-bridge converter,” IEEE Trans. Power Electronics, vol. 30, no. 3,pp. 1567-1576, Mar. 2015.
6. Gustavo A. L. Henn, R. N. A. L. Silva, Paulo P. Praça,“ Interleaved boost converter with high voltage gain”. IEEE Trans. on Power Electronics, vol 34, no. 7, pp. 7432-7447, January 2015.
7. H. Wu, Y. Xing, “Families of forward converters suitable for wide input voltage range applications,” IEEE Trans. Power Electronics, vol. 29, no.11, pp. 6006-6017, Nov. 2014.
8. Z. Guo, D. Sha, X. Liao, “Input-series-output-parallel phase-shift full-bridge derived DC-DC converters with auxiliary LC networks to achieve wide zero-voltage switching range,” IEEE Trans. Power Electronics, vol. 29, no. 10, pp. 508-513, Oct. 2014.
9. Aditi Bajpai, Arvind Mittal, “Solar Powered DC to DC Buck-Boost Converter with MPPT Control” International Journal of Electrical, Electronics and Computer Science, Vol. 3, Issue 5, July 2014.
10. F. Evran, M.T. Aydemir, “Isolated High Step-Up DC-DC Converter with Low Voltage Stress,” IEEE Trans. Power Electronics, vol. 29, no. 7, pp. 3591-3603, July. 2014.
11. Y. Chen, C. Chiu, Y. Jhang, Z. Tang, and R. Liang, “A driver for the single phase brushless dc fan motor with hybrid winding structure,” IEEE Trans. Ind. Electron., vol. 60, no. 10, pp. 4369–4375, Oct. 2013.
12. X. Huang, A. Goodman, C. Gerada, Y. Fang, and Q. Lu, “A single sided matrix converter drive for a brushless dc motor in aerospace applications,” IEEE Trans. Ind. Electron., vol. 59, no. 9, pp. 3542–3552, Sep. 2012.
13. S. Singh and B. Singh, “A voltage-controlled PFC Cuk converter based PMBLDCM drive for air-conditioners,” IEEE Trans. Ind. Appl., vol. 48, no. 2, pp. 832–838, Mar./Apr. 2012.
14. B.M. Hasaneen, Adel A.Elbaset Mohammed, “Design and simulation of DC/DC boost converter”. IEEE Trans. on Power System, July 2008.
15. B. Singh, B. N. Singh, A. Chandra, K. Al-Haddad, A. Pandey, and D. P. Kothari, “A review of single-phase improved power quality ac dc converters,” IEEE Trans. Electron., vol. 50, no. 5, pp. 962–981, Oct. 2003.

AUTHORS PROFILE

S.Senthilmurugan, received his Diploma in Electrical and Electronics Engineering from Alagappa Polytechnic college Karaikudi , DOTE, Chennai, India in 2004 with First class with Honours. He received his B.E. degree in Electrical and Electronics Engineering from Alagapaa Chettiar College of Engineering and Technology,Karaikudi (Anna University), India in 2007 with First class. He received his M.E. degree in Control and Instrumentation Engineering from College of Engineering Guindy, Anna University, India in 2010 with First class. He is currently pursuing Ph.D. in EEE from SRM Institute of Science of Technology, Kattankulathur, India. He is also an Assistant Professor (Sr.G) in the Department of Electrical and Electronics Engineering in SRM Institute of Science and Technology (SRMIST) , Kattankulathur, India since 2011. He is also holding a position of Faculty Advisor of ENFUSE student chapter in SRMIST, Dept of Electrical and Electronics Engineering having 188 student members since 2018. This chapter actively involved in conducting workshops, Conferences, Industrial visits, Tech Quiz etc by creating awareness of Energy conservation and its management. His research interests are Control Systems, Smart Grid, Virtual Instrumentation, Sensor and Networks. He has also participated in many National and International Conferences and also published papers in many National and International Journals.

Viswanathan Ganesh is a Third year UG Student. He is currently studying B. Tech EEE in SRM Institute of Science and Technology, Kattankulathur, India. He has also participated in many International Conferences and also published papers in many International Journals. His Research interests are Smart grid, Energy Management, Power Systems, Electrical Machines

Akash Prabhu is a Third year UG Student. He is currently studying B. Tech EEE in SRM Institute of Science and Technology, Kattankulathur, India. He has also participated in many International Conferences and also published papers in many International Journals. His research interests are Smart grid, Energy Management, Power Systems, Electrical Machines.

Ajay Krishna V.M is a Third year UG Student. He is currently studying B. Tech EEE in SRM Institute of Science and Technology, Kattankulathur, India. He has also participated in many International Conferences and also published papers in many International Journals. His Research interests are Smart grid, Energy Management,Power Systems, Electrical Machines.

Ajit Ram R.R is a Third year UG Student. He is currently studying B. Tech EEE in SRM Institute of Science and Technology, Kattankulathur, India. He has also participated in many International Conferences and also published papers in many International Journals. His Research interests are Smart grid, Energy Management, Power Systems, Electrical Machines.