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A NOVEL METHOD OF NEW MULTI INPUT TWO AND THREE-LEVEL DC-DC CONVERTER FOR HYBRID ELECTRIC VEHICLES

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Abstract: This paper proposes a new multi-input isolated DC-DC converter for hybrid electric vehicles application. In this work, fuel cell and energy storage system are utilized as the input sources for the proposed system. Fuel is considered as the main power supply. Utilized to charge the battery, increase the efficiency, reduce fuel economy and supplying the output load, charging and discharging the battery can be made by the FC and pv sources simultaneously or individually. The main advantage of proposed converter is that, the proposed multi input converter has a capability of providing the demanded power by load in absence of one or two resources. The three Level DC-DC converter proposed circuit carries a boost converter and capacitor cellular get a extra DC gain, the traded capacitor converters is probably the right plan. The main advantage of proposed converter is that, the proposed multi input converter has a capability of providing the demanded power by load in absence of one or two resources.

KEY WORDS: DC-DC proposed converter, FC (Fuel Cell), Photovoltaic cell(PV)

I. INTRODUCTION

One of the principle favourable circumstances of the HEV drive is to improve theefficiency of the engine drive. The key parts of the footing frameworks in crossover electric vehicles are the multi inputbidirectional DC-DC converters.Multi input bidirectional converters have consolidate the distinctive sources, such asbatteries, ultra capacitors due to expanding tirelessness on vitality emergency and ecological insurance, the Hybrid Electric Vehicles (HEVS) arereceived parcel of consideration as of late. Oil is utilized worldwide at a higher rate because of the more extensive necessity oftransport. It assumes a noteworthy job in demonstrating the vehicles with least and without utilization of petroleum.Andtherefore the other drive innovation have been progressively connected by the car ventures and thishas prompted the expanded capacitor, photovoltaic cells, fuel cells, along with former sustainable power sources, through different voltage characteristics. Multi input converters offer a financially savvy arrangement in applications which requires various info sources such has power module vehicles and sustainable power source frameworks [1]– [12].The essential thought is to coordinate various converters in eitherinput dc/dc change organize or in disconnection arrange, in additionto normally shared yield arrange. There are different multiinput topologies proposed in the writing dependent on non isolated [13] –[18] and disconnected models [19]– [22]. In [13], a non isolated multi input buck/boost converter having the equivalent switchhas be planned. Similar ideas have been connected towards four switch bi directional converter of buck, somewhere the input sourcesare associated in

equivalent [14]. Every information source is interfaced with and buck switch, as well as the staying three switchesare collective through the info sources. Two lift proposed converters are connected during arrangement along with a helper circuit is utilized to achievesoft-exchangingin [15]. In a common deduction in favour of non isolated parallel integrated multi input converters include the SEPIC converter as well as Cuk converter has been detailed, an alternate methodology support onswitched capacitor converter have been accounted for.

For proposed MI converters giving galvanic cell disconnection, larger parts of the effort have been dedicated towards the stage moved complete extension DC-Converters. In two indistinguishable current nourished full bridge converters be associated during equivalent towards interface a typical yield to improve diode-connect. A Comparison ideas have been appliedusing singular yield amendment arranges yet contributions an incorporated transformer, two current bolstered bridges are guarded in a stage moved way. The parallel association of MI sources are initial distinguished as pulsatingvoltage source cell and throbbing current-source cell, and different topologies blends includes. The mainstream of the disconnected MI proposed converters introduced during theliterature are projected while different converters otherwise offers onlythe yield organize happening the auxiliary part of the transformer. In the design of similar various information sources on theprimary side of the transformer has been proposed.

The plan normal for the acceptance engine are utilized in HEV (1-6), the outline of HEV are talked about. Byapplying reasonable beginning recurrence and voltage for the inverter encouraged acceptance engine low beginning current and highstarting torque can be acquired (7). Utilizing high recurrence transformer to interface diverse sources, where each sourceis associated by full-connect cells utilizing 12 switches for three sources (8). A present sustained half-connect topology has beenproposed in [9] to decrease the swell current in the battery utilizing stage move balance. The steadiness examinations ofmultiple input separated buck– help and forward converters along have been displayed in [10]. In these sorts ofconverters, control sharing between different sources is hard to control. In [11], vitality stream between number ofdifferent sources and the dc connect are talked about. In this topology, it is absurd to expect to replace the vitality specifically among dc sources, and furthermore, a higher number of gadgets are being used. In this manuscript another kind of MI bidirectional DC-DC converter will be proposed so as to coordinate different vitality sources. The proposed circuit will beanalysed,modelled,designed, controlled, and re-enacted. Because of the focal points like minimal effort and smaller structuremulti input bidirectional DC-DC converter are accounted for to be intended for HEV application. DC-DC converter is an electrical circuit which gives shifting voltage levels that varies from the provided voltage. DC-DC converter is utilized during assortment of use. The unregulated dc voltage is given as the contribution to the DC-DC converter. That converter creates the directed yield voltage despite the fact that the info voltage is evolving.

Because of the way that underlying expense of photo voltaic panels is high as well as so as to build the removed power as of the Photovoltaic boards, MPPT algorithm must be used. In a general examination is made between various MPPT systems as for following element, dynamic reaction, Photovoltaic voltage swell, along with utilization of sensors. The previous

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method to develop the effectiveness is towards upgrade the productivity of the electric segments.

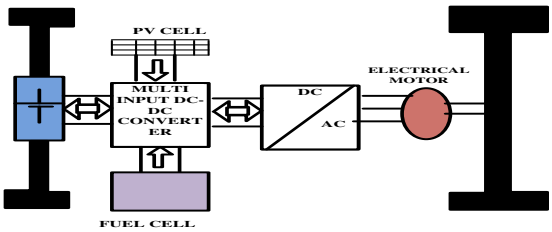

Figure. 1. Common construction of the MI (multi input) Hybrid Electric Vehicles

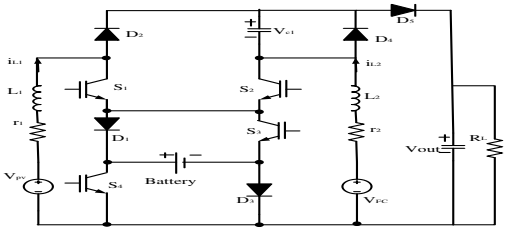

Figure. 2. Novel converter of dc–dc boost three input converter.

In this proposal, a new dc– dc three input boost converter is suggested to combine a Photo voltaic cell, an energy cell, as well as a battery all are interfaced towards the framework. Moreover, dc increase is upgraded during the regard of customary converters. At the same time, MPPT preserve the acquired designed for Photo voltaic cell. The battery will be charged as well as released so as towards the accomplish control the executives. The accompanying two areas, the suggested construction is considered as well as diverse activity method.

II.EXISTING TWO LEVELDC-DC CONVERTER

The arrangement of the suggested three-input dc–dc help converter is described. The existing converter is having two traditional lift converters, alternative additional capacitor in individual of the DC-DC converters, as well as a battery to store the energy. Normal for the existing converter is appropriate in favour of half and half frameworks. In this paper, conduct of the converter as far as dealing with the sources is broke down in power the executives and control part. At that point, Vpv and Vfc are two autonomous power sources that yield depends on normal for them. L1 and L2 are the inductances of information channels of PV board and power module. Utilizing L1 and L2 as in arrangement through info source modify Photo voltaic as well as Fuel Cell component towards current sources. r1 along with r2 are the resistances of Vpv 'S as well as Vfc 'S respectively and RL is the load resistor . S_1, S_2, S_3, and S_4 are the control switches. And the Diodes D_1, D_2, D_3, and D_4 are utilized to construct the modes, which will be portrayed. Capacitor C1 is utilized to build yield addition and yield capacitor Co is executed as a yield voltage channel. The model is working in persistent lead method towards deliver level current through slightest conceivable measure of current swell.

III. THREEE MODES OF OPERATING

In this segment, standards of the existing three level converters are talked about. Task of the DC-DC converter is separated into three states:

A: The load is provided by Photo voltaic cell and Fuel Cell also battery is not utilized.

B: The load is provided by Photo voltaic cell; Fuel Cell, along with battery, here battery is during discharging mode.

C: The load is provided by Photo voltaic cell; Fuel Cell, along with battery is during charging mode.

A. The load is provided by Photo voltaic cell and Fuel Cell also battery is not utilized:

In the condition, while shown in Figure. 3, around the three operating methods. Amid this express, the framework is working not including battery charging or releasing. In this manner, there are two ways for current to stream (through S3 and D3 or D1 and S4). In this paper, S3 and D3 is considered as basic

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way. Be that as it may, D1 and S4 could be picked as an elective way. Amid this state, switch S3 is for all time ON and turn S4 is OFF Position.

Mode 1: (0 < t <d1T): In the interim, switches are S1, S2, S3, and diode D3 is turn ON. And the Inductors L_1 and L_2 are charges by means of intensity sources Vpv and Vfc, individually [see in Fig. 3(a)].

Mode 2: (d1T < t <d2T): In this interim, turn S1 is killed and D2 is turned ON and S2, S3, and D3 are still ON. Inductor L2 is as yet charged and inductor L1 is being released by means of Vpv − Vfc.

Mode 3: (d2T < t <T): In this interim, S1 is turn ON Position along with S_2 is killed and S3 along with D3 are still ON. Inductor L1 is accused of VPV and inductor L2 is released by means of Vpv + Vc1–Vo.

Through be relevant the voltage source second equalization low above the inductors L1 and L2, voltage of capacitor C_1 along with yield voltage be able to be acquired since pursues:

$$L_1 : d_1[V_{pv} - r_1 i_{L1}] + (d_2 - d_1)[V_{Pv} - r_1 i_{L1} - V_{C1}] + (1 - d_2)[V_{PV} - r_1 i_{L1}] = 0 \quad (1)$$

$$V_{C1} = \frac{V_{Pv} - r_1 i_{L1}}{d_2 - d_1} \quad (2)$$

$$L_2 : d_2[V_{FC} - r_2 i_{L2}] + (1 - d_2)[V_{FC} + V_{C1} - r_2 i_{L2} - V_o] \quad (3)$$

$$V_o = \frac{(d_2 - d_1)[V_{FC} - r_2 i_{L2}] + (1 - d_2)[V_{FC} - r_1 i_{L1}]}{(1 - d_2)(d_2 - d_1)} \quad (4)$$

By apply the current subsequent equilibrium low more than the capacitors C_1 and C_o, voltage source of capacitor C_1,

$$C_1 : (d_2 - d_1)[i_{L1}] + (1 - d_2) i_{L2} = 0 \quad (5)$$

$$C_0 : (1 - d_2) i_{L2} = \frac{V_0}{R_{Load}} \quad (6)$$

In this mode, battery is not use in addition to therefore

$$i_{batt} = 0 \ , P_{batt} = 0 \quad (7)$$

B. Second Operating State (Load is Supplied by PV, FC, and Battery)

In this condition, as exposed in Figure. 4, around four operational methods. Amid the express, the load is provided by each and every one information source (Photovoltaic, Fuel Cell, as well as battery). In first mode, there is just a single current way. Where in other three modes, there are two current ways (through S3 and D3 or D1 and S4). In this state, current moves through D1 and S4. Switch S4 is ON state for all time in this state.

Mode 1: (0 < t <d1T): In this intervening, S_1, S_2, S_3, in addition to S_4 be turn ON position. And the Inductors L_1 and L_2 are charge by Vpv + V battery and Vfc + V battery, individually.

Mode 2: (d1T < t <d2T): In this interim, S_1, S_2, S_4, and D_1 are turn ON position. And the Inductors L_1 and L_2 are charge by Vpv and Vfc , individually.

Mode 3: (d2 T < t <d3T): during this interim, S_2, S_4, D_1, and D_2 are turn ON. Inductor L1 is released towards capacitor C1 and L2 is charged by Vfc.

Mode 4: (d3T < t <d4T): In this interim, S1, S4, D1, and D4 be turn ON. Inductor L_1 is charge by Vpv and inductor L2 releases C1 to the yield capacitor.

Through relate the voltage next parity short above the inductors L_1 along with L_2, we have

$$L_1 : d_1[V_{pv} + V_{batt} - r_1 i_{L1}] + (d_2 - d_1)[V_{Pv} - r_1 i_{L1}] + (d_3 - d_2)[V_{PV} - r_1 i_{L1} - V_{C1}] + (1 - d_3)[V_{Pv} - r_1 i_{L1}] \quad (8)$$

and then

$$V_{C1} = \frac{V_{Pv} + V_{batt} - r_1 i_{L1}}{d_2 - d_1}$$

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$$L_2 : d_1[V_{FC} + V_{batt} - i_2 i_{L2}] + (d_3 - d_2)[V_{FC} - r_2 i_{L2}] + (1 - d_3)[V_{FC+V_{C1}} - r_2 i_{L2} - V_o] \quad (9)$$

$$V_o = \frac{(d_3 - d_2)(V_{FC} + d_1 V_{batt} - r_2 i_{L2}) + (1 - d_3)(V_{PV} + d_1 V_{batt} - r_1 i_{L1})}{(1 - d_3)(d_3 - d_2)} \quad (10)$$

By apply the current next stability short above the capacitors C_1 along with C_o, voltages of capacitor C_1, we contain

$$C_1 : (d_3 - d_2)[i_{L1}] - (1 - d_3) i_{L2} = 0 \quad (11)$$

$$C_0 : (1 - d_3) i_{L2} = \frac{V_o}{R_{Load}} \quad (12)$$

In the present condition, the applied current with power of battery is able to design as (13) with (14), correspondingly

$$i_{batt} = d_1(i_{L2} + i_{L1}) \quad (13)$$

$$P_{batt} = V_{batt}[d_1(i_{L2} + i_{L1})] \quad (14)$$

C. Third process condition (Load is Supplied through Photovoltaic with Fuel Cell While Battery is during Charging sort)

In the present method, while revealed in Figure. 5, total around four operational modes. Through this condition, Photovoltaic along with Fuel Cell charges the battery as well as supply the power towards load.

Inside the first and 2nd development strategies, spherical be viable current-day strategies amid S3 truly as D3 typically D1 and S4). The way D1 and S4 is picked to circulation the modern-day-day on this case. Within the midst of this condition, turn S3 is all the time starting is OFF function simply as diode D1 may be conducts.

Mode 1: (zero < t <d1T): in this ruin, S1, S2, S4, virtually as D1 are switch on characteristic. Also, the Inductors L1 in truth as L2 are rate by using the use of Vpv and Vfc , one by one.

Mode 2: (d1T < t <d2T): in this break, S2, S4, simply as D1 are prompt feature. Also, the Inductor L1 is discharged to capacitor C1 and inductor L2 is charge by Vfc.

Mode 3: (d2 T < t < d3 T): in this spoil, S1, S2, D1, sincerely as D3 are turn on characteristic. Additionally, the Inductors L1 along L2 are price via manner of Vpv – V battery and V fc – V battery , one by one.

Mode 4: (d3 T < t < d4 T): on this gift destroy, S1, S4, D1, and D4 are set off feature. Moreover, the Inductor L1 is accuses of Vpv− V battery and inductor L2 is discharged by way of the use of manner of Vfc − VC 1 – Vo.

Figure 3 represents exchanging design for each state and every mode. To satisfy exchanging activity, a saw tooth signal while a bearer is contrasted and flags d1, d2, d3, and d4, this can autonomously manage on condition of intensity switch operations. Exclusive of in view of capitulate voltage use intensity of every source Photovoltaic, Fuel Cell, along with battery be able to be control the utilizing d1, d2, d3, and d4 diodes. The voltage addition of the exixting dc-dc two level converter is contrasted. As shown in this outline, the voltage increase of the suggested converter is advanced than the proposed converter.

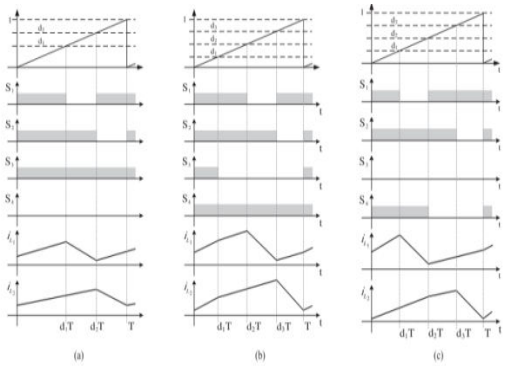

Figure 3. switch mode operations of the first three conditions. (a) First condition. (b) Second condition. (c) Third condition.

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III. Proposed Multi input inaccessible Three Level Converter

A) Proposed Description

The prepared multi input DC-DC converter is largely established at the interest of the three size separated dc-dc proposed converter. What is greater, the helper detail rectifier have the ability to likewise a half of of interface rectifier joined via a faucet twisting for low yield voltage tool, typically a whole append rectifier for raised yield voltage software as regarded in Fig.7. On the same time as the PulseWidthModuation plot now resembles thatin 3-stage dc-dc converters, the oversee multifaceted nature isn't escalated. The improve inductors, associated with the data wellsprings of severa voltages, are accuse while S2 along of S3 are because of this on characteristic, independently. Proper whilst the associated switch S2 otherwise S3 is murdered, the strength set away amid the inductor is traded within the path of the stack. The more or missing terrific is each acclimatized or compensated bythe dc interface capacitors. In the meantime, S1 in the direction of S4 be traded toapply Vdc/2, – Vdc/2, surely as 0 feature voltage over the number one sideof the transformer. In courting with the 2-prepare associate, two effective switches and lift diodes are abstained from; however the congestion diodes are added to avert the turnaround contemporary-day fromthe dc interface capacitors.

The jogging request of the circuits are given in Fig.Three.3. It want to be seen that the ones running modes are regarded as even as iL2> iL1. For this example, iL2,pkis better than simple component of the transformer at consistent u . S .. Underneath this situation, iL1,pk is humbler than critical component of thetransformer at reliable nation. If iL1> iL2, the proportionate circuitswould be now not same to the handiest showed here. Basically, thecharging/discharging current of C1 and C2 can be exchanged.

Meantime 1 [t < t0]: before t0,S3 is off and S1 is on. Theenergy placed away in L2 is launched to the heap thru the primarywinding of the transformer. The abundance electricity is traded toC1 thru the frame diode of S1. As dreams be, S1 can beturned on under zero voltage with turning into time eliminate. The currentof L1 will boom without delay below V1. Complete scale present day-day of L2 chargesC2. Then, −Vdc/2 is associated with the important facet of thetransforme

$$d\begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ v_{C1}(t) \\ v_{C2}(t) \\ i_{L0}(t) \\ v_{C0}(t) \end{bmatrix} / dt = \begin{bmatrix} V_1/L_1 \\ \left(V_2 - v_{C1}(t) - v_{C2}(t)\right)/L_2 \\ \left(i_{L2}(t)/C_1 - Ni_{L0}(t)\right)/C_1 \\ i_{L2}(t)/C_2 \\ \left(V_{C1}(t)/NL_0 - V_{C0}(t)\right)/L_0 \\ i_{L0}(t)/C_0 - v_{C0}(t)/C_0R_0 \end{bmatrix} \quad \textbf{(8)}$$

Interval 2 [t0< t < t1]: At t = t0, the current of L1 becomes equal to that of important aspect of the transformer. From this minute on, C1 releases over the essential detail of the transformer to the heap. The current of capacitor C2 is same to that of L2. The state equations are equal as in (1).

Interval 3 [t1< t < t2]: At time t = t1, the flows of inductor L2 and capacitor C2 scopes to 0. The heap contemporary is virtually supplied via capacitor C1. The current of L1 continues on placing away the strength laid low with voltage V1

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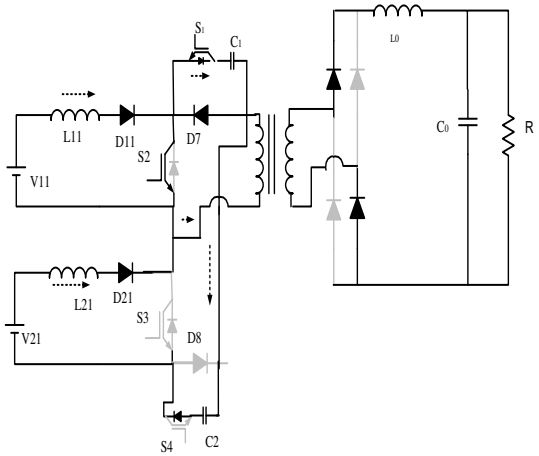
$$d\begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ v_{C1}(t) \\ v_{C2}(t) \\ i_{L0}(t) \\ v_{C0}(t) \end{bmatrix} / dt = \begin{bmatrix} V_1/L_1 \\ 0 \\ -Ni_{L0}(t)/C_1 \\ 0 \\ \left(V_{C1}(t)/NL_0 - V_{C0}(t)\right)/L_0 \\ i_{L0}(t)/C_0 - v_{C0}(t)/C_0R_0 \end{bmatrix} \quad (9)$$

Interval 4[t2< t < t3]: inside the start of this c program language period, S1is developed to wind up off. The contemporary in the spillage inductance makes D7in conduction and the essential viewpoint cutting edge freewheels, thus, 0 voltage is applied over the essential aspect of the transformer. The output inductor voltage is same to −Vo and the yield inductor current decreases directly

$$d\begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ v_{C1}(t) \\ v_{C2}(t) \\ i_{L0}(t) \\ v_{C0}(t) \end{bmatrix} / dt = \begin{bmatrix} V_1/L_1 \\ 0 \\ 0 \\ 0 \\ -V_{C0}(t)/L_0 \\ i_{L0}(t)/C_0 - v_{C0}(t)/C_0R_0 \end{bmatrix} (10)$$

Interval 5 [t3 < t < t4]: At time t = t3,switch is S3 grew to become on, on the equal time as S2is stored on. The essential thing cutting-edge continues on freewheeling and zero voltage is installation over the crucial factor; ultimately, the outputcurrent ofinductor nonstop to lower underneath yield voltage.In a comparable time V2 is attached crosswise over inductor L2 and cutting-edge increments linearlystoring the energy in L2.

$$d\begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ v_{C1}(t) \\ v_{C2}(t) \\ i_{L0}(t) \\ v_{C0}(t) \end{bmatrix} / dt = \begin{bmatrix} V_1/L_1 \\ V_2/L_2 \\ 0 \\ 0 \\ -V_{C0}(t)/L_0 \\ i_{L0}(t)/C_0 - v_{C0}(t)/C_0R_0 \end{bmatrix} (11)$$



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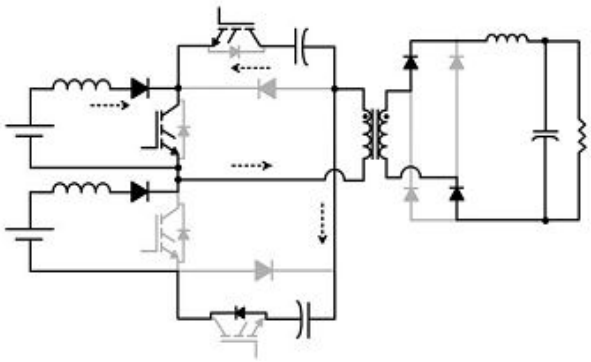

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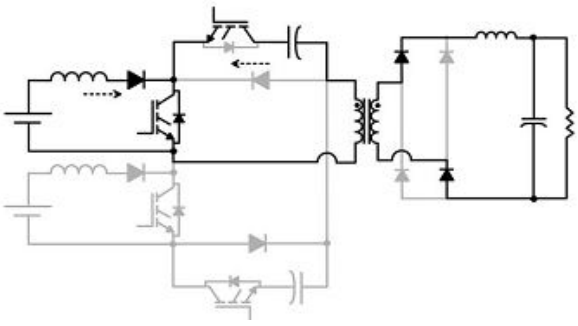

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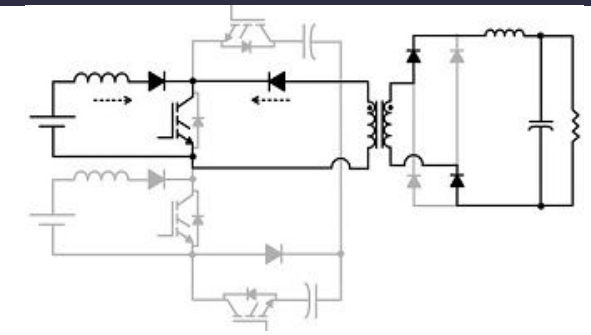

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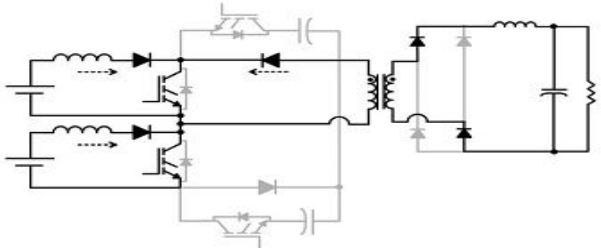

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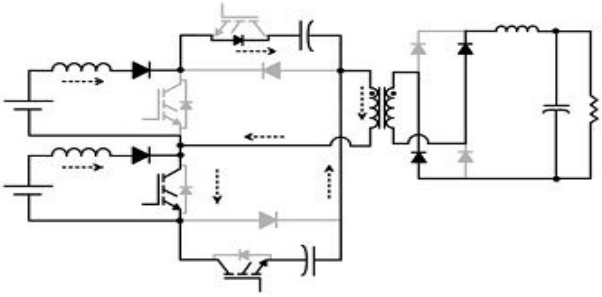

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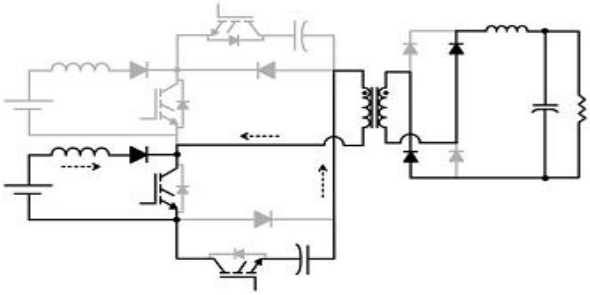

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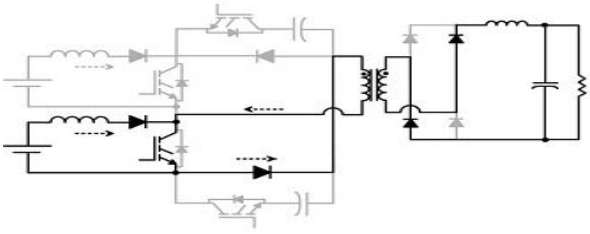

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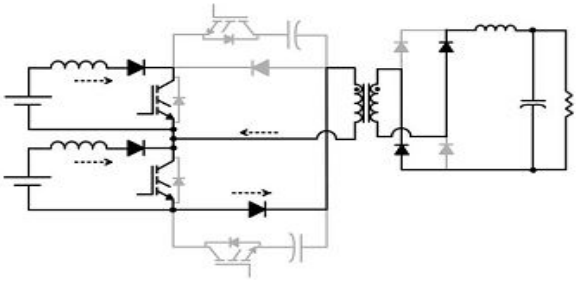

(i)

Fig.4. Operation intervals of the converter. (a) Interval 1: t < t0. (b) Interval 2: t0 < t < t1. (c) Interval 3: t_1< t < t_2. (d) Interval 4: t_2< t < t_3. (e) Interval5: t_3< t < t_4. (f) Interval 6: t_4< t < t_5. (g) Interval 7: t_5< t < t_6. (h) Interval 8: t_6< t < t_7. (i) Interval 9: t_7< t < t_8.

Interval 6 [t4 < t < t5]: At time t = t4,transfer S2 is became off. The stored power in L1 is discharged to the load in addition to to capacitor C1. The maximum current-day of L1 is smaller than the weight current in this example. The capacitor C2 discharges over to the burden and Vdc/2 is applied during the number one aspect of the transformer. The current of L2 maintains to store energy beneath the have an effect on of V2

$$d\begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ v_{C1}(t) \\ v_{C2}(t) \\ i_{L0}(t) \\ v_{C0}(t) \end{bmatrix} / dt = \begin{bmatrix} \left(V_1 - v_{C1}(t) - v_{C2}(t)\right)/L_1 \\ V_2/L_2 \\ i_{L1}(t)/C_1 \\ i_{L1}(t)/C_2 - N i_{L0}/C_2 \\ \left(V_{C2}(t)/NL_0 - V_{C0}(t)\right)/L_0 \\ i_{L0}(t)/C_0 - v_{C0}(t)/C_0 R_0 \end{bmatrix} \quad (12)$$

Interval 7 [t5 < t < t6]: At time t = t5, the energy stored in L1 is completely discharged . Its current reaches to zero at DCM. Current to the load is only supplied by C2

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$$d\begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ v_{C1}(t) \\ v_{C2}(t) \\ i_{L0}(t) \\ v_{C0}(t) \end{bmatrix} / dt = \begin{bmatrix} 0 \\ V_2/L_2 \\ 0 \\ -Ni_{L0}(t)/C_2 \\ \left(V_{C2}(t)/NL_0 - V_{C0}(t)\right)/L_0 \\ i_{L0}(t)/C_0 - v_{C0}(t)/C_0R_0 \end{bmatrix} \quad (13)$$

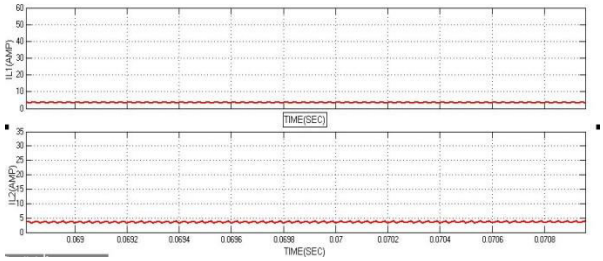
Interval 8 [t6 < t < t7]: In this time interim, S4 is killed. The current in the spillage inductance conducts D8 and the primary side current freewheels, subsequently, zero voltage is associated across the basic side of the transformer. The current of L2 increases continuously

$$d\begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ v_{C1}(t) \\ v_{C2}(t) \\ i_{L0}(t) \\ v_{C0}(t) \end{bmatrix} / dt = \begin{bmatrix} 0 \\ V_2/L_2 \\ 0 \\ 0 \\ -v_{C0}(t)/L_0 \\ i_{L0}(t)/C_0 - v_{C0}(t)/C_0R_0 \end{bmatrix} \quad (14)$$

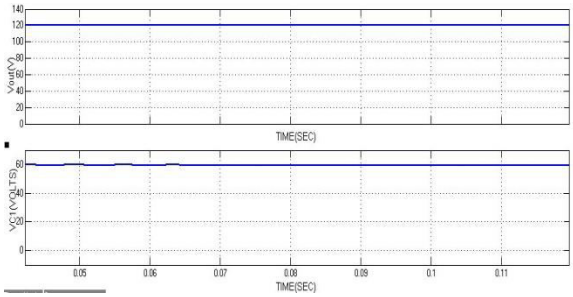
Interval 9 [t7 < t < t8]: At time t = t7,S2is have grow to be on and within the interim S3 remains at on-state. The vital element present day keeps to circulate thru D8. The present day of the two inductors L1 and L2increase straightly beneath the associated facts voltages

$$d\begin{bmatrix} i_{L1}(t) \\ i_{L2}(t) \\ v_{C1}(t) \\ v_{C2}(t) \\ i_{L0}(t) \\ v_{C0}(t) \end{bmatrix} / dt = \begin{bmatrix} V_1/L_1 \\ V_2/L_2 \\ 0 \\ 0 \\ -v_{C0}(t)/L_0 \\ i_{L0}(t)/C_0 - v_{C0}(t)/C_0R_0 \end{bmatrix} \quad (15)$$

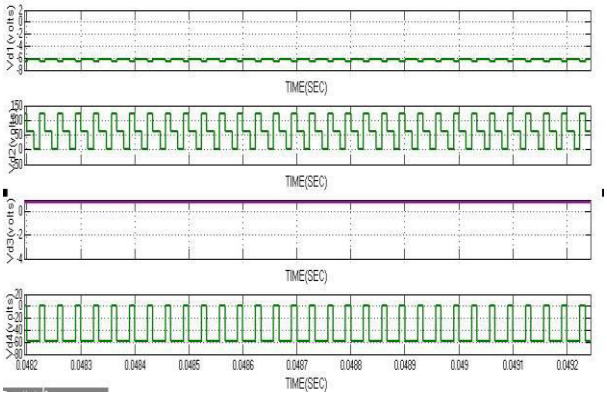
IV. MATLAB/ SIMULATION RESULTS



(a) simulation results of inductors L1 and L2 currents of the stage-1 operation



(b) Simulation results of Load voltage and capacitance voltage of the stage-1 operation



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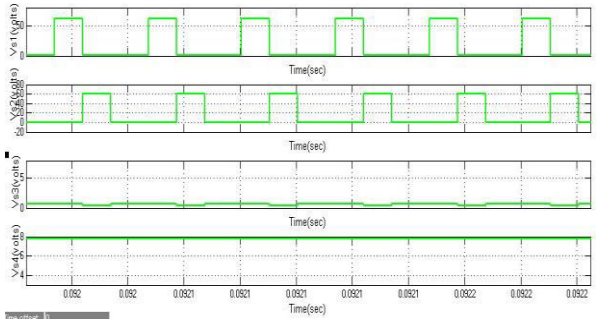
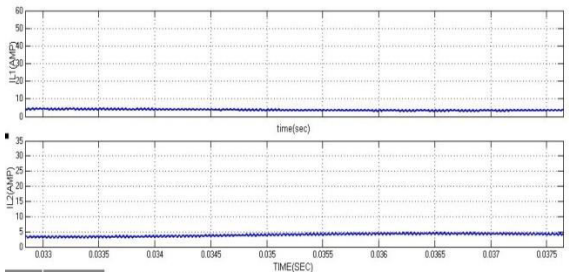
(c) simulation results of diodes voltage of the stage-1 operation

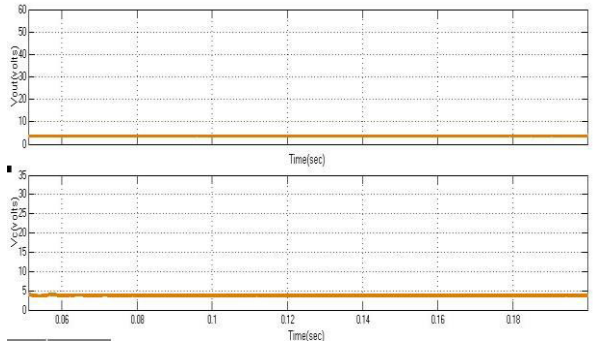


(d) Simulation results of switches voltage of the stage-1 operation

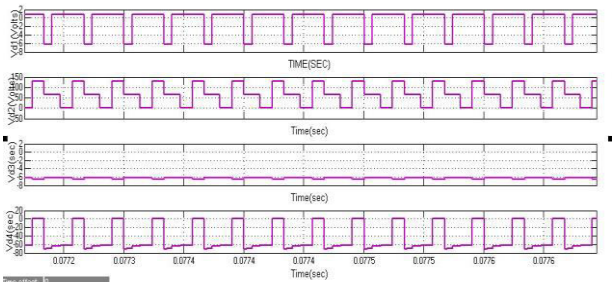
Fig. 5. Simulation results of the stage-1 operation (first state).



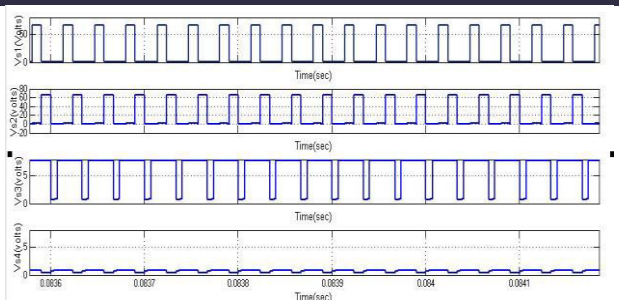
(a) simulation results of inductors L1 and L2 currents of the stage-2 operation



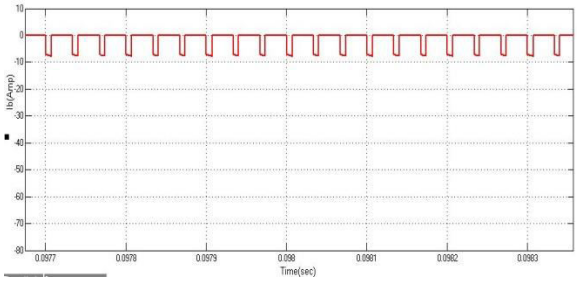
(b) Simulation results of Load voltage and capacitance voltage of the stage-2 operation



(c) simulation results of diodes voltage of the stage-1 operation

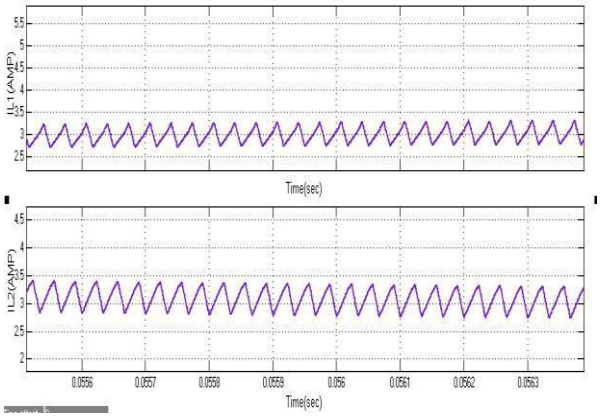


(d) Simulation results of switches voltage of the stage-2 operation

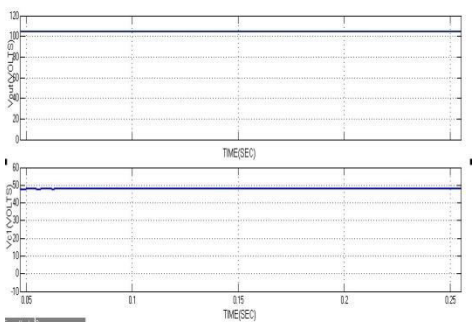


(e) Simulation results of battery current of the stage-2 operation

Fig. 6. Simulation results of the stage-2 operation (second state).



(a) simulation results of inductors L1 and L2 currents of the stage-3 operation



(b) Simulation results of Load voltage and

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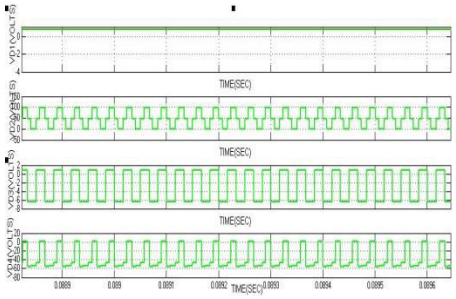
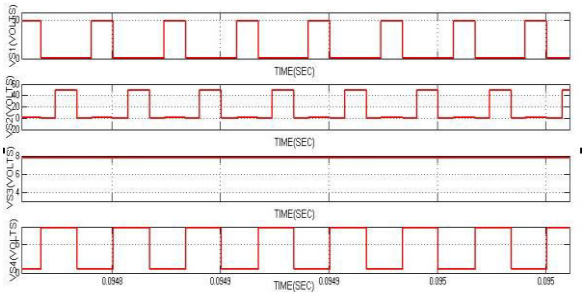
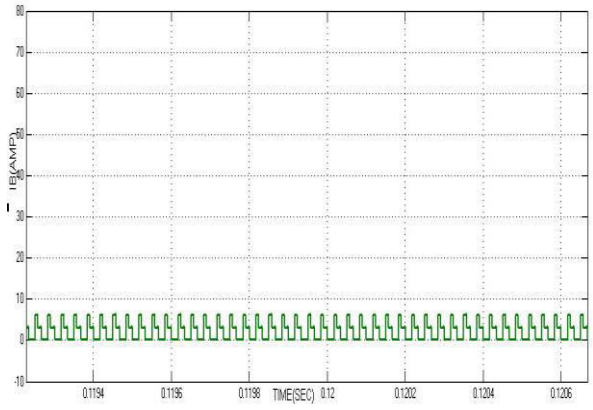
capacitance voltage of the stage-3 operation



(c) simulation results of diodes voltage of the stage-3 operation



(d) Simulation results of switches voltage of the stage-2 operation



(e) Simulation results of battery current of the stage-3 operation

Fig. 7. Simulation results of the stage-3 operation (second state).

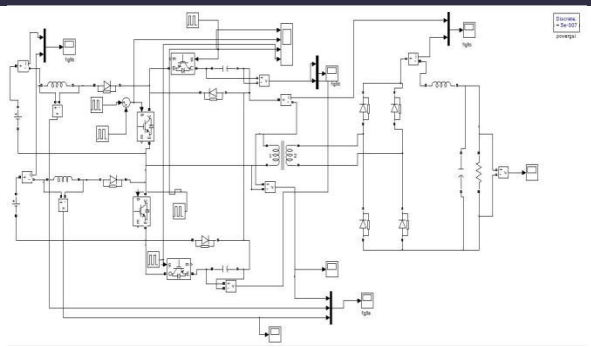
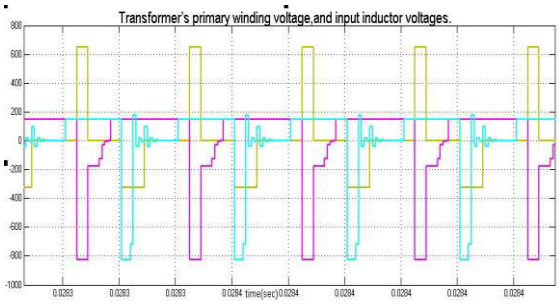
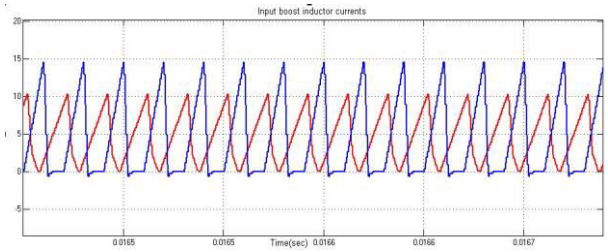


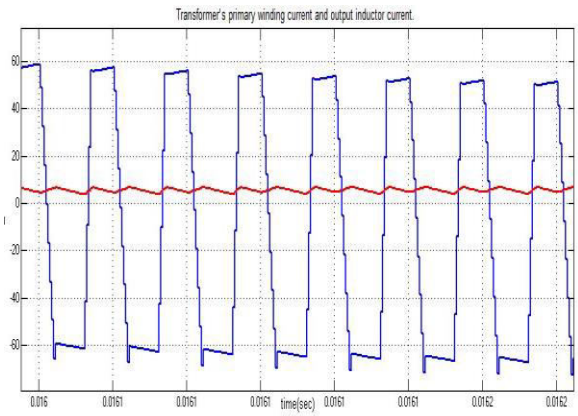
Fig. 8. Simulink diagram of proposed three levels DC-DC converter



(a) Simulation results of Transformer's primary winding voltage, and input inductor voltages



(b)) Simulation results of Input boost inductor currents.



(c) Simulation results of Transformer's primary winding current and output inductor current.

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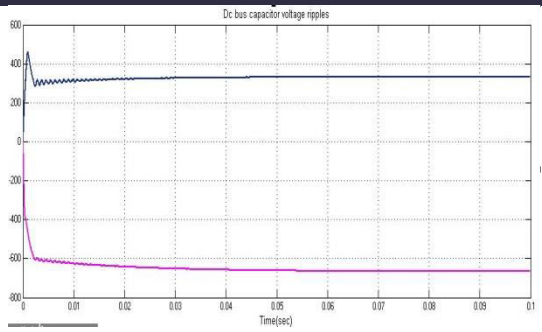
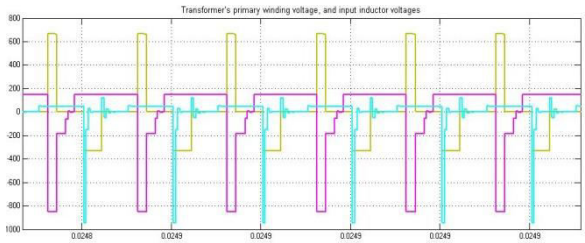
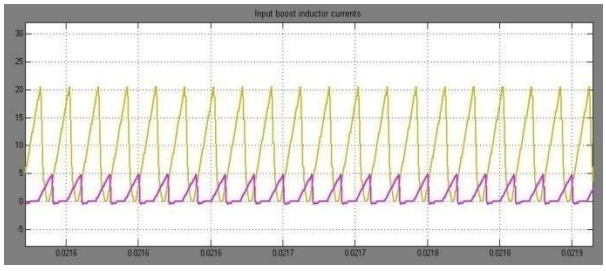


(d) Simulation results of Dc bus capacitor voltage ripples.

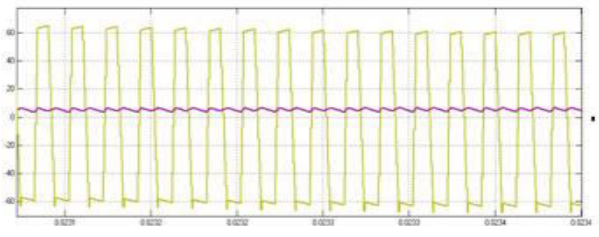
Fig. 9. Simulation results of new three level proposed DC-DC Converter at V1 &V2 are equal (150 V), & Inductor-1 (L1 =200 µH), Inductor-2 (L2 = 100 µH).



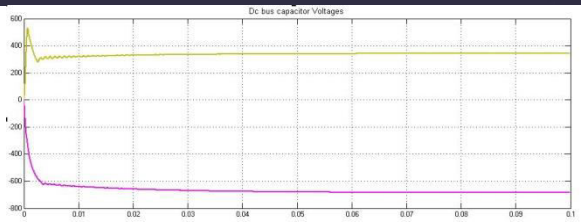
(a) Simulation results of Transformer's primary winding voltage, and input inductor voltages



(b) Simulation results of Input boost inductor currents.



(c) Simulation results of Transformer's primary winding current and output inductor current.



(d) Dc bus capacitor voltage ripples.

Fig. 10. Simulation results of new three level proposed DC-DC Converter at V1=150 V &V2=50 V, & Inductor-L1, Inductor-2 L2 are equal to 100 µH.

V. CONCLUSION

The multi input bidirectional DC-DC converter was intended to incorporate in excess of two DC sources with various voltage levels which discovers application in HEV. The multi input bidirectional converter can control the power stream between each pair of sources. The expected voltage to drive a three stage enlistment engine is gotten by photograph voltaic cells and multi input bidirectional DC-DC converter. MPPT control method is utilized to extricate the most extreme power from sun oriented radiation. Rather than utilizing singular converter in mixture framework utilizing multi input bidirectional DC-DC converter is lessens the framework size and cost. Accordingly proposed converter gives the better productivity however sounds displays in voltage source. The execution of the framework has been checked by re enactment utilizing MATLAB/SIMULINK condition.

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