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DESIGN AND PERFORMANCE ANALYSIS OF SOLAR BASED MULTI PORT DC-DC CONVRETRES FOR EV APPLICATIONS

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ABSTRACT: In this study, we presented a multi-port charger for electric vehicles that runs on solar power. Generally speaking, the solar system is crucial to EV applications. In applications involving electric vehicles (EVs) and portable electronics, multiport converters are crucial. Various single-input multi-output (SIMO) converter configurations are described in the literature. The majority of SIMO converters provide outputs with operating restrictions on inductor charging and duty ratio. In the design of SIMO converters, the cross-regulation issue remains a challenge. This paper suggests a SIMO topology to get over the previously listed restrictions. With no restrictions on duty cycle or inductor currents (i.e., iL1 > iL2 > iL3 or iL1 < iL2 < iL3), it can produce three distinct output voltages. Since the suggested topology does not have cross regulation issues, changes in the output current i03 (i02) (i01) have no effect on the load voltage V01 (V02) (V03). During control, the loads are separated from one another. The MATLAB/SIMULINK setup simulates the suggested.

KEYWORDS: SIMO, EV'S, DC-DC, Converter, Solar.

I.INTRODUCTION: The usage of sustainable power sources in electric vehicles (EVs), assistant power, and matrix-related applications has grown in popularity over the past ten years [1][5]. Compared to a few distinct single info DC converters, multiport DC converters are essential for hybridizing energy sources in various applications, which reduces the number of parts, complexity, and cost of the system [6], [7]. MPC converters have been on the market for the past ten years. In [8], an additional SIMO converter is suggested. In the meantime, this architecture generates lift, buck, and transformed yields that are autonomously managed. In either case, n C 2 switches are needed to produce 'n' voltage levels, increasing the converter's overall size and cost. In [9], unexpected errors in determining state-space conditions and result voltages for a SIMO converter presented in [8] are addressed. In contrast to single inductor SIMO converters, the single coupled inductor-based SIMO buck was presented in [10] with a lower result inductor current wave. With regard to cross-coupling difficulties, Nayak and Nath [11] lavishly introduced the relative execution of SIDO converters in light of the coupled inductor and single inductor (SI). Additionally, they proposed that the linked inductor SIDO converter performs better in transients and constant states. In addition, in a SI SIMO design, the inductor is switched between the heaps, resulting in cross-guideline problems and high waves.

Different control approaches are proposed in the writing to conquer the cross-guideline issue in a solitary inductor-based SIMO converter; the ongoing indicator regulator is introduced in [12] rather than the ordinary charge balance approach. Nonetheless, producing the obligation proportions for dynamic switches has been to some degree confounded. Additionally, the miscreant based control approach is introduced. It depends on yield current spectator, and thus it is delicate to the commotion and huge parametric varieties. In a multivariable computerized regulator based SIMO converter is proposed to limit the voltage swells, stifle the cross-guideline issues, and control the result voltages. Nonetheless, regulator configuration might prompt an expansion in intricacy.

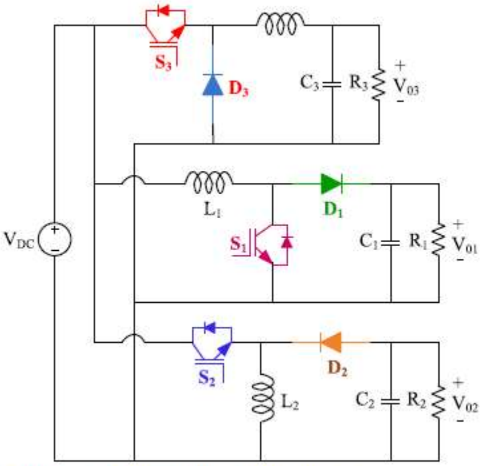


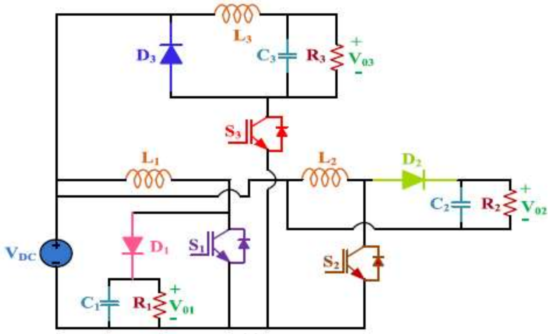
FIGURE 1. Diagram of conventional SIMO converter.

Non-segregated and single switch SIMO converter geography is introduced. It has less part and diminishes the expense of the framework. Be that as it may, it very well might be trying to autonomously direct the results. To reduce the issues in a solitary inductor SIMO converter, a non-disengaged SIMO converter is proposed in which are freely managed the result voltages and doesn't need an extra control circuit. In [16], another SIDO converter geography is proposed to coordinate buck and super lift converter for creating the move forward and step-down yield voltages for electrical vehicle applications. It has a requirement working proportion viz. D2 < D1, which restricts the activity range ofD1 by increasingD2. The geographies proposed in have less semiconductor switches. Nonetheless, the activity of the converter depends on the charging season of inductors (i.e., iL1 > iL2). So this keeps the limitation working proportion. The blend of high addition move forward and SEPIC converter-based SIMO is proposed for PV applications. In this design, both the results are higher than the stock voltage and work on the result voltage by adding the capacitors and diodes. By and by, the quantity of capacitors and diodes influences cost and conduction misfortunes. SIDO buck-boost geography is created in to produce positive and negative results. A multi-yield converter is proposed in with the diminished part count. Be that as it may, it has more diodes, which increments conduction misfortunes. A construction of SIMO design is presented in with the upsides of diminishing the uninvolved channel size and low voltage pressure. High-thickness multi-yield converter is proposed in for versatile electronic applications in view of the front-end exchanged capacitor procedure with further developed power thickness and decreased exchanging misfortunes.

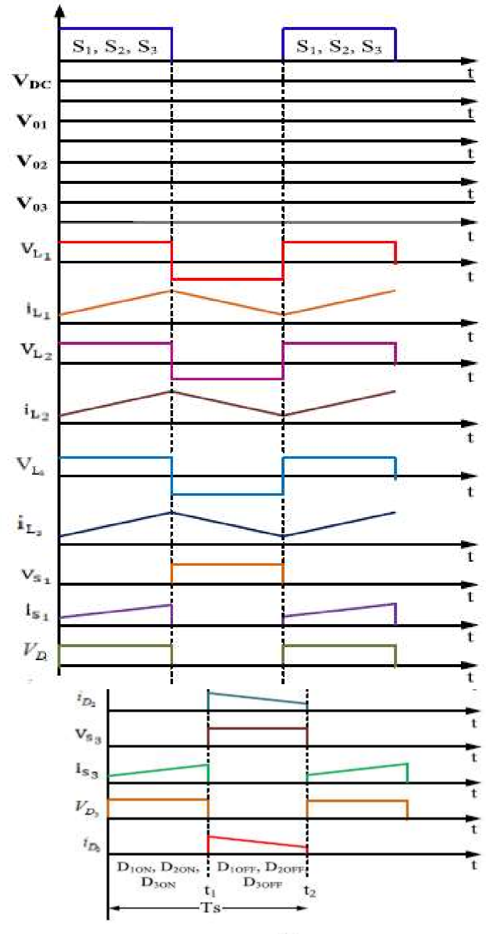
Adjusted SEPIC and interleaved-based high move forward SIMO converter are presented in [24]. It comprises of a voltage multiplier, coupled inductor, and changed capacitors to support the result voltage in reasonable energy applications. Nonetheless, it has intricacy because of additional parts. The SEPIC-CUK converter-based four-deliberately ease interleaved converter is recommended for SIMO applications. It enjoys the benefits of low wave voltage, minimized size and is reasonable for high power applications with a unique reaction. In the customary methodology, EVs' assistant power supply framework to deal with the heap prerequisites is displayed in Figure 1. It looks straightforward, yet the fundamental disadvantage of this approach is a cross-guideline issue, and the heaps are not disconnected from one another during their activity. There is likewise the possibility establishing issues while accusing the battery of at the same time turn-on loads and on the off chance that the ground is involved. Further, the circuit intricacy will increment to change over one of the negative result voltages into buck-boost activity mode.

II.PROPOSED SYSTEM: In the proposed work, the locally available power converter is the principal subject of the review. The arrangement of the circuit displayed in Figure 2(a) is to such an extent that energy put away in the inductor is bound to one result just and isn't imparted to different results during the control, which permits directing the result voltages with autonomous obligation cycles. All the more significantly, the heaps are segregated from one another during control, and the cross-guideline issue is effectively dispensed with. Additionally, everything looks great related with establishing as it is an installed power converter regardless of whether charging of battery and ground is involved.

The proposed single info three-yield DC setup is portrayed in Figure 2(a). In this setup the parts are as per the following, input voltage VDC, switches (S1-S3), diodes (D1-D3), and aloof components (L1-C1, L2-C2; and L3-C3). It can produce three different result voltages, i.e., support (V01), buck-help (V02) with positive voltage extremity, and buck (V03). The proposed converter is reasonable for autonomously controlling the result voltages by the obligation cycles D1, D2; furthermore, D3, separately. The hypothetical waveforms of circuit components are portrayed in Figure 2(b). The proposed arrangement is unique in relation to the ordinary equal mix of buck, boost, and buck-boost setup. In the proposed circuit design, the heaps are confined during the concurrent control. From the accompanying figures, one might see that during mode-1operation, load R3 alone through S3 is associated with the information power supply, yet different burdens are disengaged, as displayed in Figure 3(a). Essentially, during mode-2 just burden R1 alone through D1 is associated with the info supply, yet different burdens are segregated, as portrayed in Figure 3(b). In the proposed control procedure, every one of the heaps are detached from one another during their control in any method of activity. Notwithstanding, this element is unthinkable in the traditional equal blend of buck, boost, and buck-boost converters.



(a)

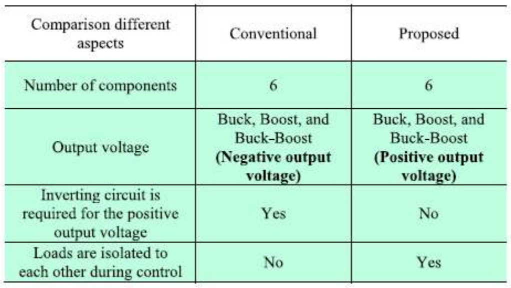


(b)

FIGURE 2. Proposed configuration: (a) SIMO configuration, (b) Theoretical waveforms.

This circuit arrangement appears to be quite straightforward, however it is unique and useful. Table 1 provides a comparison between the traditional and suggested SIMO converters in terms of the quantity of components, modes of operation, and operating circumstances

TABLE 1. Parameter specification comparison between the conventional and proposed SIMO converter.



Comparison different aspects	Conventional	Proposed
Number of components	6	6
Output voltage	Buck, Boost, and Buck-Boost **(Negative output voltage)**	Buck, Boost, and Buck-Boost **(Positive output voltage)**
Inverting circuit is required for the positive output voltage	Yes	No
Loads are isolated to each other during control	No	Yes

In the customary methodology displayed in Figure1, the primary disadvantage is the cross-guideline issue, and the heaps are not disconnected from one another during their activity. Further, the circuit intricacy will increment to change over the negative extremity of result voltages in the buck-help method of activity. The proposed structure enjoys the accompanying benefits:

a) It is a straightforward design and no suspicions on working obligation proportion (D1 > D2 > D3 or D3 < D2 < D1 or D1 = D2 = D3) b) It can produce three different result voltages, i.e., help, buck, buck-support() c) No imperatives on inductor flows (like iL1 > iL2 > iL3 or iL1 < iL2 < iL3 or iL1 =iL2 = iL3) d) Burdens are separated from one another during control and the cross-guideline issue is effectively killed e) It gives the positive buck-boost yield voltage

1) Exchanging STATE 1 Switches S1, S2, and S3 are turned ON. The ongoing stream way is portrayed in Figure 3(a); what's more, the energy port VDC charges L1, L2, and L3. Thusly, the C1 and C2 are released to the heaps (R1) and (R2), individually, though (C3) is charged. The inductor flows and capacitor voltages are addressed in Eq. (1)-(4).

$$i_{L_1}(t) = \frac{V_{DC}}{L_1}t + i_{L1(0)}, \quad v_{C_1}(t) = v_{C1(0)}e^{\frac{-1}{R_1C_1}t} \tag{1}$$

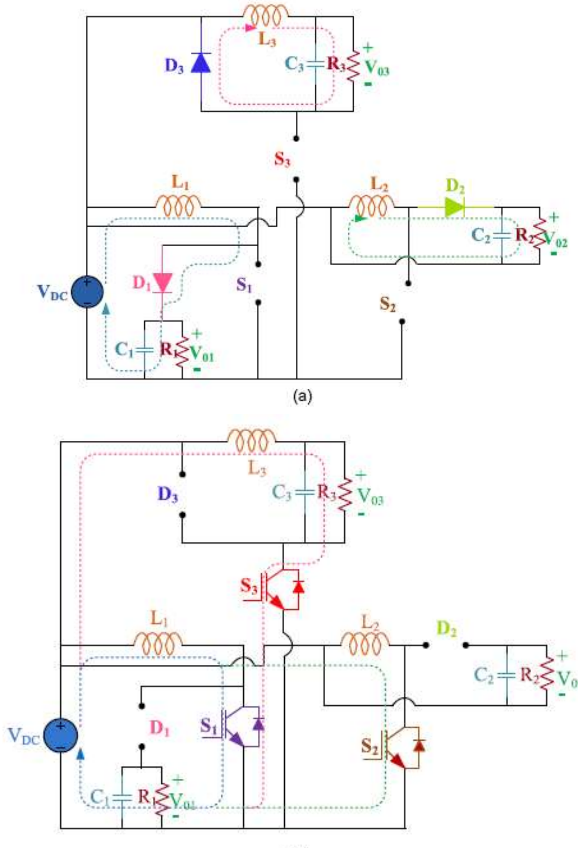
$$i_{L_2}(t) = \frac{V_{DC}}{L_2}t + i_{L2(0)}, \quad v_{C_2}(t) = v_{C2(0)}e^{\frac{-1}{R_2C_2}t} \tag{2}$$

$$i_{L_3}(t) = \frac{V_{DC}}{R_3} + e^{-\alpha t}\left[c_1 \cos\omega_d t + c_2 \sin\omega_d t\right] \tag{3}$$

$$v_{C_3}(t) = V_{DC} - \frac{L_3}{2C_3}e^{-\alpha t}\begin{bmatrix} \cos\omega_d t(\frac{\alpha c_1}{R_3} + \omega_d c_2) \\ + \sin\omega_d t(-\alpha c_2 + \frac{\omega_d c_1}{R_3}) \end{bmatrix} \tag{4}$$

2) SWITCHING STATE 2

In this condition, L1, L2, and L3 are demagnetized and, through D1, D2, and D3, respectively, supply their energy to the load.



(b)

FIGURE 3. **Operating states: (a) Switching state-1 and (b) Switching state-2.**

$$i_{L_1}(t) = \frac{V_{DC}}{R_1} + e^{-\alpha_1 t}\left[c_1 \cos\omega_{d1} t + c_2 \sin\omega_{d1} t\right] \tag{5}$$

$$v_{C_1}(t) = V_{DC} - \frac{L_1}{2C_1}e^{-\alpha_1 t}\begin{bmatrix} \cos\omega_{d1} t(\frac{c_1}{R_1} - \omega_{d1} c_2) \\ + \sin\omega_{d1} t(\omega_{d1} c_1 + \frac{c_2}{R_1}) \end{bmatrix} \tag{6}$$

$$i_{L_2}(t) = e^{-\alpha_2 t}\left[c_3 \cos\omega_{d2} t + c_4 \sin\omega_{d2} t\right] \tag{7}$$

$$v_{C_2}(t) = -L_2 e^{-\alpha_2 t}\begin{bmatrix} (-\alpha_2 c_3 + \omega_{d2} c_4)\cos\omega_{d2} t \\ + (\omega_{d2} c_3 - \alpha_2 c_4)\sin\omega_{d2} t \end{bmatrix} \tag{8}$$

$$i_{L_3}(t) = e^{-\alpha t}\left[c_5 \cos\omega_d t + c_6 \sin\omega_d t\right] \tag{9}$$

$$v_{C_3}(t) = -L_3 e^{-\alpha t}\begin{bmatrix} (-\alpha c_5 + \omega_d c_6)\cos\omega_d t \\ + (\omega_d c_5 - \alpha c_6)\sin\omega_d t \end{bmatrix} \tag{10}$$

$$\alpha_1 = \frac{1}{2R_1C_1}, \quad \omega_{d1} = \frac{1}{2}\sqrt{\left(\frac{1}{R_1^2C_1^2} - \frac{4}{L_1C_1}\right)},$$

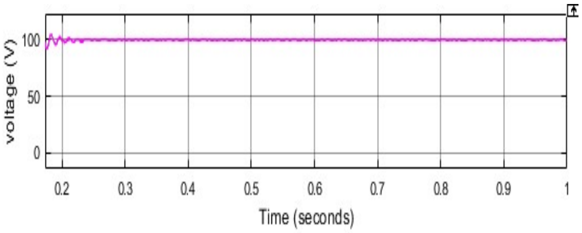
$$\alpha_2 = \frac{1}{2R_2C_2} \quad \text{and } \omega_{d2} = \frac{1}{2}\sqrt{\left(\frac{1}{R_2^2C_2^2} - \frac{4}{L_2C_2}\right)}$$

It is seen that during exchanging state-1operation, load (R3) alone through S4 is associated with the ground however different burdens are detached in any event, when the ground is involved during charging the battery, as displayed in Figure 3(a). Essentially, during exchanging state-2 just burden (R1) alone through D1 is associated with the ground, yet different burdens are separated starting from the earliest stage the heap (R1) as well as portrayed in Figure 3(b). In the proposed control system, every one of the heaps are detached from one another during their control during any method of activity. In addition, the arrangement of the circuit is to such an extent that energy put away in the inductor is restricted to one result in particular and isn't imparted to different results during the control and furthermore, which permits controlling the result voltages with free obligation cycles. Thus, the heap voltage V01 (V02) (V03) isn't impacted by the variety of burden current i03 (i02) (i01). Subsequently the proposed design with this control approach stays away from every one of the issues about cross guideline issues in any event, when the ground is involved during battery charging. All the more critically, the design is basic and it can create three free results with no presumptions on inductor flows (iL1 > iL2 > iL3 or iL1 < iL2 < iL3 or iL1 = iL2 = iL3) and additionally working obligation cycle.

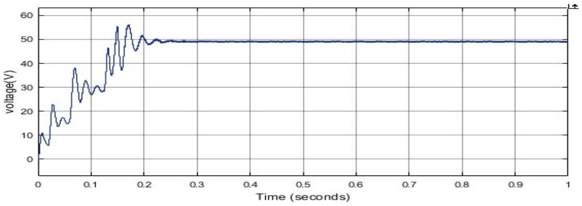
III.SIMULATION RESULTS

PI controller with constant voltage

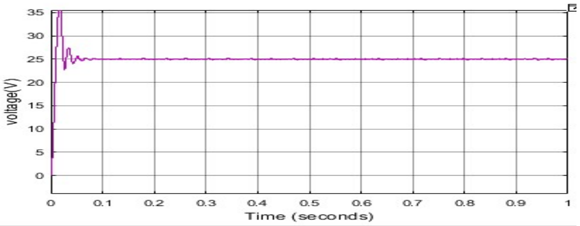
Simulation of PI controller with constant voltage



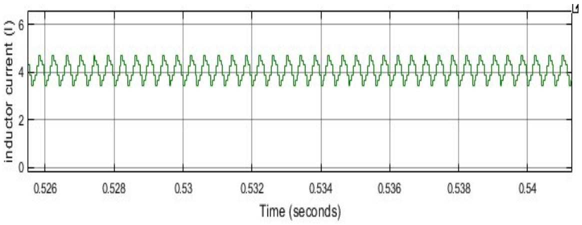
Phase 1 output voltage



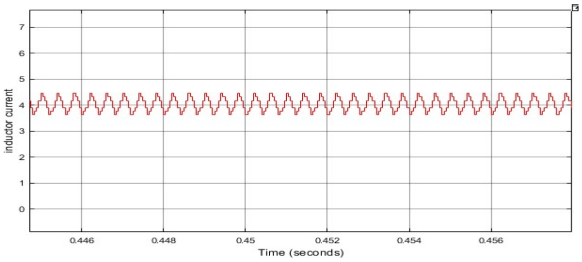
Phase 2 output voltage



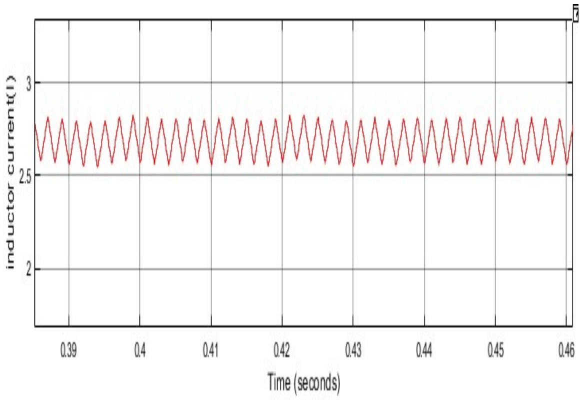
Phase 3 output voltage



Phase 1 inductor output current

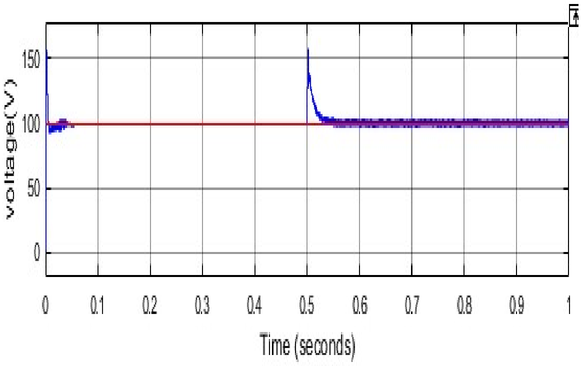


Phase 2 inductor output current

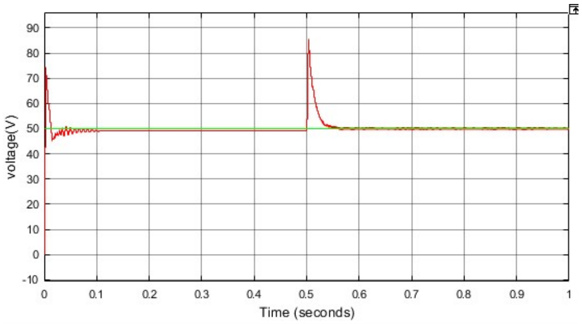


Phase 3 inductor output current

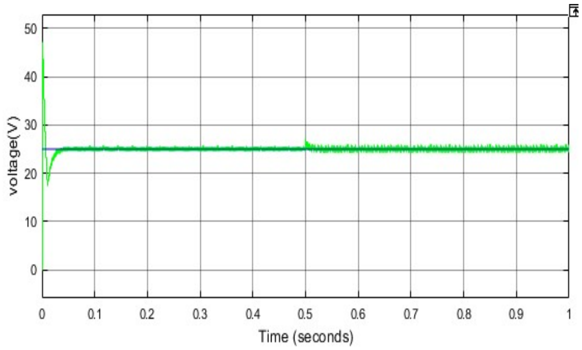
Case 2



Phase 1 output voltage

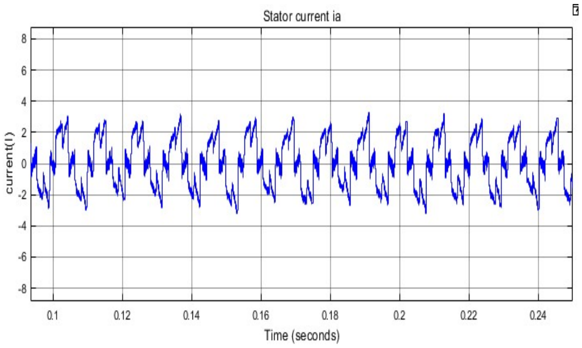


Phase 2 output voltage

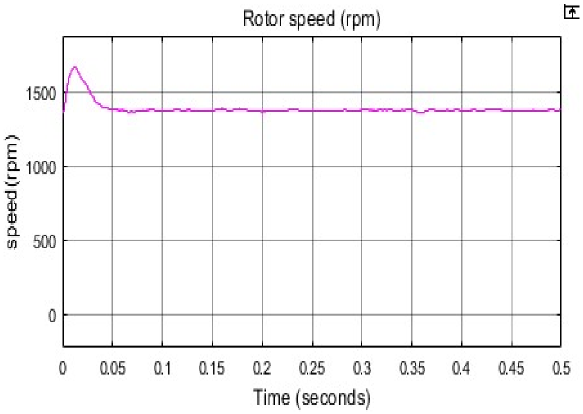


Phase 3 output voltage

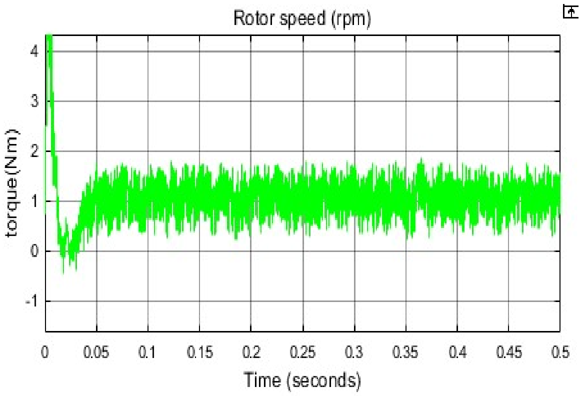
Case 3



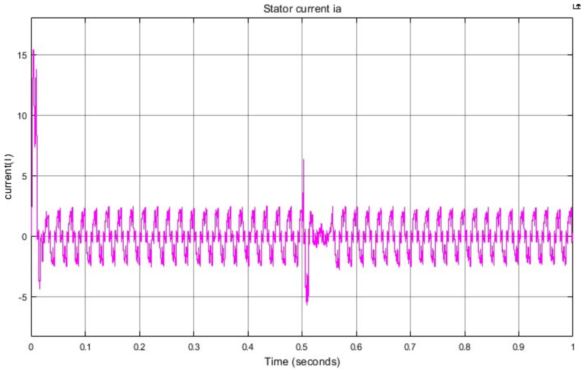
Stator current of phase 1



Rotor speed phase 1



Torque of phase 1



Stator current of phase 2

IV.CONCLUSION: We suggested a solar-based dc-dc converter for a solar EV charger in this research. The building of the SIMO converter is proposed in this study. There has been extensive discussion on operational theory and modalities of operation. The proposed configuration is simple and does not assume any particular charging or operating duty cycle of the inductors. It can supply the output voltages for buck, boost, and buck-boost with independently adjustable voltages. The output voltages are unaffected by the rapid change in inductor and load currents because the recommended topology does not have cross regulation problems. Lastly, the simulation's output confirms that the recommended converter operates as intended.

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