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MULTI-OBJECTIVE RECONFIGURABLE THREE PHASES ON-BOARD CHARGER FOR EV

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ABSTRACT

This paper deals with the control and implementation of solar photovoltaic (PV) array based multi-objective bi-directional charger beneficial for electric vehicle (EV), household load and utility. For EV, the charger provides the charging facility. For household load, the charger acts as a standalone inverter and for utility the charger acts as an active power filter. However, for providing the multi-functionality and the multimode operation capability of the charger, a reconfigurable control strategy is proposed. Moreover, an adaptive DC link voltage strategy is proposed for achieving the optimum voltage at DC link under all voltage conditions for achieving minimum ripple in grid currents. The charger also uses a voltage synchronization strategy for achieving the seamless mode transition between the grid connected and standalone modes. In grid connected mode, the charger uses a double second order generalized integrator (SOGI) based positive sequence estimator along with the improved linear sinusoidal tracer (ILST) based algorithm for generating the balanced and sinusoidal reference grid currents, under the unbalanced and distorted grid voltages. The charger is implemented in the laboratory, and the performance is presented under various steady-state and dynamic conditions.

Keywords
Electric vehicle, solar PV array, multi-objective charger, standalone, grid connected, uninterrupted supply, power quality, bi-directional power flow.

I. INTRODUCTION

Global warming issues and gasoline prices are increasing by the day. Because of its clean and environmentally favorable attributes, an electric car gets greater attention. This study proposes a greener approach to address fundamental transportation demands. When the electric cars equipped with energy storage devices are not in use, they may be linked to the grid to provide a large amount of energy for grid electricity [5]. The grid's power quality is also improved by combining energy storage with distributed energy sources. Electric vehicles emit less carbon dioxide, reduce greenhouse gas emissions, and are environmentally benign. The battery's lifetime and charging time are the two most significant issues for an electric car charging process. The restricted driving range, long charging time, and cost concerns those dealing with electric vehicle technology.

Long charging times impede the effectiveness of rapid charging solutions, hence new technologies are being developed to reduce charging times. Before going further with EV technology, infrastructure for reliable EV operation, such as charging stations and EV service stations, should be in place [1]. In EV technology, the charging station is critical, and it should be conveniently accessible. The solar PV array-based charging station should be situated in a region with sufficient sun irradiation. For a lengthy driving range, EV charging times should be decreased and accurate battery management systems used. Solar energy conversion systems are a renewable energy source that is abundant and free of charge all around the planet. Solar PV is a technology that converts solar energy into electricity. Solar PV cells have nonlinear properties and have a poor efficiency. Sun PV cell DC power production varies with solar irradiation and ambient temperature. This concept proposes a solar PV array-based charging station to reduce grid overloading while also lowering the charging stations running costs [1].

- 1-Vehicle to Grid (V2G), Vehicle to Home (V2H), and Grid to Vehicle (G2V) operation are all possible with a solar PV array-based multi-purpose EV charger.
- 2-The suggested technology will operate as an active power filter to reduce grid current harmonics.
- 3-During power exchange, the THD is within the IEEE 519 standard's limitations.

Alharbi et al. [15] have discussed the wind-PV integrated fast charging facility for the EV that optimizes the time of charging to mitigate the impact of fast charging on the power grid. Tavakoli et al. [16] have proposed the novel approach for energy exchange between the EVs and the wind energy generation unit participating in energy balancing and regulation market. Mehmood et al. [17] have discussed the optimum sizing of the battery in the wind and solar power distributed generation system. Shan et al. [18] have proposed the model predictive control of bi-directional DC-DC converter and AC-DC converter for wind PV battery micro grid. Saxena et al. [19] have discussed the grid integrated PV battery

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based system for an EV. However, the proposed system does not operate without a storage battery, and the charging of EV cannot be done. Zhang et al. [20] have proposed to utilize the parking lots for placing the PV panel to make the charging station. However, they only schedule the charging of EV to maximize the utilization of the PV array.

Yan et al. [21] have also utilized the PV battery based charging station. However, the primary aim of the work is to minimize the charging cost. Mouli et al. [22] have discussed the solar-powered EV charger. Choudhari et al. [23] have also optimized the charging cost of EV using the PV battery based charging station. From the critical review of the available literature, it is observed that the most of the work available, are related to the optimization of either the size of the PV unit, or the battery unit, or the cost of the charging, or charging scheduling to utilize the renewable energy optimally.

However, available literature lacks in an implementation of solar PV array integrated charger. Moreover, the chargers have not been much explored for other services such as a vehicle to grid active and reactive power, vehicle to home operation, power factor correction, active power filter operation etc. Moreover, the performance of the charger under the abnormality of the grid such as voltage unbalance, voltage distortion and voltage fluctuation, have not been discussed much. Therefore, this paper presents a grid-integrated PV array based EV charger that not only is used for EV charging but also for the services mentioned above. Abeywardana et al.[24] have proposed the EV charger that provides vehicle to grid reactive power. However, for providing reactive power, the DC link of VSC is regulated by the EV battery. Therefore, the EV battery is exposed to the undesirable ripple current that affects the life of the battery. Moreover, it discharges the EV battery over a long period. Similarly, Mojdehi et al. [25] have also advocated utilizing the EV as a reactive power provider. However, here also, the EV battery regulates the DC link voltage. Whereas, in the proposed paper, the active power required for DC link voltage regulation is drawn from the grid.

Therefore, the EV battery is not exposed to the ripple current. Moreover, the reactive power operation is possible even in the absence of EV, solar PV array and household loads. Restrepo et al. [26] have presented an EV charger that allows power exchange with the grid in all four quadrants. However, during the energy exchange, the power quality of grid currents and voltage is not considered. In this paper, the active power exchange with the grid always takes place at unity power factor (UPF) even with highly nonlinear household load because the only active current of the load is considered for reference grid currents generation. Due to this, only active power is exchanged with the grid. However, the harmonics and the reactive currents are compensated by the VSC.

Therefore, the charger also works as an active power filter. Monteiro et al. [27] have proposed the vehicle to home operation of the EV. However, during vehicle to home operation, the household linear loads are considered. However, the charger proposed in this paper operates with both linear and nonlinear loads. Prasanna et al. [28] have proposed a bidirectional charger topology for the charging of EVs with power factor correction. However, the operation of converter and power factor correction capability of the charger, are not discussed in under voltage and over voltage condition. In this paper, for satisfactory operation of the charger under voltage disturbances, an adaptive DC link voltage strategy is proposed. The main features of the proposed charger are as follows.

- It proposes a solar photovoltaic (PV) array, and grid-integrated electric vehicle (EV) charger, that not only is usedfor EV charging but also to supply the household load simultaneously, both in the presence of grid (grid connected) and in absence of grid (standalone).
- The proposed system operates as a standalone PV system and grid connected PV system in absence of the EV.
- In grid connected mode, the charger allows the EV owner to sell the EV energy to the grid for revenue generation in vehicle to grid mode.
- In standalone mode, the charger generates an AC voltage at the point of common coupling (PCC) to feed the household load.
- The charger is also used as an active filter for compensating the harmonics and reactive current demand of the household load so that the grid current remains sinusoidal and power exchange with the grid always takes place at UPF. For achieving this, an improved linear sinusoidal tracer (ILST) based control algorithm is used.
- The charger also provides reactive power support to the grid.
- During the outage of grid and PV array generation, the charger utilizes the EV to supply the household load in vehicle to home mode.
- The charger also synchronizes the PCC voltage to the grid voltage for seamlessly changing the mode from standalone mode to grid connected mode.
- The charger also operates in distorted and unbalanced grid voltage conditions using the double second order generalized integrator (SOGI) based positive sequence estimator.
- For satisfactory operation of charger under voltage fluctuations, the adaptive DC link voltage strategy is proposed. The proposed strategy ensures the stable operation under voltage fluctuation and also reduces the ripple in the grid currents.

II. PROPOSED SYSTEM

An EV charger presented in Fig. 1, consists of a voltage source converter (VSC) to operate the charger in standalone and grid connected modes. It is also used for synchronizing the PCC voltages to the grid voltages and for compensating the harmonics and reactive currents requirement of the load. To utilize the solar PV array maximally, a boost converter is used. However, the charging/discharging of EV is controlled using a bi-directional DC-DC converter (BDC). A nonlinear household load draws power from PCC. The grid and the charger are connected through a coupling inductor, which enables the power exchange between the grid and the charger.

Moreover, the inductor filters out the ripple current. A bi-directional power electronic switch (PES) is connected between the grid and PCC. The switch is enabled when the synchronizing pulse 'X' is given to the switch. On both sides of PES, a RC ripple filter

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is used for filtering the switching harmonics. The grid is represented by a power supply in series with the inductor.
The controller is designed such that the charger operates in multiple operating modes achieving many objectives without changing the hardware. The operating strategy of the charger is discussed in Fig. 2. The whole control is designed under standalone mode and grid connected mode.

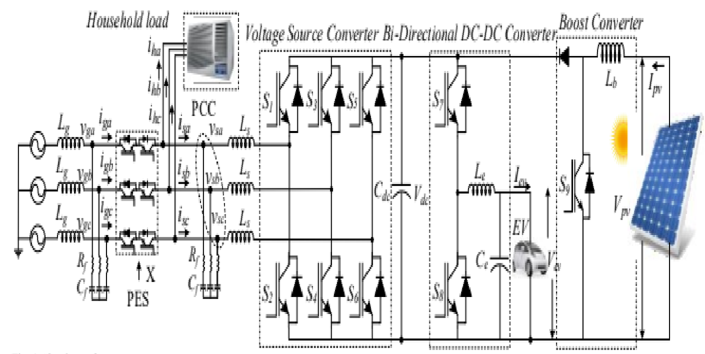

Fig. 1 Circuit topology

III. CONTROL ALGORITHMS

A. Standalone Mode Control

In standalone mode control, the charger is operated such that the charging is done in constant current/constant voltage (CC/CV) mode. The household AC loads are fed using the PV array power. Therefore, the VSC of the charger is operated as an inverter to feed the AC loads. The detail discussion of the control is given in following subsections.

I. Case I when Ppv > Pev + Ph

1) EV Charging Control in CC/CV Mode

In case, the solar PV array power is enough for EV charging and to feed the household loads. The EV charging is controlled using cascaded proportional-integral (PI) control loop in the CC/CV mode as presented in Fig. 3. The outer voltage loop regulates the battery voltage and prevents the battery to get overcharged.

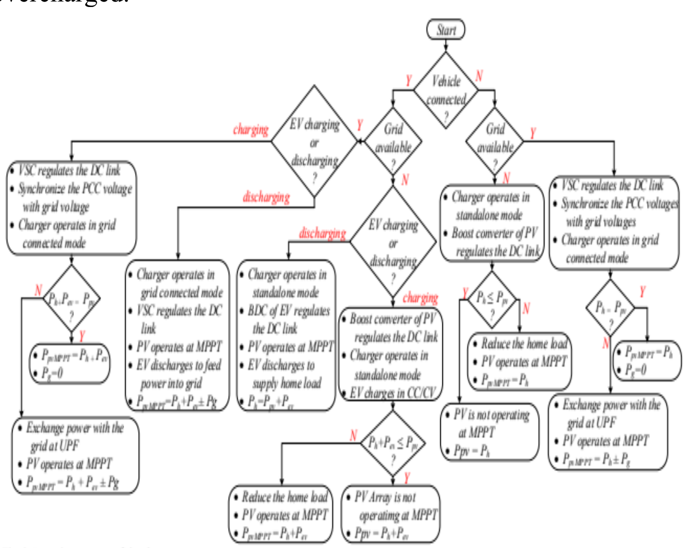

Fig. 2 operating strategy of the charger

Consequently, it generates the reference current for the inner current control loop. Therefore, when the battery is not fully charged and actual battery voltage is less than the battery voltage in fully charged condition (which is usually 10% more than the nominal voltage), the charging takes place in CC mode. However, as the battery charge level increases and the actual voltage comes closer to the reference voltage, the charging moves in the CV mode and the charging current decreases.
The inner current control loop compares the reference and the actual EV current for generating the duty cycle of the BDC using a proportional integral (PI) controller. The switching pulses for BDC, are generated using the pulse width modulated (PWM) generator.

B. DC Link Voltage Control and Boost Converter Control

This charger does not have a storage battery. Therefore, in standalone mode, the boost converter regulates the DC link voltage using a PI controller and generates the duty cycle of a boost converter. In standalone mode, the solar PV array may or may not operate at a maximum power point (MPP). The MPP operation depends on the combined demand of the EV and home loads. Therefore, the PV array generates only that much power, which is required by EV and home loads. However, in case the combined load demand exceeds the maximum solar PV array generation, the home load is reduced for satisfactory operation as discussed in Fig. 3.

II. Case II When Ppv=0 or Ppv <Ph (Vehicle-to-Home Mode)

1) EV Battery Discharging Control

When the solar PV generation either becomes less than the home load demand or becomes zero, the EV discharges to fulfill the load demand. In this case, the BDC of the charger regulates the DC link voltage, and the boost converter extracts the solar PV array maximum power (whatever amount is available). Here also, the DC link voltage is regulated using the cascaded PI controller as discussed in Fig. 3. The outer voltage loop compares the reference and the actual DC link voltages and generates the reference current for the inner current loop. However, the inner current control loop generates the duty cycle of the BDC using the reference and the actual EV current and PI controller.

2) MPPT and Boost Converter Control of Solar PV Array

The duty cycle of the boost converter is derived from the MPP control of the PV array. The control diagram of MPPT is shown in Fig. 3. An incremental conductance (INC) [29] MPPT algorithm is utilized for extracting the PV array maximum power.

C. VSC and Synchronization Control in Standalone Mode

In standalone mode, the control objective is to utilize the PV array power to generate the AC voltage at PCC for feeding the household load. For generating the sinusoidal AC voltages, the controller requires a sinusoidal reference voltage signals, which are obtained from the multiplication of reference voltage amplitude at PCC and sinusoidal signals of unit amplitude as shown in Fig. 3. The reference sinusoidal signals of unit amplitude are obtained from the given expression.

$$v_a = Sin(\theta_s), v_b = Sin(\theta_s - 2\pi/3)$$
$$v_c = Sin(\theta_s - 4\pi/3) \quad (1)$$

Where
θs is the reference phase, which is obtained from the integration of reference angular frequency. The actual voltage is compared with

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the reference voltage, and a PI controller minimizes the error, which gives the reference currents. Using the reference currents and the actual currents, the hysteresis current controller generates the gating signals for VSC. While operating in standalone mode, the load demand may exceed the total solar PV generation or vice versa. Moreover, the EV owner can also sell the battery energy to the grid for earning revenue. In both conditions, the PCC voltage needs to go in synchronism with the grid voltage for transient free power exchange. For synchronization, at first, the controller estimates the phase angles of PCC voltages and grid voltages.

A PI controller minimizes the phase error and generates a frequency correction factor (Δω) for the standalone frequency. Using the correction factor, the modified frequency is estimated as,

$$\omega_m = \omega_o + \Delta\omega \qquad (2$$

Now, using the modified frequency, a voltage is generated that minimizes the phase error. Once the phase error complies with the minimum phase error requirement stated by the IEEE 1547 standard, a synchronizing pulse 'X'=1 is generated for bi-directional PES.

D. Grid Connected Control

The aim of the grid connected control is to ensure the UPF operation of the charger. Another aim of the control is to make the grid currents sinusoidal, even with highly distorted non-sinusoidal load currents, which are usually drawn by the highly non-linear household loads. This is achieved by compensating the harmonics and reactive currents requirement of load using the VSC. To extract the fundamental frequency current from the distorted load current, the improved linear sinusoidal tracer (ILST) based filter is used. Further, the sampling and holding of fundamental frequency current at the zero crossing of the quadrature unit template give the active power current of the load current. The ILST algorithm closed loop transfer function, derived from the schematic shown in Fig. 3, is given as

$$\frac{i_h}{i_{hf}} = \frac{s\alpha}{s^3T_1 + s^2 + (\beta T_1 + \alpha)s + \beta} \qquad (3)$$

Using the active components of the load current of three phases, the active current per phase is obtained as,

$$I_{ep} = \frac{I_{epa} + I_{epb} + I_{epc}}{3} \qquad (4)$$

In grid connected mode, VSC regulates the DC link voltage, and the grid compensates the losses during the charging and discharging of the capacitor. The current corresponding to the loss (Il) is obtained using a PI controller as shown in Fig. 3. Now, the total active current per phase is given as,

$$I_p = I_{ep} - I_l \qquad (5)$$

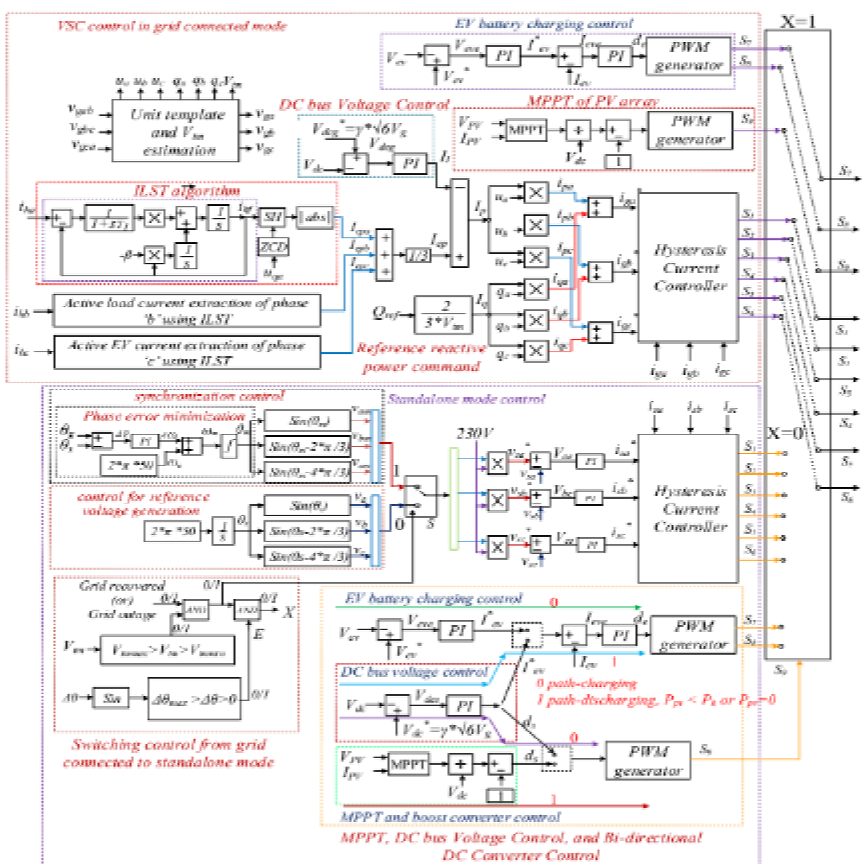

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Fig. 3 control system

The charger provides the demand based reactive power support. The current corresponding to the reference reactive power is obtained as,

$$I_q = \frac{2Q_{ref}}{3V_{tm}} \qquad (6)$$

Where
Qref is reference reactive power. Qref can be both positive and negative. Vtm is the amplitude of the PCC voltage, and it is obtained from the phase voltages as,

$$V_{tm} = \sqrt{\frac{2}{3}\left(v_{ga}^2 + v_{gb}^2 + v_{gc}^2\right)} \qquad (7)$$

Where, vga, vgb, vgc are the phase voltages. The phase voltages are obtained from the line voltages using the following expressions.

$$v_{ga} = \frac{1}{3}\left(2v_{gabp} + v_{gbcp}\right), v_{gb} = \frac{1}{3}\left(-v_{gabp} + v_{gbcp}\right)$$
$$v_{gc} = \frac{1}{3}\left(-v_{gabp} - 2v_{gbcp}\right) \qquad (8)$$

Where, vgabp, vgbcp, and vgcap are the positive sequence voltages of the grid voltages (vgab, vgbc, vgca). Since the grid voltages are distorted and unbalanced, the positive sequence voltages are needed to generate the balanced and sinusoidal unit templates which are used for reference currents generation. These positive sequence voltages from the unbalanced and distorted grid voltages are estimated using the double second order generalized integrator (SOGI) [31] as shown in Fig. 5.

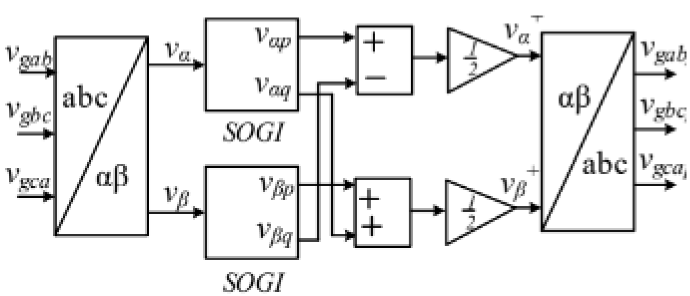

Fig. 4 Positive sequence estimation using double SOGI

Now, the total active current is multiplied with the in-phase unit templates, and reactive current is multiplied with the quadrature phase unit template to obtain the sinusoidal currents corresponding to active power and reactive power, respectively. It is given as,

$$i_{pa} = I_p * u_{a,}\ i_{pb} = I_p * u_{b,}\ i_{pc} = I_p * u_c \qquad (9)$$

$$i_{qa} = I_q * q_{a,}\ i_{qb} = I_q * q_{b,}\ i_{qc} = I_q * q_c \qquad (10)$$

The in-phase unit templates and quadrature phase unit templates are obtained as,

$$u_a = \frac{v_{ga}}{V_{tm}}, u_b = \frac{v_{gb}}{V_{tm}}, u_c = \frac{v_{gc}}{V_{tm}} \qquad (11)$$

$$q_a = -\frac{u_a}{\sqrt{3}} + \frac{u_c}{\sqrt{3}},\ q_b = \frac{\sqrt{3}u_a}{2} + \frac{(u_b - u_c)}{2\sqrt{3}}$$
$$q_c = -\frac{\sqrt{3}u_a}{2} + \frac{(u_b - u_c)}{2\sqrt{3}} \qquad (12)$$

Now using (ipa, ipb, ipc) and (iqa, iqb, iqc), the reference grid currents are obtained as,

$$i_{ga}^* = i_{pa} + i_{qa},\ i_{gb}^* = i_{pb} + i_{qb},\ i_{gc}^* = i_{pc} + i_{qc} \qquad (13)$$

These reference grid currents are compared with the sensed grid currents, and the hysteresis current controller generates the switching pulses for VSC. In grid connected mode also, the EV is charged in CC/CV mode using the cascade PI controller. The details of the control are already discussed in standalone mode control. Similarly, the boost converter control and MPPT control are also discussed in standalone mode.

C. Adaptive DC Link Voltage Control

In the weak distribution system, the under voltage/over voltage is very common. For a 230 V, three phase distribution supply, the line voltage may vary from 190V to 260V. Therefore, for continuous power exchange with the grid in all conditions, the amplitude of DC link voltage must be at least 10% higher than the peak grid voltage. In case of under voltage, the charger can operate satisfactorily with fixed DC link voltage. However, in the case of an overvoltage, the DC link voltage may not be satisfying the criteria as mentioned earlier. Therefore, the adaptive DC link voltage strategy keeps the DC link voltage higher than the peak voltage of the grid by adapting the change in the PCC voltage, so that the power exchange does not hamper under voltage fluctuation, and the DC link voltage always remains optimum.

IV. RESULTS & DISCUSSION

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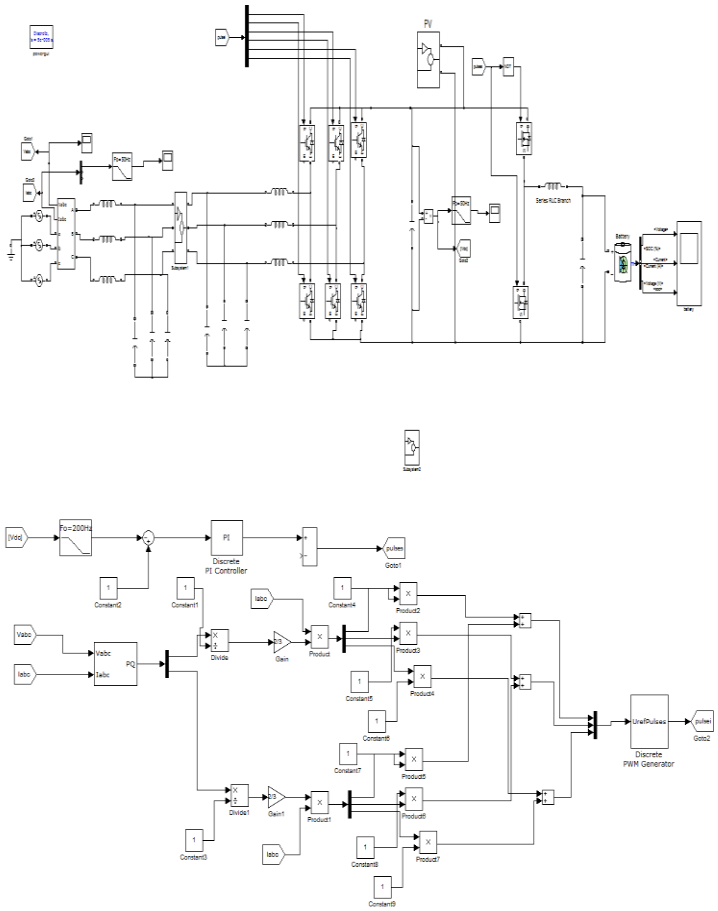

Fig. 5 simulation model

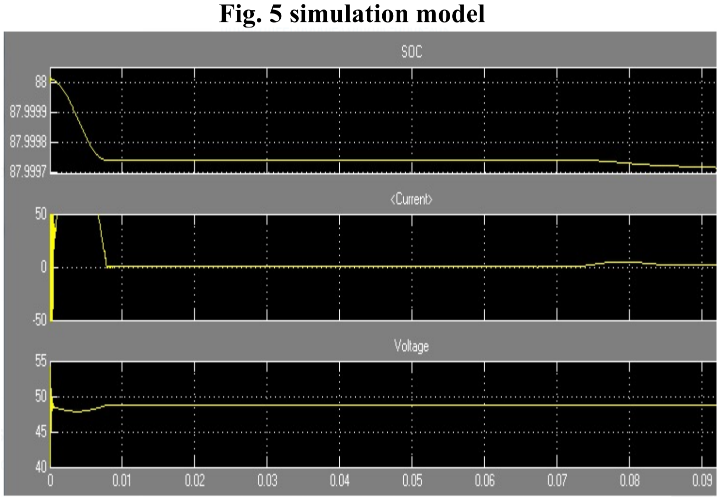

Fig. 6 battery voltage, current and soc

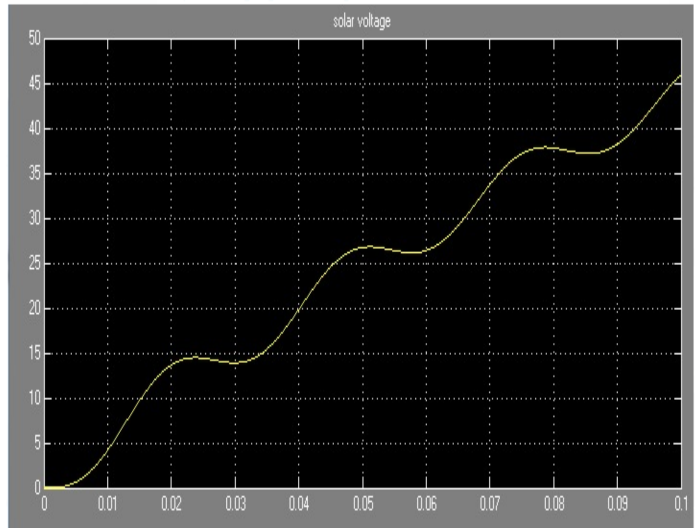

Fig.7 Solar voltage

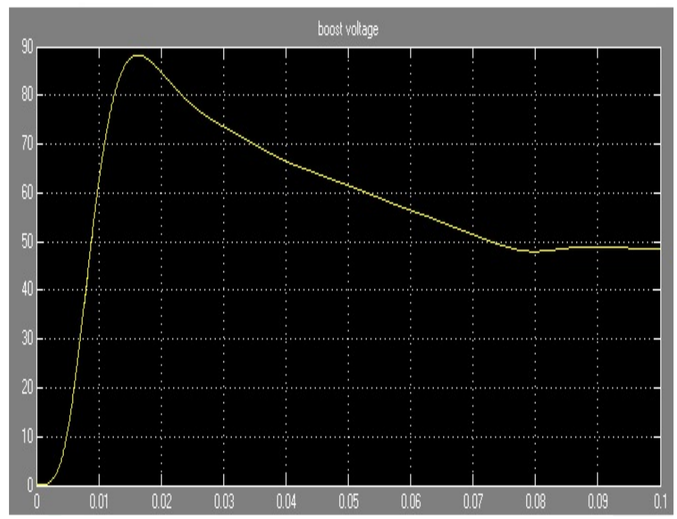

Fig. 8 Boost voltage

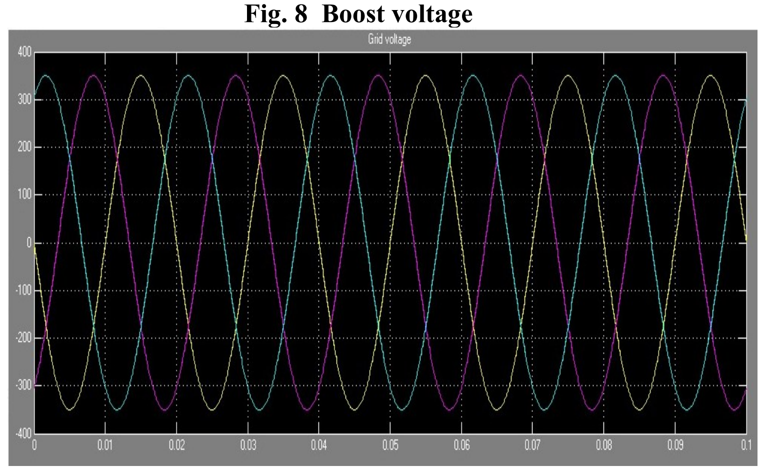

Fig. 9 Grid voltage

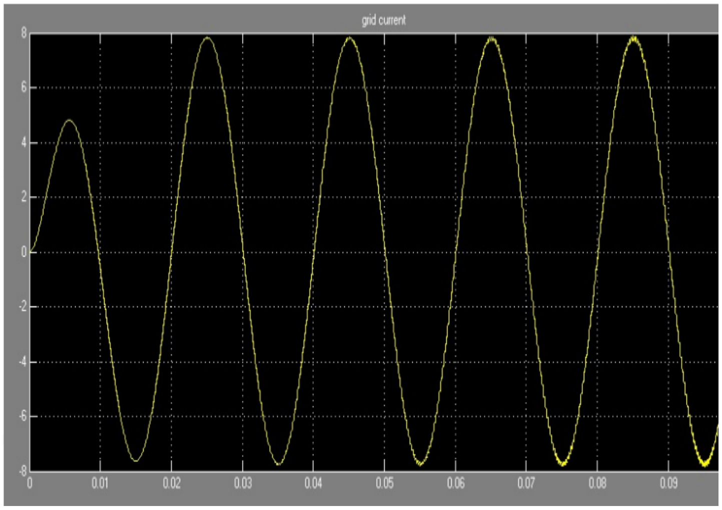

Fig. 10 Phase voltage

V CONCLUSION

A three-phase, multi-objective solar PV array based grid integrated charger is presented. The dual mode operations (standalone and grid connected modes), for EV charging and supplying the household loads, are demonstrated through test results. Moreover, these presented results have verified the charger capability to provide the reactive power support, compensate the load current harmonics and improve the quality of the PCC voltages. The capability to operate in under/over voltage conditions with adaptive DC link voltage control has also been verified. Moreover, the adaptive DC link has reduced the ripple in the grid current. In grid connected mode, the capability of the ILST algorithm to estimate the active current of load current has been verified. These presented results have demonstrated that the charger always maintains the power quality of the grid current and voltage as per IEEE 519 standard. Moreover, these presented results have validated the charger stable operation in all steady-state and dynamic conditions. Even during mode change from standalone to grid connected mode, the grid current remains stable with smooth mode transition. Therefore, the presented charger can be considered as a single solution for charging of EV, uninterruptible supply to the household load, grid power quality and stability.

REFERENCES

[1]. International Energy Agency-Global EV Outlook 2018-Towards cross-modal electrification [Online]. Available: https://webstore.iea.org/download/direct/1045?fileName =Global_EV_O utlook_2018.pdf

[2]. International Energy Agency- Renewables 2O18 - Analysis and Forecasts to 2O23 [Online]. Available: https://webstore.iea.org/download/summary/2312?fileNa me=English- Renewables-2018-ES.pdf.

[3]. M. Popescu, J. Goss, D. A. Staton, D. Hawkins, Y. C. Chong and A. Boglietti, "Electrical Vehicles—Practical Solutions for Power Traction Motor Systems," IEEE Trans. Ind. Applicat., vol. 54, no. 3, pp. 2751-2762, May-June 2018.

[4]. N. Chang, M. A. A. Faruque, Z. Shao, C. J. Xue, Y. Chen and D. Baek, "Survey of Low-Power Electric Vehicles: A Design Automation Perspective," IEEE Design & Test, Early Access.

[5]. O. Ogunrinde, E. Shittu and K. K. Dhanda, "Investing in Renewable Energy: Reconciling Regional Policy with Renewable Energy Growth," IEEE Engineering Management Review, vol. 46, no. 4, pp. 103-111,Fourth quarter, Dec. 2018. International Energy Agency-World Energy Outlook 2017. [Online]. Available: https://www.iea.org/weo2017/

[6]. P. M. de Quevedo, G. Muñoz-Delgado and J. Contreras, "Impact of Electric Vehicles on the Expansion Planning of Distribution Systems considering Renewable Energy, Storage and Charging Stations," IEEE Trans. Smart Grid, Early Access.

[7]. [A. Verma and B. Singh, "Multi-objective reconfigurable three phase on- board charger for EV," in IEEE Transportat. Electrificat. Conf. (ITEC-India), Pune, 2017, pp. 1-6.

[8]. A. Verma and B. Singh, "A Solar PV, BES, Grid and DG Set Based Hybrid Charging Station for Uninterruptible Charging at Minimized Charging Cost," in IEEE Ind. Applicat. Soc. Annual Meeting (IAS), Portland, OR, 2018, pp. 1-8.

[9]. M. S. Islam, N. Mithulananthan and K. Y. Lee, "Suitability of PV and Battery Storage in EV Charging at Business Premises," IEEE Trans. Power Syst., vol. 33, no. 4, pp. 4382-4396, July 2018.

[10]. V. Monteiro, J. G. Pinto and J. L. Afonso, "Experimental Validation of a Three-Port Integrated Topology to Interface Electric Vehicles and Renewables with the Electrical Grid," IEEE Trans. Ind. Informat., vol. 14, no. 6, pp. 2364-2374, June 2018.

[11]. M. O. Badawy and Y. Sozer, "Power Flow Management of a Grid Tied PV-Battery System for Electric Vehicles Charging," IEEE Trans. Ind. Applicat., vol. 53, no. 2, pp. 1347-1357, March-April 2017.

[12]. Z. Liu, Q. Wu, M. Shahidehpour, C. Li, S. Huang and W. Wei, "Trans active Real-time Electric Vehicle Charging Management for Commercial Buildings with PV On-site Generation," IEEE Trans. Smart Grid, Early Access.

[13]. T. Ma, A. Mohamed and O. Mohammed, "Optimal charging of plug-in electric vehicles for a car park infrastructure," in IEEE Ind. Applicat. Soc. Annual Meeting, Las Vegas, NV, 2012, pp. 1-8.

[14]. W. Alharbi and K. Bhattacharya, "Flexibility Provisions from a Fast Charging Facility Equipped with DERs for Wind Integrated Grids," IEEE Trans. Sustainable Energy, Early Access.

[15]. A. Tavakoli, M. Negnevitsky, D. T. Nguyen and K. M. Muttaqi, "Energy Exchange Between Electric Vehicle Load and Wind Generating Utilities," IEEE Trans. Power Sys, vol. 31, no. 2, pp. 1248-1258, 2016.

[16]. K. Khalid Mehmood, S. U. Khan, S. Lee, Z. M. Haider, M. K. Rafique and C. Kim, "Optimal sizing and allocation of battery energy storage systems with wind

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT
ISSN 2454-9940
www.ijasem.org
Vol 19, Issue 3, 2025

and solar power DGs in a distribution network for voltage regulation considering the lifespan of batteries," IET Renewable Power Generation, vol. 11, no. 10, pp. 1305-1315, 2017.

[17]. Y. Shan, J. Hu, K. W. Chan, Q. Fu and J. M. Guerrero, "Model Predictive Control of Bidirectional DC-DC Converters and AC/DC Interlinking Converters - A New Control Method for PV-Wind-Battery Micro grids," IEEE Trans. Sustainable Energy, Early Access.

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