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Intelligent Fuzzy Controller based Power QualityEnhancedCharger

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Abstract: **-In this paper, a solar PV (Photovoltaic) array, a battery energy storage (BES), a diesel generator (DG) set and grid based EV charging station (CS) is utilized to provide the incessant charging in islanded, grid connected and DG set connected modes. The charging station is primarily designed to use the solar photovoltaic PV array and a BES to charge the electric vehicle (EV) battery. However, in case of exhausted storage battery and unavailable solar PV array generation, the charging station intelligently takes power from the grid or DG (Diesel Generator) set. However, the power from DG set is drawn in a manner that, it always operates at 80-85% loading to achieve maximum fuel efficiency under all loading conditions. Moreover, in coordination with the storage battery, the charging station regulates the generator voltage and frequency without a mechanical speed governor. It also ensures that the power drawn from the grid or the DG set is at unity power factor (UPF) even at nonlinear loading. Moreover, the PCC (Point of Common Coupling) voltage is synchronized to the grid/ generator voltage to obtain the ceaseless charging. The charging station also performs the vehicle to grid active/reactive power transfer, vehicle to home and vehicle to vehicle power transfer for increasing the operational efficiency of the charging station. The operation of the charging station is experimentally validated using the prototype developed in the laboratory**.

Keywords: bridgeless cuk converter, pv, wind, ev charger, fuzzy logic controller.

I INTRODUCTION

The traditional gasoline trucks dominate the sustainable growth of the modern transport sector for electric cars driven by batteries [1]. The main electrical car carrier support is a charger with an on-board or off-board AC-DC converter that allows easier battery charge for BEVs (EV). A range of off board and onboard topologies for battery chargers is investigated bidirectional or unidirectional in literature at Level 1or in categories of Level 2 or Level 3. In order to maximize energy use when charging [2-4], a charger must possess a higher power quality (PQ) attribute alongside a high-power density and a small form factor. The traditional DBR EV loader is powered by a high current that adds a total harmonic distortion of just 55.3% to an input power factor (PF). Studies on PQ-based electric chargers that use a sinusoidal flow with an extremely high power factor and an extremely steeply-regulated output have been done extensively in the literature[5]. The literature on EV chargers discusses several topologies of PFC conversion systems, depending on the off-board or on-board arrangement. Diverse on-board EV loaders [6], which have a substantial benefit of high power and efficiency, are documented. A more practical off-board version nevertheless gives a decreased weight for the truck and a high-power range charging capability. Various PFC converter topologies with front-end input interleaved [7] and ZVS are reported in [8][9]. The interconnection between two phase inputs has the advantages of reduced ripple output current and lower inductor size. In addition, semiconductor equipment is operated in parallel, leading comparatively to reduced drive losses. However, the interleaved PFC converters are not the same as the traditional PFC boost converter as for poor heat use of PFC switches.
In [10] an electrically powered LLC-resonant converter is investigated, which also benefits from reduced EMI noise and low switching performance. The converter, nevertheless, is not suitable to charge electrical power across a vast power range by a sophisticated resonant converter mathematical analysis. A complete PFC conversion system, although the more complicated and larger the design of separate Gate Drivers for four semiconductor switches, is the most promising solution for electric loaders [11].

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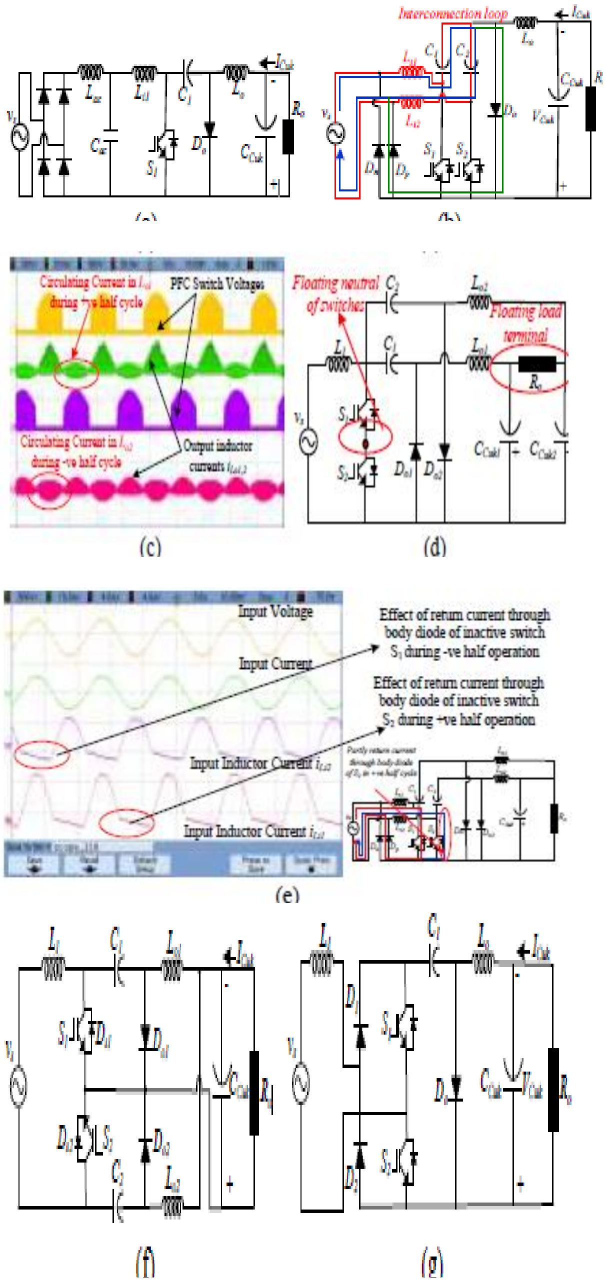

Fig. 1: Various Bridgeless Cuck Converters(a) Existing Cuck converter (b)Network topology-1(c) Topology-1 [12](d) Topology-2 [15](e) Topology-3 [16] (f) Topology-4 [17] (g) Topology-5 [18].

II LITERATUR SURVEY

C. Chan et.all.,"Power electronics difficulties in electric cars." The development of electric vehicle technology has gone ahead with the growth of energy conservation and environmental protection in a world in which there are growing worries. It is possible that in the 1990s the long-awaited practical, cost-effective electric vehicles will be realized. This document presents an overview of current and future trends in propulsion systems for electric vehicles with particular emphasis on the influence of fast electric motor development and power electronics. Power electronics difficulties are explored in other areas, such as battery charging systems, electric frequencies and other key applications for electric vehicles. Electric vehicles will be debated in the next several years on the market and the potential consequences on electric automobiles [12].

B. Tar et.al., "Battery Charger Basics overview," IEEE MWSCAS'16, pp.The present study gives an overview of the fundamental charging algorithms for battery chargers, including the circuit implementation of linear and switching battery

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chargers. First, under open circuit, discharge and charging conditions, the basic operation of batteries is discussed. The following are an overview of the pulse loading scheme and its implementation, followed by a general review of the CCCV and the unique concerns regarding the loading of lithium Ion (Li-Ion) batteries.

III PROPOSED SYSTEM CONFIGURATION AND OPERATION

These two figures show how a PV Wind built-in electric vehicle charger might look and function. During a positive half cycle, the Li1-S1-Do1-Lo1-Dp cell is active. On the other hand, the other Cuk-converter (Li2-S2-Do2-Lo2-Dn) is in use during the negative half-line process. In CCM, the Li1 and Li2 inductors are selected for the two Cuk converter cells. Although the output diode current is guaranteed, iD is zero, and DCM is entered via a switching cycle, the design of the output Lo1 and Lo2 inductors ensures this. The C1 and C2 intermediate condensers have been selected for example, the voltage over condensers remains constant during the switching time. The fact that the two S1, S2 switches are operated with the similar pulse width modulation signal, reducing cost and the complexity of the system.

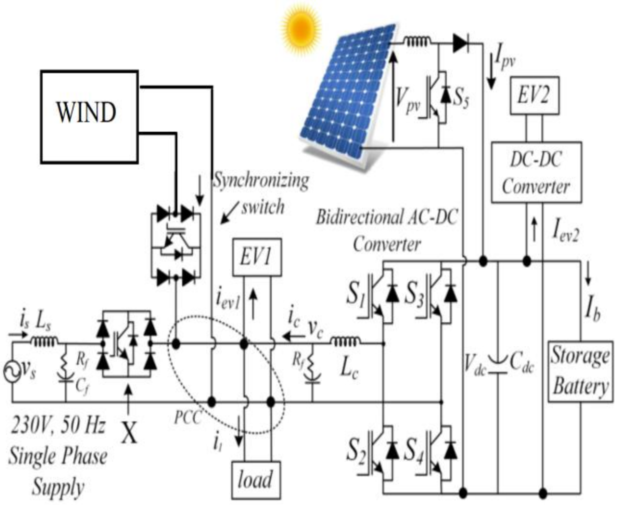

Fig.2: Block diagram of Bridgeless Cuk converter-based PV wind integrated EV charger

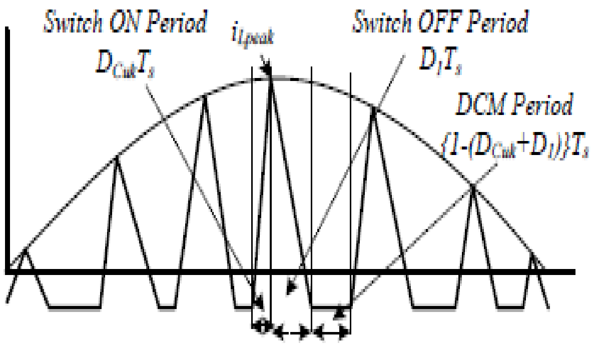

Fig.3: operating principle

The output voltage of the PFC Cuk converter is always maintained thanks to a single loop voltage control that reduces charge charging expenses. With the Fuzzy cascaded controller and DCM system, a fly-back converter is built for the DCM system's continuous current and continuous voltage charging zones (Continuous Voltage). Fig. 3 shows the Cuk converter's output current inductor during DCM PF correction.

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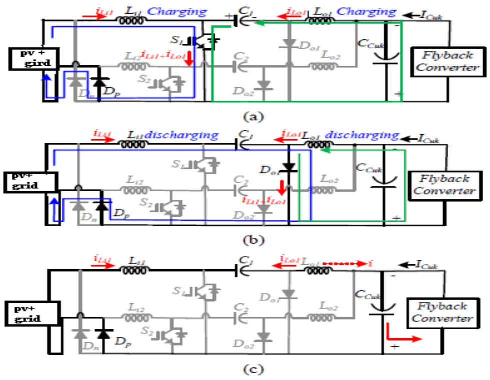

Fig.4: During positive half cycle working modes of BL Cuk converter (a) MODE-1(b) MODE-II (c) MODE-III

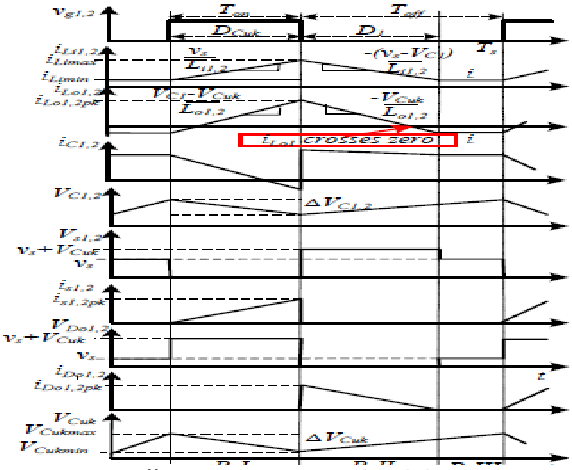

Fig.5: Different components' switching behaviour.

IV CONTROL STRATAGY OF EV CHARGER

4.1 Bridgeless PFC Converter Programming and Control

It is possible to regulate the BL PFC converter using the voltage tracker mode in intermediate drive mode. A fluid controller implements voltage tracking control by configuring the input voltage's current in accordance with the BL converter's maximum output. Using a voltage sensor, a rapid drop in voltage can be detected and the user is alerted. An established standard voltage is used as a comparison (VCukref). There is no longer a need for the voltage feedback controller's V error. A plus or minus sign is used to indicate the amount of error at each sampling point.

As Fuzzy controllers process, constantly changing duty cycles of a PWM-dependent comparator output ensures a correct output voltageWhen using PWM comparators, the output of a BL PFC converter produces pulses that are comparable to the high frequency wave.

The suggested BL Cuk converter works by transferring the PWM pulse between two switches. This DC connection voltage is obtained by applying a duty cycle limit to the wide mains voltage range. The single-voltage-sensor control method is straightforward compared to continuous-conduction converters. Because the control circuits for the converter's two halves are identical, the approach we're doing is unique. To compensate for the loss of conduction due to the inactive body diode, switches S1 and S2 are used in conjunction with a standard driver signal. A single driver signal is supplied to the driver in order to prevent the driver's physical diode from being damaged.

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TABLE I PROPOSED CHARGER DESIGN RESULTS

Components	Specifications
Input Inductance, $L_{i1,2}$	4mH
Output Inductance $L_{o1,2}$	150µH
Intermediate Capacitor $C_{1,2}$	3µF
Magnetizing Inductance, L_f	130µH
Transformer Turns ratio	0.333
DC-link Capacitor C_{Cuk}	2000µF,400V
Battery Specifications	48V, 100Ah
Charger Output Capacitor C_{Cuk}	2000µF,100V

V SIMULATION RESULTS

5.1 Extension Results

a) Nominal Voltage Improvements in Power Quality

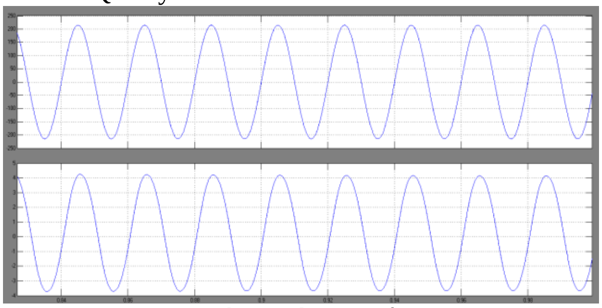

Fig.6. Voltage and current of Mains

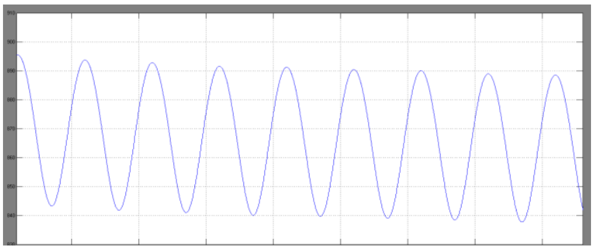

Fig.7. Power (P)

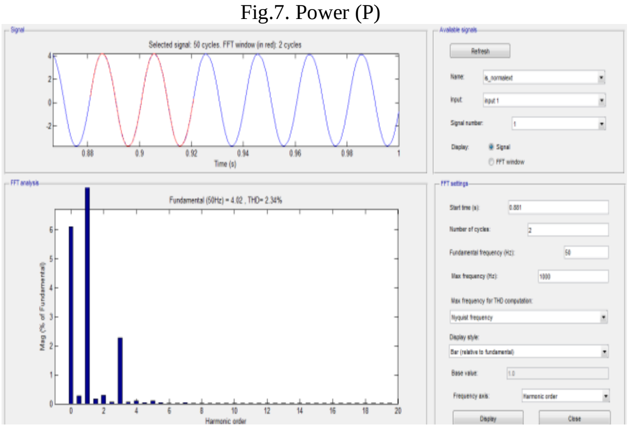

Fig.8. Source Voltage THD%

b) Improved power quality in the event of a sudden drop in source voltage

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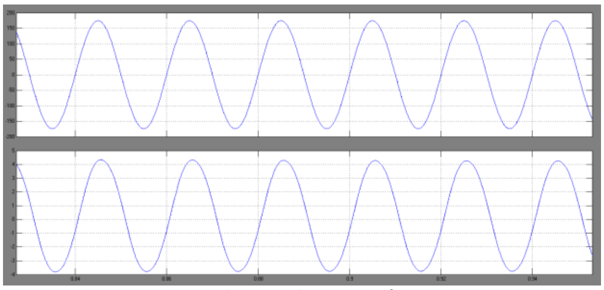

Fig.9. Voltage and current of Mains

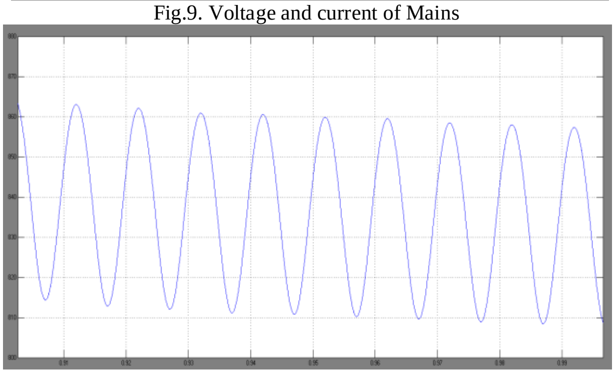

Fig.10. Power (P)

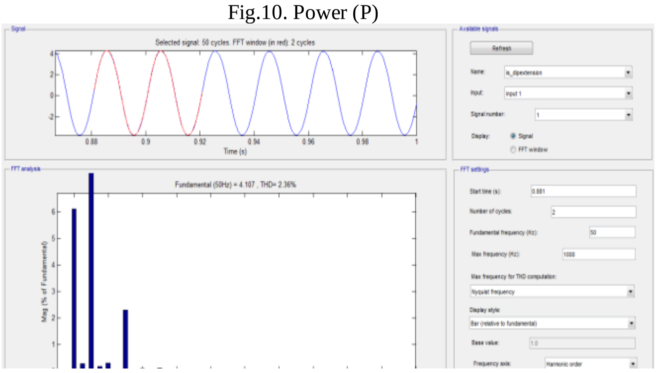

Fig 11. Source Voltage THD%

C) Improved power quality in the event of a rapid increase in source voltage

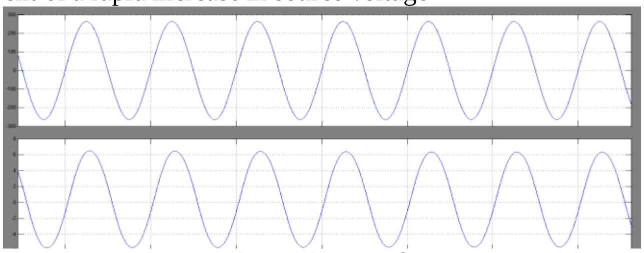

Fig.12. Voltage and current of Mains

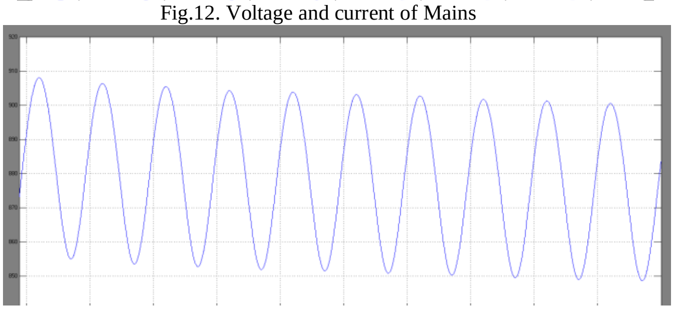

Fig.13. Power (P)

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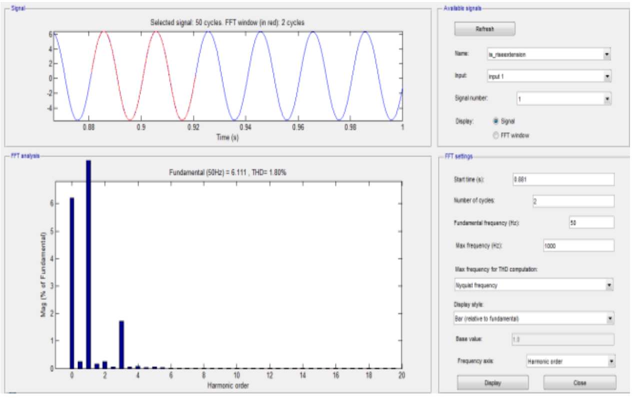

Fig.14. Source Voltage THD%

5.2comparison Table

State of voltage	THD of current with PI controller	THD of current with fuzzy controller
At nominal source voltage	3.70%	2.34%
Sudden dip in source voltage	4.06%	2.34%
Sudden rise in source voltage	2.33 %	1.79%

VI CONCLUSION

A new PQ-based PV wind integrated EV loader provides the BL Cuk converter with a smaller amount of control components done a single switching cycle. The suggested DCM-based Converter Power Factor Correction Cuk delivers good PFC properties. This reduces the capacity of the loader. An additional advantage is the absence of the undesirable capacitive connection loop in the BL Cuk converter designed to prevent undesirable conduction across the body's inactive switch. This significantly increases the load efficiency. The suggested charger showed satisfactory charge capabilities during stable conditions and over 50 percent change in grid voltage. PQ testing of the proposed charger, on the other hand, takes place within the wide input voltage range stated by IEC 61000-3-2 standards. For greater quality and efficiency of power, the new charger provides an alternative option for charging electric vehicles (EVs).

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