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RESEARCH ARTICLE

Fuzzy Logic Controller based 3-Phase Grid Tied Converter for Power Flow with Different Control Strategies

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ABSTRACT

In this work we propose fuzzy logic controller based control of bidirectional power flow in grid interfaced converters. The bidirectional power flow control feature allows in converters to charge and discharge at the same time. In addition, five charging strategies have been chosen and developed to achieve high charging efficiency while simultaneously increasing the battery's life: Charging using different methods of control strategies. To implement different methods of charging approaches, the converter employs the direct quadrature (d-q) transformation. These functions can be performed by a digital signal processor without the use of additional circuit components. This paper also examines and analyses the differences in charging power between each technique. Finally, the proposed bidirectional charger's performance and practicality are confirmed by MATLAB/SIMULINK simulation results.

Keywords : Bidirectional power flow control, Grid interfaced inverter, Digital signal processors, Fuzzy controller, Charging strategies.

INTRODUCTION

Novel power innovations, consisting of sustainable electricity era frameworks, electric automobiles and high stage consumer hardware, have swiftly advanced in latest years to address petroleum derivative use and carbon dioxide emissions challenges [1]. In those applications, the battery module is commonly gift for energy capacity. A framework linked DC-AC converter is needed to transmit electric strength among the battery and the network, whilst the 3-stage H-span circuit might be the most often used arrangement for high-strength applications. [2]. Furthermore, the converter's bidirectional strength float regulation is a critical functionality for recognizing the battery's charging and discharging capacity [3]. Though it becomes mentioned in [4], dangle-primarily based charging/releasing is likewise a key mode. Furthermore, the bidirectional charger has turn out to be an crucial issue for electric vehicle (EV) programs [5].

Various charging strategies had been created to extend the charging execution in addition to the battery length [6]. The continuous present day constant current and voltage (CC-CV) method of charging is one of the majority customarily used method of charging. When the battery voltage falls beneath a predetermined threshold, CC charging is chosen. When the battery voltage is better than the specified esteem, CV charging might be decided on, that is uncommon. Despite the reality that CC-CV charging can take care of speedy charging, the overheating phenomenon as a result of the consistent charging modern-day should injure cathode plates and shorten the battery's lifestyles. The PRC and SRC advances have been designed in reaction to this [7]. Electron debris in the battery can be homogeneously disseminated way to the PRC and SRC's 0 charging modern-day period functions. As a end result, the charging security and battery lifestyles may be multiplied. Aside from a changed PRC price, the Reflex ideas become advanced [8]. For the Reflex TM approach, the negative charging period will be remembered in comparison to standard PRC charging. According to [9], the bad charging duration can enhance the uniform appropriation of electrolyte fixing whilst also stabilizing the battery's artificial response. Furthermore, for fixed lead-corrosive batteries in electric powered motors, Reflex TM charging becomes hired [10]. The identical bidirectional method of charging idea can also to be applied to SRC charging [11]. Control and research of the SRC and PRC charging schemes were the focal point of a few articles [12]. To begin, the SRC charging mechanism and a look at of greatest charging recurrence for Li-particle batteries were presented in [13]. The impedance of a battery checked that took into consideration of DC a part of SRC charging. A two-phase Z-source booming far off charger with line recurrence sinusoidal charging became proposed in connection with [14]. Furthermore, [15] set up a web-primarily based following computation that may be used to continually disseminate and comply with the perfect charging recurrence for normal batteries for any purpose. Furthermore, demanding situations with Li-particle battery SRC charging have been proposed in [16]. Despite the achievement of these provided tactics, the bidirectional electricity glide manage combining SRC and PRC strategies together with a three-degree converter has been ignored. A three-phase battery charger the usage of PRC and CC charging turned into presented in [17]. In any event, the SRC charging function turned into no longer considered at the same time as bidirectional charging changed into being developed/it become no longer designed to release competencies.

Test System under Implementation

The test system along with control blocks of proposed system are depicted in Fig. 1. The AC link is connected to the loads where as the DC link is associated with the batteries. To achieve better control strategies and simplified converter, directly the dq transformation method adopted hear. Hence, in this article the proposed dq controller with fuzzy implementation will provide the various control strategies for the power converters.

Proposed Controller

The proposed controller for implementation of bidirectional power flow uses dq/abc transformation. The three phase voltage signals are converted into d-axis and q-axis quantities of voltages and currents using dq transformation block. The phase locked loop fixes the voltage signals on d-axis and q-axis. The reference q-axis is set to zero for achieving unity power factor. For controlling the energy transfer among the battery and grid, the discharging/charging of the battery currents are regulated. This uses the fuzzy rule base (FRB) for optimal generation of the switching pulses. The FRB for this controller is presented in Table 1.

SIMULATION RESULTS

The battery voltage, current and DC link voltages with proposed controller are shown in fig's. 2, 3 and 4 respectively. For the duration of the period of charging, the converter is in AC-DC mode of operation and also the power flows in the direction to the battery from the grid. On the dissimilar, the converter is in DC-AC mode of operation during the period of discharging and the power flows to the grid form the battery. The Fig.'s 5 and 6 are depicts that the Grid current and voltage in the grid connected system. The THD of voltage and current are shown if Fig.'s 7 and 8. The THD of current and voltages by using fuzzy logic controller are shown in fig.'s 9 and 10.

CONCLUSION

In this work, we proposed a fuzzy logic controller based control of bidirectional power flow in grid interfaced converters. The converter can work in both DC-AC (PFC) and AC-DC (inverter) modes to achieve the bidirectional control to drift the regulation. The five different charging techniques have been explored and developed in order to enhance the performance of charging and battery existence. The important contribution includes the five different methods of charging and discharging techniques are incorporated with the proposed charger. These charging strategies can be completed using the proposed converter and the d-q transformation strategy. Furthermore, the charging power discrepancies among each approach are tested in element and mathematically deduced. Finally, simulation effects generated with MATLAB/SIMULINK and it exhibit the better performance and viability in terms of THD of the proposed bidirectional charger.

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Table 1: FRB for the MSVSC controller

		Error (E)				
		NB	NS	Z	PS	PB
Change in Error (CE)	NB	NB	NB	NS	NS	Z
	NS	NB	NS	NS	Z	PS
	Z	NS	NS	Z	PS	PS
	PS	NS	Z	PS	PS	PB
	PB	Z	PS	PS	PB	PB

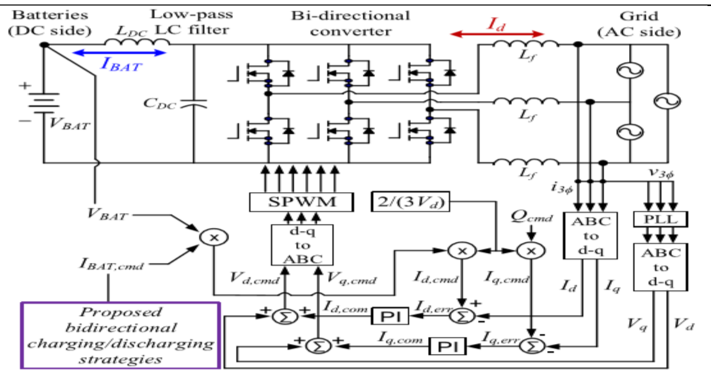

Fig.1: Test system under consideration

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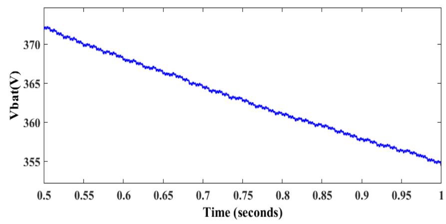

Fig..2: Battery Voltage

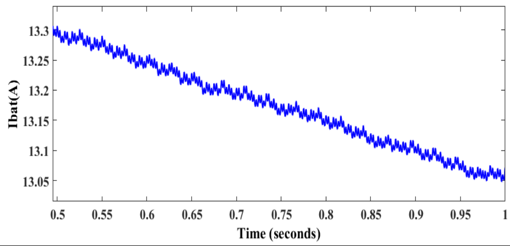

Fig. 3: Battery Current

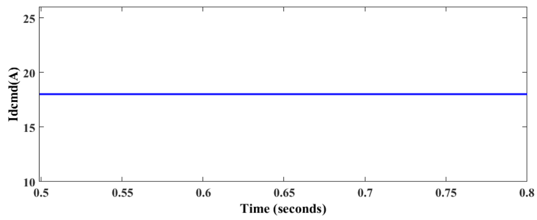

Fig. 4: DC link voltage

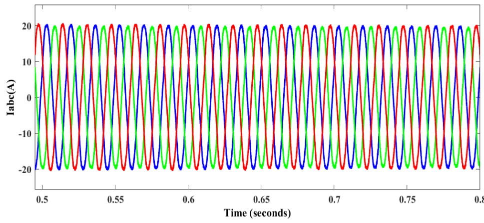

Fig. 5: Grid current

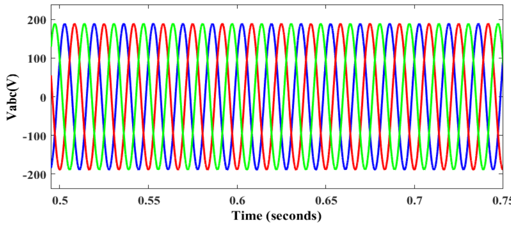

Fig.6: Grid voltage

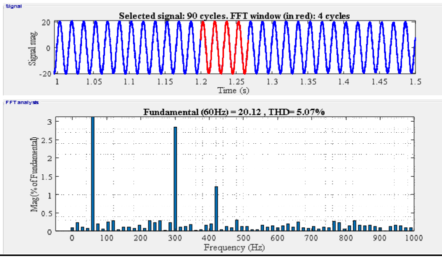

Fig.7: THD of voltage

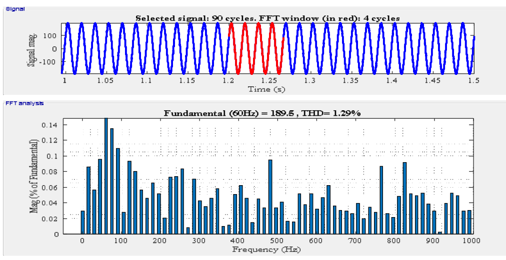

Fig.8: THD of current

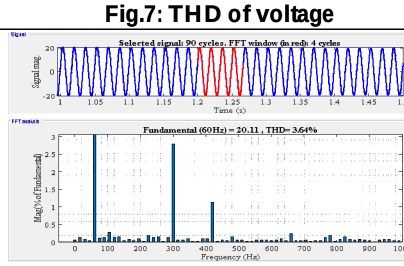

Fig.9: THD of current by using fuzzy logic controller

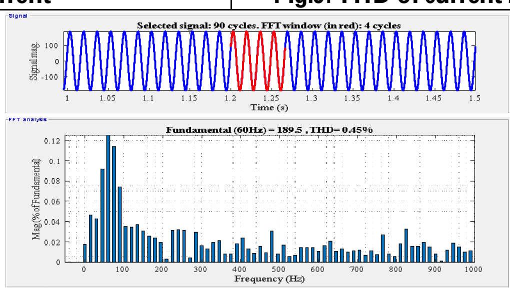

Fig.10: THD of voltage by using fuzzy logic controller