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To Improve Performance and Efficiency of Battery by Novel Pulse Current Charging Method

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Abstract: *In this paper, a novel method of pulse current charging is developed for solving these problems. The decline in the capacity of Li-ion battery is associated with a progressive change in the nature of the positive active material, i.e., from low crystallinity in the precursor material to a more defined crystallinity in the cycled mass. This behavior reduces both the available surface area and the reactivity of the active. The partial charge phase is implemented in a pulse discharge profile, typically comprising the alternation between work and rest (idle) phases. The partial charge current, duration, and minimum/maximum cell voltage achieved during the partial phase are investigated, highlighting the effects on the overall battery performance. Based on this understanding, the fast-charging principle of the battery was analyzed in this paper, and the depolarization pulse fast charging method and the high current decline fast charging method were studied, so as to provide a reference for the people interested in the topic.*

Keywords: Ramp Generator, MOSFET, Discharge Circuit, ZCD, PWM Generator, Microcontroller

I. INTRODUCTION

A pulsed-current technique is evaluated for the rapid charging of lead/acid cells that are prepared with either low-antimony or lead-calcium-tin grids. For comparative purposes, these cells are subjected to repetitive reserve-capacity cycling under either pulsed-current or conventional, invariant-current recharge. Although the latter charging is recommended by the manufacturers of the respective grids, it invokes premature capacity loss when combined with the high-rate discharge of the reserve-capacity test. Two significant benefits are found with the pulsed-current technique, namely, a reduction in recharging time by an order of magnitude (i.e., from ~10 to ~1 h), and an increase in cycle life by a factor of three to four. Temperature effects play only a minor role in prolonging battery endurance under pulsed-charging conditions. The technique also has the ability to recover the capacity of cycled cells.[1]

Power electronics is a branch of Electrical engineering that deals with the effective generation, transmission, distribution and utilization of electrical energy. Till today it has no major role in generating ions and distribution of electrical energy. However, it has to play a significant role in transmitting session of electrical energy, since high voltage D.C. transmission is gaining importance due to its advantages over A.C. transmission. The major applications of Power Electronics are found in the effective utilization of Electrical energy.

In the vision of an efficient energy ecosystem, energy storage and distribution are as important as the development of sustainable production routes. This is particularly true when considering the highly variable energy demand during a day, where the peak of the energy requested by the consumer often does not match that of energy production. Such motivation has triggered a huge interest in energy storage technologies, nowadays dominated by batteries both at the academic and industrial levels. Along with the development of new chemistries and device architectures aimed to increase battery performances and safety, significant efforts have been devoted to the battery management system (BMS). In fact, mid/high power applications, such as electric vehicles (EVs) and energy storage stations, rely on a multicell battery system comprising sub-battery packs connected in series or parallel, with the possibility of reconfiguration. In the context of large-scale battery configurations, a charge and discharge schedule is indeed required to improve the overall system efficiency and to adapt to the variable energy flow. Moreover, the exploitation of discontinuous charge and discharge showed to be an effective strategy to increase the reversibility of the system during the cycles, leading to the higher overall efficiency and lower degradation in the long term. In the case of a pulsed charge, for example, a high peak current is typically followed by a rest time where the system relaxes, limiting the onset of secondary reactions and allowing the system to work at a higher average charge current. [2]

Recent decades have seen a rapidly growing use of Lithium-ion (Li-ion) batteries, which have seen wide penetration in grid, renewable energy facilities and energy-efficient buildings. In these applications, battery management systems (BMSs) play the essential role of monitoring and regulating the operational status of the Li-ion batteries for improved performance, life, and safety. A wealth of research of advanced BMS algorithms has thus come in response to this need. Prior, the focus was mainly on the state-of-charge (SoC) and state-of-health (SoH) estimation, aging status monitoring and thermal monitoring [3].

In the electrochemical reaction, the battery discharge products Li2O2/LiO2 forms on the surface of the cathode and the products are insoluble in the electrolyte. Moreover, the by-products Li2CO3, produced between carbon catalysts/Li2O2 cannot be decomposed completely, and deposits on the surface of the cathode after a long discharge, leading to the unavailable active sites and the blockage of the mass diffusion channels [4]

II. LITERATURE SURVEY

L.T. Lam et.al. (1994) used A pulsed-current technique is evaluated for the rapid charging of lead/acid cells that are prepared with either low-antimony or lead-calcium-tin grids. For comparative purposes, these cells are subjected to repetitive reserve-capacity cycling under either pulsed-current or conventional, invariant-current recharge.

Gabriele Panzeri et. al (2021) were worked on A pulsed discharge system with an intermitting partial charge for improved battery efficiency. In this work, a lead-acid battery pack with a nominal energy of ~23.2 kWh at 1C is tested under different loading profiles, both constant and pulsed, aiming to improve the overall cycle efficiency. A partial charge phase is implemented in a pulse discharge profile, typically comprising the alternation between work and rest (idle) phases.

Huazhen Fang et. al. (2018) was performed Optimal pulse-modulated Lithium-ion battery charging: Algorithms and simulation. This paper focuses on the development of optimized pulse charging strategies for Lithium-ion (Li-ion) batteries. Aiming to improve the constant pulse charging in wide use today, we propose modulating the current pulses during the charging process for the first time to reconcile health protection with charging pace. Toward this end, we use an equivalent circuit model and then formulate the problem of optimal pulse charging with an awareness of both battery health and charging speed.

Teng Xiao et. al. (2021) was study pulse current charging strategy towards high pehigh-performancehium-oxygen batteries. Large over potential and poor cyclability are the main constraints for lithium-oxygen batteries (LOBs), which are usually related to the slow decomposition of the discharge product during oxygen evolution reaction (OER) of charging process. In this paper, a novel method of pulse current charging is developed for solving these problems. The results show, compared with the normal constant current samples, when the duty cycle is 50% and frequency is 1 Hz and, the overpotential decreases up to 25% and the cycle life improves more than 4 times.

Yuanpeng Zhu (2016) Study on fast charging method of lead-acid battery for electric vehicle. The lead acid batteries used by electric vehicles have always presented the problem of low efficiency and high loss. In order to promote the popularization and application of electric vehicles, many researchers have put forward the fast-charging method of battery. Based on this understanding, the fast-charging principle of the battery was analyzed in this paper, and the depolarization pulse fast charging method and the high current decline fast charging method were studied, so as to provide reference for the people interested in the topic. Currently, however, there is no more mature charging technology in the fast charging of lead-acid batteries in electric vehicles.

III. PROPOSED SYSTEM

As shown in fig. The advanced pulse charger consists the following hardware block. The charger unit consist semi converter circuit using two SCR and two diode-connected as a bridge. The freewheeling diode and snubber circuit is as shown in the fig. Additional filter circuit is optional. The basic terminology of pulse charger is that we have to charge battery for some duration and we have to provide a discharge path to the battery for some time. The constant current charging is basic thing which has to implement. The current which is provided to battery is sensed by the DC shunt and the feedback signal is first amplified and applied to the controller circuit. The other input to the controller circuit is set point. The set point and f/b signal both are added and processed in such way that the output current of the charger will remain constant.

The controller o/p will vary from 0% to 100% to adjust and keep output current as a constant. This controller o/p will vary from 0-5V as per the requirement. This varies the firing angle of SCR's from 0 to 180 deg. As per the variation of firing angle the current of the output will vary from minimum to maximum. The firing circuit consist ZCD, ramp generator, PWM generator and high frequency carrier generator to produce high frequency trigger. The proper isolation, amplification is provided by pulse transformer and transistor as an amplifier. The proper wave shaping circuit using RC circuit is provided to limit the gate drive of the SCR's. As per the principle working of SCRs of semi converter, one diode and one SCR will conduct for 180 deg, for positive half cycle. And other SCR and one more diode will conduct for negative half cycle. For both positive and negative half cycle current will flow in one direction. Hence the name semi - converter arises.

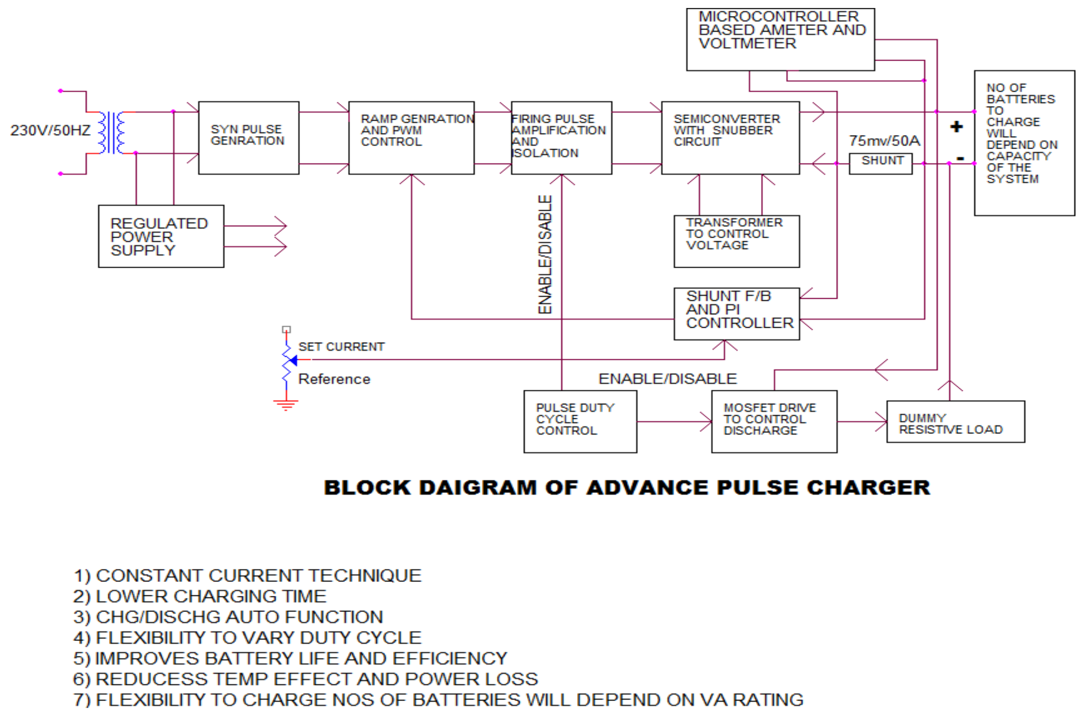

Fig. 1. Block Diagram

3.1 Synchronous Pulse Generator

A synchronous pulse generator for producing synchronization pulses that are synchronized with a preamble pattern contained in an input digital data signal. The generator contains a correlator circuit, a pulse generator circuit and a flywheel circuit. The correlator circuit is an M-bit out of N-bit preamble correlator which periodically generates timing pulses whenever M-bits in a received preamble match M-bits in an N-bit preamble pattern. The pulse generator circuit periodically generates a synchronization pulse at a rate equivalent to an expected rate of occurrence of the preambles. The flywheel circuit monitors the occurrence of the timing pulses from the correlator circuit relative to the synchronization pulse occurrences from the pulse generator circuit. Furthermore, the flywheel circuit resets the pulse generator circuit when the timing pulses are not synchronized with the synchronization pulses for a pre-defined period of time.

3.2 Ramp Generation and PWM Control

The PWM Generator block implements a PWM generator. The pulse width modulation technique controls power transfer from one electrical component to another by quickly switching between full power transfer and no power transfer. Ramp generators used in electrical generators or electric motors to avoid transients when changing a load

Some ramp generators present also the possibility to change the start-up and return flow time. A switch-mode converter varies its dc output current in response to load changes. One widely-used approach is pulse width modulation (PWM)

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that controls the power switch output power by varying its ON and OFF times. The ratio of ON time to the switching period time is the duty cycle.

3.3 MOSFET Drive

Provided that the power source is capable of supplying the current dictated by the PWM signal on the MOSFET gate, you can connect it directly to the MOSFET with no series resistor to limit the current. The current will be limited by the MOSFET only and it will dissipate any excess power as heat.

3.4 Pulse duty cycle

A PWM signal is a method for creating digital pulses to control analog circuits. A duty cycle is the fraction of one period when a system or signal is active. We typically express a duty cycle as a ratio or percentage. A period is the time it takes for a signal to conclude a full ON-OFF cycle. A 60% duty cycle is a signal that is ON 60% of the time and OFF the other 40%. Many loads are rapidly cycled on and off by a fast-acting electronic switch which accurately controls the output power of the load.

IV. RESULT AND CONCLUSION

Production This paper describes work that has been developed in order to provide a conceptual system to assist and manage. Electrical Vehicles (EV) charging process. This paper describes work that has been developed in order to provide a conceptual system to assist and manage Electrical Vehicles (EV) charging process. Following photograph shown actual model of our project:

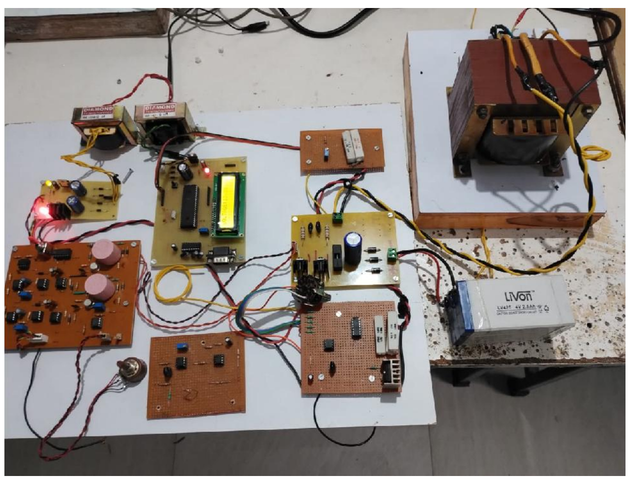

Fig. 2. Photograph of hardware.

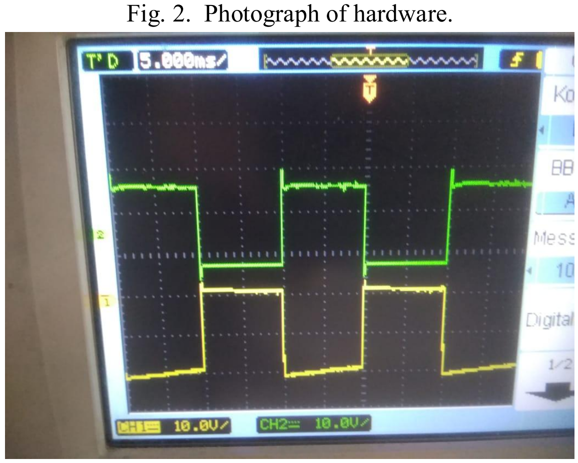

Fig. 3 Waveforms of ZCD 1 and ZCD 2

Fig. 4 Waveforms of Duty Cycle Output

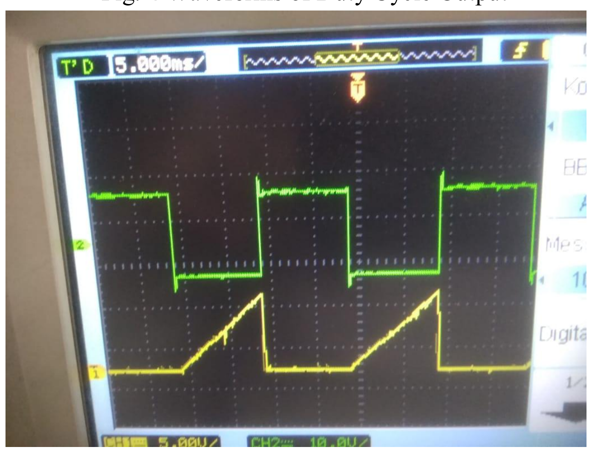

Fig. 5 Waveforms of ZCD and Respective Ramp

In this paper presents a novel method of pulse current charging on high performance of LOBs. The results show that the over potential decreases and the cycle performance are greatly improved under pulse current charging process. The pulse current reduces the concentration polarization on the surface of discharge product, increases the reaction kinetics of OER process, and promotes the decomposition of Li2O2, the over potential is reduced and improves the cycle performance of the battery ultimately. The results obtained in this work have also provided valuable information on the mechanism of premature capacity loss in both Pb-Sb and Pb-Ca-Sn cells with conventional invariant-current charging. The major findings can be summarized as follows:

1. Pulsed-current charging techniques can exert highly advantageous effects - not only in terms of accelerating battery recharge but also with respect to extending the cycle-life performance of low-maintenance batteries.
2. Recharging time can be reduced by an order or magnitude, i.e., ~ 10 to ~ 1 h' cycle life can be increased by a factor of three to four.

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REFERENCES

[1] L.T. Lam, H. Ozgun, O.V. Lim, J.A. Hamilton, L.H. Vu, D.G. Vella, D.A.J. Rand, “Pulsed-current charging of lead/acid batteries - a possible means for overcoming premature capacity loss?”, Journal of Power Sources 53 (1995) 215-228.

[2] Gabriele Panzeri, Luigi Piegari, Marco Faifer, Luca Magagnin, "A pulsed discharge system with an intermitting partial charge for improved battery efficiency", Journal of Energy Storage 36 (2021) 102367.

[3] Huazhen Fang, Christopher Depcik, Vadim Lvovich, "Optimal pulse-modulated Lithium-ion battery charging: Algorithms and simulation", Journal of Energy Storage 15 (2018) 359–367.

[4] Teng Xiao, Zhenkai Zhou, Hui Cao, Jianli Zhang, Qiang Chen, Guangya Hou, Huazhen Cao, Ming Wen, Yiping Tang, " Pulse current charging strategy towards high performance of lithium-oxygen batteries", Surfaces and Interfaces 24 (2021) 101106.

[5] Yuanpeng Zhu, "Study on Fast Charging Method of Lead-Acid Battery for Electric Vehicle", Chemistry and Power Electronics (EMCPE 2016), pp 1 to 4.

[6] Teng Xiao, Zhenkai Zhou, Hui Cao, Jianli Zhang, Qiang Chen, Guangya Hou, Huazhen Cao, Ming Wen, Yiping Tang, "Pulse current charging strategy towards high performance of lithium-oxygen batteries", Surfaces and Interfaces 24 (2021) 101106.

[7] Tirtharaj Sen, Pijush Kanti Bhattacharjee, "Design and Implementation of Firing Circuit for Single-Phase Converter", International Journal of Computer and Electrical Engineering, Vol. 3, No. 3, June 2011.

[8] Isuru Niroshana S.M., Siriroj Sirisukprasert, "8th International Conference of Information and Communication Technology for Embedded Systems (IC-ICTES), 2017.