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Charge control techniques for Battery interconnected to PV system

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Abstract- *This paper contains the outline of a three phase sunlight based battery charge controller and a relative investigation of this accuse control strategy of three ordinary sun oriented battery charge control strategies, for example, 1.Constant Current charging, 2. Two phase steady current consistent voltage charging procedure. The investigation and the near investigation of the previously mentioned charging procedures are done in MATLAB/Simulink software.*

I. INTRODUCTION

Solar energy is an essential and sustainable source of energy. As the cost of photovoltaic (PV) boards supposedly reduces constantly, PV-based power age is picking up in ubiquity for both lattice associated and remain solitary frameworks. As of now, the worldwide establishment is more than 40 GW and increments at a yearly rate of half since 2005. These days, photovoltaic (PV) energy shows up very alluring for power age due to its silent, contamination free, scale adaptability, and little upkeep. In light of the PV control age reliance on sun illumination level, encompassing temperature, and unusual shadows, a PV-based power framework ought to be supplemented by other elective energy sources to guarantee a dependable power supply [1-4]. Energy components (FCs) are developing as a promising supplementary power sources because of their benefits of cleanness, high proficiency, and high dependability. On account of long startup period and moderate dynamic reaction feeble purposes of FCs, befuddle control between the heap and the FC must be overseen by a energy stockpiling framework. Batteries are generally taken as capacity instruments for smoothing yield control, enhancing startup advances and dynamic qualities, and upgrading the pinnacle control limit.

This report presents essentials of battery innovation and charge control procedures usually utilized in stand-alone photovoltaic (PV) frameworks. This work is an assemblage of data from a few sources, including PV framework plan manuals, explores reports and information from part manufacturers. Details are given about the basic sorts of overwhelmed lead-corrosive, valve controlled lead-corrosive, and nickel-cadmium cells utilized as a part of PV frameworks, including their outline and development, electrochemistry and operational execution qualities. Correlations are given for different battery advances, and considerations for battery subsystem outline, assistant frameworks, support and security are talked about [5].

Prerequisites for battery charge control in remain solitary PV frameworks are secured, including insights about the various exchanging outlines, calculations, and operational qualities [6-7]. Day by day operational profiles are presented for various sorts of battery charge controllers, giving a top to bottom take a gander at how these controllers regulate and breaking point battery cheat in PV frameworks.

Above all, contemplations for legitimately choosing batteries and coordinating of the charge controller characteristics are exhibited. Particular proposals on voltage control set point for various charge control calculations and battery writes are leaned to help framework originators.

Motivation behind work

This work was done to address a huge need inside the PV business with respect to the application of batteries and charge control in remain solitary frameworks. A portion of the more basic issues are recorded in the following.

•Premature disappointment and lifetime forecast of batteries are significant worries inside the PV business.

•Batteries encounter an extensive variety of operational conditions in PV applications, including changing rates of charge and release, recurrence and profundity of releases, temperature vacillations, and the methods and furthest reaches of charge control. These factors make it extremely hard to precisely anticipate battery performance and lifetime in PV frameworks.

•Battery execution in PV frameworks can be ascribed to both battery plan and PV framework operational factors. A battery which isn't outlined and built for the operational conditions experienced in a PV framework will in all likelihood bomb rashly. Regardless, injurious operational conditions and lack of appropriate support will bring about disappointment of even the more strong and hearty profound cycle batteries.

•Battery makers' details frequently don't give adequate data to PV applications. The performance information displayed by battery producers is ordinarily in light of tests directed at specified, steady conditions and is frequently not illustrative of battery operation in genuine PV frameworks.

•Wide varieties exist in control controller plans and operational qualities. Right now no standards, rules, or estimating rehearses exist for battery and charge controller interfacing.

The customary energy emergency and expanding rate of ecological issue, for example, air contamination and an unnatural weather change; prompt quickly expanding rate of utilization of non-traditional or sustainable power sources as they are spotless and free from numerous perilous impacts. A standout amongst the most encouraging sustainable power sources is solar energy. Solar photovoltaic frameworks can be partitioned into two primary classes;

1. Remain solitary solar photovoltaic framework, 2. Framework associated solar photovoltaic framework. In this paper the focus is towards remains solitary photovoltaic framework. Remain solitary PV frameworks are

2. Utilized as a part of different family unit applications, for example, solar Inverter, UPS charger, straightforward solar battery charger, solar Emergency Lantern, Solar Pump and solar vehicle.

Battery is the essential energy stockpiling in a remain solitary PV framework. For the solid and safe operation of these frameworks effective battery charging is required with the goal that the framework performs well notwithstanding when the solar board isn't working around evening time or overcast climate [8-10]. A dc-dc buck converter topology is utilized here as the power molding unit between the PV board and the battery to be charged.

II. CHARGE CONTROL ALGORITHM

Constant current charging technique:

In consistent current charging system the converter gives a steady charging current to the battery which implies whatever variety of current the PV board is providing as per distinctive solar insolation levels, is bolstered to the converter and the charge controller at that point gives the required PWM flag to the converter to supply consistent current to the battery all through the charging procedure. Consequently the issue of unpredictable charging current can be maintained a strategic distance from in this strategy. The MATLAB/Simulink display for steady current charging calculation and the charge control rationale is appeared underneath in figure 1.

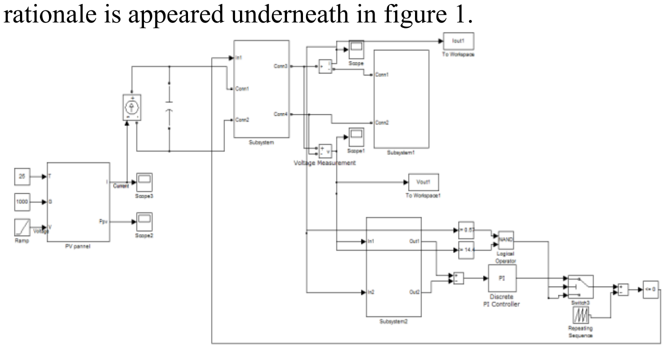

Figure 1: MATLAB/SIMULINK model of constant current PV battery charging

The In 1 is the detected battery terminal voltage (Vbattery) and out 1 is the reference charging current (Icharge) nourished to the PI controller. At the point when the battery voltage crosses the edge value of VOC as appeared in the switch piece utilized as a part of the control rationale, the charging procedure is ended and it is appeared in the control rationale by setting reference charging present as zero.

Three stage charging technique:

The three phase battery charging strategy is an altered two phase consistent current steady voltage (CC-CV) charging technique. Rather than two charging stages it has three charging stages.

The MATLAB/SIMULINK model of the three phase charging topology is appeared in the figure 2,

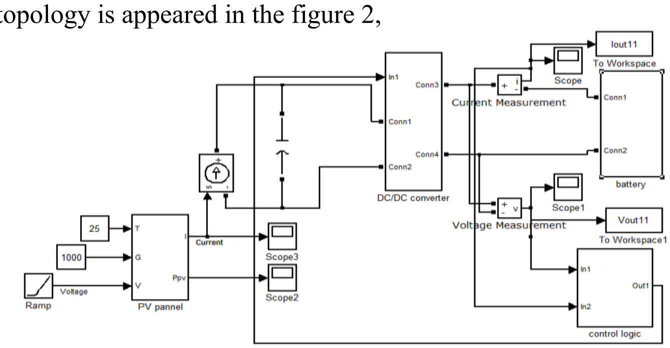

Figure 2: MATLAB/SIMULINK model of the three stage PV battery charge controller

The three stage charge control logic is shown in figure 3,

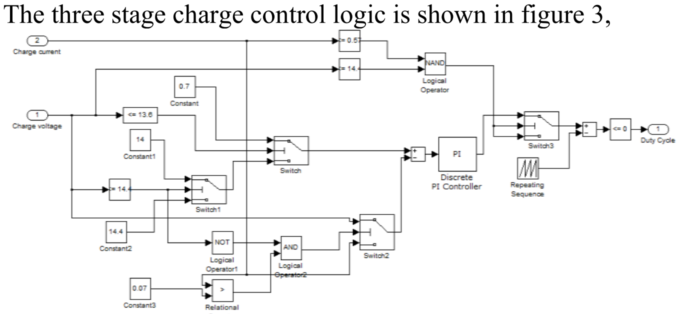

Figure 3: Control logic with PI controller for the three stage charge control algorithm

The capacity of the proposed control rationale appeared in the above MATLAB/SIMULINK show is depicted underneath. At first the released battery terminal voltage is contrasted with the stream charge voltage limit toward the start of the charging procedure. On the off chance that the battery voltage is not as much as the stream charge voltage edge (Specified by battery maker) at that point the stream charging stage is empowered. Here in the above figure20, the switch condition named V <VTrickle is chooses whether the charging current to be provided in stream mode or not. If this condition is genuine then the capitalized (0.7 ampere) is empowered and if this is false then the following switch condition comes without hesitation.

The PI controller is planned in such a way, to the point that it limits the mistake between the real and the coveted/reference benefit of charging present and as indicated by that PWM (Pulse Width Modulation) flag is given to the dc-dc buck converter. The buck converter at that point supplies the preset stream

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current to the battery. The stream charge current reference is set to C/10 amperes where C is the battery limit in Ampere-hour (Ah). The lead corrosive battery utilized here for analyze has limit of 7Ah. Thus the stream charging current set for it is 0.7 Ampere. The battery voltage begins expanding and the stream charge current is provided to the battery until the point that the battery voltage achieves the Trickle voltage limit VTrickle. Here for the 12 volts 7Ah lead corrosive battery the stream voltage limit is set to 13.6 volts as appeared in the rationale in MATLAB/SIMULINK.

Once the battery voltage achieves VTrickle then the mass charging stage is empowered. In this stage, the battery is charged by a higher current IBulk until the battery voltage is not as much as its overvoltage limits VOC. Here likewise the battery voltage is contrasted with the reference VOC and the PI controller again limits the mistake between the genuine current and mass charging reference current set as IBulk. Similarly the past condition, PWM operation is performed to give expected heartbeat to the converter. The converter at that point supplies steady current IBulk to the battery. In the figure 20 the switch condition V < VOC is performed in this phase of charging and in the event that it is genuine then the capitalized (1.4 ampere) is empowered. In the mass charging stage the reference charging current is set in light of the battery rating determination.

The mass charging current is set equivalent to the most extreme allowable charging current of the battery. Here the lead corrosive battery which is chosen has the most extreme safe charging current level of 1.4 amperes. The battery voltage increments quickly in this charging stage as a result of high charging current and the IBulk is provided to the battery until the point when the battery voltage comes to as far as possible VOC indicated as 14.4 volts for a 12 volt lead corrosive battery. Once the battery voltage comes to the overvoltage edge VOC then the charge controller changes its method of charging from steady current to consistent voltage mode called coast charging stage. Here in the above figure the third switch condition comes into operation when the second switch condition falls flat. On the off chance that this condition is genuine then the voltage over the battery terminal is kept up at VOC and the battery takes charging current in a diminishing manner. This VOC is kept up until the point when the battery running after current goes to lower edge esteem IFloat. This IFloat threshold esteem is set as C/100 where C is the appraised limit of the battery being utilized. At the point when the battery charging current goes beneath the edge estimation of IFloat, at that point the PI controller sends low(Zero)signal to the converter to end the charging procedure.

III. SIMULATION RESULTS

Correlation between the consistent current charging and the three phase charging strategy:

Here in the proposed three phase charge controller, at first the battery is accused of a current of 0.7Amperes though in the steady current charging technique if the battery is charged by a consistent current of 1 ampere and the consistent current is provided even in the mass charging stage as portrayed in the proposed calculation where the battery is charged by 1.4 ampere current.

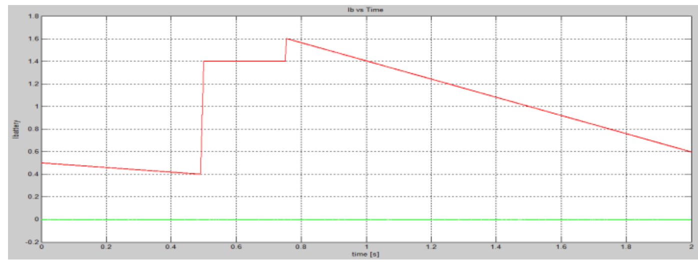

Figure 4: The charging current for constant current charging (Green) and three stage charging (Red) Algorithms

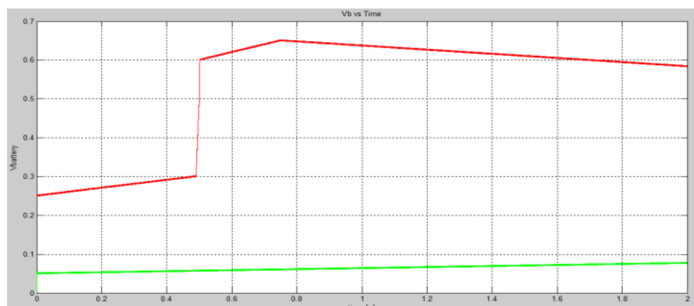

Figure 5: Battery terminal voltage for constant current charging (green) and three stage charging (red) Algorithms

Thus the proposed three phase charging sets aside substantially less opportunity to charge the battery in this mass charging stage when contrasted with the steady current is charging strategy. Another basic issue is that the battery experiences inadequate charging in steady current charging strategy in light of the fact that the charging is ended when the battery terminal voltage achieves the limit esteem Voc as appeared in figure while in the proposed three phase charging technique that edge voltage is kept up over the battery terminal until the point when the pursuing current goes to a lower edge estimation of Ifloat. Subsequently the battery is totally charged and the life cycle of the battery stays unaffected. The three phase charging calculation is beneficial over the consistent current charging strategy in these basic issues.

IV. CONCLUSION

In this undertaking a three phase battery charge controller for remain solitary photovoltaic framework is composed and a relative report is done among the three diverse PV battery charging systems. The relative investigation of the three phase accusing topology of the other three charging topologies is finished by looking at the reproduction comes about. The three phase charging strategy is favorable over the consistent current charging in the issues like charging time, required charging present and finish charging. The three phase charging calculation sets aside lesser opportunity to charge the battery, gives required charging current and voltage at various periods of charging and prompts finish charging of the battery accordingly stretching battery life by giving full charging cycle. The three phase accusing is likewise thought about of the two phase charging and it can be reasoned that the that the time taken by the three phase charging is more than the two phase charging however taking care of the security of the battery the three phase charging procedure is worthwhile over the two phase charging strategy in light of the fact that the battery is accused of high beginning current in two phase charging while in three phase charging, at first a little current called stream current is given to the battery up to a specific voltage limit called stream voltage and after that high charging current is given in the following stage called mass charging. Subsequently the battery is securely charged and stays free from overheating and gassing impact caused by finished current.

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