Hybrid power battery charge/discharge control System with microcontroller

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Abstract:
This consider points to control charging and releasing the battery for half breed vitality frameworks. The control framework works by selecting the proper vitality source to supply voltage to the stack. Additionally this control framework can direct charging and releasing the battery consequently. The voltage source comprises of two vitality, to be specific from the battery and DC source.The control framework that has been planned has the capacity to select the correct DC source when the battery capacity is less than 80%. This framework moreover features a great capacity to select a battery source when the battery comes to 100pacity and the DC source contains a voltage drop of more than 20%. This control framework is prepared with intemperate electric current security so that the security level is tall.

1. INTRODUCTION

Renewable vitality such as sun powered radiation as an vitality source to diminish the vitality emergency.Vitality from photovoltaic boards can be utilized to charge the battery. The battery charge control controls the stream of power from the photovoltaic board to the battery or DC stack [1]. Battery vitality capacity frameworks (BESS) is the foremost common vitality capacity that can be coordinates into network associated PV framework [2].Sun oriented PV vitality frameworks are utilized to change over the caught sun based light into power [3]. The different control sources that are accessible may be invarious shapes such as the utility lattice, renewable control sources such as sun oriented board and DC vitality capacity units such as batteries [4]. Numerous energy sources are coordinates within the microgrid to have for a dependable vitality supply [5].Batteries are all over, from control capacity gadget in sun oriented photovoltaic. Among them, lithiumion (Li-ion) batteries have gotten to be the foremost promising innovation for vitality capacity due to their tall vitality thickness and tall productivity [6]. The vitality administration technique ought to be decided among the renewables, vitality capacity and network [7]. Batteries are utilized as control capacity gadget in sun powered photovoltaic (PV)frameworks. They supply control when there's no solar power era within the nonappearance of daylight [8]. The estimate of vitality capacity can be done utilizing two sorts of batteries, specifically Lead-acid Lithium-ion batteries and batteries. but it ought to be considered since there is a enormous distinction between the least fetched between a lead-acid battery and a Li-ion battery [9]. Battery has the points of interest of tall vitality thickness, but with moo control thickness, brief cycle life, moderate charging and releasing speed, and numerous other inadequacies [10, 11].
Control of these cross breed batteries inside the same framework is more challenging compared to customary battery administration frameworks which basically bargain with the homogeneous battery framework [12].State of Charge is an imperative parameter of the Battery Administration Framework. It is an sign of the remaining battery capacity. It is exceptionally critical to have an exact assess of the State of Charge, to dodge over charging and over releasing of Lithium particle batteries [13]. Battery administration frameworks (BMS) to make strides run expectation exactness [14]. Lithium-ion cells moreover have a steady most extreme charge and release rate capability over the total 0-100% SOC run [15]. Existing charging techniques for lithium-ion batteries utilize a generally open-loop approach where the charge profile is pre-decided based on a priori information of cell parameters [16]. The “constant-current and constant-voltage” charging mode may be a broadly utilized charging profile, in which a battery is charged with a consistent current until a voltage constrain is come to and after that a constant-amplitude voltage is connected until the current decreases to a certain esteem, to charge the battery as completely as conceivable [17]. Charging the battery causes temperature rising [18]. A battery charger have to be more brilliantly and cognizant of battery wellbeing and bring a positive affect on client satisfaction [19]. Battery charger need to meet the extend of prerequisites, especially in current ripples in battery drift charge mode [20]. There are numerous components that influence SOC, such as battery voltage, temperature, current, battery history, battery chemistry and so on. Encompassing temperature may be a noteworthy calculate that impacts the exactness of SOC estimation [21].The SOC estimation can be progressed by precisely calculating OCV utilizing the proposed internalimpedance extraction from the battery [22]. Charging systems of battery electric current from the PV source with beat charging strategy is done to convey tall electric current to the battery without causing harm [23].Charging time can be done using different sources, the length of battery charging changes significantly depending on the AC source [24]. The batteries for photovoltaic frameworks require accurate, intuitive, and comprehensive electrical battery show which can sense the battery reaction beneath energetic conditions [25].This consider examined ways to move forward the administration framework on battery charging and releasing.Programmed settings for selecting energy sources are too considered. A control framework that has been built to overcome the issue of battery charging to avoid overcharging. The framework planned is prepared with current and voltage sensors that can screen current battery drainage. This framework is prepared with assurance against switch electrical streams which can cause harm to the battery and the board.

2. RESEARCH METHOD

Research method by designing hardware and software. The design of hardware and software will be explained in this section. The battery charging block diagram is shown in Figure 1.

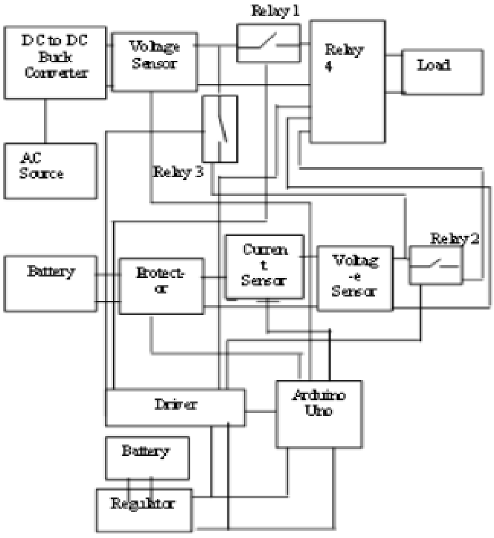

Figure 1. Block diagram of the battery charging for hybrid energy

2.1. System Design-Hardware

Control framework for battery charging are planned based on the square chart that's appeared in Figure 1. Defender in this plan comprise of a combine and diodes. The assurance circuit is utilized to secure the framework from over-burden condition. Adjacent to that when the battery voltage is more prominent than the sun powered module it is likely that the battery will send its voltage back to the solar module. Typically where the blocking diode capacities to secure the battery.

2.2. System Design-Software

Program that has been made utilizing the Arduino IDE 1.6.4 softwear. Planning program based on flowchat which has been outlined based on Arduino Mega 2560. To be able to transfer program, a association must be made to the Arduino harbour. The taking after is an clarification of the flowchart in Figure 2.

1) The control framework continuously prioritizes the DC source instead of the battery when the DC source comes to the voltage that has been set and when the DC source is underneath that which has been set at that point chooses the battery and shows it on the LCD screen.
2) The control framework chooses all switches off to stack in the event that all voltage sources are underneath 80D44
3) The control framework charges when the battery capacity is underneath 80% and will halt charging when the battery capacity is 100% and shows this status on the LCD screen.
4) The control system disengages in the event that there's an over-burden and shows this status on the LCD screen.
5) The control framework calculates the control stack to the stack and shows this status on the LCD screen.
6) The control framework calculates and gauges the remaining battery time and shows this status on the LCD screen.

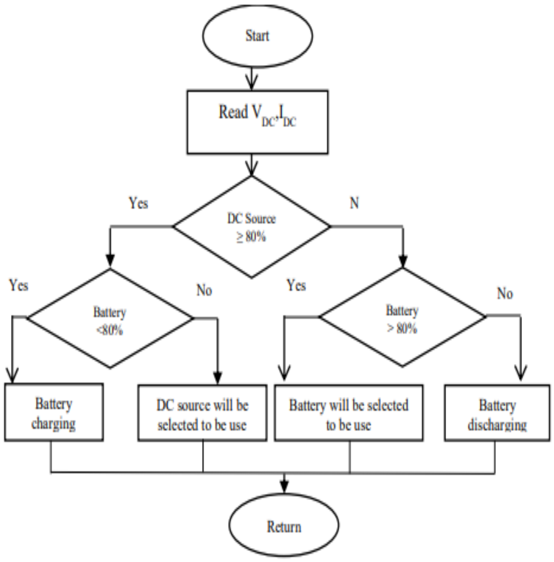

Figure 2. The Flow chart for the battery charging control program

3. RESULTS AND ANALYSIS

In this section, there are 3 parts of the design result, hardware, software, and test result.

3.1. Hardware

The equipment that has been outlined is based on the square chart in Figure 1. The battery charging control equipment comprises of Arduino Mega 2560 as a microcontroller, controller circuit, electric current sensor, voltage sensor, security circuit, transfer, and DC to DC Buck Converter. DC to DC Buck Converter as a gadget to extend (Boost) or diminish (Buck) DC voltage. Buck DC to DC converter is for investigating unsteady voltages. The voltage sensor uses a module that can peruse voltage values extending from to up to 25 volts and requires a supply of 5 DC volt. The current sensor that has been used in this framework is INA 219. The INA219 sensor may be a bi-directional framework sensor employing a shunt resistor. Transfer driver is an electronic component that capacities as an auxil-iary switch to move the stack.Hand-off drivers are utilized to drive switches for electric current control. Transfer drivers utilized summed to 4 of them to set the source of the sun oriented board, control the battery source, direct battery charging and the choice of voltage sources. The controller employments IC 7805. Controllers are utilized to control the source voltage of a Li-Ion battery that incorporates a voltage of 9 volts dc to a working voltage of 5 volts dc.
The controller circuit is utilized to supply control supply to the hand-off driver circuit. The realization of equipment improvement is appeared in Figure 3.

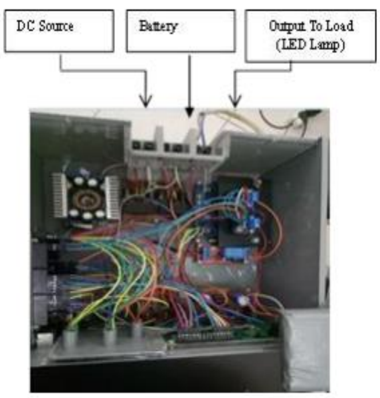

Figure 3. Picture of hardware from developing result a battery charging control system

3.2. Selection of Voltage Sources Test

Tests are carried out with the battery is set at 12.60 volt and the DC source is changed. The comes about are appeared in Table 1. In Table 1 appears the control framework continuously prioritizes DC sources or switch A when more than 12 V and the selector will chooses the source from the battery (switch B) when the DC source is less than 12 V.

Table 1. Selection of Voltage Sources Test

Step	DC Source (Switch A)	Battery Voltages (Switch B)	Switch Position On relay 4 (Switch A/B)	Output Voltages
1	15,00 volt	12,60 volt	A	14,75 volt
2	14,35 volt	12,60 volt	A	14,20 volt
3	13,47 volt	12,60 volt	A	13,25 volt
4	12,76 volt	12,60 volt	A	12,48 volt
5	12,58 volt	12,60 volt	A	12,35 volt
6	12,40 volt	12,60 volt	A	12,10 volt
7	12,00 volt	12,60 volt	A	12,60 volt
8	11,92 volt	12,60 volt	B	12,60 volt
9	11,50 volt	12,60 volt	B	12,60 volt
10	11,00 volt	12,60 volt	B	12,60 volt

3.3. Minimum Battery Capacity Test

Testing points to induce framework execution. Least battery capacity the passable for supply of loads is 80%. The test comes about appear the framework can work consequently detaching the battery to the stack when the capacity is underneath 80%. In Figure 4 appears relationship between percent of battery capacity and battery voltage. and for more point by point information can be seen in Table 2.

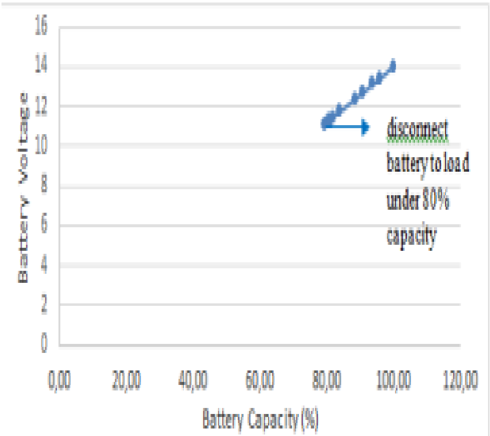

Figure 4. Relationship between percent of battery capacity and battery voltage

In Table 2 the position of the switch NC or regularly near implies that the battery is associated to the stack. Whereas on the position switch NO or regularly open means that the battery isn't associated to the stack .Transfer 2 is the battery interfacing switch to the stack. When the battery capacity is underneath 80%, transfer 2 is off. When hand-off 2 is off, the battery is charging. The voltage prerequisite to the stack is provided by DC source. Information from battery capacity testing comes about are appeared in Table 2. In Table 2 appears the comes about that when the battery voltage is littler than 11.1 volts or the battery condition is beneath 80%, transfer 2 will cut the electric current to the stack. In push 11 the battery voltage is less than 11.1 volts so hand-off 2 ordinarily opens (NO). In Table 2 appears the comes about that when the battery voltage is littler than 11.1 volts or the battery condition is beneath 80%, hand-off 2 will cut the electric current to the stack. In push 11 the battery voltage is less than 11.1 volts so hand-off 2 ordinarily opens (NO).

Table 2. Minimum Battery Capacity Test

No	Battery Voltage	% Battery Capacity	Position of Relay 2
1	14,00 V	100.00 %	NC
2	13,40 V	95.71 %	NC
3	13,13 V	93.79 %	NC
4	12,69 V	90.64 %	NC
5	12,40 V	88.57 %	NC
6	11,75 V	83.93 %	NC
7	11,45 V	81.79 %	NC
8	11,36 V	81.14 %	NC
9	11,30 V	80.71 %	NC
10	11,25 V	80.36 %	NC
11	11.1 V	79.29 %	NO
12	11 V	78.57 %	NO

3.4. Charging and Discharging Battery Test

Charging and releasing battery test are carried out to decide the work of the framework planned.In Figure 5 appears the arrange of charging the battery. The battery is charged based on DC source capacity.On the off chance that the DC source is more than 0.9 amperes, it can charge the battery. Hand-off 3 may be a switch interfacing the DC source to the battery.Test comes about are appeared in Table 3. In Table 3 appears that when DC source is 0.2 volts, 0.10 volts and 0.12 volts it cannot charge the battery. In arrange for the DC source to revive it must be more than 0.9 volts.

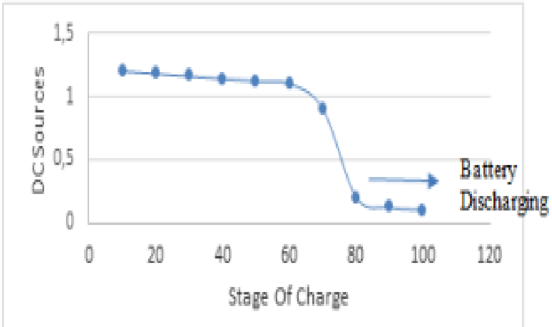

Figure 5. Relationship between DCsource and stage of charge

Table 3. Charging and Discharging Battery Test

No	DC Source (relay 2)	Position of Relay 3	LCD Screen
1	1,2 A	NC	Battery Charging
2	1,18 A	NC	Battery Charging
3	1,16 A	NC	Battery Charging
4	1,14 A	NC	Battery Charging
5	1,12 A	NC	Battery Charging
6	1,10 A	NC	Battery Charging
7	0,90 A	NC	Battery Charging
8	0,2 A	NO	Battery Discharging
9	0,12 A	NO	Battery Discharging
10	0,10 A	NO	Battery Discharging

3.5. Protection of Overload

In this inquire about an over current security framework execution test was too carried out.The reason of this assurance framework is to secure the board and stack due to over current from the battery and DC source. Testing on brief circuit security employments discovery from current sensor 1. When the current sensor peruses the current esteem of more than 5 amperes, the framework will detach the current from the DC source and the battery source. The test comes about are appeared in Table 4.

Table 4. Protection of Overload

No	Current Sensor 1	Position Of Relay 1	Position Of Relay 2	LCD Screen Status
1	1,1 A	NC	NO	Select DC Source
2	1,3 A	NC	NO	Select DC Source
3	2,8 A	NO	NC	Select Battery
4	3,2 A	NO	NC	Select Battery
5	5,1 A	NO	NO	Overload

3.6. Calculation of Electric Power

Electric control in Table 5 is gotten by increasing the electric current and voltage. Based on the calculation comes about, the normal control streaming to the stack can be known. The greatest control that can be streamed is 50 Watt DC. Tests are carried out with Driven light loads.For more detail the normal battery control and DC source are appeared in Table 5 .

Table 5. Calculation of Electric Power

No	Source Vottages (Volt)		Electric Current (Ampere)	LCD Screen
	DC Source	Battery		Electric Power (Watt)
1	15,00 V	-	1,10	16,5
2	14,49 V	-	0,52	7,5
3	13,80 V	-	1,16	16
4	13,09 V	-	0,91	11,9
5	12,09 V	-	0,43	5,2
6	-	12,80 V	1,24	15,8
7	-	12,72 V	1,81	23
8	-	12,67 V	1,53	19,3
9	-	12,15 V	0,9	10.9
10	-	11,70 V	0,3	3.51

3.7. Duration Time of the Battery

The remaining time is the length of time the battery will run out of vitality. In this think about utilizing battery with 14 V 5Ah. In case the normal electric current utilized is 5 A, the battery utilization time is 1 hour. In Figure 6 appears that the more electric current the battery employments, the battery vitality will too run out faster.In Table 6 is the estimation of the length of time based on the utilize of electric current batteries utilization. A battery with 5 Ok implies that the normal current utilized in 1 hour is 5 amperes. In case utilize an normal electric current of 0.7 amperes, the length of the battery comes to 7 hours. For more subtle elements are displayed in Table 6.

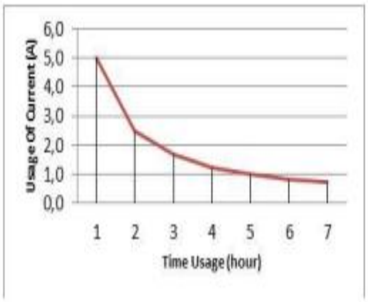

Figure 6. Relationship between usage current and time duration battery

Table 6. Time Remaining on the Battery

No	% Battery Capacity	Battery Ah Value	Usage of Current (Ampere)	Duration Time (hour)
1	100	5	5.0	1
2	100	5	2.5	2
3	100	5	1.7	3
4	100	5	1.3	4
5	100	5	1.0	5
6	100	5	0.8	6
7	100	5	0.7	7

4. CONCLUSION

Based on the comes about of testing and investigation that has been carried out the charge controller battery can work well indeed with moo fetched materials. The battery charge controller can select the correct vitality frame DC source when the voltage more than 12 V and the battery voltage less than 12.60 volts. Additionally when the DC source is less than 12 V and the battery voltage is 12.60 volts, the framework chooses the battery source.The control framework can moreover work well when the battery voltage < 11.1 volts than transfer 2 will cut the electric current to the stack. The DC source cannot charge the battery on the off chance that the voltage is less than 80%. In arrange for a DC source to charge the battery it needs more than 80% voltage. This BCR security framework too works well.When the sensor peruses a current esteem of more than 5 amperes, the framework will disengage the current from the DC source and battery source.

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