Boost Controller Effect on Battery Charger in Electrical Switchboard

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Abstract*—One of the essential elements used in electrical switchboards is the DC source. It is used for controlling the breaker, monitoring device, and starting a generator. Because of this role, it needs an uninterrupted power source type such as battery and charger. In some cases, there are no proper boost charge regulators on most battery chargers in the market. External devices do need to control the boost charge functionality. The author aims to analyze the effect of a boost charge controller in this report.

***Keywords*—VRLA, boost, charge, switchboard, electrical.**

I. Introduction

In a portion of the electrical switchboard scheme, the direct current source has a major function. It was used to power the breaker, to track the system and to start a generator. Because of this position, an uninterrupted form of power source such as the battery and charger is required. For this work, a lead acid battery is used [1].

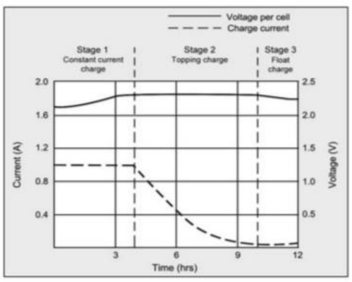


Fig. 1 VRLA three charging stage

There are several battery charging devices that are used on electrical switchboards nowadays. Information from technical support team received from the consumer suggested the battery charger product typically indicates that the charging process is not proper [2-7].

Commonly VRLA (Valve Controlled Lead Acid) use three stages of charge that consist of; boost charge, topping charge, and float charge as shown in Fig. 1 [5].

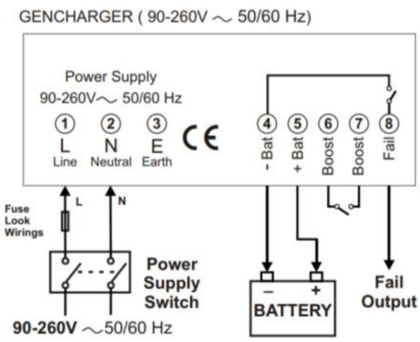


Fig. 2 Charging diagram from gencharger brand

From Fig. 2 we can see that the battery charger in the market only has a boost as a dry contact and doesn't have boost stage charge controller. So, controller is needed to close and open boost contacts, so we can get full the 3-stages of lead acid charging.

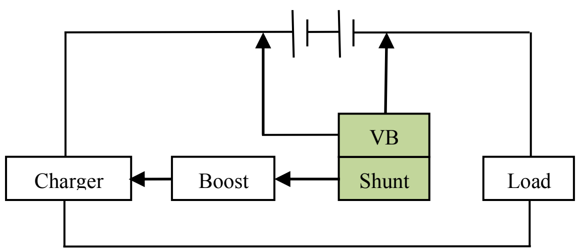


Fig. 3 Boost/bulk charge control diagram

The author will concentrate on the VRLA characteristic of the battery charger in this article. We can compare the characteristics between the controlled boost battery charger and the uncontrolled boost battery charger (Fig. 3).

II. Research Methods

A. Research Framework

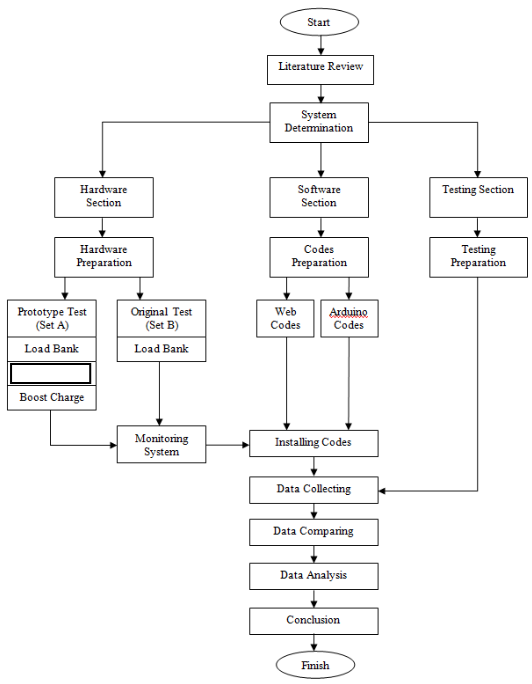


Fig. 4 Frame work

Set A battery charger system test: this set battery charger system will consist of battery charger, boost charge controller, load bank, charge discharge controller, and microcontroller as data collector, Ethernet shield for data sender and web for online monitoring. Set B battery charger system test: this set battery charger system will consist of battery charger, load bank, charge discharge control simulation, and microcontroller as data collector, Ethernet shield for data sender and web for online monitoring is shown in Fig. 4 and Fig. 5.

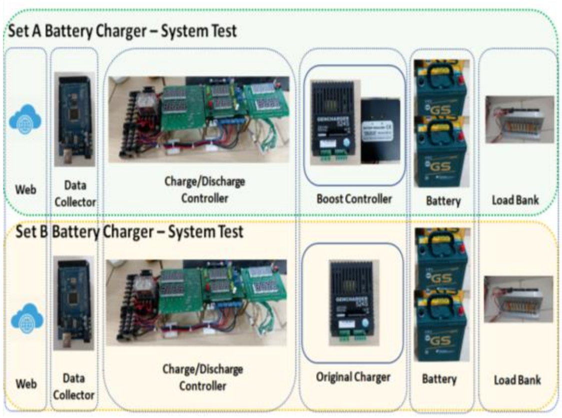


Fig. 5 Framework overview

- Boost/Bulk Charge Module

Boost/Bulk Charge is the first stage in lead acid charging method (CC). This stage is important especially when a battery supply huge amount of current in the process. After the voltage reach the maximum voltage, the current will decrease until minimum amount that we set (CV).

Boost/Bulk Charge Module will sense voltage and current (Fig. 3) of the battery and compare with parameters (Table 1), when the parameter is matched it will command relay to connect the boost dry contact (Fig. 2).

- Charge and Discharge Controller Module

Charge and Discharge Controller Module is used as simulator for this research. This module sensing the battery and the charger controlling a contact to determine when the battery should be in charge or discharge mode. In charging mode, the author used minimum battery voltage parameter to start the charging process. On the other hand, the author used maximum battery voltage and minimum charging current (as three stage charging method) parameter to start the discharge process [8-11].

TABLE I
SET VALUE OF CHARGE AND DISCHARGE CONTROLLER MODULE

No	Description	Set A	Set B	Unit
1	Maximum Battery Voltage	29,80	27,50	Volt
2	Minimum Battery Voltage	24,30	24,30	Volt
3	Minimum Charging Current	1,00	1,00	Ampere

- Load Bank

Load bank is a dummy load that will represent the real load in actual use. Load bank usually made from the use of current load such as heater, lamp, motor, etc. in our prototype, our battery system is 24VDC and 35AH, which mean its need 35A/24VDC or 840 watt load to discharge 100% at one hour. We try to make a load bank by using resistor until 1 Ohm resistant, so it will value more than 50% of DoD or 420 watt of minimum load is shown in Table 2 [5-6].

TABLE II
MEASURED RESISTANCE OF LOAD BANK

No	Specimen	Voltage (V)	R (Ohm)	Current (I)
1	Set A	24,3 - 29,8	1,1	22,1 - 27,1
2	Set B	24,3 - 27,5	1,2	20,2 - 22,9

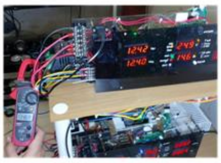
- Data Calibration

When all parameter is set up, the author compares the simulator result with calibrated measurement tools as a calibration.

TABLE III
MEASURED VOLT BATTERY CALIBERATION

ID	V Battery 1			V Battery 2		
	Simulator	Calibrator	Web	Simulator	Calibrator	Web
Set A	13,28	13,27	13,38	13,28	13,28	13,38
Picture						
Set B	12,97	12,96	12,94	12,93	12,94	13,09
Picture						

TABLE IV
MEASURED CHARGE/DISCHARGE BATTERY CALIBERATION

ID	Discharge Current			Charge Current		
	Simulator	Calibrator	Web	Simulator	Calibrator	Web
Set A	14,6	14,69	14,44	4,1	4,02	3,87
Picture						
Set B	18,7	18,81	18,52	4,2	4,17	4,11
Picture						

III. RESULT AND DISCUSSION

The first data from this work is the analysis of battery voltage between two experiments, Set A and Set B. The data includes time (minutes) and battery voltage information according to the method of multiple charging (Table 3 and Table 4).

Each set of experiment contains about 600 data, taken every 1 minute. As below, the data outcome example is shown in Table 5 and Table 6.

TABLE V
SET A CHARGE CONTROL RESULTS

No	Date/Time	V Batt 1	V Batt 2	V Batt	I Charge	I Discharge
1	2020-12-10 23:57:39	11,72	11,72	23,44	3,84	25,83
2	2020-12-10 23:58:39	11,62	11,72	23,34	3,85	26,27
3	2020-12-10 23:59:39	11,62	11,67	23,29	3,86	25,49
4	2020-12-11 00:00:39	11,57	11,43	23	3,86	25,63
5	2020-12-11 00:01:39	11,57	11,62	23,19	3,85	25,93
6	2020-12-11 00:02:39	11,62	11,62	23,24	3,85	25,83
7	2020-12-11 00:03:39	11,57	11,57	23,14	3,85	28,13
8	2020-12-11 00:04:39	11,62	11,52	23,14	3,85	25,93
9	2020-12-11 00:05:39	12,55	12,21	24,76	3,83	0
10	2020-12-11 00:06:39	12,65	12,74	25,39	3,85	0
11	2020-12-11 00:07:39	12,7	12,74	25,44	3,86	0
12	2020-12-11 00:08:39	12,74	12,55	25,29	3,85	0
13	2020-12-11 00:09:39	12,74	12,74	25,48	3,84	0
14	2020-12-11 00:10:39	12,79	12,74	25,53	3,82	0
15	2020-12-11 00:11:09	12,79	12,84	25,63	3,81	0
16	2020-12-11 00:12:49	12,79	12,94	25,73	3,83	0
17	2020-12-11 00:13:49	12,89	12,84	25,73	3,86	0
18	2020-12-11 00:14:49	12,89	12,89	25,78	3,82	0
19	2020-12-11 00:15:49	12,89	12,74	25,63	3,85	0
20	2020-12-11 00:16:49	12,89	12,94	25,83	3,83	0

With data from the Table 5 we can visualize it into Fig. 6 for analysis.

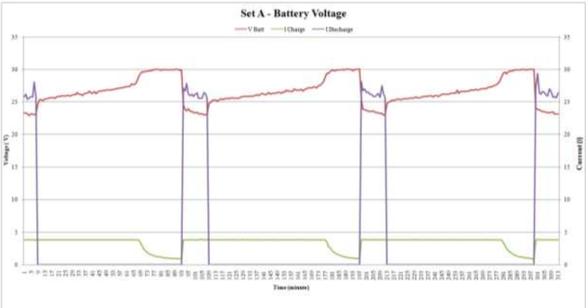


Fig. 6 Set A battery voltage and charge/discharge current

TABLE VI
SET B CHARGE CONTROL RESULTS

No	Date/Time	V Batt 1	V Batt 2	V Batt	I Charge	I Discharge
1	2020-12-10 23:56:43	12,5	12,35	24,85	4,08	21,53
2	2020-12-10 23:57:43	12,3	12,26	24,56	4,09	21,39
3	2020-12-10 23:58:43	12,26	12,21	24,47	4,06	21,24
4	2020-12-10 23:59:43	12,21	12,21	24,42	4,06	23,24
5	2020-12-11 00:00:43	12,26	12,06	24,32	4,11	23,14
6	2020-12-11 00:01:43	12,06	12,11	24,17	4,1	23,78
7	2020-12-11 00:02:43	12,21	12,06	24,27	4,11	21,09
8	2020-12-11 00:03:43	12,3	12,11	24,41	4,1	22,27
9	2020-12-11 00:04:43	12,11	12,16	24,27	4,11	21,63
10	2020-12-11 00:05:43	12,21	11,08	23,29	4,03	23,63
11	2020-12-11 00:06:43	12,16	12,01	24,17	4,12	20,95
12	2020-12-11 00:07:43	12,94	12,79	25,73	4,04	0
13	2020-12-11 00:08:43	13,13	13,04	26,17	4,08	0
14	2020-12-11 00:09:43	12,94	13,09	26,03	4,11	0
15	2020-12-11 00:10:43	13,28	13,13	26,41	4,13	0
16	2020-12-11 00:11:13	13,28	13,13	26,41	4,05	0,1
17	2020-12-11 00:12:45	13,33	13,28	26,61	4,12	0,05
18	2020-12-11 00:13:45	13,48	13,18	26,66	4,02	0,05
19	2020-12-11 00:14:45	13,48	13,33	26,81	4,02	0,15
20	2020-12-11 00:15:45	13,43	13,38	26,81	3,97	0

With data from the Table 6 we can visualize it into Fig. 7 for analysis.

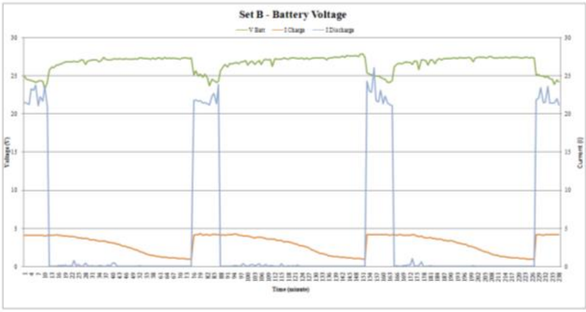


Fig. 7 Set B battery voltage and charge/discharge current

From Fig. 7 we can analyze the V Battery. Set B only have a constant graph that called float charge graph with average charging voltage 26.6 V. On the other hand set A have 2 stages (boost and topping) charge characteristic. Boost stage is the increase voltage until the voltage is in maximum. When the voltage is maximum, the topping stage will be started and battery charging current will slowly drop until 1 A (3%). The third stage-Float stage is a standby charging process [5] to speed up the experiment in this research this Float stage is not shown. But we still can see the characteristic on Set B.

In the charging current Fig. 7 (I Charge) we also can analyze that the Set A have CC-CV charge characteristic and have similar form to VRLA, the three stages charge.

IV. Conclusions and Recommendations

From this research, we can see the effect of using boost controller on original battery charger controller. With boost controller (Set A), the battery has better performance and the 3-stages charge character.

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