ASI IMPORTANT TECHNICAL BULLETIN

Date:	October 11, 2022
To:	All customers
From:	Accelerated Systems, Inc.
RE:	High power controller in-rush current limits
Models concerned:	All variants of BAC2000, BAC4000, BAC8000
Pages:	Total 5 Pages

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Summary

It has come to ASI's attention that some of our product resellers have been operating without effective pre-charge or in-rush limiting mechanisms resulting in premature failure of components in ASI high-power controllers. Pre-charging the capacitors in high-power controllers is required. Failing to pre-charge such controllers can lead to reduced reliability and premature controller failure. The pre-charge limits of the high-power controller family are as follows until further notice:

Table 1 – Tentative in-rush current limits

Controller family	In-rush current limit
BAC2000	60 A
BAC4000	180 A
BAC8000	380 A

Background

Recently there have been confirmed reports of popping noises coming from the BAC8000 controllers when first connected to live high output batteries, e.g., in SUR-RON motorcycle applications. ASI BAC high-power controllers are used in a multitude of industrial applications. No other applications have reported this problem other than those using high-output batteries without functioning in-rush limiting or pre-charge features enabled.

This noise from the controller, not the connector, has sometimes been accompanied by smoke emitted by the controller. In other cases, no smoke was present. In cases where smoke was emitted, the controller immediately failed. In other cases, without emitting smoke, the controllers later fail prematurely.

Issue Description

Returned product from the field confirmed that the power board electrolytic capacitors had been damaged during this popping event.

ASI attempted to replicate the issue with a stock 60V nominal SUR-RON Light Bee battery but could not. Current and voltage were recorded during the connection of a new, discharged controller to the battery to understand what may be causing the capacitors to fail. It is evident through the data that the stock SUR-RON has a pre-charge battery control circuit. During power-on, the battery slowly raises the voltage allowing the motor controller capacitors to charge at a slow rate. Then after a predetermined level, fully power on, resulting in a peak in-rush of 315A. This is the best practice for component reliability when coupling a battery to a motor controller.

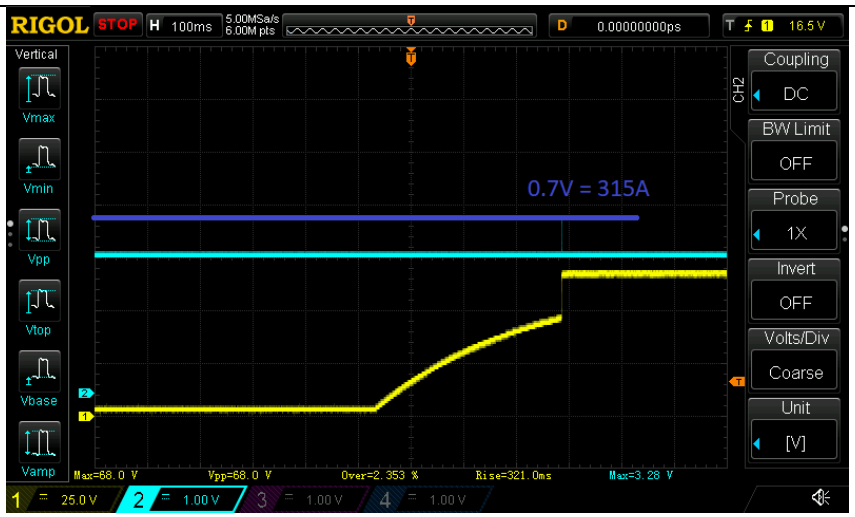

Figure 1 - SUR-RON stock battery voltage (yellow) and current (cyan), connected to BAC8000

ASI sourced an aftermarket battery, a 72V nominal SUR-RON drop-in. The controller immediately made the characteristic popping noise during the initial connection in the same manner as reported in the field. Data collected with the aftermarket battery shows no pre-charge circuit. During power connection, the battery provides a peak of 1311 Amps within ~100µs. This exceeds the in-rush current limit of the BAC8000 capacitors and other high-power controllers, i.e., BAC2000 and BAC4000.

Figure 2 – Representative 72V nominal battery in-rush current (cyan) and battery voltage (yellow) when connected to a BAC8000. Note that the directional current sensor is non-linear above 900A, or 2V from 2.5V zero point. Further testing was completed to verify the peak of 1311A.

Required Actions

Limit the in-rush current to the controller during power connection below the in-rush current limits. All in-field controllers shall have this retrofitted for controller reliability and any new sales. This can be resolved in two ways.

Option 1: Add an external pre-charge resistor in parallel with the circuit breaker and an additional fuse

With the system circuit breaker in the open position, the pre-charge resistor provides the necessary in-rush current limiting when connecting the battery before the user closes the circuit breaker. Note the circuit breaker must be open when connecting the battery or risk damaging the controller.

Table 2 - Pre-charge resistor sizing

Battery nominal voltage	Pre-charge resistor rating
36 V	250 Ω / 10 W
48 V	250 Ω / 15 W
60 V	250 Ω / 20 W
72 V	250 Ω / 30 W

When the breaker is closed, the current bypasses the resistor, and full vehicle performance is achieved.

The addition of an appropriately sized fuse is required as a secondary fail-safe should the BMS fail, not fault, or is bypassed, and the battery fails stuck in the discharge condition.

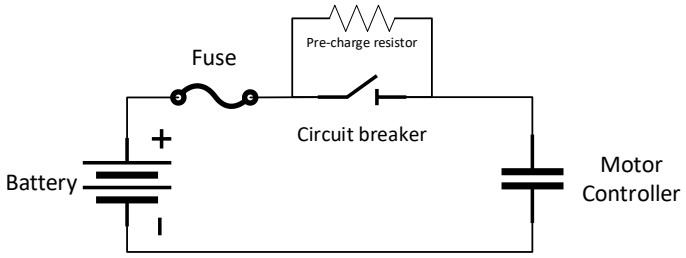

Figure 3 - Simplified pre-charge circuit with a fuse.

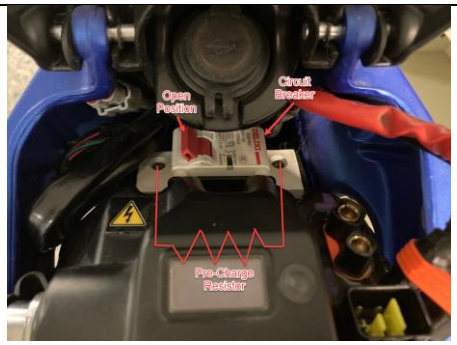

Figure 4 - SUR-RON circuit breaker, with an example where the pre-charge resistor shall run in parallel. The breaker is shown in the open position.

Option 2: Pre-charge function within the BMS triggered by battery discharge enable input.

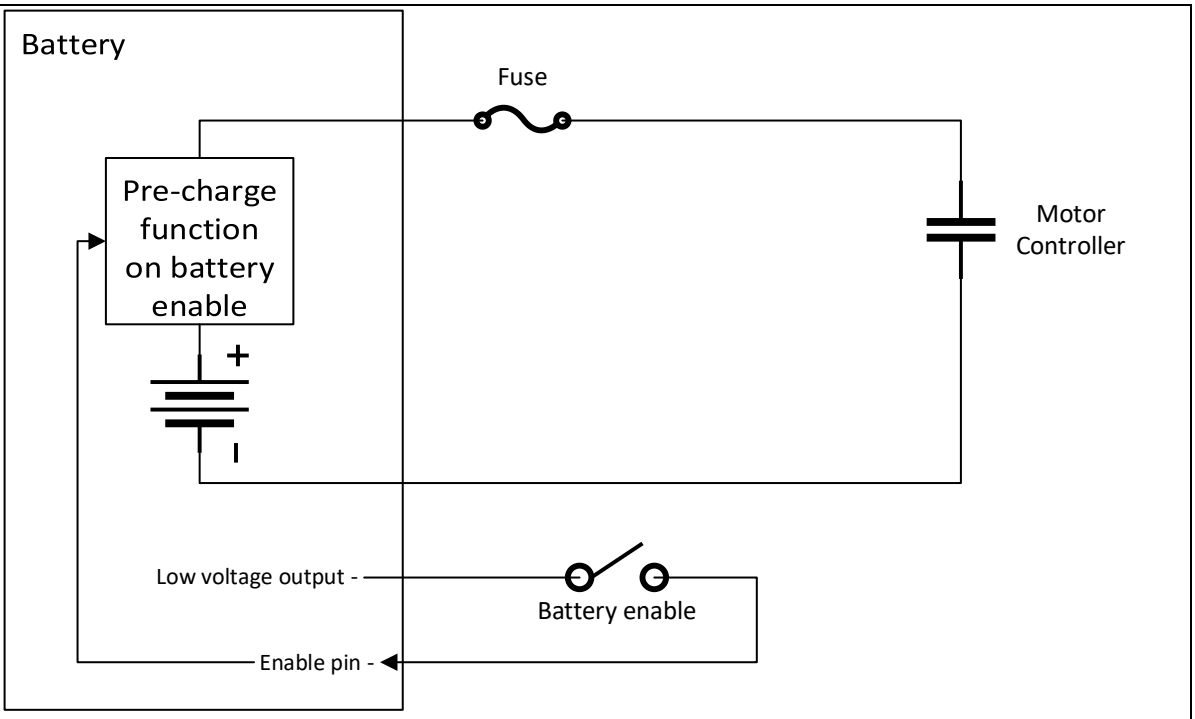

Figure 5 – Pre-charge system on battery enable