BSPD Testing Standard Procedure

Revision

- 2024/11/17, William, First version release.

Purpose

This document outlines the procedure to verify the proper functionality of the Brake System Plausibility Device (BSPD) while ensuring compliance with EV7.7 regulations. The testing ensures that the system performs accurately under any circumstance.

Related Rule

- EV7.7 Brake System Plausibility Device (BSPD)

Test Steps

:::danger Ensure the HV system remains disabled throughout the entire test. :::

1. **Driver Preparation**
   The driver gets on board and prepares for the test.
2. **Activate GLV System**
   Turn on the GLV system.
3. **Simulate Hard Braking Condition**
   a. Instruct the driver to press the brake pedal as hard as possible to simulate a hard braking scenario.
   b. Verify that **the Interlock remains closed**.
4. **Reset to Normal Condition**
   Ask the driver to release the brake pedal.
5. **Simulate Accumulator Output Exceeding 5kW**
   a. Set the laboratory power supply to 2V and 3A.

b. Connect the positive terminal to the upper green banana jack and the negative terminal to the lower green banana jack on the LV-BOX panel.
c. Activate the power supply's output.
d. Verify that **the Interlock remains closed**.

6. **Test Interlock with Combined Conditions**
a. Instruct the driver to press the brake pedal as hard as possible again while the simulated accumulator output exceeds 5kW.
b. Verify that **the Interlock opens**.

Core System Explanation

How to Detect Accumulator Output Power Exceeds 5kW?

To monitor whether the accumulator’s output power exceeds 5kW, we installed a Hall effect sensor “LEM DHAB/S118” on the positive HV bus inside the HV-BOX.

Given that we are using LiFePO4 batteries with a nominal cell voltage of 3.2V and a configuration of 108 cells in series, the total nominal voltage of the accumulator is:

$$ 345.6V = 108 \times 3.2V $$

At 5kW output power, the corresponding current is calculated as:

$$ I = \frac{5kW}{345.6V} \approx 14.46A $$

The current sensor, functioning as a transimpedance amplifier, converts the measured current into a voltage signal using the formula:

$$ V_{out} = 2.5V + (\text{Measured Current} \times 66.7mV/A) $$

At a current of 14.46A, the output voltage of the sensor will be:

$$ V_{out} = 2.5V + (14.46A \times 66.7mV/A) \approx 3.464V $$

To determine whether the output power exceeds 5kW, we use an operational amplifier (OPA) configured as a comparator with a precise voltage reference set at 3.464V. When the sensor’s output voltage exceeds this threshold, the comparator outputs a high signal, indicating that the power has surpassed the 5kW limit.

How to Detect Hard Braking?

To detect hard braking, we installed a pressure sensor “TE M3041” on the brake pipe.

This sensor outputs a voltage proportional to the brake pedal travel. To determine the threshold voltage for hard braking, we conducted a calibration by asking the driver to press the brake pedal as hard as possible, simulating a hard braking scenario. The corresponding sensor output voltage was recorded as the threshold.

Similar to the method used for detecting when output power exceeds 5kW, we use an operational amplifier (OPA) configured as a comparator. A precision voltage reference and a potentiometer are included in the circuit, allowing us to easily set the threshold voltage. When the sensor’s output voltage exceeds this threshold, the system identifies a hard braking event.

How to Simulate Accumulator Output Exceeds 5kW Without HV Operation?

To simulate the accumulator output exceeding 5kW without operating at high voltage, we wound a wire 5 times around the current sensor. Each end of the wire is connected to separate green banana jacks located on the LV-BOX panel.

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By applying a constant current, such as 1A, through the wire using a laboratory power supply, the sensor detects an equivalent current of 5A due to the 5 turns of the wire. Therefore, to simulate the accumulator output current for 5kW, we only need to apply:

$$ I_{simulate} = \frac{14.46A}{5} \approx 2.892A $$

This method allows for safe and accurate testing of the system under conditions equivalent to high-power operation.

Is the System Non-Programmable?

Yes, BSPD circuits only use operational amplifiers, voltage references, counter ICs, and oscillators to achieve all functionality and requirements.

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