INTRODUCTION

From its first debut, the Tesla Model S powertrain has undergone numerous revisions that have improved its longevity, efficiency, and power. The Model S can recoup the energy required to produce it in less than 10,000 miles. More than 60 kW of regenerative braking power is available from the drivetrain, which significantly lowers brake wear and energy consumption. Since there is an electronic power distribution between the two induction motors, there is no mechanical linkage between the front and back axles. As a matter of fact, accurate powertrain modeling and validation are paramount for critical design and control decisions of high performance electric vehicle. Described in this paper is a methodology for the design and description of Tesla Model S powertrain components. Justification of real-world vehicle system focusing on battery management system, CAN bus and regenerative braking is also provided.

MAIN COMPONENTS

Inverter and Motor

- Motor type: Liquid-cooled, 3-phase, 4-pole, AC induction
- Inverter: Variable frequency drive with regenerative braking

Single Speed Transmission

Traction Battery Pack

- The battery pack includes 16 battery modules each consisting of 444 Panasonic N18650F lithium-ion battery cells. Glycol coolant is passed through metallic inner tubes between the cells.
- Battery Pack Capacity: 85 kWh
- Battery Module: 5.3 kWh, 230 Ah
- Weight: 50 lb
- Energy Density: 212 Wh/kg
- Nominal Voltage: 22.8 V (3.8 V per cell)

On Board Charger

This onboard charger can provide up to 11.52 kW of charge to the high voltage battery. There are two basic types of charging: direct current or alternating current. If AC power is used, it can be fed from the outlet or the AC charging station. The current then passes through the charging cable to the on-board charger, which converts the AC power to DC and sends it to the battery via the Battery Management System (BMS).

High Voltage Power Distribution Module

DC-DC Converter

This converter transforms the high voltage and low current of the battery pack into low voltage and high current for charging the 12 V auxiliary battery. This liquid cooled converter works on buck or boost circuits and consists of power switches like MOSFETS, IGBTs or BJTs.

Input Voltage and Current: 400 V at 15 Amp
Output Voltage and Current: 12.8 V at 150 Amp

METHODOLGY

BATTERY MANAGEMENT SYSTEM AND CAN BUS

- Battery Management System (BMS) is one of the most crucial and essential components of an electric vehicle. The main feature of a BMS is to safeguard the battery and make the operation reliable and smooth.
- BMS monitors a range of parameters including the battery current, voltage, remaining travel range of the battery, State of Charge (SoC), State of Functioning (SoF) of a particular function or task and State of Health (SoH).
- The Controller Area Network (CAN) is one of the most preferred communication protocols in modern vehicles. It is used for the communication between numerous control units and the BMS.
- In normal cases, the communication between the battery pack and the control units is done by wiring, which becomes bulky and does not allow for adding of extra components.
- In order to solve this problem, the implementation of CAN bus communication is essential as it reduces the wiring required between the control units. It uses a single serial bus which combines all the wiring into a single node using the controlled area network protocol.

CONCLUSION

 Globally, electric vehicles have revolutionized the automotive industry for the future. Slowly, it is pacing towards the next generation of mobility that has unveiled itself as a replacement for the traditional IC engine vehicles. Battery performance is one of the key features of this development that substantially reduces the consumption of fuel. Automakers are continuously looking for better battery designs to modify the modification to improve efficiency of electric vehicles. Founded in 2003, Tesla is ranked as the most valuable automotive brand worldwide as of June 2023 and within the fourteenth most valuable brands across all industries in 2022. Globally, Tesla’s vehicle deliveries reached a record 1.31 million units in 2022 and have been steadily growing year-over-year.