Automotive PWT

29 April 2024

14:46

**Battery Management System:**

1. Battery Charging Efficiency Test:

* Evaluate the efficiency of the battery charging process under different charging rates and conditions.
* Measure the energy input into the battery and compare it to the energy stored.
* Assess the impact of temperature on charging efficiency.

>> Questions <<

Charging Rate Analysis:

- What is the charging current (in amperes) recorded during the charging process?

- How does the charging voltage (in volts) vary over time during the charging cycle?

- Can we identify any patterns or trends in charging current and voltage that correlate with charging efficiency?

Energy Input Monitoring:

- How much energy (in watt-hours or kilowatt-hours) is supplied to the battery during the charging process?

- Can we calculate the total energy input based on the integrated charging current over time?

- What percentage of the total energy supplied is effectively stored in the battery?

Battery State of Charge (SoC) Tracking:

- How does the battery's State of Charge (SoC) change over the course of the charging cycle?

- Can we observe any deviations or irregularities in SoC that may indicate inefficiencies in the charging process?

- Is there a correlation between the rate of change in SoC and charging efficiency?

Temperature Monitoring:

- What are the temperature readings (in degrees Celsius or Fahrenheit) recorded at various points in the battery during charging?

- How does temperature fluctuate throughout the charging process, and is there a noticeable impact on charging efficiency?

- Are there any temperature thresholds or limits that affect charging performance or safety?

Efficiency Calculation:

- Can we calculate the charging efficiency by comparing the energy input to the battery with the energy stored?

- What is the efficiency percentage for each charging session, and how does it vary under different conditions (e.g., charging rate, temperature)?

- Are there any trends or patterns in charging efficiency that can be attributed to specific factors or variables?

Comparison with Charging Conditions:

- How does charging efficiency differ between different charging rates or power levels?

- Is there a noticeable difference in efficiency when charging at different temperatures or under varying ambient conditions?

- Can we identify optimal charging conditions that maximize efficiency while ensuring battery health and longevity?

2. Battery Discharge Rate Test:

* Determine the rate at which the battery discharges under different driving conditions.
* Monitor voltage and current levels to assess the discharge behavior.
* Evaluate the battery's capacity to deliver power over time.

>> Questions <<

Discharge Rate Analysis:

- What is the rate of battery discharge during different driving conditions, such as city driving, highway driving, or stop-and-go traffic?

- Can we identify any patterns or trends in battery discharge rate based on vehicle speed, acceleration, or other driving parameters recorded in the CAN data?

Voltage Monitoring:

- How does the battery voltage vary over time during the discharge cycle?

- Are there any fluctuations or drops in voltage that may indicate changes in battery state or performance?

Current Levels Assessment:

- What is the magnitude and direction of current flow (discharge current) from the battery during the discharge cycle?

- Can we analyze current levels to understand how power demands fluctuate during different driving scenarios?

Discharge Behavior Analysis:

- How does the battery discharge behavior change over the course of the discharge cycle?

- Are there any significant deviations or irregularities in discharge behavior that may indicate battery degradation or system inefficiencies?

Capacity Evaluation:

- What is the total amount of energy discharged from the battery over the duration of the test?

- Can we calculate the battery's effective capacity to deliver power over time based on the discharge profile recorded in the CAN data?

Performance Assessment:

- How does the battery's discharge rate and capacity compare across different driving conditions or vehicle usage scenarios?

- Are there any factors or variables that influence the battery's ability to deliver power consistently over time?

State of Health (SoH) Estimation:

- Based on the discharge behavior observed in the CAN data, can we estimate the battery's State of Health (SoH) or overall condition?

- Are there any indications of degradation or loss of capacity that may affect long-term battery performance?

Efficiency Analysis:

- Can we assess the efficiency of the battery system in converting stored energy into usable power during discharge?

- Are there any inefficiencies or losses observed in the discharge process that may impact overall system performance?

By analyzing the vehicle's CAN data and extracting relevant information related to charging current, voltage, energy input, SoC, temperature, and efficiency, these questions can help evaluate the performance and effectiveness of the battery charging process under various conditions.

**Braking System**:

1. Brake Force Distribution Test:

* Assess the distribution of braking force between the front and rear wheels.
* Measure braking distances under various braking scenarios.
* Analyze the effectiveness of the braking system in different driving conditions.

>> Questions <<

Braking Force Distribution:

- What is the distribution of braking force between the front and rear wheels during different braking scenarios?

- Can we analyze the brake pressure data from the CAN to determine the proportion of braking force applied to each wheel?

Wheel Speed Analysis:

- How do the wheel speeds vary during braking maneuvers, and are there any differences between the front and rear wheels?

- Can we identify any wheel lock-up or skidding events based on wheel speed data recorded in the CAN?

Braking Distance Measurement:

- What are the braking distances recorded for various braking scenarios, such as emergency braking, gradual braking, or braking on different road surfaces?

- Can we calculate the braking distance based on changes in vehicle speed and wheel speed profiles captured in the CAN data?

Effectiveness in Different Driving Conditions:

- How does the effectiveness of the braking system vary under different driving conditions, such as dry, wet, or slippery road surfaces?

- Can we compare braking performance metrics, such as stopping distance or deceleration rate, across different driving conditions?

Brake Response Time:

- What is the response time of the braking system in applying brake force to the wheels following driver input?

- Can we analyze the delay between brake pedal activation and the corresponding increase in brake pressure recorded in the CAN data?

ABS Activation Analysis:

- How frequently does the Anti-lock Braking System (ABS) activate during braking maneuvers, and under what conditions?

- Can we identify ABS events based on changes in wheel speed patterns and brake pressure data recorded in the CAN?

Comparative Analysis:

- How does the distribution of braking force and braking performance compare between different vehicles or vehicle models?

- Are there any notable differences in brake force distribution or braking effectiveness that may be attributed to vehicle design or braking system specifications?

2. Emergency Braking Test:

* Evaluate the vehicle's ability to perform emergency braking maneuvers.
* Measure braking distances from different initial speeds to a complete stop.
* Assess the integration of regenerative and friction braking systems during emergency stops.

>> Questions <<

Braking Distance Measurement:

- What are the braking distances recorded for emergency braking maneuvers initiated from different initial speeds?

- Can we calculate the braking distances based on changes in vehicle speed and wheel speed profiles captured in the CAN data?

Deceleration Rate Analysis:

- How does the deceleration rate vary during emergency braking maneuvers, and how does it compare to standard braking scenarios?

- Can we analyze the rate of change in vehicle speed and brake pressure data from the CAN to determine the deceleration profile?

Brake Force Distribution:

- What is the distribution of braking force between the front and rear wheels during emergency braking?

- Can we assess the proportion of braking force applied by the regenerative braking system versus the friction braking system during emergency stops?

ABS Activation Analysis:

- How frequently does the Anti-lock Braking System (ABS) activate during emergency braking maneuvers, and under what conditions?

- Can we identify ABS events based on changes in wheel speed patterns and brake pressure data recorded in the CAN?

Regenerative Braking Integration:

- How effectively is the regenerative braking system integrated with the friction braking system during emergency stops?

- Can we analyze the transition between regenerative and friction braking modes based on changes in brake pressure and vehicle speed recorded in the CAN?

Comparative Analysis:

- How do the braking distances and deceleration rates during emergency braking compare to standard braking maneuvers?

- Are there any notable differences in brake force distribution or braking effectiveness between emergency and non-emergency braking scenarios?

System Response Time:

- What is the response time of the braking system in initiating emergency braking maneuvers following driver input?

- Can we analyze the delay between detection of the emergency braking event and the corresponding increase in brake pressure recorded in the CAN data?

**Regenerative Braking**

1. Regenerative Braking Efficiency Test:

* Measure the amount of energy recovered through regenerative braking during typical driving scenarios.
* Compare the energy regenerated under different driving conditions (e.g., city driving vs. highway driving).
* Analyze the effectiveness of regenerative braking in extending the vehicle's range.

>> Questions <<

Energy Recovery Analysis:

- How much energy is recovered through regenerative braking during typical driving scenarios, such as urban commuting or highway driving?

- Can we calculate the total energy regenerated based on changes in vehicle speed, acceleration, and battery state of charge recorded in the CAN data?

Comparative Analysis:

- How does the amount of energy regenerated differ between different driving conditions, such as city driving, highway driving, or stop-and-go traffic?

- Can we compare the effectiveness of regenerative braking in energy recovery across various driving scenarios based on the CAN data?

Regeneration Rate Assessment:

- What is the rate of energy regeneration during braking events, and how does it vary with different driving conditions?

- Can we analyze the relationship between braking intensity, vehicle speed, and the amount of energy regenerated using the CAN data?

Impact on Range:

- How does the energy recovered through regenerative braking contribute to extending the vehicle's range?

- Can we estimate the additional range gained from regenerative braking based on the energy recovered during typical driving scenarios?

Efficiency Comparison:

- What is the efficiency of regenerative braking in converting kinetic energy into stored energy in the battery?

- Can we compare the efficiency of regenerative braking between different driving conditions and braking intensities using the CAN data?

Battery State of Charge (SoC) Monitoring:

- How does regenerative braking affect the battery's state of charge (SoC) during typical driving scenarios?

- Can we analyze the change in SoC before and after regenerative braking events to assess its impact on battery management and performance?

Long-term Analysis:

- How does the effectiveness of regenerative braking in energy recovery change over time or with prolonged use?

- Can we identify any trends or patterns in regenerative braking efficiency based on historical CAN data records?

2. Regenerative Braking Response Test:

* Assess the responsiveness of the regenerative braking system to changes in driving behavior.
* Measure the rate of energy regeneration during acceleration and deceleration phases.
* Analyze the impact of regenerative braking on overall driving dynamics and vehicle stability.

>> Questions <<

Regenerative Braking Responsiveness:

- How quickly does the regenerative braking system engage in response to changes in driving behavior, such as releasing the accelerator pedal or applying the brake pedal?

- Can we analyze the time delay between driver input and the onset of regenerative braking based on changes in throttle position and brake pressure recorded in the CAN data?

Energy Regeneration Rate Analysis:

- What is the rate of energy regeneration during acceleration and deceleration phases, and how does it vary with different driving behaviors?

- Can we calculate the rate of change in energy flow (regeneration rate) based on changes in vehicle speed, acceleration, and battery state of charge captured in the CAN data?

Effect on Driving Dynamics:

- How does regenerative braking impact overall driving dynamics and vehicle stability during acceleration and deceleration phases?

- Can we assess the changes in vehicle pitch, yaw, or lateral acceleration associated with regenerative braking events using the CAN data?

Braking System Integration:

- How effectively is regenerative braking integrated with the vehicle's friction braking system during deceleration?

- Can we analyze the transition between regenerative and friction braking modes based on changes in brake pressure and vehicle speed recorded in the CAN?

Acceleration Response:

- How does the vehicle's acceleration response change when transitioning from regenerative braking to acceleration phases?

- Can we evaluate any delays or hesitations in acceleration following regenerative braking events using the CAN data?

Energy Efficiency Comparison:

- What is the efficiency of regenerative braking in converting kinetic energy into stored energy in the battery during different driving scenarios?

- Can we compare the energy regeneration rates and efficiency metrics between acceleration and deceleration phases using the CAN data?

Stability Control Assessment:

- How does the regenerative braking system interact with vehicle stability control systems to maintain stability during braking events?

- Can we identify any corrective actions or interventions by stability control systems based on changes in wheel speed, yaw rate, or other vehicle dynamics parameters recorded in the CAN data?

**Motor Torque and Acceleration/Deceleration Test**

To evaluate the performance and behaviour of the vehicle's motor torque, acceleration, and deceleration under various driving conditions using CAN data signals.

**Battery Discharge Capacity Test while Driving**

To evaluate the performance and capacity of the vehicle's battery during typical driving conditions by monitoring its discharge behaviour over a specified duration.

Similar Other tests

Energy Consumption Test:

* Objective: Evaluate the vehicle's energy consumption under different driving conditions.
* Test Setup: Drive the vehicle along predefined routes or cycles while recording CAN data signals related to energy consumption, including battery current, voltage, and state of charge.
* Test Procedure: Measure energy consumption during acceleration, cruising, and deceleration phases. Analyze the impact of driving behavior, speed, and road conditions on energy usage. Calculate energy efficiency metrics and compare them between different driving scenarios.

Regenerative Braking Efficiency Test:

* Objective: Assess the effectiveness of the regenerative braking system in recovering energy during deceleration.
* Test Setup: Conduct controlled deceleration maneuvers while monitoring CAN data signals related to motor torque reduction, battery current flow, and energy regeneration.
* Test Procedure: Measure the amount of energy regenerated during deceleration events and calculate the regenerative braking efficiency. Analyze the impact of driving behavior and road conditions on regenerative braking performance. Compare efficiency metrics between different driving scenarios.

Thermal Management System Test:

* Objective: Evaluate the performance of the vehicle's thermal management system in maintaining optimal operating temperatures for key components.
* Test Setup: Drive the vehicle under varying environmental conditions while monitoring CAN data signals related to coolant temperature, motor temperature, and battery temperature.
* Test Procedure: Assess the effectiveness of the thermal management system in controlling temperature fluctuations and preventing overheating or overcooling. Analyze the impact of driving conditions, such as high-speed driving or heavy loads, on temperature management.

Dynamic Stability Test:

* Objective: Assess the vehicle's dynamic stability and handling characteristics under different driving maneuvers.
* Test Setup: Conduct controlled cornering, lane change, and emergency avoidance maneuvers while recording CAN data signals related to vehicle speed, yaw rate, lateral acceleration, and wheel speeds.
* Test Procedure: Analyze the vehicle's response to steering inputs and evaluate its stability during dynamic maneuvers. Assess the effectiveness of stability control systems in mitigating oversteer, understeer, and loss of traction. Identify any handling anomalies or stability issues recorded in the CAN data.

Efficiency Mapping Test:

* Objective: Create efficiency maps for the vehicle's propulsion system under various operating conditions.
* Test Setup: Drive the vehicle along predefined routes or cycles while recording CAN data signals related to motor torque, vehicle speed, and energy consumption.
* Test Procedure: Analyze the relationship between motor torque, vehicle speed, and energy consumption to create efficiency maps for different driving scenarios. Identify optimal operating points for maximizing energy efficiency and range. Compare efficiency maps between different driving modes or powertrain configurations.