**Battery Swapping Service for Electric Vehicles Based on a Battery Swapping motorcycle**

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# **Problem Statement and Introduction**

The design of battery charging systems for motorcycles is an important aspect of motorcycle maintenance. One of the challenges of designing such a system is ensuring proper battery management during the charging process. The use of a Battery Management System (BMS) can help in this regard. Additionally, the use of the CanBus protocol and the ESP32 microcontroller can provide effective control over the charging process. and the swapping system is designed to enhance the performance and maximize the value of battery charging, catering to industrial tasks that require charging a large number of batteries. The goal is to reduce the burden of frequently replacing batteries after charging and to minimize costs by implementing an automatic sliding system that stops charging when the battery is fully charged.

# **Background Study**

**Battery Management System**

BMS stands for Battery Management System. It is an electronic system that is used to monitor and control the charging and discharging of rechargeable batteries. The BMS helps to ensure that the battery is charged and discharged safely, efficiently, and effectively. It typically includes a microcontroller, sensors, and other components that work together to measure the battery's voltage, temperature, and other parameters. The BMS also helps protect the battery from overcharging, over-discharging, and other potentially harmful conditions that could reduce the battery's lifespan or cause damage. It is commonly used in applications such as electric vehicles, renewable energy systems, and portable electronics.

A BMS is a complex system that typically includes the following components:

1. Microcontroller: The brain of the system that controls and monitors the battery's charging and discharging process.
2. Voltage sensors: These sensors measure the battery's voltage and provide feedback to the microcontroller to ensure that the battery is charged and discharged properly.
3. Temperature sensors: These sensors measure the battery's temperature and provide feedback to the microcontroller to prevent overheating or overcooling.
4. Current sensors: These sensors measure the battery's current and provide feedback to the microcontroller to ensure that the battery is charged and discharged safely.
5. Cell balancing circuit: This circuit helps to ensure that each individual cell in the battery is charged and discharged equally, which helps to prolong the battery's lifespan.
6. Communication interface: This allows the BMS to communicate with other systems, such as a vehicle's onboard computer or a renewable energy system's controller.

The specific features and capabilities of a BMS can vary depending on the application and the type of battery being used. Some advanced BMS systems may also include features such as:

* State of charge (SOC) estimation: This feature uses sophisticated algorithms to estimate the battery's current charge level.
* Predictive maintenance: This feature uses data from the BMS to predict when the battery will need maintenance or replacement.
* Over-the-air updates: This allows the BMS to receive software updates remotely, which can help to improve performance and add new features.
* Overall, the BMS is a critical component in many applications that rely on rechargeable batteries. It helps to ensure that the battery is used safely and efficiently, and can help to prolong the battery's lifespan.

The primary functions of a BMS are to ensure the safe and efficient operation of a battery system. These functions include:

1. State of Charge (SOC) Estimation: The BMS determines the SOC of the battery by monitoring the battery's voltage, current, and temperature. SOC estimation is critical in applications where the battery's capacity needs to be known, such as in electric vehicles.
2. Cell Balancing: The BMS ensures that each cell in the battery is charged and discharged equally, which helps to prolong the battery's lifespan.
3. Overcharge and Overdischarge Protection: The BMS prevents the battery from being overcharged or overdischarged, which can cause damage to the battery and create a safety hazard.
4. Temperature Monitoring and Protection: The BMS monitors the battery's temperature and prevents the battery from overheating or overcooling, which can cause damage to the battery and create a safety hazard.
5. Communication: The BMS communicates with other systems, such as a vehicle's onboard computer or a renewable energy system's controller, to provide information about the battery's state and to receive commands.

BMS can also have advanced features such as:

1. Fault Detection and Diagnosis: The BMS can detect and diagnose faults in the battery system, such as short circuits or cell failures.
2. Predictive Maintenance: The BMS uses data from the battery system to predict when maintenance or replacement is needed.
3. Over-The-Air Updates: The BMS can receive software updates remotely, which can improve performance and add new features.

BMS can be designed for different types of batteries, such as lithium-ion, lead-acid, or nickel-metal hydride batteries. The specific design of the BMS depends on the battery chemistry, capacity, and application requirements.

BMS can be used with different types of batteries, but it is particularly important for rechargeable batteries that are used in applications where safety and performance are critical. Some of the most common battery types that use BMS include:

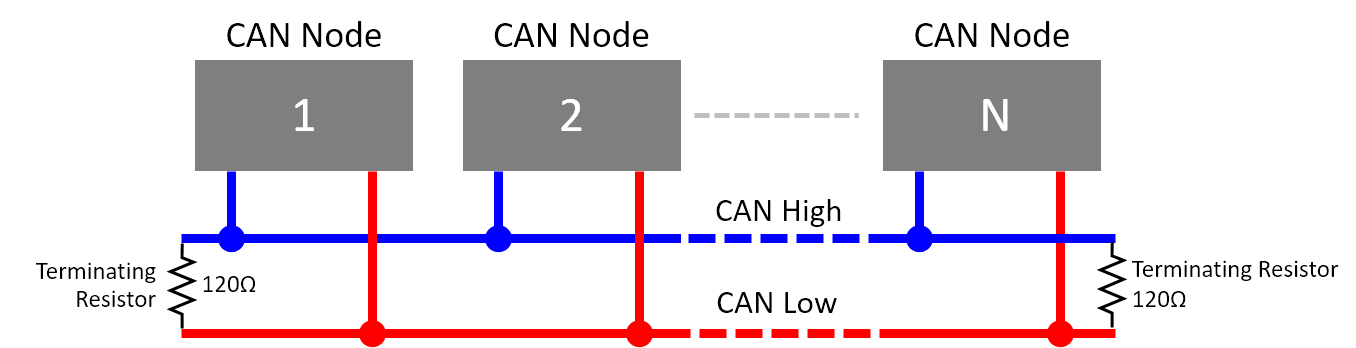
1. Lithium-ion Batteries: Lithium-ion batteries are widely used in portable electronics, electric vehicles, and renewable energy systems. They require a BMS to monitor the battery's voltage, current, and temperature to prevent overcharging, overdischarging, and overheating.
2. Lead-Acid Batteries: Lead-acid batteries are commonly used in vehicles and backup power systems. They require a BMS to prevent overcharging, which can cause the battery to release hydrogen gas and create a safety hazard.
3. Nickel-Metal Hydride Batteries: Nickel-metal hydride batteries are used in some portable electronics and hybrid vehicles. They require a BMS to prevent overcharging and over discharging, which can cause damage to the battery and reduce its lifespan.

The specific type of BMS required for a battery depends on the battery's chemistry, capacity, and application requirements. The BMS must be designed to match the specific requirements of the battery system to ensure safe and efficient operation.

**CAN Bus**

(Controller Area Network bus) A rugged, digital serial bus designed for industrial environments. Introduced by Bosch in the mid-1980s for in-vehicle communications, it is used in myriad applications including factory automation, building automation, aircraft and aerospace as well as in cars, trucks and buses. CAN bus replaced bulky wiring harnesses with a two-wire differential cable (the two wires carry inverted voltages to decrease interference).

CAN provides services at layers 1 and 2 of the OSI model and uses a broadcast method for placing frames on the wire, somewhat similar to Ethernet. Bus distance is based on speed, ranging from a maximum of 40 meters at 1 Mbps to a maximum of six kilometers at 10 Kbps. At speeds up to 125 Kbps, CAN provides fault tolerance. If one of the two wires is cut or shorted, the other keeps transmitting. See OSI model.



# **Conceptual Design**

\*\*Requirement\*\*

ต้องการที่จะสร้าง battery swapping ที่สามารถชาร์จแบตเตอรี่ที่นำมาสลับได้และยังช่วยลดจำนวนขั้วชาร์จโดยใช้การควบคุมตำแหน่งทำงานของมอเตอร์เพื่อช่วยลดจำนวนการใช้ขั้วชาร์จจากที่ต้องใช้ทุกช่องเสียบแบตเตอรี่ที่ต้องมีทุกช่อง n เหลือเป็น n-4 (สมมุติ \*ขึ้นอยู่การออกแบบทางกล)

# **Task ,Process**

| Milestone | Task | Start Date | Deliver Date |
| --- | --- | --- | --- |
| Process 2 | Mechanical design for charging system and swapping system | Mar 8, 2023 | Mar 22, 2023 |
| Electrical design | Mar 8, 2023 | Mar 22, 2023 |
| Process 3 | Able to do BMS charging system | Mar 23, 2023 | Apr 19, 2023 |
| Able to get battery charge via CAN Bus. | Mar 23, 2023 | Apr 19, 2023 |
| Process 4 | The position of the battery swapping can be controlled precisely. | Apr 20, 2023 | May 10, 2023 |

**Process 2**

* Mechanical design for charging system and swapping system

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* Electrical design [ **Nattapong Panatiragul 63340500013** ]

**Process 3**

* Able to do BMS charging system [ **Thanabordee Thammarangsee 63340500023** ]
* Able to get battery charge via CAN Bus. [ **Nattapong Panatiragul 63340500013** ]

**Process 4**

* The position of the battery swapping can be controlled precisely.

[ **Nattapong Panatiragul 63340500013** ]

# **Learning Plan**

Learn to use the CAN protocol

| หัวข้อ | สถานะ |
| --- | --- |
| Learn the basics of using the CanBus protocol. | ยังไม้ได้เรียนรู้ |
| Compare models of microcontrollers that are available for use. | ยังไม้ได้เรียนรู้ |
| Examine the device's datasheet | ยังไม้ได้เรียนรู้ |

Learn how to use a Battery Management System (BMS).

| หัวข้อ | สถานะ |
| --- | --- |
| Learn the fundamentals of how a Battery Management System (BMS) works. | ยังไม้ได้เรียนรู้ |
| can choose various devices to use in the operation of a Battery Management System (BMS). | ยังไม้ได้เรียนรู้ |

Learn and review control used to accurately manage the position of motors.

| หัวข้อ | สถานะ |
| --- | --- |
|  | ยังไม้ได้เรียนรู้ |

Learn how the ESP32 works, which is used to send data received from canbus and upload data to the cloud.

| หัวข้อ | สถานะ |
| --- | --- |
| Learn about various libraries that can assist in supporting the work. | ยังไม้ได้เรียนรู้ |

Design and find a reference model for the mechanism used to transmit the Battery Management System, ensuring that it is compatible with controlling the position of the motor.

| หัวข้อ | สถานะ |
| --- | --- |
| Design and find a reference model for the mechanism used to transmit the Battery Management System, ensuring that it is compatible with controlling the position of the motor. | ยังไม้ได้เรียนรู้ |

# **Reference:**

**Battery Management System**

[บอร์ดป้องกัน BMS ของแบตเตอรี่ลิเธียมคืออะไร? (tritekbattery.com)](https://www.tritekbattery.com/th/bms-protection-settings-of-the-lithium-battery/)

[What is a Battery Management System (BMS)? – How it Works | Synopsys](https://www.synopsys.com/glossary/what-is-a-battery-management-system.html)

**CAN Bus**

<https://www.pcmag.com/encyclopedia/term/can-bus>