1.What is a BMS? Types of BMS and differentiate types of BMS.

A Battery Management System (BMS), which controls the electronics of a rechargeable battery, whether a cell or a battery pack, becomes an important factor in ensuring the safety of electric vehicles. It protects both the user and the battery by keeping the cell within its safe operating parameters. The battery management system (BMS) monitors the battery's state of health (SOH), collects data, controls environmental factors that affect the cell, and balances them to ensure the same voltage across cells. A smart battery pack is one that has a BMS and is linked to an external communication data transfer system or a data bus. A smart battery pack can charge itself, generate error reports, detect and notify the device of any low-charge condition, and and forecast how long the battery will last or how much run-time it has left. It also reports the cell's current, voltage, and temperature and continuously self-corrects any errors to maintain prediction accuracy.

Battery management methods make the battery safe and reliable while increasing senility without causing damage. To maintain the state of the battery, voltage, current, and ambient temperature, various monitoring approaches are used. To monitor and control the charging of the battery pack, the BMS connects with the onboard charger. It also contributes to the vehicle's range by making the best use of the energy stored in it. It is a critical component in electric vehicles that ensures batteries are not overcharged or over drained, preventing battery damage and occupant danger.

The BMS performs critical operations and functionalities like:

* Voltage, Current and Temperature control and measurement
* SOC and SOH assessment
* Detection of faults
* Passive cell balancing
* Data storage
* Normally the BMS can be classified into 2:
* Hardware BMS
* Software BMS

Hardware BMS is an inevitable component of an EV. The functionality of the BMS is related to the cost of an EV, but a BMS consists of these basic functions.

* Over voltage cutoff
* Under voltage cutoff
* Continues current
* Over current detection
* Over temperature cutoff

All of the features present in hardware BMS are also present in software BMS. Data manipulation is its core function. Through CAN and Bluetooth, they can control and transmit data. A smart BMS offers benefits including online battery status monitoring for things like voltage, current, impedance, internal temperature, and more. 24/7 monitoring lowers the expense of human maintenance while enabling quick response in the case of a potential battery mishap. The system can review and evaluate uploaded data thanks to real-time warning and online balance. You can, for instance, customise the alert threshold, and if the provided data is anomalous, the system will send a server-based alarm to maintenance. A smart BMS may be known as due to all the historical data gathering, storage, and analysis.

Types of battery management systems

1. Centralized BMS Design

consists of a battery pack assembly with a single central BMS. Direct connections have been made between the central BMS and each battery package. Figure 6 depicts a centralised BMS's construction. There are various benefits to the centralised BMS. Since there is only one BMS, it tends to be more compact and more affordable. But there are drawbacks to a centralised BMS. Since every battery is directly connected to the BMS, the BMS requires a large number of ports to connect with every battery package. Large battery packs consequently have a lot of wires, cabling, connectors, etc., which makes maintenance and troubleshooting more difficult.

2.Modular BMS Topology

Similar to a centralized implementation, the BMS is divided into several duplicated modules, each with a dedicated bundle of wires and connections to an adjacent assigned portion of a battery stack. See Figure 7. In some cases, these BMS submodules may reside under a primary BMS module oversight whose function is to monitor the status of the submodules and communicate with peripheral equipment. Thanks to the duplicated modularity, troubleshooting and maintenance is easier, and extension to larger battery packs is straightforward. The downside is overall costs are slightly higher, and there may be duplicated unused functionality depending on the application.

3. Primary and inferior BMS

Although conceptually similar to the modular structure, the slaves in this scenario are more limited to just relaying measurement data, while the master is solely responsible for calculation, control, and external communication. As a result, even while the slaves' functionality tends to be simpler than that of the modular types, there may be less overhead and less unnecessary features.

4.Distributed BMS architecture

The electronic hardware and software in these topologies are contained in modules that connect to the cells through bundles of attached cabling, which is significantly different from the other topologies. A control board located on the cell or module being monitored houses all the electronic hardware in a distributed BMS.

As a result, the majority of the wiring is reduced to a few sensor wires and communication cables connecting nearby BMS units. Each BMS becomes more independent as a result and manages calculations and communications as needed. Although it appears straightforward, this integrated form could make maintenance and troubleshooting difficult because it is tucked away inside a shield module assembly. As there are more BMSs in the total battery pack construction, costs also tend to be greater.

2.What technical considerations should I make when buying a BMS to put together a battery pack?

ANS:

The six main parts of a battery management system are listed below.

1. Battery cell monitor

2. Cutoff FETs

3. Monitoring of Temperature

4. Cell voltage balance

5. BMS Algorithms

6. Real-Time Clock (RTC)

7. Battery cell monitor

1. A battery cell monitor primarily monitors the voltages for battery systems. It is a high-speed system that offers a low overall cost for high voltage measurements.

The easiest way to determine the battery pack’s charge is to monitor individual cell voltage with reference to the set voltage level.

When the voltage of the first cell reaches the voltage limit, the charging automatically trips. It indicates that the battery charging limit has been reached.

If the battery pack has a lesser charge than the average cell, then the least charged cell will reach the limit first, and the rest of the cells will be left partially charged.

2. The battery pack's load and charger must be connected and isolated by the cutoff FETs' FET driver. Voltage, current, and real-time detection circuitry measurements are used to predict behaviour.

They can be attached to either the low or high side of a battery pack.

To enable high-side connection, NMOS FETs must be activated, which calls for a charge pump driver. For the remaining circuitry, a high-side driver is used to set a reference for the solid ground.

Since a charge pump is not required in integrated systems, we use a low-side FET driver to cut expenses. In such circumstances, high voltage devices are not necessary.

Using low-side cut-off FETs, the battery pack's ground connection floats. This may have an impact on the IC's performance, making it more sensitive to insulated noise measurement.

3.Observation of Temperature

The batteries have been experiencing an ongoing rise in the delivery of currents at fixed voltages due to the growth in product needs. A catastrophic event like a fire or explosion could be brought on by the ongoing operation processes.

Temperature data allow us to determine if battery charging or discharging is desired.

Temperature sensors are used in small, portable applications to keep an eye on the energy storage system or cell cluster.

The inbuilt ADC voltage-powered thermistor keeps track of the temperature of the circuit. By using the internal voltage reference, the measuring system as a whole is improved and temperature errors are reduced.

4. Cell voltage balance

It is crucial to determine the health of the battery pack. That is why cell voltage monitoring is done to ensure that the cells are in a proper running condition for attaining a long battery life.

The operating voltage ranges from 2.5V to 4.2V in a lithium-ion battery.

The battery life is significantly affected while performing battery operations beyond the voltage range. This reduces the life of a cell, which may even make it unfit for use.

Connecting the battery pack in parallel increases the overall drive current, whereas series connection adds the overall voltage.

5. BMS Algorithms

To make quick and effective decisions in real-time based on the information received. For this purpose, a microcontroller for battery management system is needed to collect, organize and assess the information from the sensing circuitry.

Renesas’ ISL94203 is the most famous example of employing a battery management system algorithm. It is a standalone digital solution embedded in a single chip with programmable capabilities.

The memory space and microcontroller for battery management system clock cycles can be cleared using these standalone solutions.

5. Real Time Clock

The real-time clock functions as a "black box" device for time-stamping and memory storing, letting the user know the battery pack's behaviour prior to any alarming incident.

Battery authentication prevents the BMS electronics from syncing with a different battery pack.

Through a voltage reference/regulator, the peripheral power circuitry is employed around the battery management system's components

Q3. What is the purpose of BMS with communication? What are the various protocols of communication used in a BMS?

ANS:

In terms of voltage, current, and temperature, the fundamental objective of BMS is to keep the battery within the safe operating range while it is being charged, discharged, or in some circumstances, when it is open circuit.

You often utilise a BMS IC while working with a BMS. You might need to link to an external microcontroller or another external IC, depending on the BMS IC being used to control your BMS. To send and/or receive information from one another, these ICs must be able to communicate with one another. You might not be able to measure current with your BMS IC, for instance.

Therefore, you use an external IC that measures current. This current data then needs to be fed to the BMS IC. Or, another example, is you have a microcontroller connected to the BMS IC that reads the data from the IC to make decisions governing the BMS.So communication protocols are vital for a battery management system with multiple ICs to be able to communicate with each other.

1.UART

A UART (Universal Asynchronous Receiver/Transmitter) is the microchip with programming that controls a computer's interface to its attached serial devices. Specifically, it provides the computer with the RS-232C Data Terminal Equipment ( DTE ) interface so that it can "talk" to and exchange data with modems and other serial devices. As part of this interface, the UART also:

Converts the bytes it receives from the computer along parallel circuits into a single serial bit stream for outbound transmission

On inbound transmission, converts the serial bit stream into the bytes that the computer handles

Adds a parity bit (if it's been selected) on outbound transmissions and checks the parity of incoming bytes (if selected) and discards the parity bit

Adds start and stop delineators on outbound and strips them from inbound transmissions

Handles interrupt s from the keyboard and mouse (which are serial devices with special port s)

May handle other kinds of interrupt and device management that require coordinating the computer's speed of operation with device speeds.

2.12C

The IC-to-IC protocol is known as inter-integrated circuits communication (I2C). I2C is primarily designed for close-proximity communication between two integrated circuits on the same printed circuit board (PCB). Multi Master - Multi Slave topology is supported by I2C. In order to connect with slave devices, the I2C standard bidirectional interface employs a controller known as the master. Things like an RTC clock, an EEPROM, flash memory, or SD card memory are examples of slave devices. All other devices are slave devices, while the clock-generating device is the master device. To distinguish one device from another on the same I2C bus, each I2C bus device has a unique device address. A device may have one or more registers for storing data.

3.SPI

SPI, Serial Peripheral Interface, is a master-slave type protocol that provides a simple and low cost interface between a microcontroller and its peripherals.The SPI protocol uses a dedicated clock signal that is created by the master device to synchronize the transmitter and receiver or Master and Slave.One device is considered the Master of the bus (usually a microcontroller) and all the other devices (peripheral ICs or even other microcontrollers) are considered as slave devices.The microcontroller can communicate with the BMS IC via SPI communication, along with other peripheral devices that can communicate with SPI communication. These applications omc;ide memory devices such as SD cards, MMC, EEPROM, or Flash, sensors such as temperature or pressure sensors, control devices such as ADC, DAC, digital POTs, and audio codec, and other devices such as touch screen devices, LCD devices, RTC, or video game controllers.SPI communication uses 4 lines for each device. There is an input data line (receiving data), and output data line (transmitting data), a clock line, and a chip select line to identify which slave device the master is trying to communicate with. If there are multiple SPI slave devices connected to the master, then the chip select line functions to select the specific slave device either to transmit data to it or receive data from it.Specifically, the pins of a SPI bus are MOSI (Master Out, Slave In), MISO (Master In, Slave Out), SCLK (Serial clock), and CS or SS (Chip Select or Slave Select). The MOSI is how the master device transmit data to the slave and the MISO is how the master device reads information from a slave device.

 SPI communication is a full-duplex communication that occurs with very high speeds. By full duplex, it is meant that the transmission and receiving of data can occur simultaneously. This is advantageous over UART or I2C communication, in which there can only be transmission or receiving of data that can occur at a given time but not both simultaneously. The disadvantage of SPI is that 4 wires are required instead of 2 for UART and I2C.

4. CAN (Control Area Network)

Controller Area Network (CAN) is a serial network technology that was originally designed for the automotive industry, especially for European cars, but has also become a popular bus in industrial automation as well as other applications. The CAN bus is primarily used in embedded systems, and as its name implies, is a network technology that provides fast communication among microcontrollers up to real-time requirements, eliminating the need for the much more expensive and complex technology of a Dual-Ported RAM.

Introduction

CAN is a two-wire, half duplex, high-speed network system, that is far superior to conventional serial technologies such as RS232 in regards to functionality and reliability and yet CAN implementations are more cost effective.

While, for instance, TCP/IP is designed for the transport of large data amounts, CAN is designed for real-time requirements and with its 1 MBit/sec baud rate can easily beat a 100 MBit/sec TCP/IP connection when it comes to short reaction times, timely error detection, quick error recovery and error repair.CAN networks can be used as an embedded communication system for microcontrollers as well as an open communication system for intelligent devices. Some users, for example in the field of medical engineering, opted for CAN because they have to meet particularly stringent safety requirements.