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

A Battery Management System [BMS] is an electronic regulator that monitors and controls the charging and discharging of rechargeable batteries. Battery Mangement Systems of various types are used in most devices that use rechargeable batteries. BMS monitors the State of Health [SOH] of the battery, collect data, controls environmental factors that effect the cell, & balances them to ensure the same voltage across cells. Whether a cell or a battery pack, thus becomes a crucial factor in ensuring electronic vehicle safety

BMS keeps the battery safe, reliable & increase the senility without entering a damaging state. The BMS communicates with the onboard charger to monitor & control the charging of the battery pack. It also helps maximize the range of the vehicle by optimally using the amount of energy stored in it.

The BMS performs critical operations & functionalities like,
① Voltage, current & temperature control & measurement
② SOC & SOH assessment
③ Detection of faults
④ passive cell balancing
⑤ Data storage.

BMS can be classified into two. that are, ① Hardware BMS
② Software BMS

Hardware BMS : is an inevitable compontent 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

Software BMS : consist of all the features like hardware BMS. Data Manipulation is the main feature of it. They can control data, transmit data via CAN, Bluetooth.

Types of battery Mangagement systems.

1. centralized BMS Architecture

Has one central BMS in the battery pack assembly. All the battery packages are connected to the central BMS directly. It is more compact, & it tends to be the most economical since there ~~are~~ is only one BMS. There are disadvantages of a centralized BMS. Since all the batteries are connected to the BMS directly, the BMS needs a lot of ports to connect with all the battery packages. This translates to lot of wires, cabling, etc. in large battery packs, which complicates both troubleshooting & maintenance.

2. Modular BMS Topology.

The BMS is divided into several duplicated modules, each with a dedicated bundle of wires & connections to an adjacent assigned portion of a battery stack. In some cases, thes BMS submodules may reside under a primary BMS module oversight whose function is to monitor the status of the submodules & communicate with peripheral equipment

3. Primary / Suboordinate BMS

Conceptually similar to the modular topology. In this case the slaves are more restricted to just relaying measurement information, & the master is dedicated to computation & control, as well as external communication. So while like the modular types, the costs may be lower since the functionality of the slaves tends to be simpler, with likely less overhead & fewer unused features.

④ Distributed BMS Architecture

Where the electronic hardware & software are encapsulated in modules that interface to the cells via bundles of attached wiring. A distributed BMS incorporates all the electronic hardware on a control board placed directly on the cell or module that is being monitored.

2. what are the technical parameters to keep in mind while procuring a BMS for assembling a battery pack ?

Mainly, there are 6 components for a BMS

1. Battery cell monitor

- 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

2. Cutoff FETs

- FET driver is accountable for connection & isolation between load & charger of the battery pack. The behaviour prediction is done through voltage, current measurements, and real-time detection circuitry.
- They can be connected to a battery pack as low or high side
- The ground connection of the battery pack floats using low-side cut off FETs. This can affect the IC performance, making it more sensitive to insulated noise measurement.

3. Monitoring of temperature

- The continous operation processes may cause a catastrophic event such as fire or explosion.
- we can identify whether battery charging or discharging is desirable using temperature measurements.
- The circuit tempeature is monitoring by the internal ADC voltage-powered thermistor.

4. Cell voltage balance

- 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.
- connecting the battery pack in ||el ↑s the overall drive current, whereas series connection add's the

overall voltages

5. BMS algorithms

- To make quick & effective decisions in real-time based on the information received. For this purpose, a Mcontroller for battery management system is needed to collect, organize & assess the information from the sensing circuitry.
- The memory space & Mcontroller for BMS clock cycles can be cleared using these standalone solutions.

6. Real time clock

Allowing the user to know the battery pack's behaviour behaviour before any alarming event, the real-time clock acts as a black box system for time-stamping & memory storage.

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

When working with a BMS, you usually use a BMS IC. Depending on the BMS IC being used to control your BMS, you may need to connect to an external microcontroller or another external IC. These ICs need to be able to communicate with each other to send and/or receive information from one another. Communication protocols are vital for a BMS with multiple ICs to be able to communicate with each other.

1. UART → Universal Asynchronous Receiver/Transmitter.

It is the most widely used communication protocol used in BMS. UART is a form of serial communication. The UART communication is used for communication b/n the Mcontroller & the BMS IC in a BMS. It is also used for communication b/n the Mcontroller & the GSM, bluetooth, or WIFI modules. It is also used extensively for debugging purposes when developing the firmware of a BMS to check particular sections or lines of code.

using UART, the output of code can be printed & displayed on the screen. UARTs do not operate on clock signals but with baud rates. The baud rates can only vary by about 10% before the timing of the bits goes too far off. Only 2 wires are needed to transmit data b/n 2 UART devices.

② I2C → Inter-Integrated Circuits.

It is a protocol used for IC to IC communication. I2C is intended 1° for short-distance communication b/n 2 ICs on the same PCB. I2C allows multi-master-Multi Slave topology. The I2C is a standard bidirectional interface that uses a controller known as the master to communicate with slave devices. The device that generates the clock is the master device, while all other devices are slave devices. The physical I2C interface consists of the serial clock [SCL] & Serial data [SDA] lines.

③ SPI → Serial peripheral Interface.

It is a master-slave type protocol that provides a simple and low cost interface b/n a Mcontroller and its peripherals. The SPI protocol uses a dedicated clock sig that is created by the master device to synchronize the Tx & Rx on master & slave. One device is considered the Master of the bus & all the other devices that are considered as slave devices. The Mcontroller can communicate with the BMS IC via SPI communication, along with other peripheral devices that can communicate with SPI communication. SPI communication uses 4 lines for each device. There is an i/p data line & o/p data line, a clock line and a chip select line. SPI communication is a full duplex communication that occurs with very high speeds.

④ CAN → Controller Area Network.

It is widely used communication protocol in the automotive industry. CAN communication are used frequently in automotive applications because it removes all signal

noises such as electromagnetic noises. It also removes a host of wire harnesses from a system. It is one of the most robust and reliable communication protocols. The CAN protocol is used with a chip that allow for CAN communicaton. The M controller connects to the CAN chip, which then connects to the outside devices. The CAN chip has TXD and RXD pins which allow it to communicate with the microcontroller.