1). what is a BMS? Types of BMS and differentiate types of BMS.

A Battery Management System, which manages the electronics of a rechargeable battery, whether a cell or a battery pack, that becomes a crucial factor in ensuring electric vehicle safety. It safeguards both the user and the battery by ensuring that the cell operates within its safe operating parameters. BMS monitors the state of health of a battery, collects data, controls environmental factors that affect the cell, and balances them to ensure the same voltage across the cells.

A smart battery pack can manage its own charging, generate error reports, detect and notify the device of any low charge condition, and predict how long will the battery last or its remaining running time. Battery management system keeps the battery safe, reliable and ensures the security without entering a damaging state. The BMS communicates with the onboard charger to monitor and control the charging of the battery pack.

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:

1. Hardware BMS.
2. Software BMS.

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

- Overvoltage cutoff.
- Undervoltage cutoff.
- Continuous current
- Overcurrent 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. A smart BMS offers benefits such as online monitoring for battery status regarding voltage, current impedance, internal temperature etc. A smart BMS can be called a BMS data center due to all the historical data collection, storage and analysis. At the same time, you can get real-time battery information via a certain system.

Types of BMS

1. Centralised BMS architecture.

Has one central BMS in the battery pack assembly. All the battery packages are connected to the central BMS directly. The centralised BMS has some advantages. It is more compact, and it tends to be the most economical since there is only one BMS. However, there are disadvantages of a centralised BMS. Since all the batteries are connected to the BMS directly the BMS needs a lot of ports to connect with all the battery packs. This translates to lots of wires, cabling, connectors, etc. in large battery

packs, which complicates both troubleshooting and maintenance.

2. Modular BMS Topology.

Similar to a centralised implementation, the BMS is divided into several duplicated modules, each with a dedicated bundle of wires and connectors to an adjacent assigned portion of a battery stack.

3. Primary Subordinate BMS.

Conceptually similar to the modular topology, however in this case, the slaves are more restricted to just relaying measurement information and the master is dedicated to computation and control, as well as external communication.

4. Distributed BMS Architecture.

Considerably different from other topologies, where the electronic hardware and 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 battery management system.

1. Battery cell monitor.
2. Cut off FETs
3. Monitoring of Temperature.
4. Cell voltage balance.
5. BMS algorithms
6. Real-Time clock (RTC)

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

2. Cut off FETs

FET power is accountable for connection and isolation btw load and charger of the battery pack. The behaviour protection is done through voltage current measurements and realtime detection circuitry. They can be connected to a battery pack's low or high side.

3. Monitoring of Temperature.

With the increase in product requirements, the batteries have been on a constant surge in delivering currents at fixed voltages. The continuous operation prions may cause a catastrophic event such as fire or explosion.

4. Cell voltage balance.

It is crucial to determine the health of the battery pack. That is why cell 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.

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, organise and asses the information from the sensing circuitry.

6. Real-Time clock.

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

The BMS electronics is kept away from Synchronising with a thirdparty battery pack through battery authentication.

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

The main goal of BMS is to keep the battery within the safety operation region in terms of voltage, current, and temperature during the charge, the discharge and in certain cases at open circuit. 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 IC need to communicate with each other to send and / or receive information from one another.

1. UART

UART, which stands for universal Asynchronous Receiver / Transmitter, is the most widely used communication protocol used in BMS. UART is a form of serial communication, which means bits are sent one after another sequentially instead of multiple bits sent at once which is what occurs with parallel communications. It is widely used for the communication b/w the microcontroller and the BMS IC

a BMS. It is also used for communication btw the microcontroller and the GSM, Bluetooth, or WIFI modules. It is also used extensively for debugging purpose. Two UARTs communicate directly with each other. UARTs transmit data synchronously, which means there is no clock signal to synchronise the o/p of bits from the transmitting UART to the sampling of bits by the receiving UART.

2. I2C

I2C, Inter-integrated circuits communication, is a protocol used for IC to IC communication. I2C is intended primarily for short distance communication btw 2 ICs on the same printed circuit board. I2C allows Multi Master - Multi slave topology. The I2C is a std of bidirectional interface that uses a controller known as the master to communicate with slave devices.

3. SPI

SPI, Serial peripheral Interface, is a master slave type protocol that provides a simple and low cost interface btw a microcontroller and its peripherals. The SPI protocol uses a dedicated clock signal that is created by the master device to synchronise the transmitter and receiver or master and slave. One device is considered as the master of the bus and all other devices are considered as slave devices.
SPI communication is a full duplex communication that occurs with very high speeds.

4. CAN

CAN, Control Area Network, is the most 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. CAN applications can be used in simple to extremely complex applications.
The microcontroller connects to the CAN chip, which then connects to the outside devices.
So these are the most common and most used communication protocols for battery management systems.