Part5
BMS technology as the core of battery design

1. BMS objectives, Methods, Cost calculation and Case study

1-1 Objectives

The battery management system (BMS) serves an indispensable function in electronics and electronic equipment that use batteries. BMS provides protection of battery cells, management of charging and monitoring of remaining electrical capacity, as well as the control of devices based on the collected information. The larger the power output and capacity of the system, the more important BMS becomes. Although cellphone appliances and laptops can operate with a simple BMS, electric vehicles (EV) and stationary energy storage systems require a sophisticated BMS equipped with microprocessors and ICs specifically designed for battery management, which allow for advanced monitoring and controls. (**See Diagram 1**). There are multiple reasons for this. When comparing to Pb (lead) and nickel-hydrogen batteries, Li-ion batteries have a higher energy density and are vulnerable to overcharging and over-discharging, resulting in a higher risk of Li-ion battery cells igniting or exploding. Also, for a large energy storage system with higher capacity and output rate, which requires a greater number of series-connected Li-ion battery cells, it is critical to maintain a balance among cells by equalizing the output voltage and capacity.

Both laptop and EV battery packs utilize multiple battery cells . However, while there is a low chance of a laptop's battery pack being a serious threat to one's life, a flaw in an automobile battery pack can potentially cause a serious incident. BMS technology is the key to securing battery safety not only for EVs but also for hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV).

	Cell Phone	Laptop	EV
Number of Cells	1	Several	1000+
Watt Hours	Several	Dozens	10,000+
BMS Complexity	Low	Low～Mid	High

Diagram 1: the number of Li-ion cells for each end-use application, required energy capacity and BMS complexity

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BMS as an ECU

In thinking of the evolution of automobiles, it is apparent that BMS is essential technology. Befitting for a conventional vehicles' engine control unit (ECU) is the EV's BMS (battery control unit: BCU) (**See Diagram 2**). Regardless of the performance of a conventional vehicle's engine, if the ability to control the engine is not on an equal level, it becomes difficult to realize the full performance of the automobile as a whole. Similarly, regardless of the quality of battery cells in an EV, if the management and control of battery cells is poor, it is not possible to leverage the full potential of the batteries.

Currently, the automobile industry is gradually transitioning towards electric vehicles, such as HEV and EV, from vehicles that require an internal combustion engine (internal combustion engine vehicle: ICE-V), such as gasoline and diesel engines. In this transition, the core technology as a competitive differentiator changes from engine to battery, and therefore the system to control the engine is replaced by the system to control the battery. Some cars, such as HEVs, have both an engine and battery in its structure and as a result, require both an ECU and BMS.

	ICE-V		**EV**
Core Technology	engine	engine	battery
Supporting Technology	mechanical engine control technology	electronic engine control technology	battery control technology
Main Control Agent	carburetor, etc.	ECU	BMS/BCU
Relevant Infrastructure	gas station	gas station	charging stand
Technology to be standardized	fuel quality, fuel tank filler's cap shape ,etc.		charger, battery

Diagram 2: The core technologies and main control agents for conventional vehicles and electric vehicles (EVs)

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