Part 02

Developing Effective Heat Control Measures for Lithium Ion Batteries

Heat Control for Power Devices with Built-in Protective Monitoring

Lead-acid batteries are used in a variety of applications and may be provided as a device's backup power source when the power grid and the standby generator are not in service. For instance, the 48V DC backup power source for a telecommunications base station can be built using a lead-acid battery. However, more users are seeking to replace lead-acid batteries with lithium ion (Li-ion) batteries in order to save space and reduce weight.
Our 48V DC Li-ion battery module[1] (the GS Yuasa LIM Series) is ideal for telecommunication base station backup power and also for a variety of other applications. This article reviews the motivation for internalizing the circuitry used to monitor the power source and summarizes the concepts useful for heat control in such a DC power source provided with internal protective monitoring.

1. The LIM Series Module Case

Nineteen-inch racks are widely used in telecommunications installations; these racks allow for flexible device storage and addition. With that in mind, GS Yuasa designed the case for the DC 48V LIM modules to fit in a 19-inch rack (●Fig. 2).

The module cases support prismatic Li-ion cells connected in series and may include thirteen or fourteen cells depending on the requirements. Here, specifications such as the desired voltage input range and the installation environment determine how many cells are needed. The bottom of a module case includes cell holders which are offset from the corners and circuit board holders in the L-shaped space created by offsetting the cell holders (●Fig. 3). The circuit board holders allow for installation of two circuit boards inside the case.

The circuit board holders allow the circuit boards to be held vertically in the case (●Fig. 4). Additionally, the circuit board holders are separated from the cell holders so that a vertical circuit board and cell do not make contact. Separating these elements also reduces heat transfer between the circuit boards and cells.

As previously mentioned, the LIM Series module is designed to fit into a 19-inch rack, and the module is divided into a cell installation space and a circuit board installation space. This design provides for a simple construction that can facilitate heat control.

●Fig. 1 LIM40E, LIM50EN-13/LIM50EN-14

●Fig. 2 Modules in 19-inch rack

2. Circuit Board Placement

A lithium ion battery provides better energy density and charging performance than a lead-acid battery. At the same time, however, Li-ion batteries require careful handling when it comes to safety, e.g., dealing with overcharge or over discharge. More specifically, the cell voltage, temperature, and current of each cell should be continuously monitored so that the module can be detached from grid power or the base station when an abnormality is detected.

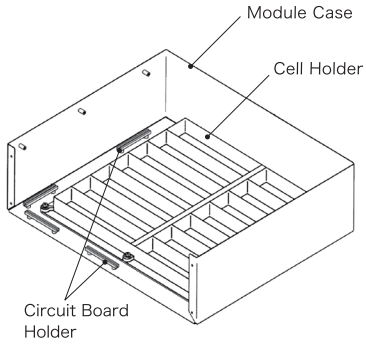
Typically, Li-ion batteries include measurement circuitry referred to as the cell monitoring unit (CMU), and a main circuit board referred to as the battery management unit (BMU). The main circuit board is often located outside the case. In contrast, the protective monitoring system in our DC 48V LIM module is internal. Our module houses both the measurement circuitry and the main circuit board inside the case (●Fig. 5). Consequently, this GS Yuasa LIM module may be adopted in systems that now use lead-acid batteries.

The measurement circuitry generates little heat since this circuitry only measures voltage and temperature, and only requires a relatively small current. The main circuit board, in contrast, tends to generate more heat because it uses large currents. The Li-ion cells surrounded by these two circuit boards will also generate heat when charged and discharged normally. Furthermore, more heat tends to radiate from the long side (the side with a large surface area) of the prismatic cells.

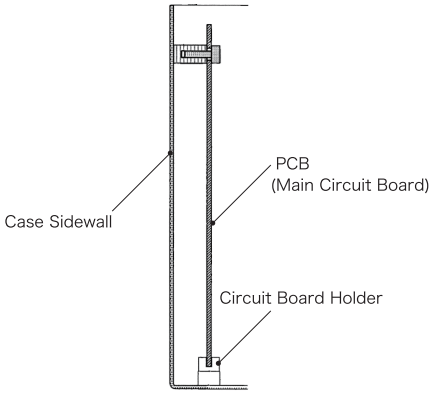
Taking advantage of this, GS Yuasa places the measurement circuitry, which generates little heat, opposite the long side of the cell and places the main circuit board, which tends to generate more heat, opposite the short side of the cells (● Fig. 5). This prevents heat transfer from a cell to the main circuit board which is already generating heat, and minimizes the impact of heat from the prismatic cells on both the circuits. A module can thus operate more stably.

This article reviewed the motivation for internalizing the circuitry used to monitor the power source and summarized the concepts useful for heat control in such a DC power source provided with internal protective monitoring. Part Three will explore the cooling techniques used in lithium ion batteries adapted for automotive applications.

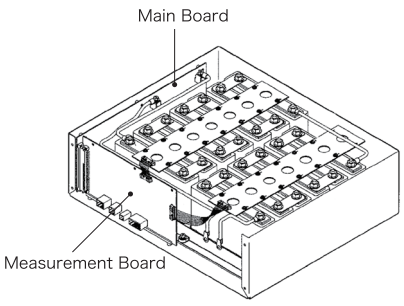
●Fig. 3 Cell Holders and Circuit Board Holders[2]



●Fig. 4 Securing the Circuit Board in the Module Case[3]



●Fig. 5 Internal Circuit Board Placement[4]



1. GS Yuasa Technical Report Volume 12, No. 2, published 2015
2. Japanese Patent Publication No. 2017-016885 (Filed in 2015)
3. Japanese Patent Publication No. 2017-016888 (Filed in 2015)
4. International Publication No. WO2017/002584 (Filed in 2015)

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