US 20230246459A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2023/0246459 A1

LEE (43) Pub. Date: Aug. 3, 2023

(54) BATTERY APPARATUS AND METHOD OF SUPPLYING VOLTAGE

(71) Applicant: LG ENERGY SOLUTION, LTD., Seoul (KR)

(72) Inventor: Sungwoo LEE, Daejeon (KR)

(73) Assignee: LG ENERGY SOLUTION, LTD., Seoul (KR)

(21) Appl. No.: 17/789,583

(22) PCT Filed: Dec. 27, 2021

(86) PCT No.: PCT/KR2021/019911

§ 371 (c)(1),
(2) Date: Jun. 28, 2022

(30) Foreign Application Priority Data

Jan. 8, 2021 (KR) 10-2021-0002663

Publication Classification

(51) Int. Cl.
H02J 7/00 (2006.01)
H01M 10/46 (2006.01)
H01M 10/44 (2006.01)

(52) U.S. Cl.
CPC ***H02J 7/0019*** (2013.01); ***H01M 10/46*** (2013.01); ***H01M 10/441*** (2013.01); ***H02J 7/007*** (2013.01); *H01M 2010/4271* (2013.01)

(57) ABSTRACT

A battery apparatus including a first battery pack for providing a first voltage, a battery management system for managing the first battery pack, and a second battery pack for providing a second voltage lower than the first voltage is provided. The second battery pack includes a plurality of battery cells, and the battery management system selects a battery cell group including a predetermined number of battery cells from among the plurality of battery cells of the second battery pack. The selected battery cell group supplies an operating voltage to an operating device of the battery management system.

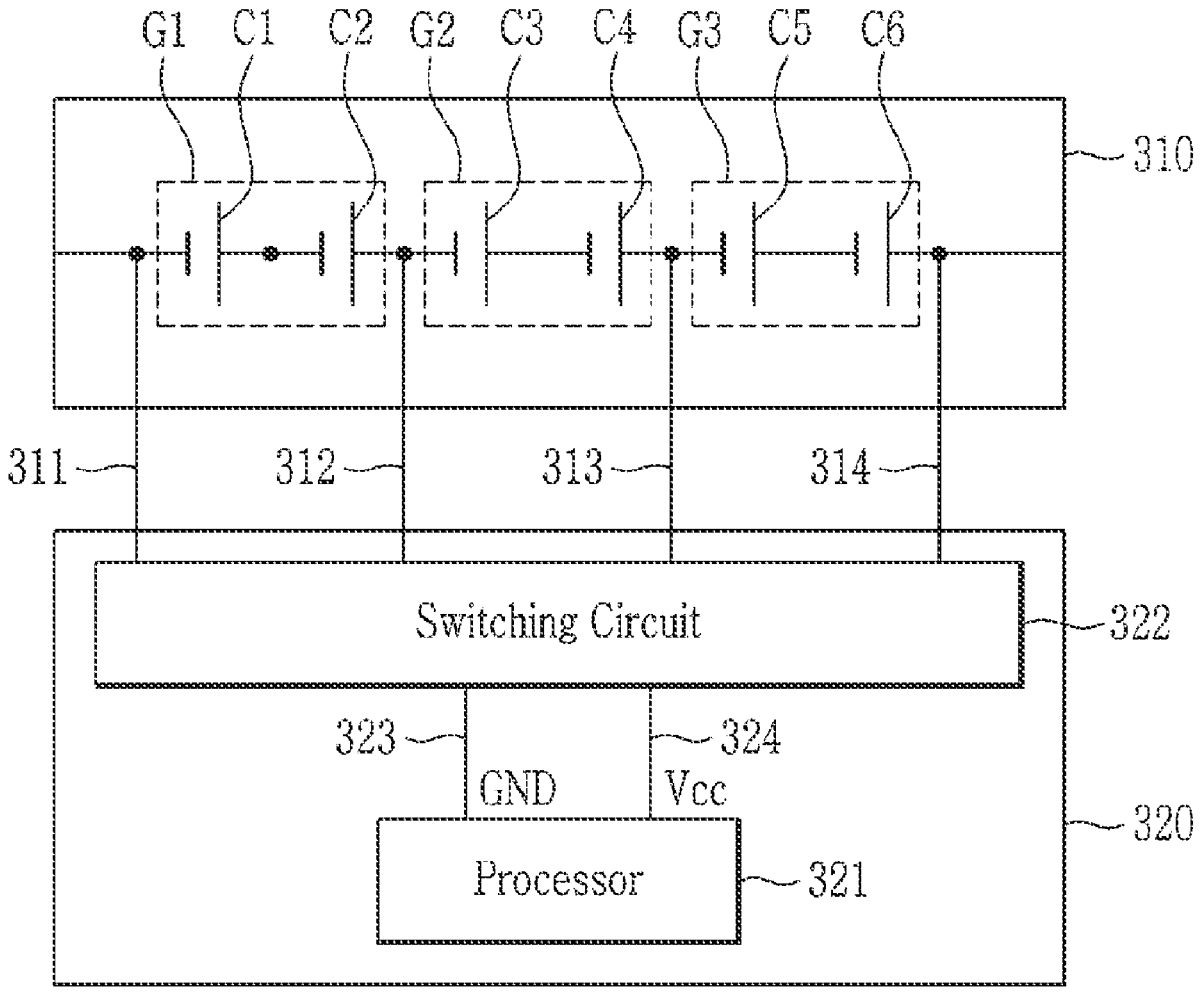


FIG. 1

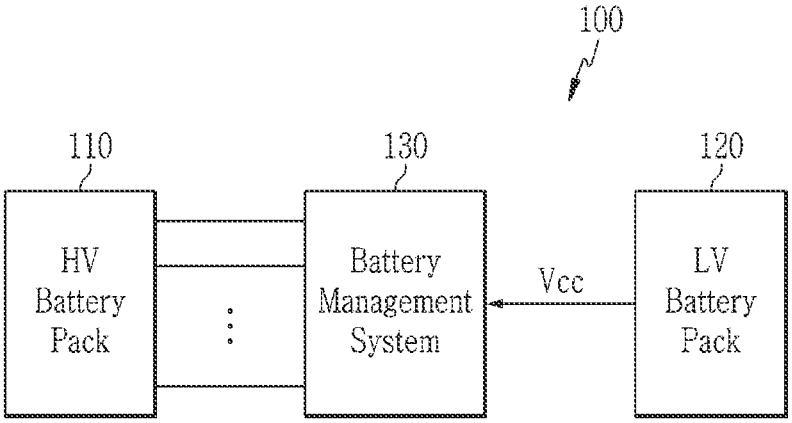

100
110
130
120
HV Battery Pack
Battery Management System
Vcc
LV Battery Pack

FIG. 2

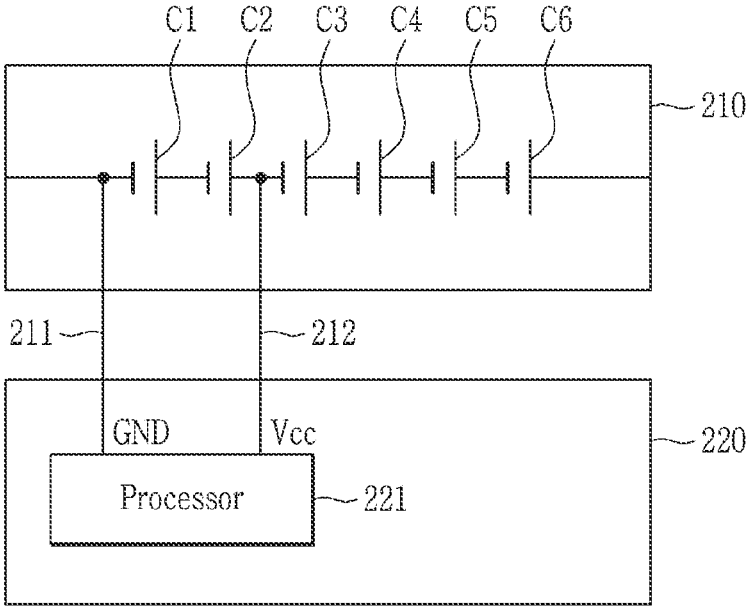

C1
C2
C3
C4
C5
C6
210
211
212
GND
Vcc
220
Processor
221

FIG. 3

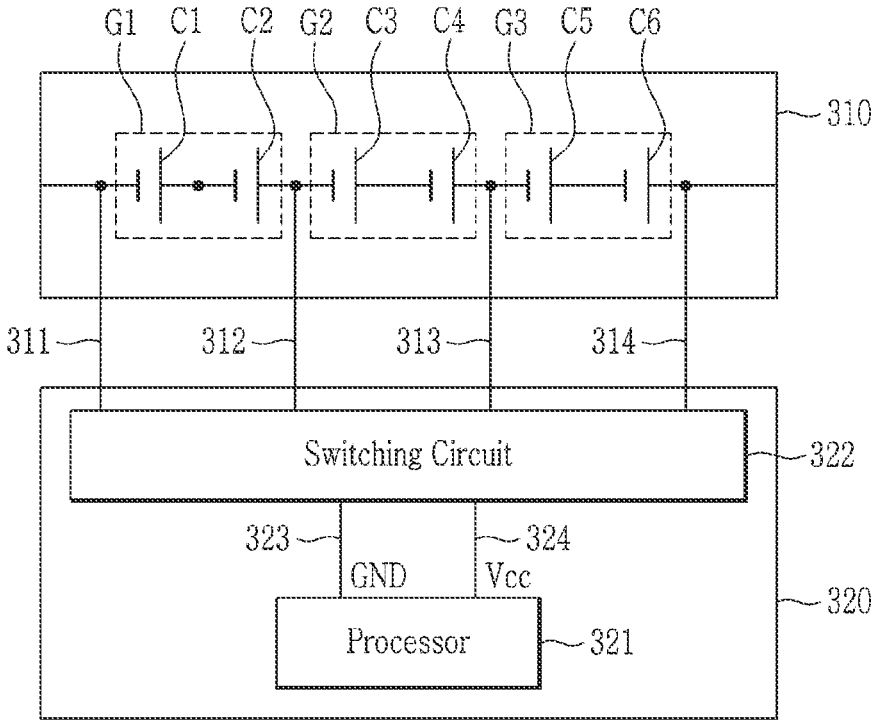

G1
C1
C2
G2
C3
C4
G3
C5
C6
310
311
312
313
314
Switching Circuit
322
323
GND
324
Vcc
320
Processor
321

FIG. 4

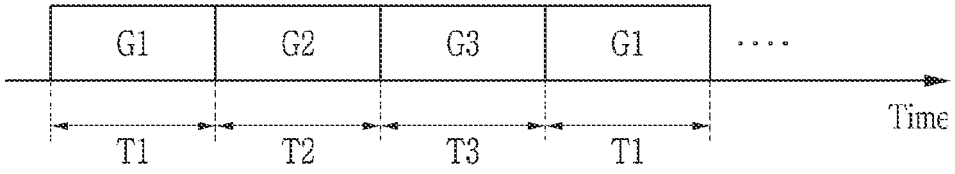

G1
G2
G3
G1
....
Time
T1
T2
T3
T1

FIG. 5

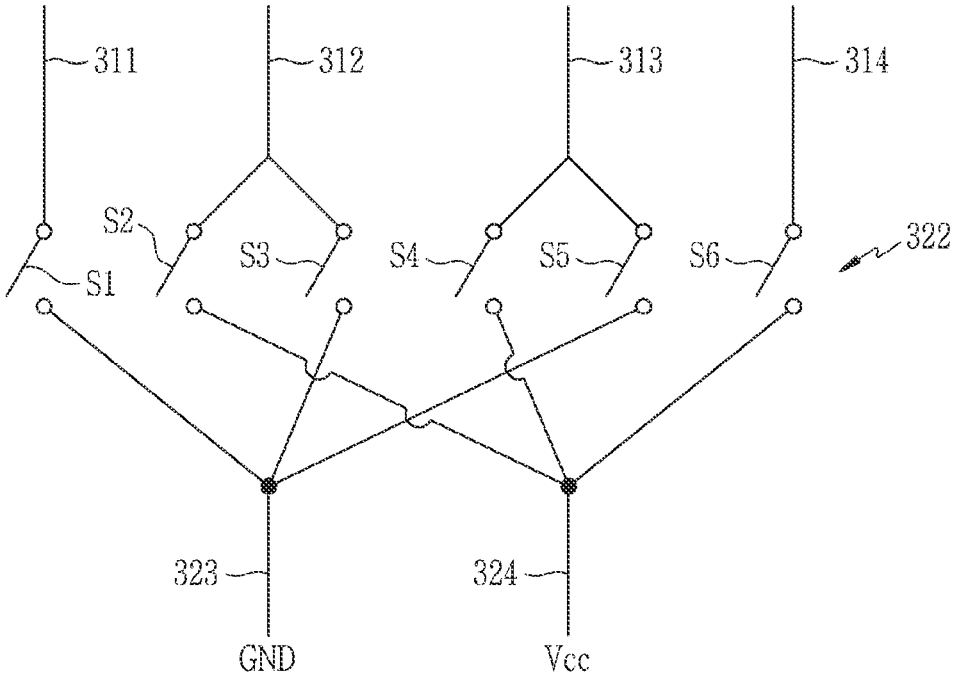
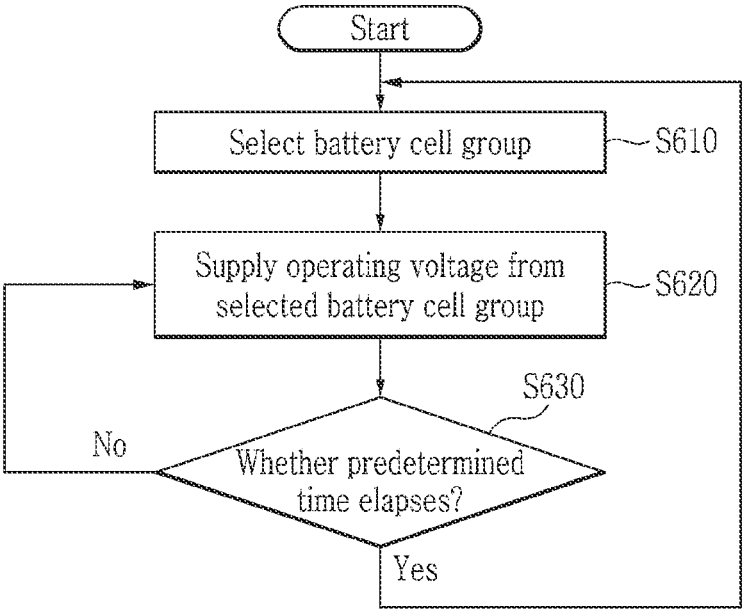


FIG. 6


Start
Select battery cell group
S610
Supply operating voltage from selected battery cell group
S620
S630
Whether predetermined time elapses?
No
Yes

BATTERY APPARATUS AND METHOD OF SUPPLYING VOLTAGE

TECHNICAL FIELD

Cross-Reference To Related Application

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2021-0002663 filed in the Korean Intellectual Property Office on Jan. 8, 2021, the entire contents of which are incorporated herein by reference.

[0002] The described technology relates to a battery apparatus and a method of supplying a voltage.

Background Art

[0003] An electric vehicle or a hybrid vehicle is a vehicle that obtains power by driving a motor mainly using a battery as a power supply. The electric vehicles are being actively researched because they are alternatives that can solve pollution and energy problems of internal combustion vehicles. Rechargeable batteries are used in various external apparatuses other than the electric vehicles.

[0004] The battery apparatus includes a battery pack and a battery management system for managing the battery pack. The battery management system monitors various information such as a voltage, a state of charge and a temperature of battery cells included in the battery and includes various circuits for monitoring the various information.

[0005] Currently, a power source for supplying power to electronic components is used to supply power to the battery management system. However, since a voltage (e.g., 12V) supplied from the power supply for supplying the power to the electronic components is higher than an operating voltage (e.g., 5V) of the battery management system, a component for lowering the voltage of the power supply is required. When the voltage is lowered in this way, electromagnetic interference (EMI) may occur in a DC/DC (direct current to direct current) converter, power consumption may increase due to a low dropout (LDO) regulator, and additional components may be required for voltage stabilization.

DISCLOSURE

Technical Problem

[0006] Some embodiments may provide a battery apparatus and a method of supplying a voltage capable of supplying an operating voltage of a battery management system without using a component for voltage drop.

Technical Solution

[0007] According to an embodiment, a battery apparatus including a first battery pack configured to provide a first voltage, a battery management system configured to manage the first battery pack, and a second battery pack configured to provide a second voltage lower than the first voltage may be provided. The second battery pack may include a plurality of battery cells, and the battery management system may select a battery cell group including a predetermined number of battery cells from among the plurality of battery cells of the second battery pack. The selected battery cell group may supply an operating voltage to an operating device of the battery management system.

[0008] In some embodiments, the first voltage of the first battery pack may not be provided as the operating voltage.

[0009] In some embodiments, the operating voltage may correspond to a sum of voltages of the predetermined number of battery cells.

[0010] In some embodiments, a first wire connected to a negative electrode of a first battery cell among the predetermined number of battery cells may be connected to a ground terminal of the operating device, and a second wire connected to a positive electrode of a last battery cell among the predetermined number of battery cells may be connected to an operating voltage supply terminal of the operating device.

[0011] In some embodiments, the plurality of battery cells of the second battery pack may be grouped into a plurality of battery cell groups, and each of the plurality of battery cell groups may include battery cells corresponding to the predetermined number. The battery management system may select the battery cell group from among the plurality of battery cell groups.

[0012] In some embodiments, the battery management system may alternately select one battery cell group from among the plurality of battery cell groups at a predetermined time interval.

[0013] In some embodiments, the battery management system may further include a switching circuit configured to select the plurality of battery cell groups.

[0014] In some embodiments, the plurality of battery cell groups may include a first battery cell group and a second battery cell group. In response to selecting the first battery cell group, the switching circuit may connect a first wire connected to a negative electrode of a first battery cell among the predetermined number of battery cells in the first battery cell group to a ground terminal of the operating device, and connect a second wire connected to a positive electrode of a last battery cell among the predetermined number of battery cells in the first battery cell group to an operating voltage supply terminal of the operating device. In response to selecting the second battery cell group, the switching circuit may connect a third wire connected to a negative electrode of a first battery cell among the predetermined number of battery cells in the second battery cell group to the ground terminal, and connect a fourth wire connected to a positive electrode of a last battery cell among the predetermined number of battery cells in the second battery cell group to the operating voltage supply terminal.

[0015] In some embodiments, the switching circuit may include a first switch connected between the first wire and the ground terminal, a second switch connected between the second wire and the operating voltage supply terminal, a third switch connected between the third wire and the ground terminal, and a fourth switch connected between the fourth wire and the operating voltage supply terminal. The battery management system may select the first battery cell group by turning on the first switch and the second switch, and may select the second battery cell group by turning on the third switch and the fourth switch.

[0016] In some embodiments, the operating device may include a processor.

[0017] According to another embodiment, a method of supplying a voltage in a battery apparatus including a first battery pack configured to supply a first voltage, a second battery pack configured to supply a second voltage lower than the first voltage, and a battery management system

configured to manage the first battery pack may be provided. The method may include selecting a first battery cell group including a predetermined number of battery cells from among a plurality of battery cells included in the second battery pack, and supplying an operating voltage to an operating device of the battery management system through the first battery cell group.

[0018] In some embodiments, the method may further include selecting a second battery cell group including the predetermined number of other battery cells from among the plurality of battery cells in response to a predetermined time elapsing after selecting the first battery cell group, and supplying the operating voltage to the operating device of the battery management system through the second battery cell group.

[0019] According to yet another embodiment, a battery apparatus including a battery pack including a plurality of battery cells and a battery management system may be provided. The battery management system may group the plurality of battery cells of the battery pack into a plurality of battery cell groups each including a predetermined number of battery cells, alternately select one battery cell group from among the plurality of battery cell groups, and providing an operating voltage to an operating device of the battery management system through the selected battery cell group.

ADVANTAGEOUS EFFECTS

[0020] According to some embodiments, it is possible to supply the operating voltage of the battery management system without using a component for lowering the voltage of the power supply.

DESCRIPTION OF THE DRAWINGS

[0021] FIG. **1** is a diagram showing a battery apparatus according to an embodiment.

[0022] FIG. **2** is a diagram for explaining supply of an operating voltage of a battery management system according to an embodiment.

[0023] FIG. **3** and FIG. **4** are diagrams for explaining supply of an operating voltage of a battery management system according to another embodiment.

[0024] FIG. **5** is a diagram showing an example of a switching circuit shown in FIG. **3**.

[0025] FIG. **6** is a flowchart showing a voltage supply method according to another embodiment.

MODE FOR INVENTION

[0026] In the following detailed description, only certain embodiments have been shown and described, simply by way of illustration. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

[0027] When it is described that an element is "connected" to another element, it should be understood that the element may be directly connected to the other element or connected to the other element through a third element. On the other hand, when it is described that an element is "directly connected" to another element, it should be understood that the element is connected to the other element through no third element.

[0028] As used herein, a singular form may be intended to include a plural form as well, unless the explicit expression such as "one" or "single" is used.

[0029] In flowcharts described with reference to the drawings, the order of operations or steps may be changed, several operations or steps may be merged, a certain operation or step may be divided, and a specific operation or step may not be performed.

[0030] FIG. **1** is a diagram showing a battery apparatus according to an embodiment.

[0031] Referring to FIG. **1**, a battery apparatus **100** includes a high voltage (HV) battery pack **110**, a low voltage (LV) battery pack **120**, and a battery management system (BMS) **130**.

[0032] The battery apparatus **100** has a structure that can be electrically connected to an external apparatus. When the external apparatus is a load, the battery apparatus **100** is discharged by operating as a power supply that supplies power to the load. The external apparatus **10** operating as the load may be, for example, an electronic device, a mobility apparatus, or an energy storage system (ESS). The mobility apparatus may be, for example, a vehicle such as an electric vehicle, a hybrid vehicle, or a smart mobility.

[0033] The HV battery pack **110** outputs a relatively high voltage and supplies power to a large-capacity load of the external apparatus. The LV battery pack **120** outputs a relatively low voltage and supplies power to a low-capacity load of the external apparatus. The voltage supplied from the HV battery pack **110** is higher than the voltage supplied from the LV battery pack **120**. In some embodiments, the large-capacity load may be a load for driving the vehicle, including, for example, a motor of the vehicle. In some embodiments, the low-capacity load of the external apparatus may be a load used to control the vehicle, for example, an electrical component.

[0034] The HV battery pack **110** and the LV battery pack **120** each include a plurality of battery cells (not shown). In some embodiments, the battery cell may be a rechargeable cell. Each battery pack **110** or **120** may include a battery module in which a predetermined number of battery cells are connected in series. In some embodiments, in each battery pack **110** or **120**, a predetermined number of battery modules may be connected in series or in parallel to supply desired power.

[0035] The HV battery pack **110** is connected to the battery management system **130** through wires (not shown). For example, each of the plurality of battery cells of the HV battery pack **110** may be connected to the battery management system **130** through the wire. The battery management system **130** may include a processor **131**. The processor **131** may collect and analyze various information about the battery cells to control charging and discharging of the battery cells, a cell balancing operation, a protection operation, and the like. In some embodiments, the processor **131** may be, for example, a micro controller unit (MCU). In some embodiments, the battery management system **130** may further include various monitoring circuits (not shown) such as cell voltage monitoring circuits.

[0036] In some embodiments, the battery management system **130** may collect and analyze various information about the battery cells of the LV battery pack **120** to control

charging and discharging of the battery cells, a cell balancing operation, a protection operation, and the like.

[0037] In some embodiments, the battery apparatus **110** may further include a separate battery management system (not shown) for the LV battery pack **120**.

[0038] An operating device of the battery management system **130**, for example, the processor **131** of the battery management system **130** may be operated by receiving an operating voltage. To this end, some battery cells of the LV battery pack **120** may supply the operating voltage Vcc for the battery management system **130**. Accordingly, a DC/DC converter for lowering the voltage of the power supply, an LDO regulator, and components for voltage stabilization may not be used. In some embodiments, the voltage of the HV battery pack **110** may be not provided as the operating voltage Vcc, and only the LV battery pack **120** may supply the operating voltage Vcc. Accordingly, the power supplied to the large-capacity load may not be affected by the supply of the operating voltage Vcc.

[0039] FIG. **2** is a diagram for explaining supply of an operating voltage of a battery management system according to an embodiment.

[0040] Referring to FIG. **2**, an LV battery pack **210** includes a plurality of battery cells connected in series. Although six battery cells C**1**, C**2**, C**3**, C**4**, C**5**, and C**6** are shown in FIG. **2** for convenience of description, the number of battery cells included in the LV battery pack is not limited thereto.

[0041] Among the plurality of battery cells of the LV battery pack **210**, some adjacent battery cells C**1** and C**2** form one battery cell group to supply an operating voltage to a battery management system **220**. For example, when a voltage of each battery cell of the LV battery pack **210** is 2.5V and the operating voltage of the battery management system **220** is 5V, the two battery cells C**1** and C**2** may supply the operating voltage.

[0042] In the battery cell group, wires **211** and **212** are connected to a negative electrode of the first battery cell C**1** and a positive electrode of the last battery cell C**2**, respectively. The wire **211** is connected to a terminal corresponding to a ground potential of the battery management system **220**, and the wire **212** is connected to a terminal for supplying the operating voltage of the battery management system **220**. In some embodiments, as shown in FIG. **2**, the wire **211** may connected to the ground terminal of the processor **221** of the battery management system **220**, i.e., a ground pin GND, and the wire **212** may be connected to an operating voltage supply terminal of the processor **221**, i.e., an operating voltage supply pin Vcc.

[0043] Accordingly, a sum (e.g., 5V) of voltages of the battery cells C**1** and C**2** included in the battery cell group may be supplied as the operating voltage of the battery management system **220**.

[0044] FIG. **3** and FIG. **4** are diagrams for explaining supply of an operating voltage of a battery management system according to another embodiment, and FIG. **5** is a diagram showing an example of a switching circuit shown in FIG. **3**.

[0045] Referring to FIG. **3**, an LV battery pack **310** includes a plurality of battery cells connected in series. Although six battery cells C**1**, C**2**, C**3**, C**4**, C**5**, and C**6** are shown in FIG. **3** for convenience of description, the number of battery cells included in the LV battery pack is not limited thereto.

[0046] A plurality of battery cells of the LV battery pack **310** are grouped into a plurality of battery cell groups G**1**, G**2**, and G**3**, and each battery cell group Gi includes battery cells that can supply a voltage corresponding to the operating voltage of the battery management system **320**. Here, i is an integer from 1 to 3. For example, when a voltage of each battery cell of the LV battery pack **210** is 2.5V and the operating voltage of the battery management system **320** is 5V, each battery cell group Gi may include two adjacent battery cells. That is, one battery cell group G**1** may include two battery cells C**1** and C**2**, another battery cell group G**2** may include two other battery cells C**3** and C**4**, and yet another battery cell group G**3** may include two other battery cells C**5** and C**6**.

[0047] In the battery cell group G**1**, wires **311** and **312** are connected to a negative electrode of the first battery cell C**1** and a positive electrode of the last battery cell C**2**, respectively. In the battery cell group G**2**, wires **312** and **313** are connected to a negative electrode of the first battery cell C**3** and a positive electrode of the last battery cell C**4**, respectively. In this case, since the positive electrode of the last battery cell C**2** of the battery cell group G**1** and the negative electrode of the first battery cell C**3** of the battery cell group G**2** are shared, the same wire **312** is connected to the positive electrode of the battery cell C**2** and the negative electrode of the battery cell C**3**. In some embodiments, a separate wire other than the wire **312** may be connected to the negative electrode of the first battery cell C**3** of the battery cell group G**2**. Similarly, in the battery cell group G**3**, wires **313** and **314** are connected to a negative electrode of the first battery cell C**5** and a positive electrode of the last battery cell C**6**, respectively. In this case, since the positive electrode of the last battery cell C**4** of the battery cell group G**2** and the negative electrode of the first battery cell C**5** of the battery cell group G**3** are shared, the same wire **313** is connected to the positive electrode of the battery cell C**4** and the negative electrode of the battery cell C**5**. In some embodiments, a separate wire other than the wire **313** may be connected to the negative electrode of the first battery cell C**5** of the battery cell group G**3**.

[0048] The battery management system **320** includes a switching circuit **322**. The switching circuit **322** is connected to the wires **311**, **312**, **313**, and **314**, and has a negative output terminal **323** and a positive output terminal **324**. The negative output terminal **323** is connected to a ground terminal of an operating device of the battery management system **320**, and the positive output terminal **324** is connected to an operating voltage supply terminal of the operating device of the battery management system **320**. In some embodiments, as shown in FIG. **3**, the negative output terminal **323** may be connected to a ground terminal of a processor **321** of the battery management system **320**, i.e., a ground pin GND, and the positive output terminal **324** may be connected to an operating voltage supply terminal of the processor **321**, i.e., an operating voltage supply pin Vcc.

[0049] The switching circuit **322** periodically switches connections among the wires **311**, **312**, **313**, and **314**, the negative output terminal **323**, and the positive output terminal **324**. In some embodiments, as shown in FIG. **4**, the switching circuit **322** may connect the wire **311** to the negative output terminal **323** and the wire **312** to the positive output terminal **324** during a first period T**1** so that the battery cell group G**1** can supply the operating voltage. After the first period T**1**, the switching circuit **322** may connect the

wire **312** to the negative output terminal **323** and the wire **313** to the positive output terminal **324** during a second period T**2** so that the battery cell group G**2** can supply the operating voltage. After the second period T**2**, the switching circuit **322** may connect the wire **313** to the negative output terminal **323** and the wire **314** to the positive output terminal **324** during a third period T**3** so that the battery cell group G**3** can supply the operating voltage. The switching circuit **322** may alternately select the plurality of battery cell groups G**1**, G**2**, and G**3** and supply the operating voltage by repeating the first period T**1**, the second period T**2**, and the third period T**3**. Accordingly, it is possible to prevent an imbalance in battery cell voltage that may occur when the operating voltage is supplied only from a specific battery cell group.

[0050] In some embodiments, the switching circuit **322** may allow two battery cell groups to simultaneously supply the operating voltage when switching to another period. Accordingly, it is possible to ensure that there is no blank period in the supply of the operating voltage.

[0051] In some embodiments, durations of the first period T**1**, the second period T**2**, and the third period T**3** may be set to be the same.

[0052] In some embodiments, the processor **321** of the battery management system **320** may control operations of the switching circuit **322**.

[0053] In some embodiments, as shown in FIG. **5**, the switching circuit **322** may include a plurality of switches S**1**, S**2**, S**3**, S**4**, S**5**, and S**6**. The switch S**1** is connected between the wire **311** and the negative output terminal **323**, and the switch S**2** is connected between the wire **312** and the positive output terminal **324**. The switch S**3** is connected between the wire **312** and the negative output terminal **323**, and the switch S**4** is connected between the wire **313** and the positive output terminal **324**. The switch S**5** is connected between the wire **313** and the negative output terminal **323**, and the switch S**6** is connected between the wire **314** and the positive output terminal **324**. Accordingly, the battery management system may turn on the switches S**1** and S**2** to select the battery cell group G**1**, turn on the switches S**3** and S**4** to select the battery cell group G**2**, and turn on the switches S**5** and S**6** to select the battery cell group G**3**.

[0054] FIG. **6** is a flowchart showing a voltage supply method according to another embodiment.

[0055] Referring to FIG. **6**, a battery management system selects one battery cell group from among a plurality of battery cells of an LV battery pack at S**610**. The selected battery cell group supplies an operating voltage to an operating device of the battery management system at S**620**.

[0056] If a predetermined time has not elapsed after selecting one battery cell group at S**630**, the operating voltage is continuously supplied from the selected battery cell group at S**620**. When a predetermined time has elapsed after selecting one battery cell group, the battery management system selects another battery cell group from the LV battery pack at S**610**. Accordingly, the newly selected battery cell group may supply the operating voltage to the operating device of the battery management system at S**620**.

[0057] By repeating the processes of S**610**, S**620**, and S**630**, the battery management system may supply the operating voltage to the operating device of the battery management system while balancing battery cell voltages.

[0058] While this invention has been described in connection with what is presently considered to be practical embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

1. A battery apparatus comprising:

a first battery pack configured to provide a first voltage;

a battery management system configured to manage the first battery pack; and

a second battery pack configured to provide a second voltage lower than the first voltage and including a plurality of battery cells,

wherein the battery management system is configured to select a battery cell group including a predetermined number of battery cells from among the plurality of battery cells of the second battery pack, and

wherein the selected battery cell group supplies an operating voltage to an operating device of the battery management system.

2. The battery apparatus of claim **1**, wherein the first voltage of the first battery pack is not provided as the operating voltage.

3. The battery apparatus of claim **1**, wherein the operating voltage corresponds to a sum of voltages of the predetermined number of battery cells.

4. The battery apparatus of claim **1**, wherein a first wire connected to a negative electrode of a first battery cell among the predetermined number of battery cells is connected to a ground terminal of the operating device, and a second wire connected to a positive electrode of a last battery cell among the predetermined number of battery cells is connected to an operating voltage supply terminal of the operating device.

5. The battery apparatus of claim **1**, wherein the plurality of battery cells of the second battery pack is grouped into a plurality of battery cell groups, and each of the plurality of battery cell groups includes battery cells corresponding to the predetermined number, and

wherein the battery management system is configured to select the battery cell group from among the plurality of battery cell groups.

6. The battery apparatus of claim **5**, wherein the battery management system is configured to alternately select one battery cell group from among the plurality of battery cell groups at a predetermined time interval.

7. The battery apparatus of claim **5**, wherein the battery management system further includes a switching circuit configured to select the plurality of battery cell groups.

8. The battery apparatus of claim **7**, wherein the plurality of battery cell groups includes a first battery cell group and a second battery cell group,

wherein the switching circuit is configured to, in response to selecting the first battery cell group, connect a first wire connected to a negative electrode of a first battery cell among the predetermined number of battery cells in the first battery cell group to a ground terminal of the operating device, and connect a second wire connected to a positive electrode of a last battery cell among the predetermined number of battery cells in the first battery cell group to an operating voltage supply terminal of the operating device, and

wherein the switching circuit is configured to, in response to selecting the second battery cell group, connect a third wire connected to a negative electrode of a first battery cell among the predetermined number of battery

cells in the second battery cell group to the ground terminal, and connect a fourth wire connected to a positive electrode of a last battery cell among the predetermined number of battery cells in the second battery cell group to the operating voltage supply terminal.

9. The battery apparatus of claim **8**, wherein the switching circuit includes:

a first switch connected between the first wire and the ground terminal;

a second switch connected between the second wire and the operating voltage supply terminal;

a third switch connected between the third wire and the ground terminal; and

a fourth switch connected between the fourth wire and the operating voltage supply terminal, and

wherein the battery management system is configured to select the first battery cell group by turning on the first switch and the second switch, and select the second battery cell group by turning on the third switch and the fourth switch.

10. The battery apparatus of claim **1**, wherein the operating device includes a processor.

11. A method of supplying a voltage in a battery apparatus including a first battery pack configured to supply a first voltage, a second battery pack configured to supply a second voltage lower than the first voltage, and a battery management system configured to manage the first battery pack, the method comprising:

selecting a first battery cell group including a predetermined number of battery cells from among a plurality of battery cells included in the second battery pack; and

supplying an operating voltage to an operating device of the battery management system through the first battery cell group.

12. The method of claim **11**, wherein the first voltage of the first battery pack is not provided as the operating voltage.

13. The method of claim **11**, further comprising:

selecting a second battery cell group including the predetermined number of other battery cells from among the plurality of battery cells in response to a predetermined time elapsing after selecting the first battery cell group; and

supplying the operating voltage to the operating device of the battery management system through the second battery cell group.

14. The method of claim **11**, wherein the operating voltage corresponds to a sum of voltages of the predetermined number of battery cells.

15. A battery apparatus comprising:

a battery pack including a plurality of battery cells; and

a battery management system configured to:

group the plurality of battery cells of the battery pack into a plurality of battery cell groups each including a predetermined number of battery cells;

alternately select one battery cell group from among the plurality of battery cell groups; and

providing an operating voltage to an operating device of the battery management system through the selected battery cell group.

* * * * *