TITLE OF INVENTION: SYSTEM AND METHOD FOR DETECTING DEFECT OF SINGLE CELL IN BATTERY SYSTEM IN WHICH PARALLEL UNIT CELLS ARE CONNECTED IN SERIES

BACKGROUND

1. Technical Field

[0001] The present disclosure relates to a system for detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series, the system being configured to detect a defective product in advance by detecting whether the battery system conforms to internal resistance DCIR and an output through an output test among battery system performance tests during a process of testing a final product (end of line (EOL)) in a mass-production line for a battery system for an xEV (HEV, PHEV, and EV).

2. Related Art

[0002] In a mass-production line for a battery system in the related art, there is a need for detectability that is an ability to accurately detect output performance of a final assembled product within a short time.

[0003] However, an output test method in the mass-production line for the battery system in the related art may detect the defect of the battery system by calculating DCIR and charging and discharging output values. However, there is a problem in that the output test method cannot detect a low-voltage cell

(defective cell).

[0004] Further, there are problems in that to detect the low-voltage cell in the battery system in the related art, an additional output performance test is required, and an additional device and an additional detection time are required.

SUMMARY

[0005] Various embodiments are directed to provide a system for detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series, the system being capable of improving detectability during an output test process being performed in a mass-production line for a battery system for an xEV in the related art.

[0006] The objects of the present disclosure are not limited to the aforementioned objects, and other objects, which are not mentioned above, may be clearly understood from the following descriptions.

[0007] In an embodiment, a system for detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series includes: a high current application unit configured to apply a high current to a battery system for a preset time; a plurality of DCIR calculation units respectively connected to input and output terminals of parallel unit cells that constitute the battery system, the

plurality of DCIR calculation units being configured to calculate DCIR (Ω) of the parallel unit cells by using the amount (ΔV) of change in voltage and the high current applied from the high current application unit; and a defect detection unit configured to monitor the DCIR (Ω) calculated by the DCIR calculation unit and configured to determine that a defect occurs when a state voltage value of a closed circuit voltage is equal to or more, by a predetermined value of the amount of change in voltage, than a state voltage value of an open circuit voltage.

[0008] The battery system may be configured by connecting, in series, the parallel unit cells in which battery cells are connected in parallel.

[0009] The high current application unit may apply one of a discharging current and a charging current.

[0010] When the high current applied to the battery system by the high current application unit is the charging current, the defect detection unit may monitor the DCIR (Ω) calculated by the DCIR calculation unit and determine that a defect occurs when a maximum state cell voltage value of the closed circuit voltage is equal to or more, by a predetermined value of the amount of change in voltage, than a maximum state cell voltage value of the open circuit voltage.

[0011] When the high current applied to the battery system by the high current application unit is the discharging current,

the defect detection unit may monitor the DCIR (Ω) calculated by the DCIR calculation unit and determine that a defect occurs when a minimum state cell voltage value of the closed circuit voltage is equal to or more, by a predetermined value of the amount of change in voltage, than a minimum state cell voltage value of the open circuit voltage.

[0012] In another embodiment, a method of detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series includes: measuring a maximum voltage of the parallel unit cell in the battery system in a state in which no charging current is applied to the battery system by a high current application unit; applying, by the high current application unit, a charging current to the battery system for a preset time; measuring a maximum voltage of the parallel unit cell for a time for which the high current application unit applies the charging current to the battery system for a preset time; determining whether a value of change in maximum voltage for the time for which the charging current is applied to the battery system is a preset reference voltage or less; and determining that the parallel unit cell has a defect when the value of change in maximum voltage for the time for which the charging current is applied to the parallel unit cell is equal to or more than a preset value of change in reference voltage in the determining of whether the value of change in maximum voltage for the time for which the charging current is applied to the battery system is the preset reference voltage or less.

[0013] The method may include determining that an output test is passed when the value of change in maximum voltage for the time for which the charging current is applied to the parallel unit cell is equal to or less than the preset value of change in reference voltage in the determining of whether the value of change in maximum voltage for the time for which the charging current is applied to the battery system is the preset reference voltage or less.

[0014] In still another embodiment, a method of detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series includes: measuring a minimum voltage of the parallel unit cell in a state in which no high current is applied to the battery system by a high current application unit; applying, by the high current application unit, a charging current to the battery system for a preset time; measuring a maximum voltage of the parallel unit cell for a time for which the high current application unit applies the high current to the battery system; determining whether a value of change in maximum voltage for the time for which the high current is applied to the battery system is a preset reference voltage or less; and determining that the parallel unit cell has a defect when the value of change in maximum voltage for the time for which the high current is applied to the parallel unit cell is equal to or more than a preset value of change in reference voltage in the determining of whether the value of change in maximum voltage for the time

for which the high current is applied to the battery system is the preset reference voltage or less.

[0015] The method may include determining that an output test is passed when the value of change in maximum voltage for the time for which the high current is applied to the battery system is equal to or less than the preset value of change in reference voltage in the determining of whether the value of change in maximum voltage for the time for which the high current is applied to the battery system is the preset reference voltage or less.

[0016] According to the embodiment of the present disclosure, it is possible to detect a defect of a low cell voltage based on a particular monitoring value of the battery system by using the output test process established in advance, thereby improving detectability without requiring additional equipment and test time.

[0017] Further, according to the embodiment of the present disclosure, it is possible to improve detectability even in case that the plurality of cells is connected to one another in parallel in the battery system.

[0018] In addition, according to the embodiment of the present disclosure, the improvement in detectability for the defect of the low cell voltage may reduce a rate of field failure reports caused by an issue of the low-voltage cell, thereby reducing the A/S costs and failure analysis time.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. 1 is a configuration block diagram for explaining a system for detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series according to the present disclosure.

[0020] FIG. 2 is a block diagram for explaining the connection between a parallel unit cell and a DCIR calculation unit in the battery system in FIG. 1.

[0021] FIG. 3 is a reference graph for explaining the type of high current applied by a high current application unit in FIG. 1.

[0022] FIG. 4 is a reference view for explaining a table for explaining OCV (V), DCIR (Ω), and output (W) detected during charging and discharging processes in FIG. 1.

[0023] FIG. 5 is a reference view for explaining a change in voltage in a defective parallel unit cell when the high current application unit in FIG. 1 applies a discharging current.

[0024] FIG. 6 is a reference view for explaining a change in voltage in a defective parallel unit cell when the high current application unit in FIG. 1 applies a charging current.

[0025] FIG. 7 is a flowchart for explaining a method of detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series according to

the embodiment of the present disclosure.

[0026] FIG. 8 is a flowchart for explaining a method of detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series according to another embodiment of the present disclosure.

[0027] FIG. 9 is a block diagram illustrating a computer system for implementing the method according to the embodiment of the present disclosure.

DETAILED DESCRIPTION

[0028] Advantages and features of the present disclosure and methods of achieving the advantages and features will be clear with reference to embodiments described in detail below together with the accompanying drawings. However, the present disclosure is not limited to the embodiments disclosed herein but will be implemented in various forms. The embodiments of the present disclosure are provided so that the present disclosure is completely disclosed, and a person with ordinary skill in the art to which the present disclosure pertains can fully understand the scope of the present disclosure. the present disclosure will be defined only by the scope of the appended claims. Meanwhile, the terms used in the present specification are for explaining the embodiments, not for limiting the present disclosure. Unless particularly stated otherwise in the present specification, a singular form also

includes a plural form. The terms "comprise (include)" and/or "comprising (including)" used in the specification are intended to specify the presence of the mentioned constituent elements, steps, operations, and/or elements, but do not exclude the presence or addition of one or more other constituent elements, steps, operations, and/or elements.

[0029] FIG. 1 is a configuration block diagram for explaining a system for detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series according to the present disclosure.

[0030] As illustrated in FIG. 1, according to an embodiment of the present disclosure, the system for detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series includes a high current application unit 110, DCIR calculation units 120, and a defect detection unit 130.

[0031] The system for detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series according to the embodiment of the present disclosure uses a method of detecting a low cell voltage or a welding defect and a busbar fastening defect and failure based on a monitoring value in a discharging or charging output test performed during an output test process in the related art.

[0032] In the case of a battery system 100 used for the embodiment of the present disclosure, a plurality of individual

cells is connected in parallel to constitute a single parallel unit cell 101, and the parallel unit cells 101, which are configured as described above, are connected in series.

[0033] In the embodiment of the present disclosure, as illustrated in FIG. 2, there will be described an example of the system for detecting a defect of a unit cell in the battery system 100 in which the parallel unit cell 101 is configured by connecting the two battery cells 1 and 2 in parallel, and six parallel unit cells 101 are connected in series.

[0034] The high current application unit 110 applies a high current to the battery system 100 for a preset time. In the embodiment of the present disclosure, as illustrated in FIG. 3, the high current application unit 110 may apply any one of a discharging current and a charging current, which is a reverse current to the discharging current, to the battery system 100.

[0035] The DCIR calculation units 120 are equal in number to the parallel unit cells 101 provided in the battery system 100 and connected to input and output terminals of the parallel unit cells 101 of the battery system 100, respectively.

[0036] The DCIR calculation unit 120 calculates DCIR (Ω) of the parallel unit cell 101 by using the amount (ΔV) of change in voltage and the high current applied from the high current application unit 110. In the present embodiment, in case that the high current provided by the high current application unit

100 is the discharging current, the amount (ΔV) of change in voltage may be calculated based on (cell min voltage OCV (before the application of current) - cell min voltage CCV (at the end of the application of current).

[0037] The defect detection unit 130 monitors the DCIR (Ω) calculated by each DCIR calculation unit and determines that a defect occurs when a state voltage value of a closed circuit voltage is equal to or more, by a predetermined value of the amount of change in voltage, than a state voltage value of an open circuit voltage.

[0038] As illustrated in FIG. 4, the defect detection unit 130 may calculate a COV (V) and a DCIR output (W) based on the type of high current applied from the high current application unit 110, i.e., based on whether the high current is the charging current or the discharging current.

[0039] In the embodiment of the present disclosure, the high current application unit 110 may apply the discharging current of the high current to the battery system 100 for a preset time. When the high current application unit 110 applies the discharging current of the high current to the battery system 100, a voltage drop occurs on a defective single cell, among the parallel unit cells 101 in the battery system 100, in accordance with internal resistance or the like, as illustrated in FIG. 5.

[0040] In this case, a calculation formula for a value (ΔV) of

change in detection reference voltage for each pulse current through a low-voltage cell detection mechanism is shown in Equation 1.

[0041] [Equation 1]

[0042] Reference Voltage ΔV [mV] = (0.7914 X Pulse current) - 28

[0043] Table 1 shows a change value calculated through the calculation formula for the value of the change in detection reference voltage for each discharging pulse current through the low-voltage cell detection mechanism.

[0044] [Table 1]

Current	Cell min Voltage OCV [V]	Cell min Voltage CCV [V]	|△V| [mV]	Calculation formula
55.6	3.78	3.76	20	Reference voltage V[mV] =(0.7914* Pulse current)-28
111.2	3.78	3.72	60	
166.8	3.78	3.68	100	
222.4	3.78	3.64	140	
278.0	3.78	3.60	200	

[0045] In another embodiment of the present disclosure, the high current application unit 110 may apply the charging current of the high current to the battery system 100 for a preset time. When the high current application unit 110

applies the charging current of the high current to the battery system 100, a voltage rise occurs on a defective single cell, among the parallel unit cells 101 in the battery system 100, in accordance with the internal resistance or the like, as illustrated in FIG. 6.

[0046] Then, the DCIR calculation unit 120 connected to the input and output terminals of each parallel unit cell 101 of the battery system 100 calculates the DCIR (Ω) by using the amount of change in voltage (ΔV) and the charging current applied from the high current application unit 110. In the present embodiment, when the high current applied from the high current application unit 110 is the charging current, the amount (ΔV) of change in voltage may be calculated based on (cell max voltage CCV (at the end of the application of current) - cell max voltage OCV (before the application of current).

[0047] In this case, a calculation formula for a value (ΔV) of change in detection reference voltage for each pulse current through a low-voltage cell detection mechanism is shown in Equation 2.

[0048] [Equation 2]

[0049] Reference Voltage ΔV [mV] = (0.7554 X Pulse current) − 12

[0050] The value (ΔV) of change in detection reference voltage may be calculated by using Equation 2.

[0051] [Table 2]

Current [A]	Cell min Voltage OCV [V]	Cell min Voltage CCV [V]	|△V| [mV]	Calculation formula
55.6	3.8	3.84	20	Reference voltage V[mV] =(0.7554* Pulse current)-12
111.2	3.8	3.86	60	
166.8	3.78	3.9	100	
222.4	3.78	3.94	140	
278.0	3.78	3.98	200	

[0052] According to the embodiment of the present disclosure, the cells are connected in parallel in the battery system. When one of the parallel unit cells 101 is defective, a battery system in the related art cannot detect the defective parallel unit cell. In the present disclosure, it is difficult to detect a defect of a single cell provided in the parallel configuration in an open circuit voltage (OCV) state. However, it is possible to detect the defect of the single cell in the parallel unit cell 101 by identifying a deviation between the cells by applying the high current.

[0053] In addition, in the present disclosure, in case of a low cell voltage or a welding defect and a busbar fastening defect, internal or external resistance of a local cell, at the time of applying discharging or charging pulse of the high current,

causes a voltage drop in case of discharging or a voltage rise in case of charging, such that the value (ΔV) is at a predetermined level or higher. It is possible to improve the power of verification by defining the value (ΔV) during the charging and discharging processes by using a Min/Max value of the single cell instead of the value (ΔV) of the voltage in the entire battery system in the related art.

[0054] When the charging current is applied by the high current application unit 110 connected to the output terminal of the battery system 100, the defect detection unit 300 monitors the value of the cell voltage outputted from the battery system 100 including the parallel unit cells each having battery cells connected in parallel. When a maximum state cell voltage value of the closed circuit voltage is equal to or more, by a predetermined value of the amount of change in voltage, than a maximum state cell voltage value of the open circuit voltage, the defect detection unit 300 may determine that a defect occurs.

[0055] Table 3 is referenced to the description of a difference between an output test according to the embodiment of the present disclosure and an output test in the related art.

[0056] [Table 3]

Classification	Basic output test	Improved output test
Charging/dis	Identical	Identical

charging application current		
Monitoring value	OCV before charging or discharging battery system	In case of applying charging current: cell max OCV voltage before charging In case of applying discharging current: cell min OCV voltage before discharging
	CCV after charging or discharging battery system	In case of applying charging current: cell max CCV voltage immediately after charging In case of applying discharging current: cell min CCV voltage immediately after discharging
	Temperature	Temperature
	Deviation between cells after charging or discharging	Deviation between cells after charging or discharging
DCIR	Measurement of internal	Measurement of internal resistance of cell unit

	resistance of entire battery system	
Remarks	Detection of low-voltage cell (defective cell) is impossible	Detection of low-voltage cell is possible In case of applying charging current: cell max CCV – cell max OCV = ΔV value is reference value or more In case of applying discharging current: cell min OCV – cell min CCV = ΔV value is reference value or more

[0057] Meanwhile, in the case of the low-voltage cell, an internal resistance (DCIR) value of the cell is high because of various failures in the cell. Therefore, it is possible to improve output test detectability by using characteristics in which, in case that an instantaneous high pulse current is applied, a voltage rise value (ΔV) increases when the current is the charging current, and a voltage drop value (ΔV) increases when the current is the discharging current.

[0058] In addition, in another embodiment of the present disclosure, the high current application unit 110 may detect a defect of the single cell in the battery system by applying the charging current of the high current to the battery system

100. Thereafter, the high current application unit 110 may verify the defect of the single cell in the battery system by applying the discharging current of the high current to the battery system 100 to perform the verification again, or the high current application unit 110 may verify the defect of the single cell in the battery system by using a reverse method.

[0059] Hereinafter, a method of detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series according to an embodiment of the present disclosure will be described with reference to FIG. 7.

[0060] The method of detecting a voltage of each of the parallel unit cells 101 in the battery system in which the parallel unit cells 101, which are each configured by connecting the plurality of cells in parallel, are connected in series will be described with reference to FIG. 8.

[0061] First, a maximum voltage of the parallel unit cell 101 is measured in a state in which no charging current is applied to the battery system 100 by the high current application unit 110 (S710).

[0062] Next, the high current application unit 110 applies the charging current to the battery system for a preset time (S720).

[0063] Thereafter, a maximum voltage of each of the parallel unit cells 101 is measured for the time for which the high

current application unit 110 applies the charging current to the battery system for the preset time (S730).

[0064] Next, whether a value of change in each maximum voltage is a preset reference voltage or less is determined for the time for which the charging current is applied to each of the parallel unit cells 101 (S740).

[0065] In the determination step S740, when the value of change in maximum voltage for the time for which the charging current is applied to the parallel unit cell 101 is equal to or more than a preset value of change in reference voltage (YES), it is determined that the parallel unit cell 101 has a defect (S750).

[0066] In contrast, in the determination step S740, when the value of change in maximum voltage for the time for which the charging current is applied to the parallel unit cell 101 is equal to or less than the preset value of change in reference voltage (NO), it is determined that the battery system is normal (S760). When the battery system 100 is normal, the DCIR is computed, an output voltage is computed, a voltage and temperature are measured, and it is determined whether the output test is passed.

[0067] A method of detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series according to another embodiment of the present disclosure will be described with reference to FIG. 8.

[0068] First, a minimum voltage of the parallel unit cell 101 is measured in a state in which no high current is applied by the high current application unit 110 (S810).

[0069] Next, the high current application unit 110 applies the charging current to the battery system for a preset time (S820).

[0070] Thereafter, a maximum voltage of each of the parallel unit cells 101 is measured for the time for which the high current application unit 110 applies the high current to each of the parallel unit cells 101 (S830).

[0071] Whether a value of change in each maximum voltage is a preset reference voltage or less is determined for the time for which the high current is applied to each of the parallel unit cells 101 (S840).

[0072] In the determination step S840, when the value of change in maximum voltage for the time for which the high current is applied to the parallel unit cell 101 is equal to or more than a preset value of change in reference voltage (YES), it is determined that the parallel unit cell 101 has a defect (S850).

[0073] In contrast, in the determination step S840, when the value of change in maximum voltage for the time for which the high current is applied to the parallel unit cell 101 is equal to or less than the preset value of change in reference voltage (NO), it is determined that the battery system is normal

(S860). When the battery system 100 is normal, the DCIR is computed, an output voltage is computed, a voltage and temperature are measured, and it is determined whether the output test is passed.

[0074] FIG. 9 is a block diagram illustrating a computer system for implementing the method according to the embodiment of the present disclosure.

[0075] Referring to FIG. 9, the computer system 1300 may include at least one of a processor 1310, a memory 1330, an input interface device 1350, an output interface device 1360, and a storage device 1340 that communicate with one another through a bus 1370. The computer system 1300 may also include a communication device 1320 coupled to a network. The processor 1310 may be a central processing unit (CPU) or a semiconductor device that executes commands stored in the memory 1330 or the storage device 1340. The memory 1330 and the storage device 1340 may include various types of volatile or nonvolatile storage media. Examples of the memory may include a read-only memory (ROM) and a random-access memory (RAM). In the embodiment of the present disclosure, the memory may be positioned inside or outside the processor, and the memory may be connected to the processor through various means known already. The memory may be a volatile or non-volatile storage medium having various shapes. For example, the memory may include a read-only memory (ROM) or a random-access memory

(RAM).

[0076] Therefore, the embodiment of the present disclosure may be implemented as a method implemented in a computer or implemented as a non-transitory computer-readable medium that stores computer-executable commands. When a computer-readable command is executed by the processor in one embodiment, the computer-readable command may perform the method according to at least one aspect of the present disclosure.

[0077] The communication device 1320 may transmit or receive a wired or wireless signal.

[0078] In addition, the method according to the exemplary embodiment of the present disclosure may be implemented in the form of program commands executable by means of various computer means and then recorded in a computer-readable medium.

[0079] The computer-readable medium may include program commands, data files, data structures, or the like, in a stand-alone form or in a combination thereof. The program commands recorded in the computer-readable medium may be designed and configured specifically for the embodiments of the present disclosure or may be publicly known and available to those skilled in the field of computer software. A computer-readable recording medium may include a hardware device configured to store and execute the program commands. For example, examples of the computer-readable recording medium may include magnetic media, such as a hard disk, a floppy disk and a magnetic tape,

optical media, such as CD-ROM and DVD, magneto-optical media, such as a floptical disk, a ROM, a RAM, and a flash memory. Examples of program commands may include high-level language codes that may be executed by a computer using an interpreter, etc., as well as machine language codes made by a compiler.

[0080] While the configuration of the present disclosure has been described above in detail with reference to the accompanying drawings, the description of the configuration is for illustrative purposes only, and various modifications and alterations may of course be made by those skilled in the art without departing from the technical spirit of the present disclosure. Accordingly, the protection scope of the present disclosure should not be limited to the above-mentioned embodiments but should be determined by the appended claims.

WHAT IS CLAIMED IS:

[CLAIM 1]

A system for detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series, the system comprising:

a high current application unit configured to apply a high current to a battery system for a preset time;

a plurality of DCIR calculation units respectively connected to input and output terminals of parallel unit cells that constitute the battery system, the plurality of DCIR calculation units being configured to calculate DCIR (Ω) of the parallel unit cells by using the amount (ΔV) of change in voltage and the high current applied from the high current application unit; and

a defect detection unit configured to monitor the DCIR (Ω) calculated by the DCIR calculation unit and configured to determine that a defect occurs when a state voltage value of a closed circuit voltage is equal to or more, by a predetermined value of the amount of change in voltage, than a state voltage value of an open circuit voltage.

[CLAIM 2]

The system of claim 1, wherein the battery system is configured by connecting, in series, the parallel unit cells in which battery cells are connected in parallel.

[CLAIM 3]

The system of claim 1, wherein the high current application unit applies one of a discharging current and a charging current.

[CLAIM 4]

The system of claim 3, wherein when the high current applied to the battery system by the high current application unit is the charging current, the defect detection unit monitors the DCIR (Ω) calculated by the DCIR calculation unit and determines that a defect occurs when a maximum state cell voltage value of the closed circuit voltage is equal to or more, by a predetermined value of the amount of change in voltage, than a maximum state cell voltage value of the open circuit voltage.

[CLAIM 5]

The system of claim 3, wherein when the high current applied to the battery system by the high current application unit is the discharging current, the defect detection unit monitors the DCIR (Ω) calculated by the DCIR calculation unit and determines that a defect occurs when a minimum state cell voltage value of the closed circuit voltage is equal to or more, by a predetermined value of the amount of change in voltage, than a minimum state cell voltage value of the open

circuit voltage.

[CLAIM 6]

A method of detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series, the method comprising:

measuring a maximum voltage of the parallel unit cell in the battery system in a state in which no charging current is applied to the battery system by a high current application unit;

applying, by the high current application unit, a charging current to the battery system for a preset time;

measuring a maximum voltage of the parallel unit cell for a time for which the high current application unit applies the charging current to the battery system for a preset time;

determining whether a value of change in maximum voltage for the time for which the charging current is applied to the battery system is a preset reference voltage or less; and

determining that the parallel unit cell has a defect when the value of change in maximum voltage for the time for which the charging current is applied to the parallel unit cell is equal to or more than a preset value of change in reference voltage in the determining of whether the value of change in maximum voltage for the time for which the charging current is applied to the battery system is the preset reference voltage or less.

[CLAIM 7]

The method of claim 6, comprising:

determining that an output test is passed when the value of change in maximum voltage for the time for which the charging current is applied to the parallel unit cell is equal to or less than the preset value of change in reference voltage in the determining of whether the value of change in maximum voltage for the time for which the charging current is applied to the battery system is the preset reference voltage or less.

[CLAIM 8]

A method of detecting a defect of a single cell in a battery system in which parallel unit cells are connected in series, the method comprising:

measuring a minimum voltage of the parallel unit cell in a state in which no high current is applied to the battery system by a high current application unit;

applying, by the high current application unit, a charging current to the battery system for a preset time;

measuring a maximum voltage of the parallel unit cell for a time for which the high current application unit applies the high current to the battery system;

determining whether a value of change in maximum voltage for the time for which the high current is applied to the battery system is a preset reference voltage or less; and

determining that the parallel unit cell has a defect when the value of change in maximum voltage for the time for which the high current is applied to the parallel unit cell is equal to or more than a preset value of change in reference voltage in the determining of whether the value of change in maximum voltage for the time for which the high current is applied to the battery system is the preset reference voltage or less.

[CLAIM 9]

The method of claim 8, comprising:

determining that an output test is passed when the value of change in maximum voltage for the time for which the high current is applied to the battery system is equal to or less than the preset value of change in reference voltage in the determining of whether the value of change in maximum voltage for the time for which the high current is applied to the battery system is the preset reference voltage or less.