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(71) Applicant *(for all designated States except US)*: **BYD COMPANY LIMITED** [CN/CN]; No. 3001, Hengping Road, Pingshan, Longgang, Shenzhen, Guangdong 518118 (CN).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **DENG, Linwang** [CN/CN]; No. 3001, Hengping Road, Pingshan, Longgang, Shenzhen, Guangdong 518118 (CN). **ZENG, Yu** [CN/CN]; No. 3001, Hengping Road, Pingshan, Longgang, Shenzhen, Guangdong 518118 (CN). **DENG, Yaming** [CN/CN]; No. 3001, Hengping Road, Pingshan, Longgang, Shenzhen, Guangdong 518118 (CN).

(74) Agent: **TSINGYIHUA INTELLECTUAL PROPERTY LLC**; Room 301, Trade Building, Zhaolanyuan, Tsinghua University, Qinghuayuan, Haidian, Beijing 100084 (CN).

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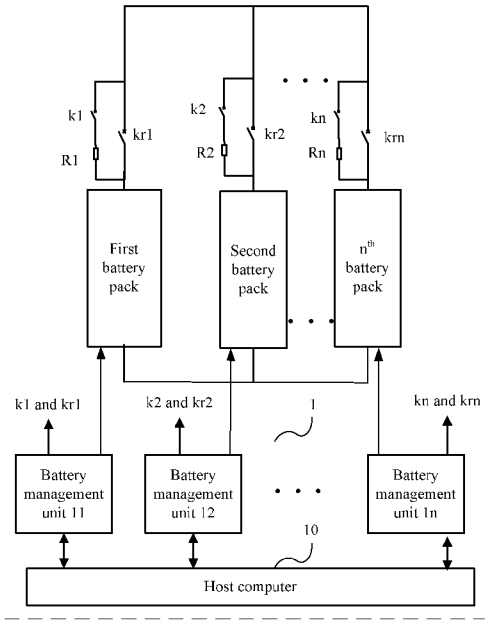

Fig. 2

(57) Abstract: A parallel device for a battery module and a controlling method thereof. The battery module includes a plurality of battery packs. The parallel device for the battery module includes: a plurality of switching units each comprising a first switch and a load connected in series and each connected with a corresponding one of battery packs in series to form a branch, wherein the branches formed of the plurality of switching units and the plurality of battery packs are connected to each other in parallel; and a controlling module (1) connected to the battery module and collecting a voltage of each battery pack, in order to calculate a voltage difference between voltages of any two of the battery packs, to compare the voltage difference with a first voltage reference to obtain a first voltage comparison, and to control at least one of the first switches corresponding to the any two of the battery packs based on the first voltage comparison. The parallel device for the battery module and the controlling method thereof can effectively avoid a big current impact when the battery packs are connected to each other in parallel, thereby prolonging the lives of the battery packs.

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PARALLEL DEVICE FOR BATTERY MODULE AND CONTROLLING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to, and benefits of Chinese Patent Application No. 201010139260.9 filed with the State Intellectual Property Office, P. R. C. on March 29, 2010, the entire contents of which are incorporated herein by reference.

FIELD

The present disclosure generally relates to a battery module, more particularly, to a parallel device and a controlling method thereof.

BACKGROUND

In the prior art, when the battery pack in a battery module are connected together in parallel, the electrodes with identical polarity are usually connected directly through wire or metallic channel to form parallel battery packs so as to supply power to external components. However, because of small resistance of the battery pack, when there is a large voltage difference between two battery packs, a large current shock will occur in the battery packs. If the value of large current shock is larger than the maximum current which the battery pack may bear, a bad effect on the battery and other components in the branch may be generated, and even the battery and other components may be damaged.

SUMMARY

The present disclosure is directed to solve at least one of the problems existing in the prior art. Accordingly, a parallel device for a battery module and a controlling method thereof are provided.

According to an aspect of the present disclosure, a parallel device for a battery module including a plurality of battery packs is provided. The parallel device comprises: a plurality of switching units, each comprising a first switch and a load which are connected in series, and each connected with a corresponding one of the battery packs in series to form a branch, in which the branches formed by the plurality of switching units and the plurality of battery packs are connected to each other in parallel; and a controlling module connected to the battery module and configured to collect a voltage of each battery pack, to calculate a voltage difference between voltages of any

two of the battery packs, to compare the voltage difference with a first voltage reference to obtain a first voltage comparison, and to control at least one of the first switches corresponding to the any two of the battery packs based on the first voltage comparison.

According to another aspect of the present disclosure, a controlling method of a parallel device for a battery module including a plurality of battery packs is provided. The parallel device comprises a plurality of switching units and a controlling module, each switching unit comprising a first switch and a load which are connected in series, and each switching unit being connected with a corresponding one of the battery packs in series to form a branch, in which the branches formed by the plurality of switching units and the plurality of battery packs are connected to each other in parallel. The controlling method comprises steps of: collecting a voltage of each battery pack and calculating a voltage difference between the voltages of any two of the battery packs; comparing the voltage difference with a first voltage reference to obtain a first voltage comparison; and controlling at least one of the first switches corresponding to the any two of the battery packs based on the first voltage comparison.

According to an embodiment of the present disclosure, the voltages between the battery packs are collected and the first switch is controlled to switch off or switch on according to the voltage comparison, and the voltage difference between the voltages of any two of the battery packs may be decreased or even eliminated, so that the interior current when the battery packs are connected in parallel may be within a permissive current range of the battery packs or may be zero. Therefore, a large current shock to the battery packs may be effectively avoided, thus prolonging the life of the battery packs and improving the reliability of the battery packs.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects and advantages of the disclosure will become apparent and more readily appreciated from the following descriptions taken in conjunction with the drawings in which:

Fig. 1 is a block diagram of a parallel device according to an embodiment of the present disclosure;

Fig. 2 is a block diagram of a parallel device according to another embodiment of the present disclosure;

Fig. 3 is a flow chart of a controlling method of a parallel device according to an embodiment

of the present disclosure; and

Fig. 4 is a flow chart of a controlling method of a parallel device according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

Reference will be made in detail to embodiments of the present disclosure. The embodiments described herein with reference to the accompany drawings are explanatory and illustrative, which are used to generally understand the present disclosure. The embodiments shall not be construed to limit the present disclosure.

Fig. 1 is a block diagram of the parallel device for a battery module in one embodiment of the present disclosure. Referring to Fig. 1, the battery module may comprise a plurality of battery packs: the first battery pack, the second battery pack, ..., and the n^{th} battery pack. The parallel device comprises a plurality of switching units, each comprising a first switch and a load which are connected in series, and each connected with a corresponding one of the battery packs in series to form a branch. The branches formed by the plurality of switching units and the plurality of battery packs are connected to each other in parallel.

Particularly, the x^{th} switching unit may comprise a x^{th} first switch and a x^{th} load connected in series with an x^{th} first switch, and be connected in series with the x^{th} battery pack to form the x^{th} branch, in which $1 \leqslant x \leqslant n$. The first branch, the second branch, ..., and the n^{th} branch may be connected in parallel to each other. For example, the first switching unit may comprise a first switch k_1 and a first load R_1 connected in series with the first switch k_1, and be connected in series with the first battery pack to form the first branch.

The parallel device also comprises a controlling module 1. The controlling module 1 may be configured to collect a voltage of the battery pack of each battery unit, and to calculate a voltage difference U between the collected voltages of any two of the battery packs. In another embodiment of the present disclosure, the controlling module 1 may be further configured to collect a current of each battery pack. The controlling module 1 may be configured to compare the voltage difference U between the voltages of any two of the battery packs with a first voltage reference U1 to obtain a first voltage comparison, and to control at least one of the first switches corresponding to the any two of the battery packs based on the first voltage comparison.

For example, if the voltage difference U between the voltages of the any two of the battery

packs is greater than the first voltage reference U1, the controlling module 1 is configured to control the at least one of the first switches corresponding to the any two of the battery packs to switch off. If all the voltage differences U are less than the first voltage reference U1, the controlling module 1 may be configured to control the first switches k_1, k_2, …, k_n to switch on. The voltage difference U1 between the voltages of any two of the battery packs are collected before the battery packs are connected in parallel, and the first switches k_1, k_2, …, k_n are switched on to balance the voltage only when the voltage difference U between the voltages of any two of the battery packs is safe for the battery packs. Therefore, the current shock due to the direct parallel connection of the battery packs may be avoided, thus avoiding damages to the battery packs.

In one embodiment of the present disclosure, the parallel device may further comprise a plurality of second switches k_{r1}, k_{r2}, …, k_{rn}. The x^{th} second switch k_{rx} may be connected in parallel to the x^{th} switching unit, in which $1 \leqslant x \leqslant n$. The control module controls the at least one of the second switches corresponding to the any two of the battery packs based on the first voltage comparison. In some embodiments of the present disclosure, the controlling module controls the at least one of the second switches to switch off if the voltage difference U is greater than the first voltage reference U1.

In some embodiments of the present disclosure, the load R_1, R_2, …, R_n may be identical with each other. The voltage difference value may be the absolute value of the voltage difference between any two of the battery packs. In some embodiments of the present disclosure, the maximum current which the battery pack may bear is I_0, and the resistance value of the loads R_1, R_2, …, R_n is R. In some embodiments of the present disclosure, $U1 \leq I_0 * 2R$.

In some embodiments of the present disclosure, the resistance values of the loads may be different and may be larger than 1 ohm. When all the voltage differences U are less than U1 and no less than zero, the first switches k_1, k_2, …, k_n may be controlled to switch on. For example, when the voltage difference U between the first battery pack and the second battery pack is no less than the first voltage reference U1, the first switches and the second switches corresponding to the first and second battery packs may be controlled to switch off, then the battery pack at the highest voltage may be controlled to discharge or the battery pack at the lowest voltage may be controlled to charge until the voltage difference U between the first battery pack and the second battery pack is in the range of [0, U1). In this way, the current in the battery packs may not exceed the maximum current I_o which the battery packs may bear, that is, the current shock may not occur.

In some embodiments of the present disclosure, the first switches k_1, k_2, ..., k_n may be controlled to switch on in sequence. The time interval for switching on the first switches k_1, k_2, ..., k_n is t, that is, when one of the first switches is switched on, another first switch may be switched on after a lapse of the time interval of t, and still another first switch may be switched on after a lapse of the time interval of t, until all the first switches are switched on. In some embodiments of the present disclosure, the time interval t may be about 0.3-0.4 S, particularly, about 0.35 S.

The controlling module 1 may be further configured to collect a current of any one of the battery packs, to compare the collected current with a current reference I to obtain a current comparison, and to control the first and second switches corresponding to the any one of the battery packs based on the current comparison I, if the voltage difference U is smaller than the first voltage reference U1. The controlling module controls the first switch corresponding to the any one of the battery packs to switch on and the second switch corresponding to the any one of the battery packs to switch off if the current is greater than the current reference I. And the controlling module controls the first switch corresponding to the any one of the battery packs to switch off and the second switch corresponding to the any one of the battery packs to switch on if the current is smaller than the current reference I.

The switching unit in the parallel device may be configured to balance the voltage difference of the voltages between any two of the battery packs so as to decrease or eliminate the voltage difference. However, when the parallel device is put into use, if the switching units are still kept in the parallel device, the load in the switching units may waste unnecessary power. Therefore, after the voltage difference U between the voltages of every two battery packs is balanced to some extent or eliminated, all the second switches may be controlled to switch on. Meanwhile, in some embodiments of the present disclosure, after switching on the second switch, the first switch corresponding to the second switch may be switched off.

In some embodiments of the present disclosure, when all the first switches are switched on and all the currents are less than the current reference I and no less than zero, the second switches k_{r1}, k_{r2}, ..., k_{rn} may be controlled to switch on. After switching on the second switch, the first switch may be switched off after a time interval. That is, after switching on the second switch k_{rx}, the first switch $_{kx}$ corresponding to the second switch k_{rx} is switched off after the time interval. Alternatively, after switching on all the second switches k_{r1}, k_{r2}, ..., k_{rn}, the first switches k_1, k_2, ..., k_n may be controlled to switch off after a second time interval. In some embodiments of the

present disclosure, the value range of the current reference I may be about [0 A, 0.5 A]. When the current of each battery pack is in a range of about 0 A to about 0.5 A, after switching on the second switch, the first switch is switched off after a time interval, thus ensuring that the current of the battery packs may not exceed the maximum current I_o which the battery packs may bear. Particularly, the value of I may be about 0 A.

In another embodiment of the present disclosure, the control module is configured to compare the voltage difference U with a second voltage reference U2 smaller than the first voltage reference U1 to obtain a second voltage comparison, and to control the at least one of the first switches and the at least one of the second switches based on the second voltage comparison, if the voltage difference U is smaller than the first voltage reference U1. The controlling module controls the at least one of the first switches to switch off and the at least one of the second switches to switch on if the voltage difference U is smaller than the second voltage reference U2; and the controlling module controls the at least one of the first switches to switch on and the at least one of the second switches to switch off if the voltage difference is greater than the second voltage reference U2.

In another embodiment of the present disclosure, when all the first switches are switched on and all the voltage differences U are less than the voltage reference U2 and no less than zero, the second switches k_{r1}, k_{r2}, …, k_{rn} may be controlled to switch on. After switching on the second switch, the first switch is switched off after a time interval, that is, after switching on the second switch k_{rx}, the first switch k_x corresponding to the second switch k_{rx} is switched off after a time interval, or after switching on all the second switches k_{r1}, k_{r2}, …, k_{rn}, the first switches k_1, k_2, …, k_n are controlled to switch off after a time interval. In one embodiment of the present disclosure, the value range of U2 may be about [0V, 0.5V]. When the voltage difference between the voltages of any two of the battery packs is no less than 0 and not greater than U2, after switching on the second switch, the first switch may be switched off after a time interval, thus ensuring that the current of the battery packs may not exceed the maximum current I_o which the battery packs may bear. Particularly, the value of U2 is about 0V.

Referring to Fig. 2, in another embodiment of the present disclosure, the controlling module may comprise a host computer 10 and a plurality of battery management units 11, 12…and 1n connected to the host computer 10. Each battery management unit is connected with one battery pack in one of the branches. As shown in Fig. 2, in some embodiments of the present disclosure,

the battery management unit 11 may be connected to the first battery pack; the battery management unit 12 may be connected to the second battery pack; ...; and the battery management unit 1n may be connected to the n^{th} battery pack.

In one embodiment of the present disclosure, the plurality of battery management units are configured to collect the voltages and send the voltages to the host computer 10; the host computer 10 is configured to calculate the voltage difference of the any two of the battery packs according to the voltages, to compare the voltage difference with the first voltage reference U1 to obtain the first voltage comparison, and to generate a first voltage signal based on the first voltage comparison; and the plurality of battery management units control the at least one of the first switches and the at least one of the second switches corresponding to the two battery packs based on the first voltage signal. In a further embodiment, the host computer 10 is further configured to compare the voltage difference with the second voltage reference U2 to obtain the second voltage comparison, and to generate a second voltage signal based on the second voltage comparison; and the plurality of battery management units control the at least one of the first switches and the at least one of the second switches corresponding to the two battery packs based on the second voltage signal.

In another embodiment of the present disclosure, each battery management unit is configured to collect a current of any one of the battery packs corresponding thereto and send the current to the host computer 10; the host computer 10 is configured to compare the current of any one of the battery packs with a current reference to obtain a current comparison, and generate a current control signal based on the current comparison; and the battery management unit is configured to control the first and second switches corresponding thereto.

In a first embodiment of the present disclosure, as shown in Fig. 3, a controlling method of the parallel device for a battery module mentioned above is provided. The controlling method comprises steps of:

S11, collecting a voltage of each battery pack and calculating a voltage difference U between the voltages of any two of the battery packs;

S12, comparing the voltage difference U with the first voltage reference U1;

S13, if the voltage difference U between the voltages of the any two of the battery packs is no less than the first voltage reference U1, switching off at least one of the first and second switches corresponding to the any two of the battery packs;

S14, if the voltage difference U between the voltages of the any two of the battery packs is less than the first voltage reference U1, further comparing the voltage difference U with the second voltage reference U2;

S15, if the voltage difference U between the voltages of the any two of the battery packs is less than the second voltage reference U2, switching off the at least one of the first switches corresponding to the any two of the battery packs and switching on the at least one of the second switches corresponding to the any two of the battery packs; and

S16, if the voltage difference U between the voltages of the any two of the battery packs is greater than the second voltage reference U2, switching on the at least one of the first switches and switching off the at least one of the second switches.

In one embodiment of the present disclosure, all the second switches may be controlled to switch on in sequence, and after a time interval, the first switches may be controlled to switch off. In another embodiment of the present disclosure, one of the second switches is switched on and one of the first switches corresponding to the one of the second switches is switched off after a time interval, another second switch is switched on and another first switch corresponding to the another second switch is switched off after the time interval, still another second switch is switched on and still another first switch corresponding to the still another second switch is switched off after the time interval, and the like, until all the second switches are switched on and all the first switches are switched off.

In a second embodiment of the present disclosure, as shown in Fig. 4, a controlling method of the parallel device mentioned above is provided. The controlling method comprises steps of:

S21, collecting a voltage of each battery pack and calculating a voltage difference U between the voltages of any two of the battery packs;

S22, comparing the voltage difference U with the first voltage reference U1;

S23, if the voltage difference U between the voltages of the any two of the battery packs is no less than the first voltage reference U1, switching off at least one of the first and second switches corresponding to the any two of the battery packs;

S24, if the voltage difference U between the voltages of the any two of the battery packs is less than the first voltage reference U1, switching on the at least one of the first switches corresponding to the any two of the battery packs and switching off the at least one of the second switches corresponding to the any two of the battery packs;

S25, collecting a current of any one of the battery packs;

S26, comparing the current of the any one of the battery packs with a current reference I, and returning to Step S24, if the collected current is no less than the current reference I; and

S27, switching on the second switch corresponding to the any one of the battery packs and switching off the first switch corresponding to the any one of the battery packs, if the collected current is less than the current reference I.

In one embodiment of the present disclosure, all the second switches are controlled to switch on in sequence, and after a time interval, the first switches are controlled to switch off. In another embodiment of the present disclosure, one of the second switches is switched on and one of the first switches corresponding to the one of the second switches is switched off after a time interval, another second switch is switched on and another first switch corresponding to the another the second switch is switched off after the time interval, still another second switch is switched on and still another first switch corresponding to the still another second switch is switched off after the time interval, and the like, until all the second switches are switched on and all the first switches are switched off.

When the current of one battery pack is greater than or equal to the current reference I, the first switch corresponding to the one battery pack is controlled to switch on and the second switch corresponding to the one battery pack is controlled to switch off.

In the above embodiments, when switching on the first switch, switching off the second switch and balancing the voltage of the battery packs, the value difference U between the voltages of any two of the battery packs, or the current of the battery packs may be compared with the voltage reference or the current reference to obtain the voltage comparison or the current comparison respectively, and the voltage comparison and the current comparison serve as an important reference for estimating the balancing degree of the battery packs. When all the voltage differences U between the voltages of any two of the battery packs are less than the second voltage reference U2 or the current of each battery pack is less than the current reference I, the second switch may be switched on and the first switch may be switched off without generating current shock. In some embodiments of the present disclosure, the values of the voltage reference U2 and the current reference I are 0. The first embodiment is different from the second embodiment in that when the voltage difference between the voltages of any two of the battery packs is less than the second voltage reference U2 at the beginning, the second switch is switched on and the first switch

is switched off directly, thus omitting the step of balancing the voltage of the battery packs.

According to an embodiment of the present disclosure, the voltages between the battery packs are collected and balanced before the battery packs are connected in parallel, and the voltage difference between the voltages of any two of the battery packs is decreased or even eliminated, so that the interior current when the battery packs are connected in parallel may be within a permissive current range of the battery packs or may be zero. Therefore, a large current shock to the battery packs may be effectively avoided, thus prolonging the life of the battery packs and improving the reliability of the battery packs.

It will be appreciated by those skilled in the art that changes could be made to the embodiments described above without departing from the broad inventive concept. It is understood, therefore, that this disclosure is not limited to the particular embodiments disclosed, but it is intended to cover modifications within the spirit and scope of the present disclosure as defined by the appended claims.

What is claimed is:

1. A parallel device for a battery module including a plurality of battery packs, comprising:

a plurality of switching units, each comprising a first switch and a load which are connected in series, and each connected with a corresponding one of the battery packs in series to form a branch, in which the branches formed by the plurality of switching units and the plurality of battery packs are connected to each other in parallel; and

a controlling module connected to the battery module and configured to collect a voltage of each battery pack, to calculate a voltage difference between voltages of any two of the battery packs, to compare the voltage difference with a first voltage reference to obtain a first voltage comparison, and to control at least one of the first switches corresponding to the any two of the battery packs based on the first voltage comparison.

2. The parallel device of claim 1, wherein the controlling module controls the at least one of the first switches to switch off if the voltage difference is greater than the first voltage reference.

3. The parallel device of claim 2, further comprising a plurality of second switches, each connected with a corresponding one of the plurality of switching units in parallel, and

wherein the control module controls the at least one of the second switches corresponding to the any two of the battery packs based on the first voltage comparison.

4. The parallel device of claim 3, wherein the controlling module controls the at least one of the second switches to switch off if the voltage difference is greater than the first voltage reference.

5. The parallel device of claim 4, wherein the control module is configured to compare the voltage difference with a second voltage reference smaller than the first voltage reference to obtain a second voltage comparison, and to control the at least one of the first switches and the at least one of the second switches based on the second voltage comparison, if the voltage difference is smaller than the first voltage reference.

6. The parallel device of claim 5, wherein the controlling module controls the at least one of the first switches to switch off and the at least one of the second switches to switch on if the voltage difference is smaller than the second voltage reference; and

wherein the controlling module controls the at least one of the first switches to switch on and the at least one of the second switches to switch off if the voltage difference is greater than the second voltage reference.

7. The parallel device of claim 5, wherein the controlling module is configured to collect a current of any one of the battery packs, to compare the current with a current reference to obtain a current comparison, and to control the first and second switches corresponding to the any one of the battery packs based on the current comparison, if the voltage difference is smaller than the first voltage reference.

8. The parallel device of claim 7, wherein the controlling module controls the first switch corresponding to the any one of the battery packs to switch on and the second switch corresponding to the any one of the battery packs to switch off if the current is greater than the current reference; and

wherein the controlling module controls the first switch corresponding to the any one of the battery packs to switch off and the second switch corresponding to the any one of the battery packs to switch on if the current is smaller than the current reference.

9. The parallel device of claim 3, wherein the controlling module further comprises:

a host computer; and

a plurality of battery management units connected to the host computer and each connected with one of the branches.

10. The parallel device of claim 9, wherein the plurality of battery management units are configured to collect the voltages and send the voltages to the host computer;

wherein the host computer is configured to calculate the voltage difference of the any two of the battery packs according to the voltages, to compare the voltage difference with the first voltage reference to obtain the first voltage comparison, and to generate a first voltage signal based on the first voltage comparison; and

wherein the plurality of battery management units control the at least one of the first switches and the at least one of the second switches corresponding to the two battery packs based on the first voltage signal.

11. The parallel device of claim 10, wherein the host computer is further configured to compare the voltage difference with the second voltage reference to obtain the second voltage comparison, and to generate a second voltage signal based on the second voltage comparison; and

wherein the plurality of battery management units control the at least one of the first switches and the at least one of the second switches corresponding to the two battery packs based on the second voltage signal.

12. The parallel device of claim 10, wherein each battery management unit is configured to collect a current of any one of the battery packs corresponding thereto and send the current to the host computer;

wherein the host computer is configured to compare the current of any one of the battery packs with a current reference to obtain a current comparison, and generate a current control signal based on the current comparison; and

wherein the battery management unit is configured to control the first and second switches corresponding thereto.

13. A controlling method of a parallel device for a battery module including a plurality of battery packs, comprising a plurality of switching units and a controlling module, each switching unit comprising a first switch and a load which are connected in series, and each switching unit being connected with a corresponding one of the battery packs in series to form a branch, in which the branches formed by the plurality of switching units and the plurality of battery packs are connected to each other in parallel, the controlling method comprising steps of:

collecting a voltage of each battery pack and calculating a voltage difference between the voltages of any two of the battery packs;

comparing the voltage difference with a first voltage reference to obtain a first voltage comparison; and

controlling at least one of the first switches corresponding to the any two of the battery packs based on the first voltage comparison.

14. The controlling method of claim 13, wherein the at least one of the first switches is controlled to switch off if the voltage difference is greater than the first voltage reference.

15. The controlling method of claim 14, wherein the parallel device further comprises a plurality of second switches each connected with a corresponding one of the plurality of switching units in parallel, and

the method further comprises controlling the at least one of the second switches corresponding to the any two of the battery packs based on the first voltage comparison.

16. The controlling method of claim 15, wherein the at least one of the second switches is controlled to switch off if the voltage difference is greater than the first voltage reference.

17. The controlling method of claim 16, further comprising: if the voltage difference is smaller than the first voltage reference, comparing the voltage difference with a second voltage

reference smaller than the first voltage reference to obtain a second voltage comparison; and controlling the at least one of the first switches and the at least one of the second switches based on the second voltage comparison.

18. The controlling method of claim 17, wherein the at least one of the first switches is controlled to switch off and the at least one of the second switches is controlled to switch on if the voltage difference is smaller than the second voltage reference; and

wherein the at least one of the first switches is controlled to switch on and the at least one of the second switches is controlled to switch off if the voltage difference is greater than the second voltage reference.

19. The controlling method of claim 16, further comprising: if the voltage difference is smaller than the first voltage reference, collecting a current of any one of the battery packs, comparing the current with a current reference to obtain a current comparison, and controlling the first and second switches corresponding to the any one of the battery packs based on the current comparison.

20. The controlling method of claim 19, wherein the first switch corresponding to the any one of the battery packs is controlled to switch on and the second switch corresponding to the any one of the battery packs is controlled to switch off if the current is greater than the current reference; and

wherein the first switch corresponding to the any one of the battery packs is controlled to switch off and the second switch corresponding to the any one of the battery packs is controlled to switch on if the current is smaller than the current reference.

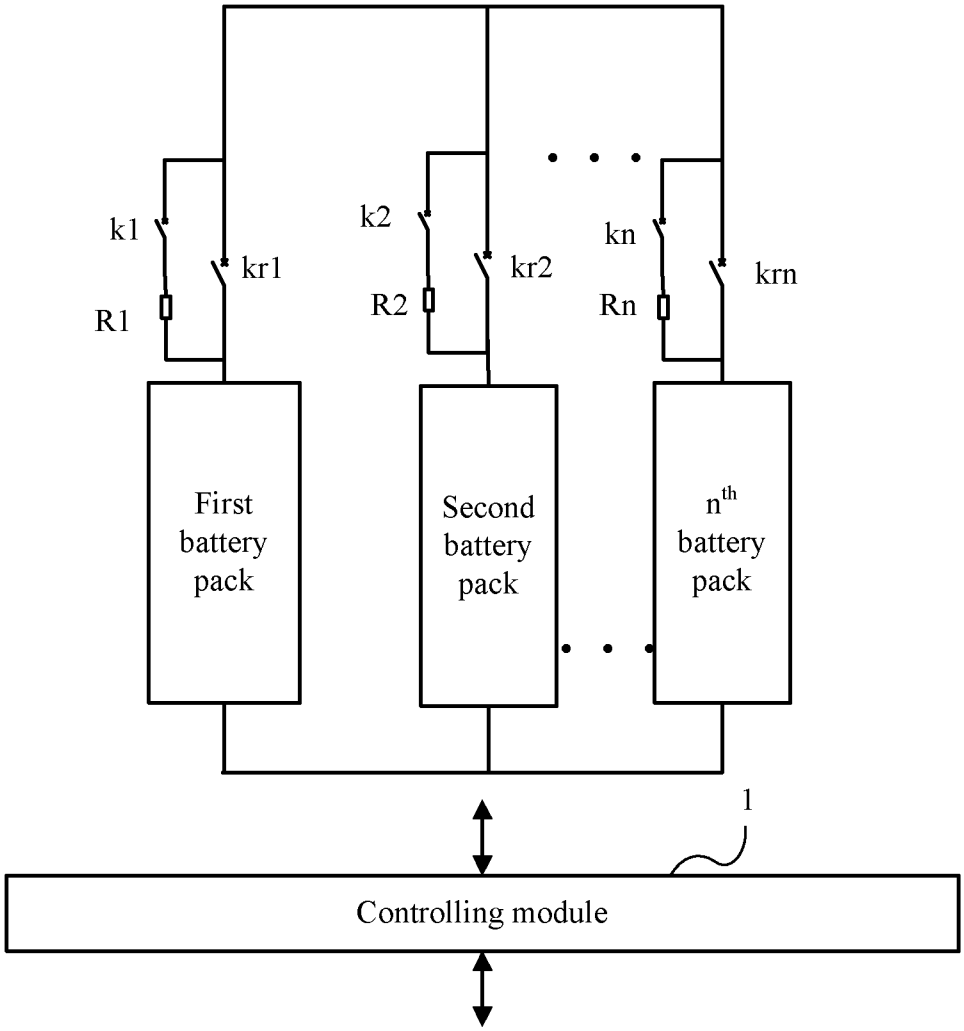
k1
kr1
R1
k2
kr2
R2
kn
krn
Rn
First battery pack
Second battery pack
nth battery pack
1
Controlling module

Fig. 1

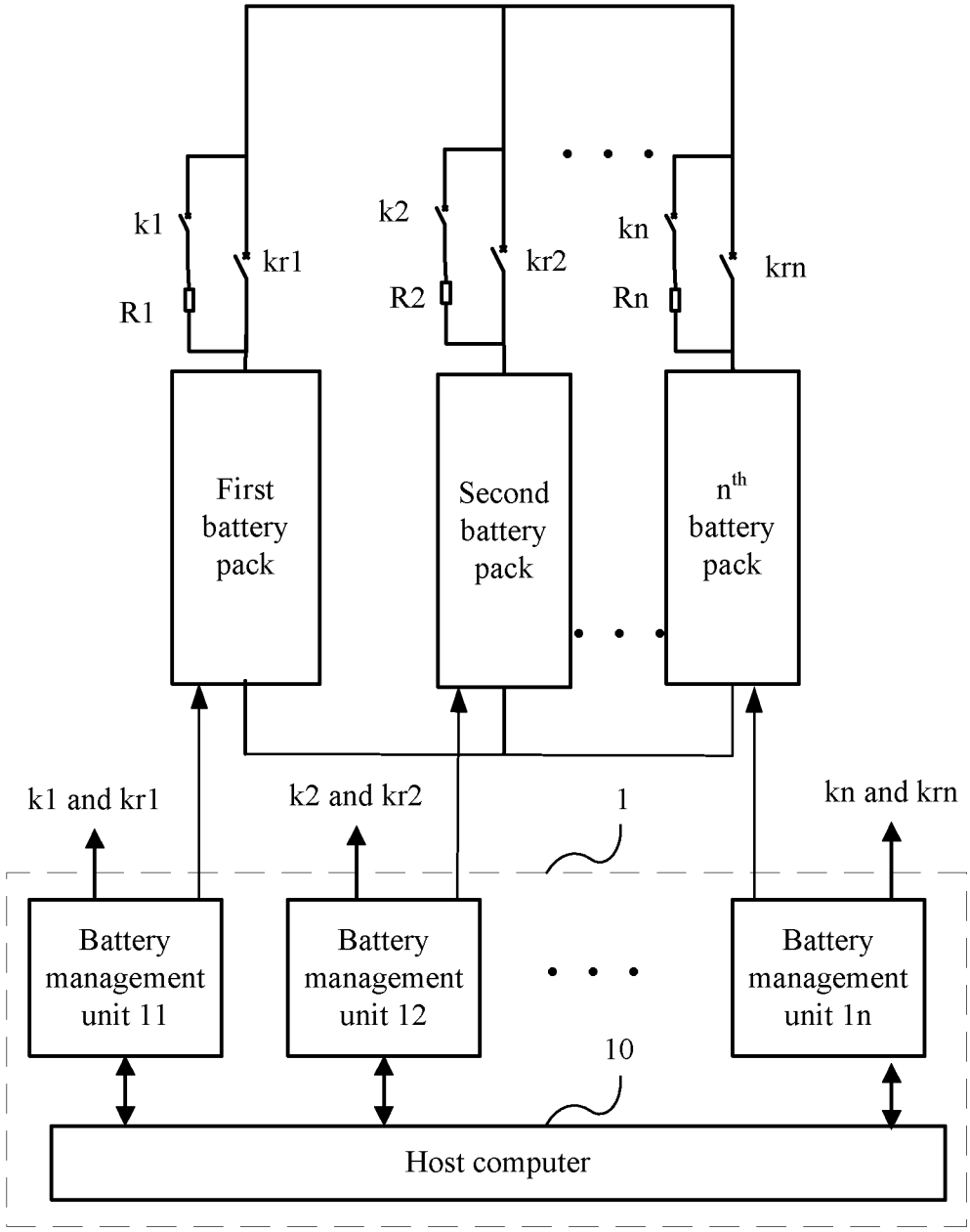
k1
kr1
R1
k2
kr2
R2
kn
krn
Rn
First battery pack
Second battery pack
nth battery pack
k1 and kr1
k2 and kr2
1
kn and krn
Battery management unit 11
Battery management unit 12
Battery management unit 1n
10
Host computer

Fig. 2

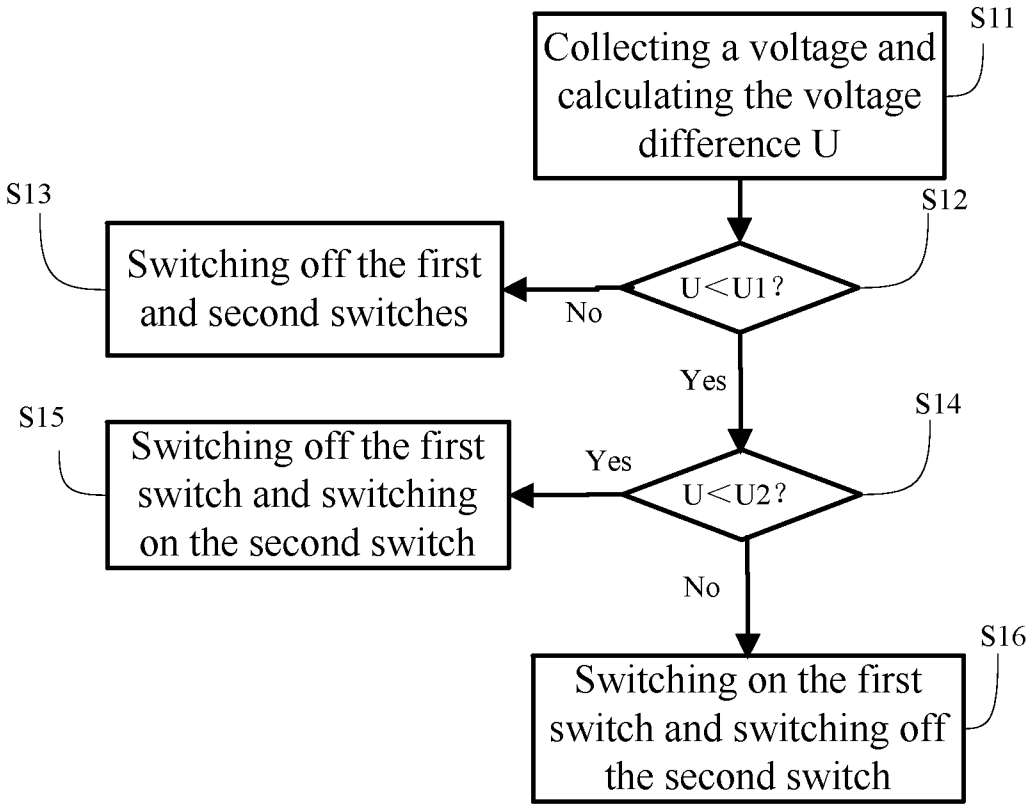
Collecting a voltage and calculating the voltage difference U
S11
S12
U<U1?
No
S13
Switching off the first and second switches
Yes
S14
U<U2?
Yes
S15
Switching off the first switch and switching on the second switch
No
S16
Switching on the first switch and switching off the second switch

Fig. 3

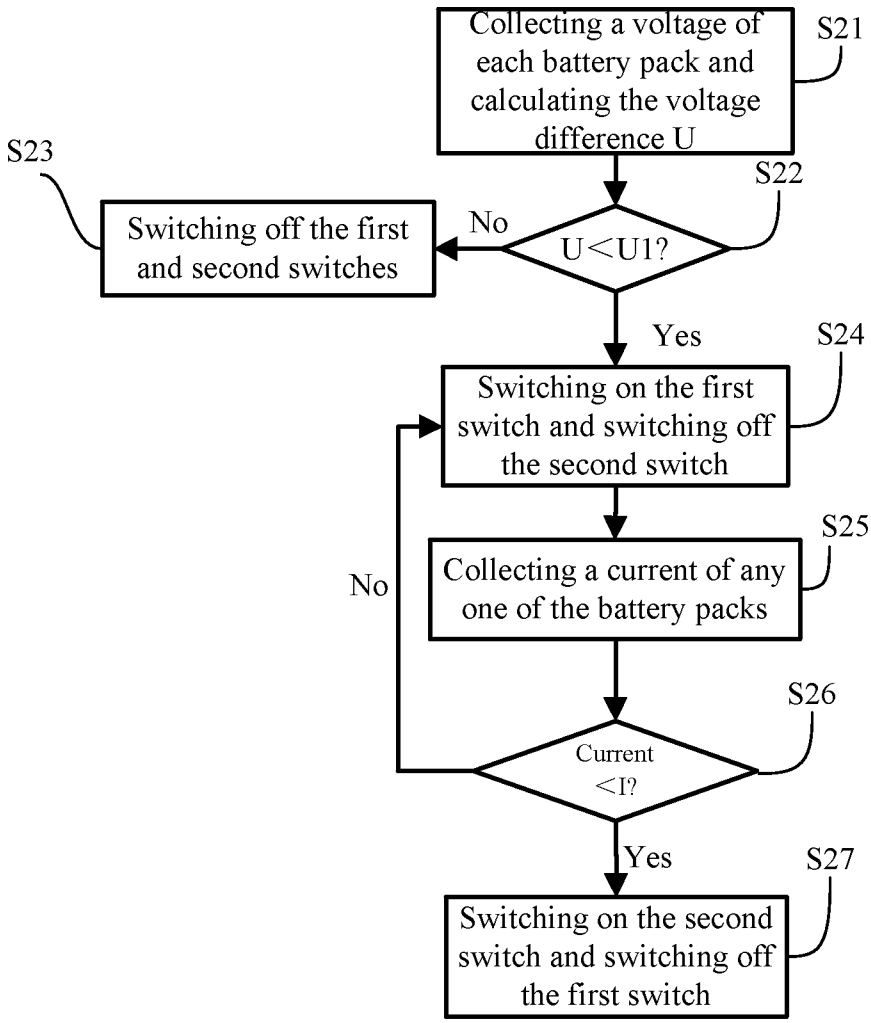
Collecting a voltage of each battery pack and calculating the voltage difference U
S21
S22
U<U1?
No
S23
Switching off the first and second switches
Yes
S24
Switching on the first switch and switching off the second switch
S25
Collecting a current of any one of the battery packs
No
S26
Current <I?
Yes
S27
Switching on the second switch and switching off the first switch

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/072227

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01M, H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, TXTWO1, CNPAT, CNTXT, CNKI: battery/cell, parallel, voltage, difference, switch, balance

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US2006/0192529A1 (MATSUSHITA ELECTRIC IND CO LTD) 31 Aug. 2006 (31.08.2006) see pages 2-3 in the description, and Fig. 1	1-20
A	CN101123359A (DONGHUA ENERGY SOURCES SCI & TECHNOLOGY CO LTD) 13 Feb. 2008 (13.02.2008) see the whole document	1-20
A	CN1983709A (WU, Yijie) 20 Jun. 2007 (20.06.2007) see the whole document	1-20
A	CN101141011A (SHANGHAI XIANGMING MIDDLE SCHOOL) 12 Mar. 2008 (12.03.2008) see the whole document	1-20
A	CN101471460A (SHENZHEN BAK BATTERY CO LTD) 01 Jul. 2009 (01.07.2009) see the whole document	1-20
A	US2008/0174274A1 (NISSAN MOTOR CO LTD) 24 Jul. 2008 (24.07.2008) see the whole document	1-20

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 May 2011 (31.05.2011)	**23 Jun. 2011 (23.06.2011)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer HAN, Beibei Telephone No. (86-10)62411809

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2011/072227

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP2009129657A (NEC TOKIN CORP) 11 Jun. 2009 (11.06.2009) see the whole document	1-20

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2011/072227

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
US2006/0192529A1	31.08.2006	CN1825676A	30.08.2006
		JP2006238619A	07.09.2006
		KR20060094897A	30.08.2006
		JP4196122B2	17.12.2008
		US7535199B2	19.05.2009
		CN100514744C	15.07.2009
CN101123359A	13.02.2008	None	
CN1983709A	20.06.2007	None	
CN101141011A	12.03.2008	None	
CN101471460A	01.07.2009	None	
US2008/0174274A1	24.07.2008	JP2008178220A	31.07.2008
JP2009129657A	11.06.2009	None	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/072227

A. CLASSIFICATION OF SUBJECT MATTER

H01M 10/48 (2006.01) i

H02J 7/00 (2006.01) i