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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)*: **LIU, Yu** [CN/CN]; No. 3001, Hengping Road, Pingshan, Longgang, Shenzhen, Guangdong 518118 (CN). **SHEN, Xiaofeng** [CN/CN]; No. 3001, Hengping Road, Pingshan, Longgang, Shenzhen, Guangdong 518118 (CN). **ZHANG, Jianhua** [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, Haidian, Beijing 100084 (CN).

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(54) **Title**: METHOD AND DEVICE FOR DETECTING PWM WAVE

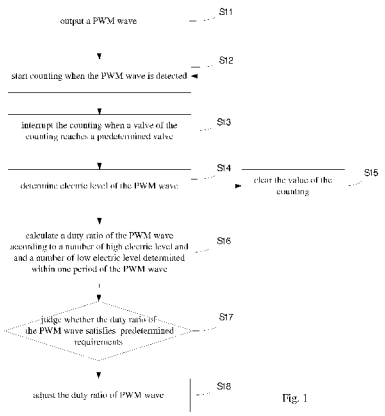


Fig. 1

(57) **Abstract**: A method for detecting PWM wave comprises: starting counting when a PWM wave is detected; interrupting the counting when a value of the counting reaches a predetermined value; determining whether electric level of the PWM wave during the interruption is high electric level or low electric level; clearing the value of the counting, starting a next counting and interrupting the next counting when a value of the next counting reaches the predetermined value; determining whether the electric level of the PWM wave during the interruption of the next counting is high electric level or low electric level; clearing the value of the counting and repeating the counting and the determining until one period of the PWM wave; and calculating a duty ratio of the PWM wave based on a number of high electric level and a number of low electric level determined within one period of the PWM wave.

WO 2011/076103 A1

METHOD AND DEVICE FOR DETECTING PWM WAVE

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority to and benefits of Chinese Patent Application No. 200910189235.9 filed with Chinese SIPO on December 22, 2009, the entirety of which is hereby incorporated by reference.

TECHNICAL FIELD

The present disclosure relates to electric vehicle field, more particularly, to a method and a device for detecting PWM wave.

BACKGROUND

With the shortage of resource, an electric vehicle as a transportation vehicle using new energy is gradually developing. It is widely known that, the main power source of the electric vehicle is battery pack, however, the battery pack is an energy-storage equipment which greatly expends on external environment, especially temperature, when the temperature is sub-zero 20 degree centigrade, the discharge performance of lithium battery is greatly decreased and nearly can't satisfy the basic requirements. However, the electric vehicle could not only operate in the warm climate, if into the cold climate, the electric vehicle may not operate normally, even can not start. In order to solve this problem, a battery heating technology is used to heat the battery pack, so that the temperature of the battery can reach the minimum desired temperature, thereby the electric vehicle can drive in the cold climate.

Typically, heating the battery is realized by a battery heating module driven by a PWM wave. To ensure reliability, the PWM wave must be detected. In the prior art, generally using a hardware circuit to detect the PWM wave. However, it can only detect the electric level of the PWM wave, such as high electric level or low electric level, but can not determine a duty ratio of the PWM wave.

SUMMARY

The present disclosure is directed to solving at least one problem associated with the prior art. Accordingly, a method and a device for detecting PWM wave are provided in embodiments of the present disclosure.

According to an embodiment of the present disclosure, a method for detecting PWM wave is provided, comprising:

(a) starting counting when a PWM wave is detected;

(b)interrupting the counting when a value of the counting reaches a predetermined value;

(c) determining whether electric level of the PWM wave during the interruption is high electric level or low electric level;

(d) clearing the value of the counting, starting a next counting and interrupting the next counting when a value of the next counting reaches the predetermined value,

(e) determining whether the electric level of the PWM wave during the interruption of the next counting is high electric level or low electric level;

(f) repeating steps (d) and (e) until one period of the PWM wave; and

(g) calculating a duty ratio of the PWM wave based on a number of high electric level and a number of low electric level determined within one period of the PWM wave.

According to another embodiment of the present disclosure, a device for detecting PWM wave is provided, comprising: a PWM wave generating module configured to generate a PWM wave; a detecting module coupled to the PWM wave generating module and configured to receive the PWM wave and determine electric level of the PWM wave; a timer coupled to the detecting module and configured to start counting when the detecting module receives the PWM wave and interrupt the counting when a value of the counting reaches a predetermined value, in which the detecting module determines whether the electric level of the PWM wave during the interruption is high electric level or low electric level; and a calculating module coupled to the detecting module to calculate a duty ratio of the PWM wave based on a number of high electric level and a number of low electric level of the PWM wave determined within one period of the PWM wave.

The present disclosure can accurately calculate the duty ratio of the PWM wave according to the number of high electric level and the number of low electric level determined and recorded within one period of the PWM wave. If the duty ratio of the PWM wave does not satisfy the predetermined requirements, the PWM wave will be adjusted to satisfy the requirements, so as to ensure the reliability of the PWM wave, thus avoid occurring of accidents.

BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 1 shows a flow chart of a method for detecting PWM wave according to an embodiment of the present disclosure;

Fig. 2 shows a schematic diagram of a device for detecting PWM wave according to an embodiment of the present disclosure;

Fig. 3 shows a schematic diagram of the MCU according to an example of the present disclosure;

Fig. 4 shows a schematic diagram of the PWM wave outputted by the MCU in Fig.3;

Fig. 5 shows a schematic diagram of the electric level determined within one period of the PWM wave according to an embodiment of the present disclosure; and

Fig. 6 shows a schematic diagram of the electric level determined within one period of the PWM wave according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

Reference will be made in detail to embodiments of the present invention. The embodiments described herein with reference to drawings are explanatory and illustrative, and are used to generally understand the present invention. The embodiments shall not be construed to limit the present invention. The same or similar elements and the elements having the same or similar functions are denoted by the same reference numerals throughout the descriptions.

A method for detecting PWM wave according to an embodiment comprises (a) starting counting when a PWM wave is detected; (b)interrupting the counting when a value of the counting reaches a predetermined value; (c) determining whether electric level of the PWM wave during the interruption is high electric level or low electric level; (d) clearing the value of the counting, starting a next counting and interrupting the next counting when a value of the next counting reaches the predetermined value; (e) determining whether the electric level of the PWM wave during the interruption of the next counting is high electric level or low electric level; (f) repeating steps (d) and (e) until one period of the PWM wave; and (g) calculating a duty ratio of the PWM wave based on a number of high electric level and a number of low electric level determined within one period of the PWM wave.

An example of the method for detecting PWM wave according to the present disclosure will be described with reference to Fig.1 and Figs. 4-6. As shown in Fig.1 and Figs. 4-6, the method for detecting PWM wave comprises the following steps.

At step S11, a PWM wave is outputted, as shown in Fig. 4. Then the counting is started when the PWM wave is detected at step S12.

When a valve of the counting reaches a predetermined valve, the counting is interrupted at step S13.

Next, at step S14, the electric level of the PWM wave is determined and recorded as high electric level or low electric level during the interruption. For example, the low electric level may denoted by “0” and the high electric level may be denoted by “1”.

At step S15, after recording the electric level of the PWM wave, the value of the counting is cleared.

Then, steps S12 to S14 are repeated until one period of the PWM wave, as shown in Figs. 4-6. Since the time of recording the electric level is very short, it is ignored here.

At step S16, the duty ratio of the PWM wave is calculated according to the number of high

electric level and the number of low electric level determined and recorded within one period of the PWM wave.

In some embodiments, the duty ratio M of the PWM wave is calculated by the formal: $M = P_h / (P_h + P_l)$, where P_h is the number of high electric level determined within one period of the PWM wave and P_l is the number of low electric level determined within one period of the PWM wave.

It will be understood that the number of high electric level and the number of low electric level may increase with increasing of the interruption times. That is, the shorter the interval time between adjacent interruptions, the larger the number of high electric level and the number of low electric level are, thereby the duty ratio may be more accurate.

In another embodiment of the present disclosure, the method for detecting the PWM wave may further include a step S17 of judging whether the duty ratio of the PWM wave satisfies the predetermined requirements. If the duty ratio of the PWM wave does not satisfy the predetermined requirements, a step S18 of adjusting the duty ratio of the PWM wave is performed so as to ensure the reliability of the PWM wave.

The device for detecting PWM wave according to an embodiment of the present disclosure will be described below.

According to the embodiment of the present disclosure, as shown in Figs. 2 and 3, the device 1 may comprise: a PWM wave generating module 11, a detecting module 12, a timer 13 and a calculating module 14.

The PWM wave generating module 11 is configured to generate a PWM wave. The detecting module 12 is coupled to the PWM wave generating module 11 and configured to receive the PWM wave generated by the PWM wave generating module 11 and to determine electric level of the PWM wave.

The timer 13 is coupled to the detecting module 12 and configured to start counting when the detecting module 12 receives the PWM wave and to interrupt the counting when a value of the counting reaches a predetermined value.

During the interruption, the detecting module 12 determines whether the electric level of the PWM wave is high electric level or low electric level and records the high electric level or low electric level.

The calculating module 14 is coupled to the detecting module 12 and configured to calculate a duty ratio of the PWM wave based on a number of high electric level and a number of low electric level of the PWM wave determined and recorded within one period of the PWM wave.

In some embodiments, the duty ratio M of the PWM wave is calculated by the formal: $M = P_h / (P_h + P_l)$, where P_h is the number of high electric level determined within one period of the PWM wave and P_l is the number of low electric level determined within one period of the

PWM wave.

In another embodiment of the present disclosure, the device may further comprise a judging module 15. The judging module 15 is coupled to the calculating module 14 and configured to judge whether the duty ratio of the PWM wave satisfies predetermined requirements so as to adjust the PWM wave if the duty ratio of the PWM wave does not satisfy the predetermined requirements. The device 1 may be connected to a battery heating module 2, as shown in Figs. 2 and 3, the PWM wave may be sent to the battery heating module 2 if the duty ratio of the PWM wave satisfies predetermined requirements.

In an example as shown in Fig. 3, the PWM wave generating module 11, the detecting module 12, the timer 13, and the calculating module 14 are all incorporated into a MCU (micro control unit) 1. The MCU 1 may have a fixed end to output the generated PWM wave, and the other ends may be served as the feedback input end to receive the PWM wave and determine the electric level of the PWM wave. As shown in Fig.3, the port P0.1 of the MCU 1 may be used as an output port to output the PWM wave, the port P0.2 of the MCU 1 may be used as an input port. The port P0.1 for outputting the PWM wave may be coupled to the input port P0.2 of the MCU 1 by a transmission line.

When the MCU 1 starts to operate, the port P0.1 starts to output the high electric level or low electric level with a fixed period and duty ratio, as shown in Fig.4, the electric level of the port P0.2 may be high electric level or low electric level. Furthermore, when the MCU 1 starts to operate, a counter in the timer 13 also starts counting, when the value of the counting reaches the predetermined value, the timer 13 interrupts the counting. During the interruption, the electric level of the port P0.2 is determined and recorded. After the recording of the electric level, the counter is reset to count again.

In some embodiments, the predetermined value may be determined based on a bus time of the MCU 1 and a frequency division value of the timer. If the bus clock rate of the MCU 1 is 48M (that is, 1/48000000 S), the frequency division value of the timer is zero (that is, there is no frequency division), the predetermined value may be 4800, in other words, the interval time between adjacent interruptions is 0.1ms. It should be appreciated that the present disclosure is not limited to the above example. A skilled person in the art may change the predetermined value as long as it is integer times of the bus clock rate of the MCU1, such as 9600 or 2400 etc. But it should be understood that the smaller the predetermined value, the larger number of electric level is, thereby the duty ratio calculated may be more accurate.

For example, supposing the period of the PWM wave is 20ms, the predetermined value is 4800, that is, the timer interrupts the counting per 0.1ms, within one period T, the electric level at the port P0.2 is recorded for 200 times. As shown in Figs.5 and 6, the black points represent the state of the electric level state, in which the high electric level is recorded for 50 times, and the

low electric level is recorded for 150 times, that is, in one period, the high electric level at the port P0.2 is 5ms, the low electric level at the port P0.2 is 15ms, thereby the duty ratio of the PWM wave is 200 divided by 50.

The present disclosure can accurately calculate the duty ratio of the PWM wave according to the number of high electric level and the number of low electric level determined and recorded within one period of the PWM wave. If the duty ratio of the PWM wave does not satisfy the predetermined requirements, the PWM wave will be adjusted to satisfy the requirements, so as to ensure the reliability of the PWM wave, thus avoid occurring of accidents.

Although explanatory embodiments have been shown and described, it would be appreciated by those skilled in the art that changes, alternatives, and modifications can be made in the embodiments without departing from spirit and principles of the disclosure. Such changes, alternatives, and modifications all fall into the scope of the claims and their equivalents.

WHAT IS CLAIMED IS:

1. A method for detecting PWM wave, comprising:

(a) starting counting when a PWM wave is detected;

(b)interrupting the counting when a value of the counting reaches a predetermined value;

(c) determining whether electric level of the PWM wave during the interruption is high electric level or low electric level;

(d) clearing the value of the counting, starting a next counting and interrupting the next counting when a value of the next counting reaches the predetermined value;

(e) determining whether the electric level of the PWM wave during the interruption of the next counting is high electric level or low electric level;

(f) repeating steps (d) and (e) until one period of the PWM wave; and

(g) calculating a duty ratio of the PWM wave based on a number of high electric level and a number of low electric level determined within one period of the PWM wave.

2. The method of claim 1, further comprising:

judging whether the duty ratio of the PWM wave satisfies predetermined requirements; and

adjusting the PWM wave if the duty ratio of the PWM wave does not satisfy the predetermined requirements.

3. The method of claim 1, wherein the duty ratio M of the PWM wave is calculated by a formula: $M = P_h / (P_h + P_l)$, where P_h is the number of high electric level determined within one period of the PWM wave and P_l is the number of low electric level determined within one period of the PWM wave.

4. A device for detecting PWM wave, comprising:

a PWM wave generating module configured to generate a PWM wave;

a detecting module coupled to the PWM wave generating module and configured to receive the PWM wave and determine electric level of the PWM wave;

a timer coupled to the detecting module and configured to start counting when the detecting module receives the PWM wave and interrupt the counting when a value of the counting reaches a predetermined value, in which the detecting module determines whether the electric level of the PWM wave during the interruption is high electric level or low electric level; and

a calculating module coupled to the detecting module and configured to calculate a duty ratio of the PWM wave based on a number of high electric level and a number of low electric level of the PWM wave determined within one period of the PWM wave.

5. The device of claim 4, further comprising a judging module coupled to the calculating module and configured to judge whether the duty ratio of the PWM wave satisfies predetermined requirements and to adjust the PWM wave if the duty ratio of the PWM wave does not satisfy the

predetermined requirements.

6. The device of claim 4, wherein the calculating module calculates the duty ratio of the PWM wave by a formula: $M = P_h / (P_h + P_l)$, where P_h is the number of high electric level determined within one period of the PWM wave and P_l is the number of low electric level determined within one period of the PWM wave.

7. The device of claim 4, wherein the PWM wave generating module, the detecting module, the timer, and the calculating module are incorporated into a MCU.

8. The device of claim 7, wherein an interval time between adjacent interruptions of the timer is determined based on a bus time of the MCU and a frequency division value of the timer.

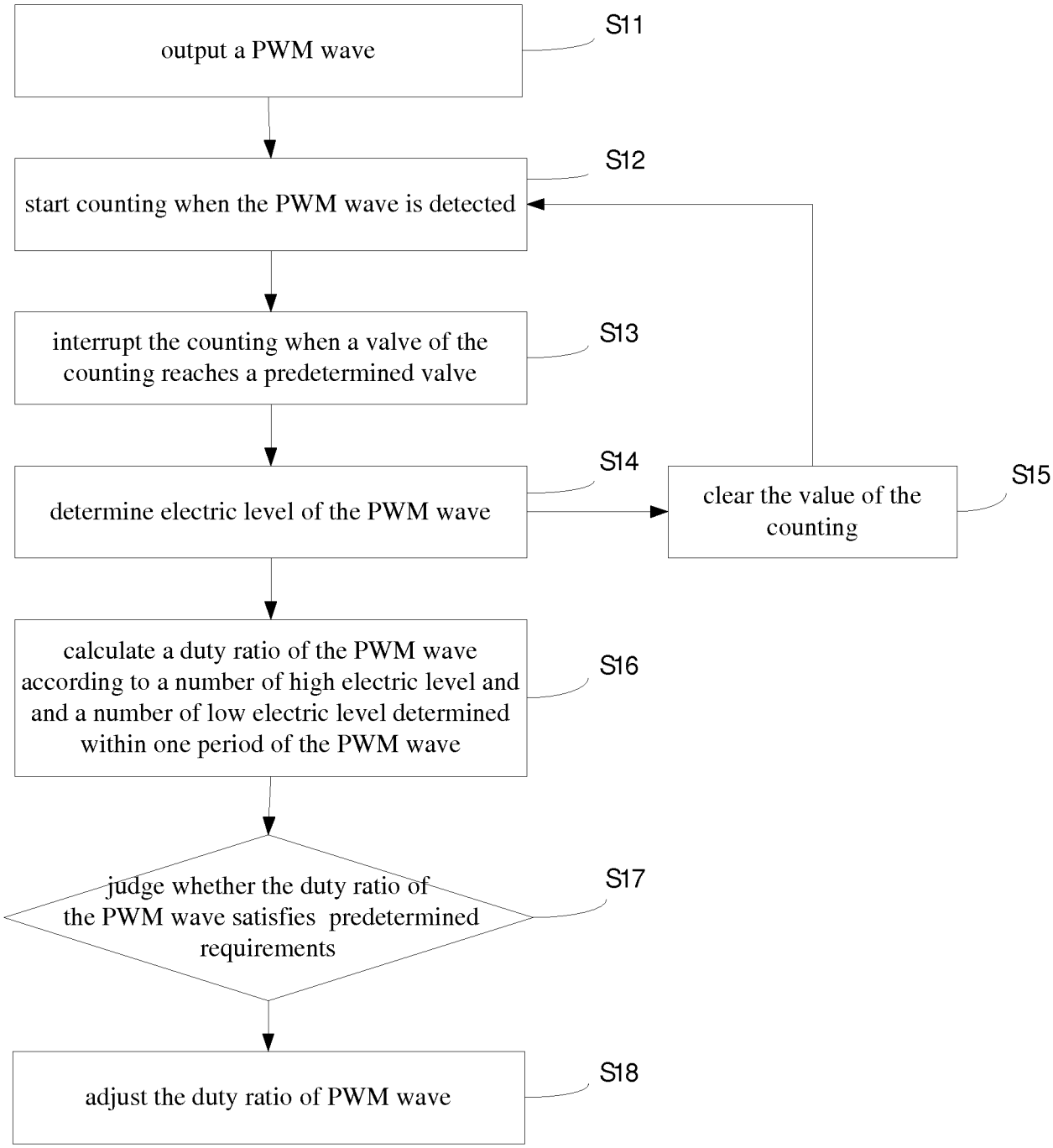

output a PWM wave
S11
start counting when the PWM wave is detected
S12
interrupt the counting when a valve of the counting reaches a predetermined valve
S13
determine electric level of the PWM wave
S14
clear the value of the counting
S15
calculate a duty ratio of the PWM wave according to a number of high electric level and and a number of low electric level determined within one period of the PWM wave
S16
judge whether the duty ratio of the PWM wave satisfies predetermined requirements
S17
adjust the duty ratio of PWM wave
S18

Fig. 1

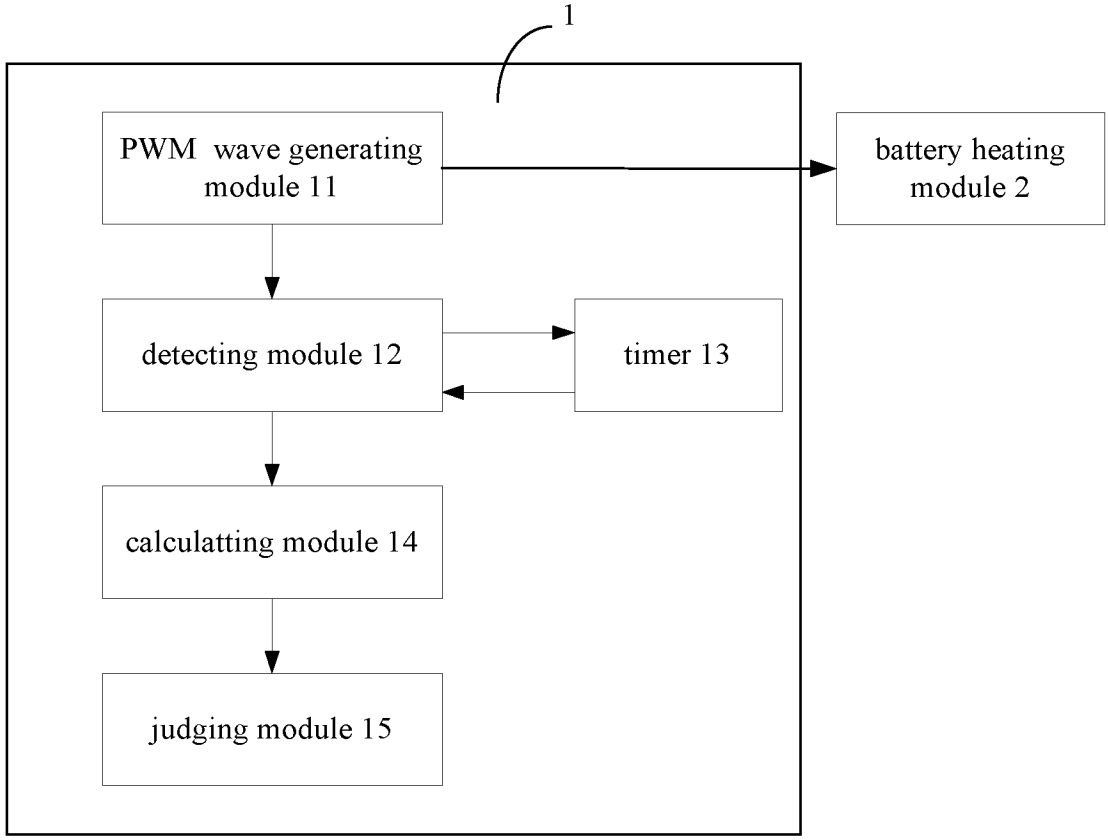


Fig. 2

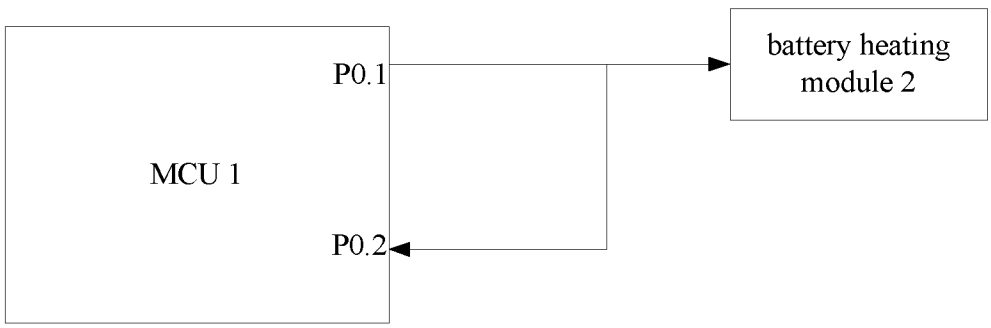


Fig. 3

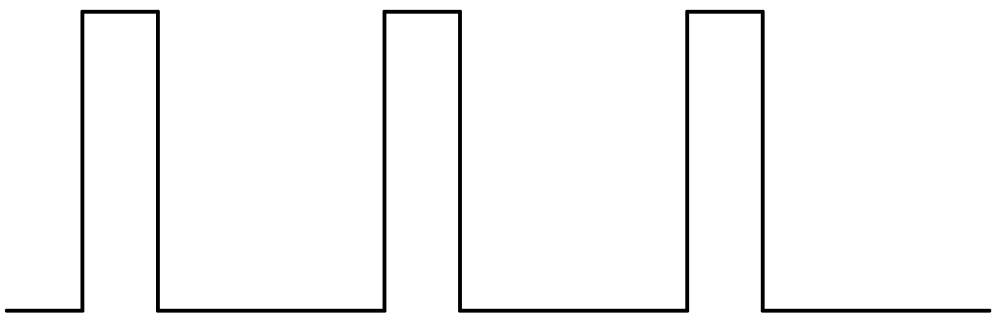


Fig. 4

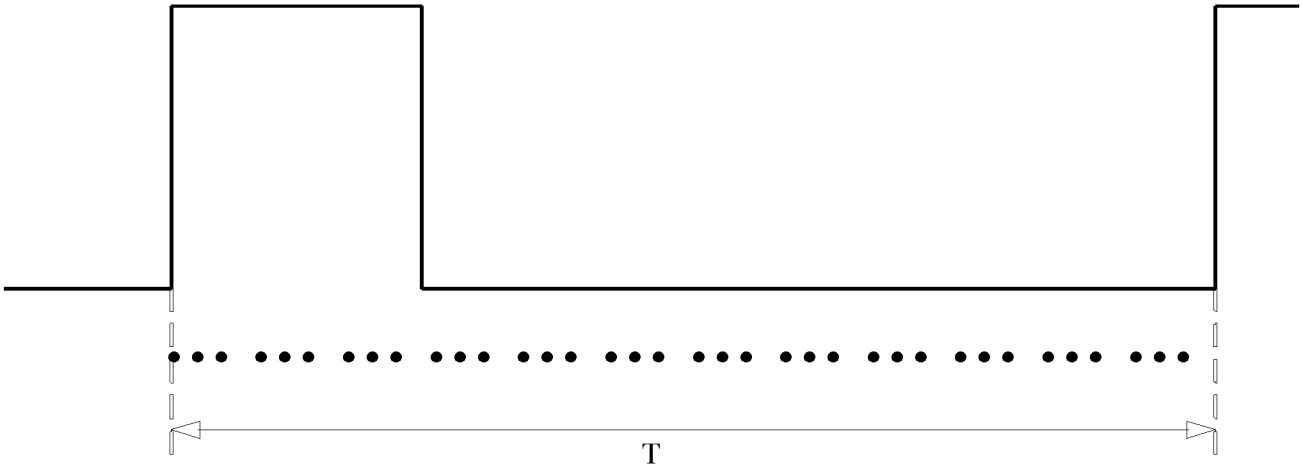


Fig.5

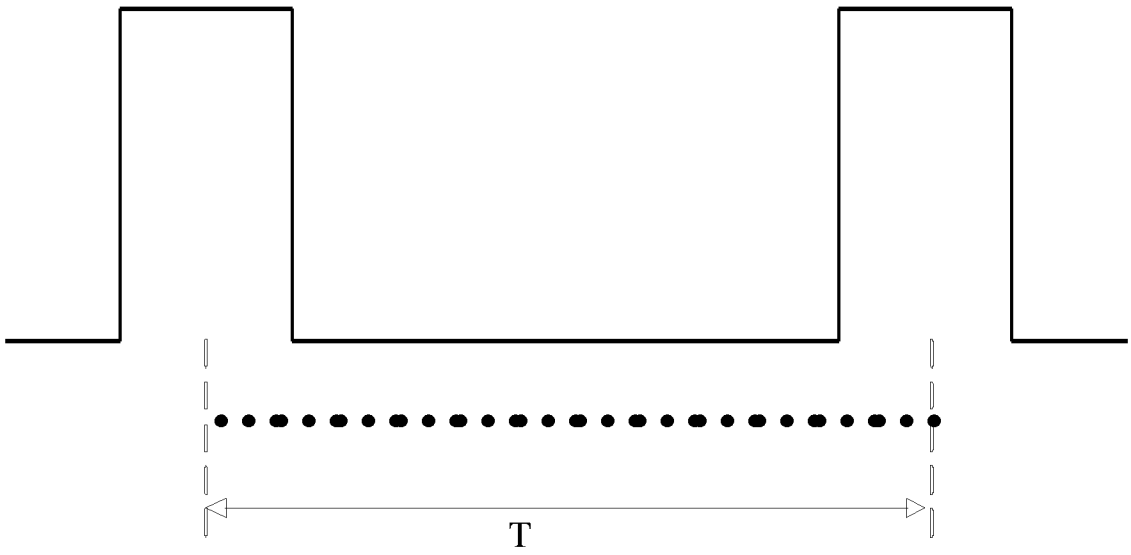


Fig.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2010/080050

A. CLASSIFICATION OF SUBJECT MATTER

G01R29/02 (2006.01) i

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)

G01R29/-,H03K5/19

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, CNPAT, CNKI: duty 2d (ratio? or cycle?), count+, tim+, interrupt+, PWM, pulse w width w modulat+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP10038907A (DENSO CORP. et al.) 13 February 1998 (13.02.1998)	1-3
Y	paragraphs [0020]-[0039]; figures 1-3	4-8
Y	US2009/0102514A1 (HSU Lu Yueh) 23 April 2009 (23.04.2009) paragraphs [0017]-[0019]; figures 1, 4	4-8
A	US2005/0225351A1 (CHEN Tseng Wen et al.) 13 October 2005 (13.10.2005) paragraphs [0019]-[0022]; figure 1	1-8
A	JP57208473A (GEN CORP.) 21 December 1982 (21.12.1982) Full text	1-8
A	JP57208474A (GEN CORP.) 21 December 1982 (21.12.1982) Full text	1-8

☐ 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
25 February, 2011 (25.02.2011)	**31 Mar. 2011 (31.03.2011)**
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 CHU, Pengjiao Telephone No. (86-10)62414180

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2010/080050

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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