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Inventor(s)	Kim; Kyusik et al.

Electronic device and controlling method thereof

Abstract

Provided is an electronic device and method for controlling the same, which controls an operation by detecting a voltage between a plurality of live terminals and thus determining whether there is an error in supplying power through a power input terminal. According to an embodiment, an electronic device includes a power input terminal including a plurality of live terminals and a neutral terminal; a voltage detection circuit connected between the plurality of live terminals for detecting a voltage between the plurality of live terminals; and a controller configured to control operation of the electronic device to be interrupted in response to a magnitude of the voltage between the plurality of live terminals smaller than a threshold.

Inventors: Kim; Kyusik (Suwon-si, KR), Gu; Hyeongmo (Suwon-si, KR), Lee; Jangwoo (Suwon-si, KR)

Applicant: SAMSUNG ELECTRONICS CO., LTD. (Suwon-si, KR)

Family ID: 1000008762416

Assignee: SAMSUNG ELECTRONICS CO., LTD. (Suwon-si, KR)

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Primary Examiner: Retebo; Metasebia T

Attorney, Agent or Firm: STAAS & HALSEY LLP

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of International Application PCT/KR2021/006440, filed May 24, 2021, and claims foreign priority to Korean application 10-2020-0089518, filed Jul. 20, 2020, which are both incorporated herein by reference in their entireties.

BACKGROUND**1. Field**

(1) The disclosure relates to an electronic device having a plurality of live terminals and a neutral terminal as a power input terminal and method for controlling the electronic device.

2.Description of Related Art

(2) In a case of electronic devices having 3-wired or 4-wired power specifications, power may be supplied by connecting the power wires to terminals of a product. The electronic device includes an electric component (e.g., a motor, a lamp, or a pump) having a rated voltage of 120 V and an electric component (e.g., a heater) having a rated voltage of 240 V, and when the power wire is wrongly connected to the terminal, 240 V may be applied to the electric component having the rated voltage of 120 V, causing damage by fire and ignition or causing malfunction as the rated voltage of 240 V is not applied to the corresponding electric component.

(3) An overvoltage detection circuit is added to the traditional electronic device to prevent damage by fire of an electric component when an overvoltage is applied in relation to a power specification of the electric component. The overvoltage detection circuit may detect an overvoltage caused by wrong connection of the power wire, but has a limitation in that no connection of the power wire or no application of power from an outlet may not be detected.

SUMMARY

(4) According to an embodiment of the disclosure, an electronic device includes a power input terminal including a first live terminal, a second live terminal, and a neutral terminal; a voltage detection circuit connected between the first live terminal and the second live terminal to detect a voltage between the first live terminal and the second live terminal; and a controller configured to control operation of the electronic device to be interrupted in response to a magnitude of the detected voltage being smaller than a threshold.

(5) According to an embodiment of the disclosure, the voltage detection circuit is configured to output a square wave by half-rectifying the detected voltage in response to the magnitude of the detected voltage being equal to or greater than the threshold.

(6) According to an embodiment of the disclosure, wherein the controller is configured to control

the electronic device to be operated in response to the voltage detection circuit outputting the square wave.

(7) According to an embodiment of the disclosure, the controller is configured to control operation of the electronic device to be interrupted in response to the voltage detection circuit outputting no square wave.

(8) According to an embodiment of the disclosure, the electronic device further includes a first electric component connected between the first live terminal and the second live terminal; a second electric component connected between the first live terminal and the neutral terminal; a first relay connected in series with the first electric component; and a second relay connected in series with the second electric component, wherein the controller is configured to control the first relay and the second relay to be turned off in response to the magnitude of the detected voltage being smaller than the threshold.

(9) According to an embodiment of the disclosure, the threshold is determined as a value between an error range of the voltage between the first live terminal and the second live terminal in normal connection of power wires and an error range of a voltage between the first live terminal and the neutral terminal in normal connection of the power wires.

(10) According to an embodiment of the disclosure, the electronic device further includes a display, wherein the controller is configured to control the display to display a message indicating that there is an error in supplying power through the power input terminal in response to the magnitude of the detected voltage being smaller than the threshold.

(11) According to an embodiment of the disclosure, the electronic device further includes a speaker, wherein the controller is configured to control the speaker to output a sound of notification indicating that there is an error in supplying power through the power input terminal in response to the magnitude of the detected voltage being smaller than the threshold.

(12) According to an embodiment of the disclosure, a method is provided of controlling an electronic device including a power input terminal having a first live terminal, a second live terminal, and a neutral terminal, the method includes detecting a voltage between the first live terminal and the second live terminal by a voltage detecting circuit connected between the first live terminal and the second live terminal; comparing a magnitude of the detected voltage with a threshold; and controlling operation of the electronic device to be interrupted in response to the magnitude of the detected voltage being smaller than the threshold.

(13) According to an embodiment of the disclosure, the voltage detection circuit is configured to output a square wave by half-rectifying the detected voltage in response to the magnitude of the detected voltage being equal to or greater than the threshold.

(14) According to an embodiment of the disclosure, the method further includes controlling the electronic device to be operated in response to the voltage detection circuit outputting the square wave.

(15) According to an embodiment of the disclosure, the controlling of the operation of the electronic device to be interrupted includes controlling the operation of the electronic device to be interrupted in response to the voltage detection circuit outputting no square wave.

(16) According to an embodiment of the disclosure, the electronic device includes a first electric component connected between the first live terminal and the second live terminal; a second electric component connected between the first live terminal and the neutral terminal; a first relay connected in series with the first electric component; and a second relay connected in series with the second electric component, wherein the controlling of the operation of the electronic device to be interrupted includes controlling the first relay and the second relay to be turned off in response to the magnitude of the detected voltage being smaller than the threshold.

(17) According to an embodiment of the disclosure, the threshold is determined as a value between an error range of the voltage between the first live terminal and the second live terminal in normal connection of power wires and an error range of a voltage between the first live terminal and the

neutral terminal in normal connection of the power wires.

(18) According to an embodiment of the disclosure, the electronic device includes a display, and the method further includes controlling the display to display a message indicating that there is an error in supplying power through the power input terminal in response to the magnitude of the detected voltage being smaller than the threshold.

(19) Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The above and other aspects, features, and advantages of certain embodiments of the present disclosure will be more apparent from the following description taken in conjunction with the accompanying drawings, in which

(2) FIG. 1 illustrates a power input terminal equipped in an electronic device, according to an embodiment.

(3) FIG. 2 is a diagram for describing a connection relation between an electric component and a power input terminal in an electronic device, according to an embodiment.

(4) FIG. 3 is a control block diagram of an electronic device, according to an embodiment.

(5) FIG. 4 is a circuit diagram of an electronic device, according to an embodiment.

(6) FIG. 5 is a circuit diagram of a voltage detection circuit, according to an embodiment.

(7) FIG. 6 is a diagram for describing a threshold of a voltage detection circuit, according to an embodiment.

(8) FIGS. 7 and 8 are diagrams for describing outputs of a voltage detection circuit, according to an embodiment.

(9) FIG. 9 is a diagram for describing an occasion when an electronic device displays a message, according to an embodiment.

(10) FIG. 10 is a flowchart of a case of detecting an error in supplying power through a power input terminal in a method of controlling an electronic device, according to an embodiment.

DETAILED DESCRIPTION

(11) Embodiments and features as described and illustrated in the disclosure are merely examples, and there may be various modifications replacing the embodiments and drawings at the time of filing this application.

(12) It will be further understood that the term “connect” or its derivatives refer both to direct and indirect connection, and the indirect connection includes a connection over a wireless communication network.

(13) The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the disclosure. It is to be understood that the singular forms “a,” “an,” and “the” include plural references unless the context clearly dictates otherwise. It will be further understood that the terms “comprise” and/or “comprising,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

(14) The terms including ordinal numbers like “first” and “second” may be used to explain various components, but the components are not limited by the terms. The terms are only for the purpose of distinguishing a component from another. Thus, a first element, component, region, layer or room discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the disclosure.

(15) Furthermore, the terms, such as “— part”, “— block”, “— member”, “— module”, etc., may

refer to a unit of handling at least one function or operation. For example, the terms may refer to at least one process handled by hardware such as field-programmable gate array (FPGA)/application specific integrated circuit (ASIC), etc., software stored in a memory, or at least one processor.

(16) Reference numerals used for method steps are just used to identify the respective steps, but not to limit an order of the steps. Thus, unless the context clearly dictates otherwise, the written order may also be practiced otherwise.

(17) According to various embodiments of the disclosure, provided is an electronic device and method for controlling the same, which controls an operation by detecting a voltage between a plurality of live terminals and thus determining whether there is an error in supplying power through a power input terminal.

(18) According to various embodiments of the disclosure, an electronic device and method for controlling the same may prevent damage by fire and ignition of an electric component or malfunction of an electric component by detecting a voltage between a plurality of live terminals and determining whether there is an error in supplying power through a power input terminal.

(19) Reference will now be made in detail to embodiments of the disclosure, which are illustrated in the accompanying drawings.

(20) FIG. 1 illustrates a power input terminal equipped in an electronic device, according to an embodiment. FIG. 2 is a diagram for describing a connection relation between an electric component and a power input terminal in an electronic device, according to an embodiment.

(21) Referring to FIGS. 1 and 2, an electronic device **1** according to an embodiment may include a power input terminal **10** connected to a power wire **20**. The electronic device **1** may receive power from an external power source (not shown) through the power input terminal **10** connected to the power wire **20**. In other words, the power wire **20** may connect an outlet (not shown) to the power input terminal **10**.

(22) The power input terminal **10** may be arranged in a housing of the electronic device **1**, and may include a plurality of live terminals **10a** and **10c** and a neutral terminal **10b**. Specifically, the power input terminal **10** may include the first live terminal (L1 terminal) **10a**, the neutral terminal (N terminal) **10b** and the second live terminal (L2 terminal) **10c**.

(23) In general, power wires **20a** and **20c** for inputting a voltage of 120 V may be connected to the plurality of live terminals **10a** and **10c**, and a neutral line **20b** may be connected to the neutral terminal **10b**. In this case, the voltage input from the first power wire **20a** connected to the first live terminal **10a** is 180 degrees out of phase with a voltage input from the second power wire **20c** connected to the second live terminal **10b**. With this, an alternate current (AC) voltage of 120 V may be applied between the live terminals **10a** and **10c** and the neutral terminal **10b**, and an AC voltage of 240 V may be applied between the plurality of live terminals **10a** and **10c**.

(24) In this case, a first electric component **30** of the electronic device **1** may be arranged between the first live terminal **10a** and the second live terminal **10c** and receive a voltage between the first live terminal **10a** and the second live terminal **10c**, and a second electric component **40** may receive a voltage between the first live terminal **10a** and the neutral terminal **10b**.

(25) That is, a rated voltage of the first component **30** may be 240 V, and a rated voltage of the second component **40** may be 120 V. Hence, the power wires **20a** and **20c** for inputting an AC voltage of 120 V may be connected to the first live terminal **10a** and the second live terminal **10c**, and the neutral line **20b** may be connected to the neutral terminal **10b**, so that the rated voltages may be applied to the first electric component **30** and the second electric component **40**, respectively.

(26) For example, the electronic device **1** may be a dryer with the first electric component **30** being a heater having a rated voltage of 240 V and the second electric component **40** being a motor, a lamp, a pump, or the like having the rated voltage of 120 V.

(27) For example, the electronic device **1** may be a cooking device with the first electric component **30** being a heater having a rated voltage of 240 V and the second electric component **40** being a

motor, a lamp, or the like having the rated voltage of 120 V.

(28) The electronic device **1** is not limited to having the above types, and the electronic device **1** may be any type of electronic device that includes an electric component having a rated voltage of 240 V and an electric component having a rated voltage of 120 V and receives power through live terminals and a neutral terminal without limitations.

(29) In this case, when the power input terminal **10** and the power wire **20** are connected without any errors, a rated voltage may be applied to each of the first electric component **30** and the second electric component **40**.

(30) When the power input terminal **10** and the power wire **20** are wrongly connected, a wrong rated voltage or no voltage may be applied to each of the first electric component **30** and the second electric component **40**.

(31) Specifically, when the neutral line **20b** is connected to other terminal than the neutral terminal **10b**, at least one of the first electric component **30** and the second electric component **40** fails to receive the rated voltage and may thus be damaged by fire or may have a degraded output.

(32) For example, when the second live terminal **10c** is not connected to the second power wire **20c** (no connection) or when the second live terminal **10c** is connected to the neutral line **20b** instead of the second power wire **20c** (wrong connection), the output of the first electric component **30** may be degraded because no rated voltage is applied to the first electric component **30** and an error in function (e.g., drying course) of the first electric component **30** may occur.

(33) Furthermore, even when the second live terminal **10c** is connected to the second power wire **20c**, but when a voltage of 240 V is not applied because the interior wiring in the place where the electronic device **1** is installed has a two-wire type, no voltage is applied to the first electric component **30** so that the first electric component **30** is not operated and an error in function (e.g., a drying course) of the first electric component **30** may occur.

(34) Accordingly, in an embodiment, the electronic device **1** detects a voltage between the plurality of live terminals **10a** and **10c** and determines an error in supplying power through the power input terminal **10**, thereby preventing damage by fire and ignition of the electric components **30** and **40** and malfunction of the electric components **30** and **40**. How to determine an error in supplying power through the power input terminal **10** will now be described in detail.

(35) FIG. 3 is a control block diagram of the electronic device **1**, according to an embodiment, and FIG. 4 is a circuit diagram of the electronic device **1**, according to an embodiment.

(36) Referring to FIGS. 3 and 4, in an embodiment, the electronic device **1** includes a voltage detection circuit **110** for detecting a voltage between the plurality of live terminals **10a** and **10c**, a storage **120** for storing various information required for control, an input **130** for receiving an input from the user, a controller **140** for controlling an operation of the electronic device **1** by determining an error in connection of the power wire **20** based on the voltage between the plurality of live terminals **10a** and **10c**, a first relay **150** for controlling supplying power to the first electric component **30**, a second relay **160** for controlling supplying power to the second electric component **40**, a display **170** for displaying an error in supplying power, and a speaker **180** for outputting a sound of notification corresponding to the error in supplying power.

(37) At least one component may be added to or omitted from the electronic device **1** to correspond to the performance of the electronic device **130** as shown in FIG. 3. Furthermore, it will be obvious to those of ordinary skill in the art that the relative positions of the components may be changed to correspond to the system performance or structure.

(38) In an embodiment, the voltage detection circuit **110** is a circuit for detecting a voltage between the plurality of live terminals **10a** and **10c**. For this, the voltage detection circuit **110** may be connected to the first live terminal **10a** and the second live terminal **10c**.

(39) Specifically, the voltage detection circuit **110** may output a square wave of a voltage by half-rectifying a voltage between the first live terminal **10a** and the second live terminal **10c** (L1-L2 voltage). The voltage detection circuit **110** may then send the square wave of the electric signal to

the controller **140** through an insulating element.

(40) In this case, the voltage detection circuit **110** may output the square wave of the voltage when the voltage between the first live terminal **10a** and the second live terminal **10c** is equal to or higher than a threshold. On the other hand, the voltage detection circuit **110** may not output the square wave of the voltage when the voltage between the first live terminal **10a** and the second live terminal **10c** is lower than the threshold.

(41) The threshold is to identify an occasion when the first power wire **20a** and the second power wire **20c** are connected to the first live terminal **10a** and the second live terminal **10c**, respectively, and a voltage is applied to each power wire **20a** or **20c**, and may be determined to be a value between an error range (e.g., $\pm 15\%$) of the voltage between the first live terminal **10a** and the second live terminal **10c** in normal connection of the power wire **20** and an error range (e.g., $\pm 30\%$) of the voltage between the first live terminal **10a** and the neutral terminal **10b** in normal connection of the power wire **20**.

(42) For example, the voltage detection circuit **110** may output a square wave of a voltage when the voltage between the first live terminal **10a** and the second live terminal **10c** corresponds to 240 V, which corresponds to a rated voltage of the first electric component **30**, and may not output a square wave of a voltage when the voltage between the first live terminal **10a** and the second live terminal **10c** corresponds to 120 V that falls short of the rated voltage of the first electric component **30**.

(43) Configuration and operation of the voltage detection circuit **110** will be described in detail in connection with FIG. 5.

(44) In an embodiment, the storage **120** may store various information required for control and may be implemented as a known type of storage medium.

(45) For example, the storage **120** may store information about a correlation between an output of the voltage detection circuit **110** and operation of the relay **150** or **160**, information about a correlation between an output of the voltage detection circuit **110** and operation of the display **170**, information about a correlation between an output of the voltage detection circuit **110** and operation of the speaker **180**, etc.

(46) In an embodiment, the input **130** may receive a user input related to an operation of the electronic device **1** from the user, and output an electric signal (voltage or current) corresponding to the received user input to the controller **140**.

(47) The input **130** may include a plurality of buttons arranged on the housing. For example, the input **130** may include a power button to power on the electronic device **1**, a mode selection button to select an operation mode, an operation start/stop button to command start and stop of operation, an option selection button to select an option of operation, etc.

(48) The plurality of buttons may include a membrane switch, a push switch activated by the pressure of the user, or a touch switch activated by a touch of a body part of the user.

(49) The input **130** may include a remote controller provided separately from the electronic device **1** and a receiver for receiving a radio signal from the remote controller. Similar to the housing, the remote controller may include a plurality of buttons.

(50) In an embodiment, the controller **140** may identify a magnitude of the voltage between the plurality of live terminals **10a** and **10c** based on the output of the voltage detection circuit **110**. Specifically, the controller **140** may determine that the voltage between the plurality of live terminals **10a** and **10c** is equal to or higher than the threshold when the voltage detection circuit **110** outputs a square wave. Furthermore, the controller **140** may determine that the voltage between the plurality of live terminals **10a** and **10c** is lower than the threshold when the voltage detection circuit **110** outputs no square wave.

(51) In an embodiment, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is equal to or greater than the threshold when the voltage detection circuit **110** outputs a square wave, and control the electronic device **1** to be

operated. For example, the controller **140** may control the first relay **150** and the second relay **160** to be turned on, so that voltages may be applied to the first electric component **30** and the second electric component **40**.

(52) In an embodiment, the controller **140** may control the operation of the electronic device **1** to be interrupted when the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold.

(53) Specifically, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold when the voltage detection circuit **110** outputs no square wave, and interrupt the operation of the electronic device **1**. For example, the controller **140** may control the first relay **150** and the second relay **160** to be turned off not to apply any voltage to the first electric component **30** and the second electric component **40**.

(54) In an embodiment, the controller **140** may control the display **170** to display a message indicating that there is an error in supplying power through the power input terminal **10** when the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold.

(55) In an embodiment, the controller **140** may control the speaker **180** to output a sound of notification indicating that there is an error in supplying power through the power input terminal **10** when the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold.

(56) The controller **140** may include at least one memory for storing a program for carrying out the aforementioned and following operations, and at least one processor for executing the program. In a case that the memory and the processor are each provided in the plural, they may be integrated in a single chip or physically distributed.

(57) In an embodiment, the first relay **150** may be arranged between the first live terminal **10a** and the second live terminal **10c** to be connected in series with the first electric component **30**. With this, the first relay **150** may be turned on or off to control supplying a voltage between the first live terminal **10a** and the second live terminal **10c** to the first electric component **30**.

(58) Specifically, when the first relay **150** is turned on, the voltage between the first live terminal **10a** and the second live terminal **10c** may be applied to the first electric component **30**, and when the first relay **150** is turned off, application of the voltage between the first live terminal **10a** and the second live terminal **10c** to the first electric component **30** may be interrupted.

(59) In an embodiment, the second relay **160** may be arranged between the first live terminal **10a** and the neutral terminal **10b** to be connected in series with the second electric component **40**. With this, the second relay **160** may be turned on or off to control supplying a voltage between the first live terminal **10a** and the neutral terminal **10b** to the second electric component **40**.

(60) Specifically, when the second relay **160** is turned on, the voltage between the second live terminal **10a** and the neutral terminal **10b** may be applied to the second electric component **40**, and when the second relay **160** is turned off, application of the voltage between the first live terminal **10a** and the neutral terminal **10b** to the second electric component **40** may be interrupted.

(61) In an embodiment, the display **170** may display a message indicating that there is an error in supplying power through the power input terminal **10** when the voltage between the plurality of live terminals **10a** and **10c** is lower than the threshold, under the control of the controller **140**.

(62) For this, the display **170** may include a known type of display panel and may be arranged on the front of the housing.

(63) In an embodiment, the speaker **180** may output a sound of notification indicating that there is an error in supplying power through the power input terminal **10** when the voltage between the plurality of live terminals **10a** and **10c** is lower than the threshold, under the control of the controller **140**.

(64) In this case, the voltage detection circuit **110**, the storage **120**, the controller **140**, the first relay

150 and the second relay **160** may be arranged on a single printed circuit board (PCB) **400** as shown in FIG. **4**. In another embodiment, however, the voltage detection circuit **110**, the storage **120**, the controller **140**, the first relay **150** and the second relay **160** may be divided onto a plurality of PCBs, which may be electrically connected to one another.

(65) Furthermore, the voltage detection circuit **110** may be connected to the first live terminal **10a** and the second live terminal **10c**. Moreover, the first relay **150** may be arranged between the first live terminal (L1 terminal) **10a** and the second live terminal (L2 terminal) **10c** and connected in series with the first electric component **30**. In addition, the second relay **160** may be arranged between the first live terminal (L1 terminal) **10a** and the neutral terminal (L2 terminal) **10b** and connected in series with the second electric component **40**.

(66) Control configuration and circuit configuration of the electronic device **1** have thus far been described. How the voltage detection device **110** detects a voltage between the plurality of live terminals **10a** and **10c** will now be described in detail.

(67) FIG. **5** is a circuit diagram of the voltage detection circuit **110**, according to an embodiment, FIG. **6** is a diagram for describing a threshold of the voltage detection circuit **110**, according to an embodiment, and FIGS. **7** and **8** are diagrams for describing outputs of the voltage detection circuit **110**, according to an embodiment.

(68) Referring to FIG. **5**, in an embodiment, the voltage detection circuit **110** may include a first link connector **510** connected to the first live terminal (L1 terminal) **10a** and a second link connector **520** connected to the second live terminal (L2 terminal) **10c**. With this, the voltage detection circuit **110** may receive a voltage input from the power wire **20** connected to the first live terminal **10a** and a voltage input from the power wire **20** connected to the second live terminal **10c**.

(69) Furthermore, the voltage detection circuit **110** may include an input resistor **530** to reduce current and voltage values of an electric signal of the input power by a preset value.

(70) Moreover, the voltage detection circuit **110** may include a photo coupler **540**, which is an element for transmitting the electric signal of the power in light and may be implemented with a light emitting diode (LED) and a transistor. An insulating material may be included between the LED and the transistor. The photo coupler **540** may output a square wave V_{out} by half-rectifying the electric signal of the power.

(71) Furthermore, the voltage detection circuit **110** may further include a low pass filter **550** that is able to eliminate high frequency components of the square wave in an embodiment.

(72) The type and number of elements that make up the voltage detection circuit **110** shown in FIG. **5** are merely an example, but are sure to be variously implemented.

(73) As described above, the voltage detection circuit **110** may receive a voltage at the first live terminal (L1 terminal) **10a** and a voltage at the second live terminal (L2 terminal) **10c**, and the voltage (L1-L2 voltage) between the first live terminal **10a** and the second live terminal **10c** reduced by the input resistor **530** may be applied to the photo coupler **540**.

(74) In this case, only when the voltage between the first live terminal **10a** and the second live terminal **10c** (L1-L2 voltage) reduced by the input resistor **530** is equal to or higher than a threshold voltage of the LED of the photo coupler **540**, light is emitted from the LED of the photo coupler **540**, turning on the transistor to output a square wave. Specifically, when the voltage between the first live terminal **10a** and the second live terminal **10c** (L1-L2 voltage) reduced by the input resistor **530** is lower than the threshold voltage of the LED of the photo coupler **540**, light is not emitted from the LED of the photo coupler **540** and no square wave is output.

(75) A resistor value of the input resistor **530** may be set based on the threshold voltage of the LED of the photo coupler **540** so that the voltage detection circuit **110** outputs the square wave only when the voltage between the first live terminal **10a** and the second live terminal **10c** (L1-L2 voltage) corresponds to a voltage in normal connection.

(76) In other words, the resistor value of the input resistor **530** may be set for the LED of the photo coupler **540** to emit light when the voltage between the first live terminal **10a** and the second live

terminal **10c** (L1-L2 voltage) is equal to or higher than the threshold.

(77) The threshold is to identify an occasion when the first power wire **20a** and the second power wire **20c** are connected to the first live terminal **10a** and the second live terminal **10c**, respectively, and voltages are applied to the respective power wires **20a** and **20c**.

(78) For this, as shown in FIG. 6, the threshold may be determined to be a value V_c between an error range ($V1 \sim V2$) of the voltage between the first live terminal **10a** and the neutral terminal **10b** in normal connection of the power wire **20** and an error range ($V3 \sim V4$) of the voltage between the first live terminal **10a** and the second live terminal **10c** in normal connection of the power wire **20**. In other words, the value V_c between the highest value $V2$ of the error range ($V1 \sim V2$) of the voltage between the first live terminal **10a** and the neutral terminal **10b** in normal connection of the power wire **20** and the lowest value $V3$ of the error range ($V3 \sim V4$) of the voltage between the first live terminal **10a** and the second live terminal **10c** in normal connection of the power wire **20** may be determined as the threshold.

(79) Specifically, the threshold may be determined to be a value (e.g., 180 V) between the error range (e.g., 84 V \sim 156 V) of the voltage (120 V) between the first live terminal **10a** and the neutral terminal **10b** in normal connection of the power wire **20** and the error range (e.g., 204 V \sim 276 V) of the voltage (240 V) between the first live terminal **10a** and the second live terminal **10c** in normal connection of the power wire **20**.

(80) With this, the power detection circuit **110** may output the square wave V_{out} by half-rectifying the electric signal of the voltage as shown in FIG. 7 when the first power wire **20a** and the second power wire **20c** are connected to the first live terminal **10a** and the second live terminal **10c**, respectively, a voltage is applied to each of the power wires **20a** and **20c**, and the voltage between the first live terminal **10a** and the second live terminal **10c** (L1-L2 voltage, e.g., 240V) is equal to or higher than the threshold.

(81) On the other hand, when the second power wire **20c** is not connected to the second live terminal **10c** and the voltage between the first live terminal **10a** and the second live terminal **10c** (L1-L2 voltage, e.g., 120V) is lower than the threshold, the power detection circuit **110** may not output the square wave V_{out} , as shown in FIG. 8.

(82) In an embodiment, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is equal to or greater than the threshold when the voltage detection circuit **110** outputs a square wave, and control the electronic device **1** to be operated. For example, the controller **140** may control the first relay **150** and the second relay **160** to be turned on, so that voltages may be applied to the first electric component **30** and the second electric component **40**.

(83) In an embodiment, the controller **140** may control the operation of the electronic device **1** to be interrupted when the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold.

(84) Specifically, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold when the voltage detection circuit **110** outputs no square wave, and interrupt the operation of the electronic device **1**. For example, the controller **140** may control the first relay **150** and the second relay **160** to be turned off not to apply any voltage to the first electric component **30** and the second electric component **40**.

(85) As such, the electronic device **1** controls the electronic device **1** to be operated only when the first power wire **20a** and the second power wire **20c** are connected to the first live terminal **10a** and the second live terminal **10c**, respectively, and voltages (of 120 V) having opposite phases are applied to the respective power wires **20a** and **20c**.

(86) With this, the electronic device **1** may prevent damage by fire and ignition of the electric components **30** and **40** or malfunction of the electric components **30** and **40** that may be caused by wrong connection between the power input terminal **10** and the power wire **20**.

(87) Furthermore, when the electronic device **1** is not operated even when being powered on, the user may recognize that there is an error in supplying power through the power input terminal **10**.

(88) In this case, when the second power wire **20c** is not connected to the second live terminal (no connection) or the second live terminal **10c** is connected to the neutral wire **20b** instead of the second power wire **20c** (wrong connection), the user may connect the second power wire **20c** to the second live terminal **10c** to supply power through the power input terminal **10**.

(89) Furthermore, when the electronic device **1** is not operated even though the second live terminal **10c** is connected to the second power wire **20c**, the user may recognize that interior wiring in the place where the electronic device **1** is installed has a two-wire type and is thus unable to supply a voltage of 240 V, and may do a wiring work on the interior wiring to apply the voltage of 240 V from an outlet, enabling power to be supplied through the power input terminal **10**.

(90) Moreover, when the electronic device **1** is not powered on even with the power button being input, the user may recognize that at least one of the first live terminal **10a** and the neutral terminal **10b** has an error in wiring, and may connect the first power wire **20a** to the first live terminal **10a** and the neutral wire **20b** to the neutral terminal **10b**, enabling power to be supplied through the power input terminal **10**.

(91) FIG. **9** is a diagram for describing an occasion when the electronic device **1** displays a message, according to an embodiment.

(92) Referring to FIG. **9**, in an embodiment, the electronic device **1** may display a message **900** indicating that there is an error in supplying power through the power input terminal **10** when the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold.

(93) Specifically, in an embodiment, when the voltage detection circuit **110** outputs no square wave, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold, and interrupt the operation of the electronic device **1** and simultaneously, control the display **170** to display the message **900** indicating that there is an error in supplying power through the power input terminal **10** (e.g., an error occurs in supplying power through the power input terminal).

(94) Furthermore, in an embodiment, when the voltage detection circuit **110** outputs no square wave, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold, and interrupt the operation of the electronic device **1** and simultaneously, control the speaker **190** to output a sound of notification indicating that there is an error in supplying power through the power input terminal **10**.

(95) In this case, the sound of notification may correspond to voice corresponding to the message of “an error occurs in supplying power through the power input terminal” or correspond to a preset sound.

(96) The user may recognize an occurrence of the error in supplying power through the power input terminal **10** based on at least one of the message **900** or the sound of notification. The user may enable power to be supplied through the power input terminal **10** by normalizing connection between the power input terminal **10** and the power wire **20** or doing a wiring work on the interior wiring to apply a voltage of 240 V from an outlet.

(97) An embodiment of a method of controlling the electronic device **1** will now be described from a perspective. As for the method of controlling the electronic device **1**, the electronic device **1** in the aforementioned embodiments may be used. Hence, what are described above with reference to FIGS. **1** to **9** may be equally applied in the following method of controlling the electronic device **1**.

(98) FIG. **10** is a flowchart of a case of detecting an error in supplying power through the power input terminal **10** in a method of controlling the electronic device **1**, according to an embodiment.

(99) In an embodiment, when the power button is input in **1010**, the electronic device **1** may detect a voltage between the plurality of live terminals in **1020**.

(100) In this case, the controller **140** may identify a magnitude of the voltage between the plurality

of live terminals **10a** and **10c** based on the output of the voltage detection circuit **110**. Specifically, the controller **140** may determine that the voltage between the plurality of live terminals **10a** and **10c** is equal to or higher than a threshold when the voltage detection circuit **110** outputs a square wave. Furthermore, the controller **140** may determine that the voltage between the plurality of live terminals **10a** and **10c** is lower than the threshold when the voltage detection circuit **110** outputs no square wave.

(101) In an embodiment, the electronic device **1** may control the electronic device **1** to be operated in **1040**, when the detected voltage is higher than the threshold in **1030**.

(102) Specifically, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is equal to or greater than the threshold when the voltage detection circuit **110** outputs the square wave, and control the electronic device **1** to be operated. For example, the controller **140** may control the first relay **150** and the second relay **160** to be turned on, so that voltages may be applied to the first electric component **30** and the second electric component **40**.

(103) In an embodiment, the electronic device **1** may control the operation of the electronic device **1** to be interrupted in **1050**, when the detected voltage is lower than the threshold in **1030**.

(104) Specifically, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold when the voltage detection circuit **110** outputs no square wave, and interrupt the operation of the electronic device **1**. For example, the controller **140** may control the first relay **150** and the second relay **160** to be turned off not to apply any voltage to the first electric component **30** and the second electric component **40**.

(105) As such, the electronic device **1** controls the electronic device **1** to be operated only when the first power wire **20a** and the second power wire **20c** are connected to the first live terminal **10a** and the second live terminal **10c**, respectively, and voltages (of 120 V) having opposite phases are applied to the respective power wires **20a** and **20c**.

(106) With this, the electronic device **1** may prevent malfunction of the electric components **30** and **40** such as damage by fire or ignition of the electric components **30** and **40** that may be caused by wrong connection between the power input terminal **10** and the power wire **20**.

(107) Furthermore, when the electronic device **1** is not operated even when being powered on, the user may recognize that there is an error in supplying power through the power input terminal **10**.

(108) In this case, when the second power wire **20c** is not connected to the second live terminal (no connection) or the second live terminal **10c** is connected to the neutral wire **20b** instead of the second power wire **20c**, the user may connect the second power wire **20c** to the second live terminal **10c** to supply power through the power input terminal **10**.

(109) Furthermore, when the electronic device **1** is not operated even though the second live terminal **10c** is connected to the second power wire **20c**, the user may recognize that interior wiring in the place where the electronic device **1** is installed has two wire type and is thus unable to supply a voltage of 240 V, and may do a wiring work on the interior wiring to apply the voltage of 240 V, enabling power to be supplied through the power input terminal **10**.

(110) Moreover, when the electronic device **1** is not powered on even with the power button being input, the user may recognize that at least one of the first live terminal **10a** and the neutral terminal **10b** has an error in wiring, and may connect the first power wire **20a** to the first live terminal **10a** and the neutral wire **20b** to the neutral terminal **10b**, enabling power to be supplied through the power input terminal **10**.

(111) In addition, in an embodiment, the electronic device **1** may display a message indicating that there is an error in supplying power through the power input terminal **10**, in **1060**.

(112) Specifically, in an embodiment, when the voltage detection circuit **110** outputs no square wave, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold, and interrupt the operation of the

electronic device **1** and simultaneously, control the display **170** to display the message **900** indicating that there is an error in supplying power through the power input terminal **10** (e.g., an error occurs in supplying power through the power input terminal).

(113) Furthermore, in an embodiment, when the voltage detection circuit **110** outputs no square wave, the controller **140** may determine that the magnitude of the voltage between the plurality of live terminals **10a** and **10c** is smaller than the threshold, and interrupt the operation of the electronic device **1** and simultaneously, control the speaker **190** to output a sound of notification indicating that there is an error in supplying power through the power input terminal **10**.

(114) The user may recognize an occurrence of the error in supplying power through the power input terminal **10** based on at least one of the message **900** or the sound of notification. The user may enable power to be supplied through the power input terminal **10** by normalizing connection between the power input terminal **10** and the power wire **20** or doing a wiring work on the interior wiring to apply a voltage of 240 V from an outlet.

(115) Meanwhile, the embodiments of the disclosure may be implemented in the form of a recording medium for storing instructions to be carried out by a computer. The instructions may be stored in the form of program codes, and when executed by a processor, may generate program modules to perform operation in the embodiments of the disclosure. The recording media may correspond to computer-readable recording media.

(116) The computer-readable recording medium includes any type of recording medium having data stored thereon that may be thereafter read by a computer. For example, it may be a read only memory (ROM), a random access memory (RAM), a magnetic tape, a magnetic disk, a flash memory, an optical data storage device, etc.

(117) The embodiments of the disclosure have thus far been described with reference to accompanying drawings. It will be obvious to those of ordinary skill in the art that the disclosure may be practiced in other forms than the embodiments of the disclosure as described above without changing the technical idea or essential features of the disclosure. The above embodiments of the disclosure are only by way of example, and should not be construed in a limited sense.

Claims

1. An electronic device comprising: a power input terminal including a first live terminal, a second live terminal, and a neutral terminal; a voltage detection circuit connected between the first live terminal and the second live terminal to detect a voltage between the first live terminal and the second live terminal; and a controller configured to control operation of the electronic device to be interrupted in response to a magnitude of the detected voltage being smaller than a threshold, wherein the voltage detection circuit is configured to output a square wave by half-rectifying the detected voltage in response to the magnitude of the detected voltage being equal to or greater than the threshold.
2. The electronic device of claim 1, wherein the controller is configured to control the electronic device to be operated in response to the voltage detection circuit outputting the square wave.
3. The electronic device of claim 1, wherein the controller is configured to control operation of the electronic device to be interrupted in response to the voltage detection circuit outputting no square wave.
4. The electronic device of claim 1, further comprising: a first electric component connected between the first live terminal and the second live terminal; a second electric component connected between the first live terminal and the neutral terminal; a first relay connected in series with the first electric component; and a second relay connected in series with the second electric component, wherein the controller is configured to control the first relay and the second relay to be turned off in response to the magnitude of the detected voltage being smaller than the threshold.
5. The electronic device of claim 1, wherein the threshold is determined as a value between an error

range of the voltage between the first live terminal and the second live terminal in normal connection of power wires and an error range of a voltage between the first live terminal and the neutral terminal in normal connection of the power wires.

6. The electronic device of claim 1, further comprising: a display, wherein the controller is configured to control the display to display a message indicating that there is an error in supplying power through the power input terminal in response to the magnitude of the detected voltage being smaller than the threshold.

7. The electronic device of claim 1, further comprising: a speaker wherein the controller is configured to control the speaker to output a sound of notification indicating that there is an error in supplying power through the power input terminal in response to the magnitude of the detected voltage being smaller than the threshold.

8. A method of controlling an electronic device including a power input terminal having a first live terminal, a second live terminal, and a neutral terminal, the method comprising: detecting a voltage between the first live terminal and the second live terminal by a voltage detecting circuit connected between the first live terminal and the second live terminal; comparing a magnitude of the detected voltage with a threshold; and controlling operation of the electronic device to be interrupted in response to the magnitude of the detected voltage being smaller than the threshold, wherein the voltage detection circuit is configured to output a square wave by half-rectifying the detected voltage in response to the magnitude of the detected voltage being equal to or greater than the threshold.

9. The method of claim 8, further comprising: controlling the electronic device to be operated in response to the voltage detection circuit outputting the square wave.

10. The method of claim 8, wherein the controlling of the operation of the electronic device to be interrupted comprises controlling the operation of the electronic device to be interrupted in response to the voltage detection circuit outputting no square wave.

11. The method of claim 8, wherein the electronic device includes: a first electric component connected between the first live terminal and the second live terminal; a second electric component connected between the first live terminal and the neutral terminal; a first relay connected in series with the first electric component; and a second relay connected in series with the second electric component, wherein the controlling of the operation of the electronic device to be interrupted comprises controlling the first relay and the second relay to be turned off in response to the magnitude of the detected voltage being smaller than the threshold.

12. The method of claim 8, wherein the threshold is determined as a value between an error range of the voltage between the first live terminal and the second live terminal in normal connection of power wires and an error range of a voltage between the first live terminal and the neutral terminal in normal connection of the power wires.

13. The method of claim 8, wherein the electronic device includes a display, and the method further comprising: controlling the display to display a message indicating that there is an error in supplying power through the power input terminal in response to the magnitude of the detected voltage being smaller than the threshold.
