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(54) **SIGNAL LIGHT, SYSTEM AND CONTROL METHOD**

(57) The present invention discloses a signal light, including a lighting circuit and a light-emitting mechanism. The light-emitting mechanism includes a plurality of groups of light-emitting diode (LED) light panels connected in parallel. The lighting circuit includes an alternating-current side main circuit, a direct-current side main circuit, and a control unit. In addition, the present invention provides a signal light system, including the signal light, a lighting control circuit, and a power supply. The present invention may implement, by improving a circuit topology, safety cut-off of a light-end main circuit to turn off the light. The present invention detects, by improvement, a voltage and a current of each string of light beads on the LED light panels, so that an operation status of each string of light beads can be reflected. When the light beads are damaged by 30% and 50%, communication is performed by a main power supply circuit through a carrier wave (without adding a new connecting wire), and status information of the LED light panels is sent to the lighting control circuit.

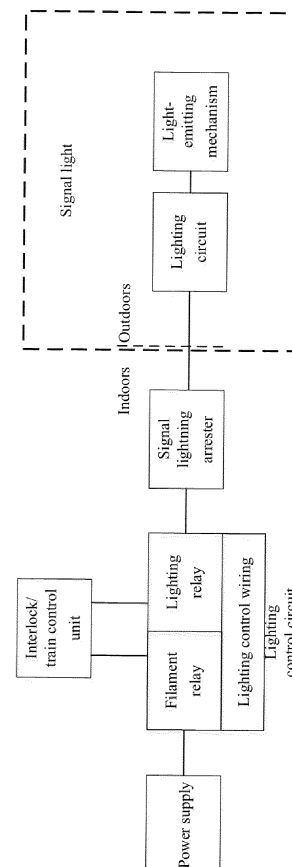


FIG. 1

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## Description

### FIELD OF TECHNOLOGY

**[0001]** The present invention belongs to the technical field of railway signal display, and particularly relates to a signal light, a system, and a control method.

### BACKGROUND

**[0002]** Safety equipment, including a signal light and its control circuit, is important equipment to command safe operation of a train. FIG. 1 is an existing railway signal display system, including an indoor power supply, a relay lighting circuit, a lightning protection element, an outdoor lighting unit, and a signal light. The relay lighting circuit includes a filament relay, a lighting relay, and a lighting control wiring.

**[0003]** A railway signal trackside color light display system includes an indoor power supply, a lighting control circuit, an outdoor lighting unit, and a signal light. A lighting supervision relay (JZXC-H18 or JZXC-16/16) contact is connected in series in the lighting control circuit, to determine a turn-on status of the controlled signal light, so that logic control of the signal light is implemented.

**[0004]** Foreign railway signal display equipment has developed to be intelligent, informationalized, networked, and maintenance-free. Since the development of domestic signal display equipment for more than 50 years, a conventional relay circuit control technology and a conventional bulb type signal light are still used, while a new light source is rarely used. Existing main problems are as follows:

Due to the non-fault safety design of an existing railway light-emitting diode (LED) signal light, there still exists the following problems during use.

1. Existing railway LED signal light equipment cannot implement safe and controllable cut-off at a light end to turn off the light. The possibility of lighting by mistake is high in the case of failure or cable interference by external signals, an interlock system cannot normally obtain a turn-on status of the signal light, and upgraded display is possible or degraded display fails.
2. Because an LED has lower power, and a current of a power supply circuit cannot be lower than a falling value of a filament relay, the existing railway LED signal light equipment has a power resistor, as a dummy load, connected in parallel to the light end. However, on the one hand, the power resistor as the load generates heat, which is easy to cause failure and reduce reliability; and on the other hand, due to the existence of the dummy load, it is possible to cause a turn-off status and detect it as the turn-on status.
3. There is no design of communication between the existing railway LED signal light and an indoor de-

tection unit, so that a current index of an outdoor LED light end is detected only by the indoor detection unit to determine whether power is cut off; and it is easily caused that the existing signal light is in the turn-off status while the filament relay is kept energized due to partial LED breakdown of the LED signal light, a low lighting current of the LED signal light that does not meet a trigger condition of an original relay circuit, a large distributed capacitance between power supply cables, and the like.

### SUMMARY

**[0005]** In view of the above problems, in one aspect, the present invention discloses a signal light, including a lighting circuit and a light-emitting mechanism, where the light-emitting mechanism includes a plurality of groups of LED light panels connected in parallel, and the lighting circuit includes an alternating-current side main circuit, a direct-current side main circuit, and a control unit;

an input end of the alternating-current side main circuit receives an electric energy input of a power supply, and an output end of the alternating-current side main circuit is coupled to an input end of the direct-current side main circuit and inputs a first control signal to the direct-current side main circuit;

an input end of the control unit is coupled to the output end of the alternating-current side main circuit and an output end of the direct-current side main circuit; an output end of the control unit is coupled to the input end of the alternating-current side main circuit and the input end of the direct-current side main circuit;

the control unit is configured to receive a current signal of the alternating-current side main circuit and a voltage signal of the direct-current side main circuit, and to feed back a second control signal and a third control signal to the alternating-current side main circuit and the direct-current side main circuit, respectively; and

the input end of the direct-current side main circuit is configured to receive the first control signal and the third control signal, input ends of the plurality of groups of LED light panels are coupled to the output end of the direct-current side main circuit, the direct-current side main circuit outputs a lighting signal according to the first control signal and the third control signal, and the LED light panels perform lighting according to the lighting signal.

**[0006]** Further, the alternating-current side main circuit includes a transformer, a protective filter module, a current acquisition module, a rectifier bridge, and a code sending switch module sequentially connected in series;

an input end of the transformer is coupled to an output end of the power supply; and

an output end of the code sending switch module is coupled to the direct-current side main circuit.

**[0007]** Further, the direct-current side main circuit includes a power factor correction (PFC) module, a safety AND module, and a constant current source module;

an input end of the PFC module receives the low-frequency power carrier signal, and an output end of the PFC module is coupled to an input end of the safety AND module;

an output end of the safety AND module is coupled to an input end of the constant current source module;

an output end of the constant current source module is coupled to the input ends of the LED light panels; and

the PFC module is grounded.

**[0008]** Further, the control unit includes a central processing unit (CPU) power supply module, a CPU1, a CPU2, a voltage acquisition module, a light intensity sensor, and a temperature sensor;

an input end of the CPU power supply module is coupled to the output end of the PFC module, and an output end of the CPU power supply module is coupled to the CPU1 and the CPU2;

an input end of the CPU1 and an input end of the CPU2 are coupled to an output end of the current acquisition module, and an output end of the CPU1 and an output end of the CPU2 are coupled to an input end of the code sending switch module;

the input end of the CPU1 and the input end of the CPU2 are coupled to the output end of the safety AND module, and the output end of the CPU1 and the output end of the CPU2 are coupled to the input end of the safety AND module;

the input end of the CPU1 is further coupled to an output end of the light intensity sensor and an output end of the temperature sensor, respectively;

the input end of the CPU2 is further coupled to the output end of the light intensity sensor and the output end of the temperature sensor, respectively;

the input end of the CPU1 and the input end of the CPU2 are further coupled to an output end of the voltage acquisition module; an input end of the voltage acquisition module is coupled to the output end of the safety AND module and the input ends and output ends of the LED light panels; and

the output end of the constant current source module is further coupled to the input end of the CPU1 and the input end of the CPU2, respectively, and the input end of the constant current source module is further coupled to the output end of the CPU1.

**[0009]** Further, the light intensity sensor is configured to detect and acquire the light intensity of the LED light

panels, and the temperature sensor is configured to acquire an operating temperature and an ambient temperature of the LED light panels.

**[0010]** Further, the code sending switch module includes a normally closed switch circuit, a first isolation circuit, a timing control circuit, a zero-crossing acquisition and comparison circuit, a second isolation circuit, and a safety power supply circuit;

an input end of the normally closed switch circuit is coupled to an output end of the rectifier bridge, and an output end of the normally closed switch circuit is coupled to the input end of the PFC module;

an input end of the timing control circuit is coupled to an output end of the first isolation circuit, an output end of the zero-crossing acquisition and comparison circuit, and an output end of the safety power supply circuit, respectively, and an output end of the timing control circuit is coupled to a control end of the normally closed switch circuit;

an input end of the first isolation circuit is coupled to the output end of the CPU1;

an input end of the safety power supply circuit is coupled to an output end of the second isolation circuit, and an input end of the second isolation circuit is coupled to the output end of the CPU2; and

an input end of the zero-crossing acquisition and comparison circuit is coupled to the alternating-current side main circuit.

**[0011]** Furthermore, the safety AND module includes a transformer, a switch, a power supply circuit, a first isolation and acquisition power supply circuit, a second isolation and acquisition power supply circuit, a first isolation drive circuit, a second isolation drive circuit, a third isolation drive circuit, an isolation control circuit, and a feedback isolation circuit;

a primary winding of the transformer is coupled to the output end of the PFC module, and a secondary winding of the transformer is coupled to the constant current source module;

an input end of the power supply circuit is coupled to the output end of the PFC module, and an output end of the power supply circuit is coupled to an input end of the isolation control circuit and an input end of the second isolation drive circuit, respectively;

the input end of the second isolation drive circuit is further coupled to an output end of the first isolation drive circuit, an output end of the second isolation drive circuit is coupled to one side of the switch, the other side of the switch is coupled to the primary winding of the transformer, and the switch is grounded;

an input end of the first isolation drive circuit is coupled to an output end of the first isolation and acquisition power supply circuit and an output end of the third isolation drive circuit, respectively;

the output end of the first isolation and acquisition power supply circuit is further coupled to the input end of the CPU1, and an input end of the first isolation and acquisition power supply circuit is coupled to the output end of the CPU1;

an input end of the third isolation drive circuit is coupled to an output end of the second isolation and acquisition power supply circuit and an output end of the isolation control circuit, respectively;

the output end of the second isolation and acquisition power supply circuit is further coupled to the input end of the CPU2, and an input end of the second isolation and acquisition power supply circuit is coupled to the output end of the CPU2;

an input end of the isolation control circuit is further coupled to an output end of the feedback isolation circuit; and

the feedback isolation circuit is coupled to the secondary winding of the transformer.

**[0012]** In another aspect, the present invention further provides a signal light system, including the signal light, where the signal light system further includes a lighting control circuit and a power supply;

the power supply is configured to provide electric energy for the signal light system;

the power supply, the lighting control circuit, and the signal light are connected in series; the lighting control circuit receives a feedback signal of the signal light and controls a lighting status of the signal light according to the feedback signal;

the lighting status of the signal light includes signal light turn-on and signal light turn-off;

a feedback signal corresponding to the signal light turn-on is a combination of a periodic rated-frequency sinusoidal current waveform and a null waveform, and is set as a safe side, and the feedback signal of the safe side includes a normal signal and a fault signal; and

a feedback signal corresponding to the signal light turn-off is a waveform other than a lighting signal, and is set as a dangerous side.

**[0013]** In another aspect, the present invention further provides a control method for a signal light, which implements, based on the signal light system, lighting control of the signal light, where the control method includes:

supplying, by a power supply, power to the signal light system, and starting the signal light system;

acquiring, by a control unit, circuit data of main circuits that includes a current signal of an alternating-current side main circuit and a voltage signal of a direct-current side main circuit, and transmitting the current signal of the alternating-current side main circuit and the voltage signal of the direct-current side main circuit to the control unit;

determining, by the control unit, whether the current signal and the voltage signal meet a preset condition; if the current signal and the voltage signal meet the preset condition, switching on a lighting circuit;

obtaining, by both a CPU1 and a CPU2 of the control unit, the current signal of the alternating-current side main circuit and the voltage signal of the direct-current side main circuit, and further determining whether data analysis results of the CPU1 and the CPU2 are consistent;

if the data analysis results of the CPU1 and the CPU2 are consistent, determining the obtained voltage signal and current signal; and

presetting working ranges of the voltage signal and the current signal, and if the voltage signal and the current signal meet the working ranges, indicating that the main circuits work normally, and sending a normal signal to a lighting control circuit.

**[0014]** Further, after the step of obtaining, by both a CPU1 and a CPU2 of the control unit, the current signal of the alternating-current side main circuit and the voltage signal of the direct-current side main circuit, and further determining whether data analysis results of the CPU1 and the CPU2 are consistent, the method further includes:

further evaluating a status of LED light panels;

if the status of the LED light panels is normal, indicating that the main circuits work normally, and sending the normal signal or a fault signal to the lighting control circuit; and

if the status of the LED light panels is abnormal, switching off the lighting circuit, sending, by the lighting circuit, a turn-off status signal to the lighting control circuit, and guiding the lighting circuit to a safe side.

**[0015]** Further, after the step of determining, by the control unit, whether the current signal and the voltage signal meet a preset condition, the method further includes the following steps:

if the current signal and the voltage signal do not meet the preset condition, switching off the lighting circuit, sending, by the lighting circuit, a turn-off status signal to the lighting control circuit, and guiding the lighting circuit to a safe side.

**[0016]** Further, after the step of supplying, by a power supply, power to the signal light system, and starting the signal light system, the method further includes the following steps:

obtaining light intensity data acquired by a light intensity sensor in real time, and determining whether the light intensity meets a preset threshold, where the preset threshold is a light intensity range corresponding to a visibility distance of LED light panels in the daytime;

if the light intensity meets the preset threshold, switching on the lighting circuit; and  
if the light intensity does not meet the preset threshold, increasing the brightness of driving the LED light panels, and until the preset threshold is met, switching on the lighting circuit.

**[0017]** Further, after the step of supplying, by a power supply, power to the signal light system, and starting the signal light system, the method further includes the following steps:

obtaining real-time temperature data acquired by a temperature sensor, and determining whether the temperature data meets a preset temperature range;  
if the temperature data meets the preset temperature range, switching on the lighting circuit; and  
if the temperature data does not meet the preset temperature range, switching off the lighting circuit, sending, by the lighting circuit, a turn-off status signal to the lighting control circuit, and guiding the lighting circuit to a safe side.

**[0018]** Further, the control method further includes: if the data analysis results of the CPU1 and the CPU2 are inconsistent, switching off the lighting circuit, sending, by the lighting circuit, a turn-off status signal to the lighting control circuit, and guiding the lighting circuit to a safe side.

**[0019]** Further, the control method further includes: if the acquired voltage signal and current signal do not meet the working ranges, switching off the lighting circuit, sending, by the lighting circuit, the turn-off status signal to the lighting control circuit, and guiding the lighting circuit to the safe side.

**[0020]** Furthermore, the evaluating a status of LED light panels specifically includes the following steps:

determining whether a voltage of the LED light panels is normal;  
if the voltage of the LED light panels is abnormal, further determining whether the LED light panels are damaged by more than 30%;  
if the LED light panels are damaged by more than 30%, further determining whether the LED light panels are damaged by more than 50%;  
if the LED light panels are damaged by more than 50%, switching off the lighting circuit, sending, by the lighting circuit, the turn-off status signal to the lighting control circuit, and guiding the lighting circuit to the safe side; and if the LED light panels are damaged by no more than 50%, indicating that the main circuits work normally, and sending the fault signal to the lighting control circuit;  
where after the step of determining whether a voltage of the LED light panels is normal, the method further includes:

if the voltage of the LED light panels is normal, indicating that the main circuits work normally, and sending the normal signal to the lighting control circuit; and

where after the step of determining whether the LED light panels are damaged by more than 30%, the method further includes:

if the LED light panels are damaged by no more than 30%, indicating that the main circuits work normally, and sending the normal signal to the lighting control circuit.

**[0021]** Compared with the prior art, this technical solution has the following advantages:

1. The present invention may implement, by improving a circuit topology, safety cut-off of a light-end main circuit to turn off the light. The high possibility of lighting by mistake in the case of failure or cable interference by external signals, and the resulting signal upgrade or failure to degrade are avoided.

2. The present invention may meet, by adding communication between indoor and outdoor modules of the signal light and improving the circuit topology, a current condition without adding a power resistor (a dummy load) connected in parallel to a light end, thus avoiding the reduced reliability caused by heating of the power resistor (the dummy load) and the detection of a turn-off status as a turn-on status.

3. The present invention detects, by improvement, a voltage and a current of each string of light beads on the LED light panels, so that an operation status of each string of light beads can be reflected. When the light beads are damaged by 30% and 50%, communication is performed by a main power supply circuit through a carrier wave (without adding a new connecting wire), and status information of the LED light panels is sent to the lighting control circuit. It is effectively avoided that the signal light is in the turn-off status while a filament relay is kept energized due to partial breakdown of the signal light, a low lighting current of the signal light that does not meet a trigger condition of an original relay circuit, a large distributed capacitance between power supply cables, and the like.

**[0022]** Other features and advantages of the present invention will be described in the following specification, and will become apparent in part from the specification, or will be understood by implementing the present invention. The objective and other advantages of the present invention may be achieved and obtained through the structures indicated in the specification, the claims, and the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0023]** To more clearly illustrate the technical solutions

in the embodiments of the present invention or in the prior art, the accompanying drawings that need to be used in the description of the embodiments or the prior art will be briefly described below. Apparently, the accompanying drawings in the description below merely illustrate some embodiments of the present invention. Those of ordinary skill in the art may also derive other accompanying drawings from these accompanying drawings without creative efforts.

FIG. 1 shows a railway signal display system according to the prior art;

FIG. 2 shows a schematic main circuit diagram of a lighting circuit of a signal light according to an embodiment of the present invention;

FIG. 3 shows a schematic circuit diagram of a code sending switch module in the lighting circuit of the signal light according to the embodiment of the present invention;

FIG. 4 shows a schematic circuit diagram of a safety AND module in the lighting circuit of the signal light according to the embodiment of the present invention;

FIG. 5 shows a schematic diagram of implementing indoor and outdoor communication by the lighting circuit of the signal light according to the embodiment of the present invention;

FIG. 6 shows a schematic waveform diagram of indoor and outdoor communication in normal and abnormal statuses of the lighting circuit of the signal light according to the embodiment of the present invention; and

FIG. 7 shows a control flowchart of the signal light according to the embodiment of the present invention.

## DETAILED DESCRIPTION OF THE EMBODIMENTS

**[0024]** To make the objectives, technical solutions and advantages of the embodiments of the present invention clearer, the technical solutions in the embodiments of the present invention will be clearly and completely described below with reference to the accompanying drawings in the embodiments of the present invention. Apparently, the described embodiments are a part rather than all of the embodiments of the present invention. All other embodiments obtained by those of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the scope of protection of the present invention.

**[0025]** Based on the problems in the prior art, in one aspect, the present invention provides a signal light used in the field of railway signal display, namely, a signal light located in a dashed line of a railway signal display system as shown in FIG. 1. The signal light includes a lighting circuit and a light-emitting mechanism, where the light-emitting mechanism includes a plurality of groups of LED light panels connected in parallel, and the lighting circuit

is as shown in FIG. 2 and includes an alternating-current side main circuit, a direct-current side main circuit, and a control unit;

5 an input end of the alternating-current side main circuit receives a power input of a power supply, and an output end of the alternating-current side main circuit is coupled to an input end of the direct-current side main circuit and inputs a first control signal to the direct-current side main circuit;

10 an input end of the control unit is coupled to the output end of the alternating-current side main circuit and an output end of the direct-current side main circuit; an output end of the control unit is coupled to the input end of the alternating-current side main circuit and the input end of the direct-current side main circuit;

15 the control unit is configured to receive a current signal of the alternating-current side main circuit and a voltage signal of the direct-current side main circuit, and to feed back a second control signal and a third control signal to the alternating-current side main circuit and the direct-current side main circuit, respectively; and

20 the input end of the direct-current side main circuit is configured to receive the first control signal and the third control signal, input ends of the plurality of groups of LED light panels are coupled to the output end of the direct-current side main circuit, the direct-current side main circuit outputs a lighting signal according to the first control signal and the third control signal, and the LED light panels perform lighting according to the lighting signal.

35 **[0026]** As shown in FIG. 2, the alternating-current side main circuit includes a transformer, a protective filter module, a current acquisition module, a rectifier bridge, and a code sending switch module sequentially connected in series; and

40 an input end of the transformer is coupled to an output end of the power supply, and the transformer is configured to convert an alternating current transmitted by the power supply into a safety voltage, where the safety voltage is a voltage required for the signal light. Specifically, a pressure range of the safety voltage is determined according to a light source of the signal light, and a staff may perform custom setting on the safety voltage according to the light source during installation, so as to protect the light source and prolong the service life of the signal light.

50 **[0027]** The protective filter module is configured to perform safety protection on electric energy in the alternating-current side main circuit, prevent the signal light from being damaged by external factors such as lightning strikes, and filter out a high-frequency harmonic in the electric energy, and a 50 Hz sinusoidal wave is retained only.

**[0028]** The current acquisition module is configured to

acquire current signals of L and N lines of an input end, respectively, and to transmit the current signals to the control unit for determination.

**[0029]** The rectifier bridge is configured to convert an alternating current in the alternating-current side main circuit into a direct current, and to supply energy to electrical equipment behind the circuit.

**[0030]** The code sending switch module is controlled by the control unit, and sends low-frequency power carrier signals with different duty cycles to an indoor space in a manner of performing on-off operation in the main circuit. FIG. 3 is a circuit block diagram of the code sending switch module.

**[0031]** As shown in FIG. 3, the code sending switch module includes a normally closed switch circuit, a first isolation circuit, a timing control circuit, a zero-crossing acquisition and comparison circuit, a second isolation circuit, and a safety power supply circuit;

an input end of the normally closed switch circuit is coupled to an output end of the rectifier bridge, and an output end of the normally closed switch circuit is coupled to the input end of the PFC module;

an input end of the timing control circuit is coupled to an output end of the first isolation circuit, an output end of the zero-crossing acquisition and comparison circuit, and an output end of the safety power supply circuit, respectively, and an output end of the timing control circuit is coupled to a control end of the normally closed switch circuit;

an input end of the first isolation circuit is coupled to the output end of the CPU1;

an input end of the safety power supply circuit is coupled to an output end of the second isolation circuit, and an input end of the second isolation circuit is coupled to the output end of the CPU2; and

an input end of the zero-crossing acquisition and comparison circuit is coupled to the alternating-current side main circuit.

**[0032]** In the code sending switch module, the normally closed switch circuit includes the control end, the input end, and the output end. When the control end is powered on and a control low level is given, the normally closed switch circuit is cut off; and when the control end is powered off or a control high level is given, the normally closed switch circuit is connected.

**[0033]** The zero-crossing acquisition and comparison circuit is configured to acquire an input waveform of the alternating-current side main circuit, and to output a 50 Hz square wave with a same phase.

**[0034]** The timing control circuit is configured to perform zero-crossing trigger on a control signal of the CPU1 by using the zero-crossing acquisition and comparison circuit as a clock. Consequently, it is ensured that on-off time of the normally closed switch circuit is alternating current zero-crossing time, and a resulting indoor communication signal contains an integral number of 50 Hz

sinusoidal waves.

**[0035]** The duty cycle of the low-frequency control signal sent by the CPU1 ranges from 10% to 90%.

**[0036]** The isolation circuits include the first isolation circuit and the second isolation circuit. Since a control signal sent by the control unit and a signal of a drive switch that is generated by the timing control circuit do not have common ground, the isolation circuits including the first isolation circuit and the second isolation circuit are arranged to isolate the control signal and the drive switch signal from each other.

**[0037]** As shown in FIG. 2, a control signal of the CPU2 and the safety power supply circuit generate a direct-current level that may be safely cut off by the CPU2, to supply power to the timing control circuit and the zero-crossing acquisition and comparison circuit. When the control signal of the CPU2 is a pulse with a certain frequency, the safety power supply circuit has normal output; and when the control signal of the CPU2 is constantly high or low, or when the control signal of the CPU2 is constantly high or low due to failure, the safety power supply circuit has no output, so that it may be ensured that in fault and abnormal statuses, the timing control circuit does not work, and the circuit is guided to a safe side.

**[0038]** An output end of the code sending switch module is coupled to the direct-current side main circuit.

**[0039]** As shown in FIG. 2, the direct-current side main circuit includes a PFC module, a safety AND module, a constant current source module, and the LED light panels;

an input end of the PFC module receives the low-frequency power carrier signal, and an output end of the PFC module is coupled to an input end of the safety AND module;

an output end of the safety AND module is coupled to an input end of the constant current source module;

an output end of the constant current source module is coupled to the input ends of the LED light panels; and

the PFC module is grounded.

**[0040]** In the direct-current side main circuit, the PFC module is a power factor correction circuit, and a duty cycle is controlled by comparing a product of an output feedback voltage and an input voltage with an input current to adjust a ratio of active power and apparent power of the circuit. The input voltage and current of the circuit have a same frequency and phase. A signal sent by the code sending switch module is easier to recognize, and the impact of harmonics generated by high-frequency switch-on/off of the internal circuit of the module on a power grid and equipment is suppressed.

**[0041]** The safety AND module includes a transformer, a switch, a power supply circuit, a first isolation and acquisition power supply circuit, a second isolation and ac-

quisition power supply circuit, a first isolation drive circuit, a second isolation drive circuit, a third isolation drive circuit, an isolation control circuit, and a feedback isolation circuit;

a primary winding of the transformer is coupled to the output end of the PFC module, and a secondary winding of the transformer is coupled to the constant current source module;

an input end of the power supply circuit is coupled to the output end of the PFC module, and an output end of the power supply circuit is coupled to an input end of the isolation control circuit and an input end of the second isolation drive circuit, respectively;

the input end of the second isolation drive circuit is further coupled to an output end of the first isolation drive circuit, an output end of the second isolation drive circuit is coupled to one side of the switch, the other side of the switch is coupled to the primary winding of the transformer, and the switch is grounded;

an input end of the first isolation drive circuit is coupled to an output end of the first isolation and acquisition power supply circuit and an output end of the third isolation drive circuit, respectively;

the output end of the first isolation and acquisition power supply circuit is further coupled to the input end of the CPU1, and an input end of the first isolation and acquisition power supply circuit is coupled to the output end of the CPU1;

an input end of the third isolation drive circuit is coupled to an output end of the second isolation and acquisition power supply circuit and an output end of the isolation control circuit, respectively;

the output end of the second isolation and acquisition power supply circuit is further coupled to the input end of the CPU2, and an input end of the second isolation and acquisition power supply circuit is coupled to the output end of the CPU2;

an input end of the isolation control circuit is further coupled to an output end of the feedback isolation circuit; and

the feedback isolation circuit is coupled to the secondary winding of the transformer.

**[0042]** Specifically, the safety AND module mainly includes the transformer and the switch, and are jointly controlled by the CPU1 and the CPU2. A secondary side of the transformer outputs a level that may be independently safely cut off by the CPU1 or the CPU2, to supply power to the subsequent circuit.

**[0043]** Only when the control signals of the CPU1 and the CPU2 are pulse signals with a certain frequency, the safety AND module has normal output.

**[0044]** When the following situation occurs:

(1) the control signal of the CPU1 is constantly high or low,

(2) the control signal of the CPU2 is constantly high or low,

(3) the control signal of the CPU1 is constantly high or low due to failure, or

(4) the control signal of the CPU2 is constantly high or low due to failure,

the safety AND module of the main circuit has no output. Consequently it may be ensured that the main circuit of the signal light is cut off and the light is turned off in the fault or abnormal status.

**[0045]** FIG. 4 is a circuit block diagram of the safety AND module.

**[0046]** The transformer is configured to isolate the input end and the output end of the direct-current side main circuit from each other.

**[0047]** The switch is configured to implement DC-DC conversion of the input end and the output end through high-frequency on-off;

**[0048]** The power supply circuit is configured to provide electric energy for the circuit of the safety AND module, and the power supply circuit is grounded.

**[0049]** The isolation and acquisition circuits include the first isolation and acquisition power supply circuit and the second isolation and acquisition power supply circuit. Since the control signal of the control unit and the signal of the drive switch do not have common ground, the safety AND module requires the isolation and acquisition circuits to isolate the signals from each other. In addition, the safety AND module will generate a feedback signal similar to the control signal of the control unit, and the isolation and acquisition circuits will acquire and output the feedback signal, which is determined by the control unit.

**[0050]** The isolation drive circuits include the first isolation drive circuit, the second isolation drive circuit, and the third isolation drive circuit. Since the control signal of the control unit and the signal of the drive switch do not have common ground, the safety AND module requires the isolation drive circuits to isolate the signals from each other.

**[0051]** The feedback isolation circuit is configured to acquire a voltage signal at the output end of the safety AND module, and to isolate and send the voltage signal to the isolation control circuit.

**[0052]** The isolation control circuit is configured to perform voltage stabilization control on the output end of the safety AND module according to the voltage signal sent by the feedback isolation circuit.

**[0053]** As shown in FIG. 2, the constant current source module is configured to convert the electrical energy output by the safety AND module into a constant current source from a constant voltage source to supply power to each string of light beads on the LED light panels. The input end of the constant current source module further receives the control signal from the CPU1.

**[0054]** Specifically, the control of the CPU1 refers to that the CPU1 sends a pulse width modulation (PWM)

signal to a control end of each constant current source module, and a current output by the constant current source module may be adjusted by adjusting a PWM duty cycle. When the LED light panels fail, according to the number of failed LED light panels, the PWM duty cycle is increased, the brightness of the non-failed LED light panels is improved, and the brightness of a whole light panel is adjusted to be the same as that of the non-failed LED light panels.

**[0055]** The plurality of groups of LED light panels are connected in parallel, and the LED light panels on each group of parallel branches are correspondingly provided with a group of constant current source modules, and a common cathode of the LED light panels on each branch is coupled to a low-level reference ground.

**[0056]** The LED light panels, as load equipment of the signal light, perform lighting according to an output signal of the main circuit.

**[0057]** As shown in FIG. 2, the control unit includes a CPU power supply module, a CPU1, a CPU2, a voltage acquisition module, a light intensity sensor, and a temperature sensor;

an input end of the CPU power supply module is coupled to the output end of the PFC module, and an output end of the CPU power supply module is coupled to the CPU1 and the CPU2;

an input end of the CPU1 and an input end of the CPU2 are coupled to an output end of the current acquisition module, and an output end of the CPU1 and an output end of the CPU2 are coupled to an input end of the code sending switch module;

the input end of the CPU1 and the input end of the CPU2 are coupled to the output end of the safety AND module, and the output end of the CPU1 and the output end of the CPU2 are coupled to the input end of the safety AND module;

the input end of the CPU1 is further coupled to an output end of the light intensity sensor and an output end of the temperature sensor, respectively;

the input end of the CPU2 is further coupled to the output end of the light intensity sensor and the output end of the temperature sensor, respectively;

the input end of the CPU1 and the input end of the CPU2 are further coupled to an output end of the voltage acquisition module; an input end of the voltage acquisition module is coupled to the output end of the safety AND module and the input ends and output ends of the LED light panels; and

the output end of the constant current source module is further coupled to the input end of the CPU1 and the input end of the CPU2, respectively, and the input end of the constant current source module is further coupled to the output end of the CPU1.

**[0058]** The CPU power supply module is configured to provide electric energy for the circuit of the control unit.

**[0059]** The CPU1 and the CPU2 are configured to ac-

quire circuit data of the main circuits, and to generate corresponding control signals, so as to complete control logic required for the signal light. The lighting circuit of the signal light implements the control method in a two-out-of-two mode, to achieve safety control.

**[0060]** The voltage acquisition module is configured to acquire an output voltage of the safety AND module and a voltage at two ends of each string of LED light panels, and to transmit an acquired voltage signal to the control unit for determination.

**[0061]** The light intensity sensor is configured to detect a light-emitting status of the LED light panels, and to correspondingly generate a light-emitting signal and transmit the signal to the control unit for determination.

**[0062]** The temperature sensor is configured to detect an operating temperature and an ambient temperature of the signal light, and to generate temperature signals and transmit the signals to the control unit for determination.

**[0063]** The voltage acquisition module is further configured to acquire an output voltage of the PFC module. According to the voltage, the control circuit determines whether safety AND and constant current source output is enabled. If the voltage is lower than a set threshold, the output of the safety AND module and the constant current source module is not enabled. The LED light panels are in the turn-off status.

**[0064]** The signal light mainly implements the control and detection of the light-emitting mechanism, and is turned on according to the input voltage, as shown in FIG. 1. The lighting circuit of the signal light is a two-out-of-two safety control module, meets a fail-safe principle, and implements drive control of the signal light, safety detection, and feedback of lighting current waveforms in different statuses to the indoor space; the light panels are of a disk type structure, so that the equipment availability is improved; and a resistive load will not be additionally arranged at the end of the signal light.

**[0065]** The signal light has the power consumption between 10 W and 15 W, which is about half lower than that of a dual-filament incandescent light, and can implement the display of red, yellow, green, blue, and lunar white light. The lighting circuit, when detecting that the number of failed LED light panels exceeds an alarm threshold (30%), sends an alarm signal, and when the number of failed LED light panels exceeds a turn-off threshold (50%), the signal light sends a broken filament signal, and cuts off a current of the lighting circuit; and the lighting circuit feeds back a lighting status (normal, alarm, and turn-off) to the lighting control circuit by modulating a current frequency and a current amplitude of the lighting circuit.

**[0066]** As shown in FIG. 5, in another aspect, the present invention provides a signal light system, including the signal light, a lighting control circuit, and a power supply;

the power supply is configured to provide electric

energy for the signal light system;  
 the power supply, the lighting control circuit, and the  
 signal light are connected in series; the lighting con-  
 trol circuit receives a feedback signal of the signal  
 light and controls a lighting status of the signal light  
 according to the feedback signal;  
 the lighting status of the signal light includes signal  
 light turn-on and signal light turn-off;  
 a feedback signal corresponding to the signal light  
 turn-on is a combination of a periodic rated-frequen-  
 cy sinusoidal current waveform and a null waveform,  
 and is set as a safe side, and the feedback signal of  
 the safe side includes a normal signal and a fault  
 signal, where the rated frequency is set to be 50 Hz  
 consistent with a filtered alternating current frequen-  
 cy of the lighting circuit; and  
 a feedback signal corresponding to the signal light  
 turn-off is a waveform other than a lighting signal,  
 and is set as a dangerous side.

**[0067]** Secure transmission of indoor and outdoor  
 lighting statuses mainly implements the function of out-  
 door and indoor communication. When outdoor lighting  
 is abnormal, an indoor unit is informed through the secure  
 transmission, and enables/disables "filament relay" con-  
 tact conditions provided externally according to this sta-  
 tus.

**[0068]** As shown in FIG. 6, ① is an AC 110 V voltage  
 waveform; ② is a current waveform transmitted indoors  
 and outdoors in the normal turn-on status of the signal  
 light, and N1 50 Hz sinusoidal current waveforms and  
 M1 null waveforms constitute one waveform group, which  
 represents that the signal light is normally turned on; (3)  
 is a current waveform transmitted indoors and outdoors  
 in the alarm status of the signal light, and N2 50 Hz si-  
 nusoidal current waveforms and M2 null waveforms con-  
 stitute one waveform group, which represents that the  
 signal light is turned on in the alarm status; and other  
 current waveforms represent that the signal light is turned  
 off.

**[0069]** Based on the above signal light and indoor com-  
 munication design, the signal light in the present inven-  
 tion has two lighting statuses ② and (3), so that no cur-  
 rent, fully-on current (such as the voltage waveform in  
 ①), and other waveforms may be determined to be in  
 the abnormal status through the indoor unit. Therefore,  
 it is determined that no current, fully-on current, and other  
 waveforms are guided to the safe side from the wave-  
 forms in ② and (3). It is determined that the waveforms  
 in ② and (3) are guided to the dangerous side from no  
 current, fully-on current, and other waveforms.

**[0070]** In another aspect, based on the definition of the  
 above safe side, the present invention provides a control  
 method for a signal light. As shown in FIG. 7, the control  
 method includes:

Step 1: supplying, by a power supply, power to the  
 signal light system, and starting the signal light sys-

tem.

Step 2: acquiring, by a control unit, circuit data of  
 main circuits that includes a current signal of an al-  
 ternating-current side main circuit and a voltage sig-  
 nal of a direct-current side main circuit, and trans-  
 mitting the current signal of the alternating-current  
 side main circuit and the voltage signal of the direct-  
 current side main circuit to the control unit.

Step 3: determining, by the control unit, whether the  
 current signal and the voltage signal meet a preset  
 condition.

Step 4: if the current signal and the voltage signal  
 meet the preset condition, switching on a lighting cir-  
 cuit.

Step 5: obtaining, by both a CPU1 and a CPU2 of  
 the control unit, the current signal of the alternating-  
 current side main circuit and the voltage signal of the  
 direct-current side main circuit, and further determin-  
 ing whether data analysis results of the CPU1 and  
 the CPU2 are consistent.

Step 6: if the data analysis results of the CPU1 and  
 the CPU2 are consistent, determining the obtained  
 voltage signal and current signal; and

if the data analysis results of the CPU1 and the CPU2  
 of the control unit are inconsistent, switching off the  
 lighting circuit, and after repair, guiding the lighting  
 circuit to a safe side from a dangerous side.

Step 7: presetting working ranges of the voltage sig-  
 nal and the current signal, and if the voltage signal  
 and the current signal meet the working ranges, indi-  
 cating that the main circuits work normally, and  
 sending a normal signal to a lighting control circuit; and

if the acquired voltage and current do not meet the  
 working ranges, switching off the lighting circuit, and  
 after repair, guiding the lighting circuit to the safe  
 side from the dangerous side.

Step 8: if the main circuits work normally, returning  
 to the Step 2, continuing to implement the control  
 method for the signal light, and until the main circuits  
 work abnormally, switching off the lighting circuit,  
 and after repair, guiding the lighting circuit to the safe  
 side from the dangerous side.

**[0071]** The implementation of the above method may  
 always keep the monitoring of a working status of the  
 lighting circuit by the lighting circuit in operation, thus  
 effectively improving the safety performance of the signal  
 light.

**[0072]** After the Step 1, the method further includes:

Step 1-1-1: obtaining light intensity data acquired by  
 a light intensity sensor in real time, and determining  
 whether the light intensity meets a preset threshold,  
 where the preset threshold is a light intensity range  
 corresponding to a visibility distance of LED light  
 panels in the daytime.

Step 1-1-2: if the light intensity meets the preset

threshold, switching on the lighting circuit; and

if the light intensity does not meet the preset threshold, increasing the brightness of driving the LED light panels, and until the preset threshold is met, switching on the lighting circuit.

**[0073]** After the Step 1, the method further includes:

Step 1-2-1: obtaining real-time temperature data acquired by a temperature sensor, and determining whether the temperature data meets a preset temperature range.

Step 1-2-2: if the temperature data meets the preset temperature range, switching on the lighting circuit; and

if the temperature data does not meet the preset temperature range, switching off the lighting circuit, and after repair, guiding the lighting circuit to the safe side from the dangerous side.

**[0074]** The Step 3 further includes the following steps: Step 3-1-1: if the current signal and the voltage signal do not meet the preset condition, switching off the lighting circuit, and after repair, guiding the lighting circuit to the safe side from the dangerous side.

**[0075]** After the Step 5, the method further includes:

Step 5-1: further evaluating a status of LED light panels.

Step 5-2: if the status of the LED light panels is normal, indicating that the main circuits work normally, and sending the normal signal or a fault signal to the lighting control circuit.

Step 5-3: if the status of the LED light panels is abnormal, switching off the lighting circuit, and after repair, guiding the lighting circuit to the safe side from the dangerous side.

**[0076]** The Step 5-1 specifically includes the following steps:

Step 5-1-1: determining whether a voltage of the LED light panels is normal.

Step 5-1-2: if the voltage of the LED light panels is abnormal, further determining whether the LED light panels are damaged by more than 30%; and if the voltage of the LED light panels is normal, indicating that the main circuits work normally, and sending the normal signal to the lighting control circuit.

Step 5-1-3: if the LED light panels are damaged by more than 30%, further determining whether the LED light panels are damaged by more than 50%; and if the LED light panels are damaged by no more than 30%, indicating that the main circuits work normally, and sending the normal signal to the lighting control circuit.

Step 5-1-4: if the LED light panels are damaged by more than 50%, switching off the lighting circuit, and

after repair, guiding the lighting circuit to the safe side from the dangerous side; and if the LED light panels are damaged by no more than 50%, indicating that the main circuits work normally, and sending the fault signal to the lighting control circuit.

**[0077]** After the Step 6, the method further includes:

determining whether the feedback signal sent by the lighting circuit to the lighting control circuit is correct through the control unit;

if the feedback signal is correct, performing the step 7; and

if the feedback signal is incorrect, switching off the lighting circuit, and after repair, guiding the lighting circuit to the safe side from the dangerous side.

**[0078]** Although the present invention has been described in detail with reference to the above-mentioned embodiments, it should be understood by those of ordinary skill in the art that they may still perform modifications on the technical solutions described in the above-mentioned embodiments or perform equivalent substitutions on part of the technical features; and these modifications or substitutions do not make the essence of the corresponding technical solutions depart from the spirit and scope of the technical solutions in the embodiments of the present invention.

## Claims

1. A signal light, comprising a lighting circuit and a light-emitting mechanism, the light-emitting mechanism comprising a plurality of groups of light-emitting diode (LED) light panels connected in parallel, **characterized in that** the lighting circuit comprises an alternating-current side main circuit, a direct-current side main circuit, and a control unit;

an input end of the alternating-current side main circuit receives an electric energy input of a power supply, and an output end of the alternating-current side main circuit is coupled to an input end of the direct-current side main circuit and inputs a first control signal to the direct-current side main circuit;

an input end of the control unit is coupled to the output end of the alternating-current side main circuit and an output end of the direct-current side main circuit; an output end of the control unit is coupled to the input end of the alternating-current side main circuit and the input end of the direct-current side main circuit;

the control unit is configured to receive a current signal of the alternating-current side main circuit and a voltage signal of the direct-current side main circuit, and to feed back a second control

- signal and a third control signal to the alternating-current side main circuit and the direct-current side main circuit, respectively; and the input end of the direct-current side main circuit is configured to receive the first control signal and the third control signal, input ends of the plurality of groups of LED light panels are coupled to the output end of the direct-current side main circuit, the direct-current side main circuit outputs a lighting signal according to the first control signal and the third control signal, and the LED light panels perform lighting according to the lighting signal.
2. The signal light according to claim 1, **characterized in that** the alternating-current side main circuit comprises a transformer, a protective filter module, a current acquisition module, a rectifier bridge, and a code sending switch module sequentially connected in series;
- an input end of the transformer is coupled to an output end of the power supply; and an output end of the code sending switch module is coupled to the direct-current side main circuit.
3. The signal light according to claim 2, **characterized in that** the direct-current side main circuit comprises a power factor correction (PFC) module, a safety AND module, and a constant current source module;
- an input end of the PFC module receives the first control signal that comprises a low-frequency power carrier signal, and an output end of the PFC module is coupled to an input end of the safety AND module; an output end of the safety AND module is coupled to an input end of the constant current source module; an output end of the constant current source module is coupled to the input ends of the LED light panels; and the PFC module is grounded.
4. The signal light according to claim 3, **characterized in that** the control unit comprises a central processing unit (CPU) power supply module, a CPU1, a CPU2, a voltage acquisition module, a light intensity sensor, and a temperature sensor;
- an input end of the CPU power supply module is coupled to the output end of the PFC module, and an output end of the CPU power supply module is coupled to the CPU1 and the CPU2; an input end of the CPU1 and an input end of the CPU2 are coupled to an output end of the current acquisition module, respectively, and an output end of the CPU1 and an output end of
- the CPU2 are coupled to an input end of the code sending switch module, respectively; the input end of the CPU1 and the input end of the CPU2 are coupled to the output end of the safety AND module, respectively, and the output end of the CPU1 and the output end of the CPU2 are coupled to the input end of the safety AND module, respectively; the input end of the CPU1 is further coupled to an output end of the light intensity sensor and an output end of the temperature sensor, respectively; the input end of the CPU2 is further coupled to the output end of the light intensity sensor and the output end of the temperature sensor, respectively; the input end of the CPU1 and the input end of the CPU2 are further coupled to an output end of the voltage acquisition module; an input end of the voltage acquisition module is coupled to the output end of the safety AND module and the input ends and output ends of the LED light panels; and the output end of the constant current source module is further coupled to the input end of the CPU1 and the input end of the CPU2, respectively, and the input end of the constant current source module is further coupled to the output end of the CPU1.
5. The signal light according to claim 4, **characterized in that** the light intensity sensor is configured to detect and acquire the light intensity of the LED light panels, and the temperature sensor is configured to acquire an operating temperature and an ambient temperature of the LED light panels.
6. The signal light according to claim 4, **characterized in that** the code sending switch module comprises a normally closed switch circuit, a first isolation circuit, a timing control circuit, a zero-crossing acquisition and comparison circuit, a second isolation circuit, and a safety power supply circuit;
- an input end of the normally closed switch circuit is coupled to an output end of the rectifier bridge, and an output end of the normally closed switch circuit is coupled to the input end of the PFC module; an input end of the timing control circuit is coupled to an output end of the first isolation circuit, an output end of the zero-crossing acquisition and comparison circuit, and an output end of the safety power supply circuit, respectively, and an output end of the timing control circuit is coupled to a control end of the normally closed switch circuit; an input end of the first isolation circuit is coupled

to the output end of the CPU1;  
 an input end of the safety power supply circuit  
 is coupled to an output end of the second isola-  
 tion circuit, and an input end of the second iso-  
 lation circuit is coupled to the output end of the  
 CPU2; and  
 an input end of the zero-crossing acquisition and  
 comparison circuit is coupled to the alternating-  
 current side main circuit.

7. The signal light according to any one of claims 4 to 6, **characterized in that** the safety AND module comprises a transformer, a switch, a power supply circuit, a first isolation and acquisition power supply circuit, a second isolation and acquisition power supply circuit, a first isolation drive circuit, a second isolation drive circuit, a third isolation drive circuit, an isolation control circuit, and a feedback isolation circuit;

a primary winding of the transformer is coupled to the output end of the PFC module, and a secondary winding of the transformer is coupled to the constant current source module;

an input end of the power supply circuit is coupled to the output end of the PFC module, and an output end of the power supply circuit is coupled to an input end of the isolation control circuit and an input end of the second isolation drive circuit, respectively;

the input end of the second isolation drive circuit is further coupled to an output end of the first isolation drive circuit, an output end of the second isolation drive circuit is coupled to one side of the switch, the other side of the switch is coupled to the primary winding of the transformer, and the switch is grounded;

an input end of the first isolation drive circuit is coupled to an output end of the first isolation and acquisition power supply circuit and an output end of the third isolation drive circuit, respectively;

the output end of the first isolation and acquisition power supply circuit is further coupled to the input end of the CPU1, and an input end of the first isolation and acquisition power supply circuit is coupled to the output end of the CPU1; an input end of the third isolation drive circuit is coupled to an output end of the second isolation and acquisition power supply circuit and an output end of the isolation control circuit, respectively;

the output end of the second isolation and acquisition power supply circuit is further coupled to the input end of the CPU2, and an input end of the second isolation and acquisition power supply circuit is coupled to the output end of the CPU2;

an input end of the isolation control circuit is further coupled to an output end of the feedback isolation circuit; and  
 the feedback isolation circuit is coupled to the secondary winding of the transformer.

8. A signal light system, comprising the signal light according to any one of claims 1 to 7, **characterized in that** the signal light system further comprises a lighting control circuit and a power supply;

the power supply is configured to provide electric energy for the signal light system;  
 the power supply, the lighting control circuit, and the signal light are connected in series; the lighting control circuit receives a feedback signal of the signal light and controls a lighting status of the signal light according to the feedback signal; the lighting status of the signal light comprises signal light turn-on and signal light turn-off;  
 a feedback signal corresponding to the signal light turn-on is a combination of a periodic rated-frequency sinusoidal current waveform and a null waveform, and is set as a safe side, and the feedback signal of the safe side comprises a normal signal and a fault signal; and  
 a feedback signal corresponding to the signal light turn-off is a waveform other than a lighting signal, and is set as a dangerous side.

9. A control method for a signal light, which implements, based on the signal light system according to claim 8, lighting control of the signal light, **characterized in that** the control method comprises:

supplying, by a power supply, power to the signal light system, and starting the signal light system;  
 acquiring, by a control unit, circuit data of main circuits that comprises a current signal of an alternating-current side main circuit and a voltage signal of a direct-current side main circuit, and transmitting the current signal of the alternating-current side main circuit and the voltage signal of the direct-current side main circuit to the control unit;  
 determining, by the control unit, whether the current signal and the voltage signal meet a preset condition;  
 if the current signal and the voltage signal meet the preset condition, switching on a lighting circuit;  
 obtaining, by both a CPU1 and a CPU2 of the control unit, the current signal of the alternating-current side main circuit and the voltage signal of the direct-current side main circuit, and further determining whether data analysis results of the CPU1 and the CPU2 are consistent;

if the data analysis results of the CPU1 and the CPU2 are consistent, determining the obtained voltage signal and current signal; and presetting working ranges of the voltage signal and the current signal, and if the voltage signal and the current signal meet the working ranges, indicating that the main circuits work normally, and sending a normal signal to a lighting control circuit.

10. The control method according to claim 9, **characterized in that** after the step of obtaining, by both a CPU1 and a CPU2 of the control unit, the current signal of the alternating-current side main circuit and the voltage signal of the direct-current side main circuit, and further determining whether data analysis results of the CPU1 and the CPU2 are consistent, the method further comprises:

further evaluating a status of LED light panels; if the status of the LED light panels is normal, indicating that the main circuits work normally, and sending the normal signal or a fault signal to the lighting control circuit; and if the status of the LED light panels is abnormal, switching off the lighting circuit, sending, by the lighting circuit, a turn-off status signal to the lighting control circuit, and guiding the lighting circuit to a safe side.

11. The control method according to claim 9, **characterized in that** after the step of determining, by the control unit, whether the current signal and the voltage signal meet a preset condition, the method further comprises the following steps:  
if the current signal and the voltage signal do not meet the preset condition, switching off the lighting circuit, sending, by the lighting circuit, a turn-off status signal to the lighting control circuit, and guiding the lighting circuit to a safe side.

12. The control method according to claim 9, **characterized in that** after the step of supplying, by a power supply, power to the signal light system, and starting the signal light system, the method further comprises the following steps:

obtaining light intensity data acquired by a light intensity sensor in real time, and determining whether the light intensity meets a preset threshold, wherein the preset threshold is a light intensity range corresponding to a visibility distance of LED light panels in the daytime; if the light intensity meets the preset threshold, switching on the lighting circuit; and if the light intensity does not meet the preset threshold, increasing the brightness of driving the LED light panels, and until the preset thresh-

old is met, switching on the lighting circuit.

13. The control method according to claim 9, **characterized in that** after the step of supplying, by a power supply, power to the signal light system, and starting the signal light system, the method further comprises the following steps:

obtaining real-time temperature data acquired by a temperature sensor, and determining whether the temperature data meets a preset temperature range; if the temperature data meets the preset temperature range, switching on the lighting circuit; and if the temperature data does not meet the preset temperature range, switching off the lighting circuit, sending, by the lighting circuit, a turn-off status signal to the lighting control circuit, and guiding the lighting circuit to a safe side.

14. The control method according to claim 9, further comprising:

if the data analysis results of the CPU1 and the CPU2 are inconsistent, switching off the lighting circuit, sending, by the lighting circuit, a turn-off status signal to the lighting control circuit, and guiding the lighting circuit to a safe side.

15. The control method according to any one of claims 9 to 14, further comprising:

if the acquired voltage signal and current signal do not meet the working ranges, switching off the lighting circuit, sending, by the lighting circuit, the turn-off status signal to the lighting control circuit, and guiding the lighting circuit to the safe side.

16. The control method according to claim 10, **characterized in that** the evaluating a status of LED light panels specifically comprises the following steps:

determining whether a voltage of the LED light panels is normal; if the voltage of the LED light panels is abnormal, further determining whether the LED light panels are damaged by more than 30%; if the LED light panels are damaged by more than 30%, further determining whether the LED light panels are damaged by more than 50%; if the LED light panels are damaged by more than 50%, switching off the lighting circuit, sending, by the lighting circuit, the turn-off status signal to the lighting control circuit, and guiding the lighting circuit to the safe side; and if the LED light panels are damaged by no more than 50%, indicating that the main circuits work normally, and sending the fault signal to the lighting control circuit;

wherein after the step of determining whether a voltage of the LED light panels is normal, the method further comprises:

if the voltage of the LED light panels is normal, indicating that the main circuits work normally, and sending the normal signal to the lighting control circuit; and  
wherein after the step of determining whether the LED light panels are damaged by more than 30%, the method further comprises:  
if the LED light panels are damaged by no more than 30%, indicating that the main circuits work normally, and sending the normal signal to the lighting control circuit.

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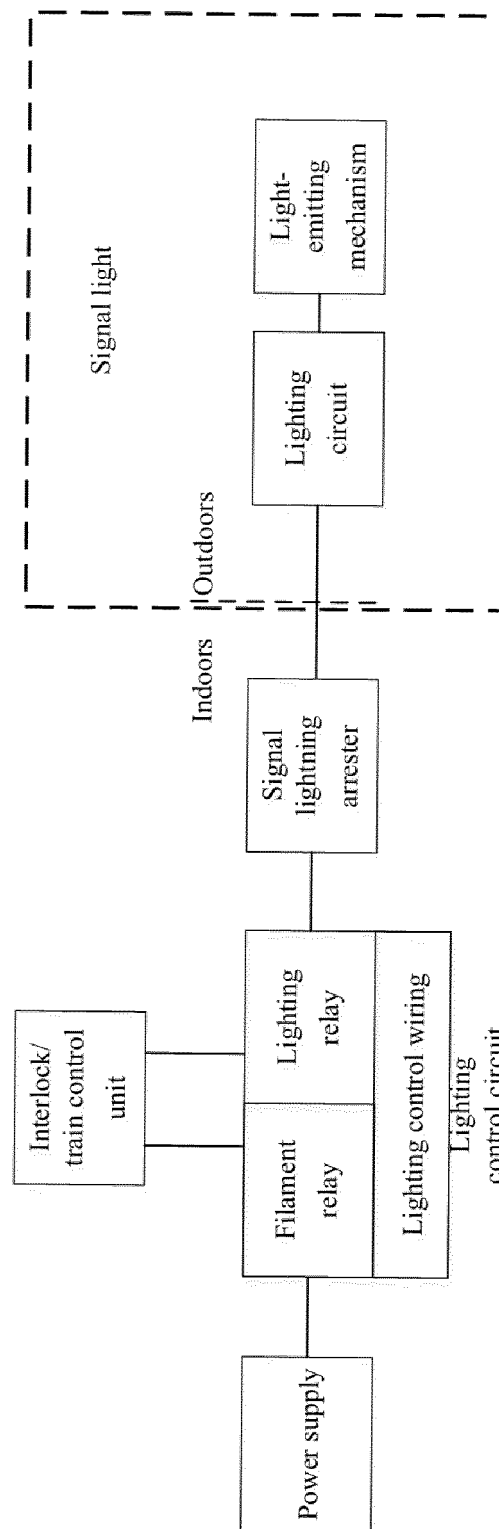


FIG. 1

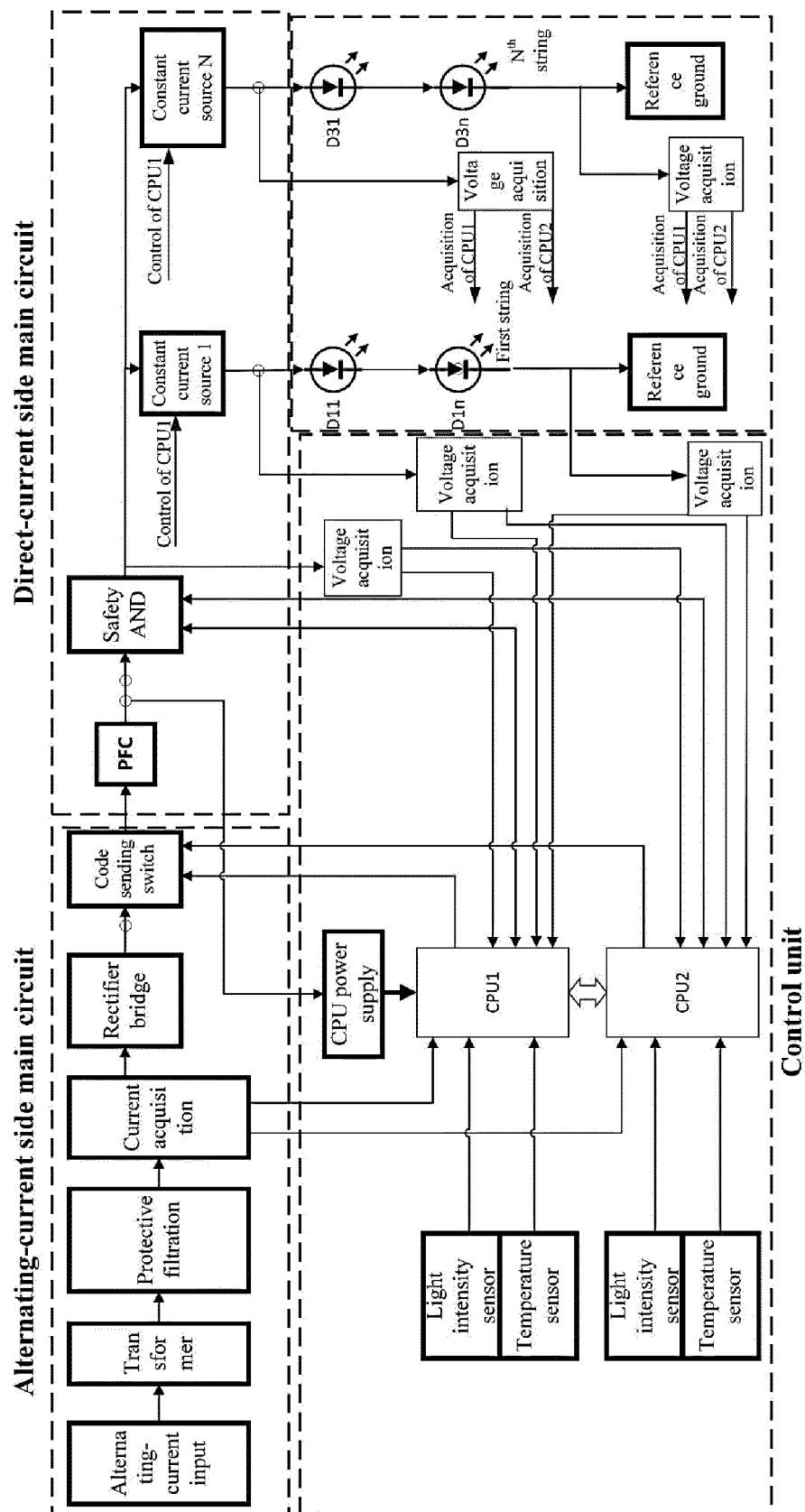


Fig.2

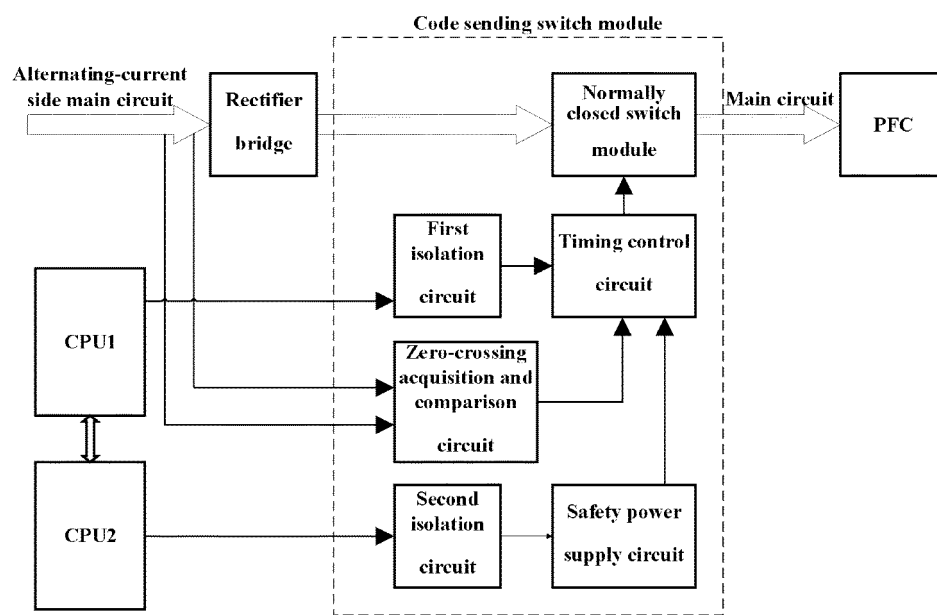


Fig.3

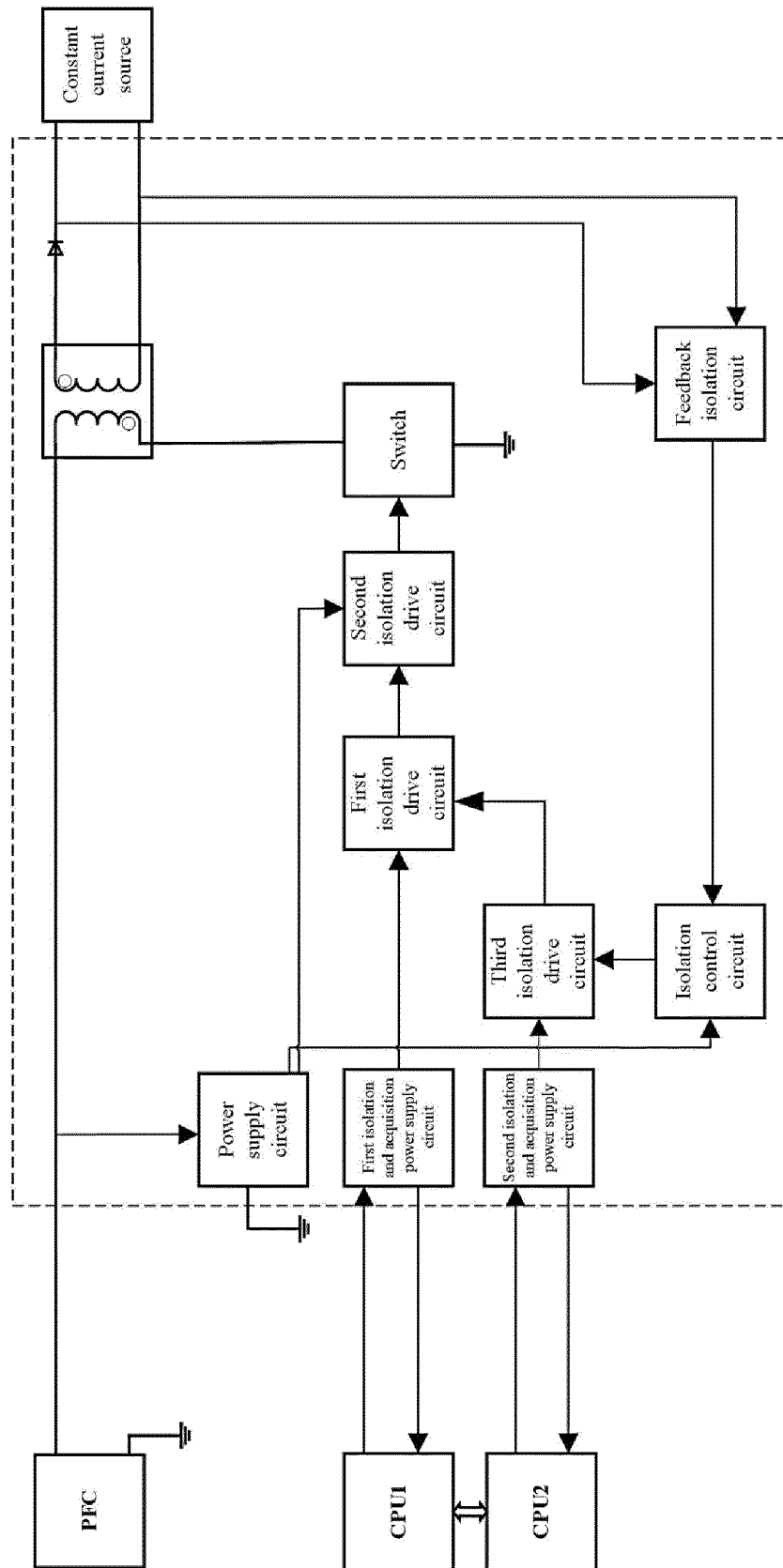


Fig.4

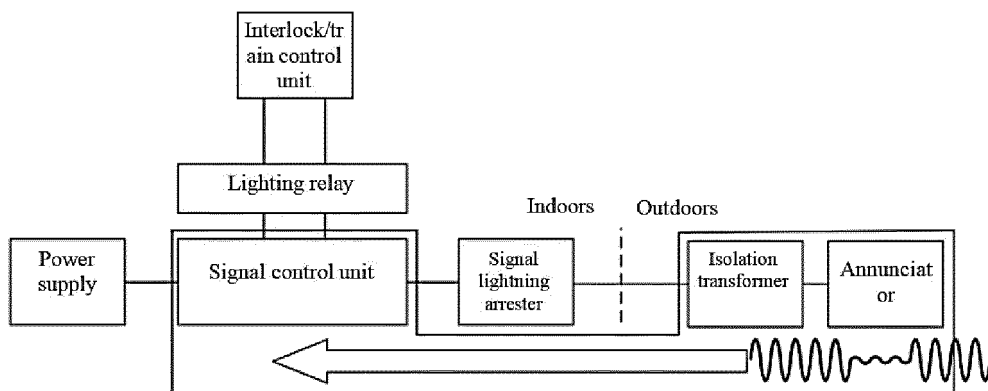


Fig.5

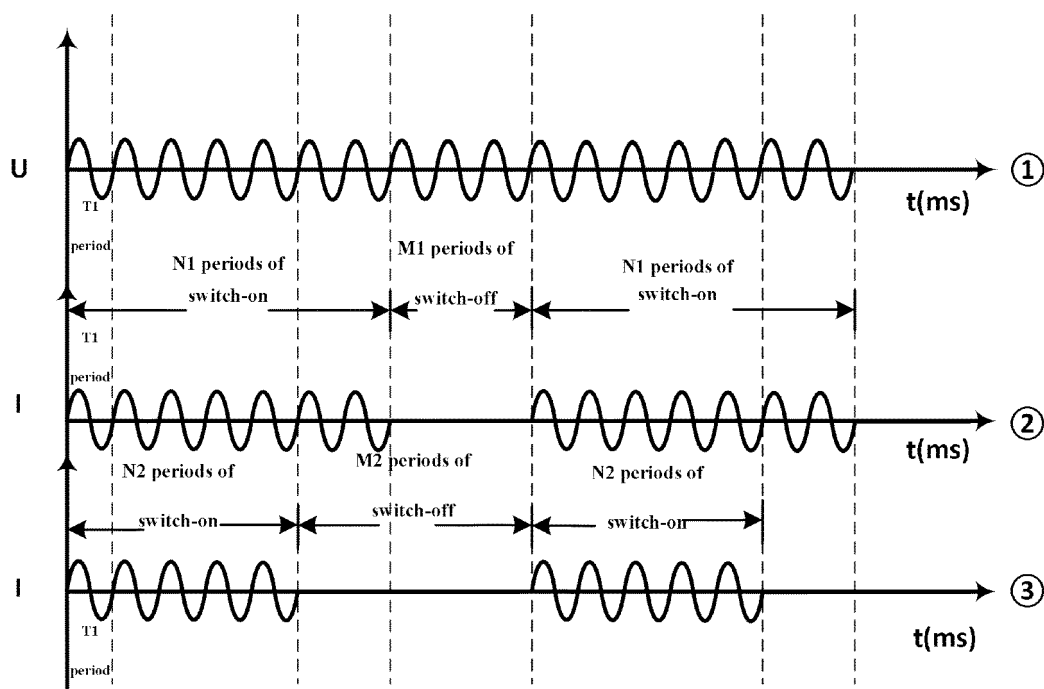


Fig.6

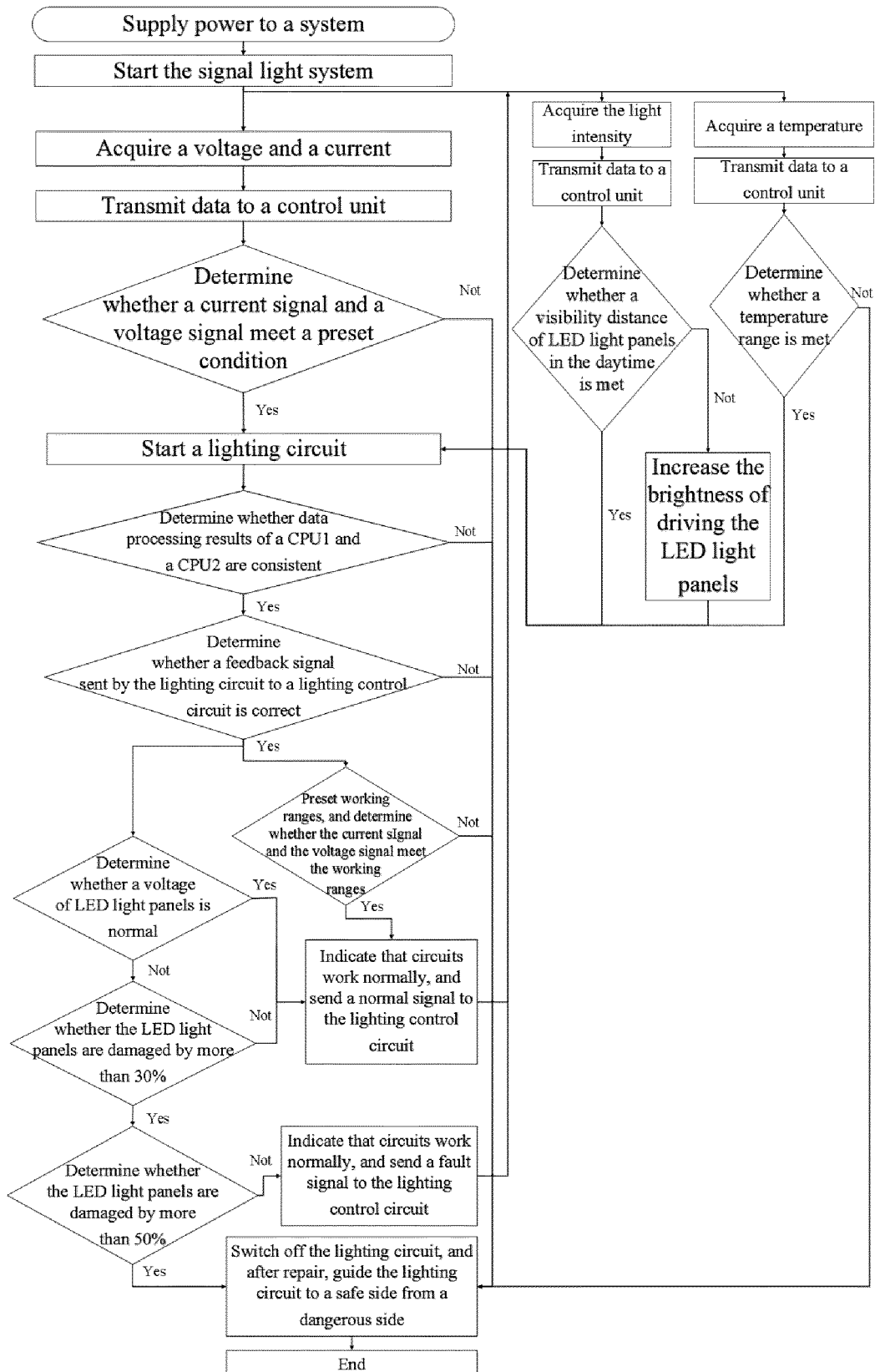


Fig.7