



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
26.12.2018 Bulletin 2018/52

(51) Int Cl.:
H05B 33/08 (2006.01)

(21) Application number: **17177293.2**

(22) Date of filing: **22.06.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(72) Inventor: **The designation of the inventor has not yet been filed**

(74) Representative: **Rüber, Bernhard Jakob**
Lumileds Germany GmbH
Intellectual Property
Philipsstraße 8
52068 Aachen (DE)

(71) Applicant: **Lumileds Holding B.V.**
1118 BG Schiphol (NL)

(54) **CIRCUIT FOR ASSISTING OUTAGE DETECTION OF LED LAMP AND CORRESPONDING LED LAMP SYSTEM**

(57) The present invention provides a circuit (300, 400) for assisting outage detection of at least one LED lamp (101), comprising: a load module (102), powered by a power supply, and configured to increase current for outage detection of the at least one LED lamp (101) to avoid undesired warnings when electrically coupled to the at least one LED lamp (101); a failure detection module (301), electrically coupled to the at least one LED lamp (101), configured to detect failure of the at least one

LED lamp (101), and: in response to detecting the at least one LED lamp (101) as a whole not failing, electrically couple the load module (102) to the at least one LED lamp (101); and in response to detecting the at least one LED lamp (101) as a whole failing, electrically decouple the load module (102) from the at least one LED lamp (101). The present invention further provides a corresponding LED lamp system (3000, 4000).

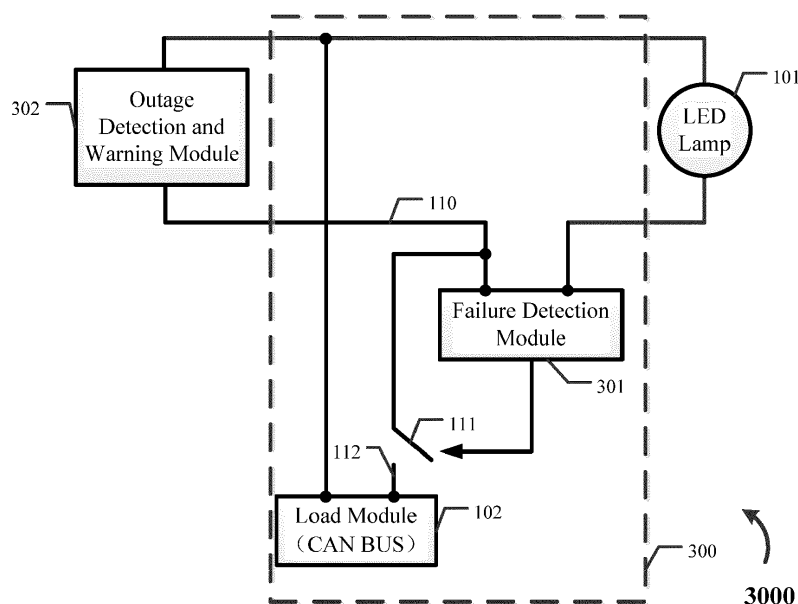


Fig. 3

Description

TECHNICAL FIELD

[0001] The present invention relates to LED lamps for vehicles, or particularly, the present invention relates to a circuit for detecting outage of an LED lamp and a corresponding LED lamp system.

BACKGROUND

[0002] Many automotive vehicles have a component which can provide a warning to the operator, such as the driver, when an exterior lamp has failed. This can be important particularly in large vehicles, where it may be difficult or impossible for the operator, such as the driver, to visually observe that an exterior lamp on the vehicle has failed.

[0003] Traditional vehicles have been developed which detect current of a halogen lamp and give warning (for example, lamp malfunction indicator or abnormal blinking) in case of detected outage - the current is below a predetermined threshold. This is generally done by a Body Control Module (BCM) of a vehicle.

[0004] More and more modern vehicles are increasingly utilizing light emitting diodes (LEDs) as a light source. These LED lamps can also fail open in a similar fashion as traditional halogen lamps. However, a typical LED lamp uses much less current than their halogen counterparts. Therefore, the current of even a normal LED lamp may be below the predetermined threshold, and result in undesired warnings for example by the BCM. The issue is complicated when a single vehicle such as a trailer may need to mount on it either halogen lamps or LED lamps at different times. The issue is further complicated by lack of a standard in the world for reporting or detection of failed lamps. For example, the predetermined thresholds for giving abnormal blinking differ among different carmakers, or even differ among the same model but of different model years by the same carmaker.

[0005] One solution to cancel the undesired warnings is to employ an extra-powered load module, which can increase current for outage detection, to be above a predetermined threshold so that for example the BCM no longer takes it as a failed LED lamp. Generally the extra-powered load module is a Controller Area Network Bus (CANBUS). However, when the LED lamp fails, the CANBUS is still consuming power and the current for outage detection is still above the threshold so that the BCM still takes the LED lamp as a normally working lamp and does not trigger any warning. It makes the driver not aware of the LED lamp's failure, and it's particularly dangerous when the LED lamp is a turn signal lamp which may possibly cause traffic accidents.

[0006] The problems mentioned above apply similarly to scenarios other than vehicles, where centralized outage detection is applied for power consumers of various

current levels, such as a smart home system, a road system, etc.

SUMMARY

[0007] Therefore, it is an object of the present invention to solve at least one of the above-mentioned problems.

[0008] According to one aspect of the invention, there is provided a circuit for assisting outage detection of at least one LED lamp, comprising: a load module, powered by a power supply, configured to increase current for outage detection of the at least one LED lamp to avoid undesired warnings when electrically coupled to the at least one LED lamp; a failure detection module, electrically coupled to the at least one LED lamp, configured to detect failure of the at least one LED lamp, and: in response to detecting the at least one LED lamp as a whole not failing, electrically couple the load module to the at least one LED lamp; and in response to detecting the at least one LED lamp as a whole failing, electrically decouple the load module from the at least one LED lamp.

[0009] Preferably, the at least one LED lamp comprises a group of LED lamps connected in series, parallel, or in a combination thereof.

[0010] Preferably, the at least one LED lamp belongs to one of: LED lamps mounted exteriorly on a vehicle, LED road lamps, or home-used LED lamps of a smart home system.

[0011] Preferably, when the at least one LED lamp belongs to LED lamps mounted exteriorly on a vehicle, the LED lamp comprises: an LED stop turn tail lamp, an LED turn signal lamp, an LED marker lamp, an LED fog lamp, an LED headlamp, an LED daytime running lamp, an LED indicator lamp, an LED interior lamp, an LED reversing lamp, an LED brake lamp, an LED navigation lamp, and/or an LED anti-collision lamp.

[0012] Preferably, the load module is a Controller Area Network (CAN) bus.

[0013] Preferably, the circuit as mentioned above further comprises: a voltage generation module, configured to generate input voltages required by the failure detection module and the load module, out of a power supply for the at least one LED lamp, without knowledge of a polarity of the power supply for the at least one LED lamp.

[0014] According to another aspect of the invention, there is provided an LED lamp system, comprising: at least one set of LED lamps, with each set of the at least one set of LED lamps comprising at least one LED lamp; an outage detection and warning module electrically coupled to each set of the at least one set of LED lamps via two power cables; and an inventive circuit for each set of the at least one set of LED lamps; wherein in each such circuit the failure detection module interrupts one of the two power cables into two parts, and electrically couples between the two parts; the outage detection and warning module being configured to: perform outage detection of the at least one set of LED lamps; and output a warning if any set, as a whole, of the at least one set

of LED lamps is in an outage.

[0015] By scenarios or as a whole, the present invention will probably avoid undesired warnings while still enable desired warnings for LED lamps, without amendments to a traditional outage detection and warning module for LED lamps, so it's easy and feasible to update traditional lamp systems without changing their traditional outage detection and warning module, particularly for vehicles, and also applicable for other systems with similar warning functionalities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention will be described in detail by reference to the following drawings, in which:

- FIG. 1 is a schematic view of an LED lamp system comprising a load module for assisting outage detection of an LED lamp in accordance with the prior art;
- FIG. 2 is a schematic view of power consumption of an LED lamp and a halogen lamp in a failed and a normal status respectively in accordance with the prior art;
- FIG. 3 is a schematic view of an LED lamp system in accordance with an embodiment of the present invention;
- FIG. 4 is a schematic view of an LED lamp system in accordance with another embodiment of the present invention;
- FIG. 5 is a perspective view of a vehicle illustrating an example environment in which embodiments of the present invention can be implemented; and
- FIG. 6 is a schematic view of power consumption of an LED lamp and a halogen lamp in a failed and a normal status respectively in accordance with the invention.

DETAILED DESCRIPTION

[0017] Embodiments of the present invention will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

[0018] As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0019] The terms outage and failing generally refer to a status of failing open, interrupting, disconnecting, breaking, and the like, or a status of insufficient operating, for example, current flowing through a lamp being below a predetermined threshold.

[0020] The objects identified with the same reference number throughout the figures represent similar or identical objects, and can have similar or identical features.

[0021] FIG. 1 is a schematic view of an LED lamp system 100 comprising a load module 102 for assisting outage detection of an LED lamp in accordance with the prior art. In figure 1, a load module 102, for example a CANBUS, is connected in parallel with an LED lamp 101, both powered by the same power supply, which load module 102 can increase current for outage detection so that for example the BCM of a vehicle no longer takes the LED lamp 101 as a failed lamp.

[0022] The LED lamp 101 can be any exterior lamp of a vehicle, such as a motorcycle, a car, a van, a truck, a trailer, or even a plane, or any kind of vehicles. The LED lamp 101 can be an LED Stop Turn Tail (STT), turn, marker, fog, head, daytime running, indicator, interior, reversing, and/or brake lamp, etc.. In particular, the LED lamp 101 can be of vital importance in the vehicle, such as a turn signal lamp and/or a brake lamp of a vehicle that help avoid a traffic accident, or a navigation lamp and/or an anti-collision lamp of a plane that help avoid a crash. It could also be a road lamp, or a home-used LED lamp of a smart home system that is under automatic outage detection similarly.

[0023] It should be understood that the LED lamp system 100 may be duplicated for multiple LED lamps.

[0024] It should also be understood that the LED lamp 101 may comprise a single LED lamp, or several LED lamps connected in series, parallel, or in any suitable combination thereof.

[0025] See also FIG. 2, which is a schematic view of power consumption of an LED lamp and a halogen lamp in a failed and a normal status respectively in accordance with the prior art. The first line of FIG. 2 shows power consumption of the LED lamp 101 together with the load module (for example, a CANBUS) 102 is about 15 W when the LED lamp 101 fails, i.e., power consumption of the LED lamp 101 is about 0 W and power consumption of the load module (for example, a CANBUS) 102 is about 15 W. It is above an outage detection threshold of 12 W, so that an outage detection module, such as the BCM of a vehicle, still takes the LED lamp 101 as a normally working lamp and does not trigger any warning. It makes the operator, such as the driver, not aware of the LED lamp's failure, which is undesired, as it's particularly dangerous when the LED lamp is a turn signal lamp, which may possibly cause traffic accidents.

[0026] The second line in FIG. 2 shows that the power consumption of the LED lamp 101 together with the load module (for example, a CANBUS) 102 is about 21 W when the LED lamp 101 is in a normal functioning status, i.e., power consumption of the load module (for example, a CANBUS) 102 is still about 15 W and power consumption of the LED lamp 101 is about 6 W.

[0027] As a comparison to a traditional halogen lamp without any extra-powered load module 102, power consumption of the traditional halogen lamp is also discussed here. As shown in the third line of FIG. 2, as there is no extra-powered load module 102 to increase current for outage detection, the detected power consumption of

the halogen lamp when it fails is about 0 W. It is obviously lower than the predetermined threshold, and thus triggers a warning of the failure. As shown in the fourth line of FIG. 2, as there is no extra-powered load module 102 to increase current for outage detection, the detected power consumption of the halogen lamp when it is in a normal functioning status, is the power consumption of the halogen lamp itself, shown as about 21 W. It is above the threshold of 12 W so that an outage detection module, such as the BCM of a vehicle, gets to know that the LED lamp is normally and does not trigger any warning.

[0028] It is noted above power values with reference to FIG. 2 are given just as an example to show the scheme, while different vehicle models have different values.

[0029] FIG. 3 is a schematic view of an LED lamp system in accordance with an embodiment of the present invention. The LED lamp system 3000 comprises an LED lamp 101, a load module 102, a failure detection module 301, and an outage detection and warning module 302. The load module 102 and the failure detection module 301 in combination can be called a circuit for assisting outage detection 300 which may be duplicated for multiple LED lamps.

[0030] It should also be understood that the LED lamp 101 may comprise one LED lamp, or a group of LED lamps connected in series, parallel, or in any suitable combination thereof. As such, the group of LED lamps should be taken as a whole to determine its failure. Therefore, there are cases that as soon as one LED lamp fails, the group of LED lamps fails (for example when the LED lamps are connected in series), or cases that the group of LED lamps may be considered not failing unless all the LED lamps fail (for example when the LED lamps are connected in parallel and a single functioning LED lamp still fulfils the purpose the group of LED lamps is designed for).

[0031] The outage detection and warning module 302 is configured to detect outage of the LED lamp 101 and triggers a warning if the LED lamp 101 is in outage, for example, its current or power consumption is below a predetermined threshold. The threshold may vary according to different scenarios of the LED lamp system 3000, however, the threshold in terms of power consumption is definitely higher than power consumption of any failed or insufficiently functioning LED lamp (generally the LED lamp consumes much less current than traditional halogen lamps, such as tens of milliamps and the threshold in terms of power consumption is even higher than power consumption of a normally functioning LED lamp), and at the meantime, lower than power consumption of the load module 102 (for example 15W). As an example but not limitation, the threshold in terms of power consumption is set to 12 W in a vehicle scenario.

[0032] The load module 101 should be powered to provide an extra current or extra power consumption for outage detection. The failure detection module 301 is electrically coupled to the LED lamp 101, particularly to one

of two power cables of the LED lamp 101. The failure detection module 301 interrupts the power cable 110 it's coupled to into two parts and connects with each part. The failure detection module 301 is powered by the power cables and can sense the current drawn by the LED lamp 101. In response to determining that the LED lamp is functioning normally the failure detection module 301 electrically couples the load module 102 to the LED lamp 101 by closing an electrical contact between extension 111 of power cable 110 and terminal 112 of load module 102, to increase current (or, in other words, to increase power consumption) for assisting outage detection, so that the current or power consumption of the LED lamp 101 together with the load module 102 is above a predetermined threshold for outage warning. As a result, no warning will be triggered by the outage detection and warning module 302 when the LED lamp is functioning normally, as desired. In response to determining that the LED lamp fails, the failure detection module 301 electrically decouples the load module 102 from the LED lamp 101 by opening the electrical contact between extension 111 of power cable 110 and terminal 112 of load module 102, so that the load module 102 is disconnected from the power cables of the LED lamp 101 and does not anymore increase the current (or power consumption) drawn by LED lamp 101. As a result, the outage detection and warning module 302 can detect the actual status of the LED lamp 101 and will trigger a warning only on a true failure of LED lamp 101, as desired.

[0033] FIG. 4 is a schematic view of an LED lamp system in accordance with another embodiment of the present invention. The LED lamp system 4000 in FIG. 4 comprises an LED lamp 101, a load module 102, a failure detection module 301 and an outage detection and warning module 302. The LED lamp system 4000 in FIG. 4 is used for outage detection of the LED lamp 101.

[0034] The load module 102 and the failure detection module 301 in combination can be called a circuit for assisting outage detection 400, which may be duplicated for multiple LED lamps.

[0035] The load module 102 is shown as a resistor R6 of for example 11 Ω that can work at 15W, for example, it is a CANBUS configured to avoid undesired warning for an LED lamp in a vehicle. One end of the resistor R6 is connected to voltage Vcc. Details of the voltage Vcc will be described in the following.

[0036] The failure detection module 301 is operationally connected to the LED lamp 101, particularly to a power cable between the LED lamp 101 and the outage detection and warning module 302. The failure detection module 301 interrupts the power cable into two parts and has its two terminals each connect with a respective part, at point A and point B respectively as shown, without any need of concerning polarities of the two parts.

[0037] In the failure detection module 301, there are several resistors R1, R2, R3, R4 and R5 connected as shown in FIG. 4, to generate a potential difference, to be input to a current monitor CM1 (e.g., INA 199 of Texas

Instruments, whose reference is set as 6V) to generate an output voltage proportional to the potential difference. A capacitor C1 is connected in between points F and G. The current monitor CM1 is in turn connected to a dual operational amplifier DOP1 (e.g., LM2904 of Texas Instruments), comprising two independent operational amplifiers OP1 and OP2. Output of the dual operational amplifier DOP1 is connected to a switch S1 (e.g., NMOS, with its gate connected to the output end of the dual operational amplifier DOP1, its drain connected to the other end of the resistor R6, and its source connected to the ground).

[0038] The failure detection module 301 further comprises a voltage generation module 401 for generating input voltages required by the failure detection module 301 and the load module 102, out of point A and B on one of the two power cables for the LED lamp 101 and C on the other of the two power cables for the LED lamp 101, without knowledge of a polarity of the two power cables for the LED lamp 101.

[0039] In the voltage generation module 401, A, B, and C points on the two power cables operate as inputs, each connecting to a diode bridge (D1, D2, D3, D4, D5, D6), the bridge rectifies polarity voltage to power others. The cathode of diodes D1, D2 and D3 are connected together to generate a stable voltage Vcc. The cathode of diodes D1, D2 and D3 are further connected to a voltage reference VR1 (e.g., TLV431 supplied of Texas Instruments) to generate a stable voltage to three resistors R9, R10 and R11 as illustrated.

[0040] In the embodiment shown in figure 4, the LED lamp system 4000 operates as follows.

[0041] When the LED 101 is activated by the operator, the voltage supply from power cables causes current to flow through the LED lamp 101 if it's functioning properly, either in the direction from point B to point C, or in the reverse direction. Current will also flow between points A and B through resistor R5, so that voltages at points A and B are different. If resistors R1, R2, R3 and R4 are properly selected, there will be a potential difference between points D and E, and thus the same between points F and G. The current monitor CM1 gets the potential difference and amplify it several times to be for example +6V or -6V (as we don't know current direction between points A and B, the potential difference between points F and G may be negative or positive). The reference input Ref of the current monitor CM1 may for example be 6V, then output of the current monitor CM1 may be about 0V or 12V in this case, which operates as an input to the dual operational amplifier DOP1, where the output of the current monitor CM1 will be compared with for example 3V in operational amplifier OP1, or with for example 9V in operational amplifier OP2. If the output of the current monitor CM1 is larger than for example 9V or smaller than for example 3V, the dual operational amplifier DOP1 will output a positive voltage to control input of the switch S1, i.e., the gate of the NMOS shown in FIG. 4. 3V and 9 V rather than 0V and 12V are applied to get prepared

for noise or unsteadiness. Values of the resistors R7 and R8 may be selectively set in order to ensure that control input of the switch S1 is working at a correct range. With a positive voltage (above 4V) between gate and source supplied to the control input of the switch S1, the switch S1 is fully turned on and allow current to flow through R6. At the meantime, as the switch S1 is on, current will flow through resistor R6 powered by Vcc, then through the switch S1, and to the ground. In other words, the load module 102 is enabled to electrically couple to the LED lamp, so that current or power consumption detected by the outage detection and warning module 302 is increased, to be above a predetermined threshold. As a result, no warning will be triggered when the LED lamp is functioning normally, as desired.

[0042] However, if the LED lamp 101 fails open, current flow to the R5 interrupted. This may cause the switch S1 to turn off, interrupting current flow from input of the switch S1 (i.e., the source of the NMOS shown as an un-limiting example in FIG. 4) to the output of the switch S1. Then current through resistor R6 to the ground is interrupted. Therefore, current or power consumption detected by the outage detection and warning module 302 is not increased by the load module 102. Then actual status of the LED lamp can be detected by the outage detection and warning module 302. As a result, at least a warning may be triggered when the LED lamp fails open, as desired.

[0043] Further, the voltage generation module 401 operates as follows. D1, D2, D3, D4, D5 and D6 act as a power rectifier, points A, B and C are from the power cables of the lamp, which are connecting to D1, D2, D3, D4, D5 and D6 respectively as shown in FIG. 4, to generate Vcc and GND, so that points A, B and C could be connected without special polarity requirements, so called polarity free. Therefore the voltage Vcc at point L is about the same as that at point C. Meanwhile, current will flow from L through the voltage reference VR1, and through resistors R9, R10 and R11 in series, and to the ground. By properly setting values of R9, R10 and R11, we may get a voltage of 9V at point I, a voltage of 6V at point J, and a voltage of 3V at point K. Then Vcc will be provided to power resistor R6, the voltage of 9V will be provided to IN- end of the operational amplifier OP2, the voltage of 3V will be provided to IN+ end of the operational amplifier OP1, and the voltage of 6V will be provided to Ref input of the current monitor CM1. The voltage generation module 401 ensures voltage of Vcc and those at points I, J and K are positive voltages desired by respective modules, without concerning the current flow directions between points A, B and C.

[0044] However, if the LED lamp 101 fails open, there will be no current through R5.

[0045] It is noted that the failure detection module 301 and the load module 102 shown in FIG 4 are only for illustration purpose and not as a limitation to implement embodiments of the present invention. One skilled in the art may think of other implementations to achieve similar

functionalities, motivated and/or prompted by our solution as described herein. For example, by properly designing the circuit by one skilled in art, the failure detection module 301 may not only detect the status of failing open, but also other outage statuses.

[0046] FIG. 5 is a perspective view of a vehicle illustrating an example environment in which embodiments of the present invention can be implemented. In this example, the circuit for assisting outage detection 300 or 400 as described above is located in the cabin 504 of a vehicle 500. Also, the outage detection and warning module 302 as described above is located in the cabin 504 of the vehicle 500. As an example, but not limitation, the load module 102 is a CANBUS configured to avoid an undesired warning for an LED lamp in the vehicle 500. As an example, but not limitation, the outage detection and warning module 302 is a Body Control Module of the vehicle. The failure detection module 301 can include any of the circuits 301 disclosed herein, mainly with reference to FIG. 3 and FIG. 4. Alternatively, the failure detection module 301, the load module 102, and the outage detection and warning module 401 can be mounted on any other parts of the vehicle 500, either together or separately. LED lamps or groups of LED lamps electrically connected in series, in parallel, or in any suitable combination thereof, can be associated with one or more circuits for assisting outage detection. For example, the two turn signal lamps 502 on the rear-vision mirror of the vehicle 500 can use two circuits for assisting outage detection separately. Alternatively, other LED lamps on the vehicle 500 can be electrically connected to any of the circuits for assisting outage detection disclosed herein. These LED lamps may be used such as for LED Stop Turn Tail (STT), turn, marker, fog, head, daytime running, indicator, interior, reversing, and/or brake lamps, etc.. The vehicle 500 can also have for example daytime running lights 501 and brake lights 503 electrically connected to one or more circuits for assisting outage detection as disclosed herein. These circuits for assisting outage detection can be electrically connected to the outage detection and warning module 302 so that LED failures can be communicated to the operator. The outage detection and warning module 302 may use different power supplies and/or ground references than the circuits used to power the LED lamps. For example, the vehicle 500 may have an independent power supply to power its LED lamps and other equipment that is isolated from the power supply of the cabin 504. The components of circuits 300 or 400 may be included within a single outer casing, such as a vehicle lamp outer casing. Alternatively, certain components may be located in separate outer casings or in an intermediary outer casing between the lamp outer casing and the vehicle.

[0047] It is noted that the vehicle 500 is only one example environment in which embodiments of the present invention can be implemented. The circuits described with reference to figures 3 and 4 are not limited to vehicles only, but are also applicable for other systems with similar

warning functionalities.

[0048] FIG. 6 is a schematic view of power consumption of an LED lamp and a halogen lamp in a failed and a normal status respectively in accordance with the invention. The first line of FIG. 6 shows power consumption of the LED lamp 101 together with the circuit for assisting outage detection 300 or 400, including the load module (for example, a CANBUS) 102, is about 0 W when the LED lamp 101 fails, i.e., power consumption of the LED lamp 101 is about 0 W and power consumption of the load module (for example, a CANBUS) 102 is also about 0 W, due to it having been decoupled from the LED lamp when the LED lamp fails. This is below the threshold of 12 W so that the outage detection and warning module 302, such as the BCM of a vehicle, knows that the LED lamp has failed and triggers a corresponding warning. It makes the operator, such as the driver, aware of the LED lamp's failure, which is desired.

[0049] The second line in FIG. 6 shows that the power consumption of the LED lamp 101 together with the circuit for assisting outage detection 300 or 400, including the load module (for example, a CANBUS) 102, is about 21 W when the LED lamp 101 is in a normal functioning status, i.e., power consumption of the load module (for example, a CANBUS) 102 is about 15 W and power consumption of the LED lamp 101 is about 6 W.

[0050] For comparison, the third and fourth lines of FIG. 6 again show the failed and normal functioning states of a traditional halogen which has already been explained in connection with FIG. 2.

[0051] While the exemplary embodiments of the present invention have been illustrated and described, it will be understood by those skilled in the art that various changes and modifications may be made, and equivalents may be substituted for elements thereof without departing from the true scope of the present invention. In addition, many modifications may be made to adapt to a particular situation and to the teaching of the present invention without departing from its central scope. Therefore it is intended that the present invention is not limited to the particular embodiments disclosed as the best modes contemplated for carrying out the present invention, but that the present invention includes all embodiments falling within the scope of the appended claims.

LIST OF REFERENCE SIGNS

[0052]

100	LED lamp system of the prior art
101	LED lamp
102	load module
110	power cable coupled to the failure detection module
111	extension of power cable 110
112	terminal of load module to be coupled to or decoupled from power cable 110
300	circuit for assisting outage detection

301 failure detection module
 302 outage detection and warning module
 400 circuit for assisting outage detection
 401 voltage generation module
 500 vehicle
 501 daytime running lights of vehicle
 502 turn signal lamps of vehicle
 503 brake lights of vehicle
 504 cabin of vehicle
 3000 LED lamp system according to an embodiment of the invention
 4000 LED lamp system according to another embodiment of the invention

Claims

1. A circuit (300, 400) for assisting outage detection of at least one LED lamp (101), comprising:

- a load module (102), powered by a power supply, configured to increase current for outage detection of the at least one LED lamp to cancel undesired warnings when electrically coupled to the at least one LED lamp (101);
 - a failure detection module (301), electrically coupled to the at least one LED lamp (101), configured to detect failure of the at least one LED lamp (101), and:

in response to detecting the at least one LED lamp (101) as a whole not failing, electrically couple the load module (102) to the at least one LED lamp (101); and
 in response to detecting the at least one LED lamp (101) as a whole failing, electrically decouple the load module (102) from the at least one LED lamp (101).

2. The circuit (300, 400) of claim 1, wherein the at least one LED lamp (101) comprises a group of LED lamps connected in series, parallel, or in a combination thereof.

3. The circuit (300, 400) of claim 1 or 2, wherein the at least one LED lamp (101) belongs to one of: LED lamps mounted exteriorly on a vehicle, LED road lamps, home-used LED lamps of a smart home system.

4. The circuit (300, 400) of claim 3, wherein when the at least one LED lamp belongs to LED lamps mounted exteriorly on a vehicle, the LED lamp comprises: an LED stop turn tail lamp, an LED turn signal lamp, an LED marker lamp, an LED fog lamp, an LED headlamp, an LED daytime running lamp, an LED indicator lamp, an LED interior lamp, an LED reversing lamp, an LED brake lamp, an LED navigation lamp,

and/or an LED anti-collision lamp.

5. The circuit (300, 400) of claim 1 or 2, wherein the load module (102) is a Controller Area Network (CAN) bus.

6. The circuit (300, 400) of claim 1 or 2, further comprising:

- a voltage generation module (401), configured to generate input voltages required by the failure detection module (301) and the load module (102), out of a power supply for the at least one LED lamp (101), without knowledge of a polarity of the power supply for the at least one LED lamp (101).

7. An LED lamp system (3000, 4000), comprising:

- at least one set of LED lamps (101), with each set of the at least one set of LED lamps (101) comprising at least one LED lamp (101);
 - an outage detection and warning module (302) electrically coupled to each set of the at least one set of LED lamps (101) via two power cables; and
 - a circuit (300, 400) according to any of claims 1- 6 for each set of the at least one set of LED lamps (101);

wherein in each such circuit (300, 400) the failure detection module (301, 401) interrupts one (110) of the two power cables into two parts, and electrically couples between the two parts; and
 wherein the outage detection and warning module (302) is configured to:

- perform outage detection of the at least one set of LED lamps (101); and
 - output a warning if any set, as a whole, of the at least one set of LED lamps (101) is in an outage.

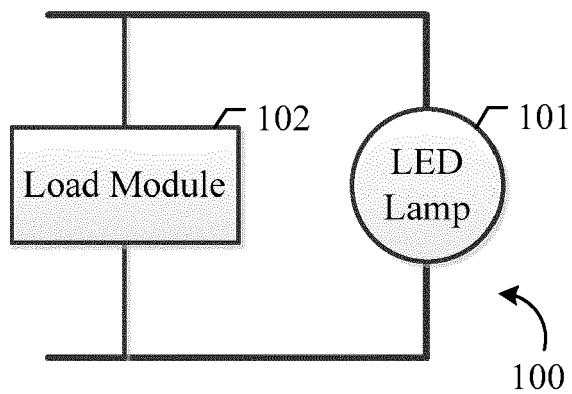


Fig. 1

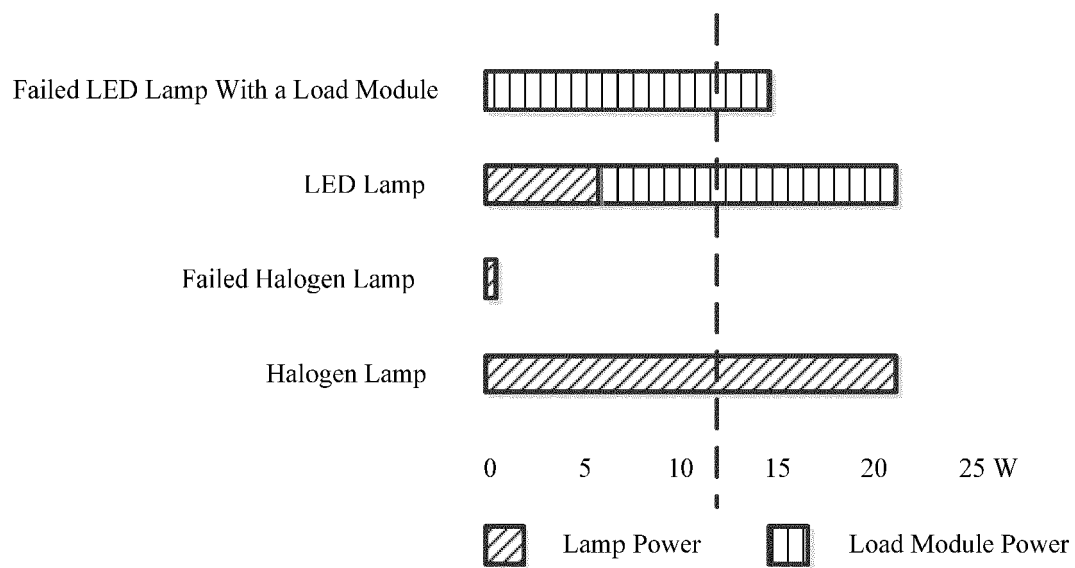


Fig. 2

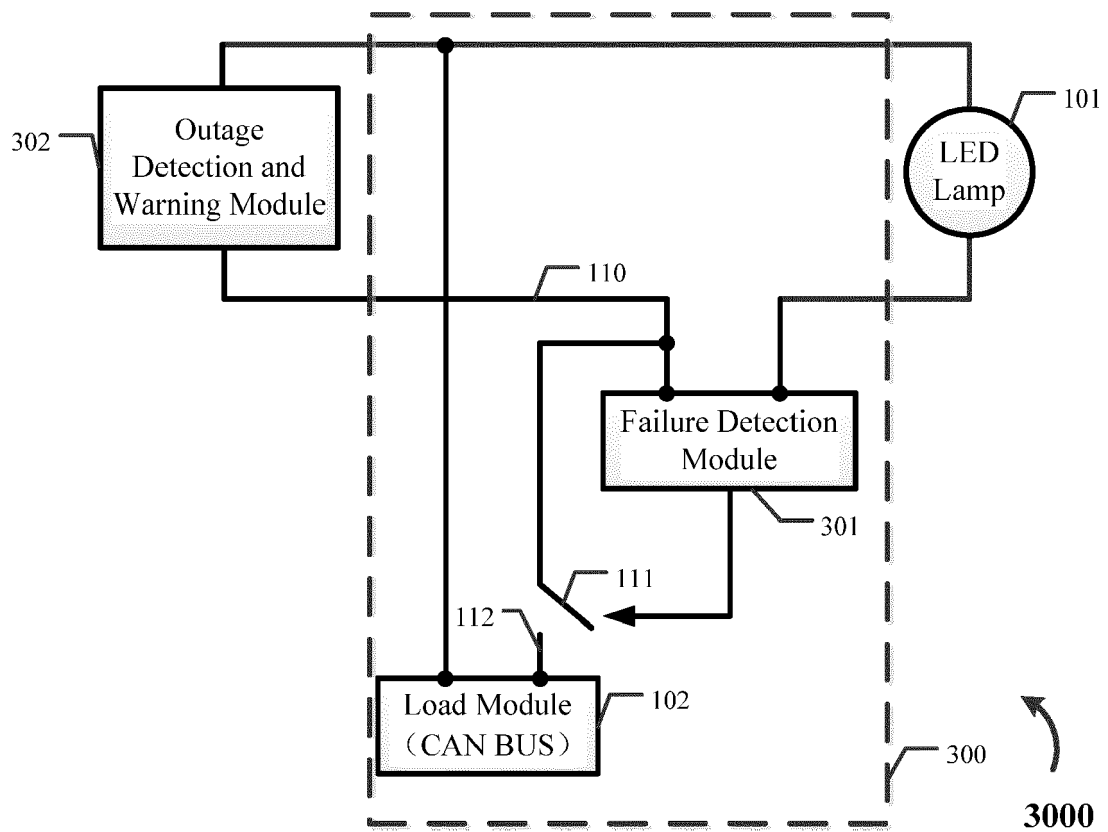


Fig. 3

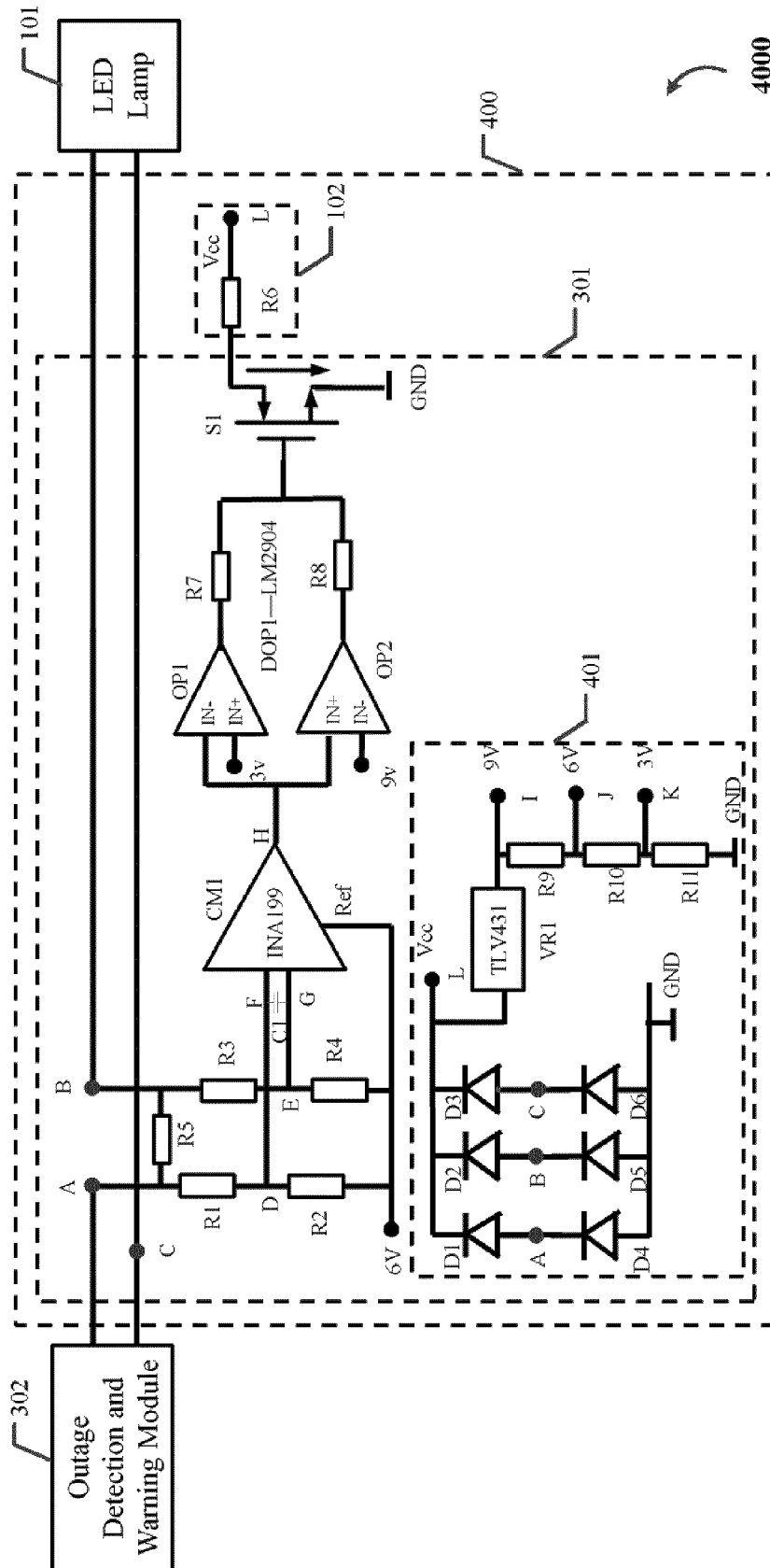


Fig. 4

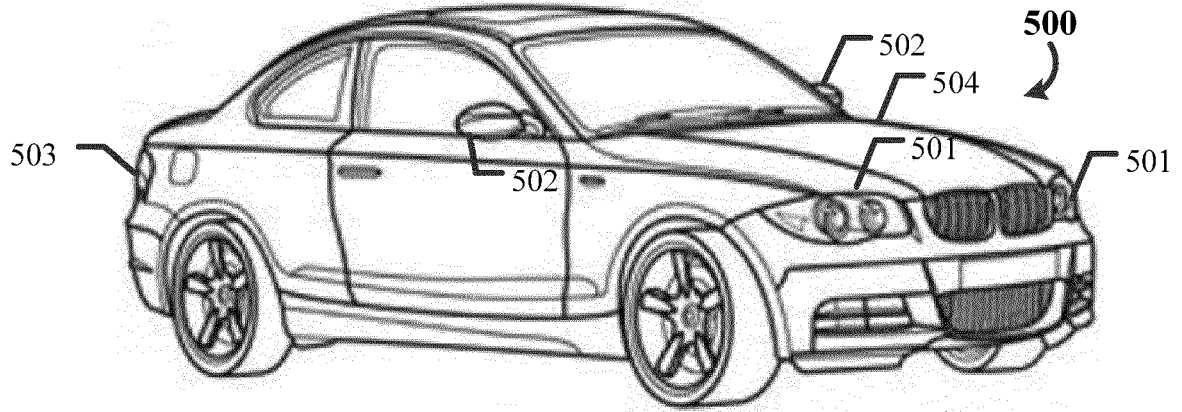


Fig. 5

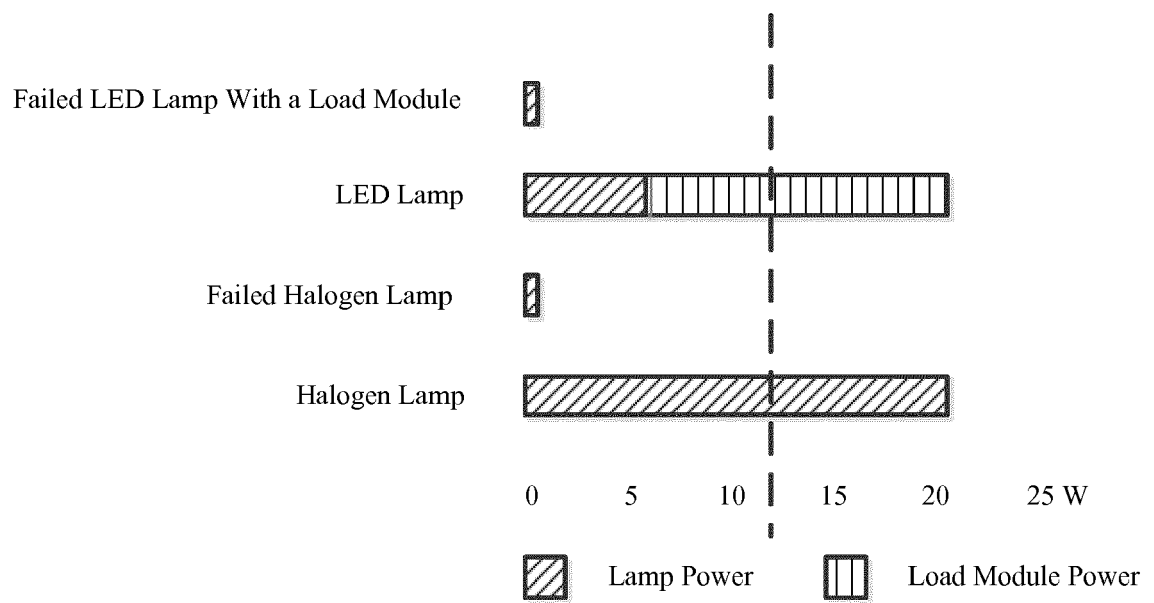


Fig. 6



EUROPEAN SEARCH REPORT

Application Number
EP 17 17 7293

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2011/062869 A1 (HSU CHENG-WEI [TW] ET AL) 17 March 2011 (2011-03-17) * column 3, line 40 - line 43; figure 3 * * column 3, line 6 - line 9 * * column 3, line 53 - column 4, line 1 * -----	1-7	INV. H05B33/08
X	EP 2 884 821 A2 (TRANSPORT TEKNIK AS [DK]) 17 June 2015 (2015-06-17) * paragraph [0015]; figures 1,5,12 * * paragraph [0028] * -----	1-7	
			TECHNICAL FIELDS SEARCHED (IPC)
			H05B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 December 2017	Examiner Garavini, Elisa
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

 1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 17 7293

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

18-12-2017

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011062869 A1	17-03-2011	CN 102009618 A	13-04-2011
		TW 201112877 A	01-04-2011
		US 2011062869 A1	17-03-2011
EP 2884821 A2	17-06-2015	EP 2884821 A2	17-06-2015
		RU 2014148523 A	27-06-2016

15

20

25

30

35

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82