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- (71) Applicant: **VALEO EQUIPEMENTS ELECTRIQUES MOTEUR** [FR/FR]; 2, rue Andre Boulle, 94046 Creteil (FR).
- (72) Inventor; and
- (71) Applicant (for BW only): **SHI, Sanbao** [CN/CN]; North Junyi Ind. Park, Huaide Vil., Fuyong Town, Baoan Dist., Shenzhen, Guangdong 518128 (CN).
- (74) Agent: **LIU, SHEN & ASSOCIATES**; 10th Floor, Building 1 10 Caihefang Road, Haidian District, Beijing 100080 (CN).

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(54) Title: DRIVING MODULE AND CONTROL UNIT OF A MOTOR VEHICLE

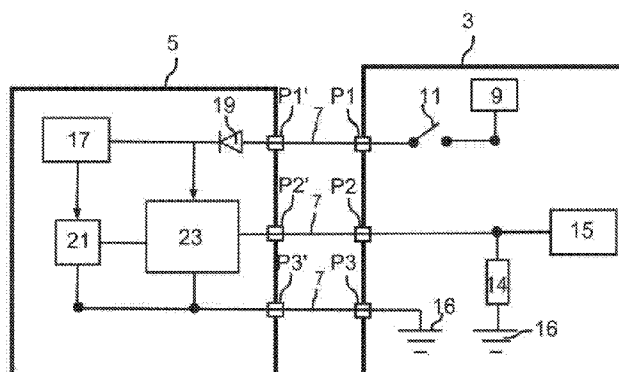


Fig. 1

(57) Abstract: A driving module (5) associated with an equipment of a motor vehicle is provided. The said driving module (5) is connected to a body controller module (3) of the motor vehicle and is configured for receiving activation signals from the body controller module (3) via an activation port (P1') and for transmitting outage signals to an outage port (P2'). The outage signals indicate a status of the associated equipment in response to the received activation signals, wherein the driving module (5) comprises: a microcontroller (21) configured for detecting an operativeness status of the associated equipment and for emitting command signals according to the detected operativeness status, and a control circuit (23) configured for converting the command signals emitted by the microcontroller (21) into outage signals adapted to the body controller module (3), wherein the control circuit (23) comprises a main transistor (Q1) coupled to the outage port (P2') and configured for modifying the value of the outage signals according to its state, wherein the control circuit (23) also comprises a protection circuit (27) configured for setting the main transistor (Q1) in a blocking state in case of a short circuit at the outage port (P2').

DRIVING MODULE AND CONTROL UNIT OF A MOTOR VEHICLE

TECHNICAL FIELD

5 The present invention refers to a driving module associated with an equipment of a motor vehicle and configured for exchanging signals with a body controller module in order to provide information to the body controller module about the status of the associated equipment. The present invention refers in particular to the control circuit used in the driving module for adapting the signals emitted by a
10 microcontroller in order to be detected by the body controller module.

BACKGROUND

 It is already known to use control circuits comprising a main transistor for adapting the signals emitted by the microcontroller of the driving module in order to
15 be detected by the body controller. The main transistor has generally its collector connected to an outage port of the body controller module and its base connected to the microcontroller either directly or via other components such as another transistor. Furthermore, in a high side configuration of the control circuit, the emitter of the main transistor is connected to a voltage supply.

20 However, with such control circuits, in case of a short circuit at the outage port of the body controller leading to the coupling of the collector of the main transistor to the ground, a higher voltage is supplied to the main transistor so that a large power has to be dissipated by the main transistor. As a consequence, an oversized transistor has to be used to withstand such high voltage and to enable power dissipation
25 without leading to a failure of the transistor due to the increase of temperature. However, such oversized transistor increases noticeably the cost of the control circuit.

It is therefore an aim of the present invention to provide an inexpensive control circuit comprising a protection of the transistor in case of a short circuit at the outage port of the body controller leading to a high voltage supplied to the main transistor.

5 SUMMARY

The present invention thus refers to a driving module associated with an equipment of a motor vehicle, the said driving module is connected to a body controller module of the motor vehicle and is configured for receiving activation signals from the body controller module via an activation port and for transmitting
10 outage signals to an outage port, the outage signals indicating a status of the associated equipment in response to the received activation signals wherein the driving module comprises:

- a microcontroller configured for detecting an operativeness status of the associated equipment and for emitting command signals according to the detected
15 operativeness status and,

- a control circuit configured for converting the command signals emitted by the microcontroller into outage signals adapted to the body controller module wherein the control circuit comprises a main transistor coupled to the outage port and configured for modifying the value of the outage signals according to its state,

20 wherein the control circuit also comprises a protection circuit configured for setting the main transistor in a blocking state in case of a short circuit at the outage port.

The use of a protection circuit configured for setting the main transistor in blocking state in case of a short circuit at the outage port enables to avoid the use of
25 an oversized main transistor that could withstand the high voltage supplied to the main transistor due to the short circuit. Indeed, if the voltage is too high and the main transistor remains in a passing state, a large power will have to be dissipated by the

main transistor which could lead to damages of the said main transistor and possibly to the other components connected to the main transistor.

According to another aspect of the present invention, the main transistor is a PNP transistor having its collector coupled to the outage port, its emitter connected to the activation port, the said activation port being configured to be connected to a voltage supply and wherein the short circuit at the outage port refers to a coupling of the outage port to the ground.

Such configuration refers to the configuration of a high side control circuit.

According to a further aspect of the present invention, the driving module comprises a second transistor having its base connected to the microcontroller, its emitter connected to the ground and its collector coupled to the base of the main transistor.

According to an additional aspect of the present invention, the base of the second transistor is connected to the microcontroller via a first resistor and to the ground via a second resistor, its emitter is connected to the ground via a third resistor, the main transistor has its emitter connected to the activation port via a fourth resistor.

According to another aspect of the present invention, the protection circuit is configured for detecting a voltage lower than a predetermined threshold at the outage port with a third transistor and for setting the second transistor, and therefore the main transistor, in a blocking state with a fourth transistor.

According to a further aspect of the present invention, the third transistor has its base coupled to the midpoint of a bridge voltage divider comprising a fifth and a sixth resistors in series coupled between the outage port and the ground, its emitter coupled to the ground and its collector connected to the microcontroller via a seventh resistor, to the ground via a capacitor and to the base of the fourth transistor, the fourth transistor has its emitter coupled to the ground and its collector coupled to the base of the second transistor.

According to an additional aspect of the present invention, the control circuit comprises an adaptation circuit coupled to the microcontroller and configured for adapting the voltage supplied by the microcontroller.

According to a further aspect of the present invention, the adaptation circuit
5 comprises a PNP transistor having its collector connected to the base of the second transistor via the first resistor, its emitter coupled to a second voltage supply and its base connected to the microcontroller via an eighth resistor and to the second voltage supply via a ninth resistor.

According to an additional aspect of the present invention, the transistors are
10 Insulated Gate Bipolar Transistors “IGBTs”.

According to another aspect of the present invention, the transistors other than the main transistor are NPN transistors.

According to a further aspect of the present invention, the driving module is a lighting driving module associated with a lighting equipment of the motor vehicle.

15 The present invention also refers to a control unit comprising a body controller module and a driving module in accordance with one of the previous claims connected to the body controller module wherein the body controller module comprises an activation element configured for transmitting an activation signal supplied by a voltage supply to the driving module and an outage port for receiving
20 an outage signal from the driving module and wherein the outage port is coupled to the ground by a pull-down resistor.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the present invention will appear more clearly
25 from the following description. The said description is achieved based on the attached drawings which represent, in a non-limited way, a possible embodiment.

On these drawings:

Fig.1 refers to a diagram of a control unit comprising a body controller module and a driving module associated with an equipment of the motor vehicle;

Fig.2 refers to a diagram of a control circuit according to a first embodiment of the present invention;

5 Fig.3 refers to a diagram of a control circuit according to a second embodiment of the present invention.

DETAILED DESCRIPTION

On these drawings, the same reference numbers refer to elements having the
10 same function.

The term “LED” refers to the acronym Light-Emitting Diode.

The terms “NPN” and “PNP” refer to a type of transistor and notably to the type of junctions used in the transistor. A NPN transistor comprises two P-N junctions having a common P layer and a PNP transistor comprises two P-N
15 junctions having a common N layer. An N layer refers to a layer with an excess of electrons while a P layer refers to a layer with an excess of holes.

The term “IGBT” refers to the acronym Insulated Gate Bipolar Transistor.

The term “connected to” is used to define the link between two electronic elements and refers either to a direct coupling or to a connection via other elements,
20 for example via a resistor while the term “coupled to” refers to a direct coupling (for example via an electric wire) without intermediate elements.

The following embodiments are only examples. Although the description refers to one or several embodiments, it does not necessarily mean that each reference refers to the same embodiment or that the features apply only to a single embodiment.
25 Simple features of different embodiments may also be combined to provide other realisations.

Fig.1 represents a diagram of a control unit 1 of a motor vehicle comprising a body controller module 3 and a driving module 5 of an equipment of the motor vehicle. The equipment refers to a lighting equipment comprising LEDs in the present case but the driving module 5 may also be adapted for other equipments of the motor vehicle. The body controller module 3 and the driving module 5 comprise communication means for communicating to each other. The body controller module 3 is configured for activating the driving module 5 when the vehicle is turned on and the driving module 5 is configured for detecting a failure of the equipment and for emitting outage signals toward the body controller module 3 according to the functioning or operativeness status of the equipment. The body controller module 3 is configured for detecting a failure of the equipment based on the outage signals received from the driving module 5.

The body controller module 3 may, for example, be linked to the driving module 5 by one or several electrical wires 7.

The body controller module 3 comprises an activation port P1 connected to a voltage supply 9, corresponding to a battery of the motor vehicle, via an activation element 11 corresponding, for example, to an activation switch. The activation switch 11 is configured to be closed at the ignition of the vehicle so that an activation signal corresponding to the voltage of the voltage supply 9 is transmitted to the driving module 5 for activating the said driving module 5.

The body controller module 3 also comprises an outage port P2 which is connected both to the ground 16 via a pull-down resistor 14 and to a processing unit 15 of the body controller module 3 which is configured for processing outage signals sent by the driving module 5. The body controller module 3 also comprises a ground port P3 which is coupled to the ground 16.

The driving module 5 comprises an activation port P1' intended to be coupled to the activation port P1 of the body controller module 3.

The activation port P1' is connected to a power supply 17, for example a low-drop out regulator via a diode 19. The driving module 5 also comprises a microcontroller 21 configured for detecting a failure of the equipment associated with the driving module 5, the LEDs in the present case, and for emitting command signals when a LED failure is detected. The microcontroller 21 is supplied by the power supply 17 and is coupled to a control circuit 23 which is configured for receiving the command signals sent by the microcontroller 21 and for converting the command signals into outage signals adapted to the body controller module 3. The outage signals are transmitted to an outage port P2' of the driving module 5 destined to be coupled to the outage port P2 of the body controller module 3. The microcontroller 21 and the control circuit 23 are also coupled to a ground port P3' intended to be coupled to the ground port P3 of the body controller module 3. The control circuit 23 is also connected to the activation port P1', for example via a diode 19.

Thus, when the vehicle starts, the activation switch 11 is closed and an activation signal corresponding to a battery voltage, for example a 13V signal is transmitted from the body controller module 3 to the driving module 5. In response to this activation signal, an outage signal is sent back by the driving module 5 to the body controller module 3 for indicating that the equipment associated with the driving module 5 operates correctly.

The aim of the control circuit 23 is therefore to ensure that the outage signals received by the body controller module 3 are adapted and can be detected so that the body controller module 3 can assess the state of the equipment associated with the driving module 5 and/or the driving module 5 itself to detect the operativeness status and notably a failure or an inoperativeness. The control circuit 23 needs therefore to be reliable and resistant against a short circuit that could happen notably at the

outage port P2 or P2' for example a short circuit of the pull-down resistor 14 and which would lead to the coupling of the outage port P2' to the ground.

Fig.2 represents an electric diagram of a control circuit 23 according to the present invention. The control circuit 23 comprises an input 25 which is coupled to the microcontroller 21 for receiving the command signals. The control circuit 23 also comprises a first transistor Q1, also called main transistor, which is a PNP transistor and a second transistor Q2 which is an NPN transistor. The base of the first transistor Q1 is coupled to the collector of the second transistor Q2. The emitter of the first transistor Q1 is connected to the activation port P1' via a fourth resistor R4 and possibly via a diode 19 as represented in figure 1 so that the emitter of the first transistor Q1 is supplied by the voltage supply 9 when the activation switch 11 is closed. The collector of the first transistor Q1 is coupled to the outage port P2'. The outage port P2' is connected to the outage port P2 of the body controller 3 and therefore both to the processing unit 15 configured for processing the outage signals sent by the control circuit 23 and to the ground 16 via a pull-down resistor 14.

The base of the second transistor Q2 is connected to the input 25 via a first resistor R1 and to the ground 16 via a second resistor R2. The emitter of the second transistor Q2 is connected to the ground via a third resistor R3.

The microcontroller 21 is configured to emit a high voltage signal in case of a correct functioning state of the lighting equipment and a low voltage signal in case of a failure detected in the lighting equipment, for example a failure of a LED. Furthermore, in case of a failure of the power supply or during an initialization of the microcontroller 21, the command signal transmitted to the input 25 of the control circuit 23 corresponds to a high impedance signal.

The low voltage refers to a voltage low enough to set the second transistor Q2 in a blocking state and the high voltage is a voltage high enough to set the second transistor Q2 in a passing state. Thus, if the second transistor Q2 is in a blocking

state, the first transistor Q1 is also in a blocking state and the outage signal transmitted to the processing unit 15 corresponds to a low voltage signal, for example lower than 1V, and if the second transistor Q2 is in a passing state, the first transistor Q1 is also in a passing state and the outage signal transmitted to the processing unit 15 is a high voltage signal provided by the voltage supply 9 via the first transistor Q1.

The control circuit 23 enables therefore to transmit outage signals corresponding to a high voltage signal (the transistor Q1 being in a passing state) if the driving module 5 is operative and functions normally and to transmit outage signals corresponding to a low voltage (the transistor Q1 being in a blocking state) for any failures of the driving module 5 and the associated equipment (LED failure, power supply outage...) which are either detected by the microcontroller 21 or lead to a command signal corresponding to a high impedance signal.

Furthermore, the control circuit 23 also comprises a protection circuit 27 which is configured for setting the first transistor Q1 in a blocking state in case of a voltage lower than a predetermined threshold is supplied to the collector of the first transistor Q1, for example due to a short circuit at the outage port P2'. Such short circuit, such as a short circuit of the pull-down resistor 14, would lead the collector of the first transistor Q1 to be coupled to the ground 16.

The protection circuit 27 comprises a third transistor Q3 which is a NPN transistor. The base of the third transistor Q3 is coupled to the midpoint of a voltage divider 29. The voltage divider 29 is made of a fifth R5 and a sixth R6 resistors coupled in series between the outage port P2' and the ground 16. The midpoint refers to the junction between resistors R5 and R6. The emitter of the third transistor Q3 is coupled to the ground 16. The collector of the third transistor Q3 is connected both to the input 25 via a seventh resistor R7, to the ground 16 via a capacitor C and to the base of a fourth transistor Q4 which is a NPN transistor. The collector of the fourth

transistor Q4 is coupled to the base of the second transistor Q2 and the emitter of the fourth transistor Q4 is coupled to the ground 16.

Thus, in case of voltage lower than a predetermined threshold supplied to the outage port P2', for example due to a short circuit of the resistor 14, the low voltage is then supplied to the base of the third transistor Q3 which becomes in a blocking state. If, at the same time, the microcontroller 21 is sending a high voltage signal on the base of the fourth transistor Q4 (and to the base of the second transistor Q2), the fourth transistor Q4 is set in a passing state so that the base of the second transistor Q2 is coupled to the ground (via the fourth transistor Q4).

As a consequence, the second transistor Q2 remains in a blocking state despite the high voltage sent by the microcontroller 21 and the first transistor Q1 also remains in a blocking state.

Thus, the protection circuit 27 enables to set the first transistor Q1 in a blocking state whatever the signal sent by the microcontroller 21 in case of an abnormal low voltage supplied at the outage port P2', for example due to a short circuit.

The predetermined threshold for the voltage depends on the value of the resistors R5, R6 of the voltage divider 29 and the voltage threshold to set the third transistor Q3 in a passing state, the threshold is for example set to be slightly higher than 0V.

Such setting in a blocking state of the first transistor Q1 enables to protect the first transistor Q1 itself and the other components of the control circuit 23 in case of a short circuit at the outage port P2'. As a consequence, with such protection circuit 27, the first transistor Q1 does not need to be oversized to withstand a high voltage supplied between its emitter and its collector, for example due to a short circuit of the resistor 14.

Besides, as the power of the command signals emitted by the microcontroller 21 may not be adapted to set the second Q2 and the fourth Q4 transistors of the control circuit 23 in a blocking and in a passing state or in the case wherein the microcontroller 21 may only emit a low voltage signal and a high impedance signal, the control circuit 23 may also comprise an adaptation circuit 31, as represented in Fig.3, configured for adapting the voltage of the command signals sent by the microcontroller 21 to the thresholds for passing from a blocking to a passing state the transistors Q2 and Q4.

The adaptation circuit 31 is located between the input 25 and the first resistor R1 and comprises a fifth transistor Q5 which is a PNP transistor. The base of the fifth transistor Q5 is connected both to the input 25 via an eighth resistor R8 and to a second voltage supply 33 via a ninth resistor R9. The second voltage supply 33 is for example a voltage supply of the motor vehicle supplying a voltage of 5V or 3,3V, for example the low-drop out regulator 17. The emitter of the fifth transistor Q5 is coupled to the second voltage supply 33 and the collector of the fifth transistor Q5 is connected to the base of the second transistor Q2 via the second resistor R2. Thus, the command signals of the microcontroller 21 enables to set the fifth transistor Q5 in a blocking state or in a passing state so that the voltage and current provided by the adaptation circuit 31 enables to set the second Q2 and the fourth Q4 transistors in blocking or in a passing state.

The present invention enables therefore, by the use of a protection circuit 27 which sets the main transistor Q1 of a control circuit 23 of a driving module 5 of an equipment of a motor vehicle in blocking state, to protect the components of the control circuit 23 in case of a short circuit at the outage port P2' of the driving module 5 without requiring to use an oversized transistor as main transistor Q1 in the control circuit 23. The components of the protection circuit 27 can be easily

implemented in a printed circuit and their cost remains low with respect to an oversized transistor.

CLAIMS

1. Driving module (5) associated with an equipment of a motor vehicle, the said driving module (5) is connected to a body controller module (3) of the motor vehicle and is configured for receiving activation signals from the body controller module (3) via an activation port (P1') and for transmitting outage signals to an outage port (P2'), the outage signals indicating a status of the associated equipment in response to the received activation signals wherein the driving module (5) comprises:

- a microcontroller (21) configured for detecting an operativeness status of the associated equipment and for emitting command signals according to the detected operativeness status and,

- a control circuit (23) configured for converting the command signals emitted by the microcontroller (21) into outage signals adapted to the body controller module (3) wherein the control circuit (23) comprises a main transistor (Q1) coupled to the outage port (P2') and configured for modifying the value of the outage signals according to its state characterized in that the control circuit (23) also comprises a protection circuit (27) configured for setting the main transistor (Q1) in a blocking state in case of a short circuit at the outage port (P2').

2. Driving module (5) in accordance with claim 1 wherein the main transistor (Q1) is a PNP transistor having its collector coupled to the outage port (P2'), its emitter connected to the activation port (P1'), the said activation port (P1') being configured to be connected to a voltage supply (9) and wherein the short circuit at the outage port (P2') refers to a coupling of the outage port (P2') to the ground (16).

3. Driving module (5) in accordance with claim 2 comprising a second transistor (Q2) having its base connected to the microcontroller (21), its emitter connected to the ground (16) and its collector coupled to the base of the main transistor (Q1).

4. Driving module (5) in accordance with claim 3 wherein the base of the

second transistor (Q2) is connected to the microcontroller (21) via a first resistor (R1) and to the ground (16) via a second resistor (R2), its emitter is connected to the ground (16) via a third resistor (R3), the main transistor (Q1) has its emitter connected to the activation port (P1') via a fourth resistor (R4).

5 5. Driving module (5) in accordance with claim 3 or 4 wherein the protection circuit (27) is configured for detecting a voltage lower than a predetermined threshold at the outage port (P2') with a third transistor (Q3) and for setting the second transistor (Q2), and therefore the main transistor (Q1), in a blocking state with a fourth transistor (Q4).

10 6. Driving module (5) in accordance with claim 5 wherein the third transistor (Q3) has its base coupled to the midpoint of a bridge voltage divider (29) comprising a fifth and a sixth resistors in series coupled between the outage port (P2') and the ground (16), its emitter coupled to the ground (16) and its collector connected to the microcontroller (21) via a seventh resistor, to the ground via a capacitor and to the
15 base of the fourth transistor (Q4), the fourth transistor (Q4) has its emitter coupled to the ground (16) and its collector coupled to the base of the second transistor (Q2).

 7. Driving module in accordance with one of the previous claims in combination with claim 4 wherein the control circuit (23) comprises an adaptation circuit (31) coupled to the microcontroller (21) and configured for adapting the
20 voltage supplied by the microcontroller (21).

 8. Driving module in accordance with claim 7 wherein the adaptation circuit (31) comprises a PNP transistor (Q5) having its collector connected to the base of the second transistor (Q2) via the first resistor (R1), its emitter coupled to a second voltage supply (33) and its base connected to the microcontroller (21) via an eighth
25 resistor (R8) and to the second voltage supply (33) via a ninth resistor (R9).

 9. Driving module (5) in accordance with one of the previous claims wherein the transistors (Q1, Q2, Q3, Q4) are Insulated Gate Bipolar Transistors "IGBTs".

10. Driving module (5) in accordance with one of the claims 3 to 9 wherein the transistors (Q2, Q3, Q4) other than the main transistor (Q1) are NPN transistors.

11. Driving module in accordance with one of the previous claims wherein the driving module (5) is a lighting driving module associated with a lighting equipment
5 of the motor vehicle.

12. Control unit (1) comprising a body controller module (3) and a driving module (5) in accordance with one of the previous claims connected to the body controller module (3) wherein the body controller module (3) comprises an activation element configured for transmitting an activation signal supplied by a voltage supply
10 (9) to the driving module (5) and an outage port (P2) for receiving an outage signal from the driving module (5) and wherein the outage port (P2) is coupled to the ground (16) by a pull-down resistor (14).

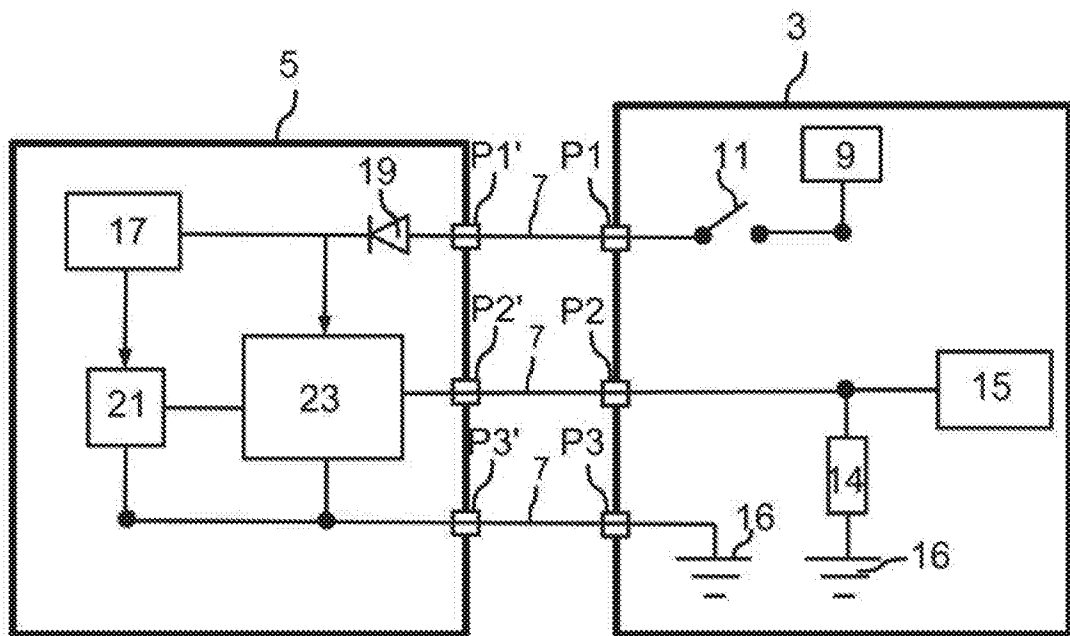


Fig. 1

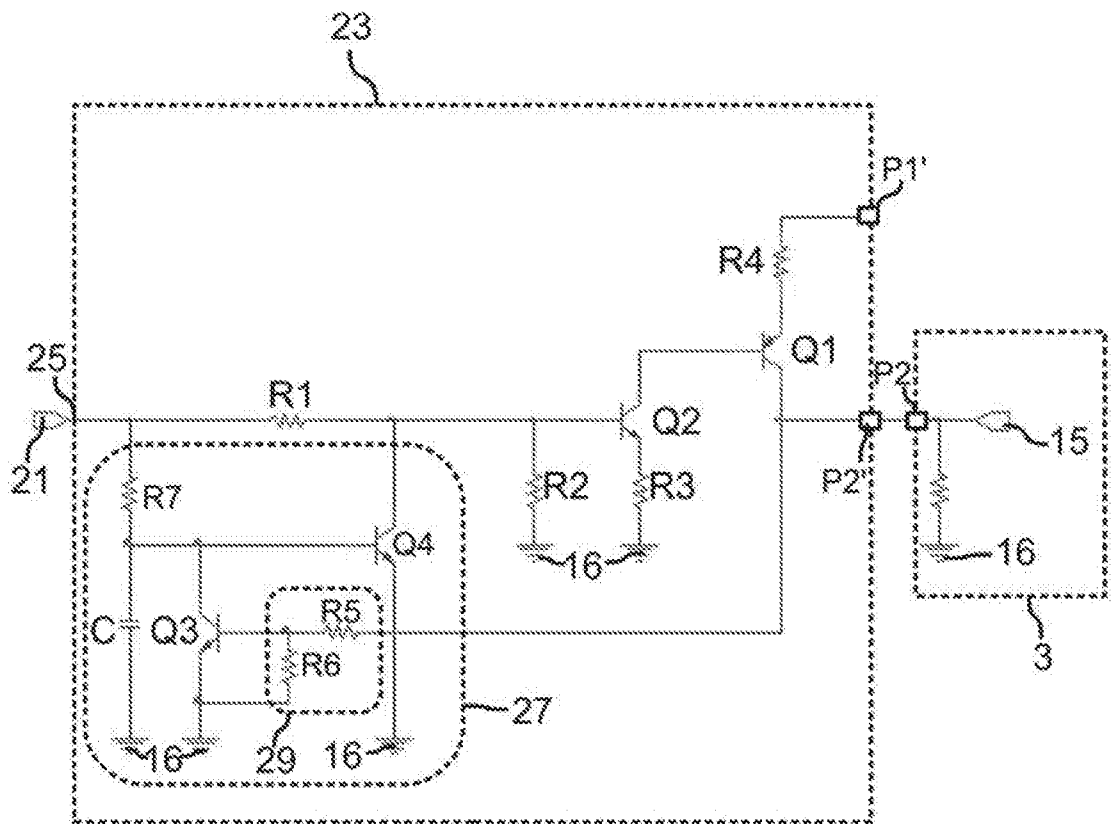
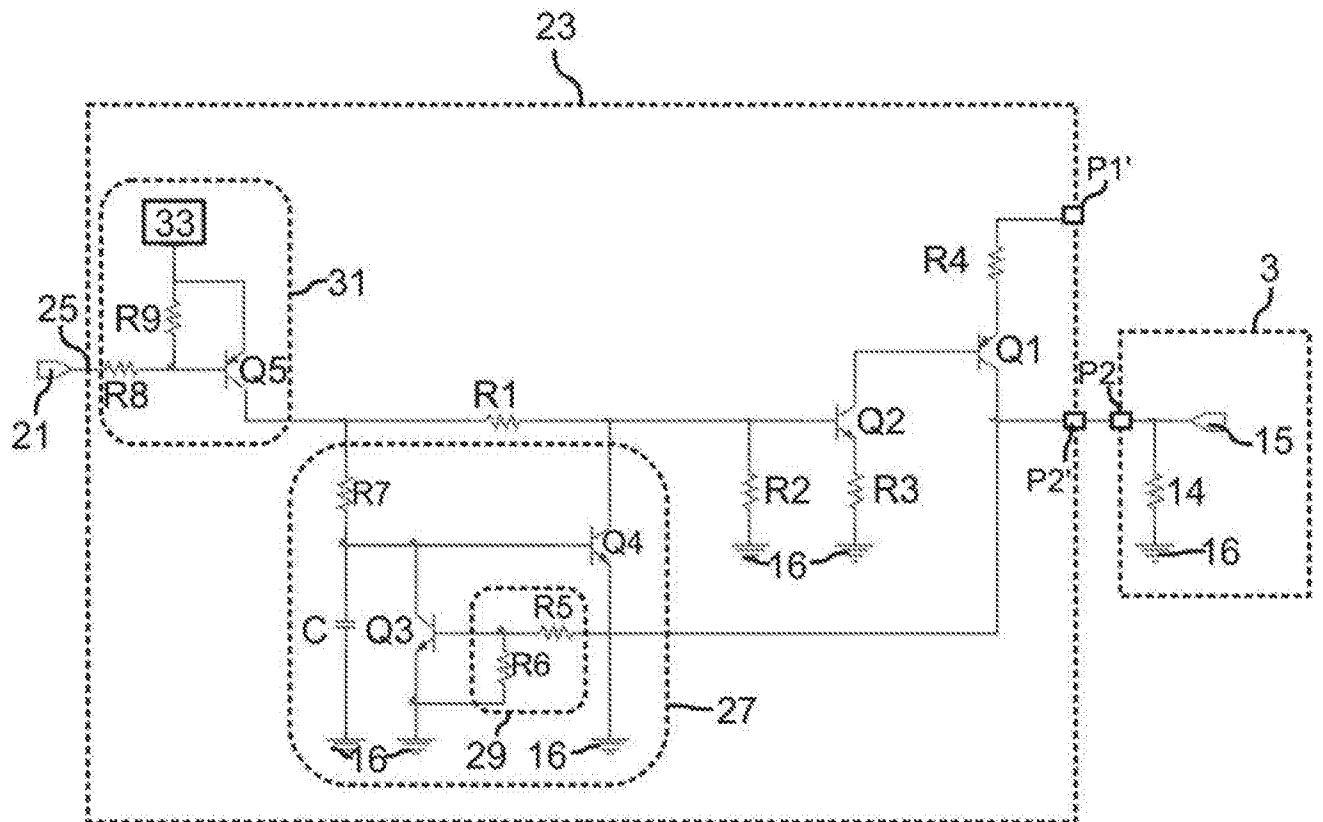


Fig. 2

**Fig. 3**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/104639

A. CLASSIFICATION OF SUBJECT MATTER

B60R 16/023(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B60R

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

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

CNABS, VEN, CNTXT, EPODOC, CNKI: vehicle, controll+, port, signal, outage, interrupt+, circuit, transistor, protect+, block +, short circuit.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	CN 102019888 A (SHANGHAI HAIMA R & D CO LTD ET AL.) 20 April 2011 (2011-04-20) the whole document	1-12
A	CN 204586726 U (VALEO INTERIOR CONTROL SHENZHEN CO LTD) 26 August 2015 (2015-08-26) the whole document	1-12
A	CN 102101457 A (XI AN KING TRUCK ELECTRON CO) 22 June 2011 (2011-06-22) the whole document	1-12
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“&” document member of the same patent family

Date of the actual completion of the international search

26 December 2016

Date of mailing of the international search report

06 January 2017

Name and mailing address of the ISA/CN

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P.R.CHINA
6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing
100088
China

Facsimile No. (86-10)62019451

Authorized officer

CHEN, Yun

Telephone No. (86-10) 62089484

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International application No.

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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