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(54) ## A BUS INTERFACE AND A METHOD FOR PREVENTION OF LOCKOUT SITUATION

(57) The present invention relates to a module for providing a powered interface, comprising at least one terminal configured to connect a bus having a non-zero DC voltage level in the quiet state; an internal power supply configured to supply a connected bus with DC power, wherein the internal power supply is designed such that it can be switched off; and a control circuitry configured to control the internal power supply, and communicate by receiving and/or sending signals over the bus. The control circuitry of the driver circuit is further configured to carry out the following steps upon receipt of an internal power supply switch-off command: switching off the internal power supply and detecting the bus voltage level at a predetermined time after switching off the internal power supply; and continuing the switched-off state of the internal power supply, when it is determined that the detected bus voltage level is above a threshold value; and switching on again the internal power supply and/or sending out a message over the bus, when it is determined that the detected bus voltage level at the predetermined time after switching off drops to or below the threshold value.

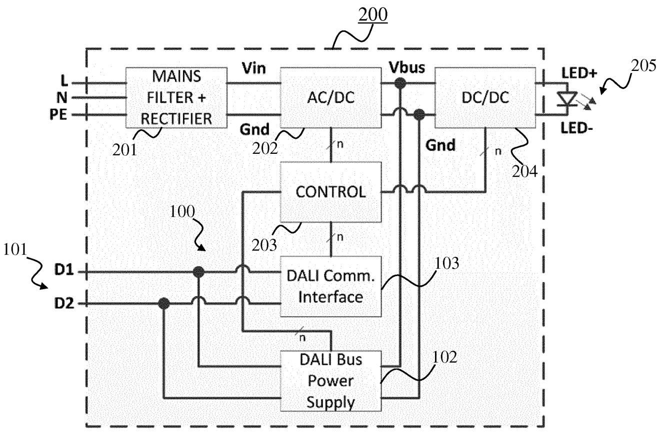

Fig. 2

EP 3 651 553 A1

Description

[0001] The present invention relates to a bus interface, and especially to a bus interface which has a local power supply module in order to supply power to a connected bus, especially a bus with a non zero DC voltage level in the quiescent state. An example for such a bus is the DALI bus.

[0002] The bus interface may be part of a bus enabled building technology device, such as e.g. a sensor or a converter for driving lighting means.

[0003] E.g. in the framework of DALI, a central bus power supply is often used. However, there is also the option of replacing such central bus power supply by one or more decentralized bus interfaces with local power supply modules, typically associated with or integrated in a bus enabled building technology device, or preferably a lighting technology device.

[0004] There is the possibility to switch off, via a dedicated command over the bus, the (bus) power supply module of such interface. The inventors have recognized the problem that a lock-out state of the bus may occur in case the last active of such local bus power supply modules in a bus interface is to be switched off.

[0005] It is an object of the present invention to overcome the above-mentioned drawbacks and to provide an improved driver circuit. More specifically, it is an object of the invention to provide a driver circuit and a method, with which a lockout situation in the DALI interface may be prevented.

[0006] This object is achieved by the features of the independent claims. The dependent claims develop further the central idea of the invention. Advantageous features of the present invention are defined in the corresponding dependent claims.

[0007] According to the present invention, the module for providing a powered interface, comprising: at least one terminal configured to connect a bus having a non-zero DC voltage level in the quiet state; an internal power supply configured to supply a connected bus with DC power, wherein the internal power supply is designed such that it can be switched off; and a control circuitry configured to control the internal power supply, and a communication block for receiving and/or sending signals over the bus. The control circuitry is further configured to carry out the following steps upon receipt of an internal power supply switch-off command: switching off the internal power supply and detecting the bus voltage level at a predetermined time after switching off the internal power supply; and continuing the switched-off state of the internal power supply, when it is determined that the detected bus voltage level is above a threshold value; and switching on again the internal power supply and/or sending out a message over the bus, when it is determined that the detected bus voltage level at the predetermined time after switching off drops to the threshold value.

[0008] The internal power supply may be switched on or switched off. Such controlling of the internal power supply advantageously prevents the lockout situation. This approach can also be used for other bus systems, for example, the bus may be based on, a DALI bus, an I2C bus, or a un:q bus (as it is described in the net4more gears specification documents).

[0009] Moreover, the driver circuit may detect a lockout situation in the driver circuity, (e.g., in its DALI interface) and switch on again the power supply and/or send out a message over the bus.

[0010] Preferably, the predetermined time is determined based on the maximum allowed capacitance of the bus.

[0011] Alternatively or in addition, the threshold value for the detected bus voltage is representative of zero.

[0012] Preferably, the control circuitry is based on a digital addressable lighting interface (DALI) communication interface, and the power supply is based on a DALI power supply. For example, in some embodiments, the control circuitry may be or may include the DALI communication interface. The control circuitry may further include, for example, microcontroller and/or Application-Specific Integrated Circuit (ASIC). It may further be configured to control the DALI communication interface, the DALI power supply, etc., without limiting the present disclosure to a specific configuration or a structure.

[0013] According to the present invention, the method of a driver circuit for providing a powered interface, comprises the steps of connecting a bus having a non-zero DC voltage level in the quiet state; supplying a connected bus with DC power, wherein the internal power supply is designed such that it can be switched off; and controlling the internal power supply, and communicating by receiving and/or sending signals over the bus, and carrying out the following steps upon receipt of an internal power supply switch-off command:

switching off the internal power supply and detecting the bus voltage level at a predetermined time after switching off the internal power supply; and
continuing the switched-off state of the internal power supply, when it is determined that the detected bus voltage level is above a threshold value; and
switching on again the internal power supply and/or sending out a message over the bus, when it is determined that the detected bus voltage level at the predetermined time after switching off drops to or below the threshold value.

[0014] Aspects and details of the invention are now explained with reference to the accompanying drawing, wherein:

FIG. 1 shows a schematic diagram of a driver circuit according to an embodiment of the present invention,

FIG. 2 shows a schematic view of the driver circuit for driving a LED load, according to an embodiment of the present invention.

FIG. 3 shows a flowchart of the method according to an embodiment of the present invention.

[0015] FIG. 1 shows a schematic diagram of a driver circuit 100 for providing a powered interface according to the present invention.

[0016] FIG. 1 shows a bus module 100, such as e.g. a DALI bus module which may be part of an actor or sensor in a lighting network. The bus module 100 comprises a terminal 101 for connection of one or more bus wires, an internal bus power supply block 102, and a bus communication block (interface logic) 103. The bus power supply block 102 is designed to supply the bus connected at 101 with electrical power, such as e.g. a DC voltage level.

[0017] The bus communication block 103 is designed for sending out and/or receiving data over/from the bus connected at 101.

[0018] A voltage divider including the resistors R1 and R2 is located between the D1 and D2 lines, near the terminal 101. The bus voltage level may be measured, for example, by further evaluating the sensed voltage VSNS of the voltage divider, which signal can be sent to a control circuitry (203 in Fig. 2) of the module 100.

[0019] The internal power supply 102 supplies a connected bus (e.g., connected to the terminal 101) with DC power.

[0020] The internal power supply 102 is designed such that it can be switched off. For example, the internal power supply 102 may be adapted such that it can be deactivated. It may also be switched off by using a switch A, and by disconnecting the voltage provided by the internal power supply 102, without limiting the present disclosure to a specific configuration or a specific procedure for switching off the power supply.

[0021] The switch A may be controlled by a signal from the same control circuitry 203 receiving the VSNS signal indicating the bus voltage level.

[0022] Moreover, the "switch-off state" of the internal power supply 102 is reprehensive of a state in which the internal power supply 102 is deactivated and/or the voltage between D+ and D- is 0V.

[0023] For example, the internal power supply 102 is an internal DALI power supply. The internal power supply is connected by its D+ line to the D1 line of the terminal 101, and by its D- line to the D2 line of the terminal 101. The switch A is located in the D-line of the internal power supply, without limiting the present disclosure. For example, the switch A may also be located in D+ line of the internal power supply, the module 100 may have more than one switch, etc. Moreover, the switch A may be used for disconnecting the internal power supply 102 from the DALI bus, e.g., when a defined command to switch off the internal power supply preferably over the bus is received.

[0024] Therefore, the internal power supply 102 is able to provide the DALI bus with DC power. For example, the internal power supply 102 provides the DALI bus with a voltage of 16 V at +/- 5% tolerance.

[0025] The internal power supply 102 is designed such that it may be in switch on state, in switch off state, or being switched on again after a switch off state.

[0026] In particular, the DALI standards are maintained with such driver circuit. As the invention relates to internal (i.e., local) power supplies for a bus, the problem can arise that the only local bus supply is inadvertently switched off by an internal or external command, resulting in a lockout state.

[0027] The invention solves this problem of the decentralized DALI power supply by performing the following procedure.

[0028] The control circuitry 203 carries out the following steps upon receipt of an internal power supply switch-off command. This command is preferably received from the connected bus.

[0029] The control circuitry 203 switches off the internal power supply 102 and detects the bus voltage level at a predetermined time after switching off the internal power supply 102. This can be a continuous monitoring or the sampling of one or more voltage levels at one or more time steps. The control circuitry 203 may control the switch A connected to the D- line of the internal power supply, and it may switch off the internal power supply. The control circuitry may detect the bus voltage level by using the voltage divider R1 and R2 which is connected between the D1 and the D2 lines of the terminal 101, and it may further evaluate the sensed voltage VSNS, as discussed above. The bus voltage level is detected at the predetermined time after switching off the internal power supply.

[0030] Moreover, the control circuitry may carry our different steps based on the detected bus voltage level.

[0031] For example, the control circuitry 203 continues the switched-off state of the internal power supply 102, if it is determined that the detected bus voltage level after a given time period is still at a sufficiently high level, indicating that there is at least one other DC power supply active and connected to the bus. E.g. this can be determined if after a given time period the voltage level on the bus did not fall below a given threshold value. The threshold level is preferably set such that it is within the high-level range of the bus protocol. If the control circuitry 203 determines that there is another power supply connected to the bus, it continues the switch off state of the internal power supply 102. For example, the control circuitry 203 controls the switch A that is located between the D2 line of the control circuitry 203 and D- line of the internal power supply 102, to be in the open state, and the internal power supply 102 can be safely deactivated.

[0032] On the other hand, the control circuitry 203 switches on again the internal power supply 102 and/or sends out a message over the bus, if it is determined that the detected bus voltage level at the predetermined time after switching off drops below threshold value. This indicates that the present internal power supply 102 is currently the only power supply active and connected to the bus. In such a case, the control circuitry 203, for example, controls the switch A that is located between the D2 line of the control circuitry 203 and D- line of the internal power supply 102, to be in the closed state. The switch A is closed again, and the internal power supply 102 is not deactivated. In other words, the lockout situation may be prevented.

[0033] In such a case, the communication interface 103 translates between logic levels (e.g., 0 to 3.3 V) that can be sent and received by the microcontroller of the gear, and the DALI bus levels are, for example, in the range of 0 V to 16 V. The internal power supply 102 provides the DALI bus with a voltage of, for example, 16 V (the high level can be in the range of 10 V to 22.5 V, according to the DALI standard).

[0034] Moreover, the switch A (which can also be in the D+ line) disconnects the internal power supply 102 from the DALI bus, if the user disables the internal power supply 102. After the predetermined time, the DALI bus voltage is measured, for example, via a voltage divider R1 and R2, and the sensed voltage VSNS can be evaluated. The predetermined time may depend on the maximum allowed capacitance of the bus. Moreover, if the measured voltage is high (i.e., it is above a threshold value), this means that an external power supply is available in the system. In this case, the internal power supply 102 can be safely deactivated.

[0035] However, if the measured voltage is low (e.g., it is at the threshold value), that means no external power supply is connected to the DALI bus, and the switch A is closed again, and the internal power supply 102 is not deactivated. In other words, a lock out situation can be prevented.

[0036] FIG. 2 shows a schematic view of the bus communication block 100 optionally incorporated in an LED gear 200, according to an embodiment of the present invention. The LED gear 200 is designed such that it supplies power to an LED (being connected to the interface 205), and it drives the connected LED.

[0037] The LED gear 200 further includes the mains filter and rectifier unit 201, as it is generally known. The LED gear 200 further includes the AC/DC block 202. The AC/DC block 202 is configured to be supplied from, for example, a rectified 230VAC mains input and it further provides, for example, a voltage V_{BUS} of 400VDC at its output.

[0038] The LED gear 200 further includes the DC/DC block 204. The DC/DC block 204 is optionally configured to be supplied by the 400VDC, and it further delivers either the input voltage for a second (cascaded) DC/DC block, or directly supplies the connected LED with an output voltage/current.

[0039] The LED gear 200 further includes the control circuitry 203. The control circuitry 203 may include, for example, a microcontroller and/or Application-Specific Integrated Circuit (ASIC). The control circuitry 203 controls the AC/DC block 202 and the DC/DC blocks 204 as well as the interface blocks, e.g., as the DALI communication interface 103 and the DALI power supply block 102.

[0040] The module 100 is incorporated in the LED gear 200. The module 100 supplies the DALI bus 101, and it communicates via the DALI bus. Moreover, the module 100 may also supply power to an external sensor that is attached to the DALI bus 101.

[0041] The DALI power supply block 102 is supplied by the 400VDC and delivers the DALI bus voltage (e.g., 16VDC) at the output. This DALI bus voltage supplies other DALI devices that are connected to the DALI bus 101 (e.g., other LED gears, sensors, etc.). The DALI interface logic block 103 that translates between DALI voltage levels and low logic levels (e.g., 0V-3.3V), and it can be evaluated by a microcontroller of the control logic block 203.

[0042] In the present embodiment, the supply voltage of the internal power supply 102 (i.e., the DALI bus power supply) is used for communication purpose and it does not drive the LEDs (e.g., that are connected to the LED gear interface 205). The internal power supply 102 can be switched off, for example, the block 102 is deactivated and the voltage between D+ and D- is 0V.

[0043] Moreover, when the LED gear 200 receives a command to switch-off the internal power supply 102 (e.g., the command may be received via the interface 101). Initially, the switch A (not shown in FIG. 2) is opened, however, the internal power supply block 102 is still activated so the bus voltage is present between D+ and D-. Furthermore, when the switch A is open, D1 and D2 are not supplied by the internal power supply 102. After the predetermined time, the voltage between D1 and D2 is evaluated using the voltage divider including the R1 and R2 (not shown in FIG. 2), as discussed above.

[0044] Moreover, when it is determined that the detected bus voltage level is above a threshold value, that means an external power supply is connected to the bus, the switch A remains open and the internal power supply 102 (i.e., the DALI bus power supply block 102) can be deactivated. Hence, the voltage between D+ and D- may go to 0V.

[0045] Furthermore, when it is determined that the detected bus voltage level at the predetermined time after switching off drops to the threshold value (if the voltage is below a certain level), that means no external power supply is connected to the bus. The switch A is being closed again, and therefore, the internal power supply 102 continues supplying the bus.

[0046] Hence, the control circuit 100 is able to prevent a lockout situation.

[0047] FIG. 3 shows a flowchart of the method 300 of a driver circuit for providing a powered interface, according to an embodiment of the present invention.

[0048] The method 300 has a first step 301 of connecting a bus having a non-zero DC voltage level in the quiet state.

[0049] The method 300 has a further step 302 of supplying a connected bus with DC power, wherein the internal power supply is designed such that it can be switched off.

[0050] The method 300 has a further step 303 of controlling the internal power supply, and communicating by receiving and/or sending signals over the bus, and carrying out the following steps upon receipt of a power supply switch-off command:

switching off the internal power supply and detecting the bus voltage level at a predetermined time after switching off the internal power supply; and
continuing the switched-off state of the internal power supply, when it is determined that the detected bus voltage level is above a threshold value; and
switching on again the internal power supply and/or sending out a message over the bus, when it is determined that the detected bus voltage level at the predetermined time after switching off drops to or below the threshold value.

Claims

1. A module (100) for providing a powered interface, comprising:

at least one terminal (101) configured to connect a bus having a non-zero DC voltage level in the quiet state;
an internal power supply (102) configured to supply a connected bus with DC power, wherein the internal power supply (102) is designed such that it can be switched off;
a control circuitry (203) configured to control the internal power supply (102),
- a bus communication block (103) for receiving and/or sending signals over the bus, wherein the control circuitry (203) is further configured to carry out the following steps upon receipt of a command for switching-off the internal power supply (102):
switching off the internal power supply (102) and detecting the bus voltage level at a predetermined time after switching off the internal power supply (102); and
continuing the switched-off state of the internal power supply (102), when it is determined that the detected bus voltage level is above a threshold value; and
switching on again the internal power supply (102) and/or sending out a message over the bus, when it is determined that the detected bus voltage level at the predetermined time after switching off drops to or below the threshold value.

2. The module (100) according to claim 1, wherein

the predetermined time is determined based on the maximum allowed capacitance of the bus.

3. The module (100) according to claim 1 or 2, wherein

the threshold value for the detected bus voltage is representative of zero.

4. The module (100) according to claims 1 to 3, wherein

bus communication block (103) is based on a digital addressable lighting interface (DALI) communication interface, and the internal power supply (102) is based on an internal DALI power supply.

5. A method for operating a module (100) for providing a powered interface, the method (300) comprising the steps of:

connecting (301) a bus having a non-zero DC voltage level in the quiet state;
supplying (302) a connected bus with DC power, wherein the internal power supply (102) is designed such that it can be switched off; and
controlling (303) the internal power supply (102), and communicating by receiving and/or sending signals over the bus, and carrying out the following steps upon receipt of an internal power supply switch-off command:

switching off the internal power supply (102) and detecting the bus voltage level at a predetermined time after switching off the internal power supply (102); and
continuing the switched-off state of the internal power supply (102), when it is determined that the detected bus voltage level is above a threshold value; and
switching on again the internal power supply (102) and/or sending out a message over the bus, when it is determined that the detected bus voltage level at the predetermined time after switching off drops to or below the threshold value.

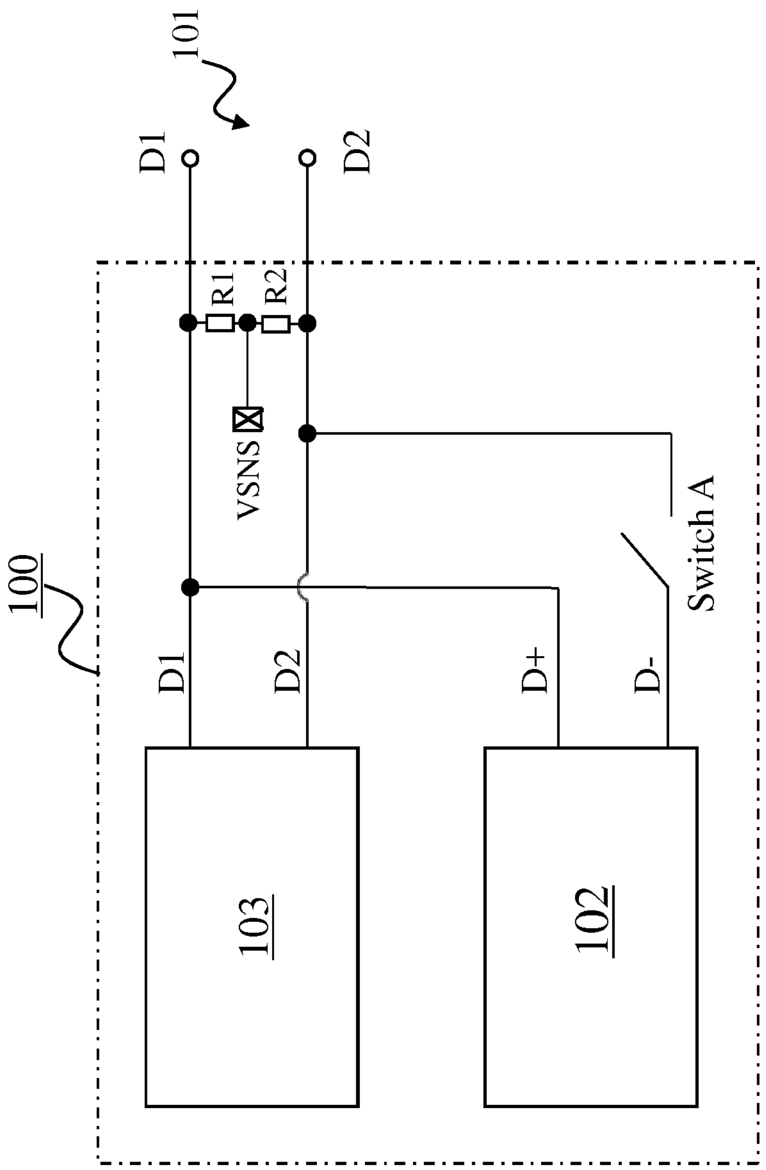

Fig. 1

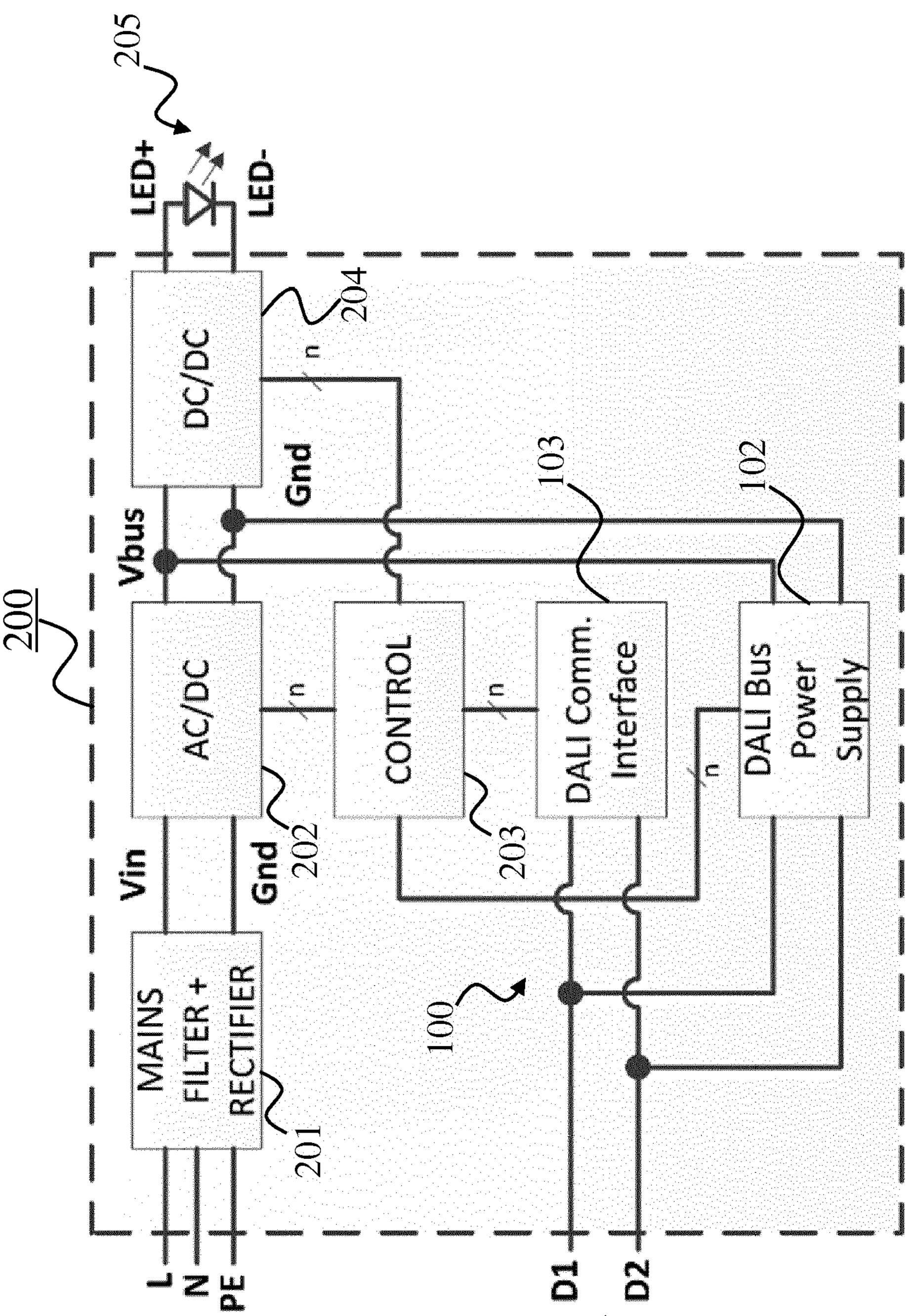
200
205
LED+
LED-
DC/DC
204
n
Gnd
Vbus
AC/DC
CONTROL
DALI Comm. Interface
DALI Bus Power Supply
103
102
n
n
n
Vin
Gnd
202
203
MAINS FILTER + RECTIFIER
201
100
L
N
PE
D1
D2
101

Fig. 2

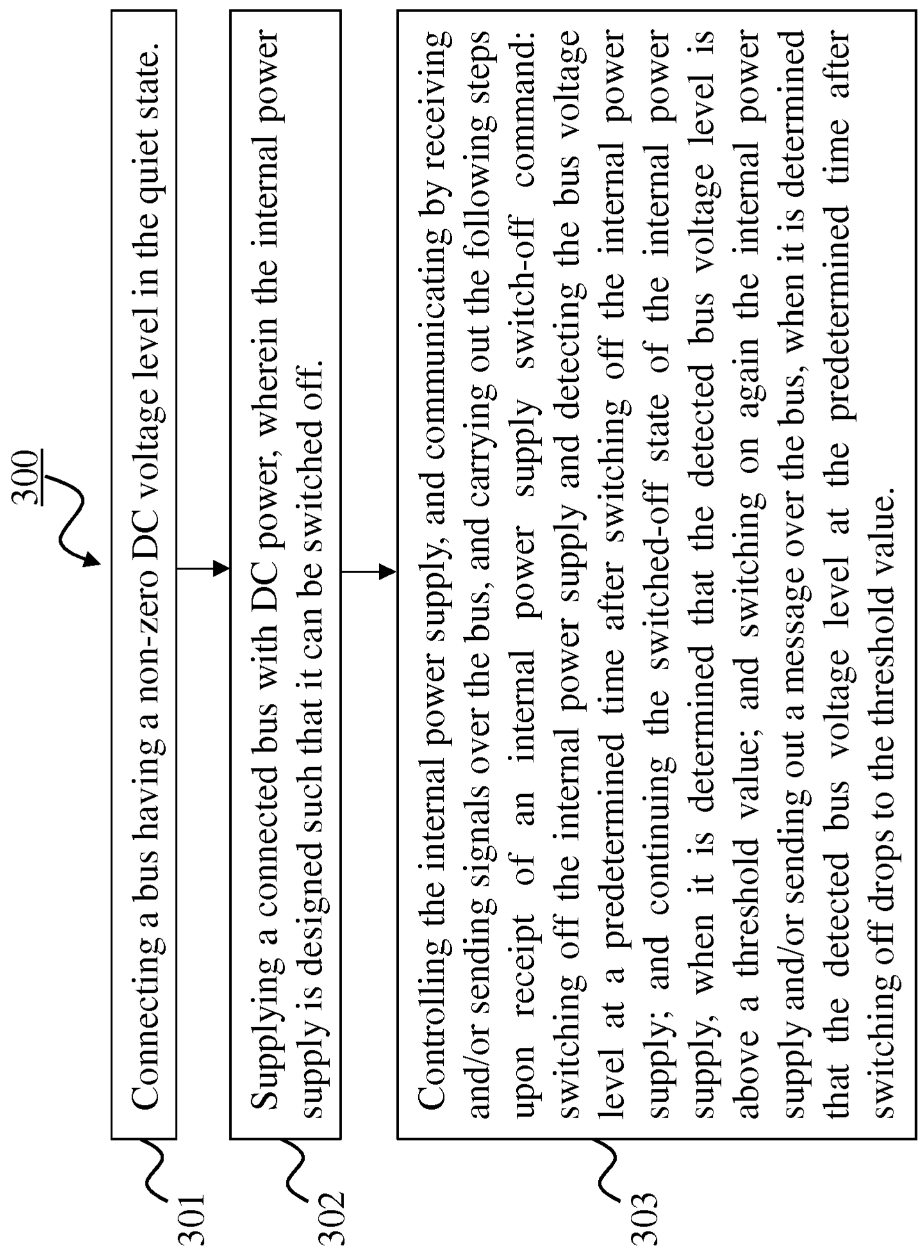
300
301
Connecting a bus having a non-zero DC voltage level in the quiet state.
302
Supplying a connected bus with DC power, wherein the internal power supply is designed such that it can be switched off.
303
Controlling the internal power supply, and communicating by receiving and/or sending signals over the bus, and carrying out the following steps upon receipt of an internal power supply switch-off command: switching off the internal power supply and detecting the bus voltage level at a predetermined time after switching off the internal power supply; and continuing the switched-off state of the internal power supply, when it is determined that the detected bus voltage level is above a threshold value; and switching on again the internal power supply and/or sending out a message over the bus, when it is determined that the detected bus voltage level at the predetermined time after switching off drops to the threshold value.

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 18 20 4500

DOCUMENTS CONSIDERED TO BE RELEVANT

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TECHNICAL FIELDS SEARCHED (IPC)

H05B
G06F

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	8 May 2019	Boudet, Joachim

CATEGORY OF CITED DOCUMENTS

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