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(54) POWERING BY A FIELDBUS DURING LOGIC LOW SIGNAL LEVEL

(57) Disclosed is a lighting control device (4), comprising a transmitter unit (41) connectable to a field bus (6) and configured to conduct a wireline transmission of the lighting control device (4) on the field bus (6) by intermittently applying a logic low signal level to the field bus (6). The logic low signal level comprises a positive voltage. The lighting control device (4) is configured for power intake off the field bus (6) when the positive voltage is present on the field bus (6). This improves the energy supply capacity of networked devices of a field bus.

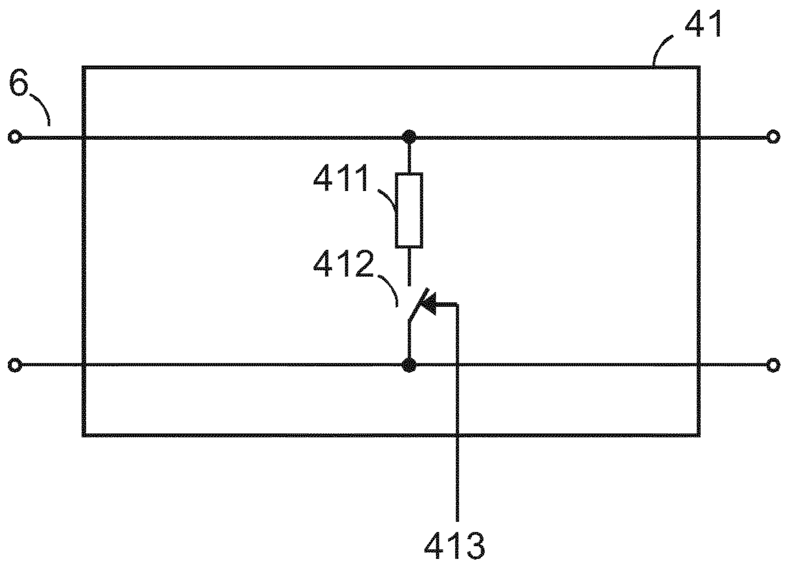

Fig. 3

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Description

Technical Field

[0001] The present disclosure relates to lighting control, and in particular, to a lighting control device powered by a field bus, and an LED driver, and a luminaire comprising the lighting control device.

Background Art

[0002] For control of networked systems, field buses may be deployed to handle network communication as well as energy supply.

[0003] In lighting control, typically a Digital Addressable Lighting Interface (DALI) bus implements wireline communication among networked devices by alternating between logic high and low signal levels (typically 16V and 0V) and realizes a limited energy supply of the networked devices with a maximum system current of 250 mA during periods when the logic high signal level is present on the field bus.

[0004] That is to say, applications with relatively high power requirements may suffer from the ultimately limited energy supply. As an example, infrared communication may be limited in terms of the maximum LED current used to light an infrared LED.

Summary

[0005] The object of the present disclosure is thus to improve the energy supply of the networked devices of a field bus.

[0006] The invention is defined by the appended independent claims. Preferred embodiments are outlined in the dependent claims and the following description and drawings.

[0007] A first aspect of the present disclosure relates to a lighting control device, comprising a transmitter unit connectable to a field bus, and configured to conduct a wireline transmission of the lighting control device on the field bus by intermittently applying a logic low signal level to the field bus, wherein the logic low signal level comprises a positive voltage. The lighting control device is configured for power intake off the field bus when the positive voltage is present on the field bus.

[0008] The positive voltage may comprise a maximum voltage specified for the transmitter unit when applying the logic low signal level to the field bus.

[0009] The transmitter unit may comprise a load and a first switch connected in series between a conductor pair of the field bus. The lighting control device may be configured to switch the first switch into its conductive state to apply the logic low signal level dropping across the load to the field bus.

[0010] The load may comprise a resistor.

[0011] The transmitter unit may further comprise a second switch connected between the conductor pair of the field bus. The lighting control device may further be configured to switch the second switch into its conductive state to short-circuit the conductor pair of the field bus.

[0012] The lighting control device may further be configured to intermittently switch the second switch into its conductive state when the first switch is in its conducting state.

[0013] The transmitter unit may further comprise a wireless communication unit and a third switch connected in series between the conductor pair of the field bus. The lighting control device may further be configured to intermittently switch the third switch into its conductive state to conduct a wireless transmission of the lighting control device via the wireless communication unit.

[0014] The transmitter unit may further comprise a fourth switch connected between the conductor pair of the field bus. The lighting control device may further be configured to alternatingly switch the third switch and the fourth switch into their respective conductive states following a modulation frequency of the wireless communication unit.

[0015] The wireless communication unit may comprise an infrared light-emitting diode, LED.

[0016] The lighting control device may further comprise an energy storage unit configured for the power intake off the field bus.

[0017] The energy storage unit may comprise a capacitor.

[0018] The transmitter unit may comprise a DALI transmitter unit, and the field bus may comprise a DALI bus.

[0019] A second aspect of the present disclosure relates to an LED driver, comprising a lighting control device according to the first aspect or any of its implementations, and a converter configured to power LED lighting means connectable to the LED driver via output terminals of the LED driver.

[0020] A third aspect of the present disclosure relates to a luminaire, comprising an LED driver according to the second aspect, and LED lighting means connected to output terminals of the LED driver.

Advantageous Effects

[0021] The present disclosure improves an energy supply of the networked devices of a field bus by enabling an energy supply of the networked devices during periods when the logic low signal level is present on the field bus, in addition to those periods when the field bus carries the logic high signal level.

[0022] Applications with relatively high power requirements such as infrared communication may particularly benefit from the improved energy supply. Infrared communication has a current demand that may exhaust the energy supply capacity of a field bus, For example, a DALI bus system may be supplied with a maximum current of 250mA for the devices in the system, which ultimately limits the infrared LED current.

[0023] Based on the temporally extended energy supply capacity, this current limitation may be relaxed. Furthermore, a transmitter unit of a lighting control device and a networked device comprising the lighting control device may be dimensioned by a lower quiescent current in those periods when the field bus carries the logic high signal level. This enables supplying more networked devices connected to the field bus and simplifying the powering of the field bus.

[0024] Advantageously, the technical effects and advantages described in relation to the lighting control device equally apply to the LED driver and the luminaire as well.

Brief Description of Drawings

[0025] The above-described aspects and implementations will now be explained regarding the accompanying drawings, in which the same or similar reference numerals designate the same or similar elements.

[0026] The features of these aspects and implementations may be combined with each other unless specifically stated otherwise.

[0027] The drawings are to be regarded as being schematic representations, and elements illustrated in the drawings are not necessarily shown to scale. Rather, the various elements are represented such that their function and general purpose become apparent to those skilled in the art.

FIG. 1 illustrates a luminaire and a LED driver under the present disclosure;

FIG. 2 illustrates a lighting control device under the present disclosure;

FIG. 3 illustrates a first implementation of the transmitter unit under the present disclosure;

FIG. 4 illustrates the bus voltage over time by the transmitter unit of FIG. 3;

FIGs. 5, 6 illustrate second and third implementations of the transmitter unit under the present disclosure;

FIG. 7 illustrates the bus voltage over time by the transmitter units of FIGs. 5, 6;

FIG. 8 illustrates a fourth implementation of the transmitter unit under the present disclosure; and

FIG. 9 illustrates the bus voltage over time by the transmitter unit of FIG. 8.

Detailed Descriptions of Drawings

[0028] FIG. 1 illustrates a luminaire 1 and an LED driver 2 under the present disclosure.

[0029] The luminaire 1 comprises an LED driver 2 and LED lighting means 3 which are connectable to the LED driver 2 via output terminals of the LED driver 2.

[0030] Input terminals of the luminaire 1 of FIG. 1 are connected to a field bus 6 which is mainly powered via an AC/DC converter 7. In particular, the field bus 6 may comprise a DALI bus.

[0031] The LED driver 2 comprises a converter 5 configured to power the aforementioned LED lighting means 3 and a lighting control device 4 under the present disclosure.

[0032] FIG. 2 illustrates a lighting control device 4 under the present disclosure.

[0033] The lighting control device 4 comprises a transmitter unit 41, a receiver unit 42, and a control unit 43 such as a microcontroller or a microprocessor.

[0034] The transmitter unit 41 is connectable to the field bus 6. Any such connectivity of the transmitter unit 41 applies to the receiver unit 42 likewise. In particular.

[0035] The transmitter unit 41 may comprise a DALI transmitter unit and is configured to conduct a wireline transmission of the lighting control device 4 on the field bus 6 by intermittently applying a logic low signal level to the field bus 6.

[0036] The logic low signal level comprises a positive voltage. In particular, the positive voltage may comprise a maximum voltage specified for the transmitter unit 41 when applying the logic low signal level to the field bus 6. For example, the positive voltage may comprise a voltage up to +4,5 V in the case of a transmitter unit 41 for a DALI bus. This logic low signal level maintains a margin to the maximum voltage of +6,5 V of the logic low signal level specified for the communication on a DALI bus.

[0037] The lighting control device 4 is configured for power intake off the field bus 6 when the positive voltage is present on the field bus 6. For example, when the positive voltage is present on the field bus 6 as the logic low signal level, a power intake of the lighting control device 4 may amount up to 250 mA (maximum system current, implying no other networked devices consuming significant currents) times +4,5 V (the maximum positive voltage specified for DALI transmitters when applying the logic low signal level to the field bus).

[0038] The lighting control device 4 may further comprise an energy storage unit (not shown) configured for the power intake off (i.e., from) the field bus 6. In particular, the energy storage unit may comprise a capacitor. The capacitor may be dimensioned following a quiescent current that takes account of an energy supply of the lighting control device 4 during periods when the logic low signal level is present on the field bus, in addition to those periods when the field bus carries the logic high signal level.

[0039] FIG. 3 illustrates a first implementation of the transmitter unit 41 under the present disclosure.

[0040] The transmitter unit 41 may comprise a load 411, which may include a resistor and a first switch 412 connected in series between a conductor pair of the field bus 6. The conductor pair may further connect the receiver unit 42 to the field bus 6 following the lighting control device 4 of FIG. 2. The lighting control device 4, in particular its control unit 43, may be configured to switch the first switch 412 into its conductive state to apply the logic low signal level dropping across the load 411 to the field bus 6, by applying an appropriate control signal 413. In other words, the load may be designed to exhibit a voltage drop between its terminals that corresponds to the logic low signal level and in particular amounts to the positive voltage of up to + 4,5 V mentioned above for a load current of 250 mA (maximum system current). This maximizes the power intake capacity of the lighting control device 4.

[0041] FIG. 4 illustrates the bus voltage V_{BUS} over time *t* following the transmitter unit 41 of FIG. 3.

[0042] FIG. 3 further indicates shaded portions, one for the logic high signal level recognized between +22,5 V and +9,5 V, and another one for the logic low signal level recognized identified between - 6,5 V and +6,5 V, as specified for DALI bus communication.

[0043] An exemplary signal curve of the control signal 413 is shown at a top of FIG. 4. By applying this control signal 413 to the first switch 412 shown in FIG. 3, the first switch 412 is switched into its conductive state when the control signal corresponds to a logic high signal.

[0044] As shown in FIG. 4, when the first switch 412 is switched into its conductive state, the bus voltage V_{BUS} drops from a quiescent voltage of +16 V applied between the conductor pair which will be recognized as the logic high signal level to a lower value which will be recognized as the logic low signal level.

[0045] More specifically, switching the first switch 412 into its conductive state gives rise to a load current across the load 411. The load current may amount up to the maximum system current of 250 mA, and depending on a dimensioning of the load 411 a particular voltage may drop across the load 411. Using Ohm's law and taking account of a power intake of the lighting control device 4, the load 411 may be dimensioned such that a target value of +4,5 V for the voltage drop across the load 411 is achieved.

[0046] As a result, the bus voltage V_{BUS} is clamped to +4,5 V whenever the first switch 412 is in its conductive state. This positive voltage is still recognized as the logic low signal level and thus does not adversely affect the communication on the field bus 6. At the same time, when the positive voltage is present at the field bus 6, the lighting control device 4 is enabled for the power intake.

[0047] Of note, the positive voltage may be present at the field bus 6 due to transmissions of any lighting control device 4 connected to the field bus 6. Accordingly, the power intake by a particular lighting control device 4 is enabled no matter which one of the lighting control devices 4 performs a transmission.

[0048] FIGs. 5 and 6 illustrate second and third implementations of the transmitter unit 41 under the present disclosure.

[0049] The transmitter units 41 of FIG. 5 and 6 may further comprise a second switch 414.

[0050] In FIG. 5, the second switch 414 is connected between the conductor pair of the field bus 6, in parallel to the series connection of the load 411 and the first switch 412 introduced in FIG. 3.

[0051] In FIG. 6, the second switch 414 is connected in parallel to the load 411 only.

[0052] The lighting control device 4 may further be configured to switch the second switch 414 into its conductive state to short-circuit the conductor pair of the field bus 6, by applying an appropriate control signal 415A/B

[0053] Both implementations have in common that the lighting control device 4 may further be configured to intermittently switch the second switch 414 into its conductive state when the first switch 412 is in its conducting state.

[0054] FIG. 7 illustrates the bus voltage V_{BUS} over time *t* following the transmitter units 41 of FIGs. 5 and 6.

[0055] An exemplary signal curve of the control signal 415A/B is shown at a top of FIG. 7. Generally the control signal 415A/B is modulated with a frequency higher than the frequency with which the communication on the field bus 6 is modulated. For example, an integer multiple may be used.

[0056] By applying the respective control signal 415A/B to the respective second switch 414 shown in FIGs. 5 and 6, said second switch 414 is switched into its conductive state when said control signal 415A/B corresponds to a logic high signal.

[0057] As shown in FIG. 7, when both the first switch 412 and the second switch 414 are switched into their conductive states, the bus voltage V_{BUS} drops from the positive voltage of +4,5 V applied between the conductor pair to the value of 0 V, corresponding to the resulting short-circuit of the conductor pair of the field bus 6.

[0058] As a result, the bus voltage V_{BUS} is clamped to 0 V whenever both the first switch 412 and the second switch 414 are in their conductive states. Depending on the implementation, said control signal 415A/B may require taking measures for not adversely affecting those periods when the logic high signal level is applied to the field bus 6. This is indicated by the dotted sections of the signal curve representing the control signal 415A/B in FIG. 7.

[0059] The resulting zero bus voltage is still recognized as the logic low signal level and thus does not adversely affect the communication on the field bus 6. At other times, when the positive voltage (e.g., +4,5 V) is present at the field bus 6, the lighting control device 4 is enabled for the power intake.

[0060] FIG. 8 illustrates a fourth implementation of the transmitter unit 41 under the present disclosure.

[0061] Of note, the transmitter unit 41 of FIG. 8 may augment any of the transmitter units 41 mentioned above.

[0062] Said transmitter units 41 may thus further comprise a wireless communication unit 416 and a third switch 417 connected in series between the conductor pair of the field bus 6. The wireless communication unit 416 may comprise an infrared light-emitting diode, LED. The lighting control device 4 may further be configured to intermittently switch the third switch 417 into its conductive state to conduct a wireless transmission of the lighting control device 4 via the wireless communication unit 416, by applying an appropriate control signal 418.

[0063] In addition, the transmitter unit 41 may further comprise a fourth switch 419 connected between the conductor pair of the field bus 6, in parallel to the series connection of the wireless communication unit 416 and a third switch 417. The lighting control device 4 may further be configured to alternatingly switch the third switch 417 and the fourth switch 419 into their respective conductive states following a modulation frequency of the wireless communication unit 416, by applying appropriate control signals 418, 420. In this implementation, the control signals 418, 420 complement one another in terms of their logic signal levels.

[0064] FIG. 9 illustrates the bus voltage V_{BUS} over time *t* following the transmitter unit 41 of FIG. 8.

[0065] Exemplary signal curves of the control signals 418, 420 are shown at a top of FIG. 9. Generally, the control signals 418, 420 are modulated with a frequency much higher than the frequency with which the communication on the field bus 6 is modulated. For example, a modulation frequency of 36 kHz may be used.

[0066] By applying the respective control signal 418, 420 to the respective switch 417, 419 shown in FIG. 8, the respective switch 417, 419 is switched into its conductive state when the respective control signal 418, 420 corresponds to a logic low signal level of +4,5 V.

[0067] As shown in FIG. 9, the switches 417 and 419 take turns in switching into their conductive states when the positive voltage of +4,5 V is present at the field bus 6. When the third switch 417 is in its conductive state, the wireless communication unit 416 is provided with a current and thus enabled to conduct a wireless transmission of the lighting control device 4.

[0068] As a result, the bus voltage V_{BUS} is clamped to about 0 V whenever one of the switches 417, 419 is in its conductive states. This is indicated by the dotted sections of the curve representing the bus voltage V_{BUS} in FIG. 9. Of note, the bus voltage V_{BUS} of about 0 V assumes that the wireless communication unit 416 exhibits only a negligible voltage drop when conducting the current just mentioned.

[0069] Said control signals 418, 420 may require taking measures for not adversely affecting those periods when the logic high signal level is applied to the field bus 6. This is indicated by the intermittent modulation of the signal curves representing the control signals 418, 420 in FIG. 9.

[0070] The resulting voltage of about 0 V is still recognized as the logic low signal level and thus does not necessarily affect the communication on the field bus 6 adversely. That is to say, the wireless transmission using the wireless communication unit 416 may simply copy the wireline transmission via the field bus 6. Alternatively, the wireless transmission using the wireless communication unit 416 may be used independently of the communication protocol of the wireline transmission on the field bus 6. In this case, other lighting control units 4 connected to the field bus 6 and receiving the copy of the wireless transmission via the field bus 6 need to be able to recognized and discard incorrect transmissions.

Claims

1. A lighting control device (4), comprising

a transmitter unit (41) connectable to a field bus (6) and configured to conduct a wireline transmission of the lighting control device (4) on the field bus (6) by intermittently applying a logic low signal level to the field bus (6), wherein the logic low signal level comprises a positive voltage;
the lighting control device (4) configured for power intake off the field bus (6) when the positive voltage is present on the field bus (6).

2. The lighting control device (4) of claim 1,
the positive voltage comprising a maximum voltage specified for the transmitter unit (41) when applying the logic low signal level to the field bus (6).

3. The lighting control device (4) of claim 1 or claim 2,

the transmitter unit (41) comprising a load (411) and a first switch (412) connected in series between a conductor pair of the field bus (6); and
the lighting control device (4) configured to switch the first switch (412) into its conductive state to apply the logic low signal level dropping across the load (411) to the field bus (6).

4. The lighting control device (4) of claim 3,
the load (411) comprising a resistor.

5. The lighting control device (4) of claim 3 or claim 4,

the transmitter unit (41) further comprising a second switch (414) connected between the conductor pair of the field bus (6); and
the lighting control device (4) further configured to switch the second switch (414) into its conductive state to short-circuit the conductor pair of the field bus (6).

6. The lighting control device (4) of claim 5, the lighting control device (4) further configured to intermittently switch the second switch (414) into its conductive state when the first switch (412) is in its conducting state.

7. The lighting control device (4) of any one of the preceding claims,

the transmitter unit (41) further comprising a wireless communication unit (416) and a third switch (417) connected in series between the conductor pair of the field bus (6);
the lighting control device (4) further configured to intermittently switch the third switch (417) into its conductive state to conduct a wireless transmission of the lighting control device (4) via the wireless communication unit (416).

8. The lighting control device (4) of claim 7,

the transmitter unit (41) further comprising a fourth switch (419) connected between the conductor pair of the field bus (6);
the lighting control device (4) further configured to alternatingly switch the third switch (417) and the fourth switch (419) into their respective conductive states following a modulation frequency of the wireless communication unit (416).

9. The lighting control device (4) of claim 7 or claim 8, the wireless communication unit (416) comprising an infrared light-emitting diode, LED.

10. The lighting control device (4) of any one of the preceding claims, further comprising an energy storage unit configured for the power intake off the field bus (6).

11. The lighting control device (4) of claim 10, the energy storage unit comprising a capacitor.

12. The lighting control device (4) of any one of the preceding claims,

the transmitter unit (41) comprising a DALI transmitter unit (41); and
the field bus (6) comprising a DALI bus.

13. An LED driver (2), comprising

a lighting control device (4) of any one of the claims 1 to 12; and
a converter (5) configured to power LED lighting means (3) connectable to the LED driver (2) via output terminals of the LED driver (2).

14. A luminaire (1), comprising

an LED driver (2) of claim 13; and
LED lighting means (3) connected to output terminals of the LED driver (2).

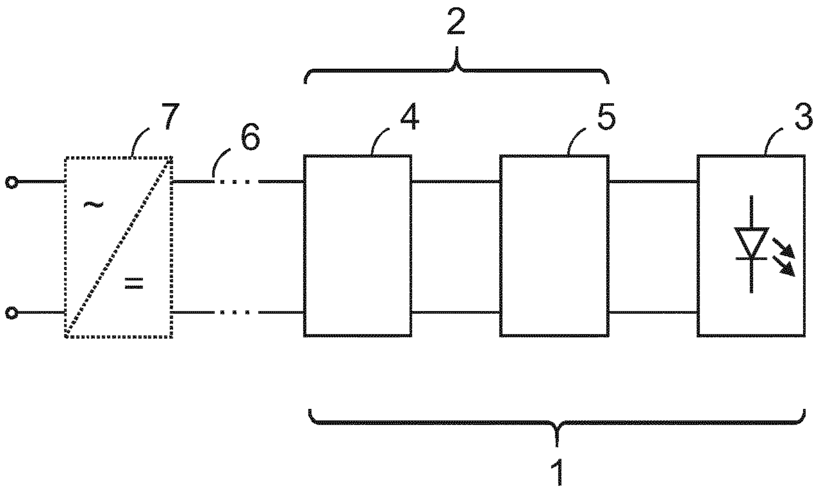

Fig. 1

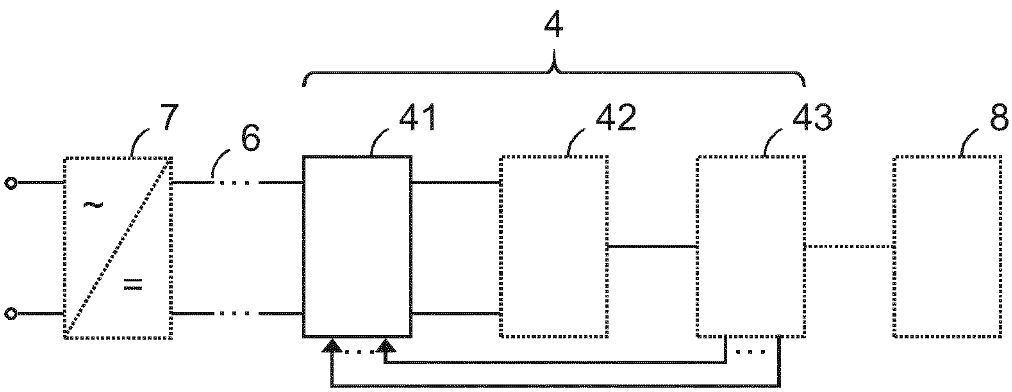

Fig. 2

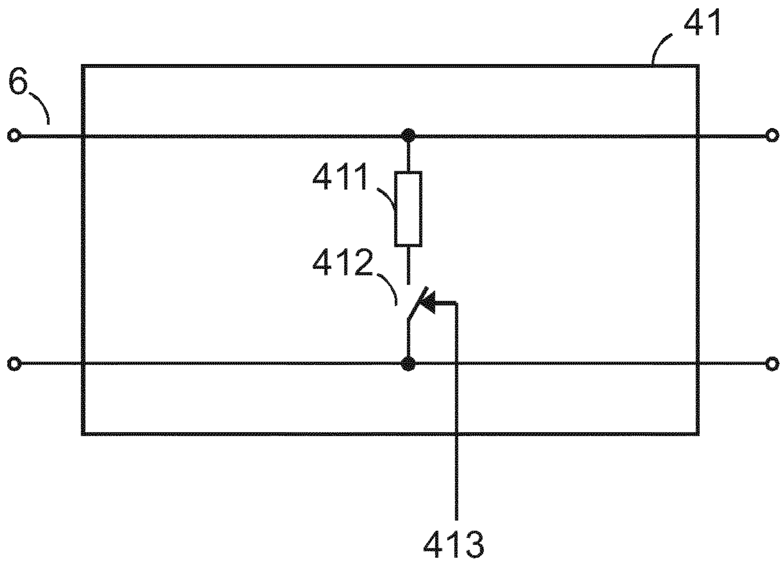

Fig. 3

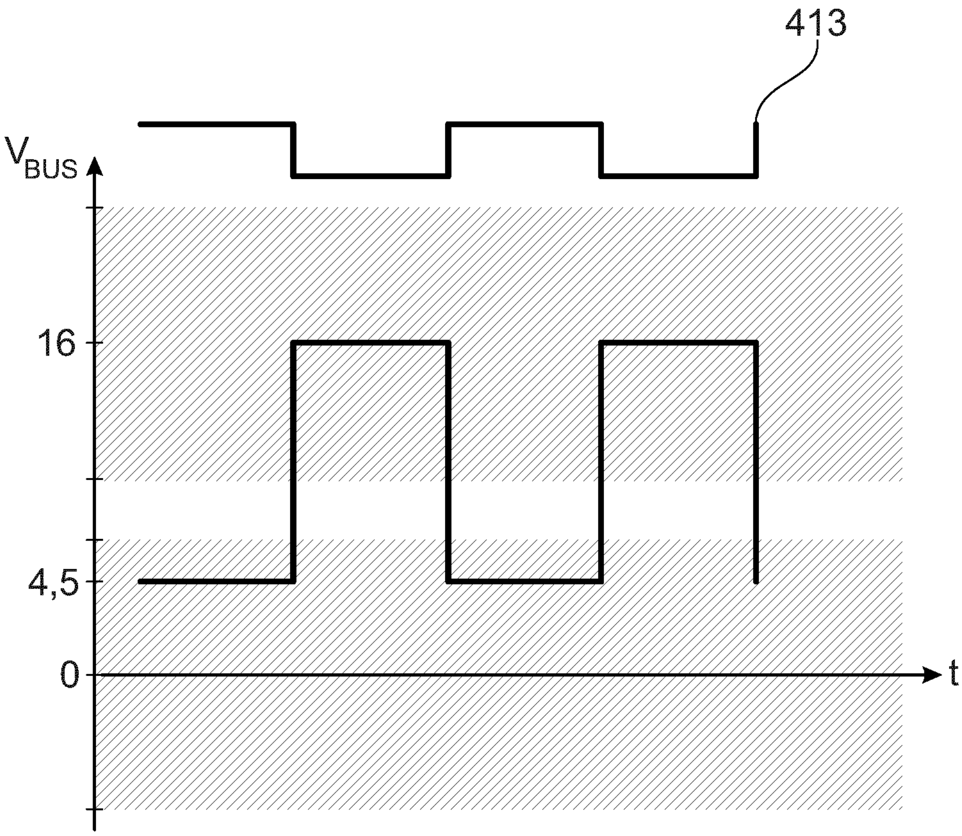

Fig. 4

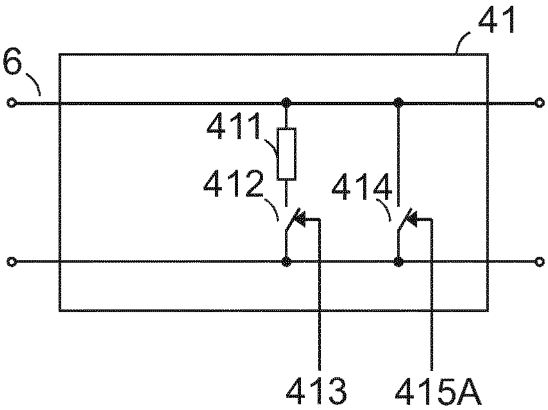

Fig. 5

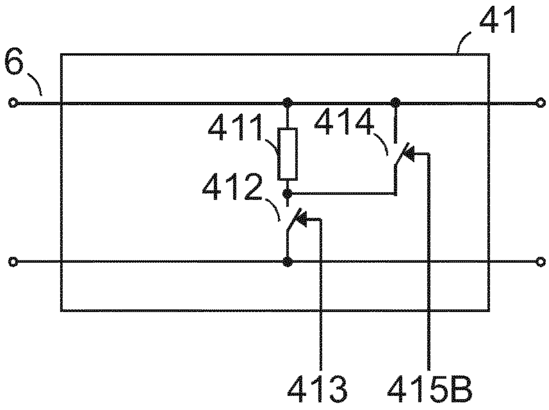

Fig. 6

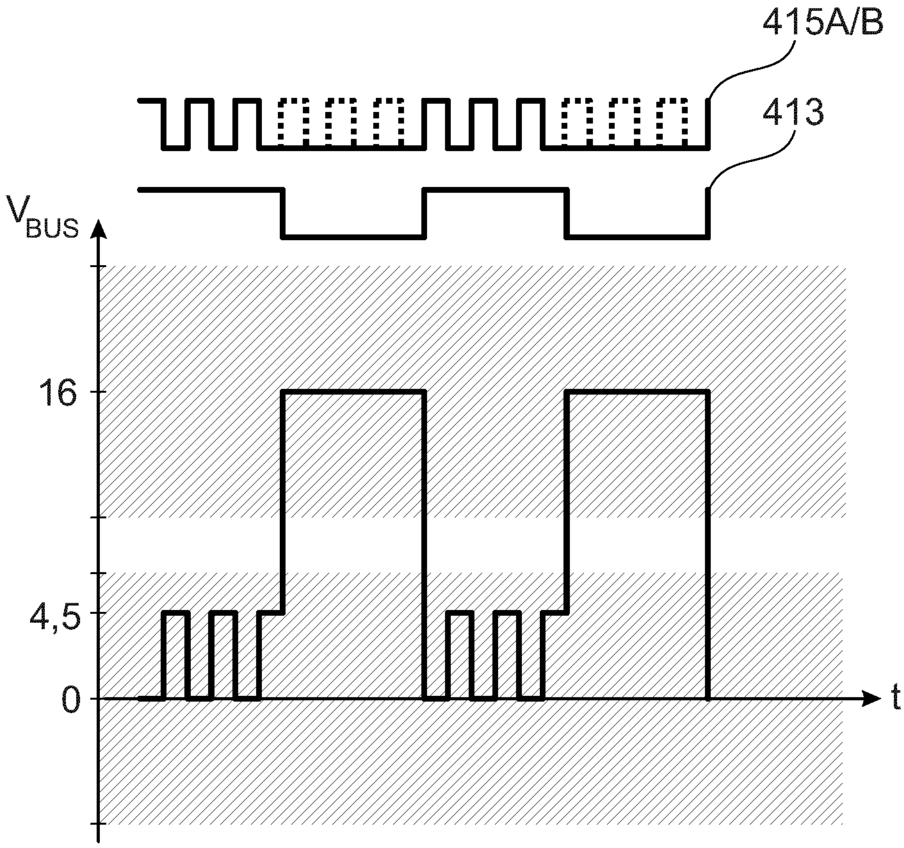

Fig. 7

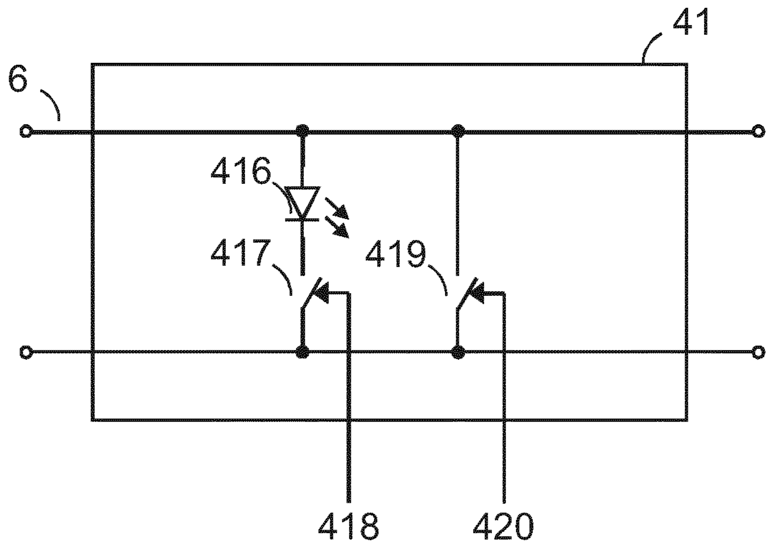

Fig. 8

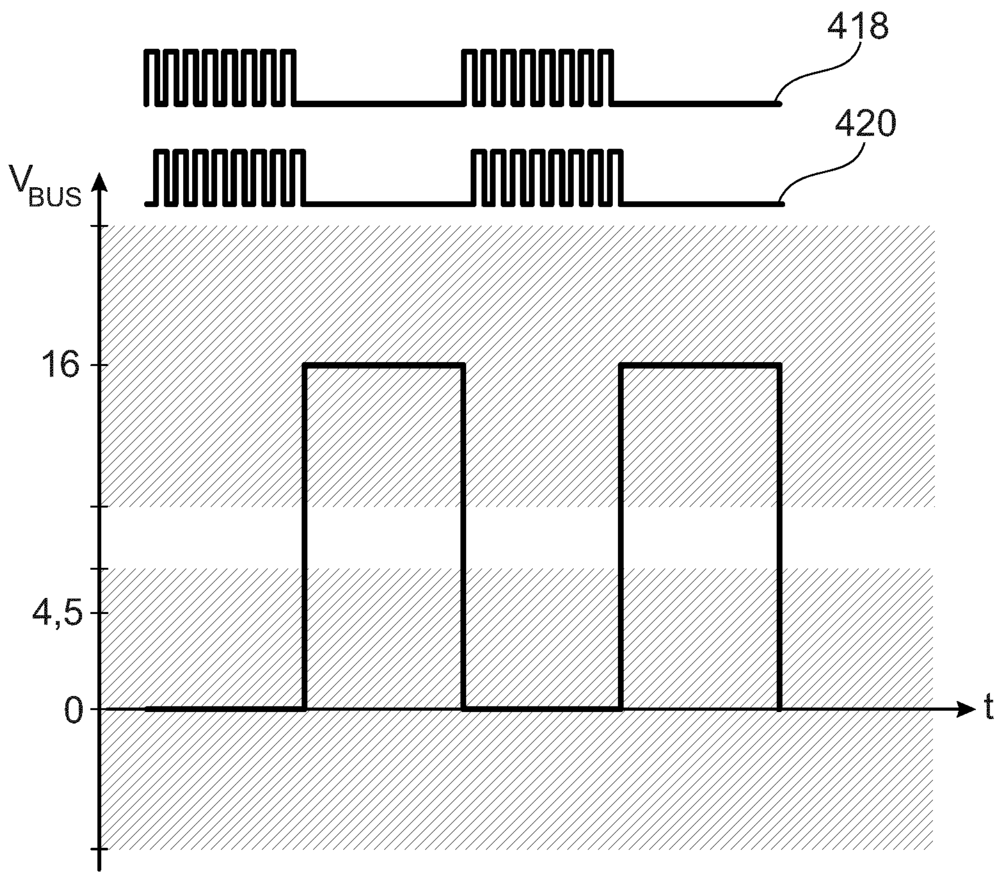

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 21 17 5610

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TECHNICAL FIELDS SEARCHED (IPC)
H05B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	20 October 2021	Erskine, Andrew

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 17 5610

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