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(54) **ISOLATED DRIVER MODULE WITH INDICATOR LED FOR COMMUNICATION**

(57) The present application discloses an isolated driver module for electrically supplying lighting means, comprising a galvanic isolation barrier, a control circuit and a status indication module arranged on the secondary side of the isolated driver module, wherein the status indication module comprises at least one indicator LED electrically supplied via supply means, and a communication module arranged on the primary side. The control circuit is configured to control the electrical supply of the at least one indicator LED via the supply means for controlling a visual indication of the status of the isolated driver module by the at least one indicator LED. Furthermore the control circuit is configured to control the electrical supply of the at least one indicator LED via the supply means such that the electrical supply is switched, in order to electromagnetically transmit information from the status indication module to the communication module. The present application further discloses a luminaire with such an isolated driver module and a method for operating such an isolated driver module.

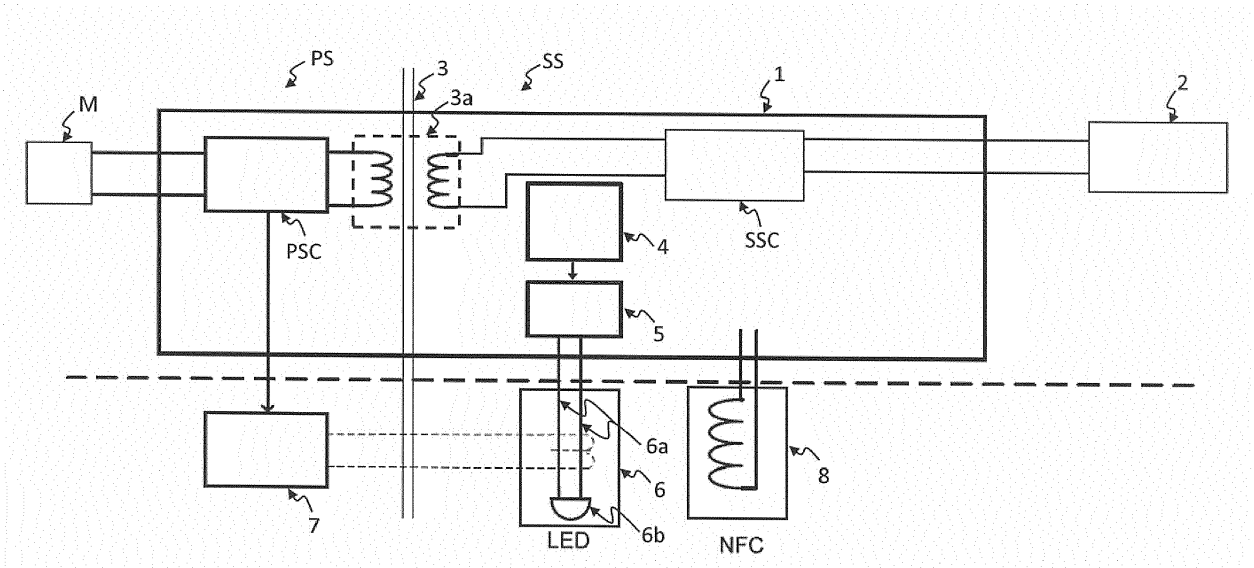

Figure 1

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Description

Field of the invention

[0001] The present invention relates to the field of isolated driver modules, such as emergency lighting driver modules, for electrically supplying lighting means. In particular the present invention relates to a communication of information of an isolated driver module for lighting means. To this end, the invention proposes an isolated driver module for electrically supplying lighting means. The invention also proposes a luminaire comprising the isolated driver module, and a method for operating the isolated driver module.

Technical background

[0002] In the prior art, isolated driver modules for electrically supplying lighting means (isolated lighting driver modules) are well known.

[0003] Usually such an isolated driver module comprises a galvanic isolation barrier that galvanically isolates a primary side from a secondary side of the isolated driver module. The primary side of the isolated driver module may be electrically connected to an external energy source, such as mains, so that the isolated driver module can be electrically supplied with electrical energy for driving the lighting means. To the secondary side of the isolated driver module the lighting means may be electrically connected in order to be electrically supplied by the isolated driver module. That is, the isolated driver module can drive the lighting means when they are electrically connected to the secondary side. The galvanic isolation barrier is provided in order to protect persons who touch components on secondary side of the converter including the LED load indicator and the battery.

[0004] On the secondary side a control circuit may be arranged for controlling components arranged on the secondary side. When the isolated driver module is an emergency lighting driver module, an energy storage, e.g. a battery, is provided on the secondary side in order for the emergency lighting driver module to be able to supply the lighting means in an emergency mode with electrical energy from the energy storage. An emergency mode could be present for example as a result of mains failure or as a result of the electrical supply from mains in a place, e.g. building, where the emergency lighting driver module is installed, failing. That is, in the emergency mode the electrical supply of the lighting means by the emergency lighting driver module is battery powered. As a result, in an emergency lighting driver module the control circuit has to be arranged on the secondary side, so that it can be supplied with electrical energy from the energy storage (battery) on the secondary side in the emergency mode. Namely, the function of the control circuit is also needed to control the emergency functionality while the mains supply is not present. Power is taken from the battery to drive the lighting means and also the control circuits to facilitate this functionality.

[0005] Furthermore, since the control circuit is arranged on the secondary side of the galvanic isolation barrier no isolation elements are needed for providing control signals from the control circuit to components arranged on the secondary side. A component arranged on the secondary side can be for example a secondary side supply circuit, such as a converter circuit for converting a voltage provided from the primary side to a higher or lower voltage for supplying the lighting means. A further component arranged on the secondary side can be for example a module, such as a status indication module.

[0006] A status LED can be mandatory to show that charger is working and battery is being charged but can have additional functions to show the status such as test modes or faults. Normal green indication (no flashing) shows battery is being charged and unit is OK - no testing ongoing.

[0007] A status could be for example that the isolated driver module is working properly (functional) or not working properly (not functional). In particular, when the isolated driver module is an emergency lighting driver module, the isolated driver module is provided due to regulatory requirements with a status indication module for visually informing a user about the status of the isolated driver module.

[0008] Typically, isolated driver modules comprise on the primary side a communication interface, such as a DALI-interface, to which a communication module is electrically connected enabling the isolated driver module to communicate to extern, with for example other driver modules or a central control unit of a lighting network.

[0009] In order for the control circuit arranged on the secondary side to communicate information respectively data via the communication interface and the communication module of the primary side to extern, isolation elements, such as an optocoupler, have to be provided for feeding information respectively data from the control circuit on the secondary side via the galvanic isolation barrier to the communication module on the primary side.

[0010] This is disadvantageous as such isolation elements, e.g. optocouplers, are expensive, occupy space, are arranged directly on the isolation barrier and have some aging effects.

[0011] Therefore, it is an object of the present invention to provide an isolated driver module for electrically supplying lighting means, wherein the above disadvantage is overcome with regard to a communication of information from a control circuit arranged on the secondary side.

[0012] These and other objects, which become apparent upon reading the following description, are solved by the subject-matter of the independent claims. The dependent claims refer to preferred embodiments of the invention.

Summary of the invention

[0013] The present invention, in one aspect, provides an isolated driver module for electrically supplying lighting means, wherein the isolated driver module comprises

- a galvanic isolation barrier, preferably a SELV isolation barrier, that galvanically isolates a primary side and a secondary side of the isolated driver module from each other, wherein the lighting means are electrically connectable to the secondary side,
- a control circuit, preferably a microcontroller, arranged on the secondary side,
- a status indication module with at least one indicator LED electrically supplied via supply means, in particular via at least one wire, wherein the status indication module is arranged on the secondary side, and
- a communication module, preferably a wireless communication module, arranged on the primary side.

[0014] Further features and aspects of the invention will become evident from the following detailed description of embodiments, when taken in connection with the figures of the enclosed drawings.

Description of preferred embodiments

[0015] In the following, the invention is described exemplarily with reference to the enclosed figures, in which

Figure 1	schematically shows a circuit diagram of an isolated driver module according to the present invention
Figure 2	schematically shows a circuit diagram of an isolated driver module according to the present invention
Figure 3	schematically shows a circuit diagram of a LED indicator driver module. This is normally connected to microcontroller on the Low Voltage/SELV side of the driver
Figure 4	schematically shows examples of the behavior of the supply current Is for the at least one indicator LED of the status indication module of an isolated driver module according to the present invention over time
Figures 5a and 5b	schematically show examples of the supply current for the at least one indicator LED of the status indication module of an isolated driver module according to the present invention
Figure 6	schematically shows an arrangement of the status indication module, the communication module and one optional further peripheral module of an isolated driver module
Figure 7	schematically shows the status indication module, the communication module and two optional further peripheral modules of an isolated driver module according to a preferred embodiment of the present invention.

[0016] **Figure 1** schematically shows a circuit diagram of an isolated driver module according to a preferred embodiment of the present invention.

[0017] According to Figure 1 the isolated driver module 1 comprises a galvanic isolation barrier 3 that galvanically isolates a primary side PS of the isolated driver module 1 from a secondary side SS of the isolated driver module 1. The galvanic isolation barrier 3 can be implemented as outlined above. In particular, the galvanic isolation barrier 3 is a SELV isolation barrier. According to Figure 1 the galvanic isolation barrier 3 is provided by a transformer 3a with a primary winding on the primary side PS and a secondary winding on the secondary side SS. The transformer 3a is preferably a safety transformer, in particular for providing a SELV isolation.

[0018] Note that is not absolutely necessary to SELV but in many cases is SELV but also the battery must be double insulated from the live supply parts even when it is not a SELV design.

[0019] As shown in Figure 1 the primary side PS of the isolated driver module 1 (also called only primary side) can be electrically connected to an external energy source M, such as mains or a supply bus. In particular, the external

energy source is a supply bus, wherein the bus voltage of the supply bus is supplied by another device connected to the bus from mains. Thus, the primary side is the input side of the isolated driver module 1 to which electrical energy, in particular an input voltage and input current, may be provided from an external energy source M. To the secondary side SS of the isolated driver module 1 (also called only secondary side) lighting means 2 can be electrically connected. When the lighting means 2 are electrically connected to the secondary side SS, the isolated driver module 1 can supply them with electrical energy, in particular with an output voltage and output current. That, is the isolated driver module 1 is configured to drive the lighting means 2 respectively electrically supply the lighting means 2, thereby controlling the light emitted by the lighting means 2. The secondary side SS is thus the output side of the isolated driver module 1 from which electrical energy, in particular the output voltage and output current can be provided to the lighting means 2.

[0020] The lighting means 2 are as outlined above. That is, the lighting means preferably comprise or correspond to at least one LED (light emitting diode), such as an organic LED, inorganic LED, etc. Additionally or alternatively, the lighting means can also comprise or correspond to another type of lighting means, such as for example a gas discharge tube.

[0021] The isolated driver module 1 and the lighting means 2 form together a luminaire according to the present invention.

[0022] On the primary side PS a primary side supply circuit PSC is arranged that is electrically connected between the input of the isolated driver module 1, to which electrical energy can be supplied from the external energy source M, and the galvanic isolation barrier 3, in particular the primary winding of the transformer 3a. On the secondary side SS a secondary side supply circuit SSC is arranged that is electrically connected between the galvanic isolation barrier 3, in particular the secondary winding of the transformer 3a, and the output of the isolated driver module, to which the lighting means 2 can be electrically connected.

[0023] The above description with regard to a primary side supply circuit and a secondary side supply circuit are also valid for the primary side supply circuit PSC and secondary side supply circuit SSC of the isolated driver module 1 shown in Figure 1.

[0024] The primary side supply circuit PSC (also called primary supply circuit), the transformer 3a providing the galvanic isolation barrier 3 and the secondary side supply circuit SSC (also called secondary supply circuit) form an electrical supply path of the isolated driver module 1. This electrical supply path is configured to electrically supply the lighting means 2 starting from electrical energy provided from an external energy source M to the primary side PS.

[0025] Preferably, the isolated driver module 1 comprises an energy storage, such as a rechargeable battery, on the secondary side SS (not shown in Figure 1), which is part of the secondary supply circuit SSC, wherein a charging circuit of the secondary supply circuit SSC (not shown in Figure 1) is configured to charge the energy storage.

[0026] In particular, the isolated driver module 1 comprises the energy storage and the charging circuit on the secondary side SS when it is an emergency lighting driver module.

[0027] As an emergency lighting driver module the isolated driver module 1 is configured to supply the lighting means 2 with electrical energy from the energy storage on the secondary side in an emergency mode. In the emergency mode the energy supply from the external energy source M to the isolated driver module 1 is not working normally or is interrupted. This can be for example due to mains failure or as a result of the electrical supply from mains in a place, e.g. building, where the emergency lighting driver module is installed, failing. I

[0028] In the normal operating mode, i.e. the energy supply from the external energy source M to the isolated driver module 1 is working properly, the charging circuit is configured to charge the energy storage with electrical energy supplied from the external energy source M via the primary supply circuit PSC and the galvanic isolation barrier 3 to the secondary supply circuit SSC. Preferably, the isolated driver module 1, may also supply in the normal operating mode the lighting means 2 with electrical energy from the energy storage, while the energy storage is being charged by the charging circuit.

[0029] The primary supply circuit PSC is preferably configured to converter an input voltage/input current, supplied from the external energy supply M, into a lower or higher voltage/current that is supplied via the galvanic isolation barrier 3, in particular via the transformer 3a, to the secondary supply circuit SSC. The secondary supply circuit SSC is preferably configured to converter the voltage/current provided from the primary supply circuit PSC to a lower or higher output voltage/ output current for electrically supplying the lighting means 2. When the secondary supply circuit SSC comprises the energy storage and the charging circuit, the charging circuit is configured to use the voltage/current provided from the primary side supply circuit PSC for charging the energy storage and the secondary supply circuit SSC is configured to electrically supply the lighting means 2 with an output voltage/output current from the electrical energy stored in the energy storage.

[0030] Preferably, the primary supply circuit PSC and/or the secondary supply circuit SSC comprises at least one converter stage, in particular an actively switched DC-to-DC-converter stage, for converting a voltage into a higher or lower voltage depending on the type of the converter stage. Examples of a DC-to-DC-converter stage are a boost converter, buck converter, flyback converter, resonant converter etc.

[0031] In particular, the charging circuit of the secondary supply circuit SSC can be a converter stage, such as a DC-

to-DC-converter stage.

[0032] The isolated driver module 1 further comprises a control circuit 4 (also called first control circuit) that is arranged on the secondary side SS. The control circuit 4 can be implemented as outlined above. That is, the control circuit is preferably a processor, a microprocessor, a controller, a microcontroller, an application specific integrated circuit ASIC or any combination of them.

[0033] The control circuit 4 is configured to control the secondary supply circuit SSC and, thus, components of the secondary supply circuit SSC as well as functions of the secondary supply circuit SSC. For example, when the isolated driver module 1 is an emergency lighting driver module and, thus, the secondary supply circuit SSC comprises an energy storage and charging circuit as described above, the control circuit 4 is configured to control the charging of the energy storage and the energy supply of the lighting means 2 by the secondary supply circuit SSC, preferably with electrical energy stored by the energy storage, in the normal operating mode. In addition, the control circuit is configured to control the electrical energy supply of the lighting means 2 by the secondary supply circuit SSC with electrical energy stored by the energy storage in the emergency mode.

[0034] As outlined already above, the control circuit is electrically supplied with electrical energy from the secondary supply circuit SSC (not shown in Figure 1). When the secondary supply circuit SSC comprises the energy storage, the control circuit 4 may be electrically supplied with electrical energy from the energy storage. In particular, when the isolated driver module 1 is an emergency lighting driver module, the control circuit is electrically supplied with electrical energy from the energy storage in the emergency mode and, preferably also in the normal operating mode.

[0035] Note that normally the control circuit will take its power from the battery in emergency mode and from a supply derived from the mains supply in normal mode. There should be a net charger current flowing to the battery when in normal mode.

[0036] The isolated driver module 1 further comprises, on the secondary side SS, a status indication module 6. The status indication module 6 can be implemented as outlined in the following.

[0037] The status indication module 6 comprises supply means 6a and at least one indicator LED 6b, which is electrically supplied via the supply means 6a. That is, the status indication module 6 comprises one or more indicator LEDs. Preferably, the one or more indicator LEDs are of the same type or of different type. In particular, the one or more indicator LEDs can emit light of different color. Preferably, each of the one or more indicator LEDs can emit light of a different color with respect to each other. Preferably, the status indication module comprises two indicator LEDs, wherein a first indicator LED is configured to emit light of a first color and a second indicator LED is configured to emit light of a second color. Preferably, the status indication module may comprise a plurality of indicator LEDs, wherein a first group of indicator LEDs is configured to emit light of a first color and a second group of indicator LEDs is configured to emit light of a second color. In particular, the one or more indicator LEDs are a bi-color LED configured to emit light of a first color and light of a second color.

[0038] For the following exemplarily description of the isolated driver module 1 according to Figure 1, it is assumed that the status indication module 6 comprises one indicator LED 6b. This description is also applicable for an isolated driver module 1 according to the present invention comprising a status indication module 6 with more than one indicator LED 6b. Preferably, the status indicator LED 6b is a bi-color LED.

[0039] The supply means 6a are preferably two wires for supplying electrical energy, in particular a supply current, to the indicator LED 6b. The indicator LED is electrically supplied with electrical energy, in particular a supply current, from the secondary supply circuit SSC (not shown in Figure 1).

It is normally not foreseen to operate the indicator LED in emergency mode or from the battery. The indicator is normally supplied from the supply of the off mains power supply which should be isolated e.g. SELV. This is not normally an issue because the communication is restricted to mains mode and not emergency. In principle it is also possible to power the indicator LED in emergency mode.

[0040] The supply means 6a of the status indication module 6 are electrically connected to a switching circuit 5 arranged on the secondary side SS. The status indication module 6, in particular the supply means 6a, is electrically connected via the switching circuit 5 to the secondary supply circuit SSC, in order to be supplied with electrical energy, in particular with the supply current, from the secondary supply circuit (not shown in Figure 1). In particular, when the secondary supply circuit comprises the energy storage, the status indication module 6, in particular the supply means 6a, is electrically connected via the switching circuit 5 to the energy storage, in order to be supplied with electrical energy, in particular with the supply current, from the energy storage (not shown in Figure 1).

[0041] The switching circuit 5 comprises at least one switch for switching the electrical supply of the indicator LED 6b. The at least one switch can be a transistor, such as a field-effect transistor (FET), in particular a metal oxide semiconductor field-effect transistor (MOSFET), or a bipolar junction transistor (BJT). That is, by controlling the at least one switch of the switching circuit 5 the electrical supply via the supply means 6a to the indicator LED can be controlled. For example, by opening the at least one switch of the switching circuit 5 (switching the switch into the non-conductive state) an electrical supply path from the secondary supply circuit SSC via the switching circuit 5 to the status indication module 6 for electrically supplying the indicator LED 6b is interrupted. As a result the indicator LED 6b is not supplied with

electrical energy and, thus, does not emit light. By closing the at least one switch of the switching circuit (switching the switch into the conductive state) the electrical supply path from the secondary supply circuit SSC via the switching circuit 5 to the status indication module 6 for electrically supplying the indicator LED 6b is present (not interrupted anymore). As a result the indicator LED 6b is supplied with electrical energy and, thus emits light.

[0042] For the following explanation it is assumed that the indicator LED 6b is supplied with a supply current as an electrical supply. The switching circuit 5 is configured to switch the supply current supplied via the supply means 6a to the indicator LED 6b. That is, the switching circuit 5 is configured to modulate the supply current, such that a modulated supply current is supplied via the supply means 6a to the indicator LED. In particular, the switching circuit 5 is configured to switch the supply current for the indicator LED 6b with a frequency that is higher than the resolution of the human eye.

[0043] The status indication module 6 is provided on the secondary side 6 of the isolated driver module 1 for visually indicating a status of the isolated driver module 1 to extern, e.g. to a user, by the indicator LED 6b. Thus, the status indication module 6 can visually inform a user about the status of the isolated driver module 1.

[0044] As outlined already above, the control circuit 4 is configured to control the visual indication of information, such as the status of the isolated driver module 1, by controlling the supply current supplied via the supply means 6a to the indicator LED 6b.

[0045] For controlling the status indication by the indicator LED 6b, the control circuit 4 is configured to control the indicator LED 6b to emit light for a predefined time, to control the indicator LED 6b to emit flashed light visible to the human eye with different frequencies and/or to control the color of the light emitted by the indicator LED 6b.

[0046] When the control circuit 4 controls the secondary supply circuit SSC and/or the switching circuit 5 to supply the supply current via the supply means 6a to the indicator LED 6b, the indicator LED is turned on and, thus, emits light. When the control circuit 4 controls the secondary supply circuit SSC and/or the switching circuit 5 to not supply the supply current (interrupt the supply of the supply current) via the supply means 6a to the indicator LED 6b, the indicator LED is turned off and, thus , does not emit light.

[0047] The isolated driver module further comprises a communication module 7 arranged on the primary side PS.. That is, the communication module 7 provides communication means to the isolated driver module for an external communication, for example with at least one other driver module or another device, such as a central control unit of a lighting network, wherein the communication module is configured for a wireless communication and/or a wired communication. Preferably, the communication module 7 is configured for a bidirectional communication.

[0048] The primary supply circuit PSC is configured to supply the communication module 7 with electrical energy (as indicated in Figure 1 by the arrow from the primary supply circuit PSC to the communication module 7).

[0049] Preferably, the isolated driver module 1 comprises on the primary side PS a second control circuit (not shown in Figure 1).. The second control circuit is configured to control the primary supply circuit PSC and/or the communication module 7. The second control circuit may be electrically supplied by the primary supply circuit PSC.

[0050] As outlined already above, according to the present invention, the control circuit 4 on the secondary side is configured to communicate (feed) information via the status indication module 6 to the communication module 7 by controlling the switching of the supply current for the indicator LED 6b. As a result, the indicator LED 6b is electrically supplied via the supply means 6a with a modulated current carrying the information. This causes an electromagnetic coupling between the supply means 6a of the status indication module 6 and the communication module allowing the information to be electromagnetically transmitted from the status indication module 6 to the communication module.

[0051] In particular, the control circuit 4 is configured to control the switching of the supply current with a frequency that is higher than the resolution of the human eye. As a result the switching is not visible to the human eye and has no impact on the status indication by the indicator LED 6b.

[0052] The switching of the supply current for the indicator LED for transmitting (feeding) information respectively data from the status indication module 6 on the secondary side SS to the communication module 7 on the primary side PS by electromagnetic coupling between the supply means 6a of the status indication module 6a and the communication module will be exemplarily described below with respect to Figures 4, 5a and 5b.

[0053] The control circuit 4 is configured to control the switching circuit 5, in particular the at least one switch of the switching circuit 5, (indicated in Figure 1 by the arrow from the control circuit 4 to the switching circuit 5) in order to control the switching of the supply current for the indicator LED 6b.

[0054] In Figure 1 the electromagnetic transmittal of information from the status indication module 6 to the communication module is indicated by dashed lines between the supply means 6a of the status indication module 6 and the communication module 7.

[0055] The switching circuit 5 may be part of the control circuit 4 or of the status indication module 6a (not shown in Figure 1).

[0056] The isolated driver module 1 preferably comprises on the secondary side SS at least one further module 8. The at least one further module 8 can be implemented as outlined. According to Figure 1 the at least one further module 8 is a near field communication module (NFC-module). In particular, the NFC-module 8 stores information respectively data regarding the isolated driver module 1, such as an address of the isolated driver module 1, an identifier (ID) of the

isolated driver module 1, operating parameters etc., that can be read out by an external NFC-device. In such a case, the control circuit 4 is preferably configured to transmit information stored in the NFC-module via the supply means 6a of the status indication module 6 to the communication module 7 on the primary side PS by controlling the switching of the electrical current for the indicator LED 6b.

[0057] As outlined already above, the at least one further module 8 can also be a different module.

[0058] For example, the at least one further module 8 can be a test-switch for initiating a self-test of the isolated driver module 1. In such a case, the control circuit 4 is preferably configured to transmit information regarding the test-switch, such as whether the test-switch is being actuated by a user, via the supply means 6a of the status indication module 6 to the communication module 7 on the primary side PS by controlling the switching of the supply current for the indicator LED 6b.

[0059] For example, the at least one further module 8 can be a sensor module comprising at least one sensor, such as a light sensor (photodetector), e.g. light dependent resistor (LDR); a smoke sensor; a fire sensor; a passive infrared sensor (PIR sensor), or a radio-frequency identification sensor (RFID sensor). In such a case, the control circuit 4 is preferably configured to transmit the measurement results of the at least one sensor module, such as the light intensity of the lighting means 2 measured by a light sensor, via the supply means 6a of the status indication module 6 to the communication module 7 on the primary side by controlling the switching of the supply current of the indicator LED 6b.

[0060] In case the isolated driver module 1 comprises more than one further module 8 on the secondary side SS, the two or more further modules can be different module types. Examples of different module types are given above, such as a module with a test-switch or a sensor module with at least one sensor.

[0061] For the following exemplarily description of the isolated driver module 1 it is assumed that the isolated driver module comprises one further module 8. This description is also applicable for an isolated driver module 1 according to the present invention with more than one further module 8 on the secondary side.

[0062] As indicated by the horizontal dashed line in Figure 1, the communication module 7, the status indication module 6 and the further module 8 may be peripheral modules of the isolated driver module 1 that are detachably connected to the primary side PS respectively secondary side SS of the isolated driver module 1. That is the communication module 7 may be detachably connected to the primary side PS of the isolated driver module 1. The status indication module 6 and the optional further module 8 may be detachably connected to the secondary side SS of the isolated driver module 1.

[0063] In addition, the communication module 7, the status indication module 6 and the further module 8 may also be detachably connected to each other. This will be explained in more detail below with regard to Figures 6 and 7.

[0064] **Figure 2** schematically shows a circuit diagram of an isolated driver module according to a preferred embodiment of the present invention. The description of the isolation driver module according to Figure 1 is also valid for the isolated driver module 1 of Figure 2. Figure 2 in particular shows the components of the isolated driver module 1 for communicating (feeding) information from the secondary side SS to the primary side PS of the isolated driver module 1 according to the present invention. Same elements in Figure 1 and Figure 2 share the same reference signs and function likewise.

[0065] As indicated in figure 2 by the arrow from the control circuit 4 to the supply means 6a of the status indication module 6, the control circuit 4 is configured to control the electrical supply of the at least one indicator LED 6b via the supply means 6a such that the electrical supply is switched, in order to electromagnetically transmit information from the status indicator module 6 to the communication module 7.

[0066] As shown in Figure 2, the communication module comprises a coupling element 7a for providing an electromagnetic coupling between the communication module 7 and the supply means 6a, when the supply current for the at least one indicator LED is switched. Namely, as a result of the switching of the supply current a modulated current is supplied via the supply means 6a to the at least one indicator LED 6b causing an electromagnetic coupling between the coupling element 7a of the communication module 7 and the supply means 6a of the status indication module 6.

[0067] Preferably, the supply means 6a of the status indication module 6 also may comprise a coupling element (not shown in Figure 2)

[0068] The coupling element 7a of the communication module 7 and the optional coupling element of the supply means 6a of the status indication module 6 may be implemented as outlined above. According to Figure 2, the coupling element 7a is an inductor. In particular, the inductor is configured to provide a magnetic coupling with the supply means 6a.

[0069] As indicated in Figure 2 the communication module is configured for a wireless communication. Additionally or alternatively, the communication module can also be configured for a wired communication (not shown in Figure 2), as outlined already above.

[0070] **Figure 3** schematically shows a circuit diagram of a switching circuit of an isolated driver module according to a preferred embodiment of the present invention for switching the electrical supply of the at least one indicator LED, in particular when the at least one indicator LED is configured to emit light of a first color and of a second color. The description of the isolation driver module according to Figure 1 and Figure 2 is accordingly valid for the switching circuit of Figure 3. Same elements in Figure 1, Figure 2 and Figure 3 share the same reference signs and function likewise.

[0071] The switching circuit 5 according to Figure 3 is configured to provide a positive current +Is and a negative current -Is as the supply current via the supply means 6a to the at least one indicator LED 6b of the status indication

module. The negative current -Is flows through the supply means 6a to the at least one indicator LED 6b in the opposite direction compared to the positive current +Is.

[0072] Preferably, the at least one indicator LED 6b is configured to emit light of a first color Col1 and a second color Col2.

[0073] Thus, the switching circuit 5 shown in Figure 3 is configured to activate the first color Col1 and the second color Col2 of the at least one LED 6b. Namely, the switching circuit 3 is configured to provide the positive current +Is as the supply current for activating the first color Col1 of the at least one LED 6b and to provide the negative current -Is as the supply current for activating the second color Col2 of the at least one LED 6b. That is, the switching circuit 5 is configured to provide a first supply current +Is for activating the first color Col1 of the at least one LED 6b and to provide a second supply current -Is for activating the second color Col2 of the at least one LED 6b, wherein the second supply current flows through the supply means 6a to the at least one indicator LED 6b in the opposite direction compared to the first supply current.

[0074] According to Figure 3, the at least one indicator LED 6b comprises or corresponds to two LEDs 31 and 32. The first LED 31 and second LED 32 differ with regard to the electrical connection of the anode and cathode, wherein the first LED 31 emits light of the first color 31, when it is forward-biased, and the second LED 32 emits light of the second color Col2, when it is forward biased. For emitting the first color Col1 more than one first LED 31 can be present and/or for emitting the second color Col2 more than one second indicator LED 32 can be present.

[0075] The at least one indicator LED 6b of Figure 3 alternatively may correspond to a single bi-color LED, which can emit light of the first color Col1 and of the second color Col2. In such a case the first LED 31 shown in Figure 3 indicates the ability of the bi-color LED to emit light of the first color Col1 and the second LED 32 shown in Figure 3 indicates the ability of the bi-color LED to emit light of the second color Col2.

[0076] The switching circuit 5 of Figure 3 comprises four switches T1, T2, T3 and T4. In particular the switching circuit 5 of Figure 3 corresponds to a bridge circuit comprising the four switches T1 to T4. The four switches T1 to T4 are preferably transistors, such as bipolar junction transistors as indicated in Figure 3. Other transistor types can also be used. The switching circuit 5 preferably further comprises four resistors R1, R2, R3 and R4 and a capacitor C1, as shown in Figure 3. The arrangement of the four switches (transistors) T1 to T4, the four resistors R1 to R4 and the capacitor C1 is as shown in Figure 3.

[0077] In particular, a first switch T1 and second switch T2 are electrically connected in series between the two input supply terminals of the switching circuit 5 to provide a first branch of the bridge circuit, wherein the supply means 6a are connected to the node (first node) between the first switch T1 and second switch T2. A third switch T3 and a fourth switch T4 are electrically connected in series between the two input supply terminals of the switching circuit 5 to provide a second branch of the bridge circuit, wherein the supply means 6a are connected to the node (second node) between the third switch T3 and fourth switch T4.

[0078] The at least one indicator LED 6b is connected via the supply means 6a to the switching circuit 5, such that the anode of the first LED 31 is connected to the second node between the third switch T3 and fourth switch T4 and the anode of the second LED 32 is connected to first node between the first switch T1 and second switch T2

[0079] In particular, a first wire of the supply means 6a is connected to the first node and a second wire of the supply means 6a is connected to the second node. Preferably, the anode of the first LED 31 is connected via the first wire to the second node and the anode of the second LED 32 is connected via the second wire to the first node.

[0080] As shown in Figure 3, the second switch T2 and the fourth switch T4 are connected to the input supply terminal of the switching circuit 5 that is connected to ground. The capacitor C1 is connected between the first node and the second node.

[0081] The switching circuit 5 comprises two control inputs IN1 and IN2 for controlling the switches T1 to T4. Thus, the control circuit 4 on the secondary side of the isolated driver module 1 (not shown in Figure 3) is configured to provide control signals to these two control inputs IN1 and IN2.

[0082] In particular, a first control input IN1 is connected, preferably via a first resistor R1, to the control terminal of the second switch T2 (control terminal of transistor T2, e.g. base of transistor T2) and the second control input IN2 is connected, preferably via a second resistor R2, to the control terminal of the fourth switch T4 (control terminal of transistor T4, e.g. base of transistor T4). The control terminal of the first switch T1 (control terminal of transistor T1, e.g. base of transistor T1) is connected, preferably via a third resistor R3 to the second node between the third switch T3 and fourth switch T4. The control terminal of the third switch T3 (control terminal of transistor T3, e.g. base of transistor T3) is connected, preferably via a fourth resistor R4 to the first node between the first switch T1 and second switch T2.

[0083] For controlling the switching circuit 5 the control circuit 4 is configured to provide a first control signal to the first control input IN1 and a second control signal to the second in put IN2.

[0084] Preferably, the second signal is the inverse of the first control signal. That is, when the control circuit 4 controls the second switch T2 to switch to the conducting state by providing a corresponding first control signal to the first control input IN1, then the control circuit 4 preferably controls the fourth switch T4 to switch to the non-conducting state, by providing a corresponding second control signal to the second control input IN2. Further, when the control circuit 4 controls the second switch T2 to switch to the non-conducting state by providing a corresponding first control signal to

the first control input IN1, then the control circuit 4 preferably controls the fourth switch T4 to switch to the conducting state, by providing a corresponding second control signal to the second control input IN2.

[0085] The control circuit 4 of the secondary side is configured to control the at least one indicator LED 6b shown in Figure 3 to emit light of the first color Col1, by controlling the second switch T2 to switch to the conducting state and the fourth switch T4 to the non-conducting state. As a result, the first switch T1 is switched to the non-conducting state and the third switch T3 is switched to the conducting state.

[0086] That is, for the at least one indicator LED 6b of Figure 3 to emit light of the first color Col1, the control circuit 4 is configured to control the switches T1 to T4 of the switching circuit 5, such that the first switch T1 and the fourth switch are non-conducting and the second switch T2 and the third switch T3 are conducting.

[0087] Therefore a positive current +Is flows via the electrical path formed by the conducting second switch T2 to the at least one indicator LED 6b and flows back from the at least one indicator LED 6b via the electrical path formed by the conducting switch T3. When the at least one indicator LED 6b is supplied with the positive current +Is, it emits light of the first color Col1.

[0088] The control circuit 4 of the secondary side is configured to control the at least one indicator LED 6b shown in Figure 3 to emit light of the second color Col1, by controlling the second switch T2 to switch to the non-conducting state and the fourth switch T4 to the conducting state. As a result, the first switch T1 is switched to the conducting state and the third switch T3 is switched to the non-conducting state.

[0089] That is, for the at least one indicator LED 6b of Figure 3 to emit light of the second color Col2, the control circuit 4 is configured to control the switches T1 to T4 of the switching circuit 5, such that the first switch T1 and the fourth switch are conducting and the second switch T2 and the third switch T3 are non-conducting.

[0090] Therefore a negative current -Is flows via the electrical path formed by the conducting switch T4 to the at least one indicator LED 6b and flows back from the at least one indicator LED 6b via the electrical path formed by the conducting switch T1. When the at least one indicator LED 6b is supplied with the negative current -Is, it emits light of the second color Col2.

[0091] In particular, when the switching circuit 5 is controlled by the control circuit 4 such that a positive current +Is is supplied to the at least one indicator LED 6b causing the indicator LED 6b to emit light of the first color Col1 (second and third switch T2 and T3 conducting, first and fourth switch T1 and T4 non-conducting), the control circuit 4 is preferably configured to switch the second switch T2 off and on (non-conducting and conducting) in order to switch the positive current +Is. As a result thereof, a positive modulated current is provided from the switching circuit 5 via the supply means 6a to the at least one indicator LED 6b. This modulated current causes an electromagnetic coupling between the supply means 6a of the status indication module 6 and the communication module 7 of the primary side (not shown in Figure 3) and, thus, information can be electromagnetically transmitted from the status indication module 6 to the communication module 7. Preferably, the control circuit inversely controls the fourth switch when switching the second switch T2 off and on.

[0092] Thus, the control circuit 4 is configured to communicate (feed) information from the secondary side to the primary side, in particular the communication module, of the isolated driver module by controlling the switching circuit 5, in particular the second switch T2, to switch the supply current +Is for the at least one indicator LED 6b, such that a modulated current is supplied via the supply means 6a to the at least one indicator LED 6b. The modulated current supplied via the supply means 6a causes an electromagnetic coupling between the supply means 6a and the communication module 7.

[0093] In particular, when the switching circuit 5 is controlled by the control circuit 4 such that a negative current -Is is supplied to the at least one indicator LED 6b causing the indicator LED 6b to emit light of the second color Col2 (second and third switch T2 and T3 non-conducting, first and fourth switch T1 and T4 conducting), the control circuit 4 is preferably configured to switch the fourth switch T4 off and on (non-conducting and conducting) in order to switch the negative current -Is. As a result thereof, a negative modulated current is provided from the switching circuit 5 via the supply means 6a to the at least one indicator LED 6b. This pulsed current causes an electromagnetic coupling between the supply means 6a of the status indication module 6 and the communication module 7 of the primary side (not shown in Figure 3) and, thus, information can be electromagnetically transmitted from the status indication module 6 to the communication module 7. Preferably, the control circuit inversely controls the second switch T2 when switching the fourth switch T4 off and on.

[0094] Therefore, the control circuit 4 is configured to communicate (feed) information from the secondary side to the primary side, in particular to the communication module, of the isolated driver module by controlling the switching circuit 5, in particular the fourth switch T4, to switch the supply current -Is for the at least one indicator LED, such that a pulsed current is supplied via the supply means 6a to the at least one indicator LED 6b. The modulated current supplied via the supply means 6a causes an electromagnetic coupling between the supply means 6a and the communication module 7.

[0095] The above described switching of the supply current for the at least one indicator LED is preferably controlled by the control circuit 4 such that the respective switch, the second switch T2 or the fourth switch T4, is switched off and on with a frequency higher than the resolution of the human eye.

[0096] **Figure 4** schematically shows examples of the behavior of the supply current Is for the at least one indicator

LED of the status indication module of an isolated driver module according to the present invention, such as the isolated driver module of Figure 1, Figure 2 or Figure 3, over time, when the at least one indicator LED is configured to emit light of a first color and of a second color and the supply current is switched for a communication of information from the status indication module to the communication module.

[0097] It is possible to show basic colour status information (visible) while at same time communicate with high frequency digital data which is invisible to the human eye.

[0098] Figure 4 comprise a first diagram (shown on the top) and a second diagram (shown on the bottom). The first diagram shows the behavior of the supply current Is supplied for activating the first color Col1 of the at least one indicator LED over time. The second diagram shows the behavior of the supply current Is supplied for activating the second color Col2 of the at least one indicator LED over time.

[0099] As can be seen in Figure 4, the polarity of the supply current Is causing the at least one indicator LED to emit light of the first Col1 is different to the polarity of the supply current Is causing the at least one indicator LED to emit light of the second color Col2. That is, the supply current for the first color Col1 flows through the supply means for to the at least one indicator LED in the opposite direction compared to the supply current for the second color Col2. Namely, according to the first diagram the supply current is positive and according to the second diagram the supply current is negative.

[0100] As indicated by the first diagram, the supply current Is is switched respectively modulated, such that a modulated current is supplied to the at least one indicator LED as electrical supply. The same applies to the supply current Is of the second diagram.

[0101] As described already above, this switching of the supply current Is causes an electromagnetic coupling between the supply means of the status indication module and the communication module, such that the behavior of the supply current over time can be obtained respectively received by the communication module on the primary side.

[0102] In particular, when information, such as digital information, is encoded onto the modulated supply current by the switching of the supply current, the information encoded on the modulated supply current can be obtained by the communication module on the primary side due to the electromagnetic coupling between the supply means of the status indication module and the communication module.

[0103] As shown in the first and second diagram Figure 4, the supply current Is is switched such that the resulting modulated current corresponds to a pulsed current. By varying the time duration between the pulses of the pulsed supply current Is, digital information can be encoded. For example, a first time duration t1 can correspond to a first logic level of the digital information ("0") and a second time duration t2 can correspond to a second logic level of the digital information ("1"), wherein the first time duration t1 and second time duration t2 are different. As can be seen in the first and second diagram of Figure 4, the first time duration t1 for indicating the first logic level ("0") is shorter than the second time duration t2 for indicating the second logic level ("1"). Thus, for the first logic level ("0") the original value I1 of the supply current is switched to another current value I2 for the first time duration t1, which is shorter compared to the second time duration t2, during which the original value I1 of the supply current is switched to the other current value I2 for the second logic level ("1").

[0104] In particular, the pulse width pw of the pulses of the pulsed current corresponds to the time duration during which the value of the supply current corresponds to the original value I1. The original value I1 of the supply current Is corresponds to the value of the supply current Is for supplying the at least one indicator LED that is present without switching. In the first diagram, the original value I1 of the supply current Is is positive in order to activate the first color Col1. In the second diagram, the original value I1 of the supply current is negative in order to activate the second color Col2.

[0105] In particular, the first and second time durations t1 and t2 are selected such that the modulated supply current has no impact on the visual indication by the at least one indicator LED, when the at least one indicator LED is supplied with the modulated supply current.

[0106] The present invention is not limited to changing the time duration between the pulses of a pulsed supply current for encoding information, in particular digital information. For example, the pulse-width pw of the pulsed current or the frequency of the switching can be changed, in order to encode information.

[0107] Preferably, the supply current Is is switched such that the resulting modulated supply current does not has an impact on the visual indication by the at least one indicator LED, when the at least one indicator LED is supplied with the modulated supply current.

[0108] In particular, the supply current Is of the first and second diagram of Figure 4 is switched such that the switching is not visible to the human eye. Preferably, the supply current is switched with a frequency higher than the resolution of the human eye.

[0109] The behavior of the current shown in the first diagram of Figure 4 can be achieved by the switching circuit of Figure 3. For achieving the original value I1 of the supply current, as shown in the first diagram, the second and third switch T2 and T3 are conducting and the first and fourth switch T1 and T4 are non-conducting. The switching of the supply current Is as shown in the first diagram of Figure 4 can then be achieved by switching the second switch T2 off and on (non-conducting and conducting) and at the same inversely switching the fourth switch T4.

[0110] Namely, when the second and third switch T2 and T3 are conducting and the first and fourth switch T1 and T4 are non-conducting the positive current value I1, shown in the first diagram, is provided to the at least one indicator LED. When in this state of the switches, the second switch T2 is switched to the non-conducting state and, thus, the third switch T3 is also switched to the non-conducting state and at the same time the fourth switch T4 is switched to the conducting state and, thus, the first switch T1 is also switched to the conducting state, the negative value I2, shown in the first diagram, is provided to the at least one indicator LED.

[0111] The behavior of the current shown in the second diagram of Figure 4 can be achieved by the switching circuit of Figure 3. For achieving the original value I1 of the supply current, as shown in the second diagram, the first and fourth switch T1 and T4 are conducting and the second and third switch T2 and T3 are non-conducting. The switching of the supply current Is as shown in the second diagram of Figure 4 can then be achieved by switching the fourth switch T4 off and on (non-conducting and conducting) and at the same inversely switching the second switch T2.

[0112] Namely, when the first and fourth switch T1 and T4 are conducting and the second and third switch T2 and T3 are non-conducting the negative current value I1, shown in the second diagram, is provided to the at least one indicator LED. When in this state of the switches, the fourth switch T4 is switched to the non-conducting state and, thus, the first switch T1 is also switched to the non-conducting state and at the same time the second switch T2 is switched to the conducting state and, thus, the third switch T3 is also switched to the conducting state, the positive current value I2, shown in the second diagram, is provided to the at least one indicator LED.

[0113] **Figures 5a and 5b** schematically show examples of the supply current for the at least one indicator LED of the status indication module of an isolated driver module according to the present invention, such as the isolated driver module of Figure 1, Figure 2 or Figure 3, when the at least one indicator LED is configured to emit light of a first color and of a second color and the supply current is switched.

[0114] The diagram of Figure 5a shows three different behaviors of the supply current Is supplied for activating the first color Col1 of the at least one indicator LED over time, in order to cause three different visual indications by the at least one indicator LED with light of the first color Col1. The diagram of Figure 5b shows two different behaviors of the supply current Is supplied for activating the second color Col2 of the at least one indicator LED over time, in order to cause two different visual indications by the at least one indicator LED with light of the second color Col2.

[0115] In Figures 5a and 5b the supply current Is is switched according to the invention, when the supply current is supplied to the at least one indicator LED. Thus, the supply current is a modulated supply current. In particular, the supply current Is is switched such that the switching is not visible to the human eye. Preferably, the supply current Is is switched with a frequency that is higher than the resolution of the human eye.

[0116] At the top of the diagram of Figure 5a the supply current Is is supplied for a predefined time and, thus, the at least one indicator LED emits light of the first color Col1 for the predefined time. In the middle of the diagram of Figure 5a the supply current is alternately supplied for a first time duration t11 and not supplied for a second time duration t12. As a result, the at least one indicator LED emits flashed light of the first color, wherein during the first time duration t11 the light is emitted and during the second time duration t12 no light is emitted. The first time duration t11 and the second time duration t12 can be the same or different.

[0117] The aim is to have a continuous colour as shown inside 5a and 5b top diagrams or flashing colours to signify different visual indication such as test or faults.

[0118] At the bottom of the diagram of Figure 5a the supply current is alternately supplied for a third time duration t13 and not supplied for a fourth time duration t14. As a result, the at least one indicator LED emits flashed light of the first color, wherein during the third time duration t13 the light is emitted and during the fourth time duration t14 no light is emitted. The third time duration t13 and the fourth time duration t14 can be the same or different.

[0119] As shown by the behavior of the supply current over time in the middle and at the bottom of Figure 5a, the at least one indicator LED can be controlled to emit flashed light with different flashing patterns.

[0120] At the top of the diagram of Figure 5b, showing continuous color, the supply current - Is is supplied for a predefined time and, thus, the at least one indicator LED emits light of the second color Col2 for the predefined time. At the bottom of the diagram of Figure 5b the supply current is alternately supplied for a fifth time duration t15 and not supplied for a sixth time duration t16. As a result, the at least one indicator LED emits flashed light of the second color Col2, wherein during the fifth time duration t15 the light is emitted and during the sixth time duration t16 no light is emitted. The fifth time duration t15 and the sixth time duration t16 can be the same or different.

[0121] Since the supply current is switched, in particular with the frequency higher than the resolution of the human eye, when the supply current is supplied to the at least one indicator LED, the communication module can obtain respectively receive the behavior of the supply current over time via the electromagnetic coupling between the supply means of the status indication module and the communication module caused by the switching of the supply current.

[0122] The different light emissions of the at least one indicator LED indicated in Figures 5a and 5b by the different behavior of the supply current Is for the at least one indicator LED can be used to visually indicate to a user different statuses of the isolated driver module.

[0123] Even the low frequency pulses of the visible light could be used to convey basic status data to the communication

interface. More detailed data can be via high frequency signalling.

[0124] For example by emitting light of the first color Col1 for the predefined time, the at least one indicator LED can visually indicates that an energy storage of the isolated driver module is charged. By emitting flashed light of the first color Col1, the at least one indicator LED can visually indicate that a self-test is carried out by the isolated driver module, wherein the flashing rate of the flashed light can indicate the type of self-test. By emitting light of the second color Col2 for the predefined time, the at least one indicator LED can visually indicate a fault condition of the isolated driver module. By emitting flashed light of the second color Col2, the at least one indicator LED can visually indicate that an energy storage, such as a battery, of the isolated driver module is either defect or the energy level of the energy storage is below a lower threshold value.

[0125] **Figure 6** schematically shows an arrangement of the status indication module 6, the communication module 7 and one optional further module 8 of an isolated driver module according to a preferred embodiment of the present invention, such as the isolated driver module of Figure 1, Figure 2 or Figure 3. Same elements in Figure 1, Figure 2 and Figure 3 share the same reference signs and function likewise.

[0126] As already described above, the communication module 7, the status indication module 6 and the optional further module 8 can be peripheral modules, wherein the communication module 7 is detachably connected to the primary side of the isolated driver module (not shown in Figure 6) and the status indication module 6 and the optional further module 8 are detachably connected to the secondary side of the isolated driver module.

[0127] In particular, the communication module 7, the status indication module 6 and the optional further module 8 can be detachably connected to each other.

[0128] Preferably, the communication module 7, the status indication module 6 and the optional further module 8 comprises mechanical connection means in order to achieve the detachable connection to the primary side respectively secondary side of the isolated driver module by means of form closure and/or friction closure.

[0129] Preferably, the communication module 7, the status indication module 6 and the optional further module 8 comprises mechanical connection means in order to achieve the detachable connection to at least another module by means of form closure and/or friction closure.

[0130] The communication module 7, the status indication module 6 and the optional further module 8 can in particular be regarded as stackable. The detachable connection in particular comprises a standardized mechanical connection, e.g. comparable to building bricks. In other words, when the communication module 7, the status indication module 6 and the optional further module 8 are detachably connected to the primary side respectively secondary side of the isolated driver module the mechanical connection between the individual modules and the primary side respectively secondary side is such that they can be detached from the primary side respectively secondary side in a non-destructive fashion. Further, when the communication module 7, the status indication module 6 and the optional further module 8 are detachably connected to each other the mechanical connection between the individual modules is such that they can be detached from each other in a non-destructive fashion.

[0131] Further, the communication module 7, the status indication module 6 and the optional further module 8 preferably comprise fastening means in order to be mounted in a case of a luminaire formed by the isolated driver module of the present invention and lighting means. The fastening means in particular comprise a clip, screw, sticky pad, bayonet cap, or a magnet connecting means.

[0132] According to Figure 6, the status indication module 6 is detachably connected to the communication module 7, such that an electromagnetic coupling can be provided between the supply means of the status indication module 6 and the communication module, in particular a coupling element of the communication module.

[0133] Nevertheless, the components of the status indication module 6 and the components of the communication module are still galvanically isolated from each other by a galvanic isolation barrier, in particular a SELV isolation barrier.

[0134] Further, according to Figure 6, the optional further module 8 is detachably connected to the status indication module 6 opposite to the side of the status indication module 6 to which the communication module 7 is connected. As a result, the optional further indication module is also galvanically isolated from the communication module 7.

[0135] According to Figure 6, only one further module 8 is provided on the secondary side of the isolated driver module. In case that more than one further module 8 is provided, the further modules can be detachably connected to the one further module shown in Figure 6 as described above. That is, a second further module can be detachably connected to the further module 8, and a third further module can be detachably connected to the second further module and so on.

[0136] Thus, the above description is also valid for an isolated driver module comprising more than one further module 8 besides the communication module 7 of the primary side and the status indication module of the secondary side.

[0137] According to Figure 6 the communication module 7 is configured for a wireless communication. Alternatively or additionally the communication module can be configured for a wired communication. Furthermore, according to Figure 6, the optional further module 8 is a NFC-module. The optional further module 8 is not limited to a NFC-module and, thus, can also be a different module, as outlined above. The at least one indicator LED of the status indication module is indicated in Figure 6 by a circle.

[0138] **Figure 7** schematically shows the status indication module, the communication module and two optional further

modules of an isolated driver module according to a preferred embodiment of the present invention, such as the isolated driver module of Figure 1, Figure 2 or Figure 3. Same elements in Figure 1, Figure 2 and Figure 3 share the same reference signs and function likewise.

[0139] The above description with respect to Figure 6 is applicable to the status indication module 7, the communication module 6 and the two optional further modules 8 and 2 of Figure 7, accordingly.

[0140] As indicated by the double arrows in Figure 7, the communication module 7, the status indication module 6, and the two optional further modules 8 and 2 can be detachably connected to each other by means of form and/or friction closure. According to Figure 7 each module comprises for this four round connectors on one side (right side) and on the opposite (left side) corresponding connectors (not shown in Figure 7) that are configured to provide a detachable connection with the four round connectors by means of form and/or friction closure. According to the present invention, each module can comprise one or more round connectors for a detachable connection by form and/or friction closure. The shape of the connectors can also be different, for example squared.

[0141] Preferably, the interconnection is both mechanical and electrical to link the parts in a modular way.

[0142] According to Figure 7, one of the optional further modules is preferably the lighting means 2, that can be electrically connected to the secondary side of the isolated driver module in order to be electrically supplied by the isolated driver module.

Claims

1. Isolated driver module (1) for electrically supplying lighting means (2), comprising

   - a galvanic isolation barrier (3), preferably a SELV isolation barrier, that galvanically isolates a primary side (PS) and a secondary side (SS) of the isolated driver module (1) from each other, wherein the lighting means (2) are electrically connectable to the secondary side (SS),
   - a control circuit (4), preferably a microcontroller, arranged on the secondary side (SS),
   - a status indication module (6) with at least one indicator LED (6b) electrically supplied via supply means (6a), in particular via at least one wire, wherein the status indication module (6) is arranged on the secondary side (SS), and
   - a communication module (7), preferably a wireless communication module, arranged on the primary side (PS),
   - wherein the control circuit (4) is configured to control the electrical supply of the at least one indicator LED (6b) via the supply means (6a) for controlling a visual indication of the status of the isolated driver module (1) by the at least one indicator LED (6b), and
   - wherein the control circuit (4) is configured to control the electrical supply of the at least one indicator LED (6b) via the supply means (6a) such that the electrical supply is switched , in order to electromagnetically transmit information from the status indication module (6) to the communication module (7).

2. Isolated driver module (1) according to claim 1, wherein the control circuit (4) is configured to control the switching of the electrical supply of the at least one indicator LED (6b) such that the switching is not visible to the human eye.

3. Isolated driver module (1) according to claim 1 or 2, wherein the control circuit (4) is configured to control the switching of the electrical supply of the at least one indicator LED (6b) such that the electrical supply is switched with a frequency higher than the resolution of the human eye, or with low frequency for visible status information.

4. Isolated driver module (1) according to any one of the previous claims,

   - wherein the communication module (7) and/or the supply means (6a) of the status indication module (6) comprises an coupling element (7a), such as a inductor or transformer, configured to provide an electromagnetic coupling between the communication module (7) and the supply means (6a), when the electrical supply of the at least one indicator LED (6b) is switched.

5. Isolated driver module (1) according to any one of the previous claims,

   - wherein the control circuit (4) is configured to transmit information visually indicated by the at least one indicator LED (6b), in particular the status of the isolated driver module (1), via the status indication module (6) to the communication module (7) by controlling the switching of the electrical supply of the at least one indicator LED (6b).

6. Isolated driver module according to any one of the previous claims,

- wherein the control circuit (4) is configured to encode digital information on the electrical supply of the at least one indicator LED (6b) by controlling the switching of the electrical supply of the at least one indicator LED (6b), in order to transmit the digital information to the communication module (7), and
- wherein preferably the communication module (7) is configured to decode the digital information.

7. Isolated driver module (1) according to any one of the previous claims, comprising

- a switching circuit (5) on the secondary side (SS) configured to switch, in particular with the frequency higher than the resolution of the human eye, a supply current (Is) for the at least one indicator LED (6b), such that a modulated current (Is) is supplied via the supply means (6a) to the at least one indicator LED (6b), wherein the switching circuit (5) is controllable by the control circuit (4).

8. Isolated driver module (1) according to claim 7, wherein

- the control circuit (4) is configured to control the switching circuit (5) to switch the supply current (Is) such that digital information, in particular the status of the isolated driver module, is encoded on the modulated current (Is).

9. Isolated driver module (1) according to claim 8, wherein

- the modulated current (Is) is a pulsed current, and
- a first pulse width of the modulated current (Is) corresponds to a first logical level of the digital information,
- a second pulse width of the modulated current (Is) corresponds to a second logical level of the digital information, and
- the first pulse width and the second pulse width have a different time duration.

10. Isolated driver module (1) according to any one of claims 7 to 9, wherein

- the at least one indicator LED (6b) is configured to emit light of a first color (Col1) and a second color (Col2), and
- the switching circuit (5) is configured to provide a positive current (+Is) as the supply current for activating the first color (Col1) of the at least one indicator LED (6b) and a negative current (-Is) as the supply current for activating the second color (Col2) of the at least one LED,
- wherein preferably the at least one indicator LED (6b) is a bi-color LED configured to emit light of the first color (Col1) and the second color (Col2).

11. Isolated driver module (1) according to any one of claims 7 to 10, wherein

- the switching circuit (5) is part of the control circuit (4), or
- the switching circuit (5) is part of the status indication module (6).

12. Isolated driver module (1) according to any one of the previous claims, comprising

- an energy storage, for example a preferably rechargeable battery, arranged on the secondary side (SS),
- wherein the energy storage is configured to electrically supply the at least one indicator LED (6b) via the supply means (6a), in particular to supply the supply current (Is) for the at least one indicator LED (6b).

13. Isolated driver module (1) according to any one of the previous claims, wherein

- the isolated driver module (1) is an emergency lighting driver module.

14. Isolated driver module (1) according to any one of the previous claims, wherein

- the communication module (7) is detachably connected with the primary side (PS), and/or the status indication module (6) is detachably connected with the secondary side (SS), and
- wherein preferably the communication module (7) and the status indication module (6) are detachably connected to each other.

15. Isolated driver module (1) according to any one of the previous claims, comprising at least one further module (8, 9), preferably a NFC-module, on the secondary side (SS),

- wherein the control circuit (4) is configured to transmit information regarding the at least one further module (8, 9) via the status indication module (6) to the communication module (7) by controlling the switching of the electrical supply of the at least one indicator LED (6b).

16. Isolated driver module (1) according to claim 15, wherein

- the at least one further module (8, 9) is detachably connected with the secondary side (SS), and
- wherein preferably the at least one further module (8, 9) is detachably connected to the status indication module (6).

17. Luminaire comprising

- an isolated driver module (1) according to any one of the previous claims, and
- lighting means (2) electrically connected to the secondary side (SS) of the isolated driver module (1),
- wherein the isolated driver module (1) is configured to electrically supply the lighting means (2).

18. Method for operating an isolated driver module (1) according to any one of the claims 1 to 16, comprising the step of

- controlling by the control circuit (4) the electrical supply of the at least one indicator LED (6b) via the supply means (6a) such that the electrical supply is switched, in order to electromagnetically transmit information from the status indication module (6) to the communication module (7).

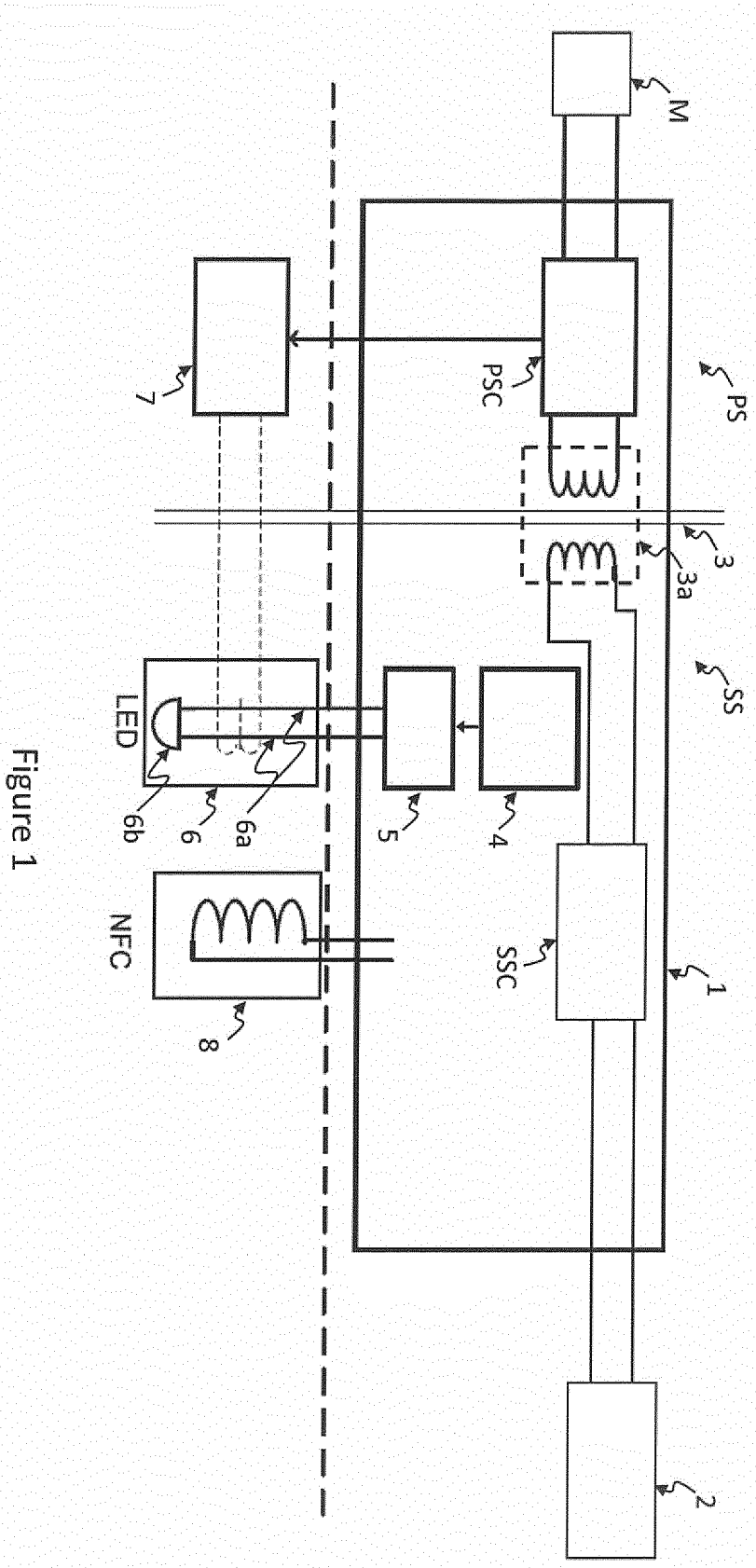

Figure 1

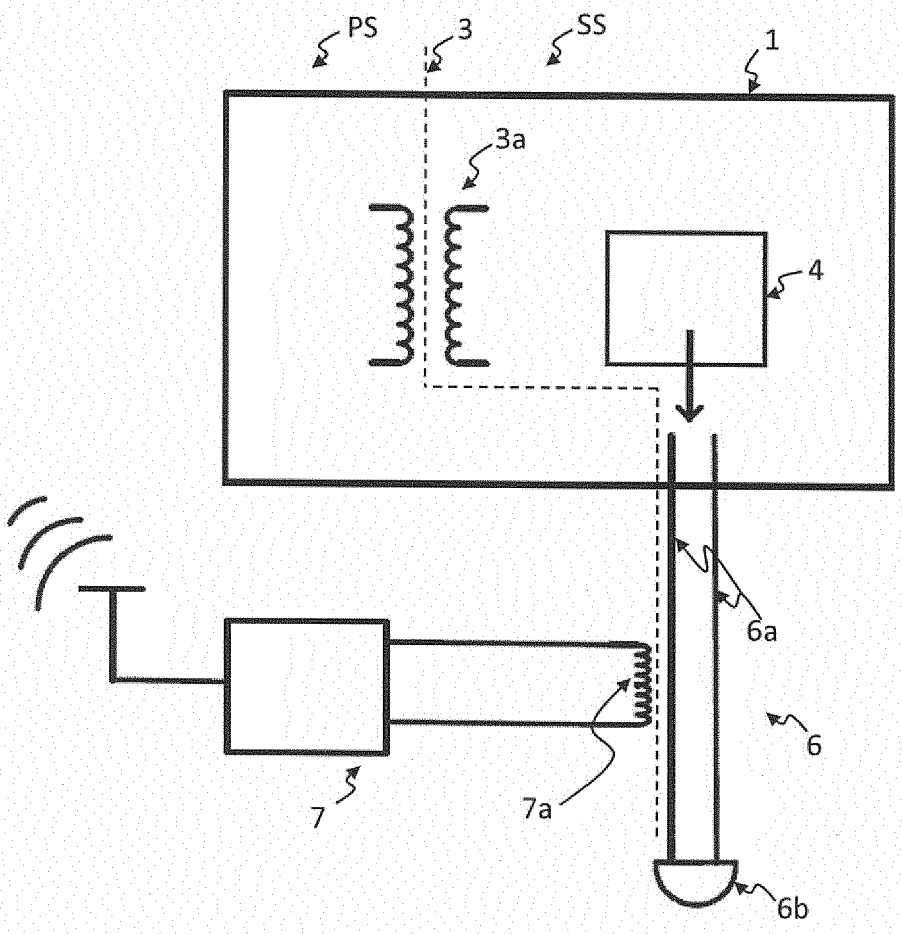

Figure 2

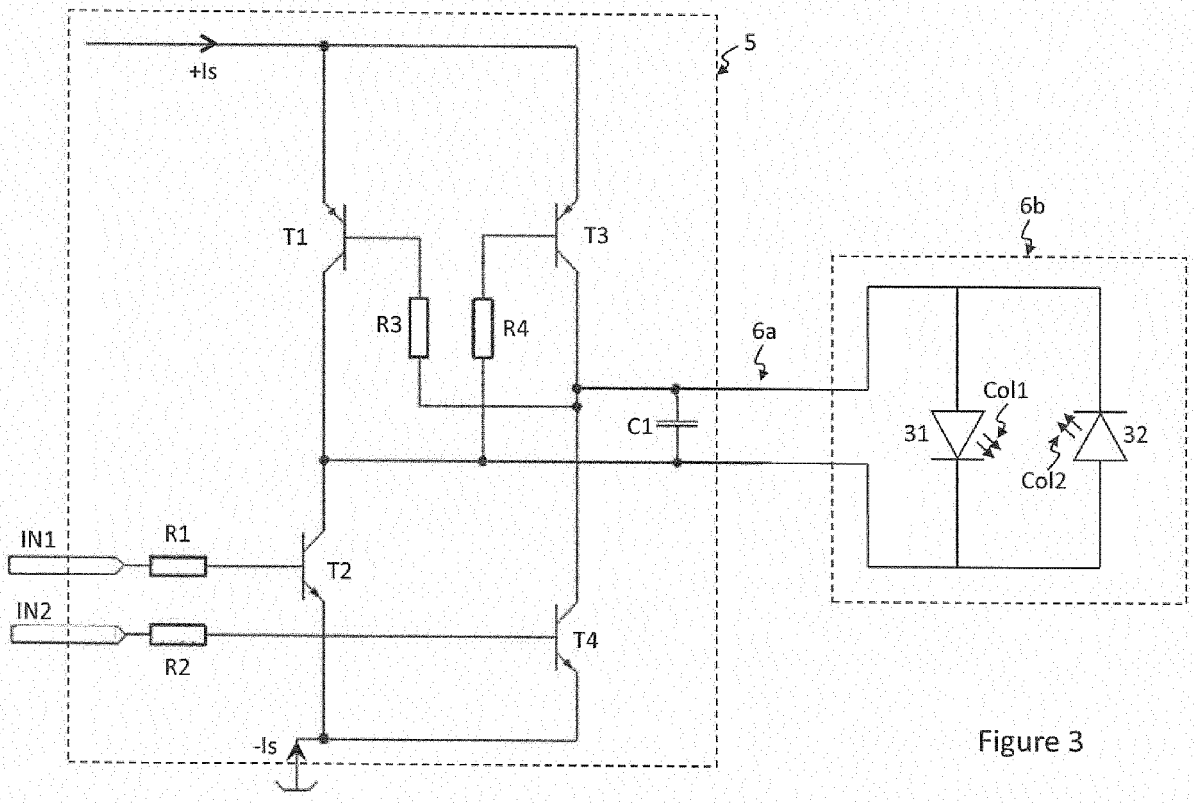

Figure 3

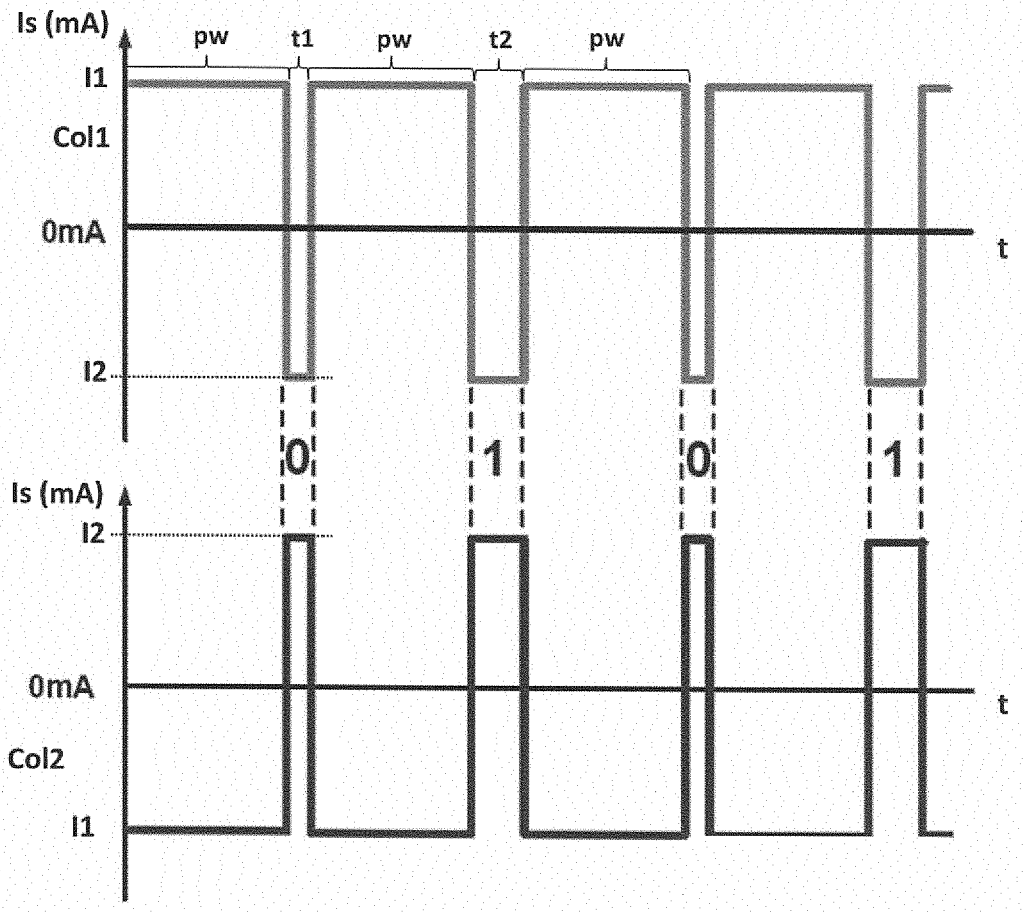

Figure 4

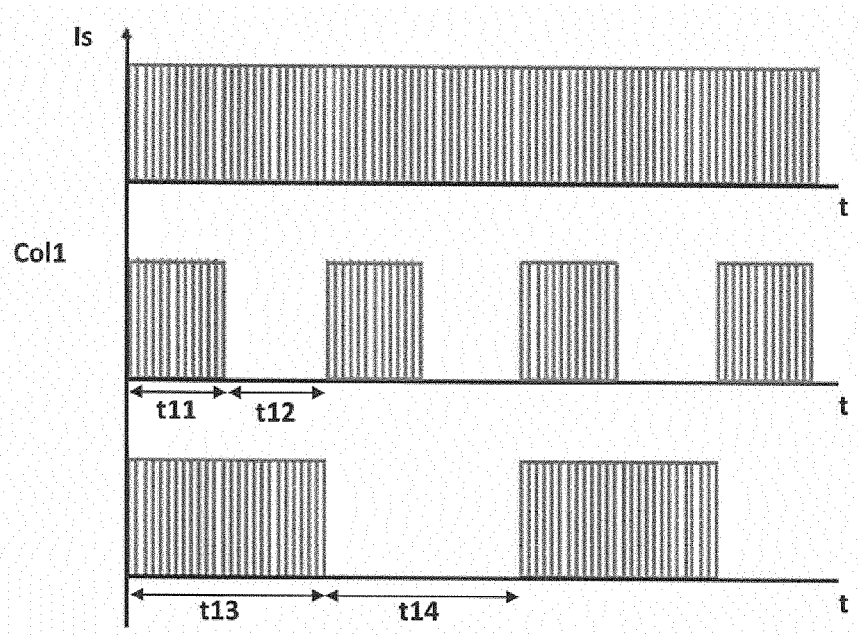

Figure 5a

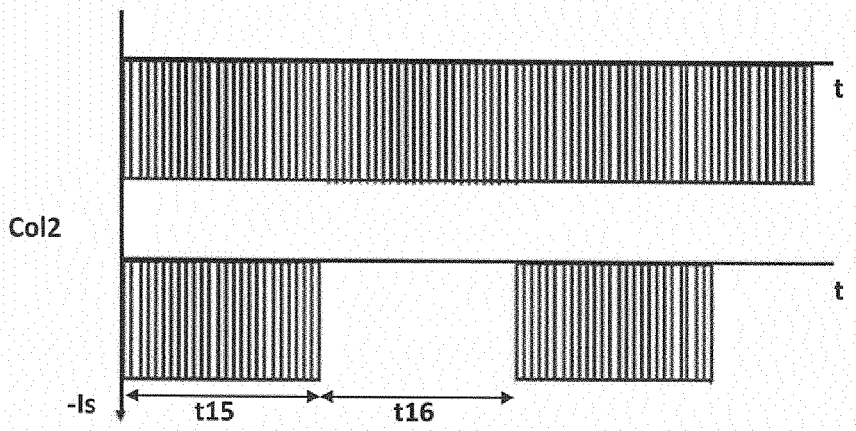

Figure 5b

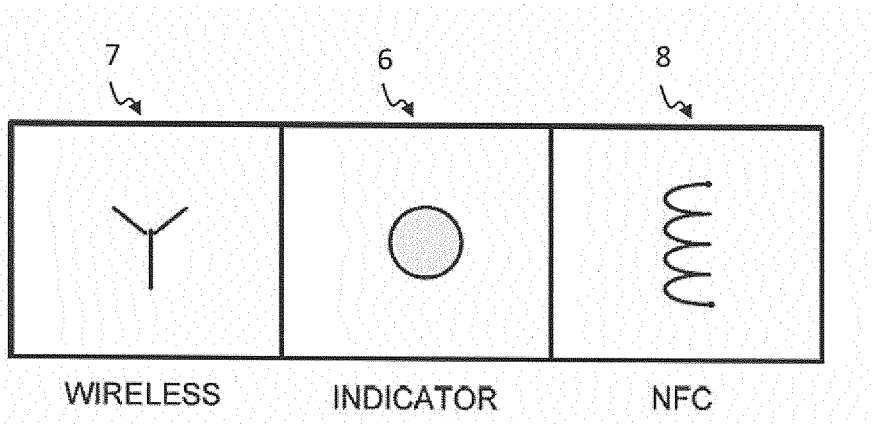

Figure 6

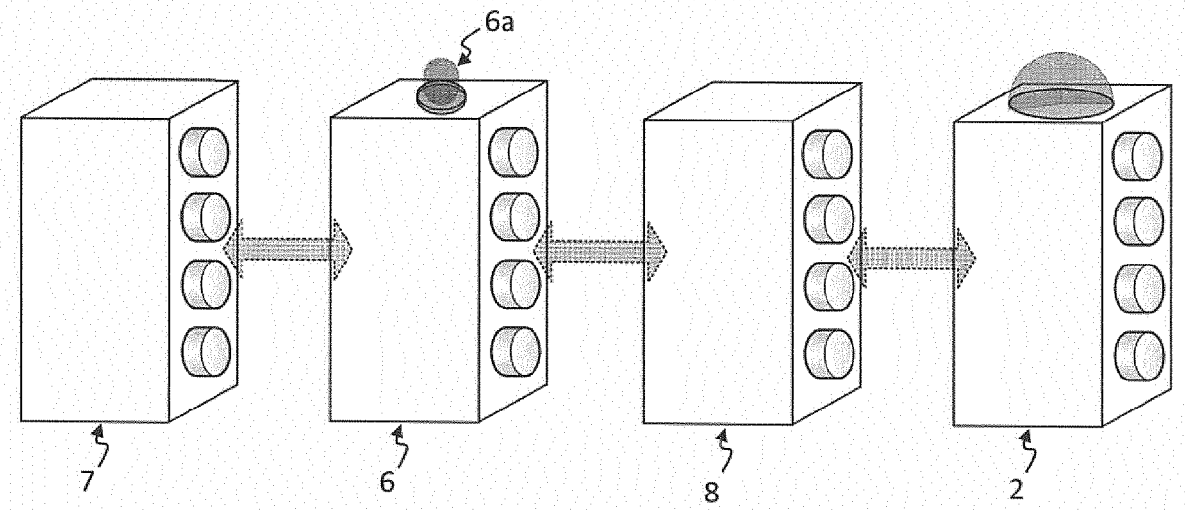

Figure 7

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EUROPEAN SEARCH REPORT

Application Number
EP 19 16 5056

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 2015/214785 A1 (JAGJITPATI SHUKLA [GB] ET AL) 30 July 2015 (2015-07-30) * [0029]-[0037], [0045]-[0046]; figures 1,4 * -----	1-18	INV. H05B33/08 H05B37/02
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 July 2019	Garavini, Elisa

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25-07-2019

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