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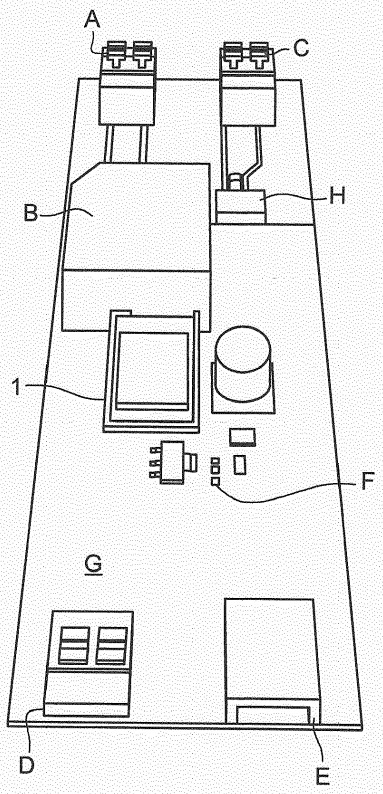
(54) **SYSTEM FOR CONTROLLING A SERIES OF LIGHTING FIXTURES**

(57) The invention relates to a system for controlling a series of lightning fixtures comprising a luminaire control module, a bus communication interface and at least one lighting driver, said luminaire control module designed to receive a set of input signals and generate a signal comprising an instruction for said series of lighting fixtures, the bus communication interface being connected to said luminaire control unit and comprising a current amplifier designed to amplify said signal comprising an instruction without modifying its characteristics and providing an amplified signal at an output terminal of said amplifier connected to one lighting fixture, the system allowing to control a large set of lighting fixtures.

Fig. 1



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Description

Technical Domain

[0001] The present invention relates to illumination, electronics and communication. In particular, the present invention concerns the controlling of luminaires and further enhancements of lighting controllers and preferably a system for controlling a series of lighting fixtures for illumination in an environment.

Technological background of the invention.

[0002] Home automation or generally building automation incorporates various aspects relating to the integrated, typically centralized and computerized control of different electric and electronic appliances, amongst other lighting. In the automation of lighting, users are seeking after optimization of lighting with respect to many different factors, such as having different lighting conditions depending on time period, occupation of rooms, timers, etc...

[0003] Technically, industrial-scale solutions for lighting automation systems require the use of special luminaires and conducting preparatory actions prior to or, at the latest, upon installation thereof through pre-wiring the walls and related other fixed structures in the target environment, i.e. hardware-based solutions.

[0004] When it relates to private home, smart lighting solutions have been developed, offering more and more integrated solutions and software-based solutions to be used with ready-to use lighting devices, thereby offering competitive solutions to the consumer, but are typically either brand specific or technology-based.

[0005] In view of the need to work with different brand and technology, especially for domestic application, several luminaire control modules are currently available on the market, used to control a wide range of available lighting fixtures by communicating with the lighting driver (one or more) of said lighting fixtures, upon an instruction, such as a instructions given by a user or a sensor. This communication is done by passing instructions between the luminaire control modules and the lighting drivers controlling these lighting fixtures.

[0006] These instructions are sent according to one the available lighting protocols i.e. DALI 1, DALI 2, 0-10V, etc.

[0007] While control modules are more and more used for domestic application, smart lighting solutions remain developed to a lesser extend in professional and industrial environment, especially because a large amount of lighting fixtures should be controlled and the lighting fixture can be separated to each other by long distance, thereby keeping preference for hardware-based solutions. Some solutions have been designed in the prior art to control a plurality of lighting fixtures.

Prior art:

[0008] The system known from US9736914 describes a method for controlling a plurality of luminaire units. The control unit comprises a wireless transceiver module, allowing the formation of mesh networks between several control units, and to control a larger amount of lighting fixtures at bigger distances. However, this means that a large amount of control units has to been installed, representing a high cost, as this is the most expensive part of a lighting system, and increasing the amount of programming, installation and maintenance time required.

[0009] US2016286628 concerns a modular wireless light control for light fixtures. The device includes a modular wireless lightning control device that includes a wireless transceiver, a first controller and a main power supply. The wireless transceiver is connected by wire to the control device, and the control device is further connected to the lighting fixtures. This system represents the drawback of having one of said modular wireless light controls for each unique lightning driver to be controlled in the system. Another drawback for industrial usage is the wireless communication, as the signal needs to be strong enough to cover large distances and pass through walls, floors and ceilings.

[0010] The system described by US2017273164 concerns a luminaire control system with a microcontroller embedded. The microcontroller can receive different input signals in several different communication protocols (Wi-Fi, Zigbee, ...). Based on that signal different output signals can be generated (DALI, I^2C, 0-10V). The microcontroller has the possibility to switch between different kind of in- and output signals and a hierarchy can be defined to switch between output signal depending on the input. Unfortunately, the microcontrollers are not able to form a mesh network between each other and do not provide the possibility to amplify the output signal. This makes industrial applications, where many lighting drivers are needed to be control, nearly impossible.

[0011] Another example is the **Casambi® CBU-ASD control module** foreseen to be connected to a series of lightening fixture. This device provides both a wireless input interface and a wired one and communicates with the lighting drivers over a wired connection by using the DALI or 0-10V protocol. However, the output current is limited to only 7mA, allowing only 2-3 lighting drivers to be connected per control module. This implies the installation of many control modules and thus an installation which is expensive and requires more programming.

[0012] Due to these limitations, industrial applications of these type of lighting control modules implies a high amount of luminaire control units to be bought and carefully put in place at the appropriate positions so that the entire set of lighting fixtures can be controlled. As these control modules often have to support a various type of protocols to control the lighting fixtures and need to be able to handle input signals coming from different type of input devices (lightning switches, smartphone appli-

cations, movement sensors,...) they are often expensive and require programming and maintenance. There is thus a need for a control system that is more suitable in these kinds of implementations than prior art control modules, providing a reliable, less expensive and maintenance requiring solution.

Brief summary of the invention

[0013] It is foreseen according to the present invention a system for controlling a series of lighting fixtures for illumination in an environment as mentioned in the beginning, characterized in that the system comprises:

a. A luminaire control unit comprising a plurality of first input ports and at least one first output port, said luminaire control unit being provided to receive at least one first input signal at one of the first input ports and to read the instruction comprised in said first input signal and to generate a corresponding output signal containing the appropriate instruction for the series of lighting fixtures,

b. A bus communication interface comprising at least one current amplifier module, at least one second input port and at least one second output port, said at least one current amplifier module comprising an input terminal connected to said at least one second input port, which is connected to one of said at least one first output port, a series of electrical current amplifier circuits comprising bipolar transistors, and an output terminal connected to one of said at least one second output port, said current amplifier module being provided for amplifying the current level of said corresponding output signal received at said input terminal through said at least one second input port and for providing an amplified version of said corresponding output signal at said output terminal connected to said second output port,

c. at least one lighting driver provided for controlling at least one lighting fixture of said series of lighting fixtures, for example an LED, said second output port of the bus communication interface being further connected to said at least one lighting driver.

[0014] It has been indeed realized according to the present invention that it is possible through the integration of a bus communication interface comprising a current amplifier module to solve at least a part of the aforesaid drawbacks by providing a device in which an output signal (second output signal) towards a lighting driver according to one of the protocols mentioned before, i.e. DALI, 0-10V, 1-10V,... is amplified without modifying the characteristic values of the signal.

[0015] The amplified version of the first signal further being transferred towards multiple lighting drivers over wires, providing a stable and industrial proof communication between the control system and the plurality of lighting drivers. Accordingly, the system of the present invention avoids the need of expensive components and maintenance overheads and offer a software-based solution without requiring to multiply the control module even when long distances exist between several lighting drivers.

[0016] Indeed, thanks to the present invention, it is now possible to have one or a limited number of control module thereby limiting the overall costs of the system. This allow to bring a system which can be also implemented at industrial or professional scale.

[0017] Preferably, according to the present invention, said bus communication interface is a DALI bus communication interface.

[0018] In this case, when more than 64 different addresses are required, the number of control module is higher than 1.

[0019] In a preferred embodiment, said control module is connected to a power supply circuit comprising at least two input pins, an AC/DC converter, and at least one voltage regulator, said at least two input pins being both connected to a voltage source, said power supply circuit comprising at least one voltage regulator, connected to at least one power input pin present in said control module .

[0020] As it can be seen, the device according to the present invention further comprises a power supply circuit comprising at least two input pins, an AC/DC converter, and at least one voltage regulator, said at least two input pins being both connected to a voltage source providing the standard 220-240 AC voltage level, said voltage regulator module providing a stable DC voltage output for said bus communication interface, said power supply further connected to said control module to provide the power necessary for normal operation of said control module.

[0021] In a preferred embodiment according to the present invention, said at least one first output ports of said control module is a plurality of first output ports, one first output port being provided for issuing a transformed signal, being a different transformed signal with respect to another first output port of said plurality of first output port, said system further comprising a switching module having at least three third input ports A, B and C and a third output port, said third input port A being connected to one first output port, said third input port B being connected to another first output port and said third input port C being connected to yet another first output port for providing a communication mode selection signal.

[0022] The configuration of the input A, B and C according to the present invention allows to provide different kind of transformed signals and compatibility with various known lighting protocols, preferably at least DALI, 0-10V, 1-10V,... , with the switching module switching between the signals provided at the input terminals based on a switching mode selection signal received at said communication mode selection terminal.

[0023] In a particular embodiment according to the present invention, said switching module comprises an

analog switching module having a number of third input ports equal to the number of first output ports.

[0024] Other embodiments according to the present invention are mentioned in the appended claims.

Detailed description of the invention

[0025] Other characteristics and advantages of the present invention will be derived from the non-limitative following description, and by making reference to the drawings.

Drawings. -

[0026]

Figure 1 shows an example of a preferred embodiment of a polyvalent connection box containing a control module **1** and a housing **A** located on a printed circuit board (PCB) **G**. The housing **A** contains a bus communication module **2**, a switching module **3**, a PWM module **4**, a power supply module **5** (illustrated in more details on Fig.2). The polyvalent connection box further comprises at least one port **D** to connect with at least one lighting driver, a port **E** to interact with other polyvalent connection boxes, a port **B** to connect the polyvalent connection box with the standard electric network, a port **C** to connect the polyvalent connection box with at least one (movement) sensor which is further connected to at least one voltage regulator **H**. The polyvalent connection box also comprises a series of electronic elements identified by F. As it can be seen, the PCB is easy to implement in both new and already existing lighting systems.

Figure 2 shows the electrical circuit and components on the PCB of Figure 1. The luminaire control unit **(1)** is located at the center of the circuit, as it needs to be physically connected to some of the input and outputs. Said module will receive the data coming from several wired input devices such as movement sensors, lighting switches but also wireless signals coming from other luminaire control units, smartphone applications and many other. These input signals will then be analyzed according to the logic and rules programmed on the said luminaire control circuit and transformed into the appropriate output signals. Luminaire control modules currently available on the market are often provided with multiple output ports, which can deliver the same output message, but encoded according to different protocols. The bus communication interface **(2)** is connected to such output ports. In the example on **Figure 2** to 2 output ports providing the output message according to the DALI 1 or DALI 2 protocol. The bus communication module will receive the 2 output signals provided at the output ports of said luminaire modular module and will provide an amplified signal at its output terminal, without modifying the characterizing elements of the signal. The output of said bus communication is further connected to a switching module **(3)**. These switching modules have an n-fold of input ports which can be connected to different kind of output signals, a mode selection port and an output port. Based on the signal received on its mode selection port, which is connected to an output port of the luminaire control unit, it will decide on which signal, received at one of the n-fold input ports, will be passed on and made available on the output port of said switching module. This output port will be then provide the output message to the connected lighting drivers.

To provide the appropriate power level to all of aforementioned modules **(1,2,3)** and other components of the electrical circuit, a power module supply module has been foreseen. This module can be connected to a general 220 volt outlet, available in almost every industrial application, and will transform the alternating voltage/current to the different levels of direct voltage/current. These different levels being the input voltage needed for the aforementioned modules **(1,2,3)**.

A PWM module **(5)** has been added to the circuit to show that the switching module is able to handle different signals on its n-fold of input ports. The switching module **(3)** will, according to the instruction received on the mode selection port, determine which off the received signals at its input ports will be put on its output port.

Figure 3 shows the electrical circuit representing said bus communication interface. The electrical circuit comprising a set of transistors, resistors and diodes being designed to amplify the signal coming from the luminaire control module at its inputs **(1,2).** In order to provide the amplified version of the input signal at the output port **(3)** a connection with a voltage source **(4)** is required. Said voltage source connection being made with the power supply as explained on Fig. 2.

Figure 4 is an electronic schema representing the switching module. As it can be seen on this example, **1 & 2** are output signals coming from either the luminaire control module or the bus communication module. The mode selection port is represented by **3**, receiving a mode selection signal coming from the luminaire control module, indicating which output protocol should be used to communicate with the external Lighting drivers. The number of instructions that can be comprised in the mode selection signal is equal or higher than the amount of input ports available on the switching module. The desired signal received on the input of the switching module will then become available on its output port as well.

Figure 5 is a schematic representation of a real-life implementation. **1** represents the system according to the invention as drawn on Fig. 1 and its internal

electrical circuit as described on Fig.2. The system is connected through its bus communication interface (and optional switching module) **2** with the lighting drivers **3**, which are further connected, and responsible for controlling a set of lighting fixtures **4**. In this case both a standard lighting switch **5** and a -wire**6** - smartphone application **7** are used to control the lighting environment with making use of the system according to the invention. Upon receiving a signal from said lighting switch, either one or a group of lighting drivers can be instructed to alter their behavior. The smartphone application embedded.

[0027] Thanks to the system according to the invention, long distance between the different lighting drivers **3** can be covered and a higher amount of said lighting drivers **3** can be controlled by one single luminaire control module.

[0028] In the drawings, the same reference numbers have been allocated to the same or analog element.

[0029] It should be understood that the present invention is not limited to the described embodiments and that variations can be applied without going outside of the scope of the appended claims.

Claims

1. A system for controlling a series of lighting fixtures for illumination in an environment, the system comprising:

a. A luminaire control unit comprising a plurality of first input ports and at least one first output port, said luminaire control unit being provided to receive at least one first input signal at one of the first input ports and to read the instruction comprised in said first input signal and to generate a corresponding output signal containing the appropriate instruction for the series of lighting fixtures,

b. A bus communication interface comprising at least one current amplifier module, at least one second input port and at least one second output port, said at least one current amplifier module comprising an input terminal connected to said at least one second input port, which is connected to one of said at least one first output port, a series of electrical current amplifier circuits comprising bipolar transistors, and an output terminal connected to one of said at least one second output port, said current amplifier module being provided for amplifying the current level of said corresponding output signal received at said input terminal through said at least one second input port and for providing an amplified version of said corresponding output signal at said output terminal connected to said second output port,

c. at least one lighting driver provided for controlling at least one lighting fixture of said series of lighting fixtures, for example an LED, said second output port of the bus communication interface being further connected to said at least one lighting driver.

2. The system according to claim 1, wherein said bus communication interface is a DALI bus communication interface.

3. The system according to claim 1 or claim 2, wherein said control module is connected to a power supply circuit comprising at least two input pins, an AC/DC converter, and at least one voltage regulator, said at least two input pins being both connected to a voltage source, said power supply circuit comprising a voltage regulator and rectifier circuit, connected to at least one power input pin present in said control module.

4. The system according to any of the claims 1 to 3, wherein said at least one first output ports of said control module is a plurality of first output ports, one first output port being provided for issuing a transformed signal, being a different transformed signal with respect to another first output port of said plurality of first output port, said system further comprising a switching module having at least three third input ports A, B and C and a third output port, said third input port A being connected to one first output port, said third input port B being connected to another first output port and said third input port C being connected to yet another first output port for providing a communication mode selection signal.

5. The system according to claim 4, wherein said switching module comprising an analog switching module having a number of third input ports equal to the number of first output ports.

Fig. 1

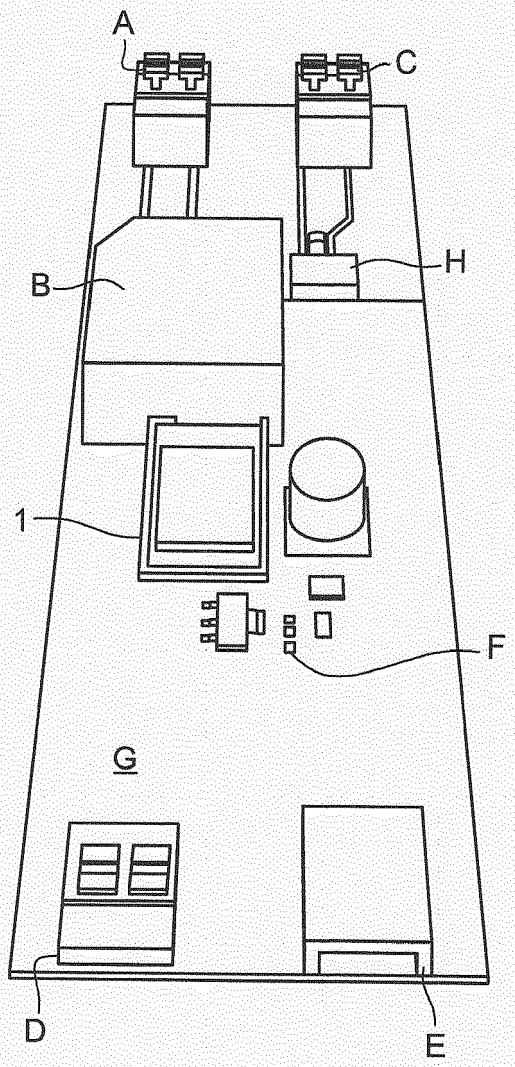


Fig. 2

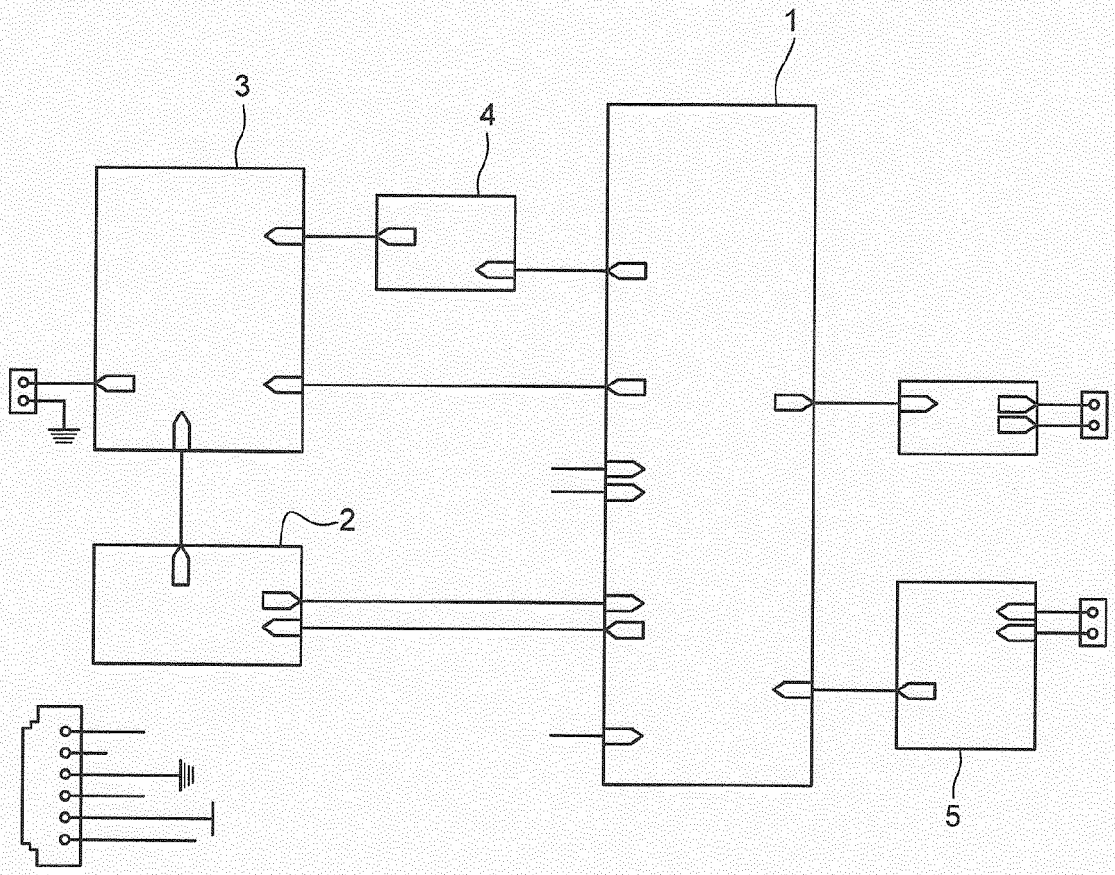


Fig. 3

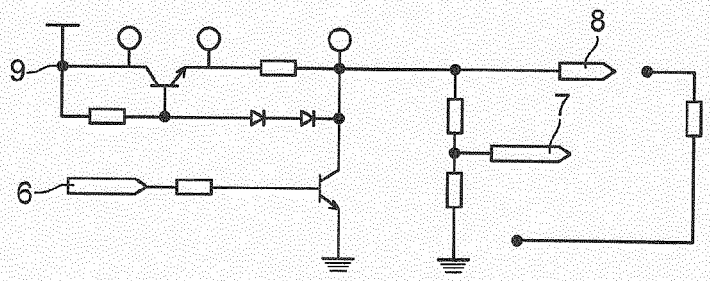


Fig. 4

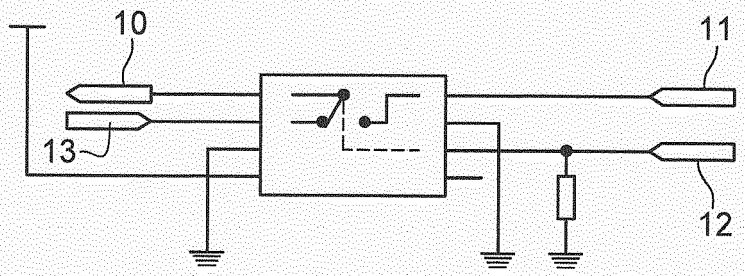
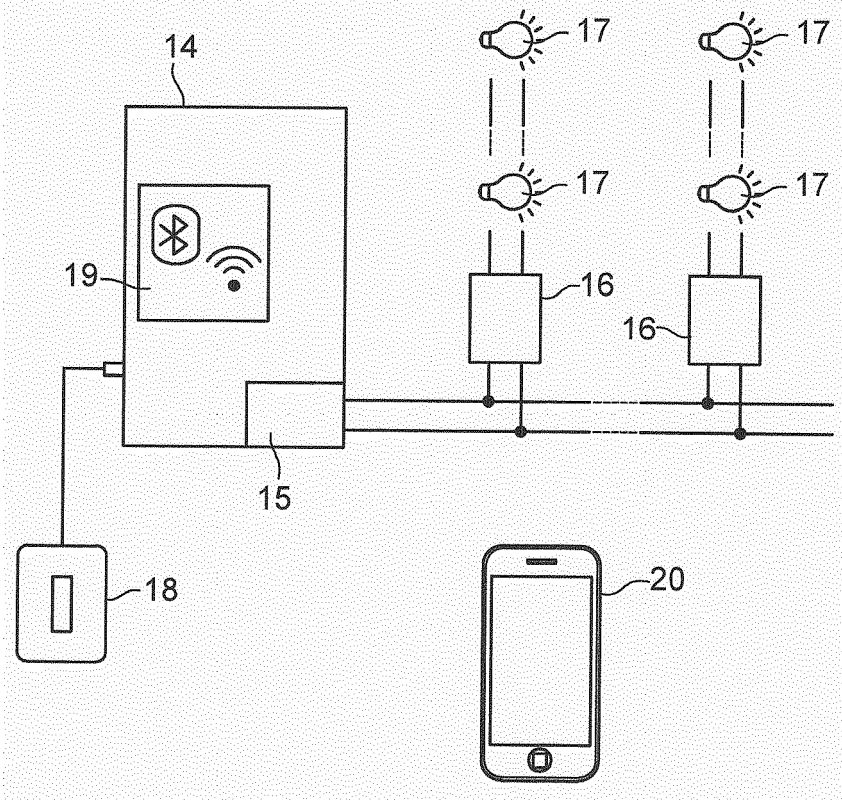


Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 19 17 9540

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 Y	DE 10 2004 047345 A1 (SIEMENS AG [DE]) 16 February 2006 (2006-02-16) * paragraphs [0001], [0014], [0022] - [0025]; figures 1,2 *	1,2,4,5 3	INV. H05B37/02
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A	US 2013/200803 A1 (BOEKLE REINHARD [AT]) 8 August 2013 (2013-08-08) * paragraphs [0001], [0025], [0032]; figure 3 *	1	
			TECHNICAL FIELDS SEARCHED (IPC) H05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 October 2019	Henderson, Richard

CATEGORY OF CITED DOCUMENTS

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02-10-2019

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REFERENCES CITED IN THE DESCRIPTION

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