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mer (120) are adapted for communicating with the RF block (130), wherein the first dimmer, the second dimmer and the RF block are galvanically isolated.



Description

Field of the invention

[0001] The present invention relates to the field of electrical dimmers. More specifically it relates to the field of dimmers which can be controlled via a radio frequency (RF) interface.

Background of the invention

[0002] Prior art dimmers which can be controlled via RF are nowadays existing. RF design for such dimmers is straightforward when only one dimmer needs to be controlled. However, when more than one electrical dimmer needs to be designed such that it can fit into one flush mounting box this is less straightforward. Size issues as well as power issues come into play. Concerning the size it is not recommended to have 2 antennas in one flush mounting box. Also with regard to the power it is better to have only one RF antenna.

[0003] Especially when the dimmer is connected in 2-wire mode power issues can become important. In 2-wire mode the neutral terminal of the dimmer is not connected with the neutral wire of an AC voltage source. In that case the power required for controlling the dimmer causes a current running through the load which is connected to the dimmer. When this load is a LED even small currents may cause unwanted lighting of the LED. Therefore it is important to reduce the power consumption of the dimmer as much as possible.

[0004] EP2624666B1 discloses two dimmers which are controlled via one RF interface over a serial link and wherein one of the dimmers is used for powering the RF module and wherein the other dimmer is galvanically isolated from the RF module.

[0005] In view of the space and power constraints described above, optimizations for dimmer devices comprising more than one dimmer and controlled via an RF interface are possible.

Summary of the invention

[0006] It is an object of embodiments of the present invention to provide a good dimmer device comprising more than one dimmer wherein the dimmers are controlled via an RF interface.

[0007] The above object is accomplished by a method and device according to the present invention.

[0008] In a first aspect, the present invention provides a dimmer device comprising a first dimmer, a second dimmer, and an RF block. The first dimmer is adapted for powering the RF block. The first dimmer and second dimmer are adapted for communicating with the RF block. The first dimmer, the second dimmer and the RF block are all galvanically isolated from one another. Thus the first dimmer, the second dimmer and the RF block are galvanically isolated at the level of the powering as

well as at the communicating level.

[0009] Dimmer devices according to embodiments of the present invention, especially dimmers which are connected in 2-wire mode only have a limited power budget.

Therefore it is an advantage of embodiments of the present invention that an RF block is shared between two dimmers. Thus only one power consuming RF block rather than two power consuming RF blocks is present. In order to reduce the power consumption even more, the first and second dimmer are galvanically isolated from the RF block. This is done for the communication links as well as for the power supply. Although additional space is required for the galvanic isolators, which is not obvious in the space limited environment of a dimmer (e.g. a flush mounting box), this has as main advantage that the voltage over the RF antenna can be controlled such that a user can safely touch the RF antenna without being injured. It is possible to position the RF antenna such that the antenna range over which it can transmit or receive data can be optimised. This is because the antenna can be positioned on places where a user might be able to touch it. Because of the galvanic isolation, the user does not have a risk of getting injured when touching the RF antenna. The antenna may for example be placed underneath the cover of the dimmer. The more the antenna is positioned outside the wall the better the signal becomes. Hence it is an advantage of embodiments of the present invention that, for a similar range, a lower power can be applied that would be required for a prior art dimmer without galvanic isolation of the RF antenna.

[0010] The galvanic isolation moreover serves as filter. Therefore a more clean power for the RF can be obtained. Due to the galvanic isolation less interference of other voltages and currents (e.g. high peak currents when the load is a LED whereby high sharp peak currents may give EMC/EMI trouble) may happen.

[0011] A dimmer device according to embodiments of the present invention may comprise a first communication link between the first dimmer and the RF block, wherein the first communication link comprises a first galvanic isolator for galvanically isolating the first dimmer from the RF block, and a second communication link between the second dimmer and the RF block, wherein the second communication link comprises a second galvanic isolator for galvanically isolating the second dimmer from the RF block.

[0012] In a dimmer device according to embodiments of the present invention, the first dimmer may comprise a power supply wherein the power supply is connected with the RF block over a first connection for transferring power towards the RF block and wherein the power supply and/or the first connection are adapted such that the power supply of the first dimmer is galvanically isolated from the RF block.

[0013] The power supply of the first dimmer may be connected with the second dimmer over a second connection for transferring power towards the second dimmer and the power supply of the first dimmer and/or the

second connection may be adapted such that the power supply of the first dimmer is galvanically isolated from the second dimmer. In this concept the galvanic isolation is advantageous as each dimmer has its own reference (its ground) to check independently its error signals (e.g. short circuit) and to have simple driving circuit of the dimmer mosfets. Another concept for example is to use only one microcontroller for both dimmers. In this concept the complexity of the different grounds/references is moved to the driving circuits of the mosfets. The advantage of the using separate microcontrollers for both dimmers is the re-use of code of the single fold dimmer. In principle only the RF communication link has to be added, core dimmer code is the same.

[0014] In a dimmer device according to embodiments of the present invention, the power supply may comprise a primary transformer coil and a secondary transformer coil per element it needs to power. It is an advantage of embodiments of the present invention that the galvanic separation between the power supply of the first dimmer and the RF block can be implemented by the transformer of the power supply. It is an advantage of embodiments of the present invention that the galvanic separation between the power supply of the first dimmer and the second dimmer can be implemented by the transformer of the power supply. When using, e.g. a flyback transformer only an extra winding, a diode, and an (electrolytic) capacitor has to be added for powering an additional element.

[0015] In a dimmer device according to embodiments of the present invention, the RF block may comprise a microcontroller. It is an advantage of embodiments of the present invention that, by using a microcontroller, different inputs can be processed and forwarded to the corresponding dimmer. The input can for example be a data stream captured by the RF antenna, the input can also come from pushing a push button, rotating a rotary.

[0016] In a dimmer device according to embodiments of the present invention, the power supply of the first dimmer may be a switched mode power supply. It is an advantage of embodiments of the present invention that efficient AC-DC power conversion is possible by using such switched mode power supply.

[0017] In a dimmer device according to embodiments of the present invention, the first dimmer and/or the second dimmer can be connected in 2 and/or 3-wire mode. Being connectable in 2-wire mode has as advantage that such a dimmer can be installed in electrical installations where no neutral wire is available. For this 2-wire mode, power consumption of the dimmer is an important issue. It is therefore an advantage of embodiments of the present invention that the RF block is shared between dimmers and that a galvanic separation is present between the dimmers and the RF-block. Being connectable in 3-wire mode has for example as advantage that the power requirements are less stringent.

[0018] In embodiments of the present invention the second dimmer comprises a power supply. The power

supply of the second dimmer thereby may comprise a primary transformer coil and a secondary transformer coil per element it needs to power.

[0019] It is an advantage of embodiments of the present invention that more than one power supply may be present and hence a backup power supply is present in the dimmer device.

[0020] Particular and preferred aspects of the invention are set out in the accompanying independent and dependent claims. Features from the dependent claims may be combined with features of the independent claims and with features of other dependent claims as appropriate and not merely as explicitly set out in the claims.

[0021] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

Brief description of the drawings

[0022]

FIG. 1 shows a schematic overview of a dimmer device in accordance with embodiments of the present invention.

FIG. 2 shows an exemplary dimmer device in accordance with embodiments of the present invention.

[0023] Any reference signs in the claims shall not be construed as limiting the scope.

[0024] In the different drawings, the same reference signs refer to the same or analogous elements.

Detailed description of illustrative embodiments

[0025] The present invention will be described with respect to particular embodiments and with reference to a drawing but the invention is not limited thereto but only by the claims. The drawing described is only schematic and is nonlimiting. In the drawing, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. The dimensions and the relative dimensions do not correspond to actual reductions to practice of the invention.

[0026] The terms first, second and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequence, either temporally, spatially, in ranking or in any other manner. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

[0027] It is to be noticed that the term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It is thus to be interpreted as specifying the presence of the stated features, inte-

gers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

[0028] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

[0029] Similarly it should be appreciated that in the description of exemplary embodiments of the invention, various features of the invention are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment. Thus, the claims following the detailed description are hereby expressly incorporated into this detailed description, with each claim standing on its own as a separate embodiment of this invention.

[0030] Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

[0031] In the description provided herein, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practiced without these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description.

[0032] Embodiments of the present invention relate to dimmer devices which comprise more than one dimmer and which can be controlled via an RF interface. Dimmer devices according to embodiments of the present invention comprise a first dimmer, a second dimmer and an RF block. Thereby the RF block is shared between the first dimmer and the second dimmer. In embodiments of

the present invention the RF block is powered by the power supply of the first dimmer. In a dimmer device according to embodiments of the present invention the dimmers and the RF block are galvanically isolated from each other. Therefore the power supply of the first dimmer and/or the connection connecting the power supply with another dimmer or with the RF block are designed such that a galvanic isolation is present between the connected components. Also the communication links between the dimmers and the RF block comprise galvanic isolators. Although it is not obvious to introduce galvanic isolators in a space limited environment such as a flush mounting box, this is done in embodiments of the present invention to reduce the power consumption of the RF block. In embodiments of the present invention the galvanic isolation between the RF block and the dimmers is such that limitations due to required safety distances between the RF block (e.g. the RF antenna) and the user are reduced or even eliminated. The voltage breakdown of the galvanic isolation can for example be designed such that the RF block becomes a SELV system (Safety Extra-Low Voltage defined by IEC). Because, in embodiments of the present invention, the required safety distances between the user and the RF block are reduced or even eliminated, the freedom for designing and positioning an RF antenna is increased. The RF antenna can for example be positioned very close to the outside of the flush mounting box or even outside the flush mounting box. This results in an improved range of the RF antenna and because of this improved range the RF power may be reduced.

[0033] A possible implementation of a dimmer device 100 in accordance with embodiments of the present invention is illustrated in FIG. 1. This figure schematically shows a first dimmer 110, a second dimmer 120 and an RF block 130. The RF block is connected to an RF antenna 131.

[0034] The dimmer device 100 comprises a first communication link 118 between the first dimmer 110 and the RF block 130. The communication link comprises a first galvanic isolator 119 for galvanically isolating the first dimmer 110 from the RF block 130.

[0035] The dimmer device 100 comprises a second communication link 128 between the second dimmer 120 and the RF block 130. The communication link comprises a second galvanic isolator 129 for galvanically isolating the second dimmer 120 from the RF block 130.

[0036] The first and second communication links 118, 128 can for example be serial communication links. The first and second galvanic isolators 119, 129 are drawn in FIG. 1 as two coils over which the coupling is done. Other galvanic isolators, such as optocouplers, may however also be possible. The galvanic isolators may also be realized by using an optical communication link, such as for instance a digital optocoupler. Other galvanic isolation may for example be capacitor based (Y2) or Hall effect based. Galvanic isolation for the power transfer is preferably achieved using a transformer. A power supply us-

ing Y2 capacitors may also be used. However, because of its smaller size and the possibility to transfer a higher amount of power, a transformer is preferable.

[0037] In FIG. 1, the first dimmer 110 comprises a power supply 112. Such a power supply may for example be a switched power supply. This power supply is connected with the RF block 130 by a first connection 139. Through this connection it is possible to transfer power to the RF block 130. In embodiments of the present invention the power supply 112 of the first dimmer and/or the first connection 139 are adapted such that the power supply 112 of the first dimmer is galvanically isolated from the RF block 130. In the example of FIG. 1 the galvanic isolation is implemented by a transformer in the power supply 112. Therefore the transformer comprises a primary transformer coil 113 and two secondary transformer coils 114, 115. The first secondary transformer coil 114 is for giving power to the first dimmer itself. It may for example be electrically connected with the microcontroller 111 for powering that microcontroller). This is illustrated with the dotted lines between the first secondary transformer coil 114 and the microcontroller. The second secondary transformer coil 115 is for giving power to the RF block 130. The transformer may for example be designed such that, during operation, the secondary transformer coils generate an output voltage of 3V. Proper care should be taken when selecting/designing the transformer. To guarantee SELV the transformer for instance has to pass a high voltage test (3750V during 1 minute). The primary transformer coil 113 and the second secondary transformer coil 115 are connected over circuitry 124, 125 to the remainder of the circuit; typically for instance a diode and a capacitor as in a typical flyback-switch mode power supply. If a lower voltage ripple is required on the output voltage (typical required for RF) extra filtering (e.g. extra inductor and capacitor,...) or even an LDO (low drop-out) regulator can be placed.

[0038] In the dimmer device, illustrated in FIG. 1, the second dimmer 120 comprises a power supply 122. In other embodiments of the present invention the power supply 112 of the first dimmer 110 is connected with the second dimmer over a second connection for transferring power towards the second dimmer. This power may for example be used for powering control electronics of the dimmer (e.g. for powering microcontrollers). In that case the power supply 112 may comprise a third secondary transformer coil which is connected with the control electronics of the second dimmer such that power can be transferred over this connection.

[0039] In that case the power supply 122 of the second dimmer 120 is not required since power can be drawn from the power supply 112 of the first dimmer 110. In that case the power supply of the first dimmer and/or the second connection are adapted such that the power supply of the first dimmer is galvanically isolated from the second dimmer. The power transfer to the second dimmer may for example be done by adding a third secondary coil to the transformer of the power supply 112 of the first dim-

mer 110, wherein this coil is coupled with the primary coil 113.

[0040] Because of the galvanic separation, the first dimmer, the second dimmer and the RF block all have three separate grounds. The first dimmer 110 has a first ground 117 shown in FIG. 1 on one side of the first galvanic isolator 119 and on the first dimmer itself. The second dimmer 120 has a second ground 127 shown in FIG. 1 on one side of the second galvanic isolator 129 and on the second dimmer itself. The RF block has a third ground 137 shown in FIG. 1 on the opposite side of the first and second galvanic isolators 119, 129 and on the RF block itself.

[0041] The dimmers illustrated in FIG. 1 can be connected either in two-wire mode or in 3-wire mode. In this example each dimmer comprises a switched line terminal 161, 165, a wired control terminal 162, 166, a line terminal 163, and a neutral terminal 164. In this example the line terminals are connected together at node 163 and the neutral terminals are connected together at node 164. The neutral terminals do not necessarily need to be connected to the neutral of an AC voltage source. When the neutral terminal is not connected this corresponds with a dimmer connected in 2-wire mode. When the neutral terminal is connected this corresponds with a dimmer connected in 3-wire mode.

[0042] The dimmers may for example be phase cut dimmers. For controlling the dimmers they may comprise a microcontroller (see microcontrollers 111 and 121 in FIG. 1).

[0043] In embodiments of the present invention the RF block 130 comprises a microcontroller 132. This microcontroller may be adapted for processing incoming data from the RF antenna 131 and for forwarding the corresponding commands to the concerned dimmer over the communication links 118, 128. Also control of the dimmers 110, 120 via push buttons or rotary devices may be enabled through the microcontroller 132. Rectangle 141 in FIG. 1 represents a possible push button or rotary device for controlling the first dimmer 110. Rectangle 142 in FIG. 1 represents a possible push button or rotary device for controlling the second dimmer 120. Also monitoring of the status of the first and second dimmer may be enabled by the microcontroller in the RF block.

[0044] In embodiments of the present invention a power supply may be present in the first dimmer and a power supply may be present in the second dimmer. In embodiments of the present invention the power supply of the second dimmer may be configured to power the first dimmer and/or to power the RF block using the secondary transformer coils. In embodiments of the present invention both the first dimmer and the second dimmer may have such a power supply. This has as advantage that such a dimmer device has a backup power supply when one of the power supplies fails. Both may for example be used for powering the RF block. In that case, if one of both power supplies fails the RF-block is still powered. In embodiments of the present invention the RF-block

may even be configured to transmit the failure information of the failing power supply to the user.

[0045] Dimmer devices according to the present invention may be used for implementing a home automation system. This can for example be implemented by combining them with a smartphone application. The RF block thereby enables communication with the smartphone application.

[0046] FIG. 2 shows an exemplary dimmer device 100 in accordance with embodiments of the present invention. The dimmer device is similar as the dimmer device in FIG. 1 except that specific implementations of the circuitry is shown. It shows for example how the secondary transformer coil 114 is connected with a controller 202 of the power supply unit 112 and with component 201 of the power supply unit for powering them. Component 201 is a pre-regulator circuit and a 2-wire/3-wire detection circuit. An example of such a pre-regulator circuit and a 2-wire/3-wire detection circuit thereof is explained in EP17200937, EP17200942, and EP17200944.

[0047] The primary transformer coil 113 and the second secondary transformer coil 115 are connected over circuitry 124, 125 to the remainder of the circuit. The connection between the circuitry 125 and the LDO voltage regulator of the RF block is via the first connection 139. A possible implementation thereof is also shown in this figure. FIG. 2 also shows a possible implementation of a switch unit 204 of the dimmer.

[0048] Optocouplers 205 are providing galvanic isolation. This is for example the case for the first communication link 118 between the microcontroller 111 of the first dimmer 110 and the microcontroller 132 of the RF block 130, illustrating a possible practical implementation of a communication link for transmitting signals (118a = Tx) and receiving signals (118b = Rx) for microcontroller 111 and transmitting signals (118c = Tx) and receiving signals (118d = Rx) for microcontroller 132. Thus, the transmitted signal of the microcontroller 111 is the received signal for the microcontroller 132 and vice versa. Hence, the communication lines are split in lines 118a and 118b between the microcontroller 111 and the optocouplers 205 and in lines 118c and 118d between the optocouplers and the microcontroller 132 of the RF block 130.

[0049] An optocoupler is also present between the control terminal 162 and the microcontroller 111. The microcontroller may be configured for receiving dimmer signals from block 203 which may for example comprise a synchronization circuit.

[0050] The second dimmer has, in this example, similar components as the first dimmer. Communication between the microcontroller 121 of the second dimmer and the microcontroller 132 of the RF block can be implemented similar to the link between the first dimmer and the RF block.

Claims

1. A dimmer device (100) comprising a first dimmer (110), a second dimmer (120), and an RF block (130),
 wherein the first dimmer (110) is adapted for powering the RF block (130) and wherein the first dimmer (110) and second dimmer (120) are adapted for communicating with the RF block (130), and wherein the first dimmer, the second dimmer and the RF block are all galvanically isolated from one another at communicating level and at power level, the first dimmer (110) comprising a power supply (112) wherein the power supply of the first dimmer (110) is galvanically isolated from the RF block (130) and from the second dimmer (120) by providing a power supply with a primary transformer coil (113) and a secondary transformer coil (114, 115) per element it needs to power and/or by providing a galvanically isolated connection (139) for transferring power towards an element it needs to power.
2. A dimmer device (100) according to claim 1, the dimmer device comprising a first communication link (118) between the first dimmer (110) and the RF block (130) wherein the first communication link (118) comprises a first galvanic isolator (119) for galvanically isolating the first dimmer (110) from the RF block (130),
 the dimmer device comprising a second communication link (128) between the second dimmer (120) and the RF block (130) wherein the second communication link (128) comprises a second galvanic isolator (129) for galvanically isolating the second dimmer (120) from the RF block (130).
3. A dimmer device (100) according to any of the previous claims, the first dimmer (110) comprising a power supply (112) wherein the power supply is connected with the RF block (130) over a first connection (139) for transferring power towards the RF block (130) and wherein the power supply (112) and/or the first connection (139) are adapted such that the power supply (112) of the first dimmer (110) is galvanically isolated from the RF block (130).
4. A dimmer device (100) according to claim 3, wherein the power supply (112) of the first dimmer (110) is connected with the second dimmer (120) over a second connection for transferring power towards the second dimmer and wherein the power supply (112) of the first dimmer and/or the second connection are adapted such that the power supply (112) of the first dimmer (110) is galvanically isolated from the second dimmer.
5. A dimmer device (100) according to any of the claims 3 or 4 wherein the power supply (112) comprises a

primary transformer coil (113) and a secondary transformer coil (114, 115) per element it needs to power.

6. A dimmer device (100) according to any of the previous claims wherein the RF block (130) comprises a microcontroller (132). 5
7. A dimmer device (100) according to any of the previous claims wherein the power supply (112) of the first dimmer (110) is a switched mode power supply. 10
8. A dimmer device (100) according to any of the previous claims wherein the first dimmer and/or the second dimmer can be connected in 2 and/or 3-wire mode. 15
9. A dimmer device (100) according to any of the previous claims wherein the second dimmer (120) comprises a power supply (122) wherein the power supply (122) of the second dimmer comprises a primary transformer coil and a secondary transformer coil per element it needs to power. 20

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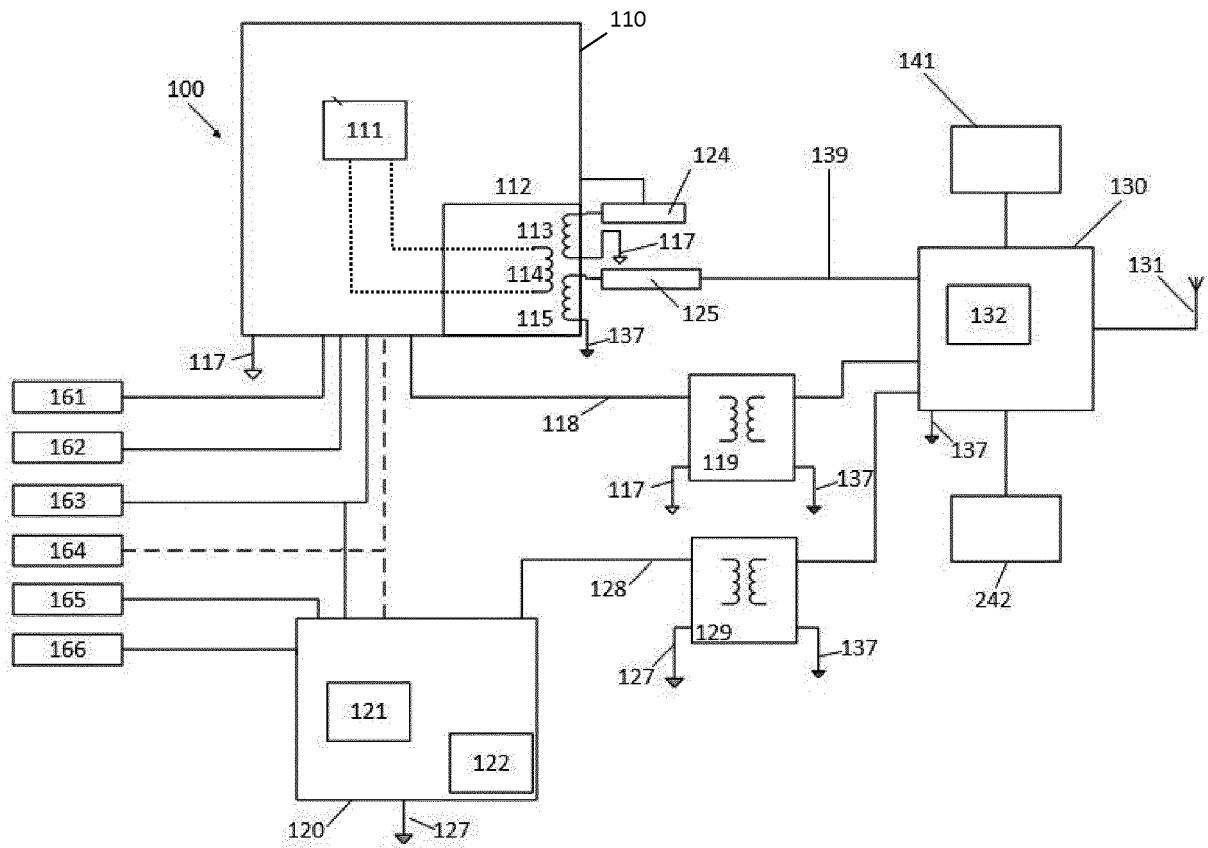


FIG. 1

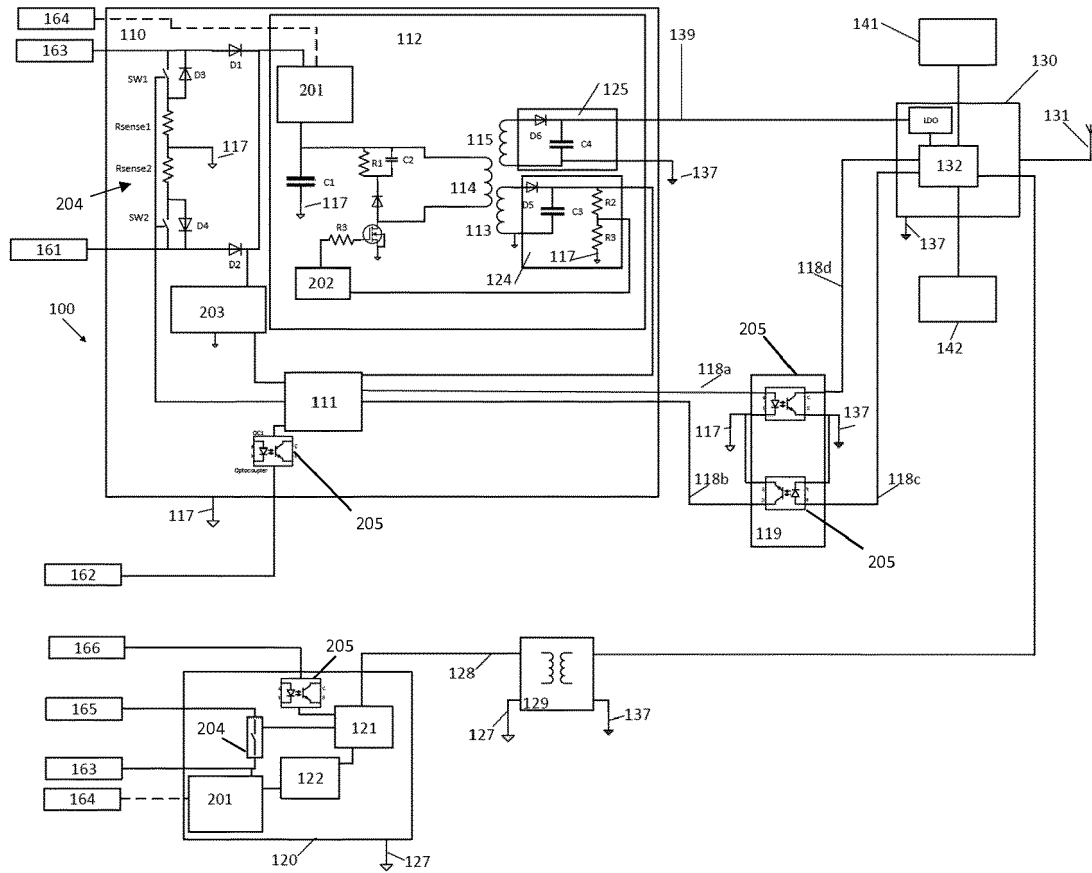


FIG. 2



EUROPEAN SEARCH REPORT

Application Number
EP 17 20 0947

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Place of search Munich		Date of completion of the search 9 February 2018	Examiner Brosa, Anna-Maria
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A	US 2016/165691 A1 (FASSBENDER WILLIAM J [US] ET AL) 9 June 2016 (2016-06-09) * abstract; figures 2-4 *	1-9	
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CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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