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(54) **TEST CONTROL DEVICE FOR AN EMERGENCY DEVICE IN A BUILDING AUTOMATION SYSTEM**

(57) A test control device for an emergency device in a building automation system, wherein the emergency device includes a test switch interface for connecting an external test switch for activating a simulated emergency mode of the emergency device, the test control device comprises a first interface, a second interface and a wireless interface. The first interface is configured to connect the test control device to the emergency device and to connect the test control device to a battery interface of the emergency device. The second interface configured to connect the test control device to an energy storage device. The wireless interface is configured to receive an activation signal for activating the simulated emergency mode of the emergency device. The test control device may be part of an emergency device, and in particular of an emergency lighting device, an emergency luminaire or an emergency ballast device. A building automation system may include at least one emergency device.

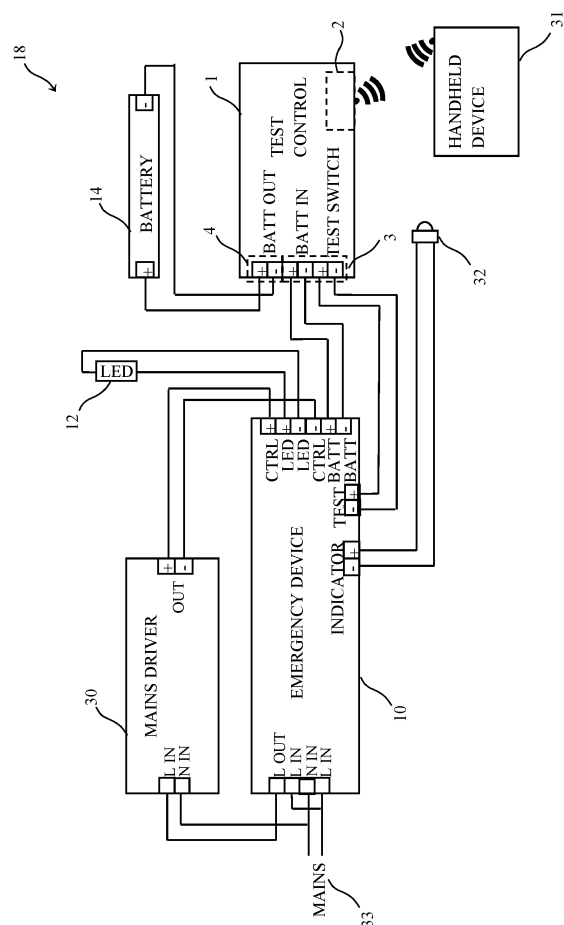


FIG. 1

Description

[0001] The invention is in the field of testing functionalities of emergency devices in building automation systems. In particular, the invention concerns a test control device for an emergency device, an emergency device and a building automation system. An emergency system represents a preferred example of the building automation system.

[0002] A building and potentially even the environment close to the building may have a plurality of different technical infrastructure devices, for example luminaires, emergency luminaires, sensor devices such as motion detectors, smoke detectors, fire detectors, actuators such as actuators for doors or for smoke outlets, switches such as on/off-switches and dimmers, and signs such as emergency exit signs.

[0003] Known emergency devices provide a constant load current to lighting modules and emergency exit signs. In case of an emergency, for example in case of a mains power failure, the emergency device provides the constant load current of a battery instead of the mains supply. The emergency devices typically comprise control circuits. The control circuits typically monitor a current operating status of the emergency device in order to detect any faults such as the mains power failure. The control circuit reports the detected operating status of the emergency device and, in particular operational readiness or detected faults, for example using signalling means, such as LEDs arranged locally or a communication network of the monitored building.

[0004] In most emergency applications, applicable statutes and regulations require performing at least one of functional tests and duration tests at predetermined time intervals and a documentation of test results and test data generated during the test.

[0005] A test switch, for example an ON/OFF-switch, arranged locally at or close to the emergency device, may enable a human operator to trigger the test locally by starting a test procedure. The test switch and a corresponding test switch interface of the emergency device is an element often found in basic emergency devices as a cost efficient solution minimizing complexity of the emergency device.

[0006] However, arranging the test switch locally at the emergency device requires the operator to initiate the test locally and to record the test results locally at each emergency device. In case of a building automation system comprising a plurality of emergency devices distributed over a large premise, testing of the emergency devices in the field is therefore cumbersome, requires significant time, and incurs considerable cost.

[0007] Alternatively, known emergency devices include a network capability, for example an interface according to the DALI^{RTM} protocol in case of emergency lighting devices (Digital Addressable Lighting Interface - DALI^{RTM}, technical standards according to IEC 62386). The interface enables connecting the emergency device

es with corresponding emergency controllers in a network. DALI^{RTM}-compatible emergency devices are technically more complex and accordingly increase cost of the DALI^{RTM}-compatible emergency device in relation to the basic emergency device.

[0008] Using an available network capability of emergency devices for controlling the test process and storing the test results requires additional wiring over the building for connecting the emergency devices in the field with at least one centralized test control device. This results in additional installation and hardware cost.

[0009] In order to address this issue, one might consider providing a gateway from the network interface (DALI^{RTM} interface) to a wireless network interface locally at each emergency device. This enables building a wireless network including the emergency devices and reduces the wiring cost in particular for building automation systems extending over a wide area. For example, the Bluetooth^{RTM} communication standard provides a suitable wireless network protocol for connecting the wireless-capable emergency devices having such gateway to the test controller.

[0010] However, the emergency device with an integrated network capability is yet a complex and expensive product, and both complexity and costs even increase further when integrating an additional gateway for linking the digital network interface (DALI^{RTM} interface) of the emergency device with the additional gateway arranged in each emergency network device.

[0011] The invention addresses the problem of providing cost effective test functionalities for devices having an emergency mode of operation over a wide range of building automation systems taking into regard the considerations discussed above concerning the current state of the art.

[0012] According to the first aspect, the test control device for an emergency device in a building automation system provides an advantageous solution to this problem. The emergency device according to a second aspect and the building automation system according to a third aspect represent further advantageous solutions.

[0013] The features of the dependent claims define further embodiments of the invention.

[0014] The first aspect of the invention concerns a test control device for an emergency device in a building automation system. The emergency device includes a test switch interface for connecting an external test switch for activating a simulated emergency mode of the emergency device. The test control device comprises a first interface, a second interface and a wireless interface. The first interface is configured to connect the test control device to the emergency device. In particular, the first interface is configured to connect the test control device to the test switch interface of the emergency device. The second interface is further configured to connect the test control device to a battery interface of the emergency device. The wireless interface is configured to connect the test control device to an energy storage device, and the wire-

less interface is configured to receive an activation signal for activating the simulated emergency mode of the emergency device.

[0015] Due to the test control device including the first interface electrically connecting the test control device to the test switch interface of the emergency device, the activation signal for the simulated emergency mode received via the wireless interface may be used to control switching the emergency device into the simulated emergency mode. Due to the test control device having the first interface connecting the test control device to the battery interface of the emergency device, and the second interface connecting the test control device to the energy storage device, the test control device is enabled to monitor electric parameters of the emergency device in the simulated emergency mode. Thus, the test control device enables to initiate testing and perform testing of the emergency device using a wireless interface, therefore without requiring a technician being physically present at the location of the emergency device, although the emergency device is of a type of emergency device without a digital communication interface.

[0016] The test control device allows full functional testing and duration testing of the emergency device from remote even for low cost emergency devices, and without additional communication wiring in the building for implementing a remote testing capability.

[0017] The emergency device and the test control device may be designed as separate products in a product portfolio of a supplier, and the test control device may be offered as an upgrade module for the basic emergency device. Thus, the test control device enables to define a product portfolio with an advantageous modularity.

[0018] The test control device may comprise a power supply configured to obtain electric energy via the first interface from the emergency device. Additionally or alternatively, the power supply may be configured to obtain electric energy via the second interface from the energy storage device.

[0019] Thus, the test control device may entirely operate from electric energy available at the location of the emergency device and without requiring any additional power supply. Preferably, the test control device operates from the emergency device, in particular a battery charging circuit of the emergency device, in order to avoid discharging the energy storage device intended to provide energy during emergency operation of the emergency device. The test control device may operate from the energy storage device if required.

[0020] Preferably, the test control device is configured to short-circuit terminals of the first interface, wherein the terminals, which are short-circuited, are connected to the test switch interface of the emergency device. It is particularly preferred to short-circuit the terminals electronically.

[0021] Short circuiting terminals of the test switch interface of the emergency device causes the same operation for switching the emergency device into the simu-

lated emergency mode as the conventional test switch performs. A wireless signal received via the wireless interface replaces the conventional pushing of the test switch. Without increasing complexity of the emergency device, and without additional wiring in the building, switching the emergency device into the simulated emergency mode is possible.

[0022] The test control device may comprise a control circuit configured to activate the simulated emergency mode of the emergency device based on at least one of the received activation signal and a preset calendar function implemented on the control circuit.

[0023] The control circuit, for example including an integrated circuit such as a microcontroller, a microprocessor, or an application specific integrated circuit (ASIC), enables to implement activating the simulated emergency mode based on receiving a signal via the wireless interface, but additionally or alternatively based on a signal provided by a timer. A timer circuit suitable for implementing a calendar function may be integral to many integrated circuits available. In order to provide a required accuracy of timing to meet the applicable standards, the timer circuit may include a crystal oscillator. Microcontroller, microprocessor, or ASICs regularly have a suitable interface for connecting to oscillator circuits, often based on a crystal oscillator. Thus, an automated testing of the emergency device at predetermined time intervals and for predetermined periods is possible, significantly enhancing the test control operation of the conventional test switch, and almost equalling the capabilities provided by a centralized test control for the building automation system.

[0024] In particular, the control circuit of the test control device may activate the simulated emergency mode of the emergency device for at least one of a function test and a duration test of the emergency device and the energy storage device.

[0025] The control circuit of the test control device of an embodiment is configured to activate the simulated emergency mode of the emergency device for a preset time period. This enables implementing a duration test of the emergency device and the energy storage device in an emergency mode of operation, for example testing the current storage capacity of the energy storage device.

[0026] Alternatively or additionally, the control circuit of the test control device of an embodiment is configured to activate the simulated emergency mode of the emergency device to activate the simulated emergency mode of the lighting device at preset time intervals. This enables implementing a functional test of the emergency device, for example testing a switchover to an emergency mode of operation of the emergency device in case of a mains supply failure according to a regulatory testing schedule.

[0027] The control circuit of the test control device may be configured to activate the simulated emergency mode of the emergency device using at least one of a relay circuit or an optocoupler circuit of the test control device.

[0028] Each a relay circuit and an a optocoupler circuit

enable to switch the emergency device into simulated emergency mode based on an signal from the control circuit of the test control device, while simultaneously maintaining electric isolation between the emergency device and other circuit portions of the test control device, for example including the control circuit.

[0029] The test control device may be configured to short-circuit terminals of the first interface, which are connected to the test switch interface of the emergency device for activating the simulated emergency mode of the emergency device.

[0030] Preferably, the test control device comprises a current monitoring circuit, which is configured to monitor at least one of a charging current to the energy storage device input via the first interface of the test control device and a discharging current from the energy storage device input via the second interface of the test control device.

[0031] Thus, the test control device may enable starting a test procedure, and monitoring the charging current provided by the emergency device to the first interface of the test control device, and output via the second interface to the energy storage device. The testing device may therefore test a charging function of the emergency device, in particular during a mains supply based standard mode of operation of the emergency device.

[0032] Additionally or alternatively, the test control device may enable starting a test procedure, and monitoring the discharging current supplied by the energy storage device to the second interface of the test control device, and output via the first interface of the test control device to the emergency device. The test control device may therefore test a battery-backed emergency operation function of the emergency device. The test control device may therefore perform a duration test of a battery-backed emergency operation function of the emergency device and the energy storage device.

[0033] The current monitoring circuit of the test control device according to a preferred embodiment comprises a current sense resistor and an amplifier circuit.

[0034] The current sense resistor (shunt) offers a cost effective solution for measuring the charging current and the discharging current. Employing an amplifier circuit in the current monitoring circuit is in particular advantageous when measuring the discharging current output by the energy storage device. The storage capacity of the energy storage device serves primarily a power supply in an emergency case.

[0035] The test control device according to an embodiment comprises a voltage monitoring circuit. The voltage monitoring is configured to monitor an output voltage of the energy storage device.

[0036] Thus, test control device is capable of starting a test procedure, and of monitoring an electrical parameter of the energy storage device, thereby performing a functional test of the energy storage device.

[0037] The test control device may comprise a memory, which is configured to store data generated during testing of at least one of the emergency device and the

energy storage device.

[0038] The test control device may accordingly store measurement data acquired during the simulated emergency mode and log data generated during the simulated emergency mode in test data locally at the test control device. Thus, the test control device generates and stores test data concerning the functional tests and duration tests, which some regulations require for emergency devices and energy storage devices in safety relevant applications. This increases the functionality of the emergency device significantly in case of using the test control device. The modularity of the product portfolio by distributing adaptations to different regulatory regions may also be improved.

[0039] The wireless interface of an embodiment may enable access to the memory for at least one of reading the data and writing the data in the memory.

[0040] Thus, the memory may be accessed via the wireless interface. Via the wireless interface, it is possible to read out the stored test data from the memory. An analysis of the test data and thereby the measurement results may be performed offline.

[0041] The read out test data may be filed for generating a test documentation of performed functional tests and duration tests.

[0042] Test procedures, test schedules or test parameters of the test procedures may be updated via the wireless interface by writing data into the memory. The test control device accordingly has wireless updating function potentially extending a product lifecycle.

[0043] The test control device according to may comprise a light sensor, which is configured to sense light emitted by a lighting module in the simulated emergency mode of the emergency device.

[0044] Thus, the test control device may test the function of the lighting module directly further improving the test functionalities.

[0045] Alternatively or additionally, the test control device of an embodiment comprises a third interface for connecting a lighting module that is supplied with a load current by the emergency device.

[0046] Thus, the test control device may test the function of the emergency device, for example by monitoring or measuring the load current to the lighting module and thereby further improving the test functionalities.

[0047] Preferably, the wireless interface is configured to operate as a wireless local area network (WLAN) interface, in particular as a Wi-FiTM interface. Alternatively or additionally, the wireless interface is configured to operate as an access point for at least one of downloading data and uploading data to the emergency device.

[0048] Thus, the wireless interface may enable at least one of downloading data from a luminaire or uploading data to the luminaire that includes the emergency device. The wireless interface as a WLAN or Wi-Fi interface enables the test control device to communicate with corresponding interfaces of smartphones, mobile computers and corresponding wireless interfaces of other building

infrastructure devices. A specific interface for building infrastructure devices such as DALI^{RTM} is not necessary for the improved functionalities provided by the test control device.

[0049] The first interface of an embodiment of the test control device may be configured to connect the test control device to the test switch interface of the emergency device in parallel to a test switch.

[0050] Thus, switching the emergency device into the simulated emergency mode is still possible even without using a communication counterpart for the wireless interface.

[0051] An emergency device according to a second aspect comprises a test control device according to one of the embodiments of the test control device.

[0052] The emergency device can be an emergency lighting device, in particular an emergency lighting device of an emergency luminaire. An emergency lighting device typically includes an emergency driver and a lighting module provided with a constant current by the emergency driver device off an energy storage device of the emergency lighting device in case of an emergency. Alternatively, the emergency device is an emergency driver device (emergency ballast device).

[0053] A building automation system according to a third aspect comprises at least one emergency device.

[0054] Preferably, the building automation system is or at least includes an emergency lighting system or an emergency guidance system.

[0055] The discussion of the invention refers to the attached drawings, in which

Fig. 1 shows an arrangement of elements of an emergency luminaire including a test control device according to an embodiment,

Fig. 2 shows a simplified circuit diagram of a test control device according to an embodiment, and

Fig. 3 provides an overview over an emergency lighting system according to an embodiment of the invention.

[0056] Same reference signs in the figures denote elements with same or corresponding functions. Discussion of as far as considered possible without adversely affecting comprehensibility.

[0057] Fig. 1 is a simplified block diagram depicting an arrangement of elements of an emergency luminaire 18 including a test control device 1 according to an embodiment of the invention.

[0058] The emergency luminaire 18 comprises a mains driver 30, an emergency device 10, a lighting module 12, and an energy storage device 14.

[0059] The lighting module 12 comprises at least one light emitting diode (LED).

[0060] The emergency device 10 supplies a load current I_{LED} via the terminals LED+ and LED- to the lighting

module 12.

[0061] The emergency luminaire 18 comprises a charge indicator 32. The charge indicator 32 may include an indicator LED, which emits light when the emergency device 10 charges the energy storage device 14 with a charge current I_{CHARGE} .

[0062] The emergency device 10 comprises a charge indicator interface with terminals INDICATOR+ and INDICATOR- for connecting the charge indicator 32 and providing an indicator current $I_{INDICATOR}$ to the charge indicator 32.

[0063] The emergency device 10 comprises a test switch interface TEST with terminals TEST+ and TEST- for connecting a test switch not depicted in fig. 1. The test switch may include a push button, which short-circuits the terminals TEST+ and TEST- when actuated. In case the emergency device 10, for example a control circuit of the emergency device 10, detects the short-circuit between the terminals TEST+ and TEST-, the control circuit may start a test procedure for performing a self-test of the emergency device 10 and/or the energy storage device 14.

[0064] In a specific example of the emergency device 10, in particular an emergency driver device, short-circuiting the terminals TEST+ and TEST- switches the emergency device 10 into a simulated emergency operation (simulated emergency operation mode) simulating an emergency situation including a power loss. The emergency device 10 operates in the simulated emergency situation based on energy from the energy storage device 14. The emergency device 10 may operate in the simulated emergency situation as long as the short-circuit between the terminals TEST+ and TEST- applies.

[0065] The test control device 10 enables not only short-circuiting the terminals TEST+ and TEST- for switching the emergency device in order to simulate an emergency situation, but also monitoring parameters of the emergency device 10 during the simulated emergency operation. Thus, the test control device 10 provides even basic emergency devices 10 that include the basic mode of switching into the simulated emergency operation mode with extensive monitoring capabilities for device parameters during the simulated emergency operation mode, which usually only form integral part of high tier emergency devices 10, which integrally include these extensive monitoring capabilities.

[0066] The energy storage device 14 shown in fig. 1 is a rechargeable battery or rechargeable battery pack storing electric energy. The energy storage device 14 may be any device suitable for storing energy, obtaining electric energy for storing and for providing electric energy from the stored energy. The energy storage device 14 in particular includes devices such as capacitors and super capacitors. The electric energy stored in the energy storage device 14 enables to provide the load current I_{LED} to the lighting module 12 in case mains supply 33 fails.

[0067] The emergency device 10 and a mains driver 30 are both connected to a mains supply 33. The mains

supply 33 provides power for the luminaire 18 in a standard operation mode (normal operation mode).

[0068] In the standard operation mode, the mains driver 30 provides the load current I_{LED} via its output terminals OUT+ and OUT- to the input terminals CTRL+ and CTRL- of the emergency device 10. In the standard operation mode, the emergency device 10 provides the load current I_{LED} input at its terminals CTRL+ and CTRL- via switches to terminals LED+ and LED- of the emergency device 10 connecting the lighting module 12. In the standard operation mode, the mains driver 30 provides the load current I_{LOAD} via the emergency device 10 to the lighting module 12 based on electric energy drawn from the mains power supply 33 via terminals L IN and N IN of a mains supply interface of the mains driver 30.

[0069] The emergency device 10 comprises a battery charging circuit to generate the charging current I_{CHARGE} .

[0070] In the standard operation mode, the emergency device 10 provides a charging current I_{CHARGE} via the test control device 1 to the energy storage device 14 based on electric energy drawn from the mains power supply 33 via terminals N IN and L IN of a mains supply interface of the emergency device 10. Preferably, the mains supply interface of the emergency device 10 is connected to mains power supply 33 independent of a mains supply interface of the mains driver 30, as the mains power supply to the mains driver 30 may be switched on or off depending on the actual demand for light.

[0071] The emergency device 10 includes a battery interface 16 including terminals BATT+ and BATT-. In the prior art, the battery interface connects the energy storage device 14 directly via wires (cables).

[0072] The test control device 1 includes a first interface 3, which comprises terminals BATT IN+ and BATT IN-. The (output) terminals BATT+ and BATT- of the emergency device 10 are connected to the (input) terminals BATT IN+ and BATT IN- of the test control device 1. The test control device 1 provides the charging current I_{CHARGE} input via the terminals BATT IN+ and BATT IN- of the first interface 3 via a second interface 4 to the energy storage device 14.

[0073] The energy storage device 14 includes battery terminals "+" and "-", which are connected with the terminals BATT OUT+ and BATT OUT- of the second interface 4 of the test control device 1.

[0074] In an emergency operating mode, the energy storage device 14 provides electric energy for supplying the emergency device 10. The emergency device 10 includes an emergency driver circuit, which generates in the emergency operation mode the load current I_{LED} and provides the load current I_{LED} via the switches of the emergency device 10 to the terminals LED+ and LED- of the emergency device 10 to the lighting module 12.

[0075] The switches of the emergency device 10 enable switching between the standard operation mode and the emergency operation mode.

[0076] In the emergency operation mode, the energy

storage device 14 provides a DC supply voltage via the terminals BATT OUT+ and BATT OUT- of the second interface 4, the terminals BATT IN+ and BATT IN- of the first interface 3 of the test control device 1 to the terminals BATT+ and BATT- of the emergency device 10.

[0077] Fig. 1 also shows a handheld device 31 including a wireless communication unit. The test control device 1 includes a wireless interface 2, which enables a wireless communication, in particular a bidirectional wireless communication between the handheld device 31 and the wireless interface 2 of the test control unit 1.

[0078] The handheld device 31 may be a smartphone, a mobile computer, a tablet computer.

[0079] Alternatively or additionally, the wireless interface 2 may communicate with other devices or communication networks, which support communication of a corresponding communication protocol the wireless interface 2 supports.

[0080] Preferably, the wireless interface 2 is configured for communication of at least one of the protocols and standards of WLAN 802.11, in particular Wi-Fi^{RTM}, and of WPAN 802.15, in particular Bluetooth^{RTM} or ZigBee^{RTM}.

[0081] It is worth noting that neither the mains driver 30 nor the emergency device 10 shown in fig. 1 include a digital communication interface such as, for example, a DALI^{RTM} interface. The test interface 1 provides even this mains driver 30 and the emergency device 10 of a basic product line without a digital communication interface with functionalities for the simulated emergency mode.

[0082] The wireless interface 2 of the test control device 1 enables accessing the test control device 1. In particular, the wireless interface 2 provides the capability to remotely, in particular via radio waves, interface the test switch interface of the emergency device 10. The test switch interface TEST including the terminals TEST+ and TEST- is connected with terminals TEST SWITCH+ and TEST SWITCH- of the first interface 3 of the test control unit 1. The test control device 1 may apply a short circuit between the terminals TEST SWITCH+ and TEST SWITCH- of the first interface 3. The emergency device 10 will detect the short circuit between the terminals TEST SWITCH+ and TEST SWITCH- at its terminals TEST+ and TEST- of the test switch interface TEST.

[0083] The test switch interface TEST may be adapted to connect the test switch to the test switch interface and in parallel and additionally the terminals TEST SWITCH+ and TEST SWITCH- of the first interface 3 of the test control device 1 to the test switch interface.

[0084] Additionally or alternatively, the first interface 3 of the test control device 1 is adapted to connect the test switch in parallel at the terminals TEST SWITCH+ and TEST SWITCH- of the first interface 3 in addition to connecting the terminals TEST+ and TEST- of the test switch interface TEST of the emergency device 1.

[0085] In the simulated emergency mode of the emergency device 10, the emergency device 10 preforms a

test procedure. The test procedure may be one particular test procedure out of a plurality of test procedures. A first type of test procedures are function tests. A second type of test procedures are duration tests. The emergency device 10 performs the test procedure over a pre-set period of time (test duration).

[0086] Test procedures of a same type may vary with respect to the technical parameters, which are tested or measured when performing the test procedure.

[0087] Technical parameters determined during a test may include detection of a mains supply failure.

[0088] Technical parameters determined during a test may include function of the switches of the emergency device for switching the load current I_{LED} from mains based standard operation mode to battery-based emergency operation mode.

[0089] Technical parameters determined during a test may include emission of light by the lighting module 12.

[0090] Technical parameters determined during a test may include measuring a value (monitoring) of the charge current I_{CHARGE} , discharge current $I_{DISCHARGE}$, load current I_{LED} , battery voltage V_{BATT} of the energy storage device 14, battery capacity of the of the energy storage device 14.

[0091] Technical parameters determined during a test may include measuring a variation of the measured values of the charge current I_{CHARGE} , discharge current $I_{DISCHARGE}$, load current I_{LED} , battery voltage V_{BATT} of the energy storage device 14, battery capacity of the of the energy storage device 14 over predetermined periods of time.

[0092] For a function test, the test duration is typically shorter than for a duration test. For example, the test duration of the function test may be 5 seconds, while the duration of the duration test is one hour. Alternative durations of the duration test are in a range of 1 to 3 hours depending on country or region and applicable local regulations.

[0093] Different types of test procedures may be performed in different time intervals. For example, a specific function test may be performed every week. A specific duration test is performed once a year.

[0094] Fig. 2 shows a simplified block diagram of a test control device 1 according to an embodiment.

[0095] The test control device 1 includes a first interface 3 and a second interface 4.

[0096] The first interface 3 is configured to connect the test control device 1 to the emergency device 10.

[0097] The first interface 3 includes terminals 3.1 (TEST SWITCH-) and 3.2 (TEST SWITCH+) for connecting the test switch interface TEST of the emergency device 10. The first interface 3 includes terminals 3.3 (BATT IN-) and 3.4 (BATT IN+) for connecting the battery interface of the emergency device 10.

[0098] The second interface 4 is configured to connect the test control device 1 to the energy storage device 14. The second interface 4 includes terminals 4.1 (BATT OUT-) and 4.2 (BATT OUT+) for connecting the corre-

sponding terminals of the energy storage device 14.

[0099] According to fig. 2, the test control device 1 comprises a control circuit 7 and a wireless interface 2.

[0100] Alternatively, the test control device 1 combines the control circuit 7 and a wireless interface 2 in a single circuit.

[0101] The control circuit 7 and the wireless interface 2 may both be integrated circuits (ICs), in particular application specific circuits (ASICs). The control circuit 7 and the wireless interface 2 may be implemented using at least one microcontroller circuit.

[0102] The control circuit 7 may include an internal memory. Alternatively or additionally, the control circuit 7 arranges a memory 8 externally to the control circuit 7. The control circuit 7 may read data, in particular program data from the memory 8, and write data, in particular test data including measurement data and test parameter data to the memory 8.

[0103] The control circuit 7 may update or overwrite program data stored in the memory 8 based on update data received via the wireless interface 2.

[0104] The control circuit 7 may read test data stored in the memory 8 in response to a request received via the wireless interface 2, and transmit the read test data via the wireless interface 2 to a requesting device. For example, an operator may request test data files stored in the memory 8 using the handheld device 31, and receive the requested test data files in response from the test control device 1. The wireless interface 2 enables access to the control circuit 7 and the memory 8.

[0105] The control circuit 7 may be an integrated circuit such as a microcontroller, a microprocessor, or an ASIC. The control circuit 7 enables to implement activating the simulated emergency mode based on receiving a signal via the wireless interface, but additionally or alternatively based on a signal provided by a timer. A timer circuit suitable for implementing a calendar function is integral to many integrated circuits currently available. In order to provide a required accuracy of timing and to comply with applicable standards, the timer circuit may include a crystal oscillator. Microcontroller, microprocessor, or ASICs regularly have a suitable interface for connecting to oscillator circuits, often based on a crystal oscillator, for a precise timing and derive clock signals therefrom.

[0106] The control circuit 7 may use a calendar function to activate a simulated emergency mode of the emergency device 10. The control circuit 7 may activate the simulated emergency mode based on the preset calendar function.

[0107] The preset calendar function enables an autonomous testing of the emergency device 10 and/or the energy storage device 14. The preset calendar function may switch the emergency device 10 into the simulated emergency mode at predetermined times, for predetermined periods, and/or at predetermined time intervals.

[0108] Additionally or alternatively, the control circuit 7 may initiate transmission of test data via the wireless interface 2 based on respective alert from the calendar

function implemented in the control circuit 7.

[0109] Additionally or alternatively, the control circuit 7 may switch the emergency device 10 into the simulated emergency mode in response to a test instruction received externally via the wireless interface 2. The test control device 1 implements a capability to test and report the test data on demand.

[0110] Additionally or alternatively, the control circuit 7 may initiate transmission of test data via the wireless interface 2 in response to a transmission instruction received externally via the wireless interface 2. In particular, an operator may use the handheld device 31 for providing the transmission instruction to the test control device 1 via the wireless interface 2.

[0111] Additionally or alternatively, a central control, for example implemented on a control device 21 may providing the transmission instruction to the test control device 1 via the wireless interface 2.

[0112] The test control device 1 implements a capability to transmit recorded test data on demand by receiving the transmission instruction.

[0113] The control circuit 7 switches the emergency device into the simulated emergency mode by applying a short-circuit between the terminals 3.1, 3.2 of the first interface 3.

[0114] The control circuit 7 may short-circuit the terminals 3.1, 3.2 by outputting a suitable switching signal to primary side inputs of an optocoupler 9. On applying the switching signal at the primary side inputs of the optocoupler 9, the secondary side outputs of the optocoupler 9 apply a short circuit between the terminals 3.1, 3.2 of the first interface 3, which are connected to the terminals TEST+ and TEST- of the test switch interface TEST of the emergency device 10. Alternatively, the test control device 1 may comprise a relay circuit, e.g. solid state relay, instead of the optocoupler 9 depicted in fig. 2. Both, the optocoupler 9 and the relay circuit provide advantageous electric isolation.

[0115] The test control device 1 of fig. 2 includes a current monitoring circuit. The current monitoring circuit is configured to monitor the charging current I_{CHARGE} to the energy storage device 14 input via the first interface 3 to the test control device 1 and output via the second interface 4 to the energy storage device 14 in the standard operation mode. The current monitoring circuit is configured to monitor a discharging current $I_{\text{DISCHARGE}}$ from the energy storage device 14 input via the second interface 4 to the test control device 1 and output to the emergency device 10 in the emergency operation mode.

[0116] The current monitoring circuit shown in fig. 2 comprises a current sense resistor (shunt) R_{SENSE} . A voltage V_{SENSE} over the resistor R_{SENSE} is representative for the charging current I_{CHARGE} and input to the control circuit 7. The control circuit 7 may measure the voltage drop over the resistor R_{SENSE} .

[0117] The current monitoring circuit including the current sense resistor R_{SENSE} furthermore provides the voltage V_{SENSE} over the resistor R_{SENSE} representative for

the discharging current $I_{\text{DISCHARGE}}$ and provides the voltage V_{SENSE} to the control circuit 7. The control circuit 7 may determine based on the voltage V_{SENSE} representative for the discharging current $I_{\text{DISCHARGE}}$ whether the load is operated normally over a predetermined period from energy stored in the energy storage device 14 based on the obtained voltage V_{SENSE} .

[0118] It is particularly advantageous, when the current monitoring circuit includes an amplifier circuit for amplifying the voltage V_{SENSE} in order to enable using a small resistance value for the sense resistor R_{SENSE} , thereby minimising losses due to inserting the R_{SENSE} into the current path. This is particularly advantageous in the emergency operation mode, when the emergency device 10 is operating from the limited energy stored in the energy storage device 14.

[0119] The amplifier circuit for amplifying the voltage V_{SENSE} may be part of the control circuit 7 in a specific embodiment of the test control device 1.

[0120] The control circuit 7 may include a light sensor 19. The light sensor 19 monitors the actual emission by the lighting module 12 and provides measurement data on the light emitted by the lighting module 12 to the control circuit 7. The light sensor 19 may be arranged at the test control device 1.

[0121] Additionally or alternatively, the test control device 1 includes a further (third) interface 5 not depicted in fig. 2, which enables connecting an (external) light sensor 19.

[0122] Additionally or alternatively, the third interface 5 to the lighting module includes terminals, which enable to route the load current I_{LOAD} from the emergency device 10, in particular terminals LED+ and LED-, to the lighting module 12 via additional terminals of the first interface 3 not depicted in figs. 1 and 2, to the test control device 1. From the test control device 1, the load current I_{LOAD} is supplied via terminals of the third interface to the lighting module 12. This enables the test control device 1 to generate further measurement data and test data on the load current I_{LOAD} .

[0123] The test control device 1 comprises the wireless interface 2. The wireless interface 2 is adapted to transmit and receive electric signals via radio waves in at least one radio frequency band.

[0124] The wireless interface preferably transmits and receives signals based on a WLAN or Wi-FiTM standard of the IEEE 802.11 family of standards in at least one ISM band of the frequency spectrum, in particular between 2400 to 2483,5 MHz, 5150 to 5350 MHz and 5470 to 5725 MHz.

[0125] The wireless interface 2 may include at least one signal modulation circuit, at least one transceiver circuit, and at least one antenna assembly.

[0126] The wireless interface 2 is capable to receive radio signals, for example a radio signal requesting the emergency converter device 10 to switch into the simulated emergency mode. The wireless interface 2 provides the received radio signal to the control circuit 7.

[0127] The converter device 10 switches in the simulated emergency mode for the time duration during which the short circuit is applied to the test switch interface comprising terminals TTEST+ and TEST- of the emergency converter device 10.

[0128] The received radio signal may instruct the control circuit 7 to switch the emergency device 10 into a specific type of simulated emergency mode, for example into a functionality test or a duration test. Alternatively or additionally, the received radio signal may request the test control device 1, in particular the control circuit 7 to monitor specific test parameters of the emergency device 10 during the test. Alternatively or additionally, the received radio signal may request the test control device 1, in particular the control circuit 7, to transmit recorded test data to a requesting device, e.g. the handheld device 31, via the wireless interface 2.

[0129] The control circuit 7 performs control of the test control device 1 based on the received radio signal provided by the wireless device.

[0130] Alternatively or additionally, the control circuit performs control of the test control device based on the calendar function and a timer function of the control circuit 7. The preset calendar function generates alerts and trigger signals at predetermined times for the simulated emergency control circuit 1 performing a predetermined action.

[0131] Predetermined actions may include switching the emergency device 10 into the simulated emergency mode, defining the specific type of test for the simulated emergency mode, and transmitting test data files via the wireless interface 2 to another device.

[0132] The test control device 1 comprises further a low voltage power supply 6 (LVPS). The LVPS 6 generates a DC voltage V_{CC} and provides the generated DC voltage as a supply voltage to the control circuit 7 and the wireless interface 2. The LVPS 6 may supply the DC voltage V_{CC} or any other suitable supply voltage to any active circuit elements of the control device 1.

[0133] The LVPS 6 may generate the supply voltage V_{CC} from the charging current I_{CHARGE} in the standard operation mode. The LVPS 6 may generate the supply voltage V_{CC} from the load current I_{LED} in the emergency operation mode.

[0134] Fig. 3 provides an overview over an emergency lighting system 20 according to a specific embodiment.

[0135] The emergency lighting system 20 of an advantageous embodiment comprises at least one emergency luminaire 18 including an emergency device 10, and at least one corresponding test control device 1.

[0136] The emergency device 10 comprises the test interface 15, the battery interface 16 and an LED interface 17.

[0137] The test interface 15 and the battery interface 16 are both connected with the corresponding terminals of the first interface 3 already discussed with reference to figures 1 and 2.

[0138] The second interface 4 of the test control device

1 connects the energy storage device 14 corresponding to the embodiment discussed with reference to figures 1 and 2.

[0139] The first interface 3 of the test control device 1 includes further terminals in order to connect the LED interface 17, in particular the terminals CTRL+ and CTRL- of the emergency device 10. The test control device 1 of fig. 3 includes a third interface 5 for connecting the lighting module 12 of the luminaire 18. The load current I_{LED} output by the emergency device 10 via terminals CTRL+ and CTRL- of the LED interface 17 is provided via the corresponding terminals of the first interface 3 and the corresponding terminals of the third interface 5 to the lighting module 12. The test control circuit 1 may include current measurement means for measuring the load current I_{LED} . The third interface 5 of the test control device 1 and routing the load current I_{LED} over the test control device 1 enables monitoring the load current I_{LED} by the test control device 1 and generating and recording respective test data.

[0140] The test control device 1 may include sensor interface 24. The sensor interface 24 of the test control device 1 enables to connect a light sensor 19 for measuring a light level of the light emitted by the lighting module 12. The light sensor 195 may include a photodetector, for example.

[0141] The light sensor 195 may provide a light measurement signal to the sensor interface 24 of the test control device 1. The sensor interface 24 provides the obtained light measurement signal to the control circuit 7.

[0142] The light sensor 19 may form part of the test control device 1, or the luminaire 18 as shown in figure 3. The light sensor 19 may include an amplifier circuit for amplifying a light measurement signal. Additionally or alternatively, the sensor interface 24 and/or the control circuit 7 includes amplifier circuitry, for example including at least one operational amplifier for amplifying the light measurement signal provided by the light sensor 195.

[0143] The control circuit 7 may generate light test data based on the obtained light measurement signal, record the generated light test data, for example in the memory 8, or provide the generated light test data to external devices, for example via the wireless interface 2.

[0144] The wireless interface 2 of the test control device 1 enables to access the test control device 1 via the WLAN based communication network 22. The wireless interface 2 may function as a wireless access point of a wireless local area network WLAN.

[0145] The communication network 22 interconnects further test control devices 1' and 1'', in particular their respective wireless interfaces, with the wireless interface 23 of a central control device 21. The test control devices 1' and 1'' may form part of further emergency luminaires 18, and/or other emergency related devices, which are included in a testing schedule, e.g. illuminated exit signs arranged in the building. The test control devices 1, 1', 1'' with their respective wireless interfaces 2 enable to implement a central reporting system for corresponding

building infrastructure devices using a building infrastructure based on WLAN or Wi-Fi common to many buildings.

[0146] The test control devices 1, 1', 1" with their respective wireless interfaces 2 enable to implement a local reporting system for corresponding building infrastructure devices using the individual access point capability of the WLAN or Wi-Fi based wireless interface 2.

[0147] The test control device 1 enables using the emergency device 10 in combination with widely available building communication infrastructure rather than relying on complex and expensive dedicated emergency systems, for example using DALI^{RTM} capable emergency devices.

Claims

1. Test control device for an emergency device (10) in a building automation system, comprising

a first interface (3) configured to electrically connect the test control device to a test switch interface (15) of an emergency device (10) for connecting an external test switch for activating a simulated emergency mode of the emergency device (10), and to connect the test control device to a battery interface (16) of the emergency device (10),
a second interface (4) configured to connect the test control device to an energy storage device (14), and
a wireless interface (2) configured to receive an activation signal for activating the simulated emergency mode of the emergency device (10).

2. The test control device according to claim 1, wherein the test control device comprises a power supply (6) configured to obtain electric energy via at least one of the first interface (3) from the emergency device (10) and the second interface (4) from the energy storage device (14).

3. The test control device according to any of the preceding claims, wherein the test control device further comprises a control circuit (7) configured to activate the simulated emergency mode of the emergency device (10) based on at least one of a activation signal received via the wireless interface (2) and a preset calendar function implemented in the control circuit (7).

4. The test control device according to claim 3, wherein the control circuit (7) is configured to activate the simulated emergency mode of the emergency device (10) using at least one of a relay circuit or an optocoupler circuit (9) of the test control device.

5. The test control device according to any of the pre-

ceding claims, wherein

the test control device is configured to short-circuit terminals (3.1, 3.2) of the first interface (3), which are connected to the test switch interface (15) of the emergency device (10) for activating the simulated emergency mode of the emergency device (10).

6. The test control device according to any of the preceding claims, wherein the test control device (7) comprises a current monitoring circuit, which is configured to monitor at least one of a charging current to the energy storage device (14) input via the first interface (3) and a discharging current from the energy storage device (14) input via the second interface (4).

7. The test control device according to claim 6, wherein the current monitoring circuit comprises at least one of a current sense resistor (R_{SENSE}) and an amplifier circuit.

8. The test control device according to any of the preceding claims, wherein the test control device comprises a voltage monitoring circuit (AMP), which is configured to monitor an output voltage of the energy storage device (14).

9. The test control device according to any of the preceding claims, wherein the test control device comprises a memory (8), which is configured to store data generated during testing of at least one of the emergency device (10) and the energy storage device (14).

10. The test control device according to claim 9, wherein the wireless interface (2) is configured to be enable access to the memory (8) for at least one of reading the data and writing the data in the memory (8).

11. The test control device according to any of the preceding claims, wherein

the test control device comprises at least one of a light sensor (19) configured to sense light emitted by a lighting module (12), when the emergency device (10) operates in the simulated emergency mode, and
a third interface (5) for connecting the lighting module (12) that is supplied with a load current by the emergency device (10).

12. The test control device according to any of the preceding claims, wherein the wireless interface (2) is configured to operate as at least one of a wireless local area network interface, and an access point for at least one of downloading data and uploading data to the emergency device (10).

13. The test control device according to any of the preceding claims, wherein
the first interface (3) is configured to connect the test
control device to the test switch interface (15) of the
emergency device (10) in parallel to the external test
switch. 5
14. An emergency device, in particular an emergency
lighting device (18), comprising a test control device
(1, 1', 1'') according to one of the preceding claims. 10
15. A building automation system, in particular an emer-
gency lighting system (20), comprising at least one
emergency device according to claim 14. 15

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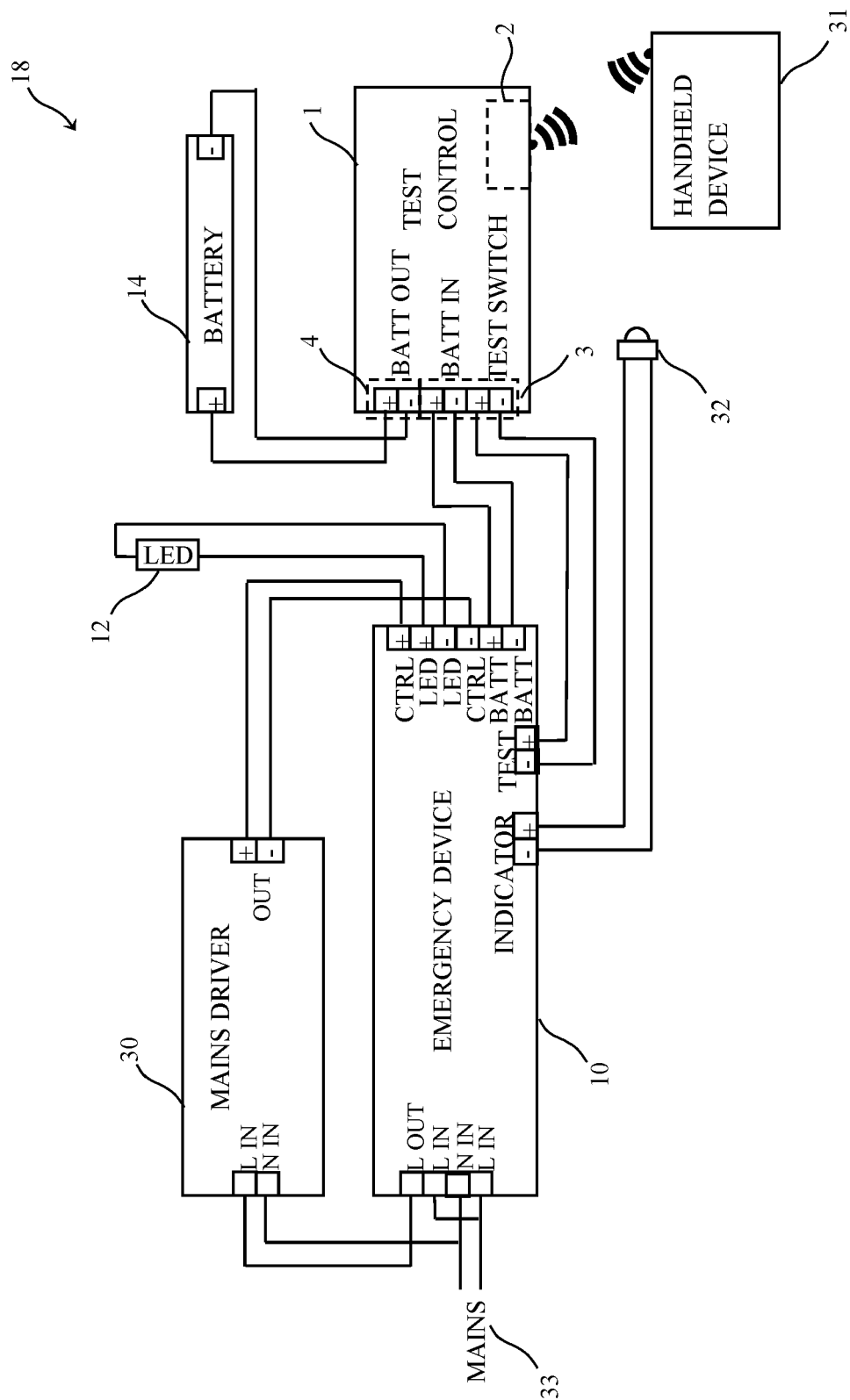


FIG. 1

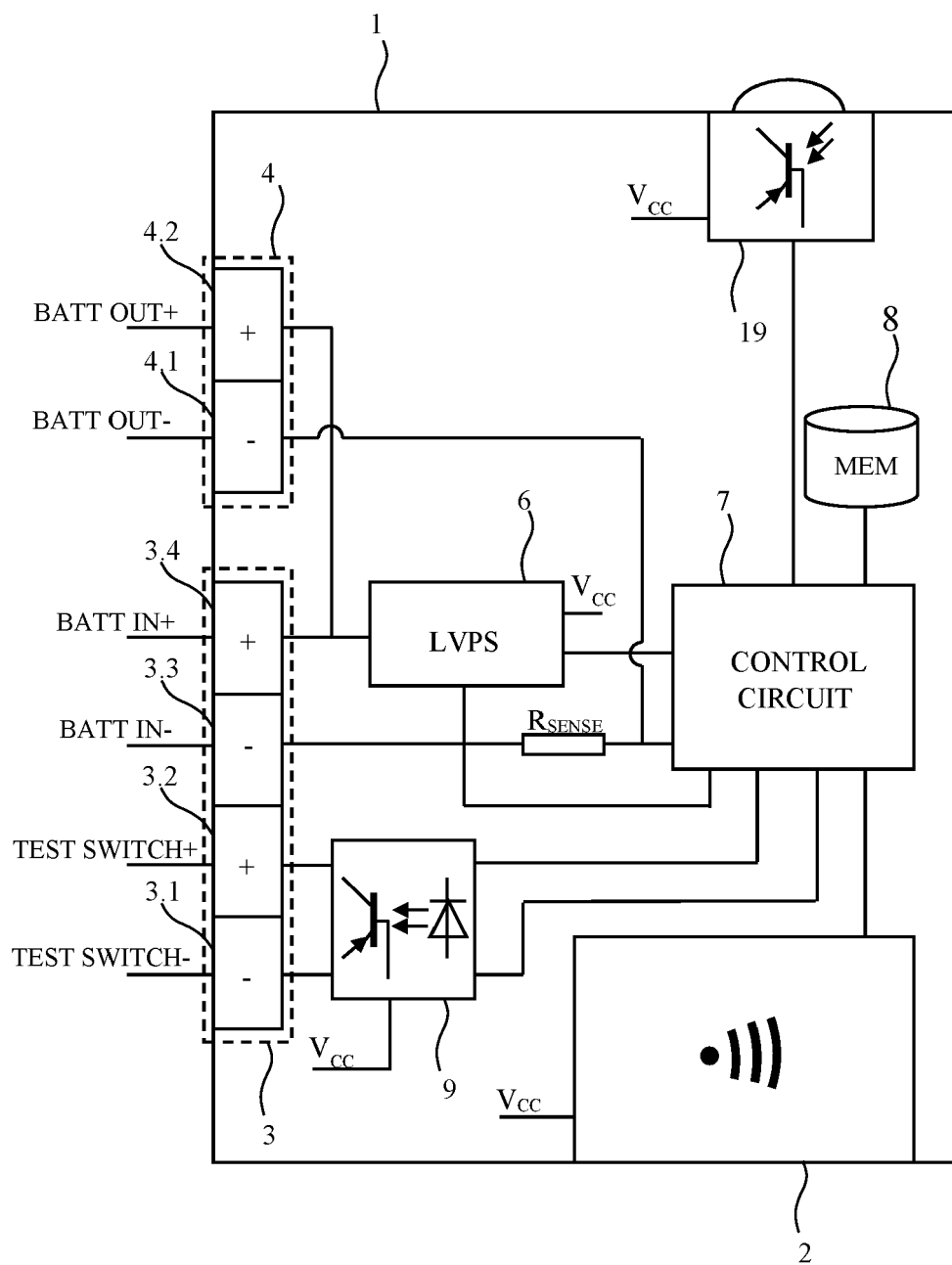


FIG. 2

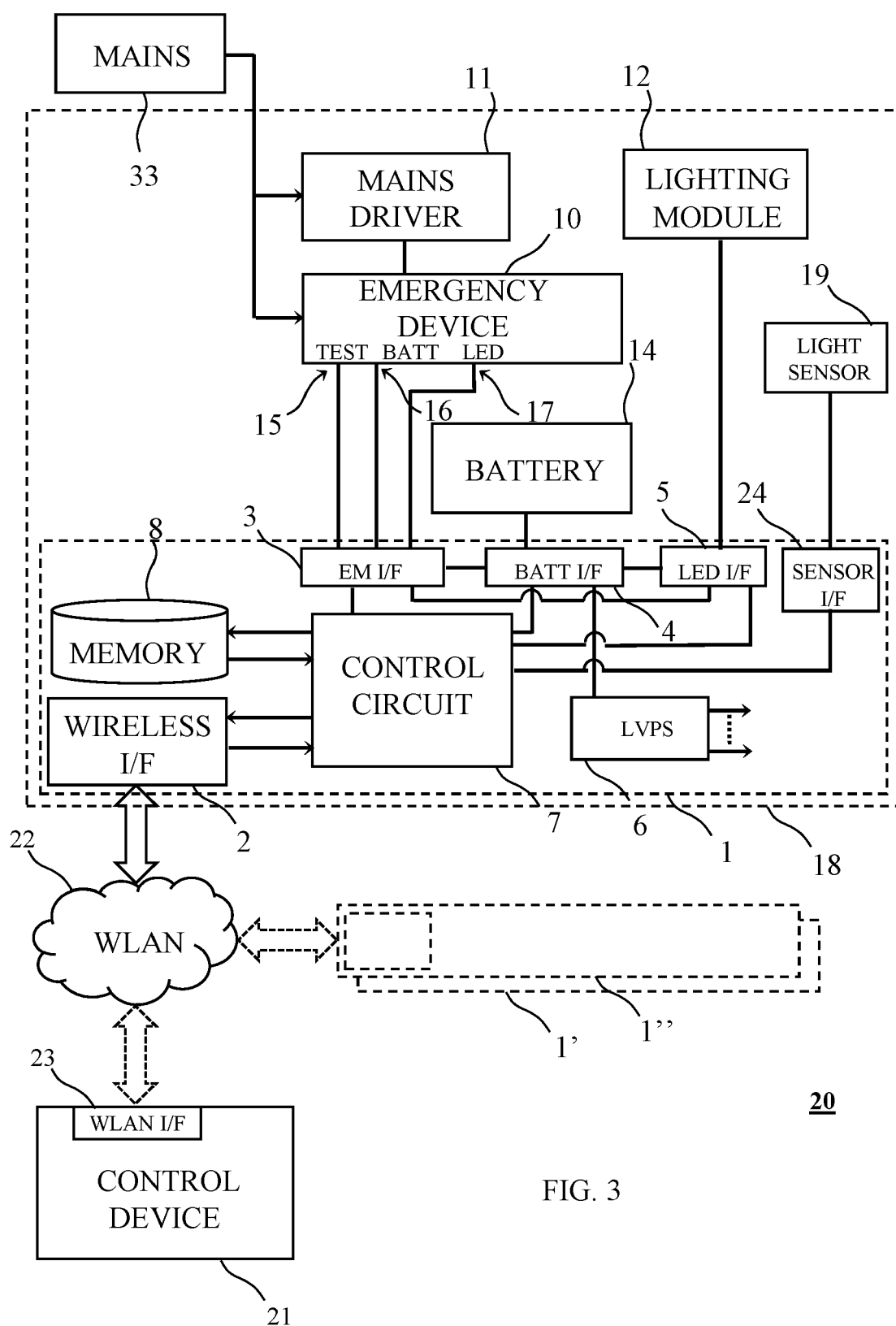


FIG. 3



EUROPEAN SEARCH REPORT

Application Number

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Place of search Munich		Date of completion of the search 23 May 2022	Examiner Kurzbauer, Werner
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	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 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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