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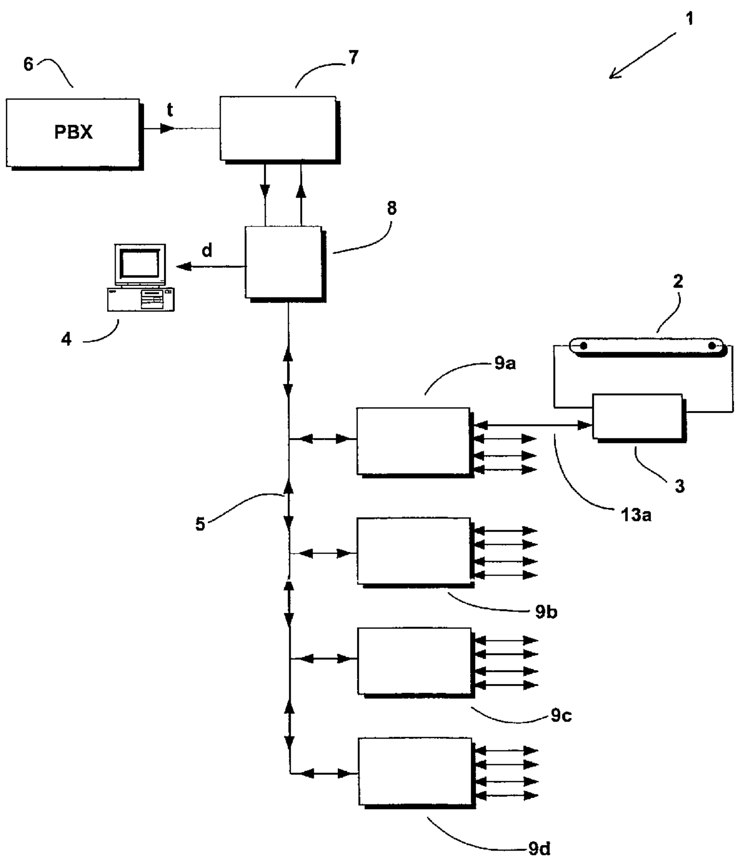

(57) Abstract: A system (1) for controlling a plurality of addressable electrical devices, *e.g.*, light fittings (2, 3), comprises a processor (7), a controller (8) and routers (9a-9d). The processor (7) communicates with a PBX (6), so that an occupant can control the lighting in their area via a telephone network. The occupant's request is converted into a signal conforming to the DALI protocol using two DALI command strings. The address portion of a first command string is used to define a fitting group number and that of the second string is used to define a short address, providing 10 bits for defining the address of the fitting, thereby overcoming the limit of 64 addresses per highway (5) that is associated with the DALI protocol. An emergency light fitting (19, 22) includes an LED (24) and a light sensor (25) for monitoring the charging of a rechargeable emergency power source (21). A second light sensor (26) is provided for testing whether the lamp (2, 23) is lit when the mains power supply is cut off.

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Electrical control system

The present invention relates to the control and maintenance of a system comprising a plurality of electrical devices according to an interface protocol, such as a lighting system that operates according to the DALI protocol. The invention also relates to a method of monitoring the performance of emergency lighting means.

Centralised control systems are used in many buildings to cut energy wastage by reducing unnecessary lighting. For example, sensors may be used to detect whether a room is unoccupied, so that light fittings in empty rooms can be switched off or dimmed automatically. Alternatively, the system may use a timer to reduce lighting levels out of business hours.

While there are benefits associated with a fully centralised control system, it is preferable for the occupants of a building to have control over the lighting in their local environment. Some systems have linked the lighting control network with the internal telephone network in a building, so that an occupant can use their telephone to override the centralised control system. For example, in the system described in GB2267585A, a warning is given to the occupants before a central controller switches off the light fittings. The occupants may override this operation by dialling a special extension number from their telephone. Their call is received by a Private Branch Exchange (PBX), which is a telephone switching system used within a private telephone network. An control unit is connected to an extension socket of the PBX and receives the incoming call. The control unit identifies the occupant's telephone extension number and determines which area of the building corresponds to it. An override signal is then transmitted to the switching module, preventing the light fittings in that area from being switched off. A more flexible system, manufactured by Environmental Management Limited, allows an occupant to request a change in their local lighting level via an internal telephone network.

A fitting in such a lighting system comprises a light source, such as a fluorescent lamp, a tungsten halogen lamp, a discharge lamp or a light emitting diode, and a switching module, which is controlled by a marshalling unit. A simple bistable switch is not suitable for use in the switching module, as the light source may have to be operated under particular conditions. For example, a fluorescent lamp may require a regulated power supply and pre-heating before use. Such tasks are performed by an electronic ballast. While the lighting levels of each individual fitting are controlled directly by the ballast, fittings can be grouped together into "scenes" and controlled as one entity, using a single controller. Such systems require one switching module for each light fitting, or groups of fittings. The supporting circuitry may become highly complex in an extensive lighting installation. Furthermore, while many modern buildings are equipped with movable partitions to provide flexibility in the arrangement of rooms, the positions of the light fittings remain fixed. It is difficult to modify a lighting system where the scenes are defined by hardwired connections in accordance with changes in a floor plan. For example, if a partition is moved, it may be necessary to re-allocate a fitting from one room to another. This would entail rewiring the relays and switches so that they are associated with another group.

This problem has been overcome by assigning addresses to the ballasts, so that each fitting can be controlled individually. A standard format for lighting control signals has been devised, known as the Digital Addressable Lighting Interface (DALI) protocol, to allow interconnection of products made by different manufacturers in an addressable system. The DALI protocol is an international standard, formally known as IEC60929, and defined in ISO Draft Standard 94006.

DALI signals employ Manchester coding, where data is represented in the changeover in the bit value between '0' and '1'. In this manner, a data value of 0 is represented as a transition in the bit value from 0 to 1, while a data value of 1 is denoted by the transition of the bit value from 1 to 0. This can be thought of as each data value being sent with its compliment and simplifies the process of detecting data errors.

A DALI command is expressed in a string of 19 bits, comprising 1 start bit, 8 address bits, 8 data bits and 2 stop bits, where the data bits encode a command, e.g.

a desired lighting level. The address bits relate to one or more ballasts, where each ballast comprises a microprocessor for receiving and responding to DALI signals. It is possible for each ballast to have its own address so that it can be controlled independently. A number of light fittings can be controlled as a group, by assigning a group address to the ballasts, without providing specialised connections between a control module and the ballasts. Furthermore, a fitting may belong to more than one group. It is not strictly necessary to assign an address to each fitting as, in any case, a fitting would respond to "broadcast" commands, i.e. commands directed to all the fittings within an installation.

The addresses are contained in an 8 bit format as follows: YAAAAAAS. The first bit, Y, indicates the type of address as follows. A '0' indicates that the address is that of an individual fitting, known as a short address, while a '1' indicates a group address. A '1' is also used in an address where a command is broadcast to all fittings in a lighting system.

In a short address, the following six bits A give the address of the fitting in terms of a number between 0 and 63. The first 3 address bits A of a group address are set to '100', leaving four bits for the group address itself, i.e. '100AAAA', where the four group address bits define a number between 0 and 15. The address in which the six address bits A are set to '111111' is reserved for broadcast commands.

The final bit, S, does not form part of the address itself, but indicates the type of command that is being sent to the fitting in the subsequent data bits. A '0' indicates that the following bits represent a desired power level, known as a direct arc command, while a '1' is used to denote any other sort of command.

The command is expressed in an 8 bit format. A direct arc command, requiring a ballast to adjust the power level of a single fitting, would therefore take the form: 0AAAAAA0 XXXXXXXX, where the first bit is a 0, indicating that the following 6 bits represent a short address, the eighth bit is a 0, indicating that the second byte conveys a desired power level, rather than a command, which would be indicated by the eighth bit being a 1. The desired power level is specified on a scale from 0 (minimum) to 254 (maximum). The minimum level is usually set to about 0.1% of the maximum power level. Other commands may relate to dimming the light up or down at a given rate, switching the lamp on or off, configuring preset values, such as a fade time, or a status enquiry.

The DALI protocol allows for bi-directional communication, where the ballast can return information following a request from a control unit. For example, the request may be an enquiry as to the status of the light fitting or its current light level. The ballast can respond to this enquiry and return the relevant data to the control unit using the following format: 1 start bit, 8 data bits, 2 stop bits.

As the fittings in a DALI system are identifiable using an address, it is possible to arrange the fittings into groups using software. The wiring is therefore simpler than in previous systems, with the multiple cables, control units and switching relays associated with prior systems replaced by a single highway, which may be a single twisted pair.

However, as addresses must be expressed in 6 bits as described above, a DALI system can accommodate only 64 ballast addresses and 16 group addresses. This has limited the suitability of systems employing this protocol for buildings with extensive lighting requirements, as these would require the provision of multiple highways.

Many lighting systems further include emergency power supply means, where a secondary power source is activated to power the lighting, or to power a separate emergency light source, in the event of a failure in the main power supply system, e.g. from a power cut. The emergency lighting system must be checked regularly by switching off the main power supply and determining whether the light sources are still on. For reasons of convenience, these tests are performed out of business hours, however it is common for these tests to require a person to walk around the building, visually inspecting each emergency light fitting. This is both time-consuming and laborious, particularly in large buildings.

This problem is addressed in the Lightmaster® 100 system, manufactured by ECS Phillips Lighting Controls. The light fittings in this system comprise a sensor that determines whether or not an emergency light source is on by monitoring the current passing through the lamp. This removes the need for visual inspection of the lighting system, however it does not indicate whether a malfunction is due to a fault in the emergency light source or the emergency power source.

In summary, at the present time, lighting control systems using the DALI protocol are limited in terms of the number of fittings that can be accommodated on a single highway. Furthermore, tests of emergency lighting provisions may be time-consuming and laborious, a problem affecting both DALI and non-DALI systems. Both these problems increase greatly with the size of the building and its lighting system.

According to a first aspect of the present invention, a method of controlling a lighting system configured to receive signals according to a predetermined protocol, wherein addresses are assigned to individual fittings or groups of fittings and a command string according to the protocol comprises an address portion, which consists of a predetermined number of bits for expressing the address, comprises using two command strings to express a single system command.

This aspect also provides a lighting control system comprising means for receiving a command and means for transmitting the command for performing the method.

The use of multiple command strings for sending a single command allows the address of the fitting or group to be expressed using a greater number of bits, enlarging the available capacity of the system. For example, two command strings can be used, where part of the first byte of each string is used to define the address. The use of a larger number of address bits increases the number of addresses available for allocation to light fittings. For example, in a DALI-compatible system, this technique circumvents the limit of 64 DALI addresses per highway that is associated with the 6 bit address used in prior systems.

According to a second aspect of the invention, an electrical control system comprises a plurality of addressable electrical devices configured to be controllable by command signals according to a predetermined protocol, the protocol defining a bit string including a predetermined number of address bits corresponding to an address for the electrical device and a predetermined number of command bits corresponding to a command to be performed by the addressed device and a controller for transmitting the command signals to the electrical devices, the controller being configured to transmit individual command signals as first and second ones of said bit strings, the first of which contains address data to direct the command signal towards one of a number of sets of the electrical devices and the second of which contains the address of a particular one of the devices within the set in accordance with the protocol, wherein the addressed device is operable to respond to data in the second of the bit strings.

This aspect further provides a controller, a router and a signal for use in the electrical control system.

According to a third aspect of the invention, an emergency fitting test unit for testing the performance of an emergency light fitting comprises means for receiving a status enquiry, means for receiving a first output from a first sensor, where the first output relates to the status of a light source, a microprocessor for formulating a response to the status enquiry according to the first output and means for converting the response into a format according to a predetermined communication protocol.

Preferably, the emergency fitting test unit comprises two light sensors. One light sensor monitors a light-emitting device, such as an LED, which is lit when a charging current is being supplied to an emergency power supply means. A second light sensor monitors the lamp associated with the light fitting. This allows the emergency lighting provisions to be monitored remotely, without requiring visual inspection of the light fittings. The test can also be performed automatically.

According to a fourth aspect of the present invention, a method of testing an emergency light fitting, which comprises a rechargeable power source and a light source comprises detecting light emitted by the light source and monitoring the charging of the rechargeable power source.

An embodiment of the invention now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram showing part of the lighting control system,
Figure 2 depicts a router,
Figures 3a – 3d show the possible arrangements of headers associated with the router,
Figure 4 depicts a light fitting comprising a known ballast,
Figure 5 shows a maintained emergency light fitting comprising emergency power supply means,
Figure 6 shows a non-maintained emergency light fitting comprising emergency power means,
Figure 7 is a detailed view of the emergency fitting test unit contained in the light fittings of Figures 5 and 6,
Figure 8 is a flowchart demonstrating the emergency lighting test procedure for a maintained emergency light fitting.

Figure 1 is a schematic diagram showing the part of the control system 1 of a lighting installation in a building. The installation comprises a number of fluorescent lamps 2, individually controlled by electronic ballasts 3 and may be monitored for maintenance or testing purposes through use of a monitoring facility, such as a computer 4. The control system comprises a highway 5 that allows bi-directional communication, so that signals may be sent from the control system 1 to the ballasts 3 and vice versa.

An occupant of the building, wishing to alter the lighting in their personal environment, dials a predetermined number, which is received by the Private Branch Exchange (PBX) 6. A software application running on a processor 7 analyses a data stream from the PBX 6 and checks which telephone numbers have been dialled by the building occupants. When the processor 7 recognises a call to the predetermined extension number, it extracts the occupant's telephone extension number and matches it to their room number using a database stored in its memory. The processor 7 transmits a signal to a controller 8, which acts as an interface between the processor 7 and the computer 4, which communicate using logic signals, and the rest of the lighting system, which uses DALI format signals. The signal contains a zone number R, the address of the relevant fitting or group associated with the occupant's room A and the command data X. The control unit 8 converts this command into a signal conforming to the DALI protocol for transmission to a router 9a through the common highway 5. A plurality of routers 9a-9d are linked to the highway 5, where each router 9 is associated with one or more zone numbers R.

The signal produced by the control unit 8 is in the following format: 100RRRR1 ZZZZZZZZ 0AAAAAAS XXXXXXXX, i.e. in the format of two DALI command strings, where the first string contains an address in the group address format and the second contains a fitting address. In the first byte, the first 3 bits are set to '100', indicating that the address is in the group address format, indicating that the following 4 bits define a group address. The next four bits, bits 4-7, specify a zone number R, which relates to an area of the building, such as a floor or section of a floor. The final bit of the first byte is set to '1', which indicates that the second byte does not represent a direct arc command. The third byte contains the address A of the fitting within zone R to which the command is to be directed, i.e. the short address. The first bit of the third byte is set to '0' to indicate that the address A relates to a fitting, rather than a group. The eighth bit of the third byte S relates to the type of command given in the fourth byte, i.e. '0' for a direct arc command, '1' for any other type of command. The fourth byte contains the command X, e.g. a new power level for the addressed fitting, a command to switch the fitting on or off or a status enquiry.

The second byte Z is not used to convey command information but is included for compliance with the format defined in the DALI protocol. A predetermined number, such as 00000001, may be sent as the second byte to facilitate recognition of the signal as the first of two command strings.

The use of two DALI command strings to convey a single command allows the fitting addresses to be defined using 10 bits, by combining the 4 bit zone number R with to one of the 64 available 6 bit short addresses. This circumvents the limit of 64 addresses per highway 5 that is associated with prior systems using the DALI protocol.

The use of a 4-bit zone number R allows up to sixteen sets of fittings to share the same DALI short addresses while operating independently of each other. Each of the routers 9a-9d can be configured to accept groups of four zones, for example, router 9a may control zones 0-3, router 9b may be used to control zones 4-7 and so on. Each zone has 64 short addresses that can be assigned to individual fittings, providing a total of 1024 available short addresses.

It would be possible to increase the number of addresses further, for example, by using one or more of the first three bits of the first byte to encode part of the zone number. In this embodiment, these bits are set to 100, but the third bit could be used to increase the number of zone number bits to 5. However, this would make the lighting control system incompatible with the DALI protocol.

The router 9a is shown in greater detail in Figure 2. The signal is received by a DALI logic circuit 10 and fed into a microprocessor 11. The router 9a has multiple outputs via a plurality of interface cards 12a-12d, each of which is associated with a set of ballasts. The interface cards 12a-12d send control signals to individual ballasts 3 via respective sub-highways 13a-13d. Two of the microprocessor inputs are connected to conductive tracks 14, each of which carries a pair of pins. The pins may be connected by one or more headers 15. A 5V voltage is applied to the tracks 14 and the arrangement of headers determines the logic levels received at the microprocessor inputs. Table 1 gives the possible header arrangements, as shown in Figure 3, and their corresponding logic levels.

Figure	Description	Logic
3A	No headers	00
3B	Single header 15, positioned as in Figure 2	01
3C	Single header 15, in opposite position to 3B	10
3D	Two headers 15, occupying both available positions	11

Table 1

The microprocessor 11 is programmed to disregard the DALI signal unless the first two bits of the zone number R correspond with the logic associated with the arrangement of the headers 15. Where the most significant bits of the zone number R correspond to the header arrangement associated with the router 9a, the remaining two bits of the zone number R specify one of its four interface cards 12a-12d. In this manner, the four bits of the zone number R uniquely identify a single interface card 12 within the lighting system. For example, router 9a comprises a header arrangement corresponding to a zone number where the first two bits are 01. Therefore, a zone number 0100 would specify interface card 12a, while 0101, 0110 and 0111 specify interface cards 12b, 12c and 12d respectively. Similarly, zone numbers 1000, 1001, 1010 and 1011 would refer to respective interface cards within router 9b. Each of the interface cards 12a-12d sends control signals to a set of fittings through its respective sub-highway 13a-d, where each set is assigned up to 64 short addresses.

When a command is received by the router 9a indicated by the first two bits of the zone number R, the microprocessor 11 directs the second command string (A and X) to one of the interface cards 12a-d as indicated by the last two bits of the zone number R. The interface card 12a then sends this command string to one or more of its associated set of ballasts 3 through its respective sub-highway 13a.

Figure 4 depicts a DALI-compatible lighting ballast 3 suitable for use with the present invention, such as the PCA 2/36 TCL EXCEL® one4all digital ballast manufactured by TridonicAtco GmbH. The ballast 3 comprises a DALI interface circuit 16, a microprocessor 17 and a high voltage circuit 18 and is powered by a 240V supply. The microprocessor 17 comprises a memory facility in which the address of the fitting and other parameters, such as its default power levels and fade times, are stored.

The interface card 12a transmits the third and fourth bytes of the original DALI signal, i.e., the short address A and the command X, to the fitting via sub-highway 13a. This signal is received by the DALI interface circuit 16. The DALI interface circuit 16 converts the DALI command into a logic signal and passes it to the microprocessor 17. The microprocessor 17 controls the high voltage circuit 18 that supplies power to the fluorescent lamp 2. Where the DALI signal conveys a direct arc command, the output of the high voltage circuit 18 is adjusted to dim the fluorescent lamp 2 up or down accordingly.

The lighting control system can interrogate an individual fitting by sending a status enquiry as the command byte X, e.g., for requesting confirmation of the present power level, or whether the lamp is switched on or off. The relevant information is returned by the microprocessor 17 and converted into a DALI signal by the DALI interface circuit 16, according to the return signal format defined in the DALI protocol, i.e., 1 start bit, 8 data bits and 2 stop bits. As the lighting control system can interrogate each fitting sequentially and the ballasts transmit return signals only when responding to an enquiry, i.e., a master/slave arrangement, it is not necessary to encode the address of the fitting in the return signal. The return signal is sent via the sub-highway 13a, the router 9a and the highway 5 to the controller 8, where it is converted back into a data signal d in its original format. The data signal d is sent to the computer 4 for viewing and/or analysis.

This system can be adapted to respond to changes in the occupants of the rooms in the building. For example, an occupant moving from one part of the building to another may keep the same telephone extension number. The extension number can be associated with the fittings in their new environment simply by modifying the database stored in the processor 7.

Furthermore, the lighting ballasts 3 can be connected to a sub-highway 13a using separable connectors, such as the telephone jacks and sockets used by British Telecom plc. The use of separable connectors facilitates moving or replacing any light fittings and reduces the likelihood of damage to the wiring during building maintenance.

This method of lighting control has been described in relation to the light fitting of Figure 4, but is equally applicable to the light fittings of Figures 5 and 6, which comprise emergency lighting circuitry. It is desirable for a significant percentage, e.g. 10%, of the light fittings in an installation to be equipped with emergency power supply means for use when the main power supply has failed, e.g. following a power cut.

The light fitting 19 of Figure 5 comprises a ballast 3 for controlling a fluorescent lamp 2, which receives DALI commands sent by interface card 12a in router 9a and responds to them as described above, in relation to Figure 4. The fitting 19 further includes an emergency ballast 20, for controlling the lamp 2 in the event of a power failure. The emergency ballast 20 is operable to direct current to a rechargeable battery 21, which is used to supply power to the lamp 2 and emergency ballast 20 when the mains supply fails or is disconnected. This arrangement is known as a "maintained" emergency fitting. The connections between the fluorescent lamp 2, the ballast 3 and the emergency ballast 20 are not shown in Figure 5 for reasons of clarity.

Figure 6 depicts a "non-maintained" emergency fitting 22. This arrangement resembles the maintained fitting 19 of Figure 5, and the same reference numbers have been used to indicate identical components. However, the non-maintained fitting further comprises a secondary lamp 23 for use as an emergency light source. The ballast 3 controls the main fluorescent lamp 2, while the emergency ballast 20 controls the second lamp 23 only.

In both types of emergency light fitting, the battery 21 is charged during normal operation, using power supplied to the emergency ballast 20. A light emitting diode 24 is provided, which is lit while current is supplied to the battery 21. The emission from the diode 24 is monitored using a light sensor 25. A second light sensor 26 is provided. In the maintained fitting 19, the second light sensor 26 monitors the light produced by the fluorescent lamp 2, while in the non-maintained fitting 22, the second light sensor 26 monitors the secondary lamp 23. The outputs from the sensors 25, 26 are sent to an emergency fitting test unit (EFTU) 27.

The EFTU 27, which may be used with either type of emergency light fitting, is shown in detail in Figure 7. The lighting sensors 25, 26 are connected to the EFTU 27 via a plug in connector 28. The sensor outputs are passed via a buffer 29 to a microprocessor 30. The address of the emergency ballast is stored using an 8-pole switch 31, which is connected to the microprocessor 30. The microprocessor 30 controls the state of relay contacts 32 in a unit 33, by means of a solenoid 34, so that a 240V supply is maintained to the emergency ballast 20 during normal operating conditions.

The status of the charging circuitry and of the emergency light source 2, 23 can be determined using the outputs of the sensors 25, 26. When the emergency ballast 20 is supplying power for charging the battery 21, the LED 24 will be lit. The light emitted by the LED 24 is detected by the first light sensor 25. Similarly, when the lamp 2, 23 is lit, its light will be detected by the second light sensor 26. The EFTU 27 can be interrogated by sending a status enquiry from computer 4, which is converted into a DALI command string by controller 8 and then sent to the EFTU 27 via highway 5, router 9a, interface card 12a and sub-highway 13a. The command string is received by a DALI interface circuit 35 and converted into a logic signal. The microprocessor 30 responds to the enquiry by formulating a return signal based on the sensor outputs. The return signal is converted into the DALI format by the DALI interface circuit 35 and returned to the controller 8 via the sub-highway 13a, interface card 12a, router 9a and highway 5. The controller 8 then converts the

DALI signal into a logic signal d and sends it to the computer 4 for viewing and/ or analysis.

The procedure for testing a maintained emergency light fitting, as shown in Figure 5, will now be described, with reference to Figure 8. Starting at step S0, the status of the emergency lighting circuitry is tested during normal operation. A command is sent to the EFTU 27, requesting the status of the charging light sensor 25 (step S1). The microprocessor 30 then samples the output of the light sensor 25 via buffer 29 and prepares a response.

According to the DALI protocol, a response to a status enquiry is made in the following manner. As noted above, the return signal format specified by the DALI protocol consists of 1 start bit, 8 data bits and 2 stop bits. The response to a status enquiry may be 'YES' or a 'NO'. A 'YES' response is indicated by a return signal in which all the data bits are set to '1'. If the response is a 'NO', a return signal is not sent. If the computer 4 does not receive a response within a predetermined time interval t, it is presumed that the response to the status enquiry is a 'NO'.

The computer 4 determines whether a response was received during the predetermined time interval t (step S2). In normal operation, a charging current would be supplied to the battery 21 by the emergency ballast 20, so the LED 24 would be lit. The output from the first light sensor 25 would, therefore, be high and the corresponding DALI return signal would take the form of a 'YES' response.

A check on the status of the fluorescent lamp 2 is made in the same way (steps S3, S4), where a 'YES' response indicates that the output of the second light sensor 26 is high, i.e., the lamp 2 is lit, and a 'NO' response, i.e., where a return signal is not received within time t, indicates that the second sensor output is low, i.e., that the lamp 2 is off.

If the 'YES' signal is received, the status of the charger and lamp are tested in emergency conditions. A command is sent to the EFTU 27 to cut off the mains supply to the light fitting 19 (step S5). This operation is performed by the microprocessor 30, which uses a solenoid 34 to open the relay contacts 32.

Following disconnection of the mains supply from the ballast 3 and the emergency ballast 20, the fluorescent lamp 2 should remain lit, as it is powered by the rechargeable battery 21 and controlled by the emergency ballast 20. The EFTU 27 is interrogated to determine the status of the lamp 2 (step S6). The interrogation is performed in the same manner as described above (step S7). If the response indicates that the lamp 2 is lit, the computer 4 requests the status of the charging sensor 25 (step S8). The computer 4 waits for a response (step S9). As the mains supply has been cut off, there should be no current passing through the charging circuitry in the emergency ballast 20.

If the emergency lighting fitting 19 is functioning correctly, the computer 4 should receive 'YES' signals from the first and second light sensors 25, 26 during normal operation, a 'YES' signal from the second light sensor 26 and a 'NO' response from the first light sensor 25 when the mains supply has been cut off.

The mains supply to the ballast is reinstated (step S10). The computer 4 investigates the status of the lamp and the LED (steps S11, S12, S13, S14) to check that both have resumed normal operation following the interruption in the power supply.

If, at any stage, the computer 4 receives an incorrect response, i.e., if the emergency light fitting 19 is not functioning properly, an appropriate alarm may be raised on the computer 4 (steps S15, S16). The computer 4 may be situated in the occupant's building, where it may be monitored by on-site maintenance staff, or at a remote location, for example the offices of a contractor responsible for upkeep of the system 1. Furthermore, the computer can be programmed to automatically send an alert to a maintenance team in the event of a fault.

The test procedure is then complete (step S17).

The testing procedure for a non-maintained fitting is similar to that shown in Figure 8, however steps S2, S3, S11 and S12 are omitted as the secondary lamp 23 is switched off during normal operation.

By using bi-directional communication, the emergency lighting system can be tested without visual inspection of each fitting and the use of two separate sensors 25, 26 provides an indication of whether a malfunction is caused by a fault in the lamp 2, 23 or the charging circuitry. The lighting system can be configured so that this test is performed automatically at a time that is convenient for the occupants of the building, e.g. out of business hours, and to repeat such tests periodically.

Although the invention has been described with respect to the above example, the invention may be used in systems comprising light sources other than fluorescent lamps, e.g., tungsten halogen lamps, discharge lamps or LEDs, where ballasts appropriate to the particular type of lamp are provided. Furthermore, its application is not limited to systems complying with the DALI protocol or to the control of lighting systems. The techniques disclosed herein may be used for controlling any system comprising a plurality of electrical devices according to a protocol wherein addresses are assigned to devices using a limited number of bits.

Claims

1. A method of controlling a lighting system configured to receive signals according to a predetermined protocol, wherein addresses are assigned to individual fittings or groups of fittings and a command string according to the protocol comprises an address portion, which consists of a predetermined number of bits for expressing the address, comprising using two command strings to express a single system command.

2. A method according to claim 1, wherein the protocol is the Digital Addressable Lighting Interface (DALI) protocol.

3. A lighting control system comprising:

means for receiving a command;

a plurality of light fittings, wherein each of said light fittings may be assigned an individual address; and

means for transmitting the command in a format according to a predetermined protocol, wherein the protocol defines a command string comprising an address portion, which consists of a limited number of bits, for expressing an address;

wherein the transmitting means is configured to express a command using multiple command strings and the address of the fitting is expressed using the address portions of more than one command string.

4. A lighting control system according to claim 3, wherein the protocol is the Digital Addressable Lighting Interface (DALI) protocol.

5. A lighting control system according to claim 4, wherein the address portion of the first command string expresses a group number and the address portion of the second command string expresses a short address.

6. A lighting control system according to claim 5, wherein the address portion of the second command string is common to a plurality of fittings.

7. An electrical control system comprising:

a plurality of addressable electrical devices configured to be controllable by command signals according to a predetermined protocol, the protocol defining a bit string including a predetermined number of address bits corresponding to an address for the electrical device and a predetermined number of command bits corresponding to a command to be performed by the addressed device; and

a controller for transmitting the command signals to the electrical devices, the controller being configured to transmit individual command signals as first and second ones of said bit strings, the first of which contains address data to direct the command signal towards one of a number of sets of the electrical devices and the second of which contains the address of a particular one of the devices within the set in accordance with the protocol;

wherein the addressed device is operable to respond to data in the second of the bit strings.

8. A system according to claim 7, further comprising at least one router connected through a highway to the controller, the router being responsive to the address data in the first bit string to direct the second bit string to a sub-highway connected to said set of devices.

9. A system according to claim 8, wherein the router is coupled to a plurality of sub-highways, where each sub-highway is associated with a set of the electrical devices.

10. A system according to claim 9, wherein at least one said device of each set has the same address data for encoding in the second bit string.

11. A system according to claim 9 or 10, further comprising a plurality of the routers connected to the highway, the address data in the first bit string including bits corresponding to an address for one of the routers, and bits corresponding to the sub-highways connected to the addressed router.

12. A controller for an electrical control system, wherein a plurality of addressable electrical devices are controlled by command signals according to a predetermined protocol defining a bit string including a predetermined number of address bits corresponding to an address for the electrical device and a predetermined number of command bits corresponding to a command to be performed by the addressed device, the controller being configured to transmit individual command signals to the electrical devices as first and second ones of said bit strings, the first of which contains address data to direct the command signal towards one of a number of sets of the electrical devices and the second of which contains the address of a particular one of the devices within the set in accordance with the protocol, the addressed device being operable to respond to data in the second of the bit strings.

13. A router for an electrical control system wherein a plurality of addressable electrical devices are controlled by command signals according to a predetermined protocol, the protocol defining a bit string including a predetermined number of address bits corresponding to an address for the electrical device and a predetermined number of command bits corresponding to a command to be performed by the addressed device, individual command signals being transmitted to the electrical devices as first and second ones of said bit strings, the first of which contains address data to direct the command signal towards one of a number of sets of the electrical devices as first and second ones of said bit strings, the first of which contains address data to direct the command signal towards one of a number of sets of the electrical devices and the second of which contains the address of a particular one of the devices within the set in accordance with the protocol, the router being operable to respond to data in the second of the bits strings to direct the second of the bit strings towards the addressed one of the set of devices, whereby the addressed device can respond to data in the second of the bit strings.

14. A command signal for an electrical control system wherein a plurality of addressable electrical devices are controlled by signals according to a predetermined protocol, the protocol defining a bit string including a predetermined number of

address bits corresponding to an address for the electrical device and a predetermined number of command bits corresponding to a command to be performed by the addressed device, the command signal comprising first and second ones of said bit strings, the first of which contains address data to direct the command signal towards one of a number of sets of the electrical devices and the second of which contains the address of a particular one of the devices within the set in accordance with the protocol, whereby the addressed device may respond to data in the second of the bit strings.

15. A method of testing an emergency light fitting, which comprises a rechargeable power source and a light source, comprising detecting light emitted by the light source and monitoring the charging of the rechargeable power source.

16. A method according to claim 15, wherein the step of monitoring comprises monitoring a light emitting device which emits light when current passes through circuitry for charging the rechargeable power source.

17. An emergency fitting test unit for testing the performance of an emergency light fitting comprising:

means for receiving a status enquiry;

means for receiving a first output from a first sensor, where the first output relates to the status of a light source;

a microprocessor for formulating a response to the status enquiry according to the first output; and

means for converting the response into a format according to a predetermined communication protocol.

18. An emergency fitting test unit according to claim 17, wherein the predetermined communication protocol is the Digital Addressable Lighting Interface (DALI) protocol.

19. An emergency fitting test unit according to claim 17 or 18, further comprising means for receiving a second output from a second sensor, where the

second output relates to the status of a charging circuit for charging a rechargeable power source.

20. An emergency fitting test unit according to claim 19, wherein the second sensor monitors emission from a light emitting device which emits light when current is supplied to the rechargeable power source.

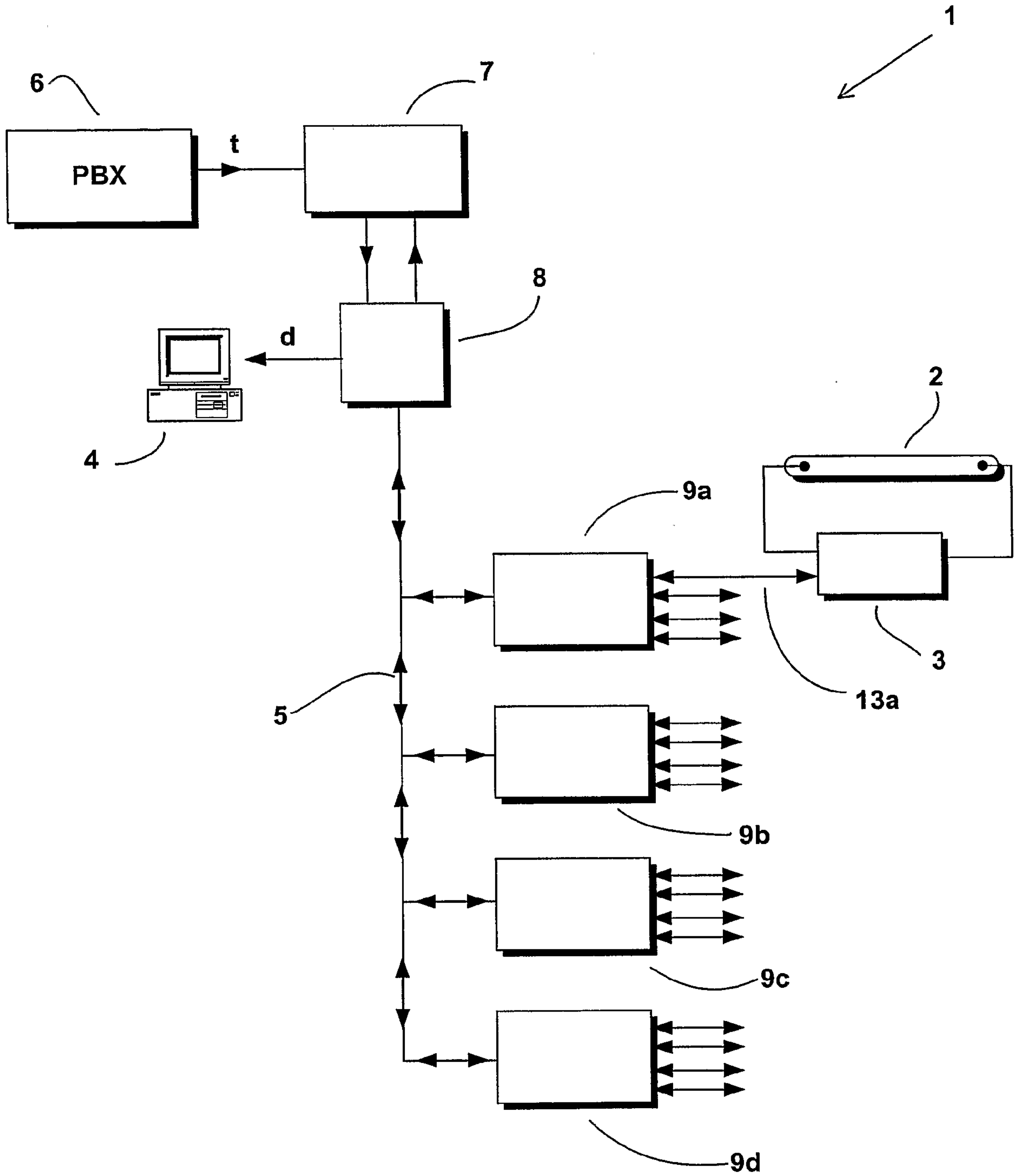

Figure 1

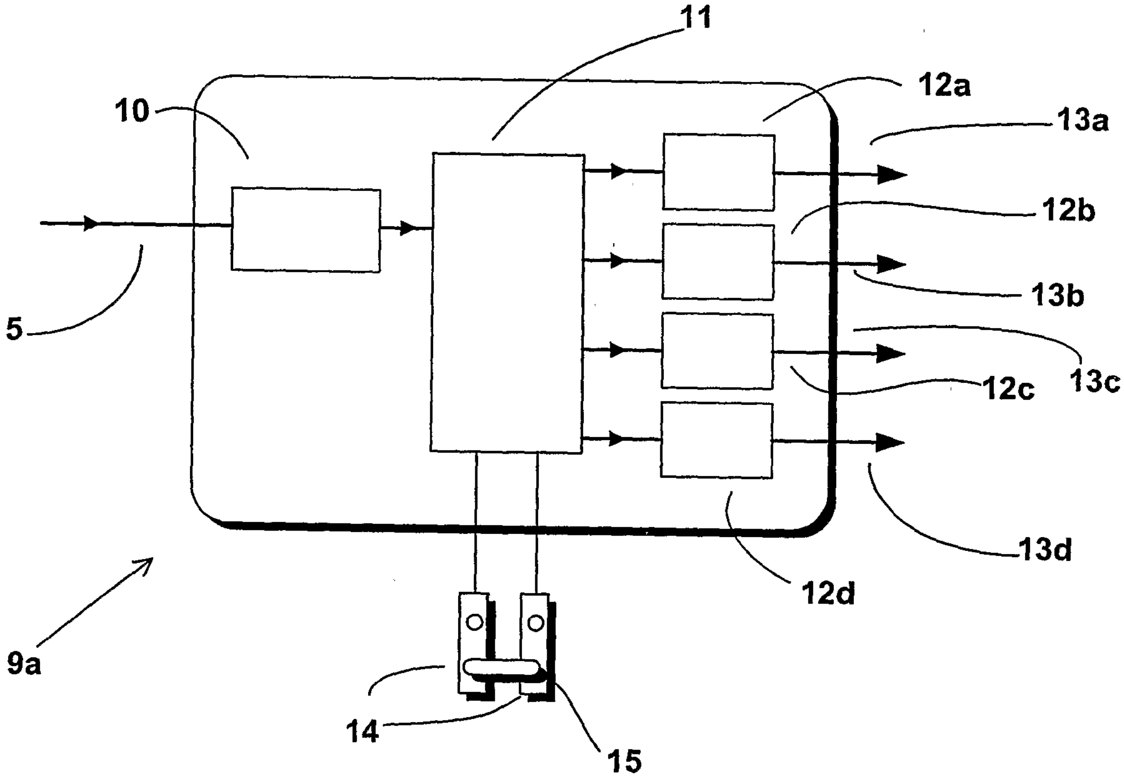

Figure 2

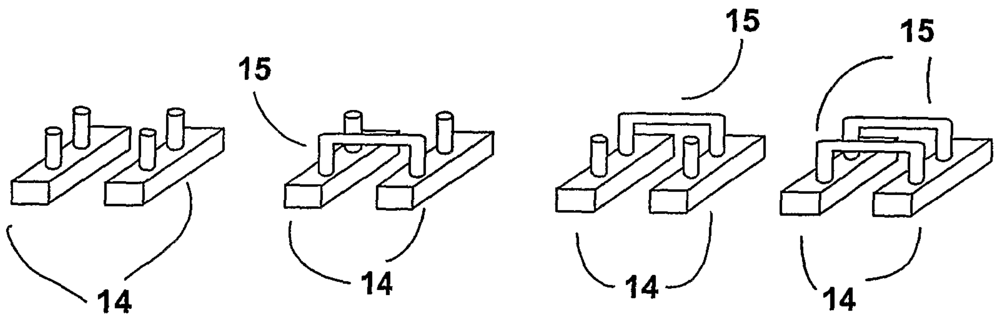

Figure 3a Figure 3b Figure 3c Figure 3d

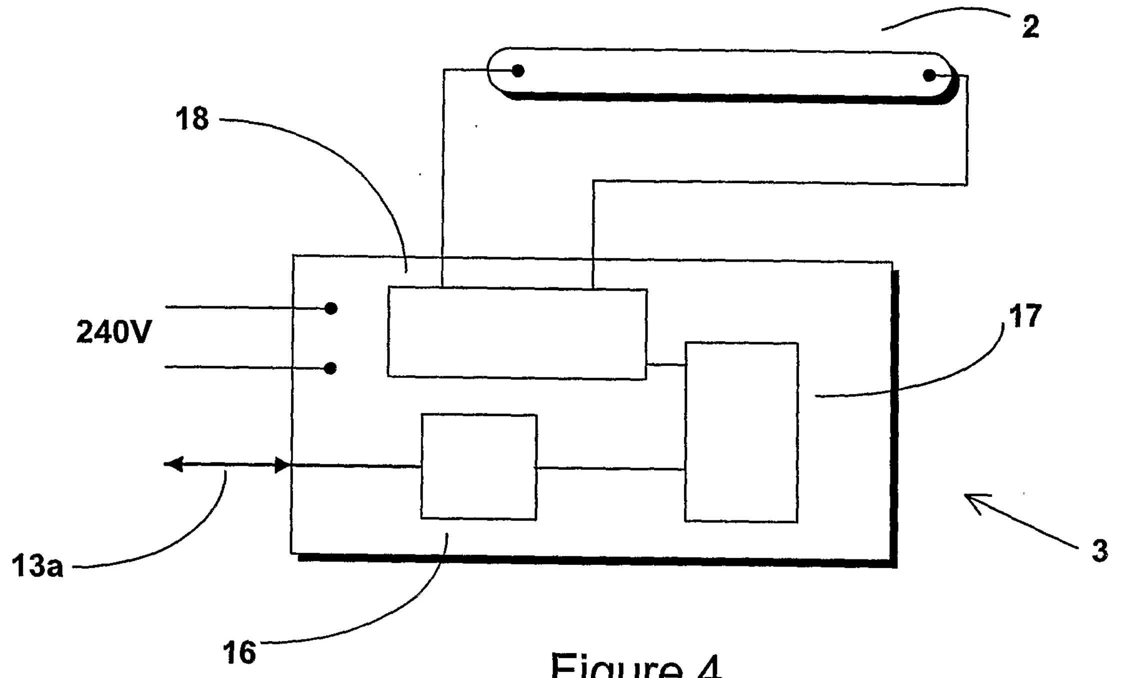

Figure 4

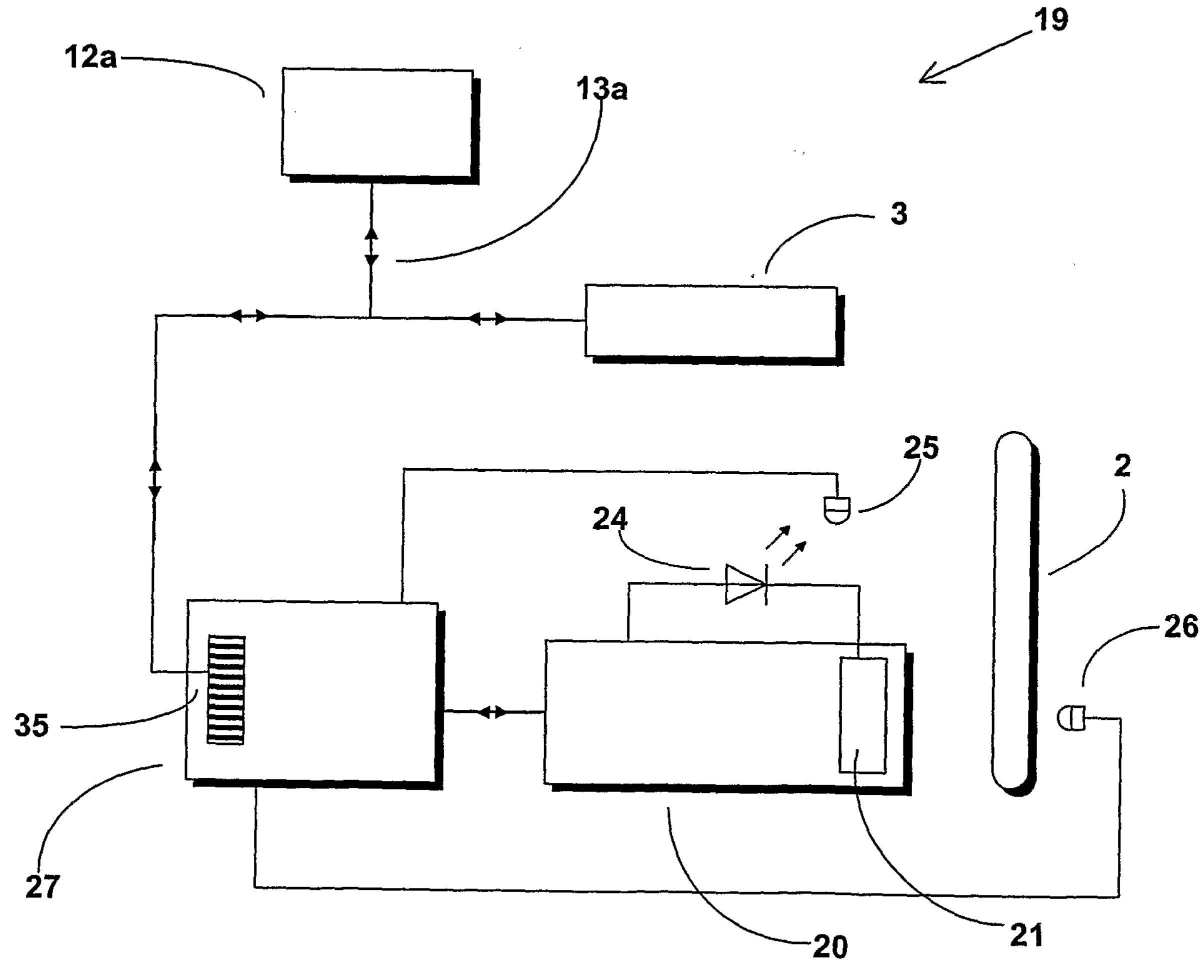

Figure 5

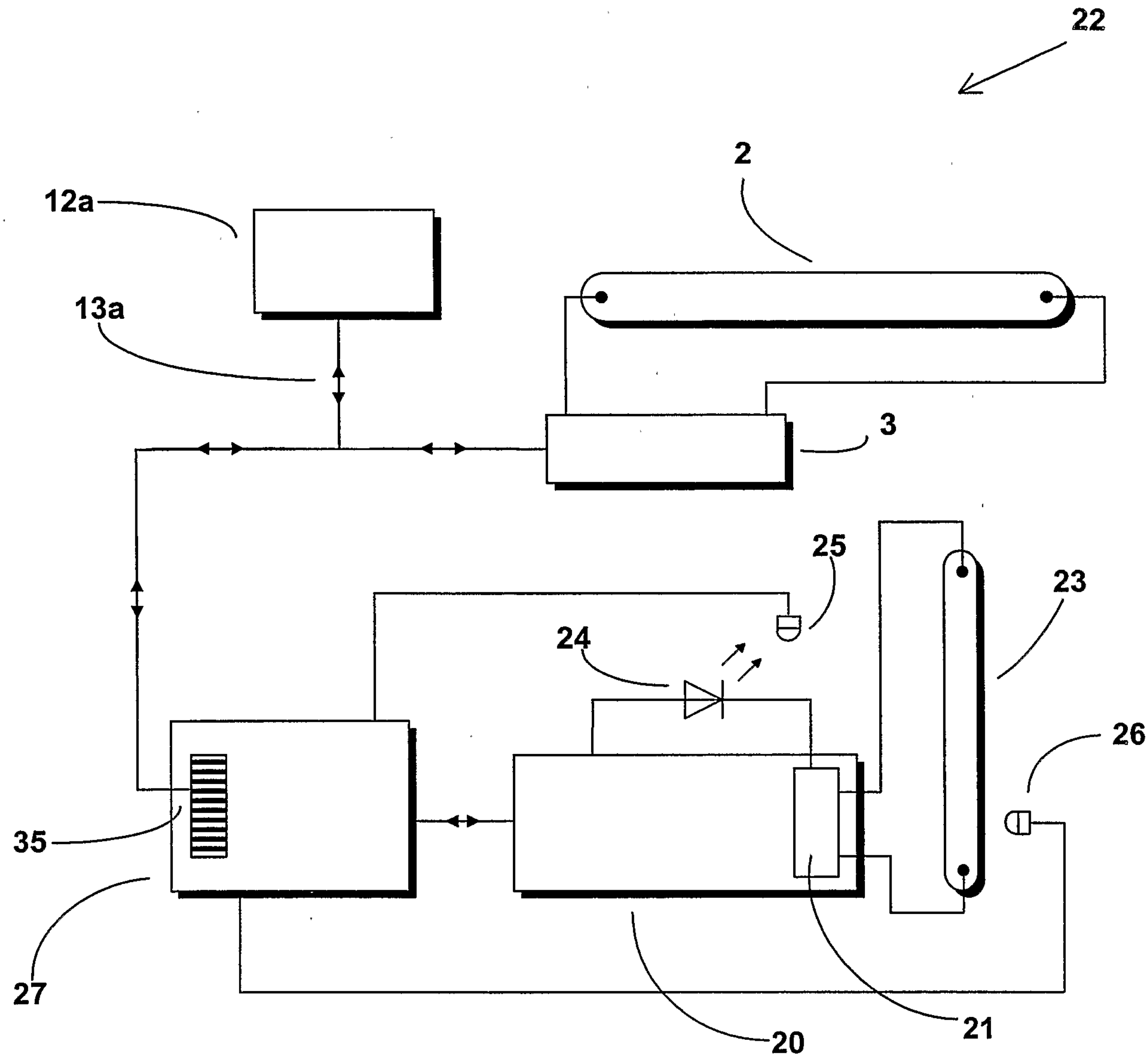

Figure 6

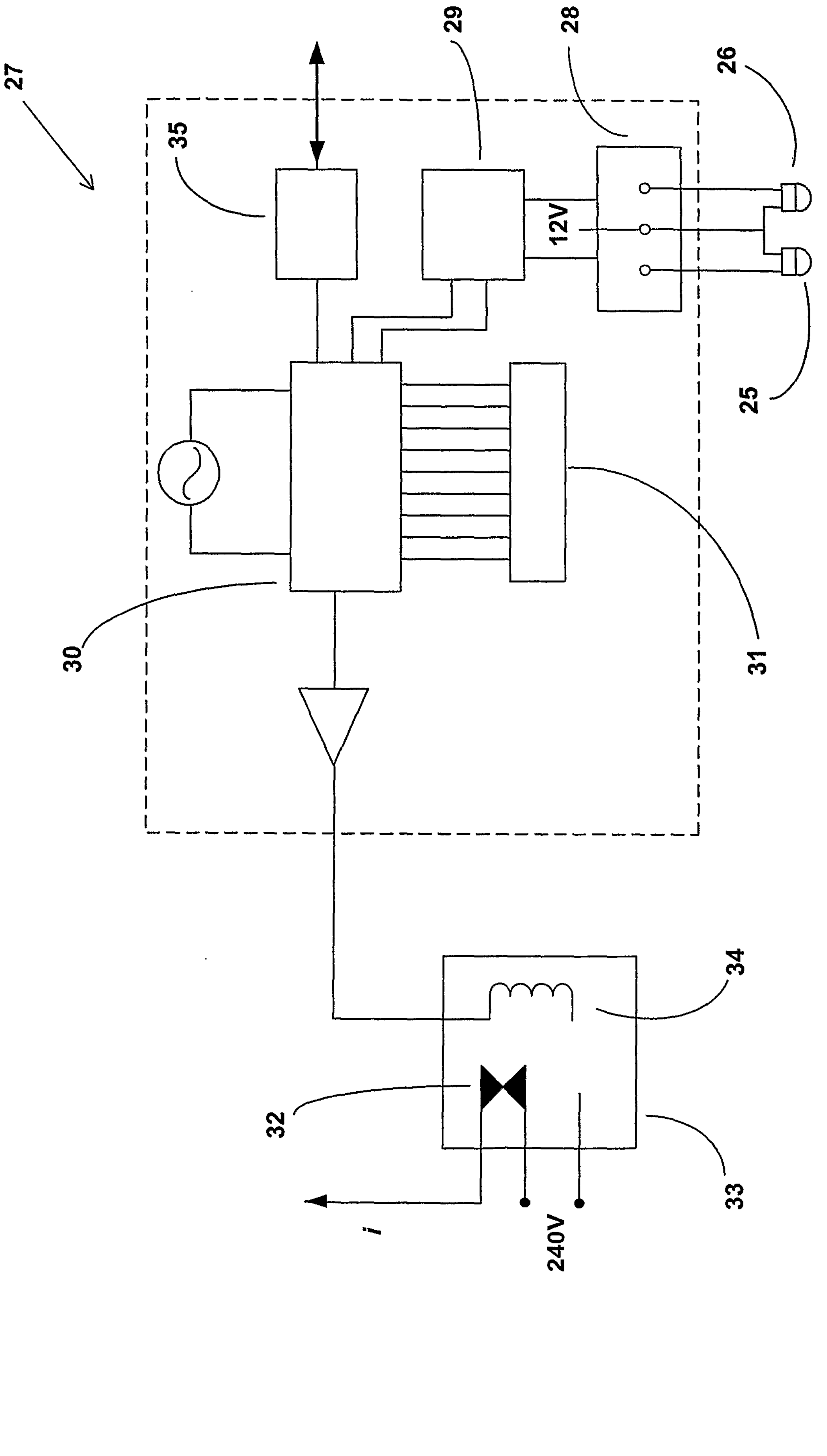

Figure 7

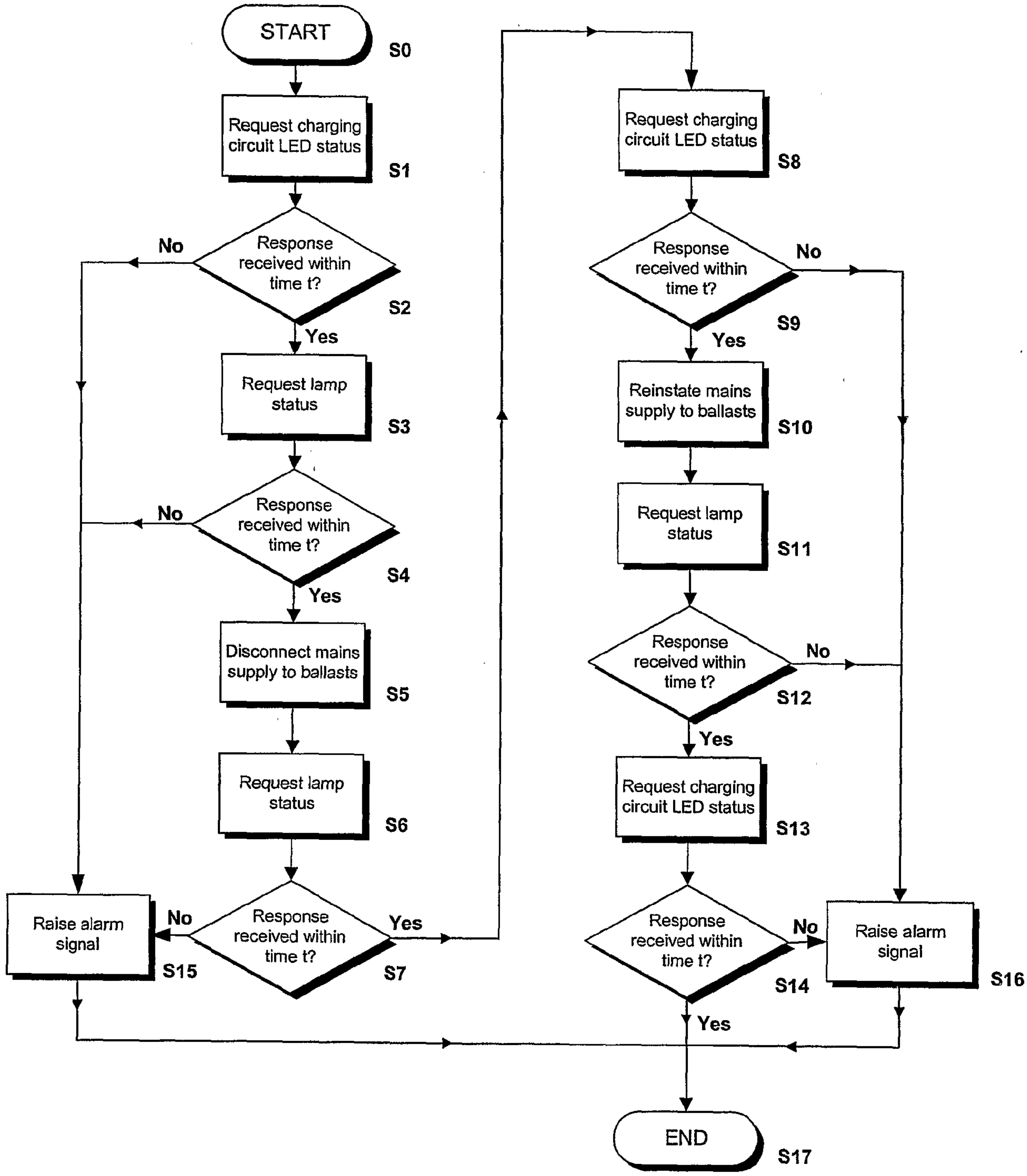
START
S0
Request charging circuit LED status
S1
Response received within time t?
S2
No
Yes
Request lamp status
S3
Response received within time t?
S4
No
Yes
Disconnect mains supply to ballasts
S5
Request lamp status
S6
Response received within time t?
S7
No
Yes
Raise alarm signal
S15
Request charging circuit LED status
S8
Response received within time t?
S9
No
Yes
Reinstate mains supply to ballasts
S10
Request lamp status
S11
Response received within time t?
S12
No
Yes
Request charging circuit LED status
S13
Response received within time t?
S14
No
Yes
Raise alarm signal
S16
END
S17

Figure 8