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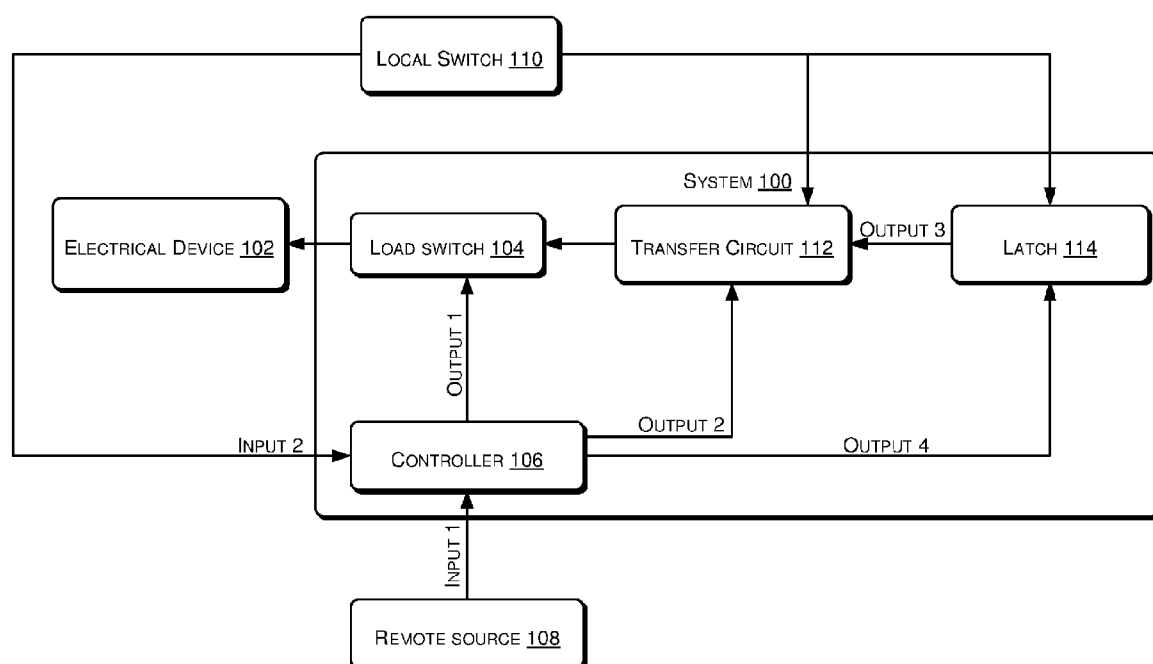


Fig. 1

(57) **Abstract:** Techniques for controlling state of an electrical device (102) are described. A system (100) for controlling the state of the electrical device (102) includes a load switch (104) connected to the electrical device (102). The load switch (104) can be actuated to change the state of the electrical device (102). A controller (106) may actuate the load switch (104) based on at least one of an actuation signal from a remote source (108) and a toggling signal from a local switch (110). Further, a transfer circuit (112) may be activated in response to a failure of the controller (106). The transfer circuit (112) may be activated or deactivated by a latch (114) connected to the transfer circuit (112) and to the controller (106).

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## CONTROLLING ELECTRICAL DEVICES

## TECHNICAL FIELD

[0001] The present subject matter relates, in general, to electrical devices and, in particular, to controlling electrical devices.

5

## BACKGROUND

[0002] Electrical devices, such as ceiling fan, electric lamp, air-conditioner (AC), and industrial equipment, may be controlled, i.e., switched on and off, from time to time. The control of an electrical device can be performed locally, for example, through a physical switch connected to the electrical device or remotely, for example, through an Internet of Things (IoT) network infrastructure.

## BRIEF DESCRIPTION OF DRAWINGS

15 [0003] The features, aspects, and advantages of the present subject matter will be better understood with regard to the following description, and accompanying figures. The use of the same reference number in different figures indicates similar or identical features and components.

[0004] Fig. 1 illustrates a system for controlling state of an electrical device, in accordance with an implementation of the present subject matter.

20 [0005] Fig. 2. Illustrates a circuit diagram representing operation of a system to control a state of an electrical device, in accordance with an implementation of the present subject matter.

[0006] Fig. 3 illustrates components of a controller and its connection to a remote source, in accordance with an implementation of the present subject matter.

25 [0007] Fig. 4 illustrates a method for controlling state of an electrical device, in accordance with an implementation of the present subject matter.

## DETAILED DESCRIPTION

[0008] Electrical devices, such as appliances, can be controlled locally or remotely. Generally, to enable the remote control of electrical devices, significant changes are to be performed in an existing local control of the electrical devices. For example, to enable simultaneous remote and local control of an electrical device, an existing local switch (such as a single pole single throw switch on a switchboard) that controls the electrical device may have to be replaced with a touch switch and a considerable amount of rewiring is to be performed. Further, conventional systems may not provide a fall back to the local control in case a controller enabling the remote control or the IoT network, through which the remote control may be performed, fails. Thus, upon failure of the remote control, it may not be possible to control the electrical devices even using the local switch.

[0009] The present subject matter relates to devices and methods for controlling electrical devices. With the devices and methods of the present subject matter, local and remote control of electrical devices can be efficiently performed.

[0010] In an implementation of the present subject matter, a system is provided that can control state of an electrical device. The system includes a load switch that is connected to the electrical device and can be actuated to change the state of the electrical device. A controller may be connected to the load switch to actuate the load switch. The load switch may be actuated based on an actuation signal received from a remote source and a toggling signal from a local switch. A transfer circuit may also be connected to the load switch and to the local switch. The transfer circuit may be activated in response to a failure of the controller to actuate the load switch based on an actuation of the local switch.

[0011] The system further includes a latch connected to the transfer circuit and to the controller. The latch may activate the transfer circuit in response to a failure of the controller and deactivate the transfer circuit in

response to an active state of the controller, such as when the controller is operational after the failure.

[0012] With the systems and methods of the present subject matter, local and remote control of the electrical devices can be performed in a simple and efficient manner. For example, an electrical device can be controlled by the local switch even at a time when remote control of the electrical device is enabled. Further, since the transfer circuit gets activated upon failure of the controller, the electrical device can be controlled using the local switch and the transfer circuit even when the controller has failed. Thus, a failsafe and a reliable operation of the electrical device is ensured. Still further, existing local switches can be retrofitted with the system of the present subject matter, thereby avoiding replacement of the existing local switches to facilitate remote control of the electrical devices. Also, the system is highly compact. Therefore, the system can be fitted behind existing switchboards to facilitate the remote control.

[0013] The above and other features, aspects, and advantages of the subject matter will be better explained with regard to the following description, and accompanying figures. It should be noted that the description and figures merely illustrate the principles of the present subject matter along with examples described herein, and should not be construed as a limitation to the present subject matter. It is thus understood that various arrangements may be devised that, although not explicitly described or shown herein, embody the principles of the present disclosure. Moreover, all statements herein reciting principles, aspects, and examples thereof, are intended to encompass equivalents thereof. Further, for the sake of simplicity, and without limitation, the same numbers are used throughout the drawings to reference like features and components.

[0014] Fig. 1 illustrates a system 100 for controlling state of an electrical device 102, in accordance with an implementation of the present subject matter. The system 100 may be referred to as a smart switch, as it enables remote control of the electrical device 102. The control of the state

of the electrical device 102 may be interchangeably referred to as controlling the electrical device 102. Further, in the following description, the actuation of a switch may refer to a turning on or turning off of the switch. Also, the terms turn-on of a switch and closing of a switch may be used interchangeably. Further, the terms turn-off of a switch and opening of a switch may be used interchangeably.

[0015] The electrical device 102 may be an electrical appliance, such as an electric lamp, electric fan, geyser, or the like. The system 100 includes a load switch 104 connected to the electrical device 102. The load switch 104 can be actuated for changing the state (on or off) of the electrical device 102. The load switch 104 may be, for example, an electromechanical relay, a solid-state relay, a transistor, thyristor, Insulated-Gate Bipolar Transistor (IGBT), triac, or the like.

[0016] To control the state of the electrical device 102, the load switch 104 is connected to a controller 106, which can actuate the load switch 104. To actuate the load switch 104, the controller 106 may provide a control signal to the load switch 104. The control signal is represented as output 1. In an example, when the value of output 1 is '1', the electrical device 102 is turned on.

[0017] The controller 106 may provide the output 1 based on an actuation signal from a remote source 108. The actuation signal is represented as input 1. To receive the input 1 and generate the output 1, the controller 106 may include a processor (not shown in Fig. 1) and a communication interface, as will be explained with reference to Fig. 3. The control of the electrical device 102 using the actuation signal received from the remote source 108 may be referred to as a remote control of the electrical device 102. Further, when the electrical device 102 can be controlled from the remote source 108, such as due to the active state of the controller 106, the electrical device 102 is said to be under remote control or remotely controllable.

[0018] In addition to being controlled remotely, the electrical device 102 can also be controlled locally through a local switch 110. The local switch 110 may be a switch that is disposed on a wall in a vicinity of the electrical device 102. In an example, the local switch 110 switch may be a single pole single throw switch. In other examples, the local switch 110 may be a single pole double throw switch, or any other type of switch. A user present in the vicinity of the electrical device 102 can control the state of the electrical device 102 by actuating the local switch 110. The control of the state of the electrical device 102 using the local switch 110 may be referred to as a local control of the electrical device 102.

[0019] Even when the electrical device 102 is controllable remotely, the state of the electrical device 102 can be locally controlled by actuation of the local switch 110. To achieve this, the controller 106 can receive an input signal, input 2, indicative of the state of the local switch 110. When the value of the input 2 changes, indicating that the local switch 110 has been actuated by the user, the controller 106 can change the value of output 1. This controls the load switch 104, which, in turn, changes the state of the electrical device 102. Therefore, when the electrical device 102 is under remote control, the local switch 110 acts as a toggle switch, by enabling toggling of the state of the electrical device 102 upon its actuation. Accordingly, the input 2 may be referred to as a toggling signal. Thus, the present subject matter enables control of the state of the electrical device 102 locally even at a time the electrical device 102 is remotely controllable.

[0020] The system 100 also includes a transfer circuit 112 to transfer control of the electrical device 102 to the local switch 110 when the controller 106 fails. Here, the failure of the controller 106 refers to a state of the controller 106 at which the controller 106 cannot control the electrical device 102. Thus, the failure of the controller 106 may be due to an off state of the controller 106 because of maintenance, fault, or the like. The failure of the controller 106 may be interchangeably referred to as controller failure.

[0021] To facilitate control of the electrical device 102, i.e., to actuate the load switch 104 based on actuation of the local switch 110, the transfer circuit 112 may be connected to the load switch 104 and to the local switch 110. Further, the connection between the transfer circuit 112 and the load switch 104 may be in parallel to the connection between the controller 106 and the load switch 104. This ensures that the transfer circuit 112 remains connected to the load switch 104 even after the controller failure.

[0022] The local switch 110 is connected to the load switch 104 through two different paths. In a first path, the local switch 110 is connected to the load switch 104 through the controller 106. This facilitates control of the electrical device 102 based on the toggling signal from the local switch 110, as explained earlier. In the second path, the local switch 110 is connected to the load switch 104 through the transfer circuit 112. The transfer circuit 112 may be activated in response to the controller failure. Accordingly, when the controller 106 fails, the transfer circuit 112 can facilitate controlling the electrical device 102 based on an actuation of the local switch 110. The control of the electrical device 102 through the transfer circuit 112 will be explained in greater detail later.

[0023] The connection of the local switch 110 to the load switch 104 through two different paths ensures that the electrical device 102 can be controlled locally in the event of the controller failure. Thus, the reliability of the system 100 is considerably improved. Further, the system 100 enables automatic transfer of control to the local switch 110 upon the controller failure.

[0024] As mentioned earlier, the transfer circuit 112 can enable control of the electrical device 102 when the controller 106 fails. Accordingly, when the remote control is active, the transfer circuit 112 may be maintained at a deactivated state. This prevents control of the electrical device 102 from the local switch 110 through both the controller 106 and the transfer circuit 112. Subsequently, when the remote control fails, the transfer circuit 112 may be activated. To maintain a deactivated state of the transfer circuit 112, in an

example, the controller 106 may send an output signal, output 2, to the transfer circuit 112. In an example, when the controller 106 is active, the value of output 2 is '0' to keep the transfer circuit 112 deactivated. When the remote control fails, the output 2 changes to a high impedance state, and the transfer circuit 112 may be activated, as the value of output 2 is no longer '0'.

[0025] The system 100 also includes a latch 114 to control the activation of the transfer circuit 112. The latch 114 may be connected to the transfer circuit 112 and may activate the transfer circuit 112 when the controller 106 fails. At other times, i.e., when the controller 106 is active, the latch 114 may keep the transfer circuit 112 deactivated. To activate the transfer circuit 112, the latch 114 may provide a transfer circuit activation signal, represented as output 3, to the transfer circuit 112. The latch 114 may also be connected to the controller 106 to detect the controller failure.

15 The use of the latch 114 to control the activation of the transfer circuit 112 improves the overall safety of the environment in which the system 100 is used, as will be explained in greater detail in later paragraphs.

[0026] When the controller 106 is active, the latch 114 receives an output signal, output 4, from the controller 106 to keep the latch 114 deactivated. The output 4 will may be interchangeably referred to as latch deactivation signal. Since the latch 114 is deactivated when the controller 106 is active, the transfer circuit 112 also remains deactivated. In an example, when the remote control is functional, the value of output 4 is '1'. Upon failure of the remote control, the value of output 4 goes to a high impedance state, causing activation of the latch 114.

[0027] Since the activation of the transfer circuit 112 is controlled based on both output 2 and output 4, it can be ensured that any glitch or noise in the output 2 or output 4 does not accidentally turn-on the transfer circuit 112. However, in some examples, if the number of General-purpose input/output (GPIOs) is to be reduced, output 2 can be removed. In such a

case, the activation of the transfer circuit 112 may be controlled by the latch 114 alone.

[0028] The latch 114 maintains the transfer circuit 112 in a deactivated state even after the controller 106 fails, and activates the transfer circuit 112 when the local switch 110 is actuated by a user. Subsequently, the electrical device 102 may be controlled through the local switch 110. The deactivation of the transfer circuit 112 by the latch 114 can improve the overall safety of the environment in which the system 100 is used. The improvement in the safety due to the latch 114 will be explained with the help of an example described below:

[0029] Consider a case when the controller 106 is active and the electrical device 102 is in an 'off' state. Consider also that the local switch 110 is at a 'closed' ('turned-on') position. If the remote control fails now, and the local switch 110 automatically takes over control of the electrical device 102, the electrical device 102 will be suddenly turned on. As will be appreciated, this is a potentially unsafe situation. However, in such a case, the transfer circuit 112 is maintained at a deactivated state by the latch 114. This ensures that the electrical device 102 is not turned on. Subsequently, the latch 114 may activate the transfer circuit 112 when the user opens the local switch 110, i.e., turns the local switch 110 off. This enables control of the electrical device 102 through the local switch 110. Therefore, the use of the latch 114 prevents a potentially unsafe situation from arising, and therefore, improves the overall safety of the environment in which the system 100 is used.

[0030] The control of state of the electrical device 102 upon the controller failure due to operation of the latch 114 is explained with the help of Table 1 below:

Table 1: Control of state of the electrical device 102 upon controller failure

| Conditions before Controller failure                          | State of Electrical Device after Controller failure |
|---------------------------------------------------------------|-----------------------------------------------------|
| Electrical Device is OFF and Local Switch is in OPEN position | OFF                                                 |

|                                                                 |                                   |
|-----------------------------------------------------------------|-----------------------------------|
| Electrical Device is OFF and Local Switch is in CLOSED position | OFF                               |
| Electrical Device is ON and Local Switch is in OPEN position    | ON/OFF (Based on a specification) |
| Electrical Device is ON and Local Switch is in CLOSED position  | ON/OFF (Based on a specification) |

[0031] From Table 1, it can be seen that the electrical device 102 is maintained at an 'off' state after the controller failure if the electrical device 102 was in the 'off' state before the controller failure, regardless of the state (turned on/turned off) of the local switch 110. This is achieved by the latch 114, which maintains the transfer circuit 112 in a deactivated state.

[0032] If the electrical device 102 was in an 'on' state before the failure of the controller 106, upon the controller failure, the electrical device 102 can be turned on or turned off based on a specification as to whether the electrical device 102 is to be turned on or off. For example, when the electrical device 102 was at an 'on' state before the controller failure, and it has been specified that the electrical device 102 is to remain at the 'on' state even after the controller failure, the electrical device 102 is turned on automatically by the transfer circuit 112 and latch 114 after the controller failure. Contrarily, if it is specified that the electrical device 102 is to turn off after the controller failure, the electrical device 102 is turned off automatically by the transfer circuit 112 and latch 114 after the controller failure.

[0033] In an example, such a specification may be made based on an amount of power consumed by the electrical device 102. For example, if the electrical device 102 is a tube light, which consumes lesser amount of power, the specification may be to maintain the electrical device 102 at an on state even after the controller failure. However, if the electrical device 102 is a geyser, the specification may be to turn off the electrical device 102 after the controller failure. Such a specification may be made by a user of the electrical device 102.

[0034] From the above, it can be understood that the use of the latch 114 ensures a safe transfer of control to the local switch 110 upon a controller failure. Further, the activation of the transfer circuit 112 based on a user actuation of the local switch 110 ensures that the user has the knowledge of the controller failure.

[0035] After the controller failure, when the remote control is active again, the controller 106 deactivates the latch 114 using the output 4 and deactivates the transfer circuit 112 using the output 2. This enables remote control of the electrical device 102. This also causes the local switch 110 to act like a toggle switch, as explained earlier.

[0036] Table 2 below illustrates valid steady state conditions for the operation of the system 100:

Table 2: Valid steady state conditions for the operation of the system 100

| State of Controller 106 | State of Switch 104 and Electrical Device 102 | Logic State of Output 1 | Logic State of Output 2 | Logic State of Output 4 | Logic State of Input 2 | State of Local switch 110 | State of Latch 114 | State of Transfer Circuit 112 |
|-------------------------|-----------------------------------------------|-------------------------|-------------------------|-------------------------|------------------------|---------------------------|--------------------|-------------------------------|
| ON                      | ON                                            | 1                       | 0                       | 0                       | 1                      | OPEN                      | OFF                | OFF                           |
|                         |                                               |                         |                         |                         | 0                      | CLOSE                     |                    |                               |
|                         | OFF                                           | 0                       | 0                       | 0                       | 1                      | OPEN                      | OFF                | OFF                           |
|                         |                                               |                         |                         |                         | 0                      | CLOSE                     |                    |                               |
| OFF                     | ON                                            | High Z                  | High Z                  | High Z                  | X                      | CLOSE                     | ON                 | ON                            |
|                         | OFF                                           | High Z                  | High Z                  | High Z                  | X                      | OPEN                      | ON                 | ON                            |

[0037] As illustrated in the Table 2, when the controller 106 is on, the controller 106 can control the state (turn on or turn off) of the load switch 104 by altering the value of output 1. For example, by providing a value of

'1' as the output 1, the load switch 104 is switched on, thereby turning on the electrical device 102. Similarly, by providing a value of '0' as the output 1, the load switch 104 is switched off, thereby turning off the electrical device 102.

5 [0038] Further, when the controller 106 is on, the output 2 and output 4 each have a value of '0', thereby maintaining the transfer circuit 112 and the latch 114 deactivated. Still further, when the controller 106 is on, the state of the local switch 110 is monitored by the controller 106 through the input 2. For example, when the local switch 110 is at an open position, the  
10 input 2 may have a value of '1', and when the local switch 110 is at a closed position, the input 2 may have a value of '0'. Based on a change in the value of input 2, the controller 106 can change the state of the electrical device 102. Thus, the local switch 110 can be used as a toggle switch.

[0039] When the controller 106 is off, such as due to the controller  
15 failure, the output signals output 1, output 2, and output 4 will be of high impedance (floating logic). In such a situation, at steady state, the latch 114 and the transfer circuit 112 are activated. The activation of the latch 114 and the transfer circuit 112 may be performed as explained in the above paragraphs. Therefore, based on the state of the local switch 110, the states  
20 of the load switch 104 and the electrical device 102 change. For example, when the local switch 110 is closed, the load switch 104 and the electrical device 102 are turned on. Similarly, when the local switch 110 is open, the load switch 104 and the electrical device 102 are turned off.

[0040] An example implementation of the system 100 is explained with  
25 reference to Fig. 2.

[0041] Fig. 2. Illustrates a circuit diagram 200 representing operation of the system 100 to control the state of the electrical device 102, in accordance with an implementation of the present subject matter.

[0042] As illustrated, the load switch 104 may be a relay having a coil  
30 202 and a contact 204. The contact 204 may be connected in series with the electrical device 102 and an electrical supply 206 that supplies electric

power to the electrical device 102. The contact 204 may close when an electric current passes through the coil 202. Thus, when the contact 204 closes, the electrical device 102 turns on.

[0043] The coil 202 may be connected to a controller switch 208. The controller switch 208 may be actuated by the controller 106 (not shown in Fig. 2). For this, the controller switch 208 may receive the output 1 from the controller 106. In an example, when the value of output 1 is '1', the controller switch 208 turns on. The controller 106 may actuate the controller switch 208 based on the input 1 or the input 2.

10 [0044] When the controller switch 208 turns on, electric current can pass through the coil 202, causing the contact 204 to close, and the electrical device 102 to turn on. Contrarily, when the controller switch 208 turns off, electric current ceases to pass through the coil 202, causing the contact 204 to open, and the electrical device 102 to turn off. This achieves control of the state of the electrical device 102 through the controller 106.

[0045] The coil 202 may also be connected to a transfer switch 210, which is part of the transfer circuit 112. As illustrated, the connection between the coil 202 and the transfer switch 210 does not involve the controller switch 208. In other words, the connection between the coil 202 and the transfer switch 210 is in parallel to the connection between the coil 202 and the controller switch 208. Therefore, even when the controller switch 208 cannot be actuated due to the controller failure, the transfer switch 210 can be actuated to enable actuation of the contact 204. This facilitates controlling the state of the electrical device 102 in the event of controller failure.

[0046] The transfer switch 210 is connected to both the load switch 104 and the local switch 110. In an example, load switch 104, the transfer switch 210, and the local switch 110 may be connected in series, and the transfer switch 210 may be in between the load switch 104 and the local switch 110. Therefore, when the transfer switch 210 is turned on, the passage of

electrical current through the coil 202 can be controlled by actuating the local switch 110. This facilitates local control of the electrical device 102.

[0047] As explained earlier, the transfer circuit 112 is maintained in a deactivated state when the remote control is active. To achieve deactivation of the transfer circuit 112, in an example, the transfer switch 210 may be kept in an open position. Contrarily, to activate the transfer circuit 112, the transfer switch 210 may be closed. The transfer switch 210 may be closed upon receiving the output 3 from the latch 114.

[0048] The latch 114 may be implemented as a memory device that can retain at least one bit of information. In an example, the memory device may be a one-bit memory device, which can retain 1 bit of information. The one-bit memory device may be interchangeably referred to as one-bit memory 114. The one-bit memory 114 may include an input port 212, output port 214, and reset port 216. The input port 212 may receive a voltage signal through an impedance 218 when the local switch 110 is at an open position. The one-bit memory 114 may provide the output 3 to the transfer circuit 112 through the output port 214. Further, the output 4 from the controller 106 may be received at the reset port 216.

[0049] When the controller 106 provides the output 4 to the one-bit memory 114, the one-bit memory 114 remains deactivated, as the output 4 is received at the reset port 216. When the controller 106 fails, the one-bit memory 114 no longer receives the output 4, and the one-bit memory 114 gets activated.

[0050] In an example, if the local switch 110 remains closed when the one-bit memory 114 gets activated, the output 3 is not sent to the transfer circuit 112. This is because the input port 212 does not receive the voltage signal through the impedance 218 when the local switch 110 remains closed. Therefore, even after the controller failure, the transfer circuit 112 is maintained at its deactivated state. As explained earlier, by keeping the transfer circuit 112 deactivated when the local switch 110 is at the closed

position, a potentially unsafe situation of inadvertently turning on an electrical device 102 is prevented.

[0051]        Thereafter, to activate the transfer circuit 112, the local switch 110 is to be manually turned off by a user. This causes the input port 212 to receive the voltage signal, which, in turn, causes the transmission of the output 3 to the transfer circuit 112. If, on the other hand, the local switch 110 was originally turned off when the one-bit memory 114 gets activated, the transfer circuit 112 may also be activated immediately after the controller failure.

10 [0052]        By activating the transfer circuit 112 upon turn-off of the local switch 110, the state of the electrical device 102 may be brought in sync with the state of the local switch 110. For instance, at the instant of controller failure, if the electrical device 102 was turned off, while the local switch 110 was turned on, there is a mismatch between the states of the electrical device 102 and that of the local switch 110. Now, by activating the transfer circuit 112 when the local switch 110 is opened, the states of the electrical device 102 and the local switch 110 match. Thus, when the controller 106 fails, the local switch 110 no longer acts as a toggle switch, as is the case when the controller 106 is active.

20 [0053]        As will be understood, using such an arrangement of the latch 114 and the transfer circuit 112, upon its activation, the latch 114 activates the transfer circuit 112 when the local switch 110 is turned off, and does not automatically activate the transfer circuit 112 even when the electrical device 102 was turned-on. Thus, upon the controller failure, the electrical device 102 that was turned on before the controller failure turns off, thereby allowing the user to realize that the controller failure has occurred. Although not shown, in another example, the transfer circuit 112 may be activated even if the local switch 110 is turned on, provided the electrical device 102 is also turned on.

30 [0054]        Once the transfer circuit 112 gets activated, the transfer switch 210 turns on. Thereafter, when the local switch 110 is closed, an electric

current passes through the coil 202, causing the contact 204 to close. As explained earlier, this causes the electrical device 102 to turn on. Similarly, when the local switch 110 is opened, electric current ceases to pass through the coil 202, causing the electrical device 102 to turn off.

5 [0055] Upon its activation, even though the one-bit memory 114 stops receiving the voltage signal when the local switch 110 is closed, the one-bit memory 114 continues to provide the output 3 to the transfer circuit 112. This is because the one-bit memory 114 retains the input it provided previously, i.e., when the one-bit memory 114 was receiving the voltage  
10 signal, and continues to output it through the output port 214. Thereafter, if the local switch 110 is opened (to turn off the electrical device 102), the one-bit memory 114 starts receiving the voltage signal, and continues to provide the output 3. Thus, it will be understood that, once the one-bit memory 114 starts providing the output 3 to the transfer circuit 112, the one-bit memory  
15 114 will continue to do so until it receives the output 4.

[0056] In an example, the one-bit memory 114 may be implemented as a D flip-flop that receives the voltage signal at both its input terminal (D) and its clock terminal (CLK). The output terminal (Q) of the D flip-flop may provide the output 3. Since the output of the D flip-flop does not change  
20 when the input of the clock moves from '1' to '0', the output 3 remains '1' even when clock terminal stops receiving the voltage signal due to closing of the local switch 110.

[0057] Although the latch 114 has been explained with reference to a one-bit memory, such as a D flip-flop, the latch 114 may be implemented in  
25 other forms as well. For example, the latch 114 may be implemented as a multi-bit memory, an electronic circuit, a digital circuit based on flip-flops, an analog memory device, and the like.

[0058] It is to be understood that the circuit 200 representing the operation of the system 100 is just one example way of implementing the  
30 system 100, and the system 100 may be implemented in any other way

based on the operation of the system 100 explained with reference to Fig. 1.

[0059] Although the system 100 is shown to control just a single electrical device 102, multiple electrical devices may be controlled simultaneously by the system 100. For this, the system 100 can include additional load switches, transfer circuits, and latches. In an example, four electrical devices can be controlled by the system 100. Further, multiple instances of the system 100 can be cascaded to extend the functionality of remote control. The cascading of the multiple instances of the system 100 can be used to achieve a common energy goal.

[0060] The controller 106 can vary in its constitution, size, and shape based on, for example, number of load switches to be controlled, types of electrical devices (high load, medium load, etc.) to be supported, communication interfaces integrated, and additional sensors integrated.

[0061] Fig. 3 illustrates the components of the controller 106 and its connection to the remote source 108, in accordance with an implementation of the present subject matter. The controller 106 includes a processor 302, a communication interface 304, modules 306, and sensor(s) 308.

[0062] The processor 302, amongst other capabilities, may be configured to fetch and execute computer-readable instructions stored in the memory. The processor 302 may be implemented as one or more microprocessors, microcomputers, microcontrollers, digital signal processors, central processing units, graphics processing units, state machines, logic circuitries, and/or any devices that manipulate signals based on operational instructions. The functions of the various elements shown in the figure, including the functional block labelled as processor 302, may be provided using dedicated hardware as well as hardware capable of executing machine readable instructions.

[0063] When provided by a processor, the functions may be provided by a single dedicated processor, by a single shared processor, or by a plurality of individual processors, some of which may be shared. Moreover,

explicit use of the term “processor” should not be construed to refer exclusively to hardware capable of executing machine readable instructions, and may implicitly include, without limitation, digital signal processor (DSP) hardware, network processor, application specific integrated circuit (ASIC), field programmable gate array (FPGA), read only memory (ROM) for storing machine readable instructions, random access memory (RAM), non-volatile storage. Other hardware, conventional and/or custom, may also be included.

[0064] The communication interface(s) 304 can enable components of the controller 106 to communicate with computing devices, web servers, and external repositories. The communication interface(s) 304 may facilitate multiple communications within a wide variety of networks and protocol types, including wireless networks, wireless Local Area Network (WLAN), RAN, satellite-based network, etc. The communication interface(s) 304 can include at least one of a Wi-Fi, LoRa (Long Range Radio), GSM (Global System for Mobile communications), GPRS (General Packet Radio Service), LTE (Long Term Evolution), 3G, and 4G interface.

[0065] The modules 306 may include routines, programs, objects, components, data structures, and the like, which perform particular tasks or implement particular abstract data types. The modules 306 may be implemented in hardware, instructions executed by a processing unit, or by a combination thereof. In an implementation, the modules 306 are machine-readable instructions which, when executed by a processor, perform any of the described functionalities. For example, the machine-readable instructions can enable the controller 106 to control the electrical device 102 based on the commands received from the remote source 108. For example, the machine-readable instructions can enable the controller 106 to generate the output 1 based on the input 1.

[0066] The sensor(s) 308 can include, but are not restricted to, a current sensor and a voltage sensor for monitoring power consumption of

the electrical device 102. In an example, the current sensor is of hall effect type.

[0067] The controller 106 can be connected to the remote source 108 through a communication network 312. The remote source 108 can include, but is not restricted to, a service on a cloud, a mobile application, a smart home controller, and a smart home gateway.

[0068] The communication network 312 may be a wireless or a wired network, or a combination thereof. The communication network 312 may be a collection of individual networks, interconnected with each other and functioning as a single large network (e.g., the internet or an intranet). Examples of such individual networks include, but are not restricted to, Global System for Mobile Communication (GSM) network, Universal Mobile Telecommunications System (UMTS) network, Personal Communications Service (PCS) network, Time Division Multiple Access (TDMA) network, Code Division Multiple Access (CDMA) network, Next Generation Network (NGN), Public Switched Telephone Network (PSTN), and Integrated Services Digital Network (ISDN). Depending on the technology, the communication network 312 includes various network entities, such as transceivers, gateways, and routers; however, such details have been omitted for ease of understanding.

[0069] Through the remote source 108, a user 314 can view and control the state of the electrical device 102. To control the state of the electrical device 102, on/off commands may be sent from the remote source 108 using an HTTP (Hypertext Transfer Protocol) server based REST (Representational state transfer) API (Application Programming Interface) calls. Other implementations based on Constrained Application Protocol (CoAP), Message Queuing Telemetry Transport (MQTT), TCP/IP, and the like are also possible. In an example, the remote source 108 is a cloud service and the user 314 accesses the cloud service through a mobile device to view and control the state of the electrical device 102. In another example, the remote source 108 is the user's mobile device.

[0070] In an implementation, the user 314 can schedule turn-on and turn-off of the electrical device 102 through the remote source 108. For example, the user 314 can schedule turn-off of a ceiling fan from 10 AM to 7 PM, the time period during which the user 314 will not be present at home.

5 The schedule may then be provided to the controller 106, which can control the state of the electrical device 102 through the load switch 104. A log of the control of the state of the electrical device 102 based on the schedule can be provided to the user 314, for example, on the user's mobile device.

[0071] The scheduled state of the electrical device 102 can be  
10 overridden by the user 314 at any point of time by actuating the local switch 110, as explained above. In an implementation, based on the overrides performed by the user 314, the remote source 108 can learn new schedules and implement it from a next cycle. For example, if the user 314 overrides a scheduled turn-off of the electric fan from 10 AM – 7 PM by turning it on  
15 at 6.30 PM regularly over a period of time, the remote source 108 can learn a new schedule of turn-off of the electric fan from 10 AM – 6.30 PM. The new schedule can then be communicated to the user 314 for approval. Upon approval by the user 314, the schedule can be activated. In an example, the learning of the new schedule is performed by the controller 106.

20 [0072] In an implementation, the remote source 108 can enable providing incentives to the user 314 for minimizing energy consumption. For enabling incentivization, the remote source 108 can provide energy consumption data of the user 314 to the utility company. Based on the energy consumption data, the utility company can provide incentives to the  
25 user 314. For example, the utility company may provide loyalty points to the user 314 when the energy consumption data provided by the remote source 108 indicates that the energy consumption is reduced on a week-to-week comparison. The loyalty points may be redeemed by the user 314 as, for example, discount in energy bills, discount on purchase of energy efficient  
30 devices, such as Compact Fluorescent Lamp (CFL) Bulbs, discounts in insurance for electrical devices having a star rating. In an example, the

loyalty points can be provided in return to the user 314 overriding an existing schedule to minimize energy consumption. Accordingly, the remote source 108 can learn a more energy efficient schedule than the existing schedule.

[0073] The energy consumption data provided by the remote source 108 to the utility company can enable peak load shifting. For this, utility company can utilize the energy consumption data of the user 314 at peak loading time. For example, if, based on the energy consumption data provided by the remote source 108, the utility company determines that the user 314 has not used water geyser from 9-10 AM, the utility company can incentivize the user 314.

[0074] In accordance with the implementation in which the remote source 108 is a cloud service, one or more services can be provided for controlling the electrical device 102 and managing the energy consumption. The one or more services can be accessed by the user 314, for example, from a mobile device. The one or more services can include, but are not restricted to, a personalized user interface, energy management, energy analytics, and convenience.

[0075] The personalized user interface can be used to view and control the state of the electrical device 102, view and manage energy consumption of the electrical device 102, provide schedules for the electrical device 102, approve learned schedules, and so on. The energy management service can be used to control the state of the electrical device 102 based on the input of the user 314, creating and learning schedules, providing incentives to the user, and the like. The energy analytics service can be used to monitor energy consumption, provide an energy consumption dashboard, perform week-on-week comparison of energy consumption, and providing personalized alerts. The convenience service can include features like authentication, authorization, electrical device mapping, electrical device onboarding, and electrical device control.

[0076] The one or more services explained above can be provided in the form of a layered architecture. The layered architecture can enable the

one or more services to be provided as a semantically composable service. Each of the one or more services may include several basic services and may be configured based on the type of subscription.

[0077] In an implementation, the firmware of the controller 106 can be updated from the remote source 108 through the communication network 312. In an implementation, the controller 106 can detect a smart home controller or a smart home gateway, for example, through the communication interface 304 or power line communication. Further, multiple systems similar to the system 100 can form an ad-hoc network to achieve a common energy goal.

[0078] Fig. 4 illustrates method 400 for controlling state of an electrical device, in accordance with an implementation of the present subject matter.

[0079] The order in which the method 400 is described is not intended to be construed as a limitation, and any number of the described method blocks may be combined in any order to implement the method 400, or an alternative method. Although the method 400 may be implemented in a variety of systems, the methods 400 is described in relation to the aforementioned system 100, for ease of explanation.

[0080] At block 402, a load switch connected to an electrical device is actuated in response to an actuation of a local switch to change the state of the electrical device. The electrical device may be, for example, the electrical device 102 and the local switch may be, for example, the local switch 110. The actuation may be performed by a controller, such as the controller 106. For example, the controller 106 may enable the electric current to pass through the coil 202 or prevent the electric current from passing through the coil 202 when the value of the input 1 changes.

[0081] The controller 106 may also actuate the load switch based on an actuation signal from a remote source. The actuation signal may be, for example, the input 1 and the remote source may be, for example, the remote source 108.

[0082] At block 404, a transfer circuit is activated in response to failure of the controller. The transfer circuit is connected to the local switch and to the load switch. The activation may be performed by a latch, such as the latch 114. In an example, the latch may activate the transfer circuit when  
5 the local switch is at a turned-off state, as explained earlier.

[0083] At block 406, the transfer circuit actuates the load switch in response to the actuation of the local switch to change the state of the electrical device. For example, when the local switch is closed, the transfer circuit closes the load switch, such as by enabling electric current to pass  
10 through the coil 202 or preventing electric current from passing through the coil 202.

[0084] After the failure, when the controller becomes operational again, the latch may be deactivated by the controller.

[0085] The present subject matter provides a simple and efficient  
15 control of an electrical device both locally and remotely. Even when the electrical device is remotely controllable, the electrical device can be controlled using the local switch. The present subject matter enables automatic transfer of control of the electrical device to a local switch upon failure of the remote control. This ensures controllability of the electrical  
20 device even when the remote control fails and a failsafe operation of the system. The system provided by the present subject matter can be retrofitted with existing local switches, thereby preventing replacement of the existing local switches to facilitate remote control of the electrical devices. The system is also highly compact. In an example, the system has  
25 dimensions of 20 mm X 10 mm. Therefore, the system can be easily fitted behind existing switchboards to facilitate the remote control. Further, minimal rewiring is to be performed for the fitting. The retrofitting does not change the user experience when operating the switchboards.

[0086] The system of the present subject matter can be used in smart  
30 homes and in smart grid infrastructure and in sectors like agriculture, automotive sector, industrial automation, simple managed services for

- energy conservation, and any other area where an electrical device is to be controlled both locally and remotely. The system can be controlled from a remote source, such as cloud service, mobile application, home gateway controller, and dedicated remote device, with ease. Further, any type of
- 5 wireless/wired technology can be used for the remote control. The system can be provided in different ways, such as behind existing switches on a switchboard (retrofit), as a box next to the switchboard with wired interfaces to the existing switches (external), and as a replacement to an existing switch (small form factor pluggable).
- 10 [0087] Although the present subject matter has been described with reference to specific embodiments, this description is not meant to be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as alternate embodiments of the subject matter, will become apparent to persons skilled in the art upon reference to the
- 15 description of the subject matter.

We claim:

1. A system for controlling state of an electrical device, the system comprising:
  - 5 a load switch connected to the electrical device and actuatable to change the state of the electrical device;  
a controller connected to the load switch to actuate the load switch, wherein the controller is to actuate the load switch based on at least one of an actuation signal from a remote source and a  
10 toggling signal from a local switch;  
a transfer circuit connected to the load switch, to be connected to the local switch, and to be activated in response to a failure of the controller to actuate the load switch based on an actuation of the local switch; and  
15 a latch connected to the transfer circuit and to the controller to activate the transfer circuit in response to the failure of the controller and to deactivate the transfer circuit in response to an active state of the controller.
2. The system as claimed in claim 1, comprising a local switch  
20 connected to the load switch through a first path and through a second path and actuatable to actuate the load switch, the first path being different from the second path, wherein the first path comprises the controller and wherein the second path comprises the transfer circuit.
3. The system as claimed in claim 1, wherein the latch is to receive a  
25 latch deactivation signal from the controller to keep the latch deactivated in response to the active state of the controller.
4. The system as claimed in claim 1, wherein the latch is to activate the transfer circuit in response to a turned-off state of the local switch.

5. The system as claimed in claim 2, wherein the transfer circuit comprises a transfer switch that is connected to the local switch and that is to turn on in response to receipt of a transfer circuit activation signal from the latch.
- 5 6. The system as claimed in claim 1, wherein the load switch comprises a relay having a coil and a contact, wherein the contact is to close in response to an electric current passing through the coil and wherein the contact connected in series to the electrical device and an electrical supply of the electrical device.
- 10 7. The system as claimed in claim 6, comprising a controller switch connected to the coil and to the controller, wherein the controller switch is to actuate in response to receiving at least one of the actuation signal and the toggling signal by the controller.
8. The system as claimed in claim 3, wherein the latch comprises a  
15 memory device comprising an input port, an output port, and a reset port, wherein the output port of the memory device is connected to the transfer circuit to activate the transfer circuit.
9. The system as claimed in claim 8, wherein the memory device is to receive the latch deactivation signal at the reset port.
- 20 10. The system as claimed in claim 1, wherein the controller comprises a sensor to monitor power consumed of the electrical device.
11. The system as claimed in claim 1, wherein the controller is to control actuation of the electrical device based on a schedule received from the remote source.
- 25 12. A method for controlling a state of an electrical device, the method comprising:

actuating, by a controller, a load switch connected to the electrical device in response to an actuation of a local switch to change the state of the electrical device;

5       activating, by a latch, a transfer circuit in response to failure of the controller, the transfer circuit connected to the local switch and to the load switch; and

actuating, by the transfer circuit, the load switch in response to the actuation of the local switch to change the state of the electrical device.

10   13.   The method as claimed in claim 12, comprising deactivating, by the controller, the latch when the controller is operational to deactivate the transfer circuit.

14.   The method as claimed in claim 12, comprising activating, by the latch, the transfer circuit in response to a turned-off state of the local switch.

15   15.   The method as claimed in claim 12, comprising actuating, by the controller, the load switch in response to receiving an actuation signal from a remote source.

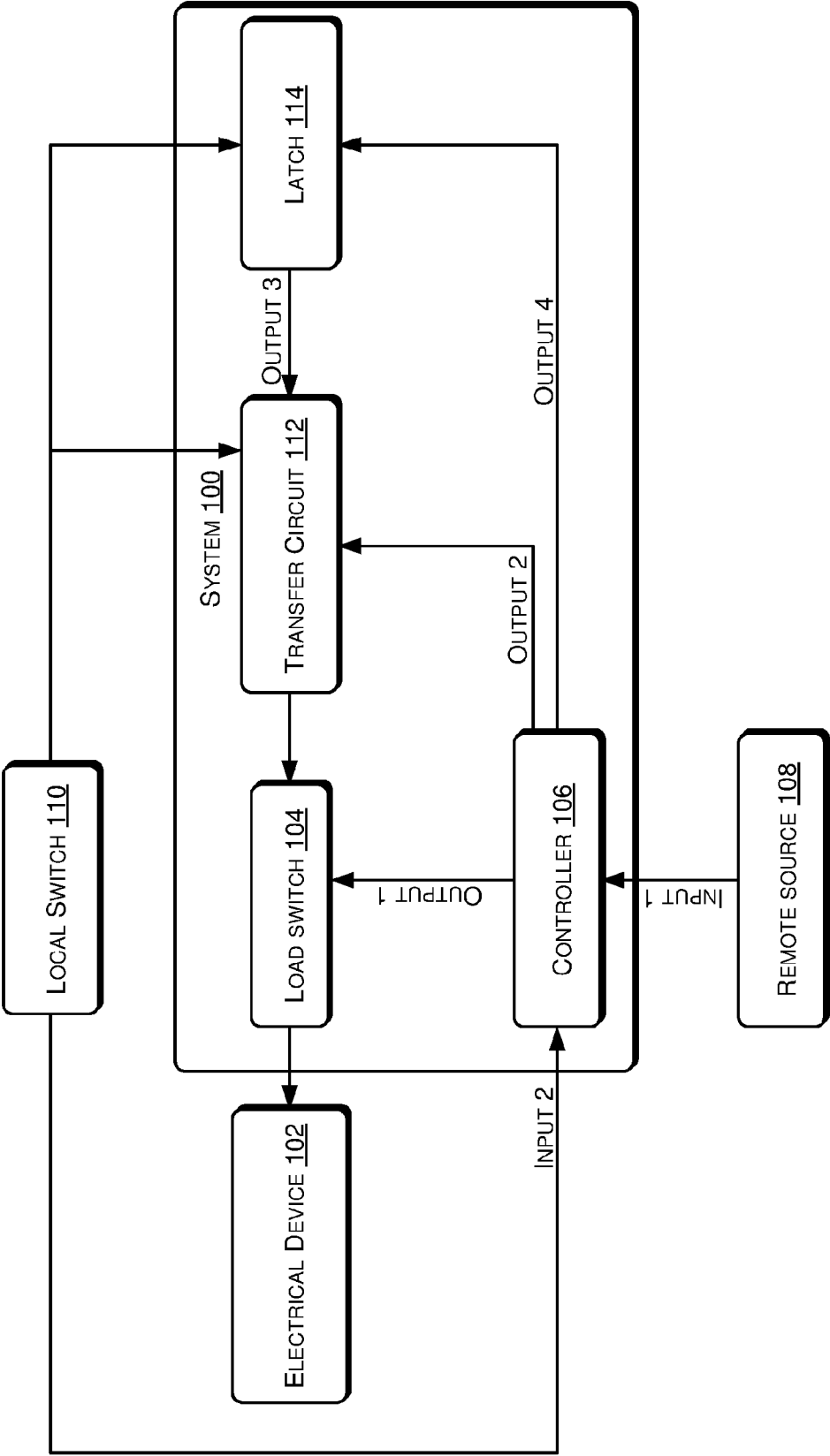


Fig. 1

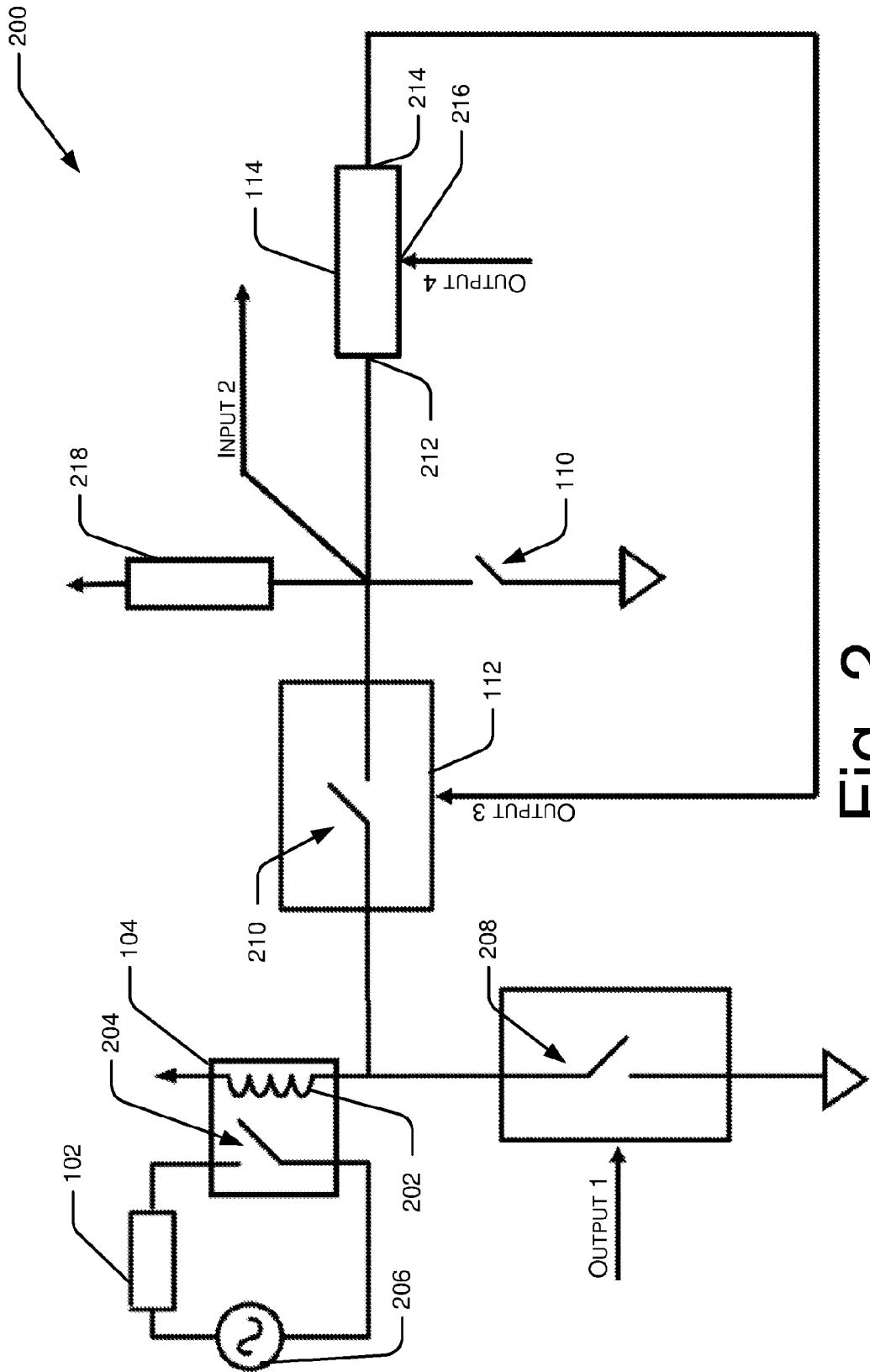


Fig. 2

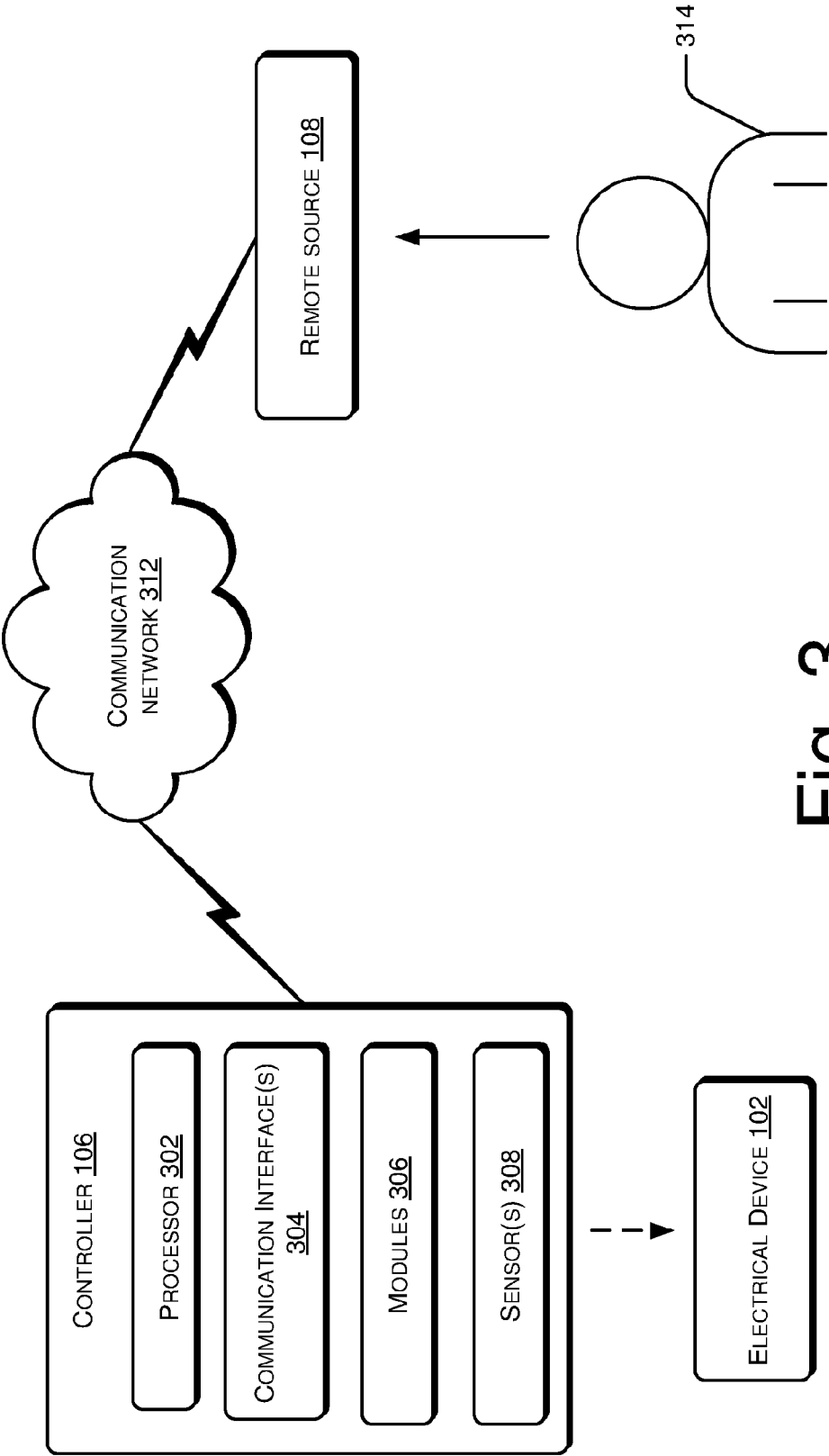


Fig. 3

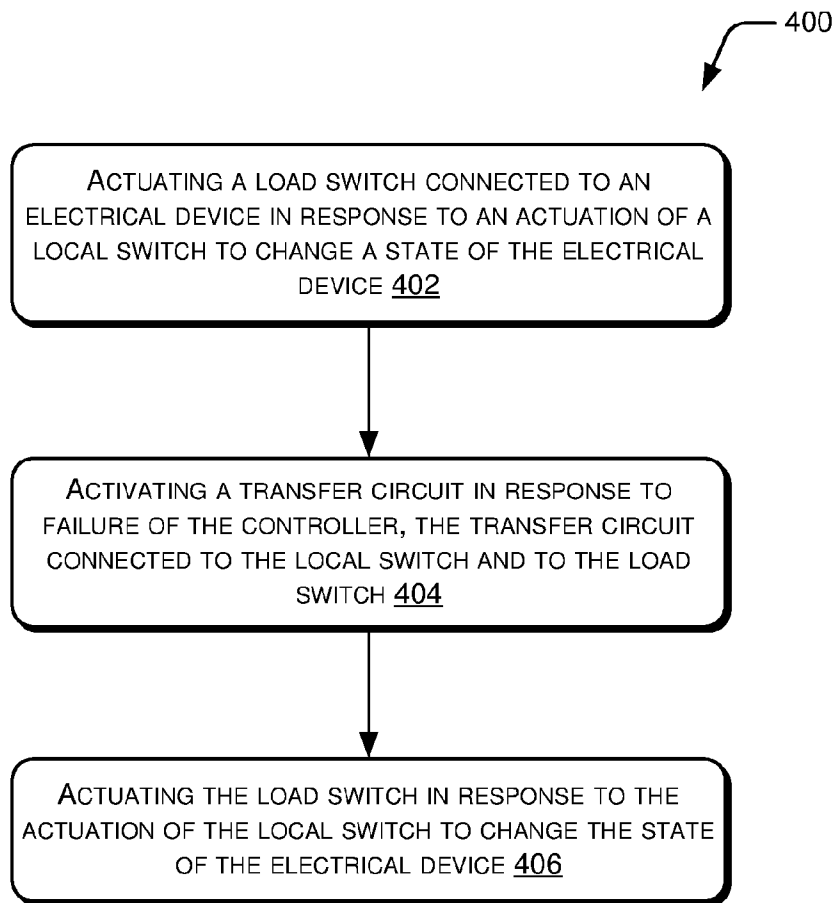


Fig. 4

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IN2018/050282

A. CLASSIFICATION OF SUBJECT MATTER  
H01H47/00, H01H9/00 Version=2018.01

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Databases- TotalPatent One, IPO Internal Database

Keywords Searched - activate, local switch, remote control, controller.

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                      | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------|-----------------------|
| Y         | US 2015/0364274 A1 (DEN AUTOMATION LIMITED),<br>17-12-2015 (17 December, 2015). Whole Document          | 1-15                  |
| Y         | US 6,327,130 B1 (SCHNEIDER ELECTRIC INDUSTRIES S.A.),<br>04-12-2001 (04 December, 2001). Whole Document | 1-15                  |
| A         | US 2016/0255702 A1 (ECHOSTAR UK HOLDINGS LIMITED),<br>01-09-2016 (01 September, 2016) Whole Document    | 1-15                  |

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| * Special categories of cited documents:                                                                                                                                | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention                                              |
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| "E" earlier application or patent but published on or after the international filing date                                                                               | "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
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| "P" document published prior to the international filing date but later than the priority date claimed                                                                  |                                                                                                                                                                                                                                                  |

Date of the actual completion of the international search

01-08-2018

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Information on patent family members

International application No.  
PCT/IN2018/050282

| Citation           | Pub.Date   | Family           | Pub.Date   |
|--------------------|------------|------------------|------------|
| US 2015/0364274 A1 | 17-12-2015 | EP 2948969 A1    | 02-12-2015 |
|                    |            | WO 2014114905 A1 | 31-07-2014 |
|                    |            | JP 2016511963 A  | 25-01-2016 |
|                    |            | CN CN105144326 A | 09-12-2015 |
|                    |            | KR 20150113060 A | 07-10-2015 |
| US 6,327,130 B1    | 04-12-2001 | EP 1009005 A1    | 14-06-2000 |
|                    |            | FR 2786919 A1    | 09-06-2000 |