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BA ME(72) Inventor: **Vuorio, Pekka****FI-03600 KARKKILA (FI)**(74) Representative: **Berggren Oy Ab****P.O. Box 16****Antinkatu 3 C****00101 Helsinki (FI)**(71) Applicant: **Helvar Oy Ab****03600 Karkkila (FI)**(54) **An apparatus for controlling the operation of an electronic ballast**

(57) A switch control apparatus, an arrangement, a method and a computer program for controlling operation of a lamp on basis of an input control signal are provided. The switch control apparatus comprises an input determination unit configured to determine the duration of the input control signal. The switch control apparatus further comprises an output determination unit configured to determine whether the duration of the input control signal exceeds a predetermined threshold, to determine, in response to the duration of the input control signal not exceeding the predetermined threshold, an output control signal having a first predetermined duration, to determine, in response to the duration of the input control signal exceeding the predetermined threshold, an output control signal having a duration that is no shorter than a second predetermined duration, which second predetermined duration is longer than the first predetermined duration, and to provide the output control signal for an apparatus configured to control operation of the lamp.

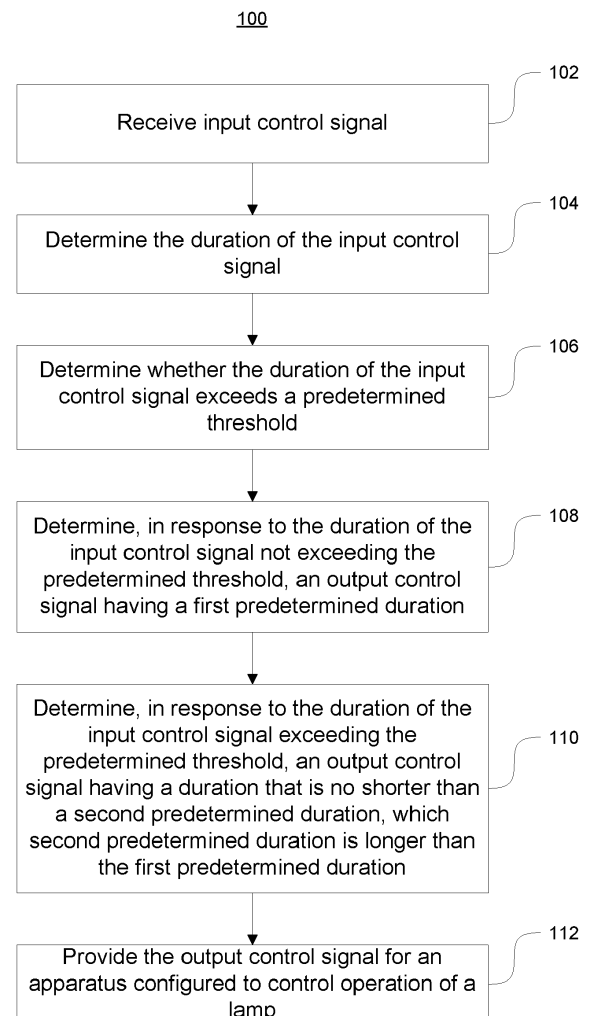


Figure 7

EP 2 632 233 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a switch control apparatus, to a switch control arrangement, to a method for controlling a switch and to a computer program for controlling a switch. In particular, the invention relates to an apparatus, to an arrangement, to a method and to a computer program for controlling switch signals for operating a lighting fixture, such as an electronic ballast driving a fluorescent lamp.

BACKGROUND OF THE INVENTION

[0002] Figure 1 schematically illustrates a switching arrangement 1 known in the art. The switching arrangement 1 comprises an upper circuit and a lower circuit, electrically isolated from each other. The upper circuit comprises a switch S1, and the lower circuit comprises an electrically controllable switch S2. The lower circuit further comprises an apparatus 2. Setting the switch S1 in closed state causes electric current to flow in the upper circuit of Figure 1, resulting in the electrically controllable switch S2 to be set in the closed state, which in turn causes electric current to flow in the lower circuit. Setting the switch S1 in open state and hence stopping the electric current from flowing in the upper circuit results in the electrically controllable switch S2 to be set in the open state, thereby stopping the flow of electric current in the lower circuit. The electrically controllable switch S2 may be for example a relay responsive to the electric current flowing in the upper circuit. The electric current flowing in the upper circuit may be considered as a control signal for controlling the flow of the electric current in the lower circuit. The electric current flowing in the lower circuit may be considered as provision of a drive signal to the apparatus 2.

[0003] The apparatus 2 may be configured to be responsive to the duration of the drive signal provided thereto such that a short drive signal, i.e. a short period of electric current flowing in the lower circuit, results in the apparatus 2 performing a first function, whereas a long drive signal results in the apparatus 2 performing a second function. Moreover, the apparatus 2 may be configured to perform the second function in dependence of the duration of a long drive signal. However, a drawback of the above-described arrangement is that the difference between 'short' and 'long' drive signals may not always be clear, thereby possibly leading to unintended behavior of the apparatus 2. As an example, different apparatuses, although performing essentially the same function, may interpret the duration of the drive signal in a different manner with respect to the drive signal being a 'short' one or a 'long' one. This may be particularly problematic in case the switching arrangement is configured to control two or more apparatuses by the same drive signal.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide an apparatus, an arrangement, a method and a computer program for controlling operation of an electronic ballast that facilitates provision of drive signals to the electronic ballast in a manner that reduces ambiguity with respect to interpretation of 'short' and 'long' drive signals, thereby improving the reliability and predictability of the operation of the electronic ballast.

[0005] The objects of the invention are reached by an apparatus, an arrangement, a method and a computer program as defined by the respective independent claims.

[0006] According to a first aspect of the invention, a switch control apparatus for controlling operation of a lamp on basis of an input control signal is provided. The switch control apparatus comprises an input determination unit configured to determine the duration of the input control signal. The switch control apparatus further comprises an output determination unit configured to determine whether the duration of the input control signal exceeds a predetermined threshold, to determine, in response to the duration of the input control signal not exceeding the predetermined threshold, an output control signal having a first predetermined duration, to determine, in response to the duration of the input control signal exceeding the predetermined threshold, an output control signal having a duration that is no shorter than a second predetermined duration, which second predetermined duration is longer than the first predetermined duration, and to provide the output control signal for an apparatus configured to control operation of the lamp.

[0007] According to a second aspect of the invention, a switch control arrangement is provided. The switch control arrangement comprises a switch control apparatus, coupled to a switch of an electric circuit, the electric circuit being configured to provide the input control signal to the switch control apparatus in response to said switch being closed. The switch control unit is further coupled to an electronic ballast, the electronic ballast being driven in accordance with the output control signal.

[0008] According to a third aspect of the invention, a method for controlling operation of a lamp is provided, the method comprising receiving an input control signal, determining the duration of the input control signal, determining whether the duration of the input control signal exceeds a predetermined threshold, determining, in response to the duration of the input control signal not exceeding the predetermined threshold, an output control signal having a first predetermined duration, determining, in response to the duration of the input control signal exceeding the predetermined threshold, an output control signal having a duration that is no shorter than a second predetermined duration, which second predetermined duration is longer than the first predetermined duration, and providing the output control signal for an apparatus configured to control operation of the lamp.

[0009] According to a fourth aspect of the invention, a computer program for controlling operation of a lamp is provided, the computer program comprising one or more sequences of one or more instructions which, when executed by one or more processors, cause an apparatus to at least perform a method in accordance with the third aspect of the invention.

[0010] The computer program may be embodied on a volatile or a non-volatile computer-readable record medium, for example as a computer program product comprising at least one computer readable non-transitory medium having program code stored thereon, the program code, which when executed by an apparatus, causes the apparatus at least to perform the operations described hereinbefore for the computer program in accordance with the third aspect of the invention.

[0011] The exemplifying embodiments of the invention presented in this patent application are not to be interpreted to pose limitations to the applicability of the appended claims. The verb "to comprise" and its derivatives are used in this patent application as an open limitation that does not exclude the existence of also unrecited features. The features described hereinafter are mutually freely combinable unless explicitly stated otherwise.

[0012] The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following detailed description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Figure 1 illustrates an example of a switching arrangement.

Figure 2 illustrates an example of a switching arrangement in accordance with an embodiment of the invention.

Figure 3 illustrates an example of a switch control apparatus in accordance with an embodiment of the invention.

Figure 4 illustrates examples of input and output control signal durations in accordance with an embodiment of the invention.

Figure 5 illustrates an example of a switching arrangement in accordance with an embodiment of the invention.

Figures 6a, 6b and 6c illustrate further examples of switching arrangements in accordance with embod-

iments of the invention.

Figure 7 illustrates a method in accordance with an embodiment of the invention.

DETAILED DESCRIPTION

[0014] Figure 2 schematically illustrates a switching arrangement 4 in accordance with an embodiment of the invention. The switching arrangement 4 comprises an upper circuit 6 and a lower circuit 8, electrically isolated from each other. The upper circuit 6 and the lower circuit 8 may be arranged to operate as discussed hereinbefore in context of the switching arrangement of Figure 1 with the exception of the upper circuit 6 of the switching arrangement 4 further comprising a switch control apparatus 10 for controlling the operation of the switch S2 and hence controlling the operation of the apparatus 2 in the lower circuit 8. The switch control apparatus 10 is configured to receive an input control signal and to provide an output control signal on basis of the input control signal.

[0015] Figure 3 schematically illustrates the switch control apparatus 10 in accordance with an embodiment of the invention. The switch control apparatus 10 comprises an input determination unit 12, configured to receive an input control signal via a suitable input to the switch control apparatus 10. The switch control apparatus 10 further comprises an output determination unit 14, operatively coupled or connected to the input determination unit 12. The output determination unit 14 is configured to provide an output control signal via a suitable output of the switch control apparatus 10.

[0016] The input determination unit 12 may also be referred to as an input determiner, an input evaluation unit, an input evaluator, etc. The output determination unit 14 may also be referred to as an output determiner, an output evaluation unit, an output evaluator, etc.

[0017] The control apparatus 10 may further comprise and/or be connected or coupled to a number of additional entities that are not shown in the example of Figure 1.

[0018] Upon and during reception of an input control signal the input determination unit 12 is configured to determine the duration of the input control signal t_{in} . In particular, the input determination unit 12 may be configured to determine the duration t_{in} as the duration of a period during which the input control signal fulfills predetermined characteristics. As an example, the predetermined characteristics may comprise a requirement that the input control signal exceeds or is no less than a predetermined voltage level. As another example, the predetermined characteristics may comprise a requirement that the input control signal exhibits electric current exceeding or being no less than a predetermined current level. The input determination unit 12 may be further configured to provide the determined duration of the input control signal to the output determination unit 14.

[0019] The output determination unit 14 may be con-

figured to receive the determined duration of the input control signal t_{in} from the input determination unit 12. The output determination unit 14 is further configured to determine whether the determined duration of the input control signal t_{in} exceeds a predetermined threshold Th_L . The predetermined threshold Th_L may be set to facilitate classification of the input control either as 'short' or 'long' durations of the input control signal, thereby enabling different determination and composition of an output control signal in dependence of the determined duration of the input control signal t_{in} .

[0020] The output determination unit 14 is further configured to determine, in response to the determined duration of the input control signal t_{in} not exceeding the predetermined threshold Th_L , an output control signal having a first predetermined duration t_S . In other words, in response to an input control signal classified as 'short' an output control signal of predetermined duration t_S is provided.

[0021] The output determination unit 14 is further configured to determine, in response to the determined duration of the input control signal t_{in} exceeding the predetermined threshold Th_L , an output control signal having a duration that is no shorter than a second predetermined duration t_L . In other words, the second predetermined duration t_L defines the minimum duration of the output control signal in case an input control signal having a duration exceeding the predetermined threshold Th_L is encountered. The second predetermined duration t_L is determined to be longer than the first predetermined duration t_S . Consequently, in response to an input control signal classified as 'long', an output control signal having a duration that is at least the second predetermined duration t_L and that is longer than the first predetermined duration t_S is determined and provided. The output control signal having a duration that is no shorter than a second predetermined duration t_L may be determined in dependence of the duration of the input control signal t_{in} .

[0022] The output determination unit 14 may be further configured to provide the determined output control signal for an apparatus configured to control operation of a lamp, e.g. to an electronic ballast configured to control operation of a fluorescent lamp.

[0023] In accordance with an embodiment of the invention, the first predetermined duration of the output control signal t_S may be set to a value that is smaller than the predetermined threshold Th_L . As examples, the predetermined threshold Th_L may be set e.g. to a value in the range 300 to 450 milliseconds, for example to 350 milliseconds, and the first predetermined duration of the output control signal t_S may be set e.g. to a value in the range 200 to 300, for example to 250 ms.

[0024] In accordance with an embodiment of the invention, the first predetermined duration of the output control signal t_S may be set equal to the predetermined threshold Th_L . As an example, the values of the predetermined threshold Th_L and the first predetermined duration t_S may be set e.g. to a value in the range 150 to

350, for example to 250 ms.

[0025] In accordance with an embodiment of the invention, the first predetermined duration of the output control signal t_S may be set to a value that is larger than the predetermined threshold Th_L . As examples, the predetermined threshold Th_L may be set e.g. to a value in the range 150 to 300 milliseconds, for example to 200 milliseconds, and the first predetermined duration of the output control signal t_S may be set e.g. to a value in the range 200 to 350, for example to 250 ms.

[0026] In accordance with an embodiment of the invention, the output determination unit 14 may be configured to determine, in response to the determined duration of the input control signal t_{in} exceeding the predetermined threshold Th_L , an output control signal as the maximum of the second predetermined duration t_L and the determined duration of the input control signal t_{in} . In other words, the duration of the output control signal is determined to be the larger of t_{in} and t_L , thereby resulting in the output control signal having the duration that is at least the second predetermined duration t_L . Hence, in order to ensure the output control signal to have a duration longer than the first predetermined duration t_S , the second predetermined duration t_L is set to a value larger than the first predetermined duration t_S . The second predetermined duration t_L may be set e.g. to a value in the range 350 to 500 milliseconds, for example to 450 milliseconds.

[0027] As a variation of using the maximum of t_{in} and t_L as the duration of the output control signal, in case the determined duration of the input control signal t_{in} exceeds second predetermined duration t_L , the duration of the output control signal may be set to a value that is smaller than t_{in} but that is still larger than t_L . Such an arrangement may enable for example terminating the provision of the output control signal at the time of detecting an end of the input control signal, provided that the accumulated duration of the output control signal already exceeds the second predetermined duration t_L .

[0028] In accordance with an embodiment of the invention, the output determination unit 14 may be configured to determine, in response to the determined duration of the input control signal t_{in} not exceeding a second predetermined threshold Th_S , that no output control signal is to be provided. Using such a limitation may enable for example discarding erroneously or accidentally generated input control signals. As an example, the second predetermined threshold Th_S may be assigned a value in the range 20 to 100 milliseconds, for example 50 milliseconds.

[0029] Note that the ranges described hereinbefore for t_S , t_L , Th_S and Th_L are provided as examples only, and values outside the exemplifying ranges are equally applicable within the scope of the invention.

[0030] In accordance with an embodiment of the invention, the input determination unit 12 may be configured to provide the information or indication of the determined duration of the input control signal to the output

determination unit 14 only after the input signal has been completely received, i.e. after the end of the input control signal has been detected. Consequently, the output determination unit 14 is configured to determine the output control signal, in particular the duration thereof, with the knowledge of the overall duration of the input control signal. In other words, the reception of an input control signal and provision of an output control signal occur sequentially without temporal overlap. An advantage of such an arrangement is that the determination of the output control signal duration is straightforward.

[0031] In accordance with an embodiment of the invention, the output determination unit 14 may be configured to provide the output control signal at least partially in parallel with reception of the input control signal. In other words, the provision of the output control signal is started while the input control signal is still being received, making the reception of the input control signal and the respective output control signal at least partially temporally overlapping. An advantage of such an approach is minimization of delay between the reception of the input control signal and provision of the respective output control signal.

[0032] According to an embodiment of the invention, the input determination unit 12 may be configured to monitor the duration of the input control signal t_{in} during reception of the input control signal. This may involve the input determination unit 12, or the switch control apparatus 10 in general, keeping up and updating information regarding the accumulated duration of an input control signal that is still continuing and making this information available to the output determination unit 14.

[0033] The monitoring may further comprise detecting an end of the input control signal and providing an indication thereof to the output determination unit 14 to be used for additional information that may be made use of in determination of the output control signal.

[0034] In accordance with an embodiment of the invention, while receiving an input control signal and providing an output control signal in parallel, the output determination unit 14 may be configured to stop ongoing provision of the output control signal in response to detecting the end of the input control signal or obtaining information indicating the end of the input control signal. In particular, the output determination unit 14 may be configured to stop ongoing provision of the output control signal in response to detecting the end of the input control signal in case the accumulated duration of the output control signal exceeds the second predetermined duration t_L . An advantage of such an arrangement is that it enables reflecting the change of status of the input control signal in the output control signal without unnecessary delay while still providing an output control signal having the desired minimum duration.

[0035] In the following, operation of an exemplifying switch control apparatus in accordance of an embodiment of the invention is described.

[0036] The exemplifying switch control apparatus is

configured to classify input control signals having duration not exceeding 350 milliseconds (ms) as 'short' input control signals and to classify input signals having duration exceeding 350 ms as 'long' input control signals. Hence, the predetermined threshold Th_L is set to 350 ms. Moreover, the first predetermined duration t_S is set to 250 ms and the second predetermined duration t_L is set to 450 ms. The exemplifying switch control apparatus is configured to provide the output control signal at least partially in parallel with reception of the input control signal. In particular, the exemplifying switch control apparatus is configured to start provision of the output control signal such that upon having received an input control signal for the duration corresponding to the first predetermined duration t_S , the apparatus is able to make a distinction between 'short' and 'long' input control signals. A number of examples of an input control signal and a resulting output control signal are provided in Figure 4.

[0037] In order to fulfill this requirement, the exemplifying switch control apparatus is configured to start provision of the output control signal at time $t_1 = t_0 + Th_L - t_S$, i.e. at $t_1 = t_0 + 350 - 250 = t_0 + 100$ ms, where t_0 denotes the start of the input control signal. Consequently, in case the input control signal is detected to be over before 350 ms from the beginning of the input control signal, i.e. to have duration not exceeding $Th_L = 350$ ms, this fact can be detected in time for stopping the provision of the output control signal at 350 ms from the beginning of the input control signal. Hence, in case the end of the input control signal is detected before 350 ms from the beginning of the input control signal, the provision of the output control signal is terminated at 350 ms to end up with a 'short' output control signal having duration specified by the first predetermined duration t_S set to 250 ms. Examples illustrating the operation in case of an input control signal not exceeding the predetermined threshold Th_L are provided in illustrations a) and b) of Figure 4.

[0038] In contrast, in case the input control signal continues beyond 350 ms from the beginning of the input control signal, the provision of the output control signal is continued at least until $t_1 + t_L$, i.e. $t_1 + 450$ ms = $t_0 + 550$ ms, even in case the input control signal is detected to be over by this time, to provide a 'long' output control signal having duration no shorter than the second predetermined duration t_L , i.e. 450 ms. An example of this is provided in illustration c) of Figure 4. Moreover, the exemplifying switch control apparatus may be configured to provide an output control signal having duration equal or essentially equal to that of the input control signal, as illustrated by an example in illustration f) of Figure 4. Alternatively, the exemplifying switch control apparatus may be further configured to terminate the provision of a 'long' output control signal upon detecting the end of the input control signal, provided that at least 450 ms of the output control signal has been already provided, as illustrated by an example in illustration e) of Figure 4.

[0039] The output determination unit 14 may be configured to provide an output control signal having prede-

terminated characteristics. As an example, the predetermined characteristics may comprise a requirement that the output control signal exhibits a predetermined voltage level or a voltage level within a predetermined range. As another example, the predetermined characteristics may comprise a requirement that the output control signal exhibits electric current exceeding or being no less than a predetermined current level, or falling within a predetermined range of electric current levels.

[0040] Figure 5 schematically illustrates an exemplifying switching arrangement 20 employing a switch control apparatus in accordance with an embodiment of the invention.

[0041] The switching arrangement 20 comprises a switch control button unit 30, a switch control unit 40, and an apparatus 50. The switch control unit 40 is coupled or connected to the switch control button unit 30 and to the apparatus 50. The switch control unit 40 is arranged to provide an output control signal to the apparatus 50 in response to an input control signal received from the switch control button unit 30. The apparatus 50 may be for example an electronic ballast configured to be operable on basis of a control signal received as input, or the apparatus 50 may be a control apparatus or a control arrangement configured to provide control signals to an electronic ballast. The electronic ballast, in turn, may be configured to drive a fluorescent lamp. As further examples, the apparatus 50 may be lighting equipment or a controller thereof of different type, for example a light emitting diode (LED), a high intensity discharge lamp (HID), etc. equipped with control arrangement that enables making use of control signals provided by the switch control unit 40.

[0042] The switch control unit 40 comprises a switch control apparatus 10a and a switching device 42. The switch control apparatus 10a is coupled to the switching device 42. The switch control apparatus 10a is configured to provide an output control signal in response to an input control signal provided thereto to the switching device 42. The switching device 42, in turn, is configured to couple a first input signal line of the apparatus 50 to a power source (e.g. to a suitable voltage source) according to output control signal issued thereat by the switch control apparatus 10a, thereby providing a driving signal corresponding to the duration of the output control signal to the apparatus 50. In particular, the switching device 42 may be configured to couple the apparatus 50 to the mains electricity in response to a control signal having predetermined characteristics (e.g. with respect to the voltage and/or current, as discussed hereinbefore) being issued thereat. Instead of the mains electricity, the apparatus 50 may be coupled to another suitable voltage source upon issuance of a control signal.

[0043] In a variation of the exemplifying switching arrangement 20 the apparatus 50 may be coupled to a suitable power source, e.g. mains electricity, and the switching device 42 may be configured to disconnect the apparatus 50 from the power source in response to an

output control signal being issued thereat by the switch control apparatus 10a, thereby providing a driving signal corresponding to the duration of the output control signal.

[0044] The switching device 42 may be for example a relay or another electrically controllable switch suitable for being controlled by output control signals of above-described type.

[0045] The switch control button unit 30 comprises a push button 32. The push button 32 is a user operable button that is arranged to cause an input control signal being provided to (or issued at) the switch control apparatus 10a of the switch control unit 40. In particular, pressing the push button 32 results in an input control signal having a duration matching or essentially matching the duration of the push button 32 being pushed to be provided to the switch control apparatus 10a. Such a push button arrangement may be implemented for example by using the push button 32 as an actuator closing a switch of an electric circuit configured to provide a control signal of above-mentioned type upon push of the button. Hence, the duration of the respective input control signal essentially corresponds to the time the switch is being closed, whereas the control signal has characteristics depending on the electric current and voltage of the electric circuit.

[0046] The switch control apparatus 10a is configured to provide output control signals to switching device 42 on basis of the input control signal provided from the switch control button unit 30 in accordance with one of the various embodiments of the switch control apparatus described hereinbefore. In particular, an output control signal issued at the switching device 42 by the switch control apparatus 10a may have the first predetermined duration t_S or a duration that is no shorter than a second predetermined duration t_L , as described hereinbefore. Consequently, the switching device 42 is configured to connect the apparatus 50 or a respective input signal line of the apparatus 50 to the input voltage for a period corresponding to the duration of the output control signal, the apparatus 50 thereby receiving a drive signal of respective duration.

[0047] In the following, for brevity, a drive signal having the first predetermined duration t_S is referred to as a 'short' drive signal and a drive signal having a duration that is no shorter than a second predetermined duration t_L is referred to as a 'long' drive signal.

[0048] The apparatus 50, for example an electronic ballast, may be configured to be responsive to a drive signal in dependence of its current state of operation. In case the apparatus 50 is switched off, it may be configured to be switched on in response to a 'short' or 'long' drive signal. Optionally, in case the apparatus 50 is switched off, the apparatus 50 may be further configured to change a value of a control parameter in a first direction in response to a 'long' drive signal, the change being proportional to the duration of the drive signal. In case the apparatus 50 is currently switched on, it may be configured to be switched off in response to a 'short' drive

signal.

[0049] In case the previous drive signal was a 'short' drive signal causing the apparatus 50 to be switched on, the apparatus 50 may be configured to change a value of a control parameter in a first direction in response to a 'long' drive signal, the change being proportional to the duration of the drive signal. As an example, the apparatus 50 may be configured to change the value of the control parameter in the first direction at a predetermined rate for the duration of a drive signal issued thereat. In case the previous drive signal was a 'long' drive signal causing the apparatus 50 to change the value of the control parameter in the first direction, the apparatus 50 may be configured to change a value of a control parameter in a second direction in response to a 'long' drive signal, the change being proportional to the duration of the drive signal. As an example, the apparatus 50 may be configured to change the value of the control parameter in the second direction at a predetermined rate for the duration of a drive signal issued thereat. In case the previous drive signal was a 'long' drive signal causing the apparatus 50 to change the value of the control parameter in the second direction, the apparatus 50 may be configured to operate as in receiving a 'long' drive signal as the next drive signal after being switched on.

[0050] In particular, a change in the first direction may involve increasing the value of the control parameter, whereas a change in the second direction may involve decreasing the value of the control parameter. As an example, if the apparatus 50 is an electronic ballast configured to drive a fluorescent lamp, the control parameter may be configured to control a dimming value of the lamp.

[0051] In the exemplifying switching arrangement 20 a pair of switch control apparatus 10a and a switching device 42 is shown. However, a switching arrangement may comprise any number of switch control apparatus - switching device pairs, each switch control apparatus arranged to control operation of a respective switching device on basis of a dedicated input control signal issued at the respective switching apparatus.

[0052] In the exemplifying switching arrangement 20 the switch control apparatus 10a of the switching unit 40 is configured to provide an output control signal to a single switching device 42. However, a switch control apparatus 10a may be arranged to provide an output control signal for a number of switching devices, thereby enabling a control of several switching devices on basis of a single output control signal of a switching apparatus 10a. Such an arrangement enables for example simultaneously or essentially simultaneously switching a number of apparatuses on or off, or changing the value of a control parameter having an effect on a number of apparatuses.

[0053] In the exemplifying switching arrangement 20 the switching device 42 of the switch control unit 40 is configured to provide drive signals to a single input signal line of a single apparatus 50. However, a switching device may be configured to provide a driving signal to a number of apparatuses or to multiple input signal lines of one or

more apparatuses. Such an arrangement enables for example simultaneously or essentially simultaneously switching a number of apparatuses on or off, or changing the value of a control parameter having an effect on a number of apparatuses.

[0054] In the exemplifying switching arrangement 20 the input control signals to the switch control unit 10a are provided via the push button 32 of the switch control button unit 30, where the push button 32 may be arranged to enable closing a switch of an electric circuit upon pushing the push button 32. However, a different arrangement may be employed to control such a switch configured to provide an input control signal to the switch control apparatus 10a. As an example, a switch may be coupled to an infrared (IR) receiver unit configured to receive IR control signals. The IR receiver unit, in turn, is configured to set the switch in the open or closed state in accordance with the received IR control signals, thereby providing an input control signal to a respective switch control unit accordingly. The IR control signals may be provided for example by a remote control unit arranged to transmit IR control signals in response to commands by a user.

[0055] In accordance with an embodiment of the invention, a switch control apparatus 10' may be configured to determine and/or provide a second output control signal according to the DALI protocol in response to a received input control signal. Such commands may comprise a subset of commands of the DALI protocol, which is defined for example in Annex E of IEC 60929. In such an arrangement the switch control apparatus 10' is coupled to the apparatus 2' via a signal line that enables provision of the second output control signal in accordance with the DALI protocol. In particular, in such an arrangement the switch control apparatus 10' may be coupled to the apparatus 2' e.g. directly instead of the switch control apparatus 10' being configured to control the operation of the apparatus indirectly via the switch S2. Such scenarios are schematically illustrated in Figures 6a and 6b. In particular, Figure 6a illustrates an arrangement where the switch control apparatus 10' is coupled directly (although possibly via one or more intervening components not shown in the figure) to the apparatus 2' and hence the apparatus 10' as exemplified in Figure 6a is configured to determine and/or provide the second output control signal only, i.e. an output control signal according to the DALI protocol referred to hereinbefore. Figure 6b illustrates an arrangement where the switch control apparatus 10' is coupled to the apparatus 2 via the switch S2 and where the switch control apparatus 10' is coupled directly (although possibly via one or more intervening components not shown in the figure) to the apparatus 2'. In the exemplifying arrangement of Figure 6b the switch control apparatus 10' is hence configured to determine and/or provide the first output control signal for controlling the operation of the apparatus 2 and to determine and/or provide the second output control signal to the apparatus 2'.

[0056] Consequently, the switch control apparatus 10'

is configured to operate like the switch control apparatus 10 described in detail hereinbefore with the exception that the switch control apparatus 10' is configured to determine, instead of or in addition to the (first) output control described in detail in context of the switch control apparatus 10, a second output control signal, wherein the switch control apparatus 10' is configured to determine and/or provide the second output control signal, which is formatted in accordance with the DALI protocol. Moreover, the structure of the switch control apparatus 10' may be similar to that of the switch control apparatus 10 illustrated in Figure 3.

[0057] As an example, in case the current status of the apparatus 2' is 'on' the switch control apparatus 10' may be configured to determine, in response to the duration of the input control signal t_{in} not exceeding the predetermined threshold Th_L , a second output control signal formatted according to the DALI command "OFF" (Command 0). In a similar manner, in case the current status of the apparatus 2' is 'off', the switch control apparatus 10' may be configured to determine, in response to the duration of the input control signal t_{in} not exceeding the predetermined threshold Th_L , a second output control signal formatted according to the DALI command "ON AND STEP UP" (Command 8).

[0058] As a further example, in case the current status of the apparatus 2' is 'on' and the most recently determined second output control signal was formatted according to the DALI command "ON AND STEP UP", the switch control apparatus 10' may be configured to determine, in response to the duration of the input control signal t_{in} exceeding the predetermined threshold Th_L , a second output control signal formatted according to the DALI command "UP" (Command 1) using a predetermined fade rate. In a similar manner, in case the most recently determined second output control signal was formatted according to the DALI command "UP", the switch control apparatus 10' may be configured to determine, in response to the duration of the input control signal t_{in} exceeding the predetermined threshold Th_L , a second output control signal formatted according to the DALI command "DOWN" (Command 2) using a predetermined fade rate.

[0059] The switch control apparatus 10' may comprise or may have an access to a memory that enables storing and accessing (e.g. writing and reading, respectively) information indicative of the current status of the apparatus 2'. As an example, such information may comprise indication of the most recently determined second output control signal. This information, together with the knowledge of the initial status of the apparatus 2' (which may be assumed to be e.g. 'off') enables the switch control apparatus 10' to determine the status of the apparatus 2'.

[0060] In accordance with an embodiment of the invention, a switch control apparatus 10" may be configured to receive an input signal formatted according the DALI protocol, determine a respective output control signal, and provide the output control signal to an apparatus

2". An exemplifying arrangement involving the switch control apparatus 10" configured to control the operation of the apparatus 2" indirectly via the switch S2 is illustrated in Figure 6c.

[0061] In particular, the switch control apparatus 10" may be configured to determine, in response to a first subset of DALI commands, an output control signal having a first predetermined duration t_S . Moreover, the switch control apparatus 10" may be configured to determine, in response to a second subset of DALI commands, an output control signal having a duration that is no shorter than a second predetermined duration t_L , which second predetermined duration is longer than the first predetermined duration. Each of the first and second subsets of DALI commands may comprise one or more DALI commands.

[0062] The first subset of DALI commands may comprise for example the DALI commands "OFF" (Command 0) and "ON AND STEP UP" (Command 8). In case the current state of the apparatus 2" is 'off' the switch control apparatus 10" may be configured to determine, in response to a DALI command "ON AND STEP UP", an output control signal having a first predetermined duration t_S . In case the current state of the apparatus 2" is 'on' the switch control apparatus 10" may be configured to determine, in response to a DALI command "OFF", an output control signal having a first predetermined duration t_S .

[0063] The second subset of DALI commands may comprise for example the DALI commands "UP" (Command 1) and "DOWN" (Command 2). In case the current status of the apparatus 2" is 'on' and the most recently received DALI command was "DOWN" or "ON AND STEP UP", the switch control apparatus 10" may be configured to determine, in response to the DALI command "UP" indicating a certain fade rate, an output control signal having a duration that is no shorter than a second predetermined duration t_L and which duration corresponds to the desired amount of fading in view of the certain fade rate. In case the current status of the apparatus 2" is 'on' and the most recently received DALI command was "UP", the switch control apparatus 10" may be configured to determine, in response to the DALI command "DOWN" indicating a certain fade rate, an output control signal having a duration that is no shorter than a second predetermined duration t_L and which duration corresponds to the desired amount of fading in view of the certain fade rate.

[0064] The switch control apparatus 10" may comprise or may have an access to a memory that enables storing and accessing (e.g. writing and reading, respectively) information indicative of the current status of the apparatus 2' and/or the most recently received DALI command. The most recently received DALI command of the first or second subsets of DALI commands together with the knowledge of the initial status of the apparatus 2" (which may be assumed to be e.g. 'off') enables the switch control apparatus 10" to determine the status of the apparatus

2".

[0065] The procedures assigned to the input determination unit 12 and the output determination unit 14 as described hereinbefore may be divided between the units in a different manner, or the switch control apparatus 10 may comprise further units that may be configured to perform some of the procedures described hereinbefore for the input determination unit 12 and the output determination unit 14. On the other hand, the procedures the input determination unit 12 and the output determination unit 14 are configured to perform may be assigned to a single processing unit within the switch control apparatus 10 instead. In particular, the switch control apparatus 10 may comprise means for determining the duration of the input control signal, means for determining whether the duration of the input control signal exceeds a predetermined threshold, and means for determining the duration of an output control signal. The switch control apparatus 10 may further comprise means for providing the output control signal for an apparatus configured to control operation of a lamp. The means for determining the duration of an output control signal may be configured to, in response to the duration of the input control signal not exceeding the predetermined threshold, determine an output control signal having a first predetermined duration, and configured to determine, in response to the duration of the input control signal exceeding the predetermined threshold, an output control signal having a duration that is no shorter than a second predetermined duration, which second predetermined duration is longer than the first predetermined duration.

[0066] Figure 7 illustrates a method 100 in accordance with an embodiment of the invention. The method 100 may be arranged to control operation of a lamp, e.g. an electronic ballast configured to drive a fluorescent lamp or lighting equipment or a controller thereof of different type, for example a light emitting diode (LED), a high intensity discharge lamp (HID), etc. equipped with control arrangement that enables making use of control signals provided by the switch control apparatus 10. The method comprises receiving an input control signal, as indicated in step 102, and determining the duration of the input control signal, as indicated in step 104. The method 100 further comprises determining whether the duration of the input control signal exceeds a predetermined threshold, as indicated in step 106. The method 100 further comprises determining, in response to the duration of the input control signal not exceeding the predetermined threshold, an output control signal having a first predetermined duration, as indicated in step 108 and determining, in response to the duration of the input control signal exceeding the predetermined threshold, an output control signal having a duration that is no shorter than a second predetermined duration, which second predetermined duration is longer than the first predetermined duration, as indicated in step 110. The method 100 may further comprise providing the output control signal for an apparatus configured to control operation of the lamp,

such as an electronic ballast controlling operation of a fluorescent lamp.

[0067] The switch control apparatus 10, 10', 10" may be implemented as hardware alone, for example as an electric circuit, as a programmable or non-programmable processor, as a microcontroller, etc. The switch control apparatus 10, 10', 10" may have certain aspects implemented as software alone or can be implemented as a combination of hardware and software.

[0068] The switch control apparatus 10, 10', 10" may be implemented using instructions that enable hardware functionality, for example, by using executable computer program instructions in a general-purpose or special-purpose processor that may be stored on a computer readable storage medium to be executed by such a processor. The switch control apparatus may further comprise a memory as the computer readable storage medium the processor is configured to read from and write to. The memory may store a computer program comprising computer-executable instructions that control the operation of the switch control apparatus 10, 10', 10" when loaded into the processor. The processor is able to load and execute the computer program by reading the computer-executable instructions from memory

[0069] While the processor and the memory are hereinbefore referred to as single components, the processor may comprise one or more processors or processing units and the memory may comprise one or more memories or memory units. Consequently, the computer program, comprising one or more sequences of one or more instructions that, when executed by the one or more processors, cause an apparatus to perform steps implementing a method in accordance with an aspect of the invention.

[0070] Reference to a processor or a processing unit should not be understood to encompass only programmable processors, but also dedicated circuits such as field-programmable gate arrays (FPGA), application specific circuits (ASIC), signal processors, etc. Features described in the preceding description may be used in combinations other than the combinations explicitly described. Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not. Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

Claims

1. A switch control apparatus for controlling operation of a lamp on basis of an input control signal, the switch control apparatus comprising
an input determination unit configured to determine the duration of the input control signal, and
an output determination unit configured to determine whether the duration of the input control

- signal exceeds a predetermined threshold,
determine, in response to the duration of the input control signal not exceeding the predetermined threshold, an output control signal having a first predetermined duration,
determine, in response to the duration of the input control signal exceeding the predetermined threshold, an output control signal having a duration that is no shorter than a second predetermined duration, which second predetermined duration is longer than the first predetermined duration, and
provide the output control signal for an apparatus configured to control operation of the lamp.
2. A switch control apparatus according to any preceding claim, wherein said first predetermined duration is shorter than the predetermined threshold.
 3. A switch control apparatus according to any preceding claim, wherein said first predetermined duration is 250 milliseconds.
 4. A switch control apparatus according to any preceding claim, wherein said predetermined threshold is 350 milliseconds.
 5. A switch control apparatus according to any preceding claim, wherein the output determination unit is configured to determine an output control signal having a duration that is the maximum of the second predetermined duration and the determined duration of the input control signal.
 6. A switch control apparatus according to claim 5, wherein the second predetermined duration is 450 milliseconds.
 7. A switch control apparatus according to any preceding claim, wherein the output determination unit is further configured to, in response to the duration of the input control signal not exceeding a second predetermined threshold, determine that no output control signal is to be provided.
 8. A switch control apparatus according to any preceding claim, wherein the output determination unit is configured to provide the output control signal at least partially in parallel with reception of the input control signal.
 9. A switch control apparatus according to claim 8, wherein the output determination unit is configured to stop provision of the output control signal in response to detecting the end of the input control signal in case the accumulated duration of the output control signal exceeds the second predetermined duration.
 10. A switch control arrangement comprising a switch control apparatus according to any of claims 1 to 9,
wherein the switch control apparatus is coupled to a switch of an electric circuit, the electric circuit being configured to provide the input control signal to the switch control apparatus in response to said switch being closed, and
wherein the switch control apparatus is coupled to an electronic ballast, the electronic ballast being driven in accordance with the output control signal.
 11. A switch control arrangement according to claim 10, wherein the switch control apparatus is coupled to the electronic ballast via an electrically controllable switch, said electrically controllable switch being configured to control provision of a drive signal to the electronic ballast in accordance with the output control signal.
 12. A method for controlling operation of a lamp, the method comprising receiving an input control signal, determining the duration of the input control signal, determining whether the duration of the input control signal exceeds a predetermined threshold, determining, in response to the duration of the input control signal not exceeding the predetermined threshold, an output control signal having a first predetermined duration,
determining, in response to the duration of the input control signal exceeding the predetermined threshold, an output control signal having a duration that is no shorter than a second predetermined duration, which second predetermined duration is longer than the first predetermined duration, and
providing the output control signal for an apparatus configured to control operation of the lamp.
 13. A computer program for controlling operation of a lamp, the computer program including one or more sequences of one or more instructions which, when executed by one or more processors, cause an apparatus to at least perform the following:

determine the duration of the input control signal,
determine whether the duration of the input control signal exceeds a predetermined threshold,
determine, in response to the duration of the input control signal not exceeding the predetermined threshold, an output control signal having a first predetermined duration,
determine, in response to the duration of the input control signal exceeding the predetermined threshold, an output control signal having a duration that is no shorter than a second predetermined duration, which second predetermined

duration is longer than the first predetermined duration, and
provide the output control signal for an apparatus configured to control operation of the lamp.

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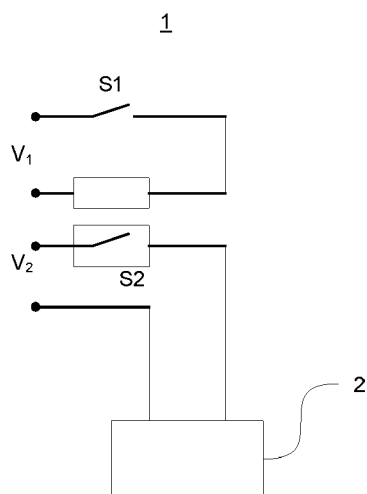


Figure 1

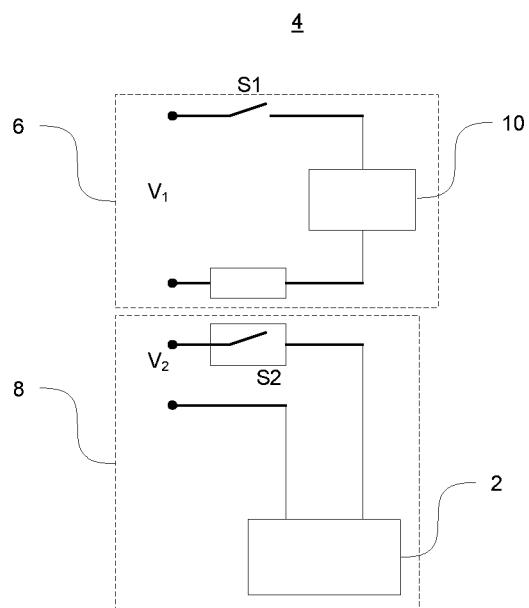


Figure 2

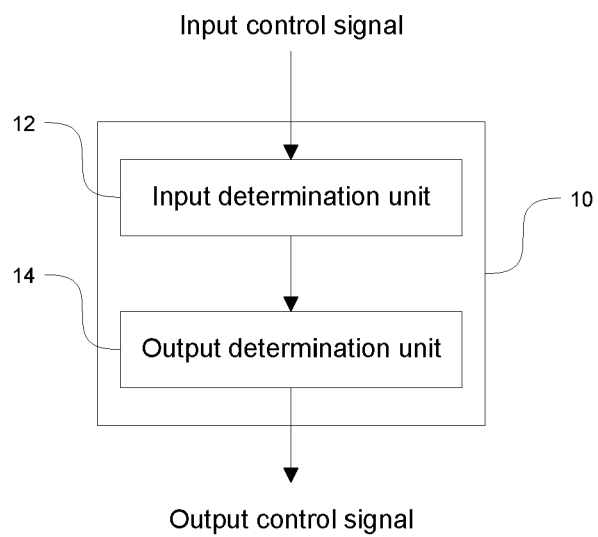


Figure 3

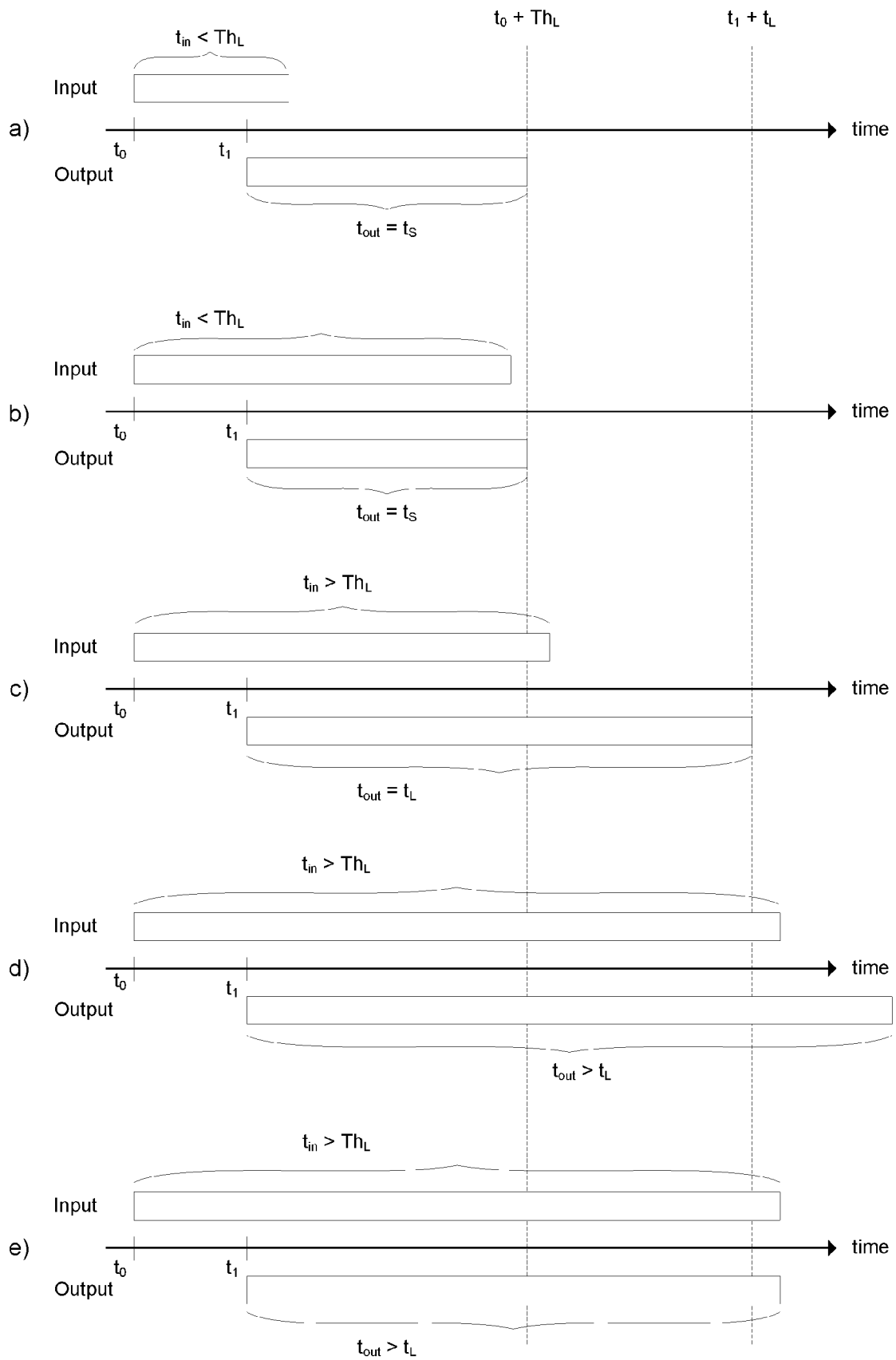


Figure 4

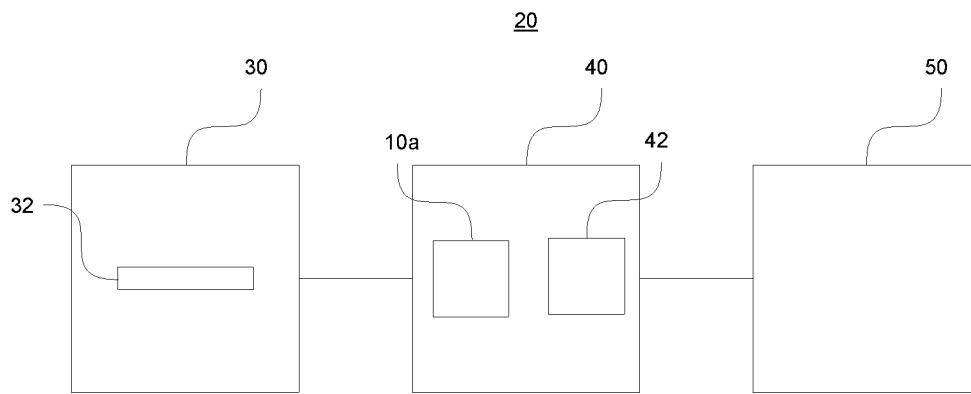


Figure 5

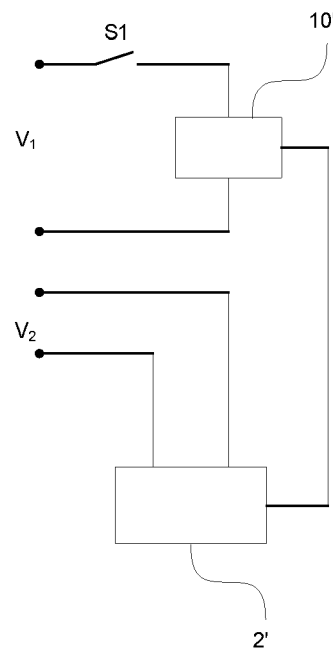


Figure 6a

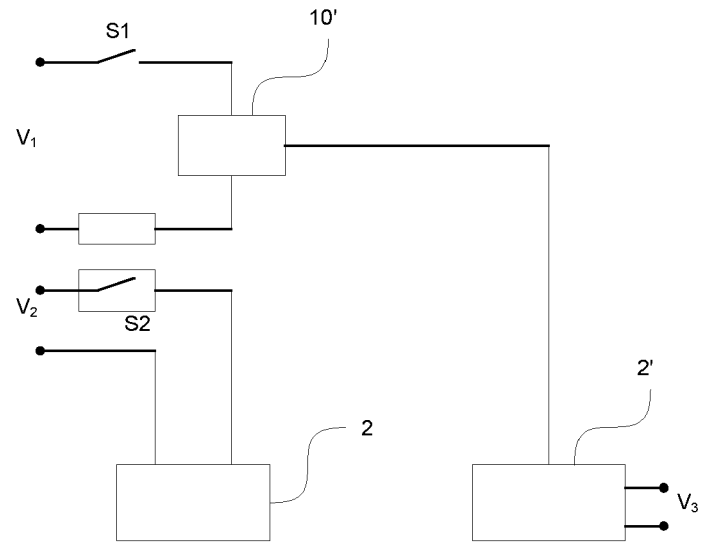


Figure 6b

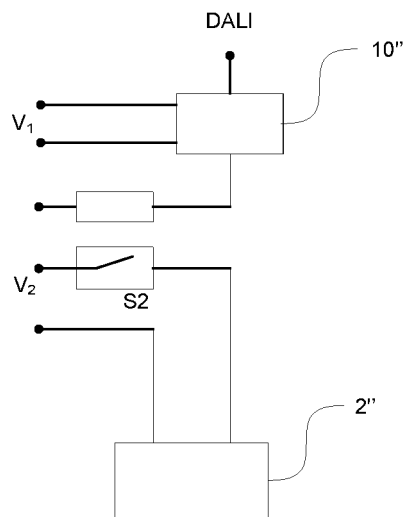


Figure 6c

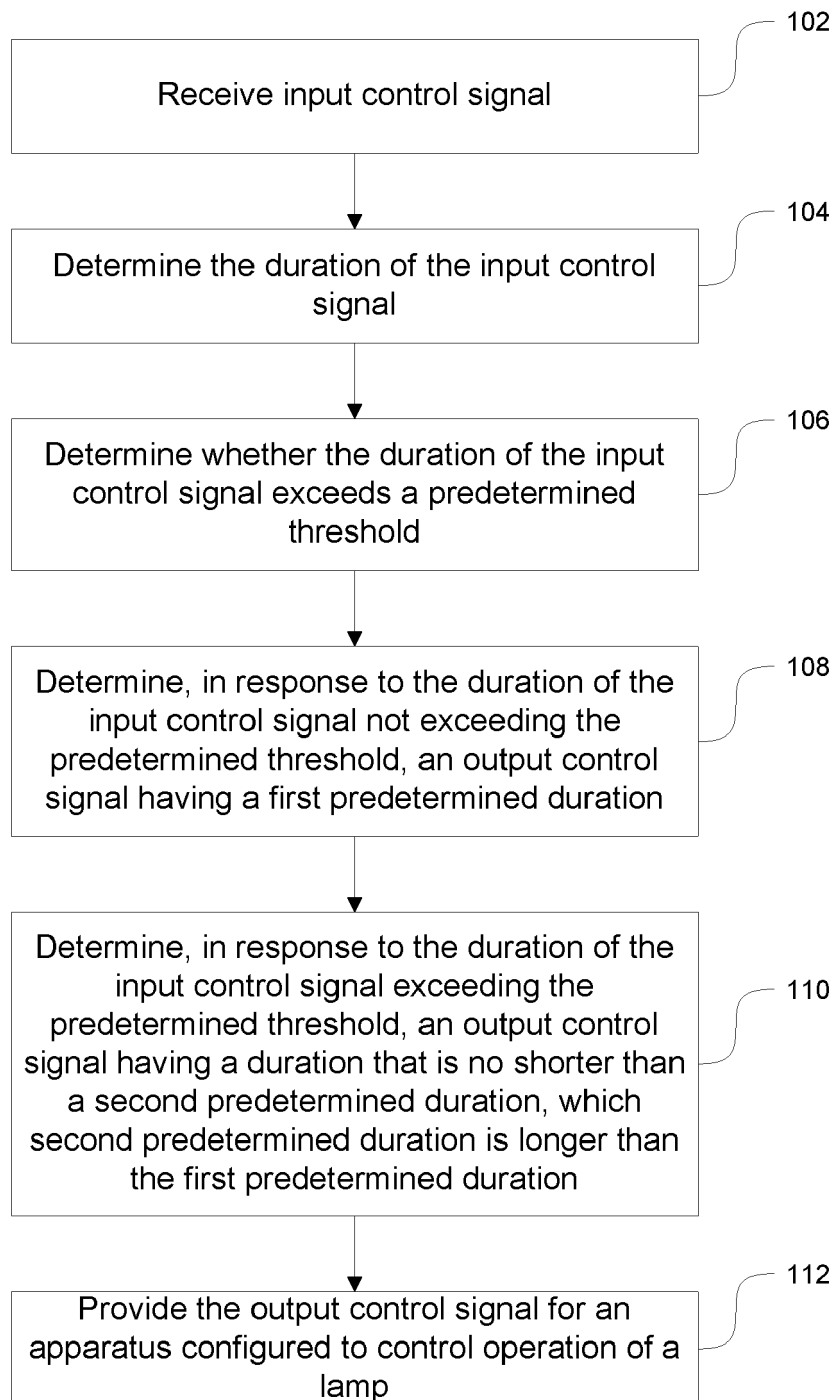
100

Figure 7



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Application Number
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