(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 495 648 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
12.06.2019 Bulletin 2019/24

(21) Application number: **18194533.8**

(22) Date of filing: **14.09.2018**

(51) Int Cl.:
F02D 41/20 *(2006.01)*
G05D 23/19 *(2006.01)*
G05F 1/45 *(2006.01)*
G05F 1/66 *(2006.01)*
F02P 19/02 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **08.12.2017 JP 2017236094**

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(54) POWER CONTROL DEVICE, POWER CONTROL SYSTEM, POWER CONTROL METHOD, AND POWER CONTROL PROGRAM

(57) Appropriate electrification control according to the number of control channels simultaneously outputting conduction control signals is realized without changing a control period. A power control device (10) includes a setting part (11), a calculation part (12) and a control part (13). The setting part (11) receives settings of the number of control channels simultaneously outputting conduction control signals and a control period. The calculation part (12) calculates an upper limit value of an electrification quantity and a delay time in starting of control of each control channel using a total number of control channels, the number of control channels simultaneously outputting the conduction control signals and the control period. The control part (13) executes conduction control and disconnection control for each control channel using the upper limit value of the electrification quantity of each control channel and the delay time in starting of control of each control channel.

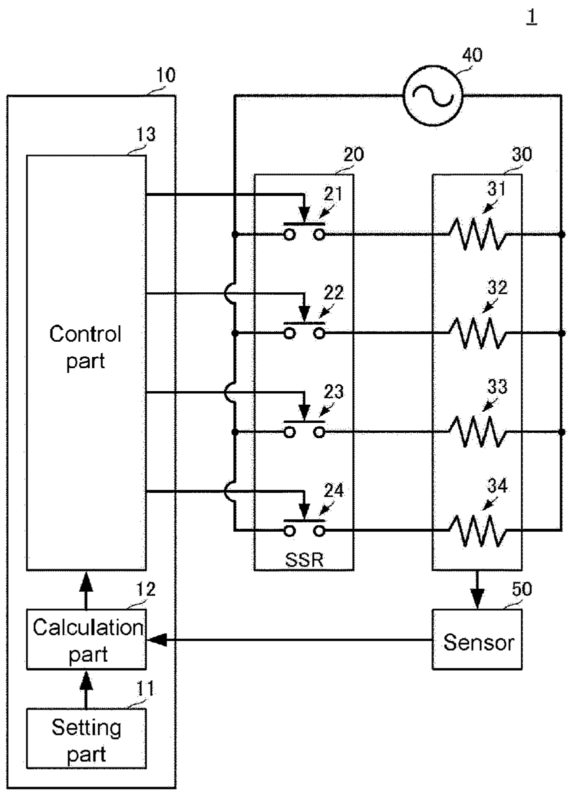

FIG. 1

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Description

BACKGROUND

Technical Field

[0001] The present disclosure relates to a technology of electrification control for loads such as heaters.

Description of Related Art

[0002] Patent Document 1 discloses a power control apparatus which controls electrifying time for a plurality of heaters. The power control apparatus includes a power control calculation part and a plurality of switch elements.

[0003] The plurality of switches are provided to correspond to the plurality of heaters one-to-one. The power control calculation part sets an individual control channel for each of the plurality of switch elements. The power control calculation part controls opening and closing of each of the plurality of switch elements using the control channel. In this manner, an electrifying time, that is, an electrification quantity, of each of the plurality of heaters is controlled.

Patent Documents

[0004] [Patent Document 1] JP 4407616

SUMMARY

[0005] In such a power control system, limitation of an electrification quantity for a load may be desired. For example, there are cases in which an overall peak current including a plurality of loads (e.g., heaters) is desired to be limited and the like. In such cases, switch elements which are simultaneously closed are limited. That is, the number of control channels which simultaneously output conduction control signals is limited.

[0006] However, in the conventional power control apparatus, it is difficult to arbitrarily vary control channels which simultaneously output conduction control signals with respect to the total number of control channels.

[0007] Accordingly, an objective of the present disclosure is to provide an electrification technology capable of performing appropriate electrification control in response to the number of control channels which simultaneously output conduction control signals.

[0008] According to an example of the present disclosure, a power control device includes a setting part, a calculation part, and a control part. The setting part receives a setting of the number of control channels simultaneously controlled to be conducted, and a setting of a control period. The calculation part calculates an upper limit value of an electrification quantity for each control channel and a delay time in starting of control of each control channel using a total number of control channels, the number of control channels simultaneously outputting conduction control signals, and the control period. The control part executes conduction control and disconnection control for each control channel using the upper limit value of the electrification quantity of each control channel and the delay time in starting of control of each control channel.

[0009] In this configuration, if the number of control channels simultaneously outputting the conduction control signals and the control period are input, time of conduction control of each control channel is automatically calculated. Accordingly, conduction control and disconnection control of each control channel according to limitations on electrification quantities of loads are realized.

[0010] In addition, according to an example of the present disclosure, the setting part receives setting of a delay time between control channels. The calculation part calculates an effective control period using a maximum number of available control channels, the delay time between control channels and the control period. The calculation part calculates the upper limit value of the electrification quantity of each control channel and the delay time in starting of control of each control channel on the basis of the effective control period.

[0011] In this configuration, time of conduction control of each control channel is automatically calculated taking into account the delay time between control channels. Accordingly, it is possible to restrain electrification quantities from exceeding limitation of electrification quantities of loads more reliably.

[0012] In addition, according to an example of the present disclosure, the calculation part acquires an electrification quantity according to calculation for feedback control for each control channel. The calculation part sets an effective electrification quantity of a control channel using the electrification quantity according to calculation for feedback control and the upper limit value of the electrification quantity.

[0013] In this configuration, it is possible to perform conduction control and disconnection control adapted to measured values of a plurality of loads while restraining electrification quantities from exceeding limitations of electrification quantities of loads.

[0014] According to the present disclosure, it is possible to perform appropriate control in response to the number of control channels for simultaneous conduction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

FIG. 1 is a functional block diagram showing an example of a power control system and a power control device according to an embodiment of the present disclosure.

FIG. 2 is a flowchart showing an example of a power control method according to an embodiment of the present disclosure.

FIG. 3 is a flowchart showing an example of a setting process and a calculation process in the power control method according to an embodiment of the present disclosure.

FIG. 4 is a flowchart showing an example of a calculation process in the power control method according to an embodiment of the present disclosure.

FIG. 5 is a timing chart showing an example of a first aspect of electrification control according to an embodiment of the present disclosure.

FIG. 6 is a timing chart showing an example of a second aspect of electrification control according to an embodiment of the present disclosure.

FIG. 7 is a timing chart showing an example of a third aspect of electrification control according to an embodiment of the present disclosure.

FIG. 8 is a timing chart showing an example of a fourth aspect of electrification control according to an embodiment of the present disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0016] Hereinafter, embodiments of the present disclosure will be described with reference to the drawings.

• Example of application

[0017] First, an example of application of a power control device according to an embodiment of the present disclosure will be described using the drawings.

[0018] FIG. 1 is a functional block diagram showing an example of a power control system and a power control device according to an embodiment of the present disclosure.

[0019] A power control device 10 includes a setting part 11, a calculation part 12 and a control part 13. The setting part 11 receives settings of a control period Ts and the number n of control channels which simultaneously output conduction control signals.

[0020] The calculation part 12 calculates an upper limit value tdm of an electrification quantity within the time of the control period Ts of each control channel, that is, upper limit value of electrification quantities of a switch element 21, a switch element 22, a switch element 23 and a switch element 24 using the control period Ts, the number n of simultaneously conducted control channels and a total number N of control channels controlled by the power control device 10 in a power control system 1. In addition, the calculation part 12 calculates a delay time tDN in starting of conduction control of each control channel with respect to a starting time of the control period Ts.

[0021] The control part 13 controls a period of conduction control and a period of disconnection control of each control channel using the upper limit value tdm of the electrification quantities and the delay time tDN. Accordingly, closing and opening of the switch element 21, the switch element 22, the switch element 23 and the switch element 24 of an SSR 20 are controlled and electrification quantities of a heater 31, a heater 32, a heater 33 and a heater 34 of a heating member 30 are controlled.

[0022] In this manner, conduction control and disconnection control of each control channel are automatically executed in response to the number of switch elements (the number of control channels) which are simultaneously controlled to be closed. Accordingly, it is possible to perform appropriate control according to a limitation of the electrification quantity of the heating member 30.

• Example of configuration

[0023] The power control device, the power control system, a power control method and a power control program according to an embodiment of the present disclosure will be described with reference to the drawings. As described above, FIG. 1 is a functional block diagram showing an example of the power control system and the power control device according to an embodiment of the present disclosure. Meanwhile, although a case in which the total number N of control channels, the number of switch elements and the number of heaters are 4 will be represented in the following description, the total number N of control channels, the number of switch elements and the number of heaters are not limited thereto as long as they are plural in number.

[0024] The power control system 1 includes the power control device 10, the SSR 20, the heating member 30, a power source 40, and a sensor 50. The power control device 10 includes the setting part 11, the calculation part 12 and the control part 13.

[0025] The SSR 20 includes the switch element 21, the switch element 22, the switch element 23 and the switch element 24. The heating member 30 includes the heater 31, the heater 32, the heater 33 and the heater 34.

[0026] The switch element 21 and the heater 31 are serially connected to constitute a first serial circuit. The switch element 22 and the heater 32 are serially connected to constitute a second serial circuit. The switch element 23 and the heater 33 are serially connected to constitute a third serial circuit. The switch element 24 and the heater 34 are serially connected to constitute a fourth serial circuit. The first serial circuit, the second serial circuit, the third serial circuit and the fourth serial circuit are connected parallel to the power source 40.

[0027] The switch element 21, the switch element 22, the switch element 23 and the switch element 24 are connected to the control part 13. The switch element 21 is closed or opened by receiving a control signal of a control channel CH1 from the control part 13. Accordingly, conduction or disconnection of the heater 31 and the power source 40 is controlled and an electrification quantity to the heater 31 is controlled. The switch element 22 is closed or opened by receiving a control signal of a control channel CH2 from the control part 13. Accordingly, conduction or disconnection of the heater 32 and the power source 40 is controlled and an electrification quantity to the heater 32 is controlled. The switch element 23 is closed or opened by receiving a control signal of a control channel CH3 from the control part 13. Accordingly, conduction or disconnection of the heater 33 and the power source 40 is controlled and an electrification quantity to the heater 33 is controlled. The switch element 24 is closed or opened by receiving a control signal of a control channel CH4 from the control part 13. Accordingly, conduction or disconnection of the heater 34 and the power source 40 is controlled and an electrification quantity to the heater 34 is controlled. These electrification quantities are set by conduction time, that is, time durations of the control signals for closing the switch elements.

[0028] The sensor 50 measures a temperature and the like of a heating target of the heating member 30 and outputs measurement data to the calculation part 12.

[0029] In this power control system 1, the power control device 10 includes the following configuration and executes the following control.

[0030] For example, the setting part 11 includes operators such as a mouse, a keyboard and a touch panel. The setting part 11 receives an operation input from a user and outputs the operation input to the calculation part 12. Specifically, the setting part 11 receives settings of the total number N of control channels, a control period Ts, and the number n of control channels simultaneously outputting conduction control signals from the user. Further, the total number N of control channels is not the total number of control channels included in the power control device 10 but is the total number of control channels connected to the heating member 30. Further, the setting part 11 receives setting of a delay time τb between control channels from the user.

[0031] The setting part 11 outputs the total number N of control channels, the control period Ts, the number n of control channels simultaneously outputting conduction control signals and the delay time τb between control channels to the calculation part 12.

[0032] For example, the calculation part 12 is realized by an information processing IC and a program installed in the IC.

[0033] The calculation part 12 calculates an effective control period Te using the total number N of control channels, the control period Ts, and the delay time τb between control channels. Specifically, the calculation part 12 calculates the effective control period Te as $Te=Ts+(\tau b \times N)$.

[0034] The calculation part 12 calculates upper limit value tdm of electrification quantities in the effective control period Te using the total number N of control channels and the number n of control channels simultaneously outputting conduction control signals. The upper limit value tdm of electrification quantities is set according to time (conduction time). Specifically, the calculation part 12 calculates the upper limit value tdm of electrification quantities as tdm=n/N. Further, the calculation part 12 calculates an upper limit value tdMm of an electrification quantity of each control channel M by dividing the upper limit value tdm of all electrification quantities by the number n of control channels simultaneously outputting the conduction control signals.

[0035] The calculation part 12 calculates a delay time tD in starting of control for each control channel using the effective control period Te and the total number N of control channels. Specifically, starting of control in order from a control channel having a smaller number in the effective control period Te is set, and the calculation part 12 calculates a delay time tDM in starting of control of a control channel M as $tDM=Te/(N \times (M-1))$.

[0036] In addition, the calculation part 12 performs calculation for feedback control of bringing a measured value (measured temperature) from the sensor 50 close to a target value (target temperature) using the measured value and calculates an electrification quantity of each control channel M in the next effective control period Te. For example, the calculation part 12 may employ PID control as feedback control. Meanwhile, a feedback control type is not limited to PID control.

[0037] The calculation part 12 compares the upper limit value tdMm of the electrification quantity of the control channel M with an electrification quantity obtained through calculation for feedback control of the control channel M. If the electrification quantity obtained through calculation for feedback control is equal to or less than the upper limit value tdMm of the electrification quantity, the calculation part 12 sets the electrification quantity obtained through calculation for feedback control to an effective electrification quantity td. If the electrification quantity obtained through calculation for feedback control is greater than the upper limit value tdMm of the electrification quantity, the calculation part 12 sets the upper limit value tdMm of the electrification quantity to the effective electrification quantity td.

[0038] The calculation part 12 outputs the effective control period Te, the effective electrification quantity (effective conduction time) td, and the delay time tDM in starting of control of the control channel M to the control part 13.

[0039] For example, the control part 13 is realized by an information processing IC having a timer function and a program installed in this IC. Meanwhile, the control part 13 may be formed using the IC same as the calculation part 12.

[0040] The control part 13 determines a conduction control signal output period for each control channel using the effective control period Te, the effective electrification quantity (effective conduction time) td, and the delay time tDM in starting of control of the control channel M. That is, the control part 13 executes conduction control and disconnection control for each control channel using the effective control period Te, the effective electrification quantity (effective conduction time) td, and the delay time tDM in starting of control of the control channel M.

[0041] It is possible to appropriately set the number of control channels simultaneously outputting the conduction control signals using the aforementioned configuration and process. In addition, it is possible to realize electrification control in response to the number of control channels simultaneously outputting the conduction control signals. Accordingly, it is possible to realize electrification control without exceeding the set upper limit value of electrification quantities.

[0042] Furthermore, it is possible to prevent the effective electrification quantity from excessively decreasing. Accordingly, it is possible to restrain occurrence of adverse effects such as unwanted delay of arrival at a target value and to realize appropriate electrification control according to feedback control.

[0043] Meanwhile, although an aspect in which the calculation part 12 and the control part 13 are realized using an IC has been shown in the above description, they may be realized by an information processing CPU, a program executed by the CPU, and an information processing device having a storage means storing the program. In this case, the information processing device may execute the process described below. FIG. 2 is a flowchart showing an example of a power control method according to an embodiment of the present disclosure. FIG. 3 is a flowchart showing an example of a setting process and a calculation process in the power control method according to an embodiment of the present disclosure. FIG. 4 is a flowchart showing an example of a calculation process in the power control method according to an embodiment of the present disclosure.

[0044] The information processing device executes the process shown in FIG. 2 as a schematic process. First, the information processing device sets control conditions (S11). Specifically, the information processing device calculates the effective control period Te using the total number N of control channels, the control period Ts and the delay time τb between control channels. In addition, the information processing device calculates the upper limit value tdm of electrification quantities in the effective control period Te using the total number N of control channels, and the number n of control channels simultaneously outputting the conduction control signals. Then, the information processing device calculates the upper limit value tdMm of an electrification quantity of each control channel M by dividing the upper limit value tdm of all electrification quantities by the number n of control channels simultaneously outputting the conduction control signals.

[0045] In addition, the information processing device calculates a delay time tD in starting of control for each control channel using the effective control period Te and the total number N of control channels. Further, the information processing device performs calculation for feedback control of bringing a measured value (measured temperature) from the sensor 50 close to a target value (target temperature) using the measured value and calculates an electrification quantity of each control channel M in the next effective control period Te.

[0046] Subsequently, the information processing device calculates an electrification quantity (effective electrification quantity td) for each control channel M (S12). Specifically, the information processing device compares the upper limit value tdMm of the electrification quantity of the control channel M with an electrification quantity obtained through the calculation of feedback control and calculates the electrification quantity (effective electrification quantity td) of each control channel, as described above.

[0047] Then, the information processing device executes control of conduction for each control channel M using the aforementioned control conditions and the electrification quantity (effective electrification quantity td) of each control channel M (S13).

[0048] For example, setting of the control conditions in step S11 is performed through the process shown in FIG. 3, for example.

[0049] First, the information processing device receives the total number N of control channels (S101). The information processing device receives the control period Ts (S102). The information processing device receives the number n of control channels simultaneously outputting the conduction control signals (S103). The information processing device receives the delay time τb between control channels (S104). Meanwhile, the order of execution of steps S101, S102, S103 and S104 by the information processing device is not limited to the aforementioned order.

[0050] Thereafter, the information processing device calculates the effective control period Te using the above-described method (S105).

[0051] Subsequently, the information processing device calculates the starting delay time tD for each control channel using the above-described method (S106). The information processing device calculates the upper limit value tdm of electrification quantities using the above-described method (S107). Meanwhile, the order of execution of steps S106 and S107 by the information processing device is not limited to the aforementioned order.

[0052] For example, calculation of the electrification quantity for each control channel in step S12 is executed through the process shown in FIG. 4.

[0053] The information processing device calculates an electrification quantity tdc according to calculation for feedback control (S201). The information processing device compares the electrification quantity tdc according to calculation for feedback control with the upper limit value tdMm of the electrification quantity of the control channel M. The information processing device sets the electrification quantity tdc as the effective electrification quantity td (S203) if the electrification quantity tdc is equal to or less than the upper limit value tdMm (S202: YES). The information processing device sets the upper limit value tdMm as the effective electrification quantity td (S203) if the electrification quantity tdc is greater than the upper limit value tdMm (S202: NO).

[0054] Next, specific aspects of control will be described using timing charts.

(1) Case in which the total number N of control channels is 4 (N=4) and the number n of control channels simultaneously outputting conduction control signal is 1 (n=1) FIG. 5 is a timing chart showing an example of a first aspect of electrification control according to an embodiment of the present disclosure.

[0055] In the aspect shown in FIG. 5, the total number N of control channels is 4 and the number n of control channels simultaneously outputting the conduction control signals is 1, as described above. In addition, a delay time between control channels is τb and a control period is Ts.

[0056] In this case, the effective control period Te=Ts+4τb. Further, upper limit values tdlm, td2m, td3m and td4m of electrification quantities for control channels CH1, CH2, CH3 and CH4 are calculated through the above-described method. In addition, delay times tD1, tD2, tD3 and tD4 in starting of control for the control channels CH1, CH2, CH3 and CH4 are calculated through the above-described method.

[0057] Further, in the case of FIG. 5, the electrification quantity according to calculation for feedback control is equal to or greater than the upper limit values in the control channels CH1 and CH3. Accordingly, effective electrification quantities td11 and td13 are set by the upper limit values td1m and td3m in the control channels CH1 and CH3. On the other hand, the electrification quantity according to calculation for feedback control is less than the upper limit values in the control channels CH2 and CH4. Accordingly, effective electrification quantities td12 and td14 are set by the electrification quantities according to calculation for feedback control in the control channels CH2 and CH4.

[0058] In a state in which the effective electrification quantities have been determined, conduction control is realized with the effective electrification quantity td11 from a time t11 having a delay time tD1 (substantially "0") with respect to a starting timing of the effective control period Te in the control channel CH1. Conduction control is realized with the effective electrification quantity td12 from a time t12 having a delay time tD2 with respect to the starting timing of the effective control period Te in the control channel CH2. Conduction control is realized with the effective electrification quantity td13 from a time t13 having a delay time tD3 with respect to the starting timing of the effective control period Te in the control channel CH3. Conduction control is realized with the effective electrification quantity td14 from a time t14 having a delay time tD4 with respect to the starting timing of the effective control period Te in the control channel CH4.

[0059] When control is performed in this manner, a period of conduction control of the control channel CH1, a period of conduction control of the control channel CH2, a period of conduction control of the control channel CH3 and a period of conduction control of the control channel CH4 do not overlap.

[0060] Accordingly, in a configuration in which the total number of control channels is 4, it is possible to reliably perform control of setting the number of control channels simultaneously outputting the conduction control signals to 1, that is, control in which upper limit values of electrification quantities have been designated according to such conduction control. In addition, it is possible to reliably realize feedback control for each control channel.

(2) Case in which the total number N of control channels is 4 (N=4) and the number n of control channels simultaneously outputting conduction control signal is 2 (n=2) FIG. 6 is a timing chart showing an example of a second aspect of electrification control according to an embodiment of the present disclosure.

[0061] In the aspect shown in FIG. 6, the total number N of control channels is 4 and the number n of control channels simultaneously outputting conduction control signal is 2, as described above. In addition, a delay time between control channels is τb=0 and a control period is Ts.

[0062] In this case, the effective control period Te=Ts. Further, upper limit values tdlm, td2m, td3m and td4m of electrification quantities for control channels CH1, CH2, CH3 and CH4 are calculated through the above-described method. In addition, delay times tD1, tD2, tD3 and tD4 in starting of control for the control channels CH1, CH2, CH3 and CH4 are calculated through the above-described method.

[0063] Further, in the case of FIG. 6, the electrification quantity according to calculation for feedback control is equal to or greater than the upper limit values in the control channels CH1 and CH3. Accordingly, effective electrification quantities td11 and td13 are set by the upper limit values td1m and td3m in the control channels CH1 and CH3. On the other hand, the electrification quantity according to calculation for feedback control is less than the upper limit values in the control channels CH2 and CH4. Accordingly, effective electrification quantities td12 and td14 are set by the electrification quantities according to calculation for feedback control in the control channels CH2 and CH4.

[0064] In a state in which the effective electrification quantities have been determined, conduction control is realized with the effective electrification quantity td11 from a time t11 having a delay time tD1 (substantially "0") with respect to a starting timing of the effective control period Te in the control channel CH1. Conduction control is realized with the effective electrification quantity td12 from a time t12 having a delay time tD2 with respect to the starting timing of the effective control period Te in the control channel CH2. Conduction control is realized with the effective electrification quantity td13 from a time t13 having a delay time tD3 with respect to the starting timing of the effective control period Te in the control channel CH3. Conduction control is realized with the effective electrification quantity td14 from a time t14 having a delay time tD4 with respect to the starting timing of the effective control period Te in the control channel CH4.

[0065] When such a control is performed, a period in which a period of conduction control of the control channel CH1 and a period of conduction control of the control channel CH2 overlap may be present. On the other hand, a period in which the period of conduction control of the control channel CH1 and a period of conduction control of the control channel CH3 overlap is not present.

[0066] Further, a period in which the period of conduction control of the control channel CH2 and the period of conduction control of the control channel CH3 overlap may be present. On the other hand, a period in which the period of conduction control of the control channel CH2 and a period of conduction control of the control channel CH4 overlap is not present.

[0067] In addition, a period in which the period of conduction control of the control channel CH3 and the period of conduction control of the control channel CH4 overlap may be present. On the other hand, a period in which the period of conduction control of the control channel CH3 and a period of conduction control of the control channel CH1 of the next effective control period overlap is not present.

[0068] Further, a period in which the period of conduction control of the control channel CH4 and the period of conduction control of the control channel CH1 of the next effective control period overlap may be present. On the other hand, a period in which the period of conduction control of the control channel CH4 and a period of conduction control of the control channel CH2 of the next effective control period overlap is not present.

[0069] In this manner, a period in which three or more control channels overlap and conduction control is performed is not present when performing this control.

[0070] Accordingly, in a configuration in which the total number of control channels is 4, it is possible to reliably perform control of setting the number of control channels simultaneously outputting the conduction control signals to 2, that is, control in which upper limit values of electrification quantities have been designated according to such conduction control. In addition, it is possible to reliably realize feedback control for each control channel.

(3) Case in which the total number N of control channels is 4 (N=4) and the number n of control channels simultaneously outputting conduction control signal is 3 (n=3) FIG. 7 is a timing chart showing an example of a third aspect of electrification control according to an embodiment of the present disclosure.

[0071] In the aspect shown in FIG. 7, the total number N of control channels is 4 and the number n of control channels simultaneously outputting conduction control signal is 3, as described above. In addition, a delay time between control channels is τb and a control period is Ts.

[0072] In this case, the effective control period Te=Ts+4τb. Further, upper limit values tdlm, td2m, td3m and td4m of electrification quantities for control channels CH1, CH2, CH3 and CH4 are calculated through the above-described method. In addition, delay times tD1, tD2, tD3 and tD4 in starting of control for the control channels CH1, CH2, CH3 and CH4 are calculated through the above-described method.

[0073] Further, in the case of FIG. 7, the electrification quantity according to calculation for feedback control is equal to or greater than the upper limit values in the control channels CH1 and CH2. Accordingly, effective electrification quantities td11 and td12 are set by the upper limit values td1m and td2m in the control channels CH1 and CH2. On the other hand, the electrification quantity according to calculation for feedback control is less than the upper limit values in the control channels CH3 and CH4. Accordingly, effective electrification quantities td13 and td14 are set by the electrification quantities according to calculation for feedback control in the control channels CH3 and CH4.

[0074] In a state in which the effective electrification quantities have been determined, conduction control is realized with the effective electrification quantity td11 from a time t11 having a delay time tD1 (substantially "0") with respect to a starting timing of the effective control period Te in the control channel CH1. Conduction control is realized with the effective electrification quantity td12 from a time t12 having a delay time tD2 with respect to the starting timing of the effective control period Te in the control channel CH2. Conduction control is realized with the effective electrification quantity td13 from a time t13 having a delay time tD3 with respect to the starting timing of the effective control period Te in the control channel CH3. Conduction control is realized with the effective electrification quantity td14 from a time t14 having a delay time tD4 with respect to the starting timing of the effective control period Te in the control channel CH4.

[0075] When control is performed in this manner, the number of control channels which are simultaneously controlled to be conducted is at most 3 and a period in which the 4 control channels simultaneously overlap and conduction control is performed is not present.

[0076] Accordingly, in a configuration in which the total number of control channels is 4, it is possible to reliably perform control of setting the number of control channels simultaneously outputting the conduction control signals to 3, that is, control in which upper limit values of electrification quantities have been designated according to such conduction control. In addition, it is possible to reliably realize feedback control for each control channel.

[0077] Meanwhile, in a configuration in which the total number of control channels is 4, normal feedback control may be executed when control of setting the number of control channels simultaneously outputting the conduction control signals to 4, that is, simultaneous electrification of all control channels connected to the heating member 30, can be performed.

(4) Case in which the total number N of control channels is 2 (N=2) and the number n of control channels

simultaneously outputting conduction control signal is 1 (n=1) FIG. 8 is a timing chart showing an example of a fourth aspect of electrification control according to an embodiment of the present disclosure.

[0078] In the aspect shown in FIG. 8, the total number N of control channels is 2 and the number n of control channels simultaneously outputting conduction control signal is 1, as described above. In addition, a delay time between control channels is τb and a control period is Ts.

[0079] In this case, the effective control period $Te=Ts+2\tau b$. Further, upper limit values td1m and td2m of electrification quantities for control channels CH1 and CH2 are calculated through the above-described method. In addition, delay times tD1 and tD2 in starting of control for the control channels CH1 and CH2 are calculated through the above-described method.

[0080] Further, in the case of FIG. 8, the electrification quantity according to calculation for feedback control is equal to or greater than the upper limit value in the control channel CH1. Accordingly, the effective electrification quantity td11 is set by the upper limit value td1m in the control channel CH1. On the other hand, the electrification quantity according to calculation for feedback control is less than the upper limit value in the control channel CH2. Accordingly, the effective electrification quantity td12 is set by the electrification quantity according to calculation for feedback control in the control channel CH2.

[0081] In a state in which the effective electrification quantities have been determined, conduction control is realized with the effective electrification quantity td11 from a time t11 having a delay time tD1 (substantially "0") with respect to a starting timing of the effective control period Te in the control channel CH1. Conduction control is realized with the effective electrification quantity td12 from a time t12 having a delay time tD2 with respect to the starting timing of the effective control period Te in the control channel CH2.

[0082] When such a control is performed, a period of conduction control of the control channel CH1 and a period of conduction control of the control channel CH2 do not overlap.

[0083] Accordingly, in a configuration in which the total number of control channels is set to 2, it is possible to reliably perform control of setting the number of control channels simultaneously outputting the conduction control signals to 1, that is, control in which upper limit values of electrification quantities is designated according to such conduction control. In addition, it is possible to reliably realize feedback control for each control channel.

[0084] Meanwhile, it is effective to execute the above-described process when feedback control is performed, and the process may not be executed when feedback control is not performed.

[0085] Furthermore, although a case of temperature control has been represented in the above description, the present disclosure is not limited to temperature control as long as a system which performs control of conduction and disconnection is adopted.

[Description of the Symbols]

[0086]

1	Power control system
10	Power control device
11	Setting part
12	Calculation part
13	Control part
20	SSR
21, 22, 23, 24	Switch element
30	Heating member
31, 32, 33, 34	Heater
40	Power source
50	Sensor

Claims

1. A power control device (10), **characterized in that** the power control device (10) comprises:

   a setting part (11) which receives a setting of the number of control channels (CH1, CH2, CH3, CH4) simultaneously outputting conduction control signals and a setting of a control period (Ts);
   a calculation part (12) which calculates an upper limit value (tdMm) of an electrification quantity for each control channel and a delay time (tDM) in starting of control of each control channel using a total number of control channels (CH1, CH2, CH3, CH4), the number of control channels (CH1, CH2, CH3, CH4) simultaneously outputting the conduction control signals, and the control period (Ts); and
   a control part (13) which executes conduction control and disconnection control for each control channel using the upper limit value (tdMm) of the electrification quantity of each control channel and the delay time (tDM) in starting of control of each control channel.

2. The power control device (10) according to claim 1, wherein the setting part (11) receives setting of a delay time (τb) between control channels (CH1, CH2, CH3, CH4), and the calculation part (12) calculates an effective control period (Te) using the total number of control channels (CH1, CH2, CH3, CH4), the delay time (τb) between control channels (CH1, CH2, CH3, CH4) and the control period (Ts) and calculates the upper limit value (tdMm) of the electrification quantity for each control channel and the delay time (tDM) in starting of control of each control channel on the basis of the effective control period (Te).

3. The power control device (10) according to claim 1 or 2, wherein the calculation part (12) calculates a conduction time according to calculation for feedback control for each control channel and sets an effective electrification quantity of the control channel using an electrification quantity according to the calculation for feedback control and the upper limit value (tdMm) of the electrification quantity.

4. The power control device (10) according to claim 3, wherein the calculation part (12) sets the effective electrification quantity of the control channel to the electrification quantity according to the calculation for feedback control if the electrification quantity according to the calculation for feedback control is equal to or less than the upper limit value (tdMm) of the electrification quantity.

5. The power control device (10) according to claim 3 or 4, wherein the calculation part (12) sets the effective electrification quantity of the control channel to the upper limit value (tdMm) of the electrification quantity if the electrification quantity according to the calculation for feedback control is equal to or greater than the upper limit value (tdMm) of the electrification quantity.

6. A power control system (1), **characterized in that** the power control system (1) comprises:

the power control device (10) according to any one of claims 1 to 5;
a plurality of loads (31, 32, 33, 34) controlled to be electrified;
a power source (40) which supplies power to the plurality of loads (31, 32, 33, 34); and
a plurality of switch elements (21, 22, 23, 24) which conduct or disconnect the power source and each of the plurality of loads (31, 32, 33, 34), the plurality of switch elements (21, 22, 23, 24) are controlled by the plurality of control channels (CH1, CH2, CH3, CH4).

7. The power control system (1) according to claim 6, comprising a sensor (50) which measures states of the loads (31, 32, 33, 34) and feeds back the states to the calculation part (12).

8. A power control method, **characterized in that** the power control method comprises:

receiving a setting of a number of control channels (CH1, CH2, CH3, CH4) simultaneously outputting conduction control signals and a setting of a control period (Ts);
calculating an upper limit value (tdMm) of an electrification quantity of each control channel and a delay time (tDM) in starting of control of each control channel using a maximum number of available control channels (CH1, CH2, CH3, CH4), the number of control channels (CH1, CH2, CH3, CH4) simultaneously outputting the conduction control signals, and the control period (Ts); and
executing conduction control and disconnection control for each control channel using the upper limit value (tdMm) of the electrification quantity for each control channel and the delay time (tDM) in starting of control for each control channel.

9. A power control program, **characterized in that** the power control program causes an information processing device to execute:

a process of receiving a setting of a number of control channels (CH1, CH2, CH3, CH4) simultaneously outputting conduction control signals and a setting of a control period (Ts);
a process of calculating an upper limit value (tdMm) of an electrification quantity of each control channel and a delay time (tDM) in starting of control of each control channel using a total number of control channels (CH1, CH2, CH3, CH4), the number of control channels (CH1, CH2, CH3, CH4) simultaneously outputting the conduction control signals, and the control period (Ts); and
a process of executing conduction control and disconnection control for each control channel using the upper limit value (tdMm) of the electrification quantity of each control channel and the delay time (tDM) in starting of control of each control channel.

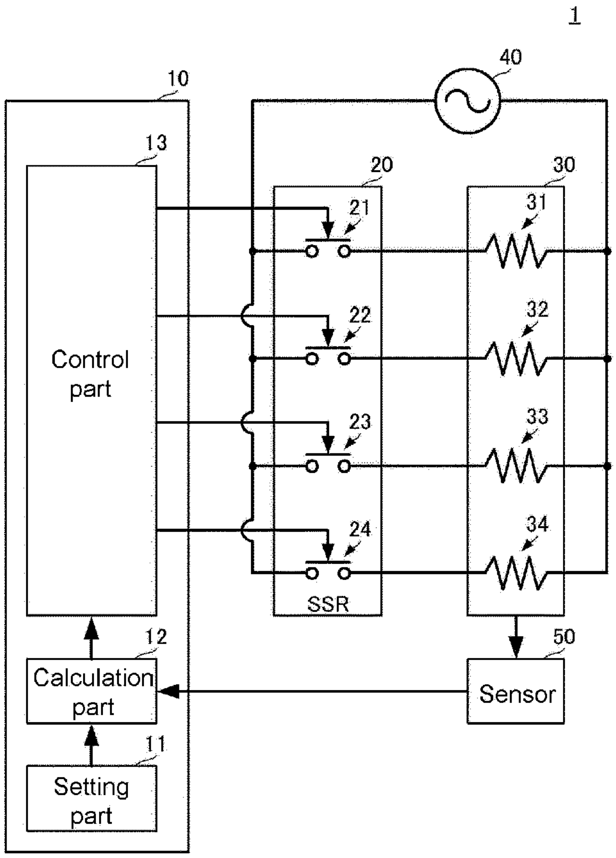
1
40
10
13
20
30
21
31
22
32
Control part
23
33
24
34
SSR
12
50
Calculation part
Sensor
11
Setting part

FIG. 1

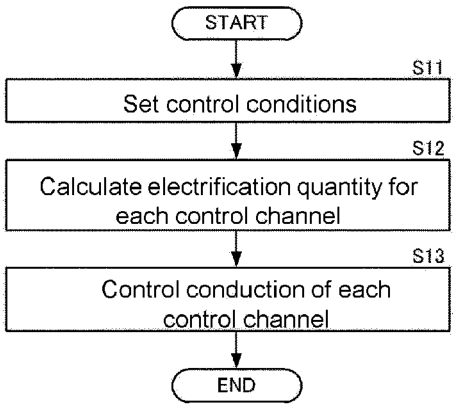
START
S11
Set control conditions
S12
Calculate electrification quantity for each control channel
S13
Control conduction of each control channel
END

FIG. 2

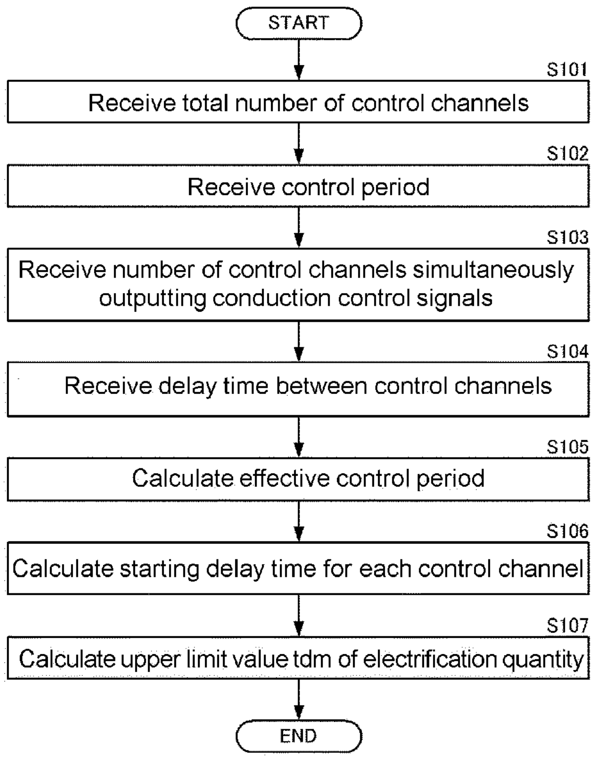
START
S101
Receive total number of control channels
S102
Receive control period
S103
Receive number of control channels simultaneously outputting conduction control signals
S104
Receive delay time between control channels
S105
Calculate effective control period
S106
Calculate starting delay time for each control channel
S107
Calculate upper limit value tdm of electrification quantity
END

FIG. 3

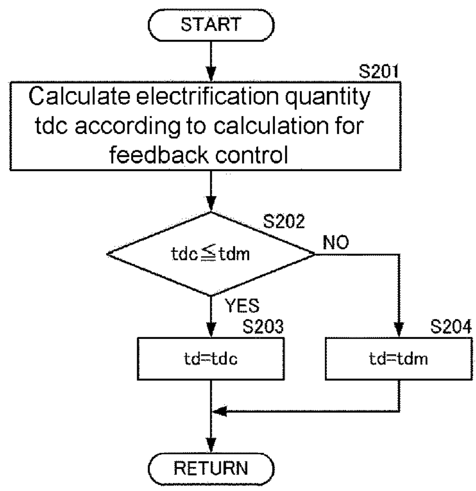
START
S201
Calculate electrification quantity tdc according to calculation for feedback control
S202
tdc≦tdm
NO
YES
S203
td=tdc
S204
td=tdm
RETURN

FIG. 4

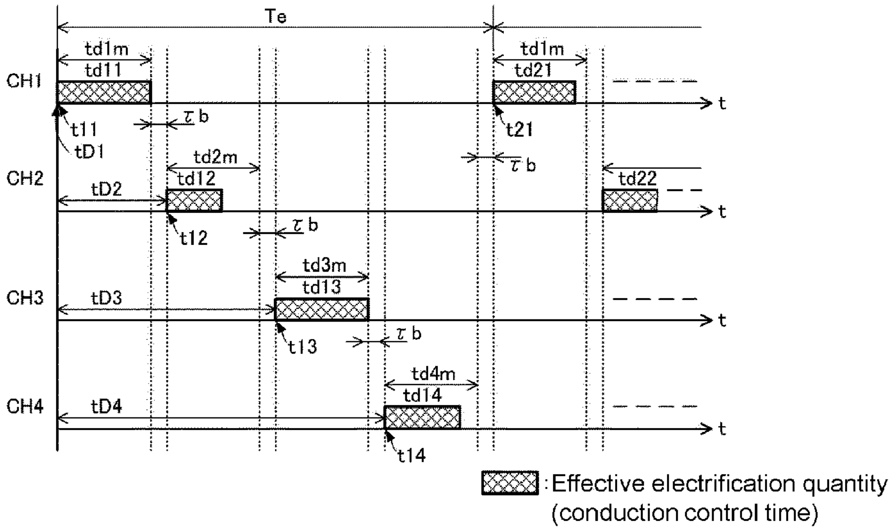
Te
td1m
td11
CH1
t11
tD1
τb
td1m
td21
t21
td2m
td12
CH2
tD2
t12
τb
td22
td3m
td13
CH3
tD3
t13
τb
td4m
td14
CH4
tD4
t14
t
:Effective electrification quantity
(conduction control time)

FIG. 5

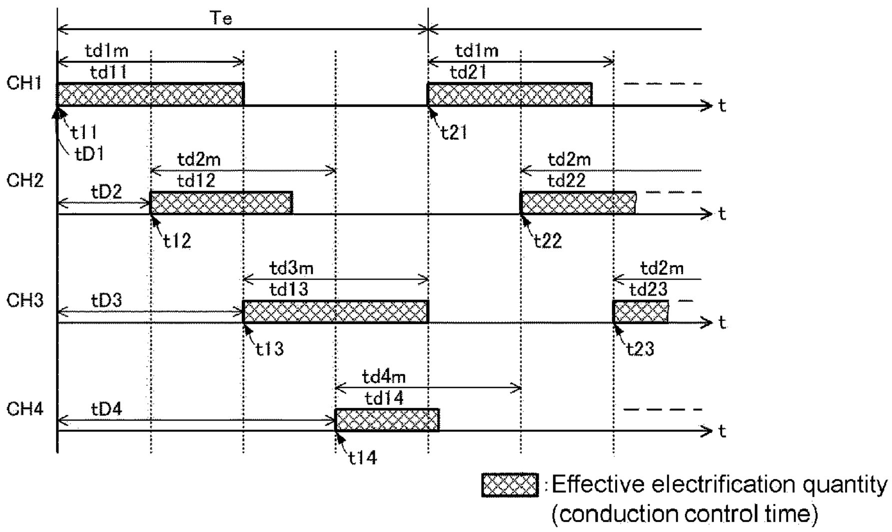
Te
td1m
td11
CH1
t11
tD1
td1m
td21
t21
td2m
td12
CH2
tD2
t12
td2m
td22
t22
td3m
td13
CH3
tD3
t13
td2m
td23
t23
td4m
td14
CH4
tD4
t14
t
:Effective electrification quantity
(conduction control time)

FIG. 6

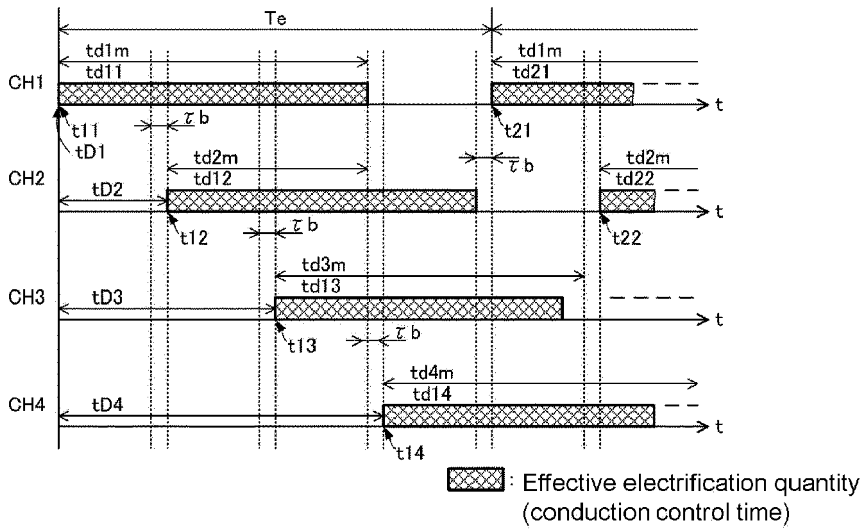
Te
td1m
td11
CH1
t
t11
tD1
τb
td1m
td21
t21
τb
td2m
td12
CH2
tD2
t12
τb
td2m
td22
t22
td3m
td13
CH3
tD3
t13
τb
td4m
td14
CH4
tD4
t14
: Effective electrification quantity
(conduction control time)

FIG. 7

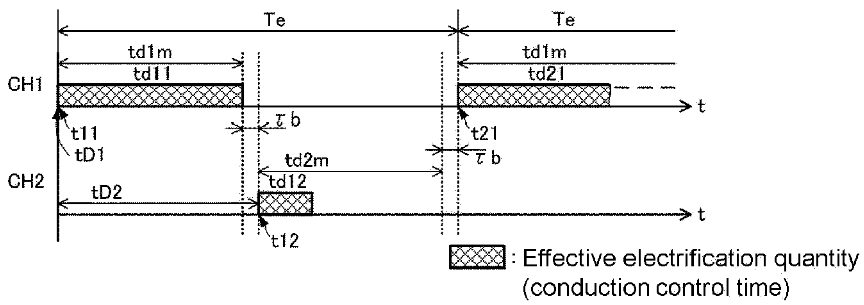
Te
Te
td1m
td11
CH1
td1m
td21
t
t11
tD1
τb
t21
τb
td2m
td12
CH2
tD2
t12
: Effective electrification quantity
(conduction control time)

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 18 19 4533

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2004/099653 A1 (HIRAYAMA HIROFUMI [JP] ET AL) 27 May 2004 (2004-05-27) * abstract; figures 5,17-22 * * paragraph [0056] - paragraph [0064] * * paragraph [0166] - paragraph [0208] *	1-9	INV. F02D41/20 G05D23/19 G05F1/45 G05F1/66 F02P19/02
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F02D
G05F
G05D
F02P

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	22 March 2019	Van der Staay, Frank

CATEGORY OF CITED DOCUMENTS

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22-03-2019

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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