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(54) **CONTROL BOARD AND WATER HEATER**

(57) The invention relates to a field of control technology, and provides a control board and a water heater. The control board includes: a primary control device, a fixed-frequency-fan relay device and a variable-frequency-heat-pump drive device. The fixed-frequency-fan relay device is connected to the primary control device, and is configured to, according to control instructions of the primary control device, drive a fixed-frequency fan to operate. The variable-frequency-heat-pump drive device is connected to the primary control device, and is configured to, according to control instructions of the primary control device, drive a variable-frequency heat pump to operate. The control board is disposed outside the fixed-frequency fan and the variable-frequency heat pump. Optionally, the control board integrated with the variable-frequency-heat-pump drive device can be disposed outside the variable-frequency heat pump, to make the variable-frequency-heat-pump drive device far away from a heat source, to avoid an influence of a heated internal environment of the variable-frequency heat pump on the variable-frequency-heat-pump drive device, and at the same time to help heat dissipations of heating elements of the variable-frequency-heat-pump drive device, and thus an operation stability of the variable-frequency-heat-pump drive device is improved.

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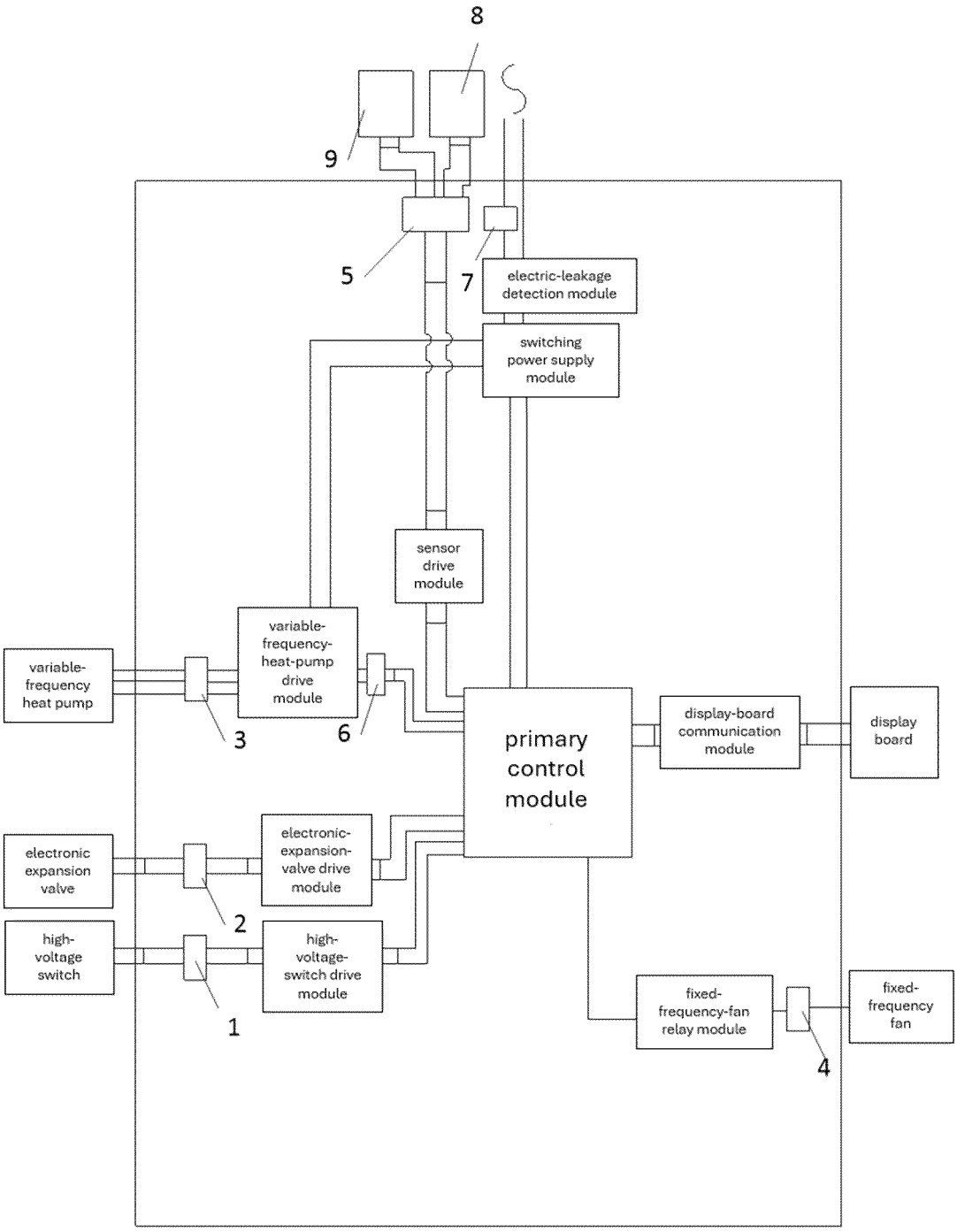
8
9
5
7
electric-leakage detection module
switching power supply module
sensor drive module
variable-frequency-heat-pump drive module
variable-frequency heat pump
3
6
primary control module
display-board communication module
display board
electronic-expansion-valve drive module
electronic expansion valve
2
high-voltage switch
high-voltage-switch drive module
1
fixed-frequency-fan relay module
fixed-frequency fan
4

Fig. 1

Description

TECHNICAL FIELD

[0001] The invention relates to a field of control technology, and in particular to a control board and a water heater.

BACKGROUND

[0002] At present, for an apparatus using a variable-frequency heat pump, a variable-frequency-heat-pump drive module is installed inside a compressor of the variable-frequency heat pump. A compressor motor of the variable-frequency heat pump will generate heat during operation. In addition, the variable-frequency-heat-pump drive module usually also comprises heating elements such as IGBT (Insulated Gate Bipolar Transistor) or MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor) or IPM (Intelligent Power Module), which themselves will also heat up.

[0003] The compressor of the variable-frequency heat pump in which the variable-frequency-heat-pump drive module is located will generate heat, as well as the heating element of the variable-frequency-heat-pump drive module will generate heat, and thus normal operations of the variable-frequency-heat-pump drive module will be affected.

SUMMARY

[0004] The invention aims to solve at least one of the existing technical problems in the related art. To this end, the invention proposes a control board. The control board integrated with the variable-frequency-heat-pump drive module can be disposed outside the variable-frequency heat pump, to make the variable-frequency-heat-pump drive module far away from a heat source, to avoid an influence of a heated internal environment of the variable-frequency heat pump on the variable-frequency-heat-pump drive module, and at the same time to help heat dissipations of heating elements of the variable-frequency-heat-pump drive module, and thus an operation stability of the variable-frequency-heat-pump drive module is improved.

[0005] A water heater is also provided according to an embodiment of the invention.

[0006] The control board according to a first aspect of the invention comprises: a primary control module, a fixed-frequency-fan relay module and a variable-frequency-heat-pump drive module. The fixed-frequency-fan relay module is connected to the primary control module and is configured to, according to a control instruction of the primary control module, drive a fixed-frequency fan to operate. The variable-frequency-heat-pump drive module is connected to the primary control module and is configured to, according to a control instruction of the primary control module, drive a variable-frequency heat pump to operate. The control board is disposed outside the fixed-frequency fan and the variable-frequency heat pump.

[0007] The control board according to an embodiment of the invention comprises: a primary control module, a fixed-frequency-fan relay module and a variable-frequency-heat-pump drive module. The fixed-frequency-fan relay module is connected to the primary control module, and is configured to, according to control instructions of the primary control module, drive a fixed-frequency fan to operate. The variable-frequency-heat-pump drive module is connected to the primary control module, and is configured to, according to the control instructions of the primary control module, drive a variable-frequency heat pump to operate. The control board is disposed outside the fixed-frequency fan and the variable-frequency heat pump. The control board integrated with the variable-frequency-heat-pump drive module can be disposed outside the variable-frequency heat pump, to make the variable-frequency-heat-pump drive module far away from a heat source, to avoid an influence of a heated internal environment of the variable-frequency heat pump on the variable-frequency-heat-pump drive module, and at the same time to help heat dissipations of heating elements of the variable-frequency-heat-pump drive module, and thus an operation stability of the variable-frequency-heat-pump drive module is improved.

[0008] Furthermore, since a traditional driving method uses measures such as disposing a heat sink to dissipate heat from the heating elements, a cost for heat dissipation is caused to be increased. In the invention, the cost for heat dissipation can be reduced without using the heat sink.

[0009] Furthermore, since the variable-frequency-heat-pump drive module is usually integrated on the compressor motor of the variable-frequency heat pump, a size of the compressor motor will be relatively large, which will lead to a higher cost of structural components for fixing the compressor motor. In the present invention, the variable-frequency-heat-pump drive module is separated from the compressor motor of the variable-frequency heat pump, and thus a height of the compressor motor is reduced, and a size of the compressor motor and a used material amount for body of the compressor motor are reduced, to help reduce a cost for fixing the compressor motor and a cost for manufacturing the compressor motor.

[0010] Furthermore, since a traditional drive method is to dispose drive modules in a heat pump and a fan respectively to drive the heat pump and the fan, it is not conducive to a unified control and maintenance of the drive modules. In the present invention, the drive modules in the heat pump and the fan are integrated into a same control board, which facilitates the unified control of the drive modules by a same primary control module and is conducive to the unified maintenance of various drive modules.

[0011] Optionally, the control board further may com-

prise a variable-frequency-heat-pump interface. The variable-frequency-heat-pump drive module is connected to a three-phase motor of the variable-frequency heat pump through the variable-frequency-heat-pump interface.

[0012] Optionally, the variable-frequency-heat-pump drive module may communicate with the primary control module through an universal asynchronous receiver-transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

[0013] Optionally, the control board may further comprise a fixed-frequency-fan interface. The fixed-frequency-fan relay module is connected to the fixed-frequency fan through the fixed-frequency-fan interface.

[0014] Optionally, the control board may further comprise a switching power supply module and an optical coupling isolation module. The variable-frequency heat pump is a high-voltage variable-frequency heat pump. A first end of the switching power supply module is connected to a Mains supply, a second end of the switching power supply module is connected to the primary control module in an isolated manner, and a third end of the switching power supply is connected to the variable-frequency-heat-pump drive module. The optical coupling isolation module is connected between the variable-frequency-heat-pump drive module and the primary control module in a non-isolated manner.

[0015] Optionally, the control board may further comprise a switching power supply module. The variable-frequency heat pump is a low-voltage variable-frequency heat pump. A first end of the switching power supply module is connected to a Mains supply, a second end of the switching power supply module is connected to the primary control module in an isolated manner. A third end of the switching power supply is connected to the variable-frequency-heat-pump drive module in an isolated manner.

[0016] Optionally, the control board may further comprise an electronic-expansion-valve drive module and an electronic-expansion-valve interface. An end of the electronic-expansion-valve drive module is connected to the primary control module, and another end of the electronic-expansion-valve drive module is connected to an electronic expansion valve through the electronic-expansion-valve interface.

[0017] Optionally, the control board according to an embodiment of the invention may further comprise an electric-leakage detection module, a current detection module, a sensor drive module, a high-voltage-switch drive module, a display-board communication module, a sensor interface and a high-voltage-switch interface. The electric-leakage detection module is connected between the switching power supply module and the Mains supply. The current detection module is connected between the electric-leakage detection module and the Mains supply. An end of the sensor drive module is connected to the primary control module, and another end of the sensor drive module is connected to temperature sensors at different positions through the sensor interface; an end of the high-voltage-switch drive module is connected to the primary control module, and another end of the high-voltage-switch drive module is connected to a high-voltage switch through the high-voltage-switch interface. An end of the display-board communication module is connected to the primary control module, and another end of the display-board communication module is connected to a display board.

[0018] The water heater according to a second aspect of the invention comprises the control board described in the first aspect.

[0019] Optionally, the water heater according to an embodiment of the invention may further comprise: a fixed-frequency fan, a variable-frequency heat pump, an electronic expansion valve, a temperature sensor, a high-voltage switch and a display board.

[0020] The above one or more technical solutions in the embodiments of the invention have at least one of the following technical effects.

[0021] The control board according to the invention comprises: a primary control module, a fixed-frequency-fan relay module and a variable-frequency-heat-pump drive module. The fixed-frequency-fan relay module is connected to the primary control module, and is configured to, according to control instructions of the primary control module, drive a fixed-frequency fan to operate. The variable-frequency-heat-pump drive module is connected to the primary control module, and is configured to, according to the control instructions of the primary control module, drive a variable-frequency heat pump to operate. The control board is disposed outside the fixed-frequency fan and the variable-frequency heat pump. The control board integrated with the variable-frequency-heat-pump drive module can be disposed outside the variable-frequency heat pump, to make the variable-frequency-heat-pump drive module far away from a heat source, to avoid an influence of a heated internal environment of the variable-frequency heat pump on the variable-frequency-heat-pump drive module, and at the same time to help heat dissipations of heating elements of the variable-frequency-heat-pump drive module, and thus an operation stability of the variable-frequency-heat-pump drive module is improved.

[0022] Furthermore, since a traditional driving method uses measures such as disposing a heat sink to dissipate heat from the heating elements, a cost for heat dissipation is caused to be increased. In the invention, the cost for heat dissipation can be reduced without using the heat sink.

[0023] Furthermore, since the variable-frequency-heat-pump drive module is usually integrated on the compressor motor of the variable-frequency heat pump, a size of the compressor motor will be relatively large, which will lead to a higher cost of structural components for fixing the compressor motor. In the present invention, the variable-frequency-heat-pump drive module is separated from the compressor motor of the variable-fre-

quency heat pump, and thus a height of the compressor motor is reduced, and a size of the compressor motor and a used material amount for body of the compressor motor are reduced, to help reduce a cost for fixing the compressor motor and a cost for manufacturing the compressor motor.

[0024] Furthermore, since a traditional drive method is to dispose drive modules in a heat pump and a fan respectively to drive the heat pump and the fan, it is not conducive to a unified control and maintenance of the drive modules. In the present invention, the drive modules in the heat pump and the fan are integrated into a same control board, which facilitates the unified control of the drive modules by a same primary control module and is conducive to the unified maintenance of various drive modules.

[0025] Some of additional aspects and advantages of the invention will be given in the following description, and some will become apparent from the following description, or will be learned through the practice of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0026] In order to more clearly illustrate the embodiments of the invention or the technical solutions in the related art, the accompanying drawings required for use in the description for the embodiments or the related art will be briefly introduced below. Obviously, the accompanying drawings described below are only some embodiments of the invention. For those skilled in the art, other accompanying drawings can be obtained based on these drawings without creative work.

[0027] FIG. 1 shows a circuit diagram of a control board according to an embodiment of the invention.

[0028] In the accompanying drawings, corresponding relationships between reference signs and component names in FIG. 1 are as follows:

[0029] 1, high-voltage-switch interface; 2, electronic-expansion-valve interface; 3, variable-frequency-heat-pump interface; 4, fixed-frequency-fan interface; 5, sensor interface; 6, optical coupling isolation module; 7, current detection module; 8, first position temperature sensor; 9, second position temperature sensor.

DESCRIPTION OF EMBODIMENTS

[0030] The embodiments of the invention are further described in detail below in conjunction with the drawings and examples. The following examples are used to illustrate the invention, but are not intended to limit the scope sought for by the invention.

[0031] In the description of the embodiments of the invention, it should be noted that the terms "center", "longitudinal", "lateral", "up", "down", "front", "back", "left", "right", "vertical", "horizontal", "top", "bottom", "inside" and "outside" and so on indicates orientations or positional relationships based on orientations or positional relationships shown in the accompanying drawings, and are only for the convenience of describing the embodiments of the invention and simplifying the description, and do not indicate or imply that the referred module or element must have a specific orientation, be constructed and operated in a specific orientation, and therefore cannot be understood as a limitation at the embodiments of the invention. Furthermore, the terms "first", "second", and "third" are used for descriptive purposes only and should not be understood as indicating or implying relative importance.

[0032] In the description of the embodiments of the present invention, it should be noted that, unless otherwise clearly stipulated and limited, the terms "connected" and "connection" should be understood in a broad sense. For example, it can be a fixed connection, a detachable connection, or an integral connection; it can be a mechanical connection or an electrical connection; it can be a direct connection or an indirect connection through an intermediate medium. For those skilled in the art, the specific meanings of the above terms in the embodiments of the present invention can be understood according to specific circumstances.

[0033] In the embodiments of the invention, unless otherwise clearly specified and limited, a first feature being "at" or "under" a second feature may indicate that the first feature and second feature are in direct contact, or the first feature and second feature are in indirect contact through an intermediate medium. Moreover, a first feature being "above", "over" and "at" the second feature may indicate that the first feature is directly above or obliquely above the second feature, or simply indicates that the first feature is higher in horizontal height than the second feature. A first feature being "below," "beneath," or "under" a second feature may indicate that the first feature is directly below or diagonally below the second feature, or simply indicate that the first feature is lower in horizontal height than the second feature.

[0034] In the description of this specification, the description with reference to the terms "one embodiment", "some embodiments", "example", "specific example", or "some examples" and so on means that the specific features, structures, materials or characteristics described in conjunction with the embodiment or example are comprised in at least one embodiment or example of the invention. In the present specification, the exemplary expressions of the above terms do not necessarily refer to the same embodiment or example. Furthermore, the specific features, structures, materials, or characteristics described may be combined in any suitable manner in any one or more embodiments or examples. Furthermore, those skilled in the art may combine and associate different embodiments or examples and features of different embodiments or examples described in this specification without mutual contradiction.

[0035] FIG. 1 shows a circuit diagram of a control board according to an embodiment of the invention. As shown in FIG.1, a control board is provided according to an em-

bodiment of the invention, which may comprise: a primary control module; a fixed-frequency-fan relay module, connected to the primary control module and configured to drive a fixed-frequency fan to operate according to a control instruction of the primary control module; and a variable-frequency-heat-pump drive module, connected to the primary control module and configured to drive a variable-frequency heat pump to operate according to an control instruction of the primary control module.

[0036] The control board is disposed outside the fixed-frequency fan and the variable-frequency heat pump.

[0037] The control board according to some embodiments of the invention can be applied to the field of mechanical apparatus such as heat-pump water heaters. Considering a drive of a heat pump, it is to drive a compressor of the heat pump.

[0038] Heat of a compressor motor of the variable-frequency heat pump is mainly generated from the following:

1. A magnetic flux will cause hysteresis loss and eddy current loss in a motor core, to generate heat;
2. A current in a motor winding will generate Joule heat, to cause the motor winding to generate heat; and
3. Motor bearings are subjected to friction and inertia, to generate heat.

[0039] In addition, heat of the heating elements in the variable-frequency-heat-pump drive module are mainly generated from the following:

1. IGBT (Insulated Gate Bipolar Transistor) or MOSFET (Metal-Oxide-Semiconductor Field-Effect Transistor) or IPM (Intelligent Power Module), upon turned on, has a resistance therein, and Joule heat is generated upon current passes therethrough, and thus the heat is generated;
2. A high-frequency switch is required for the heating elements to be switched on and off, and thus a great amount of heat is generated;
3. A higher off-voltage is required for the heating elements to be turned off, and thus a great amount of heat is generated; and
4. The heating elements have high operating temperatures, to lead to increases of on-resistance and off-voltage thereof, and thus a great amount of heat is generated.

[0040] The control board according to the invention comprises: a primary control module, a fixed-frequency-fan relay module and a variable-frequency-heat-pump drive module. The fixed-frequency-fan relay module is connected to the primary control module, and is configured to drive a fixed-frequency fan to operate according to control instructions of the primary control module. The variable-frequency-heat-pump drive module is connected to the primary control module, and is configured to drive a variable-frequency heat pump to operate according to control instructions of the primary control module. The control board is disposed outside the fixed-frequency fan and the variable-frequency heat pump. The control board integrated with the variable-frequency-heat-pump drive module can be disposed outside the variable-frequency heat pump, to make the variable-frequency-heat-pump drive module far away from a heat source, to avoid an influence of a heated internal environment of the variable-frequency heat pump on the variable-frequency-heat-pump drive module, and at the same time to help heat dissipations of heating elements of the variable-frequency-heat-pump drive module, and thus an operation stability of the variable-frequency-heat-pump drive module is improved.

[0041] Furthermore, since a traditional driving method uses measures such as disposing a heat sink to dissipate heat from the heating elements, a cost for heat dissipation is caused to be increased. In the invention, the cost for heat dissipation can be reduced without using the heat sink.

[0042] Furthermore, since the variable-frequency-heat-pump drive module is usually integrated on the compressor motor of the variable-frequency heat pump, a size of the compressor motor will be relatively large, which will lead to a higher cost of structural components for fixing the compressor motor. In the present invention, the variable-frequency-heat-pump drive module is separated from the compressor motor of the variable-frequency heat pump, and thus a height of the compressor motor is reduced, and a size of the compressor motor and a used material amount for body of the compressor motor are reduced, to help reduce a cost for fixing the compressor motor and a cost for manufacturing the compressor motor.

[0043] Furthermore, since a traditional drive method is to dispose drive modules in a heat pump and a fan respectively to drive the heat pump and the fan, it is not conducive to a unified control and maintenance of the drive modules. In the present invention, the drive modules in the heat pump and the fan are integrated into a same control board, which facilitates the unified control of the drive modules by a same primary control module and is conducive to the unified maintenance of various drive modules.

[0044] As shown in FIG. 1, optionally, the control board may further comprise a variable-frequency-heat-pump interface 3. The variable-frequency-heat-pump drive module is connected to a three-phase motor of the variable-frequency heat pump through the variable-frequency-heat-pump interface 3. The variable-frequency-heat-pump drive module can, according to the control instructions of the primary control module, drive a compressor of the variable-frequency heat pump to operate in accordance with a target speed, a target power or a target current, and feed back an actual speed, an actual power, an actual current and a fault information of the compressor of the variable-frequency heat pump to the

primary control module.

[0045] Optionally, the variable-frequency-heat-pump drive module communicates with the primary control module through a universal asynchronous receiver-transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

[0046] Optionally, the variable-frequency-heat-pump interface 3 has three pins which correspond to three-phase terminals U, V, and W of the three-phase motor in the variable-frequency heat pump, and the variable-frequency-heat-pump drive module is connected to the three-phase motor in the variable-frequency heat pump through these three pins.

[0047] A traditional variable-frequency heat pump adopts a way of PWM (Pulse Width Modulation) duty cycle communication, that is, a primary control module sends a PWM control instruction to a variable-frequency-heat-pump drive module, and the variable-frequency-heat-pump drive module drives the heat pump to operate according to the PWM control instruction. However, in this way, the compressor motor of the variable-frequency heat pump needs four wires to be connected to the primary control module through the variable-frequency-heat-pump drive module. A first wire is configured to provide a power supply voltage for the compressor motor of the variable-frequency heat pump. A second wire is used to ground the compressor motor of the variable-frequency heat pump. A third wire is configured to provide PWM control instructions for the compressor motor of the variable-frequency heat pump. A fourth wire is configured for the compressor motor of the variable-frequency heat pump to feed back a speed feedback signal to the primary control module.

[0048] Since the variable-frequency-heat-pump drive module communicates with the primary control module through a universal asynchronous receiver-transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface, the number of wires connecting the compressor motor of the variable-frequency heat pump to the primary control module through the variable-frequency-heat-pump drive module can be reduced from four to three, and three wires are respectively connected to the three-phase terminals of the compressor motor, to reduce a wiring harness cost.

[0049] Optionally, when the way of PWM duty cycle communication is adopted, there will be a transmission error and reception error of duty cycle. Such errors are due to the following: since a duty cycle is a ratio of a count value of a counter of the primary control module to a maximum value of the counter of the primary control module, the count value of the counter will be smaller if a main frequency of the primary control module is higher, to result in a smaller calculated duty cycle; and the count value of the counter will be larger if the main frequency of the primary control module is lower, to result in a larger calculated duty cycle. That is, an error in main frequency will lead to an error in duty cycle, and the primary control module has such error in main frequency when sending a PWM control signal or receiving a PWM feedback signal, to lead to a sending error or a receiving error of the duty cycle.

[0050] Due to existence of the above errors, a control accuracy of the primary control module to the motor deviates greatly from a target value, and thus operations of the heat-pump water heater are affected.

[0051] Optionally, the primary control module communicates with the variable-frequency-heat-pump drive module through a universal asynchronous receiver-transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface, to control operations of a motor. On the one hand, the wires connecting the compressor motor of the variable-frequency heat pump to the primary control module through the variable-frequency-heat-pump drive module can be reduced from four to three to reduce the wiring harness cost and improve a data transmission rate. On the other hand, a verification procedure in this type of communication can be utilized to improve an accuracy of data transmission, to enable a target index value in the control instructions to be accurately informed to a target motor, and the target motor can also accurately feed back current actual index value to the primary control module. In practice, a data transmission error can be reduced by 1%-3%, which is advantageous to improving a control accuracy of the heat-pump water heater.

[0052] As shown in FIG. 1, optionally, the control board may further comprise a fixed-frequency-fan interface 4. The fixed-frequency-fan relay module is connected to the fixed-frequency fan through the fixed-frequency-fan interface 4.

[0053] The fixed-frequency-fan relay module is equivalent to a switch of the fixed-frequency fan. The fixed-frequency-fan relay module, upon receiving the control instructions from the primary control module, drives the fixed-frequency fan to start or stop running.

[0054] The fixed-frequency fan can be conveniently controlled to start or stop running by utilizing switching characteristics of the fixed-frequency-fan relay module in the present invention.

[0055] As shown in FIG. 1, optionally, the control board may further comprise: a switching power supply module, whose first end is connected to a Mains supply; whose second end is connected to the primary control module in an isolated manner; and whose third end is connected to the variable-frequency-heat-pump drive module in a non-isolated manner; and an optical coupling isolation module 6, connected between the variable-frequency-heat-pump drive module and the primary control module.

[0056] The variable-frequency heat pump is a high-voltage variable-frequency heat pump.

[0057] Optionally, a high-voltage variable-frequency solution is adopted. The switching power supply module rectifies AC Mains electricity of 220V or 110V or the like to output 310V high-voltage DC. Since a voltage applied by the switching power supply module on a winding of the compressor motor of the variable-frequency heat pump

through the variable-frequency-heat-pump drive module is a non-isolated high voltage, an optical coupling isolation module is required to be disposed between the variable-frequency-heat-pump drive module and the primary control module to achieve an isolated communication and improve a reliability and stability of communication.

[0058] Optionally, the control board may further comprise a switching power supply module. A first end of the switching power supply module is connected to a Mains supply; a second end of the switching power supply module is connected to the primary control module in an isolated manner; and a third end of the switching power supply is connected to the variable-frequency-heat-pump drive module in an isolated manner. The variable-frequency heat pump is a low-voltage variable-frequency heat pump.

[0059] Optionally, a low-voltage variable-frequency scheme is adopted. The switching power supply module rectifies AC Mains electricity of 220V or 110V to output 36V, 24V low-voltage DC. Since a voltage applied by the switching power supply module on a winding of the compressor motor of the variable-frequency heat pump through the variable-frequency-heat-pump drive module is an isolated low-voltage, an optical coupling isolation module is required to be disposed between the variable-frequency-heat-pump drive module and the primary control module, and a reliability and stability of communication can be ensured.

[0060] As shown in FIG. 1, optionally, the control board may further comprise an electronic-expansion-valve drive module and an electronic-expansion-valve interface 2. An end of the electronic-expansion-valve drive module is connected to the primary control module, and another end of the electronic-expansion-valve drive module is connected to an electronic expansion valve through the electronic-expansion-valve interface 2.

[0061] Optionally, an electronic-expansion-valve drive module is provided which can drive the electronic expansion valve to rotate by a target number of steps according to the control instructions of the primary control module, and feed back the number of steps, by which the electronic expansion valve is actually rotated, to the primary control module.

[0062] As shown in FIG. 1, optionally, the control board may further comprise:

an electric-leakage detection module, connected between the switching power supply module and the Mains supply;

a current detection module 7, connected between the electric-leakage detection module and the Mains supply;

a sensor drive module and a sensor interface 5, an end of the sensor drive module being connected to the primary control module, another end of the sensor drive module being connected to temperature sensors at different positions through the sensor interface 5;

a high-voltage-switch drive module and a high-voltage-switch interface 1, an end of the high-voltage-switch drive module being connected to the primary control module, another end of the high-voltage-switch drive module being connected to a high-voltage switch through the high-voltage-switch interface 1; and

a display-board communication module, an end of which is connected to the primary control module, and another end of which is connected to a display board.

[0063] Optionally, the electric-leakage detection module is able to, by detecting a current difference between a zero line and a live line, detect whether there is an electric leakage, and feed back an electric-leakage status to the primary control module in a form of electrical level.

[0064] The current detection module 7 is able to, by detecting a current of the live line, determine a magnitude of a current of a load during the operation of the heat-pump water heater, and feed back a status of the current to the primary control module.

[0065] The sensor drive module is able to drive temperature sensors at different positions of the heat-pump water heater to detect temperatures at positions where the temperature sensors are located according to control instructions of the primary control module, and feed back temperatures of various positions to the primary control module.

[0066] The high-voltage-switch drive module is able to drive the high-voltage switch to detect an operating voltage of the heat-pump water heater according to the control instructions of the primary control module, and feed back a voltage signal to the primary control module when the operating voltage exceeds a preset voltage.

[0067] The display-board communication module is able to display operation indicators of the heat-pump water heater which are fed back to the primary control module according to the control instructions of the primary control module.

[0068] It should be explained that the switching power supply module can be connected to various modules to convert the AC Mains electricity into a DC, to power the primary control module, and a variable-frequency chip, a drive chip, MOSFET/IGBT/IPM in the variable-frequency-heat-pump drive module, as well as the fixed-frequency-fan relay module, an electronic-expansion-valve drive module, the high-voltage-switch drive module, the sensor drive module, the electric-leakage detection module, the current detection module 7, and the display-board communication module.

[0069] In actual application, the switching power supply module and the display-board communication module can be connected non-isolatedly to each other, and the optical coupling isolation module can be connected between the primary control module and the display-board communication module to achieve an isolated

communication and ensure a stability and reliability of communication.

[0070] The primary control module is mainly responsible for sending control instructions to various modules, and collecting and processing operating statuses and measurement values of various components which are fed back by various modules, and displaying collected data on the display board by communicating, through the universal asynchronous receiver-transmitter or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface , with the display board. The heat-pump water heater is taken as an example, the primary control module can control a water temperature of a water tank through a performance logic, and collect values from a first position temperature sensor 8 and values from the second position temperature sensor 9, and transmit these values from temperature sensors to the display board for display. The values from the first position temperature sensor 8 comprises a value from inner tank surface temperature sensor. The values of the first position temperature sensor 9 comprises a value from evaporator temperature sensor value, a value from ambient temperature sensor, a value from exhaust temperature sensor and a value from return air temperature sensor.

[0071] A plurality of functional modules is disposed on the control board to transmit the control instructions of the primary control module to the various components of the heat-pump water heater through the plurality of functional modules, and feed back actual operating statuses and measurement values of various components to the primary control module. Finally, data collected by the primary control module is processed and transmitted to the display board for display.

[0072] As shown in FIG.1, a water heater is provided according to an embodiment of the invention, which may comprise the aforementioned control board.

[0073] Since the water heater comprises the aforementioned control board, it has advantageous effects of the control board described in the aforementioned embodiments, which will not be described in detail here.

[0074] As shown in FIG. 1, optionally, the water heater may further comprise: a fixed-frequency fan, a variable-frequency heat pump, an electronic expansion valve, a temperature sensor, a high-voltage switch, and a display board.

[0075] Since, the water heater comprises the aforementioned control board, it has advantageous effects of the control board described in the aforementioned embodiments, which will not be described in detail here.

[0076] Finally, it should be noted that the above embodiments are only used to illustrate the invention, rather than to limit the invention. Although the invention has been described in detail with reference to the embodiments, those skilled in the art should understand that various combinations, modifications or equivalent substitutions of the technical solutions of the invention should be comprised in the scope sought for by the claims of the invention.

Claims

1. A control board, comprising: a primary control module, a fixed-frequency-fan relay module and a variable-frequency-heat-pump drive module, wherein,

   the fixed-frequency-fan relay module is connected to the primary control module and is configured to, according to a control instruction of the primary control module, drive a fixed-frequency fan to operate;
   the variable-frequency-heat-pump drive module is connected to the primary control module and is configured to, according to a control instruction of the primary control module, drive a variable-frequency heat pump to operate; and
   the control board is disposed outside the fixed-frequency fan and the variable-frequency heat pump.

2. The control board according to claim 1, further comprising a variable-frequency-heat-pump interface (3), wherein the variable-frequency-heat-pump drive module is connected to a three-phase motor of the variable-frequency heat pump through the variable-frequency-heat-pump interface (3).

3. The control board according to claim 1 or 2, wherein the variable-frequency-heat-pump drive module communicates with the primary control module through an universal asynchronous receiver-transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

4. The control board according to any one of claims 1 to 3, further comprising: a fixed-frequency-fan interface (4), wherein the fixed-frequency-fan relay module is connected to the fixed-frequency fan through the fixed-frequency-fan interface (4).

5. The control board according to any one of claims 1 to 4, further comprising: a switching power supply module and an optical coupling isolation module (6), wherein,

   the variable-frequency heat pump is a high-voltage variable-frequency heat pump;
   a first end of the switching power supply module is connected to a Mains supply, wherein a second end of the switching power supply module is connected to the primary control module in an isolated manner, and wherein a third end of the switching power supply is connected to the variable-frequency-heat-pump drive module in a non-isolated manner; and
   the optical coupling isolation module (6) is connected between the variable-frequency-heat-pump drive module and the primary control

module.

6. The control board according to any one of claims 1 to 5, further comprising a switching power supply module, wherein,

the variable-frequency heat pump is a low-voltage variable-frequency heat pump; and
a first end of the switching power supply module is connected to a Mains supply, wherein a second end of the switching power supply module is connected to the primary control module in an isolated manner, and wherein a third end of the switching power supply is connected to the variable-frequency-heat-pump drive module in an isolated manner.

7. The control board according to any one of claims 1 to 6, further comprising: an electronic-expansion-valve drive module and an electronic-expansion-valve interface (2), wherein,
an end of the electronic-expansion-valve drive module is connected to the primary control module, and another end of the electronic-expansion-valve drive module is connected to an electronic expansion valve through the electronic-expansion-valve interface (2).

8. The control board according to claim 5 or 6, further comprising: an electric-leakage detection module, a current detection module (7), a sensor drive module, a high-voltage-switch drive module, a display-board communication module, a sensor interface (5) and a high-voltage-switch interface (1), wherein,

the electric-leakage detection module is connected between the switching power supply module and the Mains supply;
the current detection module (7) is connected between the electric-leakage detection module and the Mains supply;
an end of the sensor drive module is connected to the primary control module, and another end of the sensor drive module is connected to temperature sensors at different positions through the sensor interface (5);
an end of the high-voltage-switch drive module is connected to the primary control module, and another end of the high-voltage-switch drive module is connected to a high-voltage switch through the high-voltage-switch interface (1); and
an end of the display-board communication module is connected to the primary control module, and another end of the display-board communication module is connected to a display board.

9. A water heater, comprising a control board according to any one of claims 1 to 8.

10. The water heater according to claim 9, further comprising: a fixed-frequency fan, a variable-frequency heat pump, an electronic expansion valve, a temperature sensor, a high-voltage switch, and a display board.

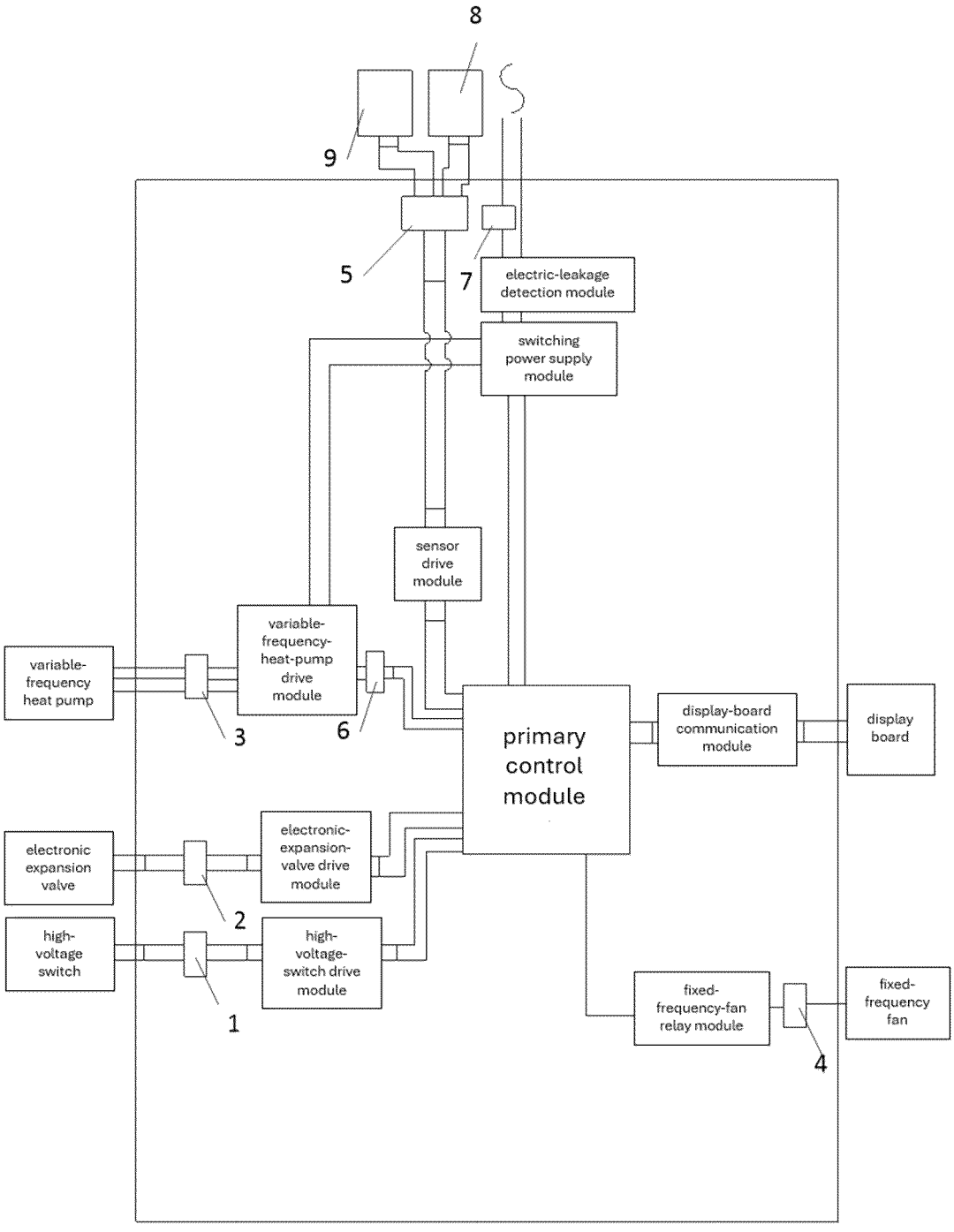
8
9
5
7
electric-leakage detection module
switching power supply module
sensor drive module
variable-frequency heat pump
variable-frequency-heat-pump drive module
3
6
primary control module
display-board communication module
display board
electronic expansion valve
electronic-expansion-valve drive module
2
high-voltage switch
high-voltage-switch drive module
1
fixed-frequency-fan relay module
4
fixed-frequency fan

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 24 21 2656

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