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(54) CONTROL BOARD, WATER HEATER, AND DRIVING METHOD

(57) The present application relates to the field of control technology, and provides a control panel, a water heater and a driving method. The control panel includes: a main control module, a fan drive module and a heat pump drive module. The fan drive module includes a variable frequency fan drive module and a fixed frequency fan relay module, and the fan drive module is connected to the main control module, for driving a variable frequency fan or a fixed frequency fan to operate based on a control instruction of the main control module. The heat pump drive module includes a variable frequency heat pump drive module and a fixed frequency heat pump relay module, and the heat pump drive module is connected to the main control module, for driving a variable frequency heat pump or a fixed frequency heat pump to operate based on a control instruction of the main control module. In the present application, based on actual requirements, a variable frequency fan drive module or a fixed frequency fan relay module can be selected and matched with the variable frequency heat pump drive module or the fixed frequency heat pump relay module, to drive a heat pump and a fan, thereby satisfying diversified driving requirements.

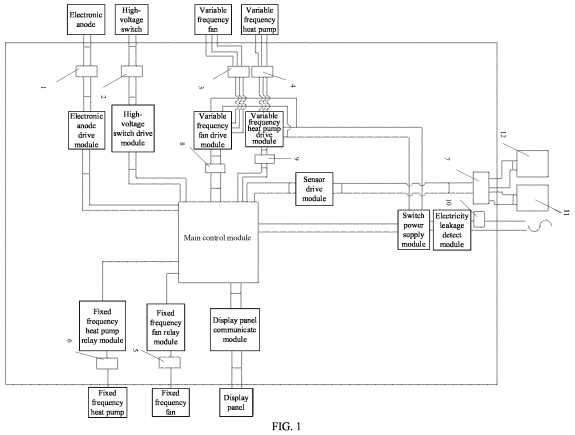

FIG. 1

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Description

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] The present application claims priority to Chinese patent application No. 202311538604.7 filed on November 17, 2023, entitled "Control Panel, Water Heater and Driving Method", Chinese patent application No. 202323112072.9 filed on November 17, 2023, entitled "Control Panel and Water Heater", Chinese patent application No. 202323112015.0 filed on November 17, 2023, entitled "Control Panel and Water Heater", Chinese patent application No. 202323138618.8 filed on November 17, 2023, entitled "Control Panel and Water Heater", and Chinese patent application No. 202323138602.7 filed on November 17, 2023, entitled "Control Panel and Water Heater", which are hereby incorporated by reference in their entireties.

FIELD

[0002] The present application relates to the field of household appliance, and in particular, to a control panel, a water heater and a driving method.

BACKGROUND

[0003] A heat pump is an efficient and energy-saving apparatus that transfers heat energy from a low-grade heat source to a high-grade heat source. The heat pump generally obtains low-grade heat energy from air, water or soil in nature, processes the low-grade heat energy with electricity, and then provides users with usable high-grade heat energy. In this procedure, only a small amount of reverse cycle net power is consumed, and a large amount of heat supply is obtained. Therefore, it can effectively utilize difficult-to-use low-grade heat energy to realize energy saving. It can be widely used in agricultural irrigation, domestic water and other fields.

[0004] In some mechanical devices, heat pumps generally need to be used together with fans. A traditional driving method is to drive the heat pump (i.e., a heat pump compressor) and the fan separately at a driving frequency in a specific mode, which is too single and cannot satisfy diversified driving requirements.

[0005] At present, for devices using variable frequency heat pumps, a variable frequency heat pump drive module is mounted inside the compressor of the variable frequency heat pump. A compressor motor of the variable frequency heat pump would generate heat during operation. In addition, the variable frequency heat pump drive module generally comprises heat elements such as insulated gate bipolar transistor (IGBT) or metal-oxide-semiconductor field-effect transistor (MOSFET) or intelligent power module (IPM), which generate heat by themselves. The heat generated from inside of the compressor of the variable frequency heat pump where the variable frequency heat pump drive module is located and the heat generated by the heat elements of the variable frequency heat pump drive module affects the normal operation of the variable frequency heat pump drive module.

[0006] As an energy-saving and environmentally friendly water heater device, heat pump water heaters are favored by more and more consumers and have become one of the important choices for home and commercial hot water supply.

BRIEF SUMMARY

[0007] The present application aims to solve at least one of the problems existing in the related art. An embodiment of the present application provides a control panel. Based on actual requirements, a variable frequency fan drive module or a fixed frequency fan relay module can be selected to match with a variable frequency heat pump drive module or a fixed frequency heat pump relay module, to drive a heat pump and a fan, thereby satisfying diversified driving requirements.

[0008] An embodiment of the present application further provides a control panel. A control panel integrated with a variable frequency heat pump drive module can be provided outside a variable frequency heat pump, which keeps the variable frequency heat pump drive module away from the heat source, thereby avoiding the influence of heat generated by internal environment of the variable frequency heat pump on the variable frequency heat pump drive module, and also assisting in heat dissipation of heat elements of the variable frequency heat pump drive module, which improves the stability of the variable frequency heat pump drive module during operation.

[0009] An embodiment of the present application further provides a control panel. A variable frequency fan drive module is integrated at a main control panel, which reduces the volume occupied by the variable frequency fan drive module. In addition, only the main control panel needs to be fixed, which reduces the number of fixed structures, and reduces costs.

[0010] An embodiment of the present application further provides a control panel. By integrating at least one of a variable frequency fan drive module and a variable frequency heat pump drive module at a main control panel, the volume of at least one of a fan and a heat pump can be effectively reduced, and heat dissipation cost can be effectively reduced.

[0011] The present application further provides a water heater and a driving method.

[0012] The control panel according to an embodiment of the present application, comprising:

a main control module, a fan drive module and a heat pump drive module,

where the fan drive module comprises a variable

frequency fan drive module and a fixed frequency fan relay module, and the fan drive module is connected to the main control module, for driving a variable frequency fan or a fixed frequency fan to operate based on a control instruction of the main control module; and

the heat pump drive module comprises a variable frequency heat pump drive module and a fixed frequency heat pump relay module, and the heat pump drive module is connected to the main control module, for driving a variable frequency heat pump or a fixed frequency heat pump to operate based on a control instruction of the main control module.

[0013] The control panel according to the embodiment of the present application comprises the main control module, the fan drive module and the heat pump drive module. The fan drive module comprises the variable frequency fan drive module and the fixed frequency fan relay module, and the fan drive module is connected to the main control module, for driving the variable frequency fan or the fixed frequency fan to operate based on the control instruction of the main control module. The heat pump drive module comprises the variable frequency heat pump drive module and the fixed frequency heat pump relay module, and the heat pump drive module is connected to the main control module, for driving the variable frequency heat pump or the fixed frequency heat pump to operate based on the control instruction of the main control module. Since the control panel is integrated with the variable frequency fan drive module, the fixed frequency fan relay module, the variable frequency heat pump drive module and the fixed frequency heat pump relay module, based on actual requirements, the variable frequency fan drive module can be selected to drive the variable frequency fan to operate and match with the variable frequency heat pump drive module to drive the variable frequency heat pump to operate, or the variable frequency fan drive module can be selected to drive the variable frequency fan to operate and match with the fixed frequency heat pump relay module to drive the fixed frequency heat pump to operate, or the fixed frequency fan relay module can be selected to drive the fixed frequency fan to operate and match with the variable frequency heat pump drive module to drive the variable frequency heat pump to operate, or the fixed frequency fan relay module can be selected to drive the fixed frequency fan to operate and match with the fixed frequency heat pump relay module to drive the fixed frequency heat pump to operate. That is, there are four optional drive modes, and the diversified driving requirements are satisfied.

[0014] Furthermore, since a traditional driving mode is to provide drive modules in a heat pump and a fan respectively to drive the heat pump and the fan, which is not conducive to unified control and maintenance of the drive modules. The present application integrates drive modules of a heat pump and a fan into a same control panel, which is convenient for unified control of the drive modules through the same main control, and is conducive to the unified maintenance of each drive module.

[0015] According to an embodiment of the present application, the control panel is provided outside the variable frequency fan, the variable frequency heat pump, the fixed frequency fan and the fixed frequency heat pump.

[0016] According to an embodiment of the present application, the control panel further comprises:

a variable frequency fan interface and a variable frequency heat pump interface,

where the variable frequency fan drive module is connected to a three-phase motor of the variable frequency fan through the variable frequency fan interface; and

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.

[0017] According to an embodiment of the present application, the variable frequency fan drive module communicates with the main control module through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface; and
the variable frequency heat pump drive module communicates with the main control module through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

[0018] According to an embodiment of the present application, the control panel further comprises:

a fixed frequency fan interface and a fixed frequency heat pump interface,

where the fixed frequency fan relay module is connected to the fixed frequency fan through the fixed frequency fan interface; and

the fixed frequency heat pump relay module is connected to the fixed frequency heat pump through the fixed frequency heat pump interface.

[0019] According to an embodiment of the present application, the control panel further comprises:

a switch power supply module, a first optocoupler isolation module and a second optocoupler isolation module,

where the variable frequency fan is a high-voltage

variable frequency fan, and the variable frequency heat pump is a high-voltage variable frequency heat pump;

a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply module is connected to the variable frequency fan drive module and the variable frequency heat pump drive module in a non-isolated manner;

the first optocoupler isolation module is connected between the variable frequency fan drive module and the main control module; and

the second optocoupler isolation module is connected between the variable frequency heat pump drive module and the main control module.

[0020] According to an embodiment of the present application, the control panel further comprises:

a switch power supply module,

where the variable frequency fan is a low-voltage variable frequency fan, and the variable frequency heat pump is a low-voltage variable frequency heat pump; and

a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply module is connected to the variable frequency fan drive module and the variable frequency heat pump drive module in an isolated manner.

[0021] According to an embodiment of the present application, the control panel further comprises:

an electronic anode drive module and an electronic anode interface,

where a first end of the electronic anode drive module is connected to the main control module, and a second end of the electronic anode drive module is connected to an electronic anode through the electronic anode interface.

[0022] According to an embodiment of the present application, the control panel further comprises:

an electricity leakage detect module, a current detect module, a sensor drive module, a high-voltage switch drive module, a display panel communicate module, a sensor interface and a high-voltage switch interface,

where the electricity leakage detect module is connected between the switch power supply module and mains electricity;

the current detect module is connected between the electricity leakage detect module and mains electricity;

a first end of the sensor drive module is connected to the main control module, and a second end of the sensor drive module is connected to temperature sensors at different positions through the sensor interface;

a first end of the high-voltage switch drive module is connected to the main control module, and a second end of the high-voltage switch drive module is connected to a high-voltage switch through the high-voltage switch interface; and

a first end of the display panel communicate module is connected to the main control module, and a second end of the display panel communicate module is connected to a display panel.

[0023] The water heater according to an embodiment of the present application, comprising:
a variable frequency fan, a fixed frequency fan, a variable frequency heat pump, a fixed frequency heat pump, an electronic anode, a temperature sensor, a high-voltage switch, a display panel and any one of the control panels as described above.

[0024] The driving method according to an embodiment of the present application, comprising:

controlling a main control module to send a variable frequency fan control signal to a variable frequency fan drive module;

controlling a variable frequency fan drive module to amplify the variable frequency fan control signal, to obtain a variable frequency fan amplified signal;

controlling the variable frequency fan drive module to send the variable frequency fan amplified signal to the variable frequency fan;

controlling the variable frequency fan to operate based on the variable frequency fan amplified signal; or

controlling a main control module to send a fixed frequency fan control signal to a fixed frequency fan relay module;

controlling the fixed frequency fan relay module to close based on the fixed frequency fan control signal, to drive a fixed frequency fan to operate.

[0025] According to an embodiment of the present application, the driving method further comprises:

controlling the main control module to send a variable frequency heat pump control signal to a variable frequency heat pump drive module;

controlling the variable frequency heat pump drive module to amplify the variable frequency heat pump control signal, to obtain a variable frequency heat pump amplified signal;

controlling the variable frequency heat pump drive module to send the variable frequency heat pump amplified signal to the variable frequency heat pump;

controlling the variable frequency heat pump to operate based on the variable frequency heat pump amplified signal; or

controlling a main control module to send a fixed frequency heat pump control signal to a fixed frequency heat pump relay module;

controlling the fixed frequency heat pump relay module to close based on the fixed frequency heat pump control signal, to drive a fixed frequency heat pump to operate.

[0026] The control panel according to an embodiment of the present application, comprising:

a main control module, a fixed frequency fan relay module and a variable frequency heat pump drive module,

where the fixed frequency fan relay module is connected to the main control module, for driving a fixed frequency fan to operate based on a control instruction of the main control module;

the variable frequency heat pump drive module is connected to the main control module, for driving a variable frequency heat pump to operate based on a control instruction of the main control module; and

the control panel is provided outside the fixed frequency fan and the variable frequency heat pump.

[0027] The control panel according to the embodiment of the present application comprises the main control module, the fixed frequency fan relay module and the variable frequency heat pump drive module. The fixed frequency fan relay module is connected to the main control module, for driving the fixed frequency fan to operate based on the control instruction of the main control module. The variable frequency heat pump drive module is connected to the main control module, for driving the variable frequency heat pump to operate based on the control instruction of the main control module. The control panel is provided outside the fixed frequency fan and the variable frequency heat pump. By providing the control panel integrated with the variable frequency heat pump drive module outside the variable frequency heat pump, the variable frequency heat pump drive module is kept away from the heat source, thereby avoiding the influence of heat generated by internal environment of the variable frequency heat pump on the variable frequency heat pump drive module, and assisting in heat dissipation of heat elements of the variable frequency heat pump drive module, which improves the stability of the variable frequency heat pump drive module during operation.

[0028] Further, since a traditional driving method dissipates heat generated from heat elements through measures such as providing a heat sink, which causes increase in heat dissipation costs, the present application does not require a heat sink, which can reduce the heat dissipation costs.

[0029] Furthermore, since the variable frequency heat pump drive module is generally integrated on a compressor motor of the variable frequency heat pump, which causes the volume of the compressor motor to be relatively large, and further causes the costs of structural members for fixing the motor to be relatively high, the present application separates the variable frequency heat pump drive module from the compressor motor of the variable frequency heat pump, which reduces the height of the motor, and further reduces the volume of the motor and the amount of material used in a motor body, thereby assisting in reducing the fixing costs of the motor and the manufacturing costs of the motor itself.

[0030] Furthermore, since a traditional driving mode is to provide drive modules in a heat pump and a fan respectively to drive the heat pump and the fan, which is not conducive to unified control and maintenance of the drive module, the present application integrates drive modules of a heat pump and a fan into a same control panel, which is convenient for unified control of the drive modules through the same main control, and is conducive to the unified maintenance of each drive module.

[0031] According to an embodiment of the present application, the control panel further comprises:

a variable frequency heat pump interface,

where 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.

[0032] According to an embodiment of the present

application, the variable frequency heat pump drive module communicates with the main control module through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

[0033] According to an embodiment of the present application, the control panel further comprises:

a fixed frequency fan interface,

where the fixed frequency fan relay module is connected to the fixed frequency fan through the fixed frequency fan interface.

[0034] According to an embodiment of the present application, the control panel further comprises:

a switch power supply module and a third optocoupler isolation module,

where the variable frequency heat pump is a high-voltage variable frequency heat pump;

a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply module is connected to the variable frequency heat pump drive module in a non-isolated manner; and

the third optocoupler isolation module is connected between the variable frequency heat pump drive module and the main control module.

[0035] According to an embodiment of the present application, the control panel further comprises:

a switch power supply module,

where the variable frequency heat pump is a low-voltage variable frequency heat pump;

a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply module is connected to the variable frequency heat pump drive module in an isolated manner.

[0036] According to an embodiment of the present application, the control panel further comprises:

an electronic expansion valve drive module and an electronic expansion valve interface,

where a first end of the electronic expansion valve drive module is connected to the main control module, and a second end of the electronic expansion valve drive module is connected to an electronic expansion valve through the electronic expansion valve interface.

[0037] According to an embodiment of the present application, the control panel further comprises:

an electricity leakage detect module, a current detect module, a sensor drive module, a high-voltage switch drive module, a display panel communicate module, a sensor interface and a high-voltage switch interface,

where the electricity leakage detect module is connected between the switch power supply module and mains electricity;

the current detect module is connected between the electricity leakage detect module and mains electricity;

a first end of the sensor drive module is connected to the main control module, and a second end of the sensor drive module is connected to temperature sensors at different positions through the sensor interface;

a first end of the high-voltage switch drive module is connected to the main control module, and a second end of the high-voltage switch drive module is connected to a high-voltage switch through the high-voltage switch interface; and

a first end of the display panel communicate module is connected to the main control module, and a second end of the display panel communicate module is connected to a display panel.

[0038] The water heater according to an embodiment of the present application, comprising any one of the control panels as described above.

[0039] According to an embodiment of the present application, the water heater further comprises: a fixed frequency fan, a variable frequency heat pump, an electronic expansion valve, a temperature sensor, a high-voltage switch and a display panel.

[0040] The control panel according to an embodiment of the present application, comprising:

a main control panel, where the main control panel is provided with a control module;

a variable frequency fan drive module, integrated at the main control panel, where an input end of the variable frequency fan drive module is electrically connected to a first output end of the control module,

and an output end of the variable frequency fan drive module is electrically connected to the variable frequency fan; and

a fixed frequency heat pump switch module, where an input end of the fixed frequency heat pump switch module is electrically connected to a second output end of the control module, and an output end of the fixed frequency heat pump switch module is electrically connected to the fixed frequency heat pump.

[0041] According to the control panel of the embodiment of the present application, the control module sends corresponding control signals to the variable frequency fan drive module and the fixed frequency heat pump switch module, and then the variable frequency fan drive module can drive the fan to operate based on target operating parameters, and the fixed frequency heat pump switch module can control a switch of the fixed frequency heat pump. The variable frequency fan drive module is integrated at the main control panel, that is, the variable frequency fan drive module and the control module can share one panel, and there is no need to provide additional control panel for the variable frequency fan, thereby effectively reducing the volume occupied by the variable frequency fan drive module. In addition, the main control panel integrated with the variable frequency fan drive module is not mounted inside the variable frequency fan, that is, no control panel for the variable frequency fan is provided inside the variable frequency fan, which can effectively reduce the volume of the variable frequency fan, reduce materials required for the production of the variable frequency fan, and reduce the costs. Only the main control panel needs to be fixed, and there is no need to provide additional fixed structure to fix the variable frequency fan drive module, which can effectively reduce the number of fixed structures and reduce costs.

[0042] According to an embodiment of the present application, the fixed frequency heat pump switch module is integrated at the main control panel.

[0043] According to an embodiment of the present application, the variable frequency fan drive module is connected to the control module for communication through at least one of a serial interface universal asynchronous receiver/transmitter (UART) or a bidirectional serial data transmission interface inter-integrated circuit (I2C) or a serial peripheral interface (SPI).

[0044] According to an embodiment of the present application, the control panel comprises a variable frequency fan interface, where the variable frequency fan interface is integrated at the main control panel, and the variable frequency fan interface is used to connect the variable frequency fan drive module with the variable frequency fan.

[0045] According to an embodiment of the present application, the variable frequency fan interface comprises a first U-phase interface, a first V-phase interface and a first W-phase interface, where the first U-phase interface is used to connect the variable frequency fan drive module with a U-phase connection end of the variable frequency fan, the first V-phase interface is used to connect the variable frequency fan drive module with a V-phase connection end of the variable frequency fan, and the first W-phase interface is used to connect the variable frequency fan drive module with a W-phase interface of the variable frequency fan.

[0046] According to an embodiment of the present application, the control panel comprises a fixed frequency heat pump interface, where the fixed frequency heat pump interface is integrated at the main control panel, and the fixed frequency heat pump interface is used to connect the fixed frequency heat pump switch module with the fixed frequency heat pump.

[0047] According to an embodiment of the present application, the control panel comprises a fourth optocoupler isolation module, where the fourth optocoupler isolation module is provided between the variable frequency fan drive module and the control module.

[0048] According to an embodiment of the present application, the control panel comprises a photovoltaic (PV) module, where the PV module is integrated at the main control panel, and the PV module is used to connect the control module with electrical grid.

[0049] The water heater according to an embodiment of the present application, comprising a variable frequency fan, a fixed frequency heat pump and any one of the above-mentioned control panels, where the variable frequency fan is electrically connected to a variable frequency fan drive module, and the fixed frequency heat pump is electrically connected to a fixed frequency heat pump switch module.

[0050] The water heater according to the present application comprises a control panel, and therefore the water heater also has all the beneficial effects of the control panel, which are not repeated here.

[0051] According to an embodiment of the present application, the control panel is provided at a space outside the variable frequency fan, and the control panel is provided at a space outside the fixed frequency heat pump; and/or

the fixed frequency heat pump switch module is provided at a space outside the variable frequency fan, and the fixed frequency heat pump switch module is provided at a space outside the fixed frequency heat pump.

[0052] The control panel according to an embodiment of the present application, comprising:

a main control panel, where the main control panel is provided with a control module;

a variable frequency fan drive module, where an input end of the variable frequency fan drive module is electrically connected to a first output end of the control module, and an output end of the variable frequency fan drive module is electrically connected

to a variable frequency fan;

a variable frequency heat pump drive module, where an input end of the variable frequency heat pump drive module is electrically connected to a second output end of the control module, and an output end of the variable frequency heat pump drive module is electrically connected to a variable frequency heat pump,

where at least one of the variable frequency fan drive module and the variable frequency heat pump drive module is integrated at the main control panel.

[0053] According to the control panel of the embodiment of the present application, the control module sends corresponding control signals to the variable frequency fan drive module and the variable frequency heat pump drive module, and then the variable frequency fan drive module can drive the fan to operate based on target operating parameters, and the variable frequency heat pump drive module can drive the variable frequency heat pump to operate based on the target operating parameters. At least one of the variable frequency fan drive module and the variable frequency heat pump drive module is integrated at the main control panel, that is, the variable frequency fan drive module, the variable frequency heat pump drive module and the control module can share one panel, and there is no need to provide additional control panel for the variable frequency fan or additional control panel for the variable frequency heat pump, thereby effectively reducing the volume occupied by the variable frequency fan drive module and the variable frequency heat pump drive module. In addition, the main control panel integrated with the variable frequency fan drive module and the variable frequency heat pump drive module is not mounted inside the variable frequency fan or the variable frequency heat pump, that is, no control panel for the variable frequency fan is provided inside the variable frequency fan, and no control panel for the variable frequency heat pump is provided inside the variable frequency heat pump, thereby effectively reducing the volume of the variable frequency fan and the variable frequency heat pump. By integrating the variable frequency fan drive module and the variable frequency heat pump drive module at the main control panel, the heat dissipation of the variable frequency fan drive module and the heat dissipation of the variable frequency fan do not affect each other, and the heat dissipation of the variable frequency heat pump drive module the heat dissipation of the variable frequency heat pump do not affect each other, which improves the heat dissipation effect, can effectively reduce the heat dissipate structure, and reduces the heat dissipation costs.

[0054] According to an embodiment of the present application, at least one of the variable frequency fan drive module and the variable frequency heat pump switch module is connected to the control module for communication through at least one of a serial interface universal asynchronous receiver/transmitter (UART) or a bidirectional serial data transmission interface inter-integrated circuit (I2C) or a serial peripheral interface (SPI).

[0055] According to an embodiment of the present application, the control panel comprises a variable frequency heat pump interface, where the variable frequency heat pump interface is integrated at the main control panel, and the variable frequency heat pump interface is used to connect the variable frequency heat pump drive module with the variable frequency heat pump.

[0056] According to an embodiment of the present application, the variable frequency heat pump interface comprises a second U-phase interface, a second V-phase interface and a second W-phase interface, where the second U-phase interface is used to connect the variable frequency heat pump drive module with a U-phase connection end of the variable frequency heat pump, the second V-phase interface is used to connect the variable frequency heat pump drive module with a V-phase connection end of the variable frequency heat pump, and the second W-phase interface is used to connect the variable frequency heat pump drive module with a W-phase interface of the variable frequency heat pump.

[0057] According to an embodiment of the present application, the control panel comprises a variable frequency fan interface, where the variable frequency fan interface is integrated at the main control panel, and the variable frequency fan interface is used to connect the variable frequency fan drive module with the variable frequency fan.

[0058] According to an embodiment of the present application, the variable frequency fan interface comprises a third U-phase interface, a third V-phase interface and a third W-phase interface, where the third U-phase interface is used to connect the variable frequency fan drive module with a U-phase connection end of the variable frequency fan, the third V-phase interface is used to connect the variable frequency fan drive module with a V-phase connection end of the variable frequency fan, and the third W-phase interface is used to connect the variable frequency fan drive module with a W-phase interface of the variable frequency fan.

[0059] According to an embodiment of the present application, the control panel comprises:

a high-voltage switch module, where the high-voltage switch module is integrated at the main control panel, an input end of the high-voltage switch module is electrically connected to the control module, an output end of the high-voltage switch module is electrically connected to a high-voltage switch, and the high-voltage switch module is used to detect a pressure at the high-voltage switch; and/or

a fifth optocoupler isolation module and a sixth optocoupler isolation module, where the fifth optocoupler isolation module is provided between the variable frequency heat pump drive module and the control module, and the sixth optocoupler isolation module is provided between the variable frequency fan drive module and the control module.

[0060] According to an embodiment of the present application, the control panel comprises a heater module, where the heater module is integrated at the main control panel, an input end of the heater module is electrically connected to the control module, and an output end of the heater module is electrically connected to a heater.

[0061] The water heater according to an embodiment of the present application, comprising a variable frequency fan, a variable frequency heat pump and any one of the above-mentioned control panels, where a variable frequency fan is electrically connected to a variable frequency fan drive module, and the variable frequency heat pump is electrically connected to a variable frequency heat pump drive module.

[0062] The water heater according to the present application has a control panel, and therefore the water heater also has all the beneficial effects of the control panel, which are not repeated here.

[0063] According to an embodiment of the present application, a first spacing is provided between the control panel and the variable frequency fan, and a second spacing is provided between the control panel and the variable frequency heat pump.

[0064] The above one or more solutions in the embodiments of the present application have at least one of the following effects.

[0065] The control panel of the present application comprises the main control module, the fan drive module and the heat pump drive module. The fan drive module comprises the variable frequency fan drive module and the fixed frequency fan relay module, and the fan drive module is connected to the main control module, for driving the variable frequency fan or the fixed frequency fan to operate based on the control instruction of the main control module. The heat pump drive module comprises the variable frequency heat pump drive module and the fixed frequency heat pump relay module, and the heat pump drive module is connected to the main control module, for driving the variable frequency heat pump or the fixed frequency heat pump to operate based on the control instruction of the main control module. Since the control panel is integrated with the variable frequency fan drive module, the fixed frequency fan relay module, the variable frequency heat pump drive module and the fixed frequency heat pump relay module, based on actual requirements, the variable frequency fan drive module can be selected to drive the variable frequency fan to operate and match with the variable frequency heat pump drive module to drive the variable frequency heat pump to operate, or the variable frequency fan drive module can be selected to drive the variable frequency fan to operate and match with the fixed frequency heat pump relay module to drive the fixed frequency heat pump to operate, or the fixed frequency fan relay module can be selected to drive the fixed frequency fan to operate and match with the variable frequency heat pump drive module to drive the variable frequency heat pump to operate, or the fixed frequency fan relay module can be selected to drive the fixed frequency fan to operate and match with the fixed frequency heat pump relay module to drive the fixed frequency heat pump to operate. That is, there are four optional drive modes, and the diversified driving requirements are satisfied.

[0066] The control panel of the present application comprises the main control module, the fixed frequency fan relay module and the variable frequency heat pump drive module. The fixed frequency fan relay module is connected to the main control module, for driving the fixed frequency fan to operate based on the control instruction of the main control module. The variable frequency heat pump drive module is connected to the main control module, for driving the variable frequency heat pump to operate based on the control instruction of the main control module. The control panel is provided outside the fixed frequency fan and the variable frequency heat pump. By providing the control panel integrated with the variable frequency heat pump drive module outside the variable frequency heat pump, the variable frequency heat pump drive module is kept away from the heat source, thereby avoiding the influence of heat generated by internal environment of the variable frequency heat pump on the variable frequency heat pump drive module, and assisting in heat dissipation of heat elements of the variable frequency heat pump drive module, which improves the stability of the variable frequency heat pump drive module during operation.

[0067] Further, since a traditional driving method dissipates heat generated from heat elements through measures such as providing a heat sink, which causes increase in heat dissipation costs, the present application does not require a heat sink, which can reduce the heat dissipation costs.

[0068] Furthermore, since the variable frequency heat pump drive module is generally integrated on a compressor motor of the variable frequency heat pump, which causes the volume of the compressor motor to be relatively large, and further causes the costs of structural members for fixing the motor to be relatively high, the present application separates the variable frequency heat pump drive module from the compressor motor of the variable frequency heat pump, which reduces the height of the motor, and further reduces the volume of the motor and the amount of material used in a motor body, thereby assisting in reducing the fixing costs of the motor and the manufacturing costs of the motor itself.

[0069] Furthermore, since a traditional driving mode is to provide drive modules in a heat pump and a fan respectively to drive the heat pump and the fan, which

is not conducive to unified control and maintenance of the drive modules, the present application integrates drive modules of a heat pump and a fan into a same control panel, which is convenient for unified control of the drive modules through the same main control, and is conducive to the unified maintenance of each drive module.

[0070] Additional aspects and advantages of the present application would be provided forth in part in the description which follows and, in part, would be apparent from the description, or may be learned by practice of the presented application.

BRIEF DESCRIPTION OF THE DRAWINGS

[0071] In order to clearly illustrate the solutions according to the present application, the accompanying drawings used in the description of the embodiments of the present application are briefly introduced below. It should be noted that, the drawings in the following description are only part embodiments of the present application. For those of ordinary skill in the art, other drawings may also be obtained based on these drawings without creative efforts.

FIG. 1 is a circuit diagram of a control panel according to an embodiment of the present application;

FIG. 2 is a circuit diagram of a control panel according to an embodiment of the present application;

FIG. 3 is a structural schematic diagram of a control panel according to an embodiment of the present application;

FIG. 4 is a structural schematic diagram of a control panel according to an embodiment of the present application, in which a variable frequency fan and a fixed frequency heat pump are connected;

FIG. 5 is a structural schematic diagram of a control panel according to an embodiment of the present application; and

FIG. 6 is a structural schematic diagram of a control panel according to an embodiment of the present application, in which a variable frequency fan and a variable frequency heat pump are connected.

Reference numerals:

[0072]

1: electronic anode interface; 2: high-voltage switch interface; 3: variable frequency fan interface; 4: variable frequency heat pump interface; 5: fixed frequency fan interface; 6: fixed frequency heat pump interface; 7: sensor interface; 8: first optocoupler isolation module; 9: second optocoupler isolation module; 10: current detect module; 11: first position temperature sensor; 12: second position temperature sensor;

2-1: high-voltage switch interface; 2-2: electronic expansion valve interface; 2-3: variable frequency heat pump interface; 2-4: fixed frequency fan interface; 2-5: sensor interface; 2-6: third optocoupler isolation module; 2-7: current detect module; 2-8: third position temperature sensor; 2-9: fourth position temperature sensor;

4-1: main control panel; 4-2: variable frequency fan drive module; 4-3: variable frequency fan; 4-4: fixed frequency heat pump switch module; 4-5: fixed frequency heat pump; 4-6: fourth optocoupler isolation module; 4-7: photovoltaic (PV) module; 4-11: control module; 4-31: variable frequency fan interface; 4-51: fixed frequency heat pump interface;

6-1: main control panel; 6-2: variable frequency fan drive module; 6-3: variable frequency fan; 6-4: variable frequency heat pump drive module; 6-5: variable frequency heat pump; 6-6: high-voltage switch module; 6-7: fifth optocoupler isolation module; 6-8: sixth optocoupler isolation module; 6-9: heater module; 6-11: control module; 6-31: variable frequency fan interface; 6-51: variable frequency heat pump interface.

DETAILED DESCRIPTION

[0073] Embodiments of the present application are further described in detail below with reference to the drawings and embodiments. The following embodiments are intended to illustrate the present application, but are not intended to limit the scope of the present application.

[0074] In the description of the embodiments of the present application, it should be noted that the orientations or positional relationships indicated by terms such as "center", "longitudinal", "lateral", "upper", "lower", "front", "rear", "left", "right", "vertical", "horizontal", "top", "bottom", "inside", "outside", etc. are based on the orientation or positional relationship shown in the drawings, and are merely for the convenience of describing the embodiments of the present application and simplifying the description, rather than indicating or implying that the apparatus or elements stated must have a particular orientation, or is provided or operated in a particular orientation, and thus is not to be construed as limiting the embodiments of the present application. Moreover, the terms "first", "second", "third", and the like are used for descriptive purposes only and are not to be construed as indicating or implying relative importance.

[0075] In the description of the present application, it should be noted that, unless explicitly specified and defined otherwise, the terms "connected to" and "connected" shall be understood broadly, for example, it may

be either fixedly connected or detachably connected, or may be integrated; it may be either mechanically connected, or electrically connected; and it may be either directly connected, or indirectly connected through an intermediate medium. The specific meanings of the terms above in embodiments of the present application may be understood by a person skilled in the art in accordance with specific conditions.

[0076] In the embodiments of the present application, unless otherwise clearly stated and defined, the first feature being located "on" or "under" the second feature means that the first feature is in direct contact with the second feature or the first feature is in contact with the second feature by an intervening media. In addition, the first feature is "on", "above" and "over" the second feature may refer to that the first feature is directly above or obliquely above the second feature, or simply refer to that the level height of the first feature is higher than that of the second feature. The first feature is "under", "below" and "beneath" the second feature may refer to that the first feature is directly below or obliquely below the second feature, or simply refer to that the level height of the first feature is lower than that of the second feature.

[0077] In the description of this specification, the description with reference to the terms "an embodiment", "some embodiments", "example", "specific example", or "some examples" etc. 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 embodiments of the present application. In this specification, the schematic representations of the above terms do not necessarily refer to the same embodiment or example. Moreover, the specific features, structures, materials or characteristics described may be combined in any one or more embodiments or examples in a suitable manner. In addition, those skilled in the art may integrate and combine the different embodiments or examples described in this specification and the features of the different embodiments or examples, without contradiction.

[0078] The inventor found that, in the related art, a heat pump water heater is provided with a heat pump control panel and a fan control panel, which occupies a certain volume and needs fixed structures to fix the heat pump control panel and the fan control panel, resulting in high costs. In general, the heat pump control panel is mounted inside the heat pump, and the fan control panel is mounted inside the fan, which lead to a large volume of the heat pump and the fan, and a high heat dissipation cost.

[0079] FIG. 1 is a circuit diagram of a control panel according to an embodiment of the present application. Referring to FIG. 1, an embodiment of the present application provides a control panel, comprising:

a main control module, a fan drive module and a heat pump drive module,

where the fan drive module comprises a variable frequency fan drive module and a fixed frequency fan relay module, and the fan drive module is connected to the main control module to drive a variable frequency fan or a fixed frequency fan to operate based on a control instruction of the main control module; and

the heat pump drive module comprises a variable frequency heat pump drive module and a fixed frequency heat pump relay module, and the heat pump drive module is connected to the main control module to drive a variable frequency heat pump or a fixed frequency heat pump to operate based on a control instruction of the main control module.

[0080] The control panel of this embodiment can be applied to the field of mechanical devices such as a heat pump water heater. A drive for a heat pump is to drive a heat pump compressor. In general, a heat pump device is only equipped with one of a variable frequency heat pump drive module and a fixed frequency heat pump drive module to match with one of a variable frequency fan drive module and a fixed frequency fan drive module. For example, a heat pump device is equipped with a variable frequency heat pump drive module and a variable frequency fan drive module, to drive the variable frequency heat pump and the variable frequency fan. This means that for any heat pump device, there is only one driving mode, and the driving mode cannot be adjusted based on an actual usage scenario.

[0081] The control panel of this embodiment comprises the main control module, the fan drive module and the heat pump drive module. The fan drive module comprises the variable frequency fan drive module and the fixed frequency fan relay module, and the fan drive module is connected to the main control module to drive the variable frequency fan or the fixed frequency fan to operate based on the control instruction of the main control module. The heat pump drive module comprises the variable frequency heat pump drive module and the fixed frequency heat pump relay module, and the heat pump drive module is connected to the main control module to drive the variable frequency heat pump or the fixed frequency heat pump to operate based on the control instruction of the main control module. Since the control panel is integrated with the variable frequency fan drive module, the fixed frequency fan relay module, the variable frequency heat pump drive module and the fixed frequency heat pump relay module, based on actual requirements, the variable frequency fan drive module can be selected to drive the variable frequency fan to operate and match with the variable frequency heat pump drive module to drive the variable frequency heat pump to operate, or the variable frequency fan drive module can be selected to drive the variable frequency fan to operate and match with the fixed frequency heat pump relay module to drive the fixed frequency heat

pump to operate, or the fixed frequency fan relay module can be selected to drive the fixed frequency fan to operate and match with the variable frequency heat pump drive module to drive the variable frequency heat pump to operate, or the fixed frequency fan relay module can be selected to drive the fixed frequency fan to operate and match with the fixed frequency heat pump relay module to drive the fixed frequency heat pump to operate. That is, there are four optional drive modes, and the diversified driving requirements are satisfied.

[0082] Furthermore, since a traditional driving mode is to provide drive modules in a heat pump and a fan respectively to drive the heat pump and the fan, which is not conducive to unified control and maintenance of the drive module, the present embodiment integrates drive modules of a heat pump and a fan into a same control panel, which is convenient for unified control of the drive modules through the same main control, and is conducive to the unified maintenance of each drive module.

[0083] In an embodiment, the control panel is provided outside the variable frequency fan, the variable frequency heat pump, the fixed frequency fan and the fixed frequency heat pump.

[0084] At present, for a device adopting a variable frequency heat pump and a variable frequency fan, the variable frequency heat pump drive module is mounted inside a compressor of the variable frequency heat pump, and the variable frequency fan drive module is mounted inside the variable frequency fan. A compressor motor of the variable frequency heat pump and a variable frequency fan motor generate heat during operation, and the heat is mainly generated by the following reasons.

1. A motor core is subjected to a magnetic flux, and then generate hysteresis loss and eddy current loss, thereby generating heat.

2. The current in a motor winding generates Joule heat, which causes the winding to generate heat.

3. A motor bearing is subjected to friction and inertia, thereby generating heat.

[0085] In addition, heat elements in the variable frequency drive module also generate heat, and the heat is mainly generated by the following reasons.

1. For an insulated gate bipolar transistor (IGBT) or a metal-oxide-semiconductor field-effect transistor (MOSFET) or an intelligent power module (IPM), a certain amount of resistance exists when it is conductive inside, and Joule heat is generated when current passes through it, thereby generating heat.

2. A high-frequency switch is required for switching on and off a heat element, thereby generating higher heat.

3. A higher turn-off voltage is required for turning off a heat element, thereby generating higher heat.

4. The operating temperature of a heat element is high, resulting in an increase in its on-resistance and turn-off voltage, thereby generating more heat.

[0086] Since the compressor of the variable frequency heat pump where the variable frequency drive module is located and the variable frequency fan generate heat from its insides, and the heat elements of the variable frequency heat pump drive module also generate heat, it is necessary to dissipate heat generated from the heat elements through measures such as providing a heat sink, to ensure the normal operation of the variable frequency drive module, however, which leads to increase in the heat dissipation costs. In addition, since the variable frequency drive module is integrated at a corresponding motor, the size of the motor become relatively large, which leads to a higher cost for structural members that fix the motor.

[0087] In this embodiment, the control panel integrated with the variable frequency fan drive module and the variable frequency heat pump drive module is provided outside the variable frequency fan and the variable frequency heat pump, and then the variable frequency drive module is kept away from the heat source, thereby avoiding the influence of heat generated by internal environment of the variable frequency fan and the variable frequency heat pump on the variable frequency drive module, and also assisting in heat dissipation of heat elements of the variable frequency drive module, which improves the stability of the variable frequency drive module during operation, and reduces the heat dissipation costs. In addition, since the variable frequency fan drive module is separated from the variable frequency fan motor, and the variable frequency heat pump drive module is separated from the compressor motor of the variable frequency heat pump, the height of each motor is reduced (for example, the height of the variable frequency fan motor can be reduced by 10 mm), and the volume of the motor and the amount of material used in a motor body is further reduced, thereby assisting in reducing the fixing costs of the motor and the manufacturing costs of the motor itself.

[0088] Referring to FIG. 1, in an embodiment, the control panel may further comprise:

a variable frequency fan interface 3, where the variable frequency fan drive module is connected to a three-phase motor of the variable frequency fan through the variable frequency fan interface 3, the variable frequency fan drive module can drive the variable frequency fan to operate according to a target speed or a target power or a target current based on the control instruction of the main control module, and feed back an actual speed, an actual power, an actual current and fault information of the

variable frequency fan to the main control module; and

a variable frequency heat pump interface 4, where 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 4, the variable frequency heat pump drive module can drive the compressor of the variable frequency heat pump to operate according to a target speed or a target power or a target current based on the control instruction of the main control module, and feed back an actual speed, an actual power, an actual current and fault information of the compressor of the variable frequency heat pump to the main control module.

[0089] Furthermore, the variable frequency fan drive module communicates with the main control module through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface; and
the variable frequency heat pump drive module communicates with the main control module through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

[0090] The variable frequency fan interface 3 has three pins corresponding to three-phase terminals U, V and W of the three-phase motor in the variable frequency fan, and the variable frequency fan drive module is connected to the three-phase motor in the variable frequency fan through these three pins.

[0091] Similarly, the variable frequency heat pump interface 4 has three pins corresponding 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.

[0092] Traditional variable frequency heat pumps and variable frequency fans adopt a pulse width modulation (PWM) duty cycle communication mode, that is, the main control module sends a PWM control instruction to the variable frequency heat pump drive module and the variable frequency fan drive module, and then the variable frequency heat pump drive module and the variable frequency fan drive module drive the heat pump and fan to operate based on the control instruction. However, in this mode, the compressor motor of the variable frequency heat pump and the variable frequency fan motor need four wires respectively for connecting to the main control module through their respective variable frequency drive modules. Taking the variable frequency heat pump as an example, the first wire is used to provide power supply voltage for the compressor motor of the variable frequency heat pump, the second wire is used to ground the compressor motor of the variable frequency heat pump, the third wire is used to provide PWM control instruction to the compressor motor of the variable frequency heat pump, and the fourth wire is used by the compressor motor of the variable frequency heat pump to feed back a speed feedback signal to the main control module. The four wires of the variable frequency fan motor are similar.

[0093] In this embodiment, since the variable frequency fan drive module and the main control module, as well as the variable frequency heat pump drive module and the main control module are all communicate 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 and the variable frequency fan motor to the main control module through their respective variable frequency drive modules can be reduced from four to three, and the three wires are connected to the three-phase terminals of each motor respectively, thereby reducing the wiring cost.

[0094] On the other hand, when adopting a PWM duty cycle communication mode, there are sending and receiving errors of the duty cycle. The errors are formed by the following reasons.

[0095] A duty cycle is the ratio of a count value of a counter of the main control module to a maximum value of the counter. If the main frequency of the main control module is too high, the count value of the counter would be too small, resulting in a small calculated duty cycle. If the main frequency of the main control module is too low, the count value of the counter would be too large, resulting in a large calculated duty cycle. That is, a main frequency error will lead to the duty cycle error, and the main control module has such a main frequency error no matter when sending PWM control signals or receiving PWM feedback signals, resulting in sending errors and receiving errors of the duty cycle.

[0096] Due to the existence of the above errors, the control of the main control module to the motor deviates greatly from the target value, which affects the operation of the entire system of the heat pump water heater.

[0097] In this embodiment, the main control module communicates through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface, to control the operation of the motor. On the one hand, the number of wires connecting the compressor motor of the variable frequency heat pump and the variable frequency fan motor to the main control module through their respective variable frequency drive modules can be reduced from four to three, thereby reducing the wiring costs and improving the data transmission rate. On the other hand, a verification procedure in this type of communication can be used to improve the accuracy of data transmission, to make a target index value in the control instruction can be accurately informed to a target motor, and the target motor can also accurately feed back the current actual

index value to the main control module. In practice, the data transmission error can be reduced by 1% - 3%, which is conducive to improving the control accuracy of the whole system.

[0098] Referring to FIG. 1, in an embodiment, the control panel may further comprise:

a fixed frequency fan interface 5, where the fixed frequency fan relay module is connected to the fixed frequency fan through the fixed frequency fan interface 5; and

a fixed frequency heat pump interface 6, where the fixed frequency heat pump relay module is connected to the fixed frequency heat pump through the fixed frequency heat pump interface 6.

[0099] The fixed frequency fan relay module is equivalent to a switch of the fixed frequency fan. When receiving a control instruction from the main control module, the fixed frequency fan relay module drives the fixed frequency fan to start or stop operating.

[0100] Similarly, the fixed frequency heat pump relay module is equivalent to the switch of the fixed frequency heat pump. When receiving the control instruction of the main control module, the fixed frequency heat pump relay module drives the fixed frequency heat pump to start or stop operating.

[0101] In this embodiment, by using a switching characteristic of the relay, the switching of the fixed frequency fan and the fixed frequency heat pump can be conveniently controlled.

[0102] Referring to FIG. 1, in an embodiment, the control panel may further comprise:

a switch power supply module, where a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply module is connected to the variable frequency fan drive module and the variable frequency heat pump drive module in a non-isolated manner;

a first optocoupler isolation module 8, where the first optocoupler isolation module 8 is connected between the variable frequency fan drive module and the main control module; and

a second optocoupler isolation module 9, where the second optocoupler isolation module 9 is connected between the variable frequency heat pump drive module and the main control module,

where the variable frequency fan is a high-voltage variable frequency fan, and the variable frequency heat pump is a high-voltage variable frequency heat pump.

[0103] In this embodiment, a high-voltage variable frequency solution is adopted. The switch power supply module rectifies AC mains electricity of 220 V or 110 V, and outputs high-voltage DC of 310 V after rectification. Since the voltage added by the switch power supply module to the variable frequency fan motor winding and the compressor motor winding of the variable frequency heat pump through the variable frequency drive module is non-isolated high voltage electricity, an optocoupler isolation module is required between the variable frequency drive module and the main control module, to achieve isolated communication and improve communication reliability and stability.

[0104] In an embodiment, the control panel may further comprise:

a switch power supply module, where a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply module is connected to the variable frequency fan drive module and the variable frequency heat pump drive module in a non-isolated manner,

where the variable frequency fan is a low-voltage variable frequency fan, and the variable frequency heat pump is a low-voltage variable frequency heat pump.

[0105] In this embodiment, a low-voltage variable frequency scheme is adopted. The switch power supply module rectifies AC mains electricity of 220 V or 110 V, and outputs low-voltage DC such as 36 V or 24 V after rectification. Since the voltage added by the switch power supply module to the variable frequency fan motor winding and the compressor motor winding of the variable frequency heat pump through the variable frequency drive module is isolated low-voltage electricity, there is no need to add an optocoupler isolation module between the variable frequency drive module and the main control module, but the communication reliability and stability still can be ensured.

[0106] Referring to FIG. 1, in an embodiment, the control panel may further comprise:

an electronic anode drive module and an electronic anode interface 1, where a first end of the electronic anode drive module is connected to the main control module, and a second end of the electronic anode drive module is connected to the electronic anode through the electronic anode interface 1.

[0107] In this embodiment, by providing an electronic anode drive module, which can drive the electronic anode to release electronic ions to neutralize metal ions in water based on the instruction of the main control mod-

ule, scaling and corrosion are reduced, and can feed back the actual neutralization state to the main control module.

[0108] Referring to FIG. 1, in an embodiment, the control panel may further comprise:

an electricity leakage detect module, where the electricity leakage detect module is connected between the switch power supply module and mains electricity;

a current detect module 10, where the current detect module 10 is connected between the electricity leakage detect module and mains electricity;

a sensor drive module and a sensor interface 7, where a first end of the sensor drive module is connected to the main control module, and a second end of the sensor drive module is connected to temperature sensors at different positions through the sensor interface 7;

a high-voltage switch drive module and a high-voltage switch interface 2, where a first end of the high-voltage switch drive module is connected to the main control module, and a second end of the high-voltage switch drive module is connected to the high-voltage switch through the high-voltage switch interface 2; and

a display panel communicate module, where a first end of the display panel communicate module is connected to the main control module, and a second end of the display panel communicate module is connected to a display panel.

[0109] The electricity leakage detect module can detect whether there is electricity leakage by detecting the current difference between a neutral wire and a live wire, and feed back an electricity leakage state to the main control module in a manner of electrical level.

[0110] The current detect module 10 can determine a load current during system operation by detecting a current of the live wire, and feed back the current state to the main control module.

[0111] The sensor drive module can drive the temperature sensors at different positions of the heat pump device to detect the temperature at the current position based on the control instruction of the main control module, and feed back the temperature of each position to the main control module.

[0112] The high-voltage switch drive module can drive the high-voltage switch to detect an operating pressure of the system based on the control instruction of the main control module, and feed back a pressure signal to the main control module in case that the operating pressure exceeds a preset pressure.

[0113] The display panel communicate module can display operation indicators fed back to the main control module based on the control instruction of the main control module.

[0114] It should be noted that the switch power supply module can be connected to each module to convert AC mains electricity into DC voltage, and to power a variable frequency chip, a drive chip, MOSFET/IGBT/IPM of the main control module and the variable frequency fan drive/variable frequency heat pump drive module, as well as the fixed frequency fan/fixed frequency heat pump relay module, the electronic anode drive module, the high-voltage switch drive module, the sensor drive module, the electricity leakage detect module, the current detect module 10 and the display panel communicate .

[0115] During actual usage, the switch power supply module and the display panel communicate module can be connected in a non-isolated manner, and an isolation optocoupler module may be connected between the main control module and the display panel communicate module, to achieve isolated communication and ensure the stability and reliability of communication.

[0116] The main control module is mainly responsible for sending control instructions to each module and collecting and processing operating states and measurement values of each component fed back by each module, and displaying collected data on the display panel by communicating with the display panel through a universal asynchronous receiver/transmitter. Taking the heat pump water heater as an example, the main control module can control the water temperature of a water tank through performance logic, collect values of a first position temperature sensor 11 (comprising a value of an inner tank surface temperature sensor) and a value of a second position temperature sensor 12 (comprising a value of an evaporator temperature sensor, a value of an ambient temperature sensor, a value of an exhaust temperature sensor and a value of an return air temperature sensor), and send these temperature sensor values to the display panel for display.

[0117] In this embodiment, by providing a plurality of functional modules on the control panel, the control instructions of the main control module can be transmitted to each component of the heat pump device through these functional modules, and actual operating states and measurement values of each component are fed back to the main control module. Finally, the data collected by the main control module is processed and transmitted to the display panel for display.

[0118] Referring to FIG. 1, an embodiment of the present application further provides a water heater, comprising: a variable frequency fan, a fixed frequency fan, a variable frequency heat pump, a fixed frequency heat pump, an electronic anode, a temperature sensor, a high-voltage switch, a display panel and the aforementioned control panel (as shown in FIG. 1).

[0119] Since the water heater of this embodiment comprises the aforementioned control panel, the water heater of this embodiment also has the beneficial effects of the

control panel described in the aforementioned embodiments, which are not repeated here.

[0120] Referring to FIG. 1, an embodiment of the present application provides a driving method, comprising:

controlling a main control module to send a variable frequency fan control signal to a variable frequency fan drive module; controlling a variable frequency fan drive module to amplify the variable frequency fan control signal to obtain a variable frequency fan amplified signal; controlling the variable frequency fan drive module to send the variable frequency fan amplified signal to the variable frequency fan; and controlling the variable frequency fan to operate based on the variable frequency fan amplified signal; and

controlling the main control module to send a variable frequency heat pump control signal to a variable frequency heat pump drive module; controlling the variable frequency heat pump drive module to amplify the variable frequency heat pump control signal to obtain a variable frequency heat pump amplified signal; controlling the variable frequency heat pump drive module to send the variable frequency heat pump amplified signal to the variable frequency heat pump; and controlling the variable frequency heat pump to operate based on the variable frequency heat pump amplified signal.

[0121] In some embodiments, the driving method may further comprise:

controlling a main control module to send a variable frequency fan control signal to a variable frequency fan drive module; controlling the variable frequency fan drive module to amplify the variable frequency fan control signal to obtain a variable frequency fan amplified signal; controlling the variable frequency fan drive module to send the variable frequency fan amplified signal to the variable frequency fan; and controlling the variable frequency fan to operate based on the variable frequency fan amplified signal; and

controlling the main control module to send a fixed frequency heat pump control signal to a fixed frequency heat pump relay module; and controlling the fixed frequency heat pump relay module to close based on the fixed frequency heat pump control signal to drive a fixed frequency heat pump to operate.

[0122] In some embodiments, the driving method may further comprise:

controlling a main control module to send a fixed frequency fan control signal to a fixed frequency fan relay module; and controlling the fixed frequency fan relay module to close based on the fixed frequency fan control signal to drive a fixed frequency fan to operate; and

controlling the main control module to send a variable frequency heat pump control signal to the variable frequency heat pump drive module; controlling the variable frequency heat pump drive module to amplify the variable frequency heat pump control signal to obtain a variable frequency heat pump amplified signal; controlling the variable frequency heat pump drive module to send the variable frequency heat pump amplified signal to the variable frequency heat pump; and controlling the variable frequency heat pump to operate based on the variable frequency heat pump amplified signal.

[0123] In some embodiments, the driving method may further comprise:

controlling a main control module to send a fixed frequency fan control signal to a fixed frequency fan relay module; and controlling the fixed frequency fan relay module to close based on the fixed frequency fan control signal to drive a fixed frequency fan to operate; and

controlling a main control module to send a fixed frequency heat pump control signal to a fixed frequency heat pump relay module; and controlling the fixed frequency heat pump relay module to close based on the fixed frequency heat pump control signal to drive a fixed frequency heat pump to operate.

[0124] In the embodiments of the present application, according to the matching of the fixed frequency drive and variable frequency drive of the fan and the fixed frequency drive and variable frequency drive of the heat pump, four different driving schemes are realized, and diverse driving requirements are satisfied.

[0125] FIG. 2 is a circuit diagram of a control panel according to an embodiment of the present application. Referring to FIG. 2, an embodiment of the present application provides a control panel, comprising:

a main control module;

a fixed frequency fan relay module, where the fixed frequency fan relay module is connected to the main control module, for driving a fixed frequency fan to operate based on a control instruction of the main control module; and

a variable frequency heat pump drive module, where the variable frequency heat pump drive module is connected to the main control module, for driving a variable frequency heat pump to operate based on a

control instruction of the main control module,

where the control panel is provided outside the fixed frequency fan and the variable frequency heat pump.

[0126] The control panel of this embodiment can be applied to the field of mechanical devices such as a heat pump water heater. A drive for a heat pump is to drive a heat pump compressor.

[0127] Source of heat of a compressor motor of the variable frequency heat pump can be referred to above, which is not repeated here.

[0128] In addition, source of heat of heat elements of the variable frequency heat pump drive module is the same as the source of the heat of the above variable frequency drive module, which is not repeated here.

[0129] The control panel of the present application comprises the main control module, the fixed frequency fan relay module and the variable frequency heat pump drive module. The fixed frequency fan relay module is connected to the main control module, for driving the fixed frequency fan to operate based on the control instruction of the main control module. The variable frequency heat pump drive module is connected to the main control module, for driving the variable frequency heat pump to operate based on the control instruction of the main control module. The control panel is provided outside the fixed frequency fan and the variable frequency heat pump. By providing the control panel integrated with the variable frequency heat pump drive module outside the variable frequency heat pump, the variable frequency heat pump drive module is kept away from the heat source, to avoid the influence of heat generated by internal environment of the variable frequency heat pump on the variable frequency heat pump drive module, and assist in heat dissipation of heat elements of the variable frequency heat pump drive module, which improves the stability of the variable frequency heat pump drive module during operation.

[0130] Further, since a traditional driving method dissipates heat of heat elements through measures such as providing a heat sink, which causes increase in heat dissipation costs. A heat sink is not required in this embodiment, which can reduce the heat dissipation costs.

[0131] Furthermore, since the variable frequency heat pump drive module is generally integrated on a compressor motor of the variable frequency heat pump, the volume of the compressor motor is relatively large, and the costs of structural members for fixing the motor are relatively high. In some embodiments of the present application, the variable frequency heat pump drive module is separated from the compressor motor of the variable frequency heat pump, which reduces the height of the motor, and further reduces the volume of the motor and the amount of material used in a motor body, thereby assisting in reducing the costs for fixing the motor and the manufacturing costs of the motor itself.

[0132] Furthermore, since a traditional driving mode is to provide drive modules in a heat pump and a fan respectively to drive the heat pump and the fan, it is not conducive to unified control and maintenance of the drive modules. In some embodiments of the present application, drive modules of a heat pump and a fan are integrated at a same control panel, which is convenient for unified control of the drive modules through the same main control, and is conducive to the unified maintenance of each drive module.

[0133] Referring to FIG. 2, in an embodiment, the control panel may further comprise:

a variable frequency heat pump interface 2-3, where 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 2-3, and the variable frequency heat pump drive module can drive a compressor of the variable frequency heat pump to operate according to a target speed or a target power or a target current based on the control instruction of the main control module, and feed back an actual speed, an actual power, an actual current and fault information of the compressor of the variable frequency heat pump to the main control module.

[0134] Further, the variable frequency heat pump drive module communicates with the main control module through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

[0135] The variable frequency heat pump interface 2-3 has three pins corresponding 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.

[0136] Traditional variable frequency heat pumps adopt a pulse width modulation (PWM) duty cycle communication mode, that is, the main control module sends a PWM control instruction to the variable frequency heat pump drive module, and then the variable frequency heat pump drive module drives the heat pump to operate based on the control instruction. However, in this mode, the compressor motor of the variable frequency heat pump needs four wires for connecting to the main control module through the variable frequency heat pump drive module,where the first wire is used to provide power supply voltage for the compressor motor of the variable frequency heat pump, the second wire is used to ground the compressor motor of the variable frequency heat pump, the third wire is used to provide PWM control instruction to the compressor motor of the variable frequency heat pump, and the fourth wire is used by the compressor motor of the variable frequency heat pump to feed back a speed feedback signal to the main control module.

[0137] In this embodiment, since the variable frequency heat pump drive module and the main control

module communicate 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 main control module through the variable frequency heat pump drive module can be reduced from four to three, and the three wires are connected to the three-phase terminals of the motor respectively, thereby reducing the wiring costs.

[0138] On the other hand, when adopting a PWM duty cycle communication mode, there are sending and receiving errors of the duty cycle. The origin of the errors can be referred to above, and is not repeated here.

[0139] Due to the existence of the above errors, the control of the main control module to the motor deviates greatly from the target value, which affects the operation of the entire system of the heat pump water heater.

[0140] In this embodiment, the main control module communicates through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface, to control the operation of the motor. On the one hand, the number of wires connecting the compressor motor of the variable frequency heat pump and the main control module through the variable frequency heat pump drive module can be reduced from four to three, thereby reducing the wiring costs and improving the data transmission rate. On the other hand, a verification procedure in this type of communication can be used to improve the accuracy of data transmission, to make a target index value in the control instruction can be accurately informed to a target motor, and the target motor can also accurately feed back the current actual index value to the main control module. In practice, the data transmission error can be reduced by 1% - 3%, which is conducive to improving the control accuracy of the whole system.

[0141] Referring to FIG. 2, in an embodiment, the control panel may further comprise:

a fixed frequency fan interface 2-4, where the fixed frequency fan relay module is connected to the fixed frequency fan through the fixed frequency fan interface 2-4.

[0142] The fixed frequency fan relay module is equivalent to a switch of the fixed frequency fan. When receiving a control instruction of the main control module, the fixed frequency fan relay module drives the fixed frequency fan to start or stop operating.

[0143] In this embodiment, by using a switching characteristic of the relay, the switching of the fixed frequency fan can be conveniently controlled.

[0144] Referring to FIG. 2, in an embodiment, the control panel may further comprise:

a switch power supply module, where a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply is connected to the variable frequency heat pump drive module in a non-isolated manner; and

a third optocoupler isolation module 2-6, where the third optocoupler isolation module 2-6 is connected between the variable frequency heat pump drive module and the main control module,

where the variable frequency heat pump is a high-voltage variable frequency heat pump.

[0145] In this embodiment, a high-voltage variable frequency solution is adopted. The switch power supply module rectifies AC mains electricity of 220 V or 110 V, and outputs high-voltage DC of 310 V after rectification. Since the voltage added by the switch power supply module to the compressor motor winding of the variable frequency heat pump through the variable frequency heat pump drive module is non-isolated high voltage electricity, an optocoupler isolation module is required between the variable frequency heat pump drive module and the main control module, to achieve isolated communication and improve communication reliability and stability.

[0146] In an embodiment, the control panel may further comprise:

a switch power supply module, where a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply is connected to the variable frequency heat pump drive module in an isolated manner,

where the variable frequency heat pump is a low-voltage variable frequency heat pump.

[0147] In this embodiment, a low-voltage variable frequency scheme is adopted. The switch power supply module rectifies AC mains electricity of 220 V or 110 V, and outputs low-voltage DC such as 36 V or 24 V after rectification. Since the voltage added by the switch power supply module to the compressor motor winding of the variable frequency heat pump through the variable frequency heat pump drive module is isolated low-voltage electricity, there is no need to add an optocoupler isolation module between the variable frequency heat pump drive module and the main control module, but the communication reliability and stability still can be ensured.

[0148] Referring to FIG. 2, in an embodiment, the control panel may further comprise:

an electronic expansion valve drive module and an electronic expansion valve interface 2-2, where a first end of the electronic expansion valve drive module is connected to the main control module, and a second end of the

electronic expansion valve drive module is connected to the electronic expansion valve through the electronic expansion valve interface 2-2.

[0149] In this embodiment, the electronic expansion valve drive module can drive the electronic expansion valve to operate to a target number of steps based on the control instruction of the main control module, and feed back the actual number of steps to the main control module.

[0150] Referring to FIG. 2, in an embodiment, the control panel may further comprise:

an electricity leakage detect module, where the electricity leakage detect module is connected between the switch power supply module and mains electricity;

a current detect module 2-7, where the current detect module 2-7 is connected between the electricity leakage detect module and mains electricity;

a sensor drive module and a sensor interface 2-5, where a first end of the sensor drive module is connected to the main control module, and a second end of the sensor drive module is connected to temperature sensors at different positions through the sensor interface 2-5;

a high-voltage switch drive module and a high-voltage switch interface 2-1, where a first end of the high-voltage switch drive module is connected to the main control module, and a second end of the high-voltage switch drive module is connected to a high-voltage switch through the high-voltage switch interface 2-1; and

a display panel communicate module, where a first end of the display panel communicate module is connected to the main control module, and a second end of the display panel communicate module is connected to the display panel connection.

[0151] The electricity leakage detect module can detect whether there is electricity leakage by detecting the current difference between a neutral wire and a live wire, and feed back an electricity leakage state to the main control module in a manner of electrical level.

[0152] The current detect module 2-7 can determine a load current during system operation by detecting a current of the live wire, and feed back the current state to the main control module.

[0153] The sensor drive module can drive the temperature sensors at different positions of the heat pump device to detect the temperature at the current position based on the control instruction of the main control module, and feed back the temperature of each position to the main control module.

[0154] The high-voltage switch drive module can drive the high-voltage switch to detect an operating pressure of the system based on the control instruction of the main control module, and feed back a pressure signal to the main control module in case that the operating pressure exceeds a preset pressure.

[0155] The display panel communicate module can display operation indicators fed back to the main control module based on the control instruction of the main control module.

[0156] It should be noted that the switch power supply module can be connected to each module to convert AC mains electricity into DC voltage, and to power a variable frequency chip, a drive chip, MOSFET/IGBT/IPM of the main control module and the variable frequency heat pump drive module, as well as the fixed frequency fan relay module, the electronic expansion valve drive module, the high-voltage switch drive module, the sensor drive module, the electricity leakage detect module, the current detect module 2-7 and the display panel communicate .

[0157] During actual usage, the switch power supply module and the display panel communicate module can be connected in a non-isolated manner, and an isolation optocoupler module may be connected between the main control module and the display panel communicate module, to achieve isolated communication and ensure the stability and reliability of communication.

[0158] The main control module is mainly responsible for sending control instructions to each module and collecting and processing operating states and measurement values of each component fed back by each module, and displaying collected data on the display panel by communicating with the display panel through a universal asynchronous receiver/transmitter. Taking the heat pump water heater as an example, the main control module can control the water temperature of a water tank through performance logic, collect values of a third position temperature sensor 2-8 (comprising a value of an inner tank surface temperature sensor) and a value of a fourth position temperature sensor 2-9 (comprising a value of an evaporator temperature sensor, a value of an ambient temperature sensor, a value of an exhaust temperature sensor and a value of an return air temperature sensor), and send these temperature sensor values to the display panel for display.

[0159] In this embodiment, by providing a plurality of functional modules on the control panel, the control instructions of the main control module can be transmitted to each component of the heat pump device through these functional modules, and actual operating states and measurement values of each component are fed back to the main control module. Finally, the data collected by the main control module is processed and transmitted to the display panel for display.

[0160] Referring to FIG. 2, an embodiment of the present application provides a water heater, comprising the aforementioned control panel (as shown in FIG. 2).

[0161] Since the water heater of this embodiment com-

prises the aforementioned control panel, the water heater of this embodiment also has the beneficial effects of the control panel described in the aforementioned embodiments, which are not repeated here.

[0162] Referring to FIG. 2, in an embodiment, the water heater further comprises a fixed frequency fan, a variable frequency heat pump, an electronic expansion valve, a temperature sensor, a high-voltage switch and a display panel.

[0163] Since the water heater of this embodiment comprises the aforementioned control panel, the water heater of this embodiment also has the beneficial effects of the control panel described in the aforementioned embodiments, which are not repeated here.

[0164] The control panel and the water heater of the present application are described below in conjunction with FIG. 3 and FIG. 4.

[0165] According to the embodiment of this application, as shown in FIG. 3 and FIG. 4, the control panel comprises a main control panel 4-1, a variable frequency fan drive module 4-2 and a fixed frequency heat pump switch module 4-4. The main control panel 4-1 is provided with a control module 4-11, the variable frequency fan drive module 4-2 is integrated at the main control panel 4-1, an input end of the variable frequency fan drive module 4-2 is electrically connected to a first output end of the control module 4-11, an output end of the variable frequency fan drive module 4-2 is electrically connected to a variable frequency fan 4-3, an input end of the fixed frequency heat pump switch module 4-4 is electrically connected to a second output end of the control module 4-11, and an output end of the fixed frequency heat pump switch module 4-4 is electrically connected to a fixed frequency heat pump 4-5.

[0166] According to the control panel of the embodiment of the present application, the control module 4-11 sends corresponding control signals to the variable frequency fan drive module 4-2 and the fixed frequency heat pump switch module 4-4, and then the variable frequency fan drive module 4-2 can drive the fan to operate based on target operating parameters, and the fixed frequency heat pump switch module 4-4 can control a switch of the fixed frequency heat pump 4-5. The variable frequency fan drive module 4-2 is integrated at the main control panel 4-1, that is, the variable frequency fan drive module 4-2 and the control module 4-11 can share one panel, and there is no need to provide an additional control panel for the variable frequency fan 4-3, thereby effectively reducing the volume occupied by the variable frequency fan drive module 4-2. In addition, the main control panel 4-1 integrated with the variable frequency fan drive module 4-2 is not mounted inside the variable frequency fan 4-3, that is, no control panel for the variable frequency fan 4-3 is provided inside the variable frequency fan 4-3, which can effectively reduce the volume of the variable frequency fan, reduce materials required for the production of the variable frequency fan 4-3, and reduce the costs. Only the main control panel 4-1 needs to be fixed, and there is no need to provide an additional fixed structure to fix the variable frequency fan drive module 4-2, which can effectively reduce the number of fixed structures and reduce costs.

[0167] It may be understood that the control panel is generally mounted outside the fan and the heat pump, and would not be mounted inside the fan or the heat pump.

[0168] It may be understood that, in the related art, since the control panel of the variable frequency fan 4-3 is mounted inside the variable frequency fan 4-3, the control panel of the variable frequency fan 4-3 and the variable frequency fan 4-3 generate heat during operation, which leads to more heat in the variable frequency fan 4-3, higher ambient temperature and poor heat dissipation effect. An additional heat dissipate structure is required to satisfy the heat dissipation requirements, resulting in higher heat dissipation costs. However, the present application integrates the variable frequency fan drive module 4-2 at the main control panel 4-1, so that the variable frequency fan drive module 4-2 and the variable frequency fan 4-3 are in different spaces, and the heat dissipation of the variable frequency fan drive module 4-2 and the heat dissipation of the variable frequency fan 4-3 do not affect each other, thereby improving the heat dissipation effect. Furthermore, less heat dissipate structures are required for satisfying the heat dissipation requirements, thereby reducing the heat dissipation costs.

[0169] It may be understood that when the water heater uses the variable frequency fan 4-3, if the control panel of the variable frequency fan 4-3 is mounted inside the variable frequency fan 4-3, since the variable frequency fan 4-3 generates heat during operation, the following situations occur: a. a motor core is subjected to a magnetic flux, and then generate hysteresis loss and eddy current loss, thereby generating heat; b. a current in a motor winding generates Joule heat, which causes the winding to generate heat; and c. a motor bearing is subjected to friction and inertia, thereby generating heat. The control panel of the variable frequency fan 4-3 is placed close to the motor body, and heat elements (IGBTs or MOSs or IPMs) of a variable frequency drive panel generate Joule heat when current passes through it, thereby generating heat. When the IGBT and MOS are turned off, a high-frequency switch is required by some heat components, and there is a turn-off voltage when turning off. The higher the turn-off voltage, the greater the heat generated. The heat component requires the high-frequency switch, and a certain amount of heat would be generated during switching on and off. The higher the switching frequency, the greater the heat generated. In addition, the higher the operating temperature of the heat component, the higher its on-resistance and off-voltage, thus generating more heat. That is to say, the variable frequency fan 4-3 also generates heat by itself, resulting in a higher ambient temperature inside the variable frequency fan 4-3, requiring structures such as heat sinks to

dissipate heat from the heat element, and increasing the heat dissipation costs. Besides, integrating the control panel of the variable frequency fan 4-3 at the fan also results in a relatively large volume of the fan, structural members are required to fix the control panel of the variable frequency fan 4-3, and the fixing cost is also high.

[0170] It may be understood that the fixed frequency heat pump switch module 4-4 is, for example, a relay.

[0171] In an embodiment of the present application, as shown in FIG. 3 and FIG. 4, the fixed frequency heat pump switch module 4-4 is integrated at the main control panel 4-1.

[0172] It may be understood that the fixed frequency heat pump switch module 4-4 and the variable frequency fan drive module 4-2 are simultaneously integrated at the main control panel 4-1, which improves the integration of the main control panel 4-1.

[0173] In an embodiment of the present application, the variable frequency fan drive module 4-2 is connected to the control module 4-11 for communication through at least one of a serial interface universal asynchronous receiver/transmitter (UART) or a bidirectional serial data transmission interface inter-integrated circuit (I2C) or a serial peripheral interface (SPI).

[0174] It may be understood that the communication between the variable frequency fan drive module 4-2 and the control module 4-11 is established through at least one of the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI. Since the communication modes such as the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI have a verification function, the accuracy of data transmission between the control module 4-11 and the variable frequency fan drive module 4-2 can be effectively improved, and the variable frequency fan 4-3 can be precisely controlled.

[0175] It may be understood that, in the related art, in a water heater, the variable frequency fan 4-3 and the control module 4-11 are connected through a PWM duty cycle communication mode. In the PWM duty cycle communication mode, a main frequency error of the chip affects the counting accuracy of the timer, thereby affecting the calculation of the duty cycle. Therefore, if the main frequency of the chip has an error, the duty cycles of sending and receiving may have certain errors. Specifically, a high main frequency will lead to a small duty cycle, and a low main frequency will lead to a large duty cycle, which eventually affects the control accuracy of the variable frequency fan 4-3. However, in some embodiments of the present application, the variable frequency fan drive module 4-2 and the control module 4-11 are connected through communication modes such as the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI, which can effectively overcome the error problem caused by the PWM duty cycle communication mode and improve the control accuracy of the variable frequency fan 4-3.

[0176] It should also be noted that when using the PWM duty cycle communication mode, four wires, that is, a voltage drain drain (VDD) signal, a ground (GND) signal, a PWM signal and a speed feedback signal, are generally required for wiring, and the cost is relatively high. The communication modes such as the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI used in the present application only require three wires to realize the connection between the variable frequency fan drive module 4-2 and the variable frequency fan 4-3, which effectively reduces the costs.

[0177] In an embodiment of the present application, as shown in FIG. 4, the control panel comprises a variable frequency fan interface 4-31. The variable frequency fan interface 4-31 is integrated at the main control panel 4-1, and the variable frequency fan interface 4-31 is used to connect the variable frequency fan drive module 4-2 with the variable frequency fan 4-3.

[0178] It may be understood that integrating the variable frequency fan interface 4-31 at the main control panel 4-1 improves the integration of the main control panel 4-1, and the connection between the variable frequency fan 4-3 and the variable frequency fan drive module 4-2 can be realized by connecting the variable frequency fan 4-3 with the variable frequency fan interface 4-31.

[0179] In some embodiments, the variable frequency fan 4-3 is, for example, detachably connected to the variable frequency fan interface 4-31, which is convenient for the disassembly and assembly of the variable frequency fan 4-3 and the replacement of the variable frequency fan 4-3.

[0180] In the embodiment of the present application, the variable frequency fan interface 4-31 comprises a first U-phase interface, a first V-phase interface and a first W-phase interface. The first U-phase interface is used to connect the variable frequency fan drive module 4-2 with a U-phase connection end of the variable frequency fan 4-3, the first V-phase interface is used to connect the variable frequency fan drive module 4-2 with a V-phase connection end of the variable frequency fan 4-3, and the first W-phase interface is used to connect the variable frequency fan drive module 4-2 with a W-phase interface of the variable frequency fan 4-3.

[0181] It may be understood that the variable frequency fan interface 4-31 has a total of three interfaces, namely, the first U-phase interface, the first V-phase interface and the first W-phase interface, that is, the variable frequency fan interface 4-31 can be connected to the variable frequency fan drive module 4-2 through three wires, and the variable frequency fan interface 4-31 can be connected to the variable frequency fan 4-3 through three wires, which further illustrates that compared with the related art, in this embodiment, fewer wires may be used to achieve the connection between the variable frequency fan drive module 4-2 and the variable frequency fan 4-3, which can effectively reduce costs.

[0182] In an embodiment of the present application, as

shown in FIG. 4, the control panel comprises a fixed frequency heat pump interface 4-51. The fixed frequency heat pump interface 4-51 is integrated at the main control panel 4-1, and the fixed frequency heat pump interface 4-51 is used to connect the fixed frequency heat pump switch module 4-4 with the fixed frequency heat pump 4-5.

[0183] It may be understood that integrating the fixed frequency heat pump interface 4-51 at the main control panel 4-1 improves the integration of the main control panel 4-1, and the connection between the fixed frequency heat pump 4-5 and a drive module of the fixed frequency heat pump 4-5 can be realized by connecting the fixed frequency heat pump 4-5 with the fixed frequency heat pump interface 4-51.

[0184] In some embodiments, the fixed frequency heat pump 4-5 is, for example, detachably connected to the fixed frequency heat pump interface 4-51, which is convenient for the disassembly and assembly of the fixed frequency heat pump 4-5 and the replacement of the fixed frequency heat pump 4-5.

[0185] In an embodiment of the present application, as shown in FIG. 4, the control panel comprises a fourth optocoupler isolation module 4-6. The fourth optocoupler isolation module 4-6 is provided between the variable frequency fan drive module 4-2 and the control module 4-11.

[0186] It may be understood that by providing the fourth optocoupler isolation module 4-6 between the variable frequency fan drive module 4-2 and the control module 4-11, the stability of the main control panel 4-1 can be effectively improved.

[0187] It may be understood that in case that the variable frequency fan 4-3 is a high-voltage variable frequency fan 4-3, it is necessary to provide a fourth optocoupler isolation module 4-6 between the variable frequency fan drive module 4-2 and the control module 4-11.

[0188] The high-voltage variable frequency scheme of the high-voltage variable frequency fan 4-3 and the high-voltage fixed frequency heat pump 4-5 refers to: for AC 220 V or 110 V and other mains electricity, DC 310 V is obtained after rectification, that is, the voltage applied to the motor winding is a non-isolated DC 310 V scheme. Therefore, optocoupler isolation is required for communication.

[0189] In case that the variable frequency fan 4-3 is a low-voltage variable frequency fan 4-3, there is no need to provide the fourth optocoupler isolation module 4-6. The low-voltage variable frequency scheme refers to output low-voltage isolation electricity such as 36V or 24V, etc., after mains electricity of AC 220 or 110 V passes through an isolation switch power supply. The used fans are all low-voltage motors. Since the voltage is isolated, optocoupler isolation is not required.

[0190] In an embodiment of the present application, as shown in FIG. 4, the control panel comprises a photovoltaic (PV) module 4-7. The PV module 4-7 is integrated at the main control panel 4-1, and the PV module 4-7 is used to connect the control module 4-11 with electrical grid.

[0191] It may be understood that the PV module 4-7 is integrated at the main control panel 4-1, which improves the integration of the main control panel 4-1.

[0192] It may be understood that the PV module 4-7 can convert the signal of the electrical grid into a signal that can be recognized by the control module 4-11, and transmit it to the control module 4-11.

[0193] It may be understood that the PV module 4-7 is a photovoltaic module, and the photovoltaic module can supply power to the control module 4-11. Since the photovoltaic module is connected to the electrical grid, the photovoltaic module can transmit excess electricity to the electrical grid, and can also use the power of the electrical grid to power the control module 4-11 and other components when its own power generation is insufficient to supply the control module 4-11 and other components.

[0194] According to the embodiment of the present application, the water heater comprises a variable frequency fan 4-3, a fixed frequency heat pump 4-5 and the above-mentioned control panel. The variable frequency fan 4-3 is electrically connected to the variable frequency fan drive module 4-2, and the fixed frequency heat pump 4-5 is electrically connected to the fixed frequency heat pump switch module 4-4.

[0195] The water heater according to the embodiment of the present application has a control panel. By integrating the variable frequency fan drive module 4-2 at the main control panel 4-1, the volume occupied by the variable frequency fan drive module 4-2 is reduced. In addition, only the main control panel 4-1 needs to be fixed, which reduces the number of fixed structures, and reduces costs.

[0196] In an embodiment of the present application, the control panel is provided outside the variable frequency fan 4-3, and the control panel is provided outside the fixed frequency heat pump 4-5.

[0197] It may be understood that the control panel is provided outside the variable frequency fan 4-3 and the fixed frequency heat pump 4-5, that is, the control panel is not provided inside the variable frequency fan 4-3, nor provided inside the fixed frequency heat pump 4-5, thereby reducing the mutual influence of the heat generated by the control panel during operation and the heat generated by the variable frequency fan 4-3 and the fixed frequency heat pump 4-5, ensuring the heat dissipation efficiency of the control panel, and further ensuring the heat dissipation efficiency of the variable frequency fan 4-3 and the fixed frequency heat pump 4-5.

[0198] In an embodiment of the present application, the fixed frequency heat pump switch module 4-4 is provided outside the variable frequency fan 4-3, and the fixed frequency heat pump switch module 4-4 is provided outside the fixed frequency heat pump 4-5.

[0199] It may be understood that the fixed frequency heat pump switch module 4-4 is provided outside the

variable frequency fan 4-3 and the fixed frequency heat pump 4-5, that is, the fixed frequency heat pump switch module 4-4 is not provided inside the variable frequency fan 4-3, nor provided inside the fixed frequency heat pump 4-5, thereby reducing the mutual influence of the heat generated by the fixed frequency heat pump switch module 4-4 during operation and the heat generated by the variable frequency fan 4-3 and the fixed frequency heat pump 4-5, ensuring the heat dissipation effect of the fixed frequency heat pump switch module 4-4, and further ensuring the heat dissipation efficiency of the variable frequency fan 4-3 and the fixed frequency heat pump 4-5.

[0200] The control panel and water heater of the present application are described below in conjunction with FIG. 5 and FIG. 6.

[0201] According to the embodiment of the present application, as shown in FIG. 5 and FIG. 6, the control panel comprises a main control panel 6-1, a variable frequency fan drive module 6-2 and a variable frequency heat pump drive module 6-4. The main control panel 6-1 is provided with a control module 6-11. An input end of the variable frequency fan drive module 6-2 is electrically connected to a first output end of the control module 6-11, an output end of the variable frequency fan drive module 6-2 is electrically connected to a variable frequency fan 6-3, an input end of the variable frequency heat pump drive module 6-4 is electrically connected to a second output end of the control module 6-11, an output end of the variable frequency heat pump drive module 6-4 is electrically connected to a variable frequency heat pump 6-5, and at least one of the variable frequency fan drive module 6-2 and the variable frequency heat pump drive module 6-4 is integrated at the main control panel 6-1.

[0202] According to the control panel of the embodiment of the present application, the control module 6-11 sends corresponding control signals to the variable frequency fan drive module 6-2 and the variable frequency heat pump drive module 6-4, and then the variable frequency fan drive module 6-2 can drive the fan to operate based on target operating parameters, and the variable frequency heat pump drive module 6-4 can drive the variable frequency heat pump 6-5 to operate based on the target operating parameters. At least one of the variable frequency fan drive module 6-2 and the variable frequency heat pump drive module 6-4 is integrated at the main control panel 6-1, that is, the variable frequency fan drive module 6-2, the variable frequency heat pump drive module 6-4 and the control module 6-11 can share one panel, and there is no need to provide additional control panel for the variable frequency fan 6-3 or additional control panel for the variable frequency heat pump 6-5, thereby effectively reducing the volume occupied by the variable frequency fan drive module 6-2 and the variable frequency heat pump drive module 6-4. In addition, the main control panel 6-1 integrated with the variable frequency fan drive module 6-2 and the variable frequency heat pump drive module 6-4 is not mounted inside the variable frequency fan 6-3 or the variable frequency heat pump 6-5, that is, no control panel for the variable frequency fan 6-3 is provided inside the variable frequency fan 6-3, and no control panel for the variable frequency heat pump 6-5 is provided inside the variable frequency heat pump 6-5, thereby effectively reducing the volume of the variable frequency fan 6-3 and the variable frequency heat pump 6-5. By integrating the variable frequency fan drive module 6-2 and the variable frequency heat pump drive module 6-4 at the main control panel 6-1, the heat dissipation of the variable frequency fan drive module 6-2 and the heat dissipation of the variable frequency fan 6-3 do not affect each other, and the heat dissipation of the variable frequency heat pump drive module 6-4 and the heat dissipation of the variable frequency heat pump 6-5 do not affect each other, which improves the heat dissipation effect, can effectively reduce the heat dissipate structure and reduce the heat dissipation cost.

[0203] It may be understood that in the related art, since the control panel of the variable frequency fan 6-3 is mounted inside the variable frequency fan 6-3, and the control panel of the variable frequency heat pump 6-5 is mounted inside the variable frequency heat pump 6-5, the control panel of the variable frequency fan 6-3 and the variable frequency fan 6-3 generate heat during operation, and the control panel of the variable frequency heat pump 6-5 and the variable frequency heat pump 6-5 generate heat during operation, which leads to more heat in the variable frequency fan 6-3 and the variable frequency heat pump 6-5, higher ambient temperature and poor heat dissipation effect. An additional heat dissipate structure is required to satisfy the heat dissipation requirements, resulting in higher heat dissipation costs. However, the present application integrates the variable frequency fan drive module 6-2 and the variable frequency heat pump drive module 6-4 at the main control panel 6-1, so that the variable frequency fan drive module 6-2 and the variable frequency fan 6-3 are in different spaces, and the variable frequency heat pump drive module 6-4 and the variable frequency heat pump 6-5 are in different spaces, thereby improving the heat dissipation effect. Furthermore, less heat dissipate structures are required for satisfying the heat dissipation requirements, thereby reducing the heat dissipation costs.

[0204] It may be understood that the control panel is generally mounted outside the fan and the heat pump, and would not be mounted inside the fan or the heat pump.

[0205] It may be understood that when the water heater uses a variable frequency compressor and a variable frequency fan 6-3, if the control panel of the variable frequency fan 6-3 is mounted inside the variable frequency fan 6-3, the control panel of the variable frequency heat pump 6-5 is mounted inside the variable frequency heat pump 6-5. Since the variable frequency fan 6-3 and the variable frequency heat pump 6-5 generate heat during operation, the following situations oc-

cur: a. a motor core is subjected to a magnetic flux, and then generate hysteresis loss and eddy current loss, thereby generating heat; b. a current in a motor winding generates Joule heat, which causes the winding to generate heat; and c. a motor bearing is subjected to friction and inertia, thereby generating heat. The control panel of the variable frequency fan 6-3 and the control panel of the variable frequency heat pump 6-5 are placed close to the motor body, and heat elements (IGBTs or MOSs or IPMs) of a variable frequency drive panel generate Joule heat when current passes through it, thereby generating heat. When the IGBT and MOS are turned off, a high-frequency switch is required by some heat components, and there is a turn-off voltage when turning off. The higher the turn-off voltage, the greater the heat generated. The heat component requires the high-frequency switch, and a certain amount of heat would be generated during switching on and off. The higher the switching frequency, the greater the heat generated. In addition, the higher the operating temperature of the heat component, the higher its on-resistance and off-voltage, thus generating more heat. That is to say, both the variable frequency heat pump 6-5 and the variable frequency fan 6-3 generate heat by themselves, resulting in a higher ambient temperature inside the variable frequency heat pump 6-5 and the variable frequency fan 6-3, requiring structures such as heat sinks to dissipate heat from the heat elements, and increasing the heat dissipation costs. Besides, integrating the control panel of the variable frequency heat pump 6-5 at the variable frequency heat pump 6-5 and integrating the control panel of the variable frequency fan 6-3 at the fan also results in a relatively large volume of the fan and the heat pump, structural members are required to fix the control panel of the variable frequency heat pump 6-5 and the control panel of the variable frequency fan 6-3, and the fixing cost is also high.

[0206] In an embodiment of the present application, at least one of the variable frequency fan drive module 6-2 and a switch module of the variable frequency heat pump 6-5 is connected to the control module 6-11 through at least one of the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI.

[0207] It may be understood that the communication between the variable frequency fan drive module 6-2 and the control module 6-11 is established through at least one of the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI, and the communication between the variable frequency heat pump drive module 6-4 and the control module 6-11 is established through at least one of the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI. Since the communication modes such as the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI have a verification function, the accuracy of data transmissions between the control module 6-11 and the variable frequency fan drive module 6-2 and between the control module 6-11 and the variable frequency heat pump drive module 6-4 can be effectively improved, and the variable frequency fan 6-3 and the variable frequency heat pump 6-5 can be precisely controlled.

[0208] It may be understood that, in the related art, in a water heater, the variable frequency fan 6-3 and the control module 6-11, as well as the variable frequency heat pump 6-5 and the chip are connected through a PWM duty cycle communication mode. In the PWM duty cycle communication mode, a main frequency error of the chip affects the counting accuracy of the timer, thereby affecting the calculation of the duty cycle. Therefore, if the main frequency of the chip has an error, the duty cycles of sending and receiving may have certain errors. Specifically, a high main frequency will lead to a small duty cycle, and a low main frequency will lead to a large duty cycle, which eventually affects the control accuracy of the variable frequency fan 6-3 and the variable frequency heat pump 6-5. However, in some embodiments of the present application, the variable frequency fan drive module 6-2 and the control module 6-11, as well as the variable frequency heat pump drive module 6-4 and the control module 6-11 are connected through communication modes such as the serial interface UART or the bidirectional serial data transmission interface I2C or the serial peripheral interface SPI, which can effectively overcome the error problem caused by the PWM duty cycle communication mode and improve the control accuracy of the variable frequency fan 6-3 and the variable frequency heat pump 6-5.

[0209] It should also be noted that when using the PWM duty cycle communication mode, four wires, that is, a voltage drain drain (VDD) signal, a ground (GND) signal, a PWM signal and a speed feedback signal, are generally required for wiring, and the cost is relatively high. The communication modes such as the serial interface UART or the bidirectional serial data transmission interface I2C or the SPI used in the present application only require three wires to realize the connections between the variable frequency fan drive module 6-2 and the variable frequency fan 6-3 and between the variable frequency heat pump drive module 6-4 and the variable frequency heat pump 6-5, which effectively reduces the costs.

[0210] In an embodiment of the present application, as shown in FIG. 6, the control panel comprises a variable frequency heat pump interface 6-51. The variable frequency heat pump interface 6-51 is integrated at the main control panel 6-1, and the variable frequency heat pump interface 6-51 is used to connect the variable frequency heat pump drive module 6-4 with the variable frequency heat pump 6-5.

[0211] It may be understood that integrating the variable frequency heat pump interface 6-51 at the main control panel 6-1 improves the integration of the main control panel 6-1, and the connection between the variable frequency heat pump 6-5 and the variable frequency heat pump drive module 6-4 can be realized by connecting the variable frequency heat pump 6-5 with the vari-

able frequency heat pump interface 6-51.

[0212] In some embodiments, the variable frequency heat pump 6-5 is, for example, detachably connected to the variable frequency heat pump interface 6-51, which is convenient for the disassembly and assembly of the variable frequency heat pump 6-5 and the replacement of the variable frequency heat pump 6-5.

[0213] In the embodiment of the present application, the variable frequency heat pump interface 6-51 comprises a second U-phase interface, a second V-phase interface and a second W-phase interface. The second U-phase interface is used to connect the variable frequency heat pump drive module 6-4 with a U-phase connection end of the variable frequency heat pump 6-5, the second V-phase interface is used to connect the variable frequency heat pump drive module 6-4 with a V-phase connection end of the variable frequency heat pump 6-5, and the second W-phase interface is used to connect the variable frequency heat pump drive module 6-4 with a W-phase interface of the variable frequency heat pump 6-5.

[0214] It may be understood that the variable frequency heat pump interface 6-51 has a total of three interfaces, namely, the second U-phase interface, the second V-phase interface and the second W-phase interface. That is to say, the variable frequency heat pump interface 6-51 can be connected to the variable frequency heat pump drive module 6-4 through three wires, and the variable frequency heat pump interface 6-51 can be connected to the variable frequency heat pump 6-5 through three wires, which further illustrates that compared with the related art, in this embodiment, fewer wires may be used to achieve the connection between the variable frequency heat pump drive module 6-4 and the variable frequency heat pump 6-5, which can effectively reduce costs.

[0215] In an embodiment of the present application, as shown in FIG. 6, the control panel comprises a variable frequency fan interface 6-31. The variable frequency fan interface 6-31 is integrated at the main control panel 6-1, and the variable frequency fan interface 6-31 is used to connect the variable frequency fan drive module 6-2 with the variable frequency fan 6-3.

[0216] It may be understood that integrating the variable frequency fan interface 6-31 at the main control panel 6-1 improves the integration of the main control panel 6-1, and the connection between the variable frequency fan 6-3 and the variable frequency fan drive module 6-2 can be realized by connecting the variable frequency fan 6-3 with the variable frequency fan interface 6-31.

[0217] In some embodiments, the variable frequency fan 6-3 is, for example, detachably connected to the variable frequency fan interface 6-31, which is convenient for the disassembly and assembly of the variable frequency fan 6-3 and the replacement of the variable frequency fan 6-3.

[0218] In the embodiment of the present application, the variable frequency fan interface 6-31 comprises a third U-phase interface, a third V-phase interface and a third W-phase interface. The third U-phase interface is used to connect the variable frequency fan drive module 6-2 with a U-phase connection end of the variable frequency fan 6-3, the third V-phase interface is used to connect the variable frequency fan drive module 6-2 with a V-phase connection end of the variable frequency fan 6-3, and the third W-phase interface is used to connect the variable frequency fan drive module 6-2 with a W-phase interface of the variable frequency fan 6-3.

[0219] It may be understood that the variable frequency fan interface 6-31 has a total of three interfaces, namely, the third U-phase interface, the third V-phase interface and the third W-phase interface, that is, the variable frequency fan interface 6-31 can be connected to the variable frequency fan drive module 6-2 through three wires, and the variable frequency fan interface 6-31 can be connected to the variable frequency fan 6-3 through three wires, which further illustrates that compared with the related art, in this embodiment, fewer wires may be used to achieve the connection between the variable frequency fan drive module 6-2 and the variable frequency fan 6-3, which can effectively reduce costs.

[0220] In an embodiment of the present application, as shown in FIG. 6, the control panel comprises a high-voltage switch module 6-6. The high-voltage switch module 6-6 is integrated at the main control panel 6-1, an input end of the high-voltage switch module 6-6 is electrically connected to the control module 6-11, an output end of the high-voltage switch module 6-6 is used to be electrically connected to a high-voltage switch, and the high-voltage switch module 6-6 is used to detect a pressure at the high-voltage switch.

[0221] It may be understood that by integrating the high-voltage switch module 6-6 at the main control panel 6-1, the main control panel 6-1 can be connected to the high-voltage switch, which improves the integration of the main control panel 6-1. In addition, the high-voltage switch module 6-6 can detect the pressure at the high-voltage switch and transmit the detection data to the control module 6-11, so that the control module 6-11 can timely know whether the pressure at the high-voltage switch exceeds a preset value.

[0222] In an embodiment of the present application, as shown in FIG. 6, the control panel comprises a fifth optocoupler isolation module 6-7 and a sixth optocoupler isolation module 6-8. The fifth optocoupler isolation module 6-7 is provided between the variable frequency heat pump drive module 6-4 and the control module 6-11, and the sixth optocoupler isolation module 6-8 is provided between the variable frequency fan drive module 6-2 and the control module 6-11.

[0223] It may be understood that by providing the fifth optocoupler isolation module 6-7 between the variable frequency heat pump drive module 6-4 and the control module 6-11, and providing the sixth optocoupler isolation module 6-8 between the variable frequency fan drive

module 6-2 and the control module 6-11, the stability of the main control panel 6-1 can be effectively improved.

[0224] It may be understood that in case that the variable frequency fan 6-3 is a high-voltage variable frequency fan 6-3, it is necessary to provide the sixth optocoupler isolation module 6-8 between the variable frequency fan drive module 6-2 and the control module 6-11. In case that the variable frequency heat pump 6-5 is a high-voltage variable frequency heat pump 6-5, it is necessary to provide the fifth optocoupler isolation module 6-7 between the variable frequency heat pump drive module 6-4 and the control module 6-11.

[0225] The high-voltage variable frequency scheme of the high-voltage variable frequency fan 6-3 and the high-voltage variable frequency heat pump 6-5 refers to: for AC 220 V or 110 V and other mains electricity, DC 310 V is obtained after rectification, that is, the voltage applied to the motor winding is a non-isolated DC 310 V scheme. Therefore, optocoupler isolation is required for communication.

[0226] In case that the variable frequency fan 6-3 is a low-voltage variable frequency fan 6-3, and the variable frequency heat pump 6-5 is a low-voltage variable frequency heat pump 6-5, there is no need to provide the fifth optocoupler isolation module 6-7 and the sixth optocoupler isolation module 6-8. The low-voltage variable frequency scheme refers to output low-voltage isolation electricity such as 36V or 24V, etc., after mains electricity of AC 220 or 110 V passes through an isolation switch power supply. The used fans or the used heat pumps are all low-voltage motors. Since the voltage is isolated, optocoupler isolation is not required.

[0227] In an embodiment of the present application, the control panel comprises a heater module 6-9. The heater module 6-9 is integrated at the main control panel 6-1. An input end of the heater module 6-9 is electrically connected to the control module 6-11, and an output end of the heater module 6-9 is electrically connected to a heater.

[0228] It may be understood that by integrating the heater module 6-9 at the main control panel 6-1, the main control panel 6-1 can be connected to the heater through the heater module 6-9 for controlling the operation of the heater, thereby improving the integration of the main control panel 6-1.

[0229] According to an embodiment of the present application, the water heater comprises a variable frequency fan 6-3, a variable frequency heat pump 6-5 and the above-mentioned control panel. The variable frequency fan 6-3 is electrically connected to the variable frequency fan drive module 6-2, and the variable frequency heat pump 6-5 is electrically connected to the variable frequency heat pump drive module 6-4.

[0230] The water heater according to the embodiment of the present application has a control panel. By integrating at least one of the variable frequency fan drive module 6-2 and the variable frequency heat pump drive module 6-4 at the main control panel 6-1, the volume of at least one of the fan and the heat pump can be effectively reduced, and the heat dissipation costs can also be effectively reduced.

[0231] In an embodiment of the present application, as shown in FIG. 5 and FIG. 6, a first spacing is provided between the control panel and the variable frequency fan 6-3, and a second spacing is provided between the control panel and the variable frequency heat pump 6-5.

[0232] It may be understood that by providing the control panel at a distance from the variable frequency fan 6-3 and the variable frequency heat pump 6-5, the mutual influence between the heat generated by the control panel during operation and the heat generated by the variable frequency fan 6-3 and the variable frequency heat pump 6-5 is reduced, the heat dissipation efficiency of the control panel is ensured, and the heat dissipation efficiency of the variable frequency fan 6-3 and the variable frequency heat pump 6-5 are further ensured.

[0233] It may be understood that the first spacing and the second spacing can be the same or different.

[0234] Finally, it should be noted that, the above embodiments are only used to illustrate the present application, but not to limit the present application. Although the present application has been described in detail with reference to the embodiments, those skilled in the art should understand that various combinations, modifications, or equivalent replacements of the solutions of the present application do not depart from the scope of the solutions of the present application, and should all cover the scope of the claims of the present application.

Claims

1. A control panel, comprising: a main control module, a fan drive module and a heat pump drive module,

   wherein the fan drive module comprises a variable frequency fan drive module and a fixed frequency fan relay module, and the fan drive module is connected to the main control module, for driving a variable frequency fan or a fixed frequency fan to operate based on a control instruction of the main control module; and
   the heat pump drive module comprises a variable frequency heat pump drive module and a fixed frequency heat pump relay module, and the heat pump drive module is connected to the main control module, for driving a variable frequency heat pump or a fixed frequency heat pump to operate based on a control instruction of the main control module.

2. The control panel of claim 1, wherein the control panel is provided outside the variable frequency fan, the variable frequency heat pump, the fixed frequency fan and the fixed frequency heat pump.

3. The control panel of claim 1 or 2, further comprising: a variable frequency fan interface and a variable frequency heat pump interface,

wherein the variable frequency fan drive module is connected to a three-phase motor of the variable frequency fan through the variable frequency fan interface; and
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.

4. The control panel of claim 3, wherein

the variable frequency fan drive module communicates with the main control module through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface; and
the variable frequency heat pump drive module communicates with the main control module through a universal asynchronous receiver/-transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

5. The control panel of any one of claims 1 to 4, further comprising: a fixed frequency fan interface and a fixed frequency heat pump interface,

wherein the fixed frequency fan relay module is connected to the fixed frequency fan through the fixed frequency fan interface; and
the fixed frequency heat pump relay module is connected to the fixed frequency heat pump through the fixed frequency heat pump interface.

6. The control panel of any one of claims 1 to 5, further comprising: a switch power supply module, a first optocoupler isolation module and a second optocoupler isolation module,

wherein the variable frequency fan is a high-voltage variable frequency fan, and the variable frequency heat pump is a high-voltage variable frequency heat pump;
a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply module is connected to the variable frequency fan drive module and the variable frequency heat pump drive module in a non-isolated manner;
the first optocoupler isolation module is connected between the variable frequency fan drive module and the main control module; and
the second optocoupler isolation module is connected between the variable frequency heat pump drive module and the main control module.

7. The control panel of any one of claims 1 to 6, further comprising: a switch power supply module,

wherein the variable frequency fan is a low-voltage variable frequency fan, and the variable frequency heat pump is a low-voltage variable frequency heat pump; and
a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supply module is connected to the variable frequency fan drive module and the variable frequency heat pump drive module in the isolated manner.

8. The control panel of any one of claims 1 to 7, further comprising: an electronic anode drive module and an electronic anode interface,
wherein a first end of the electronic anode drive module is connected to the main control module, and a second end of the electronic anode drive module is connected to an electronic anode through the electronic anode interface.

9. The control panel of any one of claims 6 to 8, further comprising: an electricity leakage detect module, a current detect module, a sensor drive module, a high-voltage switch drive module, a display panel communicate module, a sensor interface and a high-voltage switch interface,

wherein the electricity leakage detect module is connected between the switch power supply module and the mains electricity;
the current detect module is connected between the electricity leakage detect module and the mains electricity;
a first end of the sensor drive module is connected to the main control module, and a second end of the sensor drive module is connected to temperature sensors at different positions through the sensor interface;
a first end of the high-voltage switch drive module is connected to the main control module, and a second end of the high-voltage switch drive module is connected to a high-voltage switch through the high-voltage switch interface; and
a first end of the display panel communicate module is connected to the main control module, and a second end of the display panel communicate module is connected to a display panel.

10. A water heater, comprising: a variable frequency fan, a fixed frequency fan, a variable frequency heat pump, a fixed frequency heat pump, an electronic anode, a temperature sensor, a high-voltage switch, a display panel and a control panel of any one of claims 1 to 9.

11. A driving method, comprising:

controlling a main control module to send a variable frequency fan control signal to a variable frequency fan drive module; controlling the variable frequency fan drive module to amplify the variable frequency fan control signal, to obtain a variable frequency fan amplified signal; controlling the variable frequency fan drive module to send the variable frequency fan amplified signal to the variable frequency fan; and controlling the variable frequency fan to operate based on the variable frequency fan amplified signal; or

controlling a main control module to send a fixed frequency fan control signal to a fixed frequency fan relay module; and controlling the fixed frequency fan relay module to close based on the fixed frequency fan control signal, to drive a fixed frequency fan to operate.

12. The method of claim 11, further comprising:

controlling the main control module to send a variable frequency heat pump control signal to a variable frequency heat pump drive module; controlling the variable frequency heat pump drive module to amplify the variable frequency heat pump control signal, to obtain a variable frequency heat pump amplified signal; controlling the variable frequency heat pump drive module to send the variable frequency heat pump amplified signal to the variable frequency heat pump; and controlling the variable frequency heat pump to operate based on the variable frequency heat pump amplified signal; or

controlling the main control module to send a fixed frequency heat pump control signal to a fixed frequency heat pump relay module; and controlling the fixed frequency heat pump relay module to close based on the fixed frequency heat pump control signal, to drive a fixed frequency heat pump to operate.

13. A control panel, comprising: a main 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 main control module, for driving a fixed frequency fan to operate based on a control instruction of the main control module;

the variable frequency heat pump drive module is connected to the main control module, for driving a variable frequency heat pump to operate based on a control instruction of the main control module; and

the control panel is provided outside the fixed frequency fan and the variable frequency heat pump.

14. The control panel of claim 13, further comprising: a variable frequency heat pump interface,

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.

15. The control panel of claim 14, wherein the variable frequency heat pump drive module communicates with the main control module through a universal asynchronous receiver/transmitter, or a bidirectional two-wire synchronous serial bus, or a serial peripheral interface.

16. The control panel of any one of claims 13 to 15, further comprising: a fixed frequency fan interface,

wherein the fixed frequency fan relay module is connected to the fixed frequency fan through the fixed frequency fan interface.

17. The control panel of any one of claims 13 to 16, further comprising: a switch power supply module and a third optocoupler isolation module,

wherein the variable frequency heat pump is a high-voltage variable frequency heat pump;

a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner, and a third end of the switch power supplyis connected to the variable frequency heat pump drive module in a non-isolated manner; and

the third optocoupler isolation module is connected between the variable frequency heat pump drive module and the main control module.

18. The control panel of any one of claims 13 to 17, further comprising: a switch power supply module,

wherein the variable frequency heat pump is a low-voltage variable frequency heat pump;

a first end of the switch power supply module is connected to mains electricity, a second end of the switch power supply module is connected to the main control module in an isolated manner,

and a third end of the switch power supply is connected to the variable frequency heat pump drive module in the isolated manner.

19. The control panel of any one of claims 13 to 18, further comprising: an electronic expansion valve drive module and an electronic expansion valve interface,
wherein a first end of the electronic expansion valve drive module is connected to the main control module, and a second end of the electronic expansion valve drive module is connected to an electronic expansion valve through the electronic expansion valve interface.

20. The control panel of any one of claims 17 to 19, further comprising: an electricity leakage detect module, a current detect module, a sensor drive module, a high-voltage switch drive module, a display panel communicate module, a sensor interface and a high-voltage switch interface,

wherein the electricity leakage detect module is connected between the switch power supply module and the mains electricity;
the current detect module is connected between the electricity leakage detect module and the mains electricity;
a first end of the sensor drive module is connected to the main control module, and a second end of the sensor drive module is connected to temperature sensors at different positions through the sensor interface;
a first end of the high-voltage switch drive module is connected to the main control module, and a second end of the high-voltage switch drive module is connected to a high-voltage switch through the high-voltage switch interface; and
a first end of the display panel communicate module is connected to the main control module, and a second end of the display panel communicate module is connected to a display panel.

21. A water heater, comprising a control panel of any one of claims 13 to 20.

22. The water heater of claim 21, 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 panel.

23. A control panel, comprising:

a main control panel, wherein the main control panel is provided with a control module;
a variable frequency fan drive module, integrated at the main control panel, wherein an input end of the variable frequency fan drive module is electrically connected to a first output end of the control module, and an output end of the variable frequency fan drive module is electrically connected to a variable frequency fan; and
a fixed frequency heat pump switch module, wherein an input end of the fixed frequency heat pump switch module is electrically connected to a second output end of the control module, and an output end of the fixed frequency heat pump switch module is electrically connected to the fixed frequency heat pump.

24. The control panel of claim 23, wherein the fixed frequency heat pump switch module is integrated at the main control panel.

25. The control panel of claim 23 or 24, wherein the variable frequency fan drive module is connected to the control module for communication through at least one of a serial interface universal asynchronous receiver/transmitter (UART) or a bidirectional serial data transmission interface inter-integrated circuit (I2C) or a serial peripheral interface (SPI).

26. The control panel of claim 25, comprising a variable frequency fan interface, wherein the variable frequency fan interface is integrated at the main control panel, and the variable frequency fan interface is used to connect the variable frequency fan drive module with the variable frequency fan.

27. The control panel of claim 26, wherein the variable frequency fan interface comprises a first U-phase interface, a first V-phase interface and a first W-phase interface, wherein the first U-phase interface is used to connect the variable frequency fan drive module with a U-phase connection end of the variable frequency fan, the first V-phase interface is used to connect the variable frequency fan drive module with a V-phase connection end of the variable frequency fan, and the first W-phase interface is used to connect the variable frequency fan drive module with a W-phase interface of the variable frequency fan.

28. The control panel of any one of claims 23 to 27, comprising a fixed frequency heat pump interface, wherein the fixed frequency heat pump interface is integrated at the main control panel, and the fixed frequency heat pump interface is used to connect the fixed frequency heat pump switch module with the fixed frequency heat pump.

29. The control panel of any one of claims 23 to 28, comprising a fourth optocoupler isolation module, wherein the fourth optocoupler isolation module is provided between the variable frequency fan drive module and the control module.

30. The control panel of any one of claims 23 to 29, comprising a photovoltaic (PV) module, wherein the PV module is integrated at the main control panel, and the PV module is used to connect the control module with electrical grid.

31. A water heater, comprising: a variable frequency fan, a fixed frequency heat pump, and a control panel of any one of claims 23 to 30, wherein the variable frequency fan is electrically connected to a variable frequency fan drive module, and the fixed frequency heat pump is electrically connected to a fixed frequency heat pump switch module.

32. The water heater of claim 31, wherein the control panel is provided at a space outside the variable frequency fan, and the control panel is provided at a space outside the fixed frequency heat pump; and/or the fixed frequency heat pump switch module is provided at a space outside the variable frequency fan, and the fixed frequency heat pump switch module is provided at a space outside the fixed frequency heat pump.

33. A control panel, comprising:

a main control panel, wherein the main control panel is provided with a control module;
a variable frequency fan drive module, wherein an input end of the variable frequency fan drive module is electrically connected to a first output end of the control module, and an output end of the variable frequency fan drive module is electrically connected to a variable frequency fan;
a variable frequency heat pump drive module, wherein an input end of the variable frequency heat pump drive module is electrically connected to a second output end of the control module, and an output end of the variable frequency heat pump drive module is electrically connected to a variable frequency heat pump,
wherein at least one of the variable frequency fan drive module and the variable frequency heat pump drive module is integrated at the main control panel.

34. The control panel of claim 33, wherein at least one of the variable frequency fan drive module and the variable frequency heat pump switch module is connected to the control module for communication through at least one of a serial interface universal asynchronous receiver/transmitter (UART) or a bi-directional serial data transmission interface inter-integrated circuit (I2C) or a serial peripheral interface (SPI).

35. The control panel of claim 33 or 34, comprising a variable frequency heat pump interface, wherein the variable frequency heat pump interface is integrated at the main control panel, and the variable frequency heat pump interface is used to connect the variable frequency heat pump drive module with the variable frequency heat pump.

36. The control panel of claim 35, wherein the variable frequency heat pump interface comprises a second U-phase interface, a second V-phase interface and a second W-phase interface, wherein the second U-phase interface is used to connect the variable frequency heat pump drive module with a U-phase connection end of the variable frequency heat pump, the second V-phase interface is used to connect the variable frequency heat pump drive module with a V-phase connection end of the variable frequency heat pump, and the second W-phase interface is used to connect the variable frequency heat pump drive module with a W-phase interface of the variable frequency heat pump.

37. The control panel of claim 33, comprising a variable frequency fan interface, wherein the variable frequency fan interface is integrated at the main control panel, and the variable frequency fan interface is used to connect the variable frequency fan drive module with the variable frequency fan.

38. The control panel of claim 37, wherein the variable frequency fan interface comprises a third U-phase interface, a third V-phase interface and a third W-phase interface, wherein the third U-phase interface is used to connect the variable frequency fan drive module with a U-phase connection end of the variable frequency fan, the third V-phase interface is used to connect the variable frequency fan drive module with a V-phase connection end of the variable frequency fan, and the third W-phase interface is used to connect the variable frequency fan drive module with a W-phase interface of the variable frequency fan.

39. The control panel of any one of claims 33 to 38, comprising:

a high-voltage switch module, wherein the high-voltage switch module is integrated at the main control panel, an input end of the high-voltage switch module is electrically connected to the control module, an output end of the high-voltage switch module is electrically connected to a high-voltage switch, and the high-voltage switch module is used to detect a pressure at the high-voltage switch; and/or
a fifth optocoupler isolation module and a sixth optocoupler isolation module, wherein the fifth optocoupler isolation module is provided between the variable frequency heat pump drive

module and the control module, and the sixth optocoupler isolation module is provided between the variable frequency fan drive module and the control module.

40. The control panel of any one of claims 33 to 38, comprising a heater module, wherein the heater module is integrated at the main control panel, an input end of the heater module is electrically connected to the control module, and an output end of the heater module is electrically connected to a heater.

41. A water heater, comprising a variable frequency fan, a variable frequency heat pump and a control panel of any one of claims 33 to 40, wherein the variable frequency fan is electrically connected to a variable frequency fan drive module, and the variable frequency heat pump is electrically connected to a variable frequency heat pump drive module.

42. The water heater of claim 41, wherein a first spacing is provided between the control panel and the variable frequency fan, and a second spacing is provided between the control panel and the variable frequency heat pump.

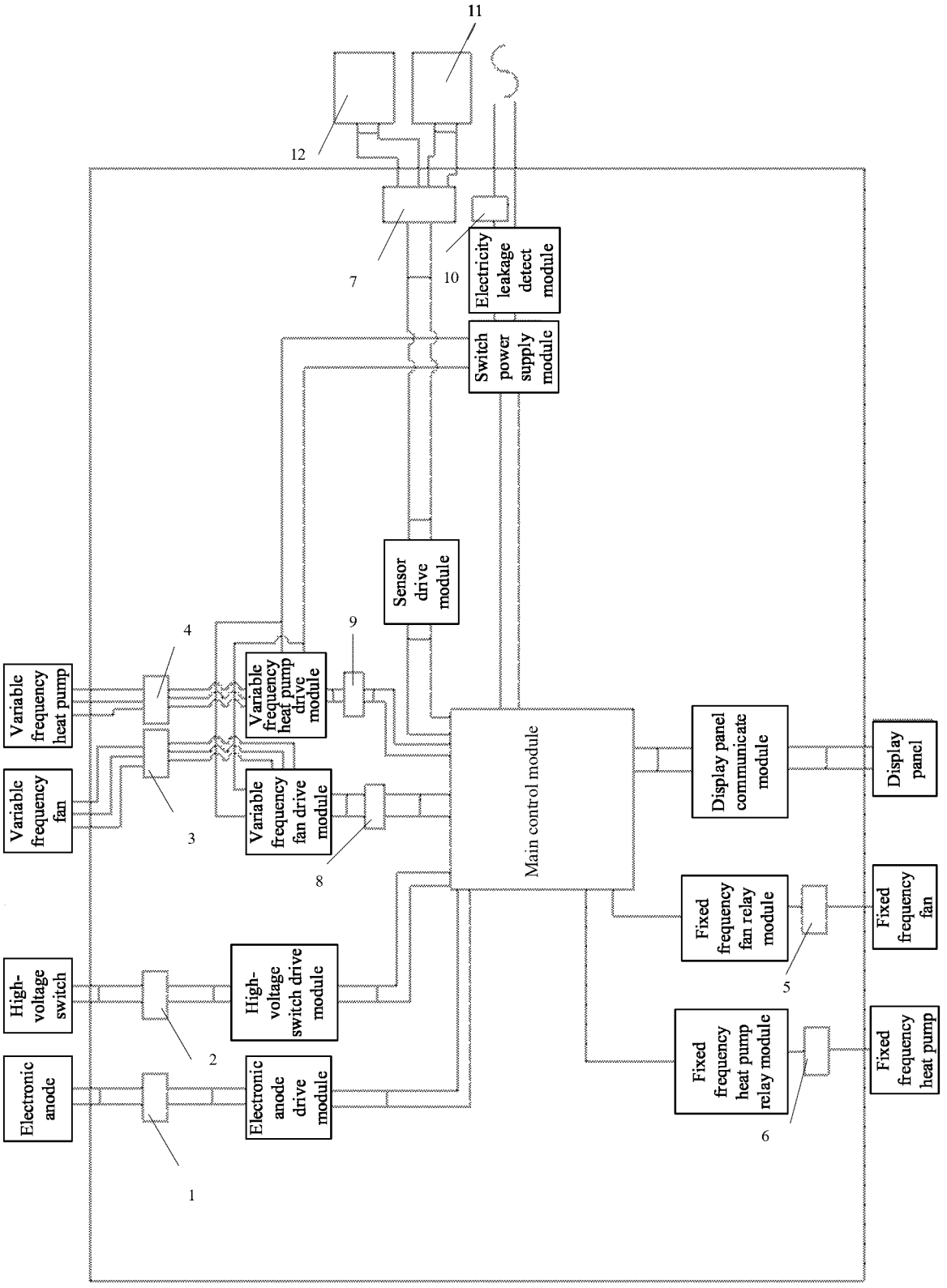
11
12
7
10
Electricity leakage detect module
Switch power supply module
Sensor drive module
4
9
Variable frequency heat pump
Variable frequency heat pump drive module
Variable frequency fan
3
Variable frequency fan drive module
8
Main control module
Display panel communicate module
Display panel
Fixed frequency fan relay module
Fixed frequency fan
5
High-voltage switch
High-voltage switch drive module
2
Fixed frequency heat pump relay module
Fixed frequency heat pump
6
Electronic anode
Electronic anode drive module
1

FIG. 1

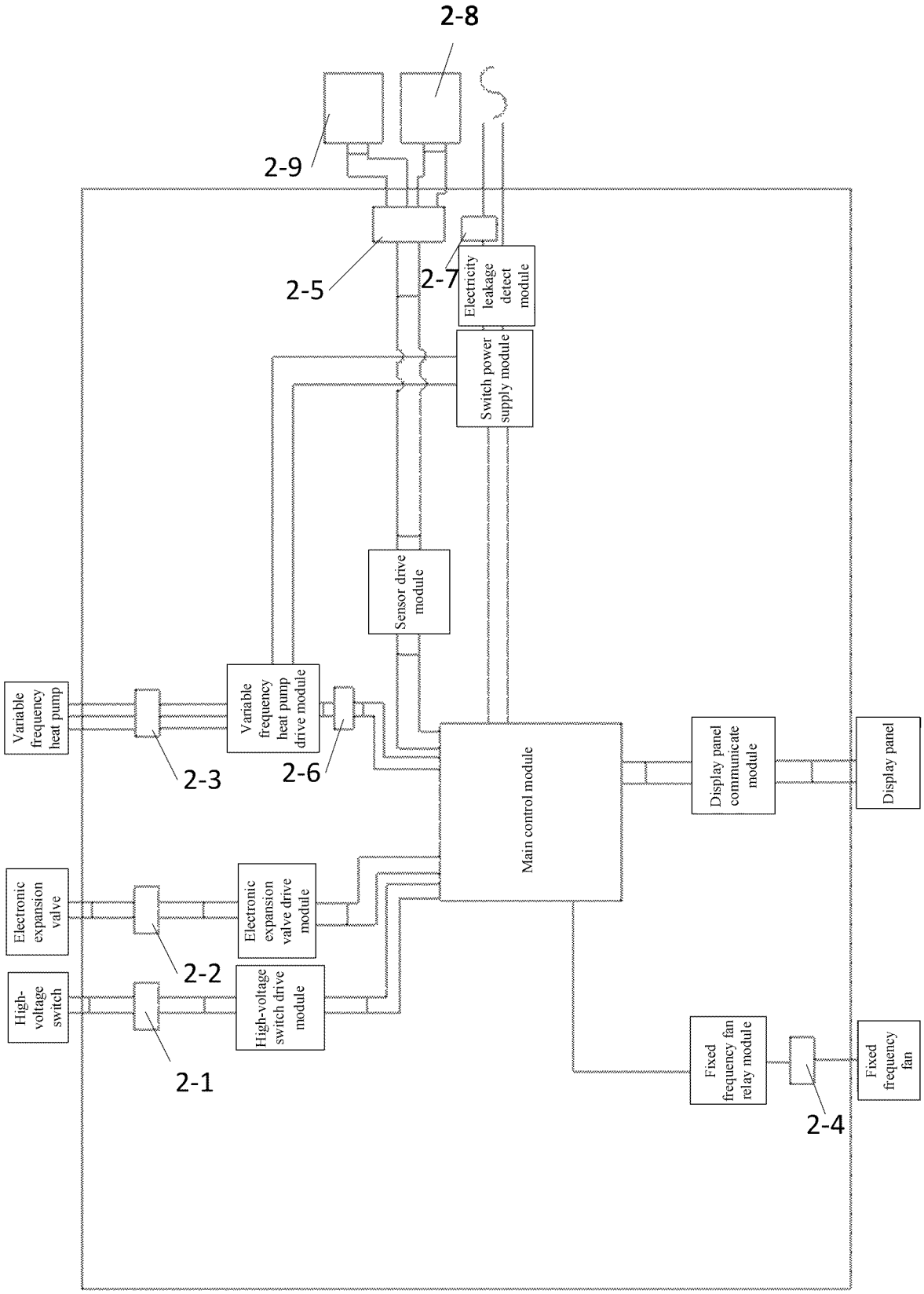
2-8
2-9
2-5
2-7
Electricity leakage detect module
Switch power supply module
Sensor drive module
Variable frequency heat pump
Variable frequency heat pump drive module
2-3
2-6
Main control module
Display panel communicate module
Display panel
Electronic expansion valve
Electronic expansion valve drive module
2-2
High-voltage switch
High-voltage switch drive module
2-1
Fixed frequency fan relay module
Fixed frequency fan
2-4

FIG. 2

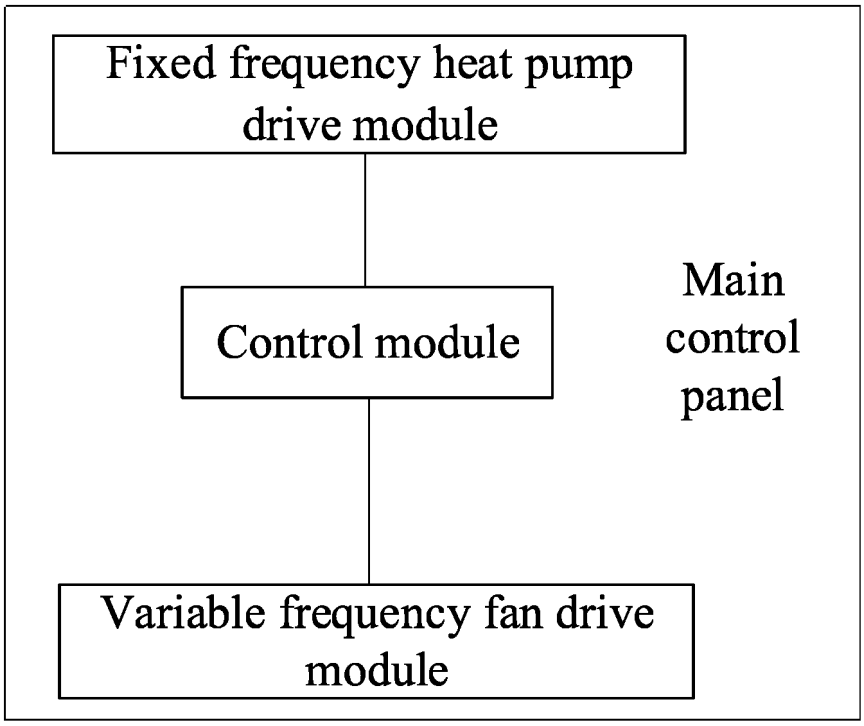
Fixed frequency heat pump drive module
Control module
Main control panel
Variable frequency fan drive module

FIG. 3

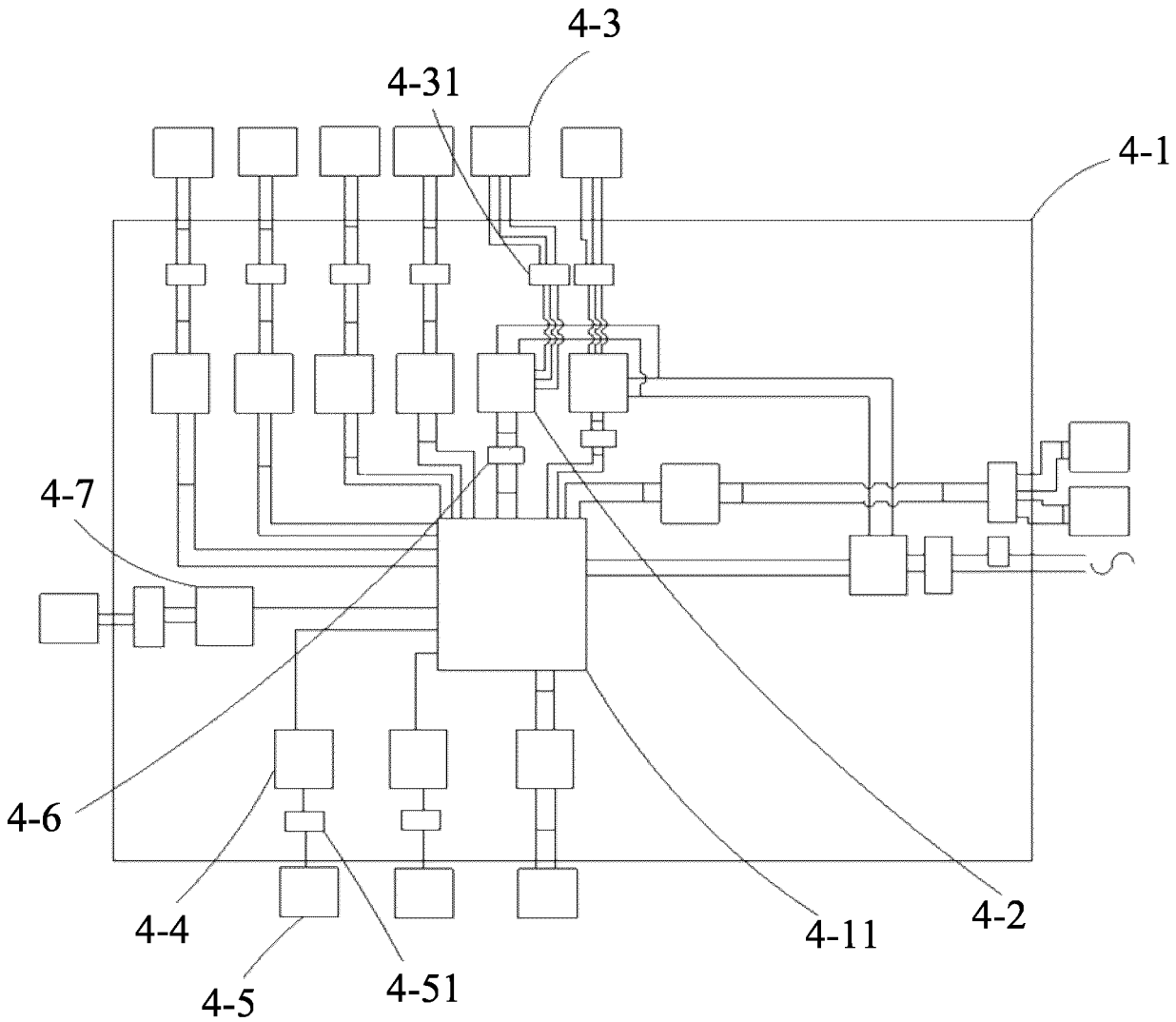

FIG. 4

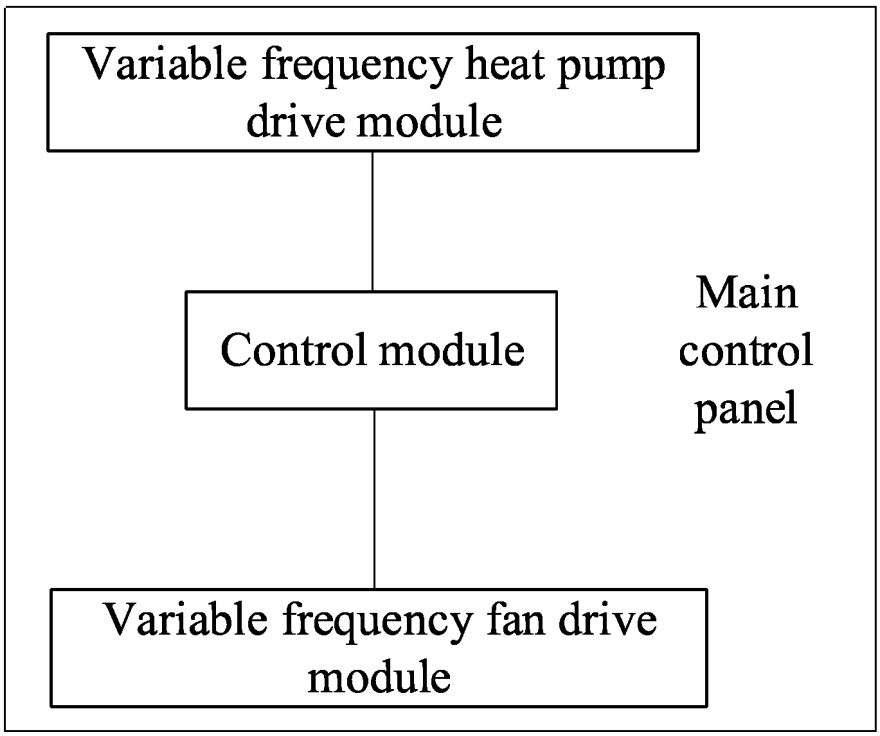
Variable frequency heat pump drive module
Control module
Main control panel
Variable frequency fan drive module

FIG. 5

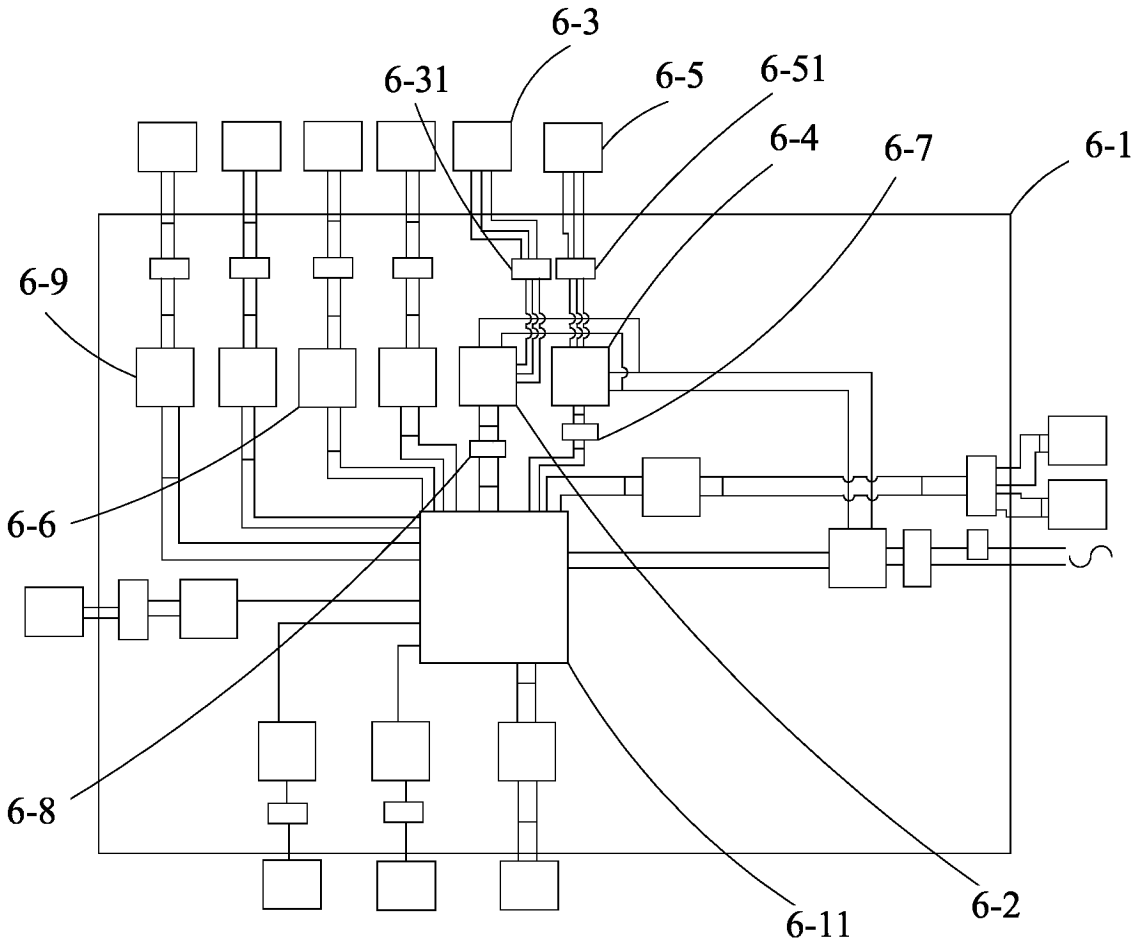

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2024/096540

A. CLASSIFICATION OF SUBJECT MATTER

F24H 9/25(2022.01)i; F24H 9/20(2022.01)i; F24H 15/345(2022.01)i; F24H 15/35(2022.01)i; F24H 15/375(2022.01)i; F24H 15/124(2022.01)i; F24H 15/395(2022.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: F24H

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

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

CNABS; CNTXT; VEN; CNKI; USTXT; EPTXT; WOTXT: 控制, 主控, MCU, 单片机, 变频, 定频, 热泵, 压缩机, 风机, 风扇, 驱动, 热水器, 热水机, control, frequency, heat pump, compressor, fan, driv+, water heater

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 111239509 A (CHINA HOUSEHOLD ELECTRIC APPLIANCE RESEARCH INSTITUTE) 05 June 2020 (2020-06-05) description, paragraphs 24-43, and figures 1 and 2	1-42
A	CN 113280551 A (PANASONIC APPLIANCES COLD CHAIN (DALIAN) CO., LTD.) 20 August 2021 (2021-08-20) description, paragraphs 54-79, and figures 1-4	1-42
A	CN 111238152 A (GUANGDONG HOMA APPLIANCES CO., LTD.) 05 June 2020 (2020-06-05) description, paragraphs 34-77, and figures 1-4	1-42
A	CN 102679499 A (SHANDONG LONGDU RUILINXIANG ELECTROMECHANICAL CO., LTD.) 19 September 2012 (2012-09-19) description, paragraphs 17-33, and figures 1 and 2	1-42
A	CN 201429155 Y (NANJING CANATAL AIR-CONDITIONING ELECTRICAL & MECHANICAL CO., LTD.) 24 March 2010 (2010-03-24) description, pages 2 and 3, and figures 1 and 2	1-42

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 August 2024	**26 August 2024**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2024/096540

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Independent claim 1 relates to a variable-frequency fan driving module, a fixed-frequency fan relay module, a variable-frequency heat pump driving module and a fixed-frequency heat pump relay module.

Independent claim 13 relates to a fixed-frequency fan relay module and a variable-frequency heat pump driving module.

Independent claim 23 relates to a variable-frequency fan driving module and a fixed-frequency heat pump switch module.

Independent claim 33 relates to a variable-frequency fan driving module and a variable-frequency heat pump driving module.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☑ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2024/096540

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 111239509 A	05 June 2020	CN 211718412 U	20 October 2020
CN 113280551 A	20 August 2021	CN 216769887 U	17 June 2022
CN 111238152 A	05 June 2020	CN 111238152 B	19 February 2021
CN 102679499 A	19 September 2012	None	
CN 201429155 Y	24 March 2010	None	

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 202311538604 **[0001]**
- CN 202323112072 **[0001]**
- CN 202323112015 **[0001]**
- CN 202323138618 **[0001]**
- CN 202323138602 **[0001]**