

AIR CONDITIONING SYSTEMS

The present invention relates to air conditioning systems.

5 The installation of remote and system controllers for air conditioners is a technical job requiring a skilled installer. The installer, by breaking jumpers, setting DIP switches or programming, instructs the air conditioning system controller as to the inclusion in the air conditioning system of a
10 wired or wireless remote controller. Many consumers would like to save the costs involved in hiring an installer, but lack the technical skills to make their own installation. In fact, some air conditioning systems must be configured at the factory.

15 Additionally, it is desirable to allow a consumer to automatically upgrade from a wired remote controller to a wireless remote controller without the necessity of a house call by an expert installer. Conversely, it is also desirable to allow a consumer
20 to automatically downgrade from a wireless remote controller to a wired remote controller, should the wireless remote controller fail.

 An object of the present invention is to provide an air conditioner which is able to operate with
25 either a wired or a wireless remote controller.

 The present invention provides an air conditioning system comprising:

30 an air conditioner including an outside heat exchange unit, an inside heat exchange unit, first refrigerant conduit connecting the outside heat exchange unit to the inside unit and including an expansion device therein, second refrigerant conduit connecting the outside unit to the inside unit and including a compressor therein;

a system controller for the air conditioning unit operably connected to the compressor;

a first portable wireless remote controller for providing commands and information to the system controller by wireless transmission;

a second portable wired remote controller for providing commands and information to the system controller by wired transmission;

means, operably connected to the system controller, for receiving wireless remote transmissions from the first portable wireless remote controller;

means, operably connected to the system controller, for receiving wired remote transmissions from the second wired remote controller when the latter is connected to the system controller; and

means, operatively associated with system controller and responsive to the wired remote receiving means, for automatically establishing a first air conditioning system operating configuration if the wired remote controller is connected to the system controller and for establishing a second air conditioning system operating configuration if the wired remote controller is not connected to the system controller.

The system may further include means, responsive to the automatic establishing means, for disabling all non-established air conditioning operation system configurations.

The first portable wireless remote controller may provide a thermostat function.

Preferably, the inside heat exchanger is within a housing which includes storage within the housing for either the first or second remote controller.

The first portable wireless controller may

include a liquid crystal display.

The invention also includes an air condition system comprising:

a compressor;

5 an outdoor heat exchanger;

an indoor heat exchanger;

an expansion device;

10 refrigeration conduit for serially connecting the compressor to the outdoor heat exchanger, the outdoor heat exchanger to the expansion device, the expansion device to the indoor heat exchanger, and the indoor heat exchanger to the compressor;

15 means for controlling the operation of the compressor, the control means including an infrared receiver and a wired remote receptacle;

20 wherein the control means includes means for determining the presence of a connector in the wired remote receptacle, and means, responsive to the determining means, for inhibiting the operation of the infrared receiver if a connector has been determined to be in the receptacle.

25 The system may include means responsive to the determining means, for inhibiting the operation of the wired remote receptacle if a connector is not in the receptacle.

The system may include means responsive to the determining means, for enabling the operation of the infrared receiver if a connector is not in the receptacle.

30 The system may include means responsive to the determining means, for enabling the operation of the wired remote receptacle if a connector has been determined to be in the receptacle.

35 In the above cases, the determining means may detect the presence or absence of a jumper within a

plug attached to the wired remote receptacle. Alternatively, the determining means may include a contact switch in the wired remote receptacle or a low power electric circuit operatively associated with the wired remote receptacle.

The invention also includes a method of configuring an air conditioner for remote control comprising the steps of:

determining if a portable wired remote controller is connected to the air conditioning system;

automatically configuring the air conditioning system to operate using the portable wired remote controller if the portable wired remote controller is connected to the air conditioning system;

automatically configuring the air conditioning system to operate with a wireless remote controller if the portable wired remote controller is not connected to the air conditioning system; and

operating the air conditioning system in accordance with the established configuration.

The method preferably includes the further steps of periodically re-executing the determining step, and excluding the operation of the nonconfigured operation until the result of the determining step changes.

The may include the further step of providing a thermostat function in the wireless remote controller.

The method may include displaying thermostat function parameters on a liquid crystal display on the wireless remote controller.

In general, the method may include the step of displaying system status and commands on a liquid crystal display on the wireless remote controller.

The method may include the further step of automatically upgrading from a wired remote controller to a wireless remote controller or the further step of

automatically downgrading from a wireless remote controller to a wired remote controller.

5 Preferably the method includes the further step of transmitting commands and information from the wireless remote controller to the air conditioning system using infrared media, ultrasonic media, radio frequency media, or spread spectrum radio frequency media.

10 In order that the invention may be well understood, an embodiment thereof, which is given by way of example only, will now be described with reference to the accompanying drawings, in which:

Figure 1 shows a split system air conditioning unit;

15 Figure 2 shows a cutaway view of the indoor section of the split system air conditioning unit of Figure 1 including a wired remote controller;

Figure 3 shows a perspective view of the indoor section of the split system air conditioning unit of Figure 1 including a wireless remote controller;

20 Figure 4 is a flow chart of the operation of the unit; and

Figure 5 shows a block diagram of the air conditioning system controller.

25 Figure 1 shows the general arrangement of a split system air conditioning unit 10 including an indoor section 12 having an inside heat exchange coil 13, and a wired remote controller 14 for controlling the operation of the split system unit 10. The split system unit 10 also includes an outside section 16
30 connected to the indoor section 12 by refrigerant conduit 18. The outside section 16 is suitable for mounting on

an exterior wall 20. The outside section 16 conventionally includes an outside heat exchange coil and a refrigerant expansion device (not shown) in a first portion 22 and a compressor (not shown) in a second portion 24. Under the control of a system controller 25, preferably located within the indoor section 12, the split system unit 10 conventionally modulates the temperature of an interior space by controlling compressor and fan speeds and times of operation. The system controller 25 is linked to the outside section 16 by an electrical connecting line 27, and is described in connection with Figure 5.

Figure 2 shows the indoor unit 12 including the wired remote controller 14. The wired remote controller 14 allows a user to enter commands and provide information to the system controller 25. The wired remote controller 14 includes a switch 26 operable to control the system mode of operation between heating, cooling, automatic, and off. The wired remote controller 14 also includes a switch 28 to control a fan mode of operation between automatic, continuous on, and off. The wired remote controller 14 includes a fan speed controller switch 30 operable to control the speed of a fan 32 within the inside unit 12. The fan 32 is operable to draw air across the inside heat exchange coil 13 from an inlet 34 and out an outlet 36. The location of the inlet 34 and the outlet 36 will vary depending on whether the indoor unit 12 is a floor standing unit or the wall mount unit shown in Figures 1 and 2. Various louvers 38, 40 are provided to direct the flow of air as it exits the outlet 36. The wired remote controller 14 also includes a temperature setpoint set switch 42 which establishes the temperature setpoint for the space being conditioned. A

timer switch 44 is operable to turn a time function on or off. The duration of the timed function is set by an hour setpoint switch 46. A button 48 is provided to turn the air conditioning system 10 on and off and display the operational status of the system 10 in a display 50.

The system controller 25 is operably connected to the wired remote controller 14 by a cable 54. The system controller 25 uses the information and commands received from the wired remote controller 14 to control the operation of the air conditioning system 10. The cable 54 of the wired remote controller 14 is connected to a system controller interface 53 within the indoor unit 12. A pop-up section 52 may be provided to provide a storage space within the indoor unit 12 for the wired remote controller 14 or a wireless remote controller 56.

Figure 3 shows the indoor unit 12 with a wireless remote controller 56 instead of the wired remote controller 14. The wireless remote controller 56 sends out infrared signals which are received at the indoor unit 12 by a infrared signal sensor 58. The signals are then forwarded to the system controller 25 and processed in a manner similar to signals received from the wired remote controller 14.

The wireless remote controller 56 includes a liquid crystal display 60 which displays system parameters such as battery status 62, the system mode of operation 64 as controlled by a system mode button 66, and, optionally, sensed temperature 68 as sensed by a temperature sensor within the wireless remote controller 56. The liquid crystal display 60 also displays the fan speed 70 as controlled by a fan speed button 72, and displays the temperature setpoint as controlled by up and down buttons 74, 76 respectively. A further section

78 of the liquid crystal display 60 displays timed control as controlled by timer buttons 80, 82 and 84. The fan operating mode 86 is also displayed on the liquid crystal display 60 and controlled by a fan mode button 88. An on/off button 90
5 controls the overall operational status of the split system air conditioning unit 10.

The wired remote controller 14 includes a plug connector 92 at the end of the cable 54 which attaches to the system controller interface 53. The attachment of this plug
10 connector 92 to the interface 53 is recognized by an indicator 94. The indicator 94 provides an indication to the system controller 25 of the split system air conditioning unit 10 that the wired remote controller 14 is physically connected to the inside unit 12. This indication 94 can be accomplished in a
15 number of ways preferably by including two extra pins 96 in the connector 92 to provide a binary input, such as by a jumper 98 shown in Figure 2, to the system controller 25 indicating that the controller is present. Alternatively, a low power electric circuit can be included which is closed by the presence of the
20 connector 92. Another alternative includes a contact switch which is depressed by the connection of the connector 92 to the inside unit 12. Many other methods of detecting this connection are possible and contemplated.

Figure 4 shows a flow chart 100.

25 At step 102, the system controller 25 of the split system air conditioning unit 10 enters this routine at initialization and regularly thereafter as part of its normal operating program. At step 104 the indicator 94 indicative of whether the connector 92 is present is checked. If a positive

response is provided by the indicator 94, the wired remote controller 14 is considered to be connected and step 106 is followed. If step 106 is followed, the air conditioning system configuration is automatically set up for a wired remote controller 14 and any signals received by the infrared signal sensor 58 are treated as invalid and excluded from the system controller 25. On the other hand, if the indication 94 at step 104 is negative, then step 108 is followed and the configuration is made for a wireless remote controller 56. Infrared signals received on the infrared sensor 58 are treated as valid signals and forwarded to the system controller 25 while signals received by the plug connector 92 are treated as invalid and excluded from the system controller 25. Consequently, if the customer desires to upgrade or downgrade the system by adding a wireless remote controller 56, or temporarily or permanently installing a wired remote controller 14, the system controller 25 will automatically and, from the customers point of view, almost instantly respond by reconfiguring the air conditioning system 10.

Figure 5 shows a block diagram of the system controller 25. The system controller 25 includes a microprocessor 120 having a 32 kilohertz quartz clock 122. A power supply 124 supplies power to the microprocessor 120, and essential data and programs are stored on an EEPROM 126. Connection 128 connects the microcomputer 120 to the infrared receiver 58. The microcomputer 120 also includes an analog interface 130 which allows the receipt of such inputs as indoor temperature 132 or heat exchanger temperature 134. A connection 136 connects the system controller interface 53 and the indicator 94 to the microcomputer 120. The microcomputer

may also be provided with an annunciator 138 to provide a visual display on the indoor unit 12 for the user's benefit, and may provide a serial communications interface 140 to a building automations system or a modem. The system controller 25 also includes an output 142 to control the fan and compressor of the outdoor unit 16 as well as an output 144 to control whatever heaters, fans and dampers are associated with the indoor unit 12. Although the system controller 25 is preferably located within the indoor unit 12, the system controller may also be located in the outdoor unit 16 if it is protected from the weather, or may be located in a third location distinct from either the indoor unit 12 or the outdoor unit 16 if desirable.

It will be appreciated from the above, that not only is the illustrated unit 10 able to operate with either a wired or a wireless remote controller, the system controller of the unit is able to automatically determine whether or not to operate using a wired or a wireless remote controller.

An advantage of the unit 10 is that it allows a consumer to install a wired or a wireless remote controller without the necessity of expert help.

The unit 10 also allows easy and automatic upgrade from a wired remote controller to a wireless remote controller or downgrade from a wireless remote controller to a wired remote controller.

It should be recognized that control of the unit 10 is not intended to be limited to infrared signals provided by the wireless remote controller 14 and contemplates the use of ultrasonic, as well as radio frequency and spread spectrum radio frequency signals. Additionally, the cable 54 linking the wired remote controller 14 to the inside unit 12 is intended to

encompass conventional variations of an electrical or fiber optic cable.

5 Finally, whilst the air conditioning system 10 described herein is a split system air conditioning unit, it will be appreciated that the present invention is intended to be applicable to all air conditioning systems.

CLAIMS:

1. An air conditioning system comprising:

an air conditioner including an outside heat exchange unit, an inside heat exchange unit, first refrigerant conduit connecting the outside heat exchange unit to the inside unit and including an expansion device therein, second refrigerant conduit connecting the outside unit to the inside unit and including a compressor therein;

a system controller for the air conditioning unit operably connected to the compressor;

a first portable wireless remote controller for providing commands and information to the system controller by wireless transmission;

a second portable wired remote controller for providing commands and information to the system controller by wired transmission;

means, operably connected to the system controller, for receiving wireless remote transmissions from the first portable wireless remote controller;

means, operably connected to the system controller, for receiving wired remote transmissions from the second wired remote controller when the latter is connected to the system controller; and

means, operatively associated with system controller and responsive to the wired remote receiving means, for automatically establishing a first air conditioning system operating configuration if the wired remote controller is connected to the system controller and for establishing a second air conditioning system operating configuration if the wired remote controller is not connected to the system controller.



2. A system as claimed in claim 1, further including means, responsive to the automatic establishing means, for disabling all non-established air conditioning operation system configurations.

5 3. A system as claimed in claim 1 or 2, wherein the first portable wireless remote controller provides a thermostat function.

10 4. A system as claimed in claim 1, 2 or 3 wherein the inside heat exchanger is within a housing which includes storage within the housing for either the first or second remote controller.

5. A system as claimed in any one of claims 1 to 4, wherein the first portable wireless remote controller includes a liquid crystal display.

15 6. An air conditioning system comprising:
a compressor;
an outdoor heat exchanger;
an indoor heat exchanger;
an expansion device;

20 refrigeration conduit for serially connecting the compressor to the outdoor heat exchanger, the outdoor heat exchanger to the expansion device, the expansion device to the indoor heat exchanger, and the indoor heat exchanger to the compressor;

25 means for controlling the operation of the compressor, the control means including an infrared receiver and a wired remote receptacle;

30 wherein the control means includes means for determining the presence of a connector in the wired remote receptacle, and means, responsive to the determining means, for inhibiting the operation of the



infrared receiver if a connector has been determined to be in the receptacle.

5 7. A system as claimed in claim 6, including means responsive to the determining means, for inhibiting the operation of the wired remote receptacle if a connector is not in the receptacle.

10 8. A system as claimed in claim 6 or 7, including means, responsive to the determining means, for enabling the operation of the infrared receiver if a connector is not in the receptacle.

15 9. A system as claimed in claim 6, 7 or 8, including means, responsive to the determining means, for enabling the operation of the wired remote receptacle if a connector has been determined to be in the receptacle.

10. A system as claimed in claim 6, 7, 8 or 9, wherein the determining means detects the presence or absence of a jumper within a plug attached to the wired remote receptacle.

20 11. A system as claimed in claim 6, 7, 8 or 9, wherein the determining means includes a contact switch in the wired remote receptacle.

25 12. A system as claimed in claim 6, 7, 8 or 9 wherein the determining means includes a low power electric circuit operatively associated with the wired remote receptacle.

13. A method of configuring an air conditioner for remote control comprising the steps of:



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determining if a portable wired remote controller is connected to the air conditioning system;

5 automatically configuring the air conditioning system to operate using the portable wired remote controller if the portable wired remote controller is connected to the air conditioning system;

10 automatically configuring the air conditioning system to operate with a wireless remote controller if the portable wired remote controller is not connected to the air conditioning system; and

operating the air conditioning system in accordance with the established configuration.

14. A method as claimed in claim 13, including the further steps of periodically re-executing the
15 determining step, and excluding the operation of the nonconfigured operation until the result of the determining step changes.

15. A method as claimed in claim 13 or 14, including the further step of providing a thermostat function in
20 the wireless remote controller.

16. A method as claimed in claim 15, including displaying thermostat function parameters on a liquid crystal display on the wireless remote controller.

17. A method as claimed in claim 13, including the
25 step of displaying system status and commands on a liquid crystal display on the wireless remote controller.

18. A method as claimed in any one of claims 13 to 17 including the further step of automatically upgrading
30 from a wired remote controller to a wireless remote



controller.

19. A method as claimed in any one of claims 13 to 17 including the further step of automatically downgrading from a wireless remote controller to a wired remote controller.

20. A method as claimed in any one of claims 13 to 18 including the further step of transmitting commands and information from the wireless remote controller to the air conditioning system using infrared media, ultrasonic media, radio frequency media, or spread spectrum radio frequency media.

21. A system controller and a wired remote controller therefor substantially as herein described with reference to Figures 1, 2, 4 and 5 of the accompanying drawings.

22. An air conditioning system substantially as herein described with reference to Figures 1, 2, 4 and 5 or Figures 3 to 5 of the accompanying drawings.