NTAF Series
RS-485 Modbus RTU Networking FCU Thermostats with 0(2)-10 VDC Fan Output

Features

- Ultra slim wall-mount unit to match any décor
- Supports Modbus RTU protpcol
- Supports standalone operation on RS-485 communication failure
- Large easy-to-read Liquid Crystal Display (LCD), with LED backlight
- A stylish bi-directional rotating dial and two compact touch keys to provide ease of operation
- Choice of constant display of ambient temperature or temperature set point value
- Output relays employed for direct connection of valve actuators for 2-wire on-off and 3-wire floating control
- Configurable operating parameters
- 2-wire on-off, 3-wire floating and 0 (2)-10 VDC output models available
- 0(2)-10 VDC fan output in a maximum of 7 steps plus auto mode
- Adjustable proportional band for proportional/3-wire floating models
- Adjustable integral time for 0(2)-10 VDC and 3-wire floating output models
- Choice of valve stroke time for 3-wire floating output models
- Field adjustable high and low occupied set point limit settings
- Choice to retain last entered settings on power resumption
- Dual-output models with auto cooling/heating changeover (deadband operation) and manual override
- Adjustable 1 to 5 K deadband for dual-output models
- Choice of operating sequence for dual-output models
- Unoccupied mode capability with field adjustable cooling and heating set points, for energy savings
- Choice of unoccupied mode activation in operating mode only or in both standby and operating modes
- Choice of fan action in unoccupied mode
- Field recalibration capability of measured temperature
- Continuous or auto fan operation
- External and seasonal changeover temperature sensor capability
- Window mode operation
- Optional infra-red remote control unit
- Optional special faceplate color available on request

General

The NTAF Series RS-485 networking room thermostats use the communication technologies of Modbus RTU protocol to monitor and supervise BLDC motor-driven fan coil units in the heating, ventilating and air-conditioning industry, and employ a simple master/slave protocol. All NTAF Series thermostats are slaves in this protocol, and can be under the control of a Mega Controls BACnet gateway, of either BMG or BMGE Series, called the master. The BMGs and BMGEs are native BACnet devices and communicate using the BACnet MS/TP or BACnet-over-Ethernet protocol.

Net 2 port of the BMG master and all slaves are daisy-chained through a RS-485 Modbus RTU network. The maximum number of NTAF slaves in a Modbus RTU network is 32.

Each BMG has 2 addresses. Net 2 address is always 0 which is the address of the Modbus RTU network. Net 1 address is the MAC address of the BACnet MS/TP network which is also set up for a maximum of 32 devices in a trunk cable length not exceeding 1000 m. The BMG gateway spontaneously detects the presence of slaves that go online in its NET 2 network.

If more than 32 BMGs are needed in the system, an additional BACnet system device is required for the second BACnet MS/TP network.

Each BMGE gateway is available with two RS-485 networks. Each network can support up to 32 NTAF Series Modbus RTU devices. The BMGE gateway spontaneously detects the presence of slaves that go online in its NET 1 and NET 2 networks.

The NTAF Series thermostats cover a wide range of fan coil applications, including 2 and 4-pipe fan coils and direct connection to BLDC motor-driven fans. Temperature sensing can be from a built-in room sensor or a remote sensor.

The 0(2)-10 VDC and 3-wire floating thermostats adopt true proportional-integral (PI) control algorithm. The microprocessor combines a proportional plus integral (PI) algorithm with advanced adaptive control logic. The proportional component of the algorithm adjusts the control output in response to changes in the measured temperature. The integral component of the algorithm adjusts the control output to eliminate offset (difference between the set point and the actual temperature). This provides precise and stable control under various system capacity and varying load conditions without the need for tuning or calibrating the control algorithm in the field. The digital display of ambient temperature, set point and operating mode provides the user with an attractive and functional thermostat that is easy to use.

A fan-speed control touch key allows control of a variable-speed fan in the form of step outputs in 0(2)-10 VDC values. The speed control key has a maximum of 8 positions: "Steps 1 to 7 plus Auto". In the step positions, the fan runs continuously at a speed corresponding to the selected fixed voltage output. In the "Auto" mode, the fan speed is temperature dependent and controlled automatically in 3 steps from lowest to highest speed. Through the parameter setup menu, the default number of steps as well as default fan output range can be changed from 3 to 7 and from 0-10 to 2-10 VDC respectively.

When operating in auto fan mode, the ambient temperature controls both the valve output and fan output simultaneously but uses different algorithms.

A bi-directional rotating dial allows change of settings such as temperature set point values.

Ordering

To order, specify complete model numbers.

Specifications

Product model numbers	See Fig.2: NTAF Series Model Number Selection Guide
Power requirements	110-230 V, +10% and -15%, 50/60 Hz
Operating temperature differential (for both 2-wire and 3-wire on-off models)	Fixed at 1 K for both cooling and heating modes
0(2)-10 VDC output impedance	Minimum 10,000 Ω
Temperature display range	5-35°C in 0.5 K increments: accuracy ±1 K (41-95ºF in 0.5 R increments, accuracy ±1 R)
Temperature set point range	5-35°C in 0.5 K increments, initial factory setting at 22°C (41-95ºF in 0.5 R increments)
Offset adjustment of temperature indication (field recalibration)	+2, +1, 0, -1 and -2 K (+2, +1, 0, -1 and -2 R) throughout the range, factory setting 0
Deadband of dual-output models	Adjustable 1 to 5 K between cooling Mode and heating Mode, factory set at 3 K(3 R)
Valve stroke time for 3-wire floating models	Accumulatively 10 to 240 s maximum in one direction, in steps of 10 s; factory setting 120 s
Proportional band for PI control	Adjustable 1 to 10 K in 1 K increments, factory setting 5 K
Integral time for PI control	Adjustable 0 to 30 minutes in 1 minute increments, factory setting 15 minutes. Setting = 0 means integral time being turned off.
Auto fan temperature differential	Fan step output changes at 2 K increments from lowest to highest speed, only Steps 2, 4 and 7 are available in auto fan mode; auto fan operation in heating mode depends on choice of auto fan action.
Sensing element	NTC thermistor, 10 kΩ@25ºC; accuracy ±0.5 K@25ºC
Unoccupied mode	Input signal from external voltage-free contact; choice of unoccupied mode activation: in operating mode only or in both standby and operating
Unoccupied temperature set point range	Field adjustable 5-35ºC in 1 K increments, separately for cooling and heating; Factory settings: 16ºC for heating and 26ºC for cooling
RS-485 communication speed	Baud rate fixed at 19,200 bps
Device MAC addressing	01-32 via parameter setup menu, factory default setting 255 (displays as FF on thermostat screen)
Proprietary Modbus RTU network guide-	Maximum 32 devices and maximum 1,000 m cable length
Enclosure	Material: Self-extinguishing, molded ABS
	Finish: Off white housing and dark grey faceplate
Electrical ratings	Valve output relays 110-230 V, 3 A resistive, 1 A inductive, 50/60 Hz
	Total rating 110-230 V, 5 A maximum, 50/60 Hz
Ambient/Storage temperature limits	0 to 50 °C / -30 to 50 °C, 10% to 90% RH non-condensing
Connectors	Non-removable line-voltage terminal blocks and removable low-voltage wire plugs
Power wires	Wire size 1 mm^2 or 18 AWG solid copper recommended
Sensor wires	22 AWG twisted shielded pair double-insulated cable
Accessories and options	See Figure 8: Optional Accessories
Agency approval	CE Mark compliant to EMC and Low Voltage Directives pending
Shipping weight	0.2 kg (0.44 lb)
Dimensions	See Figure 7: Dimensions in mm

The performance specifications above are nominal and subject to tolerances and application variables of generally acceptable industry standards. The Manufacturer shall not be liable for damages resulting from misapplication or misuse of its products.

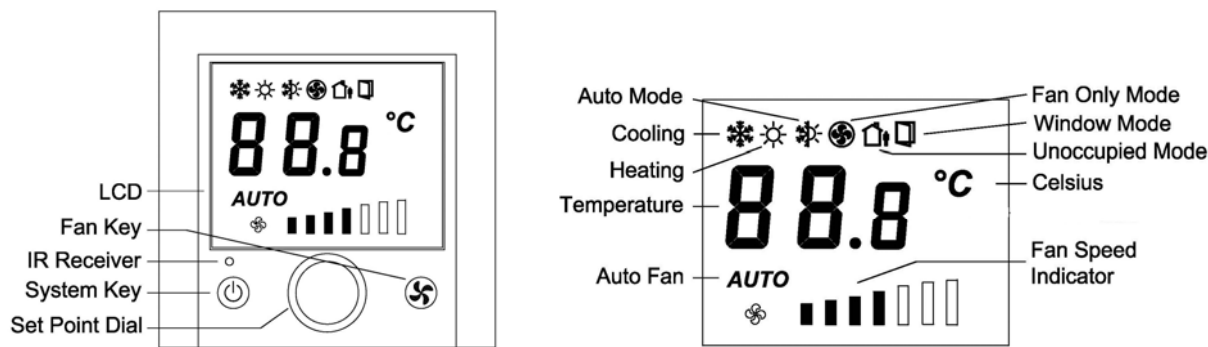## Figure 1: Display Control Unit and LCD Layout

NTAF	–	1	R
Product Type	Separator	Control Type	Options
NTAF = NTAF Series Digital Room Thermostats		**1** = Single 2-wire on-off output, cool only or heat only **1M** = Single 2-wire on-off output, manual cool/heat changeover **1A** = Single 0-10 VDC output, cool only or heat only **1AM** = Single 0-10 VDC output, manual cool/heat changeover **1F** = Single 3-wire floating output, cool only or heat only **1FM** = Single 3-wire floating output, manual cool/heat changeover **2** = Dual 2-wire on-off outputs, manual or Auto cool/heat changeover **2AH** = 0-10 VDC cooling output and 2-wire on-off output, manual or Auto cool/heat changeover	**R** = with infra-red receiver for RCU-1 **B** = without buzzer for key touch sounding **W =** with white color faceplate

Figure 3: Jumper Settings

The models NTAF-2 can be re-configured in the field to various model numbers by a qualified servicing agent, if necessary, by changing the jumper positions of JP2 and JP3. The locations of these jumpers can be found after removing the thermostat cover from its baseplate.

Model Number	Jumper Settings of JP2 and JP3	
	JP2	JP3
NTAF-1	Cut	Cut
NTAF-2	Uncut	Uncut
NTAF-1F	Cut	Uncut
NTAF-1A	Uncut	Cut

Jumper Settings of JP1 and JP4		
Jumper	Cut	Uncut
JP1	With External Sensor	With Built-in Sensor
JP4	For 2-10 VDC Output	For 0-10 VDC Output

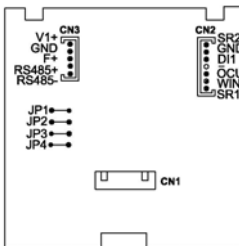*Note: JP4 is available in 0-10 VDC/2-10 VDC output models only. Factory setting is 0-10 VDC.*

Figure 4: 0(2)-10 VDC Fan Output Table

Step	Output Value for 0-10 VDC Range (VDC)	Output Value for 2-10 VDC Range (VDC)
0	0	2
1	1.43	3.15
2	2.86	4.29
3	4.29	5.43
4	5.72	6.57
5	7.15	7.71
6	8.58	8.85
7	10	10
Auto	**In auto mode, the fan will run in only 3 steps, i.e. Steps 2 , 4 and 7 as default. Number of steps can be changed via parameter setup menu.**	

Figure 5: Thermostat Errors Reporting

When the following errors are reported on the LED display unit, these errors will prevent the thermostat from normal operation and all thermostat functions will be locked out:

E-1   EEPROM read/write error
E-2*   Temperature sensor open-circuited
E-3   Temperature sensor short-circuited

* If jumper JP1 is cut open and external sensor is used, E-2 means the external sensor may have been disconnected from Terminals SR1 and GND. Check the external sensor's connectivity and resistive value. If E-2 error is still reported, return the thermostat to the manufacturer for repair.

When the error E-1 or E-3 is reported or when the error E-2 is reported without jumper JP1 being cut and external sensor being installed, return the thermostat to the manufacturer for repair.

Figure 6: Wiring Diagrams and Application Notes

Wiring and Application Notes
- Cut jumper JP1 open if an external sensor is wired to SR1 and GND. Run the wiring away from any electrical motors or power wiring. Failure to do so may result in poor thermostat performance due to electrical noise.
- Cut jumper JP4 open if 2-10 VDC proportional output is required.
- 22 or 24 AWG twisted shielded pair double-insulated cable is recommended as remote sensor wiring and its length must not exceed 25 m.
- Do not bundle and run power wiring and remote sensor wiring in the same conduit.
- The seasonal changeover sensor should be wrapped around the supply water pipe when associated with a water system. When the changeover sensor temperature exceeds 30 ºC, the thermostat enters into heating mode.
- External seasonal changeover sensor or switch is applicable to heat only or cool only 2-pipe models only.
- Unoccupied contact closure activates unoccupied mode.
- Window contact closure activates thermostat lockout mode.
- Hidden-line wiring for Terminal 4 of CN6 is applicable to dual on-off output models only.
- The thermostat outputs are designed for controlling zone valves. If used for controlling electric heaters, external contactors must be used.
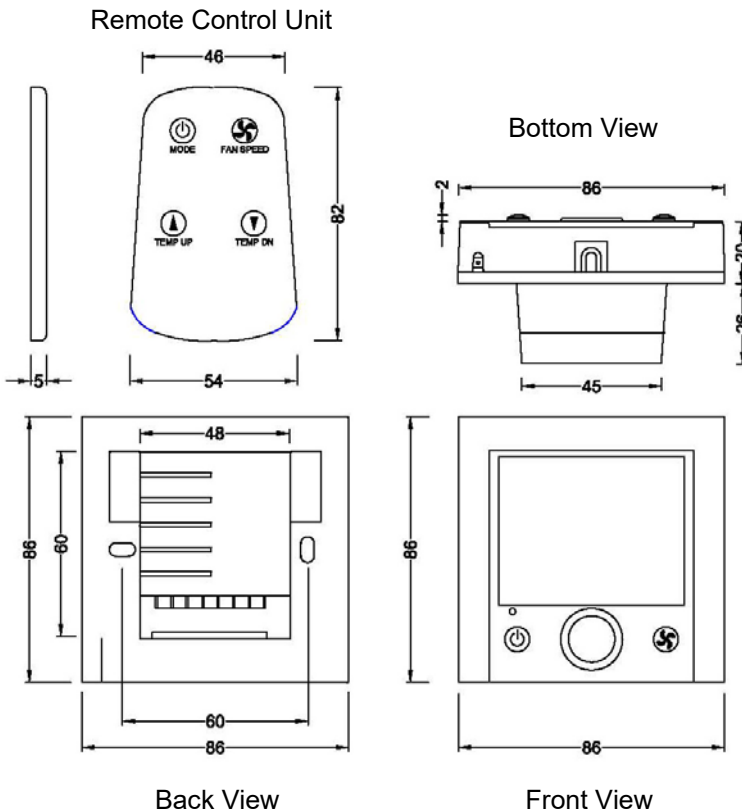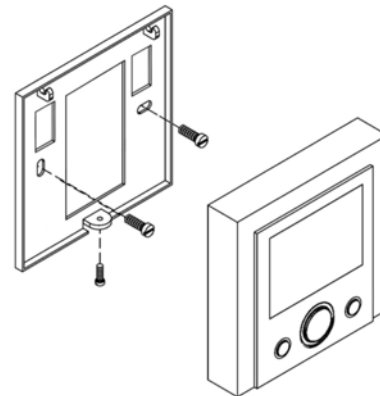
Remote Control Unit

Bottom View

Back View   Front View

Description	Part No.
Remote control unit	RCU-1
Probe temperature sensor	TE10-1
Duct temperature sensor	TE10-2
With infra-red receiver capability	NTAF-xx<u>R</u>
Without buzzer capability	NTAF-xx<u>B</u>
With white-color faceplate	NTAF-xx<u>W</u>

Mounting

The thermostat can be flush mounted or secured to a standard European 75 x 75 x 47 mm (strongly recommended) electrical box. Two mounting screws are included.

Network, Cabling & Step-down Transformer Requirements

To ensure network stability and reliable communications, particularly at high speeds on a BACnet MS/TP or Modbus RTU network for a number of devices, it is imperative that the following network, cabling step-down transformer requirements are adhered to:

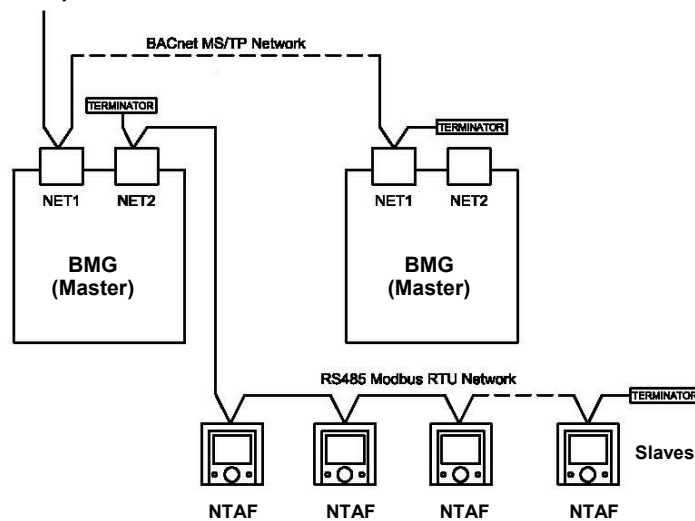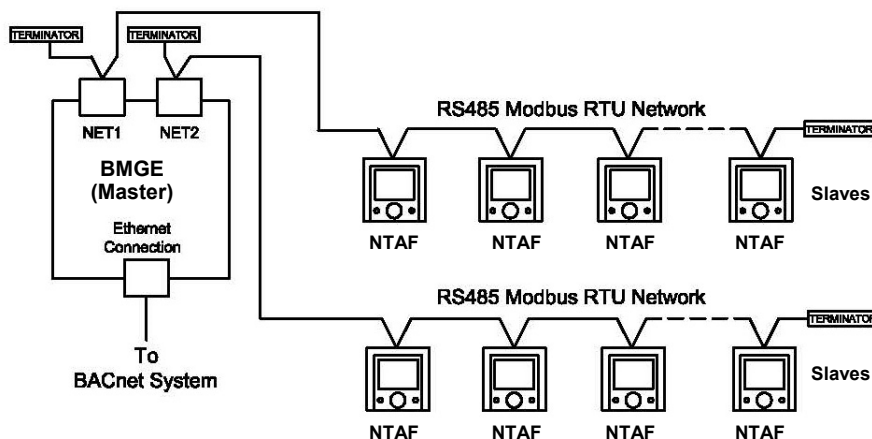| Item	Description
Cabling	It is recommended to use networking cabling that matches the following specifications: • Balanced 100 to 120 ohms nominal impedance, 22 or 24 AWG Twisted Shielded Pair (TSP) Cable • Nominal capacitance of 52 pF/m or lower • Nominal velocity of propagation of 66% or higher • Terminating the shield to ground at one end only for each isolated segment will prevent ground loops in the shield and drain RF energy to ground. Grounding at the BACnet router or controller is preferred.
Topology	Ensure the BACnet MS/TP or Modbus RTU network cable is installed as a daisy chain from one device to the next.
Maximum Nodes	The maximum number of devices is 32 per BACnet MS/TP or Modbus RTU network.
Terminator	A terminator of 120-ohm impedance must be installed at each end of each BACnet MS/TP or Modbus RTU network segment, or two per network. Ensure that this requirement is not overlooked in laying out the network architecture and when ordering product.
Cable Shielding	Use a shielded, twisted pair cable for communications. Never directly ground wire in more than one point on the shield. Doing so can induce large currents and result in communication problem.
Repeater	A repeater is not necessary unless the network is extended beyond 1,000 m.
Step-down Transformer	A separate isolated double-wound transformer is recommended for supplying 24 VAC power to each BMG or BMGE. If and when the same transformer is shared with other devices, observe the polarities of the power supply of all devices including the BMG or BMGE.

BACnet MS/TP Network Notes:
1. Ensure the recommended balanced cable is used.
2. Ensure the cable is installed as a daisy chain from one device to the next (1,000 m maximum) and the shield is grounded at one single point of the network only.
3. Ensure a MS/TP terminator is installed on each end of a MS/TP network.
4. The maximum nodes per MS/TP network is 32.

Modbus RTU Network Notes:
1. Ensure the recommended balanced cable is used.
2. Ensure the cable is installed as a daisy chain from one device to the next (1,000 m maximum) and the shield is grounded at one single point of the network only.
3. Ensure a terminator is installed on each end of each Modbus RTU network.
4. The maximum nodes per Modbus RTU network is 32

With BMG BACnet MSTP Gateway

To BACnet MS/TP Network Supervisor

BACnet MS/TP Network

TERMINATOR

TERMINATOR

NET1   NET2

NET1   NET2

BMG (Master)

BMG (Master)

RS485 Modbus RTU Network

TERMINATOR

Slaves

NTAF   NTAF   NTAF   NTAF

With BMGE BACnet-over-Ethernet Gateway

TERMINATOR   TERMINATOR

NET1   NET2

BMGE (Master)

RS485 Modbus RTU Network

TERMINATOR

Slaves

NTAF   NTAF   NTAF   NTAF

Ethernet Connection

To BACnet System

RS485 Modbus RTU Network

TERMINATOR

Slaves

NTAF   NTAF   NTAF   NTAF

WARNING

Incorrect wiring connection may cause permanent equipment damages to the thermostat.
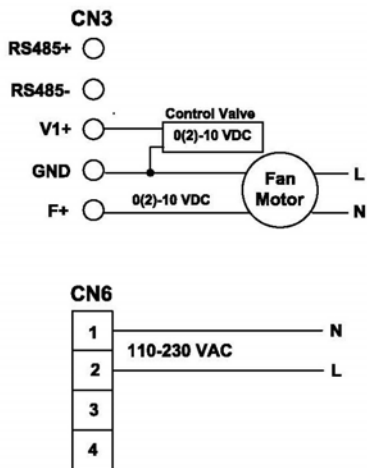
Piping Notes:
1. On a single on-off output unit, V1 can be either a 2-wire spring-return cooling or heating valve.
2. On a dual on-off output unit, V1 must be a 2-wire spring-return cooling valve and V2 a 2-wire spring-return heating valve.
3. V3 must be a 3-wire floating valve. In cooling mode, Terminal 3 output opens valve on temperature rise and Terminal 4 output closes valve on temperature drop. The action in heating mode is reversed.
4. On a single 0(2)-10 VDC output unit, V1+ can be either a 0(2)-10 VDC cooling or heating valve.
5. On a dual 0-10 VDC plus on-off output unit, V1+ must be a 0-10 VDC cooling valve and H an electric heating contactor.

Connections of Sensors and Contacts

Wiring Diagram for Single and Dual 2-Wire On-Off Valve Outputs
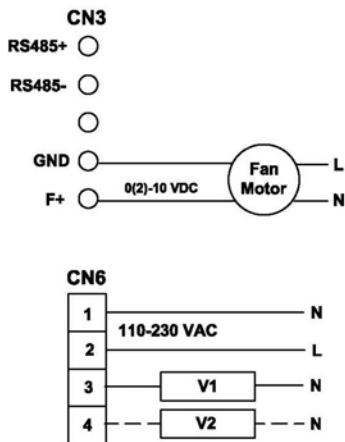
V1 and V2 are 2-wire on-off spring-return valves
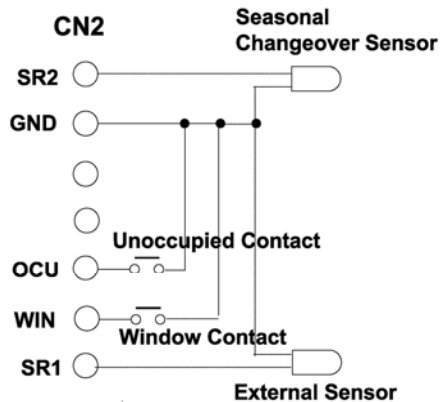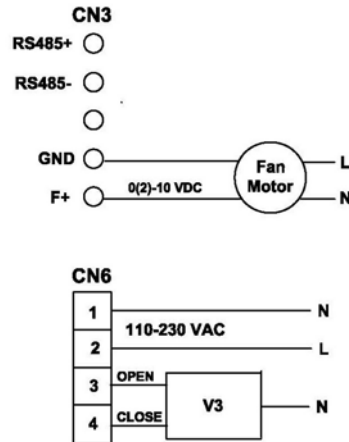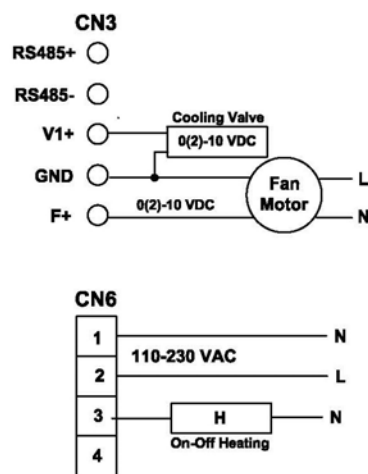
Wiring Diagram for Single 3-Wire Floating Valve Output

V3 is a 3-wire floating valve

Wiring Diagram for Single 0(2)-10 VDC Valve Output

V1+ is a 0(2)-10 VDC valve

Wiring Diagram for Dual 0(2)10 VDC Cooling Valve Output and Line-Voltage Heating Output

V1+ is a 0(2)-10 VDC cooling valve and V2 is an electric heating contactor

User Operating Mode

■ LCD shows ambient temperature constantly except when set point adjustment is being made.

■ Press the system key Φ to enter into the desired operating mode: Cool or Heat-Auto-Fan Only-Off, etc.

■ Press the fan key to change the fan speed mode: 1-2-3-4-5-6-7-Auto, etc.

■ Increase or decrease temperature set point by rotating the adjustment dial clockwise or counter-clockwise. When the dial is rotated, the LCD shows the existing set point setting.

■ In unoccupied mode, the factory temperature set points are 26 ^{o}C for cooling and 16 ^{o}C for heating. In heating mode, the fan speed can be set at "Off" or "Step 2", depending on setup menu setting, when temperature is satisfied.

■ Unoccupied mode can be activated in the following manner when the unoccupied contact closes:

For Models "1", "1A" and "1F", the unoccupied cooling or heating mode is determined by the status of the SR2 seasonal changeover sensor and the valve output is activated according to the measured temperature.

For Models "1M", "1AM" and "1FM", while in unoccupied mode, the valve output is never activated.

For Model "2" and "2AH", the unoccupied cooling or heating mode is always determined by the measured temperature and valve output is also activated according to the measured temperature.

Unoccupied mode activation in operating mode only or in both standby and operating mode will be determined by activation setting in setup menu.

When unoccupied mode is activated, all keys are locked out and no settings can be entered.

■ When the window contact is closed, the window function enabled mode is activated and locks out all thermostat functions and displays the window icon on the LCD. This function has a higher priority than the unoccupied mode.

Parameter Setup Mode

■ The thermostat allows authorized service agent to change a number of operating parameters in the field. Refer to the parameter setup manual for details.

Error reporting

■ All valve and fan outputs will be shut down when error is reported.

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