

NT500 Series

BACnet MS/TP Networking Room Thermostats with Modulating Fan Speed Control Output for Fan Coil Units

Features

- Ultra slim wall-mount network control unit to match any décor
- Supports standalone operation on BACnet MS/TP communication failure; relinquishes all network commands by a special key operation at the thermostat
- Field selectable RS-485 communication port baud rate setting: 9,600, 19,200, 38,400 or 76,800 bps
- Fan coil application database pre-loaded
- Extra large easy-to-read liquid crystal display (LCD) with LED backlight (white)
- A stylish bi-directional rotating dial and two compact touch keys to provide ease of operation
- Choice of constant display of ambient temperature, temperature set point value or percentage fan output set point value
- Output relay employed for direct connection of electric heater contactor coil to provide high current ratings
- Slim separate power supply unit to fit on all sizes of fan coil units and to provide highly reliable power source
- Configurable operating parameters
- Choice of °C or °F temperature display via parameter setup menu
- 0(2)-10 VDC fan speed control output
- Field adjustable upper and lower fan speed output set point limits
- Adjustable 1-5 K proportional band and integral time for PI control
- Choice of valve stroke time for 3-wire floating output models
- Field adjustable high and low occupied set point limits
- Field adjustable cooling and heating unoccupied set point values (applicable to some models only)
- Choice to retain last entered settings on power resumption
- 2-wire on-off, 3-wire floating and 0(2)-10 VDC output models available
- Choice of 0-10 VDC or 2-10 VDC analog outputs via parameter setup menu
- Dual-output 2-wire on-off 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
- Choice of unoccupied mode activation in operating mode only or in both standby and operating modes
- Choice of thermostat priority array

assignment from 1 to 16

- Provides thermostat keys lockout from any workstation in the network
- Window contact closure to lock out all thermostat functions
- Provides two additional digital inputs for function such as remote night setback, service/filter alarm or motion detection
- Provides one digital output for external device interlocking; output is on whenever the fan is running at any speed
- Provides one additional digital output for function such as lighting control
- 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
- Optional infra-red remote control unit available
- Optional special faceplate color available on request

General

The NT500 Series networking room thermostats are BACnet Master-Slave/Token-Passing (MS/TP) networked devices designed in strict accordance with ASHRAE standard 135-2010 and are native BACnet devices. These thermostats provide line-voltage 2-wire on-off, 3-wire floating or 0(2)-10 VDC output to water valves in 2-pipe or 4-pipe fan coil units.

The technologically advanced NT500 Series networking thermostats feature a BACnet MS/TP communication capability that enables remote monitoring and programmability for efficient space or return air temperature control.

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 NT500 Series networking thermostats also feature an intuitive user interface that makes setup and operation quick and easy.



A system mode control key allows the user to enter into the desired operating mode of cool-heat-auto-fan only-off for single- and dual-output models or auto-off for dual-output models only.

A fan mode control key allows control of a variable speed fan driven by EC motor in either "Manual" or "Auto" fan mode, via a 0-(2)10 VDC output signal. In the "Manual" fan mode, the fan runs continuously at the desired percentage speed. In the "Auto" fan mode, the fan speed is temperature dependent and controlled automatically at the desired proportional band from 0 to 100% in 5% increments. The default auto fan speed at start-up is set at 75%. During unoccupied period, the fan always runs in "Auto" fan mode.

Note that most fan coil units have factory-set minimum and maximum values built into their electronic control board as fan speed limits, to maintain indoor airflow requirements.

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

When the thermostat is first powered up, its initial set points are set at 22°C and 75% fan speed and default fan operating mode is "Auto".

Ordering

To order, specify model numbers of complete set, network control unit or power supply unit.

Figure 1: NT500 Series Model Number Selection Guide

NT500 Series Networking Room Thermostats Model Number Selection Guide (Complete Sets)				
NT5	0	1M	-	R
Product Type	Power Supply	Control Type	Separator	Options
NT5 = NT500 Series BACnet MS/TP Networking Thermostats	0 = 100-230 VAC	1 = Single output, line-voltage 2-wire on-off, cool only or heat only 1M = Single output, line-voltage 2-wire on-off, manual cool/heat changeover 1F = Single output, line-voltage 3-wire floating, cool only or heat only 1FM = Single output, line-voltage 3-wire floating, manual cool/heat changeover 2 = Dual outputs, line-voltage 2-wire on-off, Manual or auto cool/heat changeover 1A = Single output, 0(2)-10 VDC, cool only or heat only 1AM = Single output, 0(2)-10 VDC, manual cool/heat changeover 2AH = Dual outputs, 0(2)-10 VDC cooling + line -voltage on-off heating, 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

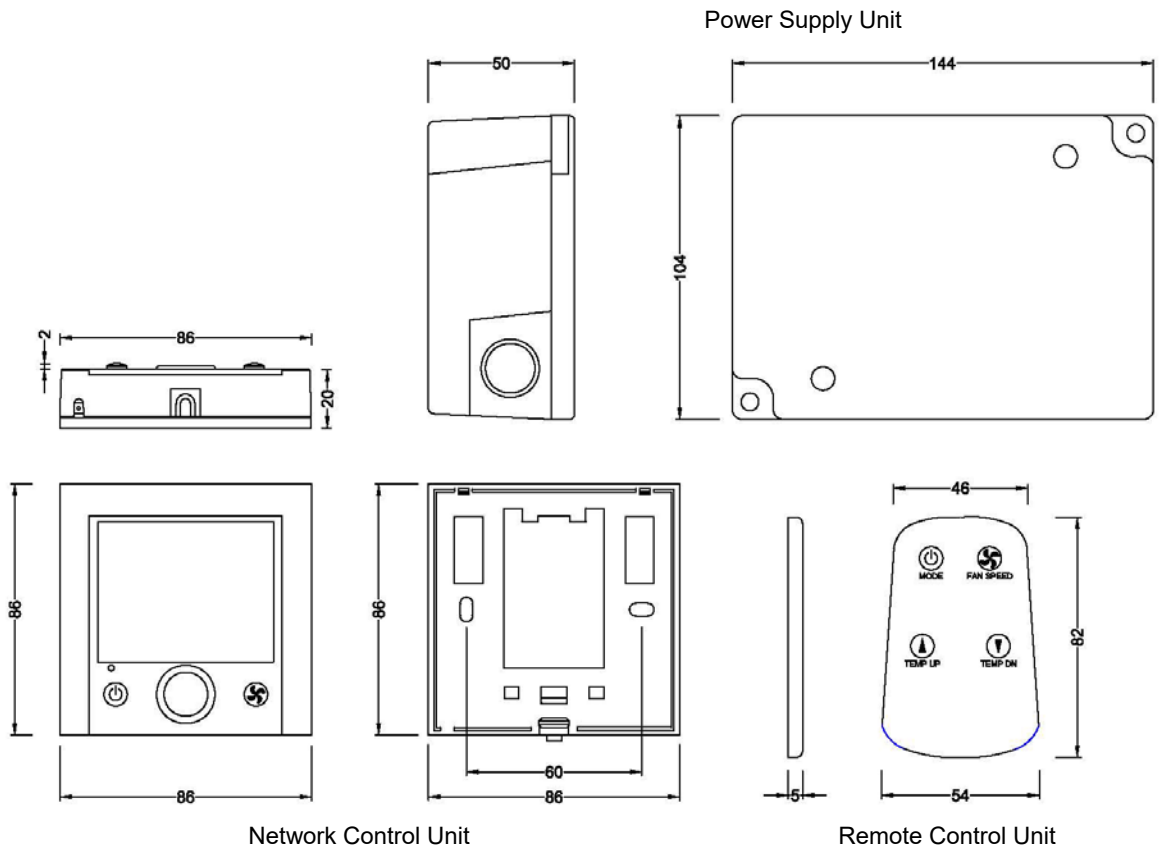
Power Supply Unit Model Number Selection Guide				
PSU5	0	1	F	M
Product Type	Power Supply	Number of Outputs	Control Type	Seasonal Changeover
PSU5 = Power Supply Unit for NT500 Series	0 = 100-230 VAC	1 = Single valve control output 2 = Dual valve control outputs	Nil = 2-wire on/off F = 3-wire floating A = 0(2)-10 VDC AH = 0(2)-10 VDC + on-off	Nil = Auto by external sensor M = Manual

Network Control Unit Model Number Selection Guide					
NCU5	1	A	M	-	R
Product Type	Number of Outputs	Control Type	Seasonal Changeover	Separator	Options
NCU5 = Network Control Unit for NT500 Series	1 = Single valve control output 2 = Dual valve control outputs	Nil = 2-wire on-off F = 3-wire floating A = 0(2)-10 VDC AH = 0(2)-10 VDC + on-off	Nil = Auto by external sensor M = Manual		Nil = No option R = with IR receiver for RCU-1 B = without buzzer for key touch sounding W = with white color faceplate

Figure 2: NT500 Series Application Guide

Model Number	Outputs	Applications	Cooling/Heating Mode	External Seasonal Changeover	System Modes	Fan Control	Unoccupied Mode
NT501	Single 2-Wire On-Off	Cooling Only or Heating Only (2-Pipe System)	Auto Only	Yes	Cool or Heat-Fan Only-Off	Manual-Auto	Yes
NT501M	Single 2-Wire On-Off	Cooling or Heating (2-Pipe System)	Manual Only	No	Cool or Heat-Fan Only-Off	Manual-Auto	Yes
NT501F	Single 3-Wire Floating	Cooling Only or Heating Only (2-Pipe System)	Auto Only	Yes	Cool or Heat-Fan Only-Off	Manual-Auto	Yes
NT501FM	Single 3-Wire Floating	Cooling or Heating (2-Pipe System)	Manual Only	No	Cool or Heat-Fan Only-Off	Manual-Auto	Yes
NT502	Dual 2-Wire On-Off	Cooling and Heating (4-Pipe System)	Manual or Auto	No	Cool-Heat-Auto-Fan Only-Off or Auto-Off	Manual-Auto	Yes
NT501A	Single 0-10 VDC	Cooling Only or Heating Only (2-Pipe System)	Auto Only	Yes	Cool or Heat-Fan Only-Off	Manual-Auto	Yes
NT501AM	Single 0-10 VDC	Cooling or Heating (2-Pipe System)	Manual Only	No	Cool or Heat-Fan Only-Off	Manual-Auto	Yes
NT502AH	Dual 0-10 VDC + 2-Wire On-Off	Cooling and Heating	Manual or Auto	No	Cool-Heat-Auto-Fan Only-Off or Auto-Off	Manual-Auto	Yes

Figure 3: Dimensions in mm



Product Specifications

Product model numbers	See Figure 1: NT500 Series Model Number Selection Guide
Power supply	100-230 V, $\pm 10\%$, 50/60 Hz
Power at Network Control Unit	12 VA, 12 VDC $\pm 10\%$
0(2)-10 VDC output impedance	Minimum 10,000 Ω
Operating temperature differential for 2-wire on-off models	Fixed at 1 K (1 R) for both cooling and heating modes
Temperature display range	5-35°C in 0.5 K increments: accuracy ± 1 K (41-95°F in 0.5 R increments, accuracy ± 1 R)
Temperature set point range	5-35°C in 0.5 K increments (41-95°F in 0.5 R increments), initial factory setting at 22°C
Temperature set point limits	Field adjustable 5-35°C (41-95°F) in 0.5 K increments
Fan speed output set point range	0-100% in 5% increments
Fan speed output set point limits	Field adjustable 0-100% in 5% increments
Fan speed zone indication icons	Single bar = 0-40% "Low" speed zone Double bars = 41-70% "Medium" speed zone Triple bars = 71-100% "High" speed zone
Constant display on LCD	Choice of ambient temperature or temperature set point value
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	Choice of 1, 2, 3, 4 or 5 K between cooling mode and heating mode, factory setting 3 K
Valve stroke time for 3-Wire floating models	Accumulatively 10 to 240 s maximum in one direction in steps of 10 s Factory setting 180 s
Proportional band for PI control	Valve outputs: Adjustable 1 to 5 K (1-5 R) in 1 K (1 R) increments, factory setting 3 K (3 R) Fan output: Adjustable 1 to 5 K (1-5 R) in 1 K (1 R) increments, factory setting 3 K (3 R)
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 mode	Temperature dependent according to proportional band setting.
Sensing element	NTC thermistor, 10 k Ω @ 25°C, accuracy ± 0.5 K @ 25°C
Unoccupied mode binary Input	From external voltage-free contact.
Unoccupied temperature set Point range	Choice of activation of unoccupied mode: in operating mode only or in both standby and operating modes Adjustable 5-35°C (41-95°F) in 1 K (1 R) increments separately for cooling and heating; Factory settings: 16°C (61°F) for heating and 26°C (79°F) for cooling
Binary inputs	3 binary inputs for external voltage-free contacts
Binary outputs	For direct Connection of valve actuators (100-230 VAC) 1 relay for 2-pipe models 2 relays for 4-pipe models
Auxiliary binary outputs	For connection to relay coils with 30 VDC@50mA external power: 2 photo-coupler triads
Analog outputs	For connection to variable speed fan and control valves: 0-(2)10 VDC
RS-485 communication speed	Selectable baud rate at 9600, 19200, 38400 or 76,800 bps (factory set at 38,400 bps)
Maximum number of BACnet device instance ID	9999 thermostat addresses: from 0001 to 9999 via parameter setup menu, factory setting "0123"
BACnet MS/TP network guidelines	Maximum 32 devices and maximum 1,000 m cable length per segment; maximum two segments per network trunk with one repeater; maximum 64 devices per network trunk; only one segment allowed at 76,800 bps baud rate
Enclosure	Material: Self-extinguishing, molded ABS Finish: Off white housing and dark grey faceplate
Protective class	IP30 (EN 60529)
Electrical ratings	Valve output 100-230 V, 5 A resistive, 2 A inductive, 50/60 Hz Total rating 100-230 V, 5 A maximum, 50/60 Hz
Ambient/storage temperature limits	0 to 55°C / -30 to 50°C, 10 to 90% RH non-condensing
Connectors	Non-removable terminal blocks and removable wire plugs
Power wires	Wire size 1 mm ² or 18 AWG solid copper recommended
PSU/NCU inter-connecting wires	Cat 5e twisted 6-conductor cable (shielded or unshielded)
Sensor wires	22 AWG twisted shielded pair double-insulated cable
RS-485 communication wires	22 AWG twisted shielded pair double-insulated cable
Input/output wires	Cat 5e twisted conductor cable (shielded or unshielded) recommended
Accessories and options	See Figure 6: Optional Accessories
Agency approval	CE Mark compliant to EMC and Low Voltage Directives, BTL Listing pending
Shipping weight	Network control unit & power supply unit together: 0.62 to 0.78 kg (1.4 to 1.7 lb)
Dimensions	See Figure 3: 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.

Thermostat Errors Reporting

When the following errors are reported on the LCD 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
- E-4 User configuration checksum error

* 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, E-3 or E-4 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.

Trouble-Shooting

Before trouble-shooting starts, ensure that the voltage output from Terminals 1 (GND) and 2 (+12 Vdc) on the power supply unit is between 12 Vdc and 15 Vdc and not higher. Higher voltage may damage the internal circuitry and components of the network control unit.

When abnormal power voltages are found, return the thermostat to the manufacturer for repair.

When there is no 12 Vdc power output, check the line voltage power and its 5 A fuse.

Figure 4: Network Control Unit and LCD Layout

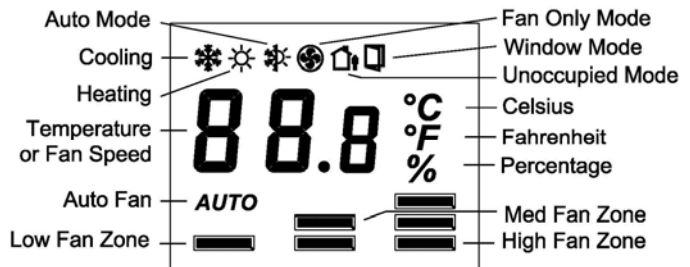
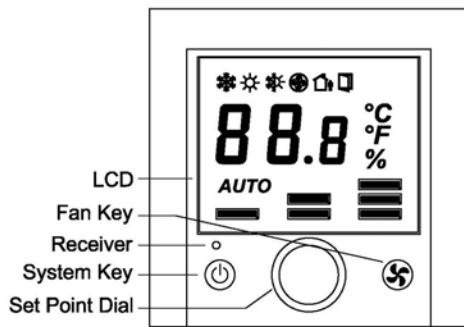


Figure 5: NCU Mounting Details

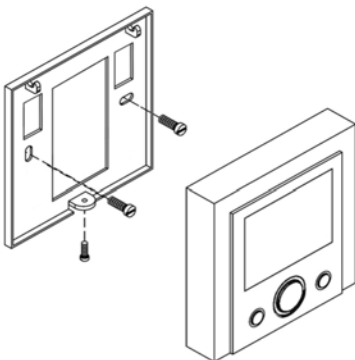


Figure 6: Optional Accessories

Description	Part Number
Remote control unit	RCU-1
Probe temperature sensor	TE10-1
Duct temperature sensor	TE10-2
With infra-red receiver capability	NT5xxx- <u>R</u>
Without buzzer capability	NT5xxx- <u>B</u>
With white color faceplate	NT5xxx- <u>W</u>

Mounting of Network Control Unit

The NT500 Series network control unit can be flush mounted or secured to a standard European 75 x 75 x 35 mm electrical box. See Fig. 5: NCU Mounting Details. Two M3.5 mounting screws for Network Control Units only are included.

Figure 7: NT800 Series Networking Room Thermostat Wiring Diagram

The networking thermostats consist of two basic units: the Network Control Unit and the Power Supply Unit. While all line-voltage wiring is terminated at the Power Supply Unit, all connections between Network Control Unit and Power Supply Unit are of low-voltage signaling wires.

Wiring and Application Notes

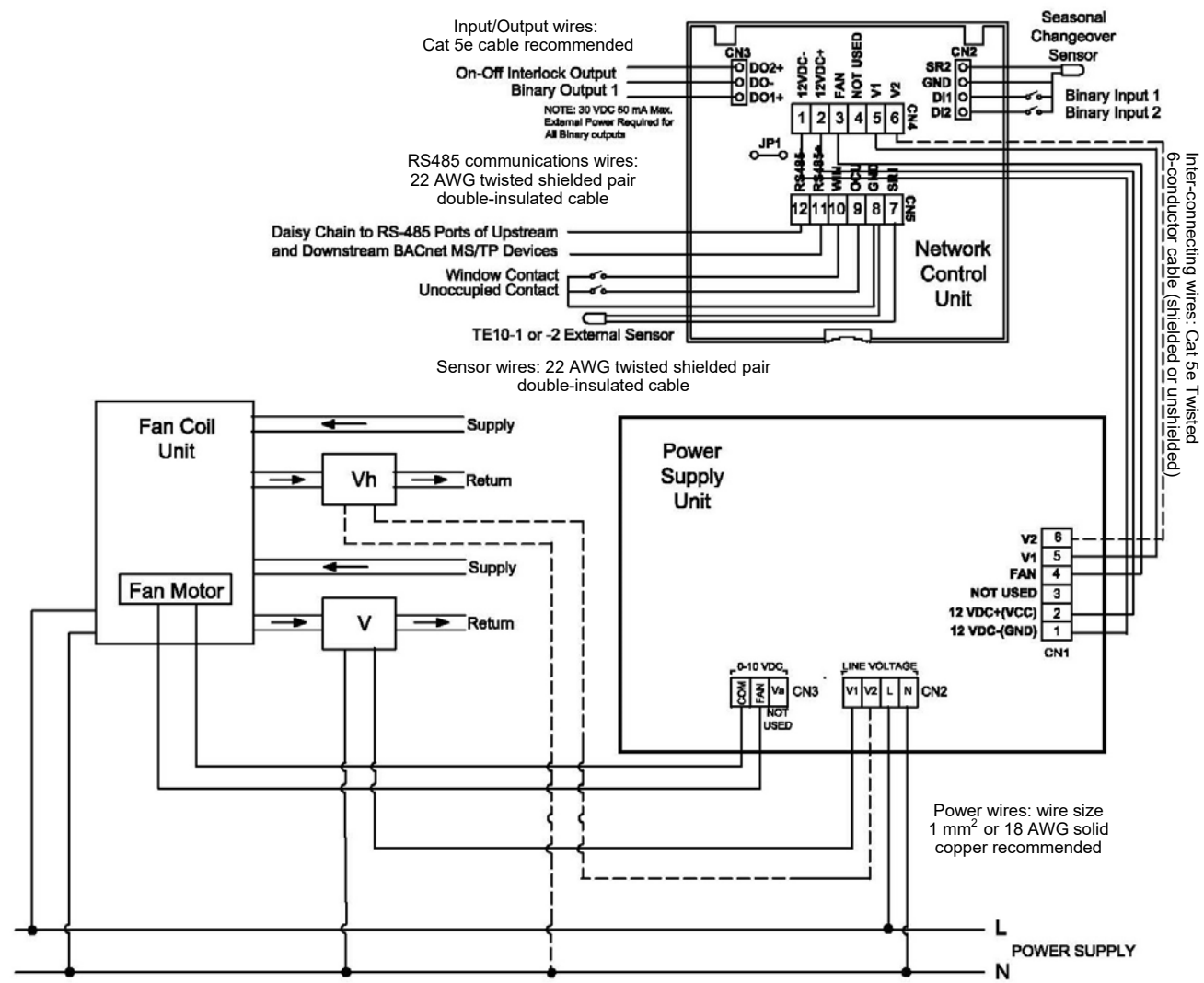
- Cut jumper JP1 if external sensor is wired to SR1 and GND. Run the wiring away from any electrical motors or power wiring. Failure to do so may result in poor thermostat performance due to electrical noise.
- 22 AWG twisted shielded pair double-insulated cable is recommended as remote sensor wiring and its length must not exceed 25 m.
- Do not bundle and run power wiring and remote sensor wiring in the same conduit.

- Connecting wires between Network Control Unit and Power Supply Unit must not exceed 15 m.
- Seasonal changeover sensor or switch is only applicable to heat only or cool only 2-pipe model only.
- 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 °C, the thermostat enters into heating mode.
- Unoccupied contact closure activates energy saving mode.
- Window contact closure locks out all thermostat functions.
- The thermostat outputs are designed for controlling zone valves. If used for controlling electric heaters, external contactors must be used.

Wiring Diagram for 0(2)-10 VDC Fan-Speed Output and Line-Voltage 2-Wire On-Off Valve Outputs

WARNING
 Incorrect wiring connection may cause permanent equipment damages to the thermostat.

- Piping Notes:**
1. For a single-output unit, V can be a 2-wire cooling or heating valve.
 2. For a dual-output unit, V must be a 2-wire cooling valve and Vh a 2-wire heating valve.
 3. Hidden-line wiring is applicable to dual-output units only.

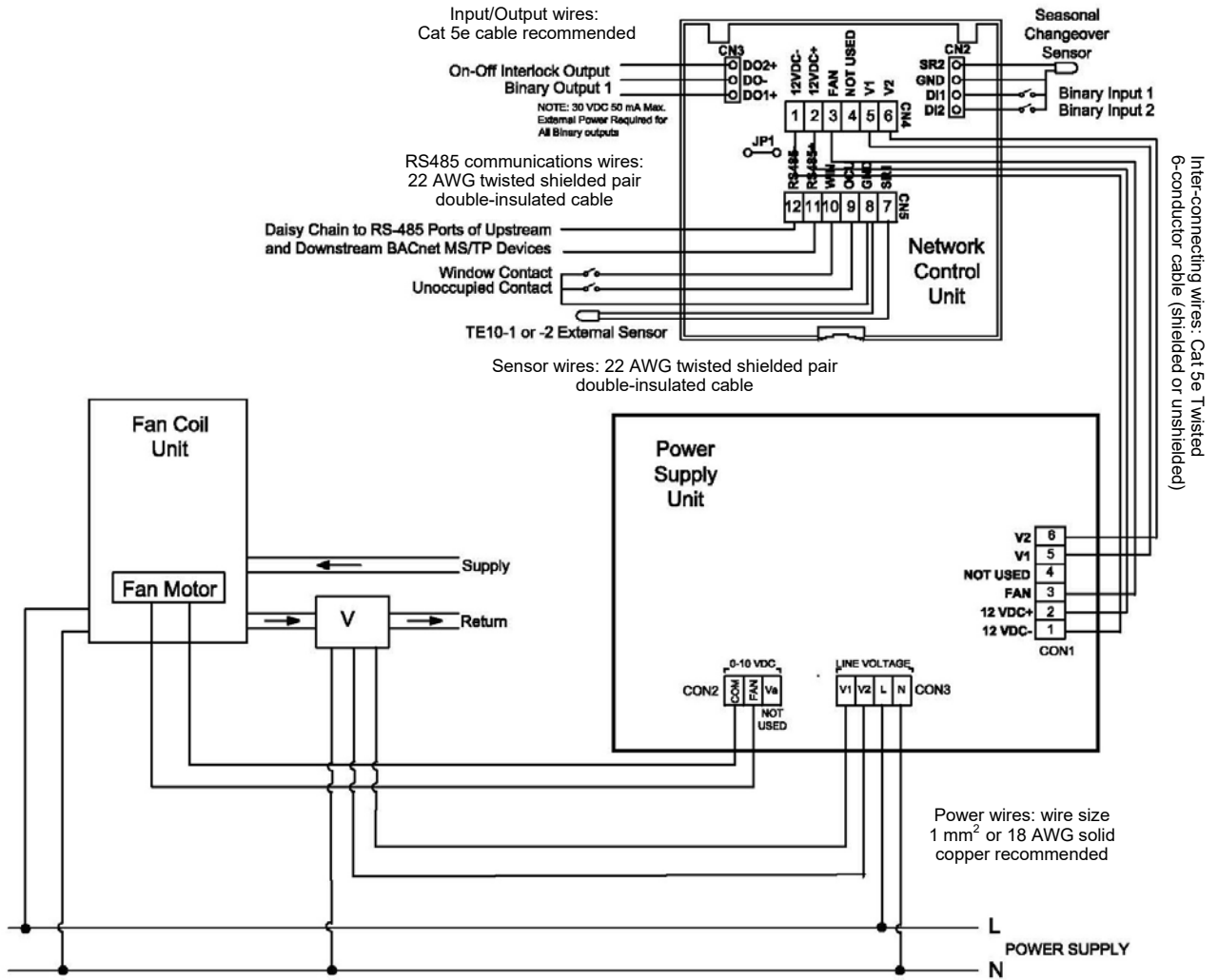


Wiring Diagram for 0-(2)10 VDC Fan-Speed Output and Single Line-Voltage 3-Wire Floating Valve Output

WARNING
 Incorrect wiring connection may cause permanent equipment damages to the thermostat.

Piping Notes:

1. V must be a line-voltage 3-wire floating valve.
2. In cooling mode, V1 output opens valve on temperature rise and V2 output closes valve on temperature drop. The action in heating mode is reversed.



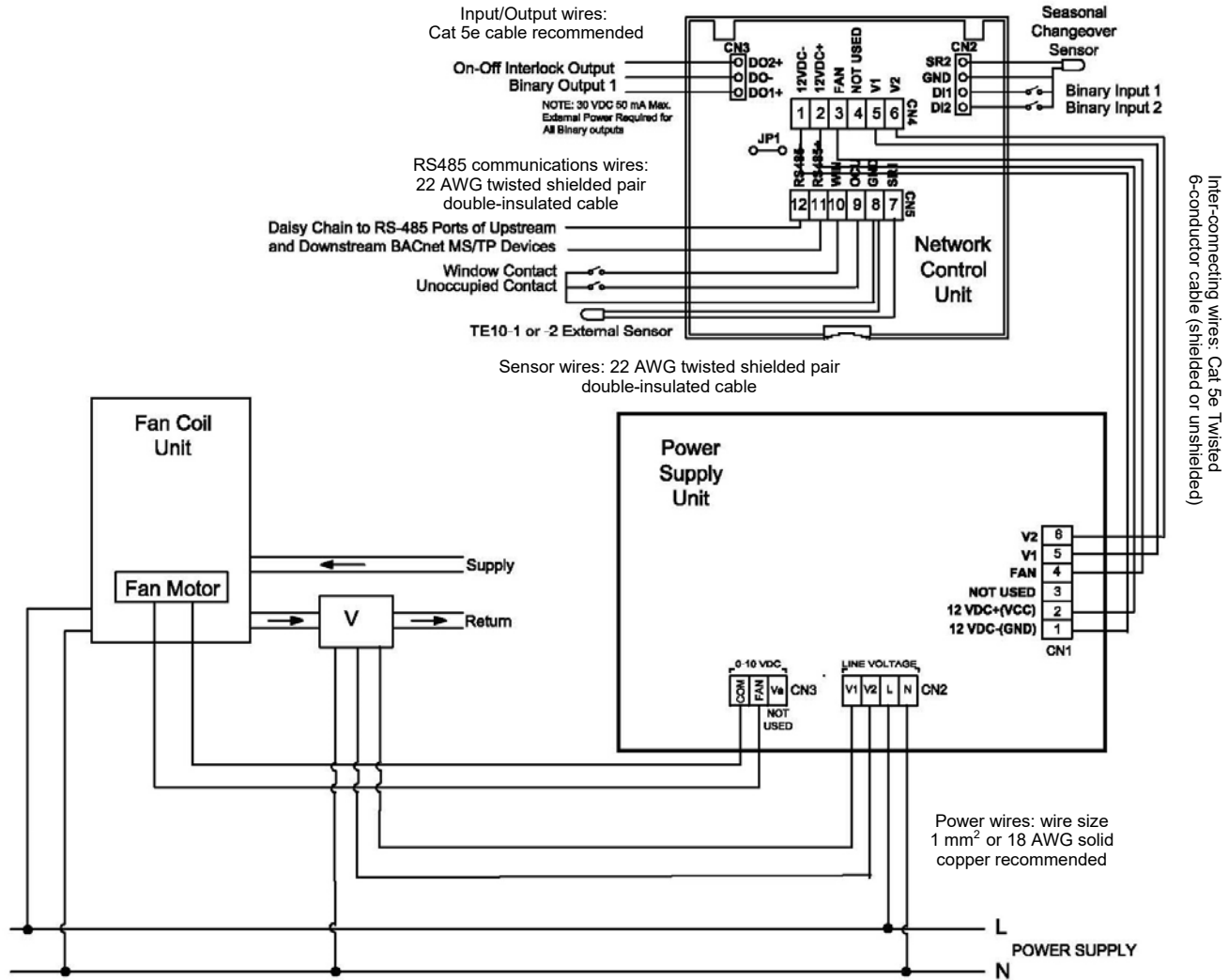
Wiring Diagram for 0(2)-10 VDC Fan-Speed Output and Single 0(2)-10 VDC Valve Output

WARNING

Incorrect wiring connection may cause permanent equipment damages to the thermostat.

Piping Notes:

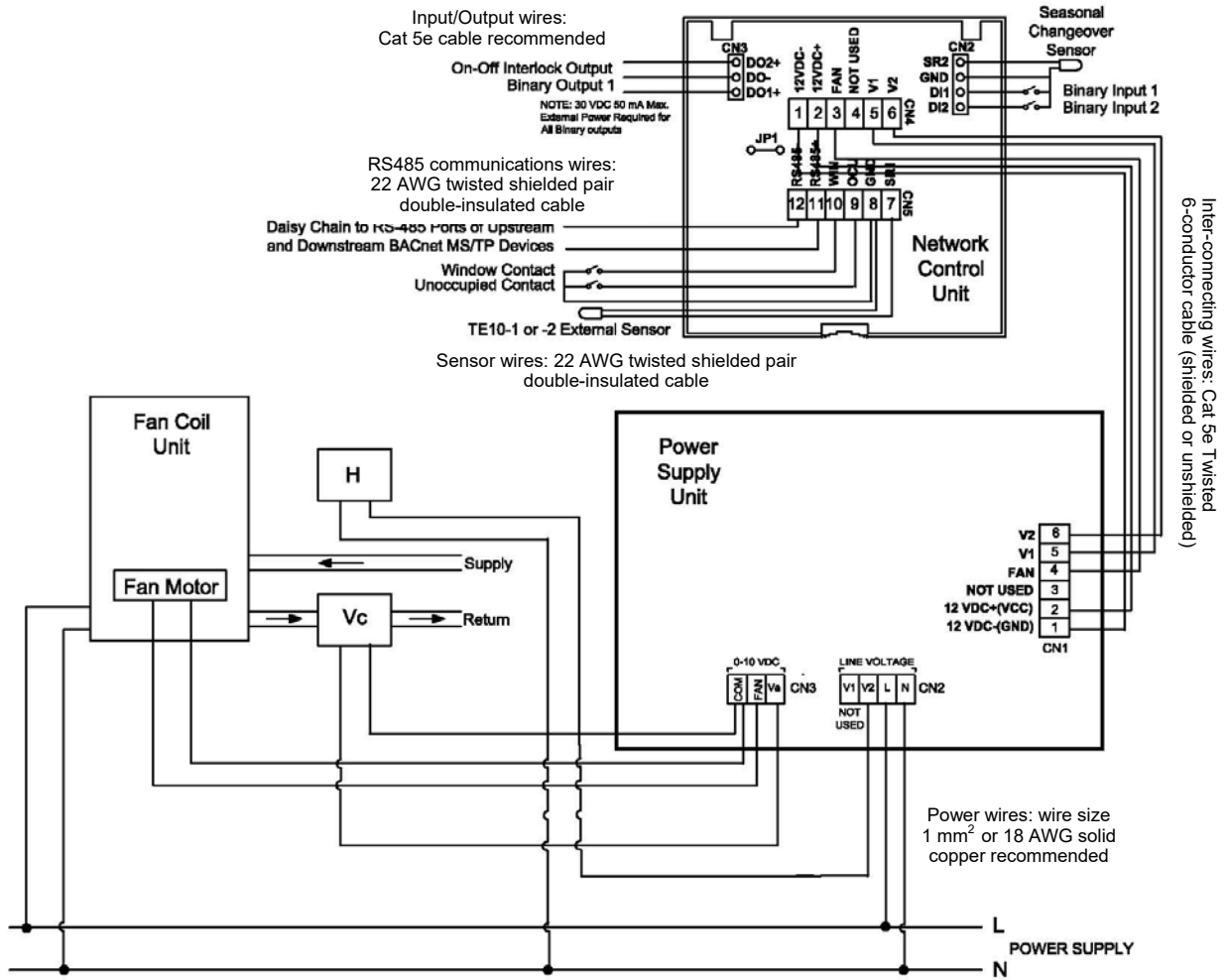
V can be a cooling or heating valve.



Wiring Diagram for 0(2)-10 VDC Fan-Speed Output, 0(2)-10 VDC Cooling Valve Output and Line-Voltage 2-Wire On-Off Heating Output

WARNING
 Incorrect wiring connection may cause permanent equipment damages to the thermostat.

- Piping Notes:**
1. Vc must be a 0-10 VDC cooling valve.
 2. H must be an electric contactor and its coil connected to line-voltage terminals V2 and N.



Network & Cabling Requirements

To ensure network stability and reliable communications, particularly at high speeds on a BACnet MS/TP network with a number of devices, it is imperative that the following network and cabling requirements are adhered to:

Item	Description
Cabling	It is recommended to use networking cabling that matches the following specifications: <ul style="list-style-type: none"> 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 MS/TP network cable is installed as a daisy chain from one device to the next.
Maximum Nodes	The maximum number of devices is 32 per MS/TP network segment and 64 per network trunk with one repeater.
Terminator	A terminator of 120-ohm impedance must be installed at each end of each MS/TP network segment, or two per MS/TP network. Ensure that this requirement is not overlooked in laying out the network architecture and 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 more than 32 nodes will be installed on a network or the MS/TP network is extended beyond 1,000 m.

Operation Notes

User Operating Mode

- LCD shows ambient temperature constantly except when temperature set point adjustment is being made or when the fan key is momentarily pressed.
- Press the system key to enter into the desired operating mode: Cool-Heat-Auto-Fan Only-Off, etc.
- Increase or decrease temperature set point in 0.5 K increments by rotating the adjustment dial clockwise or counter-clockwise. When the dial is rotated, the LCD shows the existing temperature set point value.
- Press the fan key to enter into the current fan mode. When it is in "Manual" fan mode, the LCD displays the existing fan speed set point % value. This set point value can be increased or decreased in 5% increments by rotating the dial clockwise or counter-clockwise. When it is in "Auto" fan mode which is indicated by the "Auto" logo, the LCD shows the fan speed control output in % value.
- Press the fan key again to change the fan speed mode.
- The fan running status is indicated by the "Low", "Med" or "Hi" fan speed zone icon.
- When there is no fan key operation in 10 seconds, the display reverts to ambient temperature indication.
- When the unoccupied contact closes, it overrides the operating mode and operate the thermostat in energy saving mode despite the thermostat being in operating or standby mode.
- In unoccupied mode, the factory-set temperature cut-in points are 26°C for cooling and 16°C for heating. Meanwhile, the operation of all operating keys is locked out until the unoccupied contact opens.
- During unoccupied mode, the fan always runs in "Auto" fan mode.
- Unoccupied mode can be activated in the following manner when the unoccupied contact closes:
 - For single output models with auto seasonal changeover, 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 single output models with manual seasonal changeover, the unoccupied cooling or heating status is determined by the last status of the occupied mode and the valve output is controlled according to the measured temperature.
 - For dual outputs models, 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 Window contact closes, it overrides the operating mode and operate the thermostat in off mode despite the thermostat being in operating or standby mode. Meanwhile, all operating keys are locked out until the window contact opens.

Parameter Setup Mode

- The thermostat allows authorized service agent to change a number of operating parameters in the field. For details, refer to the parameter setup manual.

Error Reporting

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

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