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**PDRC**  
**PRICE DIGITAL ROOFTOP CONTROLLER**  
**ENGINEERING GUIDE**

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## Introduction

The Price Digital Rooftop Control (PDRC) System is a reliable and technologically advanced system that provides occupant comfort and energy savings throughout an entire facility.

### SYSTEM OVERVIEW

- Can interface with virtually any packaged rooftop unit including Carrier, Lennox and Trane
- Up to 50 zones per Rooftop Controller
- Up to 10 zoned Rooftops per System
- Expandable Input/output modules allow a flexible and modular system
- Uses the ASHRAE standard BACnet for 2way communication between the Rooftop Controller and PEDC zone controllers
- Three system packages available with options for graphical interface and Ethernet connection

### VAV (Pressure Independent) Zone Control

The new Price Digital Rooftop Controller (PDRC) is designed to communicate with the Price Electronic Digital Controller (PEDC) to provide the customer with a complete system package with pressure independent VAV control of each zone. The benefits of a VAV pressure independent system are tighter room temperature control through the precise control of airflow to each zone. This will also produce energy savings since airflows will be controlled to exactly the amount required, and there will be no overshooting.

## Capabilities & Benefits

Name	Package A Basic	Package B Advanced	Package C Premium
Number of Zones per controller	50	25	50
Schedules per day	8	8	8
Rooftop Units per system	10	10	10
Holiday Scheduling *	Yes	Yes	Yes
Standard Graphics Interface *	No	Yes	Yes
Custom Graphics Interface *	No	Yes	Yes
Occupancy Control *	Yes	Yes	Yes
Heating/Cooling Lockout *	Yes	Yes	Yes
Remote Access *	No	No	Yes
EH Price Troubleshooting * (via internet)	No	No	Yes
Alarming Reporting *	No	Yes	Yes
Trend Logging *	No	Yes	Yes
Universal Inputs (0-5V,0-10V, 10K, 4-20mA)	6 (expandable)	6 (expandable)	6 (expandable)
Outputs (24 VAC @ 0.5 amps)	6 (expandable)	6 (expandable)	6 (expandable)
Duct Pressure Control *	Yes	Yes	Yes
Filter Status *	Yes	Yes	Yes
Economizer Control *	Yes	Yes	Yes
Fan Status *	Yes	Yes	Yes
Supply Air Temp. Sensing *	Yes	Yes	Yes
Outside Air Temp. Sensing *	Yes	Yes	Yes
Humidity Control *	Yes	Yes	Yes
Indoor Air Quality Sensing *	Yes	Yes	Yes
Coil Freeze Status *	Yes	Yes	Yes

\* Feature is optional

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## **Energy Saving Features**

### **1. Scheduling / Calendaring**

- Scheduling allows the system to shut down during times when cooling or heating are not required.
- Internal Calendars allow for automatic holiday scheduling, year by year (Package B and Package C only.)
- Clocks have back-up batteries with 5 years of life to protect against power outages.
- Schedules are used to save money due to reduced energy costs.

### **2. Network Occupancy Control**

- Thermostats have multiple occupancy control options including:
  - Scheduled occupancy control. (at PDRC)
  - Rooftop PDRC schedule override.
  - Zone occupancy override through the PEDC.

### **3. Economizer Operations (Typically supplied by rooftop manufacturer)**

- Using the outside air temperature sensor the rooftop will determine the percentage of outside air to use.
- This will optimize cooling by using outside air for cooling when temperatures are within the cooling air temperature range, thus saving money on cooling re-circulated air.
- When supplied by manufacturer, the cooling signal from PDRC is intercepted and used to engage the Economizer module.

### **4. Optimized Staging (Proportional integral control)**

- Suspends second stage cooling or heating when the first stage continues to meet space temperature requirements.
- Eliminates Offset Error.

### **5. Equipment Safety Timers**

- Programs a minimum off and minimum on time for the compressor to ensure that it does not cycle on and off too rapidly thus damaging the compressor.

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## **Control Strategy Features**

### **1. System Demand Polling**

- Determines the number of zones which require cooling / heating and uses that information to determine the system mode selected.
- Ex. If 8 zones are in cooling and 4 are in heating then the system is in cooling (majority rules)
- Any rules can be developed to meet unique situations.
- Standard polling options and explanations are provided in a further section.

### **2. System Heat/Cool Cycling**

- Cycle from cooling to heating when the system has been in cooling for a predetermined time and a certain number of zones still require heating.
- Ensure that zones which require heating or cooling receive it regardless of whether or not they are the majority.
- Can be used in conjunction with the polling control method.

### **3. IAQ (Indoor Air Quality)**

- IAQ sensor is used to continuously monitor system or space air quality.
- Alarms can be generated which will cause an override on the rooftop bringing in fresh air.
- This can be used in conjunction with the polling control method.

### **4. Remote Room Sensor Averaging**

- Improves total comfort of conditioned spaces by using an average of remote room sensors for large zones with hot or cold spots (i.e. Large training rooms).
- Provides a more accurate measurement of system demand for heating or cooling.
- Can be used in conjunction with the polling control method.

### **5. Zone Reheat (Duct Heater Stations, Perimeter Reheat , etc.)**

- Provides additional zone heat independent of the central HVAC system. Optional with PEDC controller.

### **6. Optimal Start or Morning Warm-Up**

- Brings the space temperature to within the occupied set points before occupants enter the space.

### **7. Supply Temperature Limit Protection**

- Shuts the HVAC unit down if supply air temperature cannot be maintained within a configurable unit-specific range (i.e. Heating temperatures exceed maximum recommended supply air temperature, so you shut the unit off).

### **8. Room Temperature Limit Protection**

- Ensures that pre-set room temperature range is never exceeded by overriding the polling strategy and providing the necessary conditioned air.
- This would be an effective way to ensure that every room will eventually get the air that it requires.

### **9. Pressure Control Bypass**

- When system design pressures are met, supply air is bypassed back to the main rooftop unit.

### **10. System Wide Set Point**

- All zones are set to a common temperature set point (i.e. 72°F)
- Set point cannot be changed at zone, it is locked as a system default.

## Primary Control Strategy Applications

### Polling Control Strategies

These are the **Primary Control Strategies** determining the mode (cooling, heating, or neutral) that the rooftop unit will be in by communicating with all the zone controllers. By polling the controllers to see which are in **cooling** mode, and which are in **heating** mode and which are neutral, the rooftop controller will then make its decision as to what temperature air it should supply and what mode it should be in.

#### 1. Average Polling

The average polling method uses the percentage of cooling, heating, or neutral the zone controller is in and sums all of the controllers then takes an average to determine how it should operate. See the following example:

##### Ex. 1

A rooftop unit is linked to 5 zone controllers and has a average polling controller strategy. The zone controllers are in the following states

Name	Room Temp. °C	Room Set Point °C	Percentage Cooling	Percentage Neutral	Percentage Heating
Office 1	25	23	100%	0	0
Board Room 1	24	23	50%	0	0
Office 2	23	23	0	100%	0
Presidents Office	22	23	0	0	50%
Lab Room	22	23	0	0	50%
<b>Total Percentage</b>			150%	100%	100%
<b>Average Percentage</b>			<b>42.86%</b>	28.57%	28.57%

For averaging, the controller will sum up the total percentage of boxes in cooling which would be 150% then divides it by the total number demanded of all the boxes at that given time. In this case the total demand is  $150\% + 100\% + 100\% = 350\%$ , so  $150\% / 350\% = 42.86\%$ .

The heating percentage would be  $50\% + 50\% = 100\%$  divided by  $350\% = 28.57\%$ .

The box in neutral is a 100% because it is completely satisfied and does not want either heating or cooling. These boxes are extremely important and cannot be ignored, consider for a moment if a building with 50 zones had 49 zones that were neutral and 1 that needed cooling. 98% of the building would be satisfied already, but if you didn't consider the neutral zones, then the rooftop would engage cooling for that single zone.

So since the total percentage of cooling is higher than the heating or neutral mode the rooftop unit will be in cooling mode.

#### Cost Savings – High

- Rooftop will not engage cooling or heating until the majority of demand is either the cooling, heating, or neutral.

#### Comfort Control – High

- Since the controller uses averages the true measure of how much cooling and how much heating is required is taken into consideration when making a decision. However it is still possible to have 99% of the zones requiring 1% heating and 1 zone requiring 100% cooling in which case the rooftop would be in cooling mode (An unlikely situation).

## 2. Weighted Average Polling

This method is similar to average polling except certain zones can have more influence on the outcome of the poll. This is optimal when there are certain zones that require greater comfort control, like a board room or the president's office.

### Ex.2

A rooftop unit is linked to 5 zone controllers and has a weighted polling controller strategy. The zone controllers are in the following states and one of them is the company meeting room. It has a weight of 4 because it is likely that there will be more people in that room than in nearby offices.

Name	Room Temp. °C	Room Set Point °C	Percentage Cooling	Percentage Neutral	Percentage Heating	Weight
Office 1	25	23	100%	0	0	1
Board Room 1	24	23	50%	0	0	1
Office 2	23	23	0	100%	0	1
Meeting Room	22	23	0	0	50%	4
Lab Room	22	23	0	0	50%	1
<b>Total Weighted Percentage</b>			150%	100%	250%	
<b>Weighted Average Percentage</b>			30%	20%	<b>50%</b>	

With this control strategy the demand has increased to 500% so the percentage cooling will be 150%/500% = 30% cooling.

The heating percentage is calculated in a different manner. For the Meeting Room the weight is 4 so the percentage heating from that room is 4 x 50% = 200%. That plus 50% from the lab gives 250%. This number divided by 500% is 50%.

Since office 2 is satisfied it is in neutral mode at 100%, divided by 500% total demand equaling 20% neutral.

Since there is a large percentage of heating required the Rooftop unit will be in heating mode.

### Cost Savings – Moderate

- Rooftop could engage cooling or heating entirely depending on the weight given to the priority zones.

### Comfort Control – High for Priority Zones – Low for all other zones

- It is great for the priority zones but poor for all other zones again depending on the weight. Ideal when certain zones cannot fall out of range or if a large percentage of occupants are in one zone.

## 3. Non-Majority Polling – Averaging, Weighted Averaging Methods

In non majority polling the amount of votes required to change from one mode to the other does not necessarily need to be 50% or more. This method is advantageous when outside temperatures are usually extreme, like in the winter time, a customer might want the unit to be in heating if even one zone calls for heat.

### Ex.3

If a non majority method is used for cooling, any arbitrary number say 20% for this example can be used to be the switching point which would mean that the system would only need 20% of the votes to be in cooling and 80% or more to be in heating or neutral. As previously stated, any percentage can be used as the switching point and this would apply to all methods of polling.

### Cost Savings – Variable

- This method can be used to delay cooling or heating modes by increasing the percentage of zones which are required to be in that mode respectively, from 50% to say 80%. However it can increase cost if the percentage is lower than 50%.

### Comfort Control – Variable

- Depending on the percentage chosen a large number of zones can go without cooling or heating when they require it, or a large number of zones will get cooling or heating when it is not required.

## Secondary Control Strategy Applications

All secondary control strategies can be used in unison with the primary strategies or in some cases entirely on their own as the primary strategies.

### 1. System Heat/Cool Cycling

This secondary strategy will cycle from one mode to another after the system has been operating in one mode for a predetermined period of time. This strategy greatly increases room comfort on the whole; by ensuring that the zone remaining in the minority of the polling strategy will still receive their heating or cooling.

#### Ex.4

For a system with 25 zones if 20 are in cooling and 5 are in heating the rooftop will be in cooling and with no System Heat/Cool Cycling those five units will never get the heating they require and will indefinitely remain in cooling mode. The Cycling will switch the rooftop to heating after a predetermined time period causing the other zone dampers to go to their minimum flow position since they will not require heat. This allows those five zones a chance to meet set point, at which time the system will cycle back.

### 2. IAQ (Indoor Air Quality)

The IAQ method is simply used to ensure high air quality with respect to the amount of fresh air being taken in by the rooftop unit. The indoor air quality sensor is used to measure CO2 levels in the conditioned space, when they are too high the sensor signal will act as an override and the fresh air intake on the rooftop unit is opened in an effort to improve the conditions.

### 3. Remote Room Sensor Averaging

This strategy improves the accuracy of a room temperature measurement for a large zone by taking an average value for a group of remote room sensors and using that value as the vote for a polling method.

#### Ex.5

A system has 5 small sized zones and 1 large zone that is 4 times larger than the rest. Since the zone is so large 4 remote room temperature sensors are used. The zones are in the following conditions and an average polling method is used:

Name	Room Temp. °C	Room Set Point °C	% Cooling	% Neutral	% Heating	Average Cooling	Average Neutral	Average Heating
Office 1	25	23	100%	0	0	100%	0	0
Board Room 1	24	23	50%	0	0	50%	0	0
Office 2	24	23	50%	0	0	50%	0	0
Presidents Office	22	23	0	0	50%	0	0	50%
Office 3	22	23	0	0	50%	0	0	50%
<b>Lab Room (sensor 1) 4x Larger</b>	25	23	100%	0	0	<b>(100 + 100 + 50 + 0) / 4 = 62.5%</b>	<b>100% / 4 = 25%</b>	<b>0</b>
<b>Sensor 2</b>	23	23	0	100%	0			
<b>Sensor 3</b>	25	23	100%	0	0			
<b>Sensor 4</b>	24	23	50%	0	0			
<b>Total Percentage</b>						<b>262.5%</b>	<b>25%</b>	<b>100%</b>
<b>Average Percentage</b>						<b>262.5/387.5 = 67.7%</b>	<b>25/387.5 = 6.45%</b>	<b>100/387.5 = 25.8%</b>

So the total demand is 262.5% + 25% + 100% = **387.5%**. We use this value to determine the average demand percentages for cooling, heating, and neutral modes.

Here we can see that the rooftop unit will be in cooling mode since the cooling demand represents 67.7% of the total demand.

### 4. Room Temperature Limit Protection

Ensure that the pre-set room temperature range is never exceeded by overriding the polling strategy and providing the necessary supply air. This is a good safety feature to have; it can insure that temperatures do not become too low or too high in a zone if it is in the minority

#### Ex.7

If a system has 10 zones and 7 are in cooling but 1 of the 3 boxes in heating drops below the temperature range of say 17 °C to 28°C (63°F – 82.4°F), the rooftop is overridden and will change to heating until the problem zone is safely back within the recommended range.

## Price Digital Rooftop Controller (PDRC) Features

### The PDRC shall provide

- Backlit easy to read LCD display
- 16 push buttons for controlling functions and accessing menus
- Occupancy control and schedule override
- Microprocessor control of all inputs and outputs
- Two-way communication with each PEDC zone controller using BACnet strategies communication protocol
- Pre-tested strategy to intelligently control Rooftop Unit based on zone loads
- Strategy and setup variables will be stored in non-volatile RAM
- Built in software timer to prevent fast cycling of outputs (safeties)
- Battery backed time of day with Scheduling
- Daylight Savings Time switchover
- Password protected menus to prevent certain users from accessing restricted functions

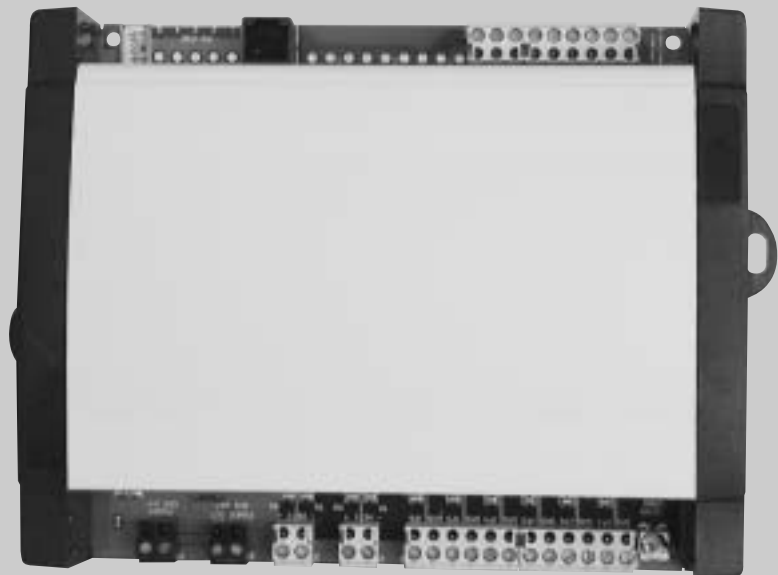
**PDRC System Controller**



### The I/O module shall provide

- Microprocessor control of all inputs and outputs
- Universal inputs that accept 0-5V, 0-10VDC, 10k Thermistor, and 4-20mA signals
- 24 VAC switched outputs at 0.5 amps each
- I/O module will communicate with PDRC via BACnet communication
- I/O modules can be added to network to allow extra inputs and outputs as needed
- Programmable safeties to prevent outputs from cycling too fast

**I/O Module**



## Price Digital Rooftop Controller (PDRC) Features

**The PEDC zone controller shall provide:**

- VAV damper controller with high accuracy, low drift air flow sensor
- Controller capable of controlling 3 stages of heat, hot water valves or analog reheat depending on control sequence selected
- Controls capable of controlling heating – cooling changeover, night setback, morning-warm up, and various other sequences
- LCD thermostat with 2-way BACnet communication to main Rooftop Controller
- Occupancy override, setpoint adjustment, and service mode with balancing and airflow adjustment modes

**Zone Controllers (PEDC - Price Electronic Digital Controls)**



**The BYPASS Damper shall provide:**

- VAV damper controller, static pressure transducer and low leakage damper assembly
- Ability to field adjust required static pressure
- A static pressure tube installed in the supply air duct 2/3 down the longest run

**Bypass Damper**



## Price Digital Rooftop Controller (PDRC) Features

The Serial (SM) is included in Package B and allows the end user to monitor and troubleshoot the entire networked system (maximum 25 PEDC's). Once connected to the 2-wire BACnet MS/TP network the serial module is run back to a PC and connected to the serial port. Using the pre-designed graphics the user can easily monitor and troubleshoot the entire system on a PC. Other features are:

- Access to entire HVAC system network (refresh rate is limited to 60 seconds – for faster access see the Ethernet Module)
- Serial Connection to a Single PC
- Low Voltage 24 VAC power for safe and easy installation
- Green and Red LED indicates power and communication with BACnet network

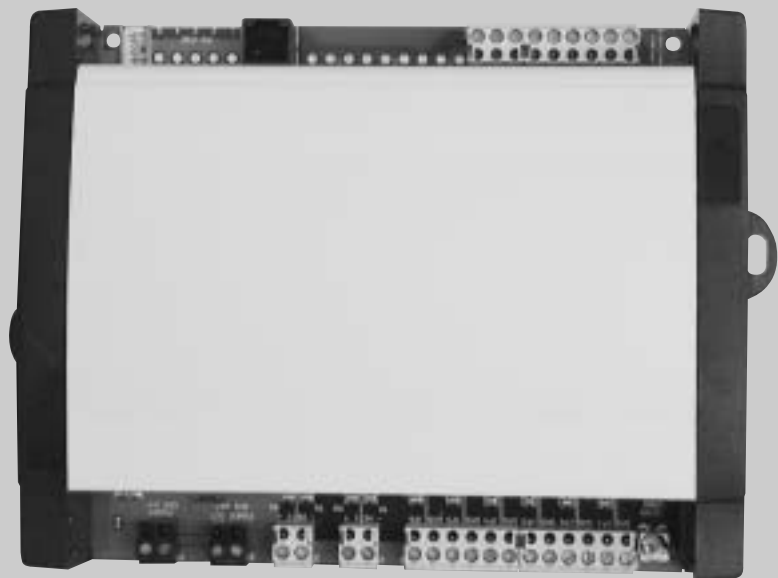
### Serial Module (SM)



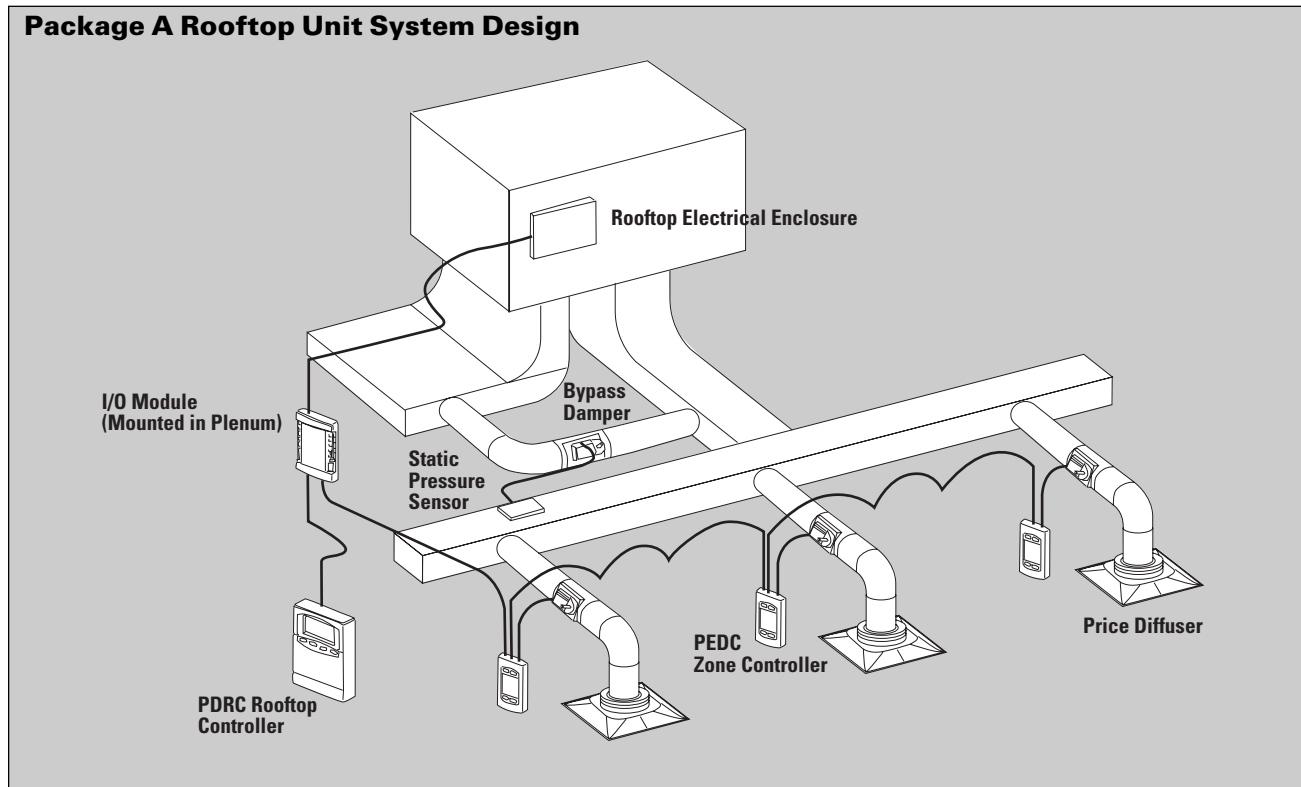
The Ethernet Module (EM) is included in Package C and allows the end user to monitor and troubleshoot the entire networked system. Once connected to the 2-wire BACnet MS/TP network the Ethernet Module is plugged into the company LAN using a standard RJ-45 connection. Using the pre-designed graphics the user can easily monitor and troubleshoot the entire system on a PC. Other features are:

- Fast and easy access to entire HVAC system network
- Ethernet connection (10-MBPS)
- Can use present Ethernet connection in building (company LAN) or a dedicated system
- Remote troubleshooting
- Low Voltage 24 VAC power for safe and easy installation
- Multi-color LEDs indicate power, Ethernet communication and BACnet MS/TP communication

### Ethernet Module (EM)



## System Layout

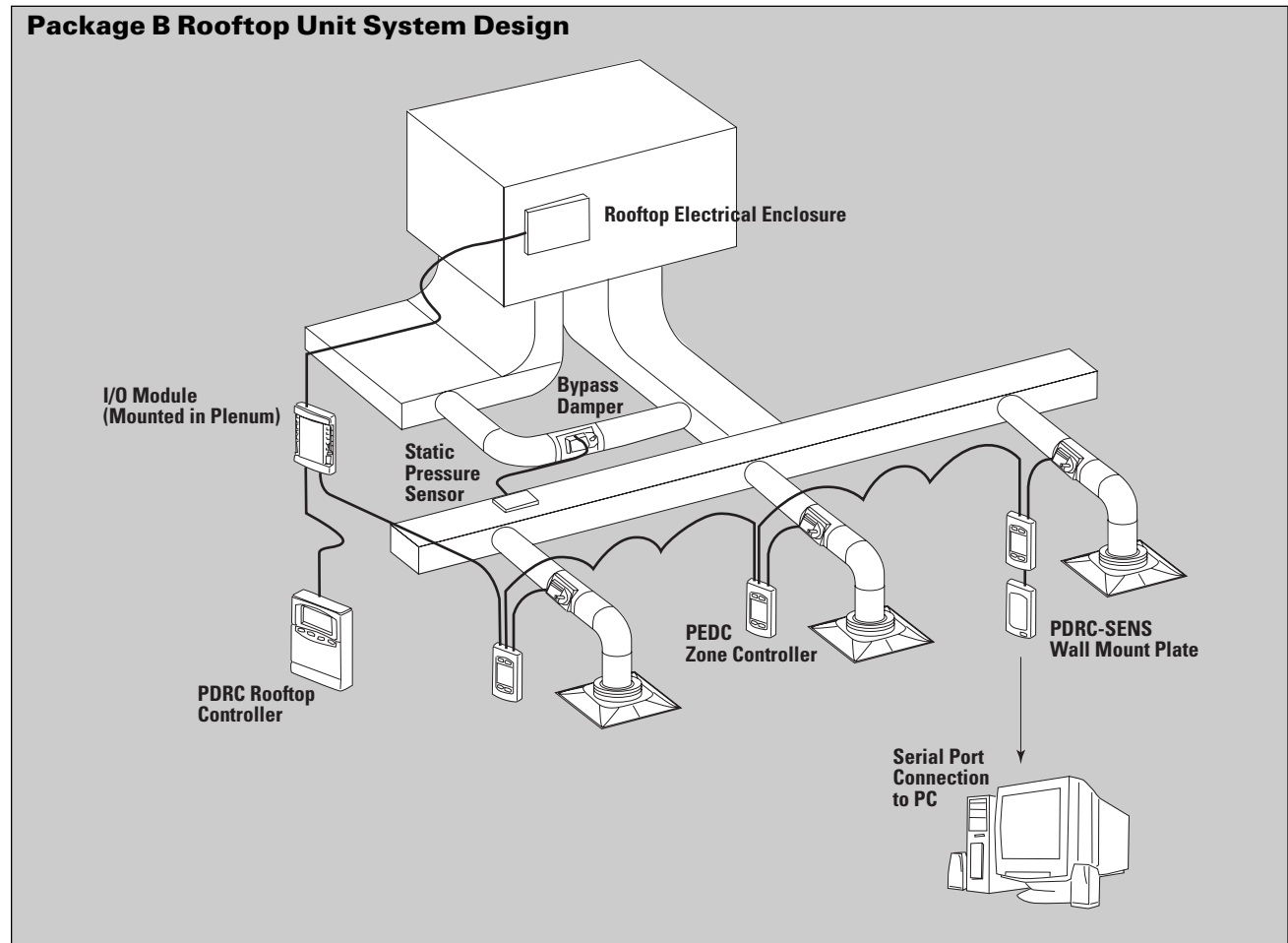


\*For specific wiring information see the PDRC Service & Installation Manual

The illustration above shows a typical Price Package A Rooftop system.

- Here a series of zones are controlled using PEDC thermostats to regulate VAV dampers, and thus regulates the airflow to the corresponding zone. (Note: The PEDC can also support fan powered terminals with reheat)
- Each zone controller is daisy-chained together and then to the Price Digital Rooftop Controller or PDRC, allowing them all to appear on the network.
- Since they are all on the network the rooftop controller has the ability to take a poll, using one of the voting methods described on pages 6, 7, and 8 to determine the mode of the rooftop unit.
- The PDRC is then wired to the I/O Module (Input/Output). The I/O module will send the controller signals to the rooftop units electrical enclosure where it will operate the rooftop unit by turning on and off the fan, cooling and heating coils, and any other options that are available to the rooftop.
- It will also receive input signals from outdoor air temperature sensors or filter status alarms and send that information back to the PDRC so the PDRC can make decisions on how to operate.

## System Layout

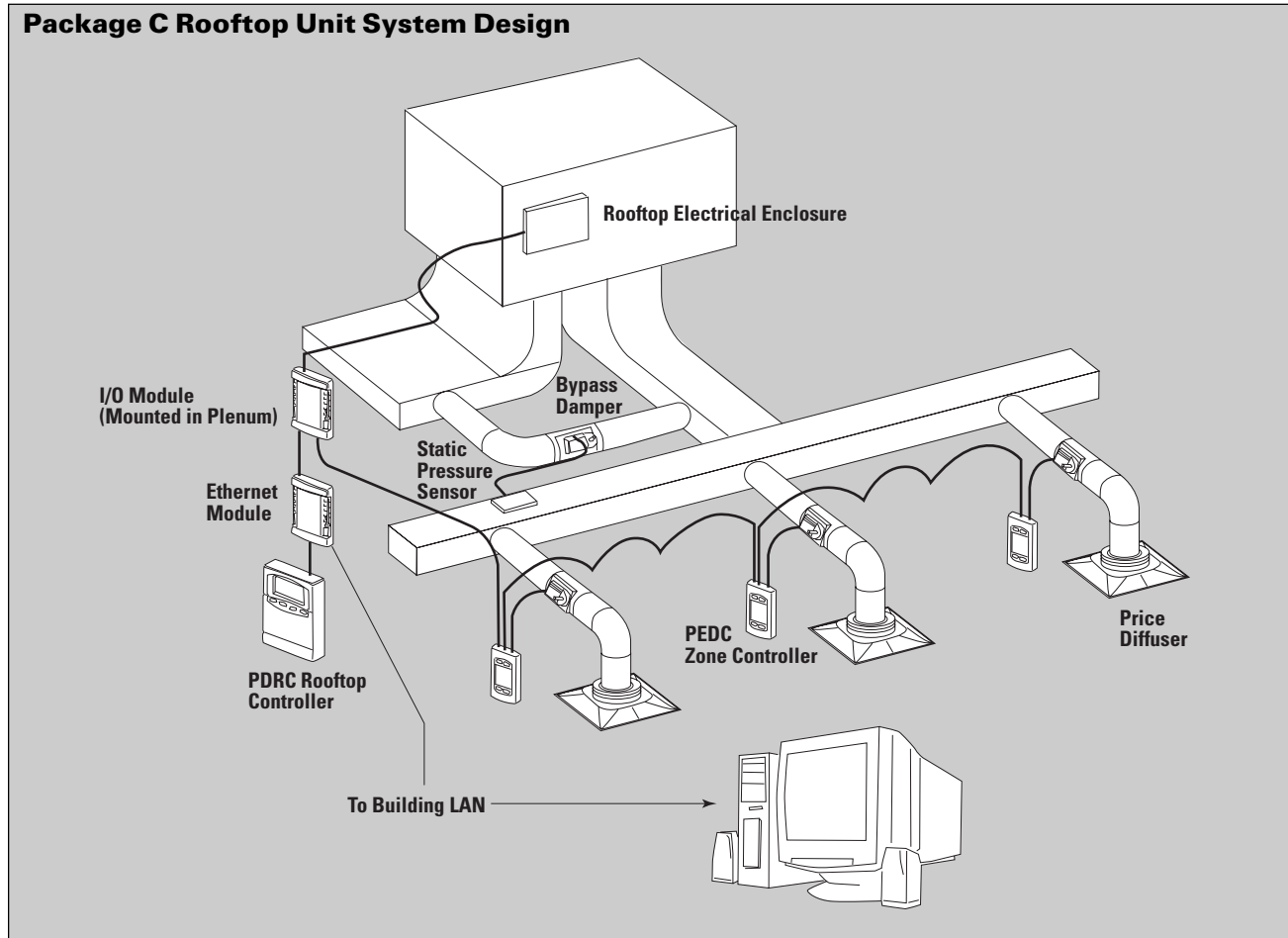


\*For specific wiring information see the PRDC Service & Installation Manual

The above illustration is for a typical Price Package B Rooftop Control System.

- This system will operate similarly to Package A except in this case a serial port connection on a thermostat or wall blank out plate is used to allow the user to view their network from a PC or laptop that has ORCAVIEW installed on it.
- Note: PDRC-SENS is typically mounted in a Controls or Mechanical Room, with a computer.

## System Layout



\*For specific wiring information see the PRDC Service & Installation Manual

The above illustration is for a typical Price Package C Rooftop Control System.

- This system will operate similarly to Package B except in this case an Ethernet module is used to allow the user to view their network from any computer on the LAN that has ORCAVIEW installed on it.
- It also allows Price to troubleshoot over the internet if problems operating the system arise.

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## Rooftop Control Packages

### Package A – Rooftop and Zone Controlled Network (No Graphical Software)

Rooftop package A is Price’s simplest form of rooftop control. It offers rooftop control capabilities such as:

- Weekend and Custom Scheduling
- Rooftop and Zone Occupancy Control
- Zone Demand Polling Strategies

It also allows individual Variable Air Volume (VAV) zone control by means of the PEDC Price digital thermostat. By using the PEDC to control the zones this package will allow the buildings to be completely networked, allowing the rooftop unit to make demand polls of the zones to determine what mode of operation the rooftop should be in.

The package includes the following components:

Qty. 1	<b>PDRC-STAT</b>	Price Digital Rooftop Controller (PDRC)
Qty. 1	<b>PDRC-IOD</b>	Input/Output Board (Digital)

### Package B – Rooftop and Zone Controlled Network with Graphical Software and Serial Port Connection

Package B offers a more advanced type of control than package A. This package comes complete with the ORCAVIEW software which provides the user with the following capabilities:

- Network Accessibility through a designated PC (using a serial port).
- Optional custom designed Graphic User Interfaces that allow the end user to view and modify system variables like set points, temperatures, pressures, schedules, etc.
- Trend logging of variables.
- Alarm reporting.

The package allows the user to view the entire network through the ORCAVIEW software provided by Price. This software is available with a Windows explorer type interface or an optional custom designed Graphical User Interface which allows the user to view all status variables like room temperatures, humidity levels, airflows, etc for every zone controller on the network, as well as change temperature and airflow set points right from the PC.

The PC uses a serial point connection between the designated PC and the network. The components provided by Price are:

Qty. 1	<b>PDRC-STAT</b>	Price Digital Rooftop Controller (PDRC)
Qty. 1	<b>PDRC-IOD</b>	Input/Output Board
Qty. 1	<b>PDRC-SFT</b>	Graphics Software
Qty. 1	<b>PDRC-SERI</b>	Serial Module
Qty.1	<b>PDRC-SENS</b>	Serial Module Wall Mount

**Package C – Rooftop and Zone Controlled Network with Front End Software with Ethernet Connection**

Package C is the most advanced package available. This package comes complete with the ORCAVIEW software which provides the user with the following capabilities;

- Network Accessibility through a designated PC (using an Ethernet connection).
- Optional custom designed Graphic User Interfaces that allow the end user to view and modify system variables like set points, temperatures, pressures, schedules, etc.
- Trend logging of Variables.
- Alarm reporting.
- Remote Troubleshooting Capabilities.

Since the connection type is now Ethernet, any computer with access to the building's Local Area Network and the ORCAVIEW software on their computer will have total access to the VAV network. This software is available with a Windows explorer type interface or an optional custom designed Graphical User Interface which allows the user to view all status variables like room temperatures, humidity levels, airflows, etc for every zone controller on the network, as well as change temperature and airflow set points right from the PC. Also, because of the Ethernet connection, Price can offer remote troubleshooting. A PDRC-SFT (graphic software) must be purchased for each computer used to monitor the network.

The PC uses a serial point connection between the designated PC and the network. The components provided by Price are:

Qty. 1	<b>PDRC-STAT</b>	Price Digital Rooftop Controller (PDRC)
Qty. 1	<b>PDRC-IOD</b>	Input/Output Board (Digital, also available in Analog)
Qty. 1	<b>PDRC-RTR</b>	Ethernet Module
Qty. 1	<b>PDRC-SFT</b>	Graphics Software

With these components you will have 6 universal inputs and 6 binary (24 VAC) outputs which can be used to control the following options;

All packages are capable of the following rooftop options:

<b>Options</b>	<b>I/O Cost</b>
1 Fan Control	1 Output
2 Cooling Stages	1 Output per stage
3 Heating Stages	1 Output per stage
4 Supply Air Temperature (SAT) Sensor	1 Input
5 Leaving Air Temperature (LAT) Sensor	1 Input
6 Outside Air Temperature (OAT) Sensor	1 Input
7 Fan Status	1 Input
8 Indoor Air Quality (IAQ) Sensor	1 Input
9 Humidity Control	1 Input

If I/O requirements exceed the provided I/O board additional PDRC-IOD modules may be purchased to increase control capabilities.

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## Graphics Interface

With the graphic interface option Price will supply your building manager with a graphical interface which more clearly displays valuable information regarding your building's equipment operations.

Standard and Custom graphics are available including:

### Standard Graphic Package

The standard package would include:

- Links to every zone and rooftop controller.
- Important details about every zone and rooftop controller displayed graphically, with equipment and ductwork illustrations and animations for on/off operations or status notifications.
- Details would include such variables as:
  - Air temperatures and set points (SAT, LAT, Room Temp.)
  - Fan Status
  - Damper positions
  - Airflow values
  - Valve positions
  - Humidity levels
  - Rooftop operations

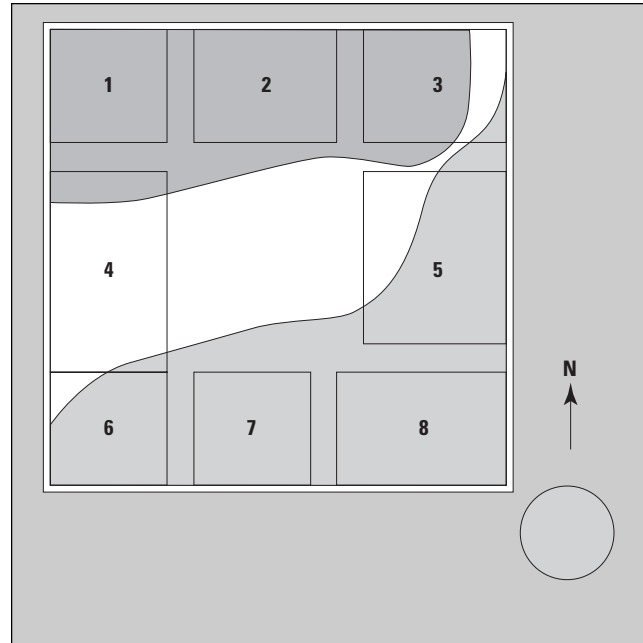
### Custom Graphics Package

The custom package could include:

- Floor plan layouts with links to every zone and rooftop controller.
- Important details about every zone and rooftop controller displayed graphically, with equipment and ductwork illustrations and animations for on/off operations or status notifications.
- Details would include such variables as:
  - Air temperatures and set points (SAT, LAT, Room Temp.)
  - Fan Status
  - Damper positions
  - Airflow values
  - Valve positions
  - Humidity levels
  - Rooftop operations
- Three dimensional illustrations with customized logos, animations or photos used to improve aesthetics.

## System Design

For an average building located in North America during the winter months the amount of sun that the south and east sides of the building receive is larger than for the north and west. The heat load supplied by the sun for a typical building might look like the illustration to the right, with the sun warming the south and east zones 5 – 8. Meanwhile, the north facing zones are receiving no additional heating from sunlight thereby causing those zones to become cooler than usual.



Since we are considering the zone as a whole a better representation may be the illustration to the right which shows the north zones to be completely cold and the south and east zones to be warmer than usual. Zone 4 is shown to remain relatively unaffected by the sun's location.

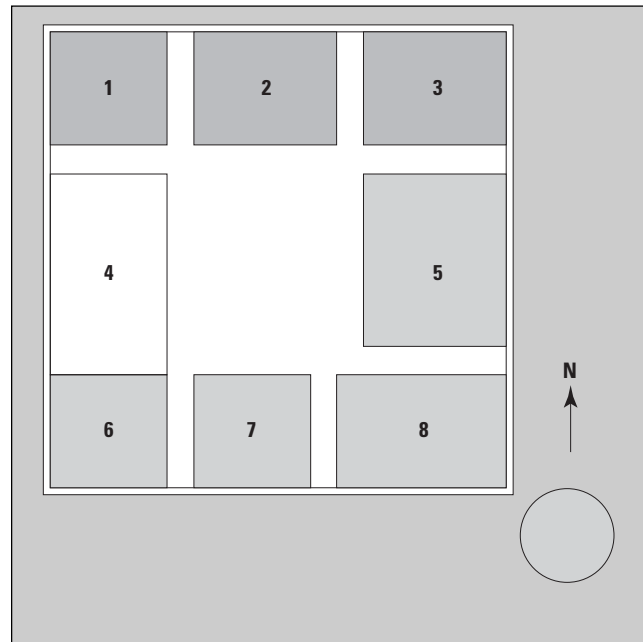
Under these conditions the following is required:

Zones 1 - 3 require heating

Zone 4 is satisfied

Zones 5 – 8 require cooling

Right away it is obvious that there is a problem. How can one rooftop provide both heating and cooling at the same time to satisfy every zone's needs?



### Rooftop Control with Polling Strategies only

In this situation, if one were to rely simply on the polling methods, problems may arise. Since there are 4 zones that require cooling due to the additional sunlight and 3 zones that require heat due to the lack of sunlight, a typical rooftop unit would go into a cooling mode and supply 55 degree air. This would be fine for zones 5-8 but will not help zones 1-3 as their dampers will close to the min cooling flow positions.

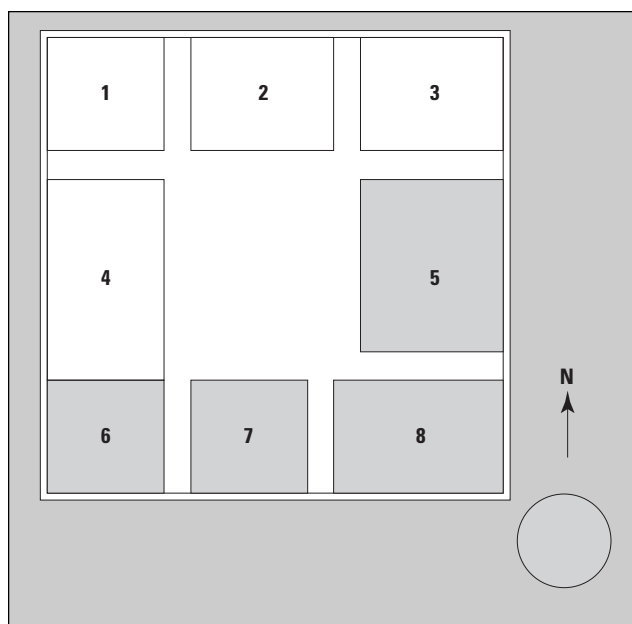
With Weighted and Averaged Polling the design improves by controlling the rooftop unit to operate in the mode which is required the most. In other words, if zones 5-8 only need a little cooling and zones 1-3 need a lot of heating, they will get their heating. However, some zones still go unsatisfied and this is often the method of choice.

### Rooftop Control with Polling and Secondary Strategies

Using additional methods of control in conjunction with the polling strategies will help to combat these problems. With methods like room temperature limiting or heat/cool cycling the rooftop unit will switch from the poll majority operation to satisfy zones that have been allowed to drop below safe set points or have been demanding heat for a predetermined amount of time.

### Heating/Cooling Cycling

In this example zones 1-3 have been requesting heat for 1 hr while the majority of zones still require cooling. With heat/cool cycling the rooftop controller will switch to heating mode to satisfy zones 1-3. Zone dampers in zones 5 - 8 will close to the minimum airflows, which may not be zero. That combined with the fact that the zones are receiving extra sunlight will increase the room temperatures. Depending on how fast the demand is met in zones 1-3 this could be a permanent solution, switching from cooling to heating every hour. This way everyone will have a satisfied room condition at some point during the day.

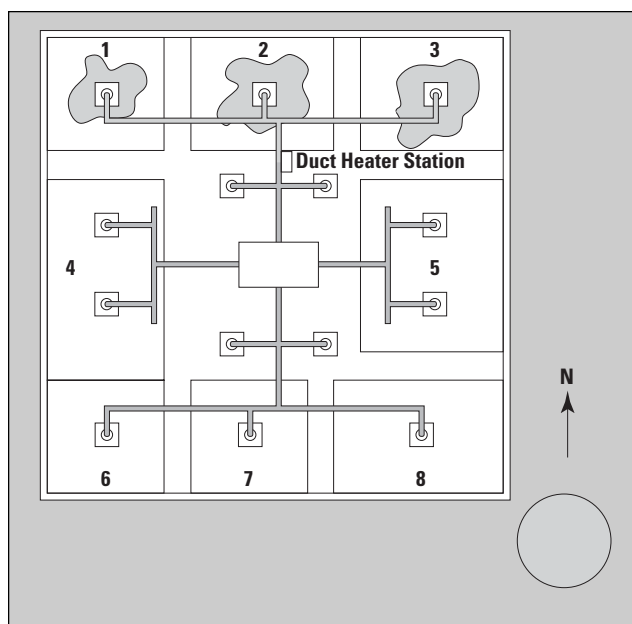


### Duct Heater Stations

Combined with the polling methods, duct heater stations are a way to provide optimum comfort for all spaces. In this example the same 3 north facing rooms are below the desired set point and are calling for heat. Since rooms 5-8 represent the majority and are calling for cooling the rooftop unit will supply cooling, and dampers for zones 1-3 will modulate to a minimum. With duct heater stations the 3 zones requiring heating can receive the heat they need by energizing an electric coil located upstream of the 3 zones. Now all the zones in the space will be satisfied.

Other reheat types include:

- Radiant Panels
- Perimeter Radiation



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## **Suggested Specifications**

The digital controller package shall include a fully programmable and network ready controller mounted in any area of the building and an expandable networked input/output (I/O) module located in the ceiling plenum near the rooftop unit. The rooftop controller will either work in a stand alone mode or through a BACnet networked system. The controller shall send the appropriate control signals to the I/O module. The I/O module will be used to control stages of cooling/heating, fan operation and any other unique features that the rooftop may have.

The controller will be a microprocessor based, proportional-integral controller that is BACnet network capable with a backlit LCD screen and a 16 button keypad interface and battery backed real-time clock.

The controller can support up to eight individual operational schedules per day. It will include onscreen menus that allow the user to adjust system configurations and troubleshooting. The controller will support 2-way communication between itself and each zone controller.

The controller will network with Pressure Independent VAV controls which will measure the airflow supplied to each zone's terminal unit through the use of a 12 pressure point, cross flow configuration inlet sensor. The sensor shall have a center averaging chamber used to accurately average the readings from the 12 pressure ports. The sensor will also supply accuracy within 5% with a 90° sheet metal elbow directly in front of the sensor.

The I/O module will support universal inputs (0-5VDC, 0-10VDC, 4-20mA, 10K) and binary 24VAC outputs. Extra I/O modules can be added as required through the BACnet network. The I/O module will have LED indicators to show active inputs and outputs.

### **Network**

With a networked system the rooftop controller will communicate with the individual zone controls using ASHRAE's BACnet MSTP protocol. Each zone controller's room demand information will be relayed to the rooftop controller and the controller will use one of the three field selectable polling strategies to determine its mode of operation.

A network system will allow the user the capabilities to access each zone controller from a single point connection either through the use of a serial port connection or Ethernet connection.

The rooftop controller and all zone controllers will have an accessible service port connection that will allow for a user to connect to the BACnet MSTP network using a PC. The BACnet MSTP network system will be viewable using a software package that provides either a Windows explorer type navigator or a graphics package navigator.

### **Polling Strategies**

Polling strategies will be field selectable through the use of a LCD screen and keypad functions. The three types of polling strategies available are Average Polling, Weighted Polling and Non-Majority polling.

The Average Polling Strategy will determine the average demand request for cooling, heating and neutral from the zone controllers by using the sum of each type of demand from every zone and dividing by the total overall system demand. The rooftop controller will then determine which operating mode the rooftop should be in by selecting the demand type with the largest average demand, and operate the appropriate stages of heating or cooling required, based on the demand.

The Weighted Polling Strategy will allow the user to select up to five individual zone controllers and their zone weights using a LCD screen and keypad. The user will have the ability to choose a zone and a multiplier from 1-10, which will multiple that zone's demand percentage, thereby allowing that zone to represent more of the total demand.

The Non-Majority polling method will allow a user to select a favored demand type and a new majority value from the controllers LCD and Keypad functions. The new majority value is the value that the favored demand must exceed in order to become the mode of operation, i.e. if the value is 25% and the favored demand is cooling then the total cooling demand of the area supplied by the rooftop only needs to be 25% of the total demand for the rooftop unit to be in cooling mode.

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**LCD + Key Pad Functions:**

1. Space temperature display
2. Space set point adjustment and display (depending on the operation mode set points can be locked)
3. Outdoor air temperature display (Optional)
4. Polling strategy selection mode
5. System mode of operation display
6. Demand percentage displays
7. Weighted and Non-Majority Polling configuration modes
8. Password protected menus
9. Night occupancy override buttons
10. Real-time battery backed clock display
11. Configurable operational schedule menus
12. Manual mode configuration menus (Troubleshooting menus)

**Software Package (Optional)**

The software package will be BACnet compatible and will provide the user with the following capabilities.

**Standard Graphic Package**

The standard package would include:

1. Network system monitoring – This will include viewing all the relevant data measured by each zone controller, such as:
  - a. Room temperature
  - b. Room set points
  - c. Supply air temperatures (with optional duct temperature sensor)
  - d. Zone operation mode
  - e. Heating and fan status
  - f. Damper position
  - g. Airflow rates
  - h. Zone controller variable status
2. Graphics Package (Optional) – The graphics package will come in either a standard format or a custom format.
  - a. The standard format graphics package will include a splash screen with hyperlinks containing the name of each zone so the user can choose the zone he wants to see then click on it for more information. The grouping of zones should also be available so a user can view multiple zones at once.
  - b. Custom format graphics are just that, custom.
3. Trend Logging – Any variable can be measured over a period of time to create trend charts to view how they are operating. Multiple variables can be graphed on one chart
  - a. Variables include room temperature, airflow, set points, damper positions etc.
4. Alarm Reporting – The user can set up event alarms that will notify the user when pre-defined situations occur. Example, if room temperature set points become too low, if supply air temperature is too high, or if a room never comes out of cooling, etc.

**Price Electronic / Digital VAV Controller (PEDC)**

The digital control package shall include a remote programmable controlling thermostat, mounted in the occupied zone and an actuator assembly consisting of an actuator, transducer and termination board for the connection to heat and fan accessories.

The programmable PEDC controller shall be a dedicated, microcontroller-based, pressure independent VAV Proportional-Integral controller mounted in the occupied zone. It will include a zone temperature sensor complete with custom LCD display, 4-button keypad and Service Port. The configurable LCD + Keypad combination will allow for the following on-screen functions/modes:

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**LCD + Keypad Functions:**

- a) Customer Mode
  - a. Space temperature/Set point display
  - b. Set point adjustment
  - c. Outdoor air temperature display (optional w/ networked system)
- b) Service + Commissioning/Balancing Mode (Password protected)
  - a. Control sequence diagnostics
  - b. VAV box calibration
  - c. Minimum/maximum airflow setting/reading
  - d. Control of VAV damper position over entire stroke (Manual Force to open/close positions)
  - e. Override and sequencing of VAV peripheral stages (e.g. Fan, Box heat, perimeter radiation valve)
  - f. Sensor calibration
  - g. Balancing
- c) Configuration Mode (Password protected)
  - a. Sequence of operation programming
  - b. VAV box configuration modification
  - c. Network configuration
  - d. Display option configuration

The programmable controller will be used in either a stand-alone operation or a daisy-chained RS-485 Building Automation networked architecture. The on-board RS-485 network port will allow for plug in connection onto a BACnet MS/TP LAN. The Service Port (RJ-11) will allow for the connection of a personal computer. Connection at the service port will allow for the full display of all VAV control parameters and Inputs/Outputs. If networked, the service tool port will display the complete Building Automation Architecture.

The VAV mounted controller shall house the differential pressure flow transducer, electric actuator and peripheral terminations (e.g. fan, reheat, perimeter radiation). The electric actuator shall be 24 VAC bi-directional, directly coupled to the damper shaft. The actuator must be capable of operating in the stalled position without overheating or mechanical damage. All components shall be factory wired, calibrated and pre-tested to ensure a fully functional unit.

The DDC control package shall be calibrated and factory set for the maximum and minimum flow rates as scheduled on the drawings.

The air terminal unit shall be designed, installed and field adjusted, if necessary, to maintain controlled pressure independent airflow.

All control components shall be mounted inside a protective metal enclosure.

**Hot Water Coils**

Hot water heating units as scheduled shall include 1, 2, 3, or 4-row coils. Coil capacities shall be as scheduled. A quick opening access panel (optional) shall be provided to allow cleaning and inspection of the coil. The coils shall be constructed of 0.500" x 0.017" copper tube. Finish shall be 0.0045" thick aluminum sine wave configuration. The coil shall be contained in a 0.030" galvanized steel casing. The coils shall be tested and certified according to ARI Standard 410. Coil connections can be right hand or left hand as detailed on the drawings. Control valves, automatic air vents, and drain vents, if required, shall be supplied and field installed by others.

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## **Electric Coils**

### **Conventional Control**

Electric heating coils shall be provided of the capacity scheduled on the drawings. The heating coils shall be factory mounted. Terminal assembly shall be UL 1995 certified. Overall length of assembly from inlet panel to discharge shall be 35 inches maximum. The heater frame and cabinet shall be constructed of heavy gauge galvanized steel. Heating elements shall be constructed of High Grade wire. Elements shall be low density and designed to minimize hot-spots and nuisance cycling of the thermal protectors. Elements shall be insulated from the steel frame by floating ceramic bushings. An automatic reset thermal cut-out shall be provided as primary protection against overheating. Heaters shall be equipped with a manual reset cut-out for secondary protection. Fused secondary thermal devices are not acceptable. A differential pressure switch shall be provided to ensure that there is adequate airflow before heater is energized. Heater controls to be accessible from the same side as the primary air controls.

### **SCR Control**

Heater shall be capable of providing proportional control using an analog input signal (0-10 VDC) from a room thermostat or other device. The SCR shall pulse the coil on and off in proportion to the thermostat demand, matching the heating capacity to the room load. The SCR controller shall employ solid state switching with zero crossover for silent operation. Mechanical contactors are not acceptable.

### **Electronic Modulation Control**

Electric heating coils shall be provided to the capacity scheduled on the drawings. The heating coils shall be factory mounted. Heater assembly shall be NRTL/C and CSA certified. Overall length of the assembly from inlet panel to discharge shall be 35 inches maximum. The heater frame and cabinet shall be constructed of heavy gauge galvanized steel. Heating elements shall be constructed of High Grade wire. Elements shall be low density and designed to minimize hot-spots and nuisance cycling of the thermal protectors. Elements shall be insulated from the steel frame by floating ceramic bushings. An automatic reset thermal cut-out shall be provided as primary protection against overheating. Heaters shall be equipped with a manual reset cut-out for secondary protection. Fused secondary thermal devices are not acceptable. Heater shall be capable of providing the proportional control using an analog input signal (or pulsed 24 VAC) from a room thermostat or other device. The Electronic Modulation Controller shall pulse the coil on and off in proportion to the thermostat demand, matching the heating capacity to the room load. Staged heaters will not be accepted. The EMC controller shall employ solid state switching with zero crossover for silent operation and minimal electrical interference. Mechanical contactors are not acceptable. Heater shall be provided with an electronic air flow sensor. The air flow sensor shall modulate the heater output proportionally based on the amount of air flow that is available to prevent tripping of the thermal safety devices and extend the element life. The electronic air flow sensor shall override any other input signal as to ensure the heater operates under safe conditions. Differential pressure type flow sensors are not acceptable.

## Technical Specifications

### Price Digital Rooftop Controller (PDRC-STAT)

<b>LCD</b>	Large font 4-digit alpha numeric display (for time or objects values) Small font 4-digit alpha numeric display (for time or unit values) 12-digit alpha numeric display (for object names or menu commands and options) 10 display icons representing different functions
<b>Keypad</b>	16 buttons (suitable for different applications) Keypad cover
<b>Power Requirements</b>	24 VAC c/w visual LED status indication 10VA
<b>Ambient Ratings</b>	32°F-131°F (0-55°C) 10-90% RH (non-condensing)
<b>Communication Port</b>	Main LAN (NET1) BACnet MS/TP @ 9,600 or 19,200 or 38,400 or 76,800 bps (default) SubLAN (NET2) BACnet MS/TP @ 9,600 or 19,200 or 38,400 or 76,800 bps Maximum of 10 nodes per MS/TP segment
<b>Temperature Sensor</b>	Thermistor Input – 10K at 77°F (25°C) Accuracy +/-0.4°F from 32-158°F (+/-0.2°C from 0-70°C) Display resolution of 0.1° Stability of 0.25°F over 5 years (0.13°C)
<b>Technology</b>	32-bit processor 512 KB (4Mb) flash Memory64 KB SRAM memory for database CPU status LEDReal Time Clock (RTC) & battery
<b>Connections</b>	AMP MTA-156 plug-in terminal (supplied)
<b>Wiring</b>	Class II
<b>Device Addressing</b>	Key Pad address range: 1-99 per BACnet segment Software address range: As per BACnet standard
<b>Size</b>	Controller board: 43/16 x 51 <sup>1</sup> / <sub>16</sub> x 1 <sup>1</sup> / <sub>8</sub> in (10.7 x 14.4 x 3.0 cm)
<b>Weight</b>	0.47 lb (215 g)
<b>Approvals/Standards</b>	UL916; CE; FCC

### Input/Output Module Digital (PDRC-IOD)

<b>Inputs</b>	6 Universal Inputs – (Supporting 0-5V, 0-10V, 10K, 4 20mA) Visual LED Status indication of each input
<b>Outputs</b>	6 Binary Triac Outputs - Jumper selection for internal or external power on binary outputs Visual LED status indication of each output
<b>Power Requirements</b>	15 VA (not including output loading) 24VAC c/w/ Visual LED status
<b>Ambient Ratings</b>	32°F-131°F (0-55°C) 10-90% RH (non-condensing)
<b>Communication Port</b>	Main LAN (NET1) BACnet MS/TP @ 9,600 or 19,200 or 38,400 or 76,800 bps (default)
<b>Technology</b>	32-bit processor 512 KB (4Mb) flash Memory64 KB SRAM memory for database CPU status LEDReal Time Clock (RTC) & battery
<b>Connections</b>	Removable screw type terminal connectors
<b>Wiring</b>	Class II
<b>Device Addressing</b>	Factory set via DIP switch
<b>Size</b>	Including Housing:6.25 x 5.75 x 3 in (15.9 x 14.6 x 7.6 cm)
<b>Weight</b>	1.0 lb (454 g)
<b>Approvals/Standards</b>	UL916; CE; FCC

## Parts List

<b>Product Code and Description</b>	<b>PRICE Part Number</b>
PEDC-D (3-Stage Digital Acuator Board and Stat)	019815-002
PEDC-T (Tri-State Acuator Board and Stat)	019815-003
PEDC-A (Analog Acuator Board and Stat)	019815-004
PDRC-SERI (RS-485 converter) (comes with PDRC-Package B)	019815-005
PDRC-SFT - (specify parallel if you need it...order will default to USB)	019815-006
TRM-768 - termination board	019815-008
PCDT - Price Controlling Digital Thermostat ONLY	019815-010
PAA-D - Price Actuator Assembly Digital Reheat ONLY	019815-011
PAA-T - Price Actuator Assembly Tri-State Reheat ONLY	019815-012
PAA-A - Price Actuator Assembly Analogue Reheat ONLY	019815-013
PEDC lables (for VAV box and stat)	019815-015
Duct Probe for PEDC and PDRC (10K with 48" leads)	019815-020
PDRC-SENS - Blank Plate Zone Sensor	019815-021
PDRC-RTR (Ethernet Module)	019815-022
PDRC-STAT (Rooftop Themostat/Controller)	019815-025
PDRC-IOD (Input/Output Module Digital)	019815-028

## Glossary

### **Bypass Pressure Control**

- Bypasses supply air before it enters the main distribution system back to the rooftop unit to maintain system pressure in a set range.

### **Cooling Mode**

- A mode of operation for the rooftop controller, during which 1 or more stages of cooling are in operation, i.e. the compressors are energized and the rooftop is supplying cool conditioned air.
- A mode of operation for the zone controllers, during which the zone controller is calling for a percentage of cooling based on the difference between the room temperature set point and the actual room temperature air between min and max cooling.
- The demand for cooling is created when the room temperature is higher than the room temperature set point.

### **Demand**

- Demand is the call for one of the three types of rooftop operation, Cooling, Heating, or Neutral Mode.

### **Economizer**

- Fresh air damper that works in conjunction with the cooling signal and the outside air temperature sensor, to provide cool outdoor air as a source of cooling when the outdoor air temperature is in the allowable range.

### **Heating Mode**

- A mode of operation for the rooftop controller, during which 1 or more stages of heating are in operation, i.e. the heating coil is energized and the rooftop unit is supplying warm conditioned air.
- A mode of operation for the zone controller, during which a demand for heat is made
- Often the demand for heat is used to energize reheat coils and is created when the room temperature is less than the room temperature set point.

### **Neutral Mode**

- A mode of operation for the rooftop controller, during which no actions (heating or cooling) are taken i.e. the majority of the space is satisfied (Fan is typically still in operation for ventilation purposes).
- A mode of operation for the zone controller, during which it is completely satisfied i.e. the room temperature is equal to the room temperature set point.

### **Night Setback**

- The reduction of room set points overnight when the space becomes unoccupied.
- Typically there is no air (i.e. the rooftop fan has shut down) since there are no people that require ventilation.

### **Primary Control Strategies**

- These are the first line of control, usually polling. They are used in conjunction with secondary strategies such as indoor air quality control or supply air temperature limiting to control the rooftop's behavior.

### **Secondary Control Strategies**

- A means of control that works in conjunction with the primary method.
- A more advanced system of control which offers more flexibility to the user.

### **Schedule**

- A time dependant way of automating the controller's functions such as night setback, morning warm-up, etc.

### **System Demand Total**

- The sum of each zone demand percentage.
- Represents the total demand of the space, regardless of what type of demand it is.

### **System Demand Percentage**

- A numerical representation of the demand per type of demand of the entire space.

### **Zone Demand**

- The demand in an individual zone.
- If the room temperature is below the set point the Zone Demand is heating.
- If the room temperature is above the set point the Zone Demand is cooling.
- If the room temperature is equal to the set point the Zone Demand is neutral.

### **Zone Demand Percentage**

- The amount of demand based on a percentage scale, 100% is consider full or max demand, 0% is considered min demand.

### **Zone Reheat**

- One of many possible types of reheat could include:
  - o Duct heaters (Electric or Hot water)
  - o Perimeter Radiation
  - o Radiant Panels





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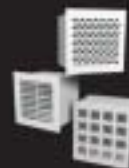
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