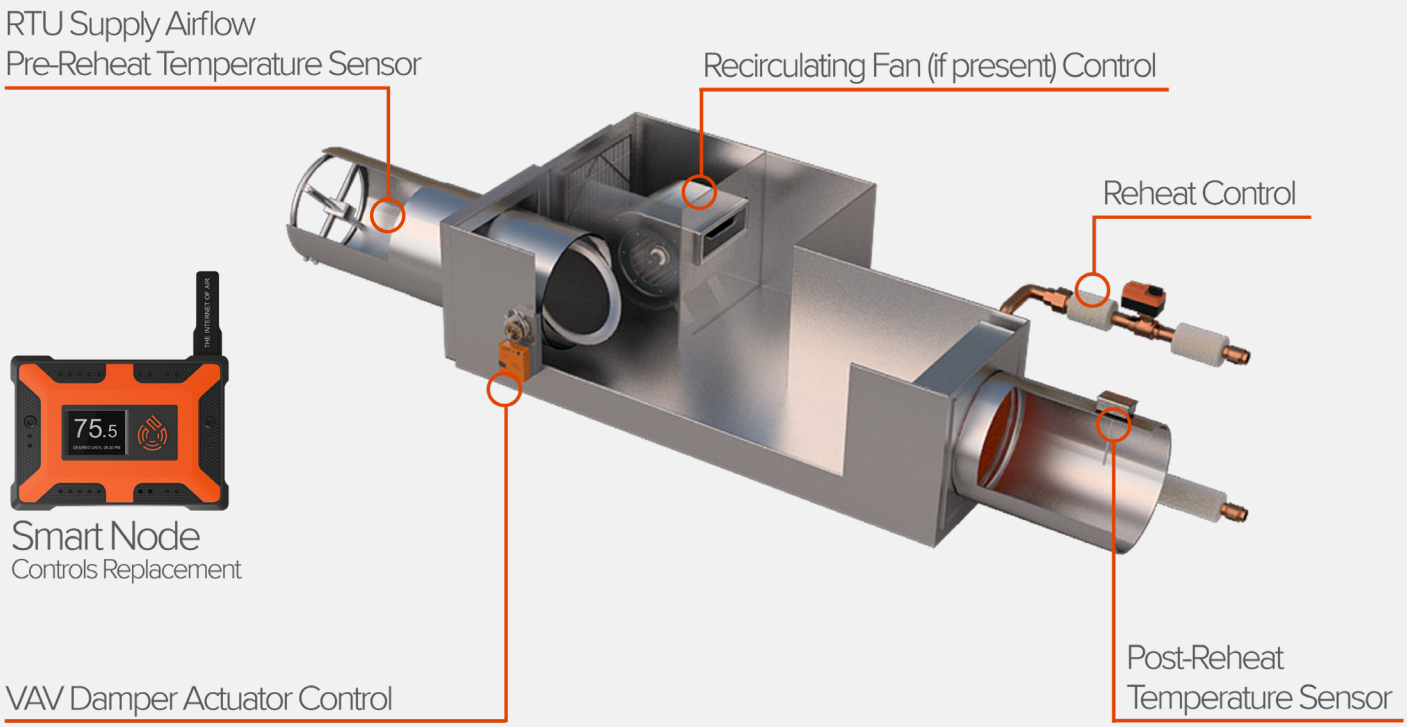
75F® Variable Air Volume with Reheat™

A unique, system-wide approach to maximizing performance



APPLICATION OVERVIEW

The 75F® Smart VAV with Reheat™ controls solution reduces install cost, improves energy efficiency, and delivers remote control and diagnostic capabilities to Variable Air Volume (VAV) zone controls systems.

VAV is an advantageous application for commercial buildings larger than 40,000 square feet with diverse loads or those that require simultaneous exterior heating and interior cooling during winter months. Where common air handling equipment may serve these zones today, VAV with Reheat allows a central RTU or AHU to serve multiple zones. This way, one duct run can provide air for ventilation and cooling while reheat can be used for zones that need heating.

Where traditional VAV systems can be costly and inefficient, 75F has encapsulated newer ASHRAE-recommended advanced VAV control sequences. This application modernizes and acknowledges today's fully modulating RTUs and AHUs.

FEATURES

- ASHRAE Guideline 36 sequences auto-updating out of the box
- Integration with both 75F Facilisight web portal and 75F Occupant App
- Dual max dampers and reheat for terminal units
- Scales from rooftop units to full air handling units
- Implemented Trim & Respond
- Variable supply air temperature and supply fan pressure based on loads
- Built-in prioritization
- Advanced modes like Forced Occupied

ADVANTAGES

- Energy savings of 20-30% over traditional VAV systems
- Adaptive building load calculations from supply air temperature and Machine Learning optimization with 75F Athena algorithms
- Dynamic Airflow Balancing while heating increases savings
- Occupancy and IAQ controls on a per zone basis for improved comfort
- Fast wireless installs with zero programming required
- Remote configuration and easy scheduling scale

HOW IT WORKS

75F® Smart VAV with Reheat™ is a full-stack solution with components that include sensors connecting to 75F Athena for cloud analysis, a 75F Central Control Unit (CCU) as a supervisor with built-in wall interface, 75F Smart Nodes as terminal equipment controllers, third-party units with actuators or 75F Smart Dampers, and Facilisight, 75F's building intelligence suite of web and mobile apps for secure remote monitoring and control.

75F's sensors connect to wireless controllers called Smart Nodes placed in each zone, capturing thousands of data points a minute and millions of data points daily on temperature and humidity throughout the building envelope. Via a 900 MHz wireless mesh network, these controllers upload to 75F Athena and a dynamic thermal model of every building where 75F is installed.

Athena's algorithms include a live weather stream and forecast data so 75F can predict optimal control strategies. Zones are configured for parameters such as the size of dampers and the min/max damper positions for tracking in the algorithms. After a few days, the 75F technology can very accurately anticipate heat loads and can use that information to predictively and proactively control the temperature and air volume in the zones or offices of a building.

This information is combined with pre-determined zone priorities and setpoints (such as desired temperature and relative humidity), to make decisions every minute at the 75F Central Control Unit. If Athena determines the optimal scheduling for a building at any point in time, the CCU delivers instructions on how equipment should operate back over the mesh network and monitors the efficiency and comfort of the HVAC system. In addition, the CCU controls the AHU heating, cooling, and fan speeds either physically or via an API.

75F's Smart Nodes receive instructions on damper position and make micro adjustments continuously, redistributing or balancing airflow dynamically to the zones that need it most.

Each building zone contains one damper that controls the flow of conditioned air into that zone. These can be third-party dampers with integrated reheat and require 0-10, 2-10, 10-0, or 10-2 volt modulating actuators. 10K thermistors are added to provide precise airflow temperature.

Each damper receives 24V AC power and sensors for room and duct temperatures. If a 75F Smart Node is connected to a sensor that detects CO_2 and that mode is enabled, damper positions will increase when CO_2 levels are above the threshold automatically.

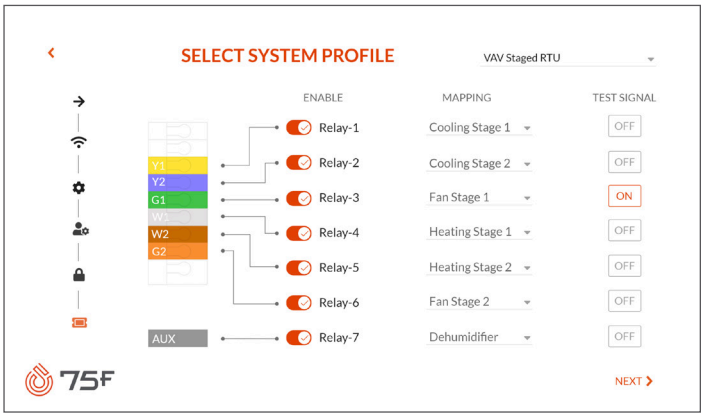
VAV SYSTEM PROFILE COMPATIBILITY

The following four profiles are available for pre-configured sequences of operation for common HVAC equipment types. All these profiles are compatible with the 75F Outside Air Optimization (OAO) application to upgrade economizers and outside air dampers and exhaust systems.

VAV STAGED RTU

In applications where buildings use a staged RTU, the CCU provides up to seven 24V relays that control the RTU. Relays may be mixed as required with a max of five stages for cooling, heating, or fan each. By default, the system is set up as two-stage cooling, two-stage heating, two-stage fan.

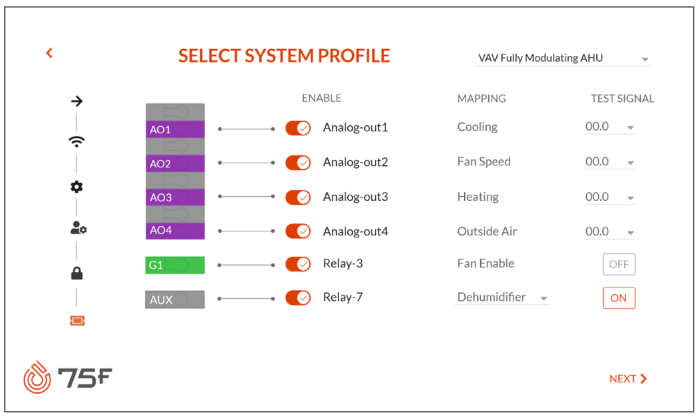
This profile is typically used for packaged RTUs and split systems with up to five stages of DX cooling.



VAV FULLY MODULATING AHU

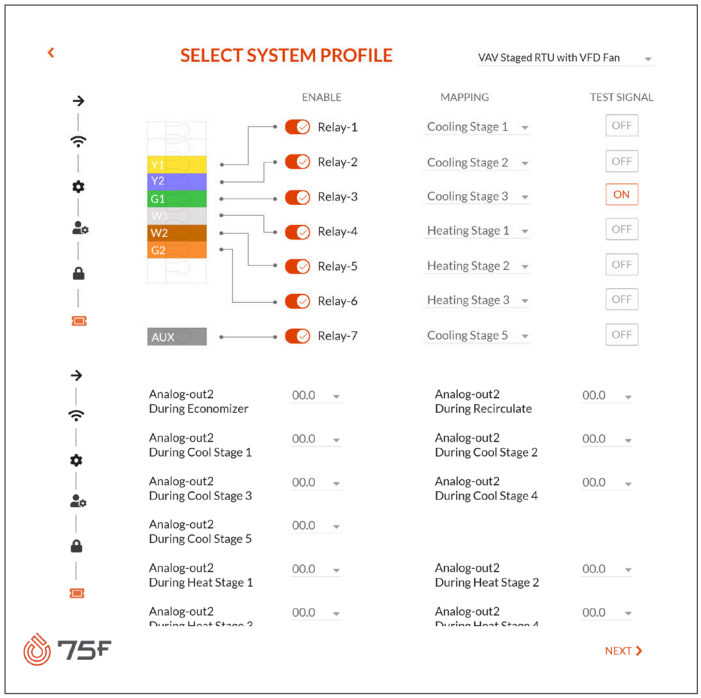
When applied to a fully modulating AHU, the CCU provides three separate 0-10V analog signals that control the AHU. These separate analog signals include cooling, fan speed, and heating.

Typical application is a built-up air handler with hot water coil and valve, chill water coil and valve, and VFD fan.



VAV STAGED RTU WITH VFD FAN

When applied to a staged RTU with VFD fan, the CCU provides up to seven 24V relays that control the RTU. 0-10V analog signals control the speed of the VFD driving the fan. This profile is typically used when a packaged RTU has been upgraded from a step-motor to VFD. The VFD frequency is optimized for each stage of the RTU with an optional minimum fan speed selection.



LIMITATIONS OF TRADITIONAL VAV SYSTEMS

Many VAV systems offer limitations. Each zone has a VAV damper to control the amount of primary air coming from the AHU along with a method of reheating air via a hot water reheat coil or an electric heater. Reheat coils are commonly controlled by modulating a valve, while electric heaters are either staged in 2-3 electric elements that can be turned on/off individually or in a single element that is turned on/off via a solid-state relay (SSR).

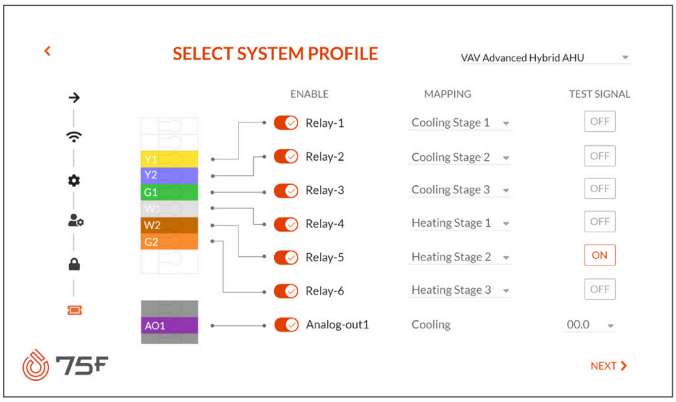
There are three main limitations to traditional VAV sequences commonly in use today:

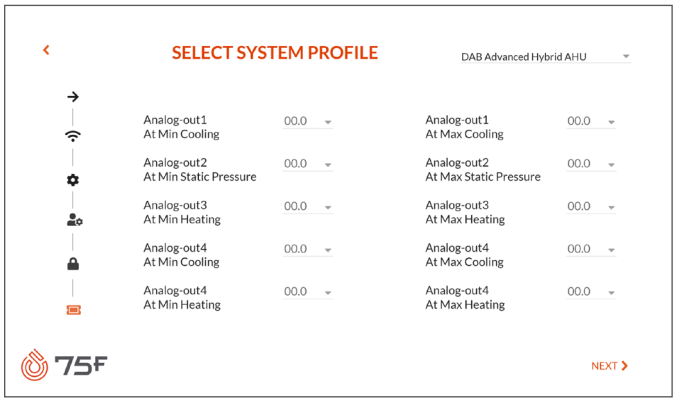
- High energy consumption and operational costs because air is first cooled and then reheated, plus minimum airflow requirements and stratification issues where occupancy is unknown.
- VAV sequences and components are rarely the same, while codes and standards change constantly. This results in poor utilization and indoor air quality.
- Hardware and installation costs are high due to wiring and programming, as well as difficulties managing interfaces and controlling the range of terminal equipment and sensors that are required.

With 75F VAV with Reheat, Guideline 36 sequences and trim and response style control loops allow buildings to maintain zone temperature with the warmest possible air at the lowest possible pressure, so equipment and energy consumption in minimized. Supply air temperature and fan speeds are continuously monitored and controlled based on zone loads to achieve the best possible thermal comfort and energy efficiency across a range of equipment types and configurations. ASHRAE-recommended Guideline 36 sequences are pre-configured while always-on cloud connectivity means 75F can push sequence upgrades and software improvements as needed. The complete VAV system is wirelessly connected and works out-of-the-box with zero programming required. Occupancy and CO_2 monitoring automatically manages setpoints and airflow in high traffic or partially occupied zones. Together this means best-in-class comfort and energy consumption in a VAV application that makes buildings more efficient, comfortable, and healthy than ever before.

VAV ADVANCED HYBRID AHU

For the most advanced or hybrid AHU's, the CCU provides up to seven 24V relays that control the AHU itself. In addition, three separate 0-10V analog signals can be used to control the AHU as well. These separate analog signals include cooling, fan speed, and heating. This profile is used anywhere where the AHU has a combination of staged equipment and modulating equipment.





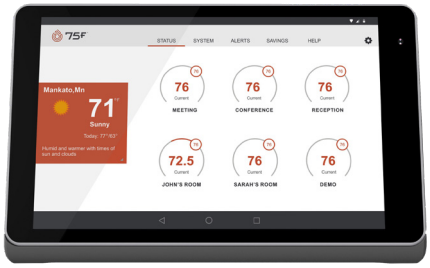
SMART NODE

75F® Smart Node™ wireless controllers in each terminal unit collect hard-wired sensor data such as zone temperature and humidity that is wirelessly transmitted to the 75F Central Control Unit™ (CCU) for holistic load calculations and central air handler control. There are multiple variants of VAV depending on the type of physical box the Smart Node is connected to. Two of the primary variants involve modulating electric or hot water reheat and 1 or 2 stage electric reheat. What makes the Smart Node so versatile is that in addition to hydronic and electric reheaters, the unit is designed to control damper actuators, parallel fans and series fans from the same device as well. Finally, two airflow temperature sensors are connected upstream and downstream of the reheat coil to deliver entering and discharge temperature data to the Smart Node and then on wirelessly to the CCU.

- 0-10, 2-10, 10-0, 102V modulating actuators
- 0-10, 2-10, 10-0, 10-2V modulating hot water valves
- 1 or 2 stage electric reheat
- Pulsed SCR electric reheat
- Two 10K thermistors for airflow temperature pre and post reheat coil

CENTRAL CONTROL UNIT

The 75F Central Control Unit connects to and controls a wide range of air handling equipment while supervising all terminal unit Smart Nodes. This ranges from single or dual unit RTU's to fully modulating AHUs with VFDs. Terminal unit parameters are reset by the CCU back to the Smart Node every 60 seconds to continuously optimize zone comfort and efficiency. Sequences leverage Trim and Response to calculate Supply air Temperatures, as well as Dual Max Algorithms per ASHRAE Guideline 36, and do so each minute for continuous and granular control.



VFD speed control, DX staging, furnace staging, and hot & chill water coil valve analog controls are all native to the CCU. Any outside air dampers and exhaust fans are controlled by a Smart Node, just as on a VAV box. In the cloud a systemCoolingLoopOutput, systemHeatingLoopOutput is calculated in real time which represents a value of 0-100% of the capacity of the central unit. This is then mapped into the appropriate type of control signal (relays or analog DC voltage) to interface correctly with the equipment. No programming or difficult integrations are required, and the full-stack solution is designed to be easy to install and to work out of the box.

OPERATING VAV WITH REHEAT

User Intent Parameters
currentTemperature
zoneCoolingTargetTemperature (affected by scheduling of desired temperatures)
zoneHeatingTargetTemperature (affected by scheduling of desired temperatures)
zoneBasePriority - configuration parameter
comfortSliderValue - value between 2-5

VAV operation favors cooling at the RTU because each VAV unit has independent reheat. When a zone needs cooling, the system switches the AHU to cooling mode and responds to drift by first opening the dampers and then sending a request to cool the air even further at a greater fan speeds or static pressures. The system works to provides the warmest supply air temperature that will satisfy cooling loads at the lowest airflow setting or fan speed. This allows buildings to meet comfort, IAQ, and ventilation requirements, while enjoying best-in-class energy consumption for applied mechanical equipment.

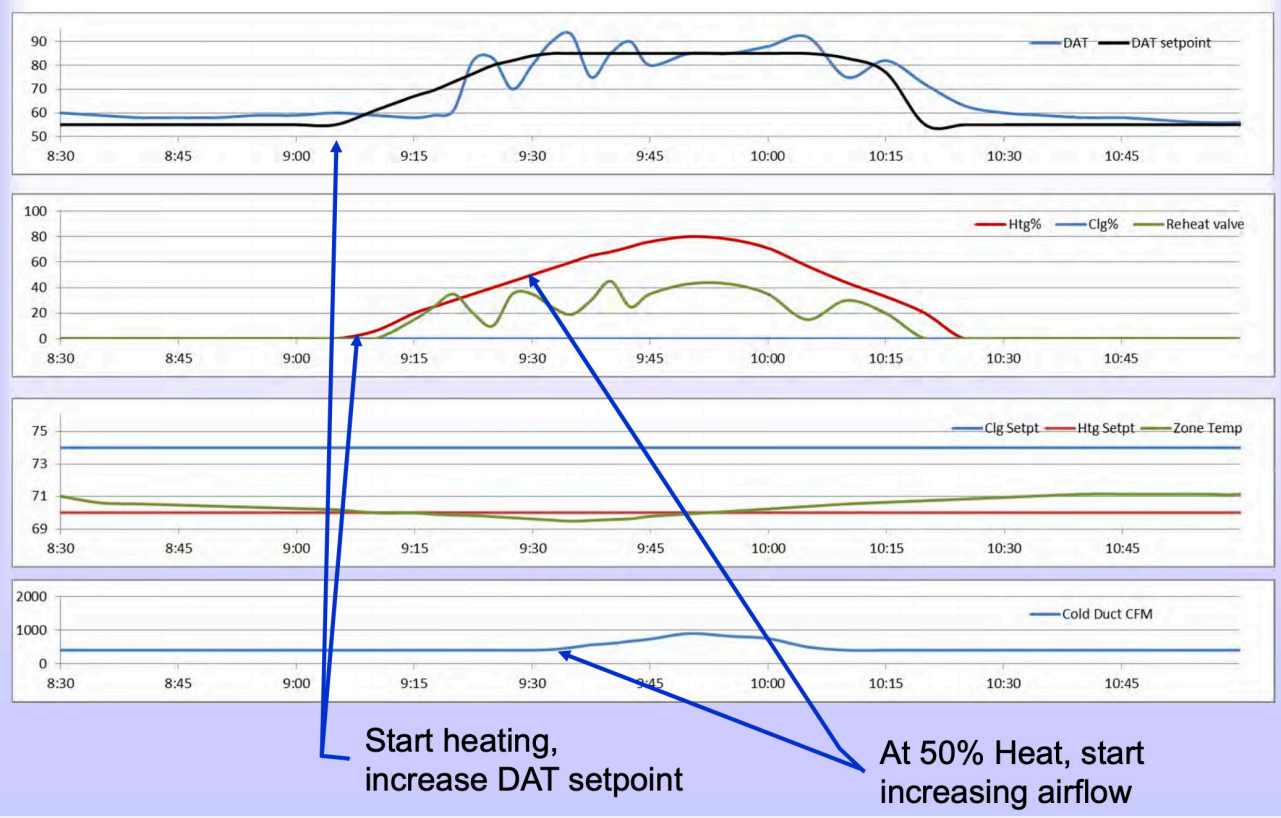
When all zones need heating, this is provided from the central AHU. Here the system operates in the same way as 75F's DAB solution: using weighted averaging to calculate the system load based on the difference between a zone's current temperature and its desired temperature. Users can assign their zones different priority levels: low, medium, high, or no priority. These will change dynamically based on how far conditions are from desired setpoints. DAB control sequences when applied to VAV applications ensure that maximum airflow is attained throughout the system and energy consumption is again minimized.

INCORPORATING ASHRAE GUIDELINE 36 INTO YOUR BUILDING SEQUENCE

The purpose behind ASHRAE Guideline 36 and its correlated RPs (1455, 1547, 1587, 1747) is to provide the mechanical design community with a resource to deliver uniform, high efficiency control sequences for HVAC systems. With 75F's advanced algorithms and continuous feedback loops, customers can achieve the objectives that ASHRAE Guideline 36 outlines with an out of the box solution for Variable Air Volume/Multi-zone AHU configurations.

ASHRAE Guideline 36 and RP 1747-Appendix A outline a list of hardwired sensors (both required and optional based on application) for optimal control loops. Although 75F's devices communicate wirelessly with each other over a wireless mesh network, sensors are hardwired into devices for reliability purposes. The exception to this is 75F's outdoor air temperature sensors. For these outdoor readings, GPS coordinated weather data measures dynamic onsite enthalpy conditions for every building. This not only eliminates the potential for sensor failure at the site, but allows the dynamic starting warmup/cool-down sequences outlined in RP 1747 to be taken a step further. RP 1747 calls for the controls system to consider zone setpoints, current sensor readouts, and a self-tuning mass/capacity correction factor; 75F utilizes all the above plus live weather forecasting to limit preconditioning time while delivering thermal comfort.

The points list provided in 1747 is comprehensive, and 75F's Smart Stat comes equipped with all of the required sensors plus most of the optional sensors as well, including CO_2 and VOC monitoring, an infrared occupancy sensor, a humidistat for measuring relative humidity, and a light sensor. While these additional sensors are not needed for all VAV/Multi-zone AHU



Dual maximum logic in action, per standard 90.1 and RP-1455.
Image: Steve T. Taylor, Taylor Engineering LLC

applications, the combination of these inputs into a single wiring point allows for a more uniform installation approach and consistency across zone feedback. It also offers building engineers unparalleled flexibility and value. For applications that do not require a DCV approach and only need basic monitoring, a dual temperature and humidistat sensor is provided.

VAV with Reheat takes an Option 1 approach to determining the Vmin setpoint for airflow at the VAV box. By utilizing a 0-10V or 2-10V actuator, 75F can control a damper until no airflow is being sensed. This default logic sets Vmin for all boxes equal to zero. This requirement for fully modulating actuators is one of the first differences typically noted about 75F controls. By dictating the actuator signal to be a 0-10V or 2-10V output, it's possible to accurately determine damper position for an optimized trim and response control logic sequence.

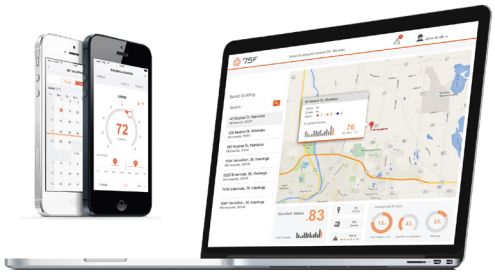
The heart of ASHRAE Guideline 36 and its related RP's is to be as efficient as possible while maintaining comfort within a space. In addition to damper position, this involves not requiring 55F off the coil to maintain a standard setpoint range and instead trimming (resetting) that SAT setpoint based on requests by the Cooling or Heating Loop algorithmically. Utilizing a trim and response style control loop the 75F system will deliver the warmest air possible to the space to maintain indoor conditions while optimizing pressure to keep fans running at their minimum. Optimum required supply air temperature (SAT) and system pressure are continuously monitored and controlled by the 75F Central Control Unit at the AHU to achieve the best possible thermal comfort and energy efficiency.

This control sequence, and the ability to accurately calculate discharge air temp and pressure across a range of HVAC equipment and systems, is what sets 75F's VAV with Reheat apart. With ASHRAE Guideline 36 out of the box, customers are maintaining zone level temperatures while enjoying best-in-class energy consumption of applied mechanical equipment.

COMPONENTS OF VAV

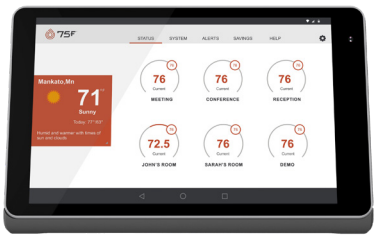
75F Variable Air Volume with Reheat includes the 75F Facilisight & Occupant App, a 75F Smart Node, and a 75F Central Control Unit – plus, a75F Wall Sensor, and two Airflow Temperature Sensors.

INCLUDED



75® Facilisight™ & Occupant App™

75F® Smart Node™



75® Central Control Unit™

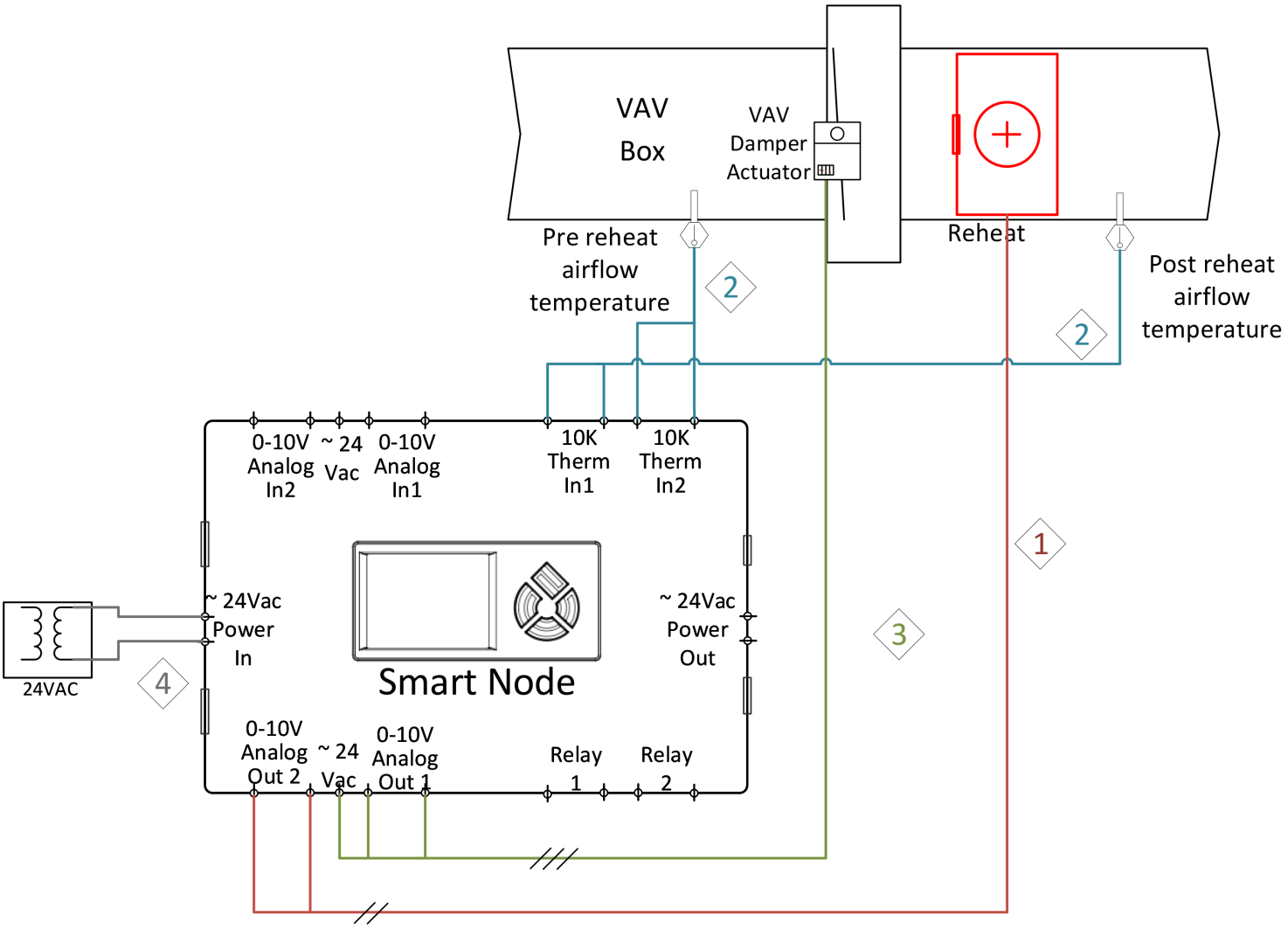
75F® Wall Sensor™

(2) Airflow Temperature Sensors

KIT OPTIONS

TYPE	PRODUCT NAME	DESCRIPTION
Standard	Smart Node, Wall Mount	Smart Node, 30’ cable, 2 Airflow Temperature Sensors, Wall Sensor
Alternate	Smart Node, Ceiling Mount	Smart Node, 30’ cable, 2 Airflow Temperature Sensors, Ceiling Sensor
	Smart Node, Flush Mount	Smart Node, 30’ cable, 2 Airflow Temperature Sensors, Flush Mount Sensor
	Smart Node, Wall Mount, White	Smart Node, 30’ cable, 2 Airflow Temperature Sensors, Wall Sensor, White
	Smart Node, Local Interface Sensor	Smart Node, 30’ cable, 2 Airflow Temperature Sensors, Local Interface Sensor
Optional	Actuator	Damper actuator, LMB24-SR-T

CONNECTIVITY



Notes:

1. 18-2 Wire to reheat. Either from Analog-2 for modulating or Relay-1 for non-modulating. 18-3 Wire is required for hot water reheat actuator valve.

2. 10k ohm bullet probe and cable (provided by 75F).

3. 18-3 wire for modulating actuator.

4. 24V AC power can be daisy chained from one Smart Node to the next.