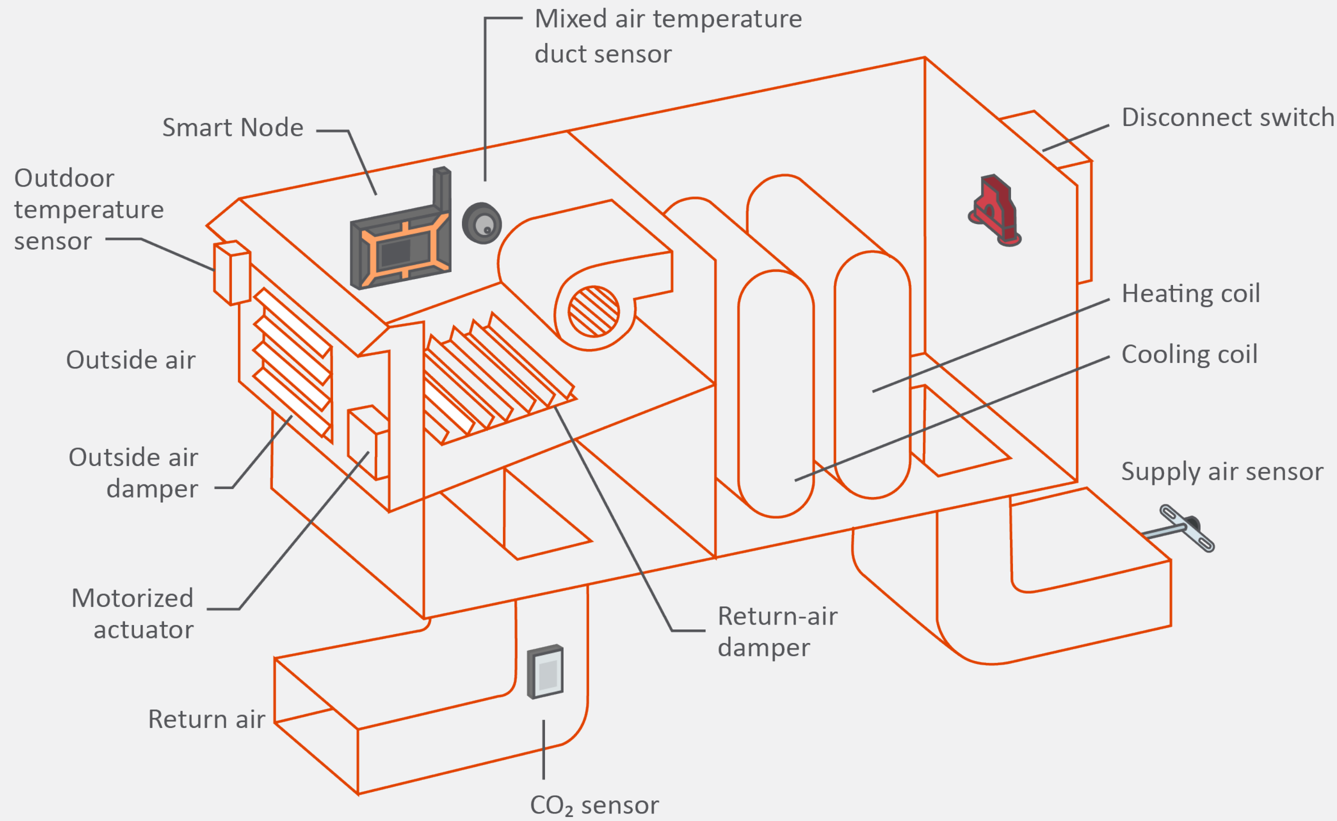
75F® Outside Air Optimization™

Save energy, provide comfort and improve indoor air quality



APPLICATION OVERVIEW

75F Outside Air Optimization (OAO) is an application that combines hardware, software and real-time weather data providing advanced sequences of operation from rooftop economizers to built-up air handlers in a wide range of commercial buildings. Facility managers who want to maximize efficiency, occupant comfort and indoor air quality (IAQ) should install OAO on all outside air applications. Customers can also add OAO to maintain pressure inside a building.

OAO's three primary benefits are Improved Efficiency, Comfort and IAQ, something it accomplishes thanks to two main application functions: Economizing and Demand Control Ventilation (DCV).

FEATURES

- Works with Variable Air Volume (VAV) and Dynamic Airflow Balancing™ (DAB) to provide advanced economizer controls to RTUs and AHUs
- Monitors and analyzes return air CO_2 for DCV
- Web-based, aggregated weather feeds for outside air temperature and humidity
- Backup temperature probe for outside air
- Return and outside air damper controls
- 2-stage exhaust fan control
- Mixed Air Temperature (MAT) and humidity sensing with a minimum temperature safety feature

ADVANTAGES

- Outside Air Optimization (OAO) from 75F uses web-based, aggregated weather feeds specific to each building.
- OAO is simple to install and works out of the box with no programming required.
- Wireless design eliminates invasive or complicated installs.
- Advanced controls allow the use of OAO on everything from simple rooftop units to sophisticated air handling units.
- Fully integrates with 75F Facilisight portal and mobile app.
- Proprietary algorithms reduce energy use by 20-30% with OAO alone. Machine learning optimizes energy efficiency, comfort, and IAQ even further.
- Enhanced features compared to traditional zone controls:
  - – Energy savings
  - – Improved Comfort
  - – Optimized IAQ
  - – Easy scheduling
  - – Remote configuration
  - – Fault detection and diagnostics

IMPROVED EFFICIENCY

The efficiency of outside air (OA) applications is dramatically improved by employing demand control ventilation (DCV) and comparative enthalpy economy sequences. 75F OAO hardware includes a CO_2 sensor installed in the air handler's return air (RA) duct to determine IAQ and derived occupancy. The OA is modulated with a 0/2-10V actuator controlling the OA and RA dampers. Conditioning OA is inefficient when temperature and humidity are far from desired indoor levels – however, OAO lets a precise amount of air in to balance IAQ and comfort in a space.

ASHRAE Standard 62.1 provides direction for the correct ventilation rates of occupied spaces. When occupancy is unknown, the standard calls for assuming the worst case — maximum occupancy — to set the minimum position of the OA damper. In reality, most spaces are not occupied at maximum ,and the result is that most indoor spaces are over-ventilated at the cost of much greater mechanical conditioning and energy cost. Using DCV, OAO from 75F delivers an ASHRAE-approved method to derive occupancy, allowing for adjustments of the OA damper according to CO_2 instead of assuming the worst case. The result is energy savings during low occupancy and improved IAQ during high occupancy.

OAO also allows buildings to maximize "free cooling", the basic function of an economizer. A basic economizer — the type typically installed in package units — measures outside air dry-bulb temperature to determine if OA is at or below a certain temperature, usually about 55°F. Based on historical weather data, the basic economizer assumes a relative humidity value to calculate an assumed enthalpy (a measure of both temperature and humidity), and will then open the OA damper to cool indoor spaces.

Because the basic economizer is assuming enthalpy based on the dry-bulb temperature and historical humidity levels for a weather zone, the formula is conservative and only provides free cooling for fraction of the available time. Comparative enthalpy economy from 75F's OAO system is a far superior method to obtain the maximum amount of free cooling because it uses real-time outside enthalpy data and compares it with real-time indoor enthalpy data to lower energy costs and improve efficiency through free cooling. Not only does the system compare the two enthalpy values, it also calculates the final enthalpy of supply air when heated up to indoor levels using psychrometric charts to ensure the resulting air meets a desired target. The result is typically three times more free cooling than a basic economizer and much better comfort for guests and occupants.

COMFORT

As explained in the previous section, most basic economizers on the market today are typically set to let in OA only when it is 55°F and lower (usually a lower limit is also set). A downside of this is that during winter months, when free cooling is used to bring down the temperature of warmer interior zones, this 55°F or colder air can cause occupant complaints. Any time supply air is noticeably hotter or colder than the indoor environment, comfort is reduced.

OAO from 75F continuously measures the temperature and humidity in all occupied spaces and very accurately calculates loads to determine what the best supply air temperature should be. During free cooling periods, 75F will partially open the OA damper to achieve an MAT that is optimal for the load conditions and which will maintain an optimal experience for the occupant. This results in improved comfort, as well as efficiency.

IAQ

The 75F OAO kit includes a CO_2 sensor in the return duct of the air handler to measure the average IAQ of the building's envelope. When occupancy is high, or when external factors are deteriorating IAQ, 75F will modulate the OA damper proportionally with IAQ values to ventilate with fresh OA to achieve minimum values. Other 75F IAQ sensors such as CO and NO_2 can be added to this sequence for spaces like parking garages or other applications. The 75F OAO sequence includes a control point to activate an exhaust fan based on how much OA is entering the envelope.

MIXED AIR TEMPERATURE (MAT) SAFETY REGULATIONS

If the MAT is above **OutsideDamperMixedAirTarget**, then the system will start progressively closing the damper until **outsideDamperMixedAirMinimum**.

This is true for both DCV and economizing systems.

Simply put, for DCV heating mode, this prevents condensation of flue gases when heating is on, and avoids corrosion due to the acidity that may be present in that condensation.

For DCV or economizing in cooling mode, this will cause super cold air to be supplied, which can lower the comfort of occupants and is not desirable.

ECONOMIZING

Economizers are a feature of HVAC systems which use cold OA to provide free cooling in a space. Outdoor Air Economizing from 75F uses forecasts and temperature data to predictively determine when OA is suitable for free cooling. When OA temperature and humidity is not sufficient to completely cool zones or rooms, then the 75F system utilizes this air instead of the return air coming from building as a prefeed to mechanical cooling. This applies only to cooling modes.

Economizer functions are typically based on two parameters, temperature and humidity. Simpler systems only use temperature for this function, whereas more sophisticated systems will use both temperature and humidity. Systems based on temperature and humidity are called enthalpy economizers, as they use the enthalpy of both the outside air and the indoor air to make constant decisions on whether to bring in OA for free cooling.

Use **averageZoneTemperature** and **averageZoneHumidity** to compute **insideAirEnthalpy**
Use **weatherOutsideTemperature** and **weatherOutsideHumidity** to determine the **outsideAirEnthalpy**
If
outsideAirEnthalpy + **enthalpyDuctCompensationOffset** < **insideAirEnthalpy**
then
economizingAvailable = true

If a building needs cooling, the 75F operating system, Renatus, uses **systemCoolingLoopOutput** to open the OA damper and will record this change as free cooling used. If any of the staged RTU profiles are used, then OAO forms the first stage of the cooling capacity. For example, where a 3-stage RTU is configured, when economizing is available it will appear as if there are 4 stages to the RTU and the economizing loop (OAO) will map to the first 25% of the **systemCoolingLoopOutput**.

If a fully modulating RTU is used, then the **economizingLoopOutput** maps to the first **economizingToMainCoolingLoopMap** as a percentage of the cooling loop.

DCV

The system uses CO_2 levels to determine the amount of OA that should be brought in to maintain the optimal IAQ. If CO_2 readings in a space are below threshold, then DCV has no affect. If CO_2 is above threshold, the 75F system will automatically and proportionately open the OA damper. In other words, DCV essentially sets the minimum damper opening level at any given time and is calculated based on either the return air CO_2 or individual spaces using a Trim and Respond system. This applies to both cooling and heating in 'Occupied Mode'.

If there are no CO_2 sensors in the space, then the system uses the return air CO_2 sensor to provide an average CO_2 level to control OA dampers appropriately. Generally, CO_2 levels are within the threshold level for most buildings the majority of the time. In this case, the system uses **outsideDamperMinOpen** while above threshold levels and the system is opened to allow more fresh air in.

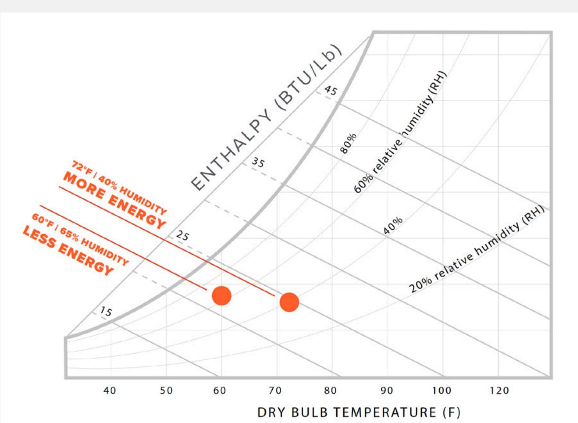
UNDERSTANDING: HUMIDITY & ENTHALPY

As water evaporates, it converts into water vapor and cools—this is why sweat or misting systems are so effective. The water vapor in the air stores a huge amount of energy. Enthalpy determines the total amount of energy in the air and is based on both humidity and temperature. While there is no simple math to determine enthalpy, a psychometric chart can be used to discover how much energy is stored in the air. This graphical representation calculates thermodynamic properties like dry-bulb temperature, wet-bulb temperature, humidity, enthalpy and air density.

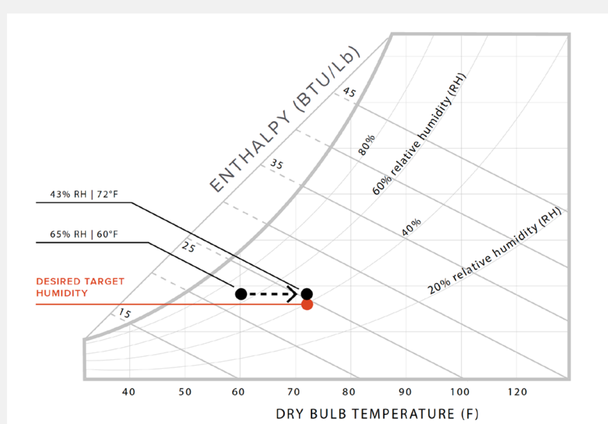
For example, a building has an inside temperature of 72°F with 40% humidity. Let's also assume that in this example the air outside is significantly cooler at 60°F with 65% humidity. To find enthalpy using a psychometric chart, like the one found below, you first find the temperature reading on the bottom horizontal axis and its associated vertical line, reading left to right. Then, you identify the humidity percentage on the sloping diagonal lines which increase with temperature. Trace both your temperature vertical line and the humidity slope until they meet. Once you have located this point, trace the corresponding diagonal enthalpy line to determine your enthalpy reading.

In the chart below we can see that 60°F with 65% humidity has less enthalpy than 72°F with 40% humidity. Therefore, according to the chart, the outdoor enthalpy is less than the indoor enthalpy, and bringing in fresh air to cool the building (instead of mechanical cooling) makes sense.

With OAO from 75F, temperature and humidity data is fed into the cloud and referenced against outdoor forecast predictions over time by 75F's cloud-based AI, Athena. Over one million data points per 50,000sq. ft. of space, and tens of thousands of separate enthalpy decisions are made each day by the 75F OAO application.



This psychometric chart indicates that air which is 72˚F with 40% humidity has more energy than air which is 60˚F with 65% humidity.



This psychometric chart indicates that air which is 60˚F with 65% humidity will end up with 43% humidity when heated to 72˚F.

CONNECTIVITY

In this setup,

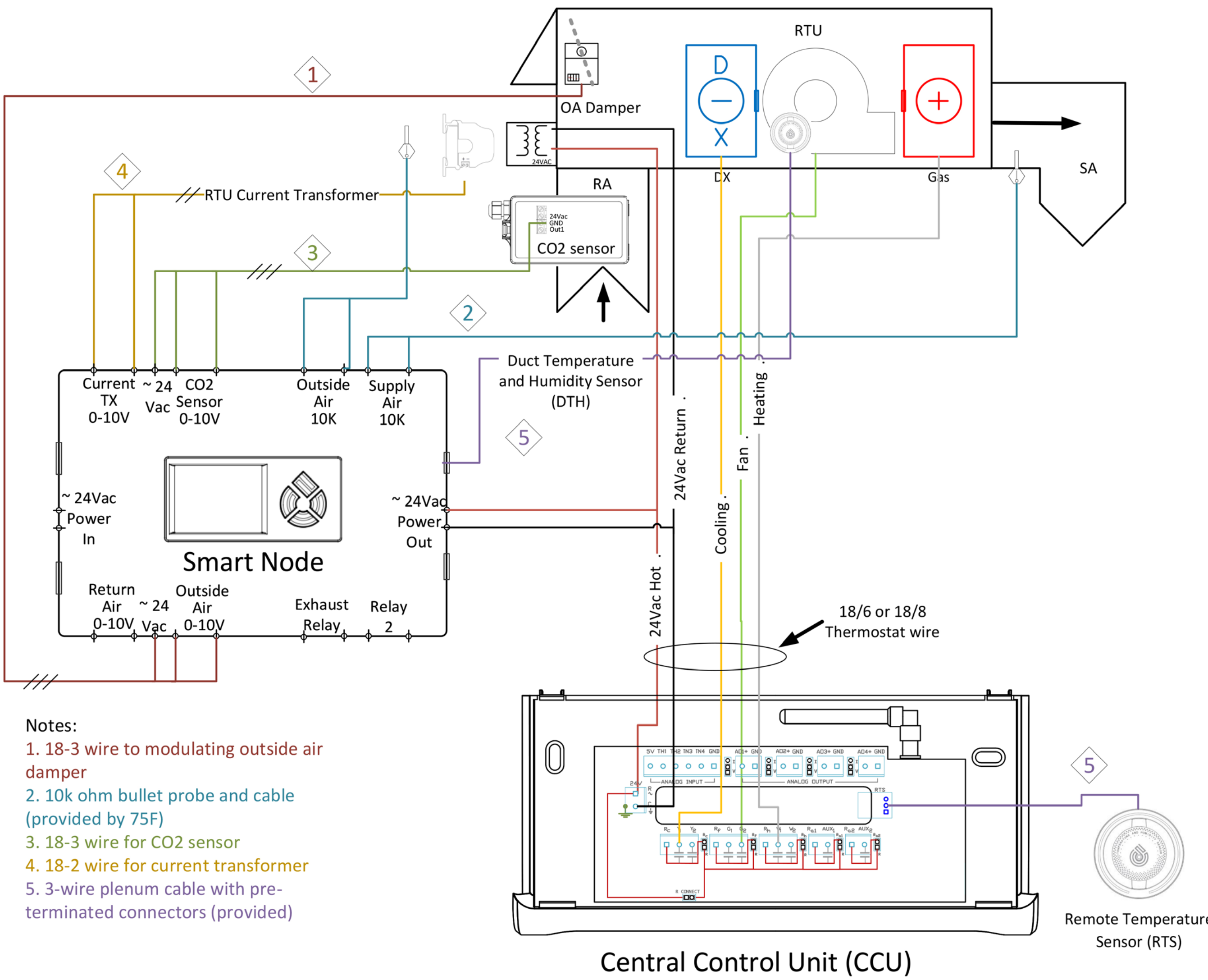
- **Analog-in1** connects to return air CO_2 sensor
- **Analog-in2** connects to RTU current transformer
- **Th-in1** connects to Outside Air Temperature
- **Th-in2** connects to Supply Air Temperature
- One Wire sensor bus connects to Duct Temperature and Humidity sensor for Mixed Air Temperature and Humidity
- **Analog-out1** connects to Outside Air Damper
- **Analog-out2** connects to Return Air Damper
- **Relay-1** connects to exhaust fan stage 1
- **Relay-2** connects to exhaust fan stage 2

FINAL DAMPER DRIVE

The outside damper output signal will modulate between **outsideDamperAtMinDrive** and **outsideDamperAtMaxDrive** as the **oaoFinalLoopOutput** changes from 0% to 100% depending on the conditions.

The return air damper works in opposition to the outside air damper and is calculated as follows:

returnAirFinalOutput = 100 - **outsideAirFinalLoopOutput**

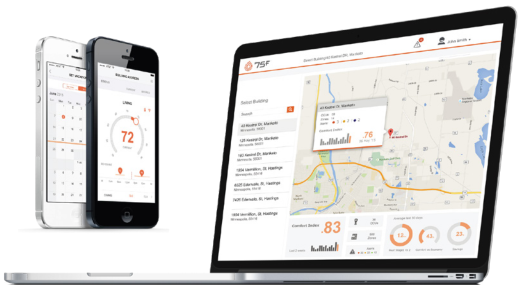


Notes:
1. 18-3 wire to modulating outside air damper
2. 10k ohm bullet probe and cable (provided by 75F)
3. 18-3 wire for CO2 sensor
4. 18-2 wire for current transformer
5. 3-wire plenum cable with pre-terminated connectors (provided)

COMPONENTS OF OAO

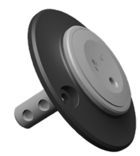
75F Outside Air Optimization includes the 75F Facilisight & Occupant App, a 75F Smart Node, and a 75F Central Control Unit – plus, one 75F Duct Temperature and Humidity Sensor, and a range of external sensors.

INCLUDED



75® Facilisight™ & Occupant App™

75F® Smart Node™



75F® Duct Sensor™

Current Switch & Sensor

Airflow Temperature Sensor

CO_2 Sensor

Outdoor Air Thermistor

KIT OPTIONS

TYPE	PRODUCT NAME	COMPONENTS
Standard	Outside Air Optimization Kit	Smart Node, CO_2, DS, CT, SAT, OAT

ADDERS

- Smart Differential Pressure Sensor Kit, with Smart Node, 24V AC Power Supply (#3510)
- NO_2 sensor
- CO_2 sensor