OptiNet®

Optimizing Ventilation Performance

FEATURES

- Sensor Suite Sensors are tailored to match specific monitoring and control needs.
- Calibration and maintenance of sensors is automatically and routinely scheduled through Aircuity's calibration depot and an Annual Sensor Services program.
- Flexible architecture for future sensor enhancements and technology updates.
- UL Listed - UL 916 Accessory Energy Management Equipment

Sensor Suite Sensors - Overview

Sensor Suite Sensors enable OptiNet to cost effectively monitor and control a breadth of environmental parameters throughout a facility. Located within a Sensor Suite, the sensors evaluate an array of environmental conditions using a shared sensing architecture. In lieu of locating individual discrete sensors in each space, OptiNet gathers air samples from the spaces and multiplexes them across the OptiNet network back to the Sensor Suite for analysis.

OptiNet's centralized sensor platform affords a more robust, cost effective approach to monitoring many parameters at many locations. A "virtual" sensor function is created as if the sensors were actually located in the environment being monitored. A shared platform additionally negates sensor errors through a true differential measurement (comparing outside to inside conditions via a common shared sensor); while minimizing calibration and maintenance costs.

Sensor Suite Sensors have unique performance specifications and product features to meet specific applications, such as demand controlled ventilation, differential enthalpy economizer control; or for monitoring only purposes. The ability to sense a variety of conditions, combined with a specific level of sensor performance, optimizes an application's potential energy savings, control or monitoring capacity.

OptiNet's Annual Sensor Services plan assures that the sensors will continue to perform today, tomorrow, and in to the future. Aircuity's Calibration Depot services routinely refresh all sensors within the Sensor Suite with factory calibrated and serviced units for unsurpassed performance and piece of mind.

ORDERING GUIDE

Refer to the individual Sensor Suite Sensors data sheets for ordering and specification details. Sensors are available to monitor and/or control:

- Carbon Dioxide
- Dewpoint Temperature
  - Relative Humidity
  - Enthalpy
- Airborne Particulates
- Total Volatile Organic Compounds
- Carbon Monoxide

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Sensor Suite Sensors - Carbon Dioxide Carbon Dioxide & Dewpoint Temp

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Carbon Dioxide

Carbon dioxide (CO2) is a colorless, odorless gas formed by metabolic activity, combustion activities, and motor vehicles in garages. Although the indoor concentrations of CO2 resulting from usual occupant activities are rarely hazardous, the gas can serve as a proxy of room ventilation rate. CO2 concentrations in indoor air increase in inverse proportion to the amounts of outdoor air that is supplied to a room, that is, the more outdoor air supplied to a room, the lower the CO2 concentration. Supplying adequate outside air is also important for diluting airborne concentrations of indoor contaminants that may build up due to materials in the space or to occupant activities. Since carbon dioxide is predictable and easily measured product of human occupancy, it is used as a marker for whether pollutants introduced from humans or other sources in the building are likely to become a nuisance or a hazard.

Dewpoint Temperature

The dewpoint is the temperature to which the air must be cooled, at constant barometric pressure, for water vapor to condense into water. The dewpoint is associated with relative humidity (RH). A high relative humidity indicates that the dewpoint is closer to the current air temperature. If the relative humidity is 100%, the dewpoint is equal to the current temperature. Given a constant dewpoint, an increase in temperature will lead to a decrease in relative humidity. Humans tend to react with discomfort to high dewpoints, as a high dewpoint corresponds with a high ambient temperature and/or a high relative humidity.

OptiNet computes the relative humidity through the sensing of dewpoint at the Sensor Suite, and temperature via a local room sensor or duct probe.

Sensor Specifications

Model Number	SEN-CO2-2A	SEN-CO2-2B	SEN-CO2-3	SEN-C2D-3
Typical Application	CO2 Based Demand Controlled Ventilation (DCV) or Monitoring	CO2 Based Demand Controlled Ventilation (DCV) or Monitoring	CO2 Based Demand Controlled Ventilation (DCV) or Monitoring	CO2 Based (DCV) or Monitoring - Dewpoint Temp, Relative Humidity*, Enthalpy*, Monitoring or Control
Sensor: Carbon Dioxide (CO2)				
Element	Dual Wavelength, Non-Dispersive Infrared Sensor	Dual Wavelength, Non-Dispersive Infrared Sensor	Dual Wavelength, Non-Dispersive Infrared Sensor	Dual Wavelength, Non-Dispersive Infrared Sensor
Range	0-3000 ppm	0-3000 ppm	0-2000 ppm	0-3000 ppm
Accuracy	± 60 ppm	± 75 ppm	± 45 ppm up to 1000 ppm	± 45 ppm up to 1000 ppm
Repeatability	± 5 ppm	± 9 ppm	± 1 ppm	± 1 ppm
Resolution	3 ppm	3 ppm	1 ppm	1 ppm
Response	25 seconds	10 seconds	10 seconds	10 seconds
Sensor: Dewpoint Temp (DPT)				
Element				Dual Wavelength, Non-Dispersive Infrared Sensor
Range				-58 to ambient DPT Deg F or 122 Deg F, whichever is less
Accuracy				Dewpoint: ± .5 Deg F RH: @ 65°F and ± .5°F ± 2% RH @ 10-60%RH ± 3% RH @ 61-90%RH
Resolution				1% RH; 1 Deg F DPT
Response				10 seconds

** Relative Humidity and Enthalpy measurements are computed from dewpoint and drybulb temperatures. Therefore, a local drybulb temperature sensor is additionally required via a room sensor, duct probe or outdoor air probe.*

ORDERING GUIDE

Sensed Parameter	Model Number	Element
Carbon Dioxide	SEN-CO2-2A	Dual Wavelength, NDIR
Carbon Dioxide	SEN-CO2-2B	Dual Wavelength, NDIR
Carbon Dioxide	SEN-CO2-3	Dual Wavelength, NDIR
Carbon Dioxide & Dewpoint Temp	SEN-C2D-3	Dual Wavelength, NDIR

Carbon Dioxide and Dewpoint Temperature (SEN-CO2-2A, 2B, 3) and (SEN-C2D-3)

All OptiNet carbon dioxide and combination carbon dioxide/dewpoint sensors use a Non-Dispersive Infrared (NDIR) technique for the measurement of CO2 and moisture. The main components of the sensor are the infrared source (lamp), the sample chamber, and infrared detector. The gas is drawn into the sample chamber, and the concentration of the target gas is measured electro-optically by its absorption of a specific wavelength in the infrared (IR) range. The IR light is directed through the sample chamber towards the detector. An optical filter in front of the detector eliminates all light except the wavelength of the selected gas molecule (CO2 or H2O). The sensor utilizes a dual wavelength configuration where the ratio of the signals is used to calculate the absorbance of the measured wavelength due to the presence of the gas. The sensors exhibit minimal cross interference due to nearly monochromatic IR measurement energies and minimal drift due to the use of a reference wavelength.

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Sensor Suite Sensors - Dewpoint Temperature
Dewpoint Temp & Carbon Dioxide

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Dewpoint Temperature

The dewpoint is the temperature to which the air must be cooled, at constant barometric pressure, for water vapor to condense into water. The dew point is associated with relative humidity (RH). A high relative humidity indicates that the dew point is closer to the current air temperature. If the relative humidity is 100%, the dew point is equal to the current temperature. Given a constant dew point, an increase in temperature will lead to a decrease in relative humidity. Humans tend to react with discomfort to high dew points, as a high dew point corresponds with a high ambient temperature and/or a high relative humidity.

OptiNet computes the relative humidity through the sensing of dewpoint at the Sensor Suite, and temperature via a local room sensor or duct probe.

Carbon Dioxide

Carbon dioxide (CO_2) is a colorless, odorless gas formed by metabolic activity, combustion activities, and motor vehicles in garages. Although the indoor concentrations of CO_2 resulting from usual occupant activities are rarely hazardous, the gas can serve as a proxy of room ventilation rate. CO_2 concentrations in indoor air increase in inverse proportion to the amounts of outdoor air that is supplied to a room, that is, the more outdoor air supplied to a room, the lower the CO_2 concentration. Supplying adequate outside air is also important for diluting airborne concentrations of indoor contaminants that may build up due to materials in the space or to occupant activities. Since carbon dioxide is predictable and easily measured product of human occupancy, it is used as a marker for whether pollutants introduced from humans or other sources in the building are likely to become a nuisance or a hazard.

Sensor Specifications

Model Number	SEN-DPT-2	SEN-C2D-3
Typical Application	**Dewpoint Temp, Relative Humidity*, Enthalpy*, Monitoring or Control**	**Dewpoint Temp, Relative Humidity*, Enthalpy*, Monitoring or Control - CO2 Based Demand Controlled Ventilation (DCV) or Monitoring**
Sensor: Dewpoint Temp (DPT)		
Element	Capacitive Polymer Sensor	Dual Wavelength, Non-Dispersive Infrared Sensor
Range	0 to ambient DPT Deg F or 70 Deg F, whichever is less	-58 to ambient DPT Deg F or 122 Deg F, whichever is less
Accuracy	Dewpoint: ± 2 Deg F RH: @ 65°F and ± .5°F ± 6% RH @10-60%RH ± 8% RH @ 61-90%RH	Dewpoint: ± .5 Deg F RH: @ 65°F and ± .5°F ± 2% RH @10-60%RH ± 3% RH @ 61-90%RH
Resolution	.25 Deg F DPT	1% RH; 1 Deg F DPT
Response	30 seconds	10 seconds
Sensor: Carbon Dioxide (CO2)		
Element		Dual Wavelength, Non-Dispersive Infrared Sensor
Range		0-3000 ppm
Accuracy		± 45 ppm up to 1000 ppm
Repeatability		± 1 ppm
Resolution		.1 ppm
Response		10 seconds

** Relative Humidity and Enthalpy measurements are computed from dewpoint and drybulb temperatures. Therefore, a local drybulb temperature sensor is additionally required via a room sensor, duct probe or outdoor air probe.*

ORDERING GUIDE

Sensed Parameter	Model Number	Element
Dewpoint Temp	SEN-DPT-2	Capacitive Polymer
Dewpoint Temp & Carbon Dioxide	SEN-C2D-3	Dual Wavelength, NDIR

Dewpoint Temperature (SEN-DPT-2)

The OptiNet dewpoint temperature sensor employs a capacitive polymer sensing element. The element combines both relative humidity and temperature measurement in a single monolithic chip using advanced CMOS processes. The sensor element is built out of a capacitor. The dielectric is a polymer which absorbs or releases water proportional to the relative environmental humidity, and thus changes the capacitance of the capacitor. The change in capacitance is measured by the onboard electronics. For a given relative humidity and temperature, an accurate and point-precise determination of the dewpoint temperature can be derived without incurring errors due to temperature gradients between discrete humidity and the temperature sensors.

Dewpoint Temp & Carbon Dioxide (SEN-C2D-3)

The OptiNet combination dewpoint/carbon dioxide sensor uses a Non-Dispersive Infrared (NDIR) technique for the measurement of CO2 and moisture. The main components of the sensor are the infrared source (lamp), the sample chamber, and infrared detector. The gas is drawn into the sample chamber, and the concentration of the target gas is measured electro-optically by its absorption of a specific wavelength in the infrared (IR) range. The IR light is directed through the sample chamber towards the detector. An optical filter in front of the detector eliminates all light except the wavelength of the selected gas molecule (CO2 or H2O). The sensor utilizes a dual wavelength configuration where the ratio of the signals is used to calculate the absorbance of the measured wavelength due to the presence of the gas. The sensors exhibit minimal cross interference due to nearly monochromatic IR measurement energies and minimal drift due to the use of a reference wavelength.

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Sensor Suite Sensors - Airborne Particulates

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Airborne Particulates (Small Particles PM2.5)

Particles in indoor air form a complex mixture that originate from a variety of sources, including the outdoors, office equipment, building materials, furnishings, and occupants. Particles are an important category of indoor air pollutants because in high enough concentrations, they can act as irritants to the eyes, skin, and respiratory tract.

Particle size affects how far particles can penetrate into the respiratory tract and determines the sites of possible health effects. Inhalable particles are those that can deposit anywhere in the respiratory tract from the nose and upper airways to the lower airways and lung tissue where gas exchange occurs. The diameter of inhaled particles that can reach the nose, mouth, trachea, and airways in the lungs but, not in the gas exchange areas is generally between 10 microns (µm) and 100 µm in aerodynamic diameter (1 micron equals approximately 1/25,000 of an inch). Particles less than 5 µm can reach the trachea and all of the airways.

In addition to indoor air quality monitoring and control, particle monitoring in healthcare settings is used for control of infectious diseases; and in research labs and vivariums to dynamically vary air change rates.

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Sensor Specifications

Model Number	SEN-PAR-1
Typical Application	**Particulate Monitoring or Control**
Sensor: Airborne Particulates - Small Particles PM2.5	
Element	Optical Particle Counter
Range	PM2.5 - .3 - 2.5µm
Accuracy	± 25% of reading
Resolution	± 10% of reading
Response	30 seconds

ORDERING GUIDE

Sensed Parameter	Model Number	Element
Particulates	SEN-PAR-1	Optical Particle Counter

Particulates (SEN-PAR-1)

A known flow rate of air passes through the sample port and measuring chamber of the optical particle counter. Laser light is scattered by individual airborne particles and is detected by the receiving optics and converted into electric pulses. The particle size is determined by analyzing the peak height of the electric pulses, which is a function of the scattered light intensity, which is in turn a function of the size of the particle that produced the scattering. Through calibration with polystyrene latex particles of known size, the relationship between electric signal pulse height and latex particle size is established. This relationship is used to determine the size of the unknown particles.

The optical particle counter determines the number of particles in a specific size category from a calibration curve established using various latex sphere sizes.

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Sensor Suite Sensors - Total Volatile Organic Compounds

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Total Volatile Organic Compounds

Volatile Organic Compounds (VOCs) include a large number of compounds commonly found in indoor and outdoor environments. Measurement of total VOCs (TVOCs) is an integrated measurement of the concentrations of all VOCs in an air sample. These compounds have many sources, such as evaporation of isopropyl alcohol, gasoline, paint solvents, spray product propellants, combustion by-products, emissions from household furnishings, and some natural sources such as many food items. Individuals with chemical sensitivities could be affected by elevated TVOC readings within a traditional commercial building. In research laboratory settings, many compounds are hazardous to human health and must be closely monitored. In libraries, museums, archive vaults, etc., TVOC levels must also be kept in check to insure preservation of sensitive documents and artifacts.

ORDERING GUIDE

Sensed Parameter	Model Number	Element
Total VOCs	SEN-TVC-1	Metal Oxide Semiconductor
Total VOCs	SEN-TVC-2	Photo Ionization Detector
Total VOCs	SEN-TVC-1&2	Combines TVC-1 and TVC-2

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Sensor Specifications

Model Number	SEN-TVC-1	SEN-TVC-2	SEN-TVC-1&2
Typical Application	Total Volatile Organic Compounds (TVOCs) Monitoring for Non-Critical Ventilation Applications	Total Volatile Organic Compounds (TVOCs) Monitoring for Non-Critical Ventilation Applications	Combines the MOS sensor (SEN-TVC-1) and the PID sensor (SEN-TVC-2) into one assembly, while supporting the individual sensing capabilities of each. This configuration is recommended for Research Lab or Vivarium applications.
Sensor: TVOCs			
Element	Metal Oxide Semiconductor (MOS)	Photoionization Detector (PID) - VOCs & other gases with ionization potentials <10.6eV	
Range	**Calibrated Range:** 0-50 ppm (as Isobutylene) **Maximum Range:** 0-100 ppm (as Isobutylene)	**Calibrated Range:** 0-5 ppm (as Isobutylene) **Maximum Range:** 0-20 ppm (as Isobutylene)	
Accuracy	± 2 ppm (as Isobutylene) or 25% of reading (whichever is greater)	± .2 ppm (as Isobutylene) or 2.5% of reading (whichever is greater)	
Resolution	1 ppm	0.01 ppm	
Response	30 seconds	30 seconds	

MOS (SEN-TVC-1)

The metal oxide semiconductor sensor provides a broad range of sensing capabilities for many VOCs, solvents and other gases. The sensing element is a heated tungsten trioxide semiconductor that exhibits a generally inverse response in its electrical resistance with exposure to VOCs and other reducing compounds. The measurement sensitivity will vary for different compounds, making the sensor suitable for use in applications where an environment must be monitored for a broad range of parameters.

As a general indicator of VOCs in a space, the device is used to detect any abnormally high levels of VOCs that would indicate the need for more detailed investigations for specific compounds. Additionally, it can be used to obtain different readings from different areas and, by comparing these results from these areas, determine potential sites or sources of VOCs, such as gasoline vapors, methanol, exhaust gases, or vaporized solvents. When used in conjunction with the PID (SEN-TVC-1&2), the MOS sensor provides complementary detection capabilities, as it will detect parameters (including but not limited to: methanol, methane, nitromethane and methylene chloride) that are either not sensed or only poorly sensed by the PID.

PID (SEN-TVC-2)

The PID uses an ultraviolet (UV) light source to break down chemicals to positive and negative ions that can easily be measured with a detector. All elements and chemicals can be ionized, but they differ in the amount of energy they require. The energy required to displace an electron and "ionize" a compound is called its Ionization Potential (IP), measured in electron volts (eV). The light energy emitted by a UV lamp is also measured in eV.

The detector measures the charge of the ionized gas and converts the signal into current. The current is then amplified and displayed as "ppm." After measurement, the ions reform into the original gas or vapor. PIDs are non-destructive; they do not "burn" or permanently alter the sample gas, which allows them to be used for sample gathering.

The largest group of compounds measured by a PID are the **Organics** – compounds containing Carbon atoms – including the following:

- **Aromatics** – compounds containing a benzene ring including: benzene, toluene, ethyl benzene and xylene
- **Ketones & Aldehydes** – compounds with a C=O bond including: acetone, methyl ethyl ketone (MEK) and acetaldehyde
- **Amines & Amides** – carbon compounds containing nitrogen, like diethylamine
- **Chlorinated hydrocarbons** – trichloroethylene (TCE), perchloroethylene (PERC)
- **Sulfur compounds** – mercaptans, sulfides
- **Unsaturated hydrocarbons** – such as butadiene and isobutylene
- **Alcohols** – like isopropanol (IPA) and ethanol

Contact the local Aircuity representative for a current list of compounds detected by the PID TVOC sensor.

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Sensor Suite Sensors - Carbon Monoxide

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Carbon Monoxide

Carbon Monoxide (CO) is a colorless, odorless, and tasteless gas produced by incomplete combustion of carbon fuels. It is a common component of exhaust from motor vehicles and heating units, such as boilers and space heaters, and also is present in tobacco smoke. Although the airborne concentrations of this gas in most indoor environments are usually low, elevated levels can occur under certain situations, such as entrainment of exhaust from trucks idling at a loading dock into a building air intake, migration of air from traffic or parking garages, or leakage of boiler flue gases into a building.

The extent of symptoms produced by CO inhalation depends on both personal activity level and airborne concentrations. Exposures to high concentrations may produce headaches, dizziness, fatigue, and nausea. Although average indoor concentrations of CO are usually less than 2 ppm, levels can reach 5 ppm to 10 ppm inside motor vehicles. Symptoms become clinically apparent when the amount of CO bound to red blood cells, termed carboxyhemoglobin, reaches approximately 10%.

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Sensor Specifications

Model Number	SEN-COM-1
Typical Application	Carbon Monoxide Monitoring or Control
Sensor: TVOCs	
Element	Electrochemical Sensor
Range	0-150 ppm
Accuracy	± 3 ppm or 5% of reading, whichever is greater
Resolution	1 ppm
Response	60 seconds

ORDERING GUIDE		
Sensed Parameter	**Model Number**	**Element**
Carbon Monoxide	SEN-COM-1	Electrochemical Sensor

Carbon Monoxide (SEN-COM-1)

The OptiNet carbon monoxide sensor relies on an electrochemical element with a diffusion cell and an additional reference electrode to measure Carbon Monoxide (CO). The basic principle of the sensor operation is when the CO is in the presence of O2, it reacts with water at the sensing electrode (anode). The flow of electrons between the anode and cathode is proportional to the amount of CO present. To minimize drift that would occur via polarization of the working electrode, a third (reference) electrode is included to provide a constant potential for which the current across the working electrode can be referenced against.

The electrochemical sensor used is very different from sensors used in typical residential CO alarms. Most residential alarms use a metal oxide sensor, a much more insensitive detector for CO that is also susceptible to interference from any volatile organic compounds (VOCs) that may be present. These sensors are typically filled with activated carbon to prevent VOCs from reaching the sensor and casing erroneous readings. Because the air has to diffuse through this bed of activated carbon, the response is much slower that that of the electrochemical sensor.

The sensor features excellent long term drift stability due to the use of a “reference electrode” configuration, and minimal reactivity to other compounds by use of an adsorptive filter that desorbs when in contact with clean air.

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