



## The Building Commissioning Process and the H.V.A.C. System

**What needs commissioning?**<sup>1</sup> HVAC system., Building controls system., Smoke control sys, Life safety systems., Lighting system & controls, Thermal envelope systems, Specialty equipment, Roofing sys.

The **commissioning process** has been described as the hinge between the construction and the use of a building. Implementation of the **commissioning process** for heating, ventilating, and air-conditioning work is the responsibility of the **HVAC** (heating - ventilation - air-conditioning) design engineer. It is simply another step in the design, construction, and acceptance of a building. Constraints to be met include sufficient time, budget and documentation to meet the building owner's expectations. See **VALTRONICS Application Note A41**, **ASHRAE Standard 62-1989R** and ASHRAE Applications Handbook for supporting info.

Traditional functional performance tests include air-handling, testing and balancing, and **VAV** (Variable-Air-Volume) box controls. In addition to these, there is now a requirement to deal with unique systems such as **IAQ** (Indoor Air Quality) sensors or carbon dioxide monitors. The verification process will address the installation location, communication, and calibration of these units. See **App Note A9** for a discussion of **CO** versus **CO<sub>2</sub>** monitoring

**Carbon dioxide (CO<sub>2</sub>)** sensors are located to monitor three (3) key areas. These are:

- **Supply air** to a given zone (a zone may be one or more rooms controlled by an air handler)
- **Return air** from that zone
- **Outside air supply** ( hopefully **FRESH AIR** of about 400 ppm or 0.04% CO<sub>2</sub> by volume)

These monitoring points (usually inside **ducts**, **although fresh air may be sampled remotely**), along with their control signals, will provide a means to maintain acceptable indoor air quality.

A wall mounted area monitor may be installed in a variable occupancy room like a conference room (refer to the diagram on page 4). It can be used in place of, or to supplement, duct mounted supply and return air sensors. Area monitors with digital displays may be used without any connection to a controller or data logger. This would require people to control the fresh air supply.

Communications between the carbon dioxide sensor and the air handling unit are made via a **4-20 mA** current loop. This may be a direct connection or it may require the use of a current-to-resistance or pressure transducer. Sometimes, there will be a communications port directed to an energy management system and/or a data logging system.

**Gas calibration** of the carbon dioxide sensors will be part of the system verification process. The importance of documentation of this phase cannot be overstated. This is the point at which the history of the facility begins and where future maintenance personnel will look for help. See **Application Note A76 for Gas Calibration Guidelines**.

1. *Building Commissioning: Benefits and Costs*, April 1998 HVAC Heating/Piping/AirConditioning p56

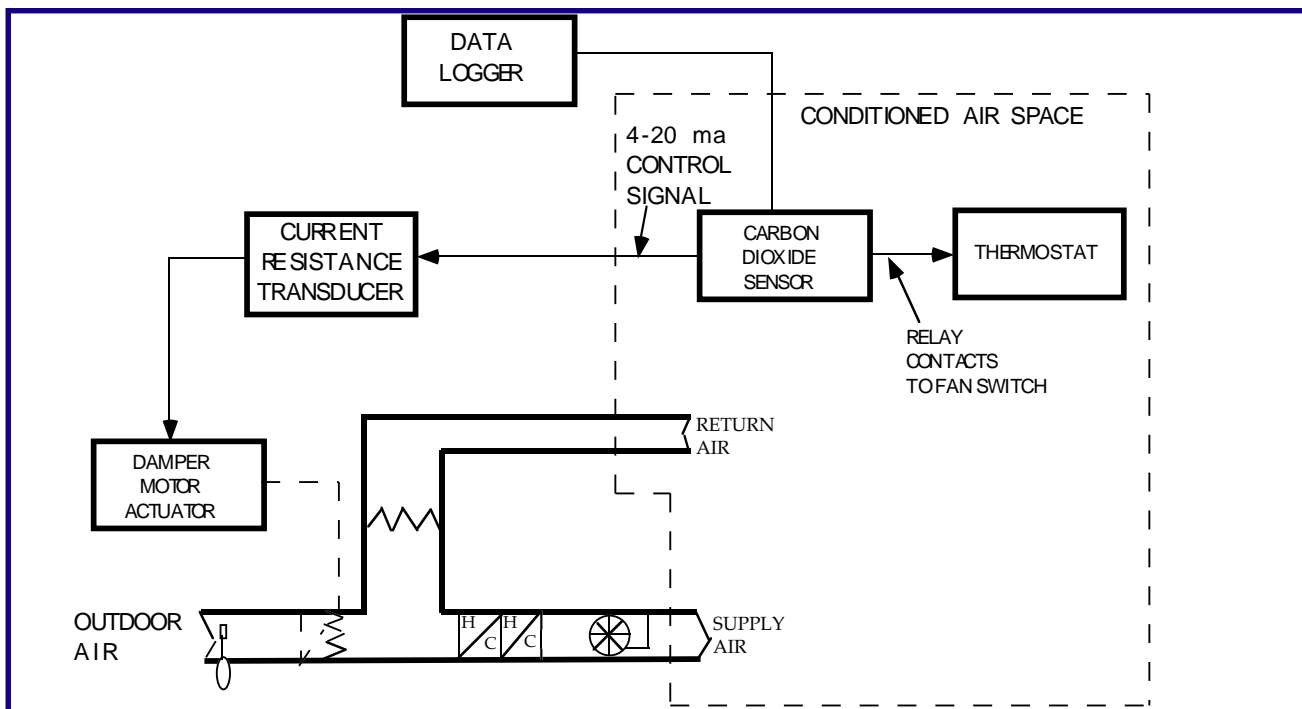


FIGURE 1

Figure 1 shows a typical, single zone HVAC system with a variable-air-volume (VAV) unit, a carbon dioxide sensor, and a damper for outside air.

The carbon dioxide sensor calibration/commissioning process should not be attempted until the HVAC control sequence has been verified. The air-handling unit must maintain temperature set points and all dampers must operate properly.

In our example in figure 1, we have chosen to use a current-to-resistance transducer to operate the remote position control on the damper motor actuator. In addition, we have used the recorder output voltage from the sensor to provide carbon dioxide readings to our energy management data logger. The last connection to the carbon dioxide sensor is to the set point relay contacts. In our example, we will use this relay contact closure to turn on the fan motor in the event that it is not already on. It will additionally provide a flag to the energy management team alerting them of questionable air quality.

In this system, proper damper operation should be verified. When the sensor is challenged with "zero" concentration of carbon dioxide (100% nitrogen is usually used for this purpose), the outside air damper will close to a minimum position. With the application of mid-scale calibration gas (for example: 1000 ppm CO<sub>2</sub> for a 2000 ppm full scale unit) the damper should open to approximately 40% of maximum.

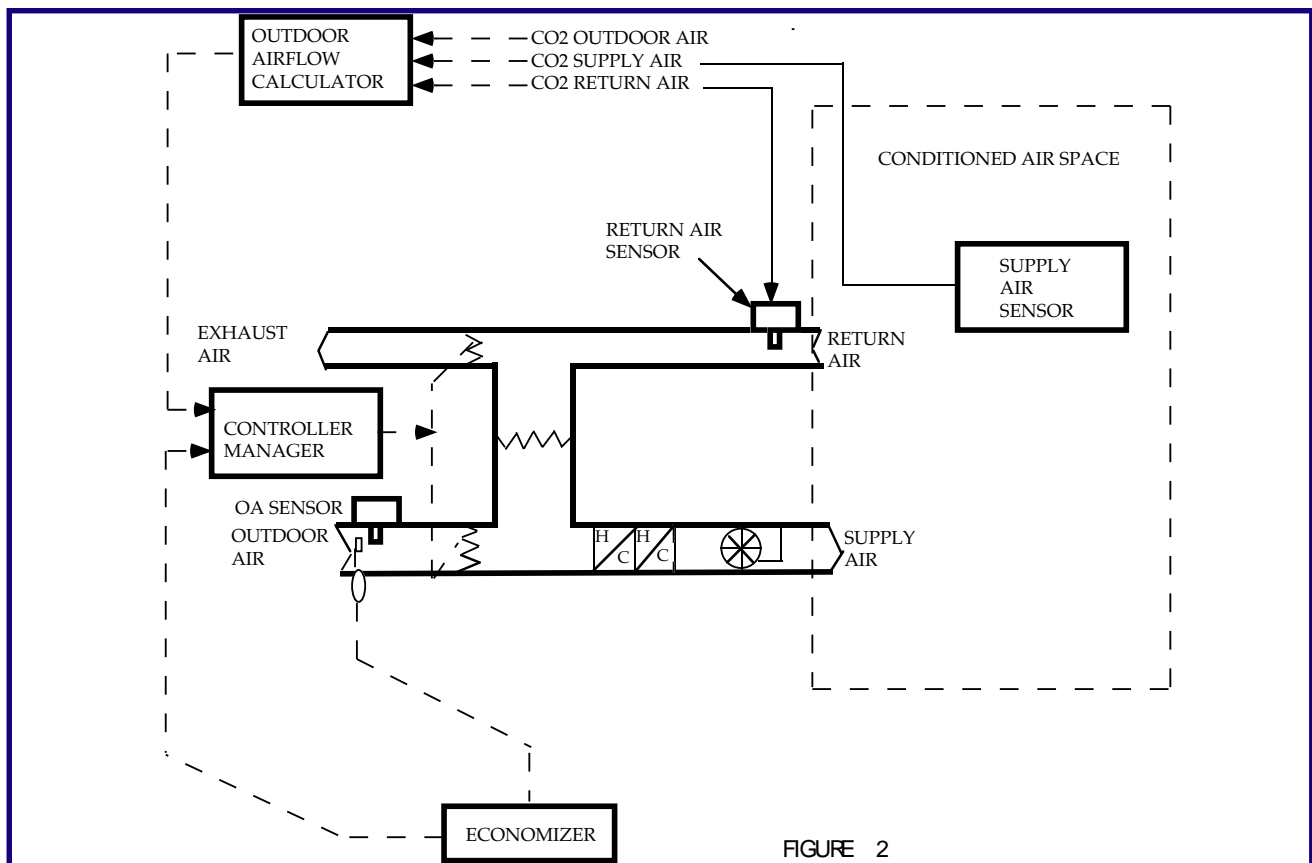


FIGURE 2

Figure 2 illustrates a more traditional HVAC system with carbon dioxide sensors monitoring outside air, return air and supply air. In this more complex system, all communications from the carbon dioxide sensors are directed to the energy management system for control.

In this more complex system, verification of damper operation must be coordinated with the energy management system. For example, when a demand for outside air is initiated by the control system, we can apply a 1000 ppm concentration of carbon dioxide to the outdoor air sensor. This will result in the outside dampers closing to a minimum position. If we then apply a "zero" concentration of carbon dioxide (100% nitrogen is usually used for this purpose) the dampers will open to a maximum position.

Similar tests may be performed on the return air and the supply air sensors.

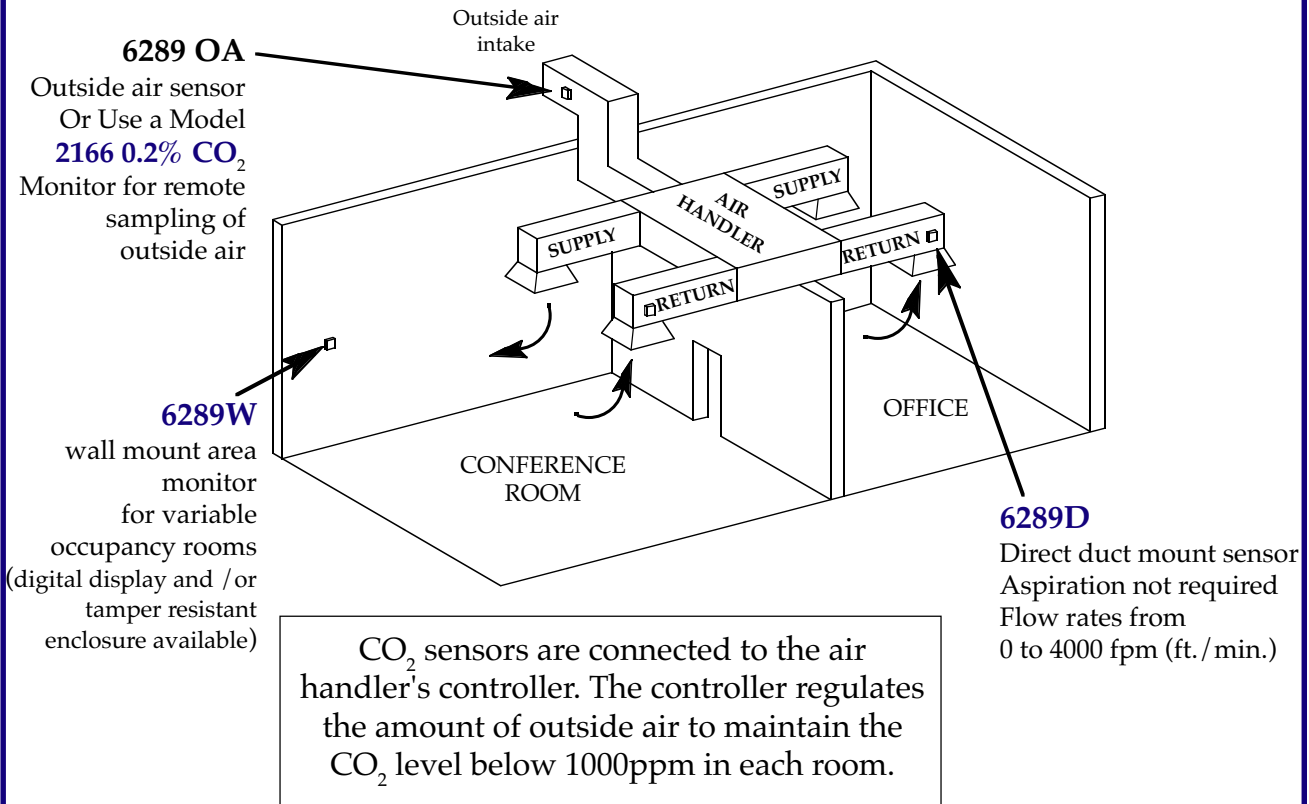
The best method of sensor calibration for both systems calls for the use of a standard gas calibration kit. These are normally available from the sensor manufacturer. By following the gas calibration procedure provided with the kit, a two-point calibration will be accomplished. These two points are usually zero concentration of carbon dioxide and mid-scale. Verification of this process should include both the local indications and point-to-point communications (i.e. verify that the sensor is connected to the proper control device).



CO<sub>2</sub> Sensors

# We make Sense out of Demand Control Ventilation

## Easy to Install • Easy to Maintain



### We'll take care of you before **and** after the sale

- Technical support
- Application solutions
- Calibration tools

Call **VALTRONICS** now to take advantage of our, low pricing and fast delivery!



3463 Double Springs Road • Valley Springs, CA 95252 • (209) 754-0707 • FAX (209) 754-0104

Refer to Application Notes A25 and A26 which explain gas calibration. Note A12 covers the effect of temperature and altitude (atmospheric pressure) on calibration. The following includes most of Application Note A26.

**Purpose:** To record the date the sensor was last calibrated and to measure the stability between calibrations. The time between calibrations (every six [6] months) may be lengthened if very little drift is recorded over two or more calibration intervals. One year is the maximum recommended time between calibration checks.

**Use:** This record of calibration and stability may be very valuable in the case of building inspections. It can be used to show inspectors and/or facilities managers that a calibration program is in effect. It will also show that the sensor is functioning within required specifications and is in compliance with ASHRAE and other building standards.

### Equipment

**Required:** Valtronics Gas Calibration Kit (see App Note A25 for gas diffusion sensors)  
Multimeter capable of measuring 5.00 volt and 4-20 mA current loop output.

Refer to the attached sample gas calibration log form.

1. At the top of the form, record the seven digit lot number (example: 0196001 indicates a unit made in Jan 96).
2. In the first column, record the date that the sensor is checked and calibrated.
3. In the second column, record the ambient air temperature surrounding the CO<sub>2</sub> sensor. This information will help you to evaluate trends in the CO<sub>2</sub> measurements.
4. In the third column, record the zero to five volt (0-5 volt) output signal while flowing nitrogen into the gas calibration tube that is supplied with the sensor. Refer to App. Note A24 (Model 2166 outside air monitor) & A25 (included in our DH Cal Kit) for more detailed calibration instructions. If this is the second time you have calibrated this sensor, compare this reading with the previous one (recorded in the fourth column and previous row - less than 6 months earlier) to check zero stability.
5. If the zero reading is within the  $\pm 0.050$  volt window, do not bother to adjust it. If it is outside of that window, adjust the ZERO (see App Note A51). Record (4th column) the reading at which it finally stabilizes (for example: +0.013 volt).  
Note: 1% of the full scale (or 20 ppm of CO<sub>2</sub>) is equivalent to 0.050 volt on the 0 to 5 volt output.
6. Using certified 1000 $\pm$ 20 ppm CO<sub>2</sub> (balance nitrogen), check and record (in the 5th column) the SPAN response by measuring the 0-5 volt output signal. This reading may be compared with the previous reading that is recorded in the 6th column and previous row (less than 6 months earlier) to check SPAN stability.
7. If the above reading is not 2.50 $\pm$ 0.125 or between 2.375 to 2.625 (950 ppm to 1050 ppm CO<sub>2</sub>), then adjust the SPAN as shown in your instruction manual. Record (in the 6th column) the reading where it finally stabilizes (for example: +2.55 volt which is equivalent to 1020 ppm CO<sub>2</sub>).
8. Columns 7-10 are optional. They are for use with the Level Detect SET POINT and its associated relay contacts to control an air damper or alarm. Three of the four columns are associated with the fixed SET POINTS of 800, 1000, or 1200 ppm (see CO<sub>2</sub> sensor manual). Column 10 is used if you opted to adjust the SET POINT to a custom level. A simple check mark (✓) will indicate that it is functioning. You may not be using the relay contact output connections if you have a computer monitoring the 4-20 mA output of several CO<sub>2</sub> sensors.

