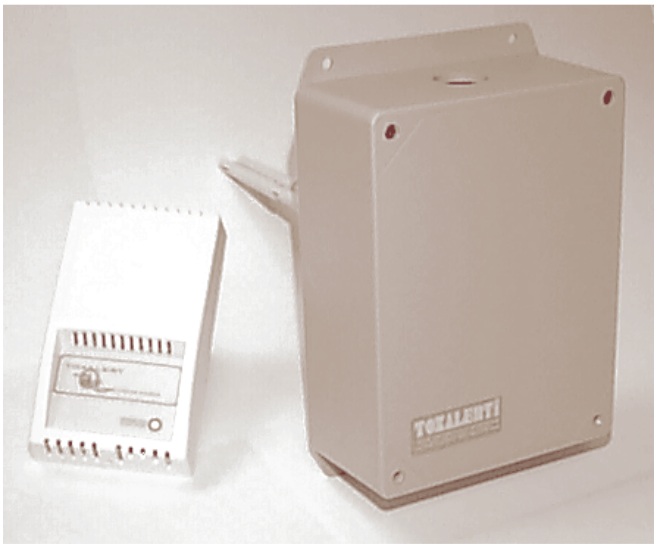
INSTRUCTION MANUAL

Air3000

Air Quality Sensor Series



Sensor Types shown: (Left) Air3000 Space Mount, (Right) Air3000 Duct Mount

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Part Number Designation

AIR-3000 - XX / X

		Output Option
		blank - Analog Stepped Output only
		R - ASO and relay outputs
		A - ASO and analog outputs
		AR - ASO, analog and relay outputs
	Enclosure	
	blank - Space	
	D - Duct	

Series

Introduction

The AIR-3000 Air Quality Monitor uses a tin dioxide semiconductor sensor to detect oxidizable gases and is specially designed to have high sensitivity to gaseous organic materials which are components of indoor air pollutants. These air contaminants include cigarette smoke, smoke from cooking, exhaust gases from automobiles, solvents and many others.

Air quality is a term covering a very broad spectrum of definitions and factors such as temperature, humidity, air flow, occupancy and where the air is used all come into play when determining air quality. The air that is considered to be acceptable in a mechanical work-shop may be quite unacceptable in an office environment.

A reliable method of measurement for air quality is found in a gas sensor based on the Taguchi principle. This gas sensor is essentially a heated element inside a porous semiconductive tube. The tube has a large surface area and is able to freely absorb gas molecules on the semiconductor surface. Electron transfer occurs between the gas molecules and the already absorbed oxygen molecules. This causes a relatively large increase in conductivity for a small change in gas concentration. This change occurs quite quickly (within a few seconds) and is completely reversible. Since the element is a semiconductor Taguchi Gas Sensor and has no moving parts, it will operate reliably for many years. The sensor responds with varying degrees of sensitivity to a wide variety of gasses, which include hydrogen, hydrocarbons, alcohols, carbon monoxide, benzene, etc.

It is readily apparent that this sensor works well in the detection of contaminants such as solvents, but what about carbon dioxide? Although the sensor does not detect carbon dioxide, it is still quite useful in human environments. As well as carbon dioxide; hydrocarbons, body odors and water vapors are emitted by breathing and perspiration. The levels of these other contaminants change at roughly the same rate as the carbon dioxide and the sensor will track these other contaminants at approximately the same rate as the carbon dioxide in occupied spaces.

The AIR-3000 may be used as either a stand-alone controller to detect levels of pollution and operate a clean-air damper directly, or it may be used as a monitor where the analog output signal is transmitted to the Building Automation System for further processing.

Many different environments can be controlled with careful adjustment of the device parameters. This allows the AIR-3000 to function equally well in a school room where the air is to be kept very clean or a utility room where the fresh air requirements are not as stringent.. The Air Quality Monitor can be used to control intake dampers at an airport where jet fumes are periodic contaminants, automatically control exhaust air on an assembly line where epoxies are used or a multitude of other applications.

Some common pollutants, in decreasing order of sensitivity, detectable by the AIR-3000. Most of these chemicals are easily detectable in quantities of 20 ppm or less.

CHEMICAL	SYMBOL	COMMON SOURCE
Methyl Ethyl Ketone	C_4H_8O	Solvents and cleaning products
Acetone	C_3H_6O	Solvents and organic synthesis
Ethyl Alcohol	C_2H_6O	Solvents and liquor fermentation
Formaldehyde	CH_2O	Disinfectants and preservatives
Hydrogen	H_2	Used in synthetics
Methyl Alcohol	CH_4O	Solvents, antifreeze and synthetics
Vinyl Chloride	C_2HCI	Textiles and polymers
Hydrogen Sulfide	H_2S	Water and putrefying matter
Methyl Chloride	CH_3CI	Solvents, paints and refrigerant
Benzene, Toluene, Xylene	C_6H_6, C_7H_8, C_8H_{10}	Solvents and motor fuels
Trichloroethylene	C_2HCI_3	Solvents and cleaning agents
Propane	C_3H_8	Fuels and chemical synthesis
Carbon Monoxide	CO	Combustion of carbon
Freon-22	$CHCIF_2$	Refrigerants and aerosols
Ammonia	NH_3	Solvents and refrigerants
Methane	CH_4	Decomposition and synthesis

Mounting Instruction

The room sensor has mounting provisions to install directly on a standard electrical box and should be mounted at a height about five feet from the floor of the area to be controlled. For best operation, do not mount the sensor near doors, opening windows, supply air diffusers or other known air disturbances.

The duct sensor should be mounted on the outside of a return air duct with the air sampling tube inserted into the duct. Mount the sensor in an easily accessible location in a straight section of duct at least five feet from comers and other items that may cause disturbances in the airflow. Avoid areas such as kitchen fume hoods where oil and grease may contaminate the sensor filter.

Wiring Instruction

The Air Quality Monitor has standard screw block connectors and easy wire access to facilitate wiring. It is recommended that shielded twisted pair wiring at least 22 AWG be used for all connections and that the device wires not be run in the same conduit with wiring used to supply inductive loads such as motors.

The device power (20-30 Vac/dc) is connected to the terminal marked **PWR**. This terminal is used for the positive dc voltage or the hot side of the ac voltage. The device is reverse voltage protected and as such will not operate if connected backwards.

The common of the power supply is connected to the terminal marked **COM**. Note that this device has a half-wave type power supply which means the power supply common is the same as the output signal common. Therefore, several devices may be connected to one power supply and the output signals all share the same signal common. Use caution when grounding the secondary of an ac transformer or when wiring multiple devices to ensure that the circuit ground point is the same on all devices and the controller.

Depending on the model, several output signal options are available from the Air Quality Monitor. The standard model comes equipped with an Analog Stepped Output (ASO) signal which is available on the terminal marked **ASO**. This signal is meant to drive a damper actuator directly in four discreet steps relative to the OK, LOW, MID and HIGH pollution levels. The signal levels are completely adjustable and each step can be set anywhere from 0 to 10 Vdc to accommodate any actuator that will accept a 0- 10 Vdc control signal. Since all steps are completely adjustable, the device can also drive a reverse acting actuator.

An optional output signal is available on the **LIN** terminal. This signal is jumper selectable for either a voltage output or a standard 4-20 mA active output signal type. When voltage mode is selected, the output can also be jumper set for either 0-5 or 0- 10 output voltage range. All of these options are clearly indicated on the device circuit board. The 4-20 mA current output signal operates in the Active mode and does not require a loop power supply. This means that **the signal current is generated by the Air Quality Monitor and must not be connected to a powered input or device damage will result.** Check the controller Analog Input to determine the proper connection before applying power. Both the current and voltage signals are referenced to the **COM** terminal. The analog output signal is typically connected directly to the Building Automation System (B.A.S.) and used as a control parameter or for logging purposes.

A second optional signal is the relay output available on the **NO**, **COM** and **NC** terminals. Note that the relay COM terminal is NOT connected to the signal COM terminal. The relay output is completely isolated and has both Normally Open (NO) and Normally Closed (NC) signals. This signal can be used to directly control an alarm, a ventilation fan or may be connected to a digital input of the B.A.S. for status monitoring.

Power Up Instruction

Verify that the Air Quality Monitor is properly wired and all connections are tight. Apply power to the device and note the status LEDs. Initially the LEDs will flash in sequence (OK, LOW, MID, HIGH and AUTO) to indicate a successful start-up. The device will then enter a three minute warm-up cycle and this is indicated by a flashing AUTO LED and a lit OK LED. This mode will continue for three minutes until the sensor has reached operating temperature.

After the initial warm-up period, the device will enter normal operation. This will be indicated by the AUTO LED being lit and also one pollution level LED being lit (OK, LOW, MID or HIGH).

Note that the sensor is calibrated at manufacture to be suitable for use in average room conditions. **The sensor filter will accumulate dust over a period of inactive time and the sensor must be allowed to burn-in before proper operation.** This time will vary depending on the storage time but the unit will be suitable for pre-commissioning after about 30 minutes. If the device will be re-calibrated, the unit should be powered for about five days before making final adjustments. Note that this time is for the sensor output only and that the ASO signal levels may be set immediately after power is applied.

Operation Theory

The Air Quality Monitor may be operated in two modes, either Automatic or Manual. It is recommended that the device be used in Auto mode for most applications.

In general, the device measures the amount of contaminants in the air and compares this reading to a base level. The base level is established and adjusted automatically for best results in the Auto mode or it can be entered manually by the user in the Manual mode of operation. The comparison of sensor reading to the base level uses a scale factor to determine if the pollution level is considered ok, low, mid or high. In Auto mode the scale factor is set by the user to control the device sensitivity for different operating environments. In Manual mode the scale factor is factory set to a predetermined value and cannot be adjusted.

Manual Mode

The manual mode is selected by using the on board keypad and is explained further in the menu section. In this mode the Air Quality Monitor will operate in the Manual base/Fixed scale mode. In this mode the scale factor (sensitivity) is factory set to 0.5 Volts and cannot be changed by the user. However, the user can set the base level on the keypad. The base level can be set in the range of 0 to 2.5 V and is displayed on the LEDs as the 5 least significant bits of a 6 bit binary number (63 steps) with the OK LED being the LSB. Note that during the set-up step, this voltage level can be measured on the ASO terminal with a DC voltmeter.

The processor measures the sensor output 0 - 5 V signal and compares it to the base level as set above. If the sensor reads a value lower than the base level + 0.5 V the OK LED will be lit, if the sensor reads a value between the base level + 0.5 V and the base level + 1.0 V then the LOW LED will be lit, etc.

For example, if the base level is set by the user to 2.0 V the following settings apply:

OK	Sensor < 2.5 V
LOW	2.5 V < Sensor < 3.0 V
MID	3.0 V < Sensor < 3.5 V
HIGH	Sensor > 3.5 V

This mode of operation is useful if the user wants to pre-set a level of air quality which must be maintained. The scale factor has been optimized for contaminants such as solvents or cigarette smoke. It must be noted that in the manual mode of operation atmospheric changes are not compensated for on the ASO output and if large changes occur a pollution level may be falsely indicated.

Auto Mode

The auto mode (factory default) is selected by using the key pad and the Air Quality Monitor will operate in the Auto base/Manual scale mode. In this mode the base level is automatically adjusted by the program to ensure optimum air quality based on the surrounding environment and the air handling system. The user can adjust the sensitivity of the device by changing the scale factor via the keypad.

The scale factor has a range of 0.05 – 0.36 V and is displayed on the LEDs as the 5 least significant bits of a 6 bit binary number (63 steps) with the OK LED being the LSB. See the following example of an LED sequence. The binary range of the scale factor is (0)00001 to (1)11111 and each count represents 4.9 mV. This value can also be measured on the ASO output terminal.

LED	**Extra Bit**	**Auto**	**High**	**Mid**	**Low**	**OK**
Status	Assumed	Off	On	On	Off	On
Binary	0	0	1	1	1	1
Scale Factor	15 x 4.9 mV + 0.05 V = 0.12 V, 001111 = 15					

The scale factor represents the sensitivity of the device, a smaller scale factor means more sensitive operation and it will take a smaller change in the pollution level to give a change in output state. On power up, the base level is initially set to the current air reading. During operation the device constantly monitors the air quality and compares the contamination level to the base level. If the sensor level falls below the base level, the base level is adjusted after one minute to equal the air level. This one minute interval of checking is indicated by a flashing OK LED. This feature always keeps the base level current to the present cleanliness of the air.

If the sensor level increases above the base level, the degree of pollution is determined by comparing the sensor level to the base level plus multiples of the scale factor. When the pollution level is determined the corresponding LED is lit. This is the same as the example shown for manual mode except the scale factor can be changed by the user on the key pad.

After pollution has been detected the level must drop below the current level for a period of one minute before the output pollution level is updated, this delay helps ensure against false indication. If the pollution level does not decrease within one hour, then the air is deemed to be saturated (cannot be improved with fresh air intake) and the base level is raised to equal the current level and the output is set back to OK.

This cycle is repeated constantly, with the base level being updated as soon as a lower air reading is obtained, to ensure the air quality is kept at the optimum value and that energy efficiency is not sacrificed.

Menu Configuration

The menu may be accessed any time after the initial three minute warmup period. The menu is controlled by using the three buttons on the circuit board labeled MODE, UP and DOWN.

Standard ASO Setup Menu

The standard setup menu has five items as shown below. Pressing the <MODE> switch once while in normal operation will set the operating mode to step 1, pressing the <MODE> switch a second time saves the value set in step 1and advances to step 2. Each press of the <MODE> switch advances the menu item and saves the previous setting to memory. Pressing the <MODE> switch during step 5 will save the value and return to normal operation.

Normal Operation		
<MODE>	1. Set OK	- allows setting of the OK ASO level
<MODE>	2. Set LOW	- allows setting of the LOW ASO level
<MODE>	3. Set MID	- allows setting of the MID ASO level
<MODE>	4. Set HIGH	- allows setting of the HIGH ASO level
<MODE>	5. Set Base/Scale	-allows setting of either the Base level if Manual Mode is selected OR allows setting of the Scale Factor if the Auto Mode is selected
<MODE>	Flashes all LEDs and returns to normal operation	

The standard menu controls the Analog Stepped Output (ASO). A typical application will have the Air Quality Monitor directly connected to drive a damper actuator with the ASO to allow fresh air into the controlled area. Once all connections are made and the warm-up period has elapsed, press the <MODE> switch once. The OK LED will flash to indicate the mode and the ASO terminal will output an analog voltage corresponding to the OK pollution level. This signal defaults to about 2 V and will drive the damper to open slightly to allow a minimum amount of fresh air into the area. To modify this value simply press the <UP> or <DOV,'N> key to increase or decrease the output signal while watching the damper position. The value will be indicated on the LEDs as a 5 bit binary number for future reference. When this adjustment is complete, press the <MODE> switch to save the value and advance to the next item.

Note that all values entered are saved in non-volatile memory and will be restored correctly in case of a power failure. The factory defaults and adjustment ranges are shown in the following table. The LOW, MID and HIGH levels are set in the same way.

Standard Menu Values

Menu Mode	Default Value	ASO Output Range	LED Status
Ok	2 V	0 – 10 V	flashing OK, value shown in binary 00000 – 11111
Low	4 V	0 – 10 V	flashing LOW, value shown in binary (0 – 31 decimal)
Mid	6 V	0 – 10 V	flashing MID, value shown in binary as above
High	8 V	0 – 10 V	flashing HIGH, value shown in binary as above
Base Level	1.8 V	1 – 3.5 V	value shown in binary, only for Manual Mode (0)00000 – (1)11111
Scale Factor	0.12 V	0.05 – 0.36 V	value shown in binary, only for Auto Mode (0)00001 – (1)11111

The Base Level or the Scale Factor menu item is selected automatically depending on the operation mode (Manual or Auto) and is displayed as a 6 bit binary number on the 5 LEDs. The voltage value is also output on the ASO terminal for verification. These levels set the sensitivity of the sensor to contaminants and can be adjusted accordingly. For the standard Air Quality Monitor, the setup is now complete.

Linear Output

The optional linear output terminal provides either a 0-5 Vdc, 0-10 Vdc or 4-20 mA signal to the automation system to represent the degree of pollution. This signal is temperature compensated to provide an accurate and reliable method of tracking the air contaminants. The output signal type is selected via clearly marked jumpers on the PCB. The output voltage or current span represents a level of pollution between 0 and 100%.

Relay Output

The optional relay output terminals provide a Form C relay contact for on/off status indication. The relay has two operational modes which may be menu selected.

The relay may be set to operate in conjunction with the ASO signal which has four distinct levels (OK, LOW, MID and IRGH). In this mode the relay trip level is set to be either LOW, MID or HIGH and when the ASO pollution level reaches the trip level the relay will be energized. For example, if the relay trip level is set to HIGH then the relay will energize whenever the ASO also indicates a HIGH pollution level.

The relay may also be set to operate in conjunction with the analog Linear output signal if this option is installed. In this mode the relay trip level can be set anywhere between 1 and 4 Volts on the 0-5 Vdc output range (20 - 80 %). The other output signal ranges are scaled accordingly as shown in the following section. In this operation mode the relay will energize when the linear output signal exceeds the preset trip level. The amount of relay hysteresis may also be programmed via the menu.

Configuration Menu

The Configuration Menu is used to set the operation mode, relay modes and for calibration. This menu is accessed during normal operation by pressing and holding the <DOWN> key and then pressing the <UP> key (then release the keys). This menu is explained below.

<DOWN> (hold key) <UP> Release keys (enters configuration menu)

1. Manual/Auto - selects the operating mode, use the <UP> or <DOWN> key to select, if the AUTO LED is lit then Auto Mode, if AUTO LED is not lit then Manual Mode, the OK and LOW LEDs flash to indicate this step

<MODE>

2. Relay Select Mode sets the relay operation mode as described above, the <DOWN> key selects ASO mode (indicated by a flashing HIGH LED) and the <UP> key selects the Linear mode (indicated by a flashing MID LED), the Linear mode will only function if the hardware Option is available.

<MODE>

3. Relay Level - if ASO mode is selected can select either LOW, MID or HIGH levels (indicated on LEDs) by using <UP> or <DOWN> keys
- if Linear mode is selected can set the level between 1 and 4 V on the 0-5 Vdc range (indicated as a binary number on LEDs) and also output to the Linear output terminal

<MODE>

4. Relay Hysteresis - if Linear mode the relay hysteresis can be set between 0 and 0.6 V on the 0-5 Vdc output range to prevent relay chatter, this is shown on the LEDs and output to the Linear output terminal

<MODE>

5. Air Offset Calibration - this menu item allows calibration of the air quality sensor but not usually adjusted by the installer, the calibration value is output on the ASO terminal.

<MODE>

6. Normal Operation - flashes all LEDs and the device returns to normal operation

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Configuration Menu Values

Menu Mode	Default Value	Linear Output Range	LED Status
Manual/Auto	Auto	n/a	AUTO LED indicates status OK and LOW flash
Relay Mode	ASO	n/a	ASO (HIGH LED flashes) Linear (MID LED flashes)
Relay Level	ASO – HIGH	n/a	LOW, MID or HIGH LED is lit
	Linear – 2.5 V 5 V 12mA	1-4 V on 5 V range 2-8 V on 10 V range 7.2–16.8 on 4–20 mA range	value shown as 5 bit binary
Relay Hysteresis	0.3 V 0.6 V 0.97 (4.97) mA	0-0.6 V on 5 V range 0-1.212 V on 10 V range 0-1.94 (4-5.94) mA	value shown as 5 bit binary Only for Linear Mode
Air Offset Calibration	Factory Cal Approx. 1.75 V	Sensor output +/- 0.6 V on ASO	6 bit binary value 0-50 00000 to 11111 to (1)10010

Specifications

Measurement ……..	Solid State TGS-800 VOC sensor
Sample Method ……..	Diffusion or flow through, sample tube for duct
Power Supply ……..	20 - 30 Vac/dc
Consumption …….....	100 mA @ 24 Vdc, 220 mA @ 24 Vac, 6VA Max.
Input Voltage Effect ……	Negligible over specified operating range
Protection Circuitry …….....	Reverse voltage protected and output limited
Operating Conditions …….....	0-40 °C (32-104 °F), 0-95 %RH non-condensing
Standard Output Signal ……..	Analog Stepped Output (ASO) in four steps representing Ok, Low, Mid and High pollution levels (each step is independently adjustable from 0- 10 Vdc)
Optional Output Signal ……..	Linear output representing 0- 100 % pollution level, jumper selectable for either 0-5 or 0- 10 Vdc or 4-20 mA, the current signal is generated by the sensor (active)
Output Drive Capability…….	500 Ω maximum for current output, 10 KΩ minimum for voltage output
Optional Relay Output….....	One Form C contact (N.O. and N.C.), status LED, 5 Amps @ 250 Vac, 5 Amps @ 30 Vdc, p.f = 1
Display ……..….	5 LEDs indicating pollution level, operational mode and programming values
Programming and Selection……	Via internal push-buttons and jumpers
Wiring Connections ……	Screw terminal block (14 to 22 AWG)
Enclosures……	Space mount enclosure 2.75"w x 4.65"h x 1.25"d (70 x II 8 x 32mm) Duct mount enclosure with sampling tube 4.8"w x 7.2"h x 2.2"d (122 x 183 x 56mm)

Wiring Diagram