Interfacing the PID-A1 and PID-AH

This Application Note explains how to connect electrically and mechanically the PID to your gas detector.

Supply voltage

The PID-A1 and PID-AH measure volatile organic compounds (VOCs) in air by photoionisation detection (PID), which is shown schematically below. Test gas (1) is presented to the membrane filter at the top of the photoionisation cell and freely diffuses into and out of the underlying chamber formed by the filter, housing walls, and a UV lamp window. The lamp emits photons (shown by arrows) of high energy UV light, transmitted through the window. Photoionisation occurs in the chamber when a photon is adsorbed by the molecule, generating two electrically charged ions, one positively charged, X+, and one negatively charged,

Y- (2a). An electric field, generated between the cathode and anode electrodes, attracts ions (2b). The resulting current, which is proportional to the concentration of the VOC, is measured and used to determine the gas concentration. The PID-A includes a third fence electrode (patented) to ensure that the amplified current does not include significant contributions due to other current sources such as water condensation on the chamber walls.

Selecting the right supply voltage

Select the best supply voltage to optimise performance for your application:

All lamps are tested to operate at a minimum supply voltage of 3.0 V before they leave the factory. However, as lamps age, the minimum operating voltage slowly increases until the lamp requires a voltage higher than the voltage rail supplied and thus do not illuminate. VOC gas sensitivity is also degraded by lower light intensity.

Alphasense recommends that the voltage is between 3.0 and 3.6V when you are supplying the regulated voltage (onboard regulator is disabled) and between 3.6 and 6VDC when the on-board regulator is enabled.

A higher supply voltage will give a brighter light and thus greater VOC gas sensitivity but will cause the output voltage linearity to decrease more quickly at higher gas concentrations within the PID-A1; the PID-AH dynamic range is too narrow for this to be a problem. Logically, a lower supply voltage will give less VOC gas sensitivity but will give a more linear output signal to allow high gas concentrations.

The more adventurous user may wish to use the lamp out detector in an external feedback loop and then steadily increase the voltage rail to compensate for an older lamp over thousands of hours of use. All this flexibility was designed into the product to be exploited by the OEM designer.

Power-up surge

While the PID takes only 33mA ± 7mA under normal operation, there is a power-up surge of about 120mA (maximum) for about 300 ms while the PID seeks resonance, thus consuming more current at power-up.

Power supply stability

When the on-board regulator is disabled, your DC power supply must be stable to within ±10mV (high frequency spikes can be 10 times greater than this). This will ensure that the digital drive circuit for the rf lamp oscillator remains in resonance, maintaining a stable lamp intensity.

Analogue output

The analogue output voltage range is from 0.0 V to (Vsupply – 0.1V); however, the VOC gas analogue output signal is scaled from 50 mV to (Vsupply – 0.1V) because:

a. The input amplifier has the best input bias current characteristics when biased at +50 mV.

b. This allows the OEM amplifiers to operate with their inputs above 0V for more flexibility.

c. This allows use of error status signal levels below the normal 50 mV base signal level. One of the major problems with all PIDs is that they do not fail safe: if the lamp does not illuminate then zero signal is interpreted as a clean environment. This problem has been addressed in the PID-A1 and PID-AH by including error status levels that are buried below the normal 50mV offset for alarm indication. These error status levels are listed below. With the PID-AH, this feature is normally disabled to avoid lamp-out signal in very clean environments (e.g. testing with zero air).

Error states (units shipped beginning 2009)

Normal operation: signal output is between 50mV and (Vsupply – 0.1 V). Voltages below 50mV indicate an error condition:

32 (±4)mV indicates lamp out, but oscillator operating correctly. Change or clean lamp.

22 (±6)mV indicates the oscillator is not working. Change PID-A1/ PID-AH or electrode stack.

2 (±2) mV indicates power removed. Fault in OEM supply voltage.

Note: Voltages outside these limits are not rigorously defined.

Zero offset correction

When determining VOC concentration, you must first subtract 50mV from the PID-A1 signal, and at least 55mV from the PID-AH signal. The increased current above the 50mV minimum for the PID-AH is due to amplified electrode stack leakage current. This current may increase to 65mV if the PID-AH is dirty, and the PID-A1 offset current may increase to 52mV when the cell is dirty. The best way to zero this offset voltage is to apply clean gas and set the zero.

Temperature correction

Increasing temperature increases slightly the PID sensitivity. At 50°C the sensitivity is about 1%higher than at 20°C. Likewise, at -20°C sensitivity will be 3% less than at 20°C. This error is negligible and temperature correction can be ignored in all but the most demanding applications.

Circuit implementation

Warning: For intrinsically safe circuits, please consult Application Note AAN 303.

Mechanical

The electrical and mechanical considerations have been simplified by designing compatibility with the standard LEL sensor configuration. Thus, it is possible to plug the PID into a standard, 20mm diameter LEL sensor position. The PID detector will operate correctly, provided the OEM external signal conditioning circuit can operate under the stated output specification range of the PID. This usually means disabling the balancing arm of the pellistor Wheatstone bridge.

Sealing the PID

The PID is designed to provide a good sealing area on the top face of the PID. It is important that when measuring VOCs with a pump, your sampling line is well sealed to the PID. Refer to the data sheet to ensure that you are sealing properly the PID without covering the gas access area.

The sealed cavity is defined by the window face at one end, an O-Ring located around the outside of the window sealing to the volume that contains the electrode stack arrangement through the PTFE filter up onto the front face. It is at this front face the OEM designer must seal upon, ensuring that the seal lies within the three segmented arcs visible on the front face. This gives a very small cavity of about 15 mm3 that opens up many exciting possibilities for analytical work in pump drawn systems.

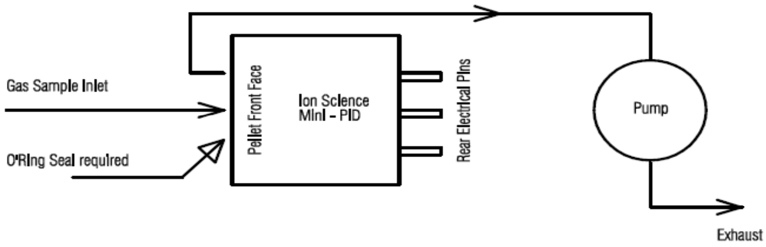
Due to the potential for minor leakage through the layers within the cell, do not exceed 5kPa differential pressure between the PID and the gas detector internal cavity to ensure good signal integrity.

CAUTION: Ensure that the lamp is firmly pushed up against the underside of the visible electrode. If the lamp does not firmly abut the electrode, the user will experience severe degradation in accuracy. Incorrect abutment will also cause a loss in pneumatic sealing.

Suggested Pneumatic Installation

May be used in open aspirated system or natural diffusion applications.

Also opem/closed pumped systems at pressures other than atmosphere (< +/-50 mbar, 5 kPa gauge).



Note: Gauge pressures > +/-50 mbar, kPa will progressively dilute sample.

PCB layout for EMC noise reduction

To optimise the performance out of the PID it is recommended that micro-strip layout techniques be used to reduce susceptibility to EMC noise:

- To minimise externally created noise superimposing itself onto the signal, the lines should be located close to the ground plane, balanced and directly coupled to a differential input Analogue-to-Digital Converter (ADC) or differential input amplifier.
- A separate signal 0V line should be connected direct to the 0V pin of the PID and run parallel with the signal line to the differential input ADC or amplifier. This single pair of signal lines should ideally be located between two ground planes or at least run for its full length directly over the top of a ground plane.
- Since the PID responds in 50-100ms, you can include an RC network on both signal lines located directly at the input of the differential input ADC or amplifier to remove 100Hz (and higher frequency) noise.
- To achieve maximal noise reduction it may be beneficial to house the entire PID-A sensor in a Faraday cage, which should be electrically connected to the ground plane.