GrayWolf Tech Notes

PID Sensor (for measuring Total Volatile Organic Compounds) Usage and Troubleshooting Guide

Relevant Products: IQ610, TG502, TG503 Probes

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PID Theory of Operation

Total Volatile Organic Compounds (TVOC) can be measured using a Photo Ionization Detector (PID). The PID sensor is comprised of filter membrane, a ultra-violet lamp and a detector electrode. Gas passes through the filter membrane to exclude particles and liquids, and is exposed to high energy ultra violet (UV) radiation which ionizes some percentage of the molecules. Some of the molecules are converted into either positively or negatively charged ions. These ions are measured by a collection electrode and converted into a current corresponding to a concentration. This relationship can be seen below:

$M + \gamma \rightarrow M^+ + e^-$

Where:

M= Target Molecule

γ= Photon

In order for a molecule to be ionized by the UV lamp, the ionization potential (IP) must be lower than the energy of the UV lamp. GrayWolf utilizes a 10.6 electron volt (eV) lamp, so anything that has a higher ionization potential will not be detected. Major components of air such as nitrogen, oxygen, methane and carbon dioxide have a higher ionization potential then the UV lamp so they are not detected by a PID sensor, as can be seen in table below. Because PIDs are not affected by the ambient air, they are used for total volatile organic compounds (TVOC)

Compound	IP (eV)
Nitrogen	14.54
Oxygen	13.61
Carbon Dioxide	13.79
Methane	12.98

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Getting Accurate Readings with your GrayWolf VOC Probe

The PID sensor is a very sensitive device. Proper care, storage, use and calibration of the PID sensor is required to yield optimal results for this product; whether your application is for low range applications, such as IAQ testing, or for high range toxic exposure screening.

Warm-up

A 20-minute warm-up and stabilization time should be sufficient for most applications. If the sensor readings are pinned at zero or are continuing to rise (or to fall) while in a stable environment, the probe may require additional warm-up time, calibration or an overnight burn-in (see Troubleshooting, Burn-In sections below).

Storage

The probe should ideally be stored in a closed plastic bag (one that doesn't emit VOCs) with one or two small desiccant packs.

For long term storage (> 2 weeks) remove the batteries. Note that probes fitted with Nitric Oxide or Ethylene Oxide sensors will require 12 hours, once probe batteries are reconnected, before use.

Storage in humid conditions greater than 60%RH may cause sensor drift, and cause long stabilization times. However, the standard 20 minute warm-up, prior to recalibration and use, should minimize high %RH storage bias.

If the sensor has been stored for a significant amount of time, it may become contaminated. This in turn may cause excessive drift of the background signal. Therefore, it is highly recommended (for ppb range sensors in particular) to run the sensor for an extended period of time before operating it after prolonged storage. Refer to the section on Contamination and Burn-In for more information.

Use

Don't blow directly on the sensor. Do not use the probe in high humidity (>90%RH) environments as condensation moisture that may result could degrade performance. At humidity's above 80%, sensor response becomes sluggish longer stabilization times are required.

Allow the probe to equilibrate to the ambient room temperature before using. Do not use the probe if you observe condensation or moisture on any part of it.

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Calibration

As a rule, calibration of the sensor at the start of each day that it is used is recommended; and daily calibration is always recommended for toxic exposure screening applications. Check the drift for your specific application with a User Calibration or Bump Test. If the sensor is used for low level exposure testing, and the environment tends to be clean, you may find that calibration frequency can be reduced to just once a week or even to longer intervals (although never more than 30 days).

Before calibration, it is very important to power the probe for at least 20 minutes. This time will be longer if the probe has been stored in very high humidity or exposed to high levels of contaminants (when in doubt, power it up overnight ahead of use).

Be sure that the readings have stabilized and are not continuing to rise/fall before attempting to calibrate. Small amounts of fluctuation in the readings are normal prior to calibration but an upward or downward trend is not.

To speed up the calibration procedure and minimize the use of your calibration gas, it is recommended that the outlet of the calibration hood (gas flow) is directed facing the PID sensor. The sensor can be identified on the probe by looking through the metal grate on the upper half of the probe with a label directly on the sensor stating “PID”. Please contact GrayWolf for details if the position of the PID sensor is not obvious to you.

If the TVOC readings lock on zero after the calibration, it may be necessary to adjust the low cal edit point to 50-100ppb. The specification for the Scott® Gas HC Free Air supplied by GrayWolf guarantees less than 100ppb THC, and may not be precisely at zero. If the ambient conditions have very low TVOC concentrations, then it is possible that the ambient conditions are lower than the HC Free Air which will force a negative value, causing WolfSense to display zero.

Background Readings

Ambient air, absent unusual pollutants, will typically read 50 to 400 ppb due to the “typical” background levels of VOCs and other ionizing compounds, although higher levels are not uncommon in indoor air.

Contamination

In polluted environments, excessive lamp window contamination can substantially degrade the sensor's performance, especially the low range ppb sensor.

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If the sensor is being exposed to dirty samples (containing heavy compounds and/or particles), the lamp window will get contaminated. The rate of the window contamination is a function of the sample gas condition, i.e. how badly it is contaminated with chemicals and particles. Contamination of the lamp window can cause partial UV light blocking, which in turn will rapidly reduce the detector's sensitivity. In this case, more frequent calibration is needed.

If the sensor has been stored for a significant amount of time, it may have become contaminated. This in turn may cause excessive drift of the background signal.

Burn-In

To correct most contamination and high humidity exposure problems, an overnight burn-in should be sufficient. During this time, the detector will clean itself and the baseline signal will drop and stabilize.

To perform a burn-in, the probe must be powered on. Hook the probe up to the AdvancedSense, WolfPack, SoMo, Ultra-Mini PC, Tablet PC or LapTop PC that is running WolfSense software. Power the device display device via its AC adapter. Older (pre-Nov 2008 probes) will need to have remaining battery power checked *or* to be powered via a GrayWolf *probe* AC adapter (probes purchased since Nov 2008 can automatically switch to drawing power from the datalogger when their batteries run low).

Note: Excessive contamination may required longer burn-in times (up to 48 hours), or lamp replacement. If you suspect your sensor is significantly contaminated, contact GrayWolf for additional assistance.

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Troubleshooting

Symptom:	Solution:
Readings are pinned at zero, sensor appears non-responsive -or- Zero reading, Check Cal icon is present on-screen.	Perform a quick "Sensor Response Test" (see section at end of this document) to verify sensor is responding. If sensor is responding but the reading then returns to zero, the sensor should be recalibrated. Note that it is normal that PID sensors will drift over time, and calibration each day that you utilize the equipment is recommended (although you may find from experience that weekly or even broader calibration intervals are sufficient for your specific application). Take care that calibration is not rushed, before probe stabilizes, as this could yield readings below zero (WolfSense will lock at zero and will not display negative numbers). Conservatively, allow the probe to warm up for an extended time period, and then recalibrate. It may be necessary to restore the factory default settings to erase any user calibration values that are causing unusual readings before another calibration is performed. Position the gas outlet from the cal hood directly at the PID sensor and make sure the reading on gas has stabilized before accepting the calibration (may take up to 10 minutes). If the TVOC readings respond to the Sensor Response Test but continue to lock on zero *after* the calibration, it may be necessary to adjust the low calibration edit point to 50-100ppb. The specification for the Scott® Gas HC Free Air supplied by GrayWolf guarantees less than 100ppb THC, and may not be precisely at zero. If the ambient conditions have very low TVOC concentrations, then it is possible that the ambient conditions are lower than the HC Free Air which will force a negative value, causing WolfSense to display zero. If there is no response during the Sensor Response Test (and you are certain you haven't used a water based product, rather than an appropriate alcohol based product or VOC containing product for your test), it is likely that the lamp in your PID sensor has failed. Contact GrayWolf or a GrayWolf authorized distributor for a Return Authorization Number to initiate PID lamp replacement.

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Symptom:	Solution:
Readings will not stabilize.	Be patient, especially with the PID sensor which is a very sensitive sensor. Try to avoid sudden temperature or %RH changes which will result in longer stabilization time. Each time the sensor is powered on, tiny amounts of contamination, which accumulate on the lens and lamp while the probe is powered down, are burned off. The stabilization time will vary depending on contaminant and moisture exposure during storage conditions. If possible, store the probe in a clean, low RH environment with desiccant to minimize the stabilization time.
Sensor readings are not as expected.	It may be necessary to restore the factory default settings to erase any user calibration values that may be causing unusual readings before another calibration is performed. Perform a quick “Sensor Response Test” (see section at end of this document). If sensor is responding, but the reading then returns to zero, the sensor should be recalibrated.

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Sensor Response Test

You can use readily available retail/commercial products to perform a simple response test of the PID sensor. This will verify the basic operation of the sensor but will not verify that it is properly calibrated.

Suitable commercially available substances for Sensor Response Tests:

Product	Contains	Suggested Use
Sharpie® Permanent Markers	Alcohols. May also contain ethylene glycol monobutyl ether	Wave the marker near the slotted openings in the probe. Do not insert marker inside the probe.
Windex® Glass and Multi-Surface Cleaners	detergents, solvents, fragrance, Ammonia and alcohol	Spray some Windex on a paper towel (or use pre-treated wipes) and wave probe several inches above the towel or wipe.
Purell® Hand Sanitizer	Ethyl Alcohol Also: Glycerin, Isopropyl Myristate, Propylene Glycol, Tocopheryl Acetate, Aminomethyl Propanol	Place a drop on a paper towel and wave probe several inches above towel.
PaperMate® Liquid Paper	Naptha	Wave the (wetted) dabber near the slotted openings in the probe.
Kensington® Surface Guardian Computer Screen Cleaner	Isopropanol and ethanol	Wave probe several inches above moist towel/wipe.
Rubbing Alcohol (any brand)	Alcohol	Dip a cotton swab in the alcohol and position it close to the probe slit closest to the PID sensor.

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Important: Do not spray or apply the product directly onto the sensor; do not immerse the probe in a container of the product; and do not insert anything inside the probe housing as you may contaminate or permanently damage the sensor or electronics.

Bump Test

You can perform a bump-test of the sensor to verify its calibration by exposing the sensor to a known concentration of test gas. Using the regulator and hood supplied with the GrayWolf Calibration Kit, attach a cylinder of gas and start gas flow. After 5-10 minutes, the readings should stabilize. If the reading is within an acceptable tolerance range of the actual concentration as shown on the gas cylinder label, then its calibration is verified. If the bump test results are not within the acceptable range, a full user calibration must be performed.

For ppb range PID sensors, zero readings should be within +/- 100 ppb, span readings within +/- 10 of the cal gas value (i.e. for 7.5 ppm isobutylene; +/- 750 ppb).

For ppm range PID sensors, zero readings should be within +/- 1 ppm, span readings within +/- 10% of the cal gas value (i.e. for 3500 ppm isobutylene; +/- 350 ppm).

Note: These ranges are provided as a guideline.

User Cal (recommended over Bump Test)

Essentially the same procedure as a Bump Test, except that you follow the User Calibration instructions on WolfSense, to not only check, but also adjust the readings to match the calibration gas. As long as you are already expending the known reference gas, and as GrayWolf makes User Cal so simple, you might as well adjust the reading!

Factory Cal

Annual calibration at a GrayWolf facility or at a GrayWolf *authorized* calibration lab for the PID (and all other sensors) is recommended for optimal performance.

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