piD-TECH® *plus*
Photoionization Sensor

User's Manual

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Introduction

The purpose of the Manual is to familiarize the customer with the piD-TECH® plus photo ionization sensor, including principle of operation, technical characteristics, as well as some PID-specific application features. The Manual will instruct customers to easily incorporate Baseline's sensor into their instrument.

Section 1 - PID Principle of Operation

The Photoionization Detector (PID) is one of the most widely used gas detection techniques. The main field of PID application is portable instruments for detection of a wide variety of organic compounds and some inorganic gases in ambient air.

A typical PID block diagram is shown in Figure 1-1. Molecules of interest (1) are being exposed to high-energy Vacuum Ultra Violet (VUV) radiation (2), generated by the gas discharge lamp (3). As a result, some percentage of these molecules is being ionized, i.e. converted into positively charged ions and negatively charged electrons according to the following equation:

$$\mathbf{M + photon \dashrightarrow M^+ + e^-}$$

To be ionized, the molecule **M** should have its Ionization Potential (IP) smaller than the energy of UV lamp photons (E). As a rule, the bigger the difference is between E an IP, the larger the detector's response. Both E and IP are usually measured in electron-volts (eV). For the Ionization Potentials of various chemicals, refer to Appendix section of this Manual.

PID lamps are typically available with nominal photon energies between 8.3 and 11.7 eV. The piD-TECH® *plus* is equipped with a 10.6 eV lamp.

The pair of electrodes (4, 5) is located in the ionization volume near the lamp window. The polarizing electrode (4) is connected to the High Voltage DC source (7), the signal electrode (5) is attached to the amplifier (6) input. The electric field, created by these two electrodes, forces both electrons and ions to drift towards their respective electrode, creating a small current. This current is amplified by the amplifier chip and the output analog signal is recorded and/or displayed in digital or analog format. The output signal is proportional to the concentration of ionizable molecules in detector's chamber and thus serves as a measure of concentration. Major air components (N2, O2, CO2) have ionization potentials greater than the UV lamp and therefore are not detected. For this reason, PID is very useful for detection of a wide range of VOCs (Volatile Organic Compounds) in ambient air, down to the low-ppb concentrations, without interference from air components.

The gaseous sample is typically being delivered to the detector chamber either by pump, or by a diffusion process.

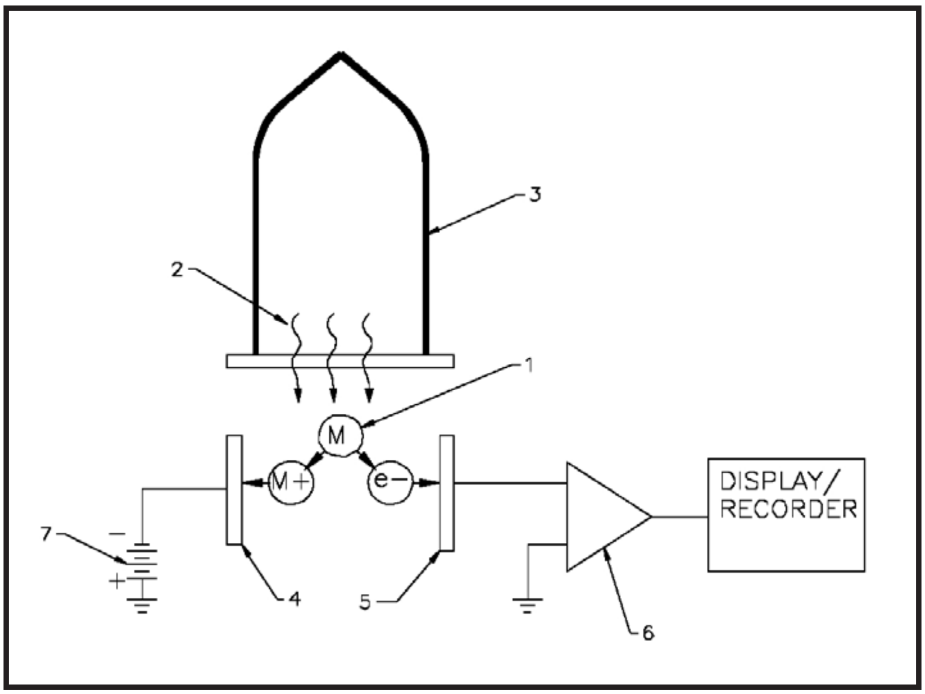


Figure 1-1 PID Principle of Operation

Section 2: Design Overview

Design Overview

piD-TECH® *plus* is designed to be mechanically interchangeable with major brands of electrochemical sensors. Therefore, it can be installed in any portable and stationary gas monitor that accepts, for example, City Technology 4P cells.

The sensor consists of a plastic housing, fitted with a removable cap on the top and three pins for electrical connections in the bottom (Figure 2-1).

The purpose of these pins is as follows:

- Positive power voltage is supplied to the sensor via pin #1
- Negative power voltage is supplied to the sensor via pin #3
- Signal voltage is delivered to outside electronics via pin #2

In the plastic cap, there is an opening that serves as an entrance port for analyzed gas (designated on the diagram as "Sample Port"). Under this cap are two filters that prevent liquids as well as particles from entering the detector cell.

The photo ionization detector and associated electronic circuits are located inside the housing.

The sensor's embedded electronics provide:

- Power supply for lamp ignition
- DC Voltage for detector operation
- Detector signal amplifier

The detector consists of an ultraminiature UV lamp with photon's nominal energy of 10.6 eV, and detector cell.

Refer to Appendix III for serviceable items and instructions.

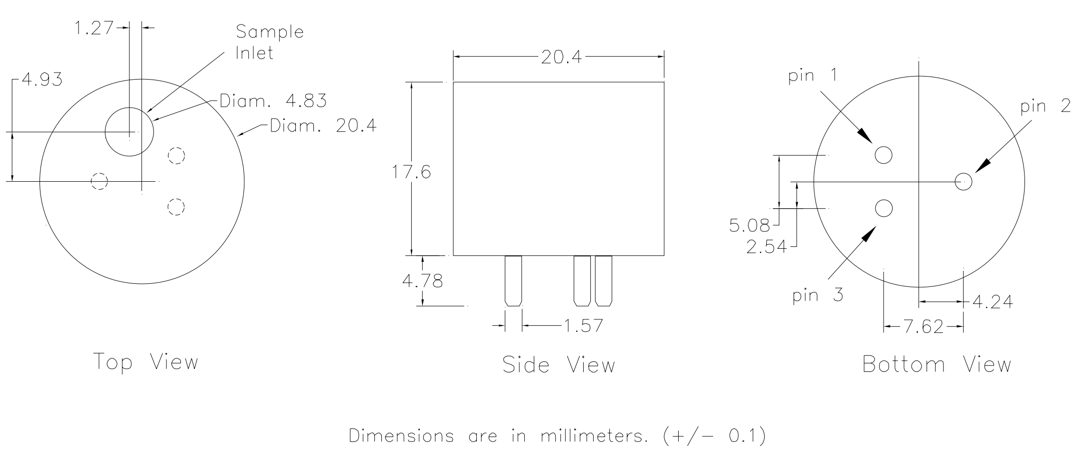


Figure 2-1 Mechanical Layout

Section 3: Specifications

3.1 Performance Characteristics

Target Gases: VOCs and other gases with Ionization Potential $\leq$10.6 eV - See Appendix I for an Ionization Potential list.
Lamp Energy: 10.6 eV
Range:
ZPP6018001 (Black Label) 2000 ppm Isobutylene
ZPP6018002 (Silver Label) 20 ppm Isobutylene
Minimum Detectable Quantity:
ZPP6018001 (Black Label) 0.1 ppm Isobutylene
ZPP6018002 (Silver Label) <0.01ppm Isobutylene
T90 Response Time: < 20 seconds (diffusion mode)
Temperature Range: -20 °C to 40 °C
Relative Humidity Range: 0 to 90% non-condensing
Humidity Response: < 1ppm @ 90% r.h.
Humidity Quenching Effect: < 15% @ 90% r.h.
Onboard Filter: To remove liquids/particles

3.2 Electrical Characteristics

Supply Voltage: 3.2V - 10V
Current: 20mA - 30mA
Power Consumption: 64mW - 300mW dependent on supply voltage
Output Signal: 0.05V - 2.5V

3.3 Physical Characteristics

Weight: <8 g
Package Type: City Technology™ 4p
Position Sensitivity: None
Servicable Parts: Lamp, detector cell, filters
Warranty Period: 18 months from date of shipment or 12 months from date of installation, which ever comes first

Section 4: Application Notes

4.1 Powering Up the Sensor After Storage

If the sensor has been stored for a significant amount of time, it may have been exposed to ambient conditions that may cause the sensor to exhibit a drifting characteristic of the baseline signal. After prolonged storage, it is recommended to operate the sensor for a period of time before operating it. The detector will clean itself and the baseline signal will drop and stabilize. If the sensor is used on a daily basis, the user should let it stabilize before use. The warm up time depends on the accuracy required.

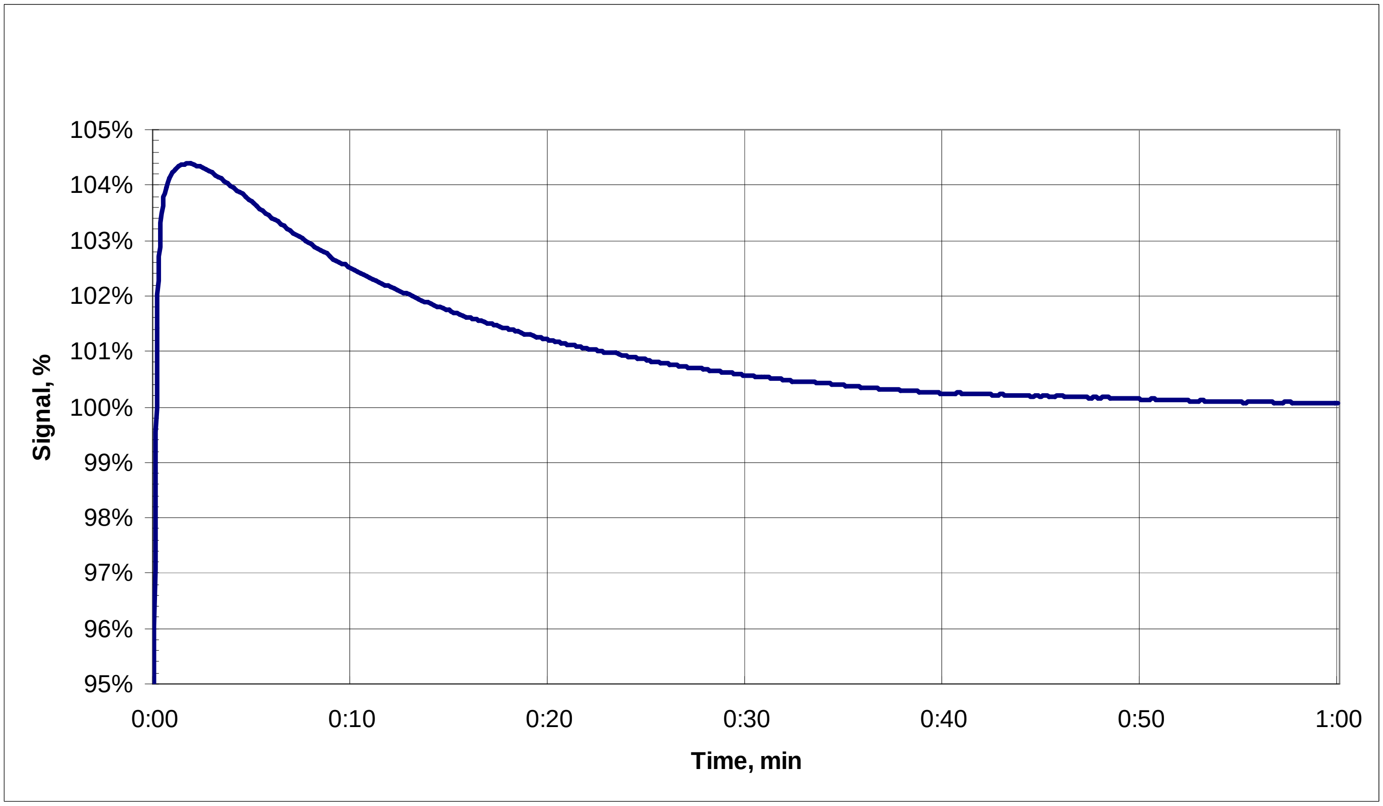


Figure 4-1 **piD-TECH®** *plus* Typical Warm Up Time

4.2 Signal Range

The nominal range of the sensor's voltage output is .05 to 2.5 Volts. With zero gas applied the sensor will generate an offset of between .05 and .1V (see chart below). If the normal concentration range of the sensor is exceeded, the maximum possible signal voltage that the sensor can produce is 2.9V.

Sensor Type	Normal Range (Isobutylene)	Zero Gas	Sensitivity @ 25°C V/ppm	Span Gas (Isobutylene)
ZPP60180001 (Black Label)	2000 ppm	50 - 60mV	.4 - 1.2mV	100 ppm
ZPP60180002 (Silver Label)	20 ppm	50 - 100mV	40 - 120mV	10 ppm

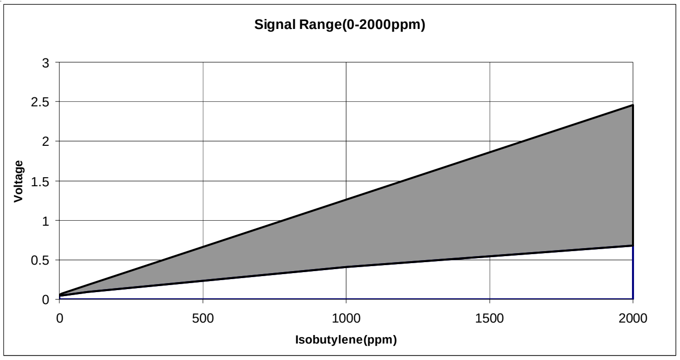


Figure 4-2 ZPP6018001 (Black Label) Signal Range Chart

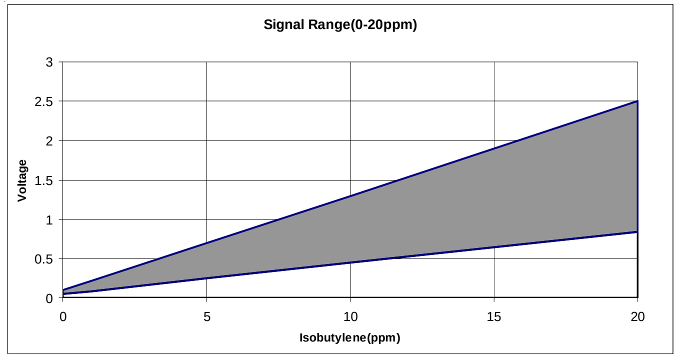


Figure 4-3 ZPP6018002 (Silver Label) Signal Range Chart

4.3 Minimum Detectable Quantity

The sensor's Minimum Detectable Quantity (MDQ) is based on a 3:1 signal to noise ratio. See figure 4-4 for an example on how to calculate MDQ.

Another factor affecting MDQ is the nature of the analyzed compound. Depending on the ionization potential of the compound and some other properties, the sensor's sensitivity varies significantly from one compound to another. If, for example, the sensor generates double the response to some compound as to Isobutylene, one should expect two times better MDQ, i.e. 0.05 ppm. With compounds to which the sensor has lesser sensitivity, the MDQ will change proportionally.

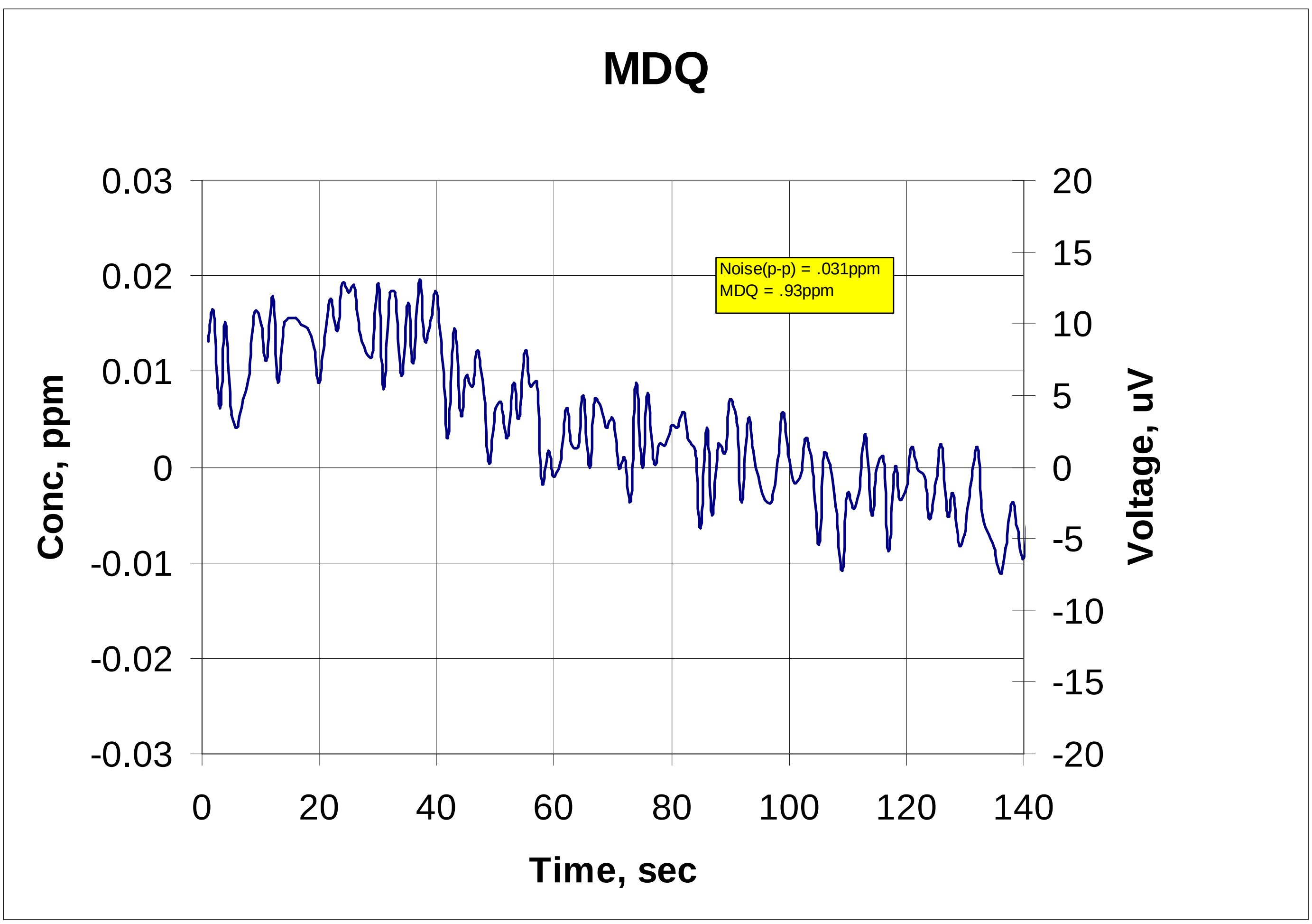


Figure 4-4 piD-TECH® plus (ZPP6018001 Black Label) Typical MDQ

4.4 Linearity

The linearity of the sensor may vary somewhat, depending on the target compound. As a rule, the greater the sensor's response to a compound, the narrower the linear range will be. If an application requires high accuracy, linearity characteristics of the sensor should be experimentally measured for this particular application's target compound. Another way to improve the accuracy of measurement is to calibrate the sensor at a concentration within the expected measurement range.

Sensor Type	Range Isobutylene	Linearity Specification
ZPP60180001 (Black Label)	2000 ppm	20%
ZPP60180002 (Silver Label)	20 ppm	10%

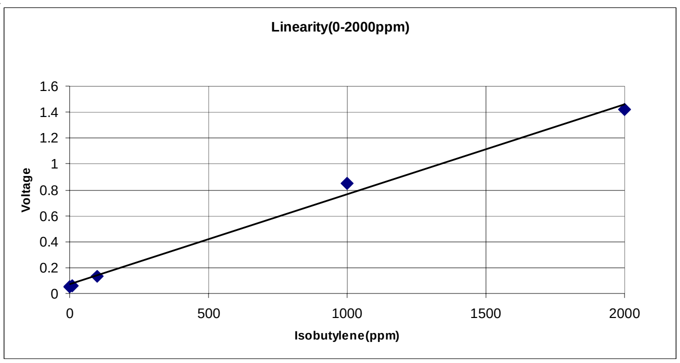


Figure 4-5 ZPP6018001 (Black Label) Linearity Chart

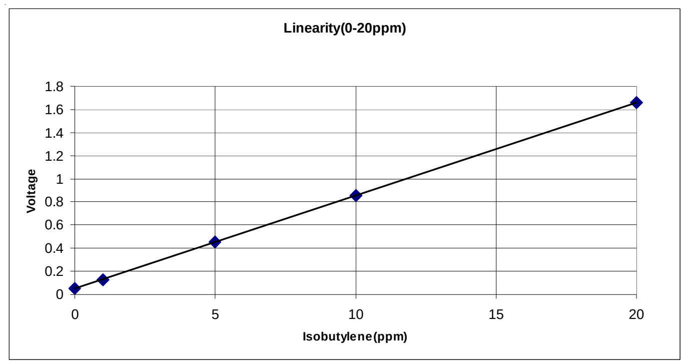


Figure 4-6 ZPP6018002 (Silver Label) Linearity Chart

4.5 Moisture Effects

There are two phenomena associated with moisture:

- Humidity Response
- Humidity Quenching Effect

In the case of Humidity Response to Moisture pure Hydrocarbon Free (HCF) air is applied to the sensor, with some humidity present in the sample. The maximum expected shift does not exceed ±1.0 ppm (Isobutylene) as shown in Figure 4-7. For improving the accuracy of low level measurements, it is recommended to zero the sensor at the same level of relative humidity (RH) as expected in the sample.

The Humidity Quenching Effect, on the other hand, reduces the sensor's sensitivity at high relative humidity. For example, response to 100 ppm Isobutylene at 90% RH will be reduced by 8% to 15% compared to response in dry air (RH=0), see

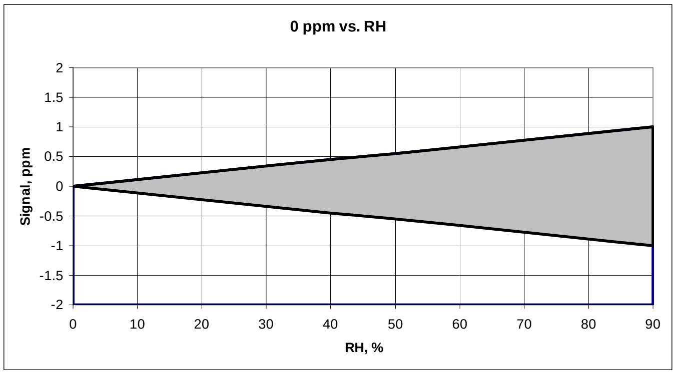


Figure 4-7 Humidity Response

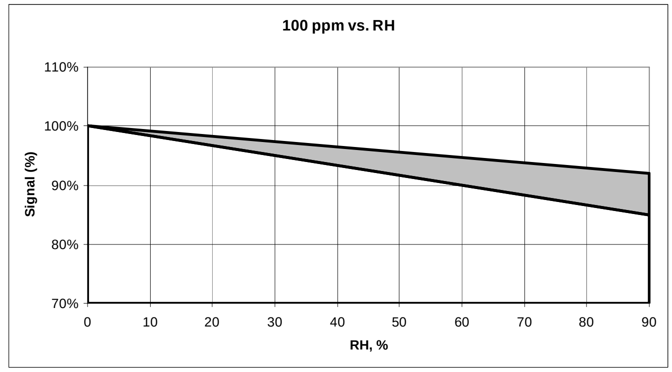


Figure 4-8 Humidity Quenching Effect

Figure 4-8.

4.6 Calibration

The sensor should be allowed to stabilize before performing a calibration. A stabilization period should also be allowed for zero gas and span gas when they are applied to the sensor during a calibration.

As a rule, calibration of the sensor on a daily basis is recommended. However, if the sensor is used in a relatively clean environment, the calibration frequency can be longer.

4.7 Span Drift

A sensor's response to gases may change with time. The common term for this is "Span Drift". The main reason for this drift is typically contamination of the lamp's window.

If the sensor is being used for ambient air applications or applications involving 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 reduce the detector's sensitivity. In this case, more frequent calibration is needed and periodic cleaning of the lamp lens. For lamp cleaning instructions refer to Appendix III.

Most VOCs (e.g. isobutylene, benzene) do not contaminate lens and the drift is very small. Typically, span drift does not exceed 10-15% per month of continuous operation. In favorable conditions over a six month period, span drift may be between 15 and 30%.

However, some compounds (such as silicones) are deposited on the lamp window at a more rapid rate. In those circumstances, span drift may be up to 10-20% over an eight hour period.

4.8 Sensor's Life Span

The life span of the sensor is basically unlimited; however, there are several components that will periodically need replaced depending on the amount of use and the sample that is applied to the sensor.

The UV lamp has a small irreversible internal degradation over time but is insignificant until after 6000 hours of operation. The lens of the lamp can also become contaminated over time if it is exposed to samples containing heavy compounds and/or particles. As explained in section 4.7 periodic calibration of the sensor will compensate for the lamp degradation. If the sensor is used for measuring low-level contaminations in pure gases, it will last as long as the lamp, i.e. >6000 hours without cleaning the lamp or servicing the sensor.

All replacement parts including the lamp, cell assembly, and filters are listed in Appendix III.

4.9 Balance Gas Effects

The sample's balance gas affects the sensor's response to the target compound. This is mainly a function of balance gas transparency for UV radiation. In a less UV-transparent gas matrix (e.g. oxygen, methane) the sensor will have less response to the same compound than in the case of a more transparent background gas (e.g. nitrogen, helium).

Balance gas properties will also affect MDQ characteristic of the sensor. In a more UV-transparent gas, better MDQ can be achieved.

4.10 Temperature Effect

The sensor has a normal operating range from -20ºC to 40ºC. The sensor will operate safely up to 60ºC without damage to the sensor; however, the performance of the sensor is not guaranteed at this elevated temperature. Ambient temperature changes do have an effect on the sensor performance. The result is a temperature dependence profile as shown in

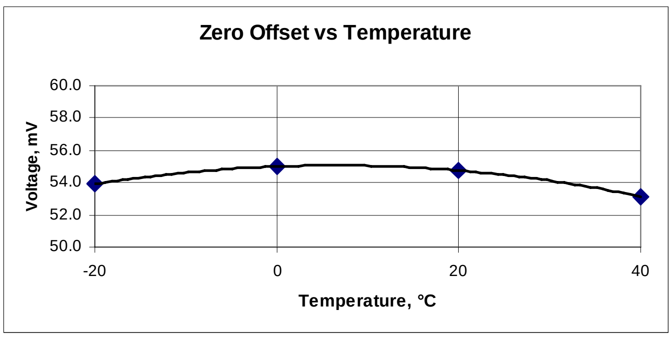


Figure 4-9 ZPP6018001 (Black Label)
Zero Temperature Profile

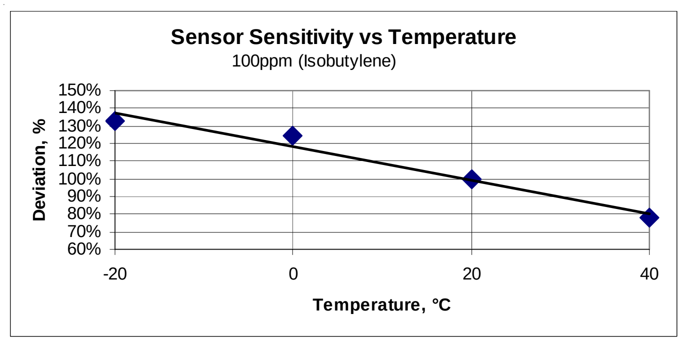


Figure 4-10 ZPP6018002 (Black Label)
100ppm Temperature Profile

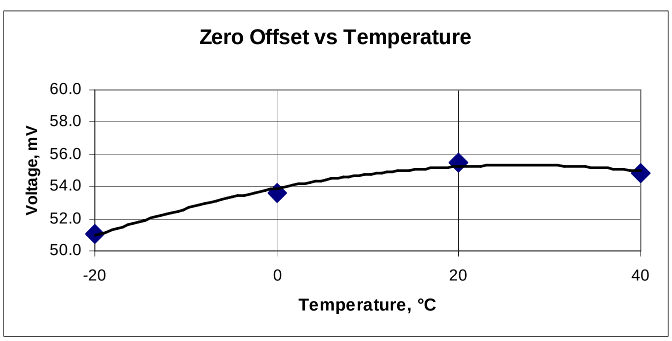


Figure 4-11 ZPP6018002 (Silver Label)
Zero Temperature Profile

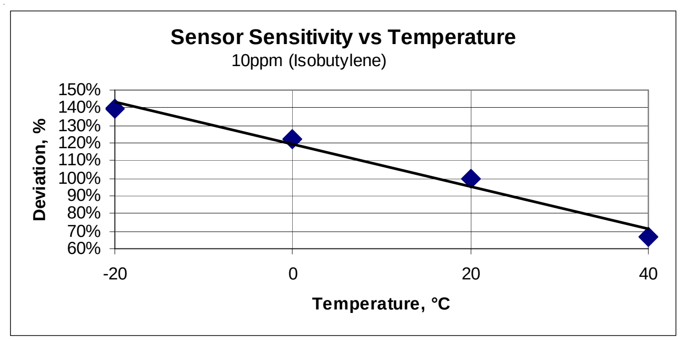


Figure 4-12 ZPP6018002 (Silver Label)
10ppm Temperature Profile

the figures below. The variance from the typical temperature profile is less than 20%.

4.11 Response Factors

The ratio between the sensitivity of Isobutylene to that of a target compound is called a Response Factor (RF). For example, the piD-TECH® plus sensor has a typical sensitivity of 1mV/ppm for Isobutylene and 2 mV/ppm for Benzene. That means that Benzene's RF is equal to 0.5. Response factors vary to some extent from one PID detector design to another. The response factors are available from various reliable literature sources.

The response factor table (Appendix II) allows the user to measure concentration of various gases without actually calibrating the sensor with the target gas. The following facts and guidelines should be kept in mind while using the response factor table:

1. All response Factors were measured in laboratory conditions, with Isobutylene as a reference compound and dry air as a balance gas.
2. The actual values of Response Factors may vary in customer's application, depending on the measurement conditions (sample humidity, background gas, lamp condition).
3. Response Factors should be used for the approximate measurements, when calibration with the actual target compound is not feasible.
4. For the best accuracy, the instrument should be calibrated with the target compound, under the application's conditions.
5. Certain gases although they have a response factor tend to be unstable and can cause a photo-chemical reaction in the PID detector. This reaction can cause some unpredictable results. An example of this is NH3 (Ammonia).

4.12 Response Time (T90/T10)

The time it takes for the signal to go from 0% to 90% of the target gas applied is referred to as the T90 response time and from 100% to 10% is called the T10 response time. The sensor response time is less than 20 seconds. Note that the response time is based on the response of the sensor and not the sample delivery system.

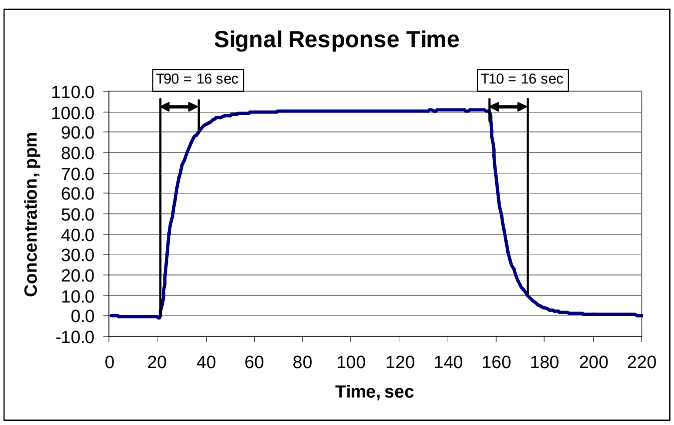


Figure 4-13 ZPP6018001 (Black Label) Response Time

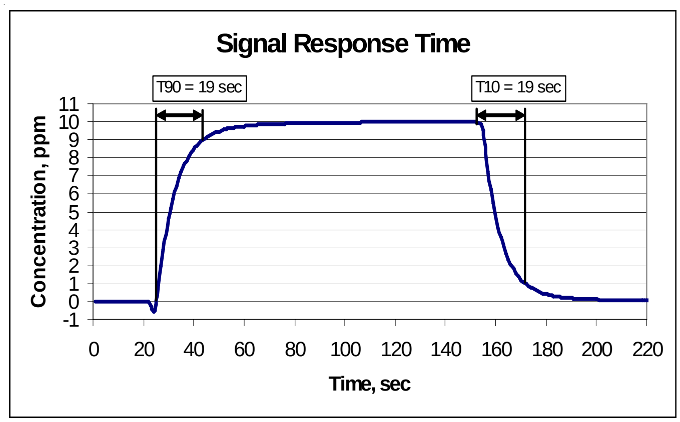
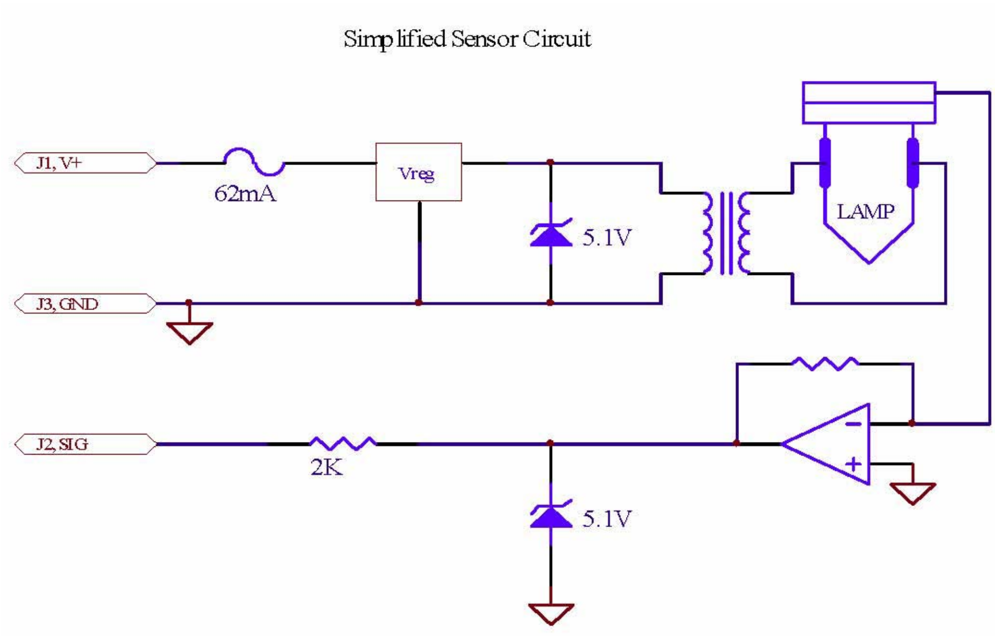


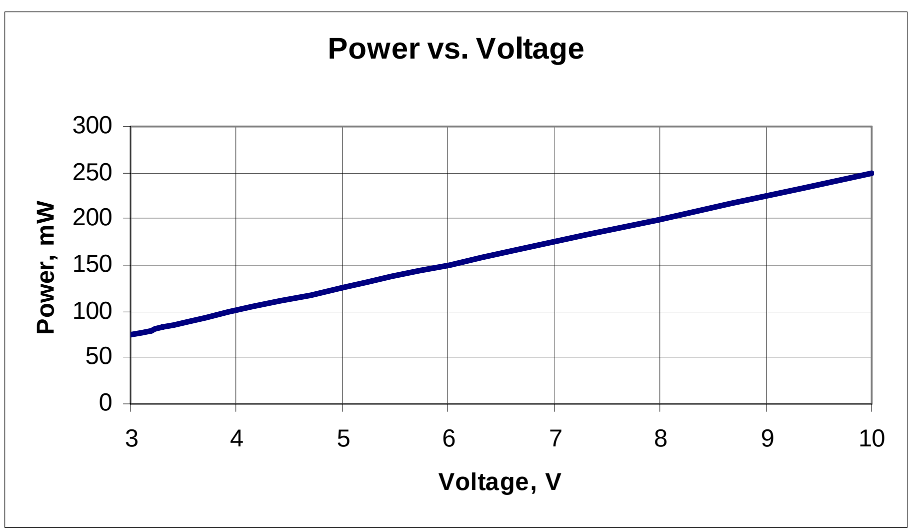
Figure 4-14 ZPP6018002 (Silver Label) Response Time

4.13 Electrical Characteristics



The electronic portion of the sensor is comprised of a barrier circuit, lamp power supply circuit, detector bias voltage circuit, and an amplifier circuit.

The supply voltage can range between 3.2V and 10V. The current consumed by the sensor is constant and ranges from 20mA to 30mA. The power consumed by the sensor will vary depending on the supply voltage. The chart below shows the relationship between supply voltage and power consumption.



The signal output of the sensor typically ranges from .05v to 2.5V. If the normal concentration range of the sensor is exceeded, the maximum possible signal voltage that the sensor can produce is 2.9V.

If the sensor is to be used in a hazardous location, refer to control drawing (7400-0108-011) for entity parameters and additional installation details.

4.14 Lamp Ignition

The lamp ignition time of the sensor can vary depending on the amount of time that the sensor has been inactive. Typically the lamp ignites within 15 seconds; however after prolonged inactivity the lamp may take longer to ignite. One method of verifying lamp ignition is to measure the current consumption of the sensor. The sensor typically consumes between 20mA and 26mA. So if the current consumption is 3 to 6mA lower than typical, the lamp has not ignited.

4.15 Sensor Maintenance

The sensor's rugged, durable design provides for trouble-free operation over the course of its lifetime. However, in certain conditions, maintenance may be required.

In a polluted environment, window contamination can degrade the sensor's performance. One indication of this problem is higher baseline noise in a sensor that was properly calibrated. Another way to detect this condition is to measure the sensor's sensitivity in terms of mV/ppm during the calibration. The signal voltage output should be verified for a given value of calibration gas as specified in section 4-2. The sensor is still useful with a sensitivity of less than this. However, in this case the sensor's MDQ is going to be higher than what is stated in the specifications. When this condition is noticed the lamp window may require cleaning. For lamp cleaning instructions refer to appendix III. Also included in appendix III are replacement parts for the sensor such as the lamp, cell assembly, and filters.

Section 5: Safety

5.1 piD-TECH Safety Certifications

The following safety certifications are issued for piD-TECH® plus (ZPP60180 **).

USA: UL 913 (Sixth Edition), For use in Class I, Division 1, Groups A, B, C, D Locations.

Europe: ATEX directives EN50014: 1997 E and EN50020: 2002 E, Ex II G EEx ia IIC, Tamb -20C to +60C

Other: IECEx Standards IEC60079-0: 2004 and IEC60079-11: 1999, Ex ia IIc Tamb = -20C to +60C

Detailed documentation for specific certification is available upon request.

Above certifications are issued for piD-TECH® plus sensor only and are not applicable to the equipment in which it is incorporated.

Patents: US Pat 6,646,444, Japan Pat 3,793,757

5.2 Special Conditions for Safe Use

1. The sensor shall be installed inside of a suitable enclosure in accordance with the end product standards.
2. The sensor was evaluated for a temperature classification of T4 when used in ambient temperatures up to +60°C.
3. The sensor is to be powered from an intrinsically safe circuit in the end product.
4. Refer to control drawing (7400-0108-011) for entity parameters and additional installation details.

Ionization Potentials

Chemical Name	IP (eV)
A	
2-Amino pyridine	8
Acetaldehyde	10.21
Acetamide	9.77
Acetic acid	10.69
Acetic anhydride	10
Acetone	9.69
Acetonitrile	12.2
Acetophenone	9.27
Acetyl bromide	10.55
Acetyl chloride	11.02
Acetylene	11.41
Acrolein	10.1
Acrylamide	9.5
Acrylonitrile	10.91
Allyl alcohol	9.67
Allyl chloride	9.9
*Ammonia	10.2
Aniline	7.7
Anisidine	7.44
Anisole	8.22
Arsine	9.89
B	
1,3-Butadiene (butadiene)	9.07
1-Bromo-2-chloroethane	10.63
1-Bromo-2-methylpropane	10.09
1-Bromo-4-fluorobenzene	8.99
1-Bromobutane	10.13
1-Bromopentane	10.1
1-Bromopropane	10.18
1-Bromopropene	9.3
1-Butanethiol	9.14
1-Butene	9.58
1-Butyne	10.18
2,3-Butadione	9.23
2-Bromo-2-methylpropane	9.89
2-Bromobutane	9.98
2-Bromopropane	10.08
2-Bromothiophene	8.63
2-Butanone (MEK)	9.54
3-Bromopropene	9.7
3-Butene nitrile	10.39
Benzaldehyde	9.53
Benzene	9.25
Benzenethiol	8.33
Benzonitrile	9.71
Benzotrifluoride	9.68
Biphenyl	8.27
Boron oxide	13.5
Boron trifluoride	15.56
Bromine	10.54
Bromobenzene	8.98
Bromochloromethane	10.77
Bromoform	10.48
Butane	10.63
Butyl mercaptan	9.15
cis-2-Butene	9.13
m-Bromotoluene	8.81
n-Butyl acetate	10.01
n-Butyl alcohol	10.04
n-Butyl amine	8.71
n-Butyl benzene	8.69
n-Butyl formate	10.5
n-Butyraldehyde	9.86
n-Butyric acid	10.16
n-Butyronitrile	11.67
o-Bromotoluene	8.79
p-Bromotoluene	8.67
p-tert-Butyltoluene	8.28
s-Butyl amine	8.7
s-Butyl benzene	8.68
sec-Butyl acetate	9.91
t-Butyl amine	8.64
t-Butyl benzene	8.68
trans-2-Butene	9.13
C	
1-Chloro-2-methylpropane	10.66
1-Chloro-3-fluorobenzene	9.21
1-Chlorobutane	10.67
1-Chloropropane	10.82
2-Chloro-2-methylpropane	10.61
2-Chlorobutane	10.65
2-Chloropropane	10.78
2-Chlorothiophene	8.68
3-Chloropropene	10.04
Camphor	8.76
Carbon dioxide	13.79
Carbon disulfide	10.07
Carbon monoxide	14.01
Carbon tetrachloride	11.47
Chlorine	11.48
Chlorine dioxide	10.36
Chlorine trifluoride	12.65

*** Certain gases tend to be unstable and can caues a photo-chemical reaction in the PID detector**

Chloroacetaldehyde	10.61
a-Chloroacetophenone	9.44
Chlorobenzene	9.07
Chlorobromomethane	10.77
Chlorofluoromethane (Freon 22)	12.45
Chloroform	11.37
Chlorotrifluoromethane (Freon 13)	12.91
Chrysene	7.59
Cresol	8.14
Crotonaldehyde	9.73
Cumene (isopropyl benzene)	8.75
Cyanogen	13.8
Cyclohexane	9.8
Cyclohexanol	9.75
Cyclohexanone	9.14
Cyclohexene	8.95
Cyclo-octatetraene	7.99
Cyclopentadiene	8.56
Cyclopentane	10.53
Cyclopentanone	9.26
Cyclopentene	9.01
Cyclopropane	10.06
m-Chlorotoluene	8.83
o-Chlorotoluene	8.83
p-Chlorotoluene	8.7

D

1,1-Dibromoethane	10.19
1,1-Dichloroethane	11.12
1,1-Dimethoxyethane	9.65
1,1-Dimethylhydrazine	7.28
1,2-Dibromoethene	9.45
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	12.2
1,2-Dichloroethane	11.12
1,2-Dichloropropane	10.87
1,3-Dibromopropane	10.07
1,3-Dichloropropane	10.85
2,2-Dimethyl butane	10.06
2,2-Dimethyl propane	10.35
2,3-Dichloropropene	9.82
2,3-Dimethyl butane	10.02
3,3-Dimethyl butanone	9.17
cis-Dichloroethene	9.65
Decaborane	9.88
Diazomethane	9
Diborane	12
Dibromochloromethane	10.59
Dibromodifluoromethane	11.07
Dibromomethane	10.49
Dibutylamine	7.69
Dichlorodifluoromethane (Freon 12)	12.31
Dichlorofluoromethane	12.39
Dichloromethane	11.35
Diethoxymethane	9.7
Diethyl amine	8.01
Diethyl ether	9.53
Diethyl ketone	9.32
Diethyl sulfide	8.43
Diethyl sulfite	9.68
Difluorodibromomethane	11.07
Dihydropyran	8.34
Diiodomethane	9.34
Diisopropylamine	7.73
Dimethoxymethane (methylal)	10
Dimethyl amine	8.24
Dimethyl ether	10
Dimethyl sulfide	8.69
Dimethylaniline	7.13
Dimethylformamide	9.18
Dimethylphthalate	9.64
Dinitrobenzene	10.71
Dioxane	9.19
Diphenyl	7.95
Dipropyl amine	7.84
Dipropyl sulfide	8.3
Durene	8.03
m-Dichlorobenzene	9.12
N,N-Diethyl acetamide	8.6
N,N-Diethyl formamide	8.89
N,N-Dimethyl acetamide	8.81
N,N-Dimethyl formamide	9.12
o-Dichlorobenzene	9.06
p-Dichlorobenzene	8.95
p-Dioxane	9.13
trans-Dichloroethene	9.66

E

Epichlorohydrin	10.2
Ethane	11.65
Ethanethiol (ethyl mercaptan)	9.29
Ethanolamine	8.96
Ethene	10.52
Ethyl acetate	10.11
Ethyl alcohol	10.48
Ethyl amine	8.86
Ethyl benzene	8.76
Ethyl bromide	10.29
Ethyl chloride (chloroethane)	10.98
Ethyl disulfide	8.27
Ethylene	10.5
Ethyl ether	9.51
Ethyl formate	10.61
Ethyl iodide	9.33
Ethyl isothiocyanate	9.14
Ethyl mercaptan	9.29
Ethyl methyl sulfide	8.55
Ethyl nitrate	11.22
Ethyl propionate	10
Ethyl thiocyanate	9.89
Ethylene chlorohydrin	10.52
Ethylene diamine	8.6

Ethylene dibromide	10.37
Ethylene dichloride	11.05
Ethylene oxide	10.57
Ethylenelmine	9.2
Ethynylbenzene	8.82

F

2-Furaldehyde	9.21
Fluorine	15.7
Fluorobenzene	9.2
Formaldehyde	10.87
Formamide	10.25
Formic acid	11.05
Freon 11 (trichlorofluoromethane)	11.77
Freon 112 (1,1,2,2-tetrachloro-1,2-difluoroethane)	11.3
Freon 113 (1,1,2-trichloro-1,2,2-trifluororethane)	11.78
Freon 114 (1,2-dichloro-1,1,2,2-tetrafluoroethane)	12.2
Freon 12 (dichlorodifluoromethane)	12.31
Freon 13 (chlorotrifluoromethane)	12.91
Freon 22 (chlorofluoromethane)	12.45
Furan	8.89
Furfural	9.21
m-Fluorotoluene	8.92
o-Fluorophenol	8.66
o-Fluorotoluene	8.92
p-Fluorotoluene	8.79

H

1-Hexene	9.46
2-Heptanone	9.33
2-Hexanone	9.35
Heptane	10.08
Hexachloroethane	11.1
Hexane	10.18
Hydrazine	8.1
Hydrogen	15.43
Hydrogen bromide	11.62
Hydrogen chloride	12.74
Hydrogen cyanide	13.91
Hydrogen fluoride	15.77
Hydrogen iodide	10.38
Hydrogen selenide	9.88
Hydrogen sulfide	10.46
Hydrogen telluride	9.14
Hydroquinone	7.95

I

1-Iodo-2-methylpropane	9.18
1-Iodobutane	9.21
1-Iodopentane	9.19
1-Iodopropane	9.26
2-Iodobutane	9.09
2-Iodopropane	9.17
Iodine	9.28
Iodobenzene	8.73
Isobutane (Isobutylene)	9.4
Isobutyl acetate	9.97
Isobutyl alcohol	10.12
Isobutyl amine	8.7
Isobutyl formate	10.46
Isobutyraldehyde	9.74
Isobutyric acid	10.02
Isopentane	10.32
Isophorone	9.07
Isoprene	8.85
Isopropyl acetate	9.99
Isopropyl alcohol	10.16
Isopropyl amine	8.72
Isopropyl benzene	8.69
Isopropyl ether	9.2
Isovaleraldehyde	9.71
m-Iodotoluene	8.61
o-Iodotoluene	8.62
p-Iodotoluene	8.5

K

Ketene	9.61

L

2,3-Lutidine	8.85
2,4-Lutidine	8.85
2,6-Lutidine	8.85

M

2-Methyl furan	8.39
2-Methyl napthalene	7.96
1-Methyl napthalene	7.96
2-Methyl propene	9.23
2-Methyl-1-butene	9.12
2-Methylpentane	10.12
3-Methyl-1-butene	9.51
3-Methyl-2-butene	8.67
3-Methylpentane	10.08
4-Methylcyclohexene	8.91
Maleic anhydride	10.8
Mesityl oxide	9.08
Mesitylene	8.4
Methane	12.98
Methanethiol (methyl mercaptan)	9.44
Methyl acetate	10.27
Methyl acetylene	10.37
Methyl acrylate	9.9
Methyl alcohol	10.85
Methyl amine	8.97
Methyl bromide	10.54
Methyl butyl ketone	9.34
Methyl butyrate	10.07
Methyl cellosolve	9.6
Methyl chloride	11.28
Methyl chloroform (1,1,1-trichloroethane)	11
Methyl disulfide	8.46
Methyl ethyl ketone	9.53

Methyl formate	10.82
Methyl iodide	9.54
Methyl isobutyl ketone	9.3
Methyl isobutyrate	9.98
Methyl isocyanate	10.67
Methyl isopropyl ketone	9.32
Methyl isothiocyanate	9.25
Methyl mercaptan	9.44
Methyl methacrylate	9.7
Methyl propionate	10.15
Methyl propyl ketone	9.39
a -Methyl styrene	8.35
Methyl thiocyanate	10.07
Methylal (dimethoxymethane)	10
Methylcyclohexane	9.85
Methylene chloride	11.32
Methyl-n-amyl ketone	9.3
Monomethyl aniline	7.32
Monomethyl hydrazine	7.67
Morpholine	8.2
n-Methyl acetamide	8.9

N

1-Nitropropane	10.88
2-Nitropropane	10.71
Naphthalene	8.12
Nickel carbonyl	8.27
Nitric oxide, (NO)	9.25
Nitrobenzene	9.92
Nitroethane	10.88
Nitrogen	15.58
Nitrogen dioxide	9.78
Nitrogen trifluoride	12.97
Nitromethane	11.08
Nitrotoluene	9.45
p-Nitrochloro benzene	9.96

O

Octane	9.82
Oxygen	12.08
Ozone	12.08

P

1-Pentene	9.5
1-Propanethiol	9.2
2,4-Pentanedione	8.87
2-Pentanone	9.38
2-Picoline	9.02
3-Picoline	9.02
4-Picoline	9.04
n-Propyl nitrate	11.07
Pentaborane	10.4
Pentane	10.35
Perchloroethylene	9.32
Pheneloic	8.18
Phenol	8.5
Phenyl ether (diphenyl oxide)	8.82
Phenyl hydrazine	7.64
Phenyl isocyanate	8.77
Phenyl isothiocyanate	8.52
Phenylene diamine	6.89
Phosgene	11.77
Phosphine	9.87
Phosphorus trichloride	9.91
Phthalic anhydride	10
Propane	11.07
Propargyl alcohol	10.51
Propiolactone	9.7
Propionaldehyde	9.98
Propionic acid	10.24
Propionitrile	11.84
Propyl acetate	10.04
Propyl alcohol	10.2
Propyl amine	8.78
Propyl benzene	8.72
Propyl ether	9.27
Propyl formate	10.54
Propylene	9.73
Propylene dichloride	10.87
Propylene imine	9
Propylene oxide	10.22
Propyne	10.36
Pyridine	9.32
Pyrrole	8.2

Q

Quinone	10.04

S

Stibine	9.51
Styrene	8.47
Sulfur dioxide	12.3
Sulfur hexafluoride	15.33
Sulfur monochloride	9.66
Sulfuryl fluoride	13

T

o-Terphenyls	7.78
1,1,2,2-Tetrachloro-1,2-difluoroethane (Freon 112)	11.3
1,1,1-Trichloroethane	11
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	11.78
2,2,4-Trimethyl pentane	9.86
o-Toluidine	7.44
Tetrachloroethane	11.62
Tetrachloroethene	9.32
Tetrachloromethane	11.47
Tetrahydrofuran	9.54
Tetrahydropyran	9.25
Thiolacetic acid	10
Thiophene	8.86
Toluene	8.82
Tribromoethene	9.27

Tribromofluoromethane	10.67
Tribromomethane	10.51
Trichloroethene	9.45
Trichloroethylene	9.47
Trichlorofluoromethane (Freon 11)	11.77
Trichloromethane	11.42
Triethylamine	7.5
Trifluoromonobromo-methane	11.4
Trimethyl amine	7.82
Tripropyl amine	7.23

V

o-Vinyl toluene	8.2
Valeraldehyde	9.82
Valeric acid	10.12
Vinyl acetate	9.19
Vinyl bromide	9.8
Vinyl chloride	10
Vinyl methyl ether	8.93

W

Water	12.59

X

2,4-Xylidine	7.65
m-Xylene	8.56
o-Xylene	8.56
p-Xylene	8.45

Response Factors

1,2,3-trimethylbenzene	0.49
1,2,4-trimethylbenzene	0.43
1,2-dibromoethane	11.7
1,2-dichlorobenzene	0.5
1,2-dichloroethane (11.7 lamp)	0.5
1,3,5-trimethylbenzene	0.34
1,4-dioxane	1.4
1-butanol	3.4
1-methoxy-2-propanol	1.4
1-propanol	5.7
2-butoxyethanol	1.3
2-methoxyethanol	2.5
2-pentanone	0.78
2-picoline	0.57
3-picoline	0.9
4-hydroxy-4-methyl-2-pentanone	0.55
4-methylbenzyl alcohol	0.8
acetaldehyde	10.8
acetic acid	11
acetone	1.2
acetophenone	0.59
acrolein	3.9
allyl alcohol	2.5
ammonia	9.4
amylacetate	3.5
arsine	2.6
benzene	0.53
bromoform	2.3
bromomethane	1.8
butadiene	0.69
butyl acetate	2.4
carbon disulfide	1.2
chlorobenzene	0.4
cumene (isopropylbenzene)	0.54
cyclohexane	1.5
cyclohexanone	0.82
decane	1.6
diethylamine	1
dimethoxymethane	11.3
dimethyl disulfide	0.3
diesel fuel #1	0.9
diesel fuel #2	0.75
epichlorhydrin	7.6
ethanol	10
ethyl acetate	4.2
ethyl acetoacetate	0.9
ethyl acrylate	2.3
ethyl ether (diethyl ether)	1.2
ethyl mercaptan	0.6
ethylbenzene	0.51
ethylene	10.1
ethylene glycol	15.7
ethylene oxide	19.5
gasoline	1.1
heptane	2.5
hydrazine	2.6
hydrogen sulfide	3.2
isoamyl acetate	1.8
isobutanol	4.7
isobutyl acetate	2.6
isobutylene	1
isooctane	1.3
isopentane	8
isophorone	0.74
isoprene (2-methyl-1,3-butadiene)	0.6
isopropanol	5.6
isopropyl acetate	2.6
isopropyl ether	0.8
isopropylamine	0.9
Jet A fuel	0.4
JP-5 fuel	0.48
JP-8 fuel	0.48
mesityl oxide	0.47
methanol (11.7 lamp)	2.5
methyl acetate	7
methyl acetoacetate	1.1
methyl acrylate	3.4
methyl benzoate	0.93
methyl ethyl ketone	0.9
methyl isobutyl ketone	1.1
methyl mercaptan	0.6
methyl methacrylate	1.5
methyl tert-butyl ether	0.86
methylamine	1.2
methylene chloride (11.7 lamp)	0.85
m-xylene	0.53
naphtalene	0.37
n,n-dimethylacetamide	0.73
n,n-dimethylformamide	0.8
n-hexane	4.5
nitric oxide	7.2
n-nonane	1.6
nitrogen dioxide (11.7 lamp)	10
n-pentane	9.7
n-propyl acetate	3.1
octane	2.2
o-xylene	0.54
phenol	1
phosphine	2.8
pinene, alpha	0.4
pinene, beta	0.4
propionaldehyde (propanal)	14.8

propylene	1.3
propylene oxide	6.5
p-xylene	0.5
pyridine	0.79
quinoline	0.72
styrene	0.4
tert-butyl alcohol	3.4
tert-butyl mercaptan	0.55
tert-butylamine	0.71
tetrachloroethylene	0.56
tetrahydrofuran	1.6
thiophene	0.47
toluene	0.53
trans-1,2-Dichloroethene	0.45
trichloroethylene	0.5
trimethylamine	0.83
turpentine - crude sulfite	1
turpentine - pure gum	0.45
vinyl acetate	1.3
vinyl bromide	0.4
vinyl chloride	1.8
vinylcyclohexane (VCH)	0.54
vinylidene chloride (1,1-DCE)	0.8

*** Certain gases tend to be unstable and can cause a photo-chemical reaction in the PID detector**

Servicable Items and Instructions

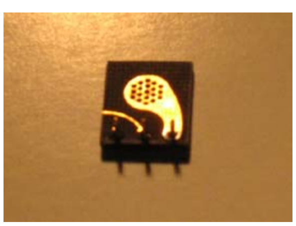
All **piD-TECH** ® **plus** Sensors contain six user replaceable components:

Filter Cap (P/N 037-581)

Spacer (P/N 042-078)

Filter Media #1 (P/N 038-083)

Filter Media #2 (P/N 037-591)



Cell Assembly (P/N 042-216)

10.6eV Lamp (P/N 038-566)

Warning

All maintenece procedures must be performed on a clean surface using clean tools. Avoid touching the lamp's window as well as the metalized portion of the Cell Assembly with your bare fingers. Fingerprints left on these parts may adversely affect the sensors operation.Latex gloves are preferred, but if they are not used, your hands must be clean and free of oils, lotions, etc. It is acceptable to hold the lamp by its glass body or by the edges of the window.

Tools Required

- X-Acto Knife (preferred) or Small Slotted Screw-driver
- Fine-Tipped Tweezers
- Latex Gloves (Optional)

Maintenance Kit List

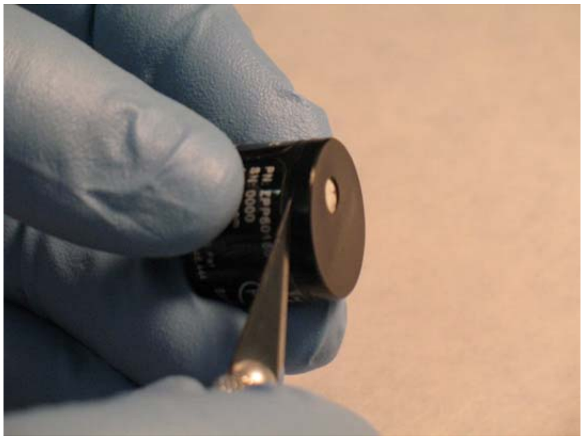
The following maintenance kits are offered:

Description	Part No
Dry Lamp Cleaning Kit	042-246
Replacement Filter Set	042-205
Replacement Filter Set w/Cap	036-211

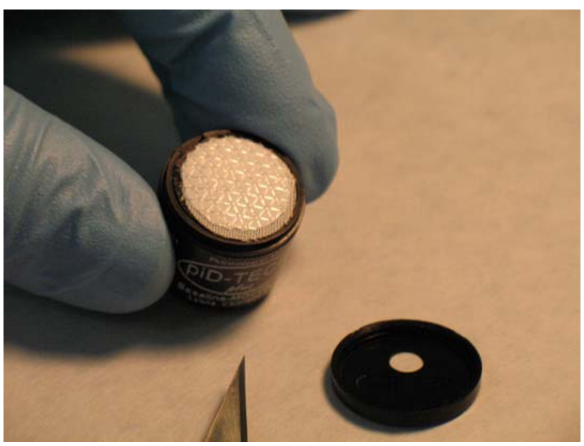
Disassembly

1. Power down the instrument according to the User's Manual and remove the sensor from the instrument.

2. Remove the Filter Cap by applying slight upward pressure with the tip of a screwdriver or X-Acto blade just below the hole in the cap and between the cap and housing, it will pop off.

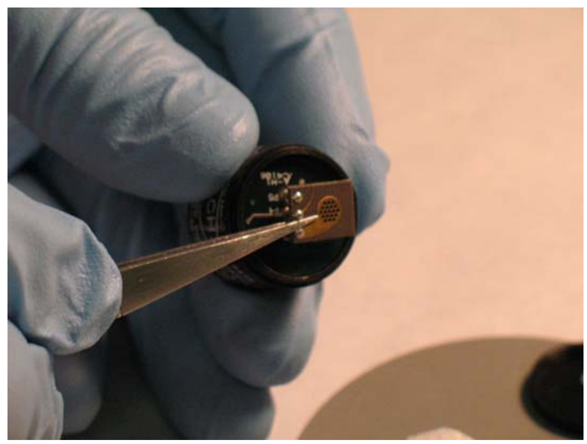


3. With fine-tipped tweezers, remove both the Filter Media and set aside.

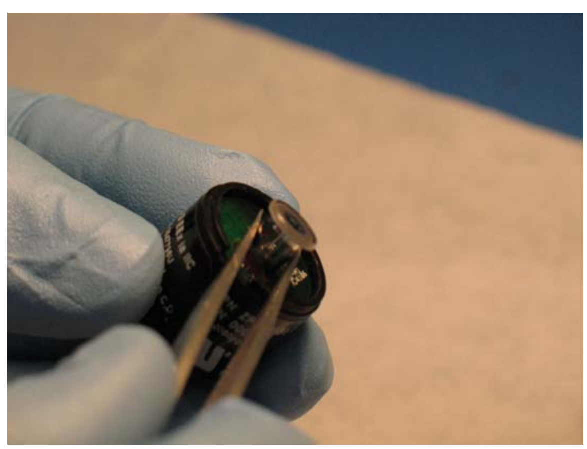


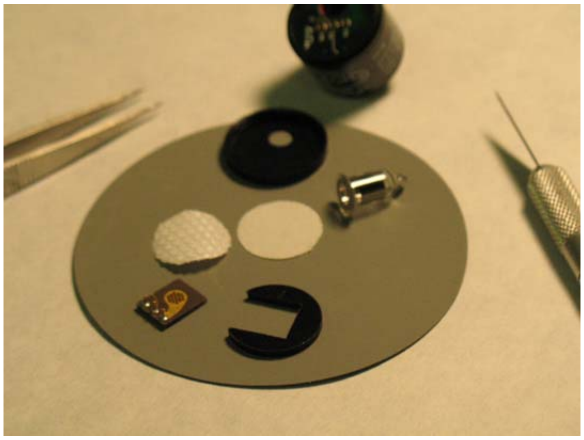
4. Using the X-Acto blade, remove the spacer and set aside.

5. With fine-tipped tweezers, carefully remove the Cell Assembly by prying under the Cell's edge where connector pins are located.



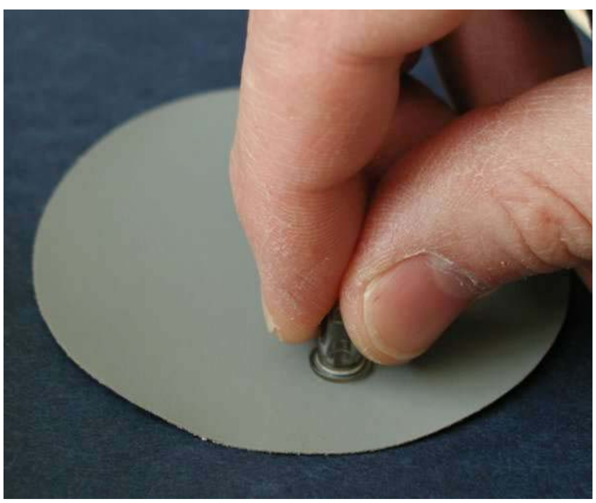
6. With fine-tipped tweezers, grasp the lamp by placing the tips in the housing notch and gently pull it out. Be careful not to scratch the lamp lens or chip edges.





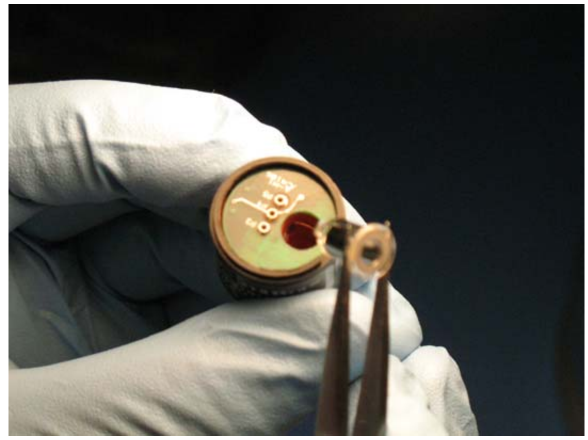
Cleaning the Lamp

Grab the lamp by the cylindrical glass body and clean the window by rubbing it against the Polishing Pad. Use a circular motion and try to keep the window surface flat relative to the pad. Five seconds of rubbing will be enough in most cases. Another indication of cleaning completeness is that you have used about 1/6th of the pads surface during the procedure.

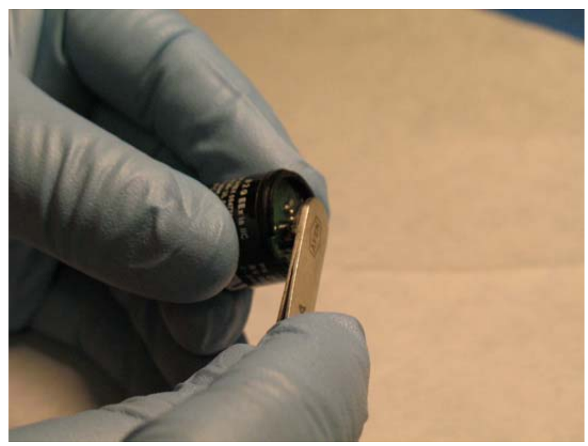


Reassembly

1. Install the lamp into the sensor, making sure that the lamps metalized pads are aligned with the corresponding excitation springs inside the lamp cavity.

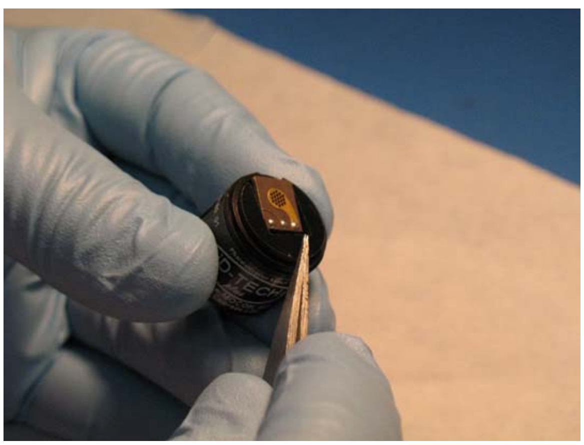


2. With the end of the clean tweezers, or the clean blade of a screwdriver, press down firmly. Be careful not to scratch the surface of the lamp.



3. Using fine-tipped tweezers, install the cell assembly. Align the pins with the corresponding sockets on the sensor and push down on the end with the pins. Make sure the cell assembly is flush with the lamp window.

4. Place the spacer around the cell assembly.



5. Place the Filter Media over the Cell Assembly centered on top of the sensor. Make sure the filters are installed in the correct order. Filter Media #2 first, then Filter Media #1 on top, with the shiny side up.

6. Alight the Cap Key with the notch on the housing. Starting at the side opposite the notch, press down until the Filter Cap snaps on to the housing. If the Cap Key is incorrectly aligned, there will be a noticeable bulge on the side of the cap.