

# Photo-Ionization Detector (PID)

## 1. Brief description

This gas sensor applies ultraviolet light to the detectable gas to ionize it. This causes an ion current to be generated. The sensor measures this current to determine the gas concentration. It detects a wide range of gases, irrespective of whether they are organic or inorganic. It is generally used to measure ppb to ppm levels of concentration of volatile organic compounds (VOCs).

Category	Detectable gas
Other methods	Toxic

## 2. Structure and principles

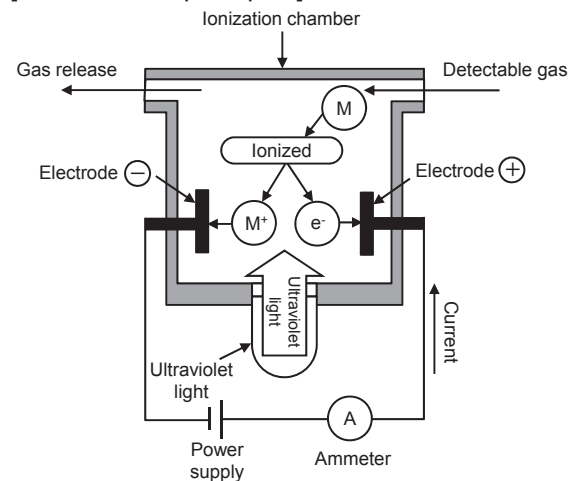
### [Structure]

The sensor consists of an ionization chamber for letting in the detectable gas, a ultraviolet lamp for applying light, and positive and negative electrodes for detecting ion currents.

### [Principles]

The detectable gas enters the ionization chamber and is exposed to ultraviolet light from the light source (ultraviolet lamp). This causes the gas to release electrons, generating cations. The generated cations and electrons are drawn by the positive and negative electrodes, which causes a current to be generated. Since this current is proportional to the gas concentration, the sensor measures the current value to determine the concentration of the detectable gas. Ionizing a detectable gas requires application of photon energy larger than the ionization energy specific to that gas. Photon energy is expressed in the unit electron volt (eV). This sensor uses a lamp having photon energies such as 10.6 eV and 11.7 eV. The larger the photon energy is, the larger amount of detectable gas the sensor can ionize.

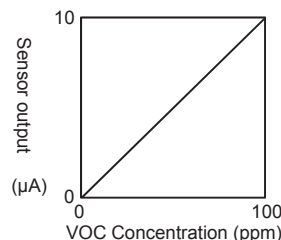
### [Structure and principles]



## 3. Features

### o Output characteristics

For a gas with a low concentration of a few hundred ppm, the sensor output is almost proportional to the gas concentration, increasing linearly with the gas concentration.



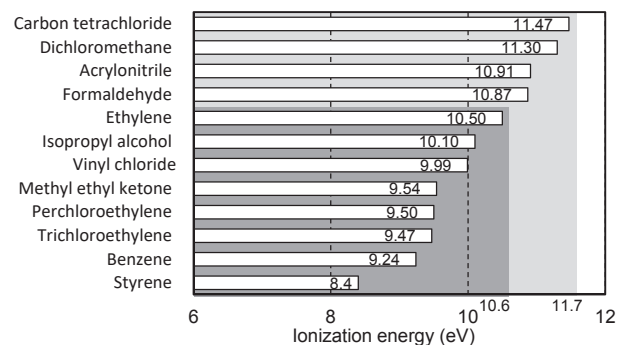
### o Ultraviolet lamp

The photon energy (eV) of a ultraviolet lamp is determined by the combination of the gas contained in the lamp and the material of the lamp window.

Gas contained	Window material	Photon energy (eV)
Xenon	Sapphire	8.4
Krypton	Magnesium fluoride	10.6
Argon	Lithium fluoride	11.7

### o Ionization energies of typical substances

By applying photon energy larger than the gas-specific ionization energy to each gas, the sensor ionizes the gas to determine the gas concentration. The sensor typically uses a lamp of 10.6 eV or 11.7 eV.



## 4. Detectable gas and molecular formula (examples)

Detectable gas (for 10.6-eV lamp)	Molecular formula	Detectable gas (for 11.7-eV lamp)	Molecular formula
Ethylene	C <sub>2</sub> H <sub>4</sub>	Carbon tetrachloride	CCl <sub>4</sub>
Isopropyl alcohol	C <sub>3</sub> H <sub>8</sub> O	Dichloromethane	CH <sub>2</sub> Cl <sub>2</sub>
Vinyl chloride	C <sub>2</sub> H <sub>3</sub> Cl	Acrylonitrile	C <sub>3</sub> H <sub>3</sub> N
Methyl ethyl ketone	C <sub>4</sub> H <sub>8</sub> O	Formaldehyde	HCHO
Perchloroethylene	C <sub>2</sub> Cl <sub>4</sub>	Acetylene	C <sub>2</sub> H <sub>2</sub>
Trichloroethylene	C <sub>2</sub> HCl <sub>3</sub>	Chloroform	CHCl <sub>3</sub>
Benzene	C <sub>6</sub> H <sub>6</sub>	Carbonyl sulfide	COS
Styrene	C <sub>8</sub> H <sub>8</sub>	Chlorine	Cl <sub>2</sub>

## 5. Products of this type (examples)

### o Stationary products

... TVOC2

### o Portable products

... GX-6000, Tiger, CUB



GX-6000