GAS MEASUREMENT LIST

- ELECTRO-CHEMICAL GAS SENSORS
  - DAVITEQ ETHYLENE C2H4 GAS SENSOR, 1500 PPM, SERI-4
  - DAVITEQ CARBON MONOXIDE CO GAS SENSOR, 200 PPM, SERI-4
  - DAVITEQ HYDRO SULFIDE H2S GAS SENSOR, 50 PPM, SERI-4
  - DAVITEQ AMMONIA NH3 GAS SENSOR, 100 PPM, SERI-4
  - DAVITEQ CHLORINE Cl2 GAS SENSOR, 20 PPM, SERI-4
  - DAVITEQ NITROGEN DIOXIDE NO2 GAS SENSOR, 20 PPM, SERI-4
  - DAVITEQ OXYGEN O2 GAS SENSOR FOR HIGH HUMIDITY 0-30%, SERI-4
  - DAVITEQ OXYGEN O2 GAS SENSOR 0-30%, SERI-4
  - DAVITEQ TRACE OXYGEN O2 GAS SENSOR 0-1%, SERI-4
  - Daviteq Electro-Chemical Gas Sensor
  - DAVITEQ FORMALDEHYDE GAS SENSOR CH2O, 10 PPM, SERI-4
- PID GAS SENSORS
  - Miniature PID Gas Sensor
- NDIR GAS SENSOR
  - Daviteq NDIR Gas Sensor

ELECTRO-CHEMICAL GAS SENSORS

DAVITEQ ETHYLENE C2H4 GAS SENSOR, 1500 PPM, SERI-4

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Seri-4 electro-chemical gas sensor
Nominal range	0-1500 ppm
Maximum overload	3000 ppm
Resolution	4 ppm
T80 response time	< 60 s
Typical Baseline Range (pure air, 20°C)	-10 ppm .. + 35 ppm
Repeatability	< 2% of reading
Accuracy	+/- 5% of reading
Zero Stability	0 .. 35ppm in pure Air, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
SENSOR LIFETIME	
Expected Operation Life	2 years in the air
Expected Long Term Output Drift in air	< 5 % of reading loss per month

CROSS SENSITIVITY DATA

Interfering Gas	Cross-Sens. [%]
CO	< 60

DAVITEQ CARBON MONOXIDE CO GAS SENSOR, 200 PPM, SERI-4

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electro-chemical gas sensor
Nominal range	0-200 ppm
Maximum overload	500 ppm
Filter	Inboard filter to remove acidic gases
Resolution	0.1 ppm
T90 response time	< 35 s
Typical Baseline Range (pure air, 20°C)	-0.5 ppm .. + 0.7 ppm
Repeatability	< 2% of reading
Accuracy	+/- 5% of reading
Zero Stability	0 .. 0.5 ppm in pure Air, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
SENSOR LIFETIME	
Expected Operation Life	3 years in the air
Expected Long-Term Output Drift in air	< 2 % of reading loss per month

We have other ranges: 500 ppm, 1000 ppm, and 2000 ppm.

CROSS SENSITIVITY DATA

Interfering Gas	Concentration (ppm)	Reading (ppm)
C2H4	1000	< 250
H2	100	< 60
H2S	20	0
NO	50	0

NO2	5	0
SO2	5	0

ELECTRO-CHEMICAL GAS SENSORS

DAVITEQ HYDRO SULFIDE H2S GAS SENSOR, 50 PPM, SERI-4

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electrochemical gas sensor
Nominal range	0-50 ppm
Maximum overload	100 ppm
Resolution	0.1 ppm
T90 response time	< 25 s
Typical Baseline Range (pure air, 20°C)	-0.1 ppm .. + 0.1 ppm
Repeatability	< 2% of reading
Accuracy	+/- 5% of reading
Zero Stability	0 .. 0.2 ppm in pure Air, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
SENSOR LIFETIME	
Expected Operation Life	2 years in the air
Expected Long-Term Output Drift in air	< 2 % of reading loss per month

We have other ranges: 100 ppm, 200ppm, 500ppm, and 2000 ppm

CROSS SENSITIVITY DATA

The table below does not claim to be complete. Interfering gases should not be used for calibration.

Interfering Gas	Concentration (ppm)	Reading (ppm)
CO	100	< 1
H2	300	< 1.2
Methyl Mercaptan (MM, CH3SH)	10	~ 5
Tert-Butyl Mercaptan (TBM, (CH3)3CSH)	10	~ 3.5

DAVITEQ AMMONIA NH3 GAS SENSOR, 100 PPM, SERI-4

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electrochemical gas sensor
Nominal range	0-100 ppm
Maximum overload	200 ppm
Resolution	0.1 ppm
T90 response time	< 35 s
Typical Baseline Range (pure air, 20°C)	-3.0 ppm .. + 3.0 ppm
Repeatability	< 3% of reading
Accuracy	5% of Reading
Zero Stability	0 .. 0.2 ppm in pure Air, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing
Temperature range	-10 °C to 50 °C
Pressure range	Atmospheric ± 10%
Humidity effect (Abrupt changes in rel. humidity causes a short-term transient signal)	< 4 ppm
SENSOR LIFETIME	
Expected Operation Life	2 years in the air
Expected Long-Term Output Drift in air	< 5 % of reading loss per 6 months

CROSS SENSITIVITY DATA

The table below does not claim to be complete. Interfering gases should not be used for calibration.

Interfering Gas	Concentration (ppm)	Reading (ppm)
Cl2	20	-55
CO	300	0
CO2	20000	0

H2	200	0
H2S	20	7
NO	20	-1
NO2	20	-20
SiH4	10	0
SO2	20	-7

Important Application Notes

Long-term exposures at high concentrations of SO2, H2S, NO, NO2, and Cl2 can affect the performance characteristics.

DAVITEQ CHLORINE Cl2 GAS SENSOR, 20 PPM, SERI-4

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electrochemical gas sensor
Nominal range	0-20 ppm
Maximum overload	200 ppm
Resolution	0.01 ppm
T80 response time	< 60 s
Typical Baseline Range (pure air, 20°C)	-0.1 ppm .. +0.2 ppm
Repeatability	< 2% of reading or 0.05ppm whichever greater
Accuracy	+/- 5% of reading
Zero stability	0 .. 0.05 ppm in pure Air, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
Humidity effect	None
SENSOR LIFETIME	
Expected Operation Life	2 years in the air
Expected Long-Term Output Drift in air	< 2 % of reading loss per month

CROSS SENSITIVITY DATA

The table below does not claim to be complete. Interfering gases should not be used for calibration.

Interfering Gas	Concentration (ppm)	Reading (ppm)
Br2	10	2.5
C2H4	100	0
CH2O	7	0
ClO2	3	~3

CO	300	0
Ethanol (C2H5OH)	60	0
F2	8	~8
H2	100	0
H2S	20	< -20
HCl	20	0
NH3	80	0
NO	50	0
NO2	20	~20
O3	1	~1
SO2	5	0

DAVITEQ NITROGEN DIOXIDE NO2 GAS SENSOR, 20 PPM, SERI-4

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electro-chemical gas sensor
Nominal range	0-20 ppm
Maximum overload	40 ppm
Filter	Inboard filter to remove acidic gases
Resolution	0.1 ppm
T90 response time	< 40 s
Typical Baseline Range (pure air, 20°C)	-0.1 ppm .. + 0.2 ppm
Repeatability	< 2% of reading
Accuracy	+/- 5% of reading
Zero Stability	0 .. 0.2 ppm in pure Air, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
SENSOR LIFETIME	
Expected Operation Life	2 years in the air
Expected Long Term Output Drift in air	< 2 % of reading loss per month

CROSS SENSITIVITY DATA

Interfering Gas	Concentration (ppm)	Reading (ppm)
C2H4	100	0
CH2O	7	0
Cl2	20	15
CO	100	0

ETHANOL (C2H5OH)	60	0
H2	100	0
H2S	20	< - 20
HCL	20	0
NH3	80	0
NO	50	0
O3	1	1
SO2	5	0

ELECTRO-CHEMICAL GAS SENSORS

DAVITEQ OXYGEN O2 GAS SENSOR FOR HIGH HUMIDITY 0-30%, SERI-4

KEY FEATURES

- For high-humidity environments
- Long-Life sensor with no consumable parts and lead-free (RoHS compliant)

APPLICATIONS

- Oxygen Monitoring in Diffusion Mode
- Continuous Air Quality Monitoring
- Safety and Environmental Control

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electrochemical gas sensor
Nominal range	0-30%
Maximum overload	100%
Filter	come with the main device
Resolution	0.1%
T90 response time	< 30s (via filter)
Typical Baseline Range (20°C)	< 0.1% in pure N2
Repeatability	< 2% of reading
Accuracy	+/- 5% of reading
Zero Stability	0 .. 0.1 % in pure Nitrogen, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	50 % to 95 % RH non-condensing
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
SENSOR LIFETIME	
Expected Operation Life	3 years in the air
Expected Long-Term Output Drift in air	< 1.33 % of reading loss per year

CROSS SENSITIVITY DATA

Interfering Gas	Concentration (ppm)	Reading (%)
C2H4	1000	0
CO	2000	0.05
H2	1000	0.01
H2S	500	-0.02
SO2	200	-0.01

ELECTRO-CHEMICAL GAS SENSORS

DAVITEQ OXYGEN O2 GAS SENSOR 0-30%, SERI-4

KEY FEATURES

- Fast equilibration time
- Long-Life sensor with no consumable parts and lead-free (RoHS compliant)

APPLICATIONS

- Oxygen Monitoring in Diffusion Mode
- Continuous Air Quality Monitoring
- Safety and Environmental Control

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electrochemical gas sensor
Nominal range	0-30%
Maximum overload	100%
Filter	come with the main device
Resolution	0.1%
T90 response time	< 28s (via filter)
Typical Baseline Range (20°C)	< 0.1% in pure N2
Repeatability	< 2% of reading
Accuracy	+/- 5% of reading
Zero Stability	0 .. 0.1 % in pure Nitrogen, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
SENSOR LIFETIME	
Expected Operation Life	3 years in the air
Expected Long-Term Output Drift in air	< 1.33 % of reading loss per year

CROSS SENSITIVITY DATA

Interfering Gas	Concentration (ppm)	Reading (%)
C2H4	1000	0
CO	2000	0.05
H2	1000	0.01
H2S	500	-0.02
SO2	200	-0.01

ELECTRO-CHEMICAL GAS SENSORS

DAVITEQ TRACE OXYGEN O2 GAS SENSOR 0-1%, SERI-4

KEY FEATURES

- Fast equilibration time
- Long-Life sensor with no consumable parts and lead-free (RoHS compliant)

APPLICATIONS

- Trace oxygen measurements
- Continuous Air Quality Monitoring
- Safety and Environmental Control

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electrochemical gas sensor
Nominal range	0-1%
Maximum overload	21%
Filter	come with the main device
Resolution	0.01%
T90 response time	< 30s (via filter)
Typical Baseline Range (20°C)	< 0.01% in pure N2
Repeatability	< 2% of reading
Accuracy	+/- 5% of reading
Zero Stability	0 .. 0.01 % in pure Nitrogen, 20oC
Temperature compensation	Yes
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
SENSOR LIFETIME	
Expected Operation Life	3 years in the air
Expected Long-Term Output Drift in air	< 1.33 % of reading loss per year

Daviteq Electro-Chemical Gas Sensor

1. Introduction

1.1 Overview

Daviteq Electro-chemical (EC) Gas sensor module is a gas measuring module that utilizes the Seri-4 electrochemical sensor with a high sensitivity to low concentrations of detected gas, high selectivity, and a stable baseline. It has an ultra-low noise amplifier to amplify the nano-ampere current signal from the sensor and delivers the stable and high-resolution output to the reading devices such as Sub-GHz transmitter, Sigfox transmitter, LoRaWAN transmitter, RS485 output transmitter, etc.

The module can support various types of gas sensors such as CO, NO, NO2, H2S, NH3, O2, O3, SO2, Cl2, HCHO...

Typical Applications: Gas, toxic gas detecting, air quality monitoring for the facility, building, pump station, HVAC...

* For some applications with high humidity ambient all the time, the sensor can come with a heater to control the humidity within the working range of the sensor.

1.2 Specification

Sensor technology	Seri-4 electrochemical gas sensor. Please check **this link** for the specifications of each gas type.
Sensor housing / Rating	SS316/SS304 housing with 316SS sintered filter / for Indoor use (buy the optional accessory rain-guard for outdoor installation) Exd versions for Zone 1/21 and 2/22.

Note: Do not install the sensor where the ambient humidity is higher than 90% RH most of the time! It will cause the sensor to malfunction.

1.3 Cross-Sensitivity Data

What is cross-sensitivity?

The electrochemical sensor is normally affected by other gas. It meant the sensor not only measure the target gas but also the other gases. If there is a concentration of other gas, it would also cause the change in sensor output with a factor listed in the below table.

Please check the cross-sensitivity data of each gas type in **this link**.

2. Detail measurement principle

A special amplifier circuit amplifies the very low current from the gas sensor to deliver stable and high resolution.

The special mechanism provides noise filtering to deliver a very stable output. The ADC chip can provide a resolution from 16-bit to 24-bit.

The circuit will deliver the digital output to the reading device.

With an ultra-low-power design, it can run on battery for 10-20 years!

The EC sensor module will deliver 02 values:

- Gas concentration, in ppm or ppb.
- The temperature of the circuit board, in oC.

3. List of Measureable Gas/Volatile

Index	Gas	Range (PPM)	Remarks
1	AsH3, Arsine	0-1	
2	CH2O, Formaldehyde	0-10, 0-50, 0-1000	
3	C2H4, Ethene, Ethylene	0-10, 0-200, 0-1500	
4	C2H4O, Ethylene Oxide	0-10, 0-100, 0-1000	
5	RCOOH, Organic Acids	0-100	
6	R3COH, Alcohols	0-200	
7	CO, Carbon Monoxide	0-200, 0-500, 0-1000, 0-2000	
8	CS2, Carbon Disulfide	0-100	
9	Cl2, Chlorine, Br2, Bromine	0-20, 0-200	
10	ClO2, Chlorine Dioxide	0-5	
11	H2, Hydrogen	0-1000, 0-4000, 0-40000	
12	H2O2, Hydrogen Peroxide	0-100, 0-500, 0-2000, 0-5000	
13	H2S, Hydrogen Sulfide	0-50, 0-100, 0-500, 0-2000	
14	HCl, Hydrogen Chloride	0-20, 0-200	
15	HF, Hydrogen Fluoride	0-10	
16	HCN, Hydrogen Cyanide	0-50	
17	NH3, Ammonia	0-100, 0-500, 0-1000, 0-2000, 0-5000, 0-10000	
18	NO, Nitric Oxide	0-25, 0-250, 0-1000	
19	NO2, Nitrogen Dioxide	0-20, 0-100, 0-500	
20	O2, Oxygen	0-1%, 0-30%,	
21	O3, Ozone	0-5, 0-100	
22	PH3, Phosphine	0-5, 0-20, 0-200, 0-2000	
23	SiH4, Silane	0-50	
24	SO2, Sulfur Dioxide	0-20, 0-100, 0-200, 0-1000, 0-2000, 0-10000	
25	VOC, Volatile Organic Compound	0-20, 0-2000 (equivalent Isobutylene)	**Applicable for:** * Alcohols: Isopropanol, Methanol, Ethanol * Aldehydes and Ketones: Formaldehyde, Acetone, * Aromatic Hydrocarbons: Xylene, Toluene * Organic acids: Formic acid, Acetic acid, Commercial vinegar * Unsaturated Hydrocarbons: Isobutylene, Ethylene

Please consult us to get detail specification of Gas sensor

4. Calibration of the Daviteq EC Gas Sensor

The Daviteq EC Gas Sensor must be connected to a reading device; normally, it is a wireless transmitter like Sub-GHz, Sigfox, or LoRaWAN.

In the reading device, the following parameter is configured in advance:

Sensor+amplifier sensitivity (mV/ppm): it is the voltage output of the amplifier circuit = Sensor current output (nA/ppm) x R_gain

For example, with an NH3 gas sensor, the default value of the Sensor current output is 110nA/ppm and R_gain = 100 Kohms.

Therefore, the default NH3 Sensor+amplifier sensitivity = 11 mV/ppm

Depending on the sensor type and R_gain value, the sensor sensitivity must be calculated and pre-configured into the reading device.

4.1 Why do we need to calibrate the gas sensor? There are some reasons:

- The sensor current output of a sensor is different from the other sensor. It is not the same value for all sensors after manufacturing.

- The sensor current output of a sensor will be changed over time. For example, the NH3 sensor current output will be reduced by about 5% of the signal per six months in clean air at 25 oC temperature.

- The R_gain of the circuit also has a 0.1% or 0.05% tolerance;

Therefore, users must calibrate the sensor before use or in a pre-defined interval (6 or 12 months, for example).

4.2 How to calibrate the EC Gas sensor?

Instructions to attach the calibration cap onto the sensor module to get Zero or Span values.

Step 1. Remove the Filter and prepare the calibration cap	**Step 2**. Attach the calibration cap to the sensor head
	

Step 3. Installed the Regulator to the Gas cylinder	**Step 4**. Attach the tube to the regulator
	

Please use the Flow Regulator with a flow rate of 2.5 LPM or 5.0 LPM.

With the 2-point calibration method, the user can define the A and B factors. Please find below the steps of calibration.

Step 1: Get the Zero value.

- Power ON the device;

- Place the device in a clean-air environment (the target value is nearly zero) at a temperature from 20 - 30 oC, in at least 60 minutes. Using the 99.99% Nitrogen gas as zero gas is better than clean air.

- After 60 minutes, force the device to send data, read and record the Raw_value.

- Recommendation: Record many Raw values at least 10 minutes apart (10 values).
Zero value is the average of the recorded Raw values

Note: the Raw_value can be positive or negative; it will be in the range of -3.00 to +3.00 ppm

Step 2: Get the Span value

Note: Keep the sensor Power ON all the time;

- Use the standard gas cylinder with a known concentration (for example, NH3 in N2 with a concentration of 25ppm or 50ppm) to supply the gas to the sensor;

- Use the calibration cap as above pictures to attach to the sensor and connect the tubing to the gas cylinder;

- Open the valve on the Cylinder slowly and make sure the gas has reached the sensor. Please use the Flow regulator 2.5 LPM or 5.0 LPM.

Notes:
- The tube length is short as possible to reduce the gas loss.

- Press a timer to start counting the time;

- After 2 minutes, force the device to send data once every minute, and stop forcing at 5 minutes. The highest

Raw_value is the Span value.

> ⚠ **Note: Get one value for Span**

- After that, immediately turn OFF the valve to save the gas;

- Remove the calibration cap from the sensor;

- Place the sensor in clean air again.

> ⚠ **Note: Always keep the sensor Power ON all the time;**

> ❗ **DO NOT PLACE THE SENSOR IN THE SPAN GAS FOR MORE THAN 5 MINUTES; IT WILL SATURATE THE SENSOR OUTPUT AND DEGRADE THE SENSOR LIFE QUICKLY.**

Step 3: Calculate the new A and B

-The calculation of new A and B values based on the basic linear formula: y = A * x + B

Where:

A and B are calibration coefficients

x is the sensor process value (example gas level in ppm) read on the reading device (RAW_VALUE in the payload), such as on the application server/network server, on the offline tool

y is the correct value. y is the value of standard gas/standard condition

Which condition of Zero value: $y_0 = A * x_0 + B$

Which condition of Span value: $y_s = A * x_s + B$

From the two formulas, the calculation of A and B as below

$$A = (y_0 - y_s) / (x_0 - x_s)$$

$$B = (y_s * x_0 - y_0 * x_s) / (x_0 - x_s)$$

-Example of A, B calculation for LoraWAN Ammonia Gas sensor (item code WSLRW-G4-NH3-100-01):

* With the condition of a clean-air environment at a temperature from 20 - 30 oC, there is no ammonia gas ($y_0 = 0$); while the NH3 level on the reading device (RAW_VALUE in the payload) is -0.25 ($x_0 = -0.25$)

* When the sensor is connected to a standard gas cylinder having an ammonia level of 25 ppm ($y_s = 25$); while the NH3 level on the reading device (RAW_VALUE in the payload) is 18.66 ($x_s = 18.66$)

*The calculation of A and B for the Ammonia gas sensor:

$$A = (0 - 25) / (-0.25 - 18.66) = 1.32205$$

$$B = (y_s * x_0 - y_0 * x_s) / (x_0 - x_s) = (25 * (-0.25) - 0 * 18.66) / (-0.25 - 18.66) = 0.33051$$

> ℹ The factory default A = 1 and default B = 0

> ℹ Use RAW_VALUE in the payload on the reading device for calibration

Step 4: Configure the new A and B into the device

- User can use the off-line tool or downlink to write the values of A and B;

- Writing the new A and B successfully meant you had done the calibration process. Congratulation!

5. Application notes for the Daviteq EC Gas Sensor

The applications will differ depending on the type of gas sensor used in the EC gas module. Please refer to some applications:

Gas type	Typical applications
NH3 Ammonia Gas	NH3 leakage detection for HVAC, Chiller... NH3 concentration in the toilet NH3 concentration in the animal farms; chicken, pig, cow... NH3 concentration in the ambient air (Air quality monitor)
H2S	H2S gas monitor for the sewage treatment system H2S gas monitor for indoor air quality H2S gas monitor for basement floor H2S gas monitor for the trash bin H2S gas monitor for solid waste treatment plant...
Cl2 Chlorine gas	Chlorine gas leakage detection in the chemical process plant Chlorine gas monitoring in ambient air in the water treatment plant Chlorine toxic gas monitoring in the City ...

6. Installation notes

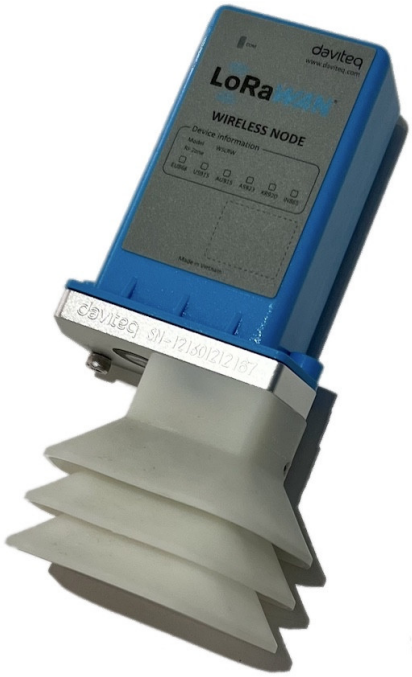
> ⚠ **Notes:**
> * Avoid the place with humidity higher than 90% RH all the time (a short time in 2-3 days is acceptable)
> * if the Sensor is intended to install outdoors, please use a rain guard to protect the sensor from rain and direct sunlight. Please **contact us** to buy this accessory.

- Place the sensor in the area to monitor the target gas concentration. Please always check the gas molecular weight v.s the air.

- For example, NH3 gas has a lighter weight than air, so the sensor must be placed at a height higher than the source of NH3 leakage. Normally, the sensor will be mounted at a height of 1.6m from the ground.

- For NH3 Odor detection in the toilet, users can place the sensor from 1.6m on the wall or on the ceiling which a height <= 2.6m

> ⚠ **Note for Outdoor installation:** For outdoor installation, please use the Rain guard to protect the sensor from raindrops or snowflakes. Please find below the steps for the installation

Step 1. Prepare the rain guard.  	**Step 2**. Insert the rain guard into the sensor filter and tighten the locking screws 

7. Troubleshooting for the Daviteq G4 Gas Sensor

No.	Phenomena		Reason	Solutions
1	The measured value is not within the expected value.	1.1	The sensor is drifted by time.	Re-calibrate the sensor
		1.2	The sensor was continuously in a high-humidity environment (> 90% RH) for more than 03 days.	Place the sensor in low humidity for its recovery. It may take up to 30 days to recover. If the sensor cannot recover after 30 days, please replace the new sensor module.
2	The measured value is always zero or near zero.	2.1	The sensor module was removed.	Please check the sensor.
		2.2	The sensor is at the end of its life.	Replace the sensor module
3	HW_Error = 1	3.1	Loosed connection of sensor module and wireless transmitter.	Check the internal wiring.
		3.2	The measuring module got a problem.	Please consult the manufacturer for a warranty or replacement.

8. Maintenance of the Daviteq G4 Gas Sensor

What?	How?	When?

Cleaning the Filter	Check and clean the filter every few months, depending on the environment. Clean the filter with warm water and soap, then use compressed air to purge it from the inside out.	Approx. 6-12 months (< 1 month for mining applications)
Re-calibration	The gas sensor may be drifting over time. Please check **the sensor specification** to identify the interval time for the re-calibration sensor. Please follow the calibration procedure in **section 3** above.	Approx. 6-12 months
Sensor replacement	Replace the new sensor module after 02 years of operation (please check **the sensor specification** of each gas type). Please see the below instructions.	Approx. 2 years

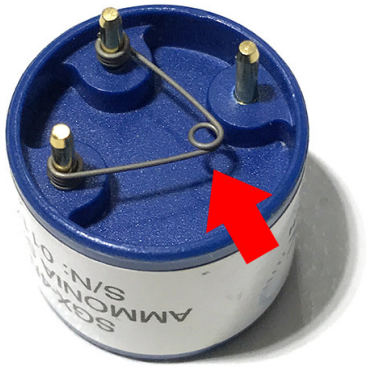
Sensor replacement instructions:

⚠ ** Please remove the batteries before doing the following steps*

Step 1. Remove the filter

Step 2. Unplug the sensor module

Step 3. Remove the spring clip on the new sensor module.



Step 4. Plug the new sensor module into the PCB

Step 5. Insert the batteries and start calibration of the new sensor as per **section 3**.

Step 6. Place the filter back.

9. Default configuration

This G4 gas sensor module has the default configuration. However, those parameters can be changed. The user can change the configuration on the wireless transmitter so that the complete sensor (transducer + wireless) delivers the proper output value. Below are some configuration parameters that store in the flash memory of the wireless transmitter.

Description	Unit	Default	Format	Property	Comment
CONSTANT_A		1	Float	R/W	Constant a for scaling measured value
CONSTANT_B		0	Float	R/W	Constant b for scaling measured value
HIGH_CUT		1E+09	Float	R/W	High cut value for scaled_value
LOW_CUT		0	Float	R/W	Low cut value for scaled_value
SENSOR+AMPLIFIER SENSITIVITY	mV		Float	R/W	Default = 11 for NH3 gas sensor

END.

DAVITEQ FORMALDEHYDE GAS SENSOR CH2O, 10 PPM, SERI-4

SENSOR SPECIFICATION

MEASURING SPECIFICATION	
Sensor type	Daviteq Seri-4 electro-chemical gas sensor
Nominal range	0-10 ppm
Maximum overload	30 ppm
Filter	-
Resolution	0.01 ppm
T90 response time	< 30 s
Typical Baseline Range (pure air, 20°C)	-0.1 ppm .. + 0.1 ppm
Repeatability	< 2% of reading
Accuracy	< +/- 5% of reading
WORKING CONDITIONS	
Relative humidity range	15 % to 90 % RH non-condensing ** Abrupt changes in RH causes a short term transient signal
Temperature range	-40 °C to 50 °C
Pressure range	Atmospheric ± 10%
SENSOR LIFETIME	
Expected Operation Life	3 years in the air
Expected Long-Term Output Drift in air	< 2 % of reading loss per month

We have other ranges: 50 ppm, and 1000 ppm.

CROSS SENSITIVITY DATA

Interfering Gas	Concentration (ppm)	Reading (ppm)
CO2	100	< 20
Ethanol (C2H5OH)	30	1
H2	100	5
H2S	20	~ 20
Methanol (CH3OH)	80	10

Methyl Mercaptan (MM, CH3SH)	10	~6
Tert-Butyl Mercaptan (TBM, (CH3)3CSH)	10	~6

PID GAS SENSORS

PID GAS SENSORS

Miniature PID Gas Sensor

Features

- Patented ‘fence’ electrode for excellent humidity resistance (from iOnScience)
- Anti-contamination design
- Reliable lamp ignition – illuminates at low temperatures
- Superior lamp life – 10.6 and 10.0 eV => 10,000 hours
- User-replaceable electrode stack in event of corrosive or mechanical damage
- Lamp out error detection (for Range 0-4000 PPM only)

Applications

- Industrial hygiene & safety monitoring
- Soil contamination and remediation
- Hazmat sites and spills
- Leak detection
- EPA Method 21 and emissions monitoring
- Arson investigation
- Indoor air quality monitoring
- Outdoor air quality monitoring

1. Selectable Ranges (Isobutylene equivalent) & Performances:

- Range: >10,000 ppm. Minimum detection limit: 500 ppb (10.6 eV Lamp). Response time in diffusion mode (T90) < 3s
- Range: 0 to 4000 ppm. Minimum detection limit: 100 ppb (10.6 eV Lamp). Response time in diffusion mode (T90) < 3s
- Range: >200 ppm. Minimum detection limit: 20 ppb (10.6 eV Lamp). Response time in diffusion mode (T90) < 8s
- Range: 0 to >100 ppm. Minimum detection limit: 5 ppb (10.0 eV Lamp). Response time in diffusion mode (T90) < 8s
- Range: 0 to >100 ppm. Minimum detection limit: 100 ppb (11.7 eV Lamp). Response time in diffusion mode (T90) < 8s
- Range: 0 to >40 ppm. Minimum detection limit: 1 ppb (10.6 eV Lamp). Response time in diffusion mode (T90) < 8s
- Range: 0 to 3 ppm. Minimum detection limit: 0.5 ppb (10.6 eV Lamp). Response time in diffusion mode (T90) < 12s

Environment:

- Relative humidity range: 0 - 99% RH, non-condensing;
- Operating Temp Range: -40 °C to +55 °C (except 0 - 40 °C for Range 3PPM sensor)

2. Response Factors for other Gases:

Our PIDs are calibrated using isobutylene, but PID is a broadband detection method with a variable sensitivity to each VOC. The relative sensitivity to each compound also varies significantly with PID photon energy (10, 10.6 or 11.7 eV). It varies much less with PID design and lamp output.

Response Factors (RFs) provide an indication of the relative sensitivity of PID to specific VOCs, relative to isobutylene. The RF of a VOC is used to convert the calibrated response of the sensor with isobutylene into a concentration of the target VOC.

Example: Toluene

- A PID 10.6 eV sensor is calibrated with isobutylene and found to have a sensitivity of 1 mV ppm-1.
- If the sensor is exposed to 100 ppm isobutylene the output will be 100 mV.
- The response factor for toluene using 10.6 eV is listed as 0.56.

- If the sensor is exposed to 56 ppm toluene then the displayed uncorrected concentration will be 100 ppm isobutylene. The corrected concentration would be 100 multiplied by the RF, 0.56, which gives the correct result of 56ppm toluene.

A complete list of response factors is shown below.

If response factors are programmed into an instrument, it is possible for target VOC to be specified, and the instrument can then display and record a concentration for that target volatile.

> **The Notes column below identifies the following:**
>
> **S**: slow. PID requires at least 30 s for a stable response.
> **V**: Variable response. The response is susceptible to small changes in ambient conditions, particularly humidity.
> **X**: Temporarily contaminating. PID responsivity may be suppressed for at least 30 min after 100 ppm-min exposure.
> **W!**: Expected to cause PID lamp window fouling. May require regular bump tests and window cleaning.

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Acenaphthalene		C12H8	208-96-8	8.12		0.7		
Acenaphthene		C12H10	83-32-9	7.80		0.7		
Acetaldehyde		C2H4O	75-07-0	10.23	**2**	**6**	**ZR**	
Acetamide		C2H5NO	60-35-5	9.69	NA	2	NA	
Acetic acid		C2H4O2	64-19-7	10.66	**4**	**28**	**ZR**	
Acetic anhydride		C4H6O3	108-24-7	10.14	2	4	NA	
Acetoin	3-hydroxybutanone	C4H8O2	513-86-0	~9.8	**1.6**	**1.4**	**2.0**	
Acetone	2-propanone	C3H6O	67-64-1	9.69	**1.7**	**1.17**	**1.20**	
Acetone cyanohydrin		C4H7NO	75-86-5	11.09	1	ZR	ZR	
Acetonitrile		CH3CN	75-05-8	12.20	**ZR**	**ZR**	**ZR**	
Acetophenone	methyl phenyl ketone	C8H8O	98-86-2	9.29	**0.8**	**0.8**	**0.8**	
Acetyl bromide		C2H3BrO	506-96-7	10.24	**1.5**	**8.0**	**ZR**	
Acetylene		C2H2	74-86-2	11.40	2	ZR	ZR	
Acetylglycine, N-		C4H7NO3	543-24-8	9.40	NA	NA	NA	S V
Acrolein		C3H4O	107-02-8	10.22	1.2	3.2	NA	
Acrylic acid		C3H4O2	79-10-7	10.60	**3**	**21**	**ZR**	
Acrylonitrile		C3H3N	107-13-1	10.91	**1.6**	**ZR**	**ZR**	
Alkanes, n-, C6+		CnH2n+2	N/A	~10	NA	1.2	NA	
Allyl acetoacetate		C7H10O3	1118-84-9	~10	NA	1.5	ZR	
Allyl alcohol		C3H6O	107-18-6	9.63	**1.1**	**2.3**	**4**	
Allyl bromide	3-bromopropene	C3H5Br	106-95-6	9.96	NA	3	NA	
Allyl chloride	3-chloropropene	C3H5Cl	107-05-1	10.05	**0.9**	**3.3**	**16**	
Allyl glycidyl ether		C6H10O2	106-92-3	~10	NA	0.8	NA	
Allyl propyl disulfide		C6H12S2	2179-59-1	~8.5	NA	0.4	NA	
Allylamine		C3H7N	107-11-9	8.80	NA	0.8	NA	S V X
Ammonia	R717	NH3	7664-41-7	10.18	5.7	**8.5**	NA	
Amyl acetate		C7H14O2	628-63-7	9.90	**0.64**	**1.8**	**9**	
Amyl alcohol		C5H12O	71-41-0	10.00	**0.75**	**2.6**	**10**	
Amyl alcohol, tert-		C5H12O	75-85-4	9.80	**1.01**	**1.5**	**2.8**	
Amyl salicylate		C12H16O3	2050-88-0	~9	**NA**	**4**	**NA**	
Anethole		C10H12O	104-46-1	~9	NA	0.4	NA	
Aniline		C6H7N	62-53-3	7.70	**0.7**	**1.0**	**0.8**	S
Anisole		C7H8O	100-66-3	8.21	**0.57**	**0.59**	**0.59**	
Anisyl aldehyde		C8H8O2	123-11-5	~9	NA	0.4	NA	
Argon		Ar	7440-37-1	15.76	ZR	ZR	NA	
Aromatic hydrocarbons, C8		H8H10	90989-38-1	~8.7		0.55	0.5	
Asphalt, petroleum fumes			8052-42-4	~9	NA	1	NA	
Benzaldehyde		C7H6O	100-52-7	9.49	**0.9**	**0.7**	**0.9**	
Benzene		C6H6	71-43-2	9.24	**0.53**	**0.50**	**0.54**	
Benzenethiol	thiophenol	C7H7S	100-53-8	8.50	**0.6**	**0.8**	**0.8**	
Benzoic acid		C7H6O2	65-85-0	9.30	NA	0.7	NA	
Benzonitrile	cyanobenzene	C7H5N	100-47-0	9.62	**0.8**	**0.5**	**0.7**	
Benzoquinone, o-		C6H4O2	583-63-1	9.30	NA	1	NA	
Benzoquinone, p-		C6H4O2	106-51-4	10.01	NA	1	NA	
Benzoyl bromide		C7H5BrO	618-32-6	9.65	NA	2	NA	
Benzyl 2-phenylacetate		C15H14O2	102-16-9	~9	NA	0.5	NA	
Benzyl acetate		C9H10O2	140-11-4	~9	NA	0.6	NA	
Benzyl alcohol		C7H8O	100-51-6	8.26	**1.3**	**1.0**	**1.6**	
Benzyl chloride		C7H7Cl	100-44-7	9.14	**0.58**	**0.7**	**0.7**	
Benzyl formate		C8H8O2	104-57-4	9.32	0.66	0.8	NA	
Benzyl isobutyrate		C11H14O2	103-28-6	~9	NA	0.5	NA	
Benzyl nitrile		C8H7N	140-29-4	9.39	**1.4**	**1.4**	**1.5**	
Benzyl propionate		C10H12O2	122-63-4	~9	NA	0.8	NA	
Benzylamine		C7H9N	100-46-9	7.56	NA	0.6	NA	S V X
Biphenyl	diphenyl	C12H10	92-52-4	8.23	NA	0.4	0.6	
Borneol		C10H18O	507-70-0	~9	NA	0.8	NA	
Boron trifluoride		BF3	7637-07-02	15.50	ZR	ZR	ZR	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Bromine		Br2	7726-95-6	10.55	0.74	15	ZR	
Bromine pentafluoride		BrF5	7789-30-2	13.17	ZR	ZR	ZR	
Bromo-2,2-dimethylpropane, 1-	neopentyl bromide	C5H11Br	630-17-1	10.04	NA	2	NA	
Bromo-2-chloroethane, 1-		C2H4BrCl	107-04-0	10.57	**0.44**	**3**	**ZR**	
Bromo-2-methylpentane, 1-		C6H13Br	25346-33-2	10.09	NA	2	NA	
Bromoacetone		C3H5BrO	598-31-2	9.73	NA	1.0	NA	
Bromoacetylene		C2HBr	593-61-3	10.31	NA	4	ZR	
Bromobenzene		C6H5Br	108-86-1	8.98	**0.34**	**0.32**	**0.32**	
Bromobutane, 1-		C4H9Br	109-65-9	10.13	**0.6**	**1.6**	**14**	
Bromobutane, 2-		C4H9Br	78-76-2	10.01	**0.62**	**0.97**	**1.6**	
Bromochloromethane		CH2ClBr	74-97-5	10.77	1	ZR	ZR	
Bromocyclohexane		C6H11Br	108-85-0	9.87	NA	2	NA	
Bromoethane		C2H5Br	74-96-4	10.29	**0.79**	**1.6**	**ZR**	
Bromoethanol, 2-		C2H5BrO	540-51-2	10.00	NA	2	NA	
Bromoethyl methyl ether, 2-		C3H7OBr	6482-24-2	10.00	2	2.5	NA	
Bromofluoromethane		CH2FBr	373-52-4	~11	1	ZR	ZR	
Bromoform	tribromomethane	CHBr3	75-25-2	10.48	**0.5**	**2.7**	**60**	
Bromopentane, 1-	n-pentyl bromide	C5H11Br	110-53-2	10.10	**0.47**	**1.1**	**3.5**	
Bromopropane, 1-	n-propyl bromide	C3H7Br	106-94-5	10.18	**0.7**	**1.5**	**70**	
Bromopyridine, 3-		C5H4BrN	626-55-1	9.75	NA	2	NA	
Bromopyridine, 4-		C5H4BrN	1120-87-2	9.94	NA	2	NA	
Bromotrifluoromethane	R13B1	CF3Br	75-63-8	11.78	NA	ZR	ZR	
Bromotrimethylsilane		C3H9BrSi	2857-97-8	10.00	**1.6**	**1.9**	**2.1**	
But-2-ynal		C4H4O	1119-19-3	10.20	NA	3	NA	
But-3-ynal		C4H4O	52844-23-2	9.85	NA	1.5	NA	
Butadiene diepoxide, 1,3-		C4H6O2	1464-53-5	10.00	1.2	4	NA	
Butadiene, 1,2-		C4H6	590-19-2	9.23		1		
Butadiene, 1,3-		C4H6	106-99-0	9.07	1.1	0.8	0.8	
Butane, n-		C4H10	106-97-8	10.63	1.5	40	ZR	
Butanediol, 2,3-		C4H10O2	513-85-9	10.26	**5.3**	**5**	**15**	
Butanedione, 2,3-	biacetyl, diacetyl	C4H6O2	431-03-8	9.56	**1.00**	**0.86**	**0.87**	
Butanoic acid		C4H8O2	107-92-6	10.17	**0.5**	**4.3**	**30**	
Butanol, 1-		C4H10O	71-36-3	10.04	**1**	**3.9**	**25**	
Butanol, 2-		C4H10O	78-92-2	10.10	**1.2**	**3.0**	**8**	
Butanone oxime, 2-		C4H9NO	96-29-7	~9		1		
Buten-3-ol, 1-		C4H8O	598-32-3	9.50	**1.3**	**1.8**	**3**	
Butene nitrile, 3-		C4H5N	109-75-1	10.20	NA	3.0	NA	
Butene, 1-		C4H8	106-98-9	9.58	NA	1.5	NA	
Butene, 2-		C4H8	107-01-7	9.10	NA	1.3	NA	
Butene, cis-2-		C4H8	590-18-1	9.13	NA	1.3	NA	
Butene, trans-2-		C4H8	624-64-6	9.13	NA	1.3	NA	
Butenoic acid, 3-		C4H6O2	107-93-7	9.75	**4**	**2**	**9**	
Butoxyethanol, 2-	Butyl Cellosolve®	C6H14O2	111-76-2	8.68	**0.8**	**1.3**	**2.3**	
Butoxyethoxyethanol		C8H18O3	112-34-5	~10	**4.8**	**3**	**13**	
Butoxyethyl acetate, 2-		C8H16O3	112-07-2	~9.8	**1.3**	**2**	**4**	
Butyl acetate		C6H12O2	123-86-4	9.91	**0.8**	**2.5**	**12**	
Butyl acetate, sec-		C6H12O2	105-46-4	9.91	**0.80**	**1.8**	**5.5**	
Butyl acrylate		C7H12O2	141-32-2	~9.6	**0.6**	**1.3**	**7**	
Butyl butyrate		C8H16O2	109-21-7	~9.7	**0.8**	**1.53**	**2.8**	
Butyl chloroformate		C5H9ClO2	592-34-7	~10.4	NA	3.2	ZR	
Butyl cyclohexan-1-ol, 4-tert-	4-(1,1-Dimethylethyl)cyclohexanol	C10H20O	98-52-2	~8.8	NA	1.4	NA	
Butyl cyclohexyl acetate, 2-tert-	2-t-butylcyclohexylacetate	C12H22O2	88-41-5	~10	NA	0.9	NA	
Butyl ether, n-	dibutyl ether	C8H18O	142-96-1	9.28	**0.42**	**0.82**	**1.10**	
Butyl glycidyl ether	2-(Butoxymethyl)oxirane	C7H14O2	2426-08-06	~10	NA	2	NA	
Butyl iodide	iodobutane	C4H9I	542-69-8	9.23	**0.3**	**0.27**	**0.25**	
Butyl isocyanate		C5H9NO	111-36-4	10.14	NA	2.5	NA	
Butyl lactate		C7H14O3	138-22-7	9.80	NA	2.5	NA	
Butyl mercaptan, n-		C4H10S	109-79-5	9.15	**0.50**	**0.8**	**0.8**	
Butyl mercaptan, tert-		C4H10S	75-66-1	9.03	**0.59**	**0.62**	**0.62**	
Butyl methacrylate		C8H14O2	97-88-1	~9.5	**0.9**	**1.2**	**1.7**	
Butyl propionate, n-		C7H14O2	590-01-2	~9.7	**0.80**	**1.9**	**4**	
Butylamine, n-		C4H11N	109-73-9	8.71	**2**	**1**	**10**	**S X**
Butylamine, sec-		C4H11N	513-49-5	8.70	**5**	**0.9**	**30**	S V X
Butylamine, tert-		C4H11N	75-64-9	8.64	**1.1**	**1.2**	**1.5**	S X
Butylbenzene		C10H14	104-51-8	8.69	**0.4**	**0.6**	**0.7**	
Butylbenzene, sec-		C10H14	135-98-8	8.68	NA	0.4	0.4	
Butylbenzene, tert-		C10H14	98-06-6	8.69	NA	0.4	0.4	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Butyldiglycol acetate		C10H20O4	124-17-4	~10	**3**	**1.6**	**15**	
Butylene carbonate, 1,2-		C5H8O3	4437-85-8	~10.4	**3.8**	**18**	**ZR**	
Butylphenol, o-sec-		C10H14O	89-72-5	7.80	NA	0.9	NA	
Butyn-1-ol, 2-		C4H6O	764-01-2	9.78	**0.6**	**0.6**	**0.6**	V
Butyn-2-one		C4H4O	1423-60-5	10.17	NA	3	NA	
Butyraldehyde		C4H8O	123-72-8	9.86	**1.2**	**1.7**	**1.9**	
Butyrolactone, gamma-		C4H6O2	96-48-0	10.26	NA	15	NA	
Butyryl chloride		C4H7ClO	141-75-3	~10.4	NA	3	ZR	
Camphene		C10H16	565-00-4	8.86	**0.46**	**0.35**	**0.6**	
Camphor		C10H16O	76-22-2	8.76	NA	0.4	NA	
Carbitol acetate		C6H16O4	112-15-12	~9	**1.0**	**1.6**	**3**	
Carbon dioxide		CO2	124-38-9	13.77	ZR	ZR	ZR	
Carbon disulfide		CS2	75-15-0	10.08	0.3	1.4	1.3	
Carbon monoxide		CO	630-08-0	14.01	ZR	ZR	ZR	
Carbon suboxide		C3O2	504-64-3	10.60	NA	10	ZR	
Carbon tetrabromide		CBr4	558-13-4	10.31	**6**	**11**	**ZR**	
Carbon tetrachloride	R10	CCl4	56-23-5	11.47	**1.7**	**ZR**	**ZR**	
Carbonyl fluoride		COF2	353-50-4	13.02	ZR	ZR	ZR	
Carbonyl sulfide		COS	463-58-1	11.18	0.4	ZR	ZR	
Carene		C10H16	13466-78-9	8.40	**0.3**	**0.4**	**0.37**	
Carvacrol		C10H14O	499-75-2	~9	NA	0.8	NA	
Carvone, R-		C10H14O	6485-40-1	9.77	**1.7**	**1.6**	**1.5**	
Caryophyllene		C15H24	13877-93-5	~9	NA	0.4	NA	
Chloral hydrate		C2H3Cl3O2	302-17-0	~10	**2.2**	**NA**	**ZR**	V
Chloramine	monochloramine	ClH2N	10599-90-3	9.85	NA	2	NA	
Chlorine	Chlorine	Cl2	7782-50-5	11.48	1	ZR	ZR	
Chlorine dioxide		ClO2	10049-04-4	10.36	ZR	ZR	ZR	
Chlorine trifluoride		ClF3	7790-91-2	12.65	NA	ZR	ZR	
Chloro-1,1,1,2-tetrafluoroethane, 2-	R-124	C2HClF4	2837-89-0	~12	ZR	ZR	ZR	
Chloro-1,1,1-trifluoroethane, 2-	R-133a	C2H2ClF3	75-88-7	~12	ZR	ZR	ZR	
Chloro-1,1,2,2-tetrafluoroethane, 1-	R-124a	C2HClF4	354-25-6	~12	ZR	ZR	ZR	
Chloro-1,1,2-trifluoroethane, 1-	R-133	C2H2ClF3	421-04-5	~12	ZR	ZR	ZR	
Chloro-1,1-difluoroethane, 1-	R-142b	C2H3ClF2	75-68-3	11.98	ZR	ZR	ZR	
Chloro-1,1-difluoroethane, 2-	R-142	C2H3ClF2	338-65-8	~11.9	ZR	ZR	ZR	
Chloro-1,1-difluoroethene, 2-	R-1122	C2HClF2	359-10-4	9.80	NA	1.5	NA	
Chloro-1,2,2-trifluoroethane, 1-	R133	C2H2ClF3	431-07-2	~12	ZR	ZR	ZR	
Chloro-1-fluoroethane, 1-	R-151a	C2H4ClF	1615-75-4	~11.7	1	ZR	ZR	
Chloro-2-fluoroethane, 1-	R-151	C2H4ClF	762-50-5	~11.7	1	ZR	ZR	
Chloro-2-propanone, 1-		C3H5ClO	78-95-5	9.92	NA	1	NA	
Chloro-3,3,3-trifluoroprop-1-ene, 1-		C3H2ClF3	102687-65-0	~11	1			
Chloroacetaldehyde	2-chloroethanal	C2H3OCl	107-20-0	10.16	NA	3	NA	
Chloroacetyl chloride		C2H2Cl2O	79-04-9	10.30	NA	8.0	NA	V
Chlorobenzene		C6H5Cl	108-90-7	9.07	**0.47**	**0.45**	**0.5**	
Chlorobutane, 1-	butyl chloride	C4H9Cl	109-69-3	10.64	**0.74**	**10**	**ZR**	
Chlorobutane, 2-		C4H9Cl	78-86-4	10.57	**1**	**5.8**	**ZR**	
Chlorocyclohexane		C6H11Cl	542-18-7	10.10	**0.5**	**2**	**20**	
Chlorodifluoromethane		CHClF2	75-45-6	12.45	ZR	ZR	ZR	
Chloroethane		C2H5Cl	75-00-3	10.97	1.1	ZR	ZR	
Chloroethanol, 2-	ethyl chlorohydrin	C2H5ClO	107-07-3	10.50	1	10	ZR	
Chloroethyl methyl ether, 2-		C3H7ClO	627-42-9	10.25	NA	2.6	NA	
Chlorofluoromethane	R31	CH2ClF	593-70-4	11.71	NA	ZR	ZR	
Chloroform	R20	CHCl3	67-66-3	11.42	**0.8**	**ZR**	**ZR**	
Chloromethane	R40	CH3Cl	74-87-3	11.28	0.74	ZR	ZR	
Chloromethoxyethane	chloromethyl ethyl ether	C3H7ClO	3188-13-4	10.30	NA	4	ZR	
Chloropentafluoroethane		C2ClF5	76-15-3	12.96	ZR	ZR	ZR	
Chloroprene	2-chlorobuta-1,3-diene	C4H5Cl	126-99-8	8.79	NA	1.3	NA	
Chloropyridine, 2-		C5H4ClN	109-09-1	9.00	NA	1	NA	
Chlorostyrene, o-		C8H7Cl	2039-87-4	~8.5	NA	0.4	NA	
Chlorothiophene, 3-		C4H3ClS	17249-80-8	8.92	0.7	0.7	0.7	
Chlorotoluene, m-		C7H7Cl	108-41-8	8.70	**0.5**	**0.5**	**0.46**	
Chlorotoluene, o-		C7H7Cl	95-49-8	8.83	0.6	0.5	NA	
Chlorotoluene, p-		C7H7Cl	106-43-4	8.69	0.3	0.4	0.3	
Chlorotrifluoroethylene	R-1113	C2ClF3	79-38-9	9.81	1	1	NA	
Chlorotrifluoromethane	R13	CClF3	75-72-9	12.60	NA	ZR	ZR	
Cinnamic aldehyde		C8H8O	104-55-2	~9	NA	0.4	NA	
Cinnamyl acetate		C11H12O2	21040-45-9	~9	NA	0.4	NA	
Cinnamyl alcohol		C9H10O	104-54-1	8.10	NA	0.4	NA	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Citral		C10H16O	5392-40-5	~8.7	**1.7**	**1.7**	**3.4**	
Citronellal		C10H18O	106-23-0	~9	NA	0.9	NA	
Citronellol		C10H20O	26489-01-0	~8.5	NA	1.0	NA	
Citronellol acetate		C12H22O2	150-84-5	~9	NA	1.5	NA	
Citronellol formate		C11H20O2	105-85-1	~9	NA	1.5	NA	
Citronellyl isobutyrate		C14H26O2	97-89-2	~9	NA	0.9	NA	
Clary propyl acetate		C11H20O3	131766-73-9	~9	**1.3**	**1.2**	**2**	
Coumarin		C9H6O2	91-64-5	~9	NA	0.4	NA	
Creosote		n/a	8021-39-4	~9	NA	1	NA	
Cresol, m-	3-methylphenol	C7H8O	108-39-4	8.36	**1.7**	**1.4**	**1.5**	
Cresol, o-	2-methylphenol	C7H8O	95-48-7	8.14	**1.4**	**1.4**	**1.5**	
Cresol, p-	4-methylphenol	C7H8O	106-44-5	8.31	1.5	1.5	1.5	
Cresyl acetate, p-		C9H10O2	140-39-6	8.60	NA	1.0	NA	
Cresyl ethyl ether, p-		C9H12O	622-60-6	~9	NA	0.8	NA	
Cresyl methyl ether		C8H10O	104-93-8	~9	NA	0.8	NA	
Crotonaldehyde		C4H6O	4170-30-3	9.73	**1.0**	**1.0**	**1.8**	
Crotonyl alcohol		C4H8O	6117-91-5	9.13	NA	0.8	NA	
Cyanogen bromide		CNBr	506-68-3	11.84	ZR	ZR	ZR	
Cyanogen chloride		CNCl	506-77-4	12.49	ZR	ZR	ZR	
Cycloalkanes		N/A	N/A	~10	NA	1.5	NA	
Cyclobutanone		C4H6O	1191-95-3	9.35	**1.6**	**1.12**	**1.10**	
Cyclobutene		C4H6	822-35-5	9.43	NA	3	NA	
Cycloheptane		C7H14	291-64-5	9.82	NA	1.1	NA	
Cyclohex-2-enedione, 1,4-		C6H6O2	4505-38-8	9.77	NA	1.0	NA	
Cyclohexane		C6H12	110-82-7	9.98	**0.64**	**1.3**	**3.3**	
Cyclohexanethiol		C6H12S	1569-69-3	~9	NA	0.5	NA	
Cyclohexanol		C6H12O	108-93-0	10.00	**0.9**	**1.6**	**2.7**	
Cyclohexanone		C6H10O	108-94-1	9.16	**0.8**	**1.0**	**1**	
Cyclohexene		C6H10	110-83-8	8.95	**0.56**	**0.9**	**1.4**	
Cyclohexyl acetate		C8H14O2	622-45-7	~9.5	NA	1.2	NA	
Cyclohexylamine		C6H13N	108-91-8	8.37	**6**	**3**	**20**	S X
Cyclooctadiene		C8H12	29965-97-7	~9.5	**0.5**	**1.0**	**1.1**	
Cyclopentadiene		C5H6	542-92-7	8.56	NA	0.8	NA	
Cyclopentane		C5H10	287-92-3	10.52	**0.7**	**10**	**ZR**	X
Cyclopentanone		C5H8O	120-92-3	9.26	**0.8**	**0.9**	**1.0**	
Cyclopentene		C5H8	142-29-0	9.01	NA	1.5	140	
Cyclopentene-1,3-dione, 4-		C5H4O2	930-60-9	9.60	NA	1.0	NA	
Cyclopropylamine		C3H7N	765-30-0	8.80	**1.1**	**1.5**	**1.7**	S V X
Cymene, p-		C10H14	99-87-6	8.29	NA	0.4	NA	
Decahydronaphthalene	4-isopropyltoluene	C10H18	91-17-8	9.14	NA	0.9	NA	
Decanal	decalin	C10H20O	112-31-2	~9	**1.6**	**1.2**	**4.0**	
Decane		C10H22	124-18-5	9.65	**0.37**	**1.2**	**4.2**	
Decenal, trans-4-		C10H18O	65405-70-01	~9	**1.2**	**1.4**	**2.4**	
Decene		C10H22	872-05-9	~9.5	NA	0.8	NA	
Decyne, 1-		C10H18	764-93-2	9.91	**0.37**	**0.43**	**0.83**	
Desfluorane	2-(difluoromethoxy)-1,1,1,2-tetrafluoroethane	C3H2F6O	57041-67-5	~11	2	ZR	ZR	
Deuterium oxide		D2O	7789-20-0	13.60	ZR	ZR	ZR	
Diacetone alcohol		C6H12O2	123-42-2	~9.6	**1.2**	**0.9**	**0.84**	
Diazine, 1,2-	1,2-diazabenzene	C4H4N2	289-80-5	9.65	NA	3	NA	
Diazine, 1,3-	1,3-diazabenzene	C4H4N2	289-95-2	9.33	NA	3	NA	
Diborane		B2H6	19287-45-7	11.38	NA	ZR	ZR	
Dibromoacetylene		C2Br2	624-61-3	9.65	NA	2	NA	
Dibromochloromethane		CHBr2Cl	124-48-1	10.59	0.7	10	ZR	
Dibromocyclohexane, 1,2-		C6H10Br2	5401-62-7	10.02	NA	3	NA	
Dibromocyclopentane		C5H8Br2	33547-17-0	10.06	NA	3	NA	
Dibromodichloromethane		CBr2Cl2	594-18-3	10.40	NA	4	ZR	
Dibromodifluoromethane		CF2Br2	75-61-6	11.07	NA	3	ZR	
Dibromoethane, 1,2-	EDB, ethylene dibromide	C2H4Br2	106-93-4	10.35	0.6	2	ZR	
Dibromoethene, 1,1-	vinylidene bromide	C2H2Br2	593-92-0	9.78	NA	1.5	NA	
Dibromoethene, 1,2-		C2H2Br2	540-49-8	9.63	NA	1.5	NA	
Dibromomethane	methylene dibromide	CH2Br2	74-95-3	10.41	**0.70**	**1.9**	**ZR**	
Dibromotetrafluoroethane, 1,2-	Dibromoperfluoroethane,1,2-	C2F4Br2	124-73-2	11.10	1	ZR	ZR	
Dichloro-1,1,1-trifluoroethane, 2,2-	R-124	C2HCl2F3	306-83-2	11.50	NA	ZR	ZR	
Dichloro-1,1-difluoroethane, 1,2-	R-132a	C2H2Cl2F2	1649-08-7	~11.7 5	ZR	ZR	ZR	
Dichloro-1,2,2-trifluoroethane, 1,2-	R-123a	C2HCl2F3	354-23-4	~11.5	NA	ZR	ZR	
Dichloro-1,2-difluoroethane, 1,2-	R-132	C2H2Cl2F2	431-06-1	~11.5	1	ZR	ZR	
Dichloro-1,2-difluoroethene, 1,2-	1,2-dichlorodifluoroethene	C2Cl2F2	598-88-9	10.20	NA	2	NA	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Dichloro-1,3-butadiene, 1,4-		C4H6Cl2	1587-29-7	~9	1	0.6	NA	
Dichloro-1-fluoroethane, 1,1-	R-141a	C2H3Cl2F	1717-00-6	~11	1	ZR	ZR	
Dichloro-1-fluoroethane, 1,2-	R-141	C2H3Cl2F	430-57-9	~11	1	ZR	ZR	
Dichloro-1-propene, 2,3-		C3H4Cl2	78-88-6	~10.5	0.7	1.4	ZR	
Dichloro-2,2,-difluoroethene, 1,1-	R-1112a	C2Cl2F2	79-35-6	9.69	1	1	NA	
Dichloro-2-butene, 1,4-		C4H7Cl	764-41-0	~9.5	1	2.0	NA	
Dichloro-2-butene, trans-1,4-	1,4-dichloro-(E)-2-butene	C4H7Cl	110-57-6	~9.5	1	2.0	NA	
Dichloroacetylene		C2Cl2	7572-29-4	9.90	NA	5	NA	
Dichlorobenzene, m-		C6H4Cl2	541-73-1	~9	**0.35**	**0.5**	**0.5**	
Dichlorobenzene, o-		C6H4Cl2	95-50-1	9.06	**0.48**	**0.6**	**0.6**	
Dichlorobenzene, p-		C6H4Cl2	106-46-7	9.06	**0.35**	**0.5**	**0.5**	
Dichlorodifluoromethane		CCl2F2	75-71-8	11.75	ZR	ZR	ZR	
Dichloroethane, 1,1-	1,1-DCA	C2H4Cl2	75-34-3	11.06	2	ZR	ZR	
Dichloroethane, 1,2-	EDC or 1,2-DCA	C2H4Cl2	107-06-2	11.05	0.6	ZR	ZR	
Dichloroethene, 1,1-	1,2-dichloroethene	C2H2Cl2	75-35-4	10.00	1	1.0	NA	
Dichloroethene, 1,2-	1,1-DCE, vinylidene chloride	C2H2Cl2	540-59-0	9.65	0.34	0.4	0.29	
Dichloroethene, cis-1,2-	c-1,2-DCE	C2H2Cl2	156-59-2	9.66	1	0.8	NA	
Dichloroethene, trans-1,2-	t-1,2-DCE	C2H2Cl2	156-60-5	9.65	0.34	0.4	NA	
Dichlorofluoromethane	R21	CHFCl2	75-43-4	12.39	ZR	ZR	ZR	
Dichloromethane	methylene chloride	CH2Cl2	75-09-2	11.32	**1.00**	**70**	**ZR**	
Dichloromethylamine		CH3Cl2N	7651-91-4	9.52	NA	2	NA	S X
Dichloropropane, 1,2-		C3H6Cl2	78-87-5	10.87	**0.70**	**ZR**	**ZR**	
Dichlorotetrafluoroethane, 1,1-	R114a	C2Cl2F4	374-07-2	12.20	ZR	ZR	ZR	
Dichlorotetrafluoroethane, 1,2-	R114	C2Cl2F4	76-14-2	12.20	ZR	ZR	ZR	
Dicyclohexylamine		C12H23N	101-83-7	~8.5	NA	0.9	NA	S X
Dicyclopentadiene		C10H12	77-73-6	7.74	**0.5**	**0.65**	**0.67**	
Diesel fuel			68334-30-5	8.00	0.4	0.8	NA	
Diethoxyethane, 1,1-	`	C6H14O2	105-57-7	9.78	**0.6**	**1.5**	**1.0**	V
Diethoxymethane		C5H12O2	462-95-3	9.70		1		
Diethyl carbonate		C5H10O3	105-58-8	~10.3	**1.2**	**7**	**ZR**	
Diethyl ether	ethyl ether	C4H10O	60-29-7	9.53	**1.1**	**1.5**	**1.4**	
Diethyl maleate		C8H12O4	141-05-9	~10	NA	2	NA	
Diethyl malonate		C7H12O4	105-53-3	10.20	NA	4	ZR	
Diethyl phosphite		C4H11O3P	762-04-9	10.31	NA	2	ZR	
Diethyl phthalate		C12H14O4	84-66-2	~9	NA	1	NA	
Diethyl sulfate		C4H10SO4	64-67-5	~10.5	**4**	**20**	**ZR**	
Diethyl sulfide		C4H10S	352-93-2	8.43	**0.5**	**0.8**	**0.7**	
Diethyl sulfone		C4H10O2S	597-35-3	9.96	NA	2.0	NA	
Diethylacetylene		C6H10	928-49-4	10.03	NA	2	NA	
Diethylamine		C4H11N	109-89-7	8.01	**NA**	**3**	**30**	S V X
Diethylaminoethanol, 2-		C6H15ON	100-37-8	8.58	NA	2.7	NA	S X
Diethylaminopropylamine, 3-		C7H18N2	104-78-9	~9	**3**	**5**	**3**	S X
Diethylchlorophosphite		C4H10ClO2P	589-57-1	9.50	**1.4**	**1.0**	**ZR**	v x
Diethylene glycol	2,2'-Oxydiethanol	C4H10O3	111-46-6	~10.3	**30**	**15**	**40**	
Diethylene glycol monoethyl ether	DEGEE	C6H14O3	111-90-0	~9	**1.2**	**1.5**	**3**	
Diethylenetriamine		C4H13N3	111-40-0	~9	NA	1	NA	S X
Diethylhydroxylamine		C4H11NO	3710-84-7	~10	**1.2**	**1.5**	**1.5**	X
Diethylsilane		C4H12Si	542-91-6	9.80	NA	2	NA	
Difluoroethane, 1,1-	R152a	C2H4F2	75-37-6	11.87	ZR	ZR	ZR	
Difluoroethane, 1,2-	R152	C2H4F2	624-72-6	11.86	ZR	ZR	ZR	
Difluoromethane	R32	CH2F2	75-10-5	12.71	ZR	ZR	ZR	
Diglycidyl ether	glycidic ether	C6H10O3	2238-07-5	~9.6	NA	3	NA	
Dihydroeugenol		C10H14O2	2785-87-7	~9	NA	0.4	NA	
Dihydrojasmone		C11H18O	1128-08-1	~9	NA	0.6	NA	
Dihydromyrcenol		C10H20O	18479-58-8	~9	NA	0.8	NA	
Dihydroxybenzene, 1,2-	catechol, benzene-1,2-diol	C6H6O2	120-80-9	8.56	NA	1	NA	
Dihydroxybenzene, 1,3-	resorcinol	C6H6O2	108-46-3	8.63	NA	1	NA	
Diiodomethane	methylene iodide	CH2I2	75-11-6	9.46	NA	1.2	NA	
Diisobutyl ketone	isovalerone	C9H18O	108-83-8	9.04	NA	0.8	0.7	
Diisobutylene	2,4,4-trimethylpent-1-ene	C8H16	107-39-1	8.91	**0.50**	**0.7**	**0.9**	
Diisopropyl ether	isopropyl ether	C6H14O	108-20-3	9.20	**0.62**	**0.70**	**0.95**	
Diisopropylamine		C6H15N	108-18-9	7.73	0.53	0.7	0.6	S X
Diisopropylbenzene		C12H18	25321-09-9	~8.8	NA	0.5	NA	
Diketene		C4H4O2	674-82-8	9.60	1.4	2.2	NA	
Dimethoxybenzene, 1,4-		C8H10O2	150-78-7	~9	NA	1.3	NA	
Dimethoxyethane, 1,2-	ethylene glycol dimethyl ether	C4H10O2	110-71-4	9.20	**0.6**	**0.9**	**1.2**	
Dimethoxymethane	formal	C3H8O2	109-87-5	10.00	**1.2**	**2.8**	**13**	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Dimethyl carbonate		C3H6O3	616-38-6	10.52	**1.5**	**60**	**ZR**	
Dimethyl chlorothiophosphate	DMPCT	C2H6ClO2PS	2524-03-0	~9	NA	1	NA	
Dimethyl disulfide	DMDS	C2H6S2	624-92-0	8.46	NA	0.2	NA	
Dimethyl ether	methyl ether	C2H6O	115-10-6	10.03	NA	1.3	NA	
Dimethyl hydrogen phosphite		C2H7O3P	868-85-9	10.53	NA	8	ZR	
Dimethyl phthalate		C10H10O4	131-11-3	9.64	NA	1	NA	
Dimethyl sulfate		C2H6O4S	77-78-1	~12	2.3	ZR	ZR	
Dimethyl sulfoxide	DMSO	C2H6OS	67-68-5	9.10	**9**	**20**	**32**	V
Dimethylacetamide N,N-		C4H9NO	127-19-5	8.81	0.8	1.3	NA	
Dimethylacetylene		C4H6	503-17-3	9.58	**0.4**	**0.19**	**0.16**	
Dimethylamine		C2H7N	124-40-3	8.24	2	1.5	NA	S X
Dimethylaminoethane, N,N-	UDMH	C2H8N2	57-14-7	8.05	0.8	1	NA	
Dimethylaminoethanol, 2-	dimethylethanolamine	C4H11NO	108-01-0	8.80	**7**	**3**	**50**	S V X
Dimethylaniline, NN-		C8H11N	121-69-7	7.12	**0.9**	**2**	**2**	S V
Dimethylboron bromide		C2H6BBr	5158-50-9	10.25	NA	4	NA	
Dimethylbutene, 2,3-		C6H12	563-78-0	9.07		0.8		
Dimethylbutyl acetate, 1,3-	sec-hexyl acetate	C8H16O2	108-84-9	~9.5	2	1.6	NA	
Dimethylcycloheptane, 1,2-		C9H18	13151-50-3	10.21	NA	1.3	NA	
Dimethylcyclohexane,1,2-	1,2-DMCH	C8H16	583-57-3	9.41	**0.45**	**0.55**	**0.9**	
Dimethylcyclopentane		C7H14	1192-18-3	9.92	NA	1.2	NA	
Dimethylethylamine, NN-	DMEA	C4H11N	598-56-1	7.74	**1.2**	**1.6**	**1.7**	S X W!
Dimethylformamide	DMF	C3H7NO	68-12-2	9.13	**1.12**	**1.3**	**1.1**	
Dimethylmethylphosphonate	DMMP	C3H9O3P	756-79-6	9.94	NA	5	NA	
Dimethyloctan-1-ol, 3,7-		C10H22O	106-21-8	~9	NA	1.2	NA	
Dimethyloctan-3-ol, 3,7-		C10H22O	78-69-3	~9	NA	1.2	NA	
Dimethylpentane, 2,4-		C7H16	108-08-7	~9.8	NA	1	NA	
Dimethylsilane		C2H8Si	1111-74-6	10.30	NA	2	ZR	
Di-n-butylamine		C8H19N	111-92-2	7.69	**1**	**6**	**4**	S X
Dioxane, 1,4-	p-dioxane	C4H8O2	123-91-1	9.13	**0.85**	**1.45**	**1.7**	
Dioxolane		C3H6O2	646-06-0	9.13	**1.47**	**2.7**	**4.5**	
Dipentene	limonene	C10H16	138-86-3	~8.6	1	0.9	0.8	
Dipentene, (+)-	limonene	C10H16	5989-27-5	~8.6	**0.45**	0.8	0.8	
Diphenyl ether	phenyl ether	C12H10O	101-84-8	8.09	**1.4**	**1.5**	**1.7**	
Dipropyl ether	propyl ether	C6H14O	111-43-3	9.30	NA	1.0	NA	
Dipropylamine		C6H15N	142-84-7	7.80	**0.7**	**1.5**	**1.5**	S V X
Dipropylene glycol		C6H14O3	110-98-5	~10	NA	4	NA	
Disilane		Si2H6	1590-87-0	9.74	NA	2	NA	
Disulfur decafluoride		S2F10	5714-22-7	12.77	NA	ZR	ZR	
Disulfur dibromide		S2Br2	13172-31-1	9.23	NA	1.5	NA	
Disulfur dichloride		S2Cl2	10025-67-9	9.40	NA	3	NA	
Di-tert-butyl-p-cresol		C15H24O	128-37-0	7.80	NA	0.3	NA	
Divinylbenzene, 1,2-		C10H10	1321-74-0	~8.2	NA	**0.7**	**0.6**	X
Divinylbenzene, 1,3-		C10H10	108-57-6	~8.3	NA	0.6	0.6	
Dodecene		C12H24	112-40-3	~8.8	NA	1.0	NA	
Enflurane		C4H2F5ClO	13838-16-9	11.70	ZR	ZR	ZR	
Epichlorohydrin	1-chloro-2,3-epoxypropane	C3H5ClO	106-89-8	10.20	**0.80**	**5**	**30**	
Epoxypropyl isopropyl ether, 2,3-	glycidyl isopropyl ether	C6H12O2	4016-14-2	~10	**0.6**	**1.2**	**1.1**	
Estragole		C10H12O	140-67-0	~9	NA	0.7	NA	
Ethane		C2H6	74-84-0	11.56	3	ZR	ZR	
Ethanol	alcohol, ethyl alcohol	C2H6O	64-17-5	10.47	**3**	**11**	**ZR**	
Ethanolamine		C2H7NO	141-43-5	10.47	**NA**	**3**	**ZR**	V X
Ethoxy-2-methylpropane, 1-		C6H14O	627-02-1	9.30	NA	1	NA	
Ethoxy-2-propanol, 1-		C5H12O2	1569-02-4	~9.6	**0.9**	**1.2**	**1.9**	
Ethoxybutane, 2-		C6H14O	19316-73-5	9.32	NA	1	NA	
Ethoxyethanol, 2-	Ethyl Cellosolve ®, EGME	C4H10O2	110-80-5	9.60	**1.7**	**2**	**5**	
Ethoxynonafluorobutane		C6H5OF9	163702-06-5	12.00		ZR	ZR	
Ethoxypropanol	PGEE	C5H12O2	52125-53-8	~9.6	0.9	1.2	1.9	
Ethyl 2,2,2-trifluoroethyl ether	TFEE	C4H7F3O	461-24-5	10.27	NA	5	NA	
Ethyl 2-methylbutyrate		C7H14O2	7452-79-1	~9	**0.72**	**1.4**	**1.8**	
Ethyl acetate		C4H8O2	141-78-6	10.01	**1.4**	**4.5**	**40**	
Ethyl acetoacetate		C6H10O3	141-97-9	~9.5	**2.2**	**2.5**	**3**	
Ethyl acrylate		C5H8O2	140-88-5	10.30	**1.0**	**2.3**	**15**	
Ethyl benzoate		C9H10O2	93-89-0	8.90	NA	0.9	NA	
Ethyl butyrate		C6H12O2	105-54-4	~9.9	**1.0**	**1.4**	**3.3**	
Ethyl chloroformate		C3H5O2Cl	541-41-3	10.64	2.0	80	ZR	
Ethyl cyanoacrylate		C6H7O2N	7085-85-0	~10	NA	1.5	NA	
Ethyl decanoate		C12H24O2	110-38-3	~9.6	**2**	**1.4**	**8**	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Ethyl formate		C3H6O2	109-94-4	10.61	**1.76**	**35**	**ZR**	
Ethyl hexanoate		C8H16O2	123-66-0	~9.75	**0.7**	**1.6**	**3.3**	
Ethyl hexanol, 2-		C8H18O	104-76-7	~9.8	1	1.5	NA	
Ethyl iodide	iodoethane	C2H5I	75-03-6	9.34	**0.30**	**0.30**	**0.30**	
Ethyl isopropyl ketone	2-methylpentan-3-one	C6H12O	565-69-5	9.10	NA	0.8	NA	
Ethyl lactate		C5H10O3	97-64-3	~10	**1.09**	**2.1**	**5**	
Ethyl mercaptan	thioethanol	C2H6S	75-08-1	9.29	**0.6**	**0.6**	**0.6**	
Ethyl methacrylate		C6H10O2	97-63-2	~9.5	**0.86**	**1.06**	**1.6**	
Ethyl methyl carbonate		C4H8O3	623-53-0	10.40	**1.2**	**18**	**ZR**	
Ethyl octanoate		C10H20O2	106-32-1	~9.7	**0.8**	**2**	**4**	
Ethyl perfluorobutyl ether		C6H5F9O	163702-05-4	~11	20	ZR	ZR	
Ethyl phenylacetate		C10H12O2	101-97-3	~9	NA	1.2	NA	
Ethyl propanoate		C5H10O2	105-37-3	10.01	**1.2**	**2.5**	**6**	
Ethyl tert-butyl ether		C6H14O	637-92-3	9.39	NA	0.8	NA	
Ethyl-2-methylbenzene, 1-	2-ethyltoluene	C9H12	611-14-3	~8.7	NA	0.5	0.5	
Ethyl-3-ethoxypropionate		C7H14O3	763-69-9	~9.5	NA	3	NA	
Ethylacetylene		C4H6	107-00-6	10.18	0.4	0.2	0.2	
Ethylamine		C2H7N	75-04-7	8.86	1	1	NA	S X
Ethylbenzene		C8H10	100-41-4	8.76	**0.54**	**0.56**	**0.6**	
Ethylcyclohexane		C8H16	1678-91-7	9.54	**0.48**	**0.8**	**1.3**	
Ethylene	ethene	C2H4	74-85-1	10.51	3	**50**	ZR	
Ethylene carbonate		C3H4O3	96-49-1	10.40	NA	ZR	ZR	
Ethylene cyanohydrin		C3H5NO	109-78-4	~10.8	1	ZR	ZR	
Ethylene dinitrate		C2H4O6N2	628-96-6	~10.8	NA	ZR	ZR	
Ethylene glycol		C2H6O2	107-21-1	10.16	**4.1**	**9**	**9**	
Ethylene glycol diacetate		C6H10O4	111-55-7	~10	NA	4	NA	
Ethylene glycol monopropyl ether	2-propoxyethanol	C5H12O2	2807-30-9	~9	**1.7**	**3**	**4**	
Ethylene oxide	oxirane	C2H4O	75-21-8	10.56	**2**	**9.0**	**ZR**	
Ethylenediamine		C2H8N2	107-15-3	8.60	**8**	**10**	**10**	S V X
Ethyleneimine		C2H5N	151-56-4	9.20	NA	2	NA	S X
Ethylhexanal, 2-		C8H16O	123-05-7	~9	NA	1.5	NA	
Ethylhexanoic acid, 2-		C8H16O2	149-57-5	~10	**2.9**	**5**	**16**	
Ethylhexenal, 2-		C8H14O	645-62-5	~9	NA	1.3	NA	
Ethylhexyl acrylate, 2-		C11H20O2	103-11-7	~9	0.5	1	NA	
Ethylmorpholine, 4-		C6H13NO	100-74-3	~8	**0.9**	**3**	**2**	S X
Ethyltoluene, 3-		C9H12	620-14-4	~8.5		0.6		
Ethyltoluene, 4-		C9H12	622-96-8	~8.5		0.6		
Eucalyptol		C10H18O	470-82-6	~9	NA	0.6	NA	
Eugenol		C10H12O2	97-53-0	~9	30	10.0	30	S
Eugenol methyl ether		C11H14O2	93-15-2	~9	NA	0.4	NA	
Fenchol		C10H18O	1632-73-1	~9	NA	0.4	NA	
Ferrocene		C10H10Fe	102-54-5	6.88	NA	0.8	NA	
Fluorine		F2	7782-41-4	15.70	NA	ZR	ZR	
Fluoro-2-propanone, 1-		C3H5FO	430-51-3	9.92	1	ZR	NA	
Fluorobenzene		C6H5F	462-06-6	9.20	**0.78**	**0.74**	**0.83**	
Fluorobenzoic acid, 4-		C7H5FO2	456-22-4	9.91	NA	2	NA	
Fluoroethane	R161	C2H5F	353-33-6	11.78	ZR	ZR	ZR	
Fluoromethane	R41	CH3F	593-53-3	12.47	ZR	ZR	ZR	
Formaldehyde		CH2O	50-00-0	10.87	**0.6**	**ZR**	**ZR**	
Formamide		CH3ON	75-12-7	10.20	NA	2	NA	
Formic acid		CH2O2	64-18-6	11.05	5	ZR	ZR	
Furan		C4H4O	110-00-9	8.88	NA	0.4	NA	
Furfural		C5H4O2	98-01-1	9.21	**1.1**	**1.1**	**1.1**	
Furfuryl alcohol		C5H6O2	98-00-0	~9.9	NA	2	NA	
Furfuryl mercaptan		C5H6OS	98-02-2	~9	**0.60**	**0.8**	**0.8**	
Gasoline			8006-61-9	~9.9	NA	0.9	1	
Geranial		C10H16O	141-27-5	~9	NA	0.6	NA	
Geraniol		C10H18O	106-24-1	~9	NA	0.7	NA	
Geranyl acetate		C12H20O2	105-87-3	~9	NA	1.2	NA	
Germane		GeH4	7782-65-2	11.34	NA	10	ZR	
Glutaraldehyde	1,5-pentanedial	C5H8O2	111-30-8	~9.6	**5**	**5**	**13**	
Glycidol	2,3-epoxypropanol	C3H6O2	556-52-5	~10.8	2	ZR	ZR	
Glycidyl methacrylate		C7H10O3	106-91-2	~10	NA	1.2	ZR	
Glycolaldehyde		C2H4O2	141-46-8	~10.4	NA	5	ZR	
Glyoxal		C2H2O2	107-22-2	10.20	**ZR**	**ZR**	**ZR**	
Guaiacol	2-methoxyphenol	C7H8O2	90-05-1	~9	NA	0.8	NA	
Halothane	fluothane, 2-bromo-2-chloro-1,1,1-trifluoroethane	CF3CHBrCl	151-67-7	11.00	0.6	ZR	ZR	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Helium		He	7440-59-7	24.59	NA	ZR	ZR	
Heptan-2-one		C7H14O	110-43-0	9.33	**0.54**	**0.85**	**0.97**	
Heptan-3-one		C7H14O	106-35-4	9.02	**0.59**	**0.73**	**0.81**	
Heptan-4-one		C7H14O	123-19-3	9.10	**0.7**	**0.9**	**1.0**	
Heptane		C7H16	142-82-5	9.92	**0.5**	**2.2**	**11**	
Heptanol		C7H16O	53535-33-4	~9.8	NA	1.7	NA	
Heptene, 1-		C7H14	592-76-7	9.34	**0.51**	**0.88**	**1.1**	
Heptylcyclopentan-1-one, 2-		C12H22O	137-03-1	~9	NA	0.8	NA	
Heptyne, 1-		C7H12	628-71-7	10.04	NA	2	NA	
Hex-1-en-3-ol		C6H12O	4798-44-1	~9	NA	0.9	NA	
Hexachlorodisilane		Cl6Si2	13465-77-5	10.40	NA	8	ZR	
Hexachloroethane	R-110	C2Cl6	67-72-1	11.22	1	ZR	ZR	
Hexafluoro-2-propanol,1,1,1,3,3,3-		C3H2F6O	920-66-1	~12		ZR	ZR	
Hexafluoroethane	R-116	C2F6	76-16-4	13.60	ZR	ZR	ZR	
Hexafluoropropene		C3F6	116-15-4	10.62	1	ZR		
Hexafluoropropylene	R1216	C3F6	116-15-4	10.60	4	ZR	ZR	
Hexamethyl cyclotrisiloxane		C6H18O3Si3	541-05-9	~10		0.3		
Hexamethyldisilazane, 1,1,1,3,3,3-.	HMDS, hexamethylsilazane	C6H18NSi2	999-97-3	8.60	**0.53**	**0.45**	**0.5**	
Hexamethyldisiloxane		C6H18OSi2	107-46-0	9.60	**0.3**	**0.31**	**0.37**	
Hexamethylene diisocyanate	1,6-diisocyanatohexane	C8H12N2O2	822-06-0	~9	NA	1.5	NA	
Hexamethyleneimine		C6H13N	111-49-9	8.41	NA	1.1	NA	S X
Hexan-2-one		C6H12O	591-78-6	9.34	NA	0.8	0.7	
Hexane		C6H14	110-54-3	10.13	**0.6**	**3**	**13**	
Hexanoic acid		C6H12O2	142-62-1	10.12	NA	4	NA	
Hexanol		C6H14O	111-27-3	9.89	**0.66**	**2.0**	**7**	
Hexenal, cis-3-		C6H10O	6728-26-3	~9		1		
Hexene, 1-		C6H12	592-41-6	9.44	**0.61**	**0.98**	**1.1**	
Hexenyl acetate, cis-3-		C8H14O2	3681-71-8	~9	**0.55**	**1.0**	**1.2**	
Hexenyl butyrate, cis-3-		C10H18O2	16491-36-4	~9	NA	1.5	NA	
Hexylaldehyde	hexanal	C6H12O	66-25-1	9.72	**0.54**	**1.2**	**1.8**	
Hydrazine		H4N2	302-01-2	8.93	2.1	3	NA	
Hydrazoic acid		HN3	7782-79-8	10.72	NA	ZR	ZR	
Hydrogen		H2	1333-74-0	15.43	ZR	ZR	ZR	
Hydrogen bromide		HBr	10035-10-6	11.62	NA	ZR	ZR	
Hydrogen chloride		HCl	7647-01-0	12.74	NA	ZR	ZR	
Hydrogen cyanide		HCN	74-90-8	13.60	ZR	ZR	ZR	
Hydrogen fluoride		HF	7664-39-3	15.98	NA	ZR	ZR	
Hydrogen iodide		HI	10034-85-2	10.39	NA	5	ZR	
Hydrogen peroxide		H2O2	7722-84-1	~11.7	ZR	ZR	ZR	
Hydrogen selenide		H2Se	7783-07-5	9.88	NA	2	NA	
Hydrogen sulfide		H2S	7783-06-4	10.46	1.5	4	ZR	
Hydrogen telluride		H2Te	7783-09-7	9.14	NA	2	NA	
Hydroxybutanal, 3-		C4H6O2	107-89-1	~9	NA	2	NA	
Hydroxycitronellal		C10H20O2	107-75-5	~9	NA	1.0	NA	
Hydroxyethyl acrylate		C5H8O3	818-61-1	~10	NA	1.2	NA	
Hydroxylamine		H3NO	7803-49-8	10.00	NA	2	NA	
Hydroxypropyl acrylate, 2-		C6H10O3	999-61-1	~9	NA	1.5	NA	
Indene		C9H8	95-13-6	8.81	**0.6**	**0.6**	**0.6**	X
Indole		C8H7N	120-72-9	7.76	NA	0.4	NA	
Iodine		I2	7553-56-2	9.31	0.1	**0.18**	0.1	
Iodobenzene		C6H5I	591-50-4	8.73	**0.3**	**0.20**	**0.2**	
Iodoethene	vinyl iodide	C2H3I	593-66-8	9.30	NA	1.2	NA	
Iodoform	triiodomethane	CHI3	75-47-8	9.25	NA	1.5	NA	
Iodomethane	methyl iodide	CH3I	74-88-4	9.54	0.26	0.4	NA	
Isoalkanes, C10-C13		C8H18O	68551-17-7	~9.6	NA	1	NA	
Isoamyl acetate		C7H14O2	123-92-2	~9.7	**0.66**	**1.5**	**6**	
Isoamyl salicilate		C12H16O3	87-20-7	~9	NA	1	NA	
Isoamylene, beta-		C5H10	513-35-9	8.69	**0.63**	**0.82**	**0.86**	
Isobornyl acetate		C12H20O2	125-12-2	~9	NA	0.5	NA	
Isobutane		C4H10	75-28-5	10.57	1.2	8	ZR	
Isobutanol		C4H10O	78-83-1	10.12	**1.1**	**3**	**13**	
Isobutyl acetate		C6H12O2	110-19-0	9.90	**0.8**	**2.0**	**10**	
Isobutyl acrylate		C7H12O2	106-63-8	~9.5	**0.80**	**1.2**	**5**	
Isobutyl chloroformate		C5H9ClO2	543-27-1	~10.4	**NA**	**10**	**70**	
Isobutylamine		C4H11N	78-81-9	8.70	**2**	**1**	**3**	S V X
Isobutylbenzene		C10H14	538-93-2	8.68	**NA**	**0.4**	**0.4**	
Isobutylene		C4H8	115-11-7	9.24	**1**	**1**	**1**	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Isobutylene epoxide		C4H8O	558-30-5	10.00	NA	3	NA	
Isobutyraldehyde		C4H8O	78-84-2	9.74	**1.5**	**1.38**	**1.46**	
Isobutyric acid		C4H8O2	79-31-2	10.24	**1.8**	**4.4**	**15**	
Isocyanic acid		HNCO	75-13-8	11.60	NA	ZR	ZR	
Isodecanol		C10H22O	25339-17-7	~9.8	1	0.9	NA	
Isodihydrolavandulal		C10H18O	35158-25-9	~9	**0.7**	**0.7**	**0.9**	
Isoeugenol		C10H12O2	97-54-1	~9	NA	0.4	NA	
Isoflurane		C3H2ClF5O	26675-46-7	~11	**50**	ZR	ZR	V
Isoheptane		C7H16	591-76-4	9.84	NA	1.2	NA	
Isojasmone		C11H18O	95-41-0	~9	NA	0.7	NA	
Isomenthone		C10H18O	1196-31-2	9.86	NA	0.6	NA	
Isononanal		C9H18O	5435-64-3	~9.6	**0.5**	**0.9**	**1.4**	
Isononanol		C9H20O	3452-97-9	~9.8	1	1.5	NA	
Isooctane	2,2,4-trimethylpentane	C8H18	540-84-1	9.86	**0.51**	**1.1**	**3.2**	
Isooctanol		C8H18O	26952-21-6	~9.8	1	1.7	NA	
Isopentane		C5H12	78-78-4	10.32	**0.5**	**5**	**30**	
Isopentanol		C5H12O	137-32-6	9.86	**0.8**	**2.0**	**6**	
Isopentene		C5H10	563-45-1	9.12	NA	0.8	NA	
Isophorone		C9H14O	78-59-1	9.07	**1.1**	**0.8**	**1.0**	
Isophorone diisocyanate		C12H18N2O2	4098-71-9	~9	NA	0.6	NA	
Isoprene	2-methyl-1,3-butadiene	C5H8	78-79-5	8.85	**0.57**	**0.9**	**1**	
Isopropanol	IPA, 2-propanol	C3H8O	67-63-0	10.17	**2**	**4.0**	**25**	
Isopropanolamine		C3H9NO	78-96-6	~ 9.6	NA	1.5	NA	S V X
Isopropoxyethanol, 2-	ethylene glycol isopropyl ether	C5H12O2	109-59-1	~10.3	**0.8**	**1.2**	**1.5**	
Isopropoxyethyl acetate, 2-		C7H14O2	19234-20-9	~9.5	NA	1.2	NA	
Isopropyl acetate		C5H10O2	108-21-4	9.99	**1.1**	**2.4**	**8**	
Isopropyl chloroformate		C4H7O2Cl	108-23-6	~10.2	NA	1.6	NA	
Isopropyl mercaptan		C3H8S	75-33-2	9.15	NA	0.6	NA	
Isopropyl nitrite		C3H7NO2	541-42-4	10.23	NA	4.0	NA	
Isopropylamine		C3H9N	75-31-0	8.72	**1**	**1**	**1**	S V X
Isopropylaminoethanol, 2-		C5H13NO	109-56-8	~9	NA	2	NA	
Isopropylcyclohexane		C9H18	696-29-7	9.33	**0.53**	**0.7**	**1.1**	
Isothiazole		C3H3NS	288-16-4	9.55	NA	3	NA	
Isovaleraldehyde		C5H10O	590-86-3	9.72	**0.8**	**1.3**	**1.5**	
Isovaleric Acid		C5H10O2	503-74-2	~10.2	**1.6**	**5.5**	**25**	
Isoxazole		C3H3NO	288-14-2	9.96	NA		NA	
Jasmal		C11H22O3	1322-17-4	~9	NA	1.4	NA	
Jasmone, cis-		C11H16O	488-10-8	~9	NA	0.5	NA	
Jet Fuel Jp-4	Jet B, wide cut aviation fuel			~9	0.42	0.8	0.7	
Jet Fuel Jp-5	kerosene aviation fuel			~9	0.46	0.7	0.6	
Jet Fuel Jp-8	kerosene aviation fuel			~9	0.32	0.7	0.6	
Kerosene	C10-C16		8008-20-6	~8	NA	0.8	0.7	
Ketene		C2H2O	463-51-4	9.62	NA	3	NA	
Krypton		Kr	7439-90-9	14.00	ZR	ZR	ZR	
Linalool oxide		C10H18O2	14049-11-7	~9	NA	0.6	NA	
Linalyl acetate		C12H20O2	115-95-7	~9	NA	1.1	NA	
Liquefied petroleum gas	LPG, predominantly propane & butanes		68476-85-7	10.95	1.5	40	ZR	
Maleic anhydride	furan-2,5-dione	C4H2O3	108-31-6	9.90	NA	2	NA	
Menthol		C10H20O	1490-04-6	~9	**2**	**0.9**	**1.8**	
Menthone		C10H18O	89-80-5	~9	NA	0.4	NA	
Mercaptoacetic acid		C2H4O2S	68-11-1	~9.8	NA	1	NA	
Mercury		Hg	7439-97-6	10.44	NV	NV	ZR	
Metaldehyde		C8H16O4	108-62-3	~9.7	**7**	**10**	**100**	
Methacrolein		C4H6O	78-85-3	9.92		1.5		
Methacrylamide		C4H7NO	79-39-0	~10	NA	2	ZR	
Methacrylic acid		C4H6O2	79-41-4	10.15	NA	2.3	NA	
Methacrylonitrile		C4H5N	126-98-7	10.34	NA	5	ZR	
Methane	natural gas	CH4	74-82-8	12.51	ZR	ZR	ZR	
Methanol		CH4O	67-56-1	10.85	**2.9**	**ZR**	**ZR**	
Methoxy-1-butanol, 3-		C5H12O2	2517-43-3	~9.56	NA	3	NA	
Methoxy-1-propanol, 2-		C4H10O2	1589-47-5	9.30	NA	2	NA	
Methoxy-2,2-dimethylpropane	methyl neopentyl ether	C6H14O	1118-00-9	9.30	NA	0.9	NA	
Methoxybutyl acetate, 3-		C7H14O3	4435-53-4	~9	NA	2	NA	
Methoxyethane	methyl ethyl ether	C3H8O	540-67-0	9.72	NA	1.0	NA	
Methoxyethanol, 2-	methyl cellosolve®, ethylene glycol monomethyl ether, EGME	C3H8O2	109-86-4	9.60	**1.2**	**3**	**6**	
Methoxyethene	methyl vinyl ether	C3H6O	107-25-5	8.95	NA	1.0	NA	
Methoxyethoxyethanol, 2-	diethylene glycol monomethyl ether	C5H12O3	111-77-3	10.00	0.9	1.4	NA	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Methoxyethyl acetate, 2-		C5H10O3	110-49-6	~9.6	**2**	**5**	**8**	
Methoxyethyl ether, 2-	diglyme, diethylene glycol dimethyl ether	C6H14O3	111-96-6	9.80	NA	1.0	NA	
Methoxymethylethoxy-2-propanol	DPGME	C7H16O3	34590-94-8	9.30	NA	1.3	NA	
Methoxypropan-2-ol, 1-	1M2P, PGME, propylene glycol methyl ether	C4H10O2	107-98-2	~9.6	**0.95**	**1.6**	**2.7**	
Methoxypropane, 2-		C4H10O	598-53-8	9.45	NA	1.2	NA	
Methoxypropyl acetate	PGMEA	C6H12O3	108-65-6	~9	**0.74**	**1.6**	**2.1**	
Methyl 2-methylpropanoate	methyl isobutanoate	C5H10O2	547-63-7	9.86	NA	2	NA	
Methyl acetate		C3H6O2	79-20-9	10.27	**1.8**	**7**	**ZR**	
Methyl acetoacetate		C5H8O3	105-45-3	9.81	NA	3	NA	
Methyl acrylate		C4H6O2	96-33-3	10.25	**1.1**	**3.6**	**80**	
Methyl anthranilate		C8H9NO2	134-20-3	~9	NA	0.4	NA	
Methyl benzoate		C8H8O2	93-58-3	9.32	NA	1.2	NA	
Methyl bromide	bromomethane	CH3Br	74-83-9	10.54	1.3	1.9	ZR	
Methyl chloroformate		C2H3O2Cl	79-22-1	11.36	1	ZR	ZR	
Methyl cyanoacrylate		C5H5O2N	137-05-3	10.98	2	ZR	ZR	
Methyl dimethylacrylate		C6H10O2	924-50-5	~9.6	NA	2.5	NA	
Methyl ethyl ketone	MEK, Butan-2-one	C4H8O	78-93-3	9.51	**1.2**	**0.96**	**2**	
Methyl ethyl ketone peroxides	MEKP	C8H18O6	1338-23-4	~9	NA	0.8	NA	
Methyl formate		C2H4O2	107-31-3	10.82	**3.5**	**ZR**	**ZR**	
Methyl heptyne carbonate		C9H14O2	111-12-6	~9	NA	1.3	NA	
Methyl ionone		C14H22O	1335-46-2	~9	NA	0.4	NA	
Methyl isobutyl ketone	MIBK, 4-methylpentan-2-one	C6H12O	108-10-1	9.30	**0.7**	**0.9**	**1.01**	
Methyl isocyanate		C2H3NO	624-83-9	10.67	1.5	5	ZR	
Methyl isopropyl ketone	MIPK, 2-methylbutan-3-one	C5H10O	563-80-4	9.31	**0.92**	**0.99**	**0.96**	
Methyl isothiocyanate		C2H3NS	556-61-6	9.25	0.4	0.6	NA	
Methyl mercaptan		CH4S	74-93-1	9.44	1	0.7	0.6	
Methyl methacrylate		C5H8O2	80-62-6	9.70	**0.92**	**1.31**	**2.1**	
Methyl perfluorobutyl ether		C5H3F9O	163702-07-6	~11	**ZR**	**ZR**	**ZR**	
Methyl phenylacetate		C9H10O2	101-41-7	~9	NA	0.4	NA	
Methyl propargyl ether		C4H6O	627-41-8	9.78	NA	2	NA	
Methyl propionate		C4H8O2	554-12-1	10.15	**1.46**	**3.8**	**36**	
Methyl propynoate		C4H4O2	922-67-8	10.30	**0.90**	**10**	**ZR**	
Methyl salicylate		C8H8O3	119-36-8	7.65	NA	0.8	NA	
Methyl sulfide	DMS, dimethyl sulfide	C2H6S	75-18-3	8.69	**0.6**	**0.8**	**0.7**	
Methyl tert-butyl ether	MTBE	C5H12O	1634-04-4	9.24	**0.8**	**1.0**	**1.02**	
Methyl thiocyanate		C2H3NS	556-64-9	9.96	**1.5**	**2.2**	**3.2**	
Methyl thioglycolate		C3H6O2S	2365-48-2	~10	**1**	**2**	**4**	S
Methyl vinyl ketone		C4H6O	78-94-4	9.65	NA	0.6	NA	
Methyl-1-butene, 2-		C5H10	563-46-2	9.12		0.8		
Methyl-1-butene, 3-		C5H10	563-45-1	9.51	NA	0.8	NA	
Methyl-2-butanol, 3-		C5H12O	598-75-4	9.88	NA	3.3	NA	
Methyl-2-butenal, 3-		C5H8O	107-86-8	~9	**1.0**	**1.00**	NA	
Methyl-2-hexenoic acid, trans-3-	TMHA	C7H12O2	027960-21-0	~10	**4**	**1.5**	**10**	
Methyl-2-propen-1-ol, 2-		C4H8O	513-42-8	9.24	**1.2**	**1.3**	**1.6**	
Methyl-2-pyrrolidinone, N-	NMP, N-methylpyrrolidone	C5H9NO	872-50-4	9.17	0.9	0.9	NA	
Methyl-5-hepten-2-one, 6-	6-Me-5-hepten-2-one	C8H14O	110-93-0	~9.4	**0.89**	**0.63**	**0.76**	
Methylamine		CH5N	74-89-5	8.97	1	1.5	NA	S X
Methylbutan-1-ol, 3-		C5H12O	123-51-3	9.80	**0.8**	**2.3**	**10**	
Methylbutanal, 2-		C5H10O	96-17-3	9.59	**0.8**	**1.2**	**1.3**	
Methylbutyric acid, 2-		C5H10O2	116-53-0	~10.2	**1.6**	**6**	**20**	
Methylcyclohexane		C7H14	108-87-2	9.85	0.53	1.1	1	
Methylcyclohexanol		C7H14O	25639-42-3	9.80	NA	2.4	NA	
Methylcyclohexanol, 4-		C7H14O	589-91-3	9.80	NA	2.4	NA	
Methylcyclohexanone, 2-		C7H12O	583-60-8	9.05	NA	1.0	NA	
Methylcyclopentane		C6H12	96-37-7	9.85	**0.4**	**2.5**	**6**	
Methylcyclopentene, 1-		C6H10	693-89-0	8.55		1.5		
Methylenepentane, 3-		C6H12	760-21-4	9.06	NA	0.9	NA	
Methylheptan-3-one, 5-	Amyl ethyl ketone	C8H16O	541-85-5	~9.1	**0.56**	**0.77**	**0.88**	
Methylhexan-2-one, 5-	MIAK, methyl isoamyl ketone	C7H14O	110-12-3	9.28	**0.58**	**0.7**	**0.91**	
Methylhydrazine		CH6N2	60-34-4	8.00	1.3	1.3	NA	
Methylmorpholine, N-		C5H11NO	109-02-4	~9.5	**1.2**	**1.2**	**1.2**	
Methylolacrylamide, N-		C4H7NO2	924-42-5	~10.3	NA	2	ZR	
Methylpent-3-en-2-one, 4-		C6H10O	141-79-7	9.10	**1.1**	**0.6**	**0.66**	
Methylpentan-2-ol, 4-	MIBC, methyl isobutylcarbinol	C6H14O	108-11-2	~9.8	**0.68**	**1.4**	**3**	
Methylpentane, 2-		C6H14	107-83-5	10.12	**0.58**	**3.0**	**34**	
Methylpentane, 3-		C6H14	96-14-0	10.08	**0.64**	**2.5**	**24**	
Methylpentane-2,4-diol, 2-	hexylene glycol	C6H14O2	107-41-5	~9.6	NA	4	NA	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Methylpropanoyl chloride, 2-		C4H7ClO	79-30-1	~9	**1.8**	**8**	**40**	
Methylpyrrole, N-		C5H7N	96-54-8	7.95	**0.56**	**0.9**	**0.8**	
Methylstyrene		C9H10	25013-15-4	8.30	**0.5**	**0.57**	**0.59**	
Methylthiopropional, 3-		C4H8OS	3268-49-3	~9.5	NA	2	NA	
Methylundecanal, 2-		C12H24O	110-41-8	~9	**1.7**	**1.0**	NA	
Mineral oil			8042-47-5	~9	NA	0.8	0.7	
Mineral spirits	Stoddard solvent, Varsol, Viscor		64475-85-0	~9	**0.4**	**0.6**	**0.9**	
Monoisobutanolamine		C4H11NO	124-68-5	~9	NA	1.6	NA	
Morpholine		C4H9NO	110-91-8	8.88	**1**	**4**	**2**	S V X
Myrcene	7-methyl-3-methylene-1,6-octadiene	C10H16	123-35-3	~8.2	**0.4**	**0.49**	**0.5**	
Naphtha, heavy aromatic			64742-94-5	~9	NA	0.4	NA	
Naphtha, hydrotrated heavy		CnH(2n+2)	64742-48-9	~10	NA	1	NA	
Naphtha, light aromatic			64742-95-6	~9	NA	0.5	NA	
Naphtha, medium aliphatic			64742-88-7	~9	NA	0.8	NA	
Naphthalene		C10H8	91-20-3	8.14	**0.8**	**0.63**	**0.67**	
Naphthol methyl ether, 2-		C11H10O	93-04-9	~9	NA	0.5	NA	
Neon		Ne	09-01-7440	21.56	ZR	ZR	ZR	
Neopentane		C5H12	463-82-1	10.21	NA	3	NA	
Neopentyl alcohol		C5H12O	75-84-3	9.72	NA	2	NA	
Nitric oxide		NO	10102-43-9	9.27	2.8	8	NA	
Nitrobenzene		C6H5NO2	98-95-3	9.92	1.6	1.7	NA	
Nitroethane		C2H5NO2	79-24-3	10.88	**2.4**	**ZR**	**ZR**	
Nitrogen		N2	7727-37-9	15.58	ZR	ZR	ZR	
Nitrogen dioxide		NO2	10102-44-0	9.58	**4.5**	**13**	**14**	
Nitrogen trifluoride		NF3	7783-54-2	12.97	NA	ZR	ZR	
Nitromethane		CH3NO2	75-52-5	11.08	**3**	**ZR**	**ZR**	
Nitropropane, 1-		C3H7NO2	108-03-2	10.81	NA	ZR	ZR	
Nitropropane, 2-		C3H7NO2	79-46-9	10.71	**2**	**ZR**	**ZR**	
Nitrous oxide		N2O	10024-97-2	12.89	NA	ZR	ZR	
Nonanal		C9H18O	124-19-6	~9	**1.3**	**1.3**	**NA**	
Nonane		C9H20	111-84-2	9.72	**0.4**	**1.4**	**4.7**	
Nonanol (mixed isomers)		C9H20O	143-08-8	~9.8	NA	1.2	NA	
Nonene (mixed isomers)		C9H18	27215-95-8	~9.3	NA	0.6	NA	
Nonene, 1-		C9H18	124-11-8	~9.4	NA	0.6	NA	
Norbornadiene, 2,5-		C7H8	121-46-0	8.38	**0.52**	**0.6**	**0.70**	
Octalactone, gamma-		C8H14O	104-50-7	~9	**4**	**3**	**NA**	
Octamethylcyclotetrasiloxane		C6H12O4Si4	556-67-2	~10	NA	0.3	NA	
Octamethyltrisiloxane		C8H24O2Si3	107-51-7	10.04	**0.24**	**0.26**	**0.31**	
Octanal		C8H16O	124-13-0	~9.6		1.1		
Octane		C8H18	111-65-9	9.80	**0.44**	**1.6**	**7**	
Octanol	capryl alcohol, octyl alcohol	C8H18O	111-87-5	~9.8	**1**	**1.6**	**6**	
Octene (mixed isomers)		C8H16	25377-83-7	~9.4	NA	0.7	NA	
Octene, 1-		C8H16	111-66-0	9.43	**0.43**	**0.7**	**1.1**	
Oxalonitrile		C2N2	460-19-5	13.57	NA	ZR	ZR	
Oxalyl bromide		C2Br2O2	15219-34-8	10.49	NA	5	ZR	
Oxygen		O2	7782-44-7	12.07	NA	ZR	ZR	
Ozone		O3	10028-15-6	12.52	NA	ZR	ZR	
Paraffin wax, fume			8002-74-2	~10	NA	1	NA	
Paraffins, normal			64771-72-8	~9.5	1	1	NA	
Paraldehyde		C6H12O3	123-63-7	~9.7	**0.75**	**2.2**	**4.8**	
Pentacarbonyl iron		FeC5O5	13463-40-6	~8	NA	1	NA	
Pentachloroethane	R120	C2HCl5	76-01-7	11.28	1	ZR	ZR	
Pentachlorofluoroethane	R111	C2Cl5F	354-56-3	~11.8	NA	ZR	ZR	
Pentafluoroethane	R125	C2HF5	354-33-6	~12.5	NA	ZR	ZR	
Pentan-2-one	MPK, methyl propyl ketone	C5H10O	107-87-9	9.38	**0.9**	**0.99**	**1.03**	
Pentan-3-one	diethyl ketone	C5H10O	96-22-0	9.31	**1**	**0.77**	**0.75**	
Pentanal	pentyl aldehyde	C5H10O	110-62-3	9.74	**0.7**	**1.5**	**1.75**	
Pentandione, 2,4-	acetyl acetone	C5H8O2	123-54-6	8.85	**0.72**	**1.2**	**0.85**	
Pentane		C5H12	109-66-0	10.35	**0.70**	**7**	**ZR**	
Pentanoic acid		C5H10O2	109-52-4	10.53	**1.6**	**8.0**	**52**	
Pentanol, 2-		C5H12O	6032-29-7	9.78	**1**	**2.0**	**16**	
Pentanol, 3-		C5H12O	584-02-1	9.76	**0.9**	**1.7**	**3.5**	
Pentene, 1-		C5H10	109-67-1	9.49	**0.63**	**0.92**	**1.00**	
Pentene, cis-2-		C5H10	627-20-3	~9		0.9		
Pentene, trans-2-		C5H10	646-04-8	~9		0.9		
Pentylcyclopentan-1-one, 2-		C10H18O	4819-67-4	~9	NA	1.0	NA	
Pentylcyclopentane		C10H20	3741-00-2	9.91	NA	1.1	NA	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Pentyne, 1-		C5H8	627-19-0	10.10	NA	3	NA	
Peracetic acid		C2H4O3	79-21-0	~11	NA	ZR	ZR	
Perchloryl fluoride	chlorine oxyfluoride	ClO3F	7616-94-6	13.60	NA	ZR	ZR	
Perfluorobutadiene	1,1,2,3,4,4-hexafluorobuta-1,3-diene	C4F6	685-63-2	9.50	NA	3	NA	
Perfluorocyclobutane		C4F8	115-25-3	13.50	ZR	ZR	ZR	
Perfluoropropane	R218	C3F8	76-19-7	13.38	NA	ZR	ZR	
Perfluoro-tert-butylamine		C4H2F9N	2809-92-9	10.40	NA	5	ZR	
Petroleum ether	Ligroin, VM&P naphtha, benzine		8032-32-4	~10	1	0.9	NA	
Phellandrene		C10H16	99-83-2	~8.2	NA	0.8	NA	
Phenethyl methyl ether, 2-		C9H12O	3558-60-9	~9	NA	0.6	NA	
Phenol	hydroxybenzene	C6H6O	108-95-2	8.51	0.9	**0.9**	1.1	
Phenoxyethanol, 2-		C8H10O2	122-99-6	~8.5	**6**	**4.5**	**10**	S
Phenoxyethyl acrylate, 2-		C11H12O3	48145-04-6	0.00		1.5		
Phenyl chloroformate		C7H5ClO2	1885-14-9	~9	NA	1.1	NA	
Phenyl propene, 2-		C9H10	98-83-9	8.35	NA	0.4	0.4	
Phenyl-2,3-epoxypropyl ether	PGE	C9H10O2	122-60-1	~8.6	NA	0.8	NA	
Phenylacetaldehyde		C8H8O	122-78-1	8.80	NA	0.7	NA	
Phenylacetic acid		C8H8O2	103-82-2	8.26	NA	1	NA	
Phenylcyclohexane		C12H16	827-52-1	8.10	NA	0.4	NA	
Phenylethanol, 2-		C8H10O	60-12-8	~10	NA	1.2	NA	
Phenylethyl acetate, 1-		C10H12O2	93-92-5	~9	NA	0.7	NA	
Phenylethyl isobutyrate, 2-		C12H16O2	103-48-0	~9	NA	1.5	NA	
Phosgene		COCl2	75-44-5	11.55	2.1	ZR	ZR	
Phosphine		PH3	7803-51-2	9.96	1.4	2	NA	
Phthalonitrile		C8H5N2	91-15-6	9.90	**ZR**	**ZR**	**ZR**	
Picoline, 3-	3-methylpyridine	C6H7N	108-99-6	9.04	**0.73**	**0.7**	**0.8**	
Pine oil		N/A	8002-09-3	~9.5	NA	1.0	NA	
Pinene		C10H16	80-56-8	8.07	0.4	0.4	0.4	
Pinene, α-		C10H16	2437-95-8	8.07	**0.43**	**0.34**	**0.48**	
Pinene, β-		C10H16	127-91-3	8.10	**0.46**	**0.5**	**0.59**	
Piperazine	1,4-diazacyclohexane	C4H10N2	110-85-0	8.72	NA	0.8	NA	
Piperidine	azacyclohexane	C5H11N	110-89-4	8.03	NA	1	0.8	S X
Piperylene	1,3-pentadiene	C5H8	504-60-9	8.60	**0.8**	**0.9**	**1.0**	
Prop-2-yn-1-ol	propargyl alcohol	C3H4O	107-19-7	10.50	**0.93**	**3.7**	**ZR**	
Propadiene	allene	C3H4	463-49-0	9.83	NA	1.0	NA	
Propan-1-ol		C3H8O	71-23-8	10.20	**1.60**	**5.4**	**40**	
Propanamide		C3H7NO	79-05-0	~9.5	NA	2	NA	
Propane		C3H8	74-98-6	11.07	1.8	ZR	ZR	
Propane-1,2-diol	propylene glycol	C3H8O2	57-55-6	10.00	**5**	**3**	**16**	
Propanolamine		C3H9NO	156-87-6	~9.5	NA	1.5	NA	S V X
Propargyl chloride	3-chloro-1-propyne	C3H3Cl	624-65-7	9.82	**0.64**	**8.4**	**ZR**	
Propen-1-imine, 2-		C3H5N	73311-40-7	9.65	NA	2	NA	S V X
Propene	propylene	C3H6	115-07-1	9.73	1	1.4	2	
Propiolic acid	2-propynoic acid	C3H2O2	471-25-0	10.45	NA	8	ZR	
Propionaldehyde	propanal, propional	C3H6O	123-38-6	9.95	**3**	**3**	**15**	
Propionic acid		C3H6O2	79-09-4	10.44	**4**	**10**	**ZR**	
Propionitrile		C3H5NO	107-12-0	11.50	5	ZR	ZR	
Propoxy-2-propanol, 1-		C6H14O2	1569-01-3	~9.5	**0.7**	**1.2**	**1.6**	
Propyl acetate, n-		C5H10O2	109-60-4	10.04	**1**	**3.0**	**17**	
Propyl butanoate		C7H14O2	105-66-8	~9.6	**0.76**	**1.3**	**2.7**	
Propyl formate		C4H8O2	110-74-7	10.54	**1.4**	**19**	**ZR**	
Propyl iodide	Iodopropane	C3H7I	107-08-4	9.26	NA	1.0	NA	
Propyl mercaptan		C3H8S	107-03-9	9.15	**0.8**	**1.0**	**0.9**	
Propyl nitrate		C3H7NO3	627-13-4	11.07	2	ZR	ZR	
Propylamine, n-		C3H9N	107-10-8	8.50	NA	1.1	NA	S X
Propylbenzene	includes cumene	C9H12	103-65-1	8.72	**0.47**	**0.5**	**0.55**	
Propylbenzene (all isomers)		C9H12	74296-31-4	8.70	NA	0.5	NA	
Propylbenzene, 2-		C9H12	98-82-8	8.71	**0.54**	**0.6**	**0.7**	
Propylene carbonate		C4H6O3	108-32-7	~10.5	**2.6**	**15**	**ZR**	
Propylene dinitrate		C3H6N2O6	6423-43-4	~11	NA	ZR	ZR	
Propylene glycol ethyl ether acetate	PGEEA	C7H14O3	98516-30-4	~9.6	NA	1.2	NA	
Propylene oxide		C3H6O	75-56-9	10.22	**1.6**	**6**	**ZR**	
Propyleneimine	2-methylaziridine	C3H7N	75-55-8	9.00	1	1.4	NA	S X
Propyne	methylacetylene	C3H4	74-99-7	10.36	NA	4	ZR	
Pyrazine		C4H4N2	290-37-9	9.29	NA	3	NA	
Pyridine		C5H5N	110-86-1	9.25	**0.9**	**0.7**	**0.87**	
Pyridinol, 4-		C5H5NO	626-64-2	9.75	NA	3	NA	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Pyridylamine, 2-		C5H6N2	504-29-0	8.10	NA	0.8	NA	
Pyrrole		C4H5N	109-97-7	8.02	**0.98**	**1.4**	**1.1**	
Pyrrolidine		C4H9N	123-75-1	8.77	**1.3**	**4**	**20**	S V X W!
Pyruvaldehyde		C3H4O2	78-98-8	9.60	NA	0.7	NA	
Rose oxide, cis-		C10H18O	16409-43-1	~9	NA	0.8	NA	
Sec-amyl acetate		C7H14O2	626-38-0	~9.9	NA	5	NA	
Sevoflurane	1,1,1,3,3,3-hexafluoro-2-(fluoromethoxy)propane	C3H3F7O	28523-86-6	11.00	2	ZR	ZR	
Silane		SiH4	7803-62-5	11.00	NA	ZR	ZR	
Stibine		SbH3	7803-52-3	9.89	NA	1.5	NA	
Styrene		C8H8	100-42-5	8.40	**0.50**	**0.45**	**0.52**	
Sulfur dichloride		Cl2S	10545-99-0	9.47	NA	2	NA	
Sulfur dioxide		SO2	7446-09-5	12.30	ZR	ZR	ZR	
Sulfur hexafluoride		SF6	2551-62-4	19.30	NA	ZR	ZR	
Sulfur tetrafluoride		SF4	7783-60-0	12.63	NA	ZR	ZR	
Sulfuryl fluoride		SO2F2	2699-79-8	13.04	NA	ZR	ZR	
TAC	Total Aromatic Hydrocarbons			~9	NA	NA	0.5	
Terpineol, α-		C10H18O	98-55-5	~9	**3**	**1.0**	**2**	
Terpinolene		C10H16	586-62-9	8.10	**0.70**	**0.6**	**0.9**	
Terpinyl acetate, α-		C12H20O2	80-26-2	~9	NA	1.2	NA	
Terpinyl methyl ether, alpha-		C11H20O	14576-08-0	~9	**0.8**	**0.7**	**1.4**	
Tert-amyl methyl ether		C6H14O	994-05-8	~9	NA	0.8	NA	
Tert-butanol	t-butyl alcohol	C4H10O	75-65-0	10.25	**1.01**	**1.6**	**2.8**	
Tert-butyl acetate		C6H12O2	540-88-5	~9.7	**0.83**	**1.05**	**1.65**	
Tert-butyl bromide		C4H9Br	507-19-7	9.92	**0.64**	**0.99**	**1.6**	
Tert-butyl formate	2-methyl-2-bromopropane	C5H10O2	762-75-4	10.52	NA	8	ZR	
Tetrabromoethane, 1,1,2,2-		C2H2Br4	79-27-6	~10	NA	2	NA	
Tetracarbonylnickel	nickel tetracarbonyl	NiC4O4	13463-39-3	8.28	NA	1	NA	
Tetrachloro-1,2-difluoroethane, 1,1,2,2-	R112	C2Cl4F2	76-12-0	11.30	1	ZR	ZR	
Tetrachloro-1-fluoroethane, 1,1,2,2-	R121	C2HCl4F	354-14-3	~11	1	ZR	ZR	
Tetrachloro-2,2-difluoroethane, 1,1,1,2-	R112a	C2Cl4F2	76-11-9	~11	1	ZR	ZR	
Tetrachloro-2-fluoroethane, 1,1,1,2-	R121a	C2HCl4F	354-11-0	~11	1	ZR	ZR	
Tetrachloroethane, 1,1,1,2-		C2H2Cl4	630-20-6	11.10	0.6	ZR	ZR	
Tetrachloroethane, 1,1,2,2-	R-130	C2H2Cl4	79-34-5	11.10	0.2	ZR	ZR	
Tetrachloroethylene	PCE, perchloroethylene	C2Cl4	127-18-4	9.33	**0.4**	**0.6**	**0.7**	
Tetrachloropyridine, 2,3,5,6-		C5HNCl4	2402-79-1	~9	NA	1	NA	
Tetraethyl orthosilicate	TEOS, ethyl orthosilicate, ethyl silicate	C8H20O4Si	78-10-4	9.77	**1.0**	**3**	**3**	W!
Tetraethyllead	TEL	C8H20Pb	78-00-2	11.10	0.2	ZR	ZR	
Tetrafluoroethane, 1,1,1,2-	R134a	C2H2F4	811-97-2	~12.2	ZR	ZR	ZR	
Tetrafluoroethane, 1,1,2,2-	R134	C2H2F4	359-35-3	~12.2	ZR	ZR	ZR	
Tetrafluoroethylene	R-1114	C2F4	116-14-3	10.12	1	15	NA	
Tetrafluoromethane	Carbon tetrafluoride	CF4	75-73-0	15.30	ZR	ZR	ZR	
Tetrahydrofuran	THF	C4H8O	109-99-9	9.41	**1.4**	**2.3**	**2.8**	
Tetrahydronaphthalene	Tetralin	C10H12	119-64-2	8.46	NA	0.4	NA	
Tetrahydropyran		C5H10O	142-68-7	9.25	**0.9**	**1.5**	**1.5**	
Tetrahydrothiophene	Thiolane	C4H8S	110-01-0	8.38	**0.46**	**0.7**	**0.5**	
Tetramethyl orthosilicate	TMOS, methyl orthosilicate, methyl silicate	C4H12O4Si	681-84-5	~10	NA	2	NA	W!
Tetramethyl succinonitrile	TMSN	C8H12N2	3333-52-6	~11	NA	NA	NA	
Tetramethylbenzene (all isomers)	Tetramethylbenzene	C10H14	95-93-2	8.06	NA	0.3	NA	
Tetramethylbutane, 2,2,3,3-		C8H18	594-82-1	9.80	NA	1	NA	
Tetramethyldisiloxane, 1,1,3,3-	dimethylsilylether	C4H14OSi2	3277-26-7	~10	**0.5**	**1**	**1.1**	
Tetramethylgermane		C4H12Ge	865-52-1	9.34	NA	2	NA	
Tetramethylguanidine, N,N,N',N'	1,1,3,3-Tetramethylguanidine	C5H13N3	80-70-6	8.43	0.8	0.6	NA	
Tetramethylsilane	TMS	C4H12Si	75-76-3	9.80	NA	2	NA	
Thioacetic acid		C2H4OS	507-09-5	10.00	**1.1**	**1.4**	**2.9**	
Thioanisole		C7H8S	100-68-5	7.94	**0.5**	**0.6**	**0.7**	
Thiocarbonyl fluoride		CSF2	420-32-6	10.45	NA	6	ZR	
Thiocyanogen		C2S2N2	505-14-6	10.50	NA	8	ZR	
Thioformaldehyde trimer		C3H6S3	291-21-4	9.35	NA	1.5	NA	
Thionyl chloride		SOCl2	7719-09-7	10.96	NA	ZR	ZR	
Thiophene		C4H4S	110-02-1	8.86	**0.53**	**0.46**	**0.4**	
Thiophosgene		CSCl2	463-71-8	9.61	NA	1	NA	
Thymol		C10H14O	89-83-8	~9	NA	0.7	NA	
Titanium-n-propoxide		C12H28O4Ti	3087-37-4	~9	NA	3	NA	
Toluene		C7H8	108-88-3	8.82	**0.55**	**0.56**	**0.60**	
Toluene-2,4-diisocyanate	TDI	C9H6N2O2	584-84-9	8.82	2	1.6	NA	
Toluenesulfonyl chloride, p-	tosyl chloride	C7H7SO2Cl	98-59-9	~9	NA	3	NA	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Toluidine, o-	2-aminotoluene	C7H9N	95-53-4	7.40	1	0.5	NA	
Tolylaldehyde, p-		C8H8O	104-87-0	9.33	NA	0.8	NA	
Triazine, 1,3,5-		C3H3N3	290-87-9	10.01	NA	6	NA	
Tributyl phosphate		C12H27O4P	126-73-8	8.91	NA	5	NA	
Tributylamine		C12H27N	102-82-9	7.40	**0.6**	**1**	**ZR**	S X
Trichloro-1,1-difluoroethane, 1,2,2-	R122	C2HCl3F2	354-21-2	11.00	1	ZR	ZR	
Trichloro-1,2-difluoroethane, 1,1,2-	R122a	C2HCl3F2	354-15-4	~11	1	ZR	ZR	
Trichloro-2,2-difluoroethane, 1,1,1-	R122b	C2HCl3F2	354-12-1	~11	1	ZR	ZR	
Trichloro-2-fluoroethane, 1,1,2-	R 131	C2H2Cl3F	359-28-4	~11	1	ZR	ZR	
Trichlorobenzene, 1,2,4-		C6H3Cl3	120-82-1	9.04	NA	0.6	0.5	
Trichloroethane, 1,1,1-	1,1,1-TCA, R-140	C2H3Cl3	71-55-6	11.00	1	ZR	ZR	
Trichloroethane, 1,1,2-	1,1,2-TCA, R-140a	C2H3Cl3	79-00-5	11.00	**0.8**	**ZR**	**ZR**	
Trichloroethylene	TCE, R-1120	C2HCl3	79-01-6	9.45	**0.5**	**0.6**	**0.8**	
Trichlorofluoromethane	R11	CCl3F	75-69-4	11.77	NA	ZR	ZR	
Trichloronitromethane		CCl3NO2	76-06-2	~13	NA	ZR	ZR	
Trichloropropane, 1,2,3-		C3H5Cl3	96-18-4	~11	**0.64**	**ZR**	**ZR**	
Trichlorotrifluoroethane, 1,1,1-	R-113a	C2Cl3F3	354-58-5	11.50	2	ZR	ZR	
Trichlorotrifluoroethane, 1,1,2-	R-113	C2Cl3F3	76-13-1	11.99	2	ZR	ZR	
Triethyl borate		C6H15O3B	150-46-9	10.13	**1.2**	**5**	**ZR**	
Triethyl phosphate		C6H15P04	78-40-0	9.79	**3.3**	**1.2**	**20**	
Triethyl phosphite		C6H15O3P	122-52-1	8.30	NA	1.5	NA	
Triethylaluminum		C6H15Al	97-93-8	~10	NA	1	NA	
Triethylamine	TEA	C6H15N	121-44-8	7.50	**0.7**	**1.3**	**1.1**	S V
Triethylbenzene		C12H18	25340-18-5	~8.3	NA	0.4	NA	
Triethylsilane		C6H16Si	617-86-7	9.50	NA	2	NA	
Trifluoroacetic acid	TFAA	C2HO2F3	76-05-1	11.46	**ZR**	**ZR**	**ZR**	
Trifluoroethane, 1,1,2-	R-143	C2H3F3	430-66-0	12.90	34	ZR	ZR	
Trifluoroethanol, 2,2,2-	TFEA	C2H3F3O	75-89-8	~12	**9.6**	**ZR**	**ZR**	
Trifluoroethene	Trifluoroethylene	C2HF3	359-11-5	10.14	NA	5	NA	
Trifluoroethyl methyl ether, 2,2,2-	trifluoroethyl methyl ether	C3H5F3O	460-43-5	10.53	NA	10	ZR	
Trifluoroiodomethane		CF3I	2314-97-8	10.28	NA	2	NA	
Trifluoromethane	Fluoroform	CHF3	75-46-7	13.86	NA	ZR	ZR	
Trimethoxymethane		C4H10O3	149-73-5	9.50	**0.71**	**4**	**10**	V
Trimethoxyvinylsilane		C5H12O3Si	2768-02-7	~9.5	**0.53**	**2.0**	**ZR**	
Trimethyl borate		C3H9BO3	121-43-7	10.00	1	NA	NA	
Trimethyl phosphate		C3H9O4P	512-56-1	10.00	**3**	**4**	**50**	S V X
Trimethyl phosphite		C3H9O3P	121-45-9	~9		2		
Trimethylamine		C3H9N	75-50-3	7.82	0.3	0.5	0.5	S V X
Trimethylbenzene mixtures	Mesitylene	C9H12	25551-13-7	8.41	0.3	0.3	0.3	
Trimethylbenzene, 1,2,4-		C9H12	95-63-6	0.00	**0.5**	**0.6**	**0.6**	
Trimethylbenzene, 1,3,5-		C9H12	108-67-8	8.39	**0.4**	**0.4**	**0.5**	
Trimethylcyclohexane, 1,2,4-		C9H18	2234-75-5	9.35	NA	1.0	NA	
Trimethylene oxide		C3H6O	503-30-0	9.65	NA	1.5	NA	
Trimethylsilane		C3H10Si	993-07-7	9.90	NA	1	NA	
Trioxane	formaldehyde trimer	C3H6O3	110-88-3	10.30	**1.6**	**13**	**ZR**	
Tropathiane		C8H16OS	67715-80-4	~9	**0.3**	**0**	**NA**	
Tungsten hexafluoride		WF6	7783-82-6	15.53	**ZR**	**ZR**	**ZR**	
Turpentine		C10H16	9005-90-7	~8.5	NA	0.6	NA	
Turpentine oil	Pinenes	C10H16	8006-64-2	~8	1	0.6	0.5	
TVOC	Total Volatile Organic Compounds			~10	1	1	1	
Undecane		C11H24	1120-21-4	9.56	**0.4**	**1.1**	**3.1**	
Vanillin		C8H8O3	121-33-5	~9	NA	1	NA	
Vinyl acetate		C4H6O2	108-05-4	9.19	**1.0**	**1.5**	**1.77**	
Vinyl bromide	Bromoethene	C2H3Br	593-60-2	9.80	NA	1.5	0.9	
Vinyl chloride	Chloroethene	C2H3Cl	75-01-4	9.99	0.6	2.1	1.9	
Vinyl ethyl ether		C4H8O	109-92-2	8.98	**0.8**	**1.0**	**0.95**	
Vinyl fluoride	Fluoroethene	C2H3F	75-02-5	10.37	NA	2	ZR	
Vinyl-2-pyrrolidinone, 1-	NVP	C6H9NO	88-12-0	9.00	**2.7**	**4.5**	**3.3**	
Vinylcyclohexene	butadiene dimer	C8H12	100-40-3	8.93	**0.44**	**0.47**	**0.7**	
Vinylene carbonate		C3H2O3	872-36-6	10.08	**1.7**	**3.5**	**5**	
Vinylidene difluoride	vinylidene fluoride	C2H2F2	75-38-7	10.29	NA	5	NA	
Vinylsilane		C2H6Si	7291-09-0	10.10	NA	1.5	NA	
Water	dihydrogen monoxide	H2O	7732-18-5	12.61	ZR	ZR	ZR	
Xenon		Xe	7440-63-3	12.13	ZR	ZR	ZR	
Xylene mixed isomers	dimethylbenzenes	C8H10	1330-20-7	8.56	**0.49**	**0.54**	**0.59**	
Xylene, m-		C8H10	108-38-3	8.56	**0.46**	**0.5**	**0.53**	
Xylene, o-		C8H10	95-47-6	8.56	**0.52**	**0.5**	**0.6**	

Chemical name	Alternative name	Formula	CAS no.	IE, eV	Lamp Type (RF)			notes
					11.7 eV	10.6 eV	10 eV	
Xylene, p-		C8H10	106-42-3	8.44	**0.51**	**0.55**	**0.59**	
Xylidine, all		C8H11N	1300-73-8	7.50	NA	0.7	0.6	

Calculating the sensor responsivity to VOC mixtures

A volatile organic compound, or VOC, is a carbon-containing chemical, which is significantly or completely vaporised at ambient temperatures.

Occasionally you will be measuring a mixture of VOCs. If the total concentration is within the linear range of the PID, then it is reasonable to assume that the concentrations are additive without interference between the different VOCs:

The correction factor for a gas mix containing PID detectable gases A, B, C... with response factors RF(A), RF(B), RF(C), in fractional proportions a:b:c is given by:

$$RF\ mix = 1/[a/RF(A) + b/RF(B) + c/RF(C)...]$$

Example: A gas mix to be monitored contains 1 part isopropanol to 4 parts acetone:

Chemical name	RF	Fractional composition
Isopropanol	4.0	0.2
Acetone	1.17	0.8

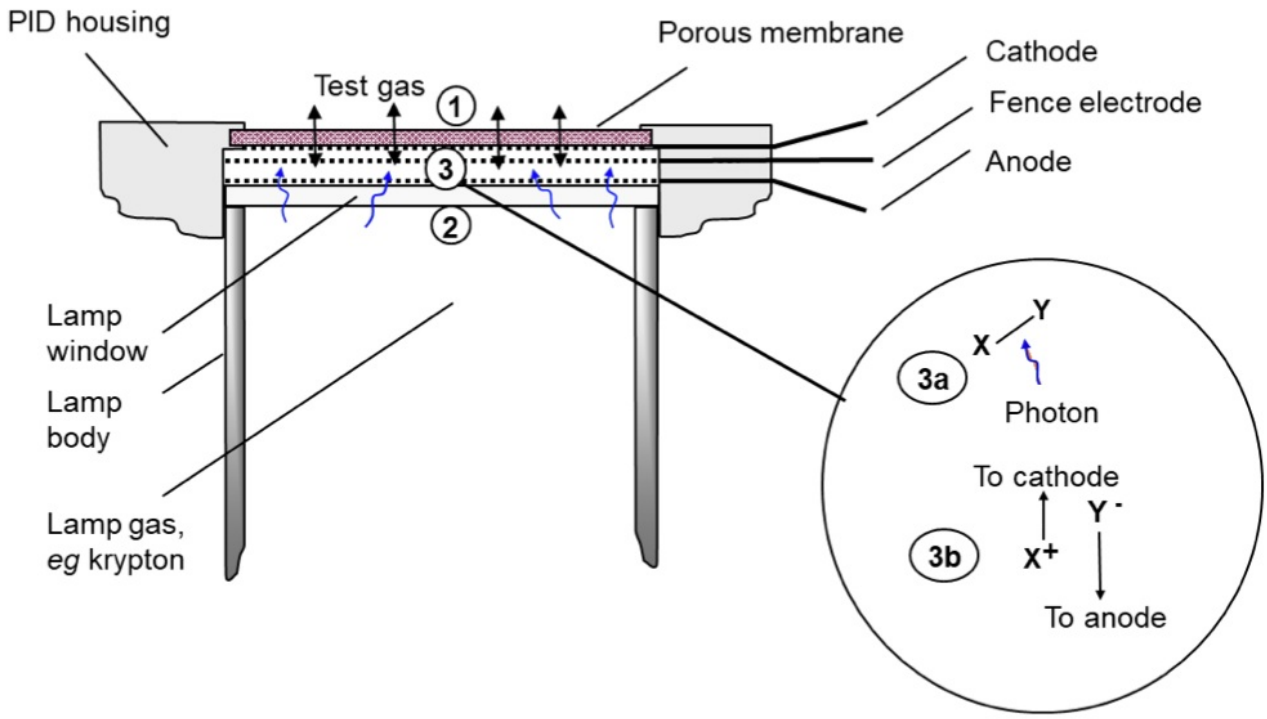
Therefore the RF of the mix will be:

RF mix = 1/[(4.0 x 0.2) + (1.17 x 0.8)] = 1/(0.8 + 0.936) = 0.58

> **Important:** remember that if you are measuring a combination of VOCs then accurate measurement of one of these VOCs will be difficult; without careful data analysis you will get only a RF averaged measurement. Also, note that in the volatilisation of mixtures of VOC's of different volatility, the more volatile fraction volatilises most rapidly, and the least volatile most slowly, leading to a change in the composition of the liquid and vapour mix.

How PID Sensor works?

The PID sensor measures volatile organic compounds (VOCs) in air by photoionisation detection (PID). The sensing mechanism is shown schematically below. Test gas (1) is presented to the external face of a porous membrane, through which it freely diffuses, into and out of a gaseous enclosure, (shown by double headed arrows). From the opposite face of the enclosure, (2) an illuminated lamp emits photons of high energy UV light, transmitted through a crystal lamp window (wavy arrows). Photoionisation occurs in the enclosure when a photon collides with a photoionisable molecule (3a) to generate two electrically charged fragments or ions, one positively charged, X+, and one negatively charged, Y- (3b). These are separated at, oppositely charged metal electrodes, being a cathode and anode, generating a tiny electric current. The current is amplified in an electric circuit (not shown) and presented as a sensor voltage output which depends on the concentration of photoionisable gas. The MiniPID 2 includes a third fence electrode which ensures that the amplified current does not include significant contributions due to other current sources such as electrolytic salt films on the chamber walls.



Volatile organic compounds (VOCs) sensed by PID sensor

Most VOCs can be detected by PID sensor. Notable exceptions are low molecular weight hydrocarbons.

Every VOC is characterised by an Ionisation Energy (IE). This is the minimum energy required to break the VOC into charged fragments or ions. Volatiles and gases in air are photo-ionised, and hence detected, when exposed to light of photon energy greater than their IE. PID sensor is provided with a light source of three different photon energies: 10.0 eV, 10.6 eV or 11.7 eV.

Standard PID sensors (PPM, PPB and HS) engage an unfiltered krypton light source, which delivers 10.6 eV UV light. The sensors respond to about 95% of volatiles, notable exceptions being most volatiles of one carbon atom, acetylene, ethane, propane and saturated (H)CFC’s

The PID 11.7 eV, which employs an argon lamp light source, responds to almost all VOCs: the few exceptions are methane, ethane and saturated fluorocarbons. 11.7 eV PID is less selective but particularly of interest in measuring formaldehyde, methanol and the lighter hydrocarbons, for which scant other sensing technology is available.

Finally, PID 10.0 eV, which engages a krypton light source and a crystal filter, responds to more limited range of VOC’s. Aromatics and most other unsaturated molecules are most readily detectable with this lamp, whereas most saturated hydrocarbons, with which they often occur, are sensed more weakly or not at all.

For detection of a volatile compound, it must be sufficiently volatile. A fairly large molecule such as alpha-pinene, (a constituent of turpentine), saturates in air at about 5000 ppm at 20 oC; this is the maximum concentration of the alpha-pinene that can be measured at 20 oC. Some compounds, e.g. machine oils and plasticisers, generate a fraction of a ppm of vapor at ambient temperatures. Because the diffusion of such large molecules is also very slow, in most scenarios they are not detectable. Organic compounds of boiling points 275 to 300 oC (at 1 atm.) are considered to be semi-volatiles and marginally detectable. Compounds of boiling point > 300 oC are considered non-volatile and undetectable.

Installation Notes

- If the PID is deployed in a wall mountable detector, the sensor is ideally located in the instrument to be as far from the wall mountings as possible, to minimise condensation phenomena caused by the air vs wall temperature disparity (consider the accumulation of particulates and heavy volatiles on shelves and kitchen

units).
- The sensor should be pointing downwards or sideways, to avoid slow accumulation of volatile in the sensor cavity, and dust.

Error States

Sensor Types		Fault Condition	Recommended Action
0-4000 ppm Sensor	**All others**		
Error 4	N/A	Lamp not illuminated	Change or clean lamp
		Electrode stack not fitted correctly	Ensure electrode stack is fitted correctly
Error 3	Error 3	Oscillator not working	Change the PID
		Misplaced electrode stack	Change electrode stack
Error 2	Error 2	Oscillator overloaded	Change electrode stack and/or PID
Error 1	Error 1	Power removed	Consult manufacturer

Calibration Guidelines

PID sensor naturally produces ozone in air, which over time acts to remove organic detritus from within the PID cavity. In many domestic and light industrial environments, the PID is self-cleaning. Re-calibration is then only needed to adjust for any decay in the PID lamp output on which the photoionisation measurement depends. In a fixed instrument, typically this will be every one to two months of cumulative sensor operation. However, when first deploying a PID instrument in a new environment, end users should be encouraged to bump test and re-calibrate as necessary. Since portable PID instruments are exposed to unknown environments, their calibration may be required more often.

Calibration of instruments containing PID usually demand measurements of ‘zero gas’, containing near zero concentrations of VOCs, and a span gas, used to calibrate the PID sensor in its linear range. Both gases are usually prepared with a ‘balance’ gas of artificial air, comprising ~80% nitrogen and ~20% oxygen. Do not use pure nitrogen as a balance gas as this delivers up to 20% more responsivity than air.

Appropriate end user calibration gases for the various MiniPID 2 sensors are identified below:

	Range	recommended zero gas max. VOC	recommended span gas isobutylene content	notes
	>4000 ppm	1 ppm	100 ppm isobutylene	Certain applications may call for higher calibration point(s)
	>10,000 ppm	1 ppm	100 ppm isobutylene	
	>40 ppm	0.1 ppm	30 ppm isobutylene	
	>200 ppm	0.1 ppm	30 ppm isobutylene	
	>3 ppm	0.1 ppm	2 ppm isobutylene	See notes on zero gas measurement
10 eV	>100 ppm	0.1 ppm	100 ppm isobutylene	
11.7 eV	>100 ppm	0.1 ppm	100 ppm propane	Isobutylene can be used

Zero gas of <0.1 ppm VOC is usually provided by ultrahigh purity (UHP) air. To enable frequent calibration, purified gas systems providing the same gas purity can be used. Lubricating oils in compressed air lines should be avoided as they will foul PIDs if exposed to the gas stream for extended times.

Some gases absorb UV light without causing any PID response (e.g. methane, ethane). In ambient atmospheres where these gases are present the measured concentration of target gas will be less than is present. Methane absorbs UV strongly, so for accurate measurements in methane containing atmospheres, calibrate with a calibration gas containing the expected methane concentration.

The HS sensor requires particular care in handling as identified in the technical article TA-14. Since air may contain semi-volatiles which give rise to a significant and slowly moving sensor response, calibration of a high sensitivity VOC detector must always be undertaken after burn-in using clean air. This will provide the zero point calibration reading.

Maintenance

Routine Maintenance

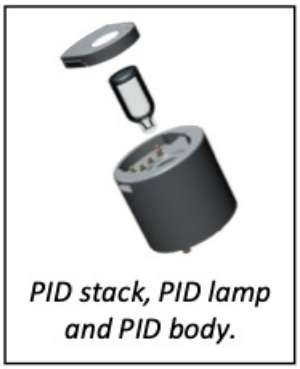
The electronics in the PID sensor are not accessible and designed to be maintenance-free.

The electrode stack is easily replaced and inexpensive. The PID stack will operate for years in most non-corrosive environments. It is recommended that end users of instruments containing PID carry at least one electrode stack in stock. The electrode stack is not toxic. Due procedures should be considered for safe disposal in the event of the stack being exposed to toxic environments.

Unscheduled Maintenance

The PID should be dismantled and stack and lamp inspected in the following circumstances:

- On exposure of the sensor to very humid, acidic (sour) and salty environments. This may cause inorganic salts to accumulate on PID enclosure walls, which ultimately compromises the screening potential of the PID fence electrode. This is often indicated by a moisture sensitive signal.
- Visual indications of liquid ingress into the electrode stack.
- A sensor error 4 indicates a failure of contact has developed between the sensor pins and the stack pads. The wings on the PID stack may fail after repeated dis- and re-assembly. It may also be caused by failure of the stack to engage fully with the sensor body, which may be corrected by refitting the lamp and stack. The PID lamp should be cleaned and replaced as necessary if the responsivity of the sensor, as measured in bump tests or during calibration, decreases unexpectedly. Note that exposure of the sensor to amines is liable to temporarily contaminate the PID lamp. Instrument design should cater for this.

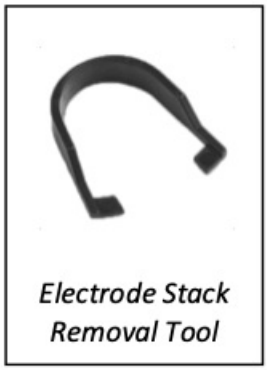


PID stack, PID lamp and PID body.

Removing the electrode stack and lamp

> ⚠ CAUTION: Only use the electrode stack removal tool. Any other tools (for example screwdrivers) may damage your PID body and will invalidate your warranty.

1. Wear gloves. Carefully remove the sensor from instrumentation.
2. Locate electrode stack removal tool in the side slots of the PID and squeeze together until electrode stack and lamp are released.
3. Lift carefully the PID body away from the electrode stack and lamp.
4. Occasionally the lamp may be temporarily lodged in the sensor body and will need to be freed carefully with tweezers. Occasionally the small spring behind the lamp will come out when the lamp is removed from the sensor. Simply replace it into the sensor body.



Inspecting the PID stack

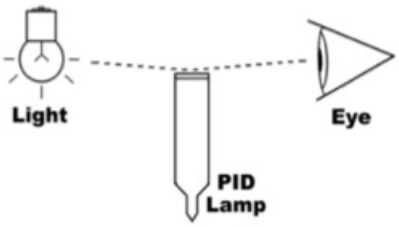
On removal of the electrode stack, carefully inspect the underside. The visible electrodes should be shiny and metallic. If there are any signs of corrosion or water ingress the stack should be replaced.

Inspecting and cleaning the PID

> ⚠ NOTE: Alumina polishing of lamps described below is appropriate for all

PID lamps except the PID 11.7 eV lamp.

Inspection of the PID lamp, as shown in the illustration, may reveal a fine film of contamination on the lamp window. However, it should be noted that window contamination is frequently not visible. Black or metallic deposits on the interior face of the lamp cannot be removed. If the deposits are extensive, the lamp must be replaced.



To clean the lamp, use of PID lamp cleaning kit A-31063. Validity of lamp warranty is compromised if lamp cleaning maintenance is not followed and lamp has obvious fouling/contamination.

1. Wear gloves. Never touch the lamp window, even with gloves.
2. Open the container of alumina polishing compound.
3. With a clean cotton bud, collect a small amount of the powder.
4. Use this cotton bud to polish the PID lamp window. Use a circular action, applying light pressure to clean the lamp window. Do not touch the lamp window with fingers.
5. Continue polishing until an audible “squeaking” is made by the cotton bud moving over the window surface. Usually this requires 15 to 30 s polishing.

6. Remove the residual powder from the lamp window with a clean cotton bud. Care must be taken not to touch the tips of cotton buds that are to be used to clean the lamps.
7. Ensure the lamp is completely dry and all detritus is removed before reassembling the lamp stack and body (see below).
8. Re-assemble the sensor lamp, stack and sensor body as described below, and reinstall sensor in the instrument.
9. Bump test the sensor. If the responsivity has recovered, then recalibrate the instrument. If not, replace the lamp.

CAUTION: The lamp cleaning kit contains alumina (CAS Number 1344-28-1) as a very fine powder. Cleaning should be undertaken in a well-ventilated area. A full material safety data sheet MSDS is available on request from Ion Science Ltd. Key safety issues are identified below:

Hazard identification:
• May cause irritation of respiratory tract and eyes

Storage:
• Keep container closed to prevent water adsorption and contamination.

Handling:
• Do not breathe in the powder. Avoid contact with skin, eyes and clothing
• Wear suitable protective clothing
• Follow industrial hygiene practices: Wash face and hands thoroughly with soap and water after use and before eating, drinking, smoking or applying cosmetics.
• The powder carries a TVL(TWA) limit of 10 mg/m^3

Assembly of MiniPID 2 electrode stack, lamp and body.

CAUTION: Do not assemble using a damaged lamp as this may rupture the stack's lamp O-ring seal.

1. Lay the electrode stack front face down on a clean, flat surface and then screw the lamp down into the O-ring until it firmly abuts against the front electrode face.
2. Place the PID body carefully down over the lamp-stack sub-assembly so as not to disturb its seating within the electrode stack and then push the body firmly onto the face down electrode stack so that both wings engage with the PID body.
3. Inspect the sensor to confirm that both wings of the electrode stack have engaged with the PID body.
4. Refit the sensor into the sensing instrumentation.
5. Re-calibrate the equipment in accordance with manufacturer's instructions.

Instrument Warranty and Service

Warranty

The standard warranty on a PID is 12 months.

Service and service centers

Daviteq is pleased to offer a number of service options for our PID product range that allows you to choose the cover that best suits your needs.

Contact Daviteq or your local distributor for service options in your area.

NDIR GAS SENSOR

Daviteq NDIR Gas Sensor

1. Introduction

1.1 Overview

Daviteq NDIR Gas sensor module is intended for automatically continuously measuring hydrocarbons or carbon dioxide concentration in the atmosphere. The sensor operating principle is based on NDIR technology, i.e., on selective absorption of LED-produced infrared radiation by gas molecules. The differential dual wavelength method allows the elimination of water vapor, optical elements contamination, and other non-selective hindrances influence.

It has ultra-low power consumption to allow it to be integrated with Wireless Devices such as Sub-GHz transmitters, Sigfox transmitters, LoRaWAN transmitters, RS485 output transmitters, etc.

It can be calibrated with target gas like CO2, CH4, C3H8, C2H4, and C2H6...

Typical Applications: Flammable gas detection and CO2 gas monitor.

1.2 Specification

Sensor technology	LED-based NDIR
Gas sampling method	Diffusion
Sensor housing / Rating	SS316/SS304 housing with 316SS sintered filter / for Indoor use (buy the optional accessory rain-guard for outdoor installation), Exd approval for Zone 1/21 or Zone 2/22 installation. For mining applications: please add extra dust filter to protect (please contact us for this accessory)
Target gas	CO2, CH4, CH4/CH4+C2H6, C3H8, C2H4,... please consult us for other HC gases
Ambient Humidity	0 - 98%
Temperature	-40 .. + 60 oC
Atmospheric pressure	80 .. 120 kPa
Warm-up time	120 sec
Measurement range, % vol.	0...1.5 (CO2 or C3H8 sensors) 0...2.5 (CH4 or C3H8 sensors) 0...5 (CH4 or CO2 sensors) 0...100 (CH4 sensors)
Reading Stability in +20 .. + 25 oC	± 0.1% vol. or ± 5% of readings (whichever is greater) for CH4 ± 0.05% vol. or ± 5% of readings (whichever is greater) for C3H8 / CO2
Zero Stability in +20 .. + 25 oC	for CH4: ± 0.1% vol. or ± 2% LEL for C2H4: ± 0.1% vol. or ± 3.8% LEL for C3H8/CO2: ± 0.05% vol. or ± 2.4% LEL
Response time T90	<= 30 sec (with sintered metal filter)
Sensor lifetime	>= 10 years
Calibration interval	Recommend recalibrating zero and span at least every 30 months

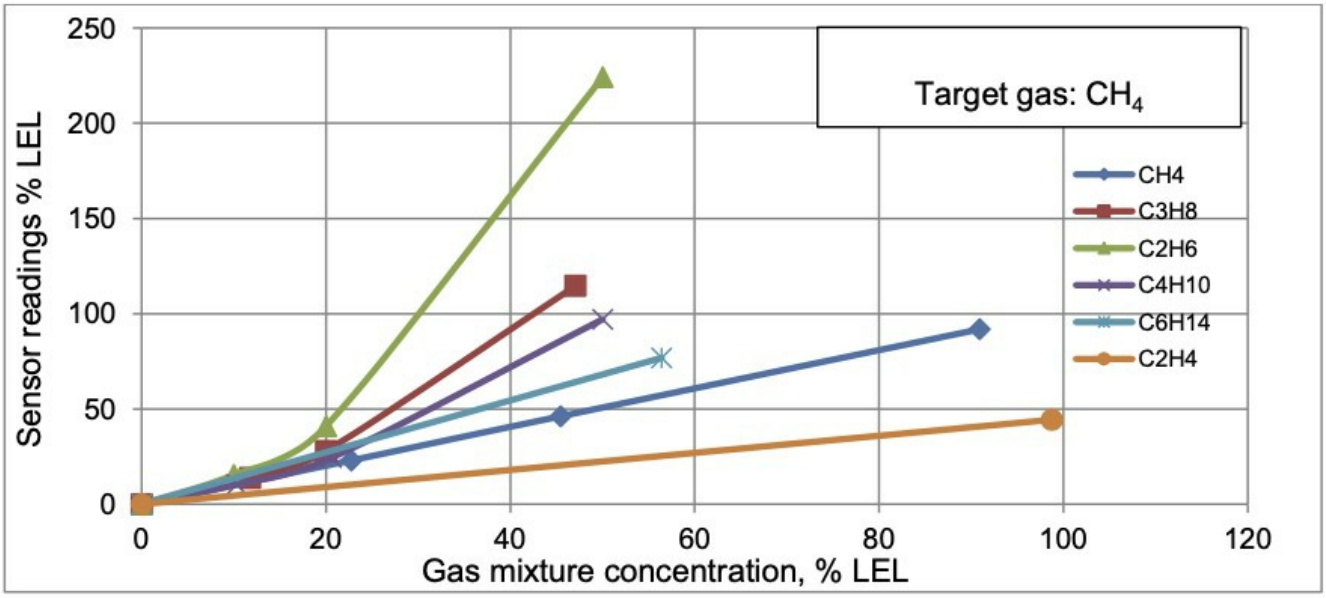
Detailed reading stability

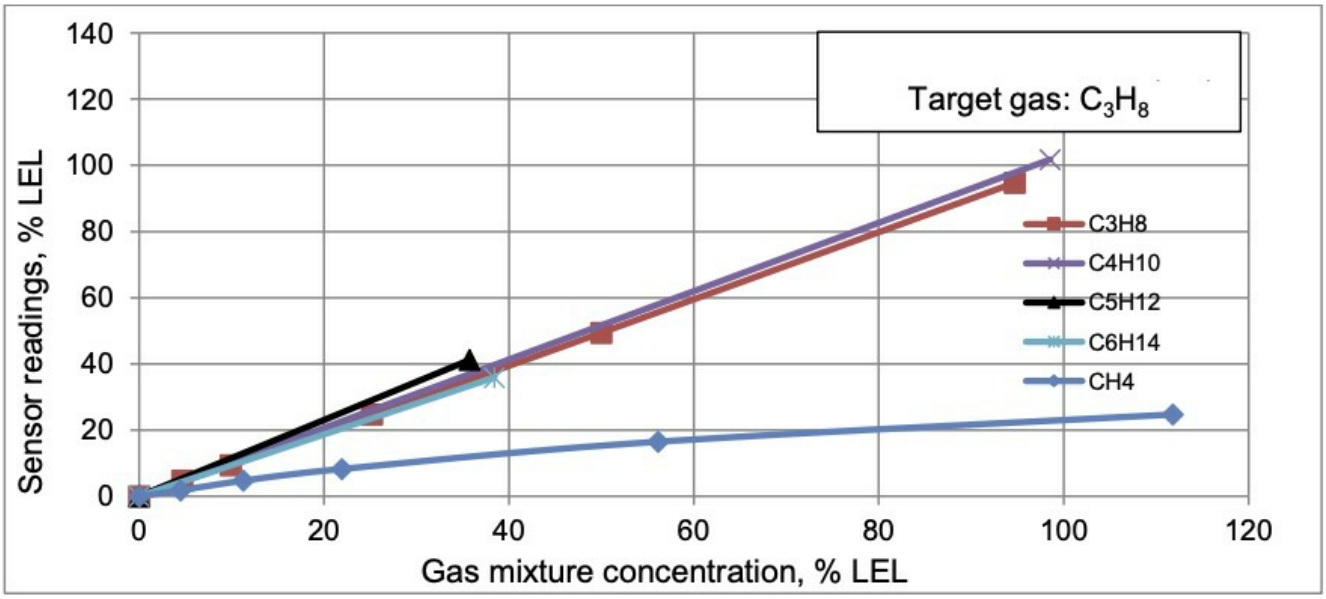
Calibration Gas	Readings stability within a temperature range	Additional variability due to pressure	Additional variability due to humidity
CH4	± 0.1% vol. or ± 5% of readings (whichever is greater) within the range of +20...+25 °C; ± 0.2% vol. or ± 10% of readings (whichever is greater) within the range of -10...+20 °C and +25...+40 °C; ± 0.4% vol. or ± 20% of readings (whichever is greater) within the range of -40...-10 °C and +40...+60 °C.	± 0.2% vol. or ± 30% of readings (whichever is greater) at 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)	± 0.2% vol. or ± 15% of readings (whichever is greater) at 40 °C (test: 20% RH, 50% RH, 90% RH)
C3H8	± 0.05% vol. or ± 5% of readings (whichever is greater) within the range of +20...+25 °C; ± 0.1% vol. or ± 10% of readings (whichever is greater) within the range of -10...+20 °C and +25...+40 °C; ± 0.2% vol. or ± 20% of readings (whichever is greater) within the range of -40...-10°C and +40...+60°C.	± 0.1% vol. or ± 30% of readings (whichever is greater) at 100 kPa (test: 80 kPa, 100 kPa, 120 kPa)	± 0.1% vol. or ± 15% of readings (whichever is greater) at 40 °C (test: 20% RH, 50% RH, 90% RH)
CO2	± 0.05% vol. or ± 5% of readings (whichever is greater) within the range of +20...+25 °C; ± 0.1% vol. or ± 10% of readings (whichever is greater) within the range of -10...+20 °C and +25...+40 °C; ± 0.2% vol. or ± 20% of readings (whichever is greater) within the range of -20...-10 °C and +40...+50 °C.	± 0.1% vol. or ± 40% of readings (whichever is greater) at 100 kPa (tested at 80 kPa, 100 kPa, 120 kPa)	± 0.1% vol. or ± 15% of readings (whichever is greater) at 40 °C (tested at 20% RH, 50% RH, 90% RH)

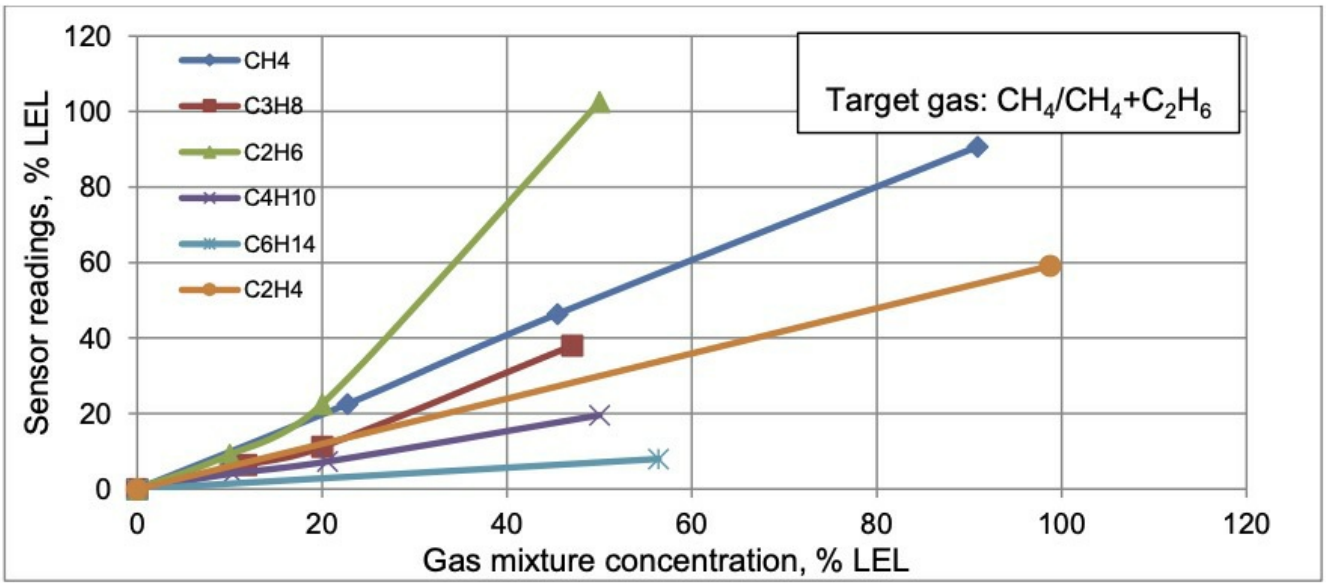
1.3 Cross-Sensitivity Data

What is cross-sensitivity?

The gas detection sensor is usually affected by other gas. It meant the sensor not only measure the target gas but also the other gases. A concentration of additional gas would also cause a change in sensor output with a factor listed in the table below.



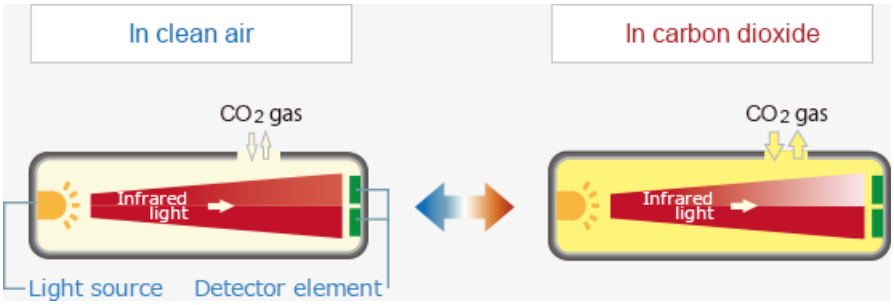




2. Principle of operation

When infrared radiation interacts with gas molecules, infrared light is absorbed by the gas molecules at a particular wavelength, causing vibration of the gas molecules. NDIR (Non-Dispersive Infrared) gas sensors detect a decrease in transmitted infrared light, which is in proportion to the gas concentration. This transmittance, the ratio of transmitted

radiation to incident energy, depends on the target gas concentration.



NDIR gas sensors consist of an infrared source, detector, optical filter, gas cell, and electronics for signal processing. A single light source, dual wavelength type gas sensor has two detectors and two optical filters of different wavelengths, which are placed in front of each detector. The infrared light that is absorbed by a target gas passes through the active filter with a particular bandwidth to detect the target gas. The infrared light that does not interact with the target gas passes through the reference filter. The difference between transmitted light intensities in these two bandwidths is converted into gas concentration. The dual wavelength sensor ensures stable measurements for a long period of operation as the aging effects of the light source or the gas cell are automatically compensated by output signals at the reference wavelength.

Mid-infrared radiation through sample gas causes a resonance of gas molecules at their natural frequency with the infrared light in the spectrum region where the energy level of infrared is equivalent to the natural frequency of gas molecules, resulting in the absorption of infrared by gas molecules in the form of molecular vibration.

The relationship between infrared transmittance and gas concentration is expressed by the Lambert-Beer law:

$$T = I / I_0 = e^{-\varepsilon cd}$$

Where T is transmittance, I is the intensity of light passed through sample gas and an optical filter,Io is the initial light intensity emitted from the source, ε is the molar attenuation coefficient, c is gas concentration, and d is the light path length.

Because ε of the target gas and the light pass lengthd are fixed with an NDIR sensor, gas concentration can be measured by measuring the target gas's transmittance within the spectrum region of the absorbed energy (wavelength).

The initial light intensity emitted from the light sourceIo is preset by calibration using zero gas which does not absorb infrared light. The initial value of the molar extinction coefficient ε is set by calibration using calibration gas of known concentration.

3. Calibration of the Daviteq NDIR Gas Sensor

The Daviteq NDIR Gas Sensor must be connected to a reading device, usually a wireless transmitter like Sub-GHz, Sigfox, or LoRaWAN.

3.1 Why do we need to calibrate the gas sensor? There are some reasons:

- The output value of a sensor is different from the other sensor. It is not the same value for all sensors after manufacturing.

- The output value of a sensor will be changed over time.

Therefore, users need to calibrate the sensor before use or in a pre-defined interval (30 months for example).

3.2 How to calibrate the NDIR Flammable Gas sensor?

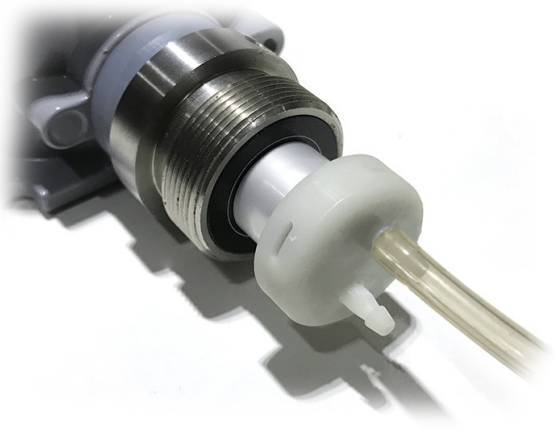
NOTE: THE BELOW CALIBRATION PROCEDURE CAN ONLY BE DONE IN THE SAFE ZONE!!!

TO CALIBRATE THE SENSOR IN HAZARDOUS ZONES, PLEASE USE SUITABLE CALIBRATION CAP (PLEASE CONTACT US)

Instructions to attach the calibration cap onto the sensor module to get Zero or Span values.

Step 1. Remove the Filter and prepare the calibration cap

Step 2. Attach the calibration cap to the sensor head



Step 3. Installed the Regulator to the Gas cylinder

Step 4. Attach the tube to the regulator

Please select the flow regulator with a flow rate of 2.5 LPM or 5.0 LPM.

With the 2-point calibration method, the user can define the A and B factors. Please find below the steps of calibration.

Step 1: Get the Zero value.

- Power ON the device;

- Place the device in a clean-air environment (the target value is nearly zero) at a temperature from 20 - 30 oC, in at least 60 minutes.

- After 60 minutes, force the device to send data, read and record the Raw_value, so now you got the Zero_value = Raw value.

Recommendation: Record many Raw values at least 10 minutes apart (10 values).
Zero value is the average of the recorded Raw values.

⚠ Note: the Raw values can be positive or negative; Its value is usually 7 (%LEL)

Step 2: Get the Span value

⚠ **Note: Keep the sensor Power ON all the time;**

- Use the standard gas cylinder with a known concentration (for example, Eythylene Air 1.35% is equivalent to 50 %LEL) to supply the gas to the sensor;

- Use the calibration cap as above pictures to attach to the sensor and connect the tubing to the gas cylinder;

- Open the valve on the Cylinder slowly and make sure the gas has reached the sensor. The flow regulator should be 2.5LPM or 5.0LPM.

⚠ **Notes:**
- The tube length is short as possible to reduce the gas loss;

- Press a timer to start counting the time;

- After 2 minutes, force the device to send data once every minute, and stop forcing at**5 minutes**;

- The highest Raw_value is the Span value.

⚠ **Note: just get one value for Span**

- After that, immediately turn OFF the valve to save the gas;

- Remove the calibration cap from the sensor;

- Place the sensor in clean air again.

⚠ **Note: Always keep the sensor Power ON all the time;**

Step 3: Calculate the new A and B

-The calculation of new A, and B values based on the basic linear formula: y = A * x + B

Where:

A, and B is calibration coefficients

x is the sensor process value (for example gas level in ppm) read on a reading device such as an application server/network server, or on the offline tool. The process value is the RAW_VALUE in the payload

y is the correct value. y is the value of standard gas/standard condition

Which condition of Zero value: $y_0=A * x_0 + B$

Which condition of Span value: $y_s=A * x_s+ B$

From the two formulas, the calculation of A, and B as below

$A = (y_0 - y_s) / (x_0 - x_s)$

$B = (y_s * x_0 - y_0 * x_s)/ (x_0 - x_s)$

-Example of A, B calculation for LoraWAN Ammonia Gas sensor (item code WSLRW-G4-NH3-100-01):

* With the condition of a clean-air environment at a temperature from 20 - 30 oC, there is no ammonia gas ($y_0 = 0$); while the NH3 level on the reading device (RAW_VALUE in the payload) is -0.25 ($x_0 = -0.25$)

* When the sensor is connected to a standard gas cylinder having an ammonia level of 25 ppm ($y_s = 25$); while the NH3 level on the reading device (RAW_VALUE in the payload) is 18.66 ($x_s = 18.66$)

*The calculation of A, and B for the Ammonia gas sensor:

A = (0 - 25) / (-0.25 - 18.66) =1.32205

B = (y_s * x_0 - y_0 * x_s)/ (x_0 - x_s) = (25 * (-0.25) - 0 * 18.66)/ (-0.25 - 18.66) = 0.33051

The factory default A = 1 and default B = 0

The RAW_VALUE in the payload is used for calibration

Step 4: Configure the new A and B into the device

- User can use the off-line tool or downlink to write the values of A and B;

- Writing the new A and B successfully meant you had done the calibration process. Congratulation!

4. Application notes for the Daviteq NDIR Gas Sensor

- Do not use a damaged sensor. It must be repaired only by personnel authorized by the manufacturer.
- Keep the sensor out of contact with aggressive substances e.g., acidic environments, which can react with metals, and solvents, which may affect polymeric materials.
- Diffusion holes of the sensor should be protected against the ingress of sprayed liquid or waterdrops.
- The sensor is not intended to measure the target gas concentration contained in fluids.
- Correct measurement is provided when the ambient temperature changes not faster than 0.6 °C/min.
- Inspection and maintenance should be carried out by suitably trained personnel.
- Persons, who have studied this UM, must be briefed on safety precautions when operating electrical equipment intended for use in explosive areas in due course.
- When dealing with a cylinder containing a gas mixture under pressure, it is necessary to follow safety regulations.
- There is no risk of pollution or negative impact on human health. The sensor contains no harmful substances that may be released during its normal operation.

5. Installation notes

Notes:

* If a sensor has been kept in transport containers at temperatures below zero centigrade, leave it at +10...+35 °C for not less than one hour.

* if the Sensor is intended to install outdoors, please use a rain guard to protect the sensor from rain and direct sunlight. Please **contact us** to buy this accessory.

- Place the sensor in the area to monitor the target gas concentration. Please always check the gas molecular weight v.s the air.

Note for Outdoor installation: For outdoor installation, please use the Rain guard to protect the sensor from raindrops or snowflakes. Please **contact us** to buy the Rainguard.

6. Troubleshooting for the Daviteq NDIR Gas Sensor

No.	Phenomena		Reason	Solutions
1	The measured value is not within the expected value.	1.1	The sensor is drifted by time.	Re-calibrate the sensor
		1.2	The sensor was spoiled.	Please consult the manufacturer for a warranty or replacement.
2	The measured value is always zero or near zero.	2.1	The sensor module was removed.	Please check the sensor.
		2.2	The sensor is at the end of its life.	Replace the sensor module
3	HW_Error = 1	3.1	Loosed connection of sensor module and wireless transmitter.	Check the internal wiring.
		3.2	The measuring module got a problem.	Please consult the manufacturer for a warranty or replacement.

7. Maintenance of the Daviteq NDIR Gas Sensor

What?	How?	When?
Cleaning the Filter	Check and clean the filter every few months, depending on the environment. Clean the filter with warm water and soap, then use compressed air to purge it from the inside out.	Approx. 6-12 months (< 1 month for Mining applications)
Re-calibration	The gas sensor may be drifting over time. Please check **the sensor specification** to identify the interval time for the re-calibration sensor. Please follow the calibration procedure in **section 3** above.	Approx. 30 months
Sensor replacement	Replace the new sensor module only when the sensor cannot respond with standard calibration gas.	> 10 years or when a problem occurs.

Sensor replacement instructions:

⚠ ** Please remove the batteries before doing the following steps. The replacement can only be done in Safe zones.*

Step 1. Unscrew the housing

Step 2. Remove the filter

Step 3. Unplug the sensor module

Step 4. Plug the new sensor module into the PCB

Step 5. Insert the batteries and start calibrating the new sensor as per **section 3**.

Step 6. Place the filter back.

8. Default configuration

This NDIR gas sensor module has the default configuration. However, those parameters can be changed. The user can change the configuration on the wireless transmitter so that the complete sensor (transducer + wireless) delivers the proper output value. Below are some configuration parameters that store in the flash memory of the wireless transmitter.

Description	Unit	Default	Format	Property	Comment
CONSTANT_A		1	Float	R/W	Constant a for scaling measured value. This value would be changed after calibration.
CONSTANT_B		0	Float	R/W	Constant b for scaling measured value. This value would be changed after calibration.
HIGH_CUT		1E+09	Float	R/W	High cut value for scaled_value
LOW_CUT		0	Float	R/W	Low cut value for scaled_value
SENSOR RESPONSE TIME	S	100	uint16	R/W	** Do not change this value*
C_H_FACTOR		4.4	Float	R/W	4.4 for CH4, 1.7 for C3H8

END.