

Application: Monitoring of air ducts

There are two different main basic gas detection applications in a process plant. Point detection and area monitoring.

To serve these two main applications the industry has developed the IR Point Detector and the Open Path Detector. Within these two main areas we can find special applications that have their own specific requirements. One of these special detection applications is monitoring of air ducts and air intakes to prevent ingress of explosive gases into these systems.

The monitoring of gas leakages in air ducts is a safety critical application. The consequence of insufficient and slow detection of combustible gases is that large volumes of gas can be sucked into living quarters or into Local Equipment Rooms etc.

Both IR point detectors and Open Path Detectors (so called cross-duct versions) are available on the market for this specific application. When evaluating these two technologies for duct monitoring it is important to know the fundamental principles behind these two technologies.

IR Point compared with Open-Path Cross-duct detectors:

Point detectors are originally designed to monitor an area so small that it is defined as a point. The open path detectors are designed to monitor larger open areas. These two basic applications require different properties of the detectors, and that is the basic element behind the specification for these two detector concepts.

However they share some common basic principles, and the differences are basically variations within these common principles. The fundamental principle for both technologies is that gases with molecules consisting of two or more different atoms, e.g. hydrocarbon gases, CO₂ and water vapor, will absorb IR energy at certain specific wavelengths. Each gas has its own specific fingerprint within the absorption spectrum.

The area covered by a gas detector is defined as the measuring path. The measuring path is defined as the area within the detector where the IR beam emitted by the detectors can be exposed to gases and thus detected due to absorption by gas molecules as described above.

The measuring path of a point detector is very short compared with an open path detector. For the Simrad GD10P point detector the measuring path is only approx. 7 cm. For the Simrad GD10L open path detector the practical measuring path can be up to 30 m.

Although the measuring paths vary as described here, another important fundamental principle is shared by both technologies. And that is that the

sensitivity to gases for both open path detectors and point detectors are depending on the length of the measuring path exposed to gas.

Both IR detector types are sending out infrared light into the measuring path. The wavelength used is different for the open path and the point detector. All manufacturers of IR hydrocarbon gas detectors are using two different wavelengths within the infrared spectrum for gas detection. For open path detectors the specific wavelength is 2,3 μm and for point detectors the specific wavelength is 3,3 μm .

The absorptiveness of hydrocarbon gases are 50 times higher for 3,3 μm wavelength compared with 2,3 μm wavelength, which in practice means that a point detector is 50 times more sensitive than an open Path detector. The reason for choosing different wavelengths for the two different detector types is to adapt the detector properties to the application they are going to serve.

Open Path detectors:

Basically open path detectors are designed to monitor larger areas covering several meters. If a 3,3 μm IR source would have been used for this application, the sensitivity combined with the long measuring path, e.g. 5-30 meters would have resulted in a gas detector capable of detecting HC gas concentrations down to ppm levels. That is much too sensitive for a safety device as a gas detector, as it would have detected small and harmless leakages like e.g. leakages from valve stem packings etc.

Another reason for not using a 3,3 μm IR source for this application is the sensitivity to external influences. One important element here is water vapour and water droplets because of precipitation that is naturally present in the atmosphere. The absorptiveness of Water vapour is very high at this specific wavelength, and this cross sensitivity makes it unsuitable for open path applications.

By using 2,3 μm wavelength the sensitivity to gases for the open path detector is adjusted according to the application needs, and it eliminates the problem of cross sensitivity to water vapour.

Output from open path detectors:

For open path detectors we have to take into consideration the long measuring path these detectors are covering. Thus the output is given as a product of gas concentration in LEL multiplied with length in meters, LELm.

LELm is an industry standard used to state the sensitivity of the open path gas detector independent of the actual measuring path where the detectors are installed. This may vary from installation to installation. It also makes it easier to compare detectors from different manufacturers.

The basics are as follows:

An explosive mix of gas and air is stated as 100%LEL (Lower Explosive Limit). The industry has defined the size and the concentration of an “industry standard” dangerous gas cloud, as a basis for a common definition of sensitivity and measuring range for open path detectors. This “dangerous” gas cloud has a diameter of 5 m and a gas concentration of 100%LEL. 100% full-scale output for an open path detector is thus 5LELm.

Point Detectors

These are designed to monitor local points. The measuring path of a standard Simrad GD10P is 7 cm. The short measuring path of the Simrad GD10P is protected from external influences like rain, snow, dust, fog etc. by a weather protection cap. To achieve the necessary sensitivity due to the short measuring path, the 3,3µm wavelength is used in the point detectors. Because of the short measuring path and the high sensitivity for HC gases, the cross sensitivity to water vapour will not have any affect on the point detectors.

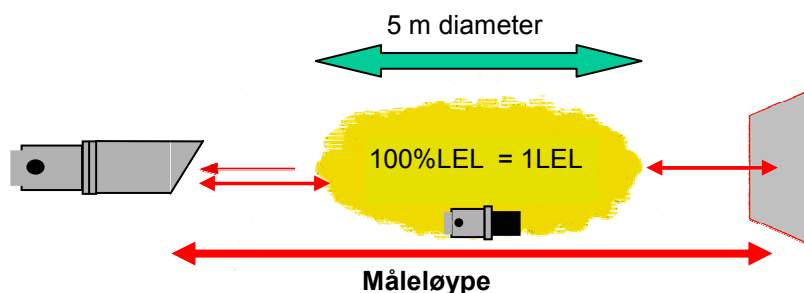
Output from open path detectors:

The output from a point detector is given as %LEL, and that shows the gas concentration measured in that specific point by the specific detector. 100% full-scale output for a point detector is thus 100%LEL.

Open path detectors compared with point detectors:

With reference to the above background information, we will look into the differences between point detectors and open path detectors.

The open path detector has a measuring range of 5LELm and the point detector has a measuring range of 100%LEL.



Based on this example both detectors will give a 100% output, i.e. the reading from the open path detector will be 5LELm (5 m x 1LEL), and the point detector 100%LEL. Based on that we can say that they are equally sensitive for this particular installation.

Duct mounted applications:

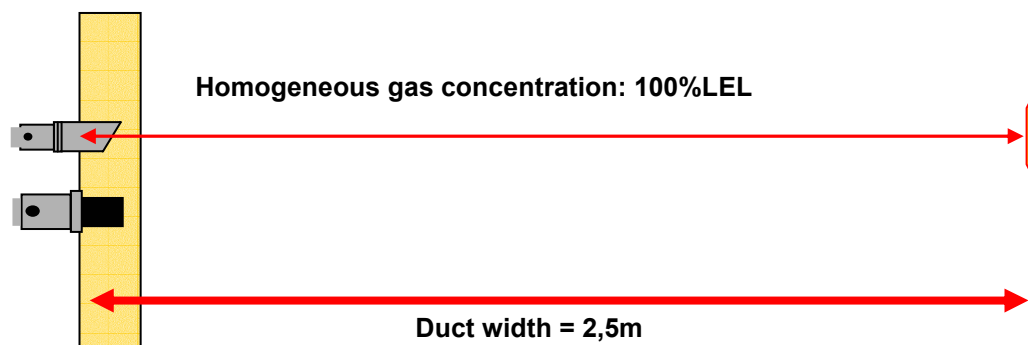
As written above by introducing LELm as a measure of the sensitivity for open path gas detectors, we can state the sensitivity of the gas detector independent of the measuring path in an actual installation. When we use the open path detector as originally designed, i.e. to monitor open areas covering several meters, then there is normally not a problem. The measuring path will normally be sufficiently long to ensure that the sensitivity is high enough provided that the gas cloud is filling the measuring path.

In this context it is important to remember that the sensitivity to gases for both types of detectors is dependent on the length of the measuring path exposed to gas.

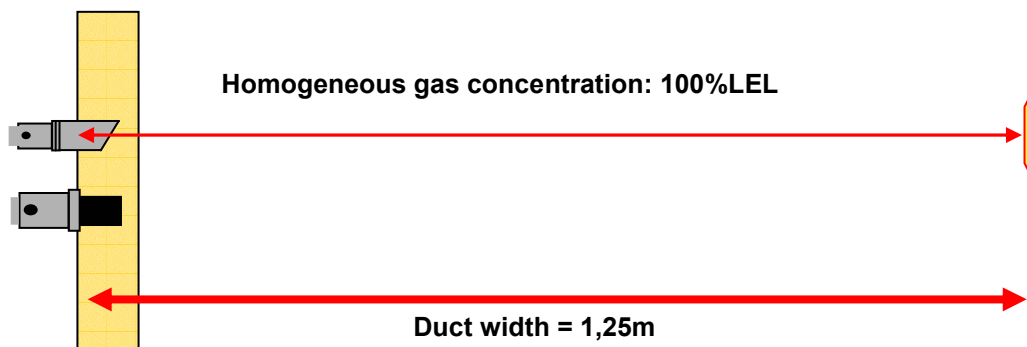
When using open path detectors to monitor air ducts the length of the measuring path is fixed by the measures of the air duct itself. Thus the sensitivity of the detector is directly depending on the duct size.

The following examples illustrate the difference between point detectors and open paths detectors for duct installations.

The figure below shows an open path detector (range 0-5LELm) with retroreflektor. A duct width of 2,5 m gives a total measuring path of 5m since the IR beam is reflected back to the detector. The point detector is a standard (0-100%LEL) range type.



In this specific example both detectors will have exactly the same sensitivity. Open path will give an output of 5LELm and the point detector will give a 100% LEL concentration.



By installing the same detectors in a duct with half the width, the following will happen. The point detector will still give a 100% output showing a concentration of 100%LEL. The open path detector has been affected by this change. The output from the open path detector is as follows: $2,5\text{m} \times 1\text{LEL} = 2,5\text{LELm}$ i.e. only 50% of full scale. The reason is the reduction of the length of the measuring path. It is only half the length compared with the previous example, and consequently the sensitivity for the open path detector has been reduced to 50% of the sensitivity specified for the instrument. In this example the point detector is twice as sensitive as the open path detector. The open path detector requires a gas concentration of 200%LEL to give 100% full output.

If the duct width is reduced further to only 0,5m (1,0m of measuring path) and with the same gas concentration of 100%LEL in the duct, the output from the open path detector will be $1,0\text{m} \times 1,0\text{LEL} = 1\text{LELm} = 20\%$ of full scale. To achieve a 100% scale output from the open path detector in this case, the gas concentration has to be 500%LEL. In this example the point detector is five times more sensitive as the open path detector.

These examples illustrates that to know the physical length of the measuring paths is important to be able to interpret the information that an open path detector is giving for such applications. Cross duct modified open path detectors available on the market are sold with

The output of open path detectors in normal installations is given as LELm as previously covered. This information is difficult to relate to in a cross duct application, since the critical information for the process operator is the gas concentration in %LEL. Since the measuring range of the Cross duct modified open path detectors are fixed by the actual measures of the duct, these detectors have an output range of 0-100%LEL.

To achieve a correct result during operation, it is imperative that the correct duct dimension in each case is entered during initial calibration of the instrument. Any wrong input here will influence the sensitivity and thus the performance of the instrument, and that may be critical for the overall safety of the plant.

Simrad GD10PE extended point detector

Simrad GD10PE is a point detector utilizing the same unique IR sources as the Simrad GD10P with a signal wavelength of 3,3 µm. It is designed specially for duct applications requiring high sensitivity and fast detection capabilities. The Simrad GD10PE has a measuring range of 0-20%LEL and as such it is 5 times more sensitive compared with the standard Simrad GD10P.

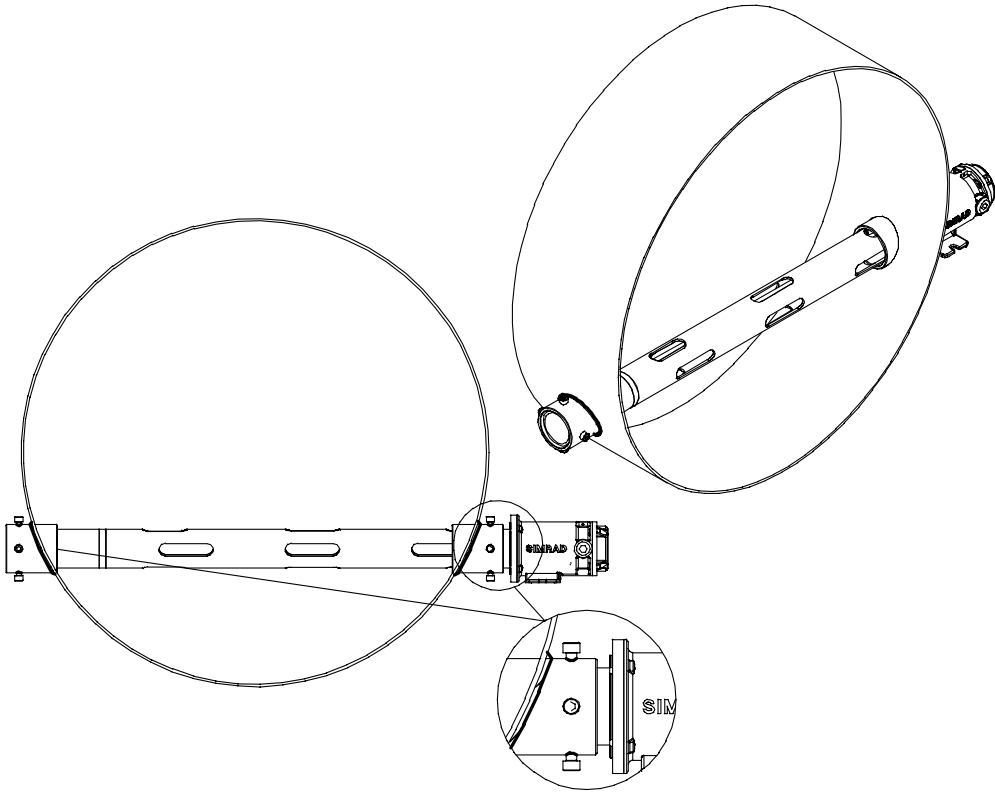
It is also ideally suited to monitor air ducts or enclosures with high temperatures, since the electronics part of the detectors is outside of the hot area. There is no need to calibrate the detector after installation as for an open path detector, thus eliminating the possibility of human error in that phase. The detector is fast in its response as illustrated in the below matrix.

The matrix shows the response time for the GD10PE when exposed to a 100%LEL concentration of gas.

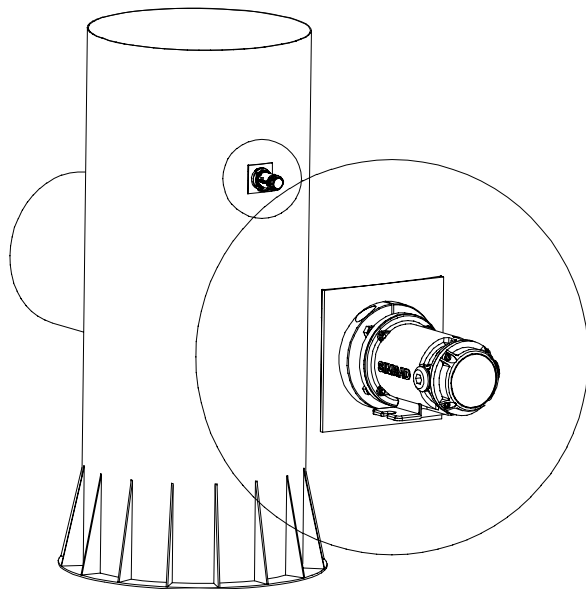
Output (%LEL)	Response time (seconds)	Output of full scale (%)
2	0,3	10
4	0,6	20
10	0,9	50
18	1,3	90

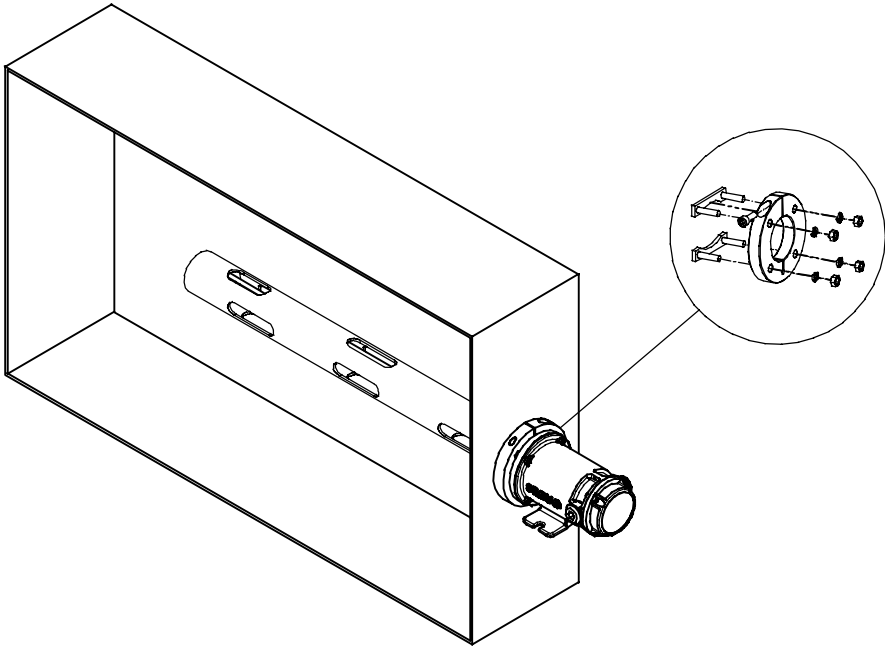
Recommended lower alarm level for Simrad GD10PE is 5%LEL, not lower than 3%LEL.

Various installation options are available – refer to attached pages:

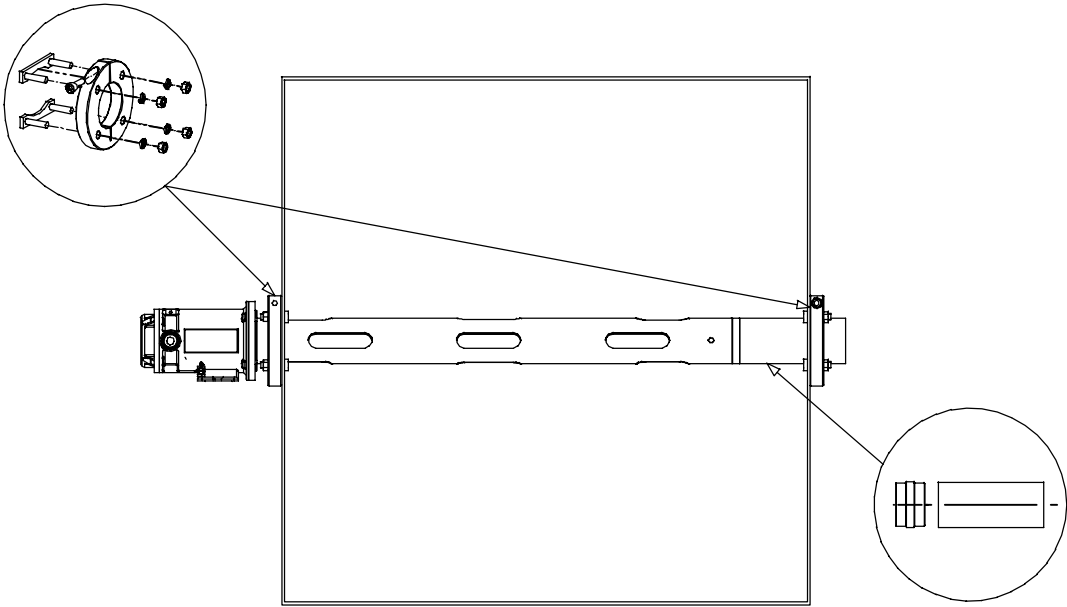


Point Extended IR in a Circular Duct





One-sided duct mounting using Mounting Flange Kit.



Dual side duct mounting using two Flange Mounting Kits and Extension Kit