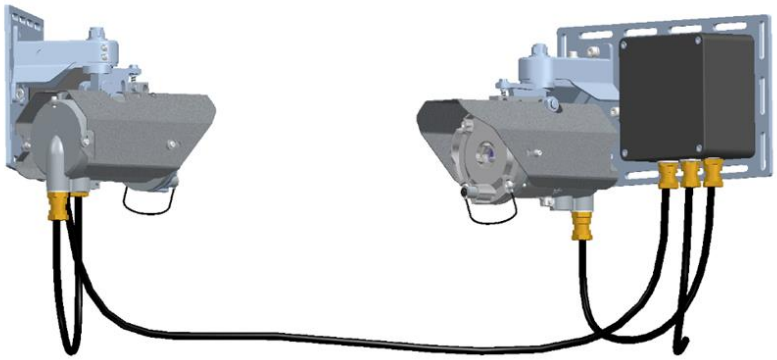
TELEDYNE
OLDHAM SIMTRONICS
Everywhereyoulook™

SAFETY MANUAL – GD1 TOXIC OPEN PATH DETECTOR



VALIDITY

This document is valid for the listed products:

Model								Description
GD1	-L0*	-31	**	-*	X	*	-A3	
	P	Transmitter and Receiver						
		31		H_2S				
			KH		0 – 200 ppm*m scale			
			KJ		0 – 500 ppm*m scale			
			KK		0 – 1 000 ppm*m scale			
			KL		0 – 2 000 ppm*m scale			
			KM		0 – 5 000 ppm*m scale			
			KN		0 – 10 000 ppm*m scale			
				0	Without display			
				1	With display on Transmitter and 4 holes on Junction Box			
				2	With display on Receiver and 4 holes on Junction Box			
				3	With display on both Transmitter and Receiver and 4 holes on Junction Boxes			
					X	SS316		
						H	4-20 mA source interface + HART®	
						J	4-20 mA sink interface + HART®	
							A3	Mark III

Table des matières

1. Introduction

This manual describes the safety related information for the installation, operation, configuration, and maintenance of the GD1 Toxic Open Path Detector.

For complete information regarding performance, installation, operation, maintenance and specifications of the GD1, please refer to the operating manual 850-816926.

2. Safety Messages

Procedures and instructions in this section may require special precautions to ensure the safety of personnel performing the operations. Information that raises potential safety issues is indicated by the word “Warning”. Always read and understand these safety messages.

3. Safety Function

The GD1 is a laser-based open path Gas Detector with a separate transmitter (TX) and receiver (RX). The TX emits infrared laser light detected by the RX. The detection principle is based on measuring the absorption of light by the gas molecules along the optical line-of-sight.

The GD1 is classified as Type B field device according to IEC61508.

The safety function of the GD1 is to:

- Provide a 4-20mA current output on Loop 1,2 and 3 that is proportional to gas concentration. The output is linear in the configured range where 4mA indicates low level and 20 mA indicates high level.
- Provide automatic internal diagnostics that detect potential problems with the detection functionality and report a failure on Loop 1,2 and 3.
  Fault levels are in the 0-4.0 mA current output range.

	Failure rates				
	SFF	λ_{SD}	λ_{SU}	λ_{DD}	λ_{DU}
GD1 Toxic Open Path Detector	91%	1140	212	2148	342

Table 1: Failure rates in FIT according to IEC 61508

Worst case diagnostic time interval for GD1 is 35 seconds.

Table below represents the analog output behavior:

Status	Output
No power	< 0.5 mA
Fault or Init mode (booting up)	1 mA
Beam bloc, alignment mode or service mode	2 mA
Early Dirty Optics Warning (90% signal reduction)	3 mA
Normal gas reading	4-20 mA

Table 2: Analogue Output Specifications

Warning

Please note that every application must be qualified by Teledyne Oldham Simtronics or a qualified distributor to verify that the GD1 is suited for the given safety application.

Warning

The safety function of the GD1 does not include:

- RS-485 Modbus communication
- HART communication

Warning

The monitoring device must be programmed to indicate a fault or overscale condition when current levels reach undercurrent (< 4mA) or overcurrent (> 20mA).

Warning

The GD1 analog signal output is not safety-rated during detector warm-up. Alternative means should be used at the jobsite to ensure facility safety during these activities.

4. Installation

For complete information regarding installation, please refer to the operating manual.

The GD1 Toxic Open Path Detector is intended for use in hazardous environments that may include explosive levels of flammable gases and vapors.
This product must be properly installed, operated and maintained. Improper installation or use could result in an explosion or fire resulting in death or serious injury.

Warning

- Do not open when energized.
- Detector must be properly installed and wiring compartment cover must be fully engaged to meet hazardous area explosion-proof/ non-incendive requirements.
- Before connecting a HART field communicator to the GD1 Toxic Open Path Detector in a potentially explosive atmosphere, make sure the field communicator is suitable and approved for use in the specific area.

5. Common Misuse Scenarios

Refer to the Installation, Commissioning and Maintenance sections of the operating manual for information on avoidance and resolution of common misuse scenarios.
No special application restrictions are necessary to meet the safety certification requirements.

6. Operation And Maintenance

Warning

All operation and maintenance procedures shall be performed by qualified personnel only.
Required maintenance training must be obtained from Teledyne Oldham Simtronics SAS or a Teledyne Oldham Simtronics SAS certified distributor.
For complete information regarding operation and maintenance, please refer to the operating manual.

6.1. Start up and diagnostic check

The GD1 may use up to 5 minutes during start up to perform necessary diagnostics checks. During this start-up and diagnostics check period, the current Loop1, 2 and 3 will be at 1mA.

6.2. Fault indication

The GD1 will signal a fault situation on the current loop outputs with a value below 3.5mA (see table on section 3-Safety Function for more details).

Warning

If any fault indication occurs, maintenance action must be taken. Operation after a fault indication might cause the detector to report wrong gas concentration that can cause damage to equipment and/or death or serious injury to personnel.

6.3. Troubleshooting

Troubleshooting should always start by inspecting the detector's lenses for contamination and/or defects. The following list may be helpful.

Issue	Possible source of problem	Suggested correction
Clean optics warning (3 mA)	Dirt on lens.	Clean optics
	Detector out of alignment.	Realign detector
Beam block (2 mA)	Dirt on lens.	Clean optics
	Detector out of alignment.	Realign detector
	Objects that block the measuring path.	Remove objects that block.
	Detector in alignment or service mode	Reboot detector by Service Interface (Ethernet), HART®, or by cutting/reconnecting power.
Fault (1 mA)	Check error code in the Service interface Status screen.	See section 6.4 - Error codes for a description and suggestion on how to solve the issue.
No Power	No power to the detector.	Verify with multi meter in the Junction box that detector has power.

Issue	Possible source of problem	Suggested correction
(0 mA)		Check both detector and system cable wires on terminal 1 and 2 in the junction box.
No wireless or cable Ethernet connection	Not connected to network	Make sure your browser is connected to the GD1 wireless network.
	Loose connector	Check that the terminal adapter is securely connected to terminals 3 – 6
	Loose wire in Junction Box	Check terminals 3 – 6. Unscrew each wire, both internal and external wiring to the terminals, and ensure wires are properly connected to the terminals.
No Ethernet cable connection	Fault on cable	Check cable.
	Device not set up to connect to fixed IP address	Configure laptop network settings to connect using static IP.
	Fault in detector	Contact TELEDYNE OLDHAM SIMTRONICS.
Fluctuating H_2S level	Noisy signal	Tune alignment as described in section 6.2 of operating manual
	Interfering detector	See section 6.3 of operating manual
Other error	Check error code in the Web Service or by HART®.	See section 6.4 - Error codes for a description and suggestion on how to solve the issue.
		Note! After solving an issue the Error code might still be displayed for some time.
Absolute transmission not as high as expected during alignment	Dirty optics	Clean optics
	Alignment of TX not optimum	Perform tuning of TX as described in section 3.3 of operating manual
	Alignment of RX not optimum	Perform tuning of RX with the same method as for TX described in section 3.3 of operating manual
	Laser beam obstructed by an object	Move the obstructing object or the GD1.

GD1 gas detector requires additional testing to be performed.

6.4. Error codes

Error #	Description	Action
1-4	Only relevant for vendor.	Contact TELEDYNE OLDHAM SIMTRONICS.
5	Issue with communication between TX and RX.	Check wiring. See actions on error 22.
6-7	Only relevant for vendor.	Contact TELEDYNE OLDHAM SIMTRONICS.
8	Issue booting up the receiver.	Check wiring. See actions on error 22.
9-13	Only relevant for vendor.	Contact TELEDYNE OLDHAM SIMTRONICS.
14	Beam block. Possibly laser from TX is obstructed by an object or alignment need to be improved.	Remove blocking object or improve alignment.
15	High transmission. Relative transmission >125%.	Redo alignment. Make sure lenses are clean before aligning
16	Timeout. Initialization took too long time.	Reboot the detector. Contact TELEDYNE OLDHAM SIMTRONICS if Error persists.
17	Unable to track the CO_2 line	Too short path length. Distance between TX and RX shall be 5 meters or more.
	Not able to find the CO line during CO verification.	Contact TELEDYNE OLDHAM SIMTRONICS.
18-21	Hardware error.	Contact TELEDYNE OLDHAM SIMTRONICS.
22	No contact with RX. Possible poor electrical connection in the Junction Box or no power at RX.	Check power on RX. Check wiring on terminals 1, 2, 11, 12 in both TX an RX Junction Box.
23-31	Hardware error.	Contact TELEDYNE OLDHAM SIMTRONICS.
32	Laser temperature too high. The detector might be too hot for the laser to start up.	Disconnect power, cool down the detector and reboot.
33-40	Software error.	Restart the detector by turning power off and on again. If problem persists please contact TELEDYNE OLDHAM SIMTRONICS.

6.5. Proof testing

Manual tests must be done periodically in order to check the safety function of the detector.

Proof test	Section	Applicable configurations
Current loop failures	6.5.3	All configurations
Gas response/Functional tests	6.5.2 and 6.5.4 and 6.5.5	All configurations
Verification of the span cell performance	6.5.6	All configurations

Table 3: Summary of proof test usage

By performing these proof tests, the Proof Test Coverage (PTC) is 79.5%

6.5.1. Cleaning of optical surfaces

1. Inhibit fault response at the control device.
2. First remove dust, sand, or other hard minerals using a soft brush or cloth, bulb blower or dry and clean compressed gas or air. If using a compressed air gun or a cloth, use it very lightly.
3. Spray the lens with a dilute solution of mild (dishwasher) detergent and water. It is a good idea to first spray richly and let the cleaner dissolve some dirt and let it drop off naturally. Repeat if necessary. If the dirt is still sticking a stronger solvent might be required, a 1:1 mix of isopropyl alcohol and water can be used.
4. Wipe the lens lightly and carefully with a clean microfiber cloth or a lens cloth, repeating step 2) and 3) until the surface is clean. Cotton swabs / Q-tips can be used as an alternative.
5. Rinse with water and wipe dry.
6. Do not touch the lenses with your fingers.
7. Re-activate fault response at the control device.

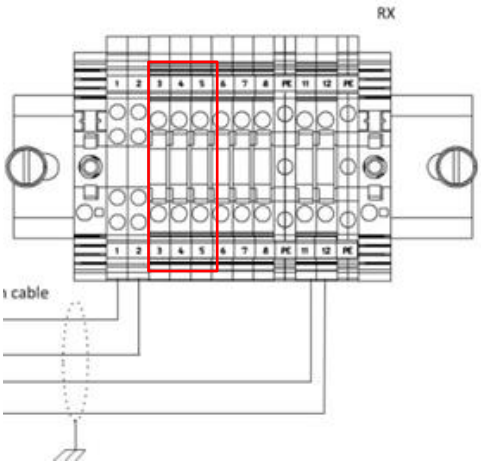
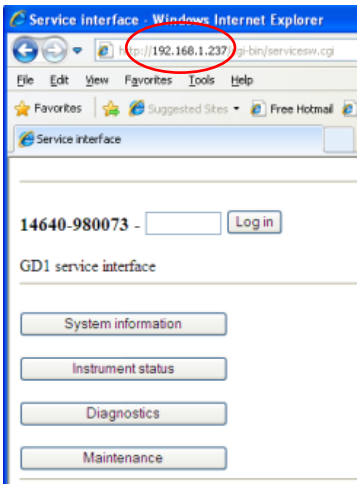
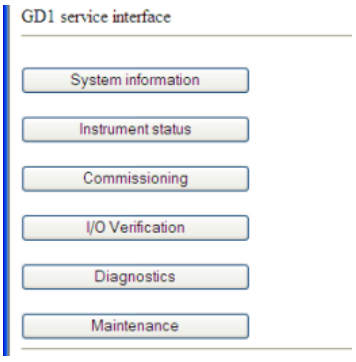
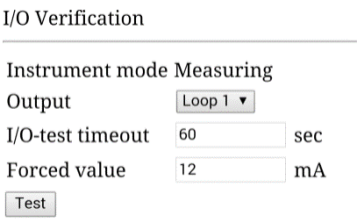
For difficult contaminants the optics can be cleaned with an equal-part mixture of isopropyl alcohol and water. Do not perform any testing of the detector before this solution has dried and residues have been wiped away.

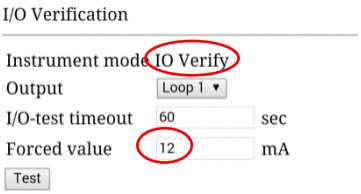
6.5.2. Visual Field inspection and Beam block test

It is possible to take advantage of the visual field inspection test to also perform function test of the detector.

1. Inhibit fault response at the control device.
2. Block the optical path between the transmitter and the receiver
3. Observe the effect on the detector 4-20 mA analogue output or through the control system. Analogue output should be fault current.
4. Unblock the optical path and proceed to the cleaning of the lens and the mirror.
5. Re-activate fault response at the control device.

6.5.3. Performing loop test

#	Description	Illustration
1	On the transmitter, connect the Ethernet adapter to the Junction Box terminals 3 - 6.	
2	Use a device having Web browsing capabilities, for example laptop, to connect with the wireless router or Ethernet cable. If using the wireless router, from your device connect to the network SSID: “GD1” In the web browser of your device, enter the GD1 Service Interface on the address http://192.168.1.237	
3	Log into the Service Interface with the Operator password: "gd1tlc" After logging in as Operator more functions are accessible as illustrated in the right image.	
4	Run loop testing in the Web interface "I/O verification" screen. Recommend to use at least 60 sec test time. Enter forced value. For example 12 mA is 50% of full scale.	

#	Description	Illustration
5	When clicking “Test” the test value will be forced on the 4-20 mA Loop1 terminal (terminal 7 in the GD1 Junction Box). Verify that the analogue output matches the test value.	

6.5.4. H2S Gas response test

In order to perform function test of the detector, a test with an H2S filled cell can be made.
This is a simple test to verify the main function of the detector. As long as the detector responds to the gas, the function of the detector is verified.

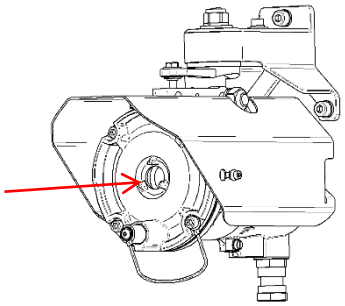
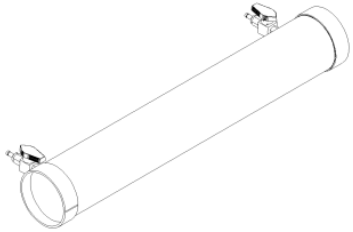
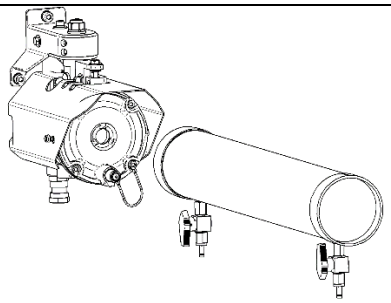
⚠ Any external alarm equipment, systems or signaling devices that could be automatically initiated by performing this test must be disabled or bypassed before performing this test!

☣ When working with Hydrogen Sulphide (H_2S) gas, observe the following:

- H2S is very toxic by inhalation
- Handle and use only in a well-ventilated space

In case of accident or if you feel unwell, seek medical advice immediately.

⚠ Read and understand the filling and discharging instructions before using the Test Cell (refer to the operating manual).

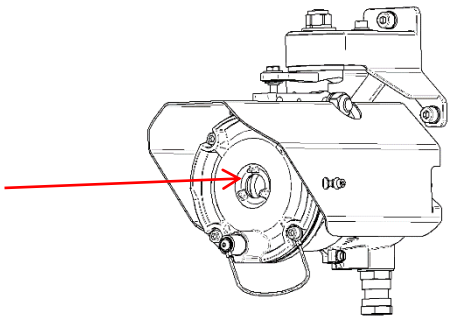
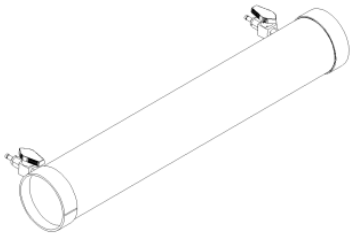
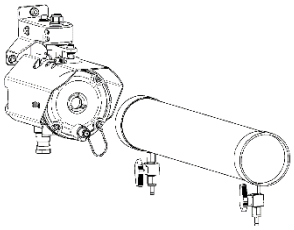
#	Step description	Illustration / response
1	Clean the lenses on the TX and RX.	
2	Fill the Test Cell as described in the operating manual.	
3	Position the Test Cell in front of the receiver (RX) as indicated in the figure.	
4	Verify the 4 – 20 mA output. The output should change according to the length of the Test Cell **multiplied** with the gas concentration. The table below contain some typical values	Expected output value (ppm*m): **<length> * <concentration>**
Note! Depending on the precision of the gas mix inside the Test Cell, do not expect to see an exact 1:1 response compared to the test gas concentration.		

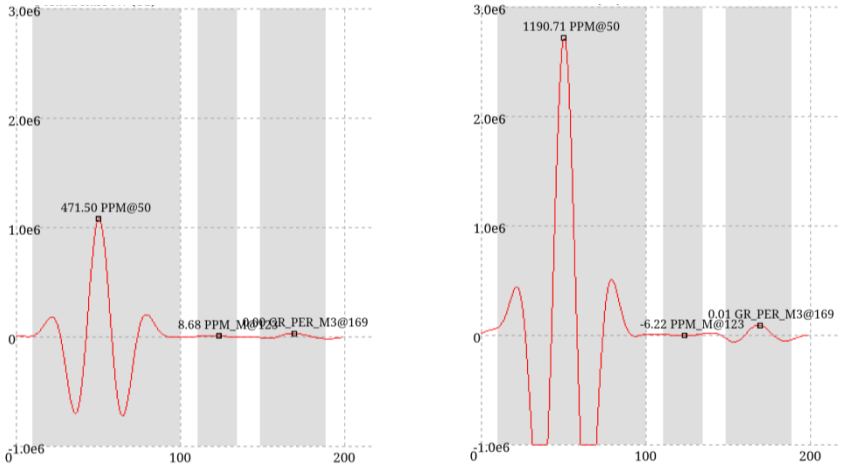
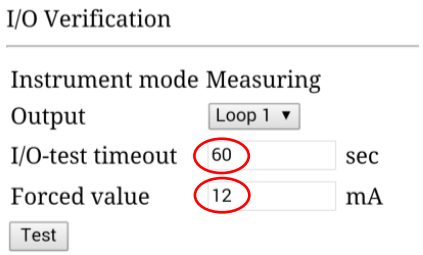
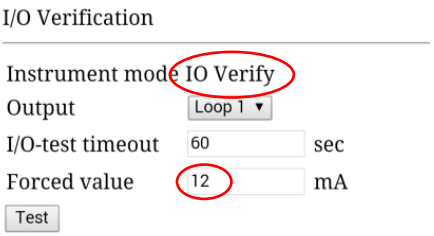
6.5.5. CO2 Gas response test

⚠ Any external alarm equipment, systems or signaling devices that could be automatically initiated by performing this test must be disabled or bypassed before performing this test!

As a non-toxic alternative to using H_2S for the functional test, the GD1 is also set up to look for a peak in the CO_2 wavelength. This response, however, is only available using a Web terminal through the service interface. The CO_2 measurement is not available on the 4-20 mA analogue output.

Connection to the GD1 web interface is described in the operating manual 850-816926 (section 6.4).

#	Step description	Illustration / response
1	Clean the lenses on the TX and RX.	
2	Fill the Test Cell with CO_2 instead of H_2S. Recommended CO_2 test gas concentration is 10 000 – 100 000 ppm (1 %vol - 10 %vol).	
3	Position the Test Cell in front of the receiver (RX) as indicated in the figure.	
4	Verify the response in the GD1 spectrum. The output should change according to the length of the Test Cell **multiplied** with the gas concentration. Below is an example with 40000 ppm CO_2 filled into the Test Cell by breath.	Expected output value (ppm CO_2): $\frac{C_{cell} * 0.54 + C_{air} * Path\_length}{Path\_length}$ Where C_{cell} and C_{air} is the CO_2 concentration in respectively the Test Cell and air.

#	Step description	Illustration / response
		
The above spectrum is found in GD1 Web interface. Spectrum to the left showing 472 ppm of CO_2 in the air. To the right a spectrum showing 1 191 ppm as a result of introducing the Test Cell filled with 40 000 ppm CO_2.The value can be verified by using the formula in step 4.		
Note! Depending on the precision of the gas mix inside the Test Cell, do not expect to see an exact 1:1 response compared to the test gas concentration.		
5	Run loop testing in the Web interface "I/O verification" screen. Recommend to use 60 sec test time. Enter test value. For example 12 mA is 50% of full scale.	
6	After the GD1 goes into "IO Verify" mode, verify that the analogue output matches the test value.	

6.5.6. Verification of the span cell performance

An internal sealed span cell is a sealed glass cell containing a sample of the target gas or a replacement gas absorbing in the same spectrum as the target gas mounted onto a servo motor. For all the GD1 H2S detector, this span cell is filled with CO (carbon monoxide).

⚠ Any external alarm equipment, systems or signaling devices that could be automatically initiated by performing this test must be disabled or bypassed before performing this test!

1. Go to “Instrument Status” in the service interface.
2. Note the readings of the Digital outputs (“Transmission” and gas reading)
3. Press the button “Toggle span mode” and note if there are any changes in the Digital output readings.
4. You should see a drop in “Transmission” and an increase in the gas reading.

⚠ If no shifts in the readings are observed, either the servo motor or the ISSC itself is defective.

The span cell will automatically toggle back after 30 seconds. This is to avoid the cell to be accidentally left in the optical path.

7. Certification

The GD1 has been certified according to ATEX Directive 2014/34/EU and IECEx scheme.

8. Marking

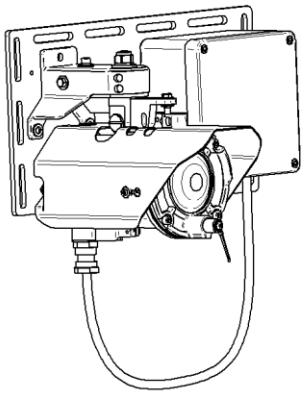
The GD1 product identification labels are shown in the figure below. The composition of the labels is in accordance with ATEX Directive 2014/34/EU.

Please refer to the operating manual for more information on the identification labels.

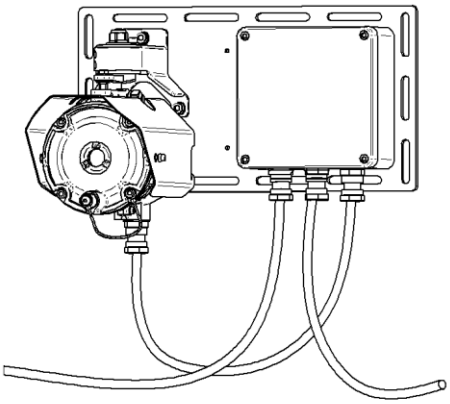
9. Product description

9.1. Instrument description

RECEIVER



TRANSMITTER



The complete GD1 system consists of a TX (transmitter) sending a laser beam to the RX (receiver). Communication to control room and power to the GD1 is connected to the TX. Between the TX and RX there is a cable with communication and power.

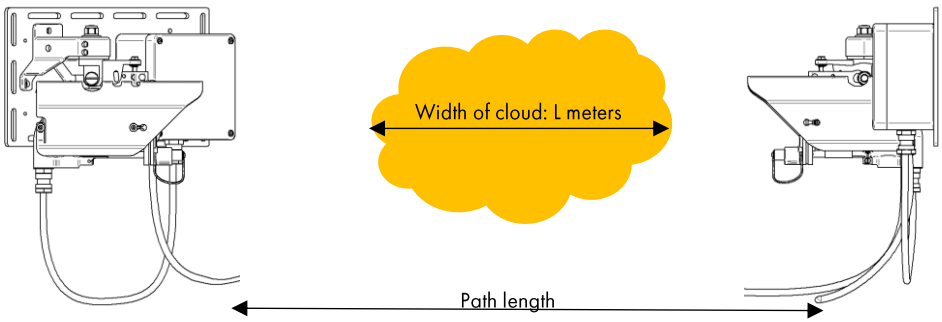
The TX unit contains the laser module with the temperature stabilized diode laser, collimating optics, and the main electronics in an explosion proof stainless steel housing.
The TX comes complete with the TX and junction box mounted on a backing plate.

The RX unit contains a focusing lens, the photo detector, the sealed span cell and the receiver electronics in identical explosion proof stainless steel housing.
The RX comes complete with the RX and junction box mounted on a backing plate.

Connection for power and optional inputs and outputs, analogue and digital, are made inside the connection box.
The TX and RX communicate on a data link (cable).

9.2. Measuring principle

Unlike a point detector, the GD1 Open Path Detector will not measure the concentration of the gas in the path between transmitter and receiver. The GD1 measures the total amount of H_2S in the path and the value returned by the GD1 is in ppm*m. Below are three examples with calculations on what value is expected on the GD1 for different gas clouds.



The drawing above illustrates a GD1 positioned with a gas cloud from a H_2S drifting into the laser beam of the GD1. The average concentration of the gas cloud is C ppm H_2S. The width of the gas cloud is L meters where the beam is crossing. If the path length is smaller than the gas cloud, the distance L will be equal to the path length. For the gas cloud in this example, we would expect the following signals from the GD1:

Example 1 - gas cloud characteristics: C = **5 ppm; L = 15 meters**
Expected measurement of the GD1 = C * L = 5 ppm * 15 m = 75 ppm*m

Example 2 - gas cloud characteristics: C = **10 ppm; L = 15 meters**
Expected measurement of the GD1 = C * L = 10 ppm * 15 m = 150 ppm*m

Example 3 - gas cloud characteristics: C = **150 ppm; L = 1 meters**
Expected measurement of the GD1 = C * L = 10 ppm * 15 m = 150 ppm*m

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Observation 1! Same cloud size will give same measurement irrespective of path length (this provided that the gas cloud is smaller than the path length).

Observation 2! If cloud size is known, the average cloud concentration can be calculated by dividing the ppm*m measurement with path length. This can typically be done only if a spreading analysis shows that the cloud always will cover the whole path length between the TX and RX, for example if the GD1 is placed sufficiently far from the leak point.

Observation 3! Example 3 shows that different cloud can give same measured value. Therefore the GD1 is typically used as a “safe fence” around an installation to signal if there is an abnormal and potentially unsafe situation, and not to measure the actual concentration of the gas.

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10. Technical specifications

Table 1 lists specifications for the GD1 Gas Detector. For a complete list of specifications, please refer to the operating manual.

Operating Manual	850-816926
Operating Temperature Range	-55°C to +65°C
Humidity Range	100% RH uncondensed
Input Voltage	18 to 32 VDC, max 15W
Ingress protection	IP66 / IP67 IEC 60529
Laser class	Class 1 according to IEC 60825-1, eye safe
Analogue outputs	Three current loop outputs Factory configurable active and passive loop

Table 4 : Environmental/Electrical Specifications