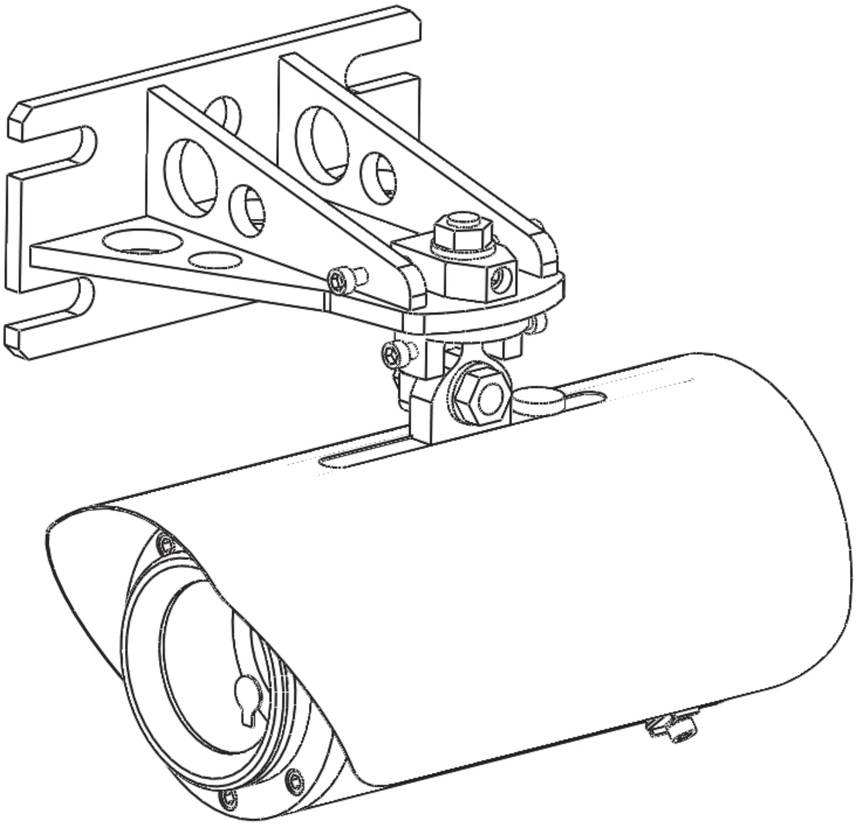

Operating Manual

Senscient ELDS™ 1000 / 2000 Series

Open Path & Cross Duct Gas Detectors

A-5170-0 / Rev 18

Read and understand this Instruction Manual before installing, operating or servicing ELDS 1000 / 2000 Series OPGD systems.

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Safety

Ensure that you read and understand these instructions **BEFORE** operating the equipment.
Please pay particular attention to the safety Warnings / Special Conditions of Safe Use.

Warnings / Special Conditions of Safe Use

WARNING

1. The Senscient ELDS™ 1000 / 2000 Series gas detectors are Baseefa ATEX certified for use in Hazardous (Explosive) Atmospheres; and CSA(UL) certified for use in Hazardous (Classified) Locations/Zones.
2. For installations in Europe (ATEX Certified) install in accordance with IEC/EN60079-14.
3. For installations in North America and Canada install in accordance with ANSI/NFPA 70, the Canadian Electrical Code C22.1 and the manufacturer's instructions.
4. Elsewhere, the appropriate local or national regulations should be used.
5. ELDS™ 1000 / 2000 Series gas detectors must be properly earthed / grounded to protect against electrical shock and minimise electrical interference. Internal and external equipotential bonding facilities are provided for this purpose. For electrical installation design considerations refer to section 3.3.
6. Operators must be fully aware of the action to be taken if the gas concentration exceeds an alarm level.
7. ELDS 1000 / 2000 Series gas detectors do not contain any parts that can be replaced or repaired by customers. If units require repair they must be safely removed from any hazardous location / area in which they are installed, and returned to Senscient. Other than the rear cover providing access to the terminals for connection purposes, the units are not intended to be opened during operational service.
8. Test gases may be toxic and/or combustible. Refer to Material Safety Data Sheets for appropriate warnings and handling procedures / precautions.
9. Do not drill holes in any housing as this will invalidate the explosion-proof protection.
10. In order to maintain electrical safety, units must not be operated in atmospheres with more than 21% v/v oxygen.
11. Ensure that the bolts which secure the front flameproof enclosure are fully tightened. The securing bolts are stainless steel M5 X 16mm socket head cap screws grade A4-70. To ensure replacement suitability contact Senscient or their approved agent/distributor.
12. Do not open the enclosure in the presence of an explosive atmosphere. Keep cover tight when energised
13. The apparatus is certified for use in Hazardous Areas at atmospheric pressures not exceeding 1.1 bar (16 psi).
14. Install only in environments with ambient temperature ranges of -40°C to +60°C.
15. For Europe (ATEX), apparatus incorporates an integral threaded cable entry (M25 x 1.5). Terminate cable only with a suitable equipment certified ATEX cable gland (not a component). To maintain water and dust ingress protection seal threads with suitable non-hardening sealant as described in IEC/EN 60079-14.

    Note: See control drawing for product specification allowing selection of cable glands.

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WARNING

16. For US/Canada the apparatus incorporates an integral threaded conduit entry (3/4”-14TPI). Install a conduit seal within 18 inches. In order to maintain ingress protection seal threads with a suitable material e.g. a non-hardening thread sealant or PTFE tape etc. See control drawing at the end of this manual.
17. For all installations use cable / conductors rated for service at temperatures ≥ 85°C
18. At all times during transit, installation and commissioning protect lens from accidental direct mechanical impact. Use Senscient OEM supplied packaging during transit.
19. The Transmitter and Receiver units must be mounted horizontally and protected from impact i.e. do not mount at floor level or in areas where moving vehicles, personnel or loads may be of concern regarding impact.

CAUTION

1. Use only approved parts and accessories with the Senscient ELDS™ 1000 / 2000 Series gas detectors.
2. To maintain safety standards, commissioning and regular maintenance of ELDS™ 1000 / 2000 Series gas detectors should be performed by qualified personnel.
3. Transit cases for the alignment telescope and gassing cell are manufactured from non-antistatic materials, and may, under certain circumstances become an electrostatic risk. It is the user’s responsibility to take adequate precautions during transportation and use if taken into hazardous areas.

Important Notices

1. Senscient Ltd. can take no responsibility for installation and/or use of its equipment if this is not done in accordance with the appropriate issue and/or amendment of the manual. The purchaser should make Senscient aware of any External effects or Aggressive substances that the equipment may be exposed to.

2. The user of this manual should ensure that it is appropriate in all details to the exact equipment to be installed and/or operated. If in doubt, the user should contact Senscient Ltd. for advice.

3. Effect of explosive atmosphere on materials.
   The Senscient ELDS™ 1000 / 2000 Series is manufactured from materials which exhibit good resistance to corrosive substances and solvents. The Ex d enclosures are made from 316L stainless steel and the explosion protected windows are made from robust and chemically inert glass. Senscient are not aware of any significant effects of explosive atmospheres upon these materials. The purchaser should make Senscient aware of any External effects or Aggressive substances that the equipment may be exposed to.

4. The final and long term effectiveness of any Gas Detector depends heavily upon the user, who must be responsible for its proper application, installation and regular maintenance.

Senscient Ltd. reserves the right to change or revise the information supplied in this document without notice and without obligation to notify any person or organisation of such revision or change.

If further details are required that do not appear in this manual, contact Senscient or one of their agents. Senscient will supply this manual in other languages of the European Union (countries covered by the ATEX directive) upon request.

Help Us to Help You

Every effort has been made to ensure the accuracy in the contents of our documents. However, Senscient can assume no responsibility for any errors or omissions in our documents or their consequences.

Senscient would greatly appreciate being informed of any errors or omissions that may be found in our documents. To this end we request that if you believe there are any errors or omissions, please send us an e-mail at info@senscient.com describing the error or omission, so that we may take the appropriate action.

Contents

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1. Introduction

The Senscient ELDS™ 1000 / 2000 Series is a range of open path, flammable and / or toxic gas detectors that is currently available in the following versions.

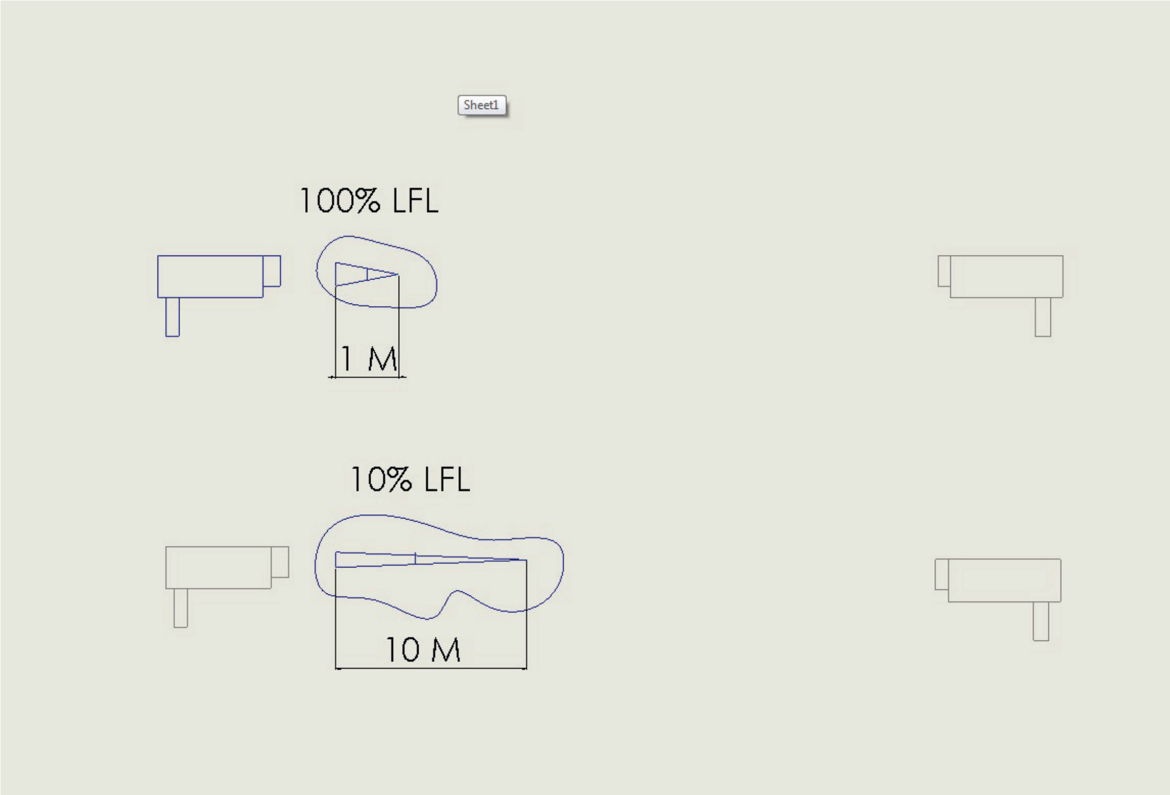
- Senscient ELDS™ Series 1000 CH_4 - Methane Detector
- Senscient ELDS™ Series 1000 Ethylene, HF, HCl, NH_3 or CO_2 Detectors
- Senscient ELDS™ Series 1000 XD – Cross Duct Methane Detector
- Senscient ELDS™ Series 2000 H_2S - Hydrogen Sulfide Detector
- Senscient ELDS™ Series 2000 CH_4 + H_2S - Simultaneous Methane & Hydrogen Sulfide Detector

The Senscient ELDS™ Series 1000 detector consists of a Transmitter unit that sends an infrared laser beam to a separate Receiver unit that can be installed on a line-of-sight at a distance of up to 200m. The ELDS 1000 Series CH_4 detector can be located where there is a risk that a leak of flammable methane gas may occur, to provide a rapid, early warning of such a hazard. The ELDS™ 2000 variants are similar, except that there are two coinciding infrared laser beams, which can either be used to detect two or more gases, or to detect a single, difficult gas with high sensitivity (e.g. Hydrogen Sulfide).

All ELDS™ gas detectors operate on the principle of absorption of infrared laser light. Gases absorb light at specific wavelengths depending on their molecular composition. Hydrocarbon gases such as methane and ethylene absorb in the infrared region of the spectrum. If a cloud of target gas is present, the specific wavelengths of the infrared laser light output by the ELDS™ Transmitter are absorbed by the gas, introducing Harmonic Fingerprints onto the signals reaching the Receiver that are proportional to the amount of gas in the beam.

The Senscient ELDS™ Transmitter unit produces the precisely controlled infrared laser light required to detect the target gases; whilst the Receiver unit contains an infrared detector and advanced signal processing electronics which look for the Harmonic Fingerprint produced by the presence of target gas in the beam-path. Each unit is housed in a robust 316L stainless steel housing. The Receiver features two 4 - 20mA analogue outputs which are used to signal the quantity of each target gas measured in the beam-path, for example 0-1LFL.m CH_4 and 0-250ppm.m H_2S for the Series 2000 detector. These outputs provide a linear relationship with the measured gas burden.

Note that open path detectors do not measure the point concentration of the target gas(es), rather they measure the integrated concentration over the length of the measurement path between the Transmitter and Receiver units. This means that the probable size of a gas cloud must be considered when estimating the concentration of gas that might be present, with alarm levels being set accordingly. The figures on the following page illustrate this.



Each of these different gas clouds will produce the same ELDS reading of 1.0 LFL.m, however only the 1st example where the gas cloud is very small actually has a potentially flammable concentration within it.

THE TRANSMITTED LASER BEAM IS CLASS 1 (EYE-SAFE) PER IEC 60825.

Senscient ELDS™ is designed for use in the most demanding environments/applications and provides a sensitive, fast and reliable response. The sophisticated ELDS™ open-path technology provides immunity to sunlight and minimises the effects of environmental factors such as rain, fog, ice, snow and condensation.

The Transmitter and Receiver units incorporate heated optics designed to minimise the build-up of humidity, condensation, snow or ice on the glass lens-windows that could otherwise obscure the optics in extreme conditions.

Both the Transmitter and the Receiver are microprocessor controlled with advanced self-diagnostics and fault finding facilities.

Local communication between an operator/technician and the gas detector system is provided via SITE (Senscient Installation & Test Environment) software running on an industrial computer, using an RS485 or Bluetooth™ wireless communication link to either the Transmitter or Receiver. SITE provides the user with a menu-style interface to select and invoke commands for commissioning and configuring the system; and for viewing the system status and readings.

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1.1. Information Notices

The types of information notices used throughout this handbook are as follows:

WARNING
Indicates hazardous or unsafe practice which could result in severe injury or death to personnel.

CAUTION
Indicates hazardous or unsafe practice which could result in minor injury to personnel, or product or property damage.

Provides useful/helpful/additional information.

If more information beyond the scope of this technical manual is required please contact Senscient.

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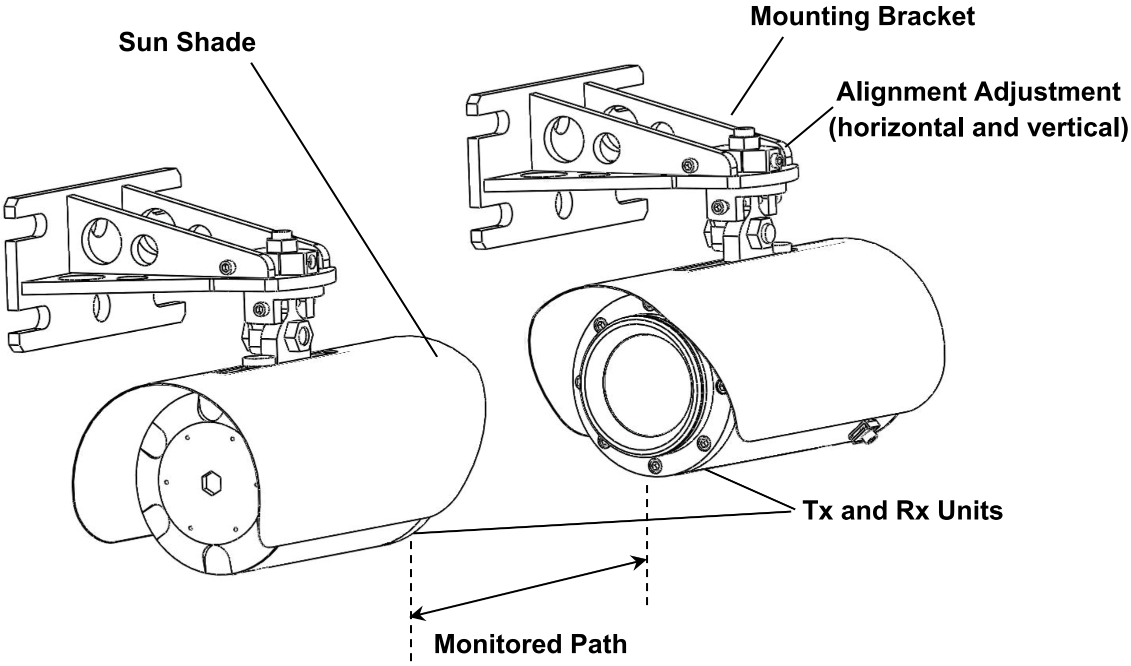
2. System Description

2.1. Introduction

Each Senscient ELDS™ 1000 / 2000 Series gas detector consists of two units, a Transmitter and a Receiver. This separate Transmitter / Receiver configuration provides the most reliable basis for open path gas detection. There are no transceiver units or retro-panels utilised in the Senscient ELDS™.



There are several operating ranges of Senscient ELDS™ gas detector, e.g.:

Series 1000	CH_4, 0 - 1000ppm.m, 0 - 1LFL.m, 0-5 LFL.m	5 - 40m
	CH_4, 0 - 1000ppm.m, 0 - 1LFL.m, 0-5 LFL.m	40 - 120m
	CH_4, 0 - 1000ppm.m, 0 - 1LFL.m, 0-5 LFL.m	120 - 200m
Series 2000	CH_4, 0 - 1LFL.m + H_2S, 0-250, 500, 1000, 15000ppm.m	5 - 60m
Series 2000	H_2S, 0-250, 500, 1000, 15000ppm.m	5 - 60m
Series 1000	XD CH_4 0 - 10%LFL, 0 - 25%LFL, 0 100%LFL	0.5 - 5m
Series 1000	Ethylene 0 - 1 LFL.m 0 - 10,000ppm.m	5 - 60m
	Ethylene 0 - 1 LFL.m 0 - 10,000ppm.m	40 - 120m
	Ethylene 0 - 1 LFL.m	120 - 200m
Series 1000	HF 0 - 25, 50, 200, 1000ppm.m	5 - 60m
	HF 0 - 50, 200, 1000ppm.m	60 - 120m
Series 1000	HCl 0 - 50ppm.m	5 - 60m
Series 1000	NH_3 0 - 1000, 5000, 15,000ppm.m	5 - 40m
	NH_3 0 - 1000, 5000, 15,000ppm.m	40 - 120m
Series 1000	CO_2 0 - 300,000ppm.m	5 - 40m
	CO_2 0 - 300,000ppm.m	40 - 120m

Refer to Senscient for additional ranges and gases.

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When designing an installation for Senscient ELDS™ 1000 / 2000 Series it is important that the correct range of the gas detector for each path to be monitored is selected and specified.

In order to avoid the problems associated with gas detectors being used beyond their specified ranges or when incorrectly aligned, a procedure within the Senscient Installation & Test Environment (SITE) checks for correct gas detector type, operating range and signal levels before allowing an ELDS OPGD to be commissioned.

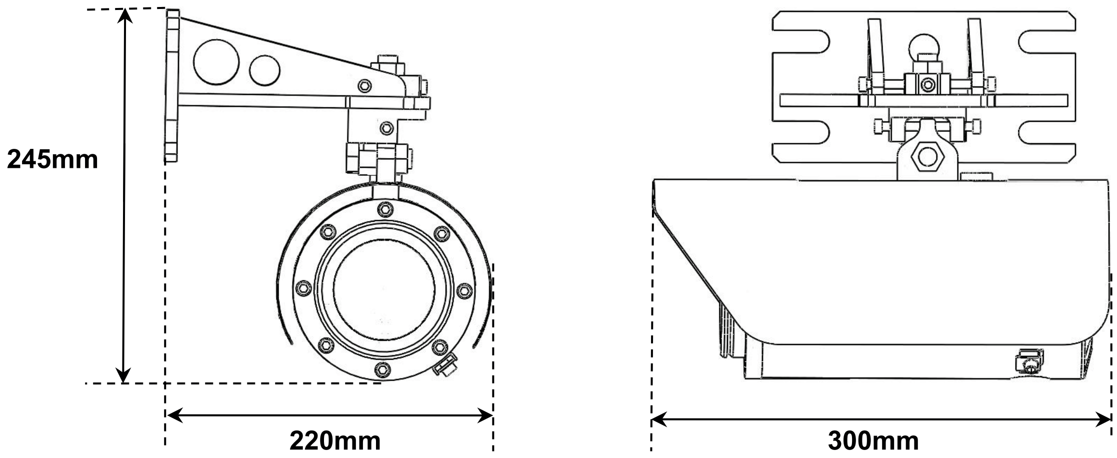
The Transmitter and Receiver are each mounted upon robust, adjustable mounting brackets. The design of the mounting and alignment arrangement for the Senscient ELDS™ 1000 / 2000 Series is highly accommodating, making it simpler to realise a good installation in a variety of locations and environments. Installation details are given in section 3.

2.2. Transmitter

The Senscient ELDS™ Transmitter produces up to two controlled-divergence beams of infrared laser light from solid-state laser diodes. The outputs from the laser diodes are partially collimated using a faceted lens, the facets of which introduce the controlled-divergence that is necessary to reduce system alignment sensitivity. The Transmitter operates continuously.

THE TRANSMITTED LASER BEAM IS CLASS 1 (EYE-SAFE) PER IEC 60825.

ATEX / CSA / UL



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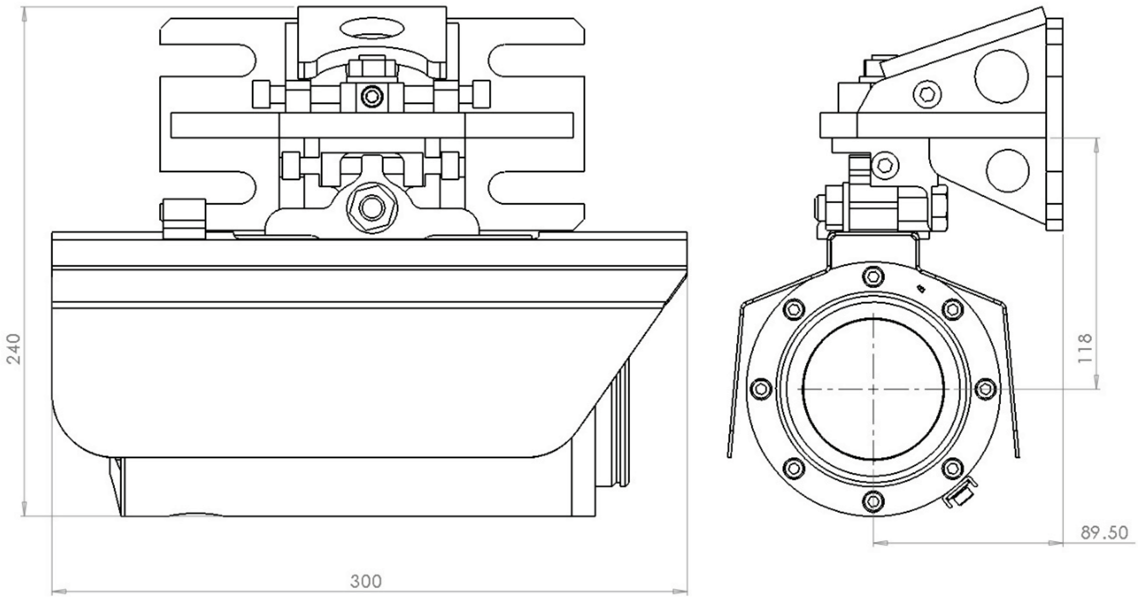


The Transmitter contains a small retained sample of the target gas(es) to be detected by the system; and uses this retained sample as a reference to maintain its laser diode(s) in Harmonic Fingerprint lock. By continuously maintaining Harmonic Fingerprint lock it is possible to be certain that whenever target gas(es) enter the system's beam-path this will introduce Harmonic Fingerprints onto the laser signal(s), which will be seen and measured by the Receiver. Maintaining Harmonic Fingerprint lock maintains detector calibration and ensures that SimuGas™ simulations faithfully simulate the presence of a pre-defined quantity of target gas(es) in the beam-path. This is the basis of the SimuGas on-demand functional test technology incorporated in Senscient's ELDS OPGDs.

The Transmitter also incorporates links which can be used to communicate with an industrial computer. Using SITE and these communication links, an industrial computer can be employed to perform alignment checks, commissioning, configuration, functional testing, diagnostic procedures and SimuGas™ tests.

The Transmitter window is heated to minimise condensation, frosting and the build-up of snow.

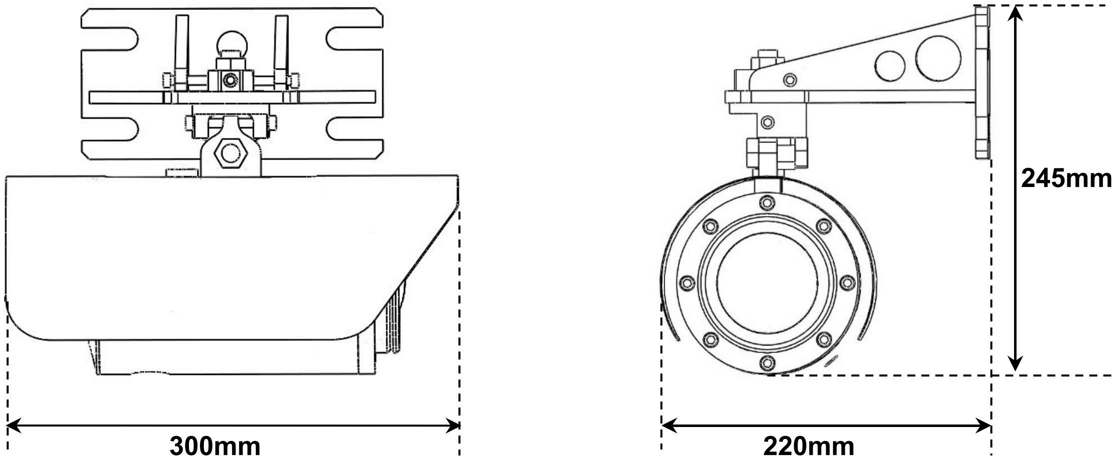
Three connections to the Transmitter are required, +24V, 0V and GND (for electrical safety).

2.3. Receiver

The Senscient ELDS™ Receiver collects infrared laser light from the Transmitter and determines the size of any Harmonic Fingerprint components that have been introduced onto the beam(s) to establish the quantity of any target gases present in the beam-path

The Receiver collects and concentrates infrared laser light from the Transmitter onto a single, infrared detector using an aspheric, condensing lens-window. The detector output is amplified and processed by a sophisticated electronic signal processing system which effectively removes any ambient light and extracts Harmonic Fingerprint information related to the quantity of target gas in the beam-path. The detector amplification chain incorporates an advanced Automatic Gain Control (AGC) system that enables it to compensate for the wide range of signal levels that can be received due to effects arising from rain, fog, snow, dirt etc. This enables the ELDS 1000 / 2000 Series to continue operating reliably in the harshest conditions that are likely to be encountered at Oil & Gas installations around the world.

ATEX / CSA / UL



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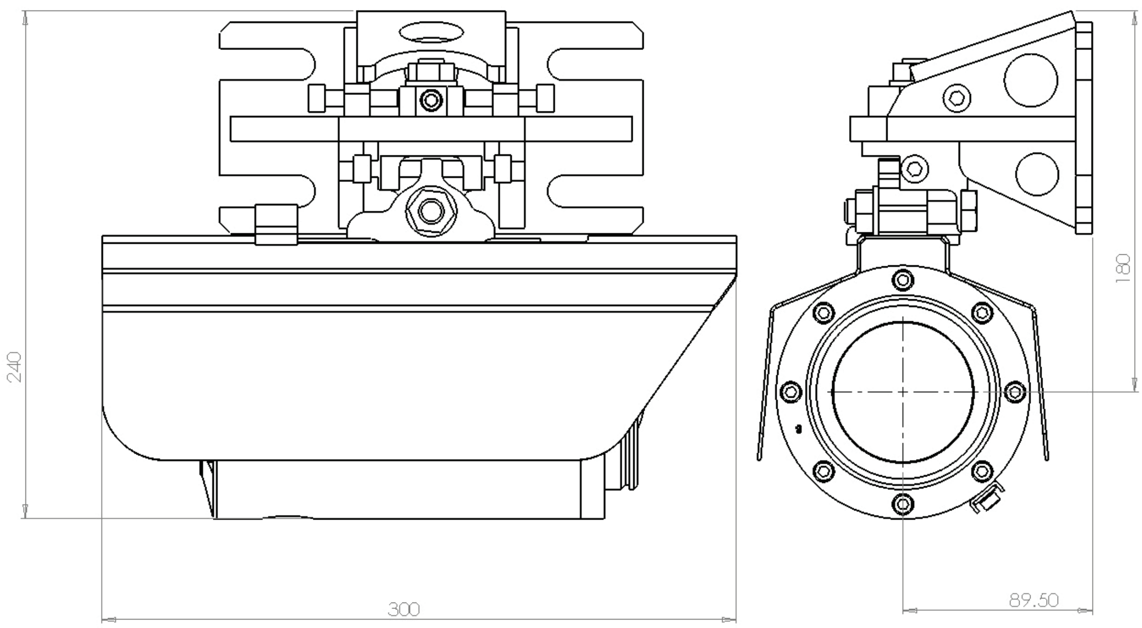


The solid state, InGaAs photodiode detectors used in the Senscient ELDS™ 1000 / 2000 Series provide an exceptional dynamic range and superb temperature and long term stability. These properties contribute significantly to the solar immunity and stability of the Senscient ELDS™ 1000 / 2000 Series.

The primary output(s) of the Receiver are two 4-20mA loop outputs which can be configured for source, sink or two-wire isolated operation. The outputs are factory calibrated to provide the appropriate full scale range for the measured species and model variant. The output is typically calibrated in units of LFL.m or ppm.m (see section 10.2 for the explanation of LFL.m and other terms).

The Receiver also incorporates links which can be used to communicate with an industrial computer. Using SITE and these communication links, an industrial computer can be employed to perform alignment checks, commissioning, configuration, functional testing, diagnostic procedures and SimuGas™ tests.

The Receiver window is heated to minimise condensation, frosting and the build-up of snow.

Between four and eight connections to the Receiver are required, depending upon the number and configuration of the 4-20mA outputs used. These connections are required to provide +24V, 0V, 4-20mA(1), 4-20mA(2) and GND (for electrical safety).

The ELDS system does not have any gas alarm set functions. The 4-20mA signal outputs from the Receiver are non-latching. If the ELDS system is intended to indicate a potentially flammable gas concentration then any auxiliary equipment (e.g. control room plc, control unit or monitoring apparatus etc.) shall have an alarm set point that is latching, requiring a deliberate action to reset. If two or more set or alarm functions are provided the lower may be non-latching.

2.4. Adjustable Mounting Bracket (ATEX / CSA / UL)

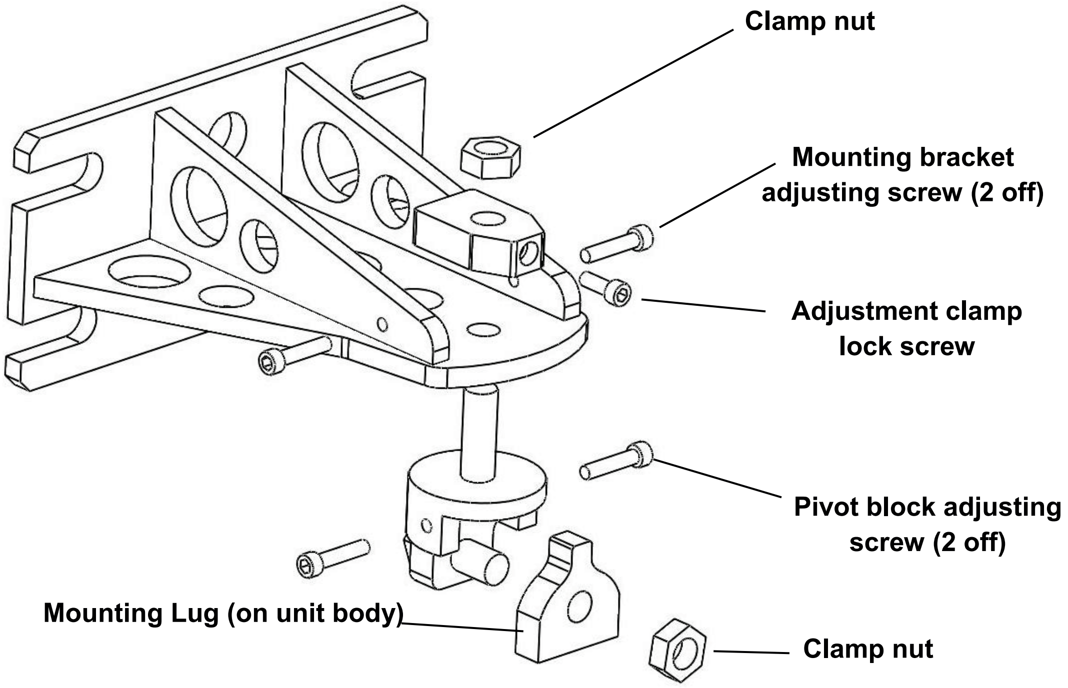
The adjustable mounting brackets for the ELDS 1000 / 2000 Series are:

- Purpose-built for the Transmitter and Receiver.
- Provide coarse and fine adjustment for quick, simple system alignment.
- Rigid, stable and robust.
- Made from 316L stainless steel.

The coarse horizontal adjustment facility enables a Transmitter or Receiver to be quickly pointed in the approximate direction of its counterpart and provides a full 360º of rotation. The fine horizontal adjustment facility enables a Transmitter or Receiver to be precisely aligned and locked-off with respect to its counterpart, and has an adjustment range of ±25º.

The fine vertical adjustment facility enables a Transmitter or Receiver to be precisely aligned and locked-off with respect to its counterpart and has an adjustment range of ±15º.

Alignment details are given in section 4.

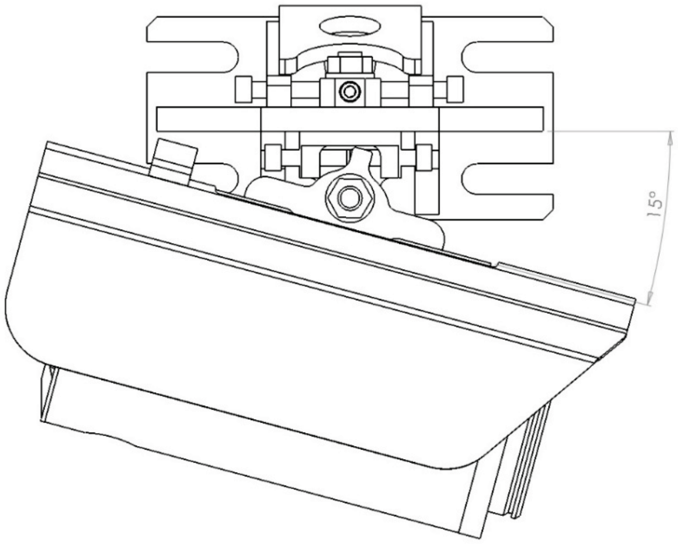


2.5. Adjustable Mounting Bracket (FM)

All FM Approved ELDS product variants are supplied with FM mounting brackets that have been engineered to tolerate the very high levels of vibration specified in FM 6325 2005.

The FM mounting brackets provide for coarse and fine alignment adjustments in both the vertical and horizontal axes.

The vertical adjustment range of the FM mounting bracket is +/-15°.



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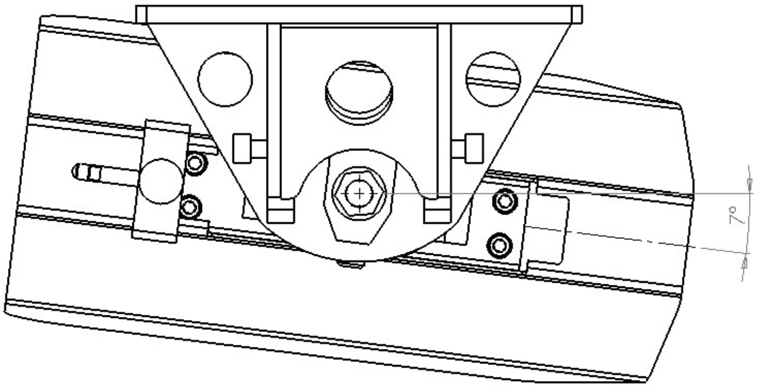
The horizontal adjustment range of the FM mounting bracket is +/-7°.



The limited horizontal adjustment range of the FM mounting bracket (+/-7°) means that care needs to be taken to ensure that the surfaces or poles upon which FM ELDS units are to be mounted will allow orientation of the horizontal axes of the units within the +/-7° adjustment range. Essentially, in the horizontal axis, FM ELDS units will need to be close to pointing at each other as-mounted; because large adjustments cannot be accommodated.

The limted horizontal adjustment range of the FM mounting bracket precludes mounting FM ELDS units with the back of the ELDS unit to the wall/pole and the beam firing away from the wall/pole.

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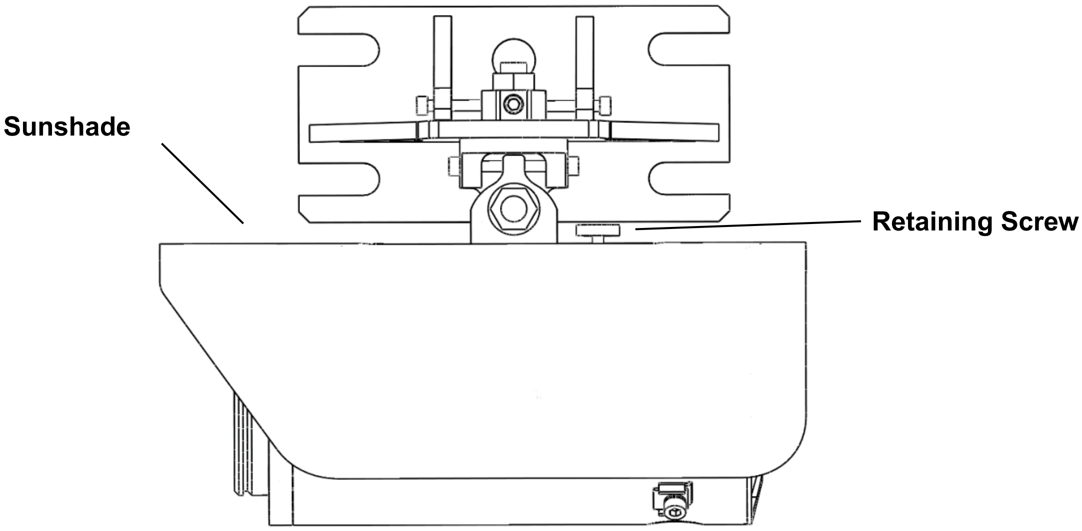
2.6. Sunshades

In order to provide Sun shading which is optimal for a wide range of operating climates, there are two sunshades available for use with ELDS™ units.

2.6.1 Standard Sunshade

The standard sunshade is suitable for use in cold, temperate and moderately warm climates; and is fitted along the mounting bar on the top of each ELDS™ unit. This sunshade's position is adjustable in order to facilitate use of the alignment telescope or provide easier access to the electrical connections inside the terminal compartment.



The standard sunshade is fixed by a single retaining screw as illustrated. Loosen this in order to allow adjustment of the position of the sunshade. Tighten the retaining screw to ensure that the sunshade remains in the desired position.

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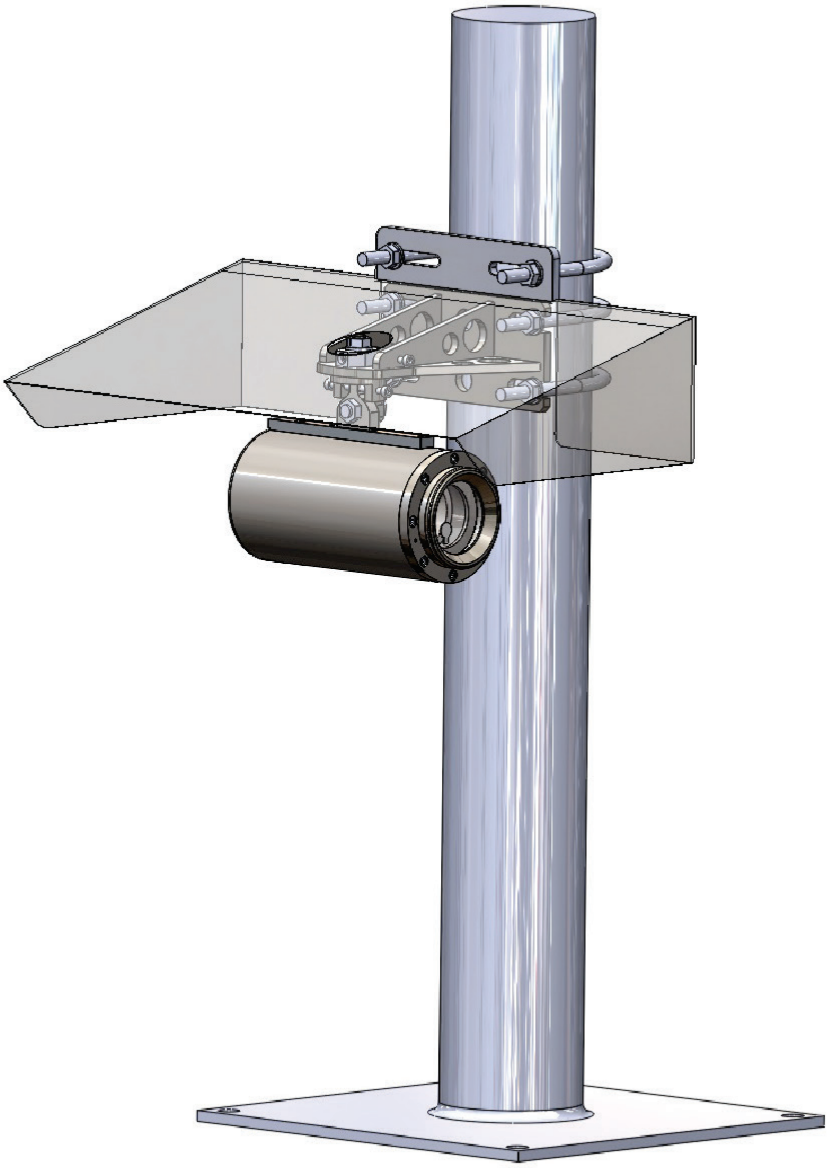
2.6.2 Enhanced Sunshade

The enhanced sunshade is designed for use in hot climates where intense, direct sunlight has the potential to significantly increase the operating temperature of ELDS™ units unless greater shading from solar radiation is provided. The enhanced sunshade is fitted above the mounting bracket, attached to the same pole, wall or mounting structure that the mounting bracket is attached to (see illustration below).



Depending upon the particular details of the installation, it may be necessary to temporarily remove the enhanced sunshade in order to gain access to the terminal compartment or use the alignment telescope. Make sure to re-fit the enhanced sunshade after completing any activities that temporarily require its removal.

2.6.3 Desert Mode

Where ELDS™ units are to be operated outdoors in very hot, dry conditions, the power dissipation and operating temperatures of Transmitter units can be beneficially reduced by configuring them to operate in Desert Mode.

When an ELDS™ Tranmsitter is configured for Desert Mode, the lens-window heater is turned off whenever the ambient air temperature is above +30°C. This reduces the Transmitter's power consumption by approximately 3W.

Desert Mode can be configured using SITE software (see section 2.7.6).

Desert Mode is specifically intended for use in hot, dry conditions. In such hot operating conditions, ELDSTM units will also benefit from being fitted with Enhanced Sunshades.

Desert Mode is only suitable for operation in hot, dry conditions where no additional heating of the lens-window will be required to prevent condensation. Desert Mode is not suitable for use in hot, humid conditions such as those found in the tropics. ELDS™ units that are to be used in humid or tropical conditions should not be configured for Desert Mode.

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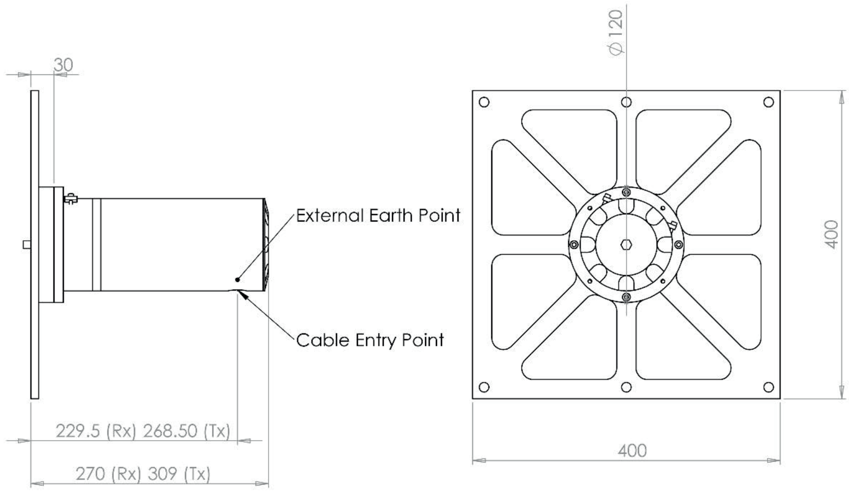
2.7. Cross Duct Mounting Plates

Cross Duct ELDS systems are designed to be mounted on the opposite sides of flat, parallel-walled ducts using one of three (3) available variants of Mounting Plate, or the standard Adjustable Mounting Bracket (ELDS VZ unit only).

The installation designer's attention is drawn to the fact that each Transmitter or Receiver unit of a Cross Duct ELDS system weighs approximately 10kg, which may be sufficient to cause unwanted bending of duct walls, especially if the duct walls are thin.

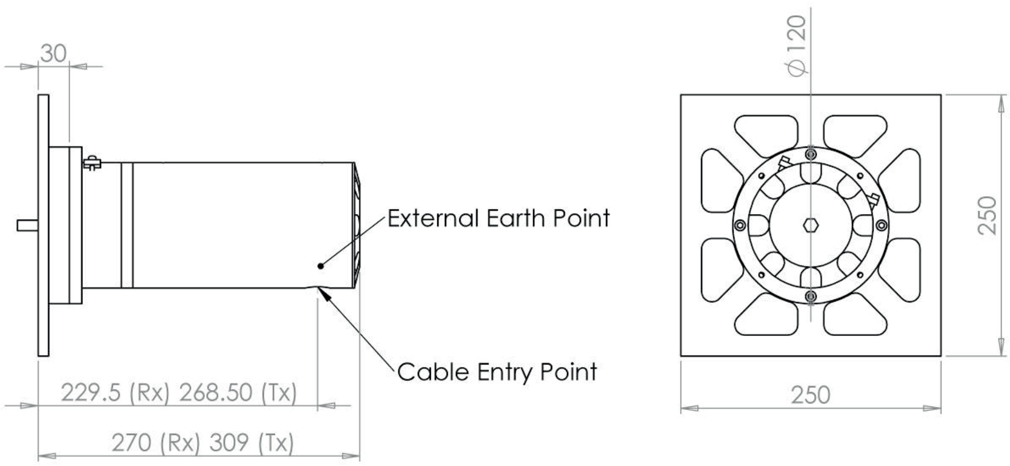
2.7.1 Standard Cross Duct Mounting Plate

The standard, 400mm x 400mm mounting plate substantially spreads the weight / load and provides localised reinforcement of the duct wall; and is therefore recommended for use wherever possible – and in particular on thin-walled ducts.



2.7.2 Small Cross Duct Mounting Plate

The small, 250mm x 250mm mounting plate is capable of being mounted on smaller ducts; but consideration needs to be given as to how the weight / load will affect the duct wall when units are so mounted. Local reinforcement / bracing of the duct wall may be required.



The installation Design Authority is responsible for ensuring that the method chosen for mounting Cross Duct ELDS units on the intended duct is sufficiently rigid and stable.

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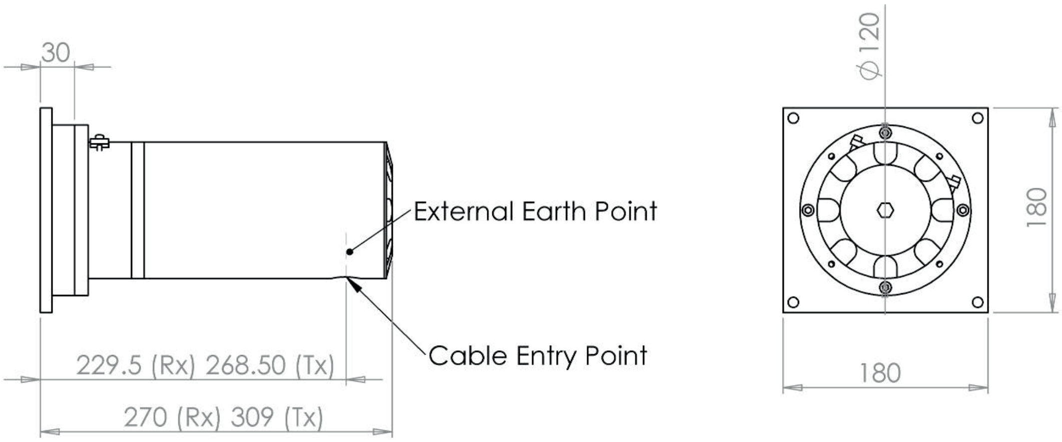
2.7.3 Retrofit Cross Duct Mounting Plate

The 180mm x 180mm retrofit mounting plate is capable of being mounted on the same mounting holes as an earlier generation of Cross Duct unit supplied by another manufacturer. There is a reasonable likelihood that mounting Cross Duct ELDS units on ducts using the retrofit mounting plate will cause bending of the duct wall. Consequently, this method of mounting Cross Duct ELDS units should only be considered for retrofit applications where it is impossible or impractical to engineer a superior mounting arrangement. In such circumstances, the installation Design Authority should also consider local reinforcement / bracing of the duct wall to reduce bending; and / or the use of alignment adjustment bushings* to provide compensation for such bending.

NB: Customer / user should retain the original installation's internal plates - to which this retrofit mounting plate will be attached.



The installation Design Authority is responsible for ensuring that the method chosen for mounting Cross Duct ELDS units on the intended duct is sufficiently rigid and stable.

* Alignment adjustment bushings are available from Senscient (Part Number A-5126-0) for use with Cross Duct ELDS systems where the duct walls are highly out-of-parallel, or have bent under load by an amount greater than the angular tolerance of the Cross Duct ELDS system. Provided that the angular errors arising from these sources are less than ±5° (per side) and the duct wall deformation is relatively stable, the alignment adjustment bushings should be capable of returning the alignment of Cross Duct ELDS systems to within their operational angular tolerance.
(**NB:** Alignment adjustment of ELDS VZ units is made possible by use of the standard Adjustable Mounting Bracket.)

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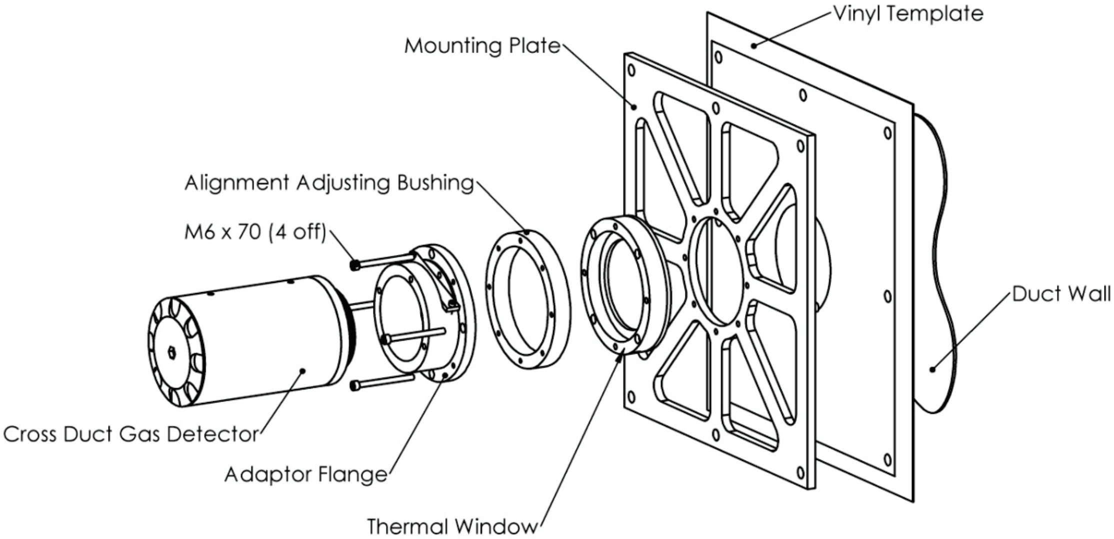
2.7.4 Thermal Window for Cross-Duct Units

In order to allow ELDS Cross Duct units to be mounted upon ducts which may temporarily reach internal temperatures that are higher than the maximum upper service temperature for which ELDS systems are certified (+60ºC), a mounting arrangement which includes a thermal window is available. This arrangement insulates an ELDS unit's lens-window from hot gases inside the duct, allowing ELDS XD units to continue being used provided that air temperatures outside of the duct are within the certified range.

Provided that there is adequate ventilation; and any in-duct temperature excursion is not of too long a duration (≤ 15 minutes), it should be possible to mount and operate XD ELDS units on ducts where air / gas temperatures inside the duct of up to 120ºC are temporarily present. Longer term operation at high duct temperatures, or operation in conditions of restricted ventilation would require measurement of the temperatures that the XD ELDS units become exposed to - in order to ensure that the maximum certified operating temperature of +60ºC is not exceeded.



2.8. SITE Installation & Maintenance Software

SITE (Senscient Installation and Test Environment) is a software application provided by Senscient to enable the installation, commissioning and testing of all types of ELDS OPGD products; and is supplied pre-installed on ATEX or CSA (UL) certified industrial computers. Due to the complexity of the computing and communications technologies employed by SITE, Senscient can only provide support to users that are running SITE on factory tested and approved platforms.

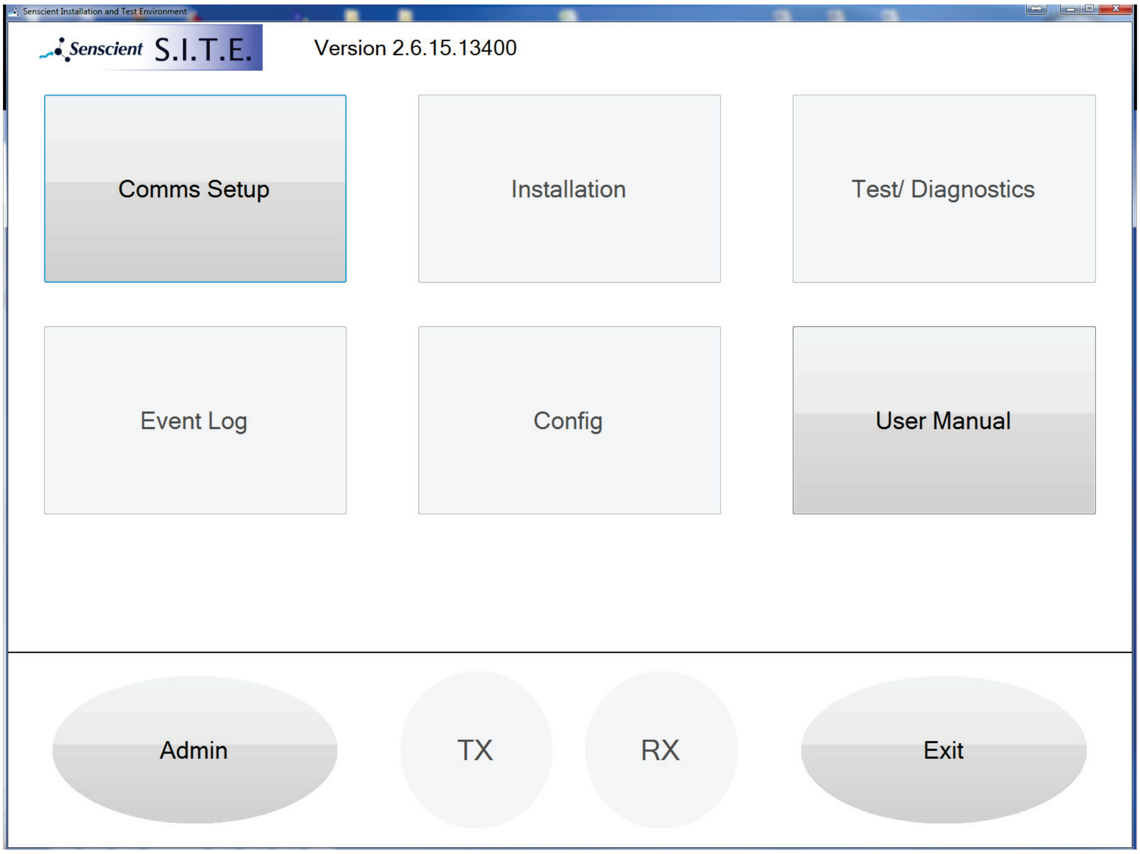
SITE is capable of communicating with ELDS units either over RS485 or Bluetooth™ * wireless communications links. The RS485 connection is made via a USB:RS485 adaptor included as part of the installation kit. The Bluetooth™ connection is built into the industrial computer and is factory activated and configured for use with SITE and ELDS units. More detailed information and guidance with respect to the type of communication link to use when working with ELDS units is provided in sections 4.5 to 4.7.

*All ELDS units can be commissioned using the RS485 communications link, regardless of their type or age. From November 2011 onwards, Bluetooth™ communications were added alongside RS485 with the introduction of Mod State 1, open-path, ELDS units. (The Mod State of ELDS units can be found on the certification / serial number label on the terminal compartment cover.)

The necessary steps to commission a system using SITE are outlined in section 4.5 and some key maintenance and problem solving guidance is provided in section 7.2. The following sections here provide an overview of SITE itself.

GB

2.8.1 SITE Main Screen



The SITE screen is divided into two areas. At the top are a sequence of ‘buttons’ that are used to access installation and maintenance facilities, to connect SITE to ELDS units and also to provide access to this Technical Manual.

The area at the bottom provides access to various administration functions via the Admin button, and also allows individual access to the Tx or Rx to be selected for operations initiated by the Config, Event Log and Installation buttons.

An outline description of these functions is provided in the following sections, however more detailed information is also provided in later sections of this document as individually detailed below.

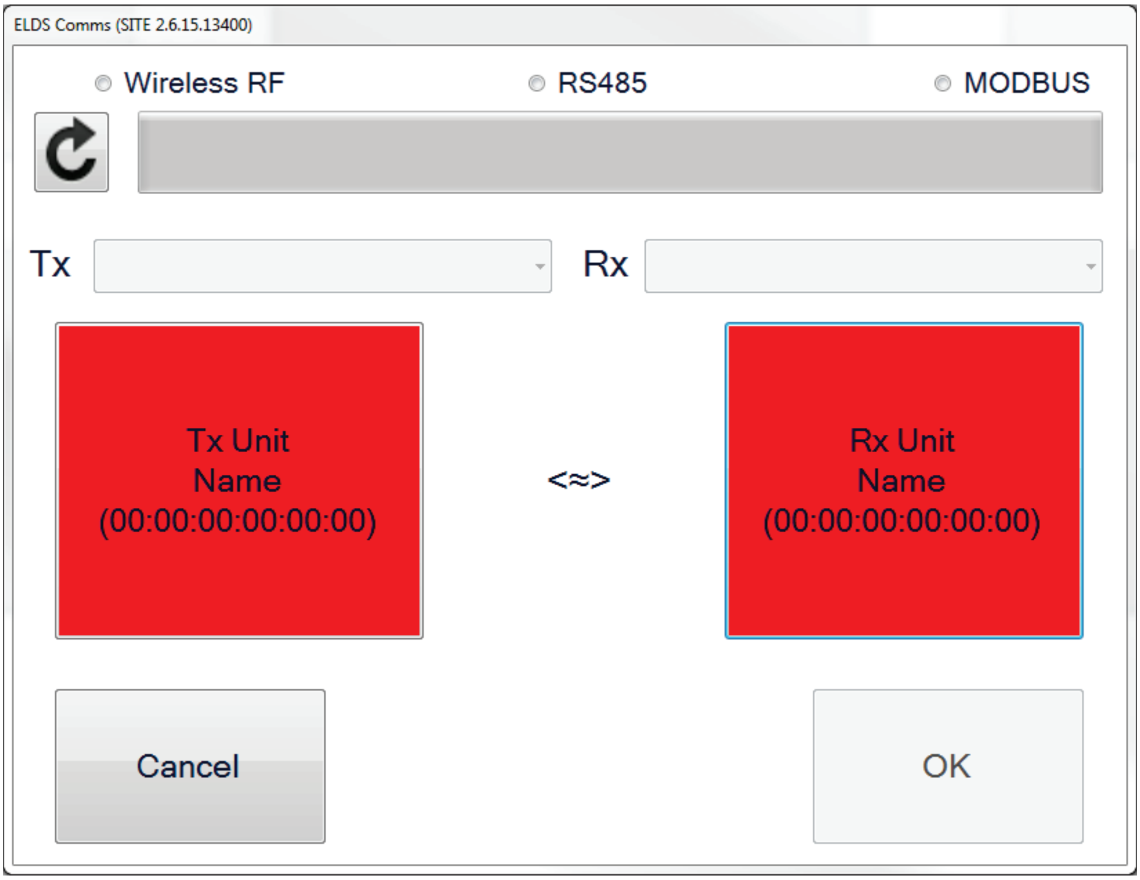
Note that the SITE version is presented at the top of the screen, 2.6.15.13400 in this example. When SITE first starts this number is truncated to just the first 3 number groups (which is sufficient to uniquely identify the SITE version), however clicking on the number will reveal the additional group which defines the precise software build version as illustrated here.

GB

2.8.2 Comms Setup

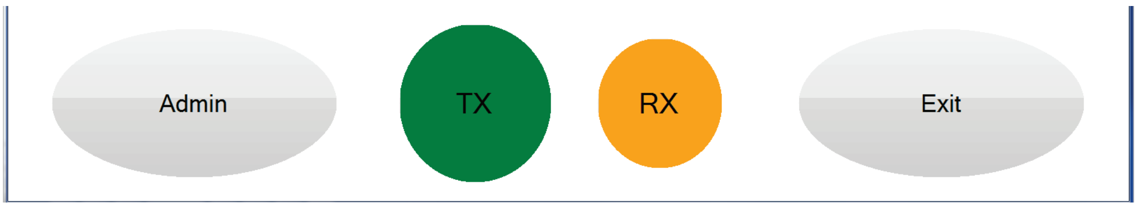
Selecting the Comms Setup button will open a separate dialogue as illustrated below which facilitates connecting SITE to an ELDS Tx, Rx or both. Further details of this are provided in section 4.5 as part of the commissioning instructions.

The majority of the functions available in SITE only become active once a connection to an ELDS unit is made in this way. As illustrated above most of the buttons except Comms Setup, User Manual and Admin are ‘greyed’ and unavailable until a connection is made.



The connection to an ELDS unit can be either via a wired (RS485) connector or via a Wireless RF (Bluetooth) link, the appropriate option is initiated by selecting the required “radio button” selector. The additional Modbus option is provided to allow units that are configured for Modbus operation to be reverted back to ELDS communication over the RS485, this is necessary in order to utilise any other facilities within SITE to maintain or inspect a unit via the RS485 link. Once connected via the “MODBUS” option in this connection dialogue box it is possible ‘un-select’ Modbus operation in the unit by navigating to the Config/Modbus page and clicking the option to disable Modbus. Details of configuring Modbus are described in detail in section 2.8.6.

Once a connection is made then one of the indicators TX or RX at the bottom of the main SITE screen will turn green and become slightly larger as illustrated here:



GB

In this case both an ELDS Transmitter and Receiver has been connected, the ‘active’ connection is to the Transmitter (the TX button is green and larger). To select the Receiver simply use the mouse or touchpad to select (click on) the RX button which will then change to green and become larger.

2.8.3 Installation

The installation button allows an ELDS Transmitter (see section 4.5.1 for more detail) or Receiver (see section 4.5.2 for more detail) to be installed.

It is essential to install an ELDS Transmitter first when installing an ELDS system. This is because essential calibration information must be copied from the Transmitter to the Receiver, so SITE must access the appropriate Transmitter before any attempt is made to install a particular Receiver. Once a Transmitter has been installed by SITE it will remember the details of that unit and so it is not necessary to re-install the Transmitter if the Receiver needs to be re-installed at a later date.

Select the appropriate unit to be installed (TX or RX) before selecting the Installation option.

2.8.4 Test/Diagnostics

The Test/Diagnostics button provides access to key information and test functions regarding the connected ELDS unit(s). These functions are described in detail in section 7.2 with specific information regarding the Receiver and Transmitter being in sections 7.2.1 and 7.2.2 respectively.

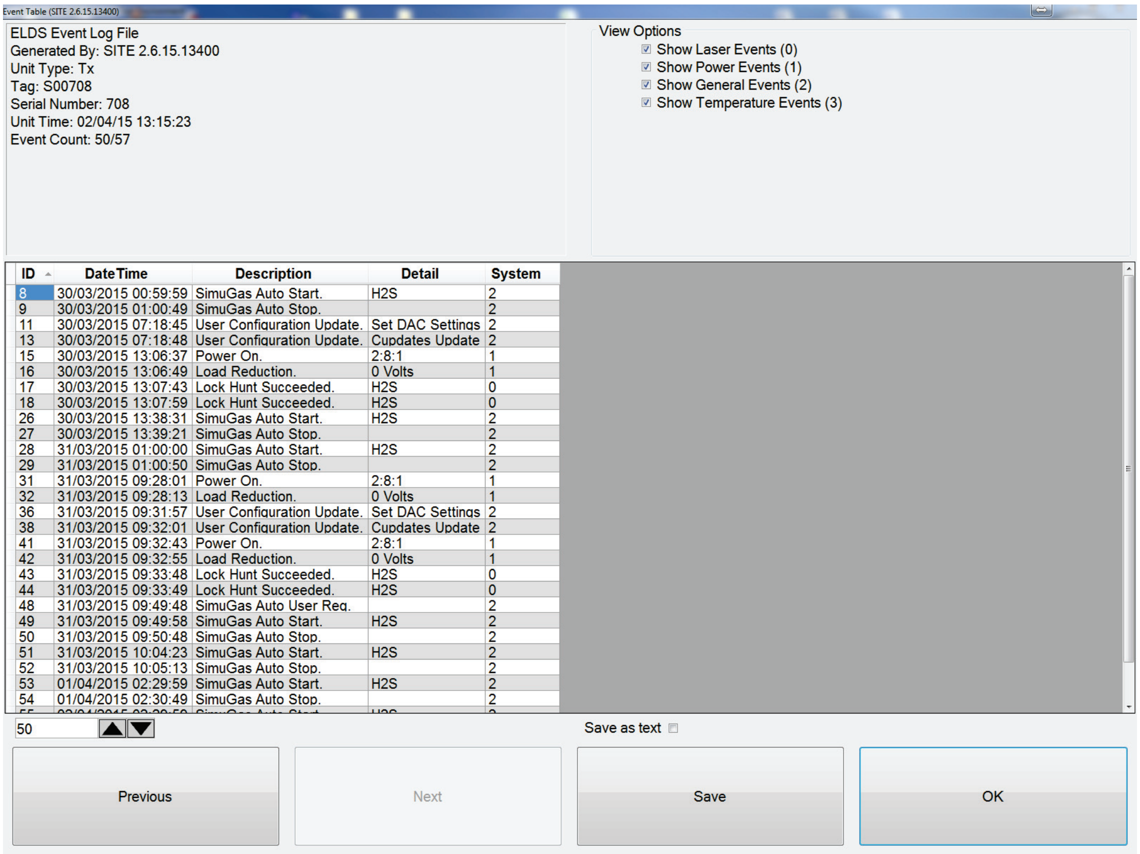
This option will provide information on either the Transmitter or Receiver or both depending on which ELDS units are connected. If only one unit is connected then the whole of the screen is filled with information regarding just that unit. If both a Transmitter and Receiver then the screen will split vertically with the Receiver information on the left side and the Transmitter on the right side.

2.8.5 Event Log

This button provides access to the internal ‘event’ log of the selected ELDS unit.

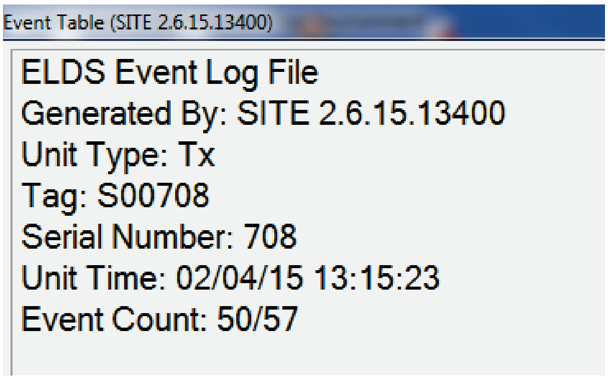
The ELDS unit selected for interrogation is determined by the TX or RX buttons at the bottom of the SITE main screen. The larger (green) button identifies the unit that will be examined.

The following screen is presented and will normally be populated by the most recent 50 events recorded in the ELDS unit selected.



The format and options of this event viewer screen are described in the following sections.

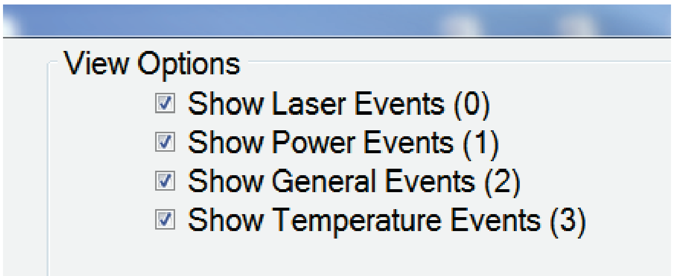
Header



The header information is presented in the top-left corner of the Events screen. Some key information about the unit and SITE version is presented along with the time of the download (based on the internal time in the ELDS unit) as well as an indication of the events selected. In this example the display has selected (read) 50 events from the unit, however the total number of events available is 57. Note that ELDS units can hold up to 186000 events, this is a rolling buffer so once it becomes full the oldest events are discarded as new events are stored.

GB

View Options



It is possible to filter the 'class' of events that are presented in the view by selecting/deselecting the options in this area (top-right of the Events screen). By default all event classes are presented, deselect the desired options to remove the associated events from the presentation.

Event List

ID	DateTime	Description	Detail	System
8	30/03/2015 00:59:59	SimuGas Auto Start.	H2S	2
9	30/03/2015 01:00:49	SimuGas Auto Stop.		2
11	30/03/2015 07:18:45	User Configuration Update.	Set DAC Settings	2
13	30/03/2015 07:18:48	User Configuration Update.	Cupdates Update	2
15	30/03/2015 13:06:37	Power On.	2:8:1	1
16	30/03/2015 13:06:49	Load Reduction.	0 Volts	1
17	30/03/2015 13:07:43	Lock Hunt Succeeded.	H2S	0
18	30/03/2015 13:07:59	Lock Hunt Succeeded.	H2S	0
26	30/03/2015 13:38:31	SimuGas Auto Start.	H2S	2
27	30/03/2015 13:39:21	SimuGas Auto Stop.		2
28	31/03/2015 01:00:00	SimuGas Auto Start.	H2S	2
29	31/03/2015 01:00:50	SimuGas Auto Stop.		2
31	31/03/2015 09:28:01	Power On.	2:8:1	1
32	31/03/2015 09:28:13	Load Reduction.	0 Volts	1
36	31/03/2015 09:31:57	User Configuration Update.	Set DAC Settings	2
38	31/03/2015 09:32:01	User Configuration Update.	Cupdates Update	2
41	31/03/2015 09:32:43	Power On.	2:8:1	1
42	31/03/2015 09:32:55	Load Reduction.	0 Volts	1
43	31/03/2015 09:33:48	Lock Hunt Succeeded.	H2S	0
44	31/03/2015 09:33:49	Lock Hunt Succeeded.	H2S	0
48	31/03/2015 09:49:48	SimuGas Auto User Req.		2
49	31/03/2015 09:49:58	SimuGas Auto Start.	H2S	2
50	31/03/2015 09:50:48	SimuGas Auto Stop.		2
51	31/03/2015 10:04:23	SimuGas Auto Start.	H2S	2
52	31/03/2015 10:05:13	SimuGas Auto Stop.		2
53	01/04/2015 02:29:59	SimuGas Auto Start.	H2S	2
54	01/04/2015 02:30:49	SimuGas Auto Stop.		2

The events are presented in the table area as illustrated here. Each event has an ID number which is effectively an 'index' to the event number within the ELDS unit, a Date/Time field which indicates the time that the event was created, a general Description field and for some events also a Detail field. The System column refers to the event class (as is identified by the View Options above).

Some events within an ELDS unit relate to system processes and are not normally displayed for users. These 'housekeeping' events have ID numbers associated and explain why the ID numbers may have 'gaps' as is the case in this example above.

GB

It is possible to re-order the displayed events by clicking on the header of any of the columns. In this example the events are ordered by ascending ID number (the default when the events are first read). Pressing the ID column header will reverse this order, or pressing any of the other column headers will order the events by the data in the appropriate column.

A detailed description of the events that may be displayed is presented in section 0 below.

Read Options

SITE will initially read the last 50 events from the connected unit, however it is possible to select/read further events if required by using the Previous or Next buttons at the bottom left of the Events screen. Each press of these buttons will read the selected number of additional events from the unit (determined by the numeric selection box).

If further events are not available then the appropriate button will be greyed and unavailable.

Output Options

The contents of the Event display can be output / saved to allow them to be incorporated into other PC applications or to be supplied back to Senscient.

Pressing the Save button (bottom right of the Events screen) will output the data in an 'internal' format that can be used by Senscient to examine the event data in full detail. This is the preferred format for supply of individual event information to Senscient (but note that Senscient generally recommends supplying full 'snapshots' rather than just the events, see section 2.8.8).

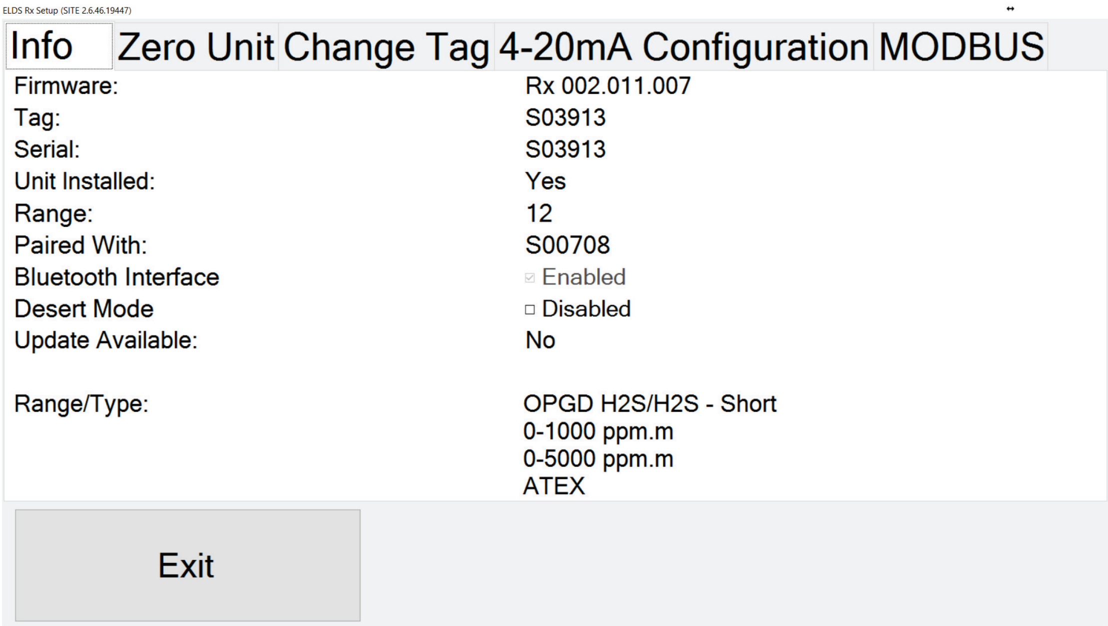
Alternatively, if the "Save as text" checkbox is selected then the data is output as text format in a "comma separate variable" (*.csv) file. Selecting this format is most useful if users wish to import the event data into a spreadsheet for presentation or analysis.

Once the Save button is pressed a standard Windows File dialogue box is presented that allows the user to select the location and name of the file that will be written.

2.8.6 Config

This button provides access to configuration information and to processes that allow the configuration to be changed once a unit has been installed.

A new screen is presented with a range of options as illustrated below:



The screen is arranged with several ‘tabs’ or pages of information and in addition up to 3 context sensitive buttons at the bottom. The ‘tabs’ displayed will depend on the unit (Tx or Rx) and also on the connection type. The example here is for a Receiver. A Transmitter will not include the “Zero Unit”, or “4-20mA Configuration” options but will include a “SimuGas” option.

Info

This tab contains key information regarding the unit including the unit identity, firmware release and configuration. In addition it provides access to two configurable items relating to Bluetooth access and the control of the window heaters on the unit.

Bluetooth Enabled/Disabled indicates if Bluetooth communication is currently facilitated on the unit. By default all ELDS units are shipped with Bluetooth communication active, however some customers may choose to inhibit this communication protocol for security reasons. The Bluetooth support can be disabled or enabled as appropriate by checking the associated checkbox. In the example above the Bluetooth is currently active so unchecking this checkbox will immediately disable the Bluetooth connectivity in the unit. Note that access to this feature is restricted by password access (see section 2.8.8 below). More details of how to disable Bluetooth are provided in section 4.5.3 below.

Desert Mode is a feature to allow the control of the window-heaters on the ELDS unit to be changed such that they are likely to be ‘off’ for a majority of the time in hot environments. This will ensure that the power consumption and internal temperature of the ELDS unit will be minimised and ensure the longest possible life of the internal components. It is recommended that the Desert Mode be enabled on units deployed in hot, dry environments where daytime temperature is likely to routinely exceed 30°C.

GB

Zero Unit

Units are normally ‘zeroed’ during installation; however it is also possible to repeat the zero process at any time. This is recommended if a unit is physically disturbed (for example if the alignment is inadvertently changed) or if units exhibit fingerprint or bad zero errors.

Change Tag

The unit ‘tag’ is normally assigned during installation but may be amended at any subsequent time as required.

4-20mA Configuration

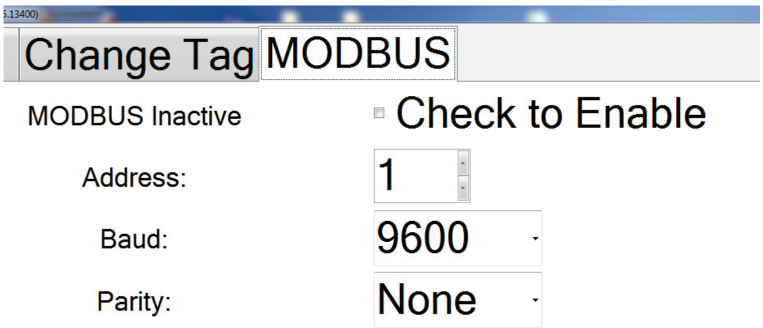
This tab provides information on the range of ‘fault’ conditions that apply to the unit and which will be signalled over the 4-20mA current loop. A description of the configuration of this is provided in section 4.5.2, item 8 therein. This tab provides repeat access to this facility should the original arrangement require adjustment at a later time.

MODBUS

MODBUS support is available from all current ELDS units and is also historically supported for most units. Units are not shipped with MODBUS support active and this tab provides a mechanism to allow MODBUS to be configured and activated as required.

MODBUS shares the RS485 communication link, once MODBUS is activated then normal interaction with the unit using SITE can only be undertaken using the Bluetooth link. Ensure that Bluetooth communication is available with a unit prior to activating MODBUS as without it further modifications or inspection of the unit with SITE will not be possible.

MODBUS can be activated through either a Bluetooth connection or via an RS485 link, however Senscient recommend the use of a Bluetooth link when activating MODBUS. The following options are presented on the MODBUS screen.



The Address must be assigned as required and must be in the range 1 to 247. This is a unique value that identifies the unit on the MODBUS link.

Baud defines the communication speed that will apply, the default setting is normally 9600 however other rates are supported and can be selected as required.

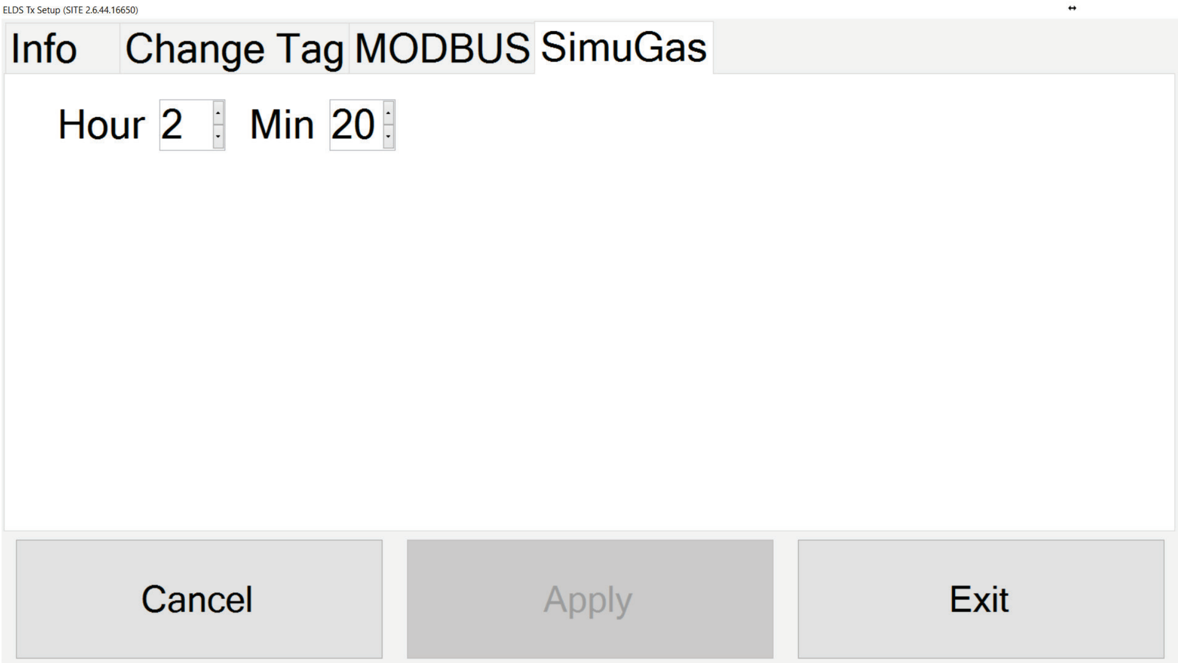
Parity defines the parity checking that will be applied to the link. The default is ‘none’ but other options are available as required from the drop-down list.

Once the required settings are selected check the “Check to Enable” option and then press the OK button at the bottom right of the dialogue. This will write the changes to the ELDS unit and enable the interface.

If this change is made via the RS485 link then SITE will not be able to communicate further with the unit and will disconnect. This process may take a short while to complete in this case.

SimuGas

This tab is provided on Tx units and allows the user to examine and change the time of day that the automatic SimuGas process will occur.



For older ELDS units the SimuGas time can be selected over the range Midnight (0 hours, 0 minutes) to 03:00 am (3 hours, 0 minutes). Units with firmware versions 002.010.018 or later will support SimuGas at any time of the day. The time can be specified in 10 minute increments. When any change is made the “Apply“ button will become enabled and will write the required changes to the unit if clicked.

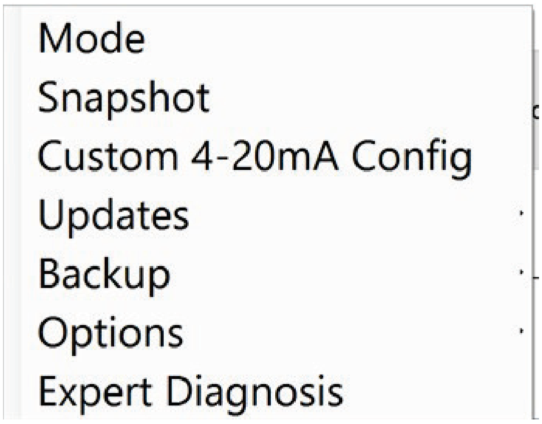
For older firmware version it is also the case that the revised SimuGas time will not apply until the pending SimuGas occurs, for such versions SITE will provide a warning following “Applying“ the change and offer the user the opportunity to re-start the Tx (which will then correctly establish the revised SimuGas time). For later firmware versions this step is not necessary and will not be presented.

2.8.7 User Manual

This provides a convenient link to this manual.

2.8.8 Admin

This provides a range of ‘administration’ items as illustrated below:



Mode

This provides access to a ‘log in’ screen and allows Senscient personnel or approved users to access more advanced features of SITE. Appropriate passwords to access these features are provided by Senscient; Senscient will normally require that users have additional training regarding the additional features provided.

Snapshot

This will instruct SITE to download a complete ‘picture’ of the connected unit. This ‘snapshot’ may take up to 2 minutes to acquire and will be automatically uploaded to the Senscient ‘service’ server if an internet connection is available. In addition the snapshot is stored on the PC running SITE and may be copied from there. The snapshot will be located in the following location within “My Documents”

\Senscient\SITE\Log\nnnn

Here nnnn represents the unit serial number of the ELDS unit, for example S01234. Note that the physical location of “My Documents” varies depending on the version of Windows being used on the PC. Generally users should find a link to the appropriate place located in the “Start” button or on their desktop.

Custom ELDS Config

This provides a direct access to the facility to adjust or configure the 4-20mA loop fault currents and behaviours (see section 2.8.6 above and also section 4.5.2 item 8 below).

Updates

This provides access to SITE updates.

If a “SITE update” is available then this sub-item will be accessible and selecting it will automatically update the copy of SITE on the PC. Note that this process does take a few minutes to complete. This option is dependent on internet access.

Senscient recommends that users keep their SITE version updated by periodically checking this option and updating when new versions of SITE become available. New versions generally provide enhanced/improved features and in addition may correct issues that might arise.

Backup

This provides the option to create a ‘zip’ backup of the current SITE installation information. This is located in the following location within “My Documents”

\Senscient\SITE\SBU

and takes the form of a ‘zipped’ folder which contains a record of the units that have been installed by SITE on the PC.

There is also an option to ‘Purge’ the current configuration. These options are provided to facilitate some advanced trouble-shooting options for Senscient engineers and are not intended for customer use.

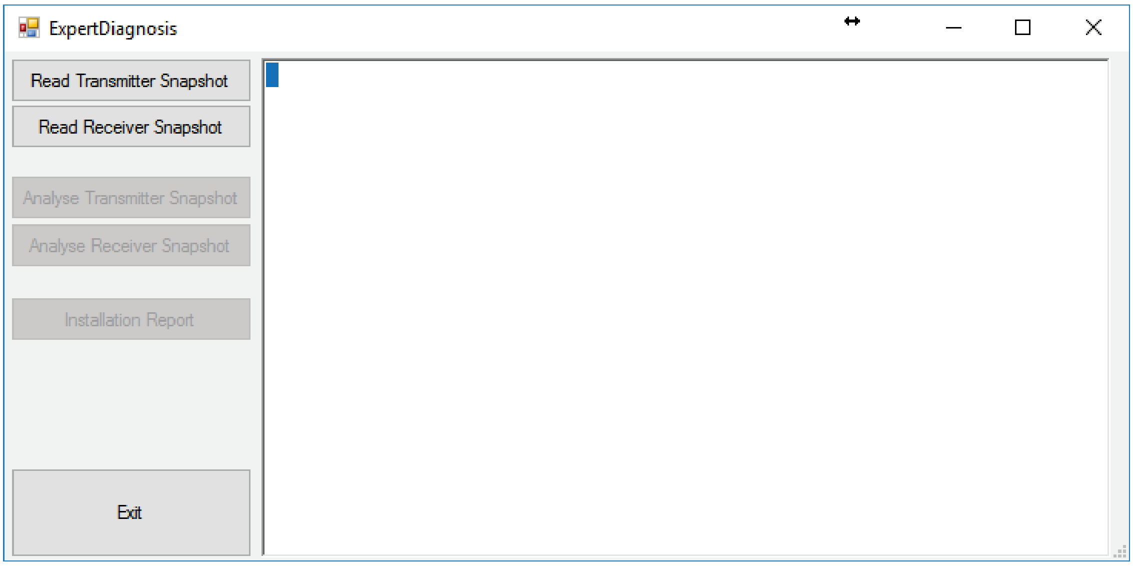
Options

Development Test, provides a facility for use by the Senscient development team. This option is not normally accessible to users.

Expert Diagnosis

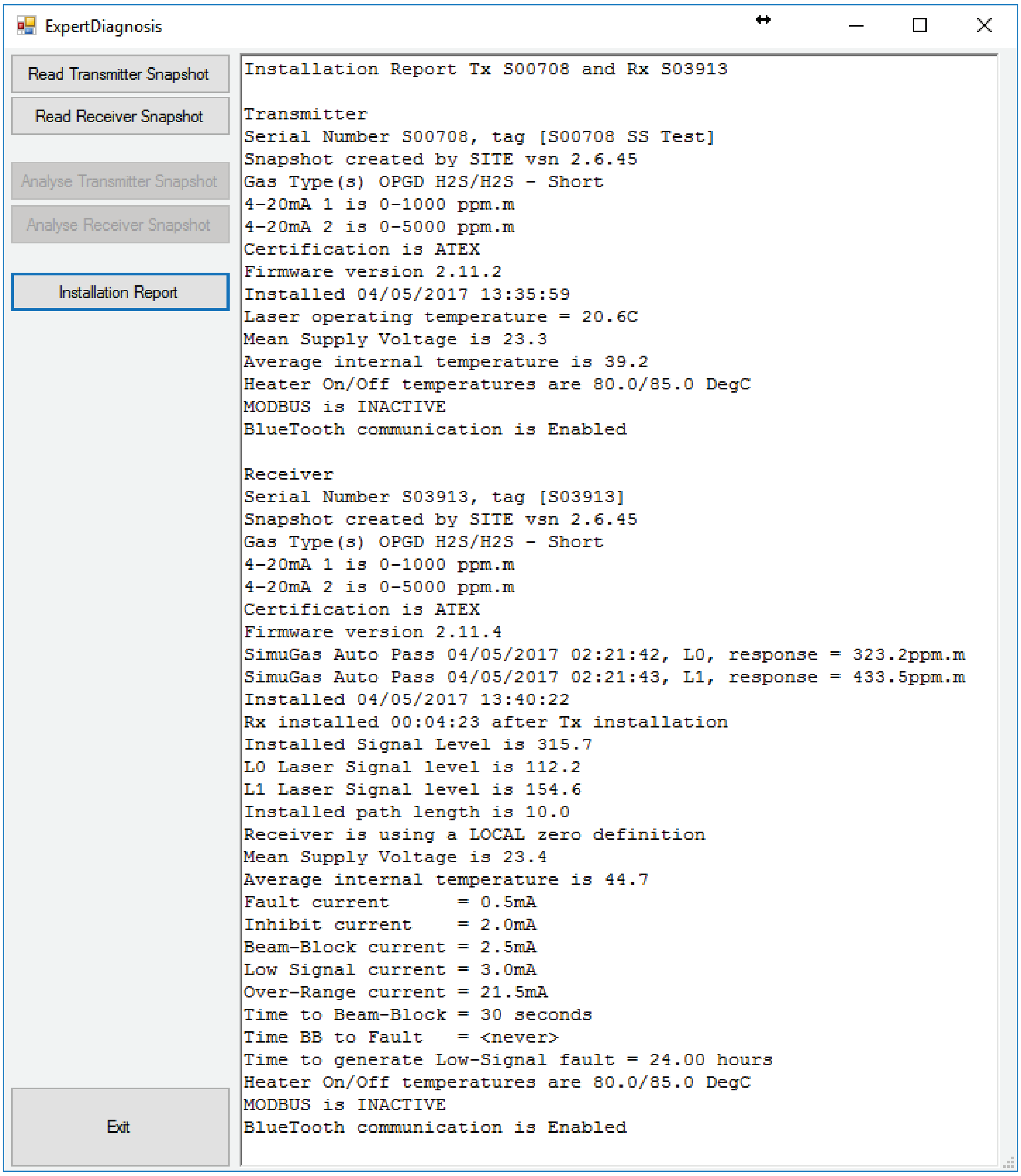
This feature provides two facilities.

Firstly it can be used to provide an installation report which details key information regarding the configuration and operational condition of a system following an installation. Selecting this facility generates a dialogue box as illustrated below.



To provide the installation report it is necessary to generate a snapshot of both the transmitter and receiver following a successful installation by SITE. Use the relevant buttons on this dialogue to access and read each snapshot, once this is done the “Installation Report” button will be enabled. Pressing “Installation Report” will initiate the process to generate the report.

The report is generated both as a separate file (a standard file selection dialogue box is presented that allows the desired location and name of the file to be selected) and also as a description within the dialogue main window. The generated file is a plain text (*.txt) file and is given a default name that identifies the serial number of both the transmitter and receiver as well as the date and time of the report. An example such report is illustrated below:



This provides a useful record of the state of a system at the time of installation which can assist possible diagnosis of any issues that might occur subsequently during the life of the product.

The two buttons “Analyse Transmitter Snapshot” and “Analyse Receiver Snapshot” are not accessible to customers; these provide more detailed analysis/diagnosis for the use of Senscient engineers.

GB

3. Installation Design & Engineering

3.1. Introduction

WARNING

The applicable National Code of Practice regarding selection, installation and maintenance of electrical apparatus for use in Hazardous Areas / Hazardous (Classified) Locations / Zones must be complied with at all times.

The Senscient ELDS™ 1000 / 2000 Series has been designed, engineered and field-tested to be the most robust, reliable Open-Path Gas Detector (OPGD) available. The design and ELDS™ technology employed in the Senscient ELDS™ 1000 / 2000 Series make it far more resistant to the adverse effects of the operating environment and non-ideal installations than previous generations of OPGDs.

With careful consideration of the intended operating environment and the installation design, the installer/operator can maximise the reliability, availability and performance achieved with ELDS™ OPGDs.

Before designing or specifying an installation for Senscient ELDS™, it is strongly recommended that the installation design authority reads and understands this chapter, and considers how the information and recommendations provided can be applied to their installation(s).

If a design authority has any queries concerning their installation design, they should contact Senscient or their local agents.

Senscient is committed to ensuring that customers achieve reliable operation of their Senscient ELDS™ OPGDs. For this reason, Senscient ELDS™ OPGDs should only be installed by fully trained personnel (trained by Senscient or a Senscient authorised trainer). This training will provide the installer with a clear understanding of the Senscient ELDS™ OPGD product and the associated accessories and tools. It will also provide familiarity with the installation, alignment and commissioning procedures, plus installation assessment skills to identify any potential problem areas.

For each installation, it is recommended that the installer should check the installation and operating environment against the Check List presented in section 4.7.

The transmitted laser beam is Class 1 (eye-safe) per IEC 60825.

3.2. Siting and Mounting

3.2.1 General

When designing an installation for a Senscient ELDS™ OPGD it is important to give consideration to where it is to be located with respect to gas leak hazards, what potential sources of problems may be encountered in this location; and how the unit is to be mounted and supported.

3.2.2 Location for Best Coverage

Guidance on the positioning of gas detectors to provide the best detection coverage is contained in national Codes of Practice. It is recommended that the installation designer consults these Codes of Practice. Senscient would advise that the best current methodology for siting all types of fixed gas detectors is based upon the expert use of gas dispersion modelling, performed for the particular area(s) of plant or facility where potential gas leak hazards exist. There are a number of organisations with the gas dispersion modelling tools and expertise necessary to perform this work. In general, for OPGDs the following positions usually provide the best results:

- Running parallel to the physical perimeter of an area of plant or facility containing potential gas leak hazards.
- Forming a continuous ‘ring-fence’ surrounding an area of plant or facility containing potential gas leak hazards.
- At sufficient distance from any potential leak sources for dispersion to produce a gas cloud of a size that will reliably be intercepted by the beam-paths of the OPGDs employed.
- Between potential leak sources and any known or likely sources of ignition.
- For natural gas: beam-path parallel to the ground / floor and above the height of most of the valves and flanges in the vicinity.
- For toxic gases: beam-path parallel to the ground / floor at ‘breathing height’ (~ 1.4m - 1.7m).
- For gas mixtures <u>significantly</u> denser than air: beam-path parallel to the ground / floor and below all potential leak sources*.
- For gas mixtures <u>significantly</u> lighter than air: beam-path parallel to the ground / floor and above all potential leak sources*.

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* In most instances the hazardous gases leaking from a plant or facility are mixtures of a number of gases with different chemical and physical properties. In a gas mixture the constituent gases will retain most of their chemical properties, but the physical properties of the gas mixture will approximate the sum of the physical properties of the constituent gases.

For sour natural gas, the above principle means that this gas mixture will be both toxic and flammable; whilst the density of this mixture will tend to be dictated by its methane content.

Only accurate gas dispersion modelling will determine the precise physical properties of a leak of sour natural gas, but typically this mixture’s density will be similar to, or even slightly lower than that of air. Only leaks of very cold natural gas or of neat hydrogen sulfide are likely to be slightly denser than air.

CAUTION
Dispersion modelling provides little support for the practice of placing hydrogen sulfide detectors close to the ground. In the majority of instances leaks of sour natural gas or hydrogen sulfide will not sink; whilst the toxicity hazard is greatest at the height where such gas can be breathed in.

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3.2.3 Location to Maximise Reliability and Availability

Care in choosing the location of ELDS™ OPGDs can contribute significantly to the overall reliability and availability.

When locating units, attempt to avoid areas where they may be adversely affected by the following:

Vibration - Angular vibration of the structure to which ELDS™ OPGD units are attached should be kept to less than ± 0.5°. Where possible, avoid locations where high levels of vibration will be directly induced into the mounting structure. If close proximity to significant sources of vibration is unavoidable, take steps to reduce coupling of this vibration and maximise the rigidity of the mounting structure.

Intense Heat - ELDS™ OPGDs are certified and specified for operation in environments up to +60°C. If sources of intense heat (flarestacks, intense sunlight, etc.) are present, the effect of these will be reduced by the fitted sunshade. If the sunshade proves insufficient in an extremely hot installation (greater than 35°C) then further shielding should be provided or the detector should be relocated.

Sources of Heavy Contamination - Avoid locations where high levels of contaminants will persistently be blown onto the unit's lens-windows. Potential sources of heavy contamination include generator/turbine exhausts, flare-stacks, drilling equipment, process vents/chimneys etc. If sources of heavy contamination cannot be avoided, consider fitting extra shielding and/or providing good access for more routine cleaning.

Snow and Ice in Ambients Below -20°C - The heated optics on ELDS™ OPGD units will melt snow or ice on the lens-windows in ambient temperatures down to approximately -20°C. Below this temperature, snow or ice blown onto the lens-window will not be melted until the ambient temperature rises. If long-term, outdoor operation in very cold climates is intended, it is recommended that extra shielding/covers are employed to prevent snow/ice from being blown onto the windows and building up.

Deluge and Flooding - Senscient ELDS™ OPGDs are rated IP66/67 and as such will not be damaged by occasional deluge or flooding. However, during such instances the unit will completely lose its IR signal and will enter the BEAM-BLOCK/FAULT state. Also, when the deluge/flooding subsides, there is the possibility that contaminants will be left on the windows. Therefore, it is recommended that ELDS™ OPGD units be located away from areas particularly prone to deluge or flooding.

Areas Prone to Subsidence and Settling - Where possible, it is recommended that ELDS™ OPGD units are not mounted on structures located where problems with subsidence, settling or thawing of permafrost are known to cause significant movement. If such locations cannot be avoided, the foundations of the mounting structure should be engineered to minimise any angular movements.

Areas Prone to Earthquakes - In locations prone to earthquakes, there is a chance that during or after an earthquake, the units of an ELDS™ OPGD will become misaligned with respect to each other. Provided that the ELDS™ OPGD units do not suffer from direct mechanical impact damage during an earthquake, they should remain undamaged by such events. Anti-vibration mounts are unlikely to be of any benefit and are not recommended. After an earthquake it is recommended that ELDS™ OPGDs are visited and their alignment be checked.

Accidental Impact - Mount Transmitter and Receiver horizontally to protect from impact. Locations where there is a likelihood of equipment, personnel or moving objects accidentally knocking ELDS™ OPGD units out of alignment should be avoided. If such locations cannot be avoided, measures including improved mechanical protection and warning notices should be considered.

Intense Electromagnetic Fields - Senscient ELDS™ OPGDs comply with FM6325 and EN50270, and as such are well protected from interference by electromagnetic fields. However, locations in close proximity to radio/radar Transmitters, heavy electrical plant and high voltage power cables may experience field strengths in excess of those specified in EN50270. Where possible, such locations should be avoided or units should be installed as far as possible from the source of the electromagnetic field. Measures including additional screening, filtering and transient suppression may also be of benefit in such locations.

3.2.4 Beam-path

The Transmitter and Receiver unit lens-windows should face each other directly across the area to be protected and, depending on the range of the system deployed, should be the following distance apart:

Senscient ELDS™ Detector Series Type	Path length between units
1000 CH_4	5 – 40m, 40 –120m, 120 – 200m
1000 Ethylene	5 – 60m
1000 HCl	5 – 60m
1000 NH_3	5 – 40m, 40 – 120m
1000 CO_2	5 – 40m, 40 – 120m
1000 HF	5 – 60m, 60 – 120m
1000 XD, Cross Duct, 0-10%LFL, 0-25%LFL, 0-50%LFL, 0-100%LFL CH_4	0.5 – 5.0m
2000 CH_4 + H_2S	5 – 60m
2000 H_2S	5 – 60m

The beam-path and immediate surrounds should be kept free of obstructions that might hinder the free movement of air in the protected area or block the infrared beam. A clear beam-path of 20cm diameter or greater is recommended. In particular, for optimum availability, avoid areas affected by the following:

- Steam vents and plumes
- Smoke stacks and chimneys
- Walkways and personnel areas
- Splash and spray, e.g. from moving equipment, cooling towers, etc.
- Parking, loading, cranes, vehicle temporary stops, e.g. bus stops, road junctions, etc.
- Vegetation, e.g. shrubs, bushes, branches, etc. - if currently clear, movement due to weather and future growth or planting must be considered

Where walkways cannot be avoided, consider indicating the beam by marking the walkway or road with paint.

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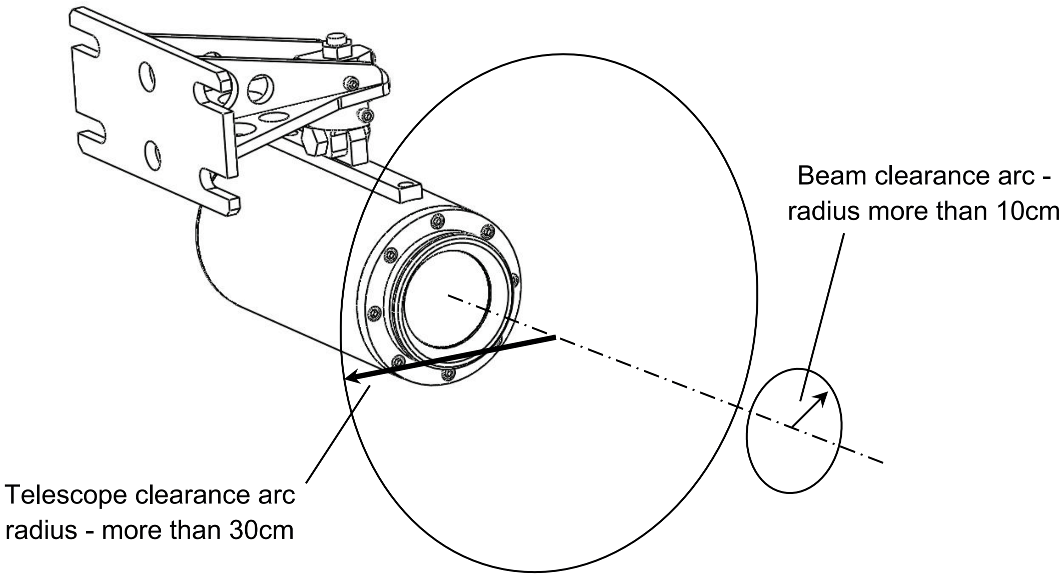


In order to fit the alignment telescope used during the alignment process, a clear accessible arc of at least 30cm radius is required close to the unit as shown above.

CAUTION

For reliable operation, a clear beam-path of at least 10cm radius or greater is recommended.

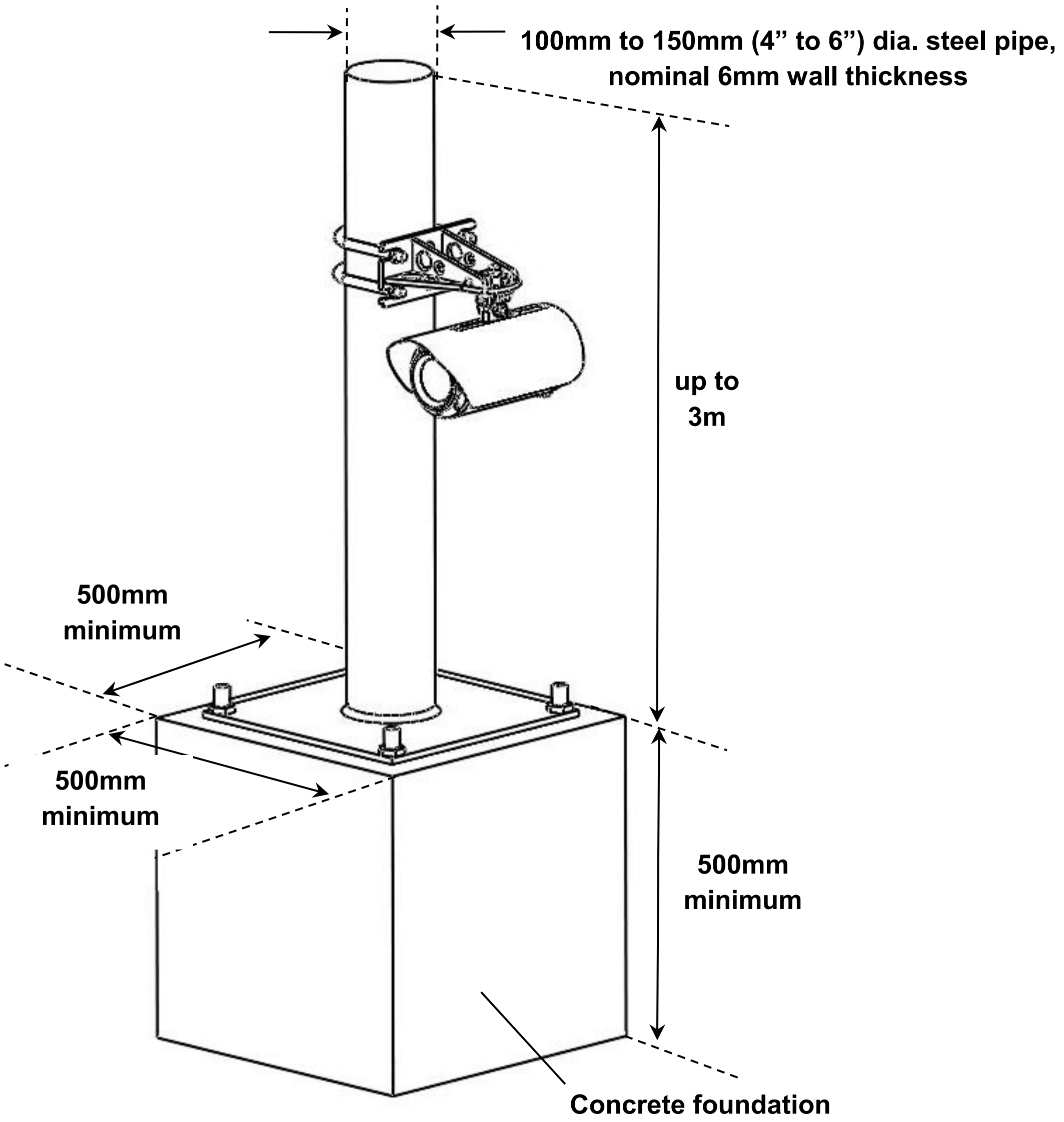
When selecting locations for ELDS units, ensure that only one ELDS Transmitter unit is within the field-of-view and pointing towards any ELDS Receiver unit. Do NOT run ELDS beam-paths such that there are multiple Transmitters running along the same axis, because the Receiver at the end of the run will see laser signals from all of the Transmitters on this axis and this may cause problems. Detailed guidance is provided in section 3.2.10.

3.2.5 Supporting Structure

The Transmitter and Receiver units should be fixed to rigid, stable supporting structures using the mounting brackets supplied.

The maximum movement of the supporting structure under all anticipated operating conditions must be ±0.5º.

If no suitable mounting structure already exists then structures similar to that shown below are recommended:



The pipe can be filled with concrete to provide extra stability if necessary.

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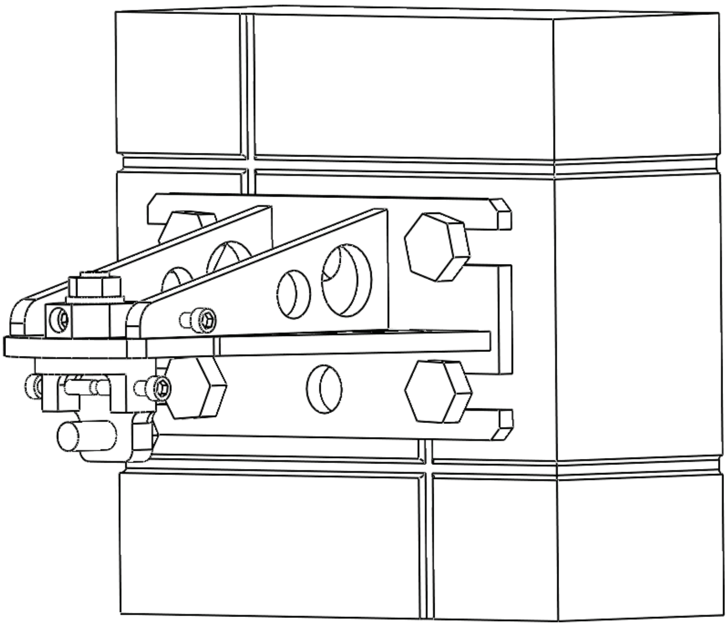
3.2.6 Wall Mounting

The mounting bracket can be directly attached to a suitable wall or similar structure as is illustrated below:



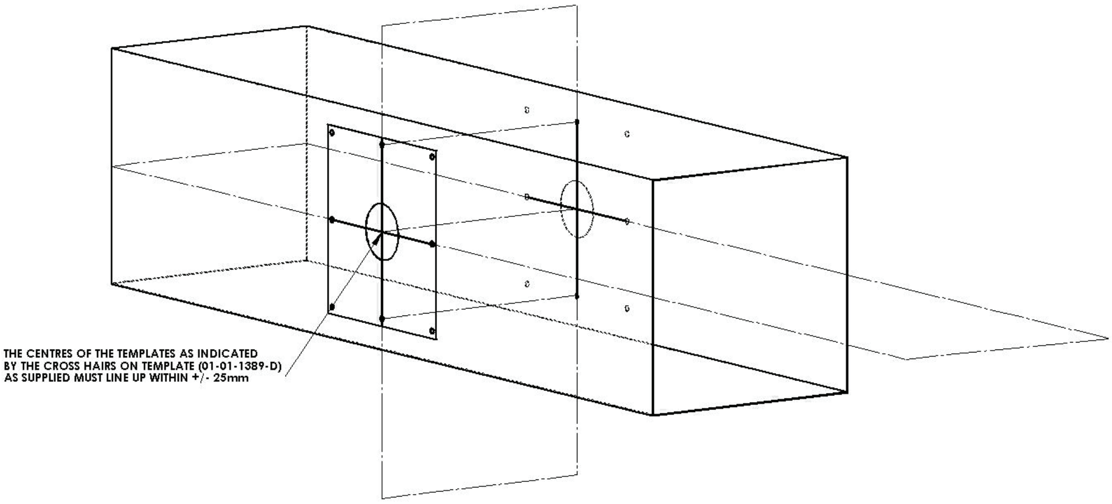
3.2.7 Orientation

Senscient ELDS™ OPGDs are solar immune and therefore there is no need to take account of the sun's movement when considering orientation.

When positioning the units do not install them with the optical axis at an angle greater than 45º to the horizontal - to avoid dirt / water build-up on the lens-windows.

3.2.8 Mounting Cross Duct ELDS Systems

Cross Duct ELDS systems are specifically designed and engineered for installation with their beam-path running across the duct, perpendicular to the direction of flow through the duct. In order to facilitate installation in this manner, the walls of the duct at the location where the Cross Duct ELDS system is to be installed must be flat and parallel to each other to within ±2.5° (per side). Provided that this requirement is met it is then a simple matter of mounting each half of the Cross Duct ELDS system directly opposite its counterpart. Self-adhesive templates (01-1389-D) are provided to assist with the location and drilling of suitable holes in the duct wall.



The most important requirement for successful installation of a Cross Duct ELDS system is that the optical centre lines, as indicated by the cross-hairs on the self-adhesive templates are directly opposite each other on the duct wall.

GB

3.2.9 Positioning Cross Duct ELDS Systems

Guidance on the positioning of gas detectors to provide the best detection coverage is contained in national Codes of Practice. It is recommended that the installation designer consults these Codes of Practice. Senscient would advise that the best current methodology for siting all types of fixed gas detectors is based upon the expert use of gas dispersion modelling, performed for the particular area(s) of plant or facility where potential gas leak hazards exist. Organisations with gas dispersion modelling tools and relevant expertise are available to perform this work on a contract or consulting basis.

There are a number of factors that Senscient would suggest be taken into consideration by designers of installations for Cross Duct gas detectors. These factors may not be relevant to all duct applications and installations but are provided to assist the installation designer in those instances where they are.

1. In general, the flow in ducts is <u>not</u> turbulent and approaches laminar flow throughout the majority of a duct's length.

2. In general, louvers and grills at duct inlets do <u>not</u> create significant flow turbulence and do <u>not</u> produce significant mixing of air or other gases entering a duct.

3. As a consequence of factors 1 & 2, for most ducts there is no location at which air and other gases entering the duct can be considered to have become uniformly mixed.

4. In most instances, any flammable gas entering a duct will proceed to flow along the duct in an approximately laminar fashion, <u>remaining on the same side and at the same height as that at which it entered the duct</u>. Any dispersion or mixing of this flammable gas with the air flowing in the duct will tend to be very gradual.

5. Where the design of an installation for Cross Duct gas detectors is intended to make use of dispersion or mixing effects, these effects must be modelled for the appropriate duct geometry, detector location(s) and flow conditions - to determine that the required dispersion or mixing will actually occur.

GB

When the installation designer takes the above factors into account, in general they will establish that the best locations for Cross Duct gas detectors are as follows:

1. As close to the duct inlet as reasonably practicable - to minimize the distance that any flammable gas has to cover before it passes through the Cross Duct detector's beam-path, minimizing any time delay before this hazardous condition is detected.
2. For tall ducts – at multiple heights running across the width of the duct, with as a minimum one Cross Duct beam-path running reasonably close to the bottom of the duct and another Cross Duct beam-path running reasonably close to the top of the duct.
3. For tall / large ducts where practicable – at multiple heights running across the width of the duct with Cross Duct beam-paths separated vertically by a 0.4m pitch.

CAUTION

Do NOT install Cross Duct ELDS units with their beam-paths running vertically in the duct. This will tend to lead to the build-up of water and contamination upon the lens-window of the unit mounted on the bottom of the duct, leading to low signal and beam-blockage problems.

The installation Design Authority must ensure that the duct hazardous (classified) location and / or hazardous area is in compliance with the ELDS unit's certification (see section 9 for ELDS certification details).

In addition, the duct environment shall not exceed the following:

Pressure: 80kPa (0.8Bar) to 110kPa (1.1Bar)

Temperature: -55ºC to +60ºC

Oxygen Content: less than 21%v/v.

3.2.10 Siting Multiple ELDS™ Systems

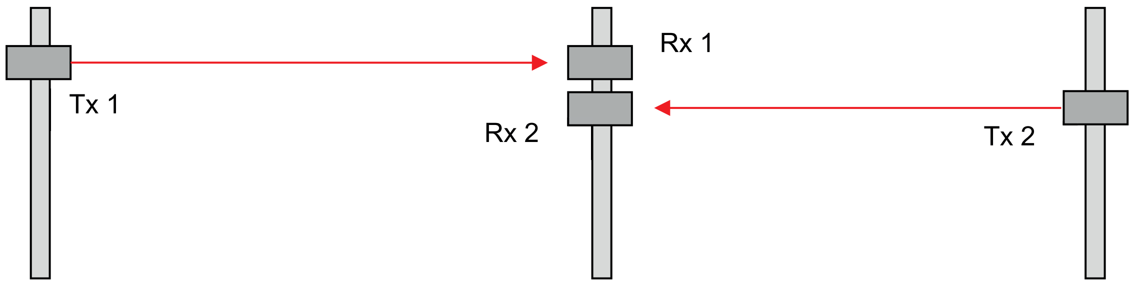
For reliable operation it is important that each ELDS™ Receiver unit only detects light from a single ELDS™ Transmitter, i.e. that ELDS™ systems are installed as a Transmitter and Receiver pair that are optically isolated from other ELDS™ systems.

In situations where multiple ELDS™ are to be installed in proximity to each other along a common border or fence line, the following mounting and orientation recommendations should be adopted.

GB

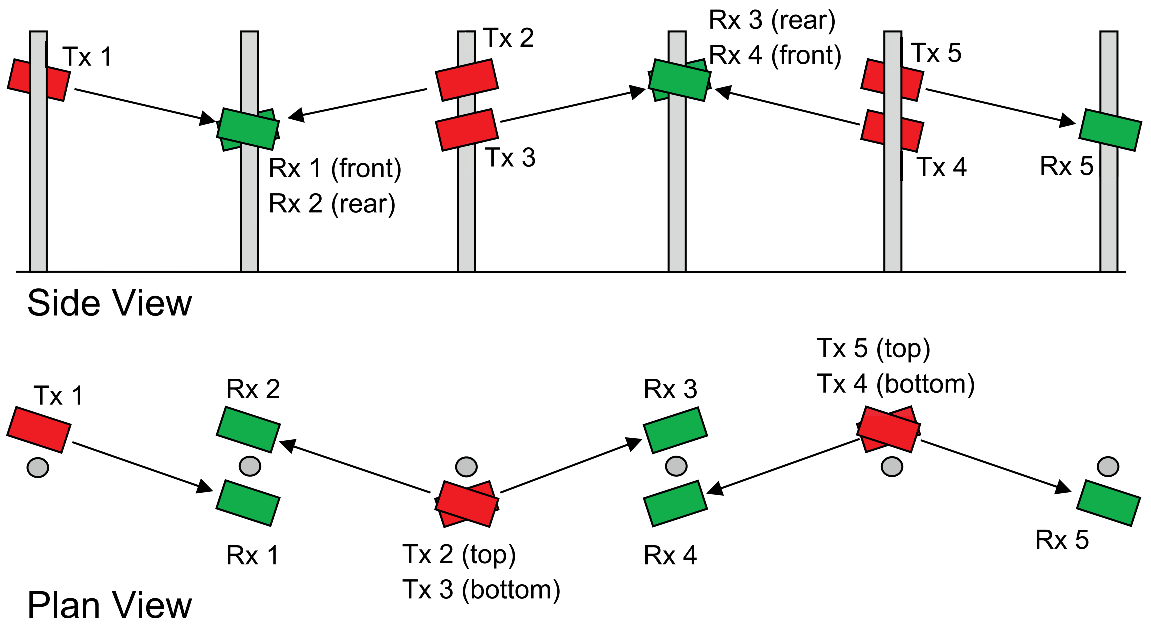
Arrangement for 2 ELDS™ Systems

Where two ELDS™ systems are to be installed along a common border or fence line, it is recommended that the units be orientated as illustrated below.



Mounting the transmitters and receivers such that the beams of the two ELDS™ systems are running in opposite directions ensures complete optical isolation. In this arrangement for two ELDS™ systems it is not necessary to make use of the heights or pole sides upon which the units are mounted to provide optical isolation.

Arrangement for Multiple ELDS™ Systems



For applications where three (3) or more ELDS™ systems are to be installed running along a common border or fence line, the arrangement illustrated above is recommended. (The ELDS™ systems pictured here are displayed with Tx units coloured red and Rx units green in order to aid interpretation of the diagram.)

Essentially, this arrangement utilises different heights on the mounting pole and also the ability to mount the units either side of the pole to maximise the angular difference between Rx units that have the potential to 'see' more than one Tx unit. In this example Rx 2 could potentially detect light from Tx 4, however because of the mounting arrangement there is an angular offset between the alignment of Tx 4 and Rx 2 which will minimise the reception of light from this non-paired Tx.

This arrangement utilises both the horizontal and the vertical variation of unit mounting to achieve the maximum possible angular separation. This alternating pattern can be repeated as many times as is necessary to cover the entire length of the border or fence line that is to be monitored.

The 'horizontal' offset of Rx units achieved by this arrangement when using a standard 4" mounting pole and Senscient mounting brackets is 0.4m. The vertical variation can be greater than this but the maximum value that can be adopted will depend on local site restrictions (height of poles, possible obstructions etc.).

Senscient recommends that a minimum height variation on the Tx poles of 0.5m be adopted. Using larger height variations than this minimum will be beneficial, especially when systems are operating over path-lengths longer than 50m.

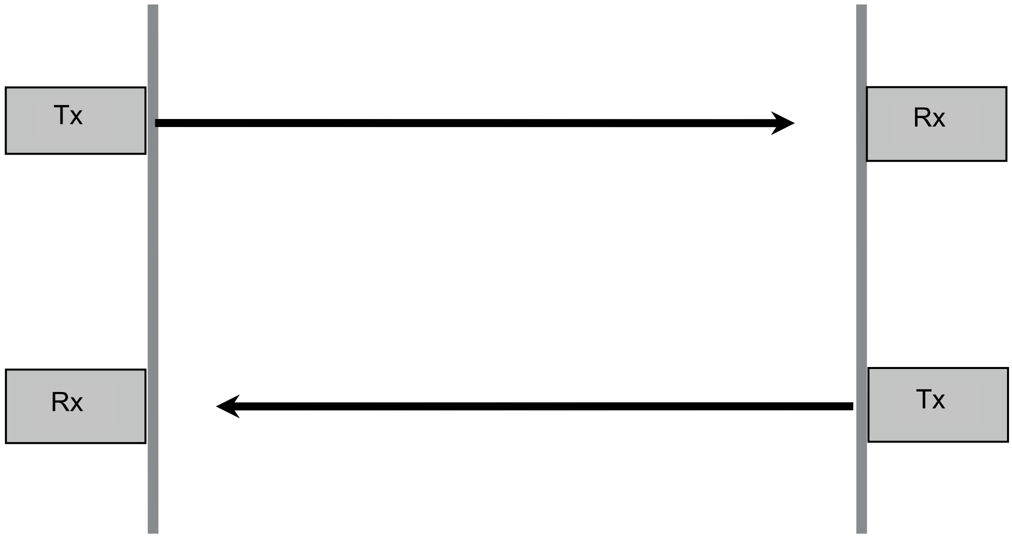
GB

Siting Cross-Duct ELDS™ Systems

In many instances, Cross-Duct units are mounted 'singularly', eliminating the potential for unit-to-unit interference. However, in some applications, multiple Cross-Duct units are installed upon a common duct; and in such cases measures to provide optical isolation need to be adopted.

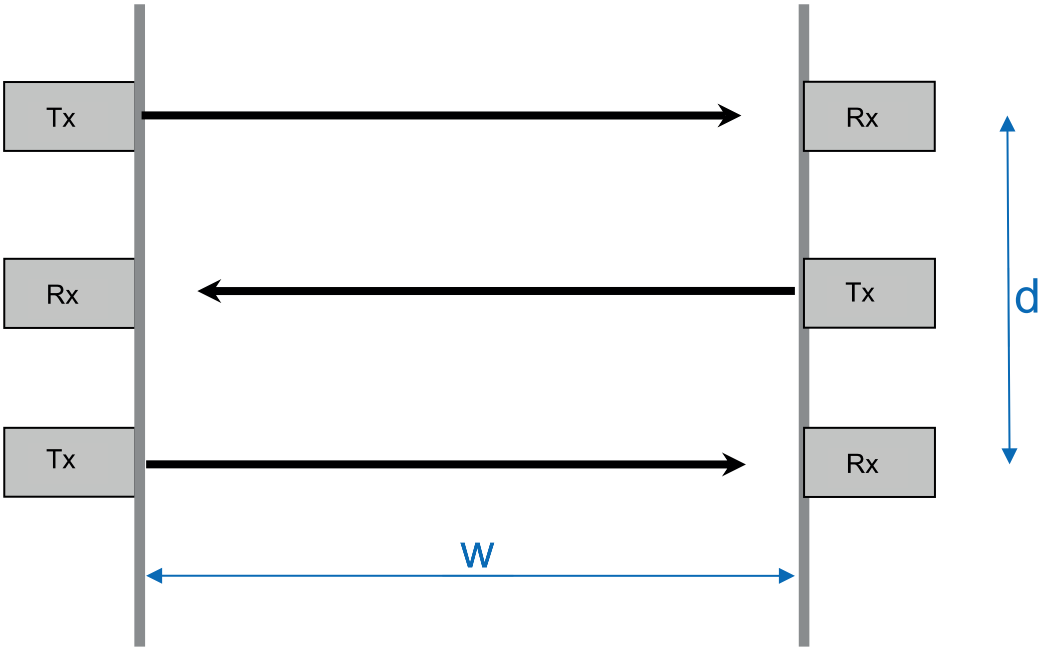
Arrangement for 2 Cross-Duct ELDS™ Systems

In applications where two (2) Cross-Duct ELDS™ systems are to be installed upon a duct, Senscient recommends that the units are mounted with their beams running in opposite directions as illustrated below.



Arrangement for Multiple Cross-Duct ELDS™ Systems

For applications where three (3) or more Cross-Duct units are required it is necessary to ensure that the maximum possible separation occurs between Rx units. The recommended arrangement for 3 systems in a duct is illustrated below.



Here 3 ELDS™ cross-duct systems are mounted at a common location in a duct of width w. The 'middle' system is mounted with the beam in the opposite direction to the top and bottom systems so it cannot interfere with either of the other two units and they cannot interfere with it. There is a possibility of interference between the two units that are mounted in the common direction however. The angular separation between these two units (top and bottom) is approximately given by the following relation:

$$\theta = \frac{d \times 180}{w\Pi}$$

where θ is the angle (in degrees) between the two transmitters pointing in the same direction and (Pi) is 3.142.

Senscient recommends that the value of be at least 10 degrees.

As an example, for a duct of width (w) of 2.5 metre the angular recommendation above would require that the separation of the top and bottom Rx units be at least 0.44m.

In another example, for a duct width of 5m the angular recommendation would require a value of d of at least 0.87m.

GB

3.3. Electrical Connections

3.3.1 Electrical Installation Design & Engineering Recommendations

All ranges of the Senscient ELDS™ 1000 / 2000 Series comply with the electrical and EMC requirements of EN50270 and FM6325. In order to maintain compliance with the applicable standards it is essential that the electrical installation of ELDS™ 1000 / 2000 Series systems is engineered accordingly.

Electrical installation standards and practices vary between countries, companies and applications. It is the responsibility of the installation design authority to determine the applicable standards and practices, and to ensure compliance with them.

⚠ CAUTION
In common with other infrared open path gas detectors, ELDS 1000 & 2000 Series OPGDs require a reliable, stable supply of +24V power in order to operate as intended. Correctly engineered PSU and cabling arrangements will contribute greatly to the reliability, safety and availability of ELDS OPGD based gas detection. Save time, money and effort by investing in quality cabling and quality power supplies.

When designing electrical installations for ELDS™ 1000 / 2000 Series systems, it is recommended that the installation design authority takes into account the following:

a. In order to comply with the applicable electrical installation standards and practices, the metal cases of units must be connected to earth / ground. Care should be taken in the design and engineering of this earth / ground connection to ensure that any electrical noise or voltage introduced onto a unit's case is no greater than the levels specified in EN50270.

b. The case earth / ground bonding arrangement must ensure that the maximum transient voltage between a unit's case and any field cable conductor is less than 1000V. Voltages in excess of this may cause permanent damage to the unit.

c. The entire length of the field cabling connected to each unit should be fully shielded / screened. This shield / screen should be connected to a low noise (clean) earth / ground, preferably at a single point.

d. The shields / screens of the field cabling should not be connected such that earth / ground loops are produced, or in a manner that will result in the shields / screens carrying large currents from heavy plant or equipment.

e. Where the shield / screen of field cabling enters the terminal compartment of an ELDS 1000 / 2000 Series unit, this shield / screen should not be connected to the unit's earth / ground terminal and should be prevented from making any contact with the unit's case. (The unit's case will be connected to a local earth / ground which will typically be noisy, and this noise should not be allowed to get onto the field cable's shield / screen.)

f. Any electrical interference induced onto the 4-20mA loop conductors by the installation must be kept below the levels necessary to comply with the general requirements of EN50270. In practice, this means that peak noise currents induced on the current loop should be no greater than ±0.25mA.

g. The use of 'two wire 4-20mA' isolated configurations effectively eliminates the problems associated with field devices being at different potentials to those in the control room, and reduces susceptibility to noise and interference pick-up on a 4-20mA loop. Isolated 'two wire 4-20mA' configurations are therefore recommended for applications where there is a long distance between the field device and the control room (e.g. > 750m), or where there are particularly strong sources of electrical noise and interference (e.g. heavy electrical plant) in the vicinity.

The isolated 4-20mA output(s) of ELDS units are passive. Correct operation of the 4-20mA output(s) in isolated mode requires a voltage source connected in series with the current loop, ideally built into the control card.

h. When a single wire is used as the primary 4-20mA signal carrying conductor, the current loop is completed by either the 0V or the +24V conductor running to the unit. In such 'single wire 4-20mA' configurations, any noise on the 0V or +24V rail is effectively introduced onto one side of the current sensing resistor in the 4-20mA loop. It is therefore beneficial to limit the level of noise and interference present on the system's 0V and +24V supply rails.

i. The level of noise on the 0V and +24V supply rails of a system can be reduced by choosing high quality power supplies that are rated for the continuous supply of the system's maximum calculated power requirement; and that have effective filtering on their outputs. Installation designers should avoid low cost, switched-mode power supplies with minimal output filtering because they are noisy, unreliable and become increasingly noisy over time.

j. The 24V supply providing power to field devices should be free from large transients and fluctuations.

k. The earth / ground at industrial facilities is typically very noisy; and therefore the level of noise on the 0V and +24V rails can be reduced by the use of power supplies that are isolated from earth / ground.

l. The use of a single, screened cable for each field device ensures maximum screening and minimum crosstalk. This should be the preferred cabling arrangement for field devices forming part of a multi-unit gas detection system.

m. Cabling arrangements which use a single multicore cable for connecting a large number of field devices compromise screening and increase the potential for crosstalk. Such arrangements should be avoided wherever possible.

n. The 4-20mA outputs of gas detectors are typically updated no more than a few times a second; whilst the electrical interference and noise introduced onto the cabling carrying a 4-20mA signal back to the control room can include components with frequencies ranging from 50Hz to 2GHz. In order to reduce false alarms due to electrical interference and noise it is therefore extremely beneficial for the 4-20mA inputs of gas detection control systems to be able to ignore high frequency components. This can be achieved by analogue filtering / conditioning of the 4-20mA input, or by appropriate processing of the digitized 4-20mA signal, or by a combination of the two. The installation designer is advised that failure to address this issue can result in an unacceptably high rate of false alarms in some industrial environments and applications.

o. All electrical equipment directly connected to a gas detection system should comply with applicable EMC standards such as EN50081, EN50270 & IEC 61000.

p. Radio, radar and satellite communication equipment is normally licensed to emit RF radiation at power levels greatly in excess of those allowed by EN50081, EN50270 & IEC 61000. Field devices should not be installed in close proximity to the antennae of radio, radar or satellite communication equipment; whilst additional filtering / screening measures may be required for reliable operation of field devices within 10 to 20 metres of such antennae.

q. The conductors carrying power to ELDS 1000 / 2000 Series units should have sufficient cross sectional area to ensure that the minimum supply voltage reaching units is 18V when they are drawing their maximum specified power. Refer to section 3.3.5 for information to assist with the selection of suitable cable.

r. The power consumption of each half of an ELDS 1000 / 2000 Series system is around 10W, which is sufficient to create a significant voltage drop due to the current flowing through the resistance of the field cabling. Where installation designers intend to ‘daisy chain’ the supply of power to an ELDS 1000 / 2000 Series system by running the +24V and 0V connections to one half of a system and from there to the other half - caution is advised. The voltage drop to the first half of the system will be the product of the total system current and the cable resistance to that point; whilst the voltage reaching the second half of the system will be still lower, further increasing the current drawn by this half of the system. A ‘daisy chain’ arrangement should be acceptable for systems installed within a few hundred metres of the control room, but for greater distances the installation designer will need to calculate the voltage drops and necessary cable resistances very carefully. Rather than use the same pair of conductors to carry +24V and 0V to the system it may prove better to use a separate pair of conductors to carry +24V and 0V to each half of the system.

s. All ELDS 1000 / 2000 Series units incorporate a power-up current limiting circuit. This circuit ensures that even during power-up, the current drawn by a unit never exceeds the maximum current that would be drawn by the unit when operating from the minimum supply voltage (18V). See 3.3.5.

t. All ELDS 1000 / 2000 Series units incorporate a brown-out survival reservoir. Under normal operating conditions this reservoir should be sufficient to enable the unit to continue operating without being reset by a +24V power brown-out of up to 10mS duration. The installation designer should therefore endeavour to ensure that any battery back-up or similar system should detect a brown-out and restore the +24V power rail within 5mS.

u. Whilst signalling readings using a 4-20mA current loop is considerably more robust than signalling readings using a voltage (which will normally drop between the field device and the control room) it is not completely immune to cable losses. Where long cable runs are employed between the field device and the control room it is possible for current to leak away through the insulation, reducing the current reaching the control room and therefore the apparent gas reading. (This can be misinterpreted as negative drift or warnings / faults being signalled.) Current leakage is not usually a problem in high quality cables manufactured from durable, resistant materials, but it can be a problem in lesser quality cables, especially after such cables have seen several years of service. The installation designer is advised to ensure that all of the insulation, protection and screening materials used in the construction of the cables employed will resist the effects of chemical attack, corrosion, mechanical wear and solar radiation that the cable is likely to experience over its anticipated service life. (Bear in mind that if the outer insulation perishes, water will get through to any armour and screening below, which will tend to corrode fairly rapidly. Once this has happened, you may have field conductors running in a solution of metallic corrosion products surrounded by an earthed conductor. This arrangement is ideal for bleeding current away from a 4-20mA loop, especially in wet conditions.)

v. Where a low noise instrument (clean) earth is employed, this instrument earth should only be connected to safety earth (usually dirty) at a single point on the site / installation. The location and arrangement of this connection should be carefully engineered to minimise the introduction of noise onto the instrument earth.

w. The terminal compartment of each ELDS 1000 / 2000 Series unit incorporates a single cable entry on the underside of the unit. This arrangement minimizes the potential for water ingress through the cable entry and discourages use of the terminal compartment for purposes for which it is not well suited. If the installation designer wishes to ‘daisy chain’ units or marshal the connections to several field devices, a separate junction box must be employed.

x. For compliance with ATEX requirements, the Ex d (flameproof) terminal compartment of ELDS 1000 / 2000 Series units can be entered by cables fitted with any suitable equipment certified ATEX cable gland (not a component).

For further details of installation requirements see ATEX Control Drawings in section 9.2.

y. For US/Canada (CSA (UL) the apparatus incorporates an integral threaded conduit entry (3/4”-14TPI). Install a conduit seal within 18 inches. In order to maintain ingress protection seal threads with a suitable material e.g. a non-hardening thread sealant or PTFE tape etc. (see Control Drawing in section 9).

3.3.2 Electrical Connections: Terminal Compartment

The Transmitter and Receiver units of the ELDS 1000 / 2000 Series OPGD both feature an integral terminal compartment which is to be used for making all electrical connections to the units. The terminal compartment is a flameproof design, and in order to comply with the applicable hazardous area protection standards, must be entered by a cable or conduit fitted with a suitable flameproof cable gland or conduit entry.

Prior to opening the terminal compartment it is recommended to slide forward the sunshade and remove the M6 X 12 screw together with the anti-tamper device using an M6 Allen key (supplied). Retain all components, and refit when installation is complete. Access to the electrical connections inside the terminal compartment can then be gained by unscrewing the threaded rear cover.
A 12mm Allen key wrench (supplied) can be used to loosen the rear cover.

3.3.3 Receiver Electrical Connections

The terminal compartment of the Receiver of an ELDS 1000 / 2000 Series OPGD contains a 12-way terminal block, by means of which most electrical connections to the unit can be made. The terminal block is capable of accepting wires of up to 2.5mm^2 or compatible bootlace ferrules. The terminal numbers, connection labels and proper functions of the connections available via the Receiver terminal block are detailed in the table below:

Terminal No.	Connection Label	Function
1	+24V	Positive connection to system power supply.
2	0V	Negative or zero volt connection to system power supply.
3	LOCAL +24V	Local connection to +24V to configure 4-20 (1) as source.
4	4-20 (1) SNK	Sink + connection for 4-20 (1)
5	4-20 (1) SRC	Source - connection for 4-20 (1)
6	LOCAL 0V	Local connection to 0V to configure 4-20 (1) as sink.
7	LOCAL +24V	Local connection to +24V to configure 4-20 (2) as source.
8	4-20 (2) SNK	Sink + connection for 4-20 (2)
9	4-20 (2) SRC	Source - connection for 4-20 (2)
10	LOCAL 0V	Local connection to 0V to configure 4-20 (1) as sink.
11	RS485 (A)	Connection to RS485 (A) (Also Modbus output.)
12	RS485 (B)	Connection to RS485 (B) (Also Modbus output.)

Conductors and insulation should be rated for operation at temperatures ≥ 85°C.

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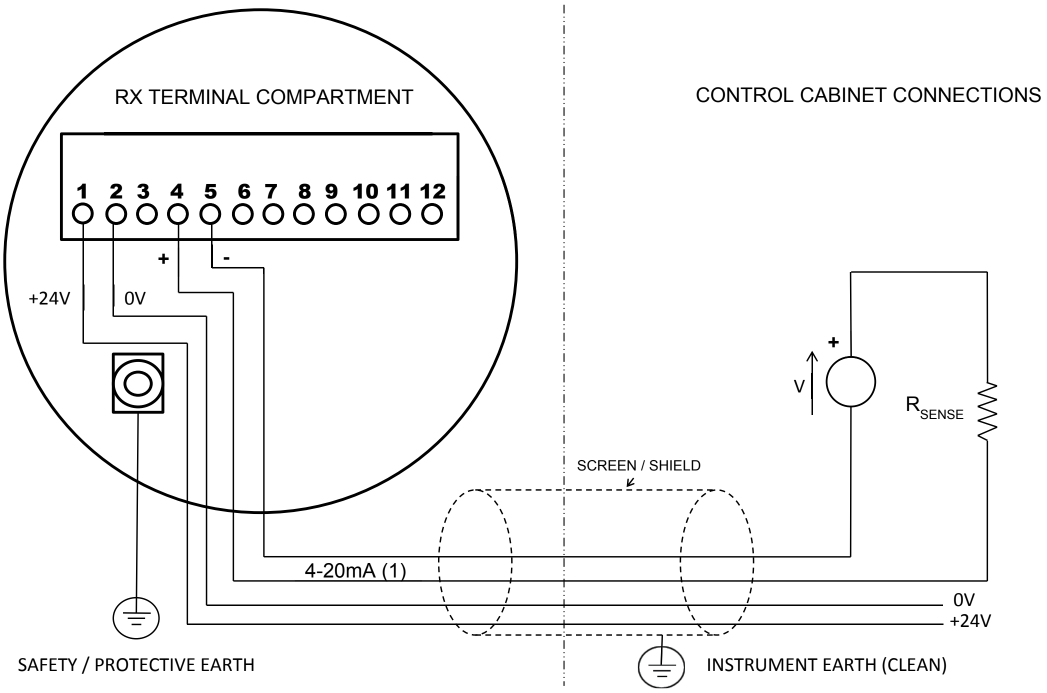
Wiring Diagram for ELDS 1000 Receiver with Isolated 4-20mA Output



The isolated 4-20mA output(s) of ELDS units are passive. Correct operation of the 4-20mA output(s) in isolated mode requires a voltage source connected in series with the current loop, ideally built into the control card.

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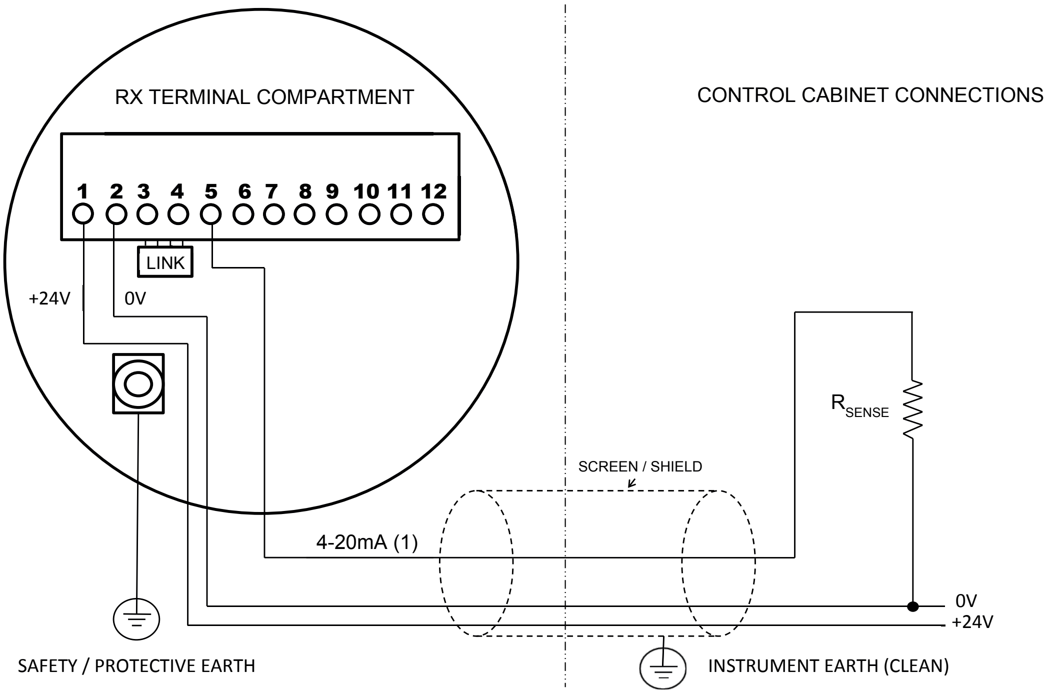
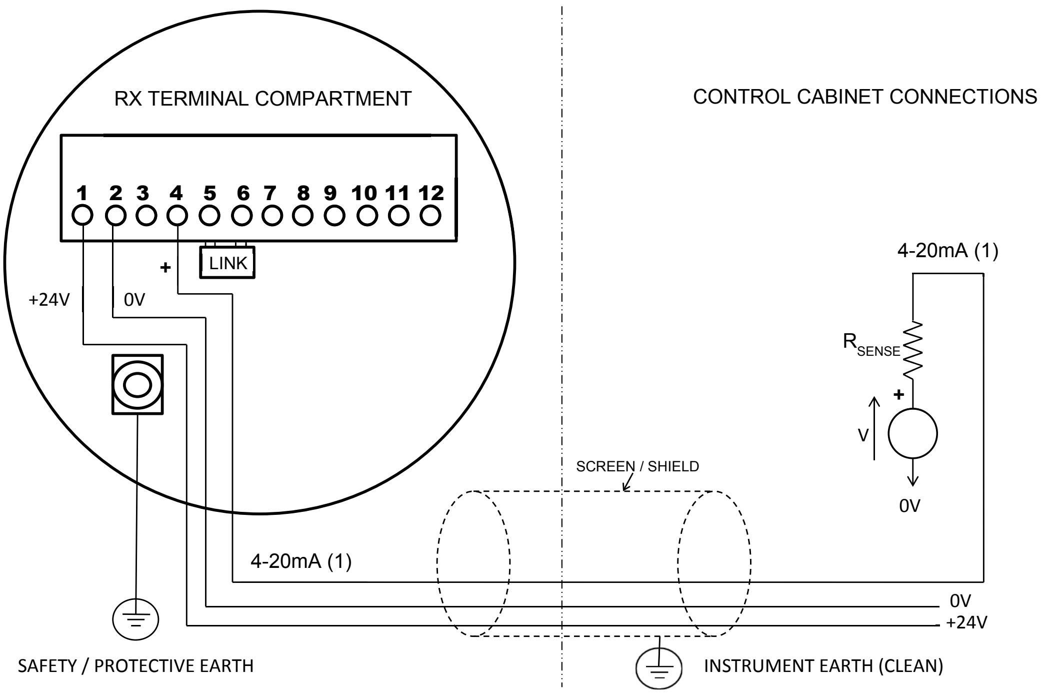
Wiring Diagram for ELDS 1000 Receiver with Current Source @ 4-20 (1)



Wiring Diagram for ELDS 1000 Receiver with Current Sink @ 4-20 (1)



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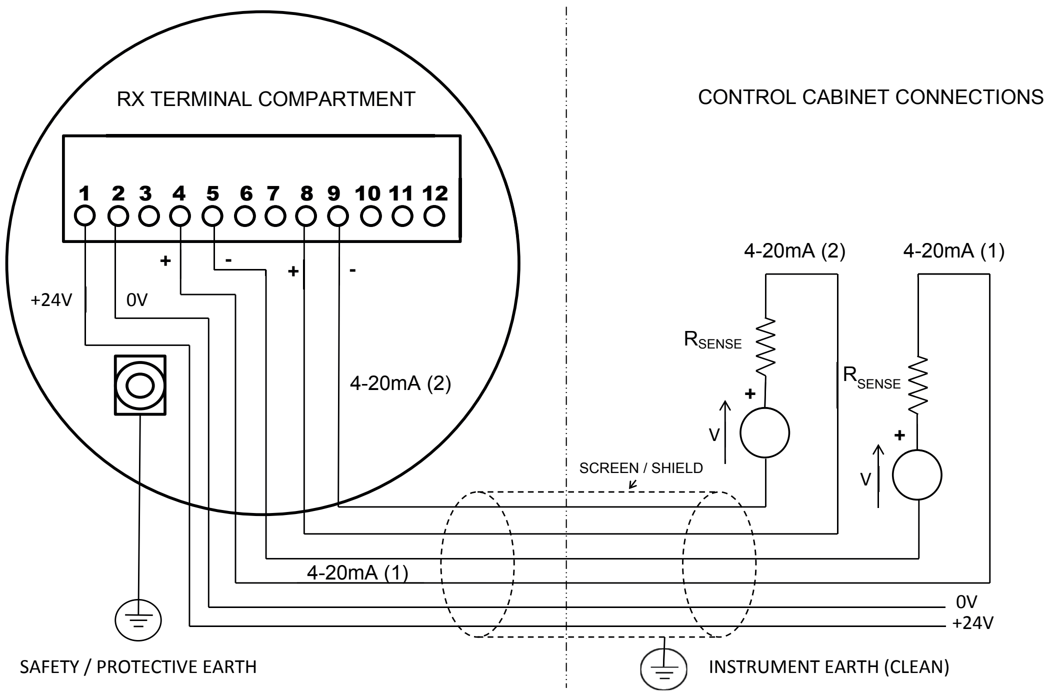
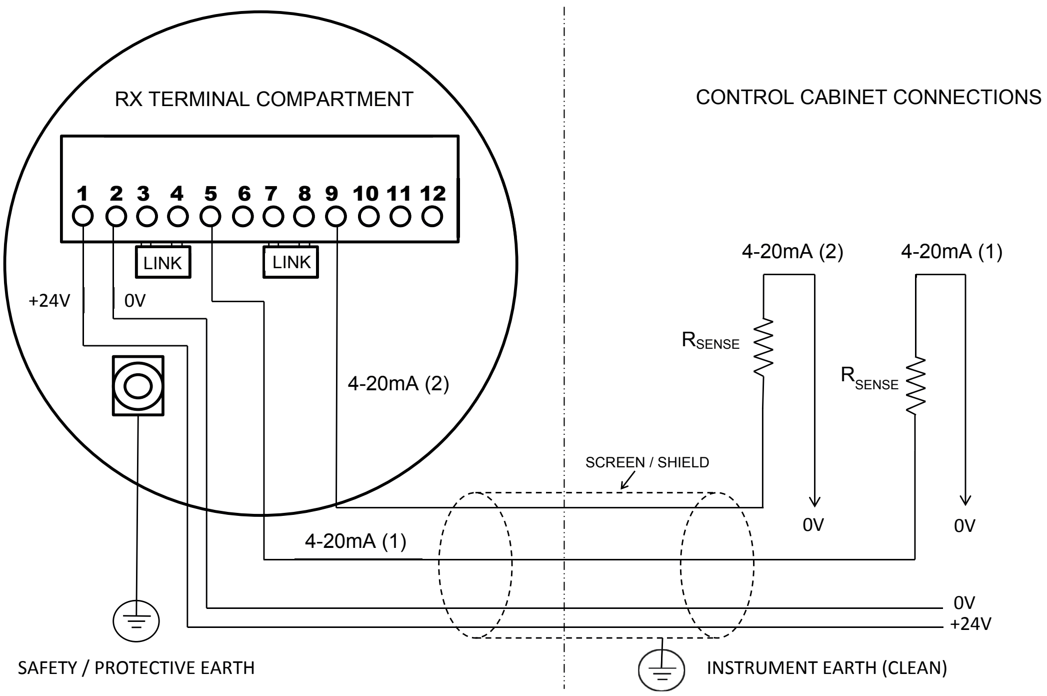
Wiring Diagram for ELDS 2000 Receiver with Isolated 4-20 (1) & 4-20 (2)



The isolated 4-20mA output(s) of ELDS units are passive. Correct operation of the 4-20mA output(s) in isolated mode requires a voltage source connected in series with the current loop, ideally built into the control card.

GB

Wiring Diagram for ELDS 2000 Receiver with Current Sources @ 4-20 (1) & 4-20 (2)



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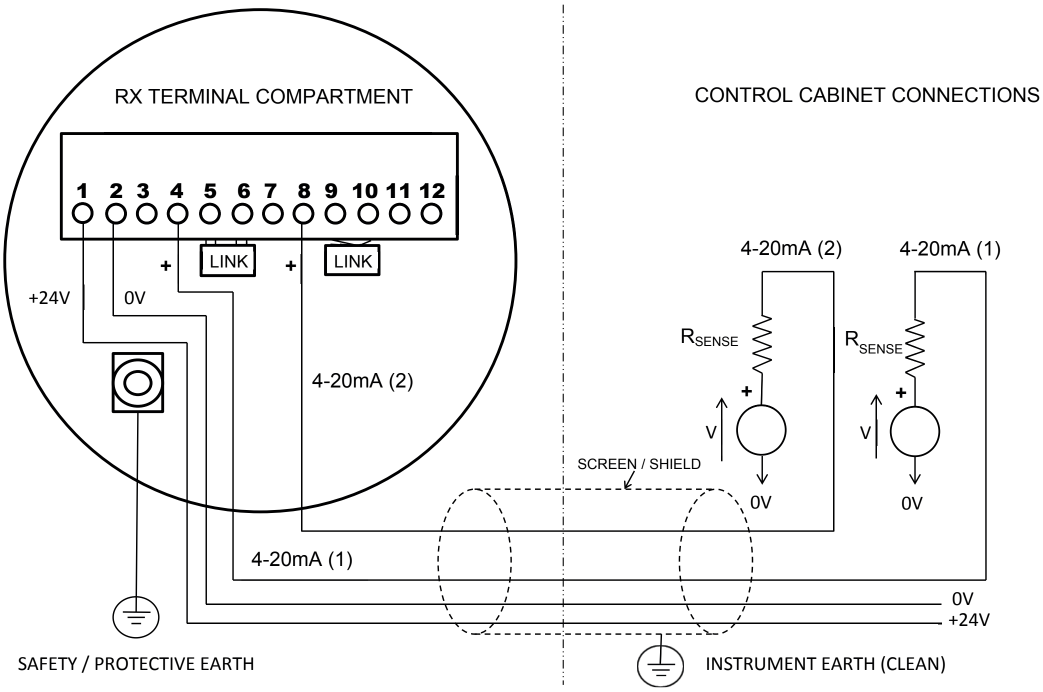
Wiring Diagram for ELDS 2000 Receiver with Current Sinks @ 4-20 (1) & 4-20 (2)



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3.3.4 Transmitter Electrical Connections

The terminal compartment of the Transmitter of an ELDS 1000 / 2000 Series OPGD contains a terminal block, by means of which most electrical connections to the unit can be made. There are two types of terminal block that can be fitted in the terminal compartment of an ELDS transmitter, an 8 way terminal block that provides the means of connecting power, 4-20mA and RS485; and a 4 way terminal block that provides the means of connecting power and RS485. From Q4 2016 onwards the standard terminal block fitted in ELDS transmitters will become the 4 way terminal block (the transmitter 4-20mA output was removed).

The terminal block terminals are capable of accepting wires of up to 2.5mm^2 or compatible bootlace ferrules. The terminal numbers, connection labels and proper functions of the connections available via the Transmitter terminal block are detailed in the tables below:

8 Way Transmitter Terminal Block

Terminal No.	Connection Label	Function
1	+24V	Positive connection to system power supply.
2	0V	Negative or zero volt connection to system power supply.
3	LOCAL +24V	Local connection to +24V to configure 4-20 (1) as source.
4	4-20 (1) SNK	Sink + connection for 4-20 (1)
5	4-20 (1) SRC	Source - connection for 4-20 (1)
6	LOCAL 0V	Local connection to 0V to configure 4-20 (1) as sink.
7	RS485 (A)	Connection to RS485 (A) (Also Modbus output.)
8	RS485 (B)	Connection to RS485 (B) (Also Modbus output.)

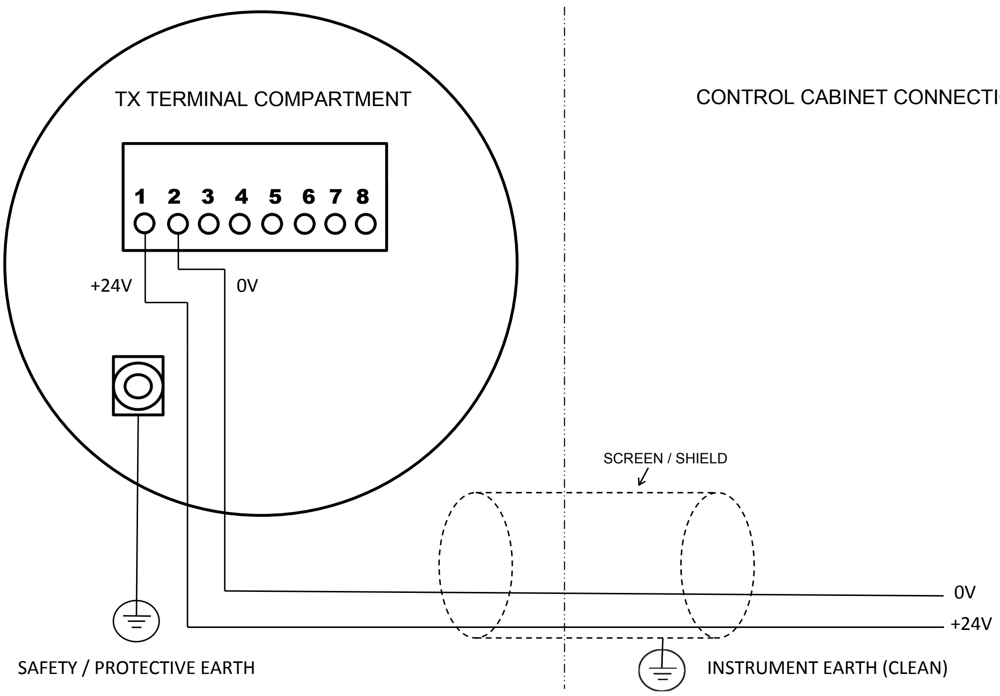
4 Way Transmitter Terminal Block

Terminal No.	Connection Label	Function
1	+24V	Positive connection to system power supply.
2	0V	Negative or zero volt connection to system power supply.
3	RS485 (A)	Connection to RS485 (A) (Also Modbus output.)
4	RS485 (B)	Connection to RS485 (B) (Also Modbus output.)

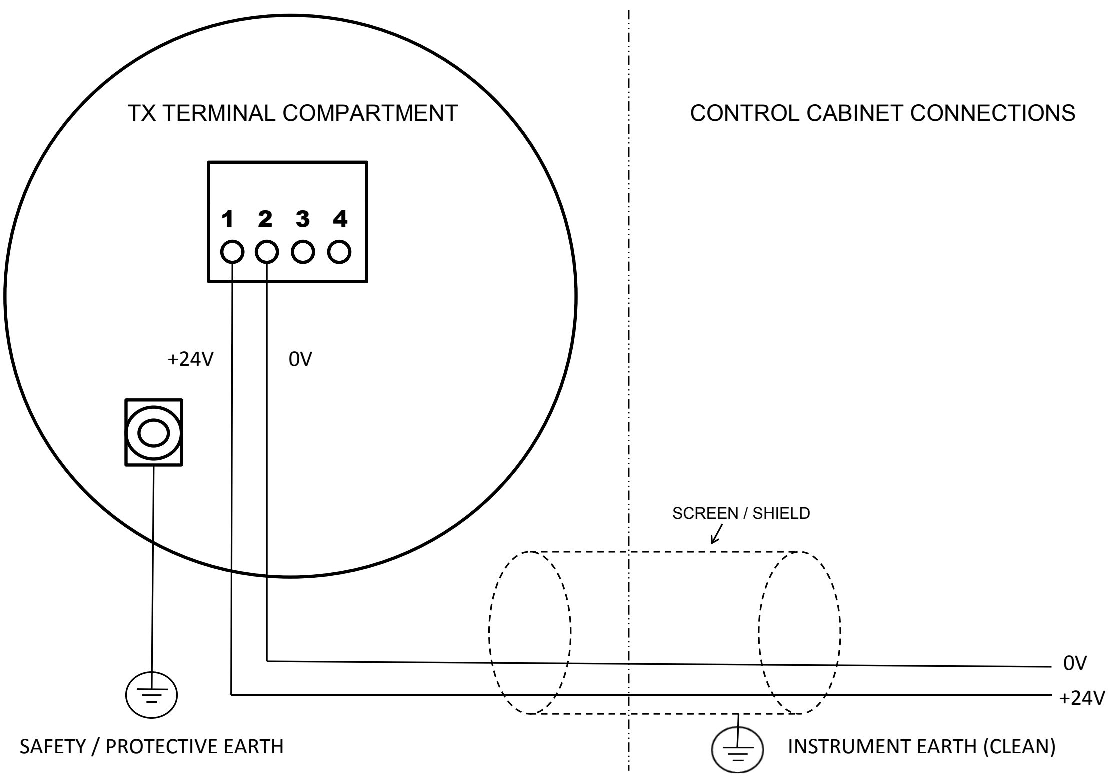
Conductors and insulation should be rated for operation at temperatures ≥ 85°C.

GB

Wiring Diagram for ELDS 1000 / 2000 Series Transmitter (8 Way Block)



Wiring Diagram for ELDS 1000 / 2000 Series Transmitter (4 Way Block)



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Power Supply Connections, Wiring & Fuses

The Senscient ELDS™ gas detector is designed to be operated from a nominal 24V DC supply. For correct operation, the supply voltage reaching the terminals must be within the range 18V to 32V.

The unit maximum power consumption and cable lengths are as follows:

Component	Maximum Power Consumption, W	Maximum Cable Length, m with 1.5mm^2 Conductors (12Ω/km)	Maximum Cable Length, m with 2.5mm^2 Conductors (7.6Ω/km)
Receiver	10W	450	710
Transmitter	12W	375	590

Control room supply voltage assumed to be +24V.

Terminal sizes:	Transmitter	0.5mm^2- 2.5mm^2 (20AWG - 14AWG)
	Receiver	0.5mm^2 – 2.5mm^2 (20AWG - 14AWG)

In order to avoid power supply interruptions due to fuse ageing / degradation, it is advisable to use a fuse in the power feed to the ELDS units that is sufficiently de-rated. The recommended fuse ratings for the power supply feeds to ELDS units are therefore as follows:

ELDS Unit(s) Supplied	Minimum Fuse Rating	Recommended Fuse Rating
Receiver (1)	0.75A	1A
Transmitter (1)	1A	1.5A
Receiver (1) plus Transmitter (1)	1.75A	2.0A

GB

4. Installation & Commissioning

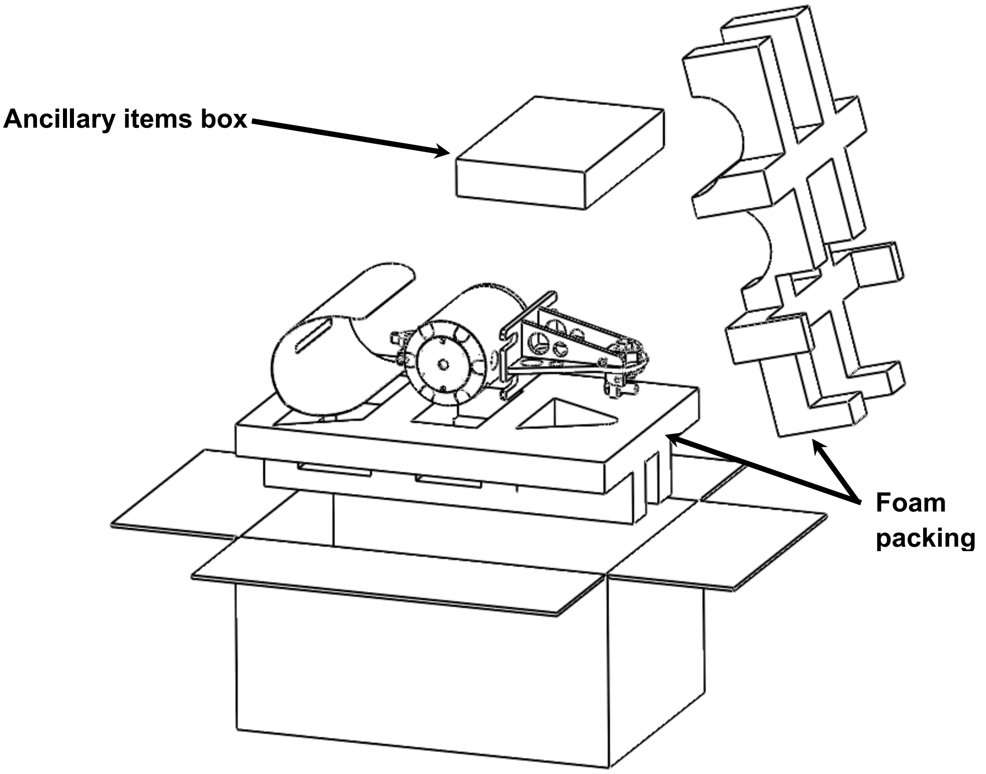
4.1. Unpacking an ELDS 1000 / 2000 Series System

Each ELDS 1000 / 2000 Series system is shipped inside custom-designed packaging intended to provide substantial protection of the units during shipment and handling.

Before unpacking the two boxes that contain a complete ELDS OPGD system, inspect the packaging for any external signs of damage.

Carefully unpack the equipment, observing any instructions that may be printed on or contained within the packaging. Check the contents for damage and against the packing note for deficiencies.

NB: In the event of damage or loss in transit, notify the carrier and Senscient or your local agent immediately.



NB: Ensure that the installer/end user of the equipment receives the technical documentation (operating instructions, manuals, etc.) contained in the packaging.

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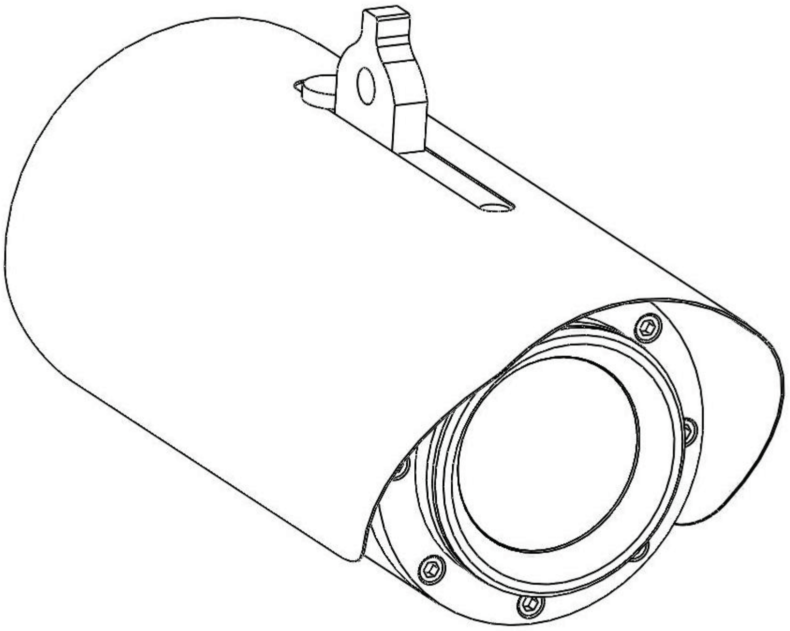
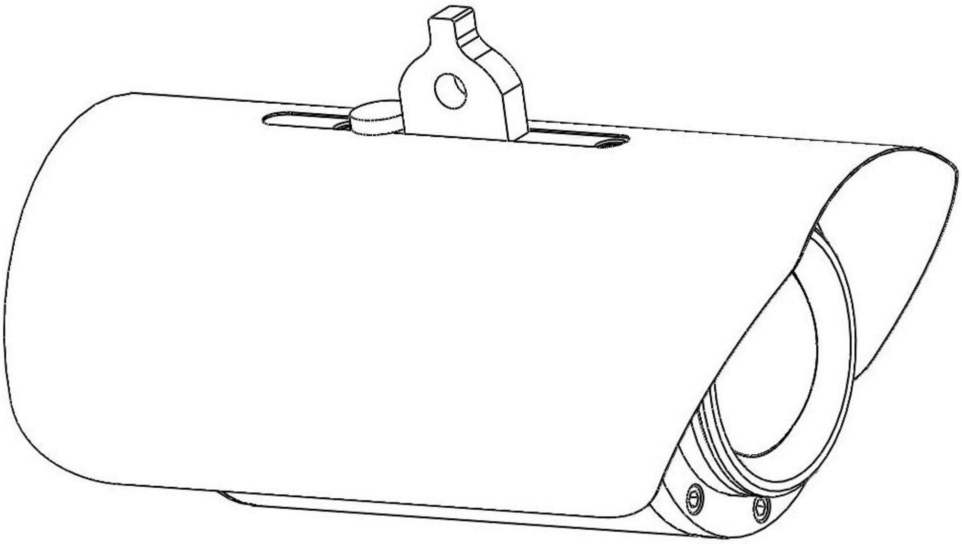
A complete shipment of an ELDS 1000 / 2000 Series OPGD system consists of the following items.



1 x ELDS™ Transmitter Assembly



1 x ELDS™ Receiver Assembly

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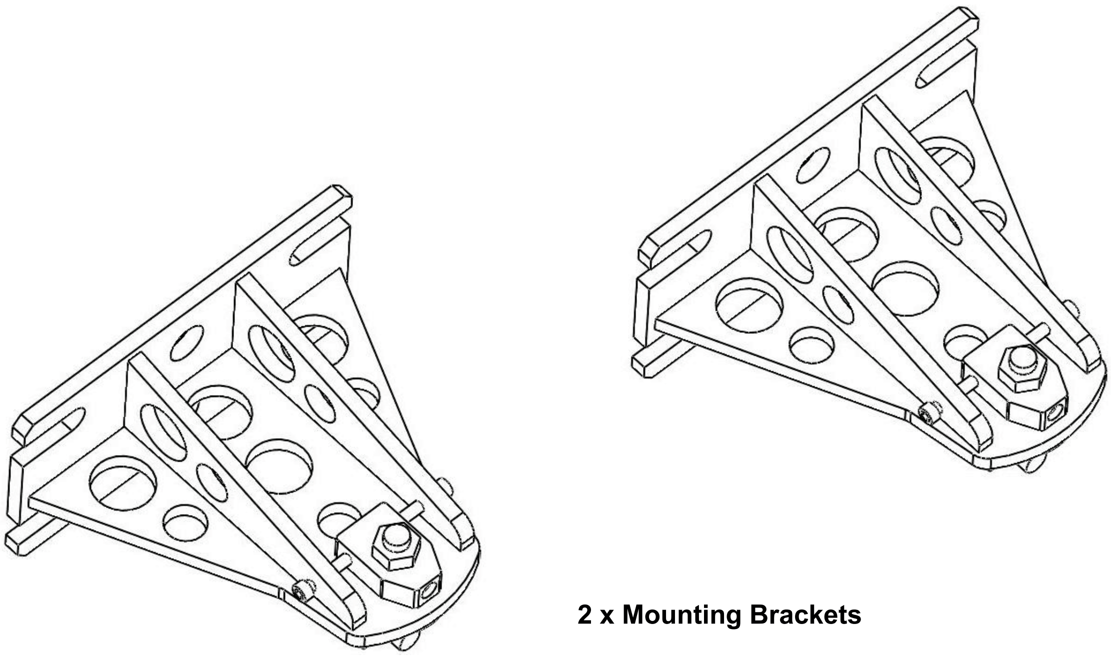
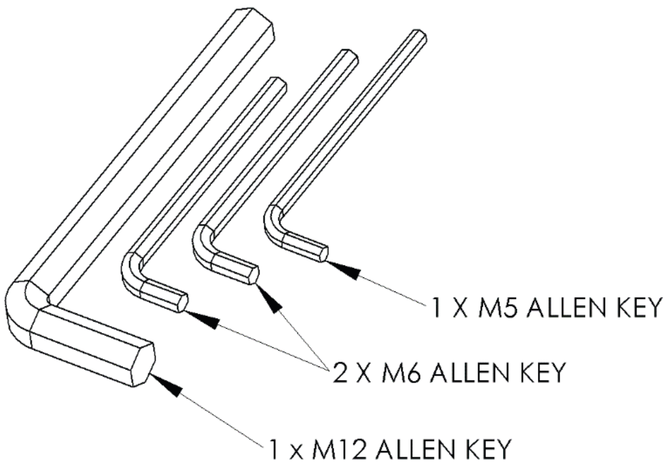


2 x Mounting Brackets



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4.2. Installation Procedure

4.2.1 General

The Senscient ELDS™ 1000 / 2000 Series OPGD is designed to allow installation and alignment to be performed by a single, trained technician.

The installation procedure is split into mechanical installation and electrical installation. Each unit needs to be mounted to a supporting structure before making the electrical connections.

4.2.2 Mechanical Installation

The mechanical installation procedure applies to both the Receiver and the Transmitter.

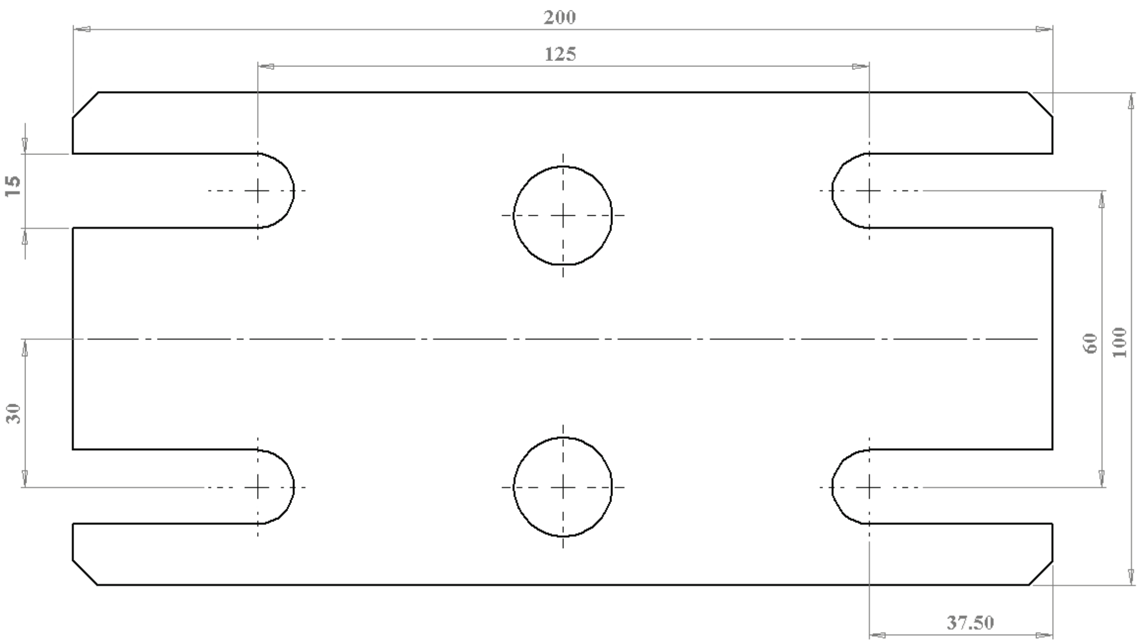
(1) Check that the gas detector equipment supplied is compatible with the required application (i.e. correct gas and operating range for application).

(2) Ensure that the Hazardous Area Certification of the equipment supplied is correct for the Hazardous Areas / Hazardous (Classified) Locations / Hazardous Zones where the equipment is to be installed.

(3) Check that the locations selected for siting the equipment are suitable - see section 3.2

(4) For each unit (Tx and Rx) fix the mounting bracket using one of the procedures described in the following sections.

Wall Mounting



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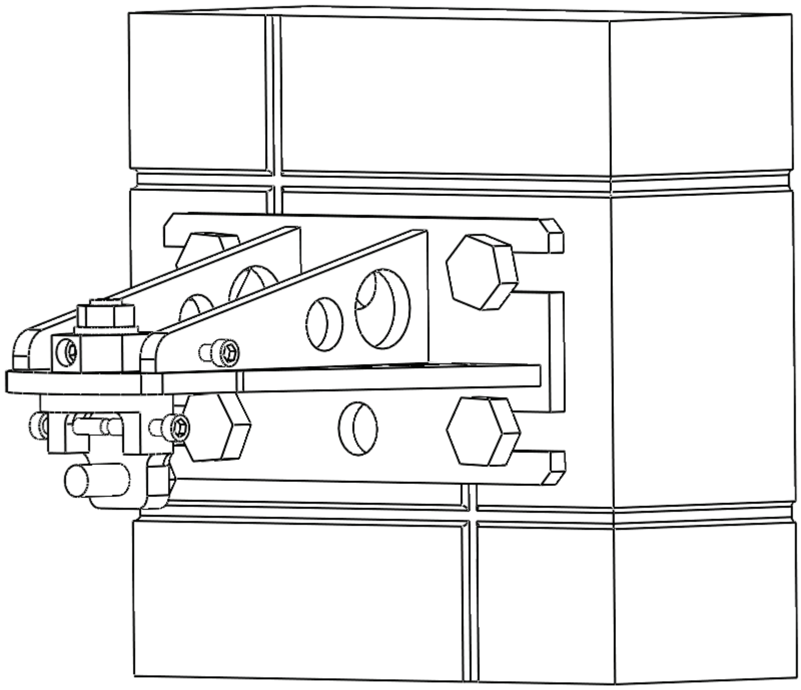
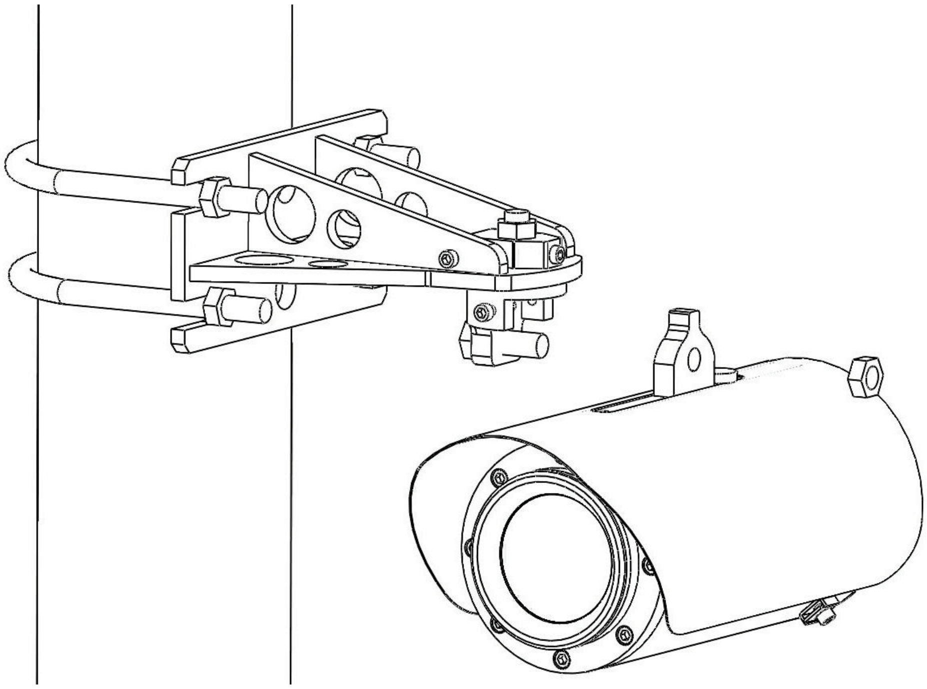
Schematic of Bracket Baseplate Showing Slot Positions for Bolts / U Bolt Fixings

Attach the mounting bracket to the wall or similar vertical surface using suitable fixing bolts as illustrated below. The choice of fixing will depend on the nature of the surface and should take regard of the weight of the unit (~13kg).



Pole Mounting

Attach the mounting bracket to the pole using suitable fixings. It is suggested that U bolts are used as illustrated below; however other techniques may also be considered provided the unit is securely attached to the pole and is prevented from slipping or rotating around the pole.



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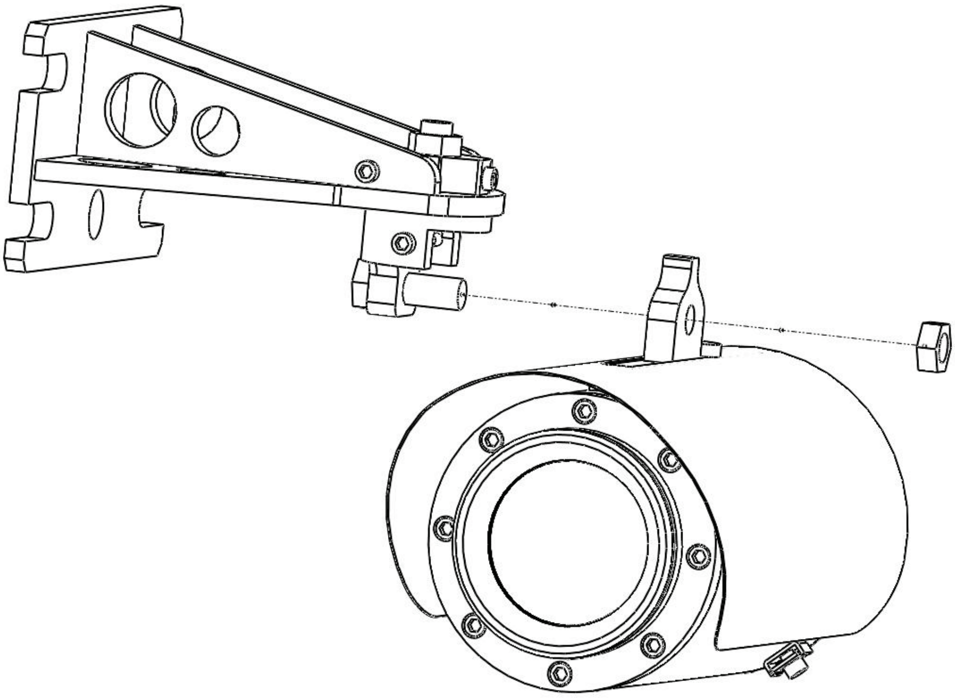
Mounting a Transmitter or Receiver

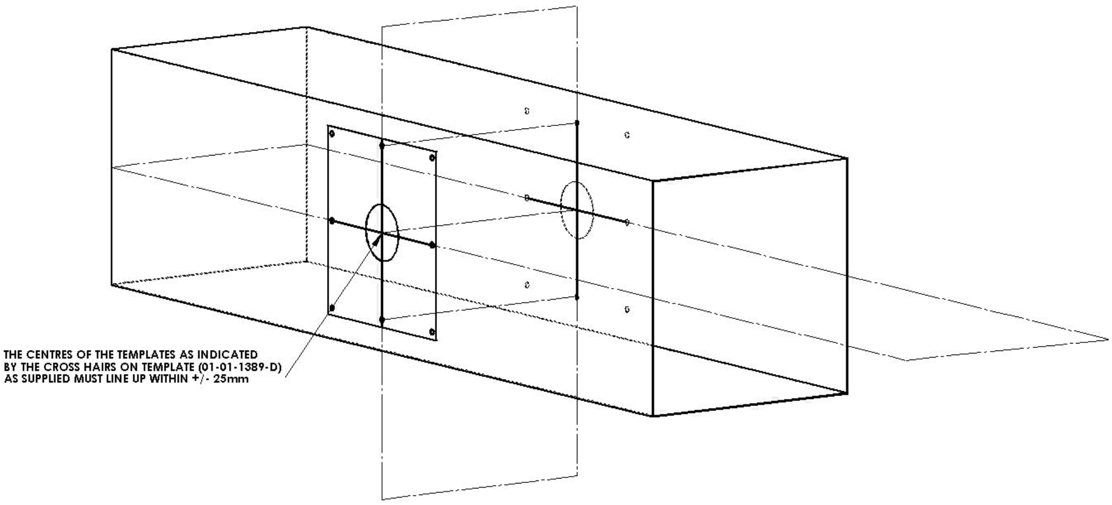
Mount a Transmitter or Receiver unit onto the bracket as illustrated below. The retaining nut should be tightened to 45Nm (wrench tight) to ensure that the unit is secure.



Mounting a Cross Duct Transmitter or Receiver

Attach the self-adhesive mounting templates to the duct wall in the position identified for mounting of the Cross Duct ELDS system. Using the templates, drill and cut the necessary mounting holes in the opposite sides of the duct.

The most important requirement for successful installation of a Cross Duct ELDS system is that the optical centre lines, as indicated by the cross-hairs on the self-adhesive templates are opposite each other on the duct wall.



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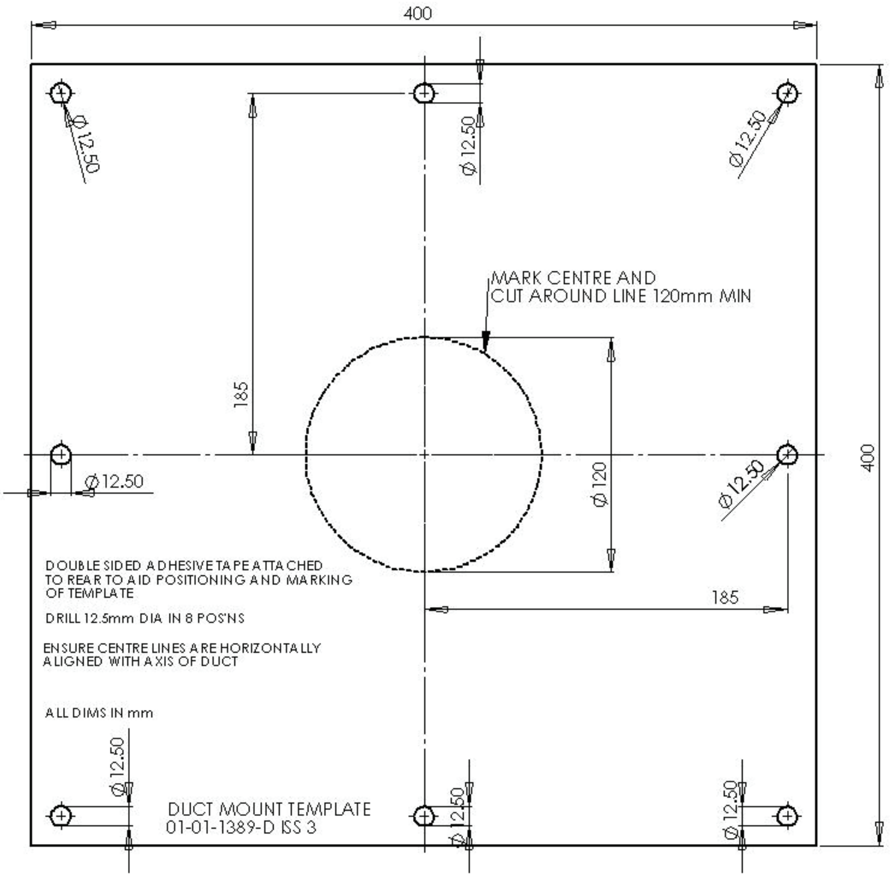
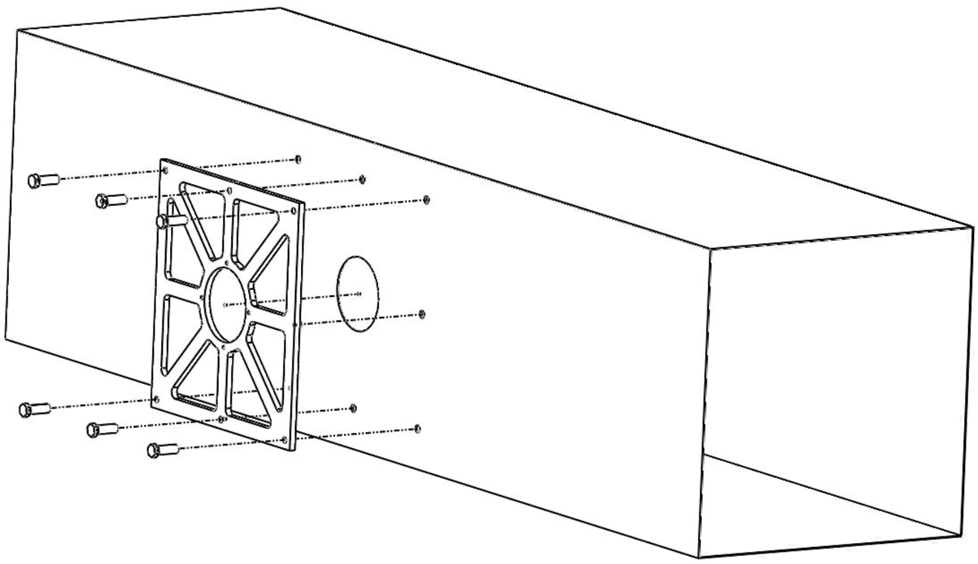
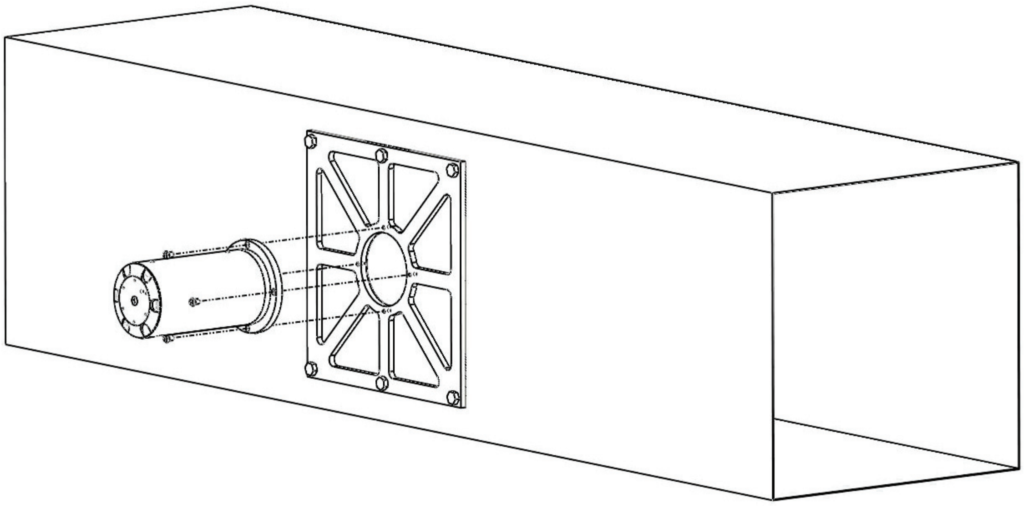
Cross Duct ELDS Mounting Template 01-01-1089-D



Bolt Mounting Plates on each side of the duct.



Bolt a Transmitter or Receiver unit to the corresponding Mounting Plate.



4.2.3 Electrical Installation

Perform electrical installation in accordance with the applicable Codes of Practice or Guidelines for the installation of electrical apparatus in Hazardous Areas/Zones.

CAUTION
Before electrical installation ISOLATE or switch OFF all associated power supplies and ensure that they remain ISOLATED or OFF during the electrical installation.

The electrical installation process should include the following steps:

1. Removal of the red plastic bungs from the terminal compartment cable entry.
2. Screwing a suitable explosion-proof M25 cable gland or ¾” NPT conduit fitting into the terminal compartment entry and making this off.
3. Feeding of field cabling or wires through the cable entry into the terminal compartment.
4. Connecting the wires required for the field connections to the unit to the appropriate terminals of the terminal block. (See section 3.3)
5. Connecting the unit’s case to safety earth / ground (equipotential bonding) using one of the internal or external earthing points provided.
6. Verification of correct connectivity back to the control room / gas detection monitoring system.

Detailed information and recommendations relating to the design and engineering of the electrical installation of ELDS OPGDs is presented in section 3.3.

GB

4.3. Alignment

In order to maximize operational reliability and availability, Senscient recommends that the alignment and commissioning of ELDS™ 1000 / 2000 Series OPGDs should be performed by personnel trained by Senscient (or authorised training partners).

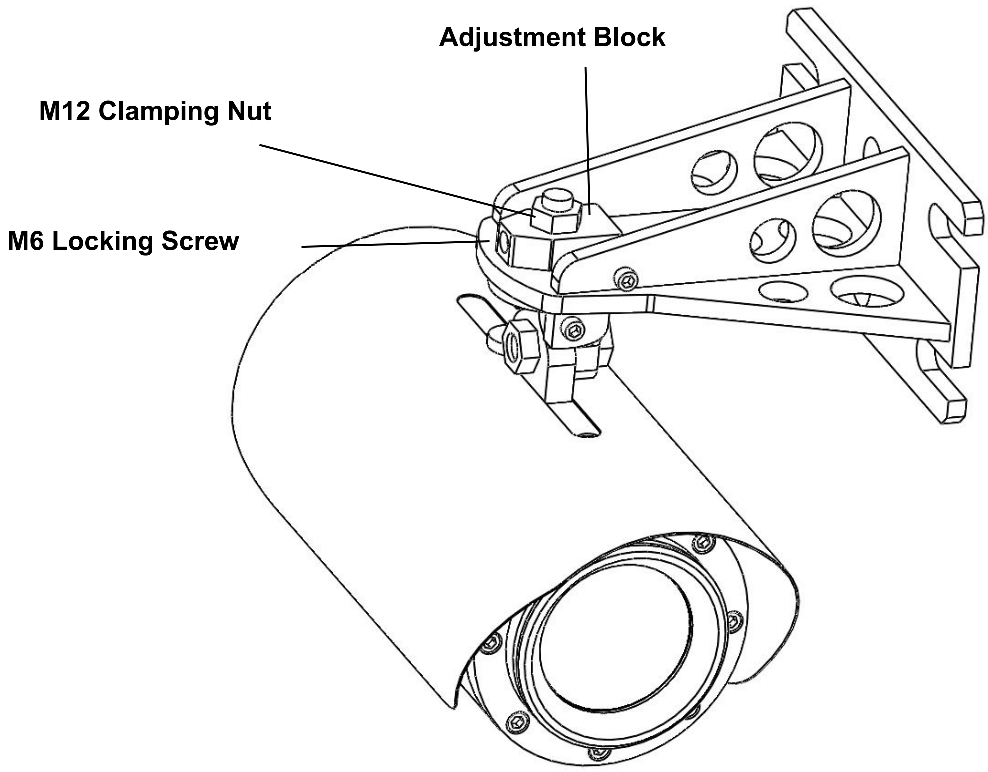
Alignment and commissioning of ELDS OPGDs can be performed by a single technician using the alignment telescope and the Senscient Installation & Test Environment (SITE) running on an industrial computer.

WARNING
Do not attempt to view the Sun through the optical telescope.

4.3.1 Initial Pointing

The mounting bracket of ELDS OPGDs is designed to enable Transmitter and Receiver units to be initially pointed in the direction of their counterpart without use of the alignment telescope or the precision adjustment mechanisms. Loosening the M12 nut and M6 locking screw on the adjustment block allows the unit hanging below to be quickly pointed in the direction of its counterpart.

Once each unit is pointing in the direction of its counterpart, the M6 locking screw should be tightened, followed by the M12 nut. Further adjustments will then only be possible by use of the precision adjustment mechanisms.



The M12 clamping nut and M6 locking screw must be fully tightened before final alignment using the telescope.

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4.3.2 Final Alignment Using Telescope

Final alignment of ELDS OPGDs can be performed by a single technician using the following equipment:

- Alignment Telescope (see APPENDIX B, section 12)
- 2×M6 hex (Allen) key

CAUTION
The alignment telescope is a precision optical alignment device. Dropping or mishandling of the alignment telescope may result in the telescope becoming incorrectly aligned. If you DROP or DAMAGE an alignment telescope STOP using it; and either CHECK that the alignment is still good using the process described in section 4.3.2, or RETURN it to Senscient for checking and re-alignment.

Notes:

- Ideally, final alignment should be performed on a clear, dry day.
- Get familiar with the workings of the adjustable parts of the mounting bracket before proceeding with the alignment procedure (See section 2.4).
- To ensure precise field alignment, the alignment telescope makes use of the same mounting datum that was used when the unit was aligned in the factory.
- The telescope incorporates eye relief adjustment for comfortable viewing. The eyepiece should be rotated to focus the image.
- Keep the telescope and prism optics clean.
- Do NOT try to adjust the cross-hairs using the telescope's elevation and windage adjusters. These were precisely set in the factory and CANNOT be adjusted to this precision in field conditions.
- If the telescope is damaged or misaligned it will need to be returned to the factory for repair and/or realignment.

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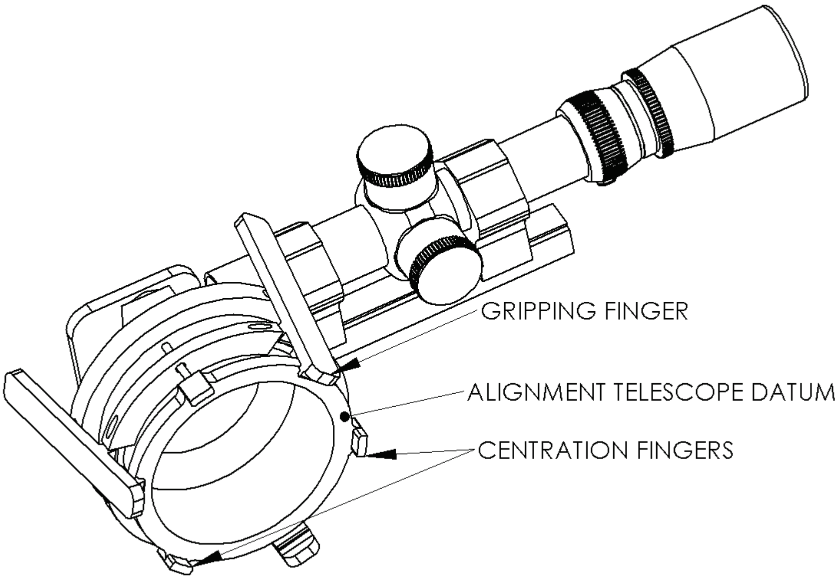
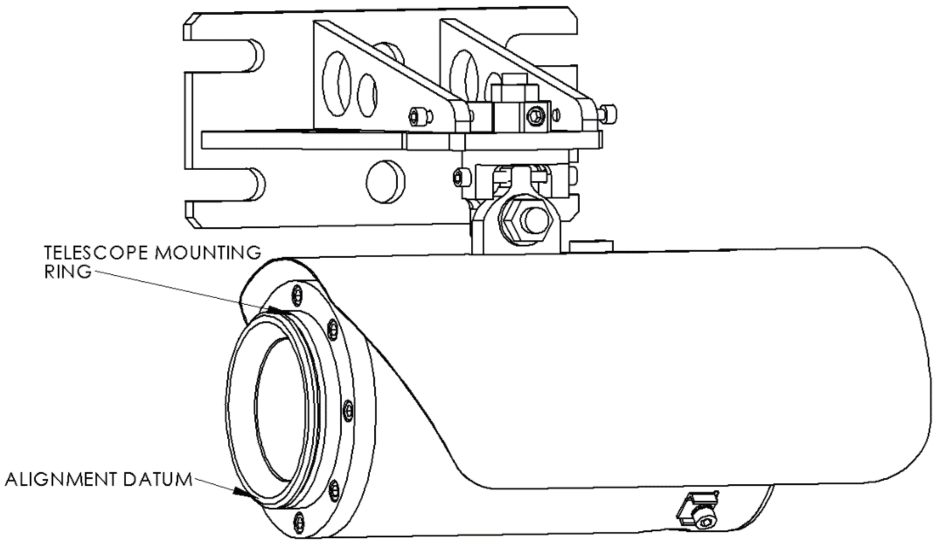
Attaching the Alignment Telescope

The primary objective when attaching the alignment telescope to a unit to be aligned is to get the alignment telescope's datum sitting correctly on the unit's alignment datum.

The alignment telescope's datum is the flat, circular ring inside the three centration fingers on the bottom of the alignment telescope mounting mechanism.



The unit's alignment datum is the flat, circular ring on the front of each unit's telescope mounting ring.



When the alignment telescope is correctly mounted, its datum is sitting flat against the unit's alignment datum.

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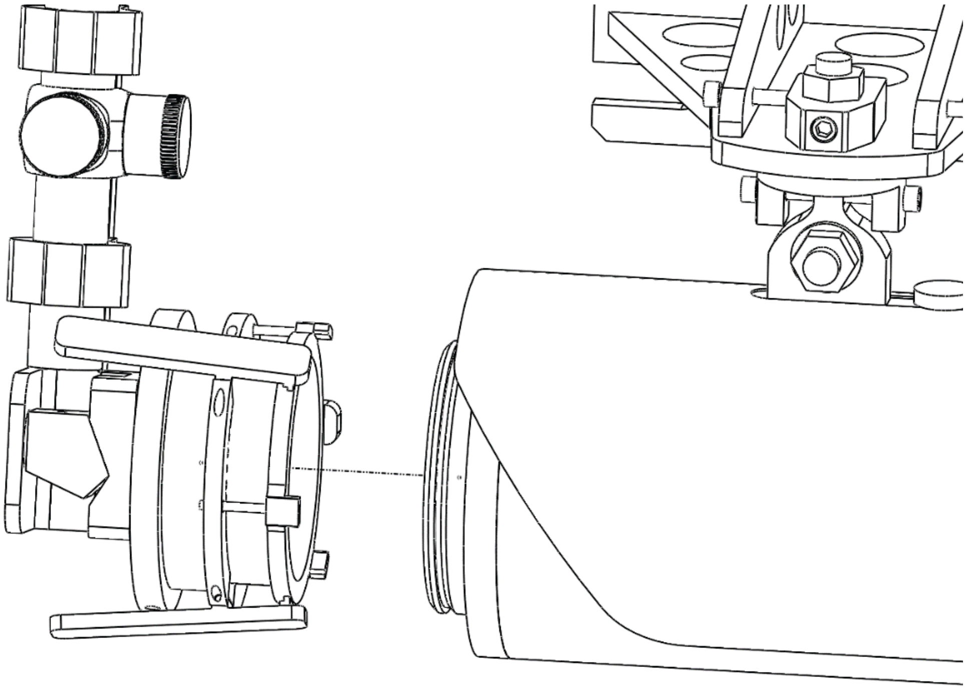
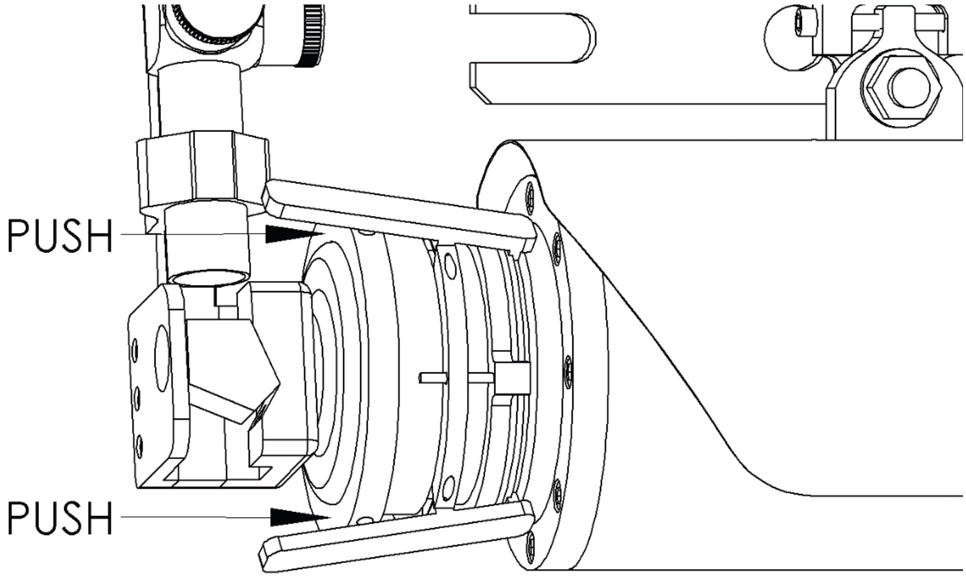
The simplest procedure for correctly attaching the alignment telescope is as follows:

(1) Hold the alignment telescope in one hand, with the three centration fingers ready to locate on the edge of the telescope mounting ring.



(2) With the centration fingers touching the edge of the telescope mounting ring, firmly push the back surface of the gripping mechanism forwards towards the unit.



(3) Push the back surface of the gripping mechanism forward until all three (3) gripping fingers have clicked into the gripping recess on the telescope mounting ring.

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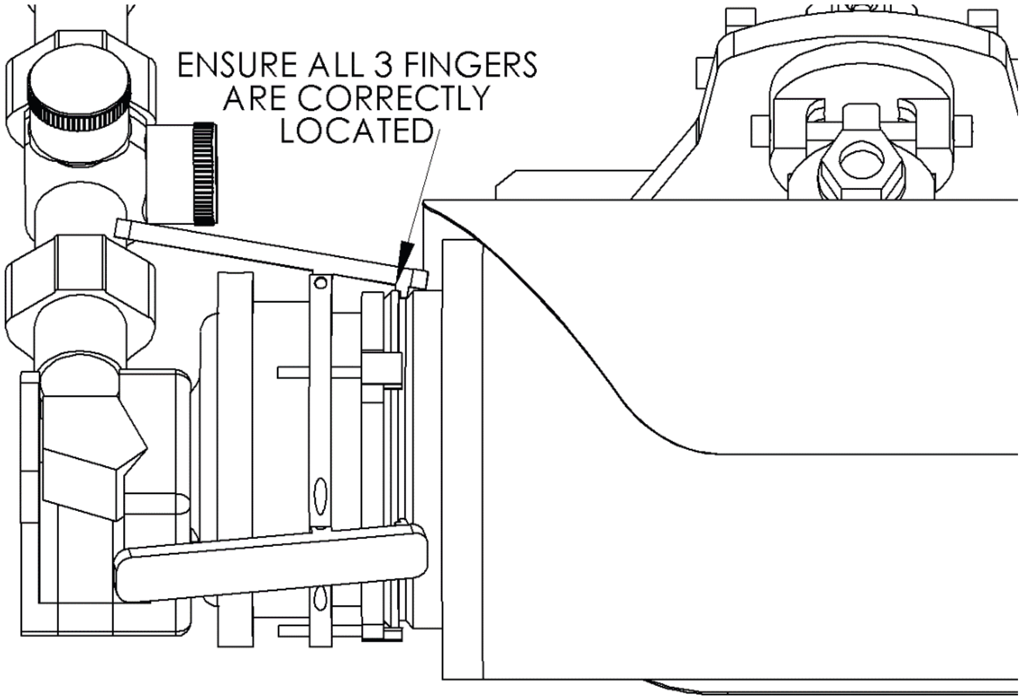

(4) When all three (3) gripping fingers have clipped into the gripping recess on the telescope mounting ring, carefully release the alignment telescope, allowing it to be pulled against the unit's mounting datum by the gripping mechanism.

(5) Double check that the alignment telescope is correctly mounted by checking that all three (3) gripping fingers are clicked into the gripping recess and that the alignment telescope's mounting datum is in contact with the unit's alignment datum all the way around the mounting ring.

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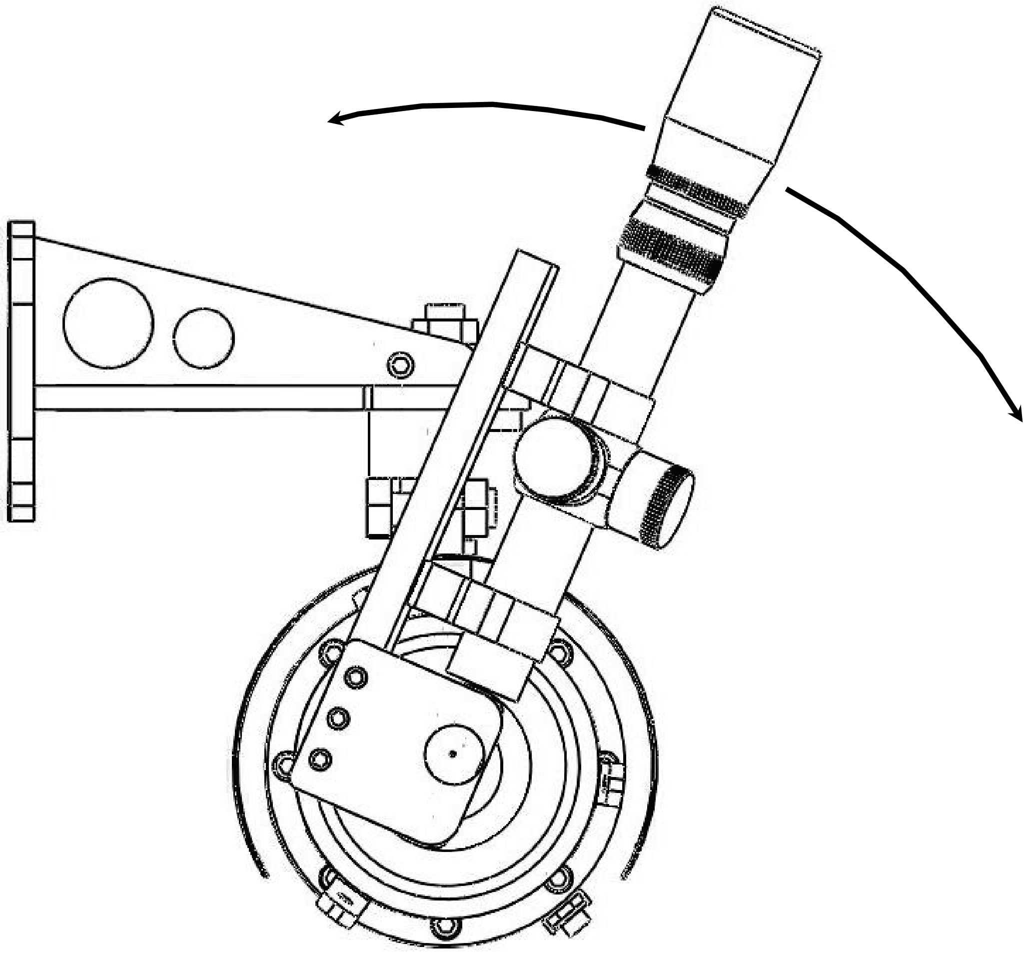
(6) Once the alignment telescope is correctly mounted on the unit's alignment datum, gently rotate the telescope such that the eye-piece is in a convenient position for viewing.

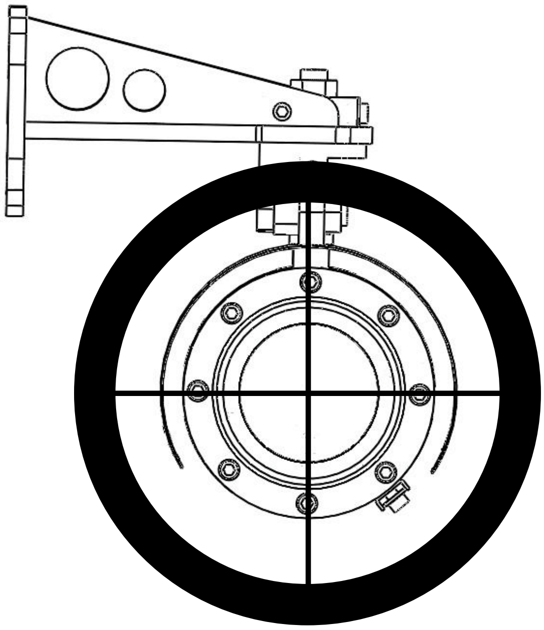


(7) With the eye-piece in a convenient position for viewing and the alignment datum's in contact, the alignment telescope is ready for use.

Final Alignment Procedure

Final alignment of Transmitter or Receiver units can be performed using just the alignment telescope and the precision adjustment mechanisms built into the mounting brackets.

The primary objective of the final alignment procedure is to align each unit such that the crosshairs on the alignment telescope is in the centre of the lens-window of the opposing unit as illustrated below:

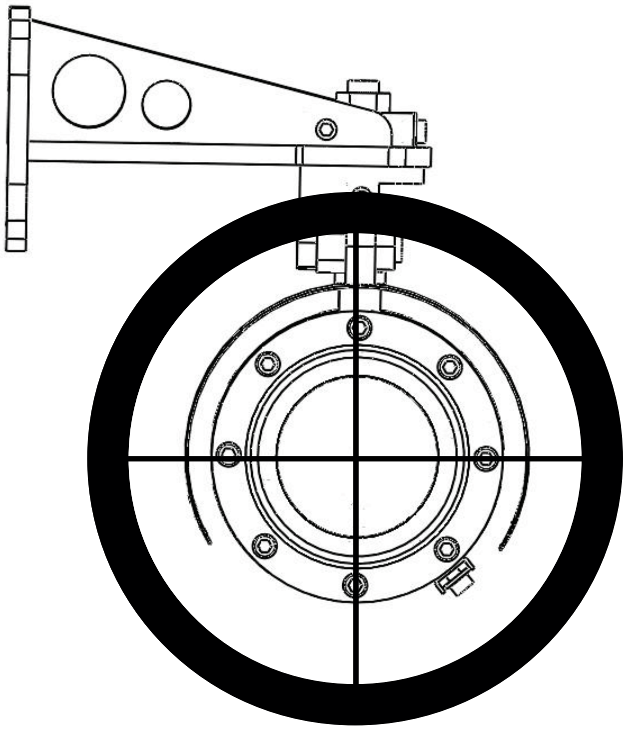


Correct Final Alignment

Notes:

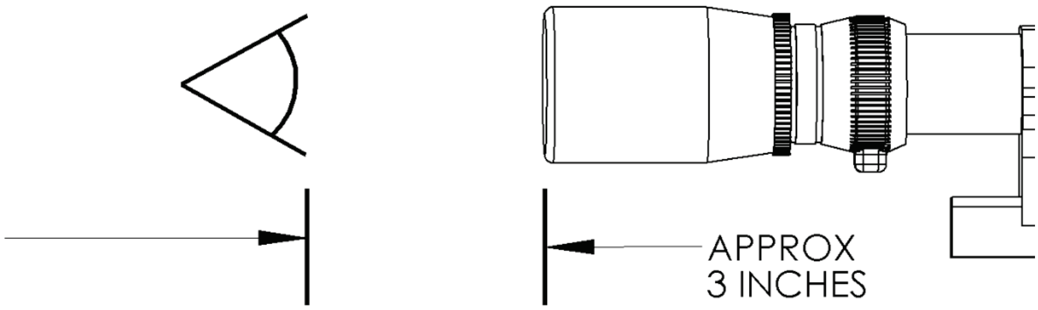
- Unlike NDIR OPGDs, Senscient ELDS 1000 / 2000 Series OPGDs are not critically sensitive to alignment.
- A small improvement in alignment can be achieved by performing alignment adjustments whilst monitoring the received signal levels using SITE running on an industrial computer. However, for ELDS 1000 / 2000 Series OPGDs these small improvements are not important or necessary. ELDS OPGD systems aligned by the correct use of the alignment telescope will perform to full specification without further alignment tuning.

In order to use the alignment telescope correctly, it is necessary to view the image produced by the telescope correctly. This requires the user to position one of their eyes on the axis of the alignment telescope. When the eye is on axis, the user will see a symmetrical, circular image field. See below:



Eye on-axis

To see the full field-of-view of the alignment telescope, the user should position their eye approximately 3 inches away from the eye-piece (See below). The alignment telescope features an eye-relief adjustment which can be adjusted to make it easier for different individuals to focus on the telescope's image.



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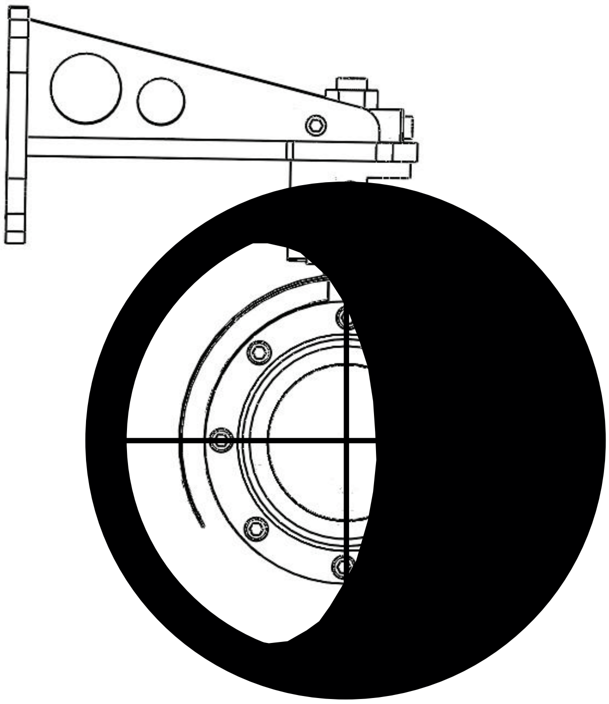
If the user's eye is not on the axis of the alignment telescope, an elliptical image field will be seen, as below. For correct use of the alignment telescope, the user must keep their eye on-axis, which will result in them seeing a symmetrical, circular image field.



Eye off-axis

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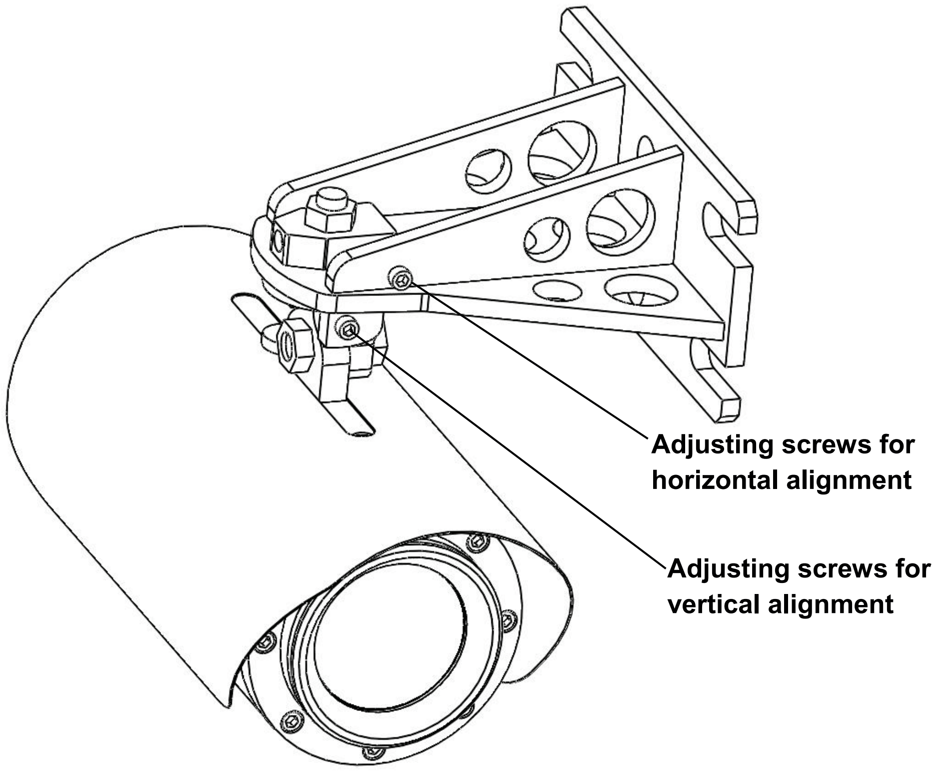
Making Alignment Adjustments

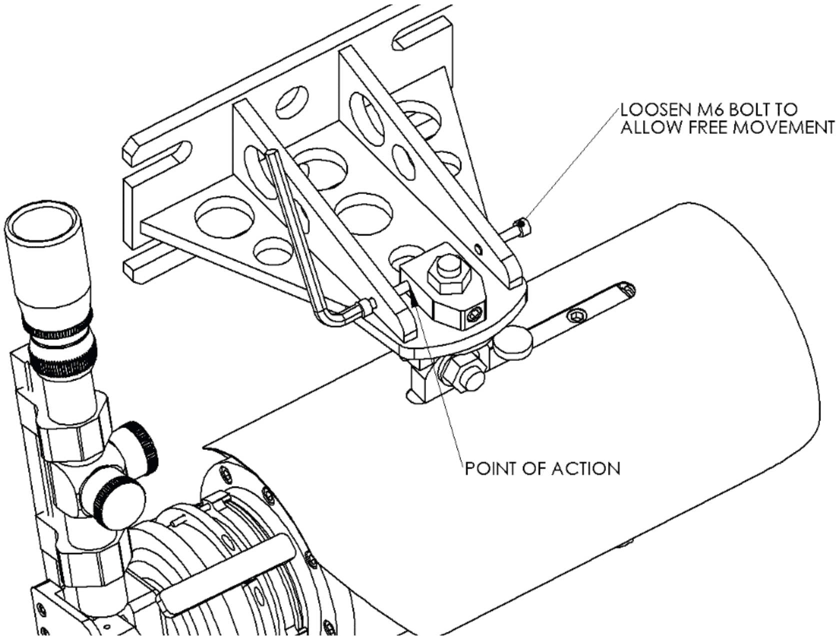
The Receiver and Transmitter units of ELDS OPGDs are mounted on brackets that allow precision alignment adjustments in the horizontal and vertical directions.

Precise adjustments of horizontal and vertical alignment can be made using the opposed pairs of M6 adjustment screws on the mounting bracket assembly. A pair of M6 Allen keys is provided with each unit to enable the adjustment screws to be rotated.

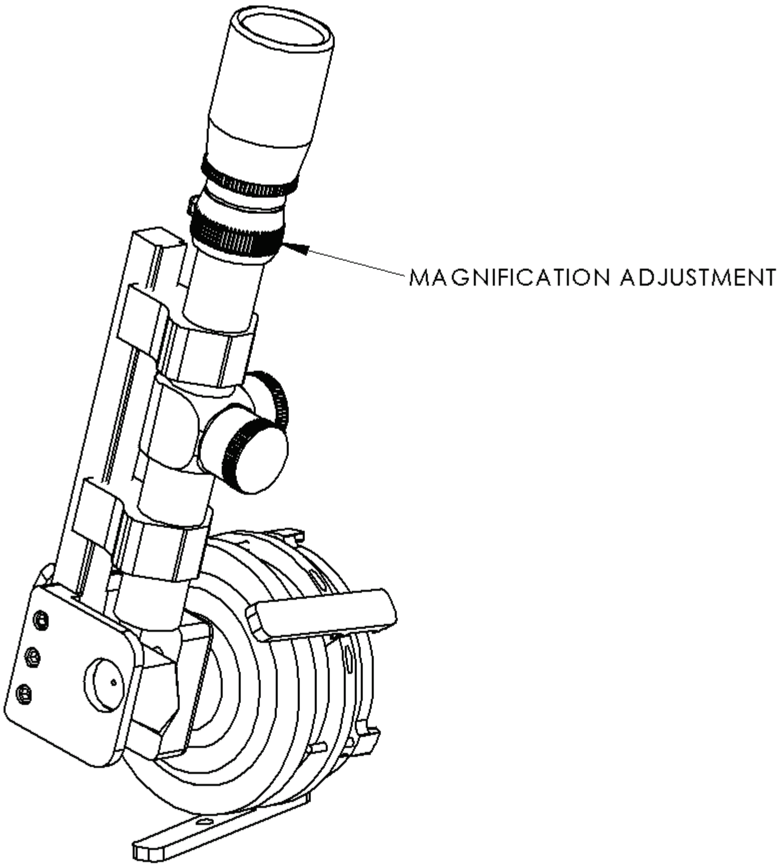


Tips:

- Achieving a good alignment is best performed iteratively. Make alignment adjustments in one axis to bring the cross-hairs nearer to the centre of the lens-window, and then make some adjustments on the other axis. Expect to go back and forth between the horizontal and vertical axes a few of times before achieving a good final alignment result.
- Initially, it is likely that the alignment will be quite a long way from ideal. When it is necessary to make relatively large alignment adjustments it is best to identify which direction needs to be moved in, and to loosen off the adjustment screw that would oppose such a movement. This enables the aligner to drive the adjustment in the desired direction without the resistance of the opposing adjustment screw.



If the alignment is a long way from ideal, it might be difficult to see the opposing unit through the alignment telescope. If this is the case, reduce the magnification of the alignment telescope using the magnification adjustment, which will allow a larger field to be seen. Once the opposing unit is more central, the magnification can be increased again to enable the opposing unit to be seen more clearly.

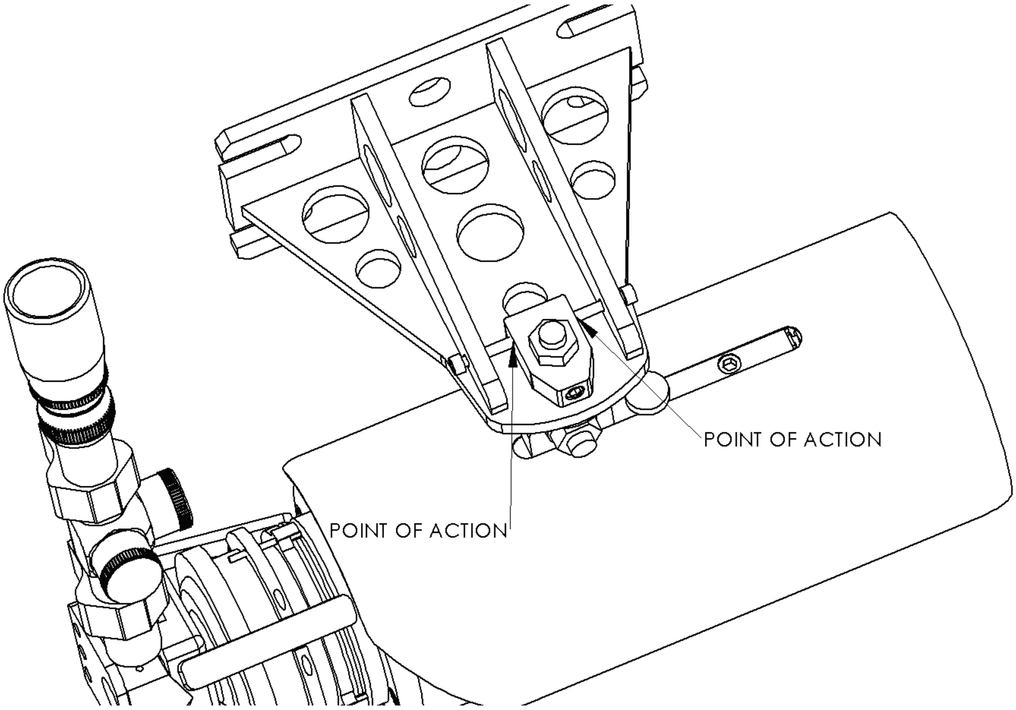


CAUTION

Do NOT try to adjust the cross-hairs using the alignment telescope's elevation and windage adjusters. These have been factory set.

Unauthorised adjustments of alignment telescopes will lead to systems being incorrectly aligned. Return an alignment telescope to Senscient if a problem with its alignment is suspected. (See section 4.3.2).

When the aligner is getting close to achieving a good alignment, they should screw in both pairs of adjustment screws such that the tips of these screws are in contact with their points of action. Final, precision alignment adjustments should be made against the resistance that arises from the screw tips being in contact with their points of action.



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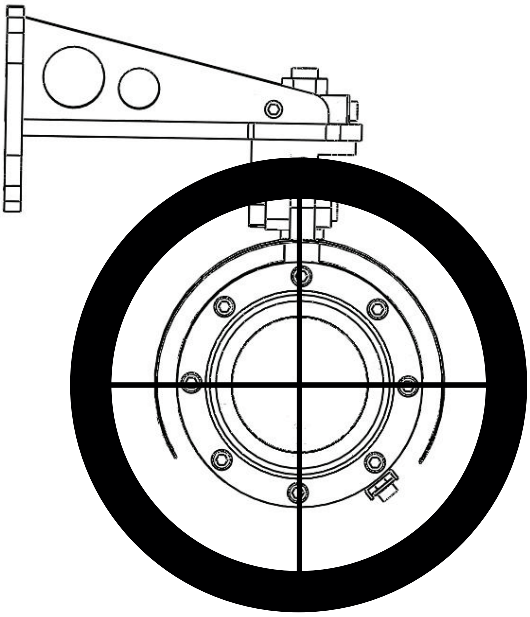
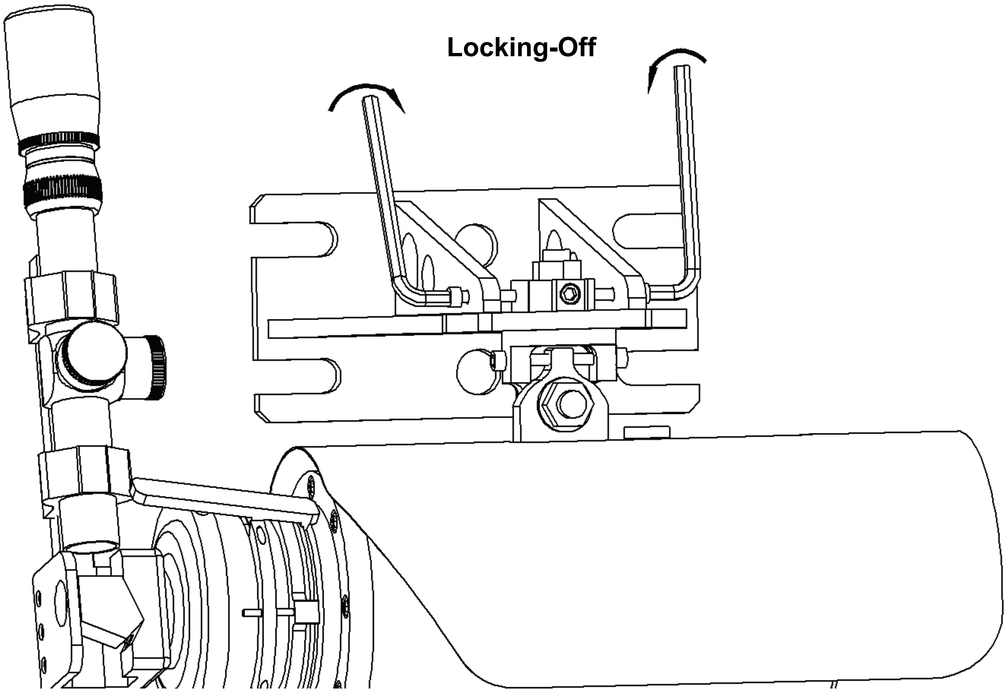
When the aligner is happy that a good, final alignment has been achieved, the alignment should be locked-off, by simultaneously rotating the opposed pair of adjustment screws in the opposite direction against each other. Performed correctly, this locking-off step should not affect the adjustment but should ensure that both adjustment screws are tight and that there is no play in the alignment of the unit.



Correct Final Alignment



Procedure for Checking Alignment Telescope

Principle of Check:

The procedure for checking the alignment of ELDS alignment telescopes makes use of the principle that a correctly aligned telescope points in exactly the same direction whatever the angle of rotation with respect to the alignment datum. This principle means that if you rotate an alignment telescope about an ELDS unit's alignment datum, the crosshairs on a correctly aligned telescope will remain centred on the same point / object within the telescope's field-of-view. If rotating an alignment telescope about the alignment datum results in significant movement of the crosshairs relative to the original point / object, the alignment telescope is not correctly aligned.

⚠ CAUTION

The alignment telescope is a precision optical alignment device. Dropping or mishandling of the alignment telescope may result in the telescope becoming incorrectly aligned.

IF you DROP or DAMAGE an alignment telescope STOP using it; and either CHECK that the alignment is still good using the process described below, or RETURN it to Senscient for checking and re-alignment.

Notes:

- The procedure for checking alignment telescopes depends upon the use of an ELDS unit that is mounted upon an extremely stable, rigid mounting structure. Only attempt to verify the alignment of an alignment telescope on an ELDS unit mounted on the most rigid and stable structure available.
- Do not attempt to check alignment telescopes on ELDS units that are mounted upon structures that can flex or move.
- Do not attempt to use this procedure to adjust the alignment of alignment telescopes. If an alignment telescope fails this alignment check it must be returned to Senscient for re-alignment.

Procedure:

(1) Carefully mount ELDS alignment telescope on alignment datum of an ELDS unit mounted upon an extremely rigid, stable structure.

(2) Carefully check that the alignment telescope datum is in perfect contact with ELDS unit alignment datum, with all spring-loaded gripping figures correctly engaged.

(3) With telescope in first position, carefully align ELDS unit so that the crosshairs of the telescope are centred upon the lens-window of the ELDS unit opposite. Lock off this alignment and double check that the crosshairs are still centred upon the lens-window of the unit opposite.

(4) Carefully rotate the alignment telescope about the alignment datum by at least 90°, ideally 180°, ensuring that the telescope's alignment datum is still in perfect contact with the ELDS unit alignment datum.

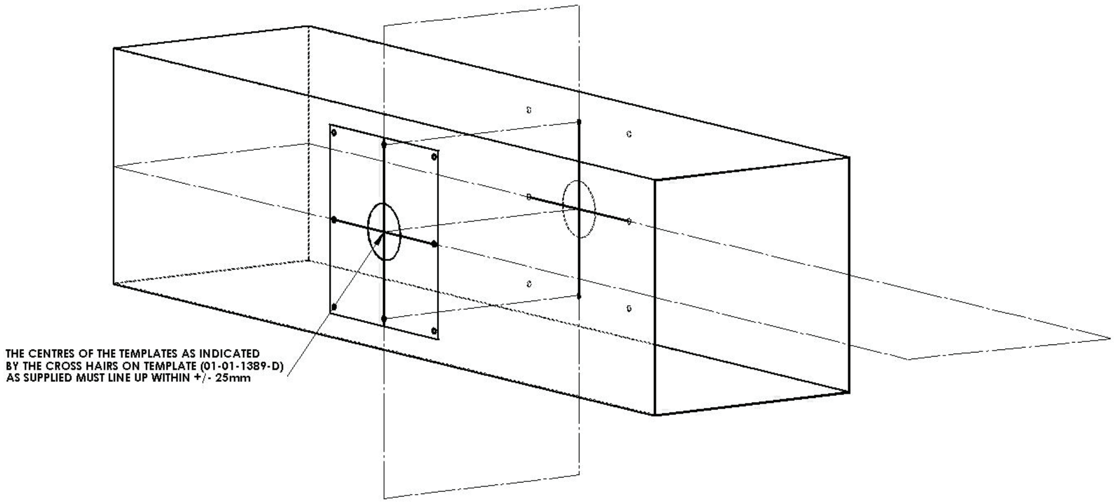
(5) With the telescope now in its second position, check where the crosshairs of the alignment telescope are pointing. Provided that the crosshairs are within a 5cm radius of the centre of the lens-window of the ELDS unit opposite, the alignment of the telescope is good and the telescope can continue to be used.

(6) IF after rotation to the second position the crosshairs of the alignment telescope are more than 5cm away from the centre of the opposite unit's lens-window, it is likely that the alignment telescope is no longer correctly aligned. In such circumstances, contact Senscient and make arrangements for the alignment telescope to be returned to Senscient for checking and re-alignment. DO NOT USE an alignment telescope that is suspected of being incorrectly aligned - this will lead to mis-aligned ELDS systems and compromised performance.

4.4. Cross Duct – Alignment Requirements

The majority of Cross Duct ELDS systems are designed to be installed and 'aligned' by simply mounting each half of the system opposite its counterpart on the other side of the duct. Provided that the duct walls are nominally parallel and sufficiently rigid that they do not deform significantly when the Cross Duct ELDS system is mounted upon them, no alignment is required.

In order to enable this simplified installation process, the Transmitter and Receiver units of a Cross Duct ELDS system have a wide field-of-view (≥ 6°), enabling these units to tolerate out-of-parallel angular errors up to ±2.5° on each side of the duct wall. All that is then necessary is that the optical centre-lines of each half of the system should be opposite each other to within ±25mm when mounted on the duct wall. This modest requirement can be met by employing normal constructional methods and tools, such that the cross-hairs on the Mounting Plate templates are positioned opposite each other when they are used to guide the drilling and cutting of the required mounting holes.



4.4.1 Cross Duct Alignment Adjustment Bushings

For installations on narrow ducts with rigid walls, Cross Duct ELDS systems can be successfully installed and commissioned by taking advantage of the simplified, no-alignment-required process that is made possible by the intentionally wide field-of-view of these systems.

However, in some instances, especially those involving retrofit of ELDS units on pre-existing installations, or on thin-walled ducts, it is possible that the mounts or duct walls will be so far out-of-parallel that the relative alignment of the RX and TX units will fall outside of the angular alignment tolerance of Cross Duct ELDS systems (±2.5° per side). In order to enable Cross Duct ELDS systems to be successfully installed on out-of-parallel mounts or ducts, Senscient provides alignment adjustment bushings.

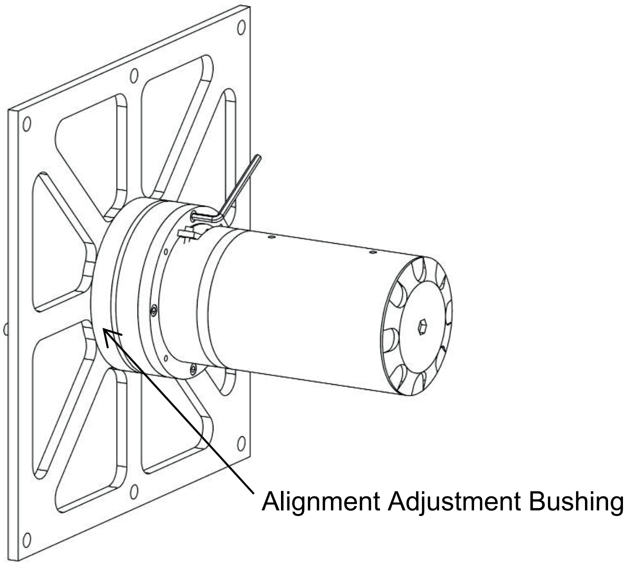
The alignment adjustment bushings are fitted between the ELDS TX or RX units and the mounting plate, providing a compressible alignment adjustment interface. The alignment adjustment bushings are made from a solid elastomer, chosen for excellent resistance to compression-set and suitability for long term use at industrial facilities. The alignment adjustment bushings provide at least ±5° angular adjustment in the horizontal and vertical planes for both the TX and RX units, enabling even significant out-of-parallel errors to be accommodated.

GB

4.4.2 Alignment Using Cross Duct Alignment Adjustment Bushings

The procedure for using alignment adjustment bushings to compensate for excessive out-of-parallel mounting or duct bending errors is as follows:

(1) Insert the alignment adjustment bushings between the ELDS TX and RX units; and their corresponding mounting plates.



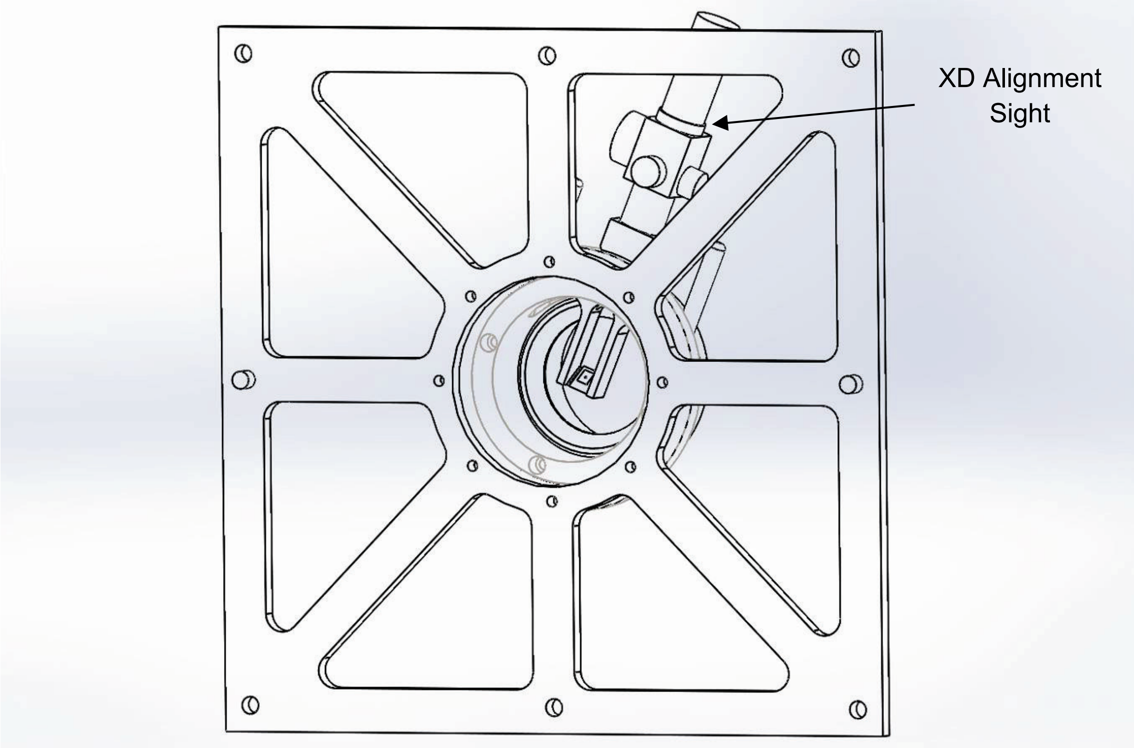
(2) Tighten all of the M6 bolts securing the TX and RX units on their respective mounting plates until the flanges on these units are in firm contact with the alignment adjustment bushings around the whole of their diameter. NB: The alignment adjustment bushings provide all of their alignment adjustment range by increasing the compression of the bushing. Consequently, the bolts should never be loosened or adjusted back from the point of firm contact.

(3) Make a connection between an industrial computer running SITE and the Receiver unit.

(4) Ensure that both the TX and RX units are powered up and have been running for at least two minutes since power-up.

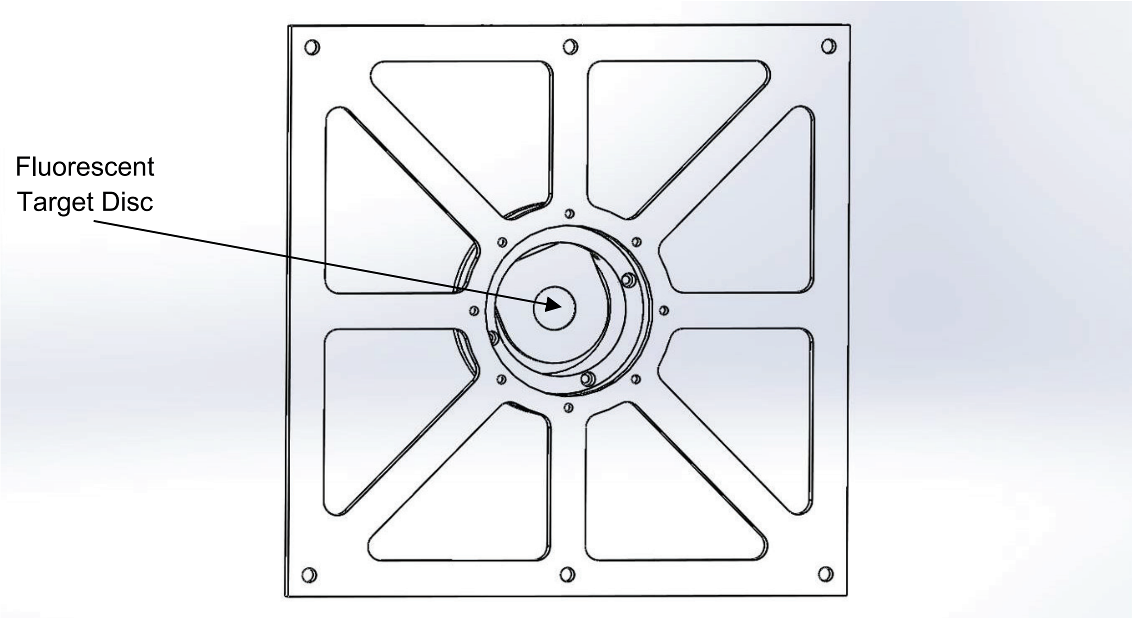
GB

(5) Insert the XD Alignment Sight into the slot of either the TX or RX unit to be aligned.



(6) Switch on the red dot of the alignment sight by rotating the corresponding knob on the sight.

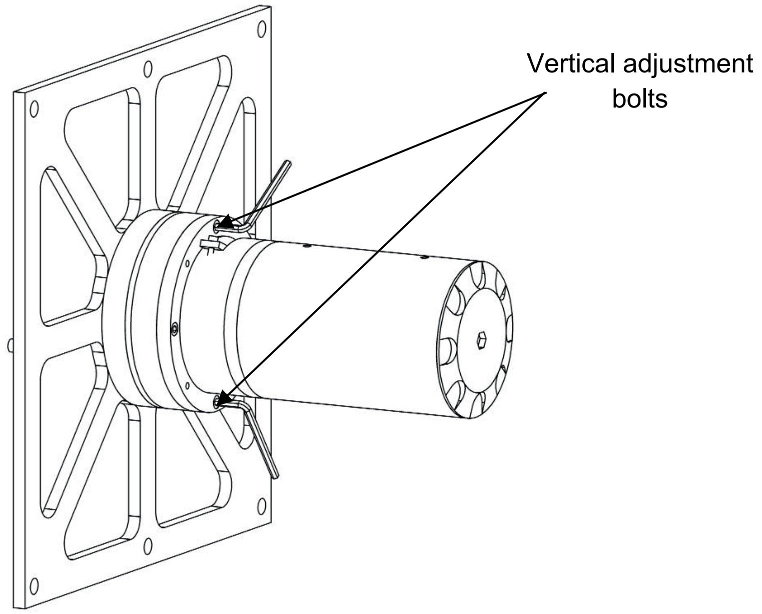
(7) Insert the fluorescent target holder into the slot of the TX or RX unit opposite, to which you are about to align the XD unit.



(8) Gradually tighten either one of the two M6 mounting / adjustment bolts intended to provide vertical alignment adjustments; whilst observing the position of the red dot with respect to the fluorescent target.

(9) Make vertical and horizontal adjustments until the red dot is in the centre of the circular fluorescent disc.

The XD Alignment Target contains a fluorescent disc that is designed to glow in the dark, enabling technicians to align XD ELDS units even when there is no light inside the duct. In order to charge up this fluorescent disc ready for use, simply expose the disc to sunlight or bright lighting for one or two minutes, which should provide sufficient charge to perform at least one alignment. Recharge the disc as and when necessary.



(10) Upon successfully completing the preceding alignment adjustment process, the signal reaching the Receiver should read somewhere between 2 and 60, depending upon duct width and the quality of alignment.

Cross Duct ELDS systems will perform fully in accordance with published specifications for signals between 2 and 60. Furthermore, they will continue to perform correctly in the event that the signal is attenuated by up to 90% due to the operating conditions in/on the duct such as haw frost, mist ingestion, dirt build-up, vibration and bending. Provided that the signal achieved after alignment adjustment is greater than 2, SITE will allow the Cross Duct ELDS system to be commissioned.

(11) Use SITE and the procedure described in sections 4.5-4.7 to commission the ELDS Cross Duct system.

GB

4.4.3 Alignment of Ventilation Zone (VZ) Cross Duct Units

Where it is necessary or desirable for Cross Duct ELDS systems to be installed across the front of the entrance to a duct, Ventilation Zone (VZ) Cross Duct ELDS systems should be used. ELDS VZ units are effectively Cross Duct ELDS units supplied with the standard Adjustable Mounting Brackets instead of Mounting Plates. The mounting brackets enable ELDS VZ units to be mounted across the front of the duct entrance and provide for any adjustment that might be required to achieve acceptable alignment in such a location.

Alignment of ELDS VZ units should be performed using the standard, Senscient-supplied Alignment Telescope and the alignment procedure described in section 4.3. Due to the wide field-of-view (≥ 6°) of Cross Duct ELDS units, users will find that small changes in alignment will have no effect upon the signal levels or performance of ELDS VZ units. Consequently, there is no need for fine-tuning of the alignment of ELDS VZ units - a quick centering of the telescope cross-hairs on each end of the system will always be sufficient.

4.5. Commissioning Using SITE

The necessary steps to commission a system are outlined in the following sections.

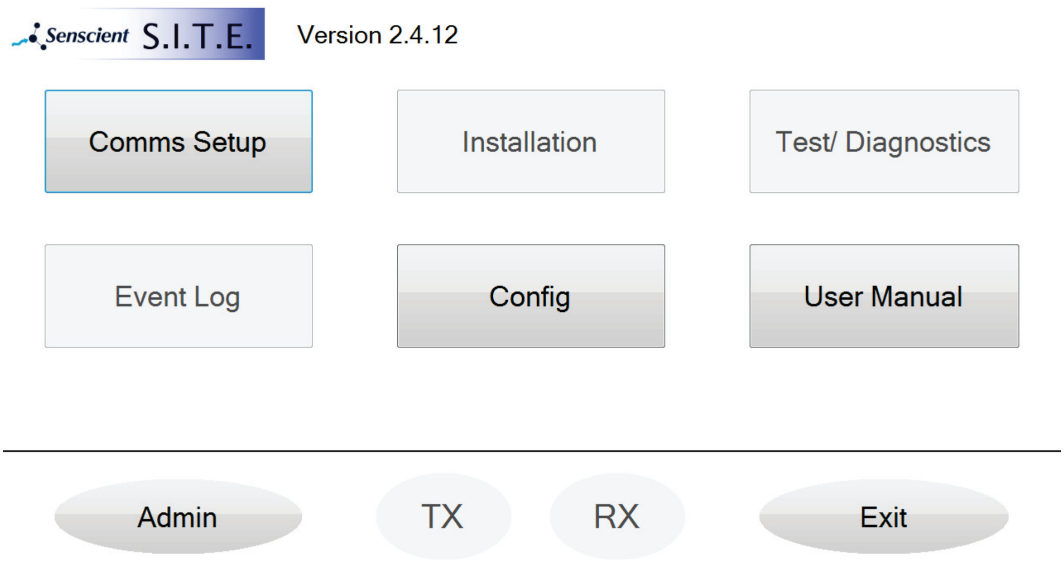
4.5.1 Commissioning a Transmitter

Calibration data is held within each Transmitter unit and is copied to the Receiver as part of the installation and commissioning process. For this reason it is necessary to **commission the Transmitter unit first**, before attempting to commission the Receiver of an ELDS system.

To run SITE, select the desktop Icon or run SITE from the Start Menu.

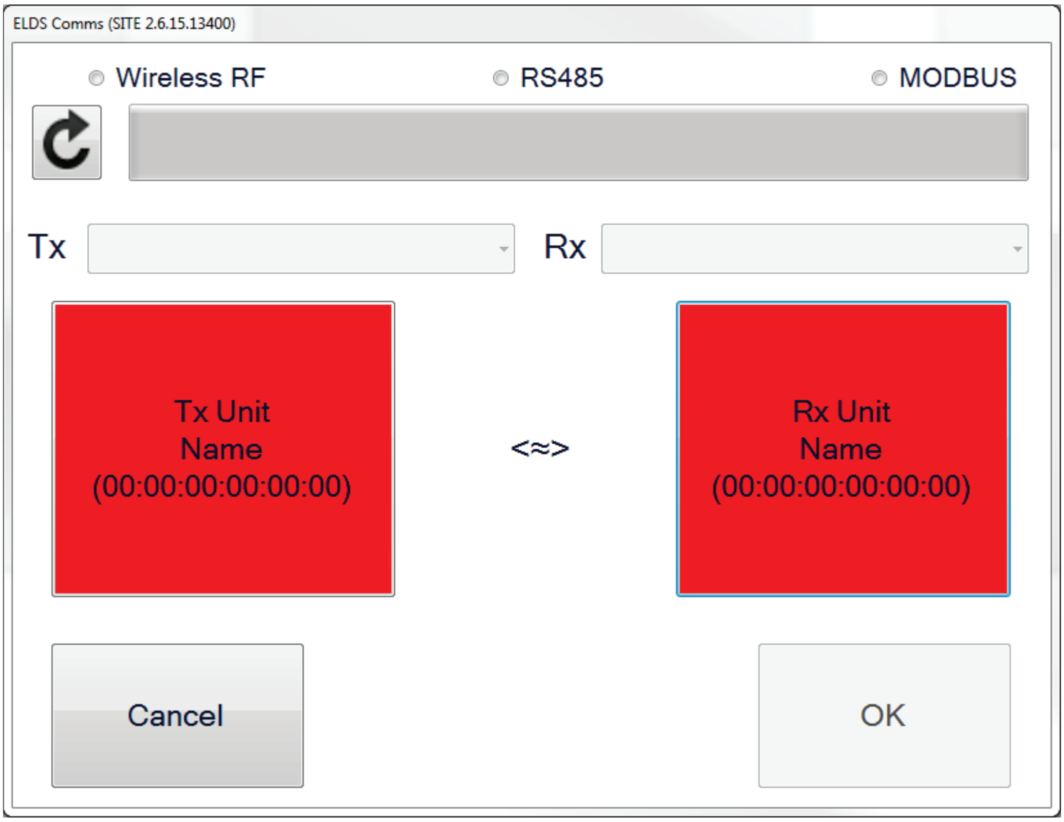
1) Communications Setup

Select **Comms Setup** on the main screen as shown below:



GB

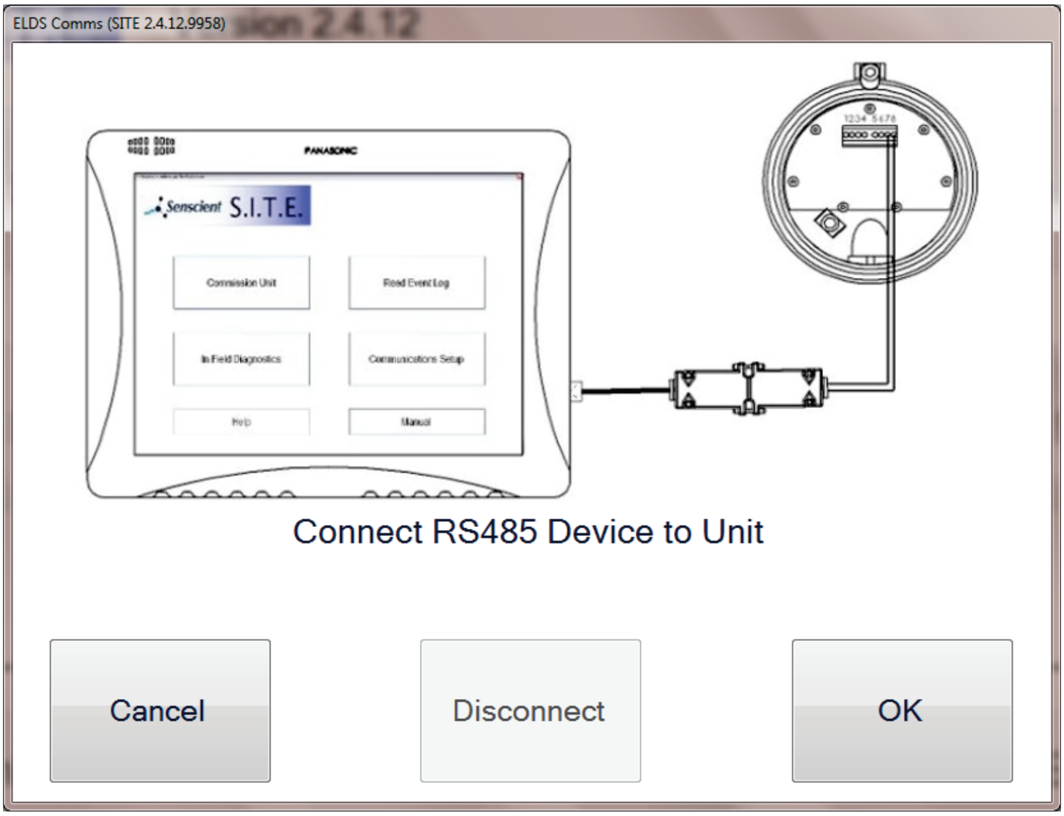
2) Select Communications Link to be used by clicking either **Wireless RF (Bluetooth)** or **RS485**



GB

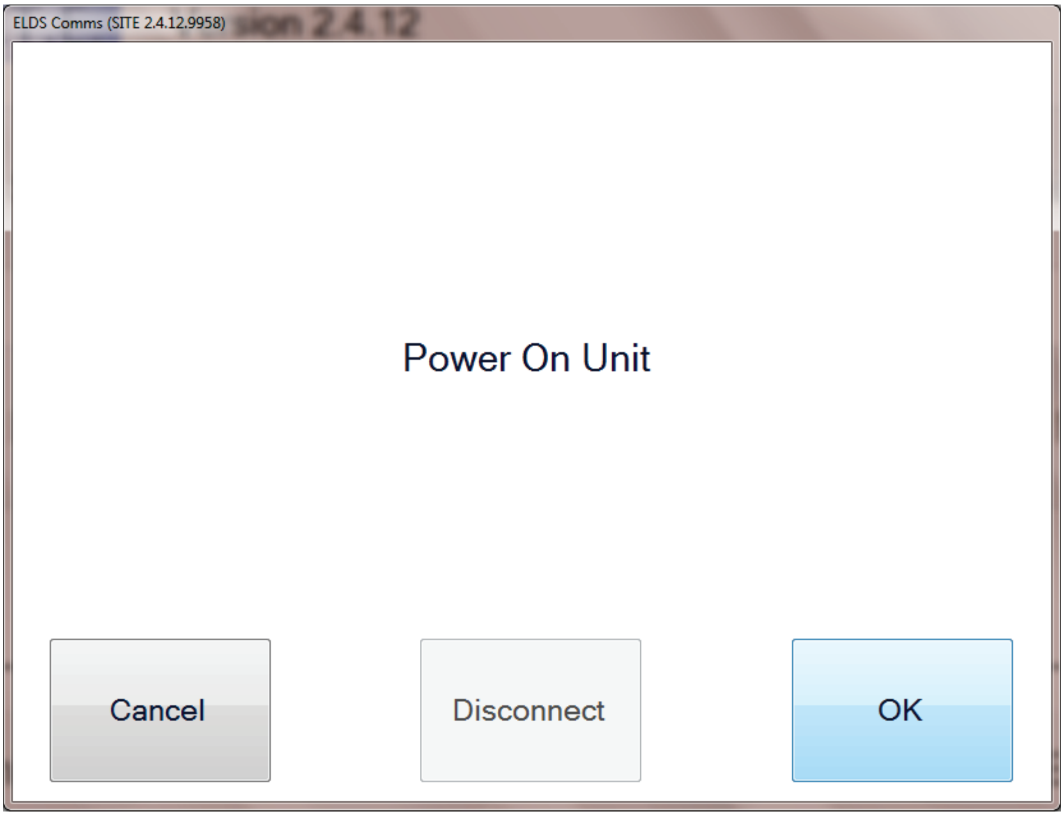
RS485

When RS485 is chosen, the screen below instructs you to make the RS485 connections to the ELDS unit that you want to communicate with. When the necessary RS485 connections have been made, click **OK**.

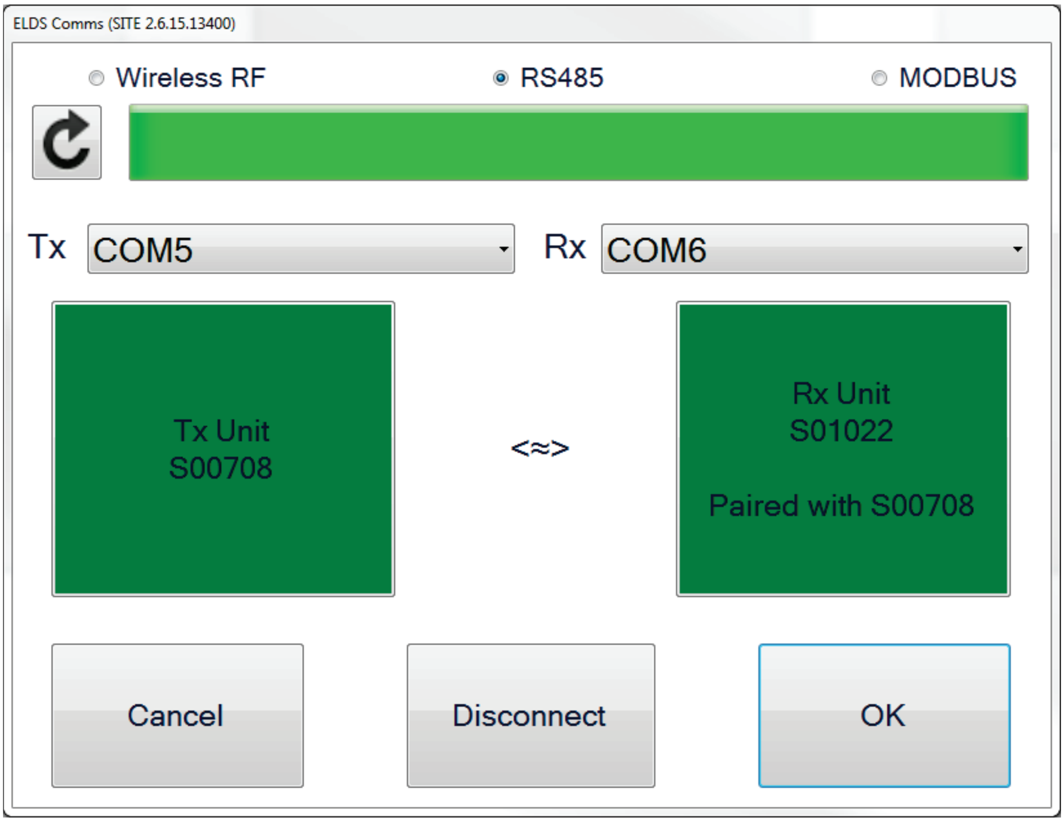


Take care to get the RS485 (A) = Purple, and RS485 (B) = Black wires connected to the correct terminals (A) and (B). The RS485 communications link does <u>not</u> work if you connect these wires the wrong way around.

If the ‘Power On Unit’ screen below is presented, no RS485 communications were possible with the ELDS unit. The most likely explanations for no RS485 communications are no power reaching the ELDS unit or incorrect connection of the RS485 leads. Check the power and RS485 connections and once corrected, re-try RS485 communications by clicking **OK**.



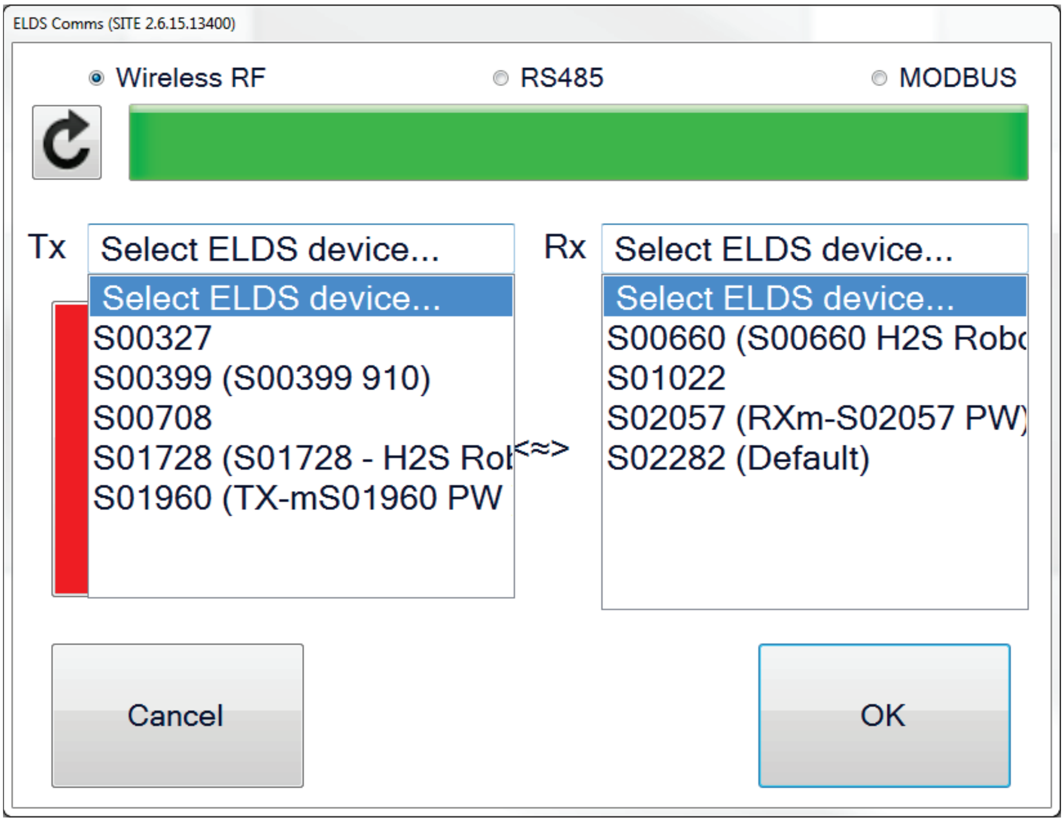
If RS485 communications can be established with the connected ELDS unit(s), a screen similar to that below will be presented. The status of RS485 communications is shown by the colour of the square RX and TX boxes, with **Green** indicating live RS485 communications and **Red** indicating no RS485 communications. When the necessary RS485 communications have been established, click **OK**. (This will return you to the Main SITE screen, ready to select **Installation**.)



GB

Bluetooth™ Wireless RF

When Wireless RF (Bluetooth™) is chosen, a search for ELDS devices available via Bluetooth is made and when this search is completed, the ELDS devices available are presented as illustrated below. Carefully select the ELDS device(s) that are to be connected to via Bluetooth (one RX and one TX can be selected simultaneously):



If the desired ELDS unit does not appear in the drop-down, click to refresh the list of units available.

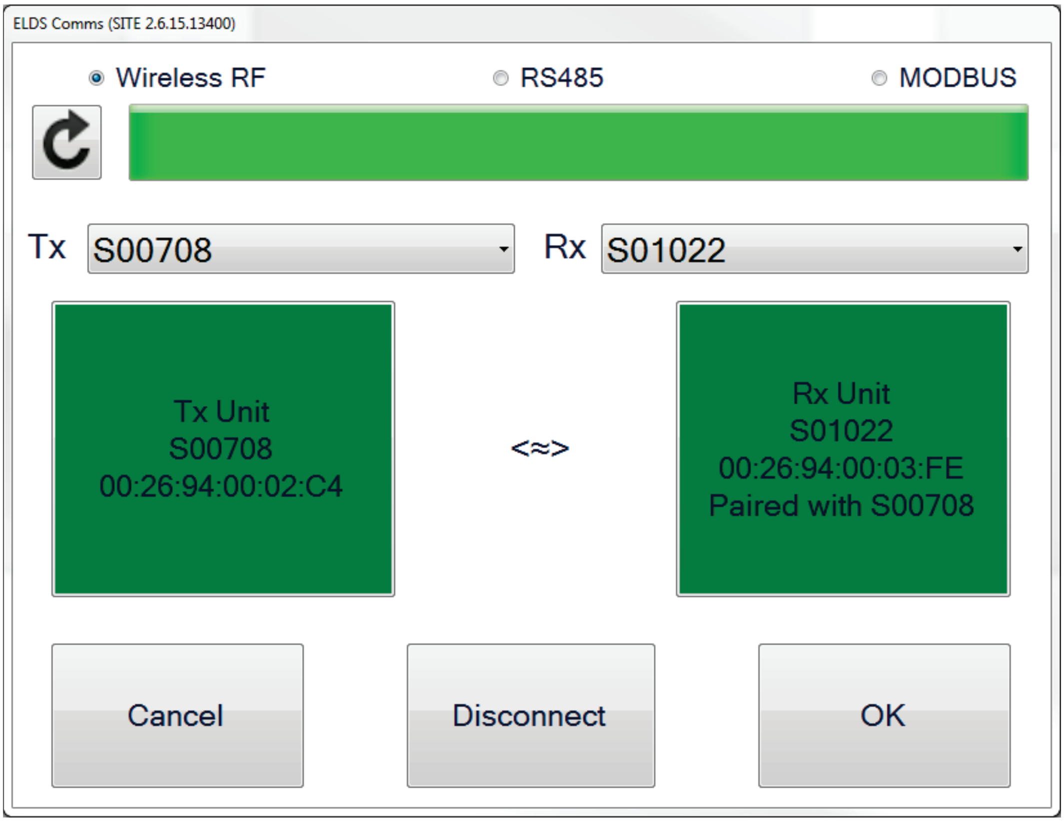
If the ELDS unit wanted still does not appear, check that power has been applied to the unit and refer to section 4.6.2 Bluetooth™ Communications:- Notes and Guidance.

CAUTION

The convenience and range of Bluetooth makes it possible to make connections to units other than those intended. Therefore, when making Bluetooth connections, take particular care to ensure that you are connecting to precisely the unit(s) that you intend to work upon at this time and location.

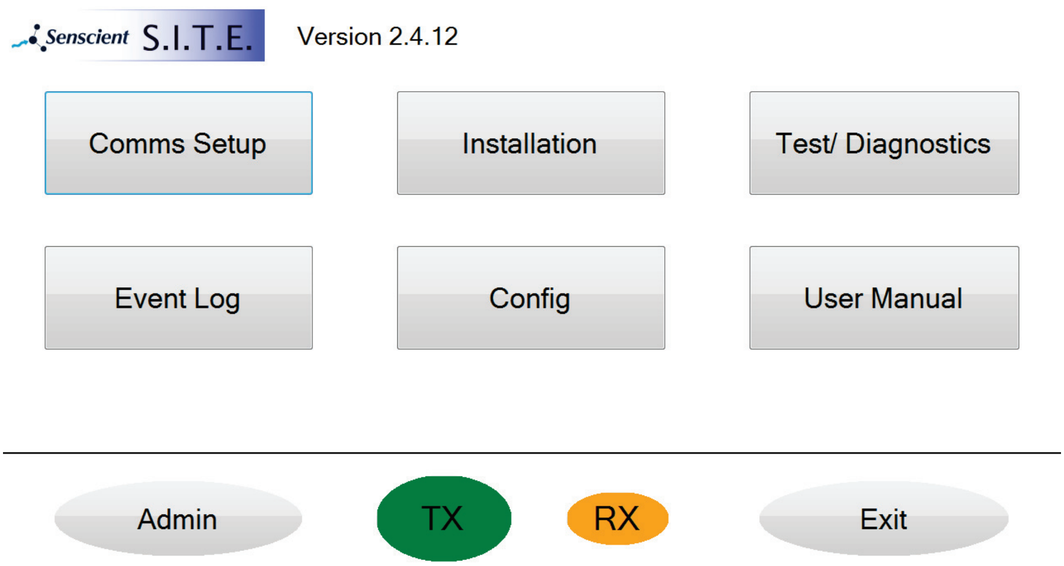
GB

Once the ELDS device(s) to be connected have been selected, SITE will establish Bluetooth connections and when this process has been completed, the square boxes corresponding to these connected devices will turn **Green**. With the required Bluetooth connections made, click **OK** to return to the Main SITE screen.



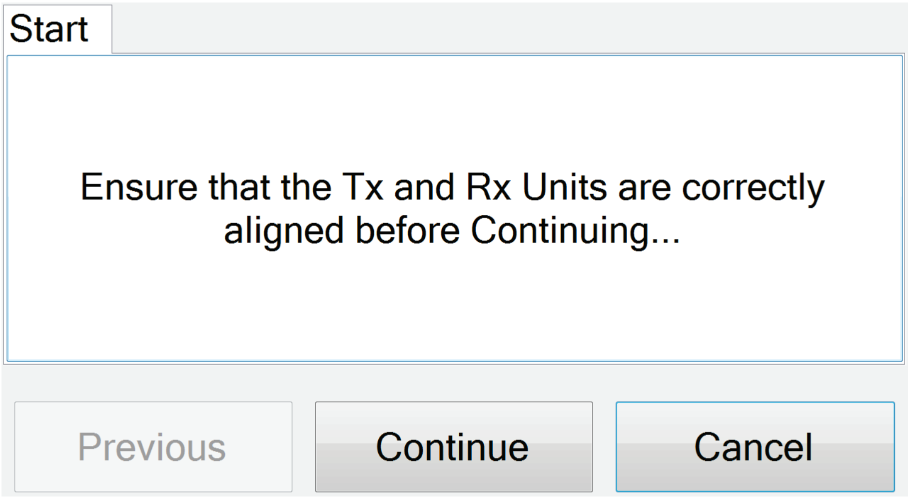
3) Commence TX Installation

Select the TX by clicking the TX button, which will turn the button **Green**. Begin the installation and commissioning process by clicking **Installation**.



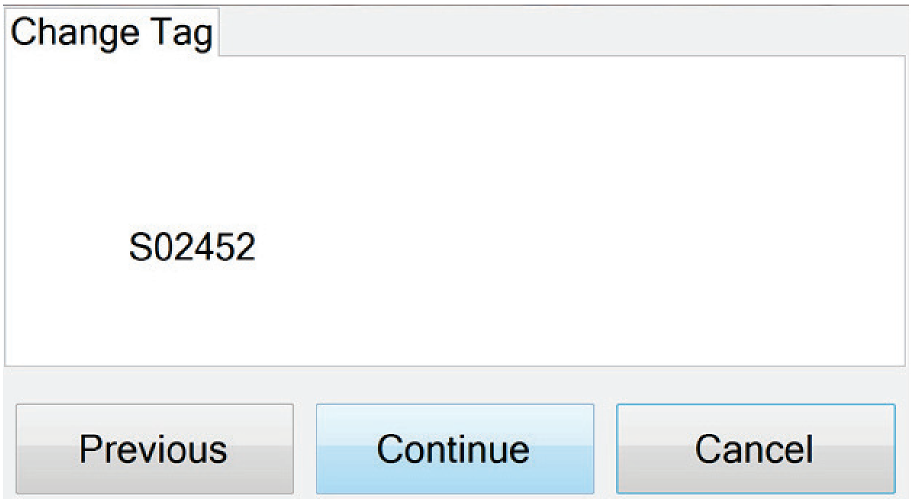
GB

Upon entering the Installation process, the screen below will be displayed, asking you to confirm that the TX and RX units are correctly aligned before continuing. Confirm this and click **Continue**.

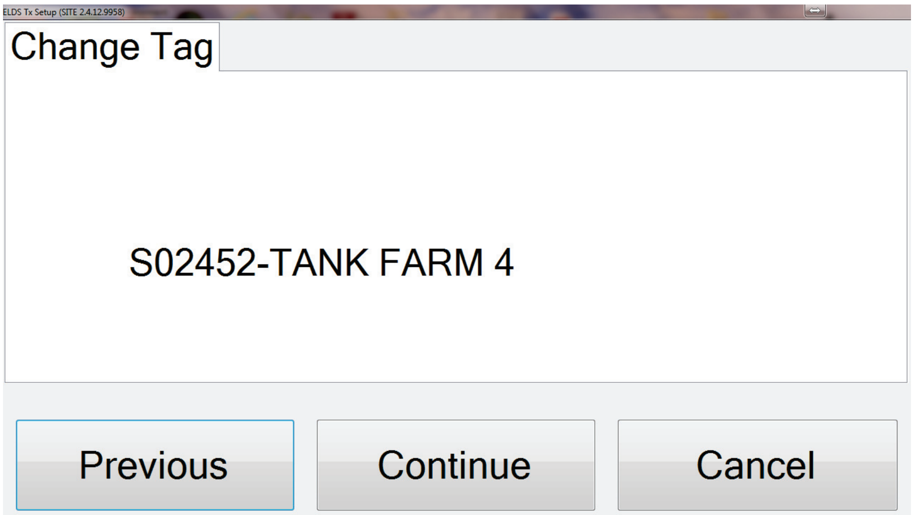


4) Changing / Setting Unit Tag

You now have the opportunity set / change the Tag that will be reported by the unit during operational service.



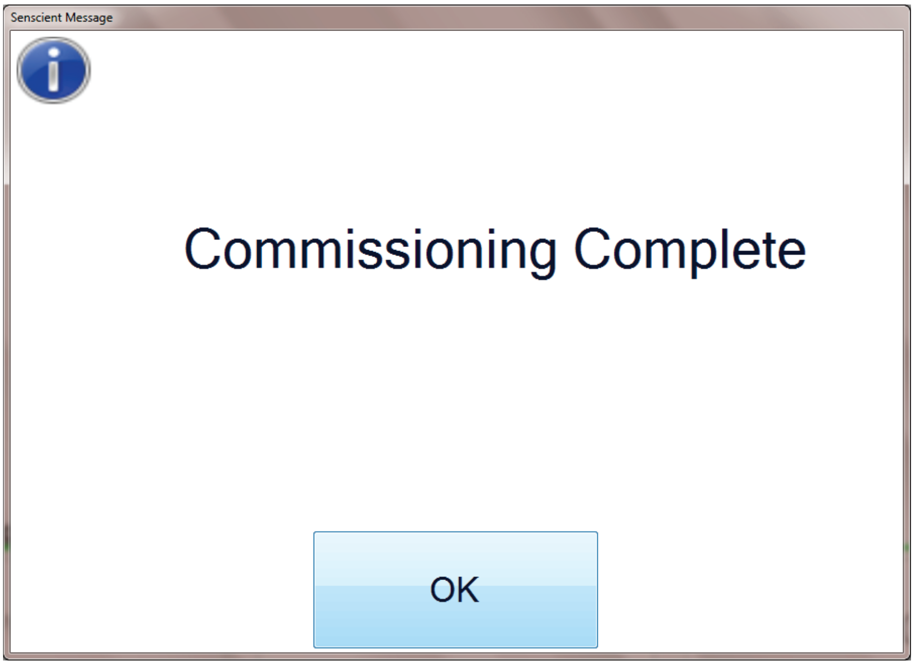
If you want to set / change the Tag, left click on the Tag being displayed and use the keyboard to make the required changes to the Tag.



When the Tag is as you want it, click **Continue**, and the Tag will be updated accordingly.

The Tag and Bluetooth friendly name are intentionally set the same. If the Tag is changed when connected via Bluetooth, there will be a slight delay whilst the Tag is updated and the Bluetooth connection is re-established with the new Tag / Bluetooth friendly name.

When SITE has completed commissioning the Transmitter, acknowledge this by clicking **OK**.



With commissioning of the Transmitter completed, you will be returned to the main SITE screen.

4.5.2 Commissioning a Receiver

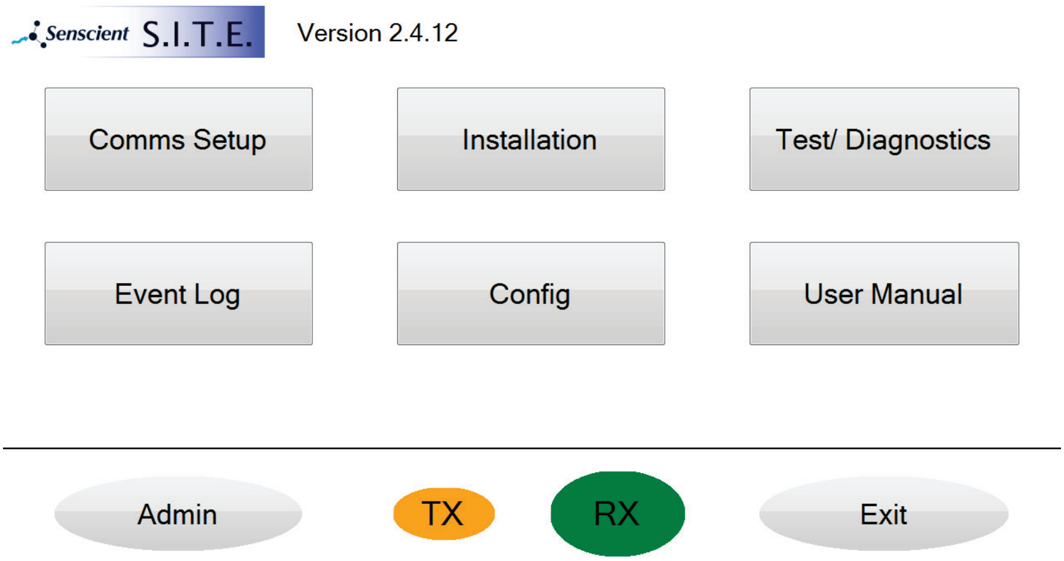
Having successfully commissioned the Transmitter with which the Receiver opposite is to be paired, SITE has all of the calibration and configuration data that it requires and is ready for Receiver commissioning.

1) Choose Communications Link and Setup Connection to Receiver

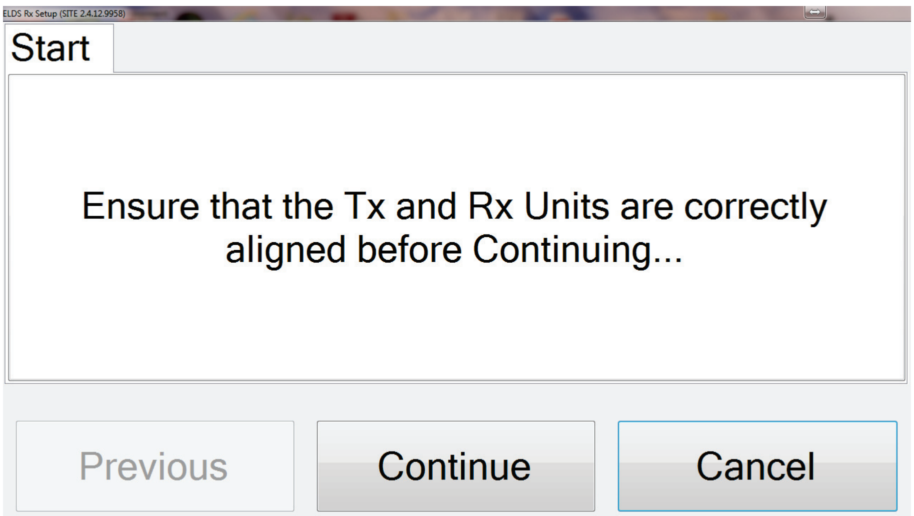
The SITE process for selecting a type of communications link (RS485 or Bluetooth™) and setting up a connection to an ELDS unit is the same for both Transmitter and Receiver units. Following the process described for choosing and setting up a connection in section 4.5.1, set up a connection to the Receiver that is to be installed and commissioned.

2) Commence Receiver Installation

To begin the Receiver installation and commissioning process, select the Receiver by clicking on the **RX** button (turning it **Green**) and then click on **Installation**.



If the Receiver has not previously been installed, the screen below will be displayed, requesting confirmation that the TX and RX units have been correctly aligned before continuing. If this is the case, click **Continue** to proceed.



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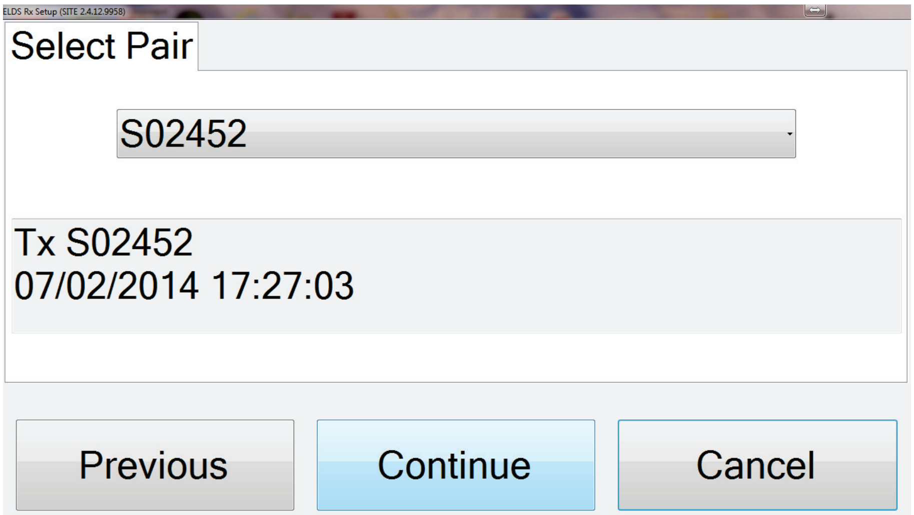
3) Select Transmitter with which to Pair Receiver

In order to calibrate and configure an ELDS system it is necessary to select the Transmitter with which a Receiver unit is to be paired. The screen shown below enables the operator to select the Transmitter with which SITE will attempt to pair the Receiver. By default, the most recently commissioned Transmitter will appear as the first possibility in the selection box. If this is not the correct Transmitter unit, use the drop-down menu to select a different Transmitter.

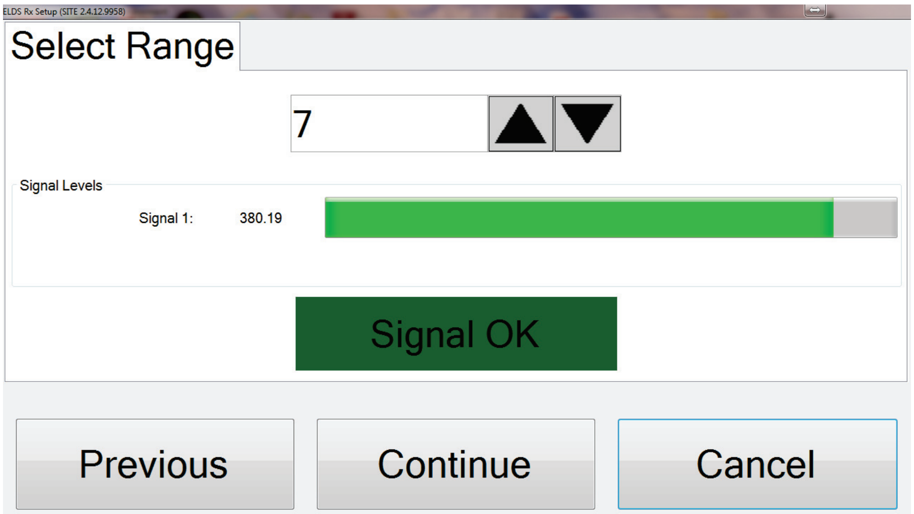


NB: Check the Transmitter information carefully to confirm that you are pairing the correct type of Transmitter with the Receiver, and that this is the correct type of ELDS unit to be installed at this particular tag location.

Having selected the correct TX unit to pair the RX with, click **Continue** to proceed.

4) Signal Level Check

After the calibration and configuration pairing information has been loaded into the Receiver, the signal level / alignment check screen below will be displayed.

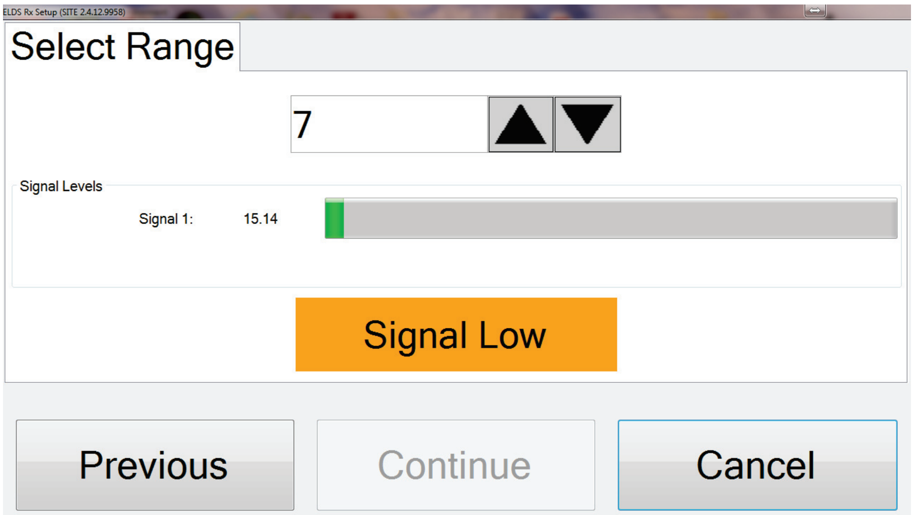


GB

SITE checks the signal reaching the Receiver by comparing the actual signals being received (displayed in the Signal Levels box as above) with the signal expected for a correctly aligned TX and RX operating over the range specified. This process requires the distance (range) in metres (m) to be entered in the Select Range box, which range can be adjusted / set using the up/down arrows.

Provided that the alignment of both the TX and RX is acceptable, the signal will meet SITE's expectation requirements and the **Green Signal OK** message box will be displayed. If this is the case, the Signal Level Check has been passed and the user should proceed to the next step by clicking **Continue**.

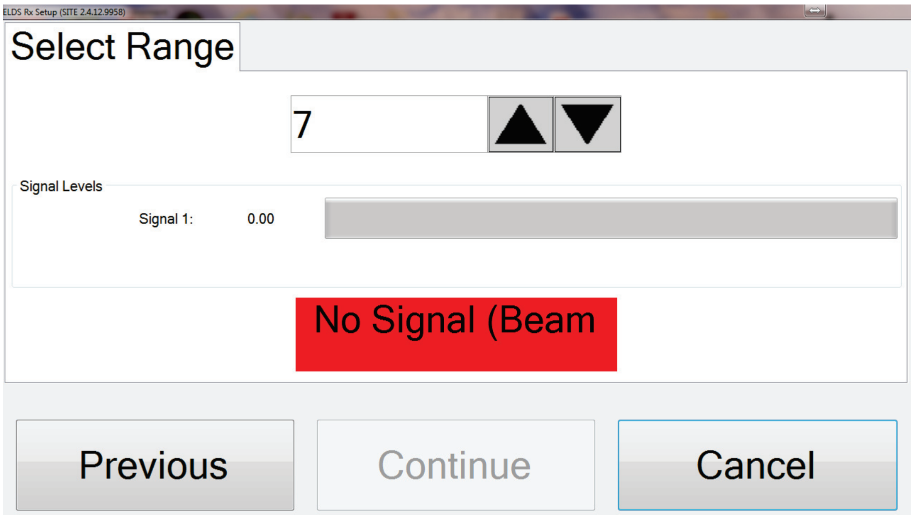
If the signals reaching the Receiver are not meeting SITE's signal expectation requirements, the screen displayed might look similar to that below, with an Amber **Signal Low** message box.



The most likely explanations for a screen similar to the above being displayed are:

- The alignment of either the TX or the RX unit to its counterpart opposite is poor. Use an alignment telescope and the ELDS alignment procedure to check and improve the alignment to achieve the expected signal.
- The lens-windows of either the TX or the RX are very heavily contaminated. Check the lens-windows and clean where required.
- The range entered in the Select Range box is significantly shorter than the range over which the system is operating, leading SITE to expect a higher signal. If so, increase the range entered in the Select Range box to the correct value.
- There is something partially obscuring the beam-path between the TX and RX, reducing the signal reaching the Receiver. Use an alignment telescope to check the beam-path and eliminate any obscuration(s), either by removing the offending object(s) or by relocating the ELDS units to somewhere with a clear, unobscured beam-path.

If there is no signal reaching the Receiver, a screen similar to that shown below will be displayed:

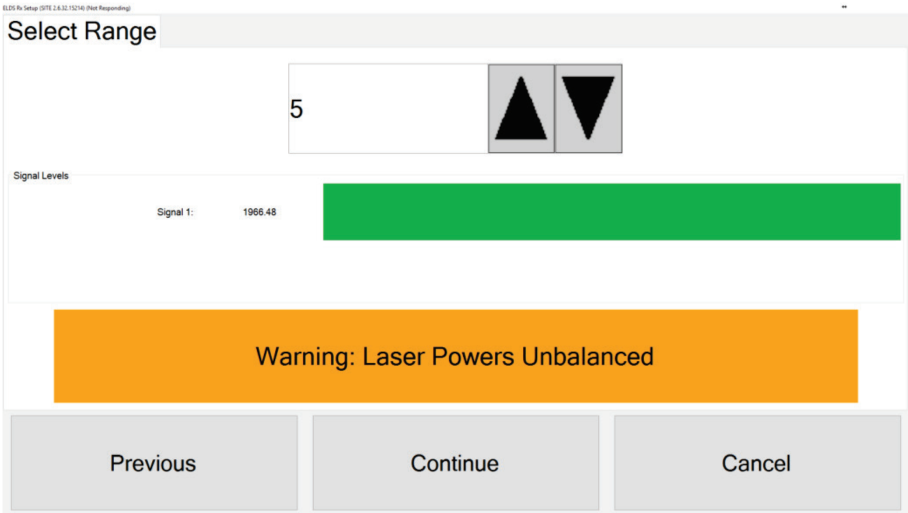


In order to continue with the commissioning process, the cause of the ‘No Signal’ problem must be identified and corrected. The most likely causes for ‘No Signal’ are listed below, along with the appropriate actions to remedy such problems:

- **Beam Blocked** – There is something in the beam-path which is completely blocking the beam-path between the Transmitter and the Receiver. Remove whatever is blocking the beam-path or relocate the system to somewhere where a clear line of sight can be obtained between the TX and RX units.
- **System Not Aligned** – The Transmitter or Receiver have not been aligned with respect to each other, or are so far from correct alignment that very little or no signal is reaching the Receiver. Use the alignment telescope and the procedure described in section 4.3 to correctly align the Transmitter and Receiver units with respect to each other.
- **No TX Power** – The Transmitter is not receiving the +24V (nominal) power supply voltage that it requires to operate. Use a multimeter to check that the +24V supply is reaching the TX unit. The voltage measured at the unit should be between +18V and +32V. If the voltage is outside of this range, correct the electrical installation to supply the unit with the specified power and voltage.
- **TX Fault** – There is a fault condition preventing the Transmitter from producing the expected output. Connect to the Transmitter unit using SITE and review the information available via the Event Log and Diagnostics menu options to determine the cause of the TX Fault.

Once the SITE software displays the green **Signal OK** screen you are ready to proceed to the next step in the commissioning process.

For dual laser units there is a further possible message. If the signal levels for each laser are very different from each other then the following will be displayed:



There are two (2) possible reasons for this.

- **The transmitter is not well aligned to the receiver.** Re-check the alignment of the Transmitter using the alignment telescope and ensure that the alignment telescope has not been damaged (be being dropped for example, the procedure to check the telescope is described in section 4.3.2). This is the most likely reason for this warning.
- **The transmitter has a large imbalance of the laser signals.** If the alignment is checked as described above and no error is found and it is also confirmed that the alignment telescope is correctly aligned then it may be that the transmitter has a larger than normal imbalance of output power for the two lasers. Normally Senscient will only supply Transmitters that have a well matched output powers, however because lasers have a range of properties and have to be ‘selected’ for each application occasionally units may have a significant difference in the signal level for each laser. SITE normally allows for such possible differences but occasionally where a transmitter is near the limit of imbalance it may be that this message will occur. Given that re-aligning the transmitter or receiver is unlikely to correct this problem when it is caused by a ‘marginal’ transmitter SITE will allow the installation to proceed even though the laser powers are badly matched. The system will function normally despite this imbalance.

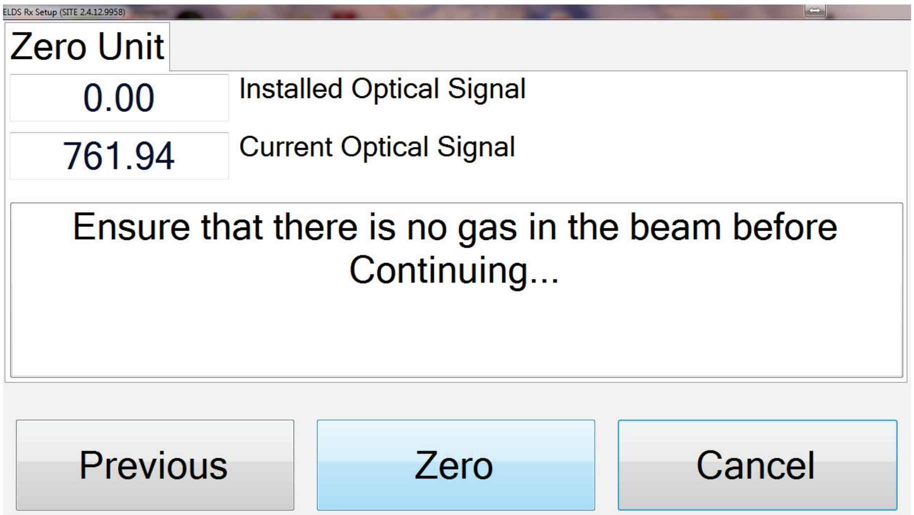
GB

5) Detector Zeroing (Where Applicable)

There are three (3) zeroing regimens for ELDS gas detectors:

- **Zeroing Essential.** For some ELDS units (specifically older and now discontinued types) it is essential that the detector is zeroed as-installed and as-aligned. In such instances, SITE enforces the requirement for detector zeroing.
- **Zeroing Advisory but Optional.** For ELDS detectors such as 0-250ppm.m H_2S, provided that an H_2S-free background is present, zeroing as-installed and as-aligned will achieve the best detector zero. In such instances, SITE offers the user the option of zeroing the unit as installed (advisory) or using the TX Factory Zero where background gas might be present in the path.
- **TX Factory Zero Known Best.** For many of the gases and measurement ranges for which ELDS gas detectors are available, the TX Factory Zero is known to be a much better zero than can be obtained in field-service conditions. In such instances, SITE automatically uses the TX Factory Zero and does not offer any other zeroing option.

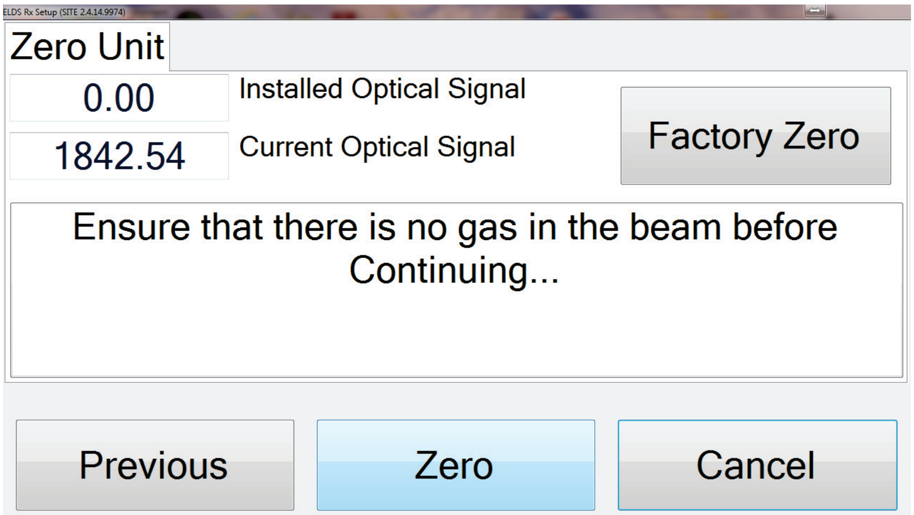
For ELDS detectors where zeroing is essential, the screen below will be displayed:



Verify that there is no gas in the beam and confirm this by clicking Zero to initiate the zeroing process. Depending upon the unit type, the zero process will take between 15 seconds and 2 minutes to complete.

Once this zeroing process has been completed, SITE will proceed to the Change Tag screen.

For ELDS detectors where zeroing is advisory but optional, the screen below will be displayed:



Where and when the user is confident that there is no gas in the beam-path, the zeroing process should be initiated by clicking **Zero**.

If the user cannot be sure that there is no gas in the beam-path and wants to use the TX Factory Zero, click **Factory Zero** to load the TX Factory Zero into the Receiver.

GB

CAUTION

Zeroing a system with target gas in the beam-path will result in a positive offset on the unit's zero position. This offset will introduce errors in the gas readings output by the system and may give rise to the spurious diagnosis of Fault or Warning conditions. Only zero a system when you are confident that there is either zero target gas or a negligibly small quantity of target gas in the beam-path.

CAUTION

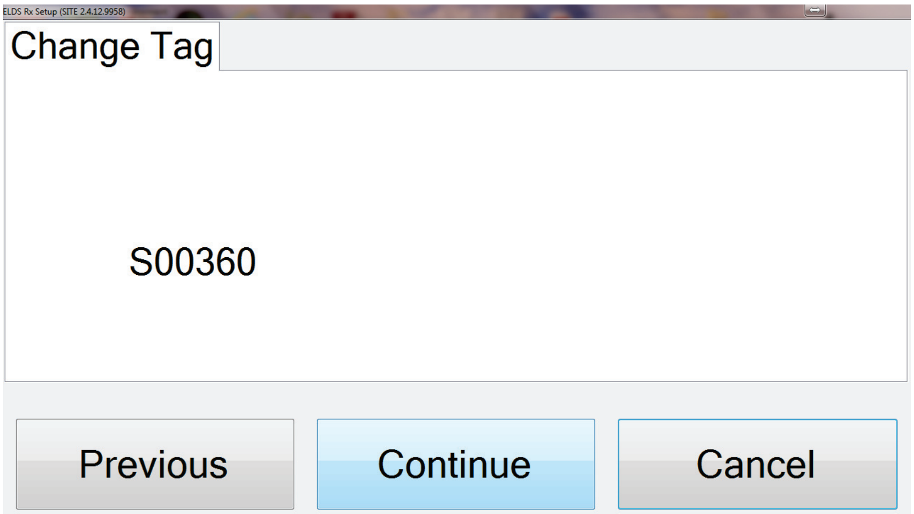
If any of the following occur during the zeroing process, the zero might not be correct:

- A release of target gas took place in or near the system.
- An object or person moved into or through the beam-path.
- A gassing cell was mistakenly inserted or left in the beam-path.

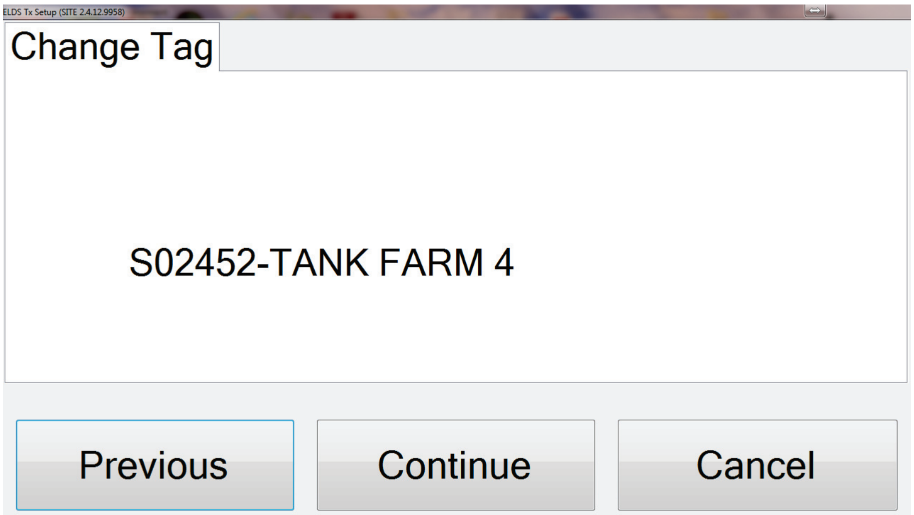
If the user suspects that any of the above occurred during zeroing, it is recommended that the unit be re-zeroed.

6) Setting / Changing Tag

You now have the opportunity set / change the Tag that will be reported by the unit during operational service.



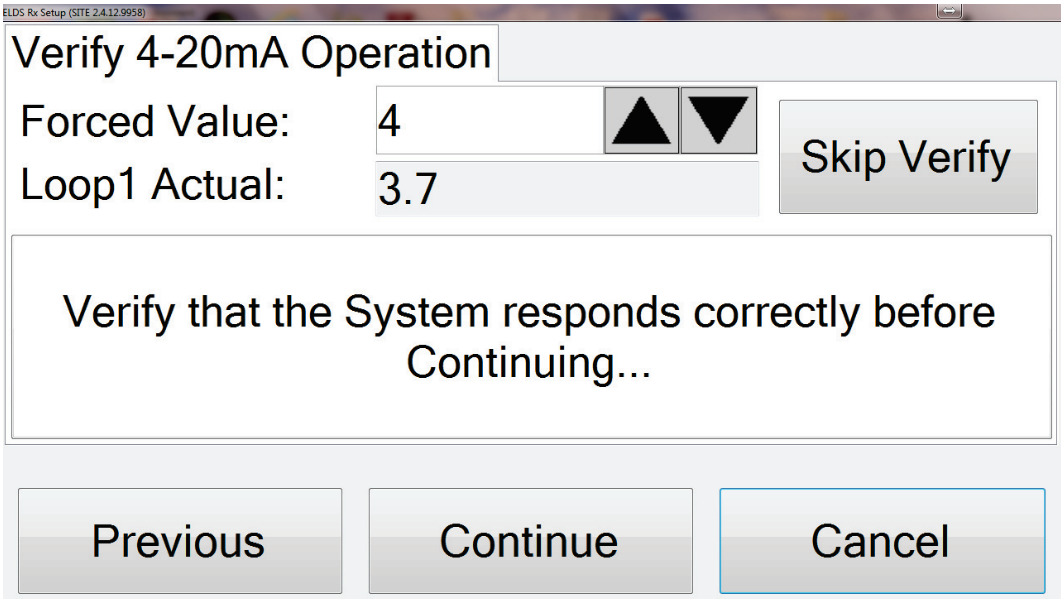
If you want to set / change the Tag, left click on the Tag being displayed and use the keyboard to make the required changes to the Tag.



GB

7) Verify 4-20mA Loop

SITE now displays the screen below, providing options for verifying the correct operation of the 4-20mA loop(s).



The 4-20mA loop verification options can be used as follows:

- **Force 4-20mA**

  Use the Up & Down arrows by the **Forced Value** box to adjust the current that is to be forced out of the Receiver’s two 4-20mA outputs. Check that the current flowing through the 4-20mA loops is correct by use of either a multi-meter, the current measured and displayed by the control system, or the Loop1 Actual current loop read-back (Mod State 2 and higher).
  NB: When using the Loop1 Actual current loop read-back feature, a ±0.5mA allowance needs to be made for the cumulative tolerances that affect the Loop1 Actual reading. In the above illustration a Forced Value of 4mA is reading back as 3.7mA, which is within the expected range.

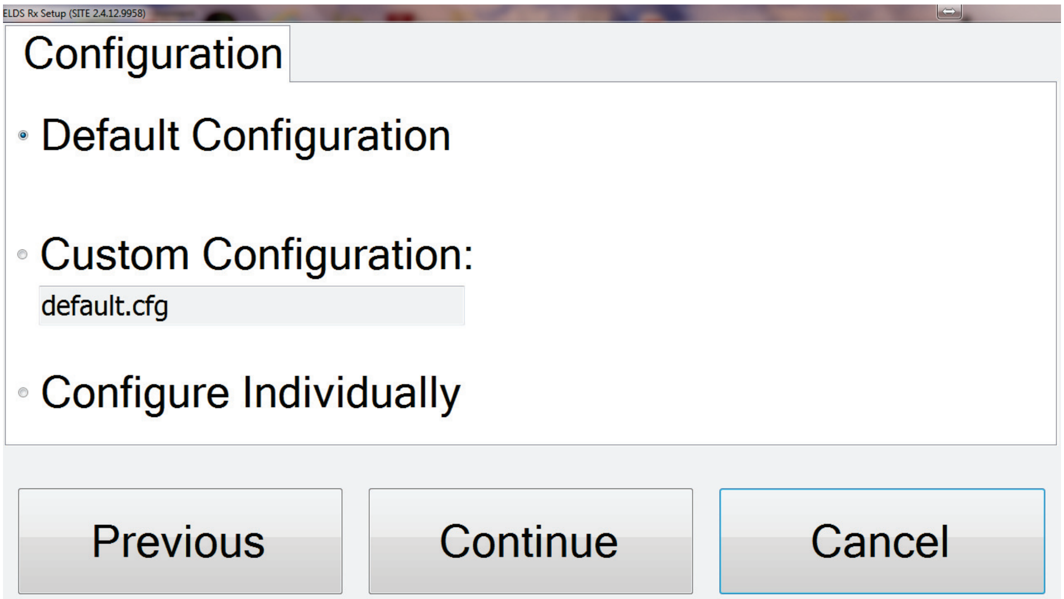
  Having satisfactorily verified the 4-20mA loop operation, click **Continue** to proceed to the next step.

- **Skip 4-20mA Verification**

  If you do not want to verify the 4-20mA output, or the 4-20mA loop is not connected at the time of performing commissioning, click **Skip Verify** to proceed to the next step.

8) Configure 4-20mA Behaviour

All ELDS systems are supplied with default configurations for the currents to be signalled on the 4-20mA outputs to indicate Low Signal, Beam-Block, Inhibit, Over-Range or Fault conditions. Users wishing to keep and use the standard default configurations can do so by clicking the **Default Configuration** button, followed by **Continue**.



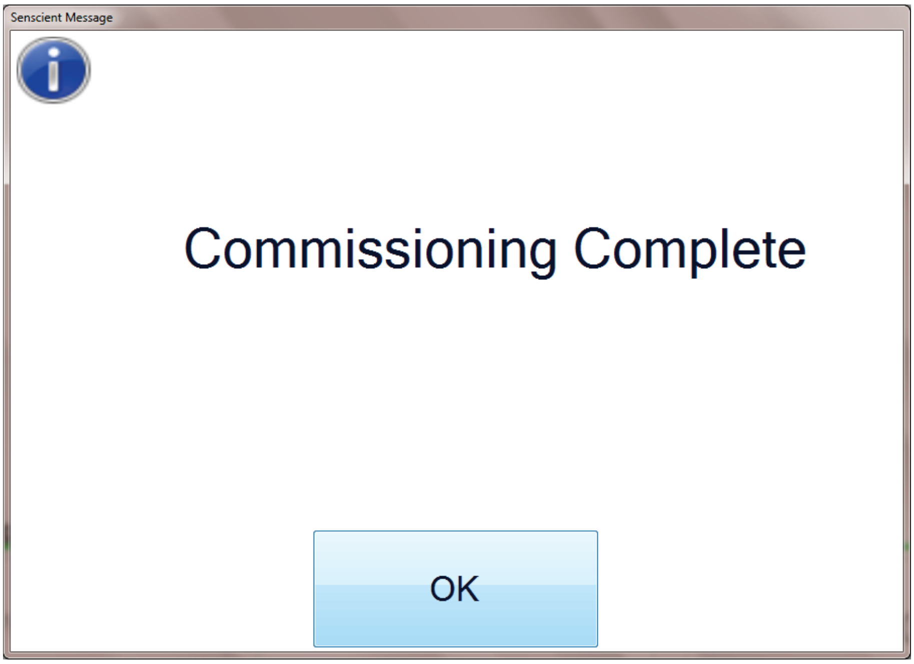
Users wishing to load a custom configuration into the connected unit can do so by clicking the **Custom Configuration** button, entering the filename of the required custom configuration; and clicking **Continue**.

Users wishing to configure these items individually can do so by clicking the **Configure Individually** button, launching the individual configuration process. The properties that can be configured individually are as follows:

- Inhibit current
- Fault current
- Beam Block current
- Time between detecting a beam blocked state and declaring a Beam-Block
- Time between declaring a Beam-Block and subsequently declaring a Fault*
- Low Signal current
- Time between detecting low signal and declaring low signal
- Over-range current.

* Default setting of -1.0 Hours configures system for no signalling of Fault due to Beam-Block.

There is now a short delay while SITE completes the writing of necessary information to the Rx unit. Once this is done the following confirmation is presented; acknowledge this by clicking **OK**.



The installation is now complete.

10) Final steps (RS485)

- Disconnect the RS485 A and B leads from the Transmitter’s terminal block.
- Carefully replace the terminal compartment lid and screw it down firmly.
- Once the terminal compartment lid is properly screwed down, attach and lock-off the anti-tamper fixture.

CAUTION
Both the explosion-proof protection and the ingress protection of the ELDS OPGD system rely upon the terminal compartment lid being screwed down fully. The lid should be tight and the O-ring compressed when the lid is properly screwed down.

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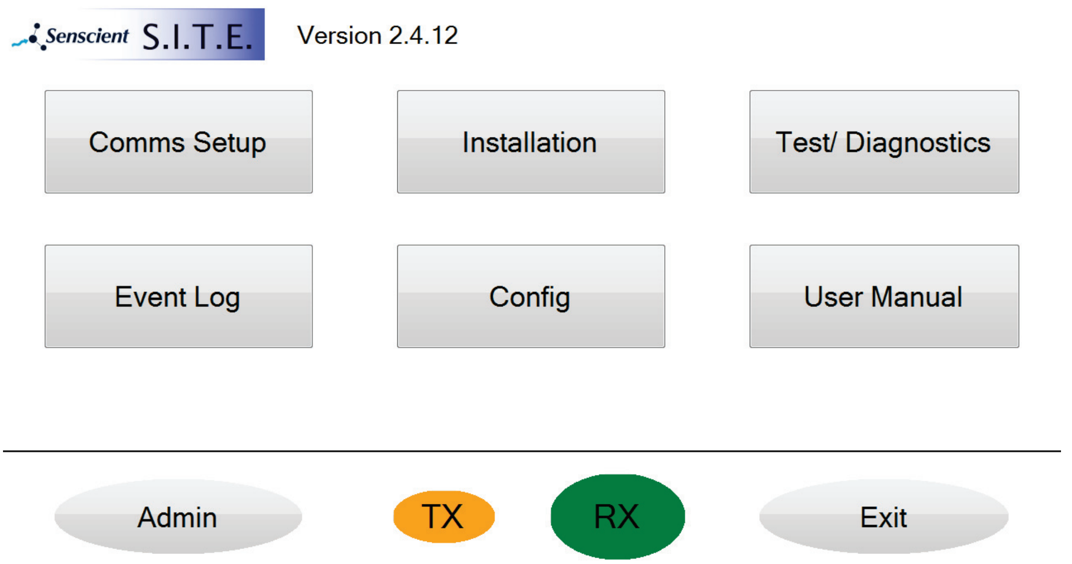
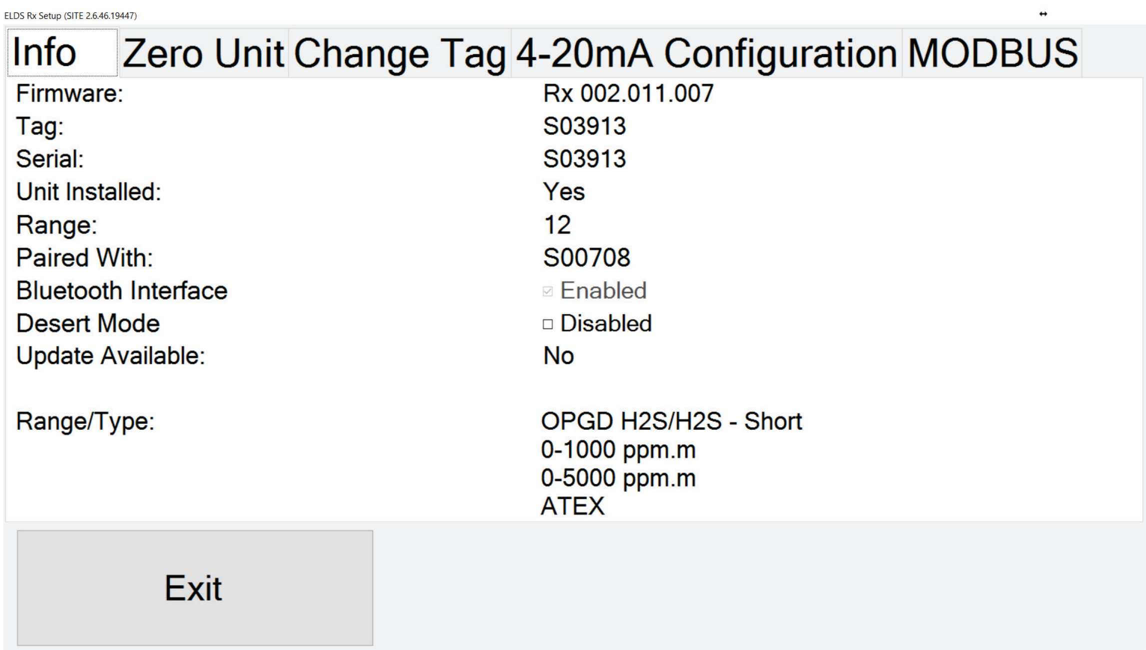
4.5.3 Disabling Bluetooth™ Wireless Operation

If required, the Bluetooth™ wireless connection to an ELDS unit can be disabled using SITE Disabling the Bluetooth wireless connection stops an ELDS unit from responding to any commands or requests received via Bluetooth. Henceforth, the unit will only respond to commands or requests received via RS485.

In order to disable Bluetooth wireless operation, from the SITE main screen click Config, and when the Info screen appears uncheck the Bluetooth Interface checkbox.

This checkbox is not normally enabled (for change), to allow it to be altered it is necessary to change the operating mode of SITE, see section 2.8.8.





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1) If a unit's Bluetooth link is disabled by sending the required SITE command via Bluetooth, when this command is received, the Bluetooth communications link to this unit will be broken. Having had communications broken in this manner, none of the other SITE screens or commands will work correctly with this unit until a new communication link is established via RS485. **Hint:** Exiting and re-entering SITE will cleanly close all communication links and make SITE ready for establishing new links.
2) To minimise the effects of 1), only disable Bluetooth where absolutely necessary, and when you are certain that all installation and commissioning activities have been completed.
3) Having been disabled, Bluetooth can only be re-enabled on a unit by sending it a SITE command via a hard-wired RS485 communications link.

4.6. ELDS Bluetooth™ Wireless Connection

All ELDS systems are now supplied* with an integrated Bluetooth™ wireless communication link based upon Bluetooth™ 2.0 transceiver modules. These Bluetooth™ transceiver modules are connected to an antenna mounted on the lens-window at the front of ELDS units. The integrated Bluetooth™ wireless communication link is in addition to the RS485 link and is intended to provide a quicker, simpler means of communicating with ELDS units.

Since Bluetooth™ is a low power, short-range, wireless communications link, users should appreciate that there will be some locations and physical environments where it will not be possible to achieve reliable Bluetooth™ communications. In such locations / environments, the user will still need to make use of the hard-wired RS485 connection.

* Mod state 1 onwards.

Cross Duct ELDS systems are installed on ducts with their Bluetooth antennae predominantly radiating into the duct. This configuration significantly reduces the amount of wireless signal outside the duct available for establishing a Bluetooth connection; and may even prevent the successful use of Bluetooth. In such circumstances, the hard-wired RS485 connection should be used to provide communications between ELDS units and SITE.

4.6.1 Bluetooth™ – Information and Properties

Bluetooth™ Transceiver Module – The Bluetooth™ transceiver module built into ELDS units is a Class 2 Bluetooth™ device. This means that its radiated power is limited to just 2.5mW.

Bluetooth™ Frequency – Bluetooth™ is a frequency-hopping, spread-spectrum wireless communications technology with emissions limited to a small frequency band centred upon 2.44GHz.

Bluetooth™ Range – A Class 2 Bluetooth™ transceiver is intended to be capable of operation over ranges up to 10 metres. However, due to the interaction between Bluetooth™ radiation and the physical environment, the useful Bluetooth™ communication range will vary significantly from location to location. In ideal environments Bluetooth™ communications may be possible over ranges of up to 20 metres or more; whilst in environments that cause problems for Bluetooth™, communication ranges may be limited to a few metres.

Bluetooth™ Potential for Interference? – Bluetooth™ operates in the globally unlicensed ISM 2.4GHz band. Low-power ISM 2.4GHz transceivers can be built, sold and used anywhere in the world without a licence. The low power, frequency-hopping, spread-spectrum emissions from Bluetooth™ devices do not cause interference problems for electrical or electronic equipment that conforms to industrial EMC standards.

Bluetooth™ Absorption by Water – Microwave radiation at around 2.44GHz is very strongly absorbed by water molecules. The human body comprises approximately 90% water and consequently Bluetooth™ radiation can be strongly absorbed by the presence of people or their limbs in the direct path of a Bluetooth™ link.

Bluetooth™ Directionality – Bluetooth™ radiation has a relatively short wavelength of just 12cm, which makes it much more directional than the longer wavelengths typically used for radio communications. This directionality makes the radiation patterns of Bluetooth™ devices narrower; and less likely to propagate around corners or behind obstructions than longer radio wavelengths.

Bluetooth™ 'Patchiness' – Bluetooth™ wireless radiation interacts with the physical environment in a manner that can produce a patchy distribution of 'zones' from which reliable Bluetooth™ communications are possible. This 'patchiness' means that relatively small changes in the location of one or other of the ends of a Bluetooth™ link can produce significant changes in the performance / reliability of a Bluetooth™ link.

4.6.2 Bluetooth™ Communications: - Notes and Guidance

In summary, when used correctly the Bluetooth™ communications link will often provide a quicker and simpler means of communicating with ELDS units than the hard-wired RS485 communications link. The following notes and guidance should help the user to get the best out of the Bluetooth™ communications link in different installations and environments:-

Proximity: Remember that Bluetooth™ is a short-range wireless communications link. In general, the closer you are to the ELDS unit you want to communicate with, the easier it will be to make a Bluetooth™ connection to it.

Use One Bluetooth™ Connection at a Time: There are no SITE functions requiring simultaneous connections to both ends of an ELDS system. Every SITE function can either be performed from just one end of an ELDS system, or at one end followed by the other. Since, in the majority of field installations it will not be possible to make reliable, simultaneous Bluetooth™ connections to both the RX and TX of an ELDS system, avoid problems by only using Bluetooth™ to connect to one end of the system at a time.

To the Fore Often Works Best: Since Bluetooth™ is directional and the antenna is on the lens-window at the front of ELDS units, you will often get a better connection somewhere to the fore of an ELDS unit than to the rear. If you can see the lens-window of the unit with which you wish to connect and you are not blocking the system's beam-path, you are probably in a good location for making a Bluetooth™ connection.

Keep Industrial Computer Stationary Once Connected: Since the strength of Bluetooth™ signals vary significantly with location, once you have made a Bluetooth™ connection it is best to keep the industrial computer stationary whilst using this connection. Moving the industrial computer introduces the possibility of the connection being lost.

Keep Out of the Bluetooth™ Path: The water in your body and limbs strongly absorbs Bluetooth™ signals, so try to keep them out of the path between the industrial computer and the ELDS unit. (NB: Bluetooth™ signals are completely harmless and present no risk to health.)

Always Give Discovery a Retry: On occasion, the Bluetooth™ device discovery process will fail to discover the device that you are trying to connect to. It is always worth giving Bluetooth™ device discovery a second try before doing anything else.

Can't Connect – Try Another Location: Since in some environments Bluetooth™ can become patchy, if you can't make a connection to a particular ELDS unit from one location, try moving to somewhere else. Even a small change in location can enable a Bluetooth™ connection to be made that was not possible in the original location.

There will be some installations and physical environments in which it is very difficult or even impossible to establish reliable Bluetooth™ communications. Senscient cannot guarantee reliable Bluetooth™ communications in every installation or environment.

Failure to achieve reliable Bluetooth™ communications with a particular ELDS unit does not mean that the ELDS unit is faulty. If it is not possible to use Bluetooth™ in a particular instance, check that power is reaching the ELDS unit and use the hard-wired RS485 communications link to perform any necessary actions.

4.7. Installation Checklist

The following information is for the guidance of personnel carrying out installation checks / tests on Senscient ELDS™ OPGDs. In general it should be noted that:

Installation of ELDS™ 1000 / 2000 Series OPGDs should be performed by personnel trained by Senscient or authorised trainers.

Detailed information concerning installation, alignment and commissioning is provided in this Technical Manual.

Senscient ELDS™ is explosion protected by a certified, explosion-proof enclosure. Carefully read the safety warnings, cautions and certification details in this manual. Ensure that they have been complied with, before and during the installation.

The following is a check list with notes to assist the installer:

- **Operating Range**

  Check the distance (preferably in metres), between the Transmitter and the Receiver.
  Is the unit being installed suitable for this operating range?

- **Detector Location**

  Check the location / position of the unit, e.g.
  West Walkway, Compressor Skid
  Is this the correct location / position for the unit?

- **Tag No**

  Check the Tag No, or equivalent, that has been allocated to the ELDS™ Receiver and Transmitter units. Do the Tag No.'s and details for the units all tie up?

- **Mod State**

  Check the Mod State of the units as indicated on their certification labels.

- **Certification**

  Check the certification of the units, e.g.
  Baseefa ATEX/IECEx (Europe),
  Is the Hazardous Area Certification of the unit correct for the Hazardous Area/Zone where it is being installed?

- **Mount Rigidity**

  Check that the units have been mounted securely to the supporting structure. Check that the supporting structure is sufficiently rigid to maintain alignment in the anticipated operating conditions. A maximum angular movement of ±1° is allowable.

  As an approximate guideline, a sufficiently rigid mount/supporting structure will only move a few millimetres (not more than ±6mm) when leaning one's body weight against it.

  When pushed hard and released, the mount/supporting structure should return quickly to its original position and should not wobble or sway. If the mount/ support is unacceptable, take steps to have the mount / supporting structure improved.

- **Vibration**

  Check the installation and its close surrounds for potential or existing sources of excessive vibration. Such sources could include heavy plant/machinery, turbines, generators etc.

  If there is the possibility that such vibration sources could be, or already are causing unacceptable movement, investigate how the effects of this vibration can be mitigated.

- **Excess Heat**

  Check the installation and its surrounds for potential sources of excessive heat. The unit is specified for ambients up to +60°C. Potential sources of excessive heat include flare-stacks, generator/turbine exhausts and steam vents. If there is the possibility that such heat sources are causing unacceptable temperatures to be reached, investigate how the effects of these sources can be reduced.

- **Supply Voltage**

  Check that the supply voltage applied to the unit is within the specified 18V to 32V range and is stable.

- **Earthing**

  Inspect the earth / ground connections to the units.

- **RFI/EMC**

  Assess the installation, cabling and its close surrounds for known or potential sources of excessive RFI/Electromagnetic Interference. Such sources could include radio/radar transmission antennae, high voltage switch-gear, large electrical generators/motors etc.

- **Contaminants**

  Assess the installation and its surrounds for sources of contaminants that could build-up on the unit’s windows. Such contaminants could include oil mist, heavy sea spray, drilling mud, dirty exhaust fumes, wave splash etc.

  If there is a realistic possibility that such contaminants could eventually completely obscure the optics, consider how the rate of build-up could be reduced or whether scheduled cleaning might be required. Senscient can provide a Storm Cowl for use in locations where the heavy build-up of contaminants upon the optics is a concern.

- **Beam Obstruction/Blocks**

  Ideally, a clear path of at least 20cm diameter should be provided between the Transmitter and the Receiver. Assess the installation and the beam-path for potentially problematic sources of beam blockage, such as moving machinery/plant, growing vegetation and places where icicles or snow-drifts could build up.

- **Functional Test**

  After completing the installation procedure, perform a functional test upon the unit using SimuGas.

- **4 - 20mA Loop Integrity**

  Test the 4 - 20mA loop integrity by forcing the unit to output a known current and monitoring this at the control room or with a multimeter inserted into the loop.

5. Functional Testing

5.1. Introduction

Senscient's ELDS 1000 / 2000 Series OPGDs are factory-calibrated with their specified gases using special equipment and procedures that are operated in a closely controlled environment. There are no physical mechanisms that will cause the gas calibration of an ELDS OPGD to change during operational service, so once an ELDS OPGD has been factory-calibrated it is calibrated-for-life.

Senscient's ELDS 1000 / 2000 Series OPGDs feature the most advanced gas detector functional testing technology currently available, enabling the correct function of OPGDs to be tested with far greater ease and frequency than has previously been possible. The key functional testing technology incorporated in Senscient's ELDS OPGDs is called SimuGas™, which is an on-command, electronic simulation of the presence of a quantity of target gas in the beam-path.

At the same time that ELDS OPGDs are factory-calibrated with their specified gases, the Harmonic Fingerprints produced by each Transmitter during SimuGas tests are configured and adjusted to make them identical to the Harmonic Fingerprints produced by the presence of real target gases in the beam-path. Senscient recommends that SimuGas tests are all that are needed to verify the correct functionality of ELDS OPGDs in field service conditions.

The flexibility afforded by SimuGas™ technology makes it possible to perform functional testing of ELDS OPGDs in two different ways, SimuGas Auto and SimuGas Live, which methods are described in detail in the following sections.

Extraction of the results of SimuGas Auto testing that are contained in the Event Log of an ELDS Receiver provides clear, documentable evidence of the correct operation of an ELDS OPGD over the entire period covered by the Event Log.

Testing OPGDs with target gases in field-service conditions is difficult, potentially hazardous and prone to the significant sources of error that are associated with uncontrolled, outdoor environments. Consequently, Senscient does not recommend gas testing ELDS OPGDs in field-service conditions and strongly recommends the use of SimuGas wherever possible.

In circumstances where operators are mandated to perform testing of gas detectors using a sample of gas, Senscient can supply a Gassing Cell or Gas Challenge Cell for use with our ELDS products. (See APPENDIX C, section 13 for further information.)

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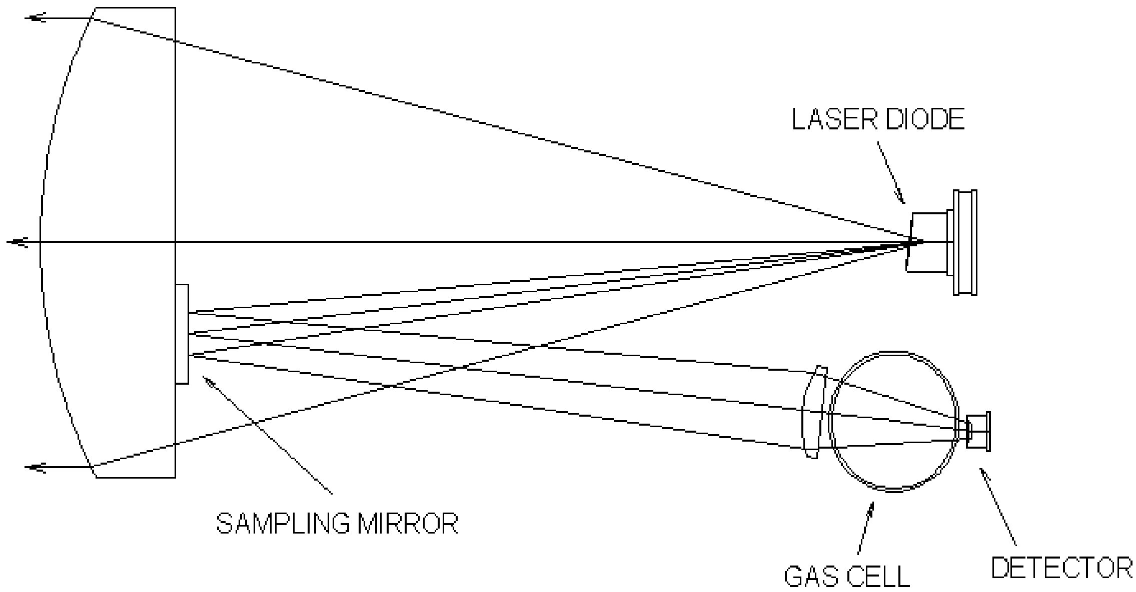
5.1.1 Harmonic Fingerprints™

In an ELDS Transmitter the drive current applied to the laser diode(s) comprises two components, a DC bias component which sets the mean operating wavelength of the laser diode(s), and a pure sinusoidal component which modulates the wavelength of the laser diode(s). Continuous registration of the wavelength(s) of the Transmitter's laser diode(s) is achieved by passing a small fraction of the laser diode output(s) through a retained sample of target gas(es) inside the Transmitter, and measuring the resulting signals from a reference detector (See below).



Transmitter: Gas Reference Channel

Using the signal reaching the reference detector through the retained gas sample, the Transmitter's microcontroller is capable of determining the precise bias and wavelength modulation components that need to be applied to the laser diode(s) in order to ensure that absorption of the laser diode's optical radiation by target gas always produces a Harmonic Fingerprint.

A Harmonic Fingerprint is a set of harmonic components introduced by target gas absorption, in which the relative amplitudes and phases of the components are known and specific to the target gas absorption line that is being scanned by the ELDS Transmitter. When the laser diode drive conditions in an ELDS Transmitter are maintained such that target gas absorption always produces a Harmonic Fingerprint, the Transmitter is said to be maintaining Harmonic Fingerprint Lock.

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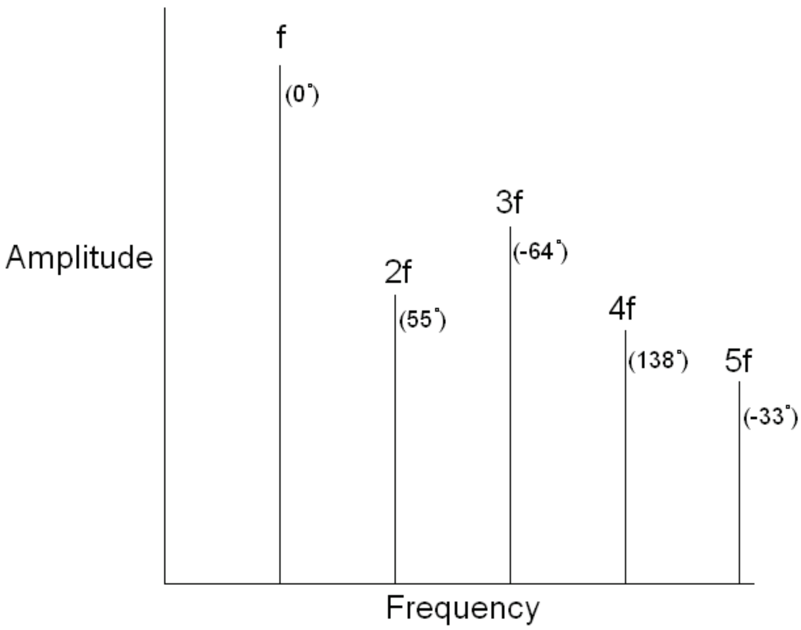

Harmonic Fingerprint for a H_2S Line at 1589.97nm

Under conditions of Harmonic Fingerprint Lock, the size of any Harmonic Fingerprint measured is proportional to the amount of target gas in the beam-path. In an ELDS OPGD system, the Receiver detects and measures the size of any Harmonic Fingerprints in the signal reaching it from the Transmitter, and uses this to determine the quantity of target gas in the monitored beam-path.

5.1.2 Electronically Synthesised Harmonic Fingerprints – SimuGas™

As described in section 5.2.1, the Transmitter in an ELDS-based OPGD is continuously using the signal from its reference detector channel to maintain Harmonic Fingerprint Lock. The Transmitter's microprocessor controls the electronic synthesis of the drive waveforms that are applied to the laser diode(s) such that the laser diode(s) remain precisely locked to the chosen target gas absorption line(s), and by so doing ensures that the sizes of each Harmonic Fingerprint component produced by target gas absorption are precisely known.

Because the Transmitter in an ELDS OPGD is electronically synthesising the drive waveforms that are applied to its laser diode(s) and knows the sizes of the Harmonic Fingerprint components produced by target gas, it is possible for a Transmitter to electronically synthesise laser diode drive waveforms which include Harmonic Fingerprint components corresponding to a quantity of target gas.

When the laser diodes in an ELDS Transmitter are driven by waveforms including Harmonic Fingerprint components corresponding to a quantity of target gas, their optical outputs include the Harmonic Fingerprint components - just as if they had been introduced by genuine optical absorption by the target gas.

This means that an ELDS Transmitter can electronically simulate the presence of a quantity of target gas in the monitored beam-path. Senscient refers to this type of electronically simulated gas as **SimuGas™**.

When the Receiver of an ELDS OPGD receives signals from the Transmitter which include SimuGas™ components, it cannot tell the difference between electronically synthesised Harmonic Fingerprint components and those produced by genuine absorption by target gas. Consequently, the Receiver processes the received signal and calculates the amount of target gas believed to be present in the beam-path - based upon the sizes of the Harmonic Fingerprint components.

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Comparing the gas quantity calculated by the Receiver to the quantity of SimuGas simulated by the Transmitter provides a powerful means of verifying the correct function of an ELDS OPGD.

SimuGas™ OPGD functionality testing offers considerable advantages over conventional OPGD testing methodologies, including the following:-

- There is no need for operators to generate, handle or apply hazardous gases to detectors in the field.
- There is no need for operators to gain direct physical access to detectors in order to test them. Commands to perform SimuGas tests can be sent remotely from wherever it is convenient, and the results of tests can be monitored remotely too.
- Because SimuGas is simple, quick and convenient it makes it possible to functionally test gas detectors much more frequently, improving the safety integrity of a fixed gas detection system.
- SimuGas™ Auto performs an automatic ELDS gas detector functionality test every 24 hours and the results of this testing are stored in the Receiver's Event Log.
- The operation and maintenance costs for a fixed gas detection system are considerably reduced.

Because of the flexibility afforded by SimuGas™ technology it is possible to perform functional testing of ELDS OPGDs in a number of different ways which are described in the following sections.

5.2. SimuGas™ Auto

The simplest way for users to realise the considerable safety integrity benefits provided by SimuGas™ technology is to make use of SimuGas™ Auto automated ELDS gas detector functionality testing that is a standard feature of ELDS systems. As standard, ELDS Transmitters perform a SimuGas Auto test with a known SimuGas level every 24 hours, with the Receiver opposite checking to confirm that each test produces acceptable results. In the unlikely event that a SimuGas Auto test does not produce acceptable results, the Receiver is configured to signal a Fault to the control system, providing an early warning about any potential problem with the ELDS OPGD system affected.

Compared to conventional OPGD testing methodologies or operator-initiated SimuGas tests, SimuGas Auto has the following advantages:

- Testing is performed without the gas detector being visited by operators.
- Testing is performed every 24 hours, providing far earlier diagnosis of any problem than tests relying upon operators visiting gas detectors.
- Testing requires no additional cabling, software or control system infrastructure. SimuGas Auto can be employed successfully using the same wiring and control systems that were used with earlier generations of gas detectors.

When performing a SimuGas™ Auto test, an ELDS OPGD system executes the following actions:

(1) Every 24 hours, at a pre-set time the Transmitter commences the procedure for a SimuGas Auto test.

(2) The Transmitter warns the Receiver that it is about to perform a SimuGas Auto test.

(3) The Receiver freezes the gas reading signalled on its 4-20mA output(s) at the value(s) immediately preceding the SimuGas Auto test.

(4) The Transmitter drives its laser diode(s) such that its output includes Harmonic Fingerprints corresponding to a pre-defined quantity of gas, and holds this SimuGas level for 30 seconds duration.

(5) The Receiver measures the size of the Harmonic Fingerprint components introduced by the SimuGas test and calculates the quantity of gas that this corresponds to.

(6) At the end of the SimuGas test, the Receiver un-freezes its 4-20mA output(s), enabling a return to the live signalling of the quantity of gas in the monitored beam-path.

(7) The Receiver compares the quantity of gas calculated to be in the monitored beam-path during the recent SimuGas test with the quantity of gas known to be simulated during SimuGas Auto tests.

(8) The Receiver assesses whether the results of the SimuGas Auto test were satisfactory, and if satisfactory continues operating as normal.

(9) The results of the SimuGas Auto test are entered into the Receiver’s Event Log, including a time and date stamp.

(10) In the unlikely event that the results of a SimuGas Auto test were not satisfactory, the Receiver updates its status and outputs the configured Fault signal on its 4-20mA output(s).

Extraction of the results of SimuGas Auto testing that are contained in the Event Log of an ELDS Receiver provides clear, documentable evidence of the correct operation of an ELDS OPGD over the entire period covered by the Event Log.

5.2.1 Operator-Initiated SimuGas Auto Test

In addition to the automatically initiated SimuGas Auto tests which are performed every 24 hours, it is possible for operators to check ELDS OPGDs for correct operation of SimuGas Auto testing during commissioning or inspection visits.

A SimuGas Auto test can be commanded using SITE software running on an industrial computer that is in communication with an ELDS Transmitter. Immediately following receipt of a SimuGas Auto command, an ELDS Transmitter executes precisely the same procedure that is executed when automatically performing a normal SimuGas Auto test.

A complete SimuGas Auto test cycle takes just under 1 minute, after which duration the results of the SimuGas Auto test should be available for retrieval from the Receiver’s Event Log using SITE.

Unlike a SimuGas Live test, an operator initiated SimuGas Auto test does not result in the signalling of gas readings on the 4-20mA outputs of ELDS Receivers. Consequently, an operator initiated SimuGas Auto test is well suited to performing detector functionality testing on ELDS OPGD systems in situations where it may be difficult to inhibit the safety system to which it is connected.

The results of an operator initiated SimuGas Auto test may be determined by inspection of the Receiver’s corresponding Event Log entries after the test has been completed.

See section 5.4 “SimuGas Levels” for details of the levels of SimuGas synthesised during SimuGas Auto tests.

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In order to ensure that each SimuGas test is performed with the ELDS OPGD in the correct state for such a test, following completion of each SimuGas test there is a 1 minute lock-out period. During this lock-out period, SITE will not allow operators to command ELDS Transmitters to perform SimuGas Auto or SimuGas Live tests. The operator is required to wait until SITE indicates that it is possible to command SimuGas tests again.

5.3. SimuGas™ Live

A SimuGas Live test enables a SimuGas functionality test to be performed with the Receiver signalling the quantities of gas calculated present in the monitored beam-path on its 4-20mA output(s).

CAUTION

When a SimuGas Live test is performed, no warning flag is sent from the ELDS Transmitter to the Receiver opposite to freeze the Receiver's 4-20mA output(s). Unless the purpose of a SimuGas Live test is to confirm correct initiation of executive actions by the connected Safety Instrumented System (SIS), the user must take steps to ensure that live gas readings being signalled on the 4-20mA output(s) of ELDS Receivers do not initiate un-wanted executive actions. Where necessary, do this before performing SimuGas Live tests.

A SimuGas Live test can be commanded using SITE software running on an industrial computer that is in communication with a Transmitter. Following receipt of a SimuGas Live command, the Transmitter drives it laser diode(s) such that their outputs include Harmonic Fingerprints corresponding to a pre-defined quantity of gas, and will hold this SimuGas level for 30 seconds duration, subsequently returning to the 'gas-free' drive waveforms.

During the SimuGas Live test the Receiver will calculate the gas level(s) present in the monitored beam-path as normal, and signal these readings over its 4-20mA output(s).

The results of a SimuGas Live test may be determined by comparison of the gas reading(s) signalled by the Receiver during the test with the gas level(s) that the Transmitter was simulating.

1) See section 5.4 "SimuGas Levels" for details of the levels of SimuGas synthesised during SimuGas Live tests.
2) In the event that a SimuGas Live test is performed when there is real target gas in the beam-path, the amount of gas seen and signalled by the Receiver will be the sum of the SimuGas level and the real gas level. Since any real target gas levels present in an open beam-path will tend to fluctuate, the summed reading signalled during a SimuGas Live test performed under such conditions will also fluctuate. This fluctuation should not be interpreted as a problem with the ELDS system or the SimuGas Live test, it is a complication arising from the conditions in the beam-path when the SimuGas test was performed.
3) Due to the potential complication noted at 2) it is preferable to perform SimuGas Live tests when there is no real gas in the monitored beam-path. This can most easily be established by checking the gas readings from the Receiver before performing a SimuGas test. If the gas readings are stable at zero, SimuGas Live testing results will be simpler to interpret.
4) In order to ensure that each SimuGas test is performed with the ELDS OPGD in the correct state for such a test, following completion of each SimuGas test there is a 1 minute lock-out period. During this lock-out period, SITE will not allow operators to command ELDS Transmitters to perform SimuGas Auto or SimuGas Live tests. The operator is required to wait until SITE indicates that it is possible to command SimuGas tests again.

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5.4. SimuGas™ Levels

The levels of SimuGas Harmonic Fingerprints synthesised during SimuGas Live and SimuGas Auto tests are factory-set taking into account the following factors:-

- Target gas or gases. (H_2S, CH_4, NH_3, etc.)
- Measurement range(s). (0-250ppm.m, 0-1LFL.m, etc.)
- Likely alarm thresholds. (20%FSD, 60%FSD, etc.)
- Ease of detection of target gas or gases. (H_2S – difficult, CH_4 – easy)
- Probability of background levels of target gas (e.g. atmospheric [CH_4] = 1.8ppm).
- Electrical limitations on the size of Harmonic Fingerprint components that can be applied to laser diode(s).

When the above factors are taken into account it is not always possible to set the SimuGas Live or SimuGas Auto levels so that they will exceed particular alarm thresholds or exercise the majority of the unit's measurement range. However, for all ELDS product variants, the factory set SimuGas Live levels will produce a measurable change in the current signalled on the Receiver's 4-20mA output(s) during this test; whilst the SimuGas Auto levels will provide a robust, reliable confirmation of ELDS OPGD gas detection functionality. This ensures that the principle benefits of SimuGas™ technology are delivered on all ELDS product variants.

The levels of SimuGas Live and SimuGas Auto tests and typical test tolerances for SimuGasAuto are presented in the table below. Note that the recorded values for these tests are expected to have some tolerance, typically small but possibly up to ±25% of the indicated value:

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Range & Gas	SimuGas Live	SimuGas Live 4-20mA o/p	SimuGas Auto (min-max)
0 – 1LFL.m CH_4 0 – 5LFL.m CH_4	3000ppm.m	5.1mA 4.2mA	1000ppm.m (500 – 1500ppm.m)
0 – 1000ppm.m CH_4	800ppm.m	16.8mA	1000ppm.m (500 – 1500ppm.m)
0 – 250ppm.m H_2S	200ppm.m	16.8mA	400ppm.m (200 – 600ppm.m)
0 – 500ppm.m H_2S 0 – 1000ppm.m H_2S 0 – 1500ppm.m H_2S 0 – 5000ppm.m H_2S 0 – 15000ppm.m H_2S	400ppm.m	16.8mA 10.4mA 8.3mA 5.3mA 4.4mA	400ppm.m (200 – 600ppm.m)
0 – 200ppm.m NH_3 0 – 1000ppm.m NH_3 0 – 5000ppm.m NH_3	150ppm.m 250ppm.m 250ppm.m	16mA 8mA 4.8mA	250ppm.m (125 – 375ppm.m)
0 – 15000ppm.m NH_3	3000ppm.m	7.2mA	1000ppm.m (500 – 1500ppm.m)
XD CH_4 (0 – 10%LFL, 0-25%LFL, 0 – 50%LFL, 0-100%LFL)	3,000ppm.m	Depends upon duct width and measurement range	1,000ppm.m (500-1,500ppm.m)
0-50ppm.m HCl	30ppm.m	13.6mA	20ppm.m (10-30ppm.m)
0-25ppm.m HF, 0-50ppm.m HF 0 – 200ppm.m HF	15ppm.m	13.6mA 8.8mA 5.2mA	15ppm.m (7.5 – 22.5ppm.m)
0 – 1000ppm.m HF	50ppm.m	4.8mA	50ppm.m (25 -75ppm.m)
0 – 50ppm.m HCl	30ppm.m	13.6mA	20ppm.m (10 – 30ppm.m)
0 – 300000ppm.m CO_2	50000ppm.m	6.7mA	50000ppm.m (25000 – 75000ppm.m)
0 – 10000ppm.m C_2H_4 0 – 1LFL.m C_2H_4	3000ppm.m	8.8mA 6.1mA	1000ppm.m (500 – 1500ppm.m)

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6. Maintenance

Senscient's ELDS™ 1000 / 2000 Series OPGDs are designed to require minimal routine maintenance. ELDS OPGD unit's contain no user-serviceable parts and are supplied factory-calibrated for life, with no need for in-service re-calibration.

CAUTION

Senscient ELDS™ OPGDs do not contain any parts that can be repaired or replaced by users. Do not open either the Transmitter or Receiver unit. The warranty of units which have been opened may be invalidated.

Senscient's ELDS™ 1000 / 2000 Series OPGDs feature the most advanced self-testing and self-diagnosis technologies incorporated into gas detection products for use in safety applications. The operation of these self-testing and self-diagnosis systems have been analysed by third party experts in safety integrity; and found to provide an exceptionally high Safe Failure Fraction (SFF), with very few failure modes that will not be detected. A Safety Instrumented System employing ELDS OPGDs will meet the requirements of SIL2 per IEC 61508-1 by proof tests being performed upon the ELDS OPGDs at an interval one to two years. The recommended proof test for an ELDS OPGD is an operator witnessed SimuGas Auto or SimuGas Live test. (See "Exida – ELDS FMEDA & SimuGas Proof Test.pdf")

THE TRANSMITTED LASER BEAM IS CLASS 1 (EYE-SAFE) PER IEC 60825.

6.1. Scheduled Inspection, Cleaning & Testing

Senscient is aware that many of the sites and facilities using gas detection equipment have working practices or procedures that require gas detectors to be serviced and tested in accordance with a schedule.

For the majority of applications, Senscient would recommend that a scheduled maintenance and testing visit be made to ELDS OPGDs annually.

Where experience of the operational conditions at a particular facility indicate that more regular maintenance visits would be beneficial, users should schedule visits at the frequency required to maintain gas detection system availability at the level appropriate to the application.

The following short procedure suggests the actions that users should consider including in any scheduled maintenance and testing of ELDS OPGD systems:

(1) Inspect the ELDS™ OPGD units and cabling for signs of physical damage. If cabling is damaged, repair the damage or replace the affected cabling with new cable and/or connectors. If an ELDS OPGD unit has suffered mechanical damage that appears to have compromised the flameproof explosion-proof protection of the unit, remove the unit from service and return it to Senscient for factory examination and repair.

(2) Clean the lens-windows of the Transmitter and Receiver units. (See section 6.2)

(3) Interrogate the Event Logs of both the Transmitter and the Receiver units; and confirm that the results for SimuGas Auto tests are as expected.

(4) Review the Event Logs and the Diagnostics screens using SITE, looking for any active Faults or Warnings. In the event that active Faults or Warnings are present, investigate these further; and attempt to clear these conditions before leaving the system. Where the root cause of active Faults or Warnings cannot be identified or remedied, download a snapshot from the affected system and send this to Senscient for expert review and advice.

(5) Check the signal level reaching the Receiver and comparing this to that which was obtained and recorded when the system was first installed and commissioned.

(6) In the event that the signal reaching the Receiver is low after the lens-windows have been cleaned, check the alignment of each end of the system using the alignment telescope. (See section 4.3.2)

(7) Perform a functional test using SimuGas™ Live or SimuGas Auto (see section 5).

6.2. Cleaning Lens-Windows

The optics of Senscient's ELDS OPGDs were designed in the expectation that operational service would result in the exposed surfaces of the TX & RX lens-windows becoming contaminated by the various airborne contaminants encountered at industrial facilities around the world. In contrast with NDIR OPGDs, the use of Harmonic Fingerprint technology in ELDS OPGDs means that none of the airborne contaminants likely to be deposited upon the lens-windows of an ELDS OPGD will give rise to false alarms or other spurious effects.

The principle effect of the build-up of contaminants upon the exposed lens-windows will be the gradual reduction of the amount of signal reaching the Receiver's infrared detector from the Transmitter. In the event of the build-up of extremely heavy contamination, this could result in an ELDS OPGD signalling either a Low Signal or a Beam-Block condition, suggesting that the system be visited and its optics cleaned if necessary.

Cleaning of the lens-windows of the TX or RX of an ELDS OPGD requires the following:

- A reasonable quantity of a pure, clear solvent such as tap water or IPA, preferably in a bottle with a nozzle through which the solvent can be squeezed.
- A quantity of clean, disposable cloth or paper towelling, preferably of a type that will remain in one piece when soaked with cleaning solvent and repeatedly rubbed.
- An alignment telescope.

The **OBJECTIVE** of cleaning the lens-windows of an ELDS OPGD is to remove any contaminants that might have built up on the exposed surfaces **WITHOUT** leaving behind a smeared film.

Achieving smear-free, film-free results is much simpler if relatively pure, clear solvents are used, such as tap water or IPA (isopropyl alcohol). **Avoid** using cleaning liquids containing detergents or that are coloured, because the detergent or colour components will tend to leave a film residue after the liquid has evaporated.

CAUTION
Do not use aggressive solvents or abrasives on the lens-windows of Senscient ELDS™ OPGD units.

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The lens-windows of the TX or RX of an ELDS OPGD should be cleaned as follows:

(1) Spray or splash a reasonable quantity of cleaning solvent onto the lens-window, allowing it to wash away any contaminants that dissolve readily.

(2) Soak a clean portion of cleaning cloth with the cleaning solvent and firmly rub the lens-window, forcibly loosening and dissolving any contaminants sticking to the lens window.

(3) Spray or splash a further quantity of cleaning solvent onto the lens-window, allowing it to wash away any contaminants loosened or dissolved by step 2.

(4) Repeat steps 2 and 3 until any and all contaminants originally on the lens-window have been washed or rubbed away. Do not re-use dirty portions of cleaning cloth - this will leave a smear-prone film.

(5) When any and all contaminants have been washed or rubbed away, dry the lens-window with a clean portion of cleaning cloth.

(6) Polish the dry lens-window with a dry, clean portion of cleaning cloth, making sure that no film is left behind.

(7) If you have had to rub the lens-window very hard to get all contaminants off, it is possible that you might have disturbed the alignment of the system. Use the alignment telescope to double-check the alignment of the recently cleaned system; and if the alignment is poor, adjust and re-lock the alignment as described in section 4.3.

7. Problem Solving

The majority of problems or faults can be diagnosed and corrected using the installation and alignment kit available for Senscient ELDS™ systems. The installation and alignment kit includes:

- Industrial computer running SITE
- Alignment Telescope

An electrical multimeter is also useful when diagnosing electrical/wiring problems.

CAUTION
Senscient ELDS™ units do not contain any user replaceable parts. Do not open the main enclosure of a Transmitter or Receiver unit. The warranty of units which have been opened may be invalidated.

7.1. The Commonest Problems, Issues or Misconceptions Affecting Successful Use of ELDS OPGDs

Extensive in-service operational experience with ELDS OPGDs has enabled Senscient to identify the commonest problems, issues or misconceptions that affect the success with which users employ these gas detectors. This short section explains these problems, issues or misconceptions; and is intended to help users to avoid experiencing them. These problems, issues and misconceptions are presented in order of descending probability / frequency of occurrence:

- **Insufficient Voltage Reaching the ELDS Units When Powered Up**

  In common with other infrared open path gas detectors, ELDS 1000 & 2000 Series OPGDs require a stable, sufficient and reliable supply of +24V power in order to operate reliably. Correctly engineered PSU and cabling arrangements will contribute greatly to the reliability and availability of an ELDS OPGD based gas detection system. Carefully review the power supply and cabling arrangements to be used to power ELDS units before the cables or power supplies are specified, purchased and installed. (See section 3.3.5 for detailed information upon ELDS power requirements and cabling.)

- **The ELDS OPGD is Generating False Gas Alarms**

  The combination of an open path gas detection configuration and the capability to detect target gas(es) at low ppm.m levels enables ELDS OPGDs to detect leaks of toxic or flammable gas(es) that are undetected by point gas detectors. This can give rise to the misconception that the gas readings being signalled by an ELDS OPGD are false; when in fact they are genuine but only being detected by the ELDS OPGD. To date there has only been a single proven instance of a false gas alarm being raised by an ELDS OPGD, the cause of which was identified and eliminated in 2010. In every other instance where false gas alarms were suspected and a proper investigation was conducted, genuine sources or causes for the gas readings that were signalled were eventually identified. In this way, many potentially dangerous gas leak sources and mechanisms were eliminated, making plants and facilities safer than they were previously.

- **The ELDS OPGD is Signalling Beam Block**

  After a predefined (configurable) time without receiving any signal from the ELDS Transmitter opposite, an ELDS Receiver will signal a Beam Block condition (2.5mA) on its 4-20mA output. There are a number of reasons why an open path gas detector might signal a Beam Block, which include loss of power to the Transmitter, a vehicle, person or object blocking the beampath, scaffolding erected in the beam, very dense fog, units being knocked out of alignment, vegetation growing up, into and blocking the beampath; and the development of a hardware fault. With there being numerous possible reasons for an OPGD to signal Beam Block, it is imperative that when such a signal is received from an ELDS OPGD, a suitably trained technician visits the detector in order to try to ascertain the root cause. For ELDS OPGDs, the majority of Beam Blocks signalled do not reflect the fact that there is a problem with the ELDS unit, but instead reflect a problem with the conditions that the unit is operating under. When these conditions are addressed, the majority of Beam Blocks signalled will go away.

- **Specifying the Most Sensitive Measurement Range for Toxic Gases**

  Based upon bad experiences where electrochemical and semiconductor toxic, point gas detectors fail to detect leaks as expected, some ELDS users have specified and ordered the most sensitive range of ELDS OPGD available for their particular toxic gas - with the objective of increasing the probability of detection.

  However, field service experience has established that using the most sensitive range available can be a mistake. By virtue of being open path toxic gas detectors, ELDS OPGDs will detect and integrate any and all of the target toxic gas that is present in their beam-path, even if this is at very low, non-hazardous levels. The consequence of using the lowest available ELDS measurement range and a correspondingly low alarm threshold can be that small, non-hazardous background levels of toxic gases; or fugitive emissions, can result in alarm signals being raised and operators becoming concerned. When this happens, users and operators eventually establish that these alarms are a nuisance; and that the measurement range that they have specified and the alarm thresholds that they have set are too low for their site and application. As a consequence of this, the commonest service visit performed by Senscient engineers (or our suitably trained selling and service partners) is to re-range ELDS OPGDs to have a higher measurement range that is more appropriate to the application. In many instances, this problem can be avoided by making use of the guidance on measurement ranges and alarm thresholds provided in Appendix G of this manual.

- **RS485 Communications Blown by Wiring Up to +24V Power**

  The ELDS RS485 communications circuitry is protected against surges and transients, but cannot withstand being unintentionally, permanently connected to the +24V power feed that is supposed to provide power to the unit. If the +24V power is connected to the RS485 circuitry by mistake, this will blow the RS485 isolation IC and RS485 communications will be lost. The only way of repairing this is by returning the unit to Senscient for a replacement PSU PCB. When wiring up ELDS units, always double check that you have not transposed the power and RS485 connections; and thereby avoid damaging RS485 communications.

- **The Bluetooth Communications Link is Less Reliable or has Shorter Range than Expected**

  There are a number of reasons why a wireless, Bluetooth communications link is not as reliable as a direct, hard-wired connection. None of these reasons are a consequence of there being something wrong with an ELDS OPGD - they are all consequences of the nature of wireless communications and how Bluetooth works. There are certain things about Bluetooth that are not common knowledge, which when known, understood and taken into account, can help to further improve the success with which Bluetooth is used. This information is presented in section 4.6.1 of this manual.

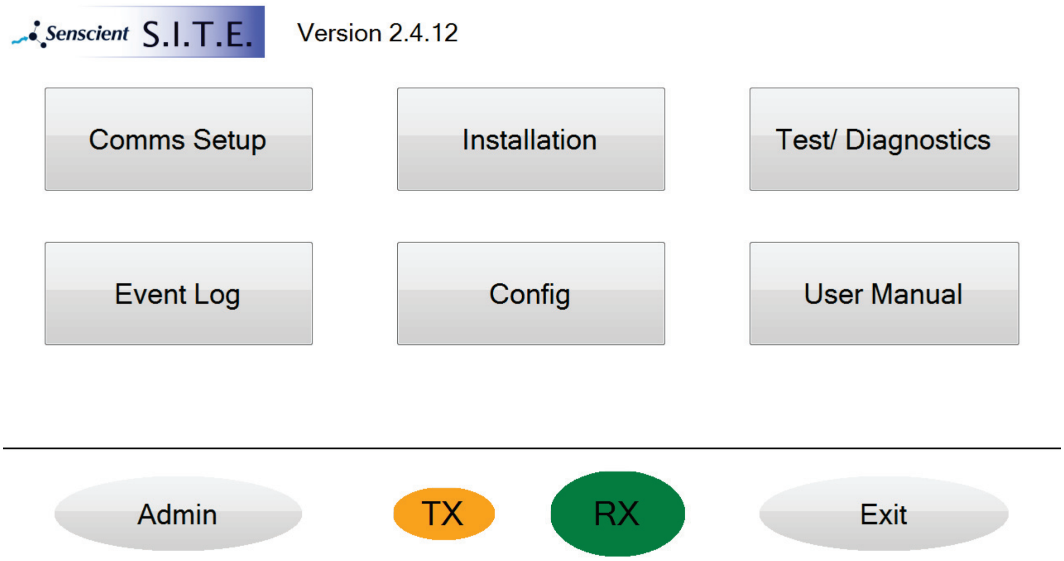
- **Modbus or HART Communications are Less Reliable than Anticipated**

  Problems with achieving reliable, long term communications using either the HART or Modbus communications protocols are encountered from time to time. These problems are not a consequence of there being anything wrong with an ELDS OPGD. If HART or Modbus communications difficulties are experienced, the most likely explanation is that electrical interference on the field cabling is causing data corruption.

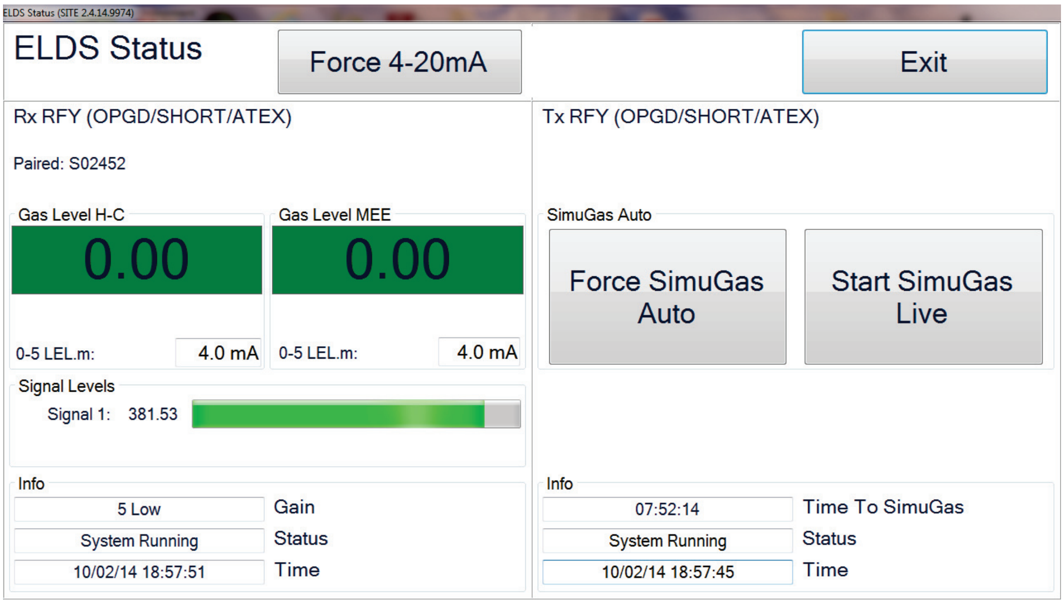
  The firmware responsible for handling HART and Modbus communications on an ELDS unit includes routines that detect interference or corruption; and that attempt to handle such problems. However, in instances where a lasting breakdown of HART or Modbus communications develops, the simplest way of resolving this problem may be cycling the power to the system, or to the ELDS unit with which communications have broken down.

7.2. SITE Diagnostics Screen

In many instances, the quickest and simplest way of identifying and diagnosing a problem with an ELDS system will be by reviewing the contents of the SITE Test/Diagnostics Screen. Select the Test / Diagnostics screen by clicking on the corresponding button in the Main SITE screen.



The SITE Test / Diagnostics screen provides the operator with a great deal of information about the status of the ELDS Transmitter or Receiver (or both) with which SITE is communicating. The information provided by the SITE Diagnostics Screen is described in the following sub-sections:



7.2.1 Receiver Diagnostics Screen

RX Unit

The RX Unit box contains information about the Type (Open Path or Cross Duct), Gas(es), Measurement Range(s) and Hazardous Area Certification of the Receiver with which SITE is communicating.

Gas Level

The Gas Level boxes contain the latest readings for each gas that the ELDS gas detector is being used to detect. Typically, these readings are updated every second, although this may vary depending upon the gas detector variant (Cross Duct ELDS systems update the gas readings on their outputs every 0.25 seconds); and the quality of the communication link. In addition to the latest readings, each Gas Level box displays the analog current that is being output on the corresponding 4-20mA output, which current provides an indication of the latest gas reading or of the status of the gas detector.

The measurement units and range are displayed in the bottom left corner of each Gas Level box.

Signal Level

Under normal circumstances, the Signal Level box displays the signal level(s) being received from each laser of the ELDS Transmitter opposite. Depending upon the path-length, alignment and prevailing visibility, the signal level(s) should be somewhere in the range 0.05 to 2,000. (NB: When SITE is used to install and commission an ELDS system, it will perform a check that the signal levels being received are reasonable for the path-length over which the system is being operated).

When there is a numeric value being displayed in the Signal Level box for the laser signal(s) being received, this indicates that valid, workable signal(s) are being received and that the ELDS system should be operating correctly as a gas detector.

Info.

The Info. Box contains information about the AGC Gain, Status and Time & Date of the Receiver with which SITE is communicating.

The Gain is an indication of the level of signal gain being provided by the Receiver’s Automatic Gain Control (AGC) amplifier. This gain level is described by the combination of two descriptors which are (High or Low) gain, and a number between 0 and 18. The very lowest level of AGC gain is 0 Low; whilst the very highest level of AGC gain is 18 High.

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The **Status** entry is an indication of the status of an ELDS OPGD system from the standpoint of the Receiver. There are a number of different Receiver Status' as detailed in the table below:

STATUS	DESCRIPTION
System Running	The ELDS system is running correctly and will detect and signal gas if present in the beam-path.
Gas Alarm	Target gas has been detected in the beam-path and is being signalled on the 4-20mA output(s).
Low Signal	The ELDS system is still operational as a gas detector but has diagnosed a Low Signal condition (dirty optics, poor alignment etc.) that might benefit from intervention to improve the operating conditions and signal levels.
SimuGas Active	A SimuGas Live or SimuGas Auto test is being performed.
Pending Beamblock	The Receiver has recently stopped receiving valid signals from the ELDS Transmitter opposite, and a diagnosis of Beam Block is pending.
Beamblock	The Receiver has not been receiving any valid signal(s) from the ELDS Transmitter opposite and a Beam Block has been diagnosed and declared.
Rapid Signal Loss	The signal reaching the Receiver was lost or reduced very rapidly, leading to the diagnosis and declaration of a rapid-signal-loss Beam Block.
Not Installed	The system has not been successfully installed and is not operational.
Simugas Fail	SimuGas Auto tests have either been failed or considered missing, leading to the diagnosis and declaration of a SimuGas Fault.
Long Term Beamblock	The ELDS system has been in Beamblock, or has seen no signal for so long (typically ≥ 7days) that it is declaring a Fault condition.
Bad Zero	Zero is not defined. Check installation and if good re-install.
Invalid Zero	The signals reaching the Receiver suggest that there is a potential problem with the quality of the zero that is being used. (Typically a negative offset.)

The **Time & Date** are the time and date being reported by the Real Time Clock of the Receiver with which SITE is communicating.

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7.2.2 Transmitter Diagnostics Screen

TX Unit

The TX Unit box contains information about the Type (Open Path or Cross Duct), Gas(es), Measurement Range(s) and Hazardous Area Certification of the Transmitter with which SITE is communicating.

SimuGas Auto Box

The SimuGas Auto box contains buttons that enable the operator to control the execution of SimuGas Auto or SimuGas Live functional test procedures.

Force SimuGas Auto

By choosing to Force SimuGas Auto, the operator instructs the Transmitter to execute a SimuGas Auto test, which test will not result in gas readings being signalled on the 4-20mA output(s) of the Receiver opposite.

There are two ways of obtaining the results of a SimuGas Auto test:

- After the SimuGas Auto test and lock-out has been completed the result(s) of the preceding SimuGas Auto test are displayed in the Receiver’s Gas Reading box for approximately 10 seconds. (This requires a live connection between SITE and the Receiver at the time of performing the SimuGas Auto test.)
- After the SimuGas Auto test has been completed, connect to the Receiver and inspect the Event Log. The last SimuGas Auto entries in the Event Log will correspond to the most recently performed SimuGas Auto test.

Start SimuGas Live

By choosing to Start SimuGas Live, the operator instructs the Transmitter to execute a live SimuGas test, which test will result in gas reading being signalled on the 4-20mA output(s) of the Receiver opposite.

CAUTION

When a SimuGas Live test is performed, no warning flag is sent from the ELDS Transmitter to the Receiver opposite to Inhibit the Receiver’s 4-20mA output(s). Unless the purpose of a SimuGas Live test is to confirm correct initiation of executive actions by the connected safety system, the user must take steps to ensure that live gas readings being signalled on the 4-20mA output(s) of ELDS Receivers do not initiate un-wanted executive actions. Where necessary, do this before performing SimuGas Live tests.

Info.

The Info. Box contains information about the SimuGas Auto Event Time, Status and Time & Date of the Transmitter with which SITE is communicating.

The **SimuGas Auto Event Time** is the time when the next SimuGas Auto test is scheduled to be performed automatically by the Transmitter.

The **Status** descriptor provides information upon the operational status of the Transmitter. Ordinarily, the Transmitter status should be ‘system running’, which means that the laser diode(s) of the Transmitter are correctly locked up on their respective target gas(es) - ready for the detection of gas should any enter the beam-path. During execution of the start-up and laser locking procedures, the status descriptor provides information as to where the Transmitter is within these procedures.

STATUS	DESCRIPTION
System Running	The transmitter is up and running correctly with its laser(s) locked onto target gas
Hunting For Gas	The transmitter is performing the gas lock hunting procedure.
Gas Hunt Complete	The transmitter has successfully completed the gas lock hunting procedure.
Full Gas Search	The transmitter is executing a full gas search in order to lock its laser(s) on target gas(es).
Failed Gas Search	The transmitter has performed a full gas search and failed to identify and lock onto the target gas(es).
Diffuser Failed	The transmitter diffuser has failed.
Not Installed	The system has not been successfully installed and is not operational.
SimuGas Active	A SimuGas Live or SimuGas Auto test is being performed.
Ambient TEC at Temperature	The ambient TEC has reached the correct temperature.
Laser Diode TEC at Temperature	The laser diode TEC has reached the correct temperature.

The **Time & Date** are the time and date being reported by the Real Time Clock of the Transmitter with which SITE is communicating.

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7.3. Troubleshooting Tables

Refer to the troubleshooting tables in this section for a list of problems, possible causes and actions.

Problem / Fault	Causes	Remedies
Output is 3mA (LOW SIGNAL)	TX or RX alignment poor for > 24 hours	1) Connect to the RX unit using SITE and check the signal levels (OSI) 2) If signal levels are low, use the alignment telescope to correct the RX alignment 3) If signal levels remain low after re-aligning RX, check the TX alignment using telescope
	Heavy contamination of optics > 24 hours	Check the TX and RX lens-windows for build-up of contamination. Clean the lens-windows if required.
	Visibility along beam-path very low for > 24 hours	1) Check that the Transmitter can be seen from the Receiver. If the Transmitter can be seen, even with some difficulty, low visibility is unlikely to be the problem 2) If the Transmitter cannot be seen from the Receiver, very low visibility could be the problem. Wait until visibility improves and verify that when this happens the unit returns to normal status (4mA).
Output is 2.5mA (BEAM BLOCK)	Beam-path is blocked	Check that the beam-path is clear from the TX to RX. Remove any obstruction if present.
	TX or RX misaligned	1) Use the alignment telescope to check the alignment of both the TX and the RX with respect to each other 2) Make and lock-off any alignment adjustments required 3) Connect to the Receiver using SITE and check the signal levels (OSI)
	No power (+24V) at TX	Check that the +24V supply is reaching the TX unit. Voltage at the unit should be between +18V and +32V.
	No TX output	▪ Connect to TX using SITE. ▪ Use Diagnostics and Event Log options to establish if there is a TX fault.
Output is 2mA (INHIBIT)	Unit has not been installed	Use SITE to complete installation and commissioning of unit.
	Unit has been Inhibited using SITE	Release output from INHIBIT state using SITE
	Unit executing power-up routine	1) Wait for 1 minute. When power-up routine is completed satisfactorily the unit's output should exit the INHIBIT state 2) If unit remains in INHIBIT, check the +24V supply is reaching the unit. If the voltage is below +18V or is fluctuating above and below +18V, the unit may be being prevented from completing power-up. (This is an electrical installation problem)

Problem / Fault	Causes	Remedies
Output is 0.5mA (FAULT)	Unit is in FAULT condition	Connect to the RX unit using SITE and use the Diagnostics and/or Event Log options to ascertain the reason for the FAULT being reported.
	Beam blocked for > 7 days	Check that beam-path is clear from the TX to the RX. Remove any obstruction if present
	TX or RX misaligned for > 7 days	1) Connect to the RX unit using SITE and check the signal levels (OSI) 2) If signal levels are low, use the alignment telescope to correct the RX alignment 3) If signal levels remain low after re-aligning RX, check the TX alignment using telescope
	TX electrical installation problem. Insufficient voltage / power.	Check that the +24V supply is reaching the TX unit. Voltage at the unit should be between +18V and +32V. Provide correct power to TX unit.
	Heavy contamination of optics > 7 days	Check the TX and RX lens-windows for heavy build-up of contamination. Clean the windows if required.
	Two or more consecutive SimuGas Processes have failed	Check TX unit is running with SITE. Request Manual SimuGas Auto (SITE).
	No SimuGas event in last 7 days	Check TX unit is running with SITE and that RX has a valid signal (beampath not blocked, alignments correct). Request Manual SimuGas Auto (SITE)
Output is 0.0mA (Hard FAULT)	No power (+24V) at RX	Check that the +24V supply is reaching the RX unit. Voltage at the unit should be between +18V and +32V.
	Incorrect 4-20mA configuration / installation	▪ Check cables and connections to the unit, especially the 4 - 20mA loop connections ▪ Check that the unit has the correctly configured 4 - 20mA output for use with the type of controller that it is connected to. Refer to section 3.3.3 for 4 - 20mA connection / configuration details.
Comms Error reported by SITE	TX or RX Unit not powered	Check that the +24V supply is reaching the TX or RX unit. Voltage at the unit should be between +18V and +32V.
	RS485 not connected correctly	Check that RS485 connections to terminals are made correctly. RS485(A) is Purple and RS485(B) is Black.
	Bluetooth connection problem	If using Bluetooth connection there are a variety of ways in which this connection can be lost. Refer to 4.7 Bluetooth Connection for more information and advice upon using Bluetooth.

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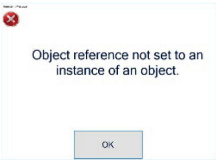
Problem / Fault	Causes	Remedies
No signal or very low signal (OSI) at Receiver	Receiver misaligned	Re-align the Receiver using the telescope
	Transmitter misaligned	Re-align the Transmitter using the telescope.
	The beam-path has become obscured	Check that the beam-path is clear from the Transmitter to Receiver. Remove any obstruction if present.
	No power at TX	Check that the +24V supply is reaching the Transmitter correctly
	Heavy contamination of optics	Check the TX and RX lens-windows for build-up of contamination. Clean the lens-windows if required.
	No TX output	▪ Connect to TX using SITE. ▪ Use Diagnostics and Event Log options to confirm TX fault.
Unit does not respond exactly as expected to the Gassing Cell	Gassing Cells only provide an approximate gas burden for functional testing	▪ Check that the response to the Gassing Cell is within the limits stated in this manual. See Appendix C ▪ Check that the Gassing Cell has been filled with the correct gas and is being used correctly
	Error in unit's zero	Verify that there is no gas in the beam-path Re-zero the unit.
	Target gas in the beam-path adding with Gassing Cell contents	There is often a small background of target gas present in the atmosphere at facilities handling or processing large quantities of volatile liquids or gases. This background gas will add to the total quantity of gas measured when a Gassing Cell is placed in the beam-path. Make allowance for errors that may be introduced by a target gas background at the facility.
	Pressurisation of the Gassing Cell	If the contents of the Gassing Cell has become pressurised this will increase the amount of gas measured. Avoid pressurising the contents of the Gassing Cell by carefully following the instructions for use of this accessory in Appendix C.
	Ambient temperature or pressure is affecting Gassing Cell contents	All open path gas detectors measure the total number of target gas molecules present in their beam-path. The density of gas molecules in a gas sample in equilibrium with the atmosphere is directly related to the prevailing atmospheric pressure and temperature. Consequently, high or low pressures, and/or high or low temperatures can significantly affect the reading produced by an open path gas detector in field-service conditions.
	Gas testing of OPGDs in field conditions is prone to errors	There is very limited control possible over the operating conditions in which OPGDs may be tested in the field. This lack of control introduces error sources that were not present when the OPGDs were calibrated in the factory. For this reason gas testing can only be used for functional testing, not calibration testing.

Problem / Fault	Causes	Remedies
Unit appears to be reporting a negative gas reading on 4-20mA	Misinterpretation of INHIBIT, BEAM-BLOCK or LOW SIGNAL currents that are output on the 4-20mA	Senscient ELDS OPGDs do ***not*** report negative gas readings on their 4-20mA outputs. ▪ Configure controller/PLC to interpret and present currents below 4mA correctly, or ▪ Familiarise operators with the interpretation of sub 4mA currents from ELDS OPGDs as follows: FAULT 0.5mA INHIBIT 2mA BEAM-BLOCK 2.5mA LOW SIGNAL 3mA or, ▪ Reconfigure the INHIBIT, BEAM-BLOCK and LOW SIGNAL currents output by the ELDS™ unit.
Event Log Dates and Times wrong	The time and date record being stored by the Real Time Clock (RTC) has been lost	1) Re-enter the time and date using SITE 2) Cycle the power applied to the unit. 3) Verify that the time and date record was maintained after cycling the power
Message "Object reference not set to an instance of an object" when using SITE.  	Intermittent or marginal connection when using BlueTooth. Might also occur if the unit firmware re-starts during a session	▪ Move the PC closer to the ELDS unit ▪ Ensure there is no obstruction between the PC and ELDS unit ▪ Ensure the power supply to the unit is robust and providing sufficient voltage

If, after following the recommendations in this section, the problem persists, please collect the following information and send it to Senscient or their representatives:

- The complete snapshots for both the TX and RX units of the system with which a problem is being experienced. These snapshot files can be extracted from units using SITE and will be exported in the .sna format.
- The current being signalled by the Receiver's 4-20mA output(s) when the problem being reported is present.

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7.4. Event Logs

The Transmitter and Receiver units of ELDS systems both maintain Event Logs, which logs record any and all significant events experienced by the units during operational service. These events will include rapid signal loss, beam-block, low signal, detection & signalling of gas, installation & commissioning, zeroing, changes to configuration items, loss of power, restoration of power, execution of SimuGas Auto or SimuGas Live tests, results of SimuGas Auto tests, forced 4-20mA output, achievement of laser lock and any other Fault or Warning condition that may be diagnosed or declared.

The information recorded in the Event Logs of ELDS systems make it simple to confirm and document the correct operation of such systems, in particular by using the results of SimuGas Auto tests. Event Log information can also be analysed by sufficiently experienced parties to diagnose problems that may be affecting the operation of a system and suggest appropriate remedial actions.

The best means of obtaining reliable analysis and diagnosis of any problem affecting an ELDS system is to download snapshots from the Transmitter and Receiver unit in the .sna format and to send them to Senscient or their local representative. These snapshots will contain all of the recent entries into the unit's Event Logs as well as other useful information.

The table below provides information about all of the Event Log entries that are displayed by SITE. This information is sufficient to allow basic analysis of ELDS Event Logs.

Event Title	Event Description, Properties and Parameters
Power On	The +24V supply of power to the ELDS unit was brought up at this time.
Input V High	The voltage received on the +24V power supply input of the ELDS unit exceeded the maximum specified operating voltage (>+32V) at the time of this event log entry. *(Check for correct / compatible power supply.)*
Input V Low	The voltage received on the +24V power supply input of the ELDS unit fell below the minimum specified operating voltage (<+18V) at the time of this event log entry. *(Check power supply and cabling.)*
Input V Ok	The voltage received on the +24V power supply input of the ELDS unit returned to within the specified operating range at the time of this event log entry.
SimuGas Auto start	The Transmitter automatically commenced execution of the SimuGas Auto test procedure at this time.
SimuGas Auto Stop	The Transmitter completed execution of the SimuGas Auto test procedure at this time.
SimuGas Fault Raised	The diagnosis and declaration of a SimuGas Fault was made at this time. *(Check optics, alignment and general operating conditions.)*
SimuGas Fault Cleared	A SimuGas Auto test was passed, clearing the SimuGas Fault diagnosis at this time.
No SimuGas Fault	No SimuGas Auto test was observed during the seven (7) preceding days, leading to the diagnosis and declaration of a No SimuGas Fault at this time. *(Check Transmitter for SimuGas Auto enabled and +24V power.)*
SimuGas Auto User Req.	The Transmitter was user commanded to perform a SimuGas Auto test at this time.
SimuGas Auto Pass	A SimuGas Auto test was successfully performed at this time. The average, stable gas reading for this channel during the SimuGas Auto test was as follows:-

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Event Title	Event Description, Properties and Parameters
SimuGas Auto Fail	A SimuGas Auto test was performed and the result obtained fell outside the pass criteria for this test. *(Check optics, alignment and general operating conditions.)*
Lock Hunt Succeeded	The laser diode(s) in the ELDS Transmitter were successfully locked onto their target gas(es) at this time.
Lock Hunt Failed	A cycle of the process performed to lock the laser diode(s) of the Transmitter onto their target gas(es) has been completed, but has failed. *(Further locking cycles will be initiated automatically.)*
Lost Laser Lock (F0/F1) Lost Laser Lock (F2/F3)	One or more of the laser diodes in the ELDS Transmitter lost lock onto their target gas(es) at this time. *(Re-locking will be initiated automatically.)*
Beam Block	The ELDS signal reaching this Receiver has been zero for longer than the configured Time-to-Beam-Block. Consequently a Beam-Block condition has been diagnosed and declared at this time. *(Check for obstruction of beam-path, dirty optics, mis-alignment and +24V power at Transmitter.)*
Low Light	The ELDS signal reaching this Receiver has been below the Low Light threshold for long enough to require the recording of a Low Light event log entry at this time. *(Check for obstruction of beam-path, dirty optics and mis-alignment.)*
Gas Above DB Starts	Target gas has been detected in the ELDS beam-path and started to be signalled on the 4-20mA output at this time. The first gas reading signalled was as follows:-
Gas Above DB Ends	The detection and signalling of target gas ceased at this time. The highest gas reading detected and signalled during this gas event was as follows:-
Recovered from BB	The system recovered from a previous Beam-Block condition at this time.
Into BB	The system entered and declared Beam-Block at this time. *(Check for obstruction of beam-path, dirty optics, mis-alignment and +24V power at Transmitter.)*
Recovered from BB Fault	The system recovered from a previous Beam-Block Fault condition at this time.
Into BB Fault	The system diagnosed and declared a Beam-Block Fault at this time. *(Check for obstruction of beam-path, dirty optics, mis-alignment and +24V power at Transmitter.)*
Enter Ultra Low Signal	The ELDS signal reaching the Receiver fell to an ultra-low level at this time. (No further loss of signal can be tolerated. If a further loss of signal occurs, this will result in the diagnosis and signalling of a Beam-Block.) *(Check for obstruction of beam-path, dirty optics and mis-alignment.)*

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Event Title	Event Description, Properties and Parameters
Recover Ultra Low Signal	The ELDS signal reaching the Receiver has increased and a recovery from ultra-low signal conditions has been diagnosed at this time.
Temperature Over	The ambient operating temperature has exceeded the maximum specified operating temperature at this time. *(Check for localised sources of excessive heat.)*
Recovering from LL Cond	The ELDS unit has recovered from conditions that led to the diagnosis of the Low Light.
Into LL Condition	The ELDS unit has diagnosed and entered the Low Light condition.
Recovering from LL State	The ELDS unit has recovered from the conditions that led to the diagnosis of the Low Light state.
Into LL State	The ELDS unit has diagnosed and entered the Low Light state.
Config Settings Error	An error has been detected in the configuration settings of the unit. (Error correction procedures will be executed automatically to attempt to identify and correct the configuration.)
Config CRC Error	The CRC of the configuration settings has been calculated and there appears to be an error. (Error correction procedures will be executed automatically to attempt to identify and correct the configuration.)
Time Update (initial time)	The time of the Real Time Clock (RTC) has been updated.
Time Update (new time)	The time stored in the Real Time Clock (RTC) has been updated.
User Configuration Update	The user has updated the configuration settings of the system at this time.
System Installed	The ELDS system was successfully installed and commissioned at this time.
Watchdog Restart	A watchdog restart was executed at this time.
Settings Initialised	The settings of this ELDS unit were initialised at this time.
SimuGas Manual Start	The Transmitter was commanded to execute a SimuGas Live test which started at this time.
SimuGas Manual Stop	The Transmitter completed a SimuGas Live test at this time.
CH_4 SimuGas High BG	A SimuGas Auto test was performed recently with a high background of methane in the beam-path. The high methane background was therefore used to confirm the correct functionality of the ELDS gas detector at this time.
Unit Type Update	The unit type was updated at this time.
Negative Gas Fault Starts	A Negative Gas Fault was diagnosed and declared at this time. *(Check that unit has good zero, re-zeroing in known, target-gas-free conditions if believed necessary.)*
Negative Gas Fault Ends	A previously diagnosed Negative Gas Fault was cleared or ended at this time.
Ultra-Low Signal	The ELDS signal reaching the Receiver fell to an ultra-low level at this time. *(Check for obstruction of beam-path, dirty optics and mis-alignment.)*
Invalid Date/Time	The date or time stamp of this event log entry is invalid or corrupted.
SimuGas Pass - High Background	A SimuGas Auto test was performed recently with a high background of target gas in the beam-path. The high target gas background was used to confirm the correct functionality of the ELDS gas detector at this time.
Power On	Produced whenever an ELDS unit powers up or re-starts.

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8. Specifications

8.1. System

Gases & Ranges

For Methane, the following LFL concentrations are assumed. Units are appropriately calibrated in the factory depending on the required certification.

Certification	%v/v for 1LFL
ATEX, IECEx, EAC TR-CU, InMetro	4.4
CSA(UL), FM	5.0

Gases, Ranges & Path Lengths

ELDS Receiver units contain two 4-20mA current loops that are used to signal gas levels. For dual gas units each loop is used for an individual gas, however for single gas units the second output loop will provide an alternative measurement of the gas measurement; and this may be of a different full scale to the primary output. Details of this are contained in the following table. A full specification of the different ranges for each output is provided for each ELDS part number in Appendix H.

Gas	Open Path Ranges	Available Path Lengths
Methane (CH_4)	0-1 / 0-1 LFL.m, 0-5 / 0-1 LFL.m 0-1,000ppm.m / 0-1 LFL.m	5-40m, 40-120m, 120-200m
Methane (CH_4) & Hydrogen Sulphide (H_2S)	0-1 LFL.m (CH_4) 0-250 ppm.m (H_2S) 0-500 ppm.m (H_2S) 0-1,000 ppm.m (H_2S) 0-15,000 ppm.m (H_2S)	5-60m
Hydrogen Sulphide (H_2S)	0-250 / 0-500 ppm.m 0-500 / 0-1000 ppm.m 0-1,000 / 0-5000 ppm.m 0-1,500 / 0-5000 ppm.m 0-5,000 / 0-10,000 ppm.m 0-15,000 / 0-500 ppm.m	5-60m
Hydrogen Fluoride (HF)	0-25 / 0-100 ppm.m (Only 5-60m Path Length) 0-50 / 0-100 ppm.m 0-200 / 0-100 ppm.m 0-1,000 / 0-500 ppm.m	5-60m, 60-120m
Ammonia (NH_3)	0-1,000 / 0-500 ppm.m 0-5000 / 0-1000 ppm.m 0-15000 ppm.m	5-40m, 40-120m
Hydrogen Chloride (HCl)	0-50 / 0-100 ppm.m	5-60m
Carbon Dioxide (CO_2)	0-300,000 / 0-100,000 ppm.m	5-40m, 40-120m
Ethylene (C_2H_4)	0-1 / 0-1 LFL.m, 0-10,000ppm.m / 0-1LFL.m	5-40m, 40-120m, 120-200m

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Gas	Open Path Ranges	Available Path Lengths
Cross Duct XD		
Methane (CH_4)	0-10% / 0-10% LFL 0-25% / 0-25% LFL 0-100% / 0-100% LFL	0.5 – 5m
Cross Duct XC		
Methane (CH_4)	0-25% / 0-25% LFL 0-100% / 0-100% LFL	0.5 – 5m
Ventilation Zone		
Methane (CH_4)	0-10% / 0-10% LFL 0-25% / 0-25% LFL 0-100% / 0-100% LFL	0.5 – 5m

Typical Performance - Open Path

Parameter	Value
Response Time	T90 ≤ 3 seconds Flammable (Free-space gas release) T90 ≤ 5 seconds Toxic e. g. H_2S T90 ≤ 6 Seconds (Per FM6325 using Gassing Cell)
Repeatability	≤ ±5%FSD
Linearity	≤ ±5%FSD

Typical Performance – Cross Duct XD Units & Ventilation Zone VZ Units

Parameter	Value
Response Time	T_{90} ≤ 1 second
Repeatability	≤ ±5% FSD
Linearity	≤ ±5% FSD

Typical Performance – Cross Duct XC Units

Parameter	Value
Response Time	T_{90} ≤ 0.25 seconds
Repeatability	≤ ±5% FSD
Linearity	≤ ±5% FSD

Service Availability

The percentage of time that a unit will be available and operating (ignoring forced interruptions such as blocked beam or power supply outages etc.), should be 99% or greater. In order to achieve high service availability, ELDS™ OPGDs should be installed, operated and maintained in accordance with the recommendations of this Technical Manual.

Environmental

Parameter	Value
Ingress Protection	IP66/67, NEMA type 4/4X/6
Enclosure Material	316L stainless steel
Lens Material Tx	Faceted Optical Glass
Lens Material Rx	Aspheric Optical Glass
Operating Temperature (Including Storage)	-40ºC to +60ºC **Note:** Where sources of heat (flare stacks or direct sunlight and ambient temperatures in excess of 35°C) might be present then additional shielding might be required.
Humidity	0 - 100%RH (non-condensing)
Vibration*	10-150Hz, 2g

* Excludes mounting structure and/or ventilation ducting

Waste electrical products should not be disposed of with household waste. Recycle where facilities exist.

Safety Integrity
Suitable for use in SIL2 Safety Systems per IEC 61508

Electrical:	
Operating Voltage	Tx & Rx +24V DC , (+18 to +32V DC)
Power Consumption	Tx = 12 W (max), Rx = 10 W (max)
Outputs (Analog x 2)	4-20 mA Configurable for 2 wire isolated or single wire, sink or source. Primary range on 4-20mA(1) Secondary range on 4-20mA(2)
Low Signal	3 mA (configurable 1 to 4 mA)
Beam Block	2.5 mA (configurable 0 to 3.5 mA)
Inhibit	2 mA (configurable 1 to 3.5 mA)
Fault	0.5 mA (configurable 0 to 1 mA)
Over Range	21.5mA (configurable 20 to 21.9mA)
Outputs (Digital x 2)	HART 7.1 & MODBUS RTU supported

Mechanical: - Open Path Units & Ventilation Zone VZ Units	
Size	Tx/Rx 140 mm dia. x 300 mm
Weight	ATEX / CSA / UL: Tx/Rx 12 kg each (c/w bracket) FM: Tx 13.4 kg, Rx 12.4 kg each (c/w bracket)
Sun / Deluge Protection	Tx & Rx supplied with sun / deluge protection
Mounting	Tx & Rx supplied with mounting brackets incorporating fixing holes / slots for flat surface or metal pole mounting. (Note: mounting poles should be of 4” to 6” (100mm to 150mm) diameter. Fixing bolts / U-bolts are not supplied)

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Mechanical: - Cross Duct XD & XC Units	
Size	Tx/Rx 140 mm dia. x 300 mm Mounting Plate (c/w fixing holes) Three size options 180mm x 180mm 250mm x 250mm 400mm x 400mm
Weight (Module)	Tx = 12.8 kg Rx = 13.8 kg
Weight (Mounting Plate)	180 mm sq. 1.6 kg each 250 mm sq. 2.7 kg each 400 mm sq. 5.5 kg each
Mounting	Both Tx & Rx units require a mounting plate (ordered separately), for flat duct wall fixing. (Fixing bolts are not supplied.)

Optical:	
Uses HARMONIC FINGERPRINT to ensure no false alarms during adverse environmental conditions, misalignment or partial obscuration.	
Alignment	± 0.25°
Obscuration	operates up to 95%
Heated Optics	Tx & Rx lenses are continuously heated
Laser Beam	Class 1 (Eye Safe) IEC 60825-1

Calibration:
Units are supplied factory calibrated for life, no routine calibration required.

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Certification & Approvals

CSA and UL

Class I Div 1 Groups B C & D T5

Class II Div 1 Groups E F & G T5

Class III Div 1

Ex d IIB + H2 T5

Class I, Zone 1, AEx d IIB + H2 T5

Tamb = -40°C to +60°C

Entry: ¾” NPT

ATEX / IECEx

Exd IIB + H2 T5 Gb

Ex tb IIIC T100°C IP66/67

Tamb -40°C to +60°C Entry: M25

(EAC TR-CU CofC)

1EXDIIBT5/H2X

Tamb = -40°C to +60°C

Entry: M25

InMetro

Ex d IIB + H2 T5 Gb

ou

Extb IIIC T100OC Db IP66/67

Tamb:-40°C a +60°C

Entry: M25

FM

Class I Div 1 Groups B C & D T5

Class II Div 1 Groups E F & G T5

Class III Div 1

Ex d IIB + H2 T5

Class I, Zone 1, AEx d IIB + H2 T5

T_{amb} = -40°C to +60°C [-40°F to 140°F]

Entry: ¾” NPT

FM 6325 2005: Performance of Combustible Open Path Monitors

GB

Gas	ATEX	CSA/UL	EAC TR CU CofC	InMetro
Methane	✓	✓	✓	✓
Methane + Hydrogen Sulphide	✓	✓	✓	✓
Hydrogen Sulphide	✓	✓	✓	✓
Hydrogen Fluoride	✓	✓	✓	✓
Ammonia	✓	✓	✓	✓
Hydrogen Chloride	✓	✓	✓	✓
Carbon Dioxide	✓	✓	✓	✓
Ethylene	✓	✓	✓	✓

Part Number (Examples)

Senscient ELDS V-GGGG-C

V	Path Lengths
S	Short Range (5m-40m & 5m-60m dependent on the gas)
M	Medium Range (40m-120m)
L	Long Range (120m -200m)
VZ	Ventilation Zone Configuration (0.5m-5m)
XD	Cross Duct & HVAC Configuration (0.5m-5m)
XC	Cross Duct & Coal Bed Combustion Configuration (0.5m-5m)

Open Path Devices

GGGG	Gas & Range
1012	0 - 1LFL.m CH_4
1080	0-1,000 ppm.m NH_3
2013	0 – 1LFL.m CH_4 & 0 - 250ppm.m H_2S

C	Certification
1	FM
2	
3	ATEX / IECEx
4	CSA (UL)
5	EAC TR-CU CofC Russia, Kazakhstan and Belarus
6	
7	InMetro (Brazil)

9. Certification

9.1. General

ATEX/IECEx for Europe (Baseefa)

II 2 GD Ex d IIB + H2 T5 Gb

II 2 D Ex tb IIIC T100°C Db IP66/67

T_{amb} -40 to +60ºC

EU-Type Examination Certificate No: Baseefa10ATEX0066X

Quality Assurance Notification (QAN) No: FM10ATEXQ0010

Quality Assurance Report (QAR) No: IECEx BAS 13.0015X

Ingress Protected IP66/67

Standards: EN60079-0, 1, EN60079-1, EN 60079-31, EN60529, EN50270

CSA Certified for US and Canada

Class I, Div1, Groups B, C, D

Class II/III Div1, Groups E, F, G

Exd IIB+H2 T5

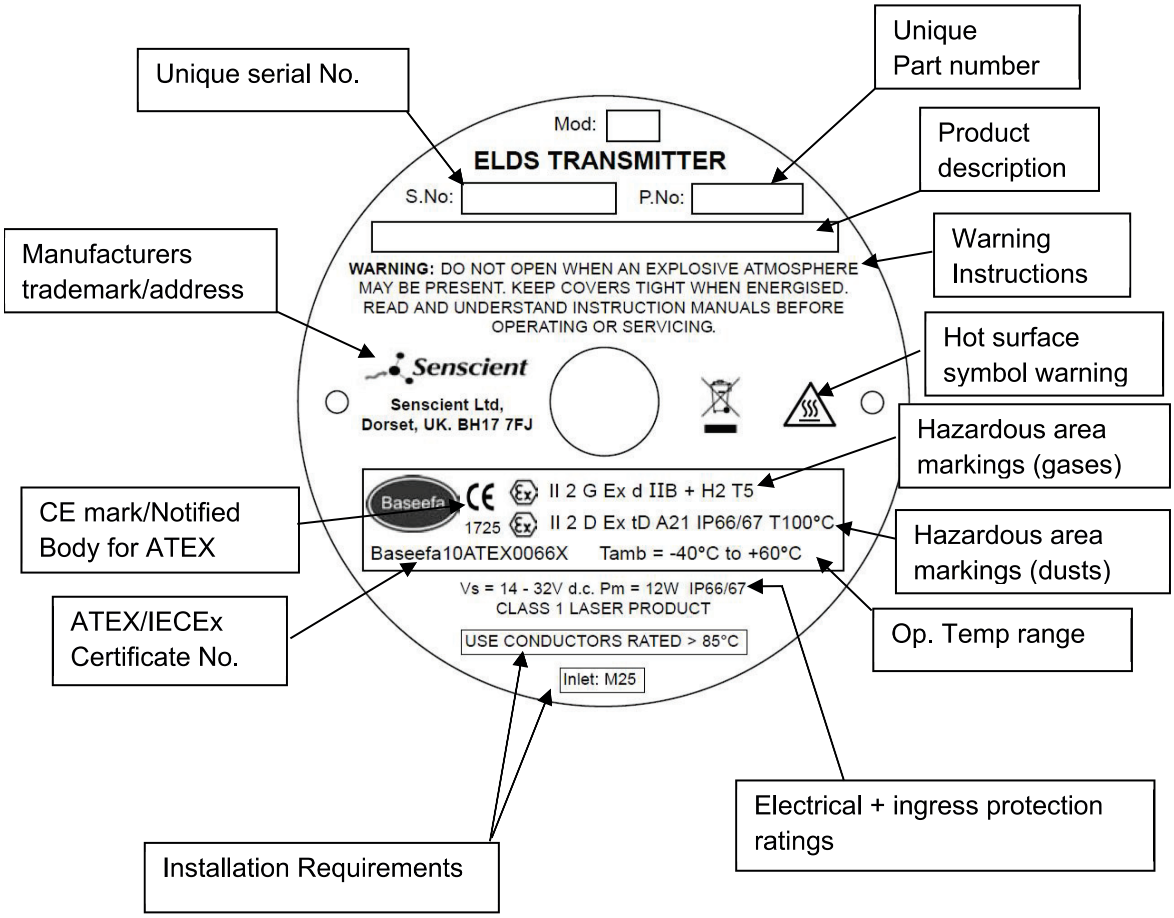
Class I, Zone 1, AExd IIB+H2 T5

T_{amb} = -40ºC to +60 ºC

CSA Master Contract MC 248589

Ingress Protected:	IP66/67 Type 4X/6 Stainless IP66/67 Type 4/6 Aluminium
Standards:	CSA C22.2 No 0-M91 CSA C22.2 No 25:1966 CSA C22.2 No 30:1986 CSA C22.2 No 94:1991 CSA C22.2 No 142:1987 CAN/CSA EN60079-0 5th Edition CAN/CSA EN60079-1 6th Edition CSA C22.2 No 60529:2005 UL 50, 11th Edition UL 916, 3rd Edition UL 1203, 4th Edition UL 60079-0, 5th Edition UL 60079-1, 6th Edition ANSI/ISA 60529:2004

9.1.1 ATEX Label Combustible or Combustible and Toxic



ATEX Certification Label for Tx Unit (Receiver is Similar)

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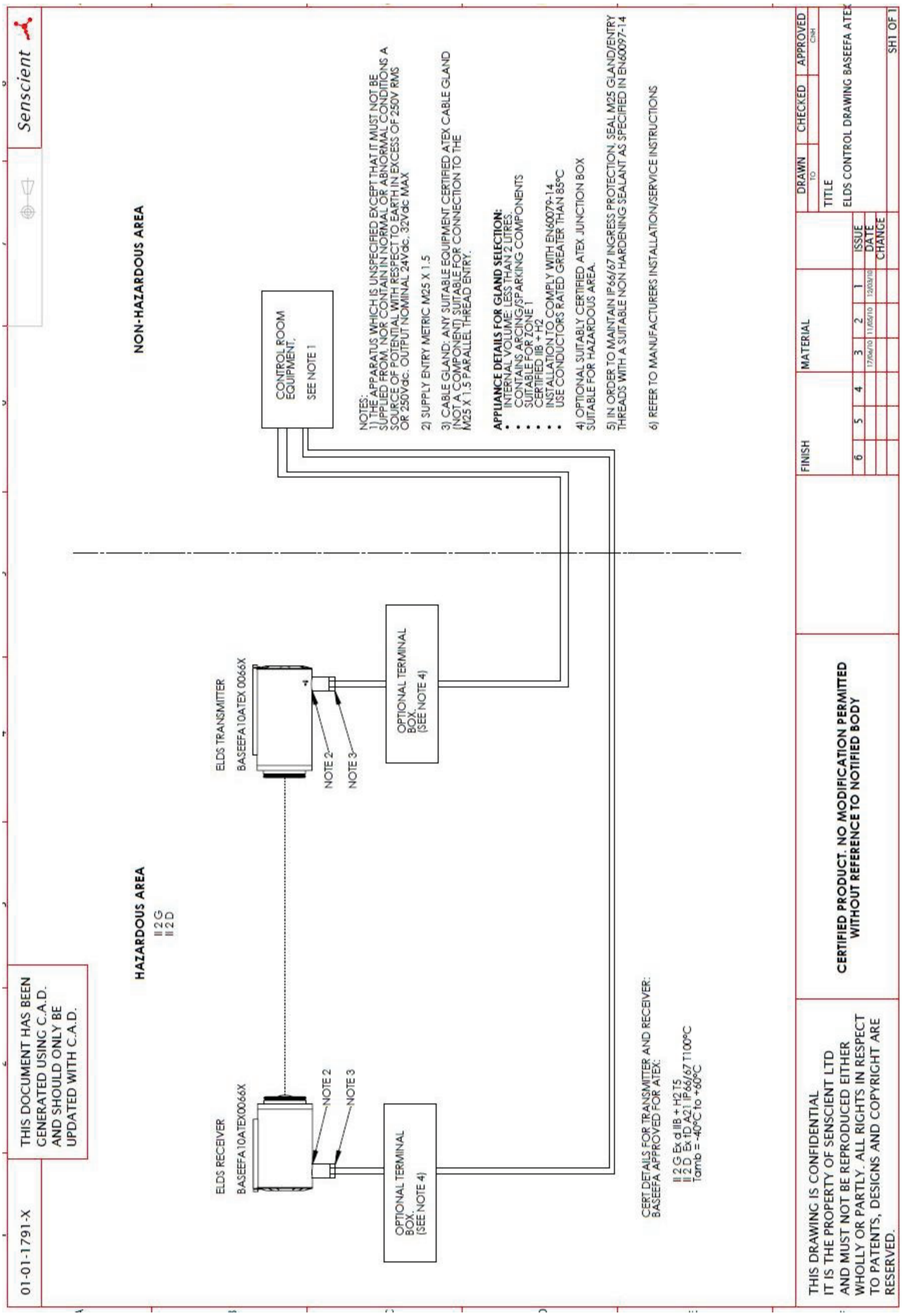
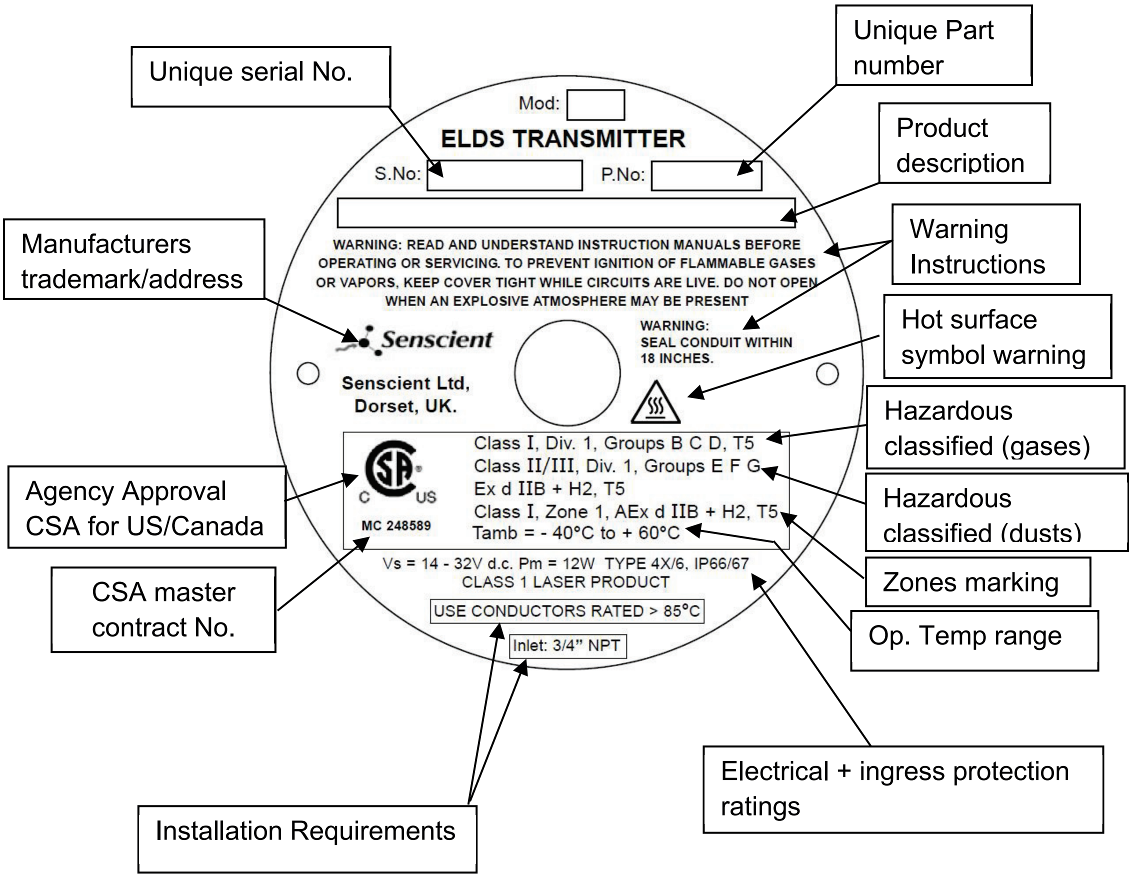
9.1.2 Control Drawing CENELEC / ATEX



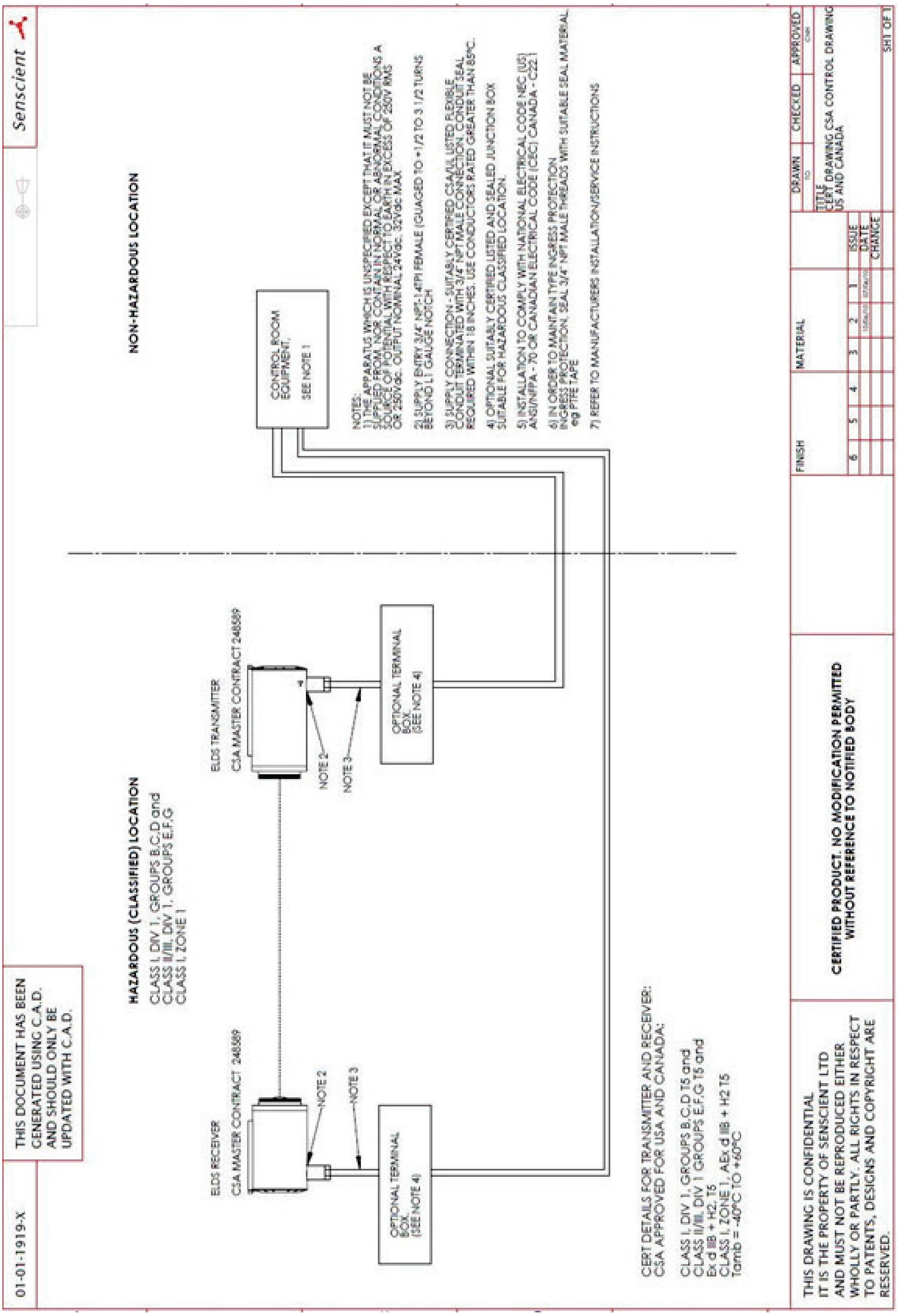
9.1.3 CSA Bilingual Label (English & French) Combustible or Combustible and Toxic for US/Canada



Label for Tx Unit (Receiver is Similar) Note

GB

9.1.4 Control Drawing CSA US/Canada



10. Warranty

10.1. Express Warranty

Seller warrants that this product is free from mechanical defects and faulty workmanship under normal use and service conditions, and provided that the product is maintained and used in accordance with Seller’s instructions and/or recommendations. This warranty extends for two years (24 months) from the date of shipment, in new and unused condition, from an authorized seller of MSA products. Any goods that have been repaired or replaced during the warranty period are warranted only for the remainder of the unexpired portion of the original warranty period.

The warranty excludes normal wear and tear and excludes liability for defects that are the result of abuse, accident, misuse, alteration or modification, or for defects that are due to a failure to install, maintain, or use the product in accordance with Seller’s instructions. This warranty is nontransferable.

No oral or written information, advice or statement given by an agent, dealer, employee or representative of Seller may bind Seller to any affirmation, representation or modification of the warranty concerning the goods sold under this contract. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, AND IS STRICTLY LIMITED TO THE TERMS HEREOF. MSA SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

10.2. Exclusive Remedy

It is expressly agreed that Purchaser’s sole and exclusive remedy for breach of the above warranties shall be the repair or replacement of any goods, at Seller’s option, proven to be defective, if notified by Purchaser within the applicable warranty period.

Replacement equipment and/or parts will be provided at no cost to Purchaser, Ex-Works MSA’s Plant – UK. Failure of Seller to successfully replace any nonconforming equipment or parts shall not cause the remedy established hereby to fail of its essential purpose.

10.3. Exclusion of Consequential Damages

Purchaser specifically understands and agrees that under no circumstances will Seller be liable to Purchaser for economic, special, incidental, or consequential damages or losses of any kind whatsoever, including but not limited to, loss of anticipated profits and any other loss caused by reason of non-operation of the goods. This exclusion is applicable to claims for breach of warranty, tortious conduct, or any other cause of action against Seller.

10.4. Post-Warranty Service and Repairs

If a customer has elected to pay for the repair or replacement of goods after the initial product warranty has expired, the warranty on such parts or products repaired shall be 180 days from date of shipment of the repaired or replaced goods by MSA. In addition, such warranty shall be subject to the same exclusions and limitations of liability set forth herein.

For additional information about any part of this warranty, please contact the Customer Service Department at +44 (0)1202 606460.

11. Appendix A – Glossary

11.1. Terminology

Ex d

Flame proof or explosion-proof within the confines of European standards EN60079-0.1. An enclosure that can withstand the pressure developed during the internal explosion of an explosive mixture and that prevents transmission of the explosion to any explosive atmosphere surrounding the enclosure.

Lower Flammable Limit (LFL)

The lowest concentration of a flammable gas or vapour in air which can be ignited.

RS485

An industry-wide serial communication link specification (physical layer / hardware).

Modbus

An industry-wide serial communication protocol (software layer).

HART

An industry-wide, FSK-based, digital signalling protocol providing bidirectional communications on top of the analog signal on a 4-20mA loop.

11.2. Measurement Units

LFL.m

Lower Flammable Limit metres (LFL.m). Open path detectors measure the total amount of gas present in the beam-path. LFL.m readings are calculated by multiplying the flammability (LFL) of the gas in a gas cloud by the cloud’s size (m)

LFL.m monitoring can be particularly beneficial when ELDS™ gas detectors are protecting the perimeter of a plant or process, by greatly reducing the number of detectors required and providing the ability to detect gas at concentrations that are too low to be detected by point detectors.

ppm.m

Parts (by volume) per million metres. Open path detectors measure the total amount of gas present in the beam-path; ppm.m readings are calculated by multiplying the concentration (ppm) of the gas in a gas cloud by the cloud’s size (m). ppm.m units are typically used for toxic gases, which generally need to be detected and/or measured at much lower concentrations than flammable gases.

11.3. Abbreviations

TX	Transmitter
RX	Receiver
EMC	Electro-Magnetic Compatibility
IP	Ingress Protection
LFL	Lower Flammable Limit
LR	Long Range
MR	Medium Range
NPT	National Pipe Thread
RFI	Radio Frequency Interference
SR	Short / Standard Range
SIL	Safety Integrity Level
OPGD	Open Path Gas Detector
NDIR	Non-Dispersive Infrared
ELDS	Enhanced Laser Diode Spectroscopy
CSA	Canadian Standards Authority
UL	Underwriters Laboratory
FM	Factory Mutual
ppm	Parts per million
%v/v	Percentage by volume

12. Appendix B – Accessories & Spare Parts

12.1. ELDS™ Accessories & Spare Parts

The following tables list the part numbers for accessories and spare parts available for use with ELDS systems.

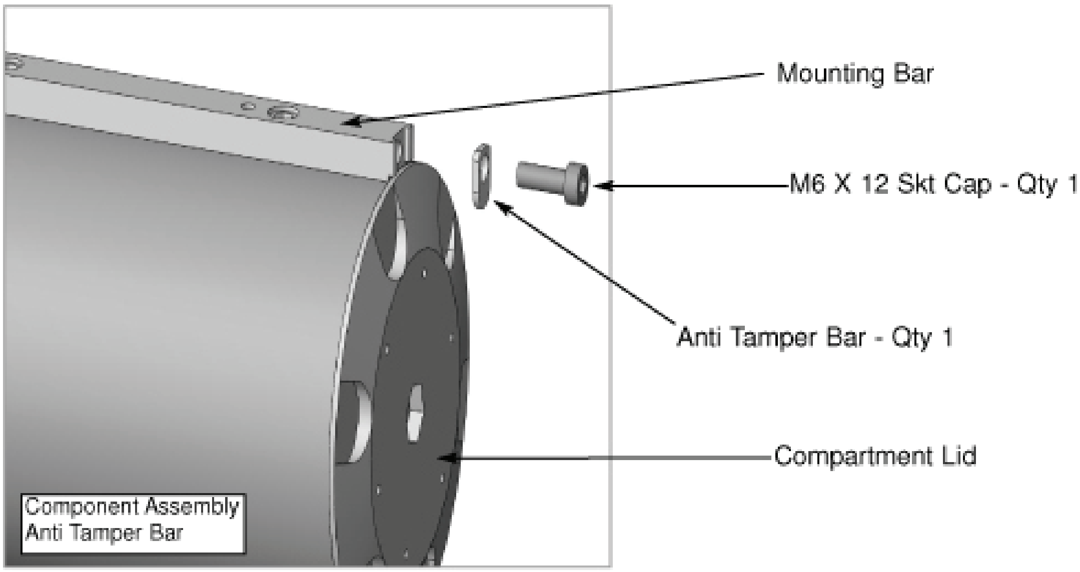
All open-path ELDS units are supplied with sunshades and mounting brackets; whilst all cross-duct ELDS units are supplied with one of the three available types of mounting plate. Fixings for attaching ELDS units to their intended supporting structures vary widely depending upon the installation / application and are not included.

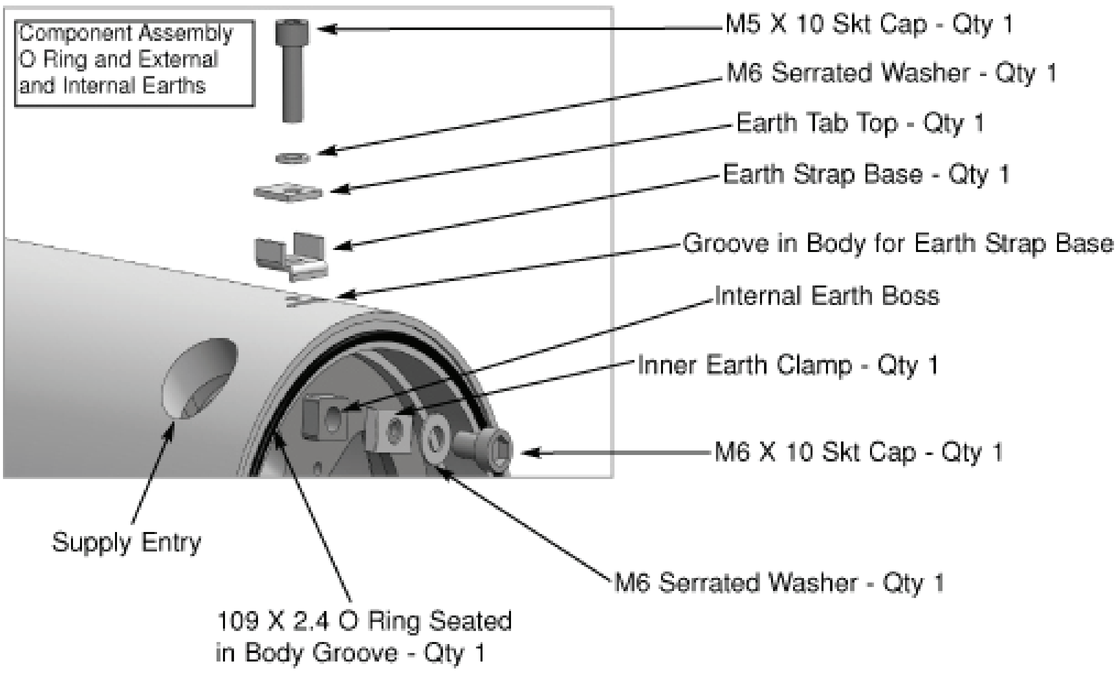
Accessories	**Part Number**
Gassing Cell incl. Case	A-5030-2
Alignment Scope for Open Area Systems incl. Case	A-5000-1
Alignment Sight for VZ Systems incl. Case	A-5001-1
Alignment Sight and Target for XC & XD Systems incl. Case	A-5002-1
Interface Terminal (Tablet) for Safe Area Use, with S.I.T.E Software & Interface Cable	A-5065-0
Interface Terminal (Tablet) for Hazardous Area Use (Zone 2 & Class I Div 2), with S.I.T.E. Software & Interface Cable	A-5060-5
Interface Terminal (Computer) for Hazardous Area Use (CCC approved for China), ANSI/ISA 12.12.01 with S.I.T.E. Software & Interface Cable	A-5060-6
Cross-Duct (XC & XD) Gassing Cell, CH_4	A-5121-2
Cross Duct (XC & XD) Alignment Adjustment Bushings (pair), plus fixings	A-5130-0

Spare Parts	**Part Number**
Sunshade (Non FM Version)	A-5080-1
Sunshade Retainer Screw (Non FM Version)	A-5080-2
Enhanced Sunshade for Non FM Version used in Hot Humid Climates	A-5081-2
TX and RX Back End Component Spares Kit: *(Includes components for Inner and External Earth, Anti-Tamper Bar and Rear Body 109 X 2.4 O Ring).*	A-5080-3
Mounting Bracket Assembly (Non FM Version)	A-5080-4
M12 Allen Key for Use on Terminal Enclosure	A-5080-5
Compartment Lid *(Note: Includes attached Certification Plate, and is only supplied following customer confirmation of original Serial Number.)*	A-5080-6

GB

The following two diagrams identify the correct component assembly locations for fitting the rear compartment lid anti tamper bar, as well as the internal and external earths (see below). Ensure that these components are assembled and fitted in the correct positions.





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13. Appendix C – Functional Testing Using Gas

13.1. Introduction

Senscient's ELDS 1000 / 2000 Series OPGDs are factory-calibrated with their specified gases using special equipment and procedures that are operated in a closely controlled environment. ELDS™ Transmitters use their retained sample of target gas(es) to achieve and maintain Harmonic Fingerprint lock. Provided that Harmonic Fingerprint lock is maintained, there are no physical mechanisms that will cause the gas calibration of an ELDS OPGD to change during operational service, so once an ELDS OPGD has been factory-calibrated it is calibrated-for-life.

A Safety Instrumented System employing ELDS OPGDs will meet the requirements of SIL2 per IEC 61508-1 by proof tests being performed upon the ELDS OPGDs at an interval of one to two years. The recommended proof test for an ELDS OPGD is an operator witnessed SimuGas Auto or SimuGas Live test. (See "Exida – ELDS FMEDA & SimuGas Proof Test.pdf"). Senscient advises that witnessed SimuGas tests are all that are needed to verify the correct functionality of ELDS OPGDs in field service conditions.

Testing OPGDs with target gas(es) in field-service conditions is difficult, potentially hazardous and prone to the significant sources of error that are associated with uncontrolled, outdoor environments. Consequently, Senscient does not recommend testing ELDS OPGDs with target gas(es) in field-service conditions and recommends the use of SimuGas wherever possible.

In circumstances where operators are mandated to perform testing of gas detectors using a sample of gas, Senscient can supply a Gassing Cell or Gas Challenge Cell for use with our ELDS products. The procedures for correct use of a Gassing Cell or Gas Challenge Cell are detailed in the following sections along with applicable limitations.

13.2. Testing with the Gassing Cell

Where operators are mandated to test ELDS OPGDs with gas in field-service conditions, these tests can be performed using the Gassing Cell, but operators are advised that such tests will be subject to much greater margins of error than the original factory calibration.

The compact design of the Gassing Cell only allows gas response checking to be performed using relatively high concentration test gases. Gases which can be satisfactorily used inside the Gassing Cell include methane, propane, butane, hydrogen sulphide and carbon-dioxide.

WARNING

Operators must follow the applicable safe handling procedures when using flammable or toxic gases in conjunction with the Gassing Cell. Operators are advised to consult with the responsible Health & Safety Officer (or equivalent) to establish the applicable safe handling procedures.

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CAUTION

The Gassing Cell supplied by Senscient has been very carefully designed and tested for use with our laser-based ELDS OPGD products. ONLY use a Senscient supplied Gassing Cell in conjunction with ELDS OPGDs.

CAUTION

The Gassing Cell utilises thin film windows which are relatively fragile. Do not attempt to clean these windows using a brush or cloth. In order to remove any dust from the windows, careful use of an air-duster is recommended.

13.2.1 Procedure for Filling Gassing Cell

CAUTION

The physical and chemical properties of some of the gases that can be detected by ELDS OPGDs make it impossible to achieve a known, stable burden of such gases inside the Gassing Cell. For this reason, Senscient advises against attempts to use ammonia, hydrogen chloride or hydrogen fluoride gas inside the Gassing Cell.

(1) In order to ensure the best possible results when using a Gassing Cell to check the response of an ELDS unit, only use in-date cylinders of calibration-grade gas containing 20% or more of their original fill pressure.

(2) Do not use gas from cylinders that are nearly empty or that are very close to their expiry date; since the gas in such cylinders will almost certainly produce low readings.

(3) The Gassing Cell is designed to be filled and shut-off / sealed, so that it can subsequently be used for testing over approximately an 8hour period.

(4) Before connecting the gas cylinder to the Gassing Cell, open both of the Gassing Cell's valves.

(5) Always use a flow regulator on the gas cylinder to protect the Gassing Cell from exposure to excessive pressure and/or flow.

(6) Attach the tubing running from the flow regulator to one of the Gassing Cell inlets / outlets.

(7) Open the flow regulator and fill the Gassing Cell with gas. (NB: Maximum flow-rate of 1 litre/min.)

(8) The volume of the Gassing Cell is approximately 1 litre. In order to ensure that the Gassing Cell is completely and uniformly filled with gas at the same concentration as that in the cylinder, it is essential that a quantity of gas corresponding to 5 times the Gassing Cell volume has been flowed through the cell.

At a flow rate of 1 litre / min it will take at least 5 minutes to completely, uniformly fill the Gassing Cell with gas at the same concentration as that in the gas cylinder. Do not attempt to use the Gassing Cell until it has been properly filled as described.

(9) Once the Gassing Cell has been filled with the test gas, it is necessary to stop the filling process in a manner which does not pressurise the gas inside the Gassing Cell.

(10) First, turn off the flow of gas into the Gassing Cell by turning off the flow regulator on the gas cylinder.

(11) Second, prevent further flow of gas into the Gassing Cell by closing the valve on the cell inlet to which the gas cylinder is connected.

(12) Finally, close off the outlet valve on the Gassing Cell, thereby sealing off the cell ready for use.

Ideally, the test gas concentration should be selected to generate a reading from the unit that is between 0.5× and 1× full scale.

The integrated LFL.m concentration in the cell can be calculated using the following formula:

Int(LFL.m)ELDS	**= Lcell * (Concv/v / LFLv/v)**
Int(LFL.m)ELDS	**= 0.236 * (Concv/v / LFLv/v)**

Where:

Int(LFL.m)ELDS	**= Integrated LFL.m reading output by Senscient ELDS™**
Lcell	**= Length of cell in metres (0.236m for the Senscient Calibration Cell)**
Concv/v	**= Gas concentration in %v/v**
LFLv/v	**= Lower Flammability Limit of the gas in %v/v**

The integrated ppm.m concentration in the cell can be calculated from the following formula:

Int(ppm.m)ELDS	**= Lcell * Concppm**
Int(ppm.m)ELDS	**= 0.236 * Concppm**

Where:

Int(ppm.m)ELDS	**= Integrated ppm.m reading output by Senscient ELDS™**
Concppm	**= Gas concentration in ppm by volume**

CAUTION

Tests performed using the Gassing Cell cannot be used to evaluate the response time of an ELDS OPGD - the Gassing Cell is ONLY suitable for verifying the steady-state response to target gas(es). The reason for this is that when a Gassing Cell is introduced into the beam-path of an ELDS OPGD system, the windows, window guards and walls of the Gassing Cell significantly reduce the signal reaching the ELDS Receiver unit. In order to make measurements following such significant changes in signal levels, the Receiver unit has to adjust the detector amplifier's gain to compensate for the signal changes. Adjusting the amplifier gain to a new level and allowing this to stabilize takes time; and the amount of time taken varies depending upon exactly how the Gassing Cell was introduced.

Consequently, do NOT interpret the time taken to respond to target gas inside a Gassing Cell as being indicative of the time taken to respond to a genuine leak or release of target gas into the beam-path of an ELDS OPGD. The time taken to respond to target gas inside a Gassing Cell is longer than the response to a genuine leak / release will be, and is also more variable. The response time for real leaks / releases is tested by Senscient using special equipment and procedures that enable the genuine speed of response to be measured, which equipment and procedures do not make use of the Gassing Cell..

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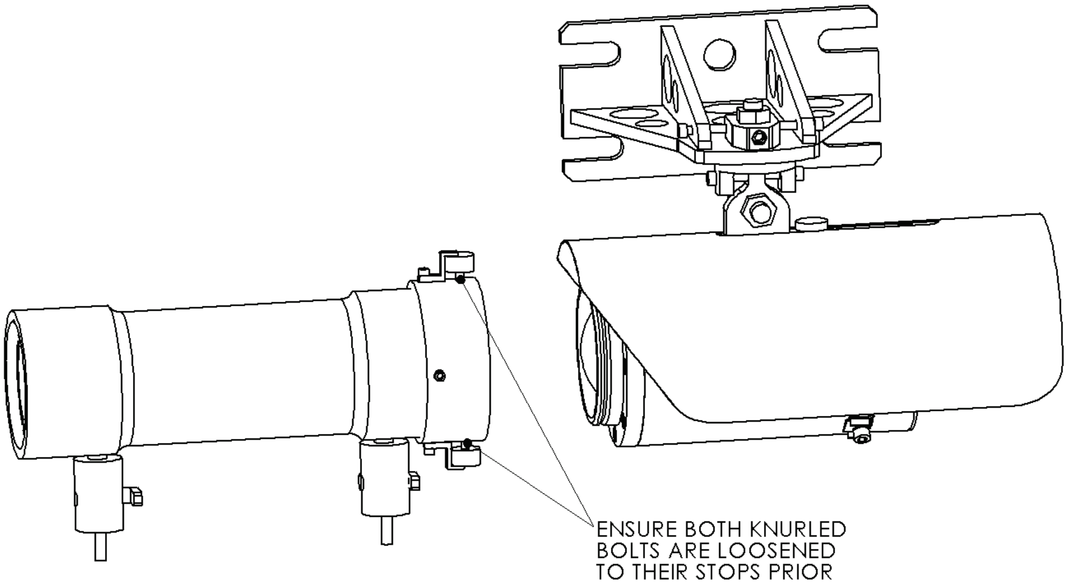
13.2.2 Procedure for Testing Gas Response Using Gassing Cell

The gassing cell is designed to fit onto the front of an ELDS™ Transmitter or Receiver unit. It may be helpful to move the sun shield to the furthest back position to allow better access to the clamping bolts on the cell when fitting the cell.



In common with all optical gas detectors the ELDS™ OPGD responds to the total quantity of gas in the beam. When attempting to check gas response using a Gassing Cell, the quantity of gas in the beam will be affected by atmospheric pressure and ambient temperature. Suitable allowance for these factors must be made when assessing the gas response of the detector. Errors of the order of ±15% of reading should be expected; whilst errors as large as ±30% of reading may occur at times.

When testing the gas response of an OPGD, the very best results will be obtained when the unit's windows are clean, the alignment is good and the system has the best zero possible.

Where high or unstable background levels of target gas are known to be present, the factory zero will usually be the best zero available. However, in installations where there is no target gas background or where this background is small and stable, zeroing the system as-installed may further improve zero quality.

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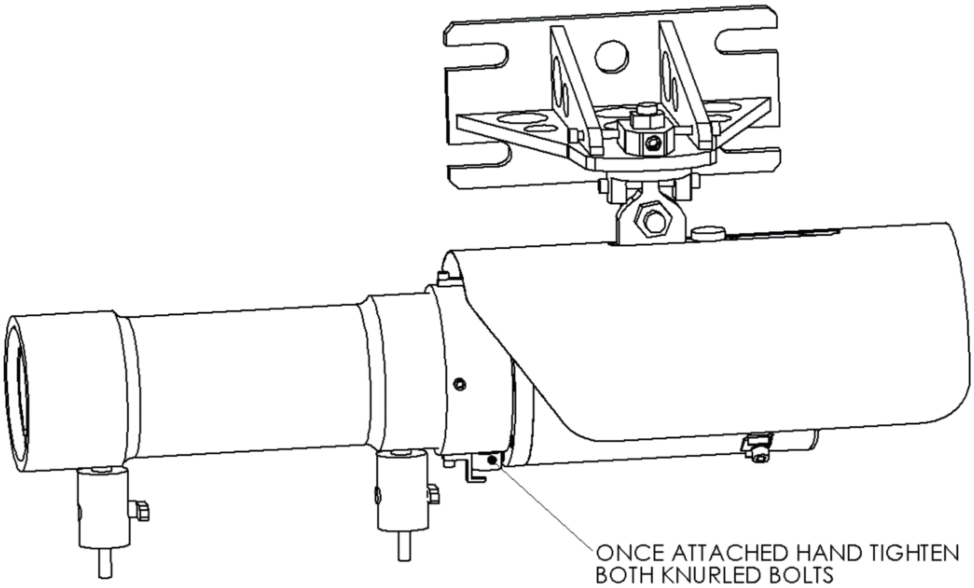

Typical* Gassing Cell Response for 5%V/V CH_4 = 100%LFL

Test Gas Conc.	Cell Burden	Response Range	4-20mA o/p
1,000ppm CH_4 (0-1,000ppm.m)	236 ppm.m	200 – 275 ppm.m	7 – 9 mA
20% V/V CH_4 (0-1LFL.m)	0.94 LFL.m	0.8 – 1.1 LFL.m	16.5 – 21.5mA(O/R)
20% V/V CH_4 (0-5LFL.m)	0.94 LFL.m	0.8 – 1.1 LFL.m	6.5 - 8mA
60% V/V CH_4 (0-5LFL.m)	2.83 LFL.m	2.4 – 3.3 LFL.m	11.5 – 15mA
65% V/V CH_4 (0-5LFL.m)	3.07 LFL.m	2.5 – 3.5 LFL.m	11.5 – 15.5mA

* Table values reflect typical errors of ±15% of reading. Larger test errors are possible.

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Typical* Gassing Cell Response for 4.4%V/V CH_4 = 100%LFL

Test Gas Conc.	Cell Burden	Response Range	4-20mA o/p
1,000ppm CH_4 (0-1,000ppm.m)	236 ppm.m	200 – 275 ppm.m	7 – 9 mA
20% V/V CH_4 (0-1LFL.m)	1.07 LFL.m	0.97 – 1.2 LFL.m	19 – 21.5mA(O/R)
20% V/V CH_4 (0-5LFL.m)	1.07 LFL.m	0.97 – 1.2 LFL.m	6.5 – 8.5mA
60% V/V CH_4 (0-5LFL.m)	3.22 LFL.m	2.7 – 3.6 LFL.m	12 – 16mA
65% V/V CH_4 (0-5LFL.m)	3.49 LFL.m	3.0 – 3.9 LFL.m	13 - 17mA

* Table values reflect typical errors of ±15% of reading. Larger test errors are possible.

Recommended Test Gas & Typical* Gassing Cell Responses for Toxic Gases

Gas & Measurement Range	Test Gas [ ]	Cell Burden	Response Range	4-20mA O/P
0-250ppm.m H_2S	500ppm	118ppm.m	83 – 153 ppm.m	9.3 – 13.8mA
0-500ppm.m H_2S	1,000ppm	236ppm.m	177 – 295 ppm.m	9.7 – 13.4mA
0-1,000ppm.m H_2S	2,000ppm	472ppm.m	378 – 566 ppm.m	10.0 – 13.1mA
0-1,500ppm.m H_2S	2,000ppm	472ppm.m	378 – 566 ppm.m	8.0 – 10.0mA
0-15,000ppm.m H_2S	15,000ppm	3,540ppm.m	3,000 – 4,070ppm.m	7.2 – 8.4mA
0-300,0000ppm.m CO_2	400,000ppm	94,400ppm.m	80,000 – 109,000	8.3 – 9.8mA

* Table values reflect errors of between ±15% and ±30% of reading depending upon gas and measurement range.

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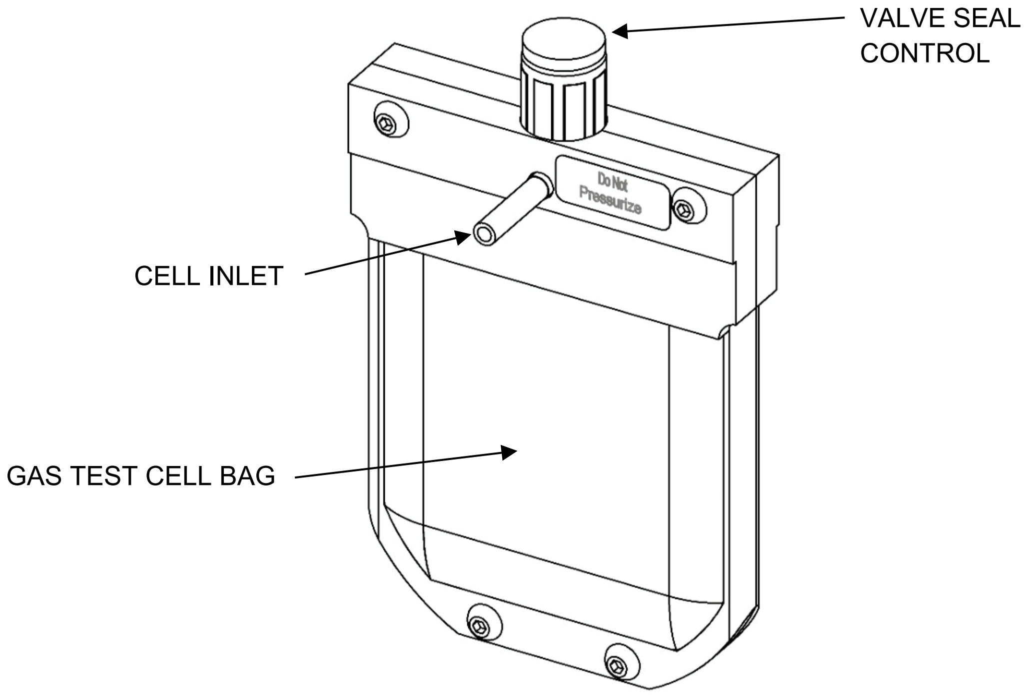
13.3. Testing Cross Duct ELDS Systems with the Refillable Gas Test Cell

Senscient's Cross Duct ELDS systems are supplied factory calibrated for life and do not require re-calibration in the field. Where users must undertake response checks with gas, these can be performed using the Cross Duct Refillable Gas Test Cell.

The Cross Duct Refillable Gas Test Cell comprises a small, Tedlar gas sample bag inside a carrier that can be inserted into the cell aperture in front of the Receiver of an XD system. Because the gas bag has flexible walls and becomes inflated when filled with test gas, the total burden of gas introduced by this cell can vary significantly. Consequently, the Cross Duct Refillable Gas Test Cell is only suitable for performing a gas detection functionality check (a "bump" test) and cannot be used to quantify gas response or verify calibration (ELDS systems are factory calibrated-for-life and do not require calibration checks to be performed.)

The Cross Duct Refillable Gas Test Cell is designed to be filled with 100%V/V methane at atmospheric pressure. When fully filled and inflated, the walls of the gas bag inside a Gas Test Cell are approximately 8mm to 12mm apart, which means that the total cell burden will be between 8,000ppm.m & 12,000ppm.m methane.

CAUTION
ONLY the Senscient supplied Cross Duct Refillable Gas Test Cell should be used with Cross Duct ELDS systems.



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The Cross Duct Refillable Gas Test Cell can be filled by following the procedure below:

(1) Open the cell filling valve by carefully rotating the brown valve seal control anti-clockwise until there is a gap of approximately 1mm between the brown valve seal control and the white valve body. (This fully opens the filling valve.)

(2) Carefully press the Gas Test Cell bag walls together such that any gas inside the bag is pushed out through the opened filling valve. (This step should ensure that there is no gas inside the Gas Test Cell bag before filling.)

(3) Connect up a flow regulated supply of 100%v/v methane to the filling valve inlet.

(4) Turn on the supply of 100%v/v methane and watch the Gas Test Cell bag inflate. When the Gas Test Cell bag is full, the walls at the centre of the bag will be approximately 8-12mm apart. Once full inflation has been reached, switch off the supply of test gas.*

(5) Disconnect the test gas. Allow any pressure that might have built inside the Gas Test Cell to be relieved through the open filling valve.

(6) Close the cell filling valve by carefully rotating the brown valve seal control clockwise until valve is finger tight. (**NB:** The cell filling valve is shut when the valve seal control is finger tight and should not be further tightened using hand tools.)

CAUTION

In order to achieve best results and avoid the risk of bursting the Gas Test Cell bag, take care not to pressurise or overfill the Gas Test Cell when filling.

If during use for testing, the reading produced by a Gas Challenge Cell is significantly lower than expected it is possible that some of the methane may have escaped from the cell. In such circumstances refill the cell with methane and re-test.

Cross Duct ELDS systems are configured to signal readings on their 4-20mA outputs that are scaled in proportion to %LFL. Cross Duct ELDS units calculate the %LFL based upon the assumption that there is a uniform concentration of gas across the whole width of the duct.

$$\%LFL = \frac{(\text{ppm.m Gas Measured}) \times 100}{(100\%LFL \text{ in ppm}) \times \text{Duct Width (m)}}$$

Where:

ppm.m Gas Measured	= Number of ppm.m methane measured
100% LFL in ppm	= 100% LFL of methane expressed in ppm
Duct Width	= Width of duct in metres (m)

GB

Example:

For a Cross Duct ELDS system installed across a 2.0metre wide duct, with a 0-25%LFL measurement range, and for 100%LFL = 5%V/V methane:

Cross Duct Gas Challenge Cell ≈ 10,000ppm.m (8,000ppm.m – 12,000ppm.m)

$$\%LFL = \frac{10{,}000 \times 100}{(50{,}000) \times 2.0}$$

$$\%LFL = 10.0\%LFL$$

For a 0-25%LFL measurement range, the current output for 10.0%LFL on the 4-20mA output should be:

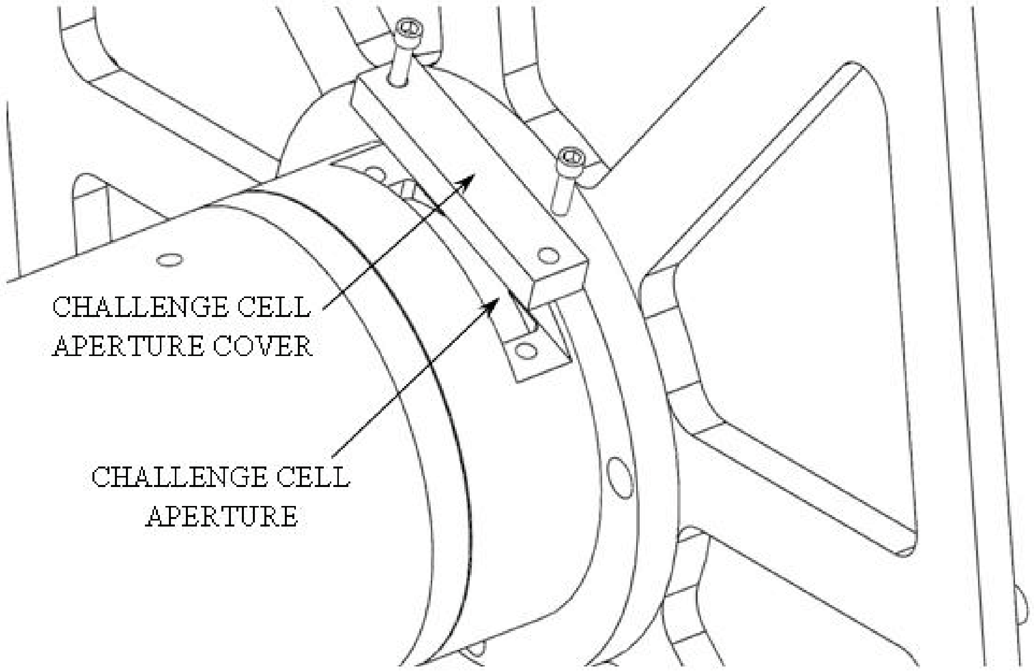
$$I_{4\text{-}20} = 4mA + \frac{10.0 \times 16}{25.0} = 10.4mA$$

CAUTION

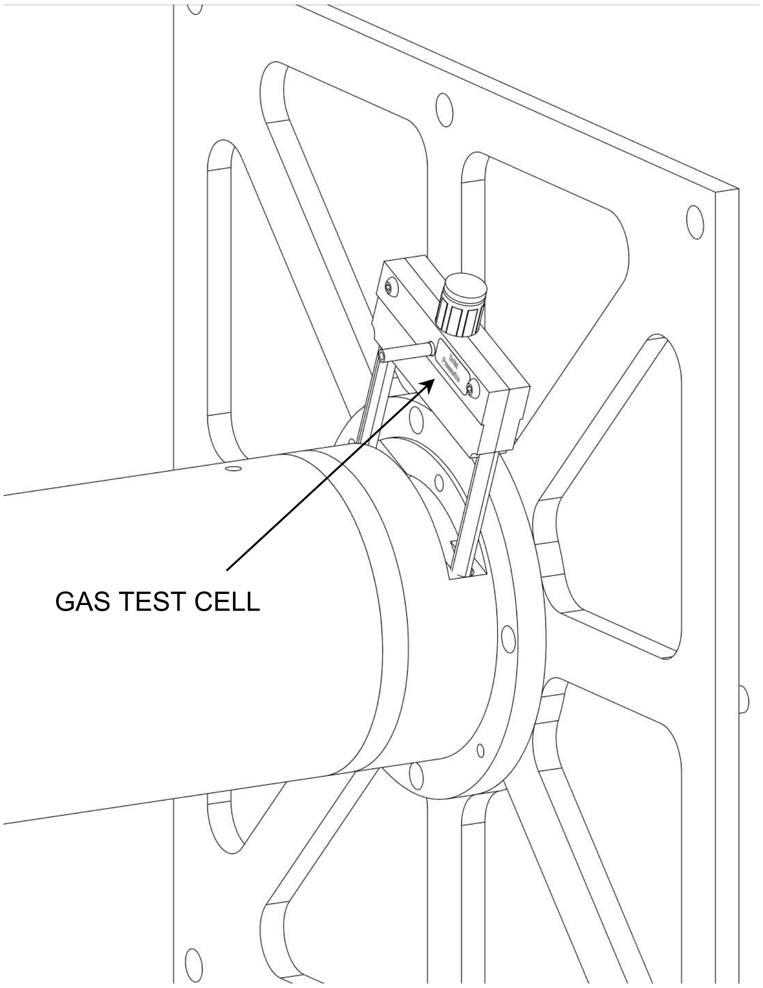
The significant difficulties and errors associated with in-field gas testing of open path gas detectors (including cross duct types) result in large test error margins (≈±30%) that may lead to unwarranted concerns about detector calibration. When testing the response of ELDS gas detectors in field-service conditions, any unexpected results are far more likely to be due to test errors, rather than a problem with an ELDS unit's calibration. This is why most OPGD manufacturers (including Senscient) do not allow in-field gas calibration of this type of gas detector; and recommend that gas response checks only be treated as 'bump-tests' not calibration verification checks.

Cross Duct ELDS systems can be supplied with 4-20mA outputs scaled for 0-10%LFL, 0-25%LFL and 0-100%LFL. For all available measurement scales, 0%LFL will be signalled as a current of 4mA. Readings between 0% and 100% of the measurement scale will be signalled by a proportional current between 4mA and 20mA.

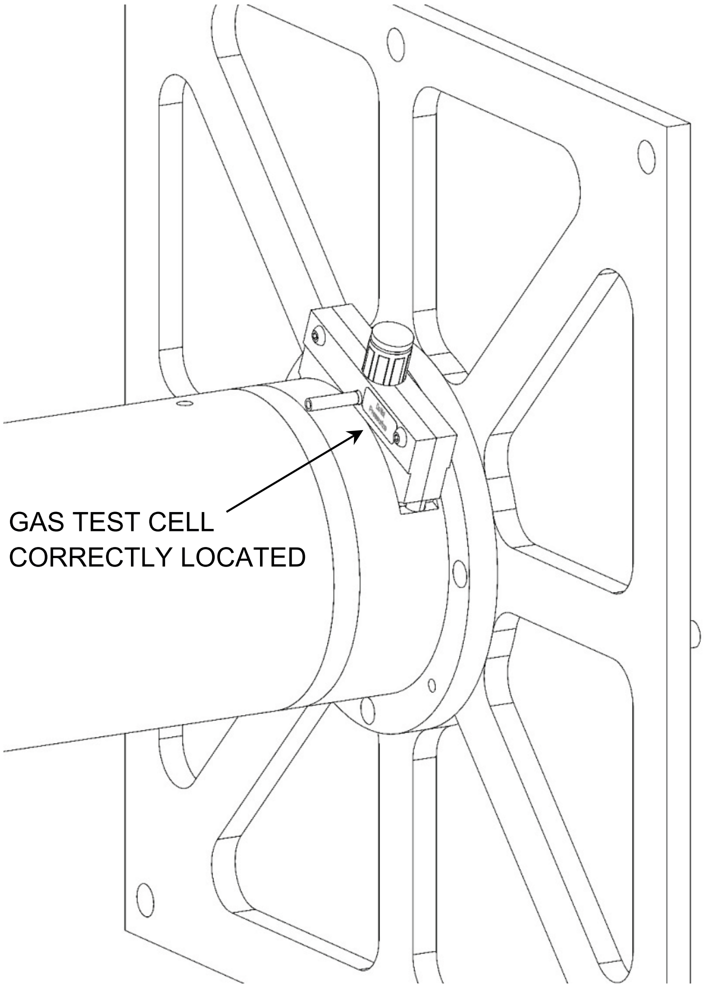
In order to use the Refillable Cross Duct Gas Test Cell, the Gas Test Cell Aperture needs to be uncovered. The Gas Test Cell Aperture can be uncovered by removing the two M5 bolts which secure the aperture cover and removing the cover from the aperture.



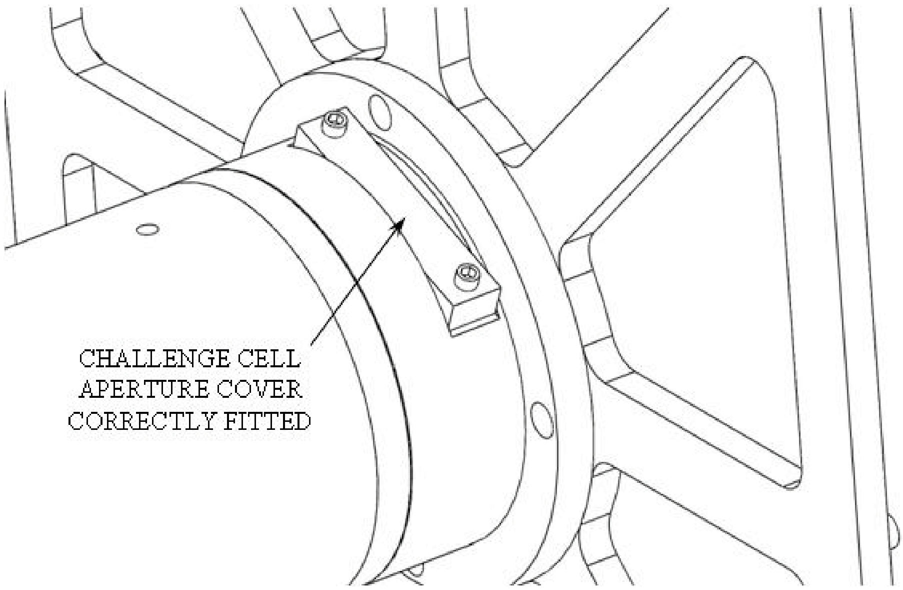
Once the Cell Aperture is uncovered, the Cross Duct Gas Challenge Cell can be inserted into the measurement path of the Cross Duct ELDS system that is being tested as illustrated below.



Fully insert the cell as illustrated below:



Verify the response of the Cross Duct ELDS system being tested by monitoring the system's 4-20mA output or the gas reading using SITE. After completing the test, remove the Gas Challenge Cell and replace the Challenge Cell Aperture Cover.



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14. Appendix D – Manufacturer's EC Declarations

MSA
The Safety Company

EU Declaration of Conformity

The undersigned, representing the manufacturer:

Senscient Limited
Unit F1, Arena Business Centre
Holyrood Close, Poole, Dorset
BH17 7FP UK

Hereby declares that the product(s), listed below:

Senscient ELDS 1000/2000 Series
Open Path & Cross Duct Gas Detectors

Are in conformity with the provisions of the following EU Directive(s), when installed, operated, serviced and maintained in accordance with the supplied manufacturers installation and operating/service documentation:

2014/30/EU	EMC Directive
2014/34EU	ATEX Directive

And that the standards and/or technical specifications referenced below have been applied and/or considered:

EMC Standards:

EN50270: 2015	Electromagnetic Compatibility – Electrical Apparatus for the Detection and Measurement of Combustible Gases Toxic Gases or Oxygen - (Test Report TRA-035003-38-01A)

ATEX Standards:

EN60079- 0: 2012+A11:2013	Explosive Atmospheres – Part 0: Equipment General Requirements
EN60079- 1: 2014	Explosive Atmospheres – Part 1: Equipment Protection by Flameproof Enclosures "d"
EN60079-31:2014	Explosive Atmospheres – Part 31: Equipment dust ignition protection by enclosures "t" (Baseefa Certification Report No 15/0613
EN60079-28-2015	Explosive Atmospheres – Part 28: Protection of equipment and transmission systems using optical radiation.
EN60529 +A1: 1991/2001	Degree of Protection Provided by Enclosures (IP Code). (Baseefa Certification Report No 09C0810)

Design/Construction: In Accordance with Good Engineering Principles

Certification: II 2 GD Ex db IIB + H2 T5 Gb Ex tb IIIC T100°C Db, IP66/67 Tamb - 40°C to + 60°C

Notified Body for ATEX:	*Certificate No(s):*	*Notified Body for QAN*	*Certificate No(s):*
Baseefa Ltd Rockhead Business Park Staden Lane Buxton Derbyshire SK17 9RZ UK	Baseefa10ATEX0066X Notified Body No: 1180	FM Approvals Ltd 1 Windsor Dials Windsor Berkshire SL4 1RS UK	FM10ATEXQ0010 Notified Body No: 1725

Year of CE Marking:

Commencement: 2010

For and on behalf of the authorised manufacturer in the EU community:

Signature: L. R

Date of Signature: 28/3/2018

Name: Lee Richman

Position: Chief Technical Officer, (MSA/Senscient Limited, Poole, Dorset, UK.)

Senscient EU Declaration of Conformity Baseefa Rev 4
Uncontrolled When Printed – Check Latest Issue

GB

Senscient

Senscient Limited.
Unit F1-2,
Arena Business Centre
Holy Rood Close
Poole, Dorset
BH17 7FJ

Declaration of Conformity to EU RoHS

Products listed below that are manufactured by Senscient Ltd are in compliance with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (also known as "RoHS Recast"). In addition, this declaration of conformity is issued under the sole responsibility of Senscient Ltd. Specifically, products manufactured do not, to the knowledge of the certifier, contain the substances listed in the table below in concentrations exceeding the Maximum Control Value (MCV) and will be compliant as of the date listed.

Substance	Maximum Control Value
Lead (Pb)	0.1% by weight (1000 ppm)
Cadmium (Cd)	0.01% by weight (100 ppm)
Mercury (Hg)	0.1% by weight (1000 ppm)
Hexavalent Chromium (Cr6+)	0.1% by weight (1000 ppm)
Poly Brominated Biphenyls (PBB)	0.1% by weight (1000 ppm)
Poly Brominated Diphenyl ethers (PBDE)	0.1% by weight (1000 ppm)

Exemptions:

No RoHS exemptions claimed for any parts or materials covered by this DoC.

Product Identification:

NOTE: Use one or more of these choices:

- "All parts manufactured by Senscient Ltd."

Date of Issue: 14/09/2015
Place of Issue: Poole UK

Signature:

Name: Steve Carpenter
Title: QA and H&S Manager
Telephone: +441202606459
Email: SCarpenter@senscient.com

GB

15. Appendix E – HART Communications

15.1. Overview

Following the release of ELDS systems at Mod state 2, all ELDS Receivers incorporate a HART compatible communications modem / link in the 4-20mA(1) output. The HART communications modem / link provided inside the ELDS Receiver is configured to be a Slave Transmitter device, with the intention that this be used in a conventional HART Master / Slave loop.

The HART communications modem incorporated into ELDS Receivers supports all Universal HART Commands as defined in HCF_SPEC-127, Revision 7.1 except for Command 6*. At the time of writing, Common Practice and Device Specific HART commands are not supported.

* Command 6 – Write Polling Address is not supported because it would provide a means by which an ELDS gas detector could be made to permanently stop signalling gas readings via the analogue current on its 4-20mA output. This command is only required to enable HART devices to be put into loop current mode for use in a multi-drop configuration, a configuration that is not used in gas detection systems. The existence of a loop current mode would compromise the safety integrity of an ELDS gas detector's primary output (4-20mA output), which is why this mode and command are not implemented or supported by ELDS units.

An ELDS HART Device Descriptor (DD) is available from Senscient, our distributors or agents. This DD file will facilitate the automatic selection/configuration of ELDS units onto an existing HART communication system. The ELDS HART DD is not currently included in the DD library distributed by the HART Foundation.

15.2. Electrical Connections / Configuration

Since the HART communications modem in the 4-20mA(1) output of ELDS Receivers is configured to be a Slave device working in a conventional HART Master / Slave loop, the electrical connections / configuration for such an installation should be in accordance with any of the three following arrangements for isolated (2 wire), source or sink (1 wire):

In order to conform to relevant HART physical layer specifications, the impedance of the HART Primary Master (Current Input) must be between 230Ω and 600Ω within the normal frequency band (950Hz to 2500Hz).

The electrical connection diagram shown for an isolated HART loop on 4-20mA(1) assumes that there is a separate, isolated power supply inside or provided locally to the HART Master input. This arrangement will provide the most reliable operation when an isolated, 2-wire HART loop is being employed. However, it is recognized that it is also possible to energize this loop by making use of the same +24V supply that is powering the field devices. Such an arrangement would see the +24V supply connected to provide the voltage source shown in the diagram for the 'isolated' HART loop.

Only 4-20mA(1) incorporates a HART modem / link. The 4-20mA(2) output is just an ordinary 4-20mA output.

The two (2) 4-20mA outputs incorporated into each ELDS Receiver unit are completely independent and electrically isolated. Consequently, 4-20mA(2) can be configured as isolated, source or sink. Refer to section 3.3.3 for details of the wiring options which all remain available for 4-20mA(2) when using 4-20mA(1)'s HART capability.

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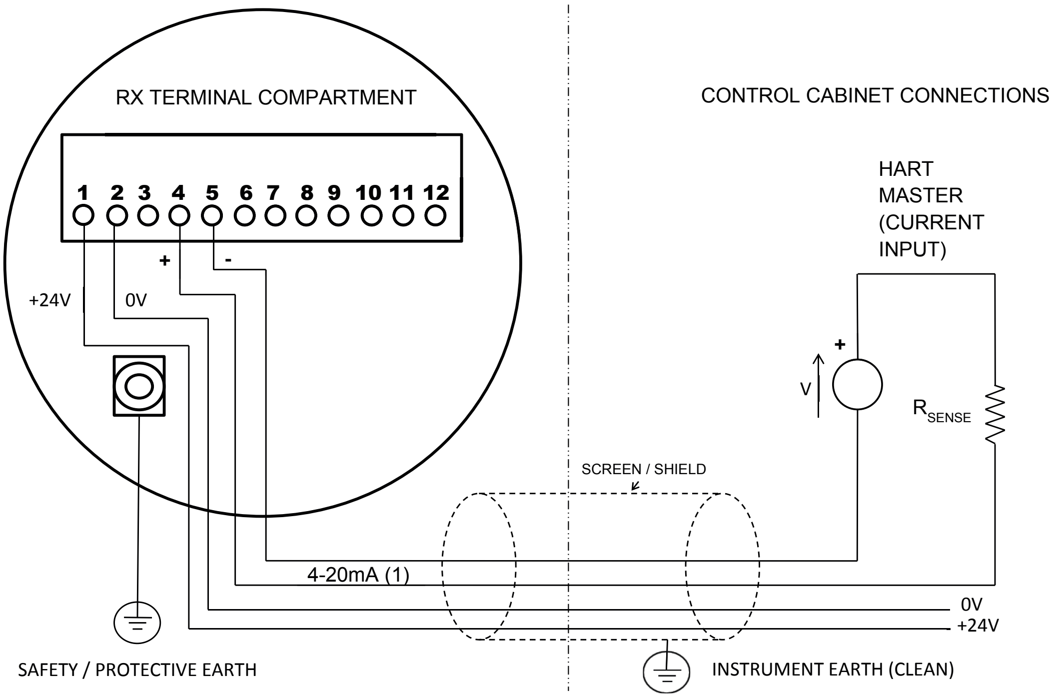
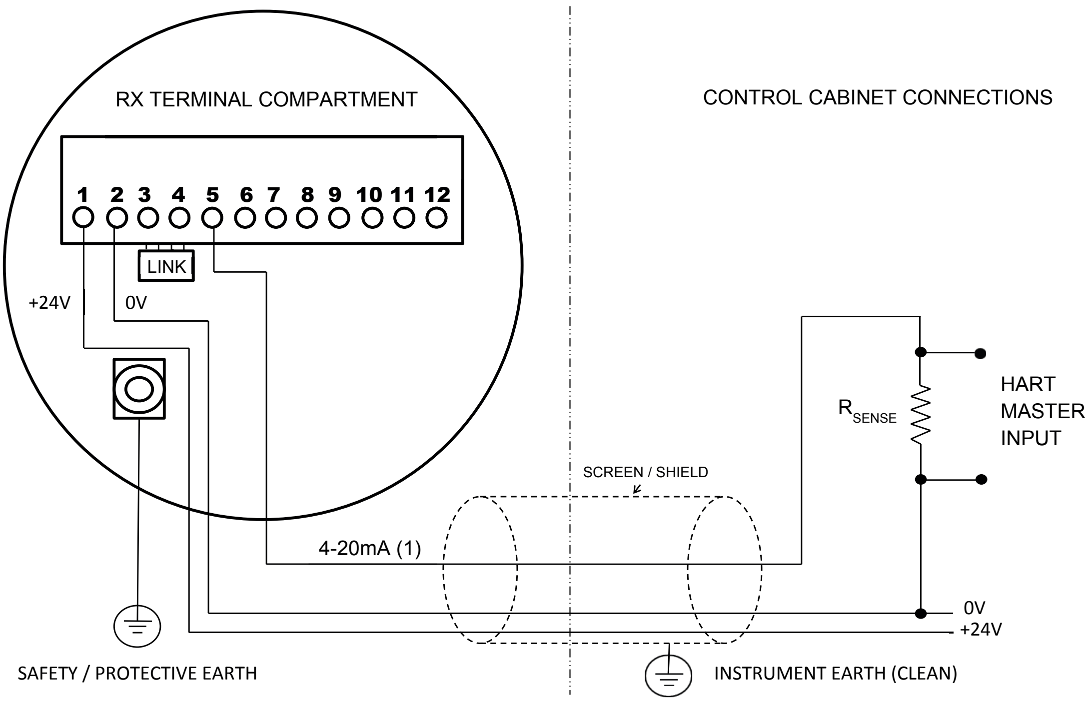
RX WIRING DIAGRAM: HART 4-20 (1) ISOLATED



RX WIRING DIAGRAM: HART 4-20 (1) SOURCE



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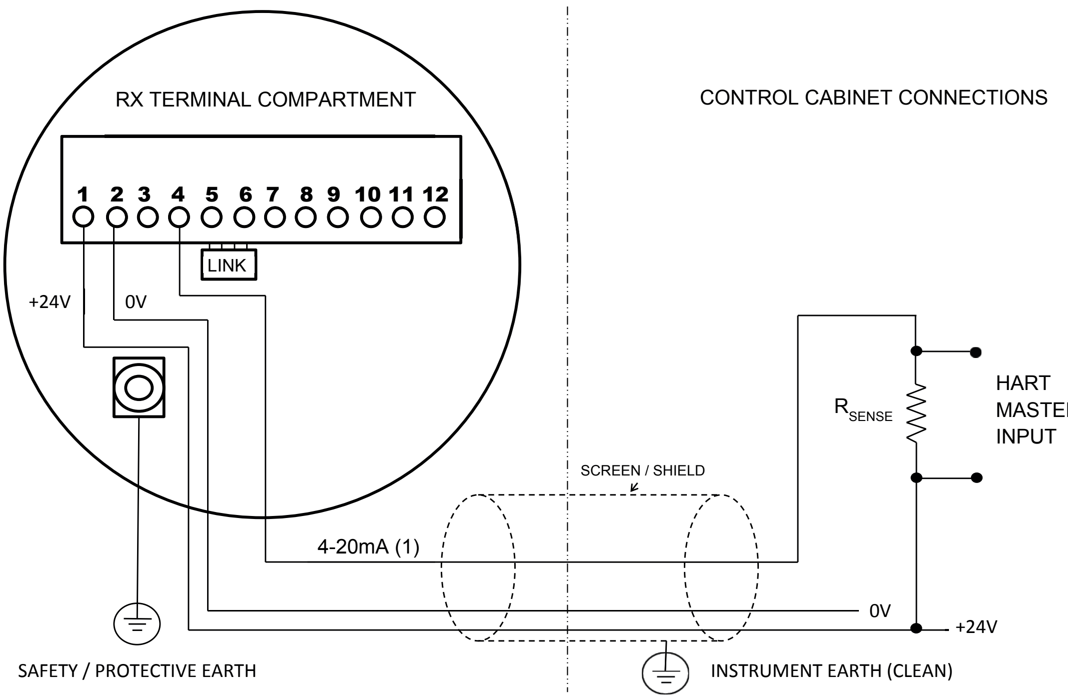
RX WIRING DIAGRAM: HART 4-20 (1) SINK



ELDS HART Device Electrical Characteristics

The electrical characteristics of the HART device incorporated into 4-20mA(1) of ELDS Receiver units are as below:

Parameter	Value
Minimum R_{tt}	100kΩ
Maximum C_{tt}	5nF
Minimum Operating Current	1mA
Maximum Operating Current	22mA
Minimum Operating Voltage	5V
Maximum Operating Voltage	32V

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15.3. Details of ELDS Data Available via HART

The HART communications modem incorporated into ELDS Receivers supports all Universal HART Commands as defined in HCF_SPEC-127, Revision 7.1, except Command 6.

At the time of writing, Common Practice and Device Specific HART commands are not supported and there is no HART capability in ELDS Tx units.

The most useful information available by way of HART from an ELDS system includes the following:-

Gas Measurements (‘Burdens’) – ELDS systems measure gas ‘burdens’, which are effectively the integrated concentration of the target gas along the whole of the monitored optical path. The gas ‘burden’ for each output is mapped to the HART primary and secondary variables.

Although the 4-20mA output range is inherently limited by the maximum current that can be output (typically 21.5mA), the values passed to the HART primary and secondary variables are not restricted, allowing the user to monitor gas levels that are beyond the 4-20mA output / measurement ‘range’ of the instrument.

Analogue 4-20mA(1) Level – The analogue current that is to be output by 4-20mA(1) output of an ELDS Receiver can be obtained using the appropriate universal HART command.

Last SimuGas Event – Information regarding the last detected Simu-Gas event is made available in the Tag/Descriptor/Date fields (HART command 13) and the Tertiary (tv) and Quaternary (qv) variables. Values are in ppm.m units irrespective of the range/output of the primary and secondary variables. The unit will have 0.0 for each of these values on power-up.

Serial Number and TAG – The unit serial number and current user TAG is made available through the HART interface, with it being possible to change the user TAG via HART if required.

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15.3.1 HART ELDS-Specific Information

As mentioned earlier, all Universal HART commands are supported by ELDS Receivers and operate as defined in the relevant HART specifications. In the interests of clarity, this Appendix does not attempt to describe all of the Universal HART commands and responses in detail. The following table describes HART commands that will lead to responses that will contain ELDS-specific information.

ELDS-Specific Information

Command	ELDS Data	Description
0 Read Unique Identifier	Manufacturer ID	Senscient is 0x6067 ELDS 1000/2000 device is 0xE1D0
1 Read Primary Variable	Units field / Primary Variable	Units values are: 240 = ppm.m 241 = LFL.m 242 = LFL The variable value is not limited to the ELDS ‘full scale’ which is normally imposed by the limited range of the 4-20mA output
3 Read Dynamic Variables and Loop Current	1st Loop Current, gas values and last SimuGas values	The loop current (in mA) is explicitly coded in this HART command, the 4 dynamic variables contain the following data: PV, gas reading for 1st laser SV, gas reading for 2nd laser TV, SimuGas response 1st laser QV, SimuGas response 2nd laser
12 Read Message	Firmware Revision	This returns a packed ASCII message that identifies the ELDS firmware revision. This message is re-asserted every time the Rx is powered up.
13 Read Tag, Descriptor, Date	Last SimuGas result	The Tag field is user writable via the HART connection and can be used by the customer to identify the ELDS unit if required. The Descriptor contains a message describing the result of the last SimuGas Auto trial (pass/fail) and the date identifies the date of this test. The content of the descriptor are detailed fully below in section 15.3.2

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Command	ELDS Data	Description
20 Read Long Tag	ELDS TAG	This contains the ASCII representation of the ELDS unit TAG. This should not be confused with the short tag supported by command 13 above.
22 Write Long Tag	ELDS TAG	This allows the ELDS unit TAG to be updated.
48 Read Additional Device Status	ELDS Status Information	This provides information relating to the following items: Beamblock L0 and L1 Lowlight Over Temperature UnderTemperature BlueTooth (set if configured) WindowHeater State (on/off) Valid zero and Span Data Rapid Signal Loss suppression Fingerprint Failure Laser Lock Status Negative Gas faults Diffuser Status Rx not receiving FSK packets These items are contained in the additional ‘bytes’ of data available via command 48 and are detailed below in section 15.3.2.

15.3.2 SimuGas Information over HART

In order to enable the results of the last SimuGas test performed by an ELDS system to be made available using Universal HART commands, the response to HART command 13 – Read Tag, Descriptor, Date will contain the following information:

Message	Description
NO SG EVENT	There has been no SimuGas event since the Rx was last powered. The date will be 01/01/2000 (default entry)
SG FAIL: nnnn.n	The last SimuGas event was a failure. nnnn.n is the recorded SimuGas value. The Date field indicates the date that the test was performed.
SG PASS: nnnn.n	The last SimuGas event was successful. nnnn.n is the recorded SimuGas value. The Date field indicates the date that the test was performed
SG HIBG: nnnn.n	The last SimuGas event detected a high gas background during the test. nnnn.n is the level of the background (always in ppm.m units). The test is treated as a pass by the ELDS unit. The Date field indicates the date that the test was performed.

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Additional ELDS Device Status Information is provided in response to HART command 48, in accordance with the following table. Note that many of these items are for advanced fault finding and are not described in detail here. Basic Beam-Block and Low Light information is generally useful for customer examination:

Byte	Bit	Value
0	7	0 = Tx, 1 = Rx
	6	Beam block L0
	5	Beam block L1
	4	Low Light
	3	Over Temperature
	2	Under Temperature
	1	BlueTooth (set if configured)
	0	Window Heater (0 = off, 1 = on)
1	7	Valid Zero if asserted. there are different flags relating to different fingerprint components
	6	
	5	Valid Span if asserted. There are different flags relating to different fingerprint components
	4	
	3	Rapid Signal Loss Suppression for Laser 0 (1st laser)
	2	Rapid Signal Loss Suppression for Laser 1 (2nd laser)
	1	Finger-print failure for Laser 0 primary harmonics
	0	Finger print failure for Laser 1 primary harmonics
2	7	Laser 0 primary harmonics locked
	6	Laser 1 primary harmonics locked
	5	Laser 0 primary harmonics lock failure
	4	Laser 1 primary harmonics lock failure
	3	Laser 0 negative gas fault
	2	Laser 1 negative gas fault
	1	Diffuser failure
	0	Receiver not receiving primary data
3	7	Laser 0 secondary harmonics locked
	6	Laser 1 secondary harmonics locked
	5	Laser 0 secondary harmonics lock failure
	4	Laser 1 secondary harmonics lock failure
	3	Valid Zero if asserted. there are different flags relating to different fingerprint components
	2	
	1	Valid Span if asserted. There are different flags relating to different fingerprint components
	0	
4	7	Finger print failure for Laser 0 secondary harmonics
	6	Finger print failure for Laser 1 secondary harmonics

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16. Appendix F – MODBUS Communications

ELDS units can be configured to provide Modbus communications via the unit's RS485 communications interface. Ordinarily, the RS485 communications interfaces of ELDS units are configured to communicate using a Senscient proprietary protocol which enables installation, commissioning and testing of ELDS units using SITE software running on a laptop/tablet. When RS485 communications are configured to support MODBUS, the Senscient proprietary operations are not available via RS485, but will remain available through Bluetooth.

Modbus is a multi-drop system that allows several instruments to be connected to a common controller. Instruments are assigned a specific address and will only respond to Modbus messages that specify this address correctly.

ELDS supports a subset of the standard as detailed below.

Feature	Description/Specification
Protocol	RTU
Data Rate	110 to 256000 Baud. Default = 9600
Parity	None, Odd, Even, Mark or Space. Default = None
Stop Bits	1
Unit Address Range	1 to 255. Default Rx=1, Tx=2
Time to start response to request	Typically < 0.1mS
Supported Modbus Commands. **NOTE:** Modbus Broadcast commands are not supported	0x01 Read Coils,
	0x02 Read Discrete Inputs
	0x03 Read Holding Registers
	0x04 Read Input Registers
	0x05 Write Single Coil
	0x06 Write Single Holding Register
	0x0F Write Multiple Coils
	0x10 Write Multiple Input Registers

The ELDS unit then acts as a slave and provides a range of information and control facilities using a range of Coils, Inputs, Holding Registers and Input Registers as described in the following tables.

Although the Modbus standard specifies all register types starting at address 1 it is common in many Modbus controllers to include offsets in the address ranges that are used to define the different type of registers within a slave. For example, Coils may be specified in the range 1 to 9999 and Holding Registers in the range 40001 to 49999. In the tables below the address values are defined starting at 1 for each register type - users may need to add the appropriate offset relevant to the Modbus controller they are actually using.

There are 27 single bit inputs defined as follows:

Input	Content
1	Unit Type (0=Rx, 1=Tx)
2	BB Laser 0
3	BB Laser 1
4	Low Light
5	Over Temperature
6	Under Temperature
7	Window Heater (0 if off, 1 if on)
8	Laser 0 Zero (0 if invalid, 1 if valid)
9	Laser 1 Zero (0 if invalid, 1 if valid)
10	Laser 0 Span (0 if invalid, 1 if valid)
11	Laser 1 Span (0 if invalid, 1 if valid)
12	L0 Rapid Signal Loss (1 if asserted)
13	L1 Rapid Signal Loss (1 if asserted)
14	L0 Fingerprint Failed (1 if asserted)
15	L1 Fingerprint Failed (1 if asserted)
16	L0 Locked
17	L1 Locked
18	L0 Lock Failed
19	L1 Lock Failed
20	L0 Fault
21	L1 Fault
22	L0 Inhibit
23	L1 Inhibit
24	L0 Over-Range
25	L1 Over-Range
26	L0 Negative Gas Fault
27	L1 Negative Gas Fault

These are read only and can be read using the Modbus command 0x02 (Read Discrete Inputs).

There are 5 single bit Coils (or bit input/output registers) as follows.

Coil	Applies	Content
1	Tx	Implement Undisclosed Simu-Gas(with marker), Coil will return to zero once Tx has completely finished the process. Note, following setting the value subsequent reads will show the Coil value still at zero for about 10 seconds. The value will be asserted once the SimuGas process (timer driven in the Firmware) starts. The value then remains asserted for about 1½ minutes whilst the Simu-Gas is operating
2	Tx	Implement disclosed Simu-Gas (no marker), Coil will return to zero once Tx has completely finished the process
3	Rx	Assert Test values to 4-20mA outputs, must write zero back to this coil to revert to gas monitoring. **NOTE**: The controller must ensure that this value is written back to zero as otherwise the ELDS Receiver will not be able to monitor gas. The actual test current is specified by Holding register 7 (see below).
4	Rx	L0 Zero Calibration, value will be reset to 0 once zero completed
5	Rx	L1 Zero Calibration, value will be reset to 0 once zero completed

These are read/write bit data and can be read using the Modbus command 0x01 (Read Coils) and can be written using commands 0x05 (Write Single Coil) or 0x0F (Write Multiple Coils).

Each of these registers are available on both ELDS Transmitter and Receiver units, however 1 and 2 only ‘apply’ to Transmitter units; whilst 3, 4 and 5 only ‘apply’ to Receiver units.

There are 41 Input Registers. These are all 16 bit (unsigned) quantities as follows:

Input	Applies	Content	Comment
1	Rx	L0 Gas Value, ppm	ppm.m
2	Rx	L1 Gas Value, ppm	
3	Tx & Rx	L0 Full Scale Range	ppm.m
4	Tx & Rx	L1 Full Scale Range	
5	Tx & Rx	Firmware Major Version	
6	Tx & Rx	Firmware Minor Version	
7	Tx & Rx	Firmware Build Version	
8	Tx & Rx	Unit Serial Number	Serial Numbers are Factory Set
9	Tx & Rx	Paired Unit Serial Number	
10	Rx	L0, Last Simu-Gas Result	ppm.m
11	Rx	L1, Last Simu-Gas Result	
12	Rx	L0 Signal ValueA	Signal = ValueA×ValueB/1000, units are internal ELDS scale
13	Rx	L0 Signal ValueB	
14	Rx	L1 Signal ValueA	
15	Rx	L1 Signal ValueB	
16	Rx	L0 Gas ValueA	Gas = ValueA×ValueB/1000, units are ppm.m
17	Rx	L0 Gas ValueB	
18	Rx	L1 Gas ValueA	
19	Rx	L1 Gas ValueB	
20	Rx	Last SG Year	base 2000, so 2011 would be represented by the year value 11

Input	Applies	Content	Comment
21	Rx	Last SG Month	1 to 12
22	Rx	Last SG Day	1 to 31
23	Rx	Last SG Hour	0 to 23
24	Rx	Last SG Minute	0 to 59
25	Rx	Last SG Second	0 to 59
26	Rx	No. Good SimuGas	Per laser, for a dual laser system a single SG process will normally produce +2 counts for No. Good
27	Rx	No. Bad SimuGas	
28	Rx	L0 Last Gas Value	ppm.m
29	Rx	L1 Last Gas Value	ppm.m
30	Rx	L0 Last Gas Year	Base 2000
31	Rx	L0 Last Gas Month	1 to 12
32	Rx	L0 Last Gas Day	1 to 31
33	Rx	L0 Last Gas Hour	0 to 23
34	Rx	L0 Last Gas Minute	0 to 59
35	Rx	L0 Last Gas Second	0 to 59
36	Rx	L1 Last Gas Year	Base 2000
37	Rx	L1 Last Gas Month	1 to 12
38	Rx	L1 Last Gas Day	1 to 31
39	Rx	L1 Last Gas Hour	0 to 23
40	Rx	L1 Last Gas Minute	0 to 59
41	Rx	L1 Last Gas Second	0 to 59

These are read only and can be read using the Modbus command 0x04 (Read Input Registers).

There are two separate outputs of the measured gas values for the Receiver units. The ‘simple’ form (Inputs 1 and 2) contain the gas value in ppm.m units. These outputs are restricted to the range 0 to 65535 ppm.m which is sufficient to cover the normal full scale range of most ELDS variants. The second form of output is used to duplicate the gas results (Inputs 16 to 19) as well as providing the signal level for each laser (Inputs 12 to 15). For these each output is coded using two registers, the actual value is then formed using the product of both registers divided by a scaling factor of 1000. This allows a much greater dynamic range for these outputs (good accuracy is maintained for values from 0.1 to 4×106. These then greatly extend the quality of output of the gas results as well as providing a full diagnostic measure of the signal level for each laser.

17. Appendix G – Measurement Range Guidelines

Scope:

This Appendix provides guidelines intended to assist designers of safety systems with the task of selecting and specifying appropriate measurement ranges and alarm thresholds for the use of ELDS Open Path Gas Detectors.

Notice:

The design and engineering of a safety system requires the responsible Design Authority to take into account all of the potential safety hazards that are to be addressed by the safety system, the means or techniques that are to be employed to provide the required level of safety / protection, all applicable national or international health & safety legislation; and any relevant policies, procedures or working practices of the companies that will be involved in the deployment, operation or maintenance of the safety system. Gas detectors can only ever form part of a safety system and it is the responsibility of the Design Authority to ensure that the entirety of any safety system provides the required level of safety / protection.

Disclaimer:

These guidelines are general and cannot take account of all of the factors that may need to be considered when designing and engineering a safety system for a specific application. These guidelines reflect Senscient's views; they do not constitute legal or professional advice. Senscient does not accept responsibility; and is not liable for any damages arising in contract, tort or otherwise from the use of any material contained in these guidelines.

Guideline Measurement Ranges and Alarm Thresholds for ELDS Open Path Methane (CH_4) Detectors

Application ►	Early Leak Warning	Flammable Hazard Detection
Path Length 5-30 m	R 0-1,000ppm.m A1: 250ppm.m A2: 500ppm.m	R 0-1LFL.m A1: 0.2LFL.m A2: 0.4LFL.m
Path Length 30-60 m	R 0-1,000ppm.m A1: 400ppm.m A2: 600ppm.m	R 0-1LFL.m A1: 0.2LFL.m A2: 0.4LFL.m
Path Length 60-90 m	R 0-1,000ppm.m A1: 500ppm.m A2: 750ppm.m	R 0-1LFL.m A1: 0.3LFL.m A2: 0.5LFL.m
Path Length 90-120 m	R 0-5,000ppm.m A1: 1,000ppm.m A2: 1,500ppm.m	R 0-1LFL.m A1: 0.4LFL.m A2: 0.6LFL.m

Key:

R: Guideline measurement range
A1: Guideline first alarm threshold
A2: Guideline second / high alarm threshold

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Guideline Measurement Ranges and Alarm Thresholds for ELDS Open Path Ethylene (C_2H_4) Detectors

Application ►	Early Leak Warning	Flammable Hazard Detection
Path Length 5-30 m	R 0-10,000ppm.m A1: 2,000ppm.m A2: 3,500ppm.m	R 0-1LFL.m A1: 0.2LFL.m A2: 0.4LFL.m
Path Length 30-60 m	R 0-10,000ppm.m A1: 2,000ppm.m A2: 4,000ppm.m	R 0-1LFL.m A1: 0.2LFL.m A2: 0.4LFL.m
Path Length 60-90 m	R 0-10,000ppm.m A1: 2,000ppm.m A2: 4,000ppm.m	R 0-1LFL.m A1: 0.3LFL.m A2: 0.5LFL.m
Path Length 90-120 m	R 0-10,000ppm.m A1: 2,500ppm.m A2: 5,000ppm.m	R 0-1LFL.m A1: 0.4LFL.m A2: 0.6LFL.m

Key:

R: Guideline measurement range
A1: Guideline first alarm threshold
A2: Guideline second / high alarm threshold

Guideline Measurement Ranges and Alarm Thresholds for ELDS XD, VZ and High Temp XD Methane (CH_4) Detectors

Application ►	Flammable Hazard Detection
Path Length 0.5-5.0 m 0-10%LFL	A1: 2%LFL A2: 4%LFL
Path Length 0.5-5.0 m 0-25%LFL	A1: 5%LFL A2: 10%LFL
Path Length 0.5-5,0 0-100%LFL	A1: 25%LFL A2: 50%LFL

Key:

R: Guideline measurement range
A1: Guideline first alarm threshold
A2: Guideline second / high alarm threshold

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Guidelines for Open Path Flammable Gas Detectors with 0-5LFL.m Measurement Ranges (Methane)

In order to comply with earlier requirement specifications based upon NDIR open path gas detectors, ELDS units can be supplied with a measurement range of 0-5LFL.m. A 0-5LFL.m (0-500%LFL.m) measurement range is suitable for providing alarms concerning very large flammable gas releases that will require immediate, emergency action to prevent explosion or fire.

A 0-5LFL.m measurement range is not suitable for providing an early warning about a flammable gas release, a warning that might allow remedial action to be taken to prevent a much larger and more dangerous leak from occurring. In order to provide early warnings about developing flammable gas leaks, lower measurement ranges need to be employed. ELDS units are available with 0-1LFL.m, 0-10,000ppm.m and 0-1,000ppm.m measurement ranges. These guidelines recommend the use of a 0-1LFL.m measurement range to provide alarms about flammable gas hazards that are likely to require immediate, emergency action; and 0-10,000ppm.m or 0-1,000ppm.m measurement ranges to provide early warning about a developing flammable gas leak.

Application ►	Gas	Alarm Threshold
Path Length 5-30 m	0-5LFL.m Methane	A1: 0.75LFL.m A2: 1.5LFL.m
Path Length 30-60 m	0-5LFL.m Methane	A1: 1.0LFL.m A2: 2.0LFL.m

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Guideline Measurement Ranges and Alarm Thresholds for ELDS Open Path H_2S Detectors

[H_2S] ►	0-1% V/V			1-10% V/V			10-100% V/V		
Pressure ►	< 10 Bar	10-100 Bar	> 100 Bar	< 10 Bar	10-100 Bar	> 100 Bar	< 10 Bar	10-100 Bar	> 100 Bar
Path Length 5-15 m	R 0-250 ppm.m A1: 75ppm.m A2: 150ppm.m	R 0-250 ppm.m A1: 100ppm.m A2: 200ppm.m	R 0-500 ppm.m A1: 150ppm.m A2: 250ppm.m	R 0-500 ppm.m A1: 150ppm.m A2: 250ppm.m	R 0-500 ppm.m A1: 200ppm.m A2: 300ppm.m	R 0-1,000 ppm.m A1: 300ppm.m A2: 450ppm.m	R 0-500 ppm.m A1: 200ppm.m A2: 300ppm.m	R 0-1,000 ppm.m A1: 300ppm.m A2: 450ppm.m	R 0-1,000 ppm.m A1: 400ppm.m A2: 600ppm.m
Path Length 15-30m	R 0-250 ppm.m A1: 150ppm.m A2: 225ppm.m	R 0-500 ppm.m A1: 200ppm.m A2: 300ppm.m	R 0-500 ppm.m A1: 300ppm.m A2: 450ppm.m	R 0-500 ppm.m A1: 200ppm.m A2: 300ppm.m	R 0-1,000 ppm.m A1: 300ppm.m A2: 450ppm.m	R 0-1,000 ppm.m A1: 450ppm.m A2: 675ppm.m	R 0-1,000 ppm.m A1: 300ppm.m A2: 450ppm.m	R 0-1,000 ppm.m A1: 400ppm.m A2: 600ppm.m	R 0-1,000 ppm.m A1: 500ppm.m A2: 750ppm.m
Path Length 30-60 m	R 0-500 ppm.m A1: 300ppm.m A2: 450ppm.m	R 0-1,000 ppm.m A1: 450ppm.m A2: 675ppm.m	R 0-1,000 ppm.m A1: 600ppm.m A2: 900ppm.m	R 0-1,000 ppm.m A1: 450ppm.m A2: 675ppm.m	R -1,000 ppm.m A1: 500ppm.m A2: 750ppm.m	R 0-1,000 ppm.m A1: 600ppm.m A2: 900ppm.m	R 0-1,000 ppm.m A1: 500ppm.m A2: 750ppm.m	R 0-1,000 ppm.m A1: 600ppm.m A2: 900ppm.m	R 0-1,000 ppm.m A1: 600ppm.m A2: 900ppm.m

Key:

R: Guideline measurement range
A1: Guideline first alarm threshold
A2: Guideline second / high alarm threshold

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Guideline Measurement Ranges and Alarm Thresholds for ELDS Open Path HF Detectors

Application ►	Health / Environmental	Leak Hazard Detection
Path Length 5-30 m	R 0-25ppm.m A1: 7.5ppm.m A2: 15ppm.m	R 0-100ppm.m A1: 40ppm.m A2: 75ppm.m
Path Length 30-60 m	R 0-50ppm.m A1: 15ppm.m A2: 30ppm.m	R 0-200ppm.m A1: 75ppm.m A2: 150ppm.m
Path Length 60-90 m	R 0-100ppm.m A1: 30ppm.m A2: 60ppm.m	R 0-500ppm.m A1: 150ppm.m A2: 300ppm.m
Path Length 90-120 m	R 0-200ppm.m A1: 50ppm.m A2: 100ppm.m	R 0-1,000ppm.m A1: 250ppm.m A2: 500ppm.m

Guideline Measurement Ranges and Alarm Thresholds for ELDS Open Path Ammonia (NH_3) Detectors

Application ►	Health / Environmental	Leak Hazard Detection
Path Length 5-30 m	R 0-1,000ppm.m A1: 150ppm.m A2: 250ppm.m	R 0-1,000ppm.m A1: 300ppm.m A2: 500ppm.m
Path Length 30-60 m	R 0-1,000ppm.m A1: 250ppm.m A2: 400ppm.m	R 0-1,000ppm.m A1: 400ppm.m A2: 600ppm.m
Path Length 60-90 m	R 0-1,000ppm.m A1: 400ppm.m A2: 600ppm.m	R 0-5,000ppm.m A1: 1,000ppm.m A2: 1,500ppm.m
Path Length 90-120 m	R 0-1,000ppm.m A1: 500ppm.m A2: 750ppm.m	R 0-5,000ppm.m A1:1,500ppm.m A2: 2,000ppm.m

Guideline Measurement Ranges and Alarm Thresholds for ELDS Open Path HCl Detectors

Application ►	Health / Environmental
Path Length 5-30 m	R 0-50ppm.m A1: 15ppm.m A2: 25ppm.m
Path Length 30-60 m	R 0-50ppm.m A1: 20ppm.m A2: 30ppm.m
Path Length 60-90 m	R 0-50ppm.m A1: 30ppm.m A2: 40ppm.m
Path Length 90-120 m	R 0-50ppm.m A1: 30ppm.m A2: 40ppm.m

Guideline Measurement Ranges and Alarm Thresholds for ELDS Open Path Carbon Dioxide (CO_2) Detectors

Application ►	Leak Hazard Detection
Path Length 5-30 m	R 0-300,000ppm.m A1: 60,000ppm.m A2: 120,000ppm.m
Path Length 30-60 m	R 0-300,000ppm.m A1: 60,000ppm.m A2: 120,000ppm.m
Path Length 60-90 m	R 0-300,000ppm.m A1: 120,000ppm.m A2: 180,000ppm.m
Path Length 90-120 m	R 0-300,000ppm.m A1:180,000ppm.m A2: 240,000ppm.m

18. Appendix H – 4-20mA Current Output Ranges

ELDS Receiver units contain two 4-20mA current loops that are used to signal gas levels. For dual gas units each loop is used for an individual gas, however for single gas units the second output loop will provide an alternative measurement of the gas that may be of a different full scale to the primary output. The table below details this for each ELDS part number.

Part No.	Description	4-20mA Full Scale Range		Certification
		1	2	
L-1012-1	1LFL.m CH_4 FM Long Range	1 LFL.m	1 LFL.m	FM
L-1012-3	1LFL.m CH_4 ATEX Long Range	1 LFL.m	1 LFL.m	ATEX/BASEEFA
L-1012-4	1LFL.m CH_4 CSA Long Range	1 LFL.m	1 LFL.m	CSA/UL
L-1012-5	1LFL.m CH_4 EAC TR-CU Long Range	1 LFL.m	1 LFL.m	EAC TR-CU
L-1012-7	1LFL.m CH_4 InMetro Long Range	1 LFL.m	1 LFL.m	InMetro
L-1015-1	5LFL.m CH_4 FM Long Range	5 LFL.m	1 LFL.m	FM
L-1015-3	5LFL.m CH_4 ATEX Long Range	5 LFL.m	1 LFL.m	ATEX/BASEEFA
L-1015-4	5LFL.m CH_4 CSA Long Range	5 LFL.m	1 LFL.m	CSA/UL
L-1015-5	5LFL.m CH_4 EAC TR-CU Long Range	5 LFL.m	1 LFL.m	EAC TR-CU
L-1015-7	5LFL.m CH_4 InMetro Long Range	5 LFL.m	1 LFL.m	InMetro
L-1092-3	1LFL.m Ethylene ATEX Long Range	1 LFL.m	1 LFL.m	ATEX/BASEEFA
L-1092-4	1LFL.m Ethylene CSA Long Range	1 LFL.m	1 LFL.m	CSA/UL
L-1092-5	1LFL.m Ethylene EAC TR-CU Long Range	1 LFL.m	1 LFL.m	EAC TR-CU
L-1092-7	1LFL.m Ethylene InMetro Long Range	1 LFL.m	1 LFL.m	InMetro
M-1009-3	1LFL.m / 1000ppm.m CH_4 ATEX Medium Range	1 LFL.m	1000 ppm.m	ATEX/BASEEFA
M-1009-4	1LFL.m / 1000ppm.m CH_4 CSA Medium Range	1 LFL.m	1000 ppm.m	CSA/UL
M-1009-5	1LFL.m / 1000ppm.m CH_4 EAC TR-CU Medium Range	1 LFL.m	1000 ppm.m	EAC TR-CU
M-1009-7	1LFL.m / 1000ppm.m CH_4 InMetro Medium Range	1 LFL.m	1000 ppm.m	InMetro
M-1010-3	1000ppm.m CH_4 ATEX Medium Range	1000 ppm.m	1 LFL.m	ATEX/BASEEFA
M-1010-4	1000ppm.m CH_4 CSA Medium Range	1000 ppm.m	1 LFL.m	CSA/UL
M-1010-5	1000ppm.m CH_4 EAC TR-CU Medium Range	1000 ppm.m	1 LFL.m	EAC TR-CU
M-1010-7	1000ppm.m CH_4 InMetro Medium Range	1000 ppm.m	1 LFL.m	InMetro
M-1012-1	1LFL.m CH_4 FM Medium Range	1 LFL.m	1 LFL.m	FM
M-1012-3	1LFL.m CH_4 ATEX Medium Range	1 LFL.m	1 LFL.m	ATEX/BASEEFA
M-1012-4	1LFL.m CH_4 CSA Medium Range	1 LFL.m	1 LFL.m	CSA/UL
M-1012-5	1LFL.m CH_4 EAC TR-CU Medium Range	1 LFL.m	1 LFL.m	EAC TR-CU
M-1012-7	1LFL.m CH_4 InMetro Medium Range	1 LFL.m	1 LFL.m	InMetro
M-1015-1	5LFL.m CH_4 FM Medium Range	5 LFL.m	1 LFL.m	FM
M-1015-3	5LFL.m CH_4 ATEX Medium Range	5 LFL.m	1 LFL.m	ATEX/BASEEFA
M-1015-4	5LFL.m CH_4 CSA Medium Range	5 LFL.m	1 LFL.m	CSA/UL
M-1015-5	5LFL.m CH_4 EAC TR-CU Medium Range	5 LFL.m	1 LFL.m	EAC TR-CU
M-1015-7	5LFL.m CH_4 InMetro Medium Range	5 LFL.m	1 LFL.m	InMetro
M-1051-3	50ppm.m HF ATEX Medium Range	50 ppm.m	100 ppm.m	ATEX/BASEEFA
M-1051-4	50ppm.m / 100ppm.m HF CSA Medium Range	50 ppm.m	100 ppm.m	CSA/UL
M-1052-4	200ppm.m / 100ppm.m HF CSA Medium Range	200ppm.m	100 ppm.m	CSA/UL
M-1054-3	1000ppm.m HF ATEX Medium Range	1000 ppm.m	500 ppm.m	ATEX/BASEEFA
M-1054-4	1000ppm.m HF CSA Medium Range	1000 ppm.m	500 ppm.m	CSA/UL
M-1070-3	300000ppm.m CO_2 ATEX Medium Range	300000 ppm.m	100000 ppm.m	ATEX/BASEEFA
M-1070-4	300000ppm.m CO_2 CSA Medium Range	300000 ppm.m	100000 ppm.m	CSA/UL
M-1070-5	300000ppm.m CO_2 EAC TR-CU Medium Range	300000 ppm.m	100000 ppm.m	EAC TR-CU
M-1070-7	300000ppm.m CO_2 InMetro Medium Range	300000 ppm.m	100000 ppm.m	InMetro
M-1080-3	1000ppm.m / 500ppm.m NH_3 ATEX Medium Range	1000 ppm.m	500 ppm.m	ATEX/BASEEFA

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Part No.	Description	4-20mA Full Scale Range		Certification
		1	2	
M-1080-4	1000ppm.m / 500ppm.m NH_3 CSA Medium Range	1000 ppm.m	500 ppm.m	CSA/UL
M-1080-5	1000ppm.m / 500ppm.m NH_3 EAC TR-CU Medium Range	1000 ppm.m	500 ppm.m	EAC TR-CU
M-1080-7	1000ppm.m / 500ppm.m NH_3 InMetro Medium Range	1000 ppm.m	500 ppm.m	InMetro
M-1082-3	5000ppm.m / 1000ppm.m NH_3 ATEX Medium Range	5000 ppm.m	1000 ppm.m	ATEX/BASEEFA
M-1082-4	5000ppm.m / 1000ppm.m NH_3 CSA Medium Range	5000 ppm.m	1000 ppm.m	CSA/UL
M-1087-3	15000ppm.m / 5000ppm.m NH_3 ATEX Medium Range	15000 ppm.m	5000 ppm.m	ATEX/BASEEFA
M-1087-4	15000ppm.m / 5000ppm.m NH_3 CSA Medium Range	15000 ppm.m	5000 ppm.m	CSA/UL
M-1091-3	10000ppm.m Ethylene ATEX Medium Range	10000 ppm.m	10000 ppm.m	ATEX/BASEEFA
M-1091-4	10000ppm.m Ethylene CSA Medium Range	10000 ppm.m	10000 ppm.m	CSA/UL
M-1091-5	10000ppm.m Ethylene EAC TR-CU Medium Range	10000 ppm.m	10000 ppm.m	EAC TR-CU
M-1091-7	10000ppm.m Ethylene InMetro	10000 ppm.m	10000 ppm.m	InMetro
M-1092-3	1LFL.m Ethylene ATEX Medium Range	1 LFL.m	1 LFL.m	ATEX/BASEEFA
M-1092-4	1LFL.m Ethylene CSA Medium Range	1 LFL.m	1 LFL.m	CSA/UL
M-1092-5	1LFL.m Ethylene EAC TR-CU Medium Range	1 LFL.m	1 LFL.m	EAC TR-CU
M-1092-7	1LFL.m Ethylene InMetro Medium Range	1 LFL.m	1 LFL.m	InMetro
S-1009-3	1LFL.m / 1000ppm.m CH_4 ATEX Short Range	1 LFL.m	1000 ppm.m	ATEX/BASEEFA
S-1009-4	1LFL.m / 1000ppm.m CH_4 CSA Short Range	1 LFL.m	1000 ppm.m	CSA/UL
S-1009-5	1LFL.m / 1000ppm.m CH_4 EAC TR-CU Short Range	1 LFL.m	1000 ppm.m	EAC TR-CU
S-1009-7	1LFL.m / 1000ppm.m CH_4 InMetro Short Range	1 LFL.m	1000 ppm.m	InMetro
S-1010-3	1000ppm.m CH_4 ATEX Short Range	1000 ppm.m	1 LFL.m	ATEX/BASEEFA
S-1010-4	1000ppm.m CH_4 CSA Short Range	1000 ppm.m	1 LFL.m	CSA/UL
S-1010-5	1000ppm.m CH_4 EAC TR-CU Short Range	1000 ppm.m	1 LFL.m	EAC TR-CU
S-1010-7	1000ppm.m CH_4 InMetro Short Range	1000 ppm.m	1 LFL.m	InMetro
S-1012-1	1LFL.m CH_4 FM Short Range	1 LFL.m	1 LFL.m	FM
S-1012-3	1LFL.m CH_4 ATEX Short Range	1 LFL.m	1 LFL.m	ATEX/BASEEFA
S-1012-4	1LFL.m CH_4 CSA Short Range	1 LFL.m	1 LFL.m	CSA/UL
S-1012-5	1LFL.m CH_4 EAC TR-CU Short Range	1 LFL.m	1 LFL.m	EAC TR-CU
S-1012-7	1LFL.m CH_4 InMetro Short Range	1 LFL.m	1 LFL.m	InMetro
S-1015-1	5LFL.m CH_4 FM Short Range	5 LFL.m	1 LFL.m	FM
S-1015-3	5LFL.m CH_4 ATEX Short Range	5 LFL.m	1 LFL.m	ATEX/BASEEFA
S-1015-4	5LFL.m CH_4 CSA Short Range	5 LFL.m	1 LFL.m	CSA/UL
S-1015-5	5LFL.m CH_4 EAC TR-CU Short Range	5 LFL.m	1 LFL.m	EAC TR-CU
S-1015-7	5LFL.m CH_4 InMetro Short Range	5 LFL.m	1 LFL.m	InMetro
S-1017-3	5LFL.m / 5000ppm.m CH_4 ATEX Short Range	5 LFL.m	5000 ppm.m	ATEX/BASEEFA
S-1050-3	25ppm.m HF ATEX Short Range	25 ppm.m	100 ppm.m	ATEX/BASEEFA
S-1050-4	25ppm.m HF CSA Short Range	25 ppm.m	100 ppm.m	CSA/UL
S-1050-5	25ppm.m HF EAC TR-CU Short Range	25 ppm.m	100 ppm.m	EAC TR-CU
S-1050-7	25ppm.m HF InMetro Short Range	25 ppm.m	100 ppm.m	InMetro
S-1051-3	50ppm.m HF ATEX Short Range	50 ppm.m	100 ppm.m	ATEX/BASEEFA
S-1051-4	50ppm.m HF CSA Short Range	50 ppm.m	100 ppm.m	CSA/UL
S-1051-5	50ppm.m HF EAC TR-CU Short Range	50 ppm.m	100 ppm.m	EAC TR-CU
S-1051-7	50ppm.m HF InMetro Short Range	50 ppm.m	100 ppm.m	InMetro
S-1052-3	200ppm.m HF ATEX Short Range	200 ppm.m	100 ppm.m	ATEX/BASEEFA
S-1052-4	200ppm.m HF CSA Short Range	200 ppm.m	100 ppm.m	CSA/UL
S-1052-5	200ppm.m HF EAC TR-CU Short Range	200 ppm.m	100 ppm.m	EAC TR-CU
S-1052-7	200ppm.m HF InMetro Short Range	200 ppm.m	100 ppm.m	InMetro
S-1054-3	1000ppm.m HF ATEX Short Range	1000 ppm.m	500 ppm.m	ATEX/BASEEFA

Part No.	Description	4-20mA Full Scale Range		Certification
		1	2	
S-1054-4	1000ppm.m HF CSA Short Range	1000 ppm.m	500 ppm.m	CSA/UL
S-1060-3	50ppm.m HCl ATEX Short Range	50 ppm.m	100 ppm.m	ATEX/BASEEFA
S-1060-4	50ppm.m HCl CSA Short Range	50 ppm.m	100 ppm.m	CSA/UL
S-1060-5	50ppm.m HCl EAC TR-CU Short Range	50 ppm.m	100 ppm.m	EAC TR-CU
S-1060-7	50ppm.m HCl InMetro Short Range	50 ppm.m	100 ppm.m	InMetro
S-1070-3	300000ppm.m CO_2 ATEX Short Range	300000 ppm.m	100000 ppm.m	ATEX/BASEEFA
S-1070-4	300000ppm.m CO_2 CSA Short Range	300000 ppm.m	100000 ppm.m	CSA/UL
S-1070-5	300000ppm.m CO_2 EAC TR-CU Short Range	300000 ppm.m	100000 ppm.m	EAC TR-CU
S-1070-7	300000ppm.m CO_2 InMetro Short Range	300000 ppm.m	100000 ppm.m	InMetro
S-1080-3	1000ppm.m / 500ppm.m NH_3 ATEX Short Range	1000 ppm.m	500 ppm.m	ATEX/BASEEFA
S-1080-4	1000ppm.m / 500ppm.m NH_3 CSA Short Range	1000 ppm.m	500 ppm.m	CSA/UL
S-1080-5	1000ppm.m / 500ppm.m NH_3 EAC TR-CU Short Range	1000 ppm.m	500 ppm.m	EAC TR-CU
S-1080-7	1000ppm.m / 500ppm.m NH_3 InMetro Short Range	1000 ppm.m	500 ppm.m	InMetro
S-1081-3	1000ppm.m / 5000ppm.m NH_3 ATEX Short Range	1000 ppm.m	5000 ppm.m	ATEX/BASEEFA
S-1082-3	5000ppm.m / 1000ppm.m NH_3 ATEX Short Range	5000 ppm.m	1000 ppm.m	ATEX/BASEEFA
S-1082-4	5000ppm.m / 1000ppm.m NH_3 CSA Short Range	5000 ppm.m	1000 ppm.m	CSA/UL
S-1084-3	200ppm.m / 100ppm.m NH_3 ATEX Short Range	200 ppm.m	500 ppm.m	ATEX/BASEEFA
S-1087-3	15000ppm.m / 5000ppm.m NH_3 ATEX Short Range	15000 ppm.m	5000 ppm.m	ATEX/BASEEFA
S-1087-4	15000ppm.m / 5000ppm.m NH_3 CSA Short Range	15000 ppm.m	5000 ppm.m	CSA/UL
S-1091-3	10000ppm.m Ethylene ATEX Short Range	10000 ppm.m	10000 ppm.m	ATEX/BASEEFA
S-1091-4	10000ppm.m Ethylene CSA Short Range	10000 ppm.m	10000 ppm.m	CSA/UL
S-1091-5	10000ppm.m Ethylene EAC TR-CU Short Range	10000 ppm.m	10000 ppm.m	EAC TR-CU
S-1091-7	10000ppm.m Ethylene InMetro Short Range	10000 ppm.m	10000 ppm.m	InMetro
S-1092-3	1LFL.m Ethylene ATEX Short Range	1 LFL.m	1 LFL.m	ATEX/BASEEFA
S-1092-4	1LFL.m Ethylene CSA Short Range	1 LFL.m	1 LFL.m	CSA/UL
S-1092-5	1LFL.m Ethylene EAC TR-CU Short Range	1 LFL.m	1 LFL.m	EAC TR-CU
S-1092-7	1LFL.m Ethylene InMetro Short Range	1 LFL.m	1 LFL.m	InMetro
S-2013-1	1LFL.m CH4 250ppm.m H_2S FM USA/Canada Short Range	1 LFL.m	250 ppm.m	FM Perf. USA/Canada
S-2013-3	1LFL.m CH4 250ppm.m H_2S ATEX Short Range	1 LFL.m	250 ppm.m	ATEX/BASEEFA
S-2013-4	1LFL.m CH4 250ppm.m H_2S CSA Short Range	1 LFL.m	250 ppm.m	CSA/UL
S-2013-5	1LFL.m CH4 250ppm.m H_2S EAC TR-CU Short Range	1 LFL.m	250 ppm.m	EAC TR-CU
S-2013-7	1LFL.m CH4 250ppm.m H_2S InMetro Short Range	1 LFL.m	250 ppm.m	InMetro
S-2023-1	1LFL.m CH4 1000ppm.m H_2S FM USA/Canada Short Range	1 LFL.m	1000 ppm.m	FM Perf. USA/Canada
S-2033-1	1LFL.m CH4 500ppm.m H_2S FM USA/Canada Short Range	1 LFL.m	500 ppm.m	FM Perf. USA/Canada
S-2033-3	1LFL.m CH4 500ppm.m H_2S ATEX Short Range	1 LFL.m	500 ppm.m	ATEX/BASEEFA
S-2033-4	1LFL.m CH4 500ppm.m H_2S CSA Short Range	1 LFL.m	500 ppm.m	CSA/UL
S-2033-5	1LFL.m CH4 500ppm.m H_2S EAC TR-CU Short Range	1 LFL.m	500 ppm.m	EAC TR-CU
S-2033-7	1LFL.m CH4 500ppm.m H_2S InMetro Short Range	1 LFL.m	500 ppm.m	InMetro
S-2043-3	1LFL.m CH4 15000ppm.m H_2S ATEX Short Range	1 LFL.m	15000 ppm.m	ATEX/BASEEFA
S-2043-4	1LFL.m CH4 15000ppm.m H_2S CSA Short Range	1 LFL.m	15000 ppm.m	CSA/UL
S-2043-5	1LFL.m CH4 15000ppm.m H_2S EAC TR-CU Short Range	1 LFL.m	15000 ppm.m	EAC TR-CU
S-2043-7	1LFL.m CH4 15000ppm.m H_2S InMetro Short Range	1 LFL.m	15000 ppm.m	InMetro
S-2052-3	250ppm.m H_2S ATEX Short Range	250 ppm.m	500 ppm.m	ATEX/BASEEFA
S-2052-4	250ppm.m H_2S CSA Short Range	250 ppm.m	500 ppm.m	CSA/UL

Part No.	Description	4-20mA Full Scale Range		Certification
		1	2	
S-2052-5	250ppm.m H_2S EAC TR-CU Short Range	250 ppm.m	500 ppm.m	EAC TR-CU
S-2052-7	250ppm.m H_2S InMetro Short Range	250 ppm.m	500 ppm.m	InMetro
S-2053-3	1000ppm.m H_2S ATEX Short Range	1000 ppm.m	5000 ppm.m	ATEX/BASEEFA
S-2053-4	1000ppm.m H_2S CSA Short Range	1000 ppm.m	5000 ppm.m	CSA/UL
S-2053-5	1000ppm.m H_2S EAC TR-CU Short Range	1000 ppm.m	5000 ppm.m	EAC TR-CU
S-2053-7	1000ppm.m H_2S InMetro Short Range	1000 ppm.m	5000 ppm.m	InMetro
S-2054-3	15000ppm.m H_2S ATEX Short Range	15000 ppm.m	500 ppm.m	ATEX/BASEEFA
S-2054-4	15000ppm.m H_2S CSA Short Range	15000 ppm.m	500 ppm.m	CSA/UL
S-2054-5	15000ppm.m H_2S EAC TR-CU Short Range	15000 ppm.m	500 ppm.m	EAC TR-CU
S-2054-7	15000ppm.m H_2S InMetro Short Range	15000 ppm.m	500 ppm.m	InMetro
S-2055-3	1500ppm.m H_2S ATEX Short Range	1500 ppm.m	5000 ppm.m	ATEX/BASEEFA
S-2056-3	250ppm.m H_2S ATEX Short Range (Dual 250ppm.m outputs)	250 ppm.m	250 ppm.m	ATEX/BASEEFA
S-2057-3	500ppm.m H_2S ATEX Short Range	500 ppm.m	1000 ppm.m	ATEX/BASEEFA
S-2057-4	500ppm.m H_2S CSA Short Range	500 ppm.m	1000 ppm.m	CSA/UL
S-2057-5	500ppm.m H_2S EAC TR-CU Short Range	500 ppm.m	1000 ppm.m	EAC TR-CU
S-2057-7	500ppm.m H_2S InMetro Short Range	500 ppm.m	1000 ppm.m	InMetro
S-2058-3	5000ppm.m H_2S ATEX Short Range	5000 ppm.m	10000 ppm.m	ATEX/BASEEFA
S-2058-4	5000ppm.m H_2S CSA Short Range	5000 ppm.m	10000 ppm.m	CSA/UL
VZ-1020-3	10% LFL CH_4 VZ ATEX	0.1 LFL	0.1 LFL	ATEX/BASEEFA
VZ-1020-4	10% LFL CH_4 VZ CSA	0.1 LFL	0.1 LFL	CSA/UL
VZ-1020-5	10% LFL CH_4 VZ EAC TR-CU	0.1 LFL	0.1 LFL	EAC TR-CU
VZ-1020-7	10% LFL CH_4 VZ InMetro	0.1 LFL	0.1 LFL	InMetro
VZ-1021-3	25% LFL CH_4 VZ ATEX	0.25 LFL	0.25 LFL	ATEX/BASEEFA
VZ-1021-4	25% LFL CH_4 VZ CSA	0.25 LFL	0.25 LFL	CSA/UL
VZ-1021-5	25% LFL CH_4 VZ EAC TR-CU	0.25 LFL	0.25 LFL	EAC TR-CU
VZ-1021-7	25% LFL CH_4 VZ InMetro	0.25 LFL	0.25 LFL	InMetro
VZ-1022-3	100% LFL CH_4 VZ ATEX	1.0 LFL	1.0 LFL	ATEX/BASEEFA
VZ-1022-4	100% LFL CH_4 VZ CSA	1.0 LFL	1.0 LFL	CSA/UL
VZ-1022-5	100% LFL CH_4 VZ EAC TR-CU	1.0 LFL	1.0 LFL	EAC TR-CU
VZ-1022-7	100% LFL CH_4 VZ InMetro	1.0 LFL	1.0 LFL	InMetro
XC-1021-3	25% LFL CH_4 XD Coal ATEX	0.25 LFL	0.25 LFL	ATEX/BASEEFA
XC-1021-4	25% LFL CH_4 XD Coal CSA	0.25 LFL	0.25 LFL	CSA/UL
XC-1021-5	25% LFL CH_4 XD Coal EAC TR-CU	0.25 LFL	0.25 LFL	EAC TR-CU
XC-1021-7	25% LFL CH_4 XD Coal InMetro	0.25 LFL	0.25 LFL	InMetro
XC-1022-3	100% LFL CH_4 XD Coal ATEX	1.0 LFL	1.0 LFL	ATEX/BASEEFA
XC-1022-4	100% LFL CH_4 XD Coal CSA	1.0 LFL	1.0 LFL	CSA/UL
XC-1022-5	100% LFL CH_4 XD Coal EAC TR-CU	1.0 LFL	1.0 LFL	EAC TR-CU
XC-1022-7	100% LFL CH_4 XD Coal InMetro	1.0 LFL	1.0 LFL	InMetro
XD-1020-3	10% LFL CH_4 XD ATEX	0.1 LFL	0.1 LFL	ATEX/BASEEFA
XD-1020-4	10% LFL CH_4 XD CSA	0.1 LFL	0.1 LFL	CSA/UL
XD-1020-5	10% LFL CH_4 XD EAC TR-CU	0.1 LFL	0.1 LFL	EAC TR-CU
XD-1020-7	10% LFL CH_4 XD InMetro	0.1 LFL	0.1 LFL	InMetro
XD-1021-3	25% LFL CH_4 XD ATEX	0.25 LFL	0.25 LFL	ATEX/BASEEFA
XD-1021-4	25% LFL CH_4 XD CSA	0.25 LFL	0.25 LFL	CSA/UL
XD-1021-5	25% LFL CH_4 XD Coal EAC TR-CU	0.25 LFL	0.25 LFL	EAC TR-CU

Part No.	Description	4-20mA Full Scale Range		Certification
		1	2	
XD-1021-7	25% LFL CH_4 XD Coal InMetro	0.25 LFL	0.25 LFL	InMetro
XD-1022-3	100% LFL CH_4 XD ATEX	1.0 LFL	1.0 LFL	ATEX/BASEEFA
XD-1022-4	100% LFL CH_4 XD CSA	1.0 LFL	1.0 LFL	CSA/UL
XD-1022-5	100% LFL CH_4 XD EAC TR-CU	1.0 LFL	1.0 LFL	EAC TR-CU
XD-1022-7	100% LFL CH_4 XD InMetro	1.0 LFL	1.0 LFL	InMetro

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