LKD

Detection and indication of refrigerant leaks

11/2016

USER MANUAL

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The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Eliwell nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein.
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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Eliwell software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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SAFETY INFORMATION

Important Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to inform of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards.
Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result** in death or serious injury**.**

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, **could result** in death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result** in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel.
No responsibility is assumed by Eliwell for any consequences arising out of the use of this material.
A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

Permitted use

Note: This product cannot be used in place of a SAFETY device.
It must be used only to signal an alarm.

Sensors monitor a point as opposed to an area. If the gas leak does not reach the sensor then no alarm will be raised. Therefore, it is extremely important to carefully select the sensor location.
Also consider ease of access for maintenance.

- Install the sensor inside the room at a proper height depending on the refrigerant. Being gases heavier than air, it is normally recommended to position **LKD** sensor lower than the average height of people inside the room.
- With heavier than air gases such as halocarbon and hydrocarbon refrigerants such as R404A, propane, and butane sensors should be located near ground level. With lighter than air gas e.g. ammonia, the sensor needs to be located above the equipment to be monitored on a bracket or high on a wall within 300 mm of. With similar density or miscible gases, such as CO2, sensors should be mounted about head high – say 1.5m.
- install sensor away from draughts and heat sources.

Prohibited use

Any use other than that expressed above under Permitted use is strictly prohibited.

The relay contacts supplied are of an electromechanical type and subject to wear. Functional safety protection devices, specified in international or local standards, must be installed externally to this device.
Do not mount **LKD** sensors:

- under reflective surfaces (e.g.: mirrors);
- inside electrical boards;
- in or near bathrooms.

Liability and residual risks

Eliwell Controls srl, as a distributor of MURCO Ltd products, declines all liability for damage due to:

- installation/use other than expressly specified and, in particular, in conflict with the safety prescriptions set down in regulations and/or specified in this document
- tampering with and/or modification of the product
- installation/use on panels that do not comply with statutory laws and regulations

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Disposal

The appliance (or the product) must be disposed of separately in compliance with the local standards in force on waste disposal.

ABOUT THE BOOK

Document Scope

This document describes the Gas detector and accessories including installation and wiring information.

Validity Note

The technical characteristics of the devices described in this manual also appear online.
The characteristics that are presented in this manual should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the manual and online information, use the online information as your reference.

Related Documents

Title of Documentation	Reference Document Code
Instruction Sheet LKD Leak Detector	9IS64478

You can download these technical publications and other technical information from our website at:
www.eliwell.com

Product Related Information

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices, prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires.
- Always use a properly rated voltage sensing device to confirm the power is removed.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

Failure to follow these instructions will result in death or serious injury.

This equipment has been designed to operate outside of any hazardous location.

Only install this equipment in zones known to be free of hazardous atmosphere.

⚠ DANGER

POTENTIAL FOR EXPLOSION

Install and use this equipment in non-hazardous locations only.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION DUE TO ELECTROSTATIC DISCHARGE DAMAGE

- Keep equipment in the protective conductive packaging until you are ready to install the equipment.
- Only install equipment in approved enclosures and / or locations that prevent casual access and provide electrostatic discharge protection as defined by IEC 1000-4-2.
- Use a conductive wrist strap or equivalent field force protective device attached to an earth ground when handling sensitive equipment.
- Always discharge yourself by touching a grounded surface or approved antistatic mat before handling the equipment.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use appropriate safety interlocks where personnel and/or equipment hazards exist.
- Install and operate this equipment in an enclosure, or other locations that are appropriate for its rated environment.
- Power line and output circuits must be wired and fused in compliance with local and national regulatory requirements for the rated current and voltage of the particular equipment.
- Do not use this equipment in safety-critical machine functions.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

CHAPTER 1
Introduction

1.1. General Description

The state-of-the-art **LKD** gas sensors can detect the leak of a wide range of gases:

- » R134a, R404A,
- » R507A, NH3,
- » R290, R600a,
- » CO_2, R410A,
- » R22, R407A,
- » R407F, R448A,
- » R450, R449A,
- » R513A.

Two models available:

- with Semiconductor (**SC**): for refrigerant gases
- with Infrared technology (**IR**): for CO_2

One of the most important features is that they can be used:

- stand-alone, thanks to a relay-activated digital output that can control a buzzer, siren, etc.
- the modbus version can be built into an Eliwell or third-party remote management system (eg. Televis**Go**), thanks to an integrated modbus RS485 (n.b. only model that has it is the **CN4** connector).

The main applications are as follows:

- Compressor racks
- LT or MT cold rooms
- Refrigerated cabinets

Detection of an excessive concentration of gas (above the factory-set limit) results in the transmission of an alarm signal to the supervisor (if connected to the network) and the activation of an on-site acoustic and visual signal. **LKD** gas detector ensures a prompt detection of gas leaks thus reducing the risk of machine downtime.

1.2. Technical data

The main technical features of LKD series are:

Model (➔):	**SEMICONDUCTOR** NH3, HFO, HC e HFC	**INFRARED** CO_2
IP rating:	**LKD 100:** IP41 (applications MT)	
	LKD 100 5 m: IP41 (IP66 Sensor)	
	LKD 200: IP66 (applications LT)	
Dimensions	• **LKD 100 and LKD 100 5 m:** 86x142x53 mm (3.38x5.59x2.09 in.) • **LKD 200:** 175x165x82 mm (6.89x6.50x3.23 in.)	
Power supply:	12/24 Vac/dc ±20 % 50/60 Hz	
Power Consumption (at 12 V):	153 mA	136 mA
Analogue outputs:	0-5 V, 1-5 V, 0-10 V, 2-10 V, 4-20 mA	
Digital outputs:	1 relay at 1 A 24 Vac/dc	
Buzzer:	YES	
Selectable alarm delay:	0, 1, 5, 10 min	
Connections:	1 RS485 for connection to supervisor Modbus (depending on model)	
Typical operating range:	**See " Typical operating range" table**	

Model (➔):	SEMICONDUCTOR NH3, HFO, HC e HFC	INFRARED CO_2
Temperature range:	• **LKD 100 and LKD 100 5 m:** -20 ... +50 ºC (-4 ... 122 °F) • **LKD 200:** -40 ... +50 ºC (-40 ... 122 °F)	
Humidity range:	0 ... 95 % (non condensing)	
Acoustic alarm:	enabled/disabled	
Power supply display:	Green LED	
Alarm display:	Red LED	
Fault status:	1 V, 2 mA	
Fault indication**:**	Red LED ON - Green LED OFF	
Sensor service life:	5-8 years	8-10 years
T50 alarm threshold:	76 s	25 s
T90 alarm threshold:	215 s	90 s
Reset time:	600 s	210 s

1.3. Typical operating range

REFRIGERANT	RANGE 0…100%	LIMIT OF SENSOR LINEARITY	DEFAULT ALARM THRESHOLD
CO_2	0...10.000 ppm	100%	5.000 ppm
NH3	0...1.000 and 0...10.000 ppm	100%	500 ppm and 5.000 ppm
R134a	0...1.000 ppm	100%	500 ppm
R404a	0...1.000 ppm	100%	500 ppm
R507a	0...1.000 ppm	100%	500 ppm
R290	0…2.000 ppm	100%	1.000 ppm
R600	0…2.000 ppm	100%	1.000 ppm
R410A	0...1.000 ppm	100%	500 ppm
R22	0...1.000 ppm	100%	500 ppm
R407A	0...1.000 ppm	100%	500 ppm
R407F	0...1.000 ppm	100%	500 ppm
R448A	0...1.000 ppm	100%	500 ppm
R450	0...1.000 ppm	50%	500 ppm
R449A	0...1.000 ppm	50%	500 ppm
R513A	0...1.000 ppm	50%	500 ppm

NOTE: Models marked “without AO” does not provide a linearized analogue output.

1.5. Test/function instruction

The **LKD** is calibrated in the factory and does not require to be calibrated on installation.
After installation the units should be bump tested.

Expose the sensors to test gas:

- using an Eliwell ampoule (NH3, CO_2, etc.)
- using a test cylinder (appropriate to the installation)
- open the valve of a cigarette lighter (only for Semiconductor units) without igniting it and hold it over the vent holes on the upper right side of the **LKD**. The gas is heavier than air and should fall into the **LKD**.

This will put the system into alarm:

- The red LED will light showing the system is in alarm.
- The delay will prevent the siren sounding or relay switching for the preset delay, if delay is set.

With a bump test you can see the functions of the sensor:

- the red LED will light
- the relay and sounder will function
- the output selected (for example 0-10 V) will show the gas level.

To test the siren and or relay function, check the delay is set at zero using the header as shown on the installation diagram and expose to gas as above. You can mute the siren by removing the jumper **J3**. After the gas has

Before testing the sensors on site the **LKD** must have been powered up and allowed to stabilize.

1.6. Annual Test

According to the manufacturer, and as indicated by the F-Gas regulation it suggests a test frequency of at least annually sensor.

In case of application of particularly heavy usage environment you may require more frequent inspections.

However local regulations may specify the nature and frequency of this test.
NOTE:

- After exposure to a substantial gas leak, sensor should be checked and replaced if necessary..
- Sensor calibration is recommended every three years.
- In order to ensure a correct functioning of the unit, a replacement of the gas sensor is recommended every 6 years.

CHAPTER 2
Mechanical installation

2.1. Before Starting

Read and understand this chapter before beginning the installation of your system. The use and application of the information contained herein require expertise in the design of automated control systems. Only you, the user, machine builder or installer, can be aware of all the conditions and factors present during installation and setup, operation, and maintenance of the machine or process, and can therefore determine the automation and associated equipment and the related safeties and interlocks which can be effectively and properly used. When selecting automation and control equipment, and any other related equipment or software, for a particular application, you must also consider any applicable local, regional or national standards and/or regulations. Pay particular attention in conforming to any safety information, different electrical requirements, and normative standards that would apply to your machine or process in the use of this equipment.

⚠ WARNING

REGULATORY INCOMPATIBILITY

Be sure that all equipment applied and systems designed comply with all applicable local, regional and national regulations and standards.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

2.2. Disconnecting Power

All options and modules should be assembled and installed before installing the control system on a mounting rail, into a panel door or onto a mounting surface. Remove the control system from its mounting rail, mounting plate or panel before disassembling the equipment.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires.
- Always use a properly rated voltage sensing device to confirm the power is removed.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

Failure to follow these instructions will result in death or serious injury.

2.3. Operating Environment

This equipment has been designed to operate outside of any hazardous location. Only install this equipment in zones known to be free of a hazardous atmosphere.

⚠ DANGER

POTENTIAL FOR EXPLOSION

Install and use this equipment in non-hazardous locations only.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Install and operate this equipment according to the conditions described in the Environmental and electrical characteristics.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

2.4. Installation Considerations

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use appropriate safety interlocks where personnel and/or equipment hazards exist.
- Install and operate this equipment in an enclosure appropriately rated for its intended environment.
- Power line and output circuits must be wired and fused in compliance with local and national regulatory requirements for the rated current and voltage of the particular equipment.
- Do not use this equipment in safety-critical machine functions.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The **LKD** devices are intended for wall mounting.
Care must be taken to avoid damage from electrostatic sources when handling this equipment. In particular exposed connectors and, in some cases, exposed printed circuit boards are vulnerable to electrostatic discharge.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION DUE TO ELECTROSTATIC DISCHARGE DAMAGE

- Keep equipment in the protective conductive packaging until you are ready to install the equipment.
- Only install equipment in approved enclosures and / or locations that prevent unauthorized access and provide electrostatic discharge protection as defined by IEC 1000-4-2.
- Use a conductive wrist strap or equivalent field force protective device attached to an earth ground when handling sensitive equipment.
- Always discharge yourself by touching a grounded surface or approved antistatic mat before handling the equipment.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The mechanical mounting varies depending on the version which is being installed (LKD 100 or LKD 200).
There are no different mounting instructions for semi-conductor and IR models except for their positioning inside the room to be monitored, which depends on the specific behavior of the monitored gas.

2.5. Mounting of LKD 100 model

The following pictures show dimensions and mounting diagram for LKD 100 model.

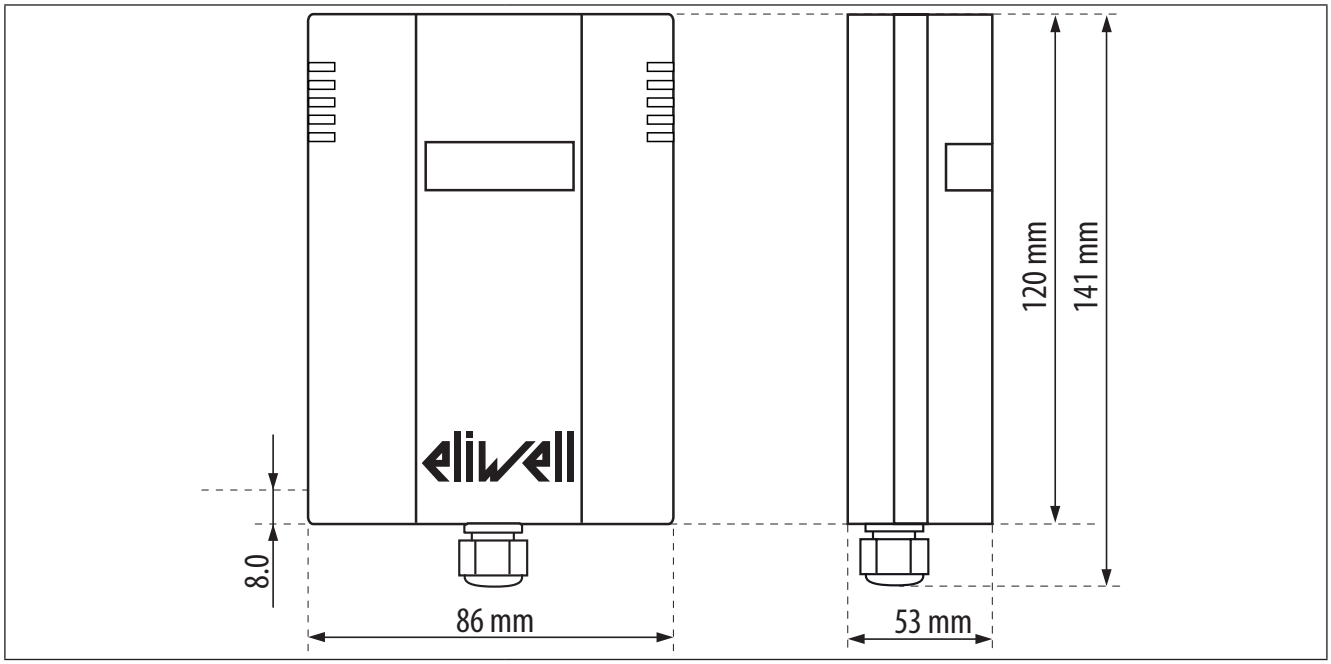


Fig. 1. LKD 100 dimensions

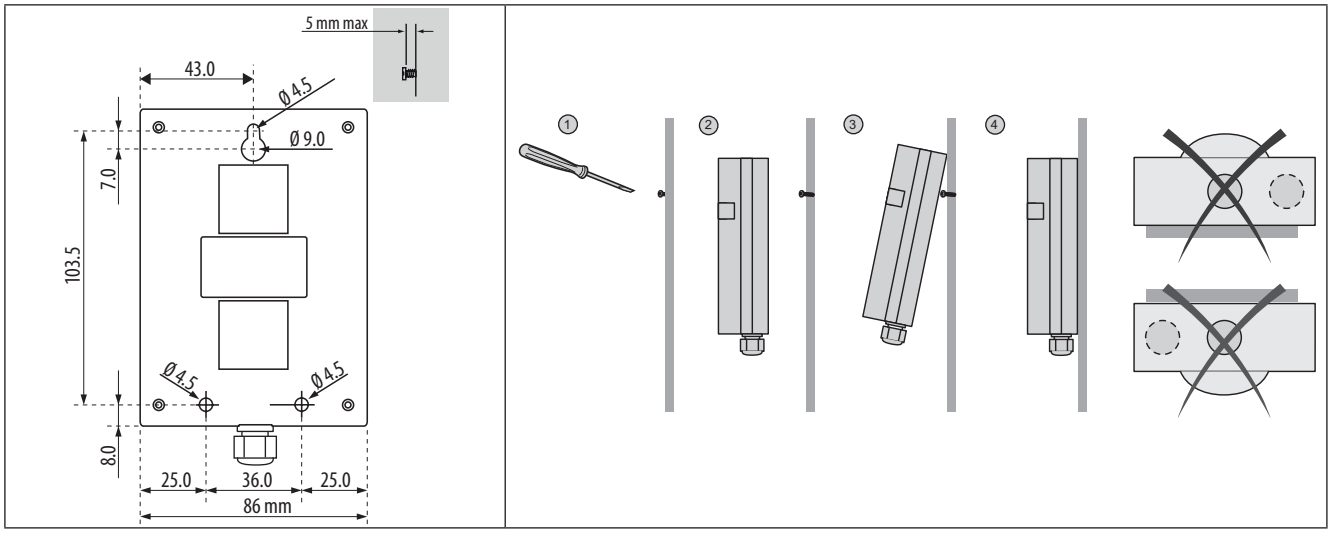


Fig. 2. LKD 100 mounting

2.6. Mounting of LKD 100 5 m model

The following pictures show dimensions and mounting diagram for LKD 100 5 m model.

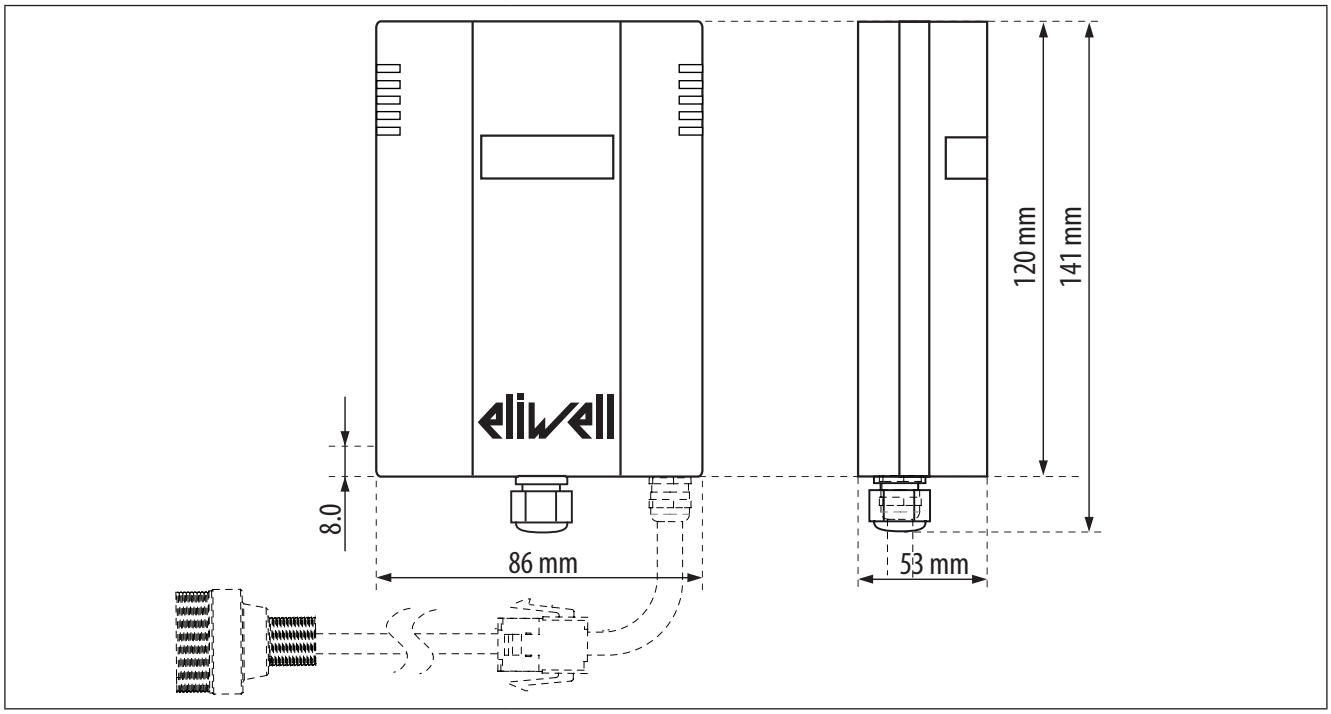


Fig. 3. LKD 100 5 m dimensions

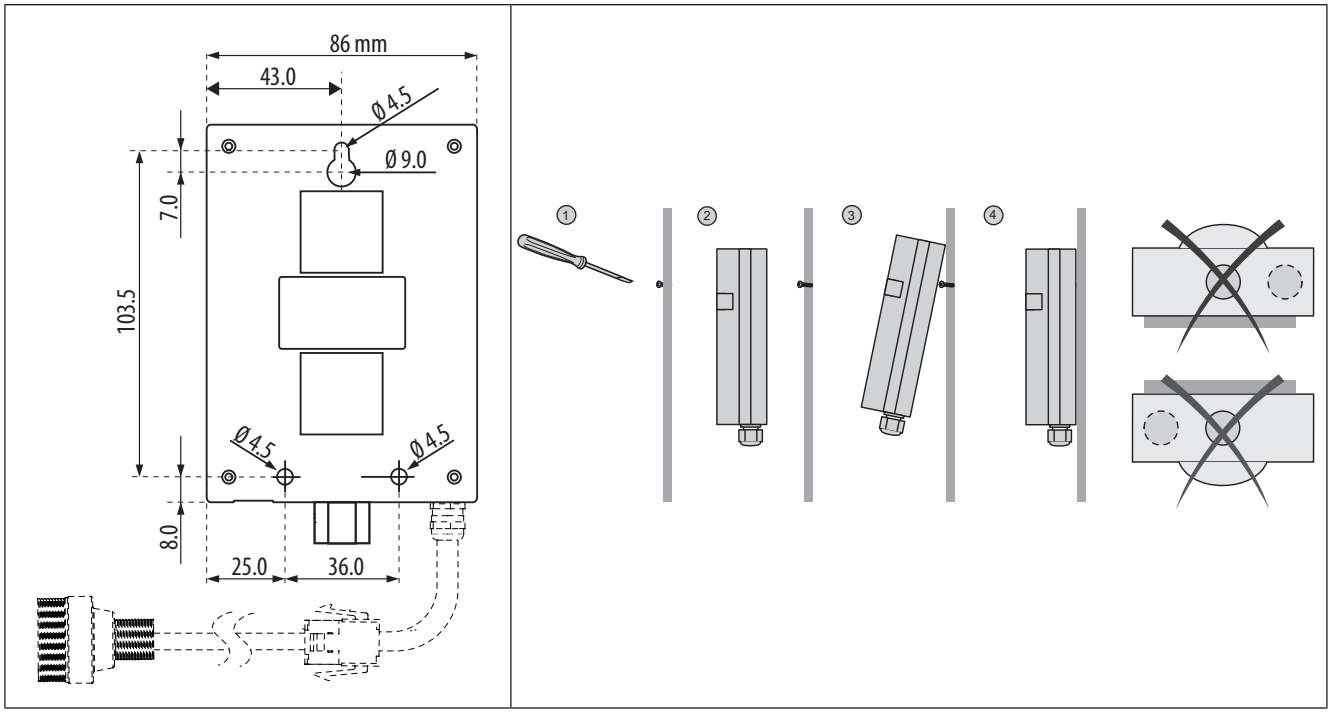


Fig. 4. LKD 100 5 m mounting

2.7. Mounting of LKD 200 model

The following pictures show dimensions and mounting diagram for LKD 200 model.

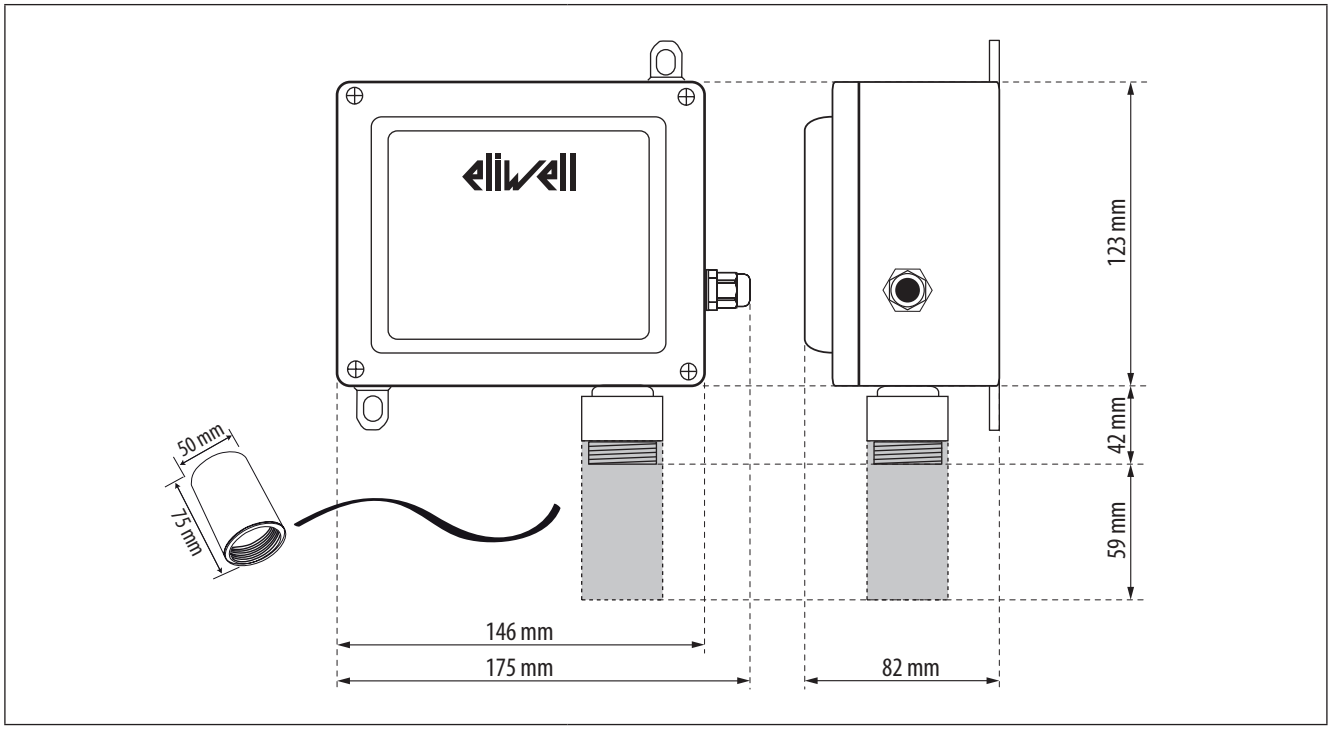


Fig. 5. LKD 200 dimensions

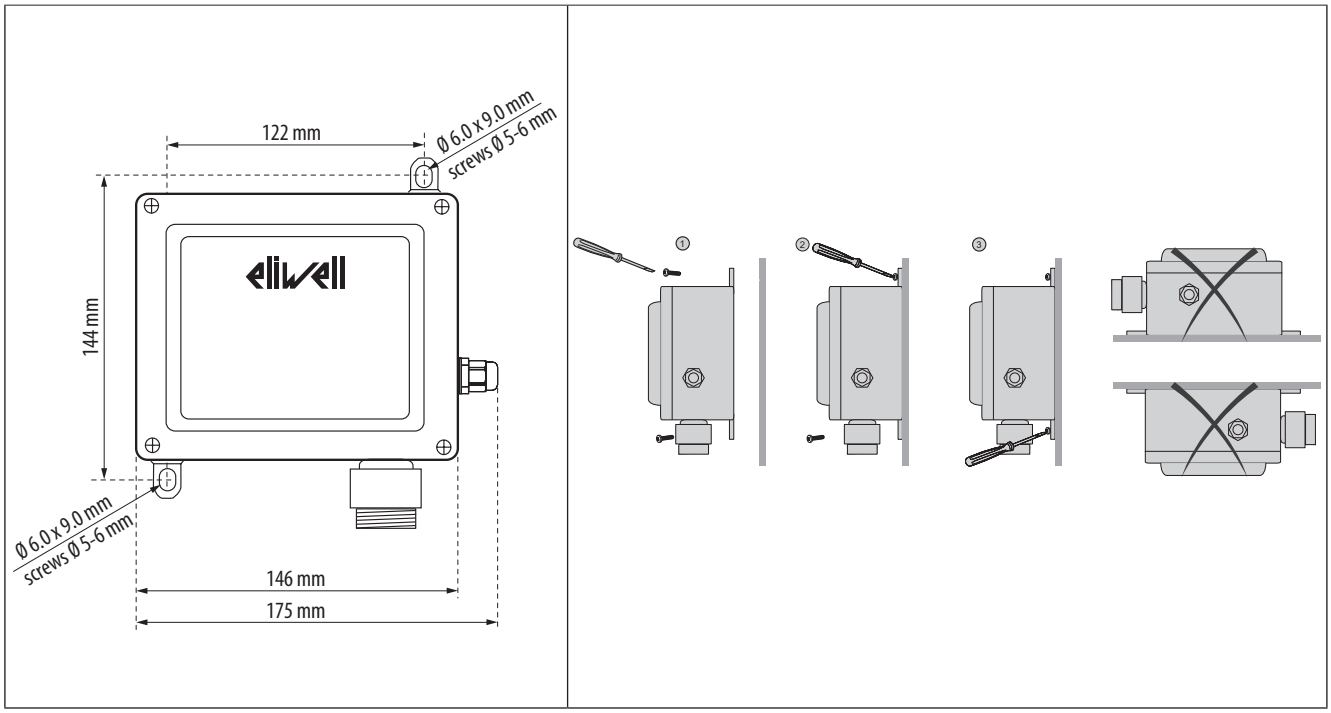


Fig. 6. LKD 200 mounting

CHAPTER 3

Installation and Maintenance

3.1. Installation instructions

The following steps must be followed:

1. **To open the Sensor enclosure**: the procedure varies depending on the model:
   - **LKD 100 and LKD 100 5 m**: press the fixing device on the top of the box to open it. To close it, follow the contrary steps; don't forget to insert the cable clamp in the proper slot on the bottom of the instrument.
   - **LKD 200:** unscrew the 4 allen screws on the top surface of the instrument. To close it, follow the contrary steps.
2. **Power supply**: 12-24 Vac/dc, connect power supply cable at positions **0V** and **+V** at connector block **CN1**.

   NOTES: - For AC voltage (ac), set jumpers J1 = ON and J2 = OFF (See wiring diagram).
   - For DC voltage (dc), set jumpers J1 = OFF and J2 = ON (See wiring diagram).

   Default factory setting is direct voltage (dc).
   Use 2 cores of a 4-core cable, low voltage alarm type (typically 7/0,2 mm^2)
3. **Output**: depending on the type of unit used (Standard or Modbus), it is possible to set the analog output as Voltage Output (V) or Current Output (mA) by means of the jumpers.
   - Standard Model: set jumpers **Jx** and **Jy** (See wiring diagram).
   - Modbus Model: set jumpers **J7**, **J8**, **J9** and **J10** (See wiring diagram).

   Default factory setting is mA (on Standard model) and always active (on Modbus model).
   Connect the other two cores of the 4-core cable used for the power supply to terminal block **CN2** in the following positions:
   - Current output 4...20mA: Connect the cores of the cable to terminals **3** (**0 V**) and **5** (**I**) of **CN2**.
   - Voltage outputs 0...5 V, 0...10 V, 1...5 V and 2...10 V: Connect the cores of the cable to terminals **3** (**0 V**) and **4** (**V**) of **CN2**.

   NOTE: You can common the two zeros and use 3 core cable if preferred.
4. **Relay setpoint**: The potentiometer **P1** sets the trip point for the relay and sounder using the 0-5V scale.

   The measurement can be effected between Test Point **TP3** (**0 V**) and **TP1** (**VREF** on Standard model and **Alarm** on Modbus model). A reading of **2,5 V** corresponds to half the range (500 ppm on a scale from 0 to 1000 ppm).
   Default factory setting is 50 % of the range.
5. **Time delay**: A time delay for the operation of the relay and sounder can be selected using jumpers J5 and J6.

   J5 = OFF, **J6** = OFF : 0 minutes (no delay)
   J5 = ON, **J6** = OFF : 1 minute
   J5 = OFF, **J6** = ON : 5 minutes
   J5 = ON, **J6** = ON : 10 minutes

   Default factory setting is **J5** = OFF and **J6** = OFF.
6. **Sounder**: The sounder can be disabled using jumper **J3**.
   Default factory setting is option enabled.

NOTE: There is a 5-minute power up delay to allow the sensor to stabilize. This can be cancelled by momentarily shorting between either of the upper and lower pads of SW1 or SW2.

3.2. Location instruction

3.2.1. Location of sensors

Sensors must be located within the appropriate wire lengths from the central control unit (if used).
In all cases the sensor supplied is designed for maximum sensitivity to a particular gas (e.g.: R134a, NH3, R290, etc.).

However, in certain circumstances, false alarms may be caused by the occasional presence of sufficiently high concentrations of other gaseous impurities.

If such a situation is likely to arise installers should check that sensor (s) of suitable cross sensitivity can be supplied.

Examples of situations where such abnormalities may arise include:

- Plant room maintenance activity involving solvent or paint fumes or refrigerant leaks.
- Plant rooms in fruit ripening/storage facilities because of accidental gas migration (bananas - ethylene, apples - carbon dioxide)
- Heavy localized exhaust fumes (carbon monoxide, dioxide, propane) from engine driven forklifts in confined spaces or close to sensors.

A response delay may be selected to minimise any problems that might arise.

3.2.2. Machinery rooms

There is NO ABSOLUTE RULE in determining the number of sensors and their location.
However a number of simple guidelines will help to make a decision.

Sensors monitor a point as opposed to an area.

NOTE: If the gas leak does not reach the sensor then no alarm will be raised.

Therefore, it is extremely important to carefully select the sensor location.
Also consider ease of access for maintenance.

The size and nature of the site will help to decide which method is the most appropriate to use.
Locations requiring the most protection in a machinery or plant room would be around compressors, pressurized storage vessels, refrigerant cylinders or storage rooms or pipelines.
Most vulnerable are valves, gauges, flanges, joints (brazed or mechanical), filling or draining connections, etc.

When mechanical or natural ventilation is present mount a sensor in the airflow.
In machinery rooms where there is no discernable or strong airflow then options are:

- Point Detection, where sensors are located as near as possible to the most likely sources of leakage, such as the compressor, expansion valves, mechanical joints or cable duct trenches.
- Perimeter Detection, where sensors completely surround the area or equipment.
- With heavier than air gases such as halocarbon and hydrocarbon refrigerants such as R404A, propane, and butane sensors should be located near ground level.
- With lighter than air gas e.g. ammonia, the sensor needs to be located above the equipment to be monitored on a bracket or high on a wall within 300 mm of, or on the ceiling provided there is no possibility of a thermal layer trapped under the ceiling preventing gas reaching the sensor.
  (**NOTE**: At very low temperatures, such as in a refrigerated cold store, ammonia gas becomes heavier than air).
- With similar density or miscible gases, such as CO_2, sensors should be mounted about head high – say 1.5m.
- Sensors should be positioned a little way back from any high-pressure parts to allow gas clouds to form. Otherwise any leakage of gas is likely to pass by in a high-speed jet and not be detected by the sensor.
- Make sure that pits, stairwells and trenches are monitored since they may fill with stagnant pockets of gas.
- If a pressure relief vent pipe is fitted to the system, it may be a requirement to mount a sensor to monitor this vent pipe. It should be positioned about 2 m above the PRV to allow gas clouds to form.
- With racks or chillers pre-fitted with refrigerant sensors, these should be mounted so as to monitor the compressors or if extract ducts are fitted the airflow in the duct may be monitored.

3.2.3. Refrigerated spaces

In refrigerated spaces sensors should be located in the return airflow to the evaporators on a sidewall, below head height is preferred, or on the ceiling, not directly in front of an evaporator.
In large rooms with multiple evaporators, sensors should be mounted on the central line between 2 adjacent evaporators, as turbulence will result in airflows mixing.

3.2.4. Chiller

In the case of small water or air-cooled enclosed chiller units mount the sensor so as to monitor airflow to the extract fans.
With larger models also place a sensor inside the enclosure under or adjacent to the compressors.

In the case of outdoor units:

- such as enclosed air-cooled chillers or the outdoor unit for VRV/VRF systems mount the sensor so as to monitor airflow to the extract fan. With large units also place a sensor inside the enclosure under or adjacent to the compressors.

In the case of non-enclosed outdoor units:

- If there is an enclosed machinery section then locate a sensor there.
- In the case of units with enclosed compressors, mount sensors in the enclosures.
- Where you have protective or acoustic panels mount the sensor low down under the compressors where it is protected by the panels.
- With air-cooled chillers or air-cooled condensers with non-enclosed condenser sections it is difficult to effectively monitor leaks in the coil sections. With some designs it will be possible using an airflow sensor to monitor airflow to the start – up fans in the front or rear sections.
- If there is a possibility of refrigerant leaks into a duct or air-handling unit install a sensor to monitor the airflow.

Weatherproof sensors should be used for unprotected outdoor applications.

3.2.5. Air Conditioning - Direct systems VRF/VRV

It is suggested to install at least one detector in each space occupied taken into account.
Also the location of detectors shall be chosen in relation to the refrigerant.

Sensors shall be located where the refrigerant from the leak will collect. In this case refrigerants are heavier than air and detectors should have their sensors mounted low or other similar Category Class A spaces.
Ceiling or other voids if not sealed are part of the occupied space.

Following a list of things to do and not to do:

DO'S	DON'TS
• mount the in-room sensor at less than the normal heights of the occupants (between 200-500mm off the floor) • away from draughts and heat sources like radiators etc. • avoid sources of steam	Do not mount **LKD** sensors: • under reflective surfaces (e.g.: mirrors) • inside electrical boards • in or near bathrooms.

3.3. Typical settings

An example of typical setting is:

- **Gas**: refrigerant R404A
- **Range**: 0-1000 ppm
- **Alarm setpoint**: 500 ppm

For a particular unit please refer to the gas settings shown on the rating plate.

3.4. Operating instruction

1. **On powering up**: the sensor will sense the presence of gas after an initial warm-up delay of 5 minutes. The green LED will flash at 1 second intervals during the warmup (not for MODBUS model).
2. **In alarm condition**:
   - the green LED stays ON;
   - the red LED will be ON;
   - the buzzer operates (if it has not been disabled using jumper **J3** and after a delay if this option has been selected using jumpers **J5** and **J6** or using modbus command);
   - the relay output activates (after a delay if this option has been selected using jumpers **J5** and **J6** or using modbus command);
   - the voltage or current output changes proportional to gas concentration.
3. **Fault condition**:
   - the green LED will be OFF;
   - the red LED will be ON;
   - a voltage or current fault output will activate:
     - current fault: **2 mA** on the 4-20 mA output;
     - voltage fault: **0,5 V** on the 1-5 V output and **1,0 V** on the 2-10 V output.

3.5. Functions customizations

The functions listed below, need to be agreed with the customer, so that the system will operate as required:

1. **Alarm signal delay**: applicable to the acoustic alarm (buzzer) and to the relay in order to avoid false alarms. The delay is set by using jumpers **J5** and **J6**.

   J5 = OFF, **J6** = OFF : 0 minutes (no delay)
   J5 = ON, **J6** = OFF : 1 minute
   J5 = OFF, **J6** = ON : 5 minutes
   J5 = ON, **J6** = ON : 10 minutes

   The default value is 0 minutes.
2. **Buzzer**: the units have an internal buzzer. It is possible to disable it by removing jumper **J3**. The default setting is "buzzer enabled".
3. **Output**: set the requested analog output (current or voltage)

   Gas detectors can activate external systems such as fans or shut down and activate sirens, warning lights or connect to most BMS, SCADA, or other control systems using one or more outputs.

   - 4...20 mA, 0...5 V, 1...5 V, 0...10 V or 2...10 V.
   - Relay 1 A at 24 Vdc

CHAPTER 4
Connections and configurations

4.1. Wiring Best Practices

The following information describe the wiring guidelines and associated best practices to be respected when using the **LKD**.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires.
- Always use a properly rated voltage sensing device to confirm the power is removed.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

Failure to follow these instructions will result in death or serious injury.

4.1.1. Wiring Guidelines

The following rules must be applied when wiring an **LKD Leak Detector**:

- Make connections as short as possible and do not wind them around electrically connected parts.
- Verify that the operating conditions and environment are within the specification values.
- Use proper wire sizes to meet voltage and current requirements.
- Use copper conductors (required).

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use twisted pair, shielded cables for all, analog I/O and communication signals (1).
- Ground cable shields for all analog I/O and communication signals at a single point (1)(2).
- Route communication and I/O cables separately from power cables.

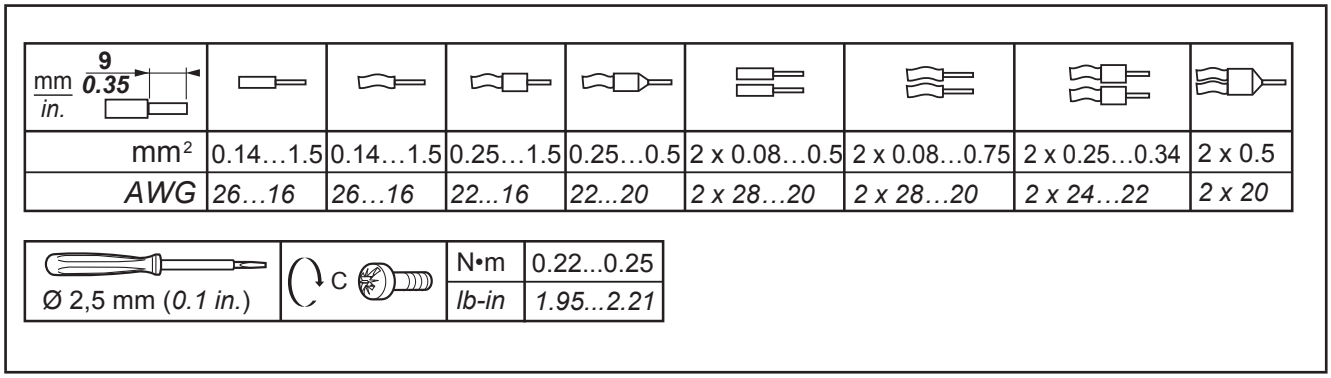
Failure to follow these instructions can result in death, serious injury, or equipment damage.

(1) If you do not use shielded cable for these connections, electromagnetic interference can cause signal degradation. Degraded signals can cause the controller or attached modules and equipment to perform in an unintended manner.

(2) Multipoint grounding is permissible if connections are made to an equipotential ground plane dimensioned to help avoid cable shield damage in the event of power system short-circuit currents.

4.1.2. Rules for Removable Screw Terminals Block

The following table presents the cable types and wire sizes for a **3.50 pitch** removable screw terminals block:

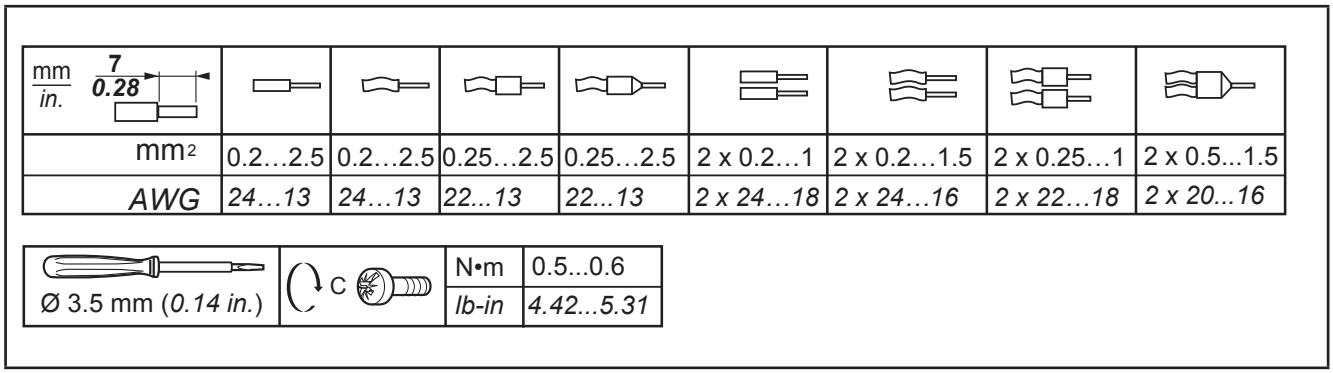


mm / in. 9 / 0.35								
mm²	0.14…1.5	0.14…1.5	0.25…1.5	0.25…0.5	2 x 0.08…0.5	2 x 0.08…0.75	2 x 0.25…0.34	2 x 0.5
AWG	*26…16*	*26…16*	*22...16*	*22...20*	*2 x 28…20*	*2 x 28…20*	*2 x 24…22*	*2 x 20*

Ø 2,5 mm (*0.1 in.*)	C	N•m	0.22...0.25
		lb-in	*1.95...2.21*

Fig. 7. Pitch 3.50 mm (0.14 in.)

The following table presents the cable types and wire sizes for a **5.08** or **5.00 pitch** removable screw terminals block:



mm / in. 7 / 0.28								
mm²	0.2…2.5	0.2…2.5	0.25…2.5	0.25…2.5	2 x 0.2…1	2 x 0.2…1.5	2 x 0.25…1	2 x 0.5...1.5
AWG	*24…13*	*24…13*	*22...13*	*22...13*	*2 x 24…18*	*2 x 24…16*	*2 x 22…18*	*2 x 20...16*

Ø 3.5 mm (*0.14 in.*)	C	N•m	0.5...0.6
		lb-in	*4.42...5.31*

Fig. 8. Pitch 5.08 mm (0.20 in.) or 5.00 mm (0.197 in.)

⚠ ⚠ DANGER

LOOSE WIRING CAUSES ELECTRIC SHOCK

Tighten connections in conformance with the torque specifications.

Failure to follow these instructions will result in death or serious injury.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.

Failure to follow these instructions will result in death or serious injury.

4.1.3. Protecting Outputs from Inductive Load Damage

If your controller or module contains relay outputs, these types of outputs can support up to ~250 V (~240 V if SSR). Inductive damage to these types of outputs can result in welded contacts and loss of control. Each inductive load must include a protection device such as a peak limiter, RC circuit or flyback diode. Capacitive loads are not supported by these relays.

⚠ WARNING

RELAY OUTPUTS WELDED CLOSED

- Always protect relay outputs from inductive alternating current load damage using an appropriate external protective circuit or device.
- Do not connect relay outputs to capacitive loads.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Depending on the load, a protection circuit may be needed for the outputs on the controllers and certain modules. Inductive loads using DC voltages may create voltage reflections resulting in overshoot that will damage or shorten the life of output devices.

⚠ CAUTION

OUTPUT CIRCUIT DAMAGE DUE TO INDUCTIVE LOADS

Use an appropriate external protective circuit or device to reduce the risk of inductive direct current load damage

Failure to follow these instructions can result in injury or equipment damage.

Choose a protection circuit from the following diagrams according to the power supply used. Connect the protection circuit to the outside of the controller or relay output module.

4.2. Standard semiconductor model

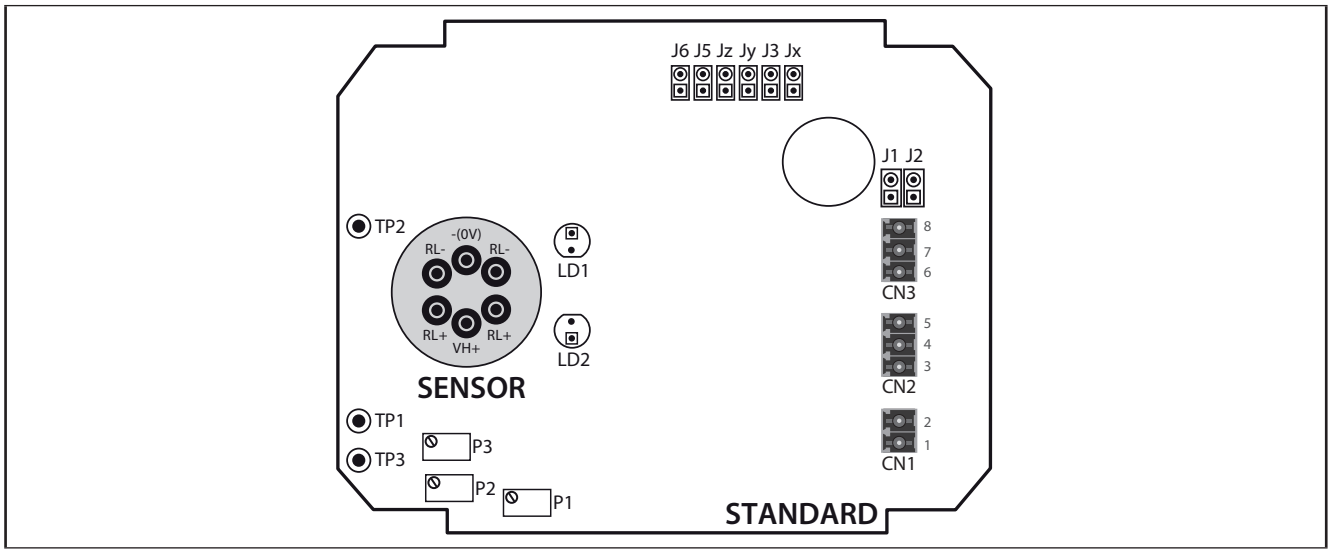


Fig. 9. Standard semiconductor model connection diagram

ELECTRICAL CONNECTIONS and CONFIGURATION		
CN1	**Power Supply** **J1** = ON, **J2** = OFF ➞ **AC** : **1** = AC , **2** = dc (12...24 Vac) **J1** = OFF, **J2** = ON ➞ **DC** : **1** = 0 V , **2** = V+ (12...24 Vdc)	
CN2	**Output signals** **3** = **0 V** (0 Volts, ground) **4** = **V** (The voltage output settings are: **Jx** = OFF, **Jy** = OFF ➞ Voltage output = 0 ... 10 V **Jx** = ON, **Jy** = OFF ➞ Voltage output = 0 ... 5 V **Jx** = OFF, **Jy** = ON ➞ Voltage output = 2 ... 10 V **Jx** = ON, **Jy** = ON ➞ Voltage output = 1 ... 5 V **5** = **I** (Current output = 4 ... 20 mA) **NOTE**: Current output needs to be enabled using Jy (**Jy = ON**)	
CN3	**Relay** **6** = **NO** (Normally Open) **7** = **COM** (Common) **8** = **NC** (Normally Closed)	
P1	**Alarm Potentiometer: P1 (Alarm)**: Adjust alarm setpoint for the sounder and relay.	**Note:** Factory setting. Do not adjust unless for re-calibration.
P2	**ZERO Potentiometer: P2 (ZERO)**: Adjust the zero level voltage for the output signal.	
P3	**SPAN Potentiometer: P3 (SPAN)**: Adjust output signal span.	
J1, J2	**Power Supply Jumper** (ON • OFF) **J1** = ON, **J2** = OFF : Unit is set for AC power supply **J1** = OFF, **J2** = ON : Unit is set for DC power supply	
J3	**Sounder Jumper** (ON • OFF) **ON** = Sounder enabled (Audible alarm if Setpoint reached) **OFF** = Sounder disabled (No audible alarms)	
J5, J6	**Sounder & Relay delay Jumper** (ON • OFF) **J5** = OFF, **J6** = OFF : 0 minutes (no delay) **J5** = ON, **J6** = OFF : 1 minute **J5** = OFF, **J6** = ON : 5 minutes **J5** = ON, **J6** = ON : 10 minutes	
Jx, Jy	**Jumper Jx and Jy (Voltage output range selection)** (ON • OFF) **Jx** = OFF, **Jy** = OFF ➞ Voltage output setting = 0 ... 10 V **Jx** = ON, **Jy** = OFF ➞ Voltage output setting = 0 ... 5 V **Jx** = OFF, **Jy** = ON ➞ Voltage output setting = 2 ... 10 V **Jx** = ON, **Jy** = ON ➞ Voltage output setting = 1 ... 5 V	
Jz	**NOT USED**	
TP1	**Setpoint Voltage Test Point TP1** (**VREF**): Sounder and relay setpoint Voltage.	
TP2	**Vs Sensor Voltage Test Point TP2** (**Vs**): Vs sensor voltage.	
TP3	**0 V Test Point TP3** (**0 V**): Board ground plane connection.	

4.3. Modbus semiconductor model

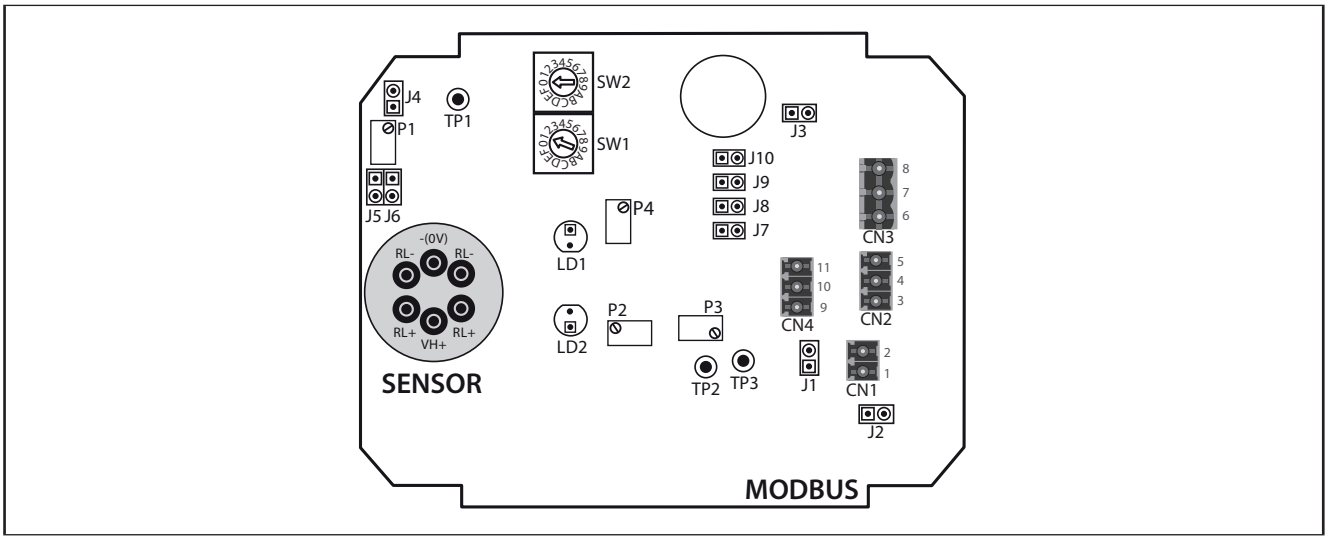


Fig. 10. Modbus semiconductor model connection diagram

ELECTRICAL CONNECTIONS and CONFIGURATION	
CN1	**Power Supply** **J1** = ON, **J2** = OFF ➞ **AC** : **1** = ac , **2** = ac (12...24 Vac) **J1** = OFF, **J2** = ON ➞ **DC** : **1** = 0 V , **2** = V+ (12...24 Vdc)
CN2	**Output signals** **3** = **0 V** (0 Volts, ground) **4** = **V** (The voltage output settings are: **J7** = ON, **J8, J9, J10** = OFF ➞ Voltage output = 0 ... 5 V **J8** = ON, **J7, J9, J10** = OFF ➞ Voltage output = 0 ... 10 V **J9** = ON, **J7, J8, J10** = OFF ➞ Voltage output = 1 ... 5 V **J10** = ON, **J7, J8, J9** = OFF ➞ Voltage output = 2 ... 10 V **5** = **I** (Current output = 4 ... 20 mA)
CN3	**Relay** **6** = **NO** (Normally open) • **7** = **COM** (Common) • **8** = **NC** (Normally Closed)
CN4	**Modbus (RS485)** **9**= **GND** (Ground - Isolated from 0 V) • **10** = **Tx/Rx+** (Non inverting Modbus Signal) • **11** = **Tx/Rx-** (Inverting Modbus Signal)
P1	**Alarm Potentiometer:** **P1 (Alarm)**: Adjust alarm setpoint for the sounder and relay.
P2	**ZERO Potentiometer:** **P2 (ZERO)**: Adjust the zero level voltage for the output signal.
P3	**SPAN Potentiometer:** **P3 (SPAN)**: Adjust output signal span.
P4	**4...20 mA Potentiometer:** **P4 (4-20mA)**: Adjust the 4 to 20 mA current output.
J1, J2	**Power Supply Jumper** (ON • OFF) **J1** = ON, **J2** = OFF : Unit is set for AC power supply **J1** = OFF, **J2** = ON : Unit is set for DC power supply
J3	**Sounder Jumper** (ON • OFF) **ON** = Sounder enabled (Audible alarm if Setpoint reached) • **OFF** = Sounder disabled (No audible alarms)
J4	**Reset Jumper** (ON • OFF) **ON** = Stop Unit operation • **OFF** = Normal functioning
J5, J6	**Sounder & Relay delay Jumper** (ON • OFF) **J5** = OFF, **J6** = OFF : 0 minutes (no delay) **J5** = ON, **J6** = OFF : 1 minute **J5** = OFF, **J6** = ON : 5 minutes **J5** = ON, **J6** = ON : 10 minutes
J7, J8 J9, J10	**Jumper J7, J8, J9 e J10 (Voltage output range selection)** (ON • OFF) **Jumper J7** (Voltage output setting: 0 ... 5 V) : **J7** = ON, **J8, J9, J10** = OFF **Jumper J8** (Voltage output setting: 0 ... 10 V): **J8** = ON, **J7, J9, J10** = OFF **Jumper J9** (Voltage output setting: 1 ... 5V) : **J9** = ON, **J7, J8, J10** = OFF **Jumper J10** (Voltage output setting: 2 ... 10 V): **J10** = ON, **J7, J8, J9** = OFF
TP1	**Setpoint Voltage Test Point TP1** (**Alarm**): Sounder and relay setpoint Voltage.
TP2	**Vs Sensor Voltage Test Point TP2** (**Vs**): Vs sensor voltage.
TP3	**0 V Test Point TP3** (**0 V**): Board ground plane connection.

Note:
Factory setting.
Do not adjust unless for re-calibration.

ELECTRICAL CONNECTIONS and CONFIGURATION	
SW1, SW2	**Address**. The valid address has a range of 0 ... 247 and the value is ADR = [SW1 + (SW2x16)]. Example: • SW1=1, SW2=0 ➞ ADR= 1 (Valid address) • SW1=1, SW2=1 ➞ ADR= 17 (Valid address) • SW1=7, SW2=F ➞ ADR= 247 (Valid address) • SW1=F, SW2=F ➞ ADR= 255 (Reserved) **NOTES**: 1) SW1 and SW2 are hexadecimal dial switches. 2) see full Address Table on the Modbus chapter.

4.4. Standard infrared model

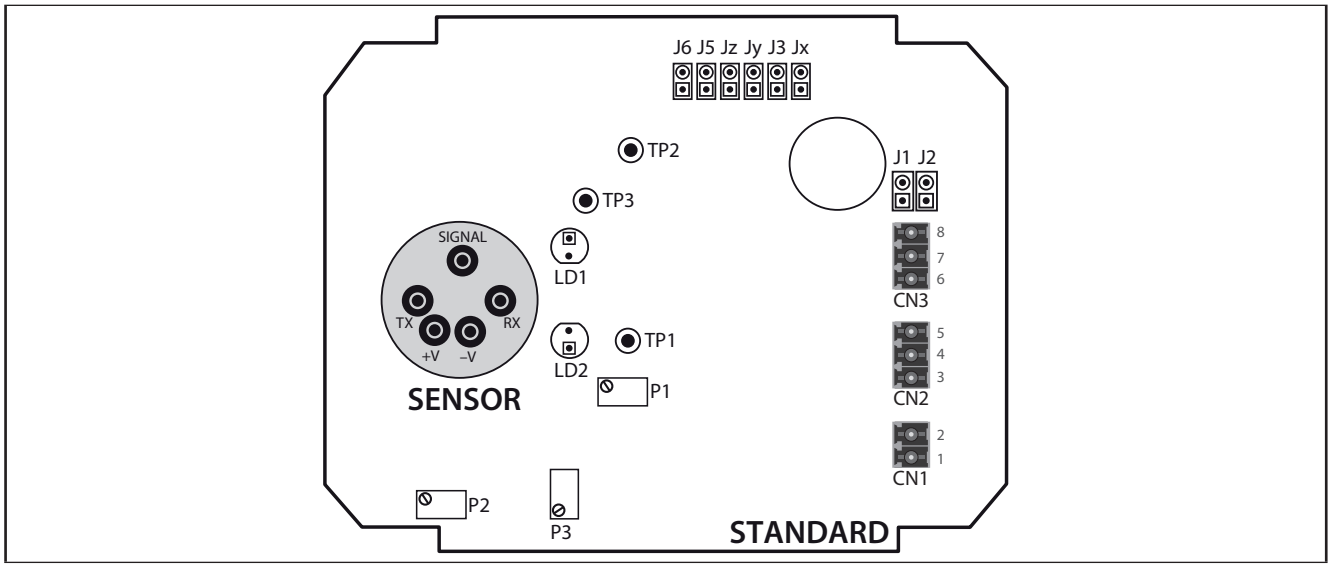


Fig. 11. Standard infrared model connection diagram

ELECTRICAL CONNECTIONS and CONFIGURATION		
CN1	**Power Supply** **J1** = ON, **J2** = OFF ➞ **AC** : **1** = ac , **2** = ac (12...24 Vac) **J1** = OFF, **J2** = ON ➞ **DC** : **1** = 0 V , **2** = V+ (12...24 Vdc)	
CN2	**Output signals** **3** = **0 V** (0 Volts, ground) **4** = **V** (The voltage output settings are: **Jx** = OFF, **Jy** = OFF ➞ Voltage output = 0 ... 10 V; **Jx** = ON, **Jy** = OFF ➞ Voltage output = 0 ... 5 V; **Jx** = OFF, **Jy** = ON ➞ Voltage output = 2 ... 10 V; **Jx** = ON, **Jy** = ON ➞ Voltage output = 1 ... 5 V) **5** = **I** (Current output = 4 ... 20 mA) **NOTE**: Current output needs to be enabled using Jy (**Jy = ON**)	
CN3	**Relay** **6** = **NO** (Normally Open) **7** = **COM** (Common) **8** = **NC** (Normally Closed)	
P1	**Alarm Potentiometer: P1 (Alarm)**: Adjust alarm setpoint for the sounder and relay.	**Note:** Factory setting. Do not adjust unless for re-calibration
P2	**ZERO Potentiometer: P2 (ZERO)**: Adjust the zero level voltage for the output signal.	
P3	**SPAN Potentiometer: P3 (SPAN)**: Adjust output signal span.	
J1, J2	**Power Supply Jumper** (ON • OFF) **J1** = ON, **J2** = OFF : Unit is set for AC power supply **J1** = OFF, **J2** = ON : Unit is set for DC power supply	
J3	**Sounder Jumper** (ON • OFF) **ON** = Sounder enabled (Audible alarm if Setpoint reached) **OFF** = Sounder disabled (No audible alarms)	
J5, J6	**Sounder & Relay delay Jumper** (ON • OFF) **J5** = OFF, **J6** = OFF : 0 minutes (no delay) **J5** = ON, **J6** = OFF : 1 minute **J5** = OFF, **J6** = ON : 5 minutes **J5** = ON, **J6** = ON : 10 minutes	

ELECTRICAL CONNECTIONS and CONFIGURATION	
Jx, Jy	**Jumper Jx and Jy (Voltage output range selection)** (ON • OFF) **Jx** = OFF, **Jy** = OFF ➞ Voltage output setting = 0 ... 10 V **Jx** = ON, **Jy** = OFF ➞ Voltage output setting = 0 ... 5 V **Jx** = OFF, **Jy** = ON ➞ Voltage output setting = 2 ... 10 V **Jx** = ON, **Jy** = ON ➞ Voltage output setting = 1 ... 5 V
Jz	**NOT USED**
TP1	**Setpoint Voltage Test Point TP1** (**VREF**): Sounder and relay setpoint Voltage.
TP2	**Vs Sensor Voltage Test Point TP2** (**Vs**): Vs sensor voltage.
TP3	**0V Test Point TP3** (**0 V**): Board ground plane connection.

4.5. Modbus infrared model

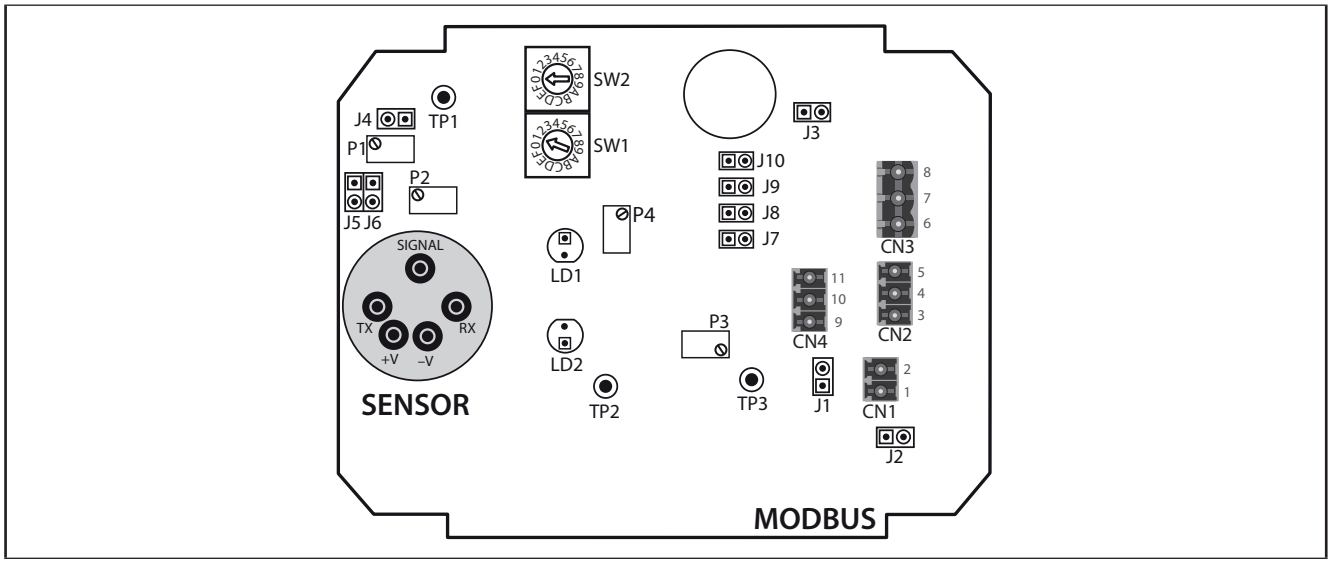


Fig. 12. Modbus infrared model connection diagram

ELECTRICAL CONNECTIONS and CONFIGURATION		
CN1	**Power Supply** **J1** = ON, **J2** = OFF ➞ **AC** : **1** = ac , **2** = ac (12...24 Vac) **J1** = OFF, **J2** = ON ➞ **DC** : **1** = 0V , **2** = V+ (12...24 Vdc)	
CN2	**Output signals** **3** = **0 V** (0 Volts, ground) **4** = **V** (The voltage output settings are: **J7** = ON, **J8, J9, J10** = OFF ➞ Voltage output = 0 ... 5 V **J8** = ON, **J7, J9, J10** = OFF ➞ Voltage output = 0 ... 10 V **J9** = ON, **J7, J8, J10** = OFF ➞ Voltage output = 1 ... 5 V **J10** = ON, **J7, J8, J9** = OFF ➞ Voltage output = 2 ... 10 V **5** = **I** (Current output = 4 ... 20 mA)	
CN3	**Relay** **6** = **NO** (Normally open) • **7** = **COM** (Common) • **8** = **NC** (Normally Closed)	
CN4	**Modbus (RS485)** **9** = **GND** (Ground - Isolated from 0 V) • **10** = **Tx/Rx+** (Non inverting Modbus Signal) • **11** = **Tx/Rx-** (Inverting Modbus Signal)	
P1	**Alarm Potentiometer:** **P1 (Alarm)**: Adjust alarm setpoint for the sounder and relay.	**Note:** Factory setting. Do not adjust unless for re-calibration
P2	**ZERO Potentiometer:** **P2 (ZERO)**: Adjust the zero level voltage for the output signal.	
P3	**SPAN Potentiometer:** **P3 (SPAN)**: Adjust output signal span.	
P4	**4...20 mA Potentiometer:** **P4 (4-20 mA)**: Adjust the 4 to 20 mA current output.	
J1, J2	**Power Supply Jumper** (ON • OFF) **J1** = ON, **J2** = OFF : Unit is set for AC power supply **J1** = OFF, **J2** = ON : Unit is set for DC power supply	
J3	**Sounder Jumper** (ON • OFF) **ON** = Sounder enabled (Audible alarm if Setpoint reached) • **OFF** = Sounder disabled (No audible alarms)	
J4	**Reset Jumper** (ON • OFF) **ON** = Stop Unit operation • **OFF** = Normal functioning	

ELECTRICAL CONNECTIONS and CONFIGURATION	
J5, J6	**Sounder & Relay delay Jumper** (ON • OFF) **J5** = OFF, **J6** = OFF : 0 minutes (no delay) **J5** = ON, **J6** = OFF : 1 minute **J5** = OFF, **J6** = ON : 5 minutes **J5** = ON, **J6** = ON : 10 minutes
J7, J8 **J9, J10**	**Jumper J7, J8, J9 e J10 (Voltage output range selection)** (ON • OFF) **Jumper J7** (Voltage output setting: 0 ... 5 V) : **J7** = ON, **J8, J9, J10** = OFF **Jumper J8** (Voltage output setting: 0 ... 10 V): **J8** = ON, **J7, J9, J10** = OFF **Jumper J9** (Voltage output setting: 1 ... 5 V) : **J9** = ON, **J7, J8, J10** = OFF **Jumper J10** (Voltage output setting: 2 ... 10 V): **J10** = ON, **J7, J8, J9** = OFF
TP1	**Setpoint Voltage Test Point TP1** (**Alarm**): Sounder and relay setpoint Voltage.
TP2	**Vs Sensor Voltage Test Point TP2** (**Vs**): Vs sensor voltage.
TP3	**0 V Test Point TP3** (**0 V**): Board ground plane connection.
SW1 **SW2**	**Address**. The valid address has a range of 0 ... 247 and the value is ADR = [SW1 + (SW2x16)]. Example: • SW1=1, SW2=0 ➞ ADR= 1 (Valid address) • SW1=1, SW2=1 ➞ ADR= 17 (Valid address) • SW1=7, SW2=F ➞ ADR= 247 (Valid address) • SW1=F, SW2=F ➞ ADR= 255 (Reserved) **NOTES**: 1) SW1 and SW2 are hexadecimal dial switches. 2) see full Address Table on the Modbus chapter.

CHAPTER 5
Connections examples

5.1. Example of stand-alone connections

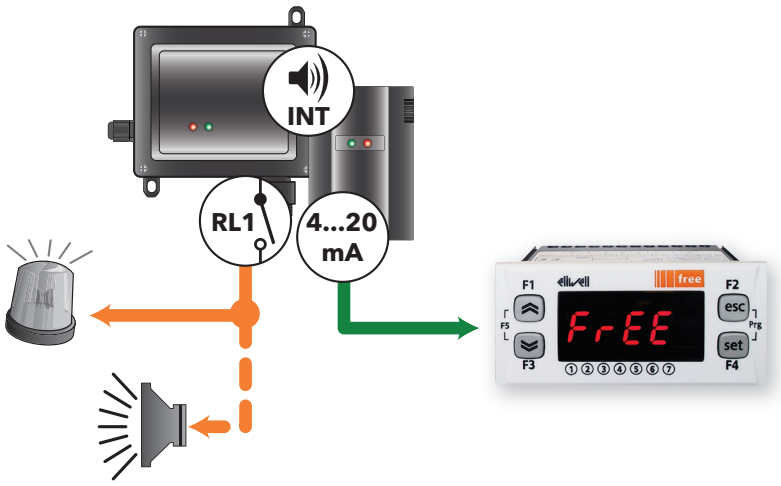


Fig. 13. LKD stand-alone

⚠ CAUTION

OUTPUT CIRCUIT DAMAGE DUE TO INDUCTIVE LOADS
Use an appropriate external protective circuit or device to reduce the risk of inductive direct current load damage
Failure to follow these instructions can result in injury or equipment damage.

5.2. Example of network connection

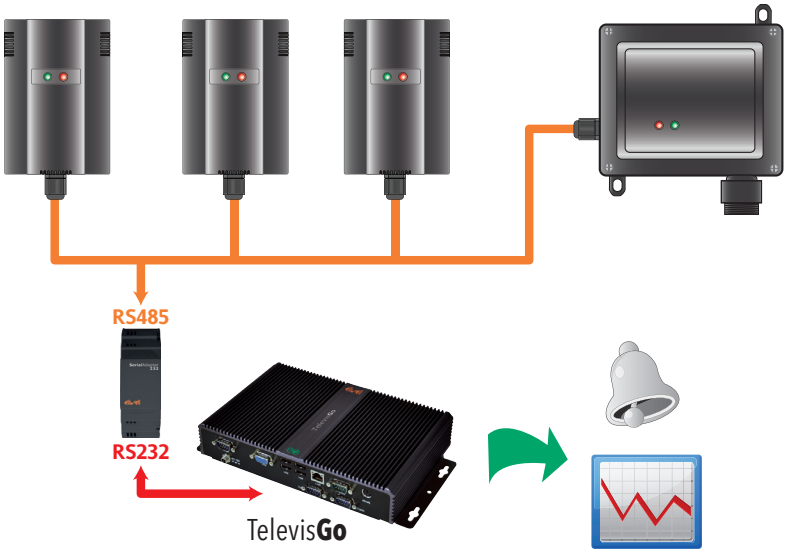


Fig. 15. LKD network

CHAPTER 6
Troubleshooting

Here is a list of some of the error signals which might occur:

DEFECT:	Green/Red light on sensor is not lit.
CAUSE:	• power supply. • possible wiring fault. • **LKD** possibly damaged in transit.
RESOLUTION:	• check power supply. • check wiring. • install another **LKD** unit to confirm the presence of a fault.
DEFECT:	Red LED light ON and green LED light OFF to indicate a fault.
CAUSE:	• sensor element may be disconnected from board. • sensor element has been damaged or has reached end of life.
RESOLUTION:	• check to see sensor element is properly inserted into board. • change sensor.
DEFECT:	You experience spurious alarms in the absence of a leak.
CAUSE:	Presence of sufficiently high concentrations of other gaseous impurities.
RESOLUTION:	Contact technical support for instructions and support.

CHAPTER 7
Modbus RTU protocol

7.1. Modbus RTU protocol (remote terminal unit)

The **CN4** Connector (**9** = **GND**, **10** = **Tx/Rx+**, **11** = **Tx/Rx-**) is an RS-485 port for communicating between **LKD** gas detectors and the Remote Supervision system in Modbus-RTU protocol.
The meaning of terminals is listed below:

- **Tx/Rx+** is the non-inverting data signal
- **Tx/Rx-** is the inverted data signal
- **GND** is the board ground plane.

7.2. Address

There are 256 available selections and the addresses are numbered 0 to 255 inclusive.

Addresses are selected by rotating the hexadecimal dial switches SW1 and SW2.

Nota: Values 1 to 247 are valid / usable addresses providing a unique identity for each gas detector.
Addresses 248 to 255 and address 0 are reserved for implementing specific features.

Modbus data with a zero in the address field is received by all detectors (irrespective of the address selected by the dial switches) to enable the master device to broadcast simultaneously to all the detectors.

Switch **SW1** selects addresses 0 to 15 and switch **SW2** multiplies the address by a factor of 16.

ADDRESS	SW1	SW2	SELECTION
0	0	0	RESERVED
1	1	0	Address 1
2	2	0	Address 2
⋮	⋮	⋮	⋮
9	9	0	Address 9
10	A	0	Address 10
11	B	0	Address 11
12	C	0	Address 12
13	D	0	Address 13
14	E	0	Address 14
15	F	0	Address 15
16	0	1	Address 16
17	1	1	Address 17
⋮	⋮	⋮	⋮
246	6	F	Address 246
247	7	F	Address 247
248	8	F	RESERVED
249	9	F	RESERVED
250	A	F	RESERVED
⋮	⋮	⋮	⋮
254	E	F	Selects 9,600 Baud (bits per second)
255	F	F	Selects 19,200 Baud (bits per second)

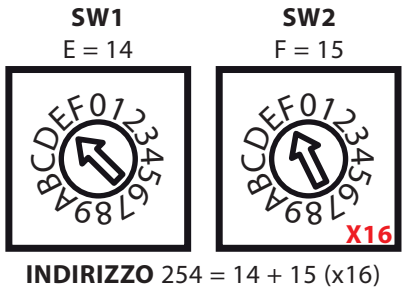


Fig. 16. SW1 and SW2 selectors

As an example, address 254 is reserved for setting the Baud rate to 9,600 bits per second.
To choose a baud rate, select the address and reset the gas detector by shorting jumper **J4** or by cycling the power on and off. The desired Modbus address (**1...247**) can subsequently be selected.

7.3. Technical Data

Baud Rate:	9600,19200 bit per second
Start:	1 bit
Data:	8 bit
Parity:	1 bit
Stop:	1 bit
Retry:	500 ms
End of Message	3,5 characters (a silent of 3.5 characters indicates the end of a message, a new message can begin after this interval)

7.4. Function code

Function codes specify the action to be performed on the data in the registers of the gas detector.

FUNCTION CODE	ACTION	REGISTERS	
01	Read Output Digital Status flags	4000	read / writable
02	Read Input Digital Status flags	3000	read only
03	Read Output Analogue Holding Registers	2000	read / writable
04	Read Input Analogue Input Registers	1000	read only
05	Write to Output Digital Status flags	4000	writable
06	Write to Output Analogue Holding Registers	2000	writable
43/14	Read Device ID	---	read only

7.5. Register map

The Register Map specifies the details of storage locations (registers and flags) within the detectors.

Analogue Input Registers
(Input Registers are read only) **Function Code 04**

REGISTER	DESCRIPTION	RANGE	M.U.
1000	Gas concentration level (% of full scale)	0...100	%
1001	Gas concentration level (parts per million)	0...65,535	ppm
1003	Sensor full scale	0...65,535	ppm
1004	Alarm Setpoint (% of full scale)	0...100	%
1005	Sensor timer	0...65,535	hours
1006	Modbus Address	1...247	---
1007	Software version	100	---

7.5.1. Register 1000 and 1001: Gas concentration level

The real time gas concentration is available in different formats:

- Register 1000 maintains the detected concentration in percentage (% of full scale).
- Register 1001 maintains the detected concentration in parts per million (ppm).

For example: a value of 33 represents, in register 1000, 33% of the maximum detectable gas concentration.

7.5.2. Register 1003: Sensor full scale (in ppm)

The full scale sensor level is the maximum detectable gas concentration for the detector.
This maximum rating is stored in register 1003, so, for the example register 1003, holds the value 1000 to represent 1000 parts per million (ppm).

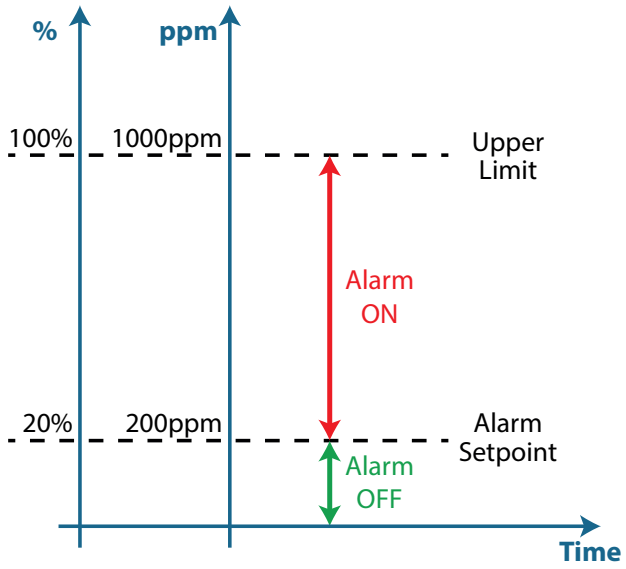


Fig. 17. Example of gas concentration

7.5.3. Register 1004: Alarm setpoint

The alarm setpoint is the threshold at which the gas concentration has reached a level to warrant the activation of the red LED alarm indication, the relay, the sounder and the Alarm flag by setting a 1 in register 3000.

The alarm setpoint can be controlled using the detector hardware by adjusting the potentiometer **P1** and monitoring the voltage on test point **TP1** with respect to test point **TP3** (0 V).

Alternatively a software value can be written into register 2000 to set the alarm level in ppm and override the hardware potentiometer setting until the software value is reset back to zero, so although register 1004 is a read only register, its value can be modified by writing to register 2000.

The alarm setpoint register 1004 is measured as a percentage of the full scale so for example, 1.0 Volt measured between test points **TP1** and **TP3** corresponds to a 20 % Alarm Setpoint given that the maximum voltage is 5.0 Volts.

The alarm setpoint register 1004 will contain 20 to represent 20 % and this corresponds to a 200 ppm for a detector with a full scale range of 1000 ppm.

If a delay time is set in 2001 register (valued between 0 and 59 mins), when an alarm occurs:

- the red LED and the Alarm Flag will be immediately activated
- the relay and the sounder will be activated after the delay period is expired

After that the delay period is elapsed, the relay switches ON and the sounder din is audible.

NOTE: The duration of the delay is measured from the instant when the gas concentration reaches the alarm setpoint and the red LED and the alarm flag are activated.

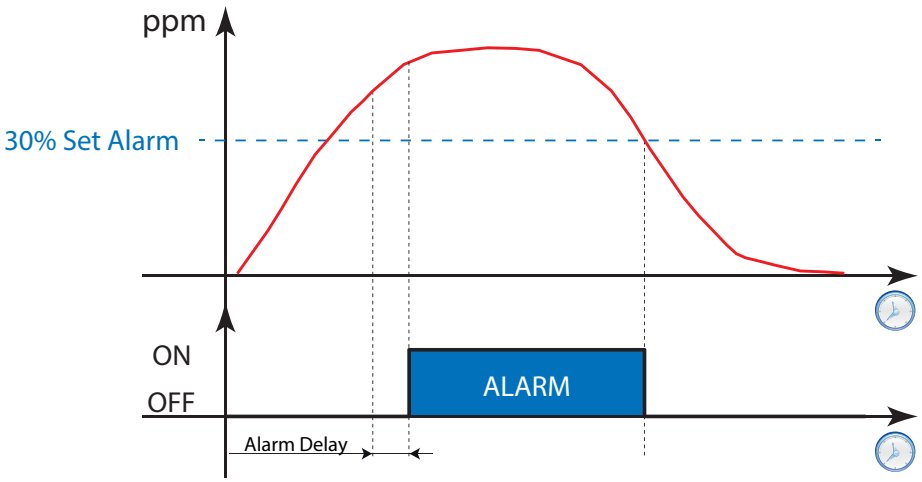


Fig. 18. Alarm activation delay

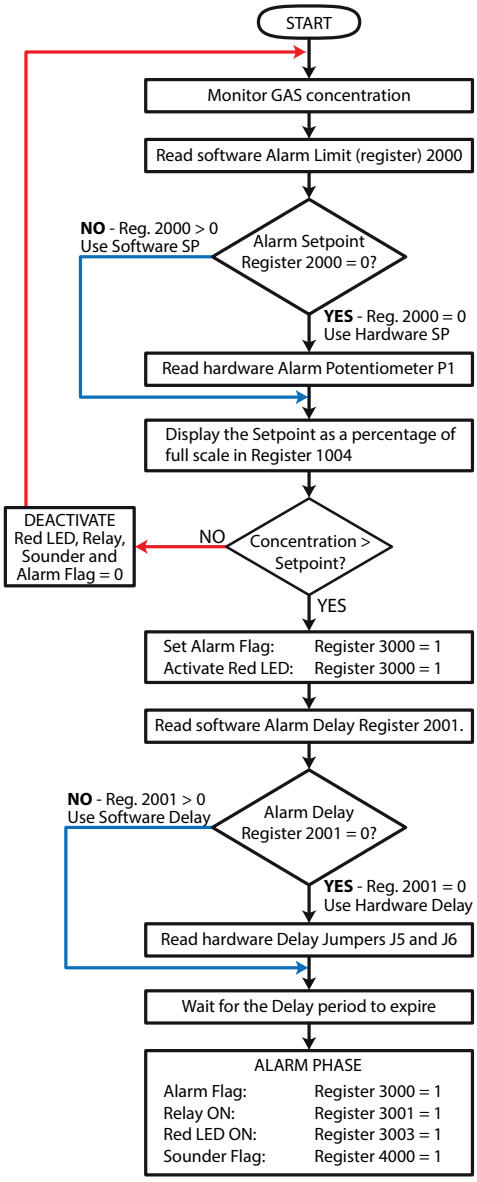


Fig. 19. Alarm setpoint flowchart

7.5.4. Register 1005: Sensor timer

The sensor timer register keeps a count of the number of hours the sensor is on.
The register is incremented every hour and after one year the register will exceed 8760 hours and the Test Flag will be set to 1 to indicate that the detector requires testing.

The Test Flag Register is located at address 4001 and can be cleared to indicate that the sensor and detector have passed the annual test.

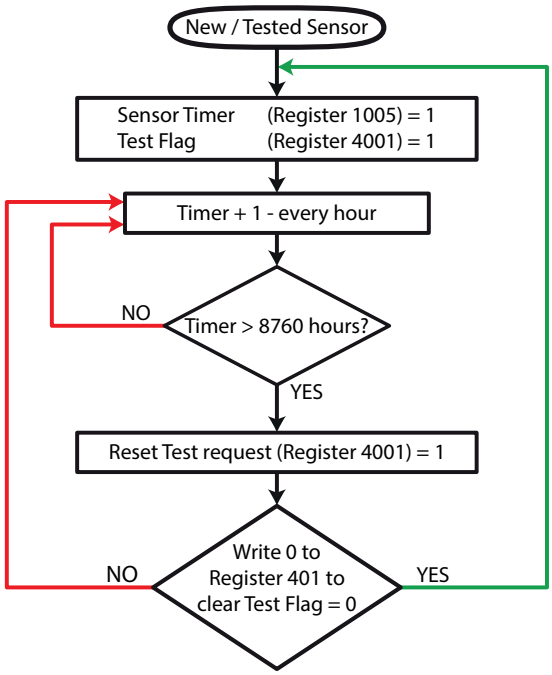


Fig. 20. Sensor timer flowchart

7.5.5. Register 1006: Modbus address

The Modbus address is the value of address set by the hexadecimal switches.

7.5.6. Register 1007: Software version

The software version is the revision of firmware operating on the processor of the detector.

Analogue Output Registers
(Output / Registers are readable & writable)
Function code 03 : read
Function code 06 : write

REGISTER	DESCRIPTION	RANGE	DETAILS
2000	Alarm setpoint (ppm)	0...65,535	alarm setpoint / threshold in parts per million
2001	Alarm delay	0...59	the Alarm Delay is the time in minutes after the gas concentration exceeds the alarm level and the Alarm Flag Register 300 is set to 1.
2002	Sounder mute duration	0...59	the Sounder Delay is the time in minutes the sounder is deactivated for during the alarm phase when the gas concentration exceeds the alarm set point.

7.5.7. Register 2000: Alarm setpoint (in ppm)

The alarm setpoint register 2000 stores the software setting for the alarm setpoint in parts per million (ppm). Writing the value zero into this register will enable the hardware potentiometer **P1** to determine the alarm setpoint.

If a value greater than zero and less then the full scale sensor limit in ppm is written into register 2000 then the hardware potentiometer setting is ignored and the value written into register 2000 determines the alarm setpoint.

For example, writing the value 500 into the alarm setpoint register 2000 effectively overrides the hardware alarm set point on the potentiometer **P1** and sets the alarm gas concentration threshold to 500 parts per million and will be displayed as 50 in register 1004 to represent 50 % for a detector with a full scale range of 1000 ppm.

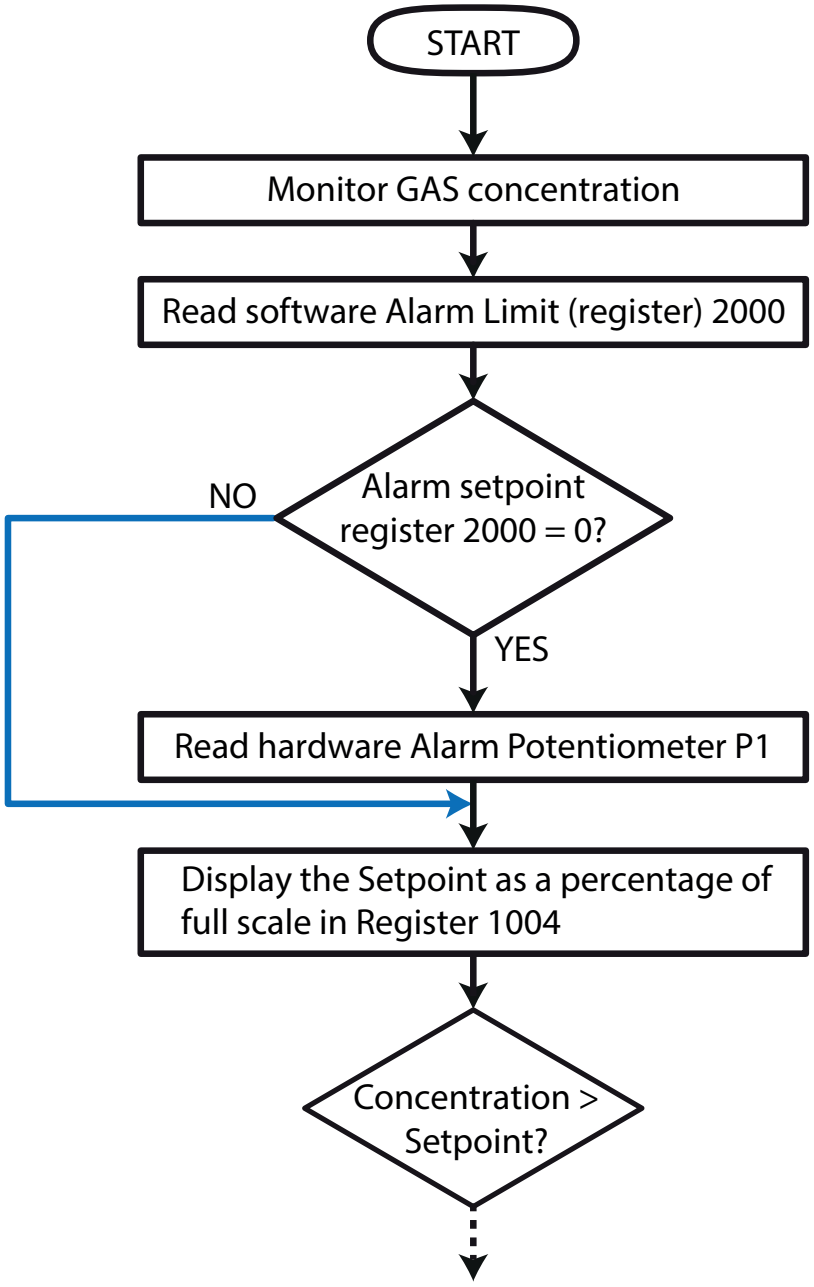


Fig. 21. Alarm setpoint flowchart

7.5.8. Register 2001: Alarm delay

The Alarm Delay Register 2001 stores the software alarm delay period up to 59 minutes and the jumpers **J5** and **J6** set the hardware alarm delay period.

The alarm delay is the duration between the unit detecting a gas concentration above the alarm set point and the activation of the relay and the sounder.

Only modbus model: If jumpers **J5** and/or **J6** are present (ON) during the connection of modbus cable (on **CN4**), the software value is cleared following a restart whereby the power to the detector is turned off and then turned on again.

Following this restart the delay period is determined by hardware setting of jumpers J5 and J6.

If there are no jumpers on both **J5** and **J6** the delay period written into the alarm delay register 2001 is used as the delay and is memorized and reused after a power cycle when the power is turned off and back on.

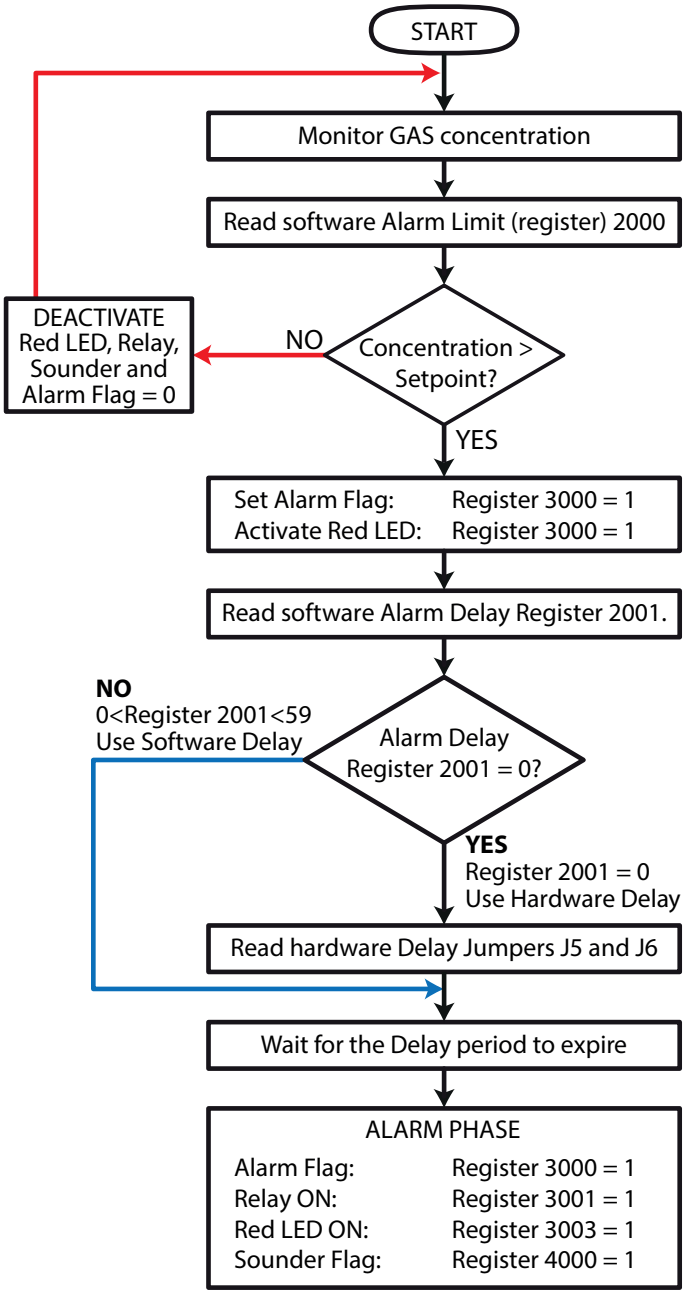


Fig. 22. Alarm delay flowchart

7.5.9. Register 2002: Sounder mute duration

The sounder mute duration is the time in minutes the sounder is deactivated for during the alarm phase (when the gas concentration has reached or exceeds the alarm setpoint).
The alarm condition will activate the red LED and set the alarm flag to the value 1.
The relay and the sounder will subsequently activate following any delay period and the alarm flag in register 3000. The relay flag in register 3001 and the sounder flag in register 4000 will all be set to the value 1 to indicate the active alarm state.
Clearing the Sounder Flag, by writing the value zero into register 4000 will deactivate the sounder for the period defined by the sounder delay register 2002. The sounder delay is in minutes and the maximum value is 59 so for example if the value in register 2002 is **25**, then the sounder will be disabled for **25** minutes during an alarm condition. After this 25 minute mute period, the sounder will be reactivated if the detector is still detecting gas concentrations at or above the alarm setpoint, otherwise the sounder will not be reactivated if the gas concentration has fallen below the alarm setpoint.

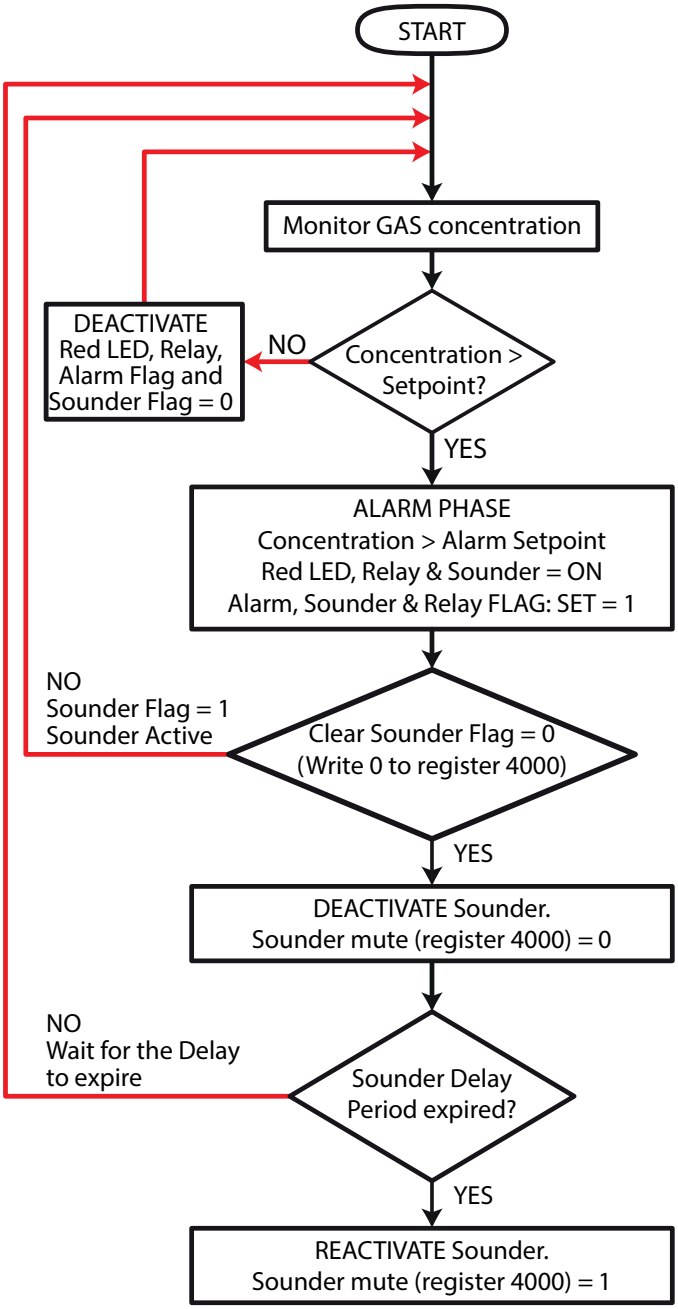


Fig. 23. Sounder mute duration flowchart

Input Status Flags
(Input Status Flags are read only) **Function code 02**

REGISTER	DESCRIPTION	RANGE	DETAILS
3000	Alarm	0/1	**0**: Gas concentration is less than the alarm setpoint. **1**: Gas concentration is greater or equal to alarm setpoint
3001	Relay	0/1	**0**: Relay is not active. **1**: Relay is active.
3002	Probe Error	0/1	**0**: Sensor present / in circuit and no open circuit fault detected. **1**: Sensor absence or open circuit sensor fault is detected.
3003	Red LED	0/1	**0**: Red LED is OFF No alarm or fault condition exists. **1**: Red LED is ON. Alarm Indication or Fault Indication if green LED is OFF.
3004	Green LED	0/1	**0**: Green LED is OFF. No power or fault condition if the red LED is ON. **1**: Green LED is ON. Power indicator, detector powered ON.
3005	Sensor saturated	0/1	**0**: The gas level is between zero and the full-scale range. **1**: The gas level is outside the bounds of zero and the unit full-scale.
3006	Sensor startup	0/1	**0**: The unit is operating normally. **1**: The unit is starting up.

Output Status Flags
(Output Status Flags are readable & writable)
Function code 01: read; **Function code 05**: write

REGISTER	DESCRIPTION	RANGE	DETAILS
4000	Sounder flag	0/1	**0**: Sounder is OFF. **1**: Sounder is ON.
4001	Sensor test required	0/1	**0**: Sensor does not require testing yet. **1**: Sensor ON / operating for more than 1 year and requires testing.

Read Device ID
(Read-only) **Function code 43/14**

This function code allows reading the identification and additional information relative to the physical and functional description of the device.
The implementation of this function follows the specification '*MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b'*, section 6.21 as published by the Modbus Organization.

The following Object IDs have been implemented::

OBJECT ID	NAME/DESCRIPTION	TYPE	VALUE	NOTES
0x00	VendorName	ASCII String	“INVENSYS”	
0x01	ProductCode	ASCII String	“00DE_0401” “00DF_0401”	Semiconductor version Infrared version
0x02	MajorMinorRevision	ASCII String	“0FA0_0001” “0FA1_0001”	Semiconductor version Infrared version

The following “Read Device ID code” options have been implemented:

01: request to get the basic device identification (stream access)
04: request to get one specific identification object (individual access)

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