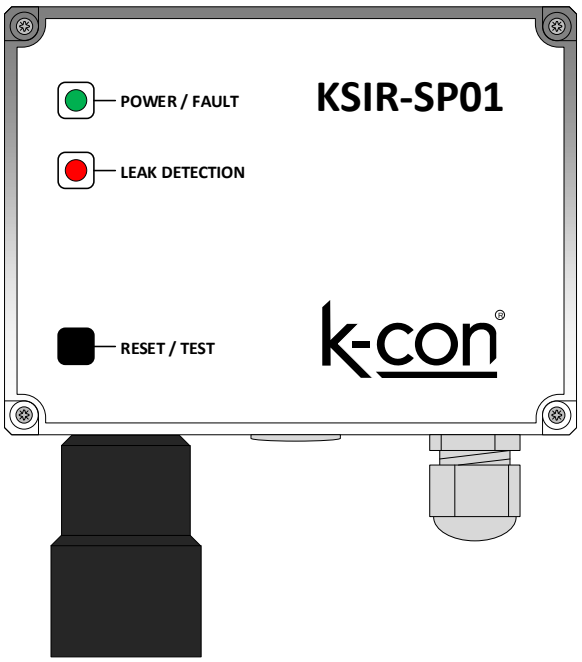
Refrigerant Leak Monitoring System for HCFC/HFC/HC Refrigerants and Carbon Dioxide

Installation and operation manual

Version 3.5



Manufactured for
MITSUBISHI ELECTRIC UK

MITSUBISHI ELECTRIC

Contents

Safety Precautions

Before installing the unit, make sure you read all the "Safety precautions".

Definition of symbols

Alert	Symbol	Description
Danger		Will result in death or serious injury if not avoided.
Warning		Could potentially result in death of serious injury if not avoided.
Caution		Could potentially result in damage to the product, injury or damage to the environment if not avoided.
Information		Information notes relating to the operation of the product.

 Warning:

Carefully read the labels affixed to the main unit.

 Warning:

- Ask the dealer or an authorised technician to install the unit.
- Improper installation by the user may result in water leakage, electric shock, or fire.
- Use the specified cables for wiring. Make the connections securely so that any outside forces acting on the cables are not applied to the terminals. Inadequate connection and fastening may generate heat and cause a fire.
- Never repair the unit. If the controller must be repaired, consult the dealer.
  If the unit is repaired improperly, electric shock, or fire may result.
- When handling this product, always wear protective equipment. EG: Gloves, full arm protection namely boiler suit, and safety glasses.
  Improper handling may result in injury.
- If refrigerant gas leaks during installation work, ventilate the room.
  If the refrigerant gas comes into contact with a flame, poisonous gases will be released.
- Install the controller according to this Installation Manual.
  If the unit is installed improperly, electric shock, or fire may result.
  Have all electric work done by a licensed electrician according to "Electric Facility Engineering Standard", "Interior Wire Regulations" and the instructions given in this manual and always use a special circuit.
- If the power source capacity is inadequate or electric work is performed improperly, electric shock and fire may result.
  Keep the electric parts away from any water - washing water etc...
  Contact may result in electric shock, fire or smoke.
- After completing installation work, make sure that refrigerant gas is not leaking.
  If the refrigerant gas leaks and is exposed to a fan heater, stove, oven, or other heat source, it may generate noxious gases.
- Do not reconstruct or change the settings of the protection devices. If the pressure switch, thermal switch, or other protection device is shorted or operated forcibly, or parts other than those specified by Mitsubishi Electric are used, fire or explosion may result.

To dispose of this product, consult your dealer. Do not use a leak detection additive.

Precautions for devices that use HCFC and HFC refrigerants


Caution:

- Do not use the existing refrigerant piping.
  The old refrigerant and refrigerator oil in the existing piping contains a large amount of chlorine which may cause the refrigerator oil of the new unit to deteriorate. Use refrigerant piping made of C1220 (CU-DHP) phosphorus deoxidized copper as specified in the JIS H3300" Copper and copper alloy seamless pipes and tubes". In addition, be sure that the inner and outer surfaces of the pipes are clean and free of hazardous sulphur, oxides, dust/dirt, shaving particles, oils, moisture, or any other contaminant.
  Contaminants on the inside of the refrigerant piping may cause the refrigerant residual oil to deteriorate.

- Store the piping to be used during installation indoors and keep both ends of the piping sealed until just before brazing.
  (Store elbows and other joints in a plastic bag.) If dust, dirt, or water enters the refrigerant cycle, deterioration of the oil and compressor problems may result.

- Use ester oil, ether oil or alkylbenzene (small amount) as the refrigerator oil to coat flares and flange connections.
  The refrigerator oil will degrade if it is mixed with a large amount of mineral oil.

- Use liquid refrigerant to fill the system.
  If gas refrigerant is used to seal the system, the composition of the refrigerant in the cylinder will change and performance may drop.

- Do not use a refrigerant other than what is specified..
  If the incorrect refrigerant (R22, etc.) is used, the chlorine in the refrigerant may cause the refrigerator oil to deteriorate.

- Use a vacuum pump with a reverse flow check valve.
  The vacuum pump oil may flow back into the refrigerant cycle and cause the refrigerator oil to deteriorate.
  Do not use the following tools that are used with conventional refrigerants. (Gauge manifold, charge hose, gas leak detector, reverse flow check valve, refrigerant charge base, vacuum gauge, refrigerant recovery equipment.)

- If the conventional refrigerant and refrigerator oil are mixed, the refrigerant may deteriorate.
  If water is mixed in the refrigerant, the refrigerator oil may deteriorate.
  Since HCFC and HFC refrigerants do not contain any chlorine, gas leak detectors for conventional refrigerants will not react to it.

- Do not use a charging cylinder. Using a charging cylinder may cause the refrigerant to deteriorate.
  Be especially careful when managing the tools.

- If dust, dirt, or water gets in the refrigerant cycle, the refrigerant may deteriorate.

Before installation

Caution:

- Do not install the unit where combustible gas may leak.
  If the gas leaks and accumulates around the unit, an explosion may result.
- Ground the unit.
  Do not connect the ground wire to gas or water pipes, lightning rods, or telephone ground lines. Improper grounding may result in electric shock.
- Install the power cable so that tension is not applied to the cable. Tension may cause the cable to break and generate heat which may, in turn, cause fire.
- Install a leak circuit breaker, as required.
  If a leak circuit breaker is not installed, electric shock may result.
- Use power line cables of sufficient current carrying capacity and rating.
  Cables that are too small may leak, generate heat, and cause a fire.
- Use only a circuit breaker and fuse of the specified capacity.
  A fuse or circuit breaker of a larger capacity or a steel or copper wire may result in a general unit failure or fire.
- Be very careful regarding product transportation.
  Two people should be used to carry products of 20kg or more.
- Some products use PP bands for packaging. Do not use any PP bands for a means of transportation.
- Safely dispose of the packing materials.
  Packing materials, such as nails and other metal or wooden parts, may cause stabs or other injuries.
  Tear apart and throw away plastic packaging bags so that children will not play with them - If children play with a plastic bag which has not been torn apart, they face the risk of suffocation.

Before starting a test run

Caution:

- Do not touch the switches with wet fingers.
  Touching a switch with wet fingers can cause electric shock.
- Do not touch the refrigerant pipes during and immediately after operation.
  During and immediately after operation, the refrigerant pipes may be hot or cold, depending on the condition of the refrigerant flowing through the refrigerant piping, compressor, and other refrigerant cycle parts. Your hands may suffer burns or frostbite if you touch the refrigerant pipes.
- Do not operate the air conditioner with the panels and guards removed.
  Rotating, hot, or high-voltage parts can cause injuries.
- Do not turn off the power immediately after stopping operation.
  Always wait at least five minutes before turning off the power. Otherwise, water leakage and other problems may occur.

Disclaimer

Warranty:
All products manufactured on behalf of Mitsubishi Electric UK are warranted against defective materials for a period of three years from the date of delivery to the original purchaser.

Warning:

Mitsubishi Electric UK assumes no liability for damages consequent to the user of this product. We reserve the right to change this manual at any time without notice. The information furnished by us is believed to be accurate and reliable. However, no responsibility is assumed by us for its use, nor for any infringements of patents or other rights of third parties resulting from its use.

1. Overview

The KSIR-SP01 is an infra-red gas detection unit, capable of detecting a range of gases. The unit can be used as a stand-alone detection unit and can also be integrated into larger BMS and refrigeration control systems. The unit can be easily configured in the field using on board DIP switches.

Supported gases;

R404a R134a R407a R410a R125 R1234yf R1234ze R32
R744 (Co2) R290 (Propane)

Please specify the required gas when ordering. Other gases available on request.

SP-ir units must be ordered according to the refrigerant to be detected. Refer to product labelling for details of the refrigerant that the unit will detect.

The unit supports either a single or dual alarm threshold, providing a fault and alarm relay outputs if using a single alarm threshold, or alarm and critical alarm relay outputs if using dual alarm thresholds.

1.1 Specification

In the interest of continued product development, the manufacturer reserve the right to make improvements to products with notice or obligation.

General	Operating temperature range	-25°C to +40°C
	Storage temperature range	-40°C to +85°C
	Operating humidity range	0-95% RH non-condensing
	Weight	0.87kg
	Main enclosure material	Polycarbonate
	Enclosure dimensions	H 120mm (190mm with sensor housing) W 160mm D 95mm
	IP Rating	IP54
Electrical	Power supply	24VAC 50Hz / 24VDC – 100mA
	Relays	2 x SPDT (Common, Normally Open, Normally Closed) 5A / 24VAC Contact rating
Measurement	Method	NDIR (Non-dispersive Infra-red)
	Measurement range (FS)	Order request, gas dependant – typically; 0-1000ppm 0-21000ppm (Propane) 0-2000ppm 0-10000ppm (Co2) 0-20000ppm (Co2)
	Accuracy	+/- 2% of FS range
	Resolution	0.5% of FS range
	Long term drift	+/- 3% of FS range/year
	Response time (T90)	<30 seconds
	Warmup time	60 seconds for full operation @ 25DegC 30 minutes for full specification @ 25DegC
Interfaces	RS485 Network	Modbus RTU
	Analogue	Selectable; 0-20mA (4-20mA sensing range) 0-5V (1-5V sensing range) 0-10v (2-10V sensing range)
	Digital	Alarm relay Fault OR Critical Alarm relay (selectable operation) Alarm reset / Self test voltfree contact sensing input + Local reset button on enclosure
	Indicators	Tri-colour – Power / Fault / Status LED Red – Alarm LED Internal buzzer
	Configuration	2 x 8 way DIP switches Certain settings also available via Modbus

2. Enclosure

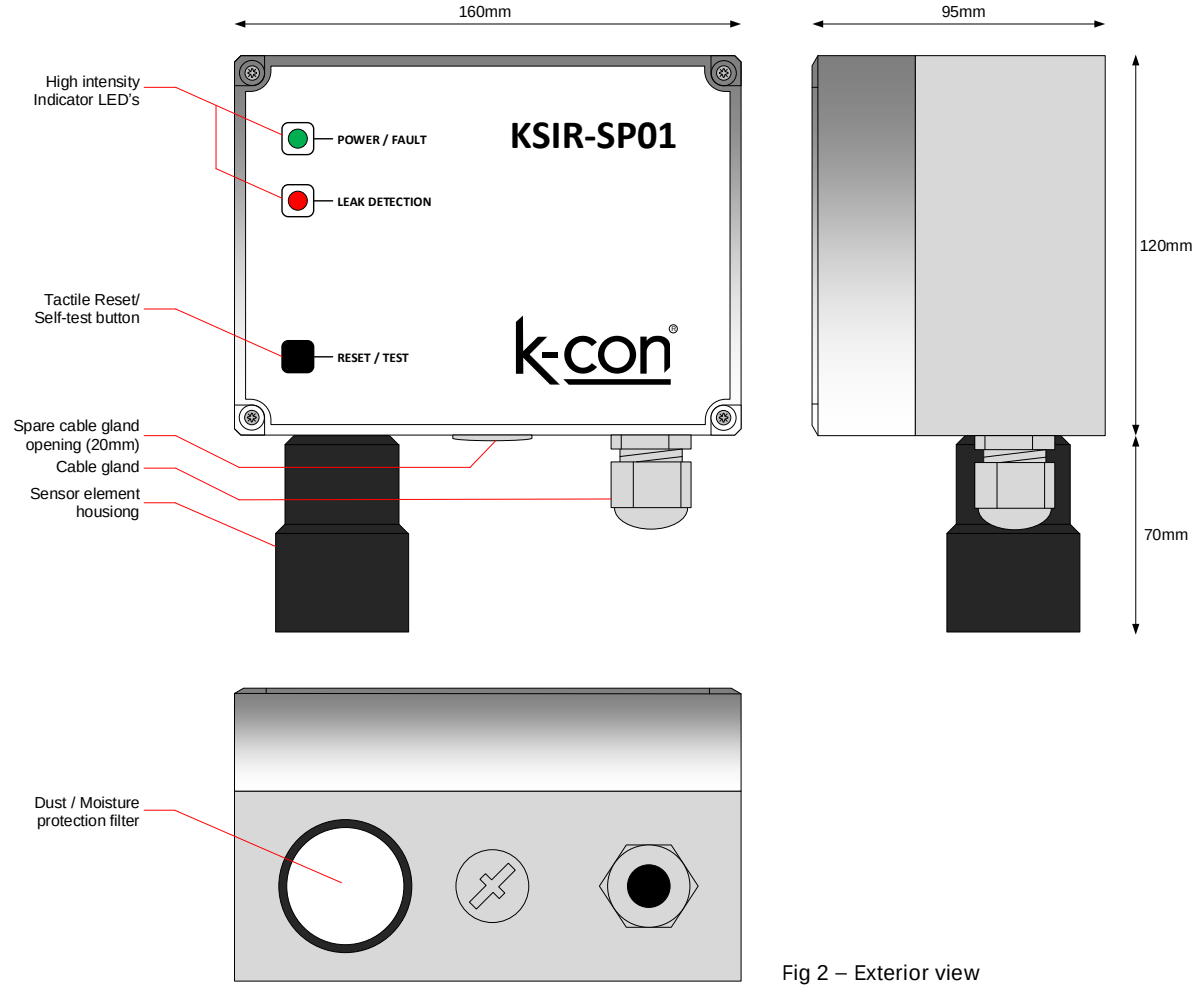


Fig 2 – Exterior view

2.1 Mounting details

In order to mount the unit, remove the lid of the enclosure (taking care to disconnect the lid connection cable), use the 4 x fixing positions provided within each corner of the enclosure;

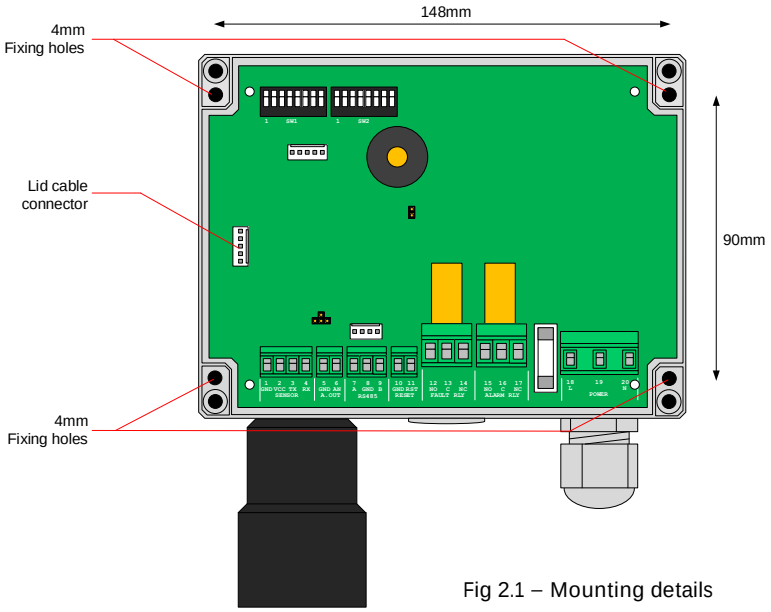


Fig 2.1 – Mounting details

3. Main board

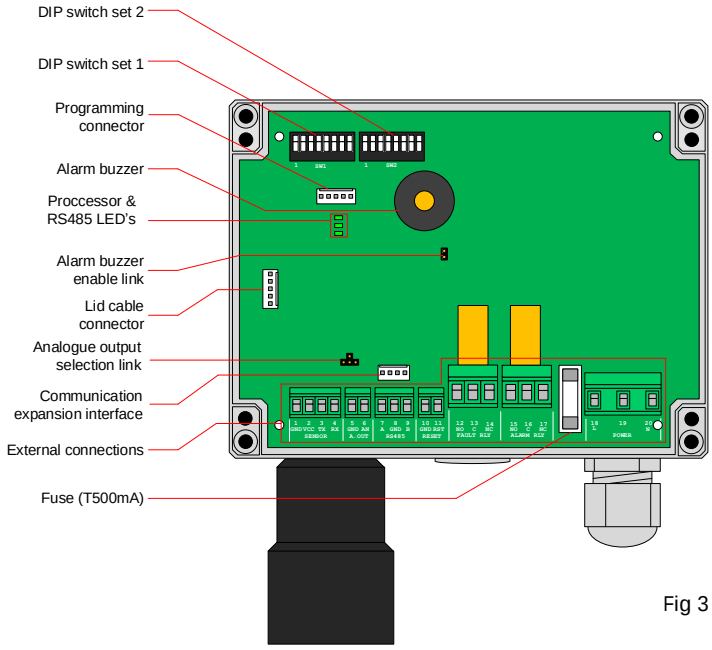


Fig 3 – Main board features

3.1 DIP Switch sets 1 & 2

The DIP switches SW1 and SW2 are used to configure the unit.

With the exception of the engineers mode DIP switch (SW2 – 8), switches are only read at initial power up. If any changes are made, power must be cycled in order for the new settings to take effect.

DIP Switch set 1 (SW1)							
Switch 1	Switch 2	Sets ***Alarm Thresholds*** - † See notes for sensors for other gases					
		Setup Mode 1 (Single alarm)		Setup Mode 2 (Dual alarm)			
		Co2 Sensors	HFC/HFO/HCFC Sensors	Co2 Sensors		HFC/HFO/HCFC Sensors	
				Alarm	Critical Alarm	Alarm	Critical Alarm
OFF	OFF	1000ppm*	50ppm*	2000ppm*	9500ppm*	50ppm*	800ppm*
ON	OFF	2000ppm	100ppm	5000ppm	9500ppm	100ppm	800ppm
OFF	ON	5000ppm	200ppm	2000ppm	10000ppm	200ppm	800ppm
ON	ON	9500ppm	500ppm	5000ppm	10000ppm	500ppm	800ppm

Switch 3	Switch 4	Sets ***Alarm Delay***
OFF	OFF	0 minutes **or** set via Network
ON	OFF	1 minutes
OFF	ON	5 minutes
ON	ON	30 minutes

Switch 5	Sets ***Alarm Latch***
OFF	Alarm does not latch relay
ON	Alarm does latch relay

Switch 6	Sets ***Fault Latch or Critical Alarm Latch****
OFF	Fault / Critical Alarm does not latch relay**
ON	Fault / Critical Alarm does latch relay**

Switch 7	Sets ***Alarm Relay Failsafe***
OFF	Alarm relay failsafe = OFF
ON	Alarm relay failsafe = ON

Switch 8	Sets ***Fault or Critical Alarm Relay Failsafe****
OFF	Fault / Critical Alarm relay failsafe = OFF**
ON	Fault / Critical Alarm relay failsafe = ON**

Notes
*Switches 1 & 2 must be set OFF if Network (Modbus) settable threshold(s) are to be setup.
**Relay operation dependant on setup mode.
† For other gases not listed, an alarm threshold of 1ppm and a critical alarm threshold of 2ppm will be used for all DIP switch settings. Thresholds may still be changed via Network (Modbus) if required (see *)

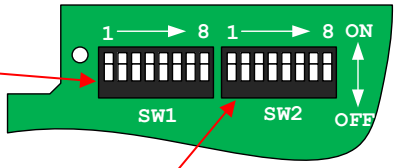


Fig 3.1 – DIP Switches

DIP Switch set 2 (SW2)					
Switch 1	Switch 2	Switch 3	Switch 4	Switch 5	Sets ***Network Address***
OFF	OFF	OFF	OFF	OFF	Address 32
ON	OFF	OFF	OFF	OFF	Address 1
ON	ON	ON	OFF	OFF	Address 7
ON	ON	ON	ON	ON	Address 31
Note : only 4 x examples shown – 32 different addresses will be possible using DIP switches as binary array. **See** *5.3 Modbus addresses* **for full list of address settings.**					

Switch 6	Switch 7	Sets ***Setup Mode***
OFF	OFF	Mode 1 – Single alarm threshold
ON	OFF	Mode 2 – Dual alarm threshold
OFF	ON	Mode 3 – Reserved for future use***
ON	ON	Mode 4 – Reserved for future use***

Switch 8	Sets ***Engineers Mode***
OFF	Normal operation
ON	Switches unit into Engineers Mode

*** Unit will operate as Mode 1 if set to Mode 3 or Mode 4.

3.2 Programming connector

Used to program firmware into the unit – factory use only.

3.3 Alarm buzzer & enable link

The alarm buzzer operates when an alarm or critical alarm is detected. The alarm buzzer can be disabled by removing the alarm buzzer enable link.

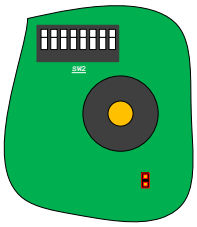


Fig 3.3 – Alarm buzzer and enable link

3.4 Processor & RS485 LED's

The processor and alarm LED's will indicate the operational status of the unit;

LED	Description
Processor	Will flash 1sec ON/OFF when the unit is operating
RS485 TX	Will flash when RS485 data is transmitted
RS485 RX	Will flash when RS485 data is received

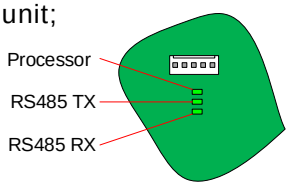


Fig 3.4 – Processor & RS485 LED's

3.5 Lid cable connector

The lid cable connector connects the Tri-colour power / fault LED, the Leak Alarm LED and the Reset / Self-test button to the main board.

3.6 Analogue output selection link

The analogue output selection link selects how the analogue output will operate;


0 to 5VDC


0 to 20mA


0 to 10VDC

See section *4.15 Analogue output* for further details on the analogue output operation

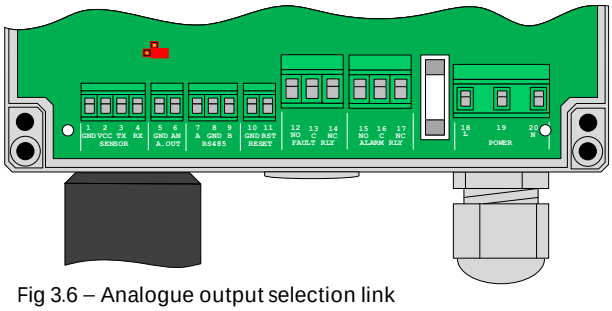


Fig 3.6 – Analogue output selection link

3.7 Communication expansion interface

The communication expansion interface is reserved for future use, to connect additional communication devices to the KSIR-SP01.

3.8 External connections

It is good practice to ensure all external connections are made of using ferrule crimp terminations.

3.8.1 Sensor connection

The sensor connector connects power and data signals from the sensor to the main PCB.

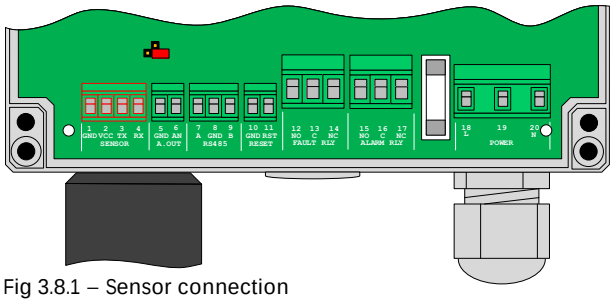


Fig 3.8.1 – Sensor connection

Pin ID	Description	Colour
1	Ground	Black
2	VCC	Red
3	Data A	Green
4	Data B	White

The sensor maybe mounted remotely to the main unit, up to a maximum cable length of 3M. This option must be specified when ordering the unit, see *Appendix 1* for more details..

3.8.2 Analogue output connection

The analogue output can be used by third party monitoring systems to monitor the basic status and measure gas concentration from the unit.

For more details on the analogue output operation see section *4.13 Analogue output*.

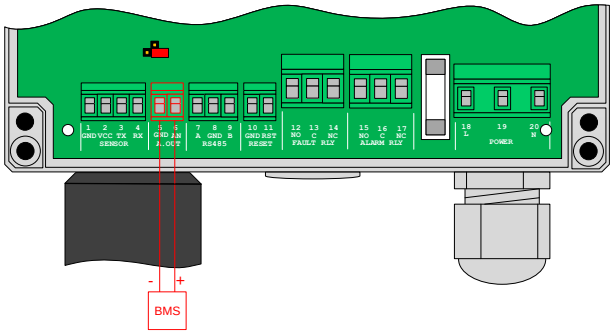


Fig 3.8.2 – Analogue output connection

Pin ID	Description
5	Ground (-)
6	Signal (+)

3.8.3 RS485 Network connection

The RS485 network connection can be used by third party monitoring system to monitor detailed unit status, measure gas concentration and setup variables within the unit. Multiple KSIR-SP01 units (up to 32) can be connected onto the same RS485 network.

For more details on the analogue output operation see section *5. RS485 Network interface*.

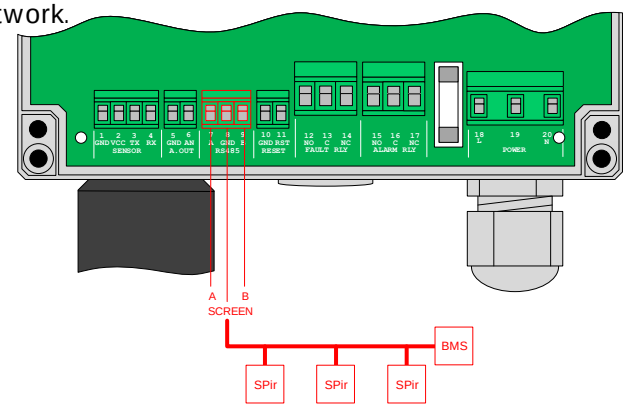


Fig 3.8.3 – RS485 Network connection

Pin ID	Description
7	Data A
8	Ground (Screen)
9	Data B

Beldan type twisted pair cable should be used for RS485 connections

3.8.4 Reset / Self-test input connection

The reset / self-test input is used to reset a latched alarm, mute the alarm buzzer or initiate a unit self-test. A "volt-free" contact (normally open) should be connected to the input.

Pin ID	Description
10	Ground
11	Input

More details on resetting latched alarms, Muting the alarm buzzer and unit self-tests can be found in sections *4.6.1 Muting the alarm buzzer* and *4.16 Self-test*

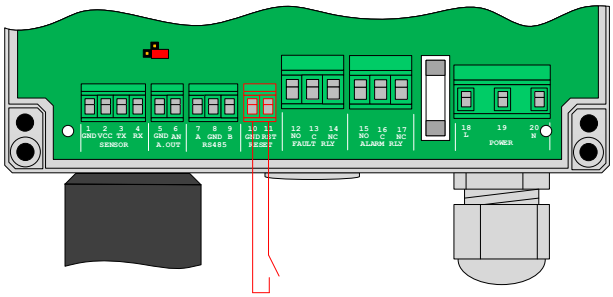


Fig 3.8.4 – Reset / Self-test input connection

3.8.5 Fault / Critical alarm and alarm relay connections

The fault / critical alarm and alarm relays can be connected to local alarm buzzers, beacons for local indication of faults and alarms. They can also be used by third party systems for fault and alarm monitoring.

Pin ID	Description
12	Fault / Critical Alarm – Normally open
13	Fault / Critical Alarm – Common
14	Fault / Critical Alarm – Normally closed
15	Alarm – Normally open
16	Alarm – Common
17	Alarm – Normally closed

The operation of the fault / critical alarm and alarm relays maybe inverted (set fail-safe), see section *4.11 Alarm and Fault relay failsafe operation.*

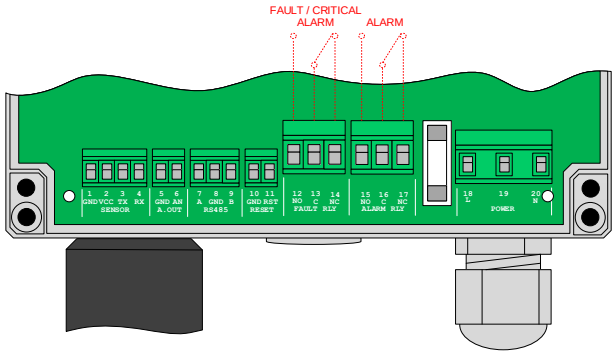


Fig 3.8.5 – Fault / Critical alarm and Alarm relay connections

The fault / critical alarm relay will operate as either a fault relay OR critical alarm relay – depending on the Setup Mode selected (see section *3.1 Dip switch sets 1 & 2*).

3.8.6 Power connection

The unit must be connected to a 24VAC or 24VDC power supply (100mA nominal load).

If 24VAC powered, the supply transformer must be SELV (Seperated Extra Low Voltage)

Pin ID	Description
18	24VAC L / 24VDC +
19	Not used
20	24VAC N / GND

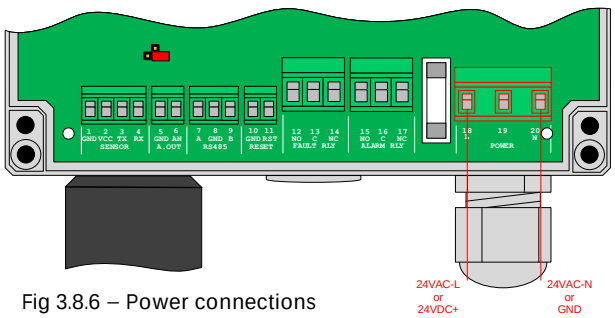


Fig 3.8.6 – Power connections

3.9 Fuse

The unit is fitted with a T500mA (0.5A Anti-surge) replaceable fuse.

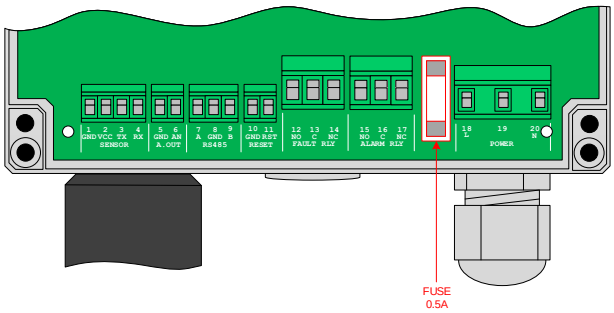


Fig 3.8.2 – Fuse

4. Unit operation

4.1 Configuration

The unit must be configured using the DIP switches by the installer (see section *3.1 DIP Switch sets 1 & 2*), if using the RS485 network interface some settings may also be configured via this interface. The following items may be configured;

Item	Configurable via
Alarm threshold	DIP switches or RS485 Modbus
Alarm / Critical alarm delay	DIP switches or RS485 Modbus
Critical alarm threshold	DIP switches or RS485 Modbus
Alarms / Critical Alarm latching or non-latching	DIP switches
Faults latching or non-latching	DIP switches
Alarm / Critical alarm relay failsafe or non-failsafe	DIP switches
Fault relay failsafe or non-failsafe	DIP switches

If the analogue output is to be used, the installer must also select the output range and type via the analogue output selection jumper link, see section *3.5 Analogue output selection jumper.*

If the buzzer is to be used, the installer must ensure the buzzer enable link is fitted, see section *3.3 Alarm buzzer & enable link.*

4.2 Warmup

When the unit is powered up, initially the unit will enter sensor Warmup mode, and will remain in this mode for 1 minute. During this time gas concentration measurements will not be made. Once warmup has been completed, gas concentration measurement will commence, however the fully specified performance may not be reached until the unit has been powered up for 2 hours.

The Power LED will remain steady AMBER whilst the unit is in warmup mode.

4.3 Gas concentration measurement

After the initial warmup, the unit will continuously monitor the gas concentration, until power is removed from the unit.

4.4 Pre-alarms

If a gas leak is present, and the gas concentration has exceeded the *Alarm threshold*, or *Critical Alarm Threshold* (if operating in dual threshold setup mode 2), but this has not yet exceeded the *Alarm Threshold* or *Critical Alarm Threshold* for the duration of the *Alarm Delay*, the unit will indicate a pre-alarm - the leak alarm LED will flash RED slowly (1 second ON, 5 seconds OFF).

4.5 Alarms & Critical Alarms

If a gas leak is present, and the gas concentration has exceeded the *Alarm Threshold*, and has exceeded the *Alarm Threshold* for the duration of the *Alarm Delay*, the unit will indicate an alarm – the leak alarm LED will turn steady RED and the alarm relay will change state. If enabled, the alarm buzzer will also switch ON and pulse ½ second ON, ½ second OFF.

If operating in dual threshold setup mode 2, and the gas concentration has exceeded the *Critical Alarm Threshold*, and has exceeded *the Critical Alarm Threshold* for the duration of the *Alarm Delay*, the unit will indicate an Critical alarm – the leak alarm LED will flash fast RED (1/8th second ON, 1/8th second off) and the critical alarm relay will change state. If enabled, the alarm buzzer will also switch ON steady.

alarms and critical alarms will clear once the gas concentration falls below *Alarm Threshold* or *Critical Alarm Threshold* minus 2% of the sensor full scale operation (ie 2% sensor full scale = *The Alarm Hysteresis*), or if power is removed from the unit.

4.5.1 Muting the alarm buzzer

The alarm buzzer maybe muted for 1 hour by pressing the reset button on the front panel of the unit, or activing the reset input.

If the alarm or critical alarm clears whilst the buzzer is muted, the buzzer will remain switched off until a new alarm, critical alarm or a self-test occurs.

4.6 Latched alarms

If set *Alarms Latching* or *Critical Alarms Latching*, when an alarm or critical alarm occurs and then clears, the alarm or critical alarm relay will remain in the alarm or critical alarm state and the Leak alarm LED will flash RED (½ second ON, ½ second OFF). The alarm relay and leak alarm LED will remain like this until either the alarm is reset (see section *4.10 Resetting latched alarms, critical alarm and faults*), a new alarm or critical alarm occurs, or power is removed from the unit.

4.7 Faults

If a fault develops within the unit or sensor element, the unit will indicate a fault – the power LED will turn steady RED. If operating in single threshold setup mode 1 the fault relay will also change state.

The unit will remain in fault until either the fault clears, or power is removed from the unit.

i Fault codes maybe accessed via the network interface, contact the manufacturer for details on fault codes.

i A fault will not occur if the unit fails to communicate to a Modbus master device.

i If faults are disabled via the RS485 Modbus Network, the power LED will switch off during normal operation.

4.8 Latched faults

If set to latch faults, when a fault occurs and then clears, the power LED will flash RED (½ second ON, ½ second OFF) and if operating in single threshold setup mode 1, the fault relay will remain in the fault state. The fault relay and fault LED will remain like this until either the fault is reset (see section *4.10 Resetting latched alarms, critical alarms and faults*), a new fault occurs, or power is removed from the unit.

i If using setup mode 2, faults will always latch the fault LED status.

4.9 Resetting latched alarms, critical alarm and faults

If a latched alarm, critical alarm or fault is present on the unit, these maybe reset by pressing the reset button on the front panel of the unit, activing the reset input or if power is removed from the unit. A latched alarm, critical alarm and fault may also be cleared via the network interface.

4.10 Alarm and Fault / Critical Alarm relay failsafe operation

Failsafe operation will invert the operation of each relay, as show below;

Alarm relay		
Terminal	Non-failsafe operation	Failsafe operation
Pin 15	**Open** contact when no alarm	**Closed** contact when no alarm
Pin 16	Common	Common
Pin 17	**Closed** contact when no alarm	**Open** contact when no alarm
Critical Alarm relay (if operating in dual threshold setup mode 2)		
Terminal	Non-failsafe operation	Failsafe operation
Pin 12	**Open** contact when no critical alarm	**Closed** contact when no critical alarm
Pin 13	Common	Common
Pin 14	**Closed** contact when no critical alarm	**Open** contact when no critical alarm
Fault relay (if operating in single threshold setup mode 1)		
Terminal	Non-failsafe operation	Failsafe operation
Pin 12	**Open** contact when no fault	**Closed** contact when no fault
Pin 13	Common	Common
Pin 14	**Closed** contact when no fault	**Open** contact when no fault

Failsafe operation allows third party systems to detect if power is lost to the unit, or if signal connections to the unit have been broken.

4.11 Warnings

The sensor may produce warnings whilst continuing to operate. Should this occur the Power / Fault LED will flash AMBER.

Warning codes maybe accessed via the network interface, contact the manufacturer for details on warning codes.

4.12 Front panel LED Indicators

The units front panel LED indicators operate as follows;

Power / Fault LED	
Green Steady	Unit working correctly, no faults, or warnings detected.
Off	Faults disabled via the RS485 Modbus network
Amber Steady	Unit warming up.
Amber Flashing	Unit in warning mode.
Red Steady	The unit has been configure to latch faults and a fault has previously been detected but has now cleared.
Red Flashing	Unit has detected a fault.
Leak Alarm LED	
Red Steady	An alarm has been detected and is still active.
Red Fast Flash (1/8th second ON/OFF)	A critical alarm has been detected and is still active (if operating in dual threshold setup mode 2).
Red Flash (1/2 second ON/OFF)	The unit has been configured to latch alarms and critical alarms and a alarm or critical alarm has previously been detected but has now cleared.
Red Slow Flash (1 second ON 5 second OFF)	The gas concentration is above the alarm or critical alarm threshold, but has not yet been above the threshold for long enough to generate an alarm.

When in Engineers mode or in Self-test, the front panel LED operation will differ from that explained above, see sections *4.15 Self-test* and *4.15 Engineers mode.*

4.13 Analogue output

The analogue output indicates the basic status of the unit, as well as the current measured gas concentration. The range and type of the output can be changed using the analogue output linl link, see section *3.5 Analogue output selection link.*

Unit state	4-20mA	0-10VDC	0-5VDC	0-100%
Fault	2mA	1VDC	0.5VDC	10%
Warmup	3mA	1.5VDC	0.75VDC	15%
PPM Value	4mA > 20mA	2VDC > 10VDC	1VDC > 5VDC	20% > 100%
Self-test	10mA then 0mA	5VDC then 0VDC	2.5VDC then 0VDC	50% then 0%

The analogue output value maybe overridden via the Network interface.

The analogue output will operate in the same manner regardless of the setup mode selected.

4.14 Self-test

The unit includes a self-test feature which can be used to verify the operation of the LED indicators, relays and analogue output. To initiate a self-test, press and hold the reset button on the front panel of the unit for 2 seconds, or activate the reset input for 2 seconds.

When the self-test is initiated, the unit will enter a 10 second self-test cycle;

Time	Power / Fault LED	Leak Alarm LED	Fault / Critical Alarm Relay	Alarm Relay	Alarm Buzzer	Analogue Output
0-5 secs	ON	ON	OFF (ON if set for failsafe operation)	ON (OFF if set for failsafe operation)	ON (Pulsing)	50%
5-10 secs	OFF	OFF	ON (OFF if set for failsafe operation)	OFF (ON if set for failsafe operation)	OFF	0%

A self-test may also be initiated via the network interface.

A self-test may only be initiated if the unit is healthy, the following conditions will stop a self-test occurring;

Alarm
Critical Alarm
Fault
Latched Alarm (the latched alarm must be cleared, before the self-test starts)
Latched Critical Alarm (the latched critical alarm must be cleared, before the self-test starts)
Latched Fault (the latched fault must be cleared, before the self-test starts)
Warm-up mode
Engineers mode

4.15 Engineers Mode – Factory reset

The engineer's mode allows access to special functions, such as a factory reset. To enable engineer's mode, DIP switch set 2 switch 8 must be switched ON. This switch is monitored continuously, and so power does not need to be cycled if this switch setting is changed.

When entering engineer's mode, the power / fault and leak alarm LED's will turn OFF. Pressing the reset button will toggle through each special function, the power / fault and leak alarm LED's will indicate the special function selected;

Button Press	Special Function	Power / Fault LED	Leak Alarm LED
1st	1. Factory Reset	ON (Flash 1 sec ON/OFF)	ON (Flash 1 sec ON/OFF)
2nd	2. Reserved for factory use only	ON (Flash 1 sec ON/OFF)	OFF
3rd	3. Reserved for factory use only	OFF	ON (Flash 1 sec ON/OFF)
4th	1. Factory Reset……	ON (Flash 1 sec ON/OFF)	ON (Flash 1 sec ON/OFF)

Once factory reset is selected, and indicated via the LED's – pressing and holding the reset button for 10 seconds will activate a factory reset – the LED's will flash at a faster rate once this is confirmed – and will then switch OFF.

If the engineer's mode is selected, but no reset button activation has been detected for 10 minutes – the unit will resume normal operation.

Special functions 2 and 3 are reserved for factory use only.

5. RS485 Network interface

The unit provides an RS485 network interface using the Modbus RTU communication protocol.

Baud rate : 9600bps
Data bits : 8
Parity : None
Stop bits : 1

5.1 Input registers

Input registers				
Function	**Start register number**	**Data type**	**Number of registers**	**Comment**
Concentration	0	uint16	1	Target gas concentration PPM reading after manipulation
Warmup	2	uint16	1	Indicates whether the sensor is in warmup 0 = Normal 1 = In Warmup
Warning status	3	uint16	1	Indicates sensor in any other warning condition (other than warmup) 0 = Normal 1 = Warning
Warning status flag	4	uint16	1	Flag Sensor warning reading: Mapped directly from sensor warning
Fault	5	uint16	1	Indicates whether any error is currently being reported from the sensor or the sensor is not communicating. 0 = Normal 1 = Fault
Fault latched	6	uint16	1	Indicates whether the fault LED / Relay is latched due to a previous error. 0 = Normal 1 = Fault Latched
Fault flag	7	uint16	1	Sensor error reading: Mapped directly from sensor error
Alarm	8	uint16	1	Indicates whether the alarm LED / Relay is activated due to current high PPM reading. 0 = Normal 1 = Alarm
Alarm latched	9	uint16	1	Indicates whether the fault LED / Relay is latched due to a previous high reading PPM 0 = Normal 1 = Alarm Latched
Alarm reset input	10	uint16	1	Indicates whether the alarm reset button / input is currently active. 0 = Normal 1 = Reset
Self test initiated	11	uint16	1	Indicates whether a self test is currently active. 0 = Normal 1 = Self test
Alarm reset input latched	12	uint16	1	Indicates whether the alarm reset button / input has been activated within the last 60 seconds 0 = Normal 1 = Reset
Self test initiated latched	13	uint16	1	Indicates whether a self test has been activated within the last 60 second 0 = Normal 1 = Self test
Firmware version	14	uint16	1	Unit firmware version
Sensor full scale value	57	uint16	1	Sensor full scale value converted to PPM for all sensor types
Critical Alarm	60	uint16	1	Indicates whether the critical alarm LED / Critical alarm /Fault Relay is activated due to current critical alarm high PPM reading. 0 = Normal 1 = Alarm
Critical Alarm latched	61	uint16	1	Indicates whether the fault LED / Relay is latched due to a previous critical alarm high PPM reading. 0 = Normal 1 = Alarm Latched
Engineers Mode	62	uint16	1	Indicates whether the unit is in Engineer mode. 0 = Setup mode 1 = Engineer mode

Input registers				
Function	**Start register number**	**Data type**	**Number of registers**	**Comment**
Setup Mode	63	uint16	1	Indicates in which set-up mode the unit is operating: 1 to 4.

Registers 1, 15 > 56, 58. 59 are reserved for factory use.

5.2 Holding registers

Holding registers				
Function	**Start register number**	**Data type**	**Number of registers**	**Comment**
Alarm threshold	0	uint16	1	PPM alarm threshold. Will initially be as value of DIP switch. May only be changed if DIP switch left set to lowest alarm threshold. Range 1 > 10000ppm
Alarm delay	1	uint16	1	PPM alarm & critical alarm delay Initially as value of DIP switch. May only be changed if DIP switch left set to 0mins. Range 0-60mins
Alarm reset	2	uint16	1	Reset latched Fault / Alarm "or'd" with Alarm reset button/input. 0 = Normal 1 = Reset. Returns to Normal once latch fault / alarm has been reset
Self test	3	uint16	1	Initiates a unit self test. 0 = Normal 1 = Self test. Returns to Normal once self test has been completed
Disable alarms	4	uint16	1	Disables all alarm detection control of relay and LED. 0 = Normal 1 = Disabled. Returns to Normal if power is reset.
Disable faults	5	uint16	1	Disables all fault (error) detection control of relay and LED. 0 = Normal 1 = Disabled. Returns to Normal if power is reset.
Override alarm relay	6	uint16	1	Forces ON alarm relay. 0 = Normal = Force On. Returns to Normal if power is reset.
Override fault / critical alarm relay	7	uint16	1	Forces ON fault relay 0 = Normal = Force On. Returns to Normal if power is reset.
Override analogue output	8	uint16	1	Forces the analogue output to a certain value. -1 - 100% - If set to -1 output is not overridden. Returns to -1 if power is reset. 0% = 0V or 0mA 100% = 10V or 20mA.
Critical alarm level	10	uint16	1	Critical alarm threshold in PPM. Will initially be as value of DIP switch. May only be changed if DIP switch left set to OFF OFF. Range 0-20000, but must be >= normal alarm threshold + alarm hysteresis. Cannot be set lower than the Alarm Level. Only active in set-up mode 2.

5.3 Modbus addresses

Modbus network addresses are set using DIP switch set 2, switches 1 > 5, addresses 1 > 32 and be used;

DIP Switch set 2 (SW2)					
Switch 1	**Switch 2**	**Switch 3**	**Switch 4**	**Switch 5**	**Sets *Network Address***
ON	OFF	OFF	OFF	OFF	Address 1
OFF	ON	OFF	OFF	OFF	Address 2
ON	ON	OFF	OFF	OFF	Address 3
OFF	OFF	ON	OFF	OFF	Address 4
ON	OFF	ON	OFF	OFF	Address 5
OFF	ON	ON	OFF	OFF	Address 6
ON	ON	ON	OFF	OFF	Address 7
OFF	OFF	OFF	ON	OFF	Address 8
ON	OFF	OFF	ON	OFF	Address 9
OFF	ON	OFF	ON	OFF	Address 10
ON	ON	OFF	ON	OFF	Address 11
OFF	OFF	ON	ON	OFF	Address 12
ON	OFF	ON	ON	OFF	Address 13
OFF	ON	ON	ON	OFF	Address 14
ON	ON	ON	ON	OFF	Address 15
OFF	OFF	OFF	OFF	ON	Address 16
ON	OFF	OFF	OFF	ON	Address 17
OFF	ON	OFF	OFF	ON	Address 18
ON	ON	OFF	OFF	ON	Address 19
OFF	OFF	ON	OFF	ON	Address 20
ON	OFF	ON	OFF	ON	Address 21
OFF	ON	ON	OFF	ON	Address 22
ON	ON	ON	OFF	ON	Address 23
OFF	OFF	OFF	ON	ON	Address 24
ON	OFF	OFF	ON	ON	Address 25
OFF	ON	OFF	ON	ON	Address 26
ON	ON	OFF	ON	ON	Address 27
OFF	OFF	ON	ON	ON	Address 28
ON	OFF	ON	ON	ON	Address 29
OFF	ON	ON	ON	ON	Address 30
ON	ON	ON	ON	ON	Address 31
OFF	OFF	OFF	OFF	OFF	Address 32

6. Maintenance

It is recommended a basic operational maintenance check is carried out annually;

It is advised to temporarily disable or override any remote alarm systems connected to the units relays or analogue output whilst carrying out a basic operational maintenance check.

1. Ensure the sensor head and filter and clean and clear of debris.

2. Carry out a unit self-test, press and hold the reset button on the front of the unit for 10 seconds to initiate a self-test (see section *4.16 Self-test*).

If the reset input is being used – a self-test should **ALSO** be initiated via this input as well.

3. Carry out a "bump" test to ensure the basic operation of the sensor.

HFC Sensors:

- Ensure that the alarm delay is set to the minimum and the alarm threshold is set to <200ppm when carrying out a bump test.
- For HCFC and HFC sensors use nail-varnish remover (Acetone) to stimulate the sensor. Simply shake the acetone container, remove the container lid and hold this directly onto the sensor, an alarm should occur.
- Ensure the alarm delay and threshold are reset to the required settings after completing a bump test.

CO2 Sensors:

- Ensure that the alarm delay is set to the minimum and the alarm threshold is set to >5000ppm when carrying out a bump test.
- To stimulate the sensor, simply breathe over it (human breath contains typically 4% or 40000ppm CO2) – an alarm should occur.
- Ensure the alarm delay and threshold are reset to the required settings after completing a bump test.

Recalibration of the unit is not required as part of the annual operational maintenance check.

6.1 Repairs

Faulty sensors maybe replaced by the user, contact the manufacturer for replacement sensor ordering information.

To replace the sensor:

- Ensure that power is removed from the unit.
- Remove the lid of the enclosure, disconnect the lid connection cable from the main PCB.
- Unplug the sensor connector (4 way plug, terminals 1, 2, 3, 4) and unscrew the connector form the sensor cables.
- Unscrew the sensor from the main enclosure.
- Screw the new sensor to the enclosure.
- Refit the connector to the sensor cables (see section *3.7.1 Sensor connection* for details), plug the sensor connector back on the main PCB.
- Reconnect the lid connection cable, refit the lid of the enclosure.
- Restore power to the unit.

For all other repairs, contact the manufacturer.

Appendix 1: Remote sensors

The unit maybe purchased for remote sensor mounting, and will be supplied with a mounting bracket and 3m cable, contact the manufacturer for details.

Connections for remote sensors supplied by the manufacturer;

Pin ID	Description	Colour
1	Ground	Black
2	VCC	Red
3	Data A	Green
4	Data B	White
Connect to GND	Screen	Black (Rubber Sleeve)

The cable maybe shortened if required – however the screen should always be used, and connected to GND.

3m is the standard cable length supplied for remote sensor mounting, do not extend the cable – contact the manufacturer if you require a greater cable length – maximum available 15m.

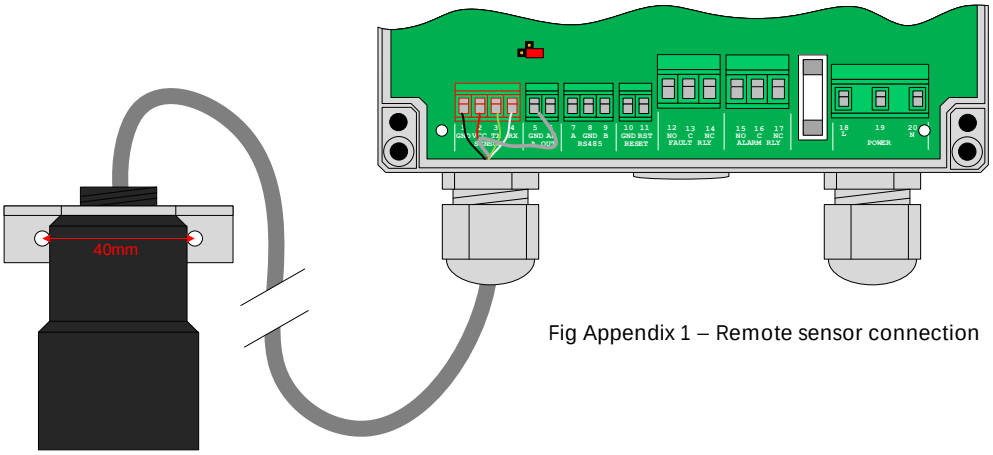


Fig Appendix 1 – Remote sensor connection

Appendix 2: Beacon interface PCB

A Beacon interface PCB is available from the manufacturer, to simplify wiring on site to warning beacon/buzzers.

The PCB provides switched signals direct to Beacon/Buzzers, for both the Alarm and Fault/Critical alarm outputs. The signals are protected by a 500mA PTC (auto reset) Fuse. The PCB simply plugs into the KSIR-SP01 main PCB via the Alarm and Fault/Critical alarm relay connector sockets.

The Beacon interface PCB has been designed to work with 24VDC beacon buzzers – available from the manufacturer.

Connector	Terminal	Description
Power Out	+	24VDC Power to KSIR-SP01 main board
	-	GND
Power In	+	24VDC Power in
	-	GND
Alarm	+	Switched 24VDC Alarm signal
	-	GND
Flt/Crit	+	Switched 24VDC Fault / Critical Alarm signal
	-	GND

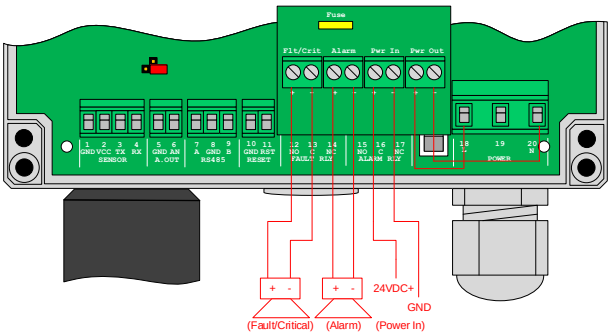


Fig Appendix 2 – Beacon interface PCB connections

Appendix 3: Installation practices, what looks good

The following diagrams show preferred installation examples, for various scenarios on site.

General notes;

1. Use screws with wall plugs for brick and plaster walls.
2. Use self-drilling screws for coldroom wall mounting.
3. Always use ferrule crimps.
4. Use PVC conduit glue for securing parts together.
5. Use a spirit level.
6. Drilling additional holes in the main enclosure may invalidate the warranty.

Summary of recommended parts;

20mm rigid white conduit – RS 917-2139 – Screwfix 57073
20mm white conduit saddle – RS 917-2006 – Screwfix 35862
20mm white conduit coupler – RS 917-2004 –Screwfix 63776
20mm white flexible conduit – RS 250-7799 – Screwfix 38177
20mm white conduit fitted (with bush) – RS 917-2056 – Screwfix 70059
20mm white conduit terminal box – RS 917-2050 – Screwfix 82434
10mm grey flexible conduit – RS 429-688
PVC Conduit glue – RS 179-6160 – Screwfix 5327V

i These parts are referenced for guidance only, similar parts maybe used from other suppliers.

Remote sensor – standard wall mounting;

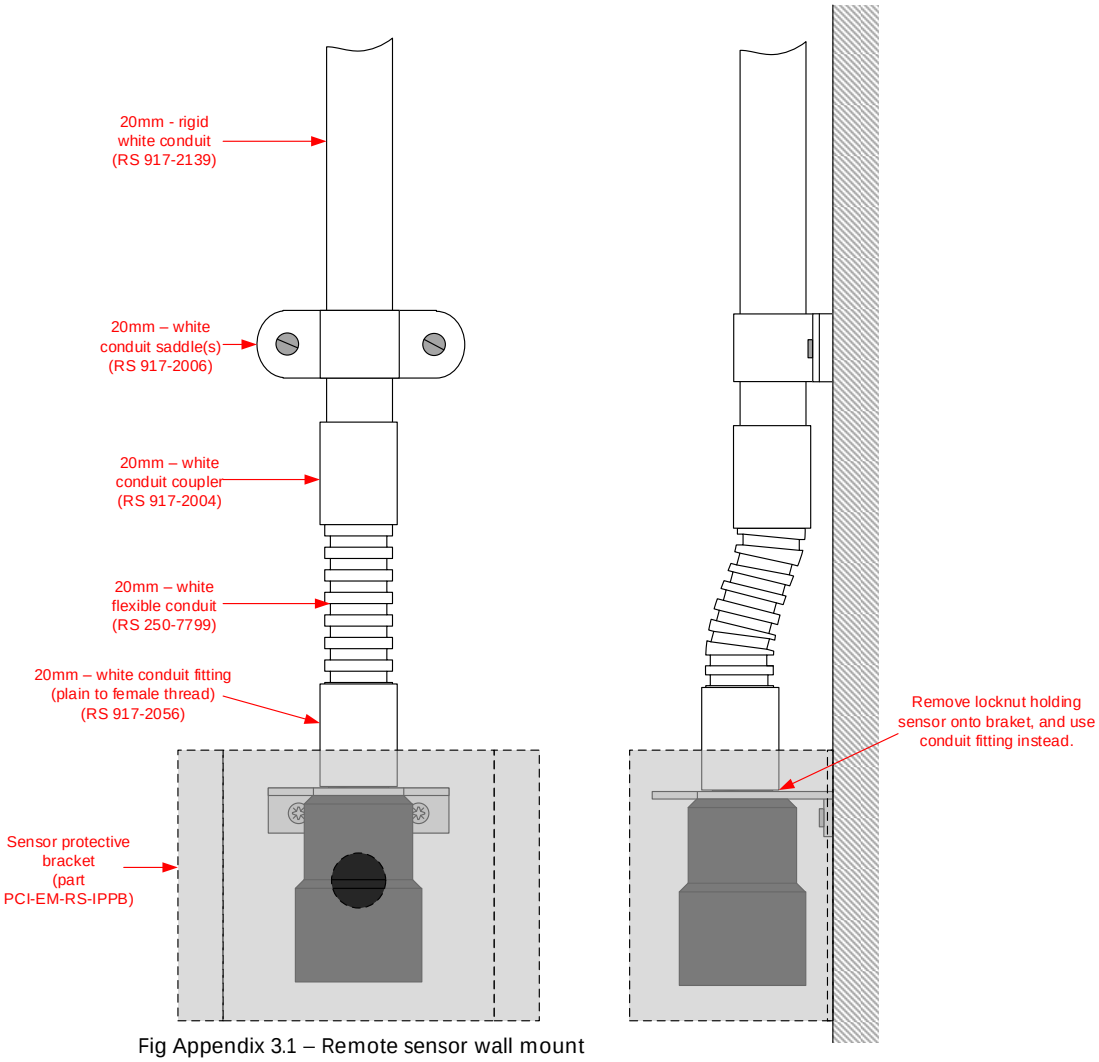


Fig Appendix 3.1 – Remote sensor wall mount

Remote sensor – inside coldroom mounting;

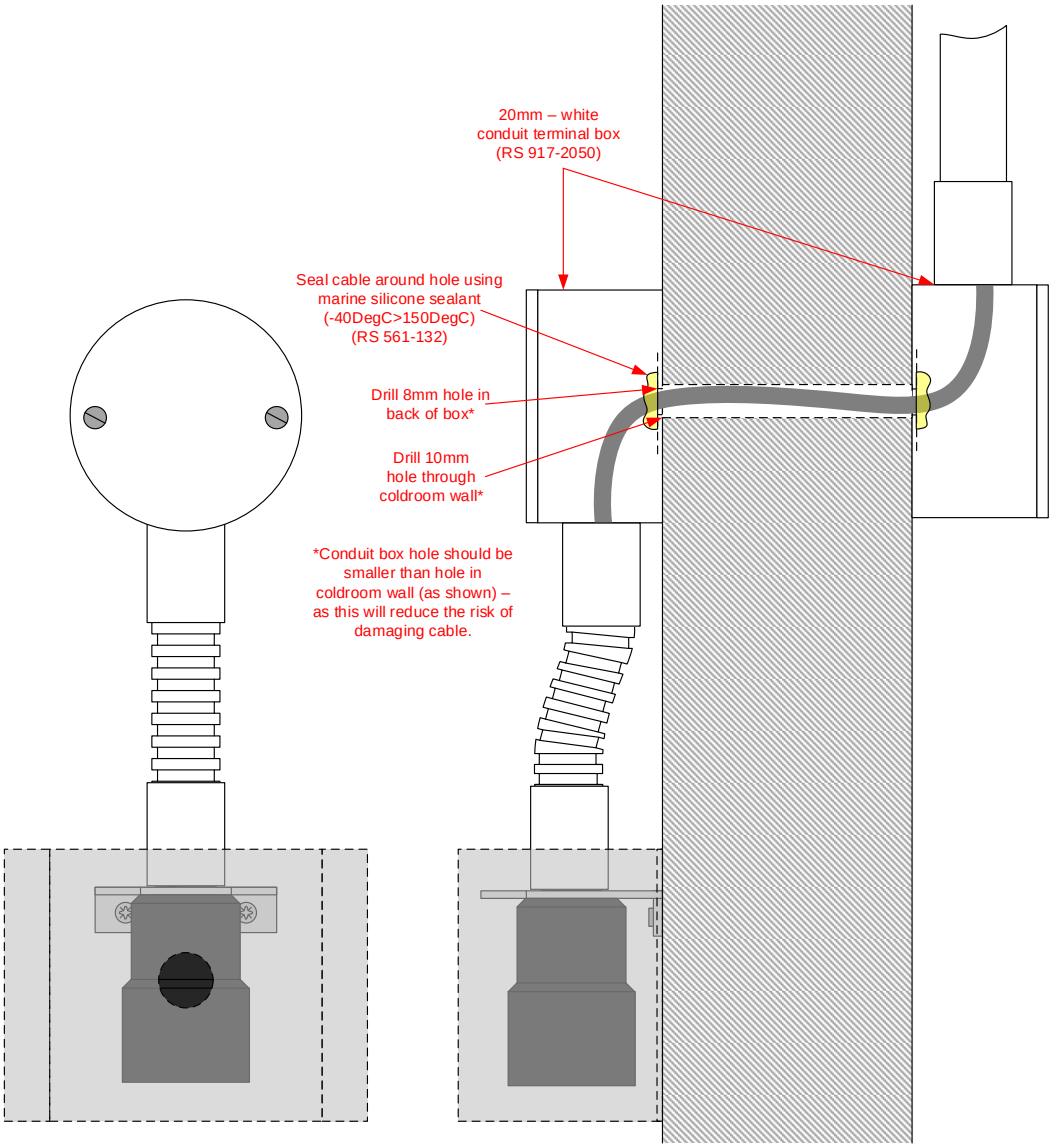


Fig Appendix 3.2 – Remote sensor coldroom wall mount

Remote sensor – inside coldroom mounting, limited access to exterior coldroom wall;

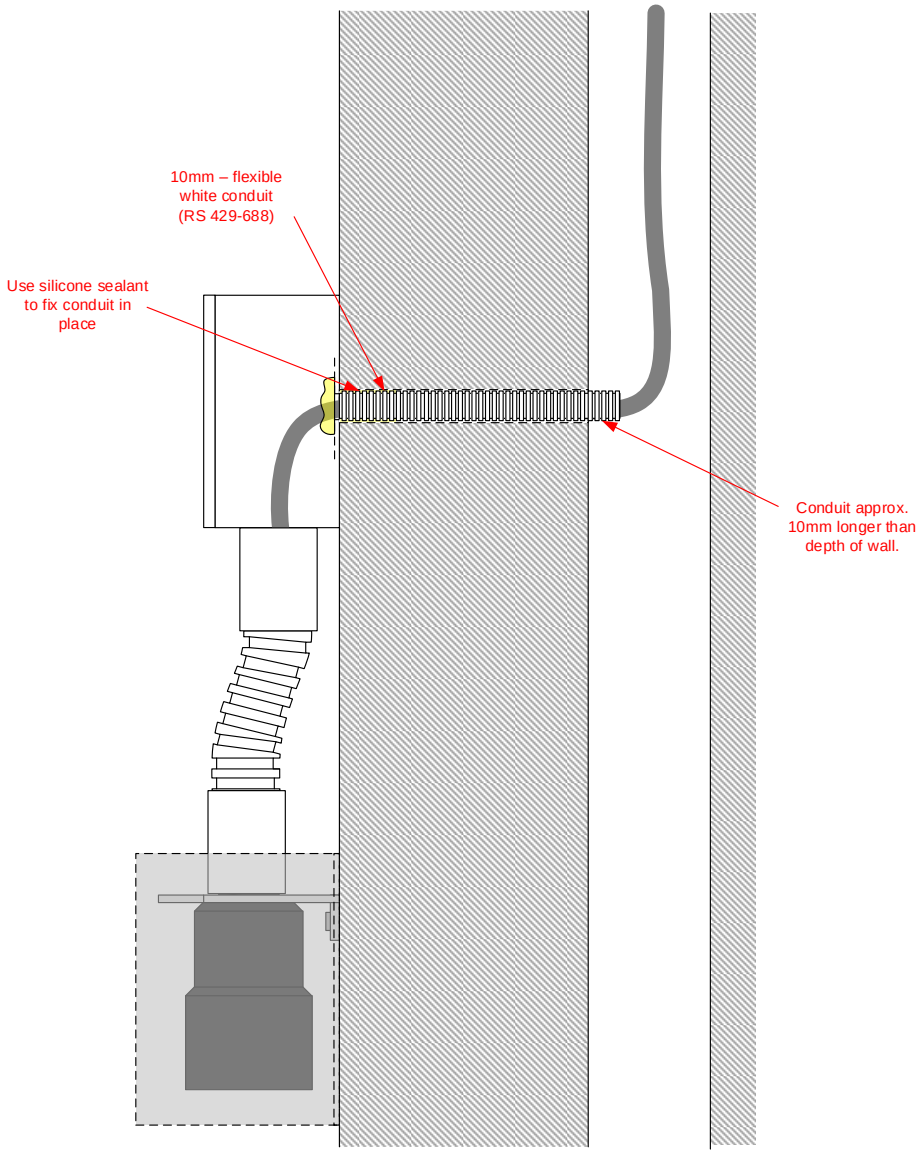


Fig Appendix 3.3 – Remote sensor coldroom wall mount, limited access

KSIR-SP01 main unit mounting;

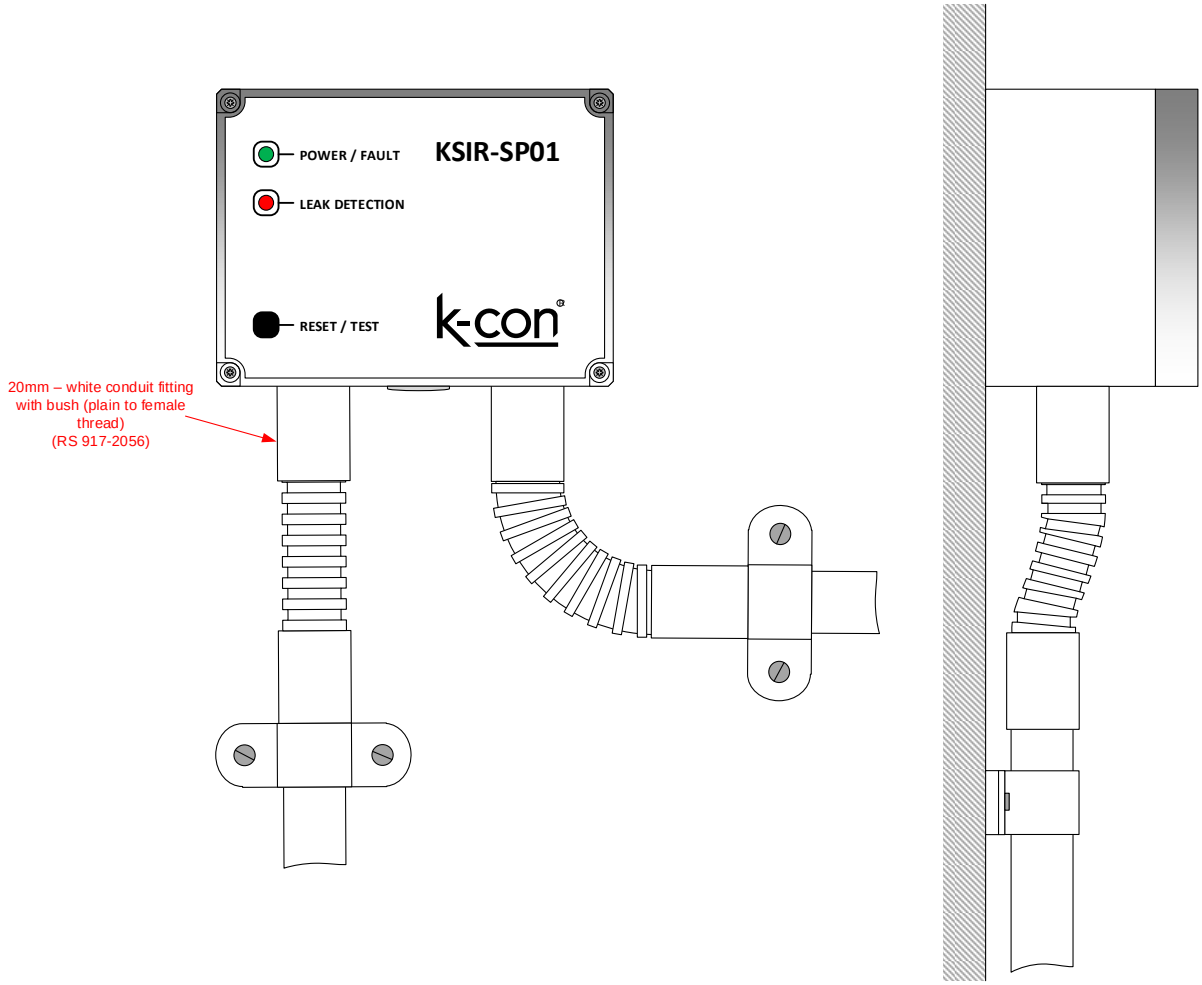


Fig Appendix 3.4 – Unit mounting

Revisions

Software version : 17
Release date : 21/02/2018

1.0	13/02/2017	First Draft – KR
1.1	24/02/2017	Added maintenance details – KR Amended specification Corrected fuse rating Added remote sensor details
1.2	24/02/2017	Corrected wire colors on remoter sensor connection – KR
1.3	07/03/2017	Enclosure gland entries reduced – KR Various minor amendments and corrections CO2 alarm thresholds changed Updated formatting style
2.0	21/06/2017	Updated self-test operation - KR Modbus registers updated Added setup modes and dual alarm thresholds Added full network address list setup details Added figure numbers New engineers mode factory reset feature added
2.1	15/09/2017	Updated power supply details – KR
3.0	18/10/2017	Added warning and information symbols - KR Updated remote sensor screen connection
3.1	20/11/2017	Added declaration of conformity – KR
3.2	22/03/2018	Added Beacon interface PCB details – KR
3.3	19/09/2018	Amended list of gases supported - KR
3.4	12/11/2018	Added power rating - KR Added "what looks good section" to appendix
3.5	06/12/2018	Update refrigerant guidance notes – KR Added additional notes for DIP switch setup for other gases, including Propane

Notes