IRNET-PRO IR SENSOR SERIES

INSTALLATION, MAINTENANCE, SAFETY EMPLOY HANDBOOK

- MT2415 -

REV: 18

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1.Introduction

The IRNET family of infrared gas detection sensors use the technique of NDIR (Non Dispersive Infrared) to monitor the presence of *hydrocarbons, carbon dioxide, SF6 and refrigerant gases*. This technique is based on the fact that the gas has unique and well-defined light absorption curve in the infrared spectrum, that can be used to identify itself. The gas concentration can be determined by using a suitable infrared source and analysing the energy absorption of the light that passes through the gas.

The IRNET-P sensor contains the necessary optics, electronics and firmware to provide an output that is linearized, and temperature compensated, proportional to the concentration of the target gas.
The standard version is provided with both analogue (voltage or dynamic pellistor) and digital output.
The IRNEX-P version is provided also with some features that make it available for the use in hazardous classified areas.
IRNET PRO is a family of IR sensors for different kind of applications.
IREF LITE version is the latest product launched, designed for low cost application for refrigerant gas detection.
Here are listed the main characteristics of each version:

Sensor Features								
Sensor Type	**Size 20 mm**	**Size 32 mm**	**Atex/IECEx Certification**	**CO2/HC Gasses**	**SF6/Ref. Gasses**	**Constant Power**	**Bridge Mode**	**Threshold mode**
IRNET PRO	X	X		X		X	X	
IRNEX PRO	X		X	X		X	X	
IREF PRO		X		X	X			
IREF LITE		X			X			X

2. Function

The sensor consists of an infrared light source, an optical cavity, a dual output pyroelectric detector, a thermistor to monitor the temperature and the appropriate electronic circuits.

The gas diffuses into the optical cavity through a special PTFE membrane designed to enhance the ingress protection (IP) of gasket enclosures. Inside the cavity, the lamp emits an infrared pulsing radiation that gets partially absorbed by the gas present.

The pyroelectric detector is sensitive to the changes in terms of thermal energy and returns two output signals in response to the pulsed light from the infrared light source:
an active output signal that decreases in amplitude when the target gas is present in the cavity (the thermal energy of the light gets absorbed by the gas)
a reference output signal that measures the light intensity of the infrared source (this signal remains unaffected by the presence of target gas).

Correct sensor functionalities are guaranteed inside its own measurement range and under operating specification (temperature, humidity, gas concentration range). See chapter 4 for details.

Thermistor measures the sensor internal temperature that is being used to correct the temperature deviations of the sensor components, this temperature is normally higher than ambient temperature.

Inside the sensors, is present the appropriate electronic front-end to process these signals and give out a signal proportional to the target gas. All the IRNET sensors are available in two different pin-out:

<u>Standard 5 pins version</u>
In the standard **5 pins*** version of IRNET-P, the sensor provides an analogue output (voltage or dynamic pellistor, linearized and temperature compensated) and digital communication (serial protocol available on request).
The output signal levels of analogue output signal in zero and full-scale conditions can be customized at customer's request.
Digital output is a UART format, comprising 8 data bits, 1 start bit, 1 stop bit and no parity.
Contact N.E.T. for protocol details.

<u>3 pins version</u>
The **3 pins*** version Is a direct pellistor replacement, it has no communication pins and provides only the analogue output. (voltage or dynamic pellistor, linearized and temperature compensated)
The output signal levels of analogue output signal in zero and full-scale conditions can be customized at customer's request.

*IREF LITE version is only available with negative polarity and 5 pin version.

3. Identification Code

The IRNET-P sensor is available in several different models; for carbon dioxide, hydrocarbon, SF6 and refrigerant detection in various ranges. The sensor part number of is composed according to the scheme below:

Part number: INP 20 – CO2 1 – NC VS N – 3S

Options available

Pin number & certification:
3 = 3 pin version without SIL certification
3S = 3 pin version with SIL certification
S = 5 pin version with SIL certification
(Left blank) = 5 pin version without SIL certification

Polarity
N = Negative
P = Positive

Output:*
VS = standard voltage output [0.4 V—2 V] dc
VR = customized rising voltage output
BR = customized rising bridge output [Vcc/2 ± Δ)] dc
(not available in low power version and 32mm series)

Certification:
NC = not certified
AX: ATEX certified (not available in 32mm series)
EX: IECEx certified (not available in 32mm series)

Range:
L = 0-100% LEL (hydrocarbons, R1234yf, R1234ze and R32 according to IEC 60079-20-1)
V = 0 - 100% vol (methane, propane and CO2)
D = 0 -10 %vol
T= 0 - 20% vol (CO_2)
P = 0 - 5000 ppm (CO_2)
1 = 0 - 1% vol (CO_2)
2 = 0 - 2% vol (CO_2 and propane)
4 = 0 – 4.4& vol (methane)
5 = 0 - 5% vol (CO_2 and methane)
B= 0-2000 ppm (SF_6 and refrigerant gasses)
M= 0-1000 ppm (SF_6)

*Gas**:*
CO2 = CO_2
CH4 = Methane
ETH = Ethane
PRO = Propane
PRY = Propylene
BUN = Butane
BUI = Isobutane
SF6 = Sulfur exafluoride
R134A = Tetrafluoroethane
*Other refrigeran gasses****

Size:
20 = 20 mm diameter (not available IREF version)
32 = 32 mm diameter (not available in low power version)

Sensor type:
INP = for hydrocarbons and CO_2
IFP = for SF6 and refrigerant gasses (ppm and LEL range)
IFL = for IREF LITE (LEL range)

* In case of customized VR output the requested zero and full range voltage must be indicated in the order. In case of customized BR output the requested sensitivity, voltage must be indicated in the order.
(e.g. 100mV=100% sensor full-scale)

** Sensors are fully characterized for these gases and the calibration is performed each time with the specific gas.
For other hydrocarbons on request, N.E.T can verify the feasibility and provide a correction factor based on the response of a Propane sensor for each target gas. Please refer to **"MT3456"** for 20 mm and **"MT4007"** for 32 mm, for more information.
For refrigerant gases please refer to **"MT5762"** for cross reference factor calculation.

*** Other refrigerant gasses are available, please see website for further information.

4. General Technical specifications

Product Specifications

General	**Operating temperature range**	-40 to +60 °C; (IREF -20°C to +50°C) ;(IREF LITE 0-50°C)
	Storage temperature range	-40 to +85 °C
	Operating humidity range	0-95% non condensing
	Gas types	CH_4, C_3H_8, CO_2, SF_6, R134A other refrigerant gasses
	Weight	44 grams (IRNET-P-32, IREF-P-32 and IFL-P-32) 22 grams (IRNET-P-20)
	MTBF	≥ 5 years
	Patent information	MI2013A000478, EP14001065, US14/219631, CA2.847.491
	Software and digital technology	Designed for use in a detector that complies to EN 50271
	Electromagnetic Compatibility (EMC)	Designed for use in a detector that complies to EN 50270
	Optic	Metal optical path opportunely treated to increase brightness and prevent oxidation
	Enclosure	Stainless steel
	Calibration	Individually calibrated with temperature compensation, test report supplied.
Measurement	**Sensing method**	NDIR (active and reference signals)
	Measurement range	0-100% LEL (hydrocarbons, R1234yf, R1234ze and R32 according to IEC 60079-20-1) 0 - 100% vol (methane, propane and CO2) 0 - 10% vol (CO_2) 0 - 20% vol (CO_2) 0 - 30% vol (CO_2) 0 - 5000 ppm (CO_2) 0 - 1% vol (CO_2) 0 - 2% vol (CO_2 and propane) 0 - 4.4% vol (methane) 0 - 5% vol (CO_2 and methane) 0 - 2000 ppm (SF_6 and refrigerant gasses) 0 - 1000 ppm (SF_6)
Electrical	**Power voltage**	3.0-5.5 Vdc (IRNET-P-20) 3.5-5.5 Vdc (IRNET-P-32) 4.5-5-5 Vdc (IREF & IREF LITE)
	Operating current	75-85 mA Idc (IRNET-P-20) 50-55 mA Idc (IRNET-P-20 low power version) 110-120 mA Idc (IRNET-P-32) 85 mA Idc averaged @ 5Vdc (IREF)
	Warm up time	60 s for full operation @ 25 °C At least 30 min for full specification @ 25 °C
Communication	**Digital communication**	MODBUS protocol communication (available on request)
Signal Output	**Analog output (voltage mode)**	Standard voltage [0.4 V—2 V] dc (other voltages available on request)
	Analog output (bridge mode)	[Vcc/2 ± Δ)] dc (Δ value is to be specified by the customer) (not available in 32mm versions)

4.1 SIL certification details

SIL Certification Details		
Certification	SIL certification number	PS-23125-22-L-01
	Reference standards	EN 50402:2017; EN 61508:2010 parts 1 to 7
	Systematic and random integrity	SIL3 capable, SIL2 or SIL3 depending on configuration
	Performance approval	Designed for use in a detector that complies to IEC EN 60079-29-1

4.2 Atex/IECEx certification details (IRNEX-P)

ATEX/IECEx Certification Details		
ATEX certification	Certificate number:	CESI11ATEX039U by Notified Body CESI
	Reference standards:	EN IEC60079-0:2018, EN60079-1:2014, EN60079-11:2012, EN50303:2000
	ATEX marking:	II 2G Ex db IIC Gb I M2 Ex db I Mb I M1 Ex db+ia I Ma
	Rating:	Vmax=5.5 V, Imax=100 mA, Ui=5.5 V, Ii=100 mA
IECEx certification	Certificate number:	IECEx CES 12.0008U by Notified Body CESI
	Reference standards:	IEC60079-0:2017, IEC60079-1:2014, IEC60079-11:2011
	IECEx marking:	Ex db IIC Gb Ex db I Mb Ex db + ia I Ma
	Rating:	Vmax=5.5 V, Imax=100 mA, Ui=5.5 V, Ii=100 mA

5. Electrical connections and Employ

5.1 Power supply (V+ and V- pins)

These pins must be connected to the voltage power supply in the correct manner. Positive version has the two pins switched in respect to the Negative version.

The operative voltage range of the IRNET sensors are:
32mm IRNET version can be powered at 3.5V-5.5V (except IREF sensors)
32mm IREF and IREF LITE versions can be powered at 4.5V-5.5V
20mm version can be powered at 3V-5.5V (available in both negative and positive versions).

Operation outside the above limits will results in a fault indication or wrong sensor functionality.

5.2 Digital interface (TX / RX pins)

The standard (5pins version) IRNET-P sensor is provided with 2 pins for TX and RX communication.
Standard Communication speed for 32mm series: 4800bps*
Standard Communication speed for 20mm series: 38400bps*

The digital communication pins TX / RX operate at a 2.8V logic levels, whereas IREF LITE product operates at 3,3V logic levels

Digital Communication		
Digital Interface	**Digital signal format**	8 data bits, 1 stop bit, no parity
	Standard Baud rate	38400 bps as Default; 4800,9600,19200 bps

(Serial communication protocol available on request)
** Other communication speeds are available on request.*

5.3 Output (signal pin)

<u>Voltage output</u>

The signal pin provides a linearized and temperature compensated analogue output that is proportional to the gas concentration:
Standard voltage output is [0,4 – 2 V] dc (see figure below) otherwise the zero and full-scale voltage level can be configured to customer specification.
In case of customized voltage output in the purchase order should be selected the VR code and the corresponding zero and full-scale levels should be indicated.

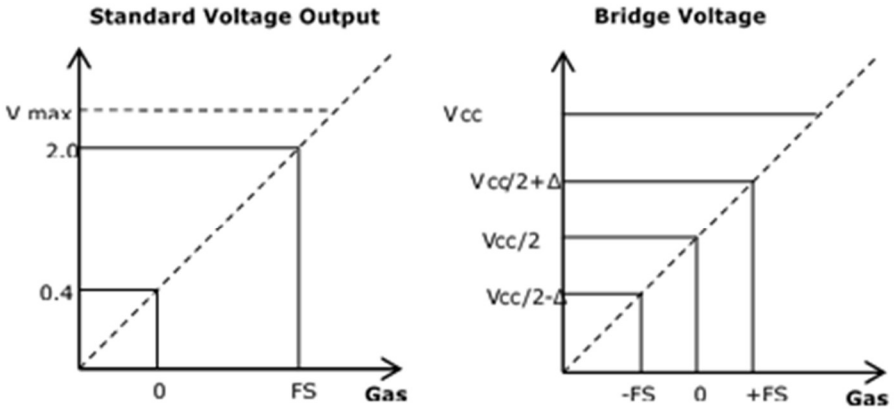


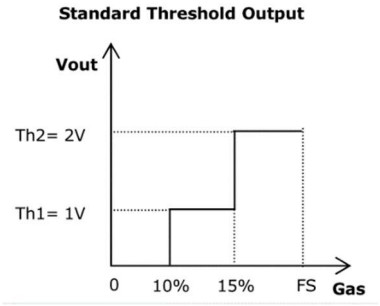
Fig. 2 Characteristics of output voltage

Bridge output
(not available in 32mm versions)

Bridge voltage output should be selected when replacing a pellistor type sensor. In this case, the output voltage level varies between Vcc/2 and Vcc/2 ± Δ (see the above figure 2).
The default level for Δ is 100mV otherwise this value can be configured to customer specification.
In case of bridge mode two different modalities are available:
Bridge rising mode (BR): Vcc/2 + Δ
Bridge falling mode (BF): Vcc/2 – Δ
Referring output voltage reading between Vout and GND.
Inside the purchase order should be selected the BR code and the Δ level should be indicated.

Threshold output

This output is available only inside IREF LITE product, in this case the analogue output has two threshold levels selectable through digital communication, standard threshold levels are imposed by default to 10% and 15% F.S whereas analogue output levels are associated to 1V and 2V.
User can change these levels as preferred.



5.4 Sensor calibration

IRNET-P sensors are factory calibrated with the target gas at various temperatures, in order to set the various internal coefficients for the gas concentration calculations and the correct functionality in the complete temperature range.
A calibration report is supplied along with the sensors, in a CD-ROM/USB Key (.pdf files) or in paper format.
All the IRNET sensors carry out a calibration warranty guaranteed for 1 year from the calibration date.

5.5 Sensor power up

To guarantee a correct linearity and functionality of the sensor, the installation and power up must be performed in a clean environment.

5.6 Warm-up time

Once powered-on, the voltage at the signal pin is held at “zero voltage” value. This condition is maintained for a default “warm-up” time of 60 seconds; after this time, the output voltage represents the calculated gas value.
The output level that is read using the digital communication is held at zero and the corresponding warm-up condition is indicated inside the proper register.
To meet accuracy specification, IRNET sensor could take up to 1 hour, it is due to the thermal stabilization time.

5.7 Target gas

Sensors are fully characterized for a number of gases and the calibration is performed each time with the specific gas.
N.E.T. can supply sensors fully characterized for these gases:

CO2 (CO2): 0-5000ppm, 0-1%vol, 0-2%vol, 0-5%vol, 0-10%vol, 0-20%vol, 0-100%vol
CH4 (Methane): 0-100% LEL (0-4.4%vol, 0-5%vol), 0-100%vol
ETH (Ethane): 0-100% LEL (0-2.4%vol)
PRO (Propane): 0-100% LEL (0-1.7%vol, 0-2.1%vol), 0-100%vol
PRY (Propylene): 0-100% LEL (0-2%vol)
BUN (n-Butane): 0-100% LEL (0-1.4%vol)
BUI (Iso-Butane): 0-100% LEL (0-1.3%vol)
SF6 (Sulfur exafluoride): 0-1000ppm, 0-2000ppm
R134a (Tetrafluoroethane): 0-2000ppm
Other refrigerant gasses available

For the complete list of refrigerant gasses available please refer to website.

5.8 Fault status

The sensor constantly makes controls on the status of internal components, like active and reference signals levels, power supply etc. These controls ensure that the sensor is operating within its correct parameters, and that no internal faults are present.
If any fault condition is detected, in case of a standard voltage output configuration or threshold mode, the output value is set to 50% of the zero value (the output will be set to 0,2V under fault conditions). This means that in order to clearly identify the fault status, the minimum voltage for the customized output zero level is 0,2V.
If the bridge output is used, the output value under fault condition is zero level – Δ (in case of rising mode) or zero level + Δ (in case of falling mode).
If the digital communication is used, in case of fault, the concentration is set to -20% F.S. and the corresponding error is shown in the proper register.

5.9 Over-range

If the gas concentration exceeds the full-scale range, the sensor's output will be blocked at 120% of the full-range value (for standard voltage, 2.32V; for bridge rising voltage, zero level +120% of Δ; for bridge falling voltage, zero level -120% of Δ). The sensor will return to normal behaviour as the gas concentration decrease.
The linearity of the output is only guaranteed up to the full-scale of the sensor.
In case of threshold mode output, maximum analogue output level is blocked to the second threshold level.
If customer wants to perform an over-range test with target gas (with 100 % volume or a value higher than sensor full scale), use a flow rate lower than 0,5 lit./min. If it's used a flow rate higher than 0,5 lit./min the sensor can generate SW_ERROR, this condition could be also present in case of excessive gas concentration used for the test (see **"MT3701 MODBUS Manual"** for details).

5.10 Cross sensitivity

N.E.T. can provide cross references factors to detect other hydrocarbons gases using a Propane sensor with range 0-2.1% vol as reference. These coefficients are meant to be set on the detector as a correction of the detector's gas reading. N.E.T. can supply cross reference factors for some gases, please refers to the specific manual for detailed list of gases:
(LEL values are set according to IEC 80079-20-1)

These are codes of the specific document: **"MT3456"** for 20 mm and **"MT4007"** for 32 mm.

For refrigerant gases please refer to **"MT5762"** for cross reference factor calculation.

5.11 Threshold mode functionality

IREF-LITE sensors have the possibility to set two thresholds levels (for analogue output).
It's possible to set analogue output in order to have 2 different levels once gas concentration overcome the threshold level.
In the sensors are present 6 registers to set parameters of two different threshold levels:

- **Threshold1/2:** represent values of threshold level, this value is expressed as % FS
  It is possible to use only one of the two thresholds, in this case it is only needed to set to 0 the respective value of Threshold 2 register
  Values inserted in these registers should be positive and between 3 and FS value
  Threshold 1 and Threshold 2 should be set at different levels
  Thresholds level should be set at value higher than hysteresis value
  Threshold 2 should be higher than Threshold 1

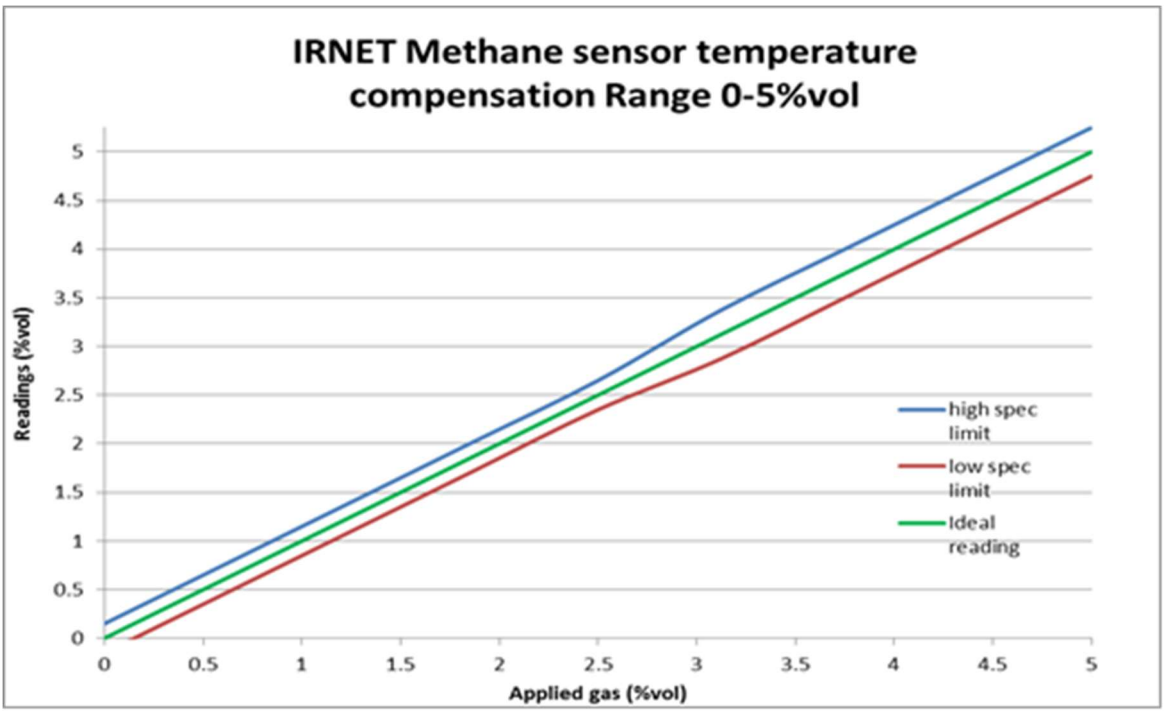
- **Hyst 1/2 LOW cost:** it is the value of hysteresis of threshold level.
- This value is expressed as % FS.
- In case concentration is higher than threshold 1 then once the concentration will decrease, threshold 1 condition will be maintained until gas concentration will be higher than Threshold 1- Hyst 1, the same is valid also for threshold 2.
  Hysteresis value should be lower than threshold 1 and threshold 2 levels
  Difference between Threshold 1-Hyst 1 must be lower than Threshold 2-Hyst 2 value
  Difference between Threshold 1-Hyst 1 must be higher than 3.

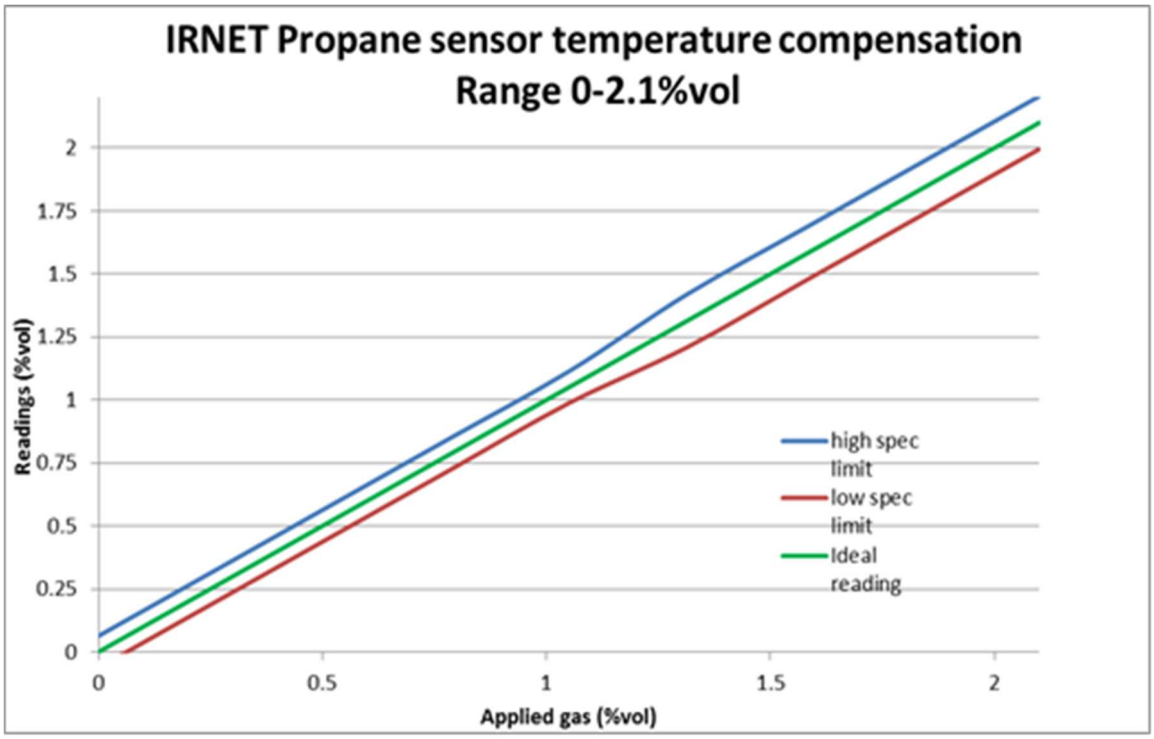
- **Analog Threshold1/2:** it's the value of analogue output associated to the threshold levels.
  Analogue threshold value should be set between 0,5 and 2,0 V
  Analogue threshold 1 should be set at value lower than Analogue threshold 2

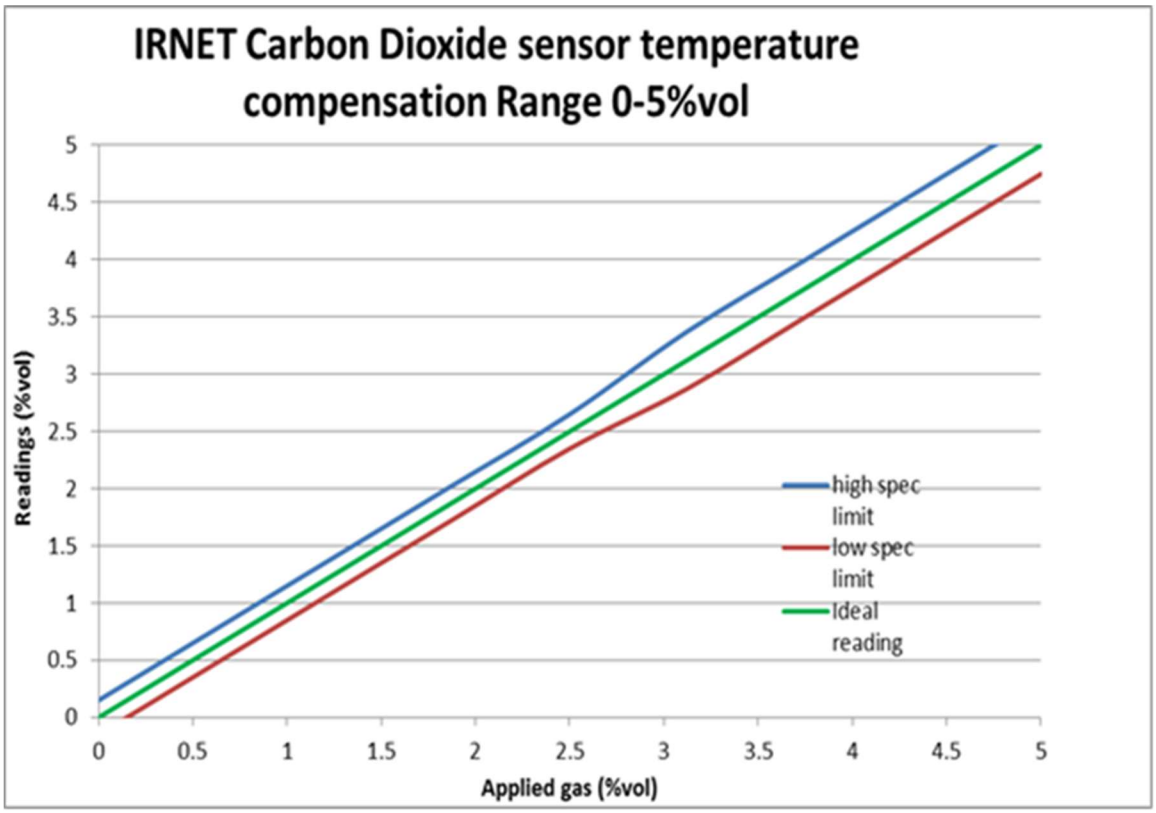
Analogue threshold 1 and Analogue threshold 2 should be set at different levels

5.12 Temperature compensation

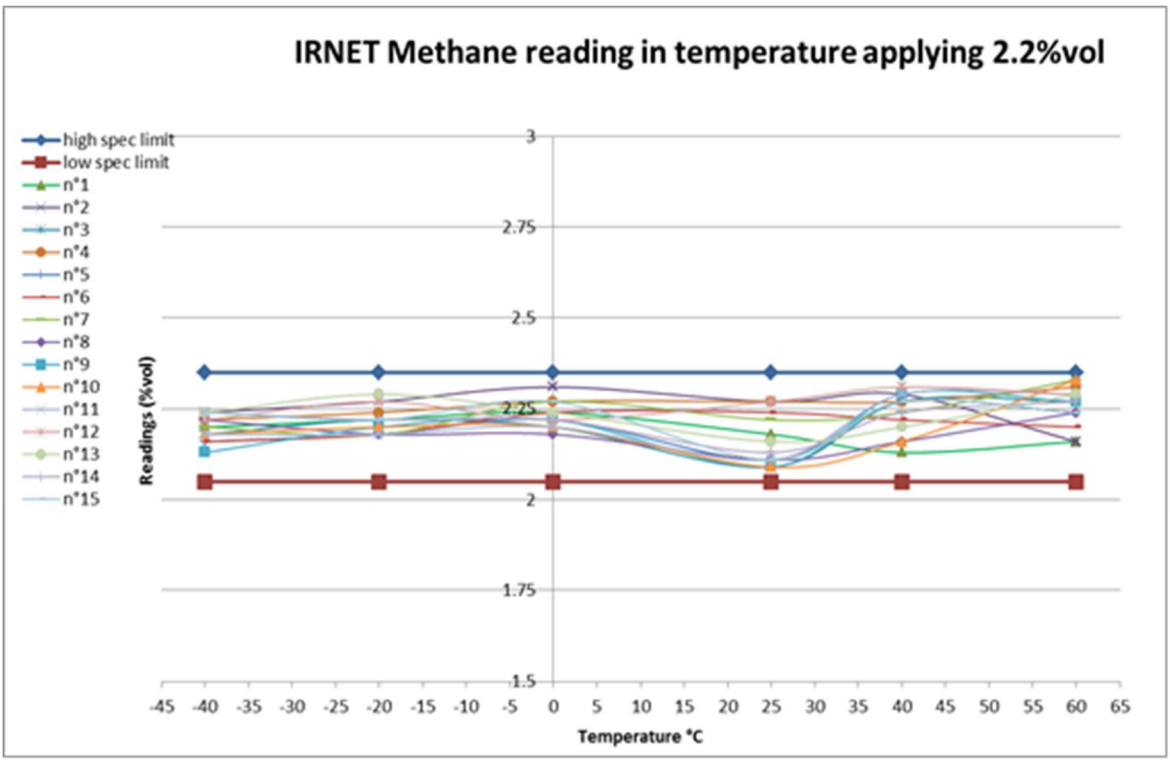
Sensors are tested individually in climatic chambers at temperature extremes to adjust the internal thermistor compensation. Performances in the temperature range are depending by the specific sensor that is used.
Once is used a calibration correction factor, the temperature performances defined in the datasheet may not be valid because the temperature compensation is based on the base sensor and there may be errors in the cross-referred readings at temperatures different from the calibration temperature.

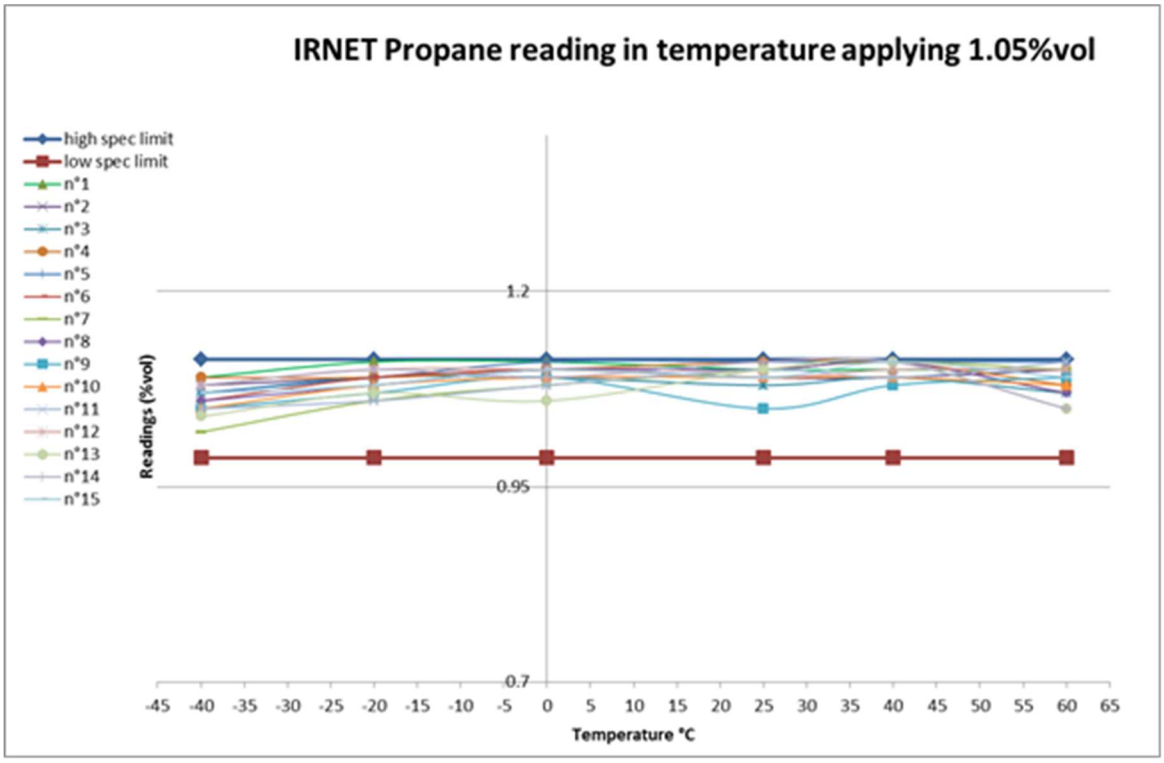



IRNET Propane sensor temperature compensation Range 0-2.1%vol
Readings (%vol)
Applied gas (%vol)
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
0
0.5
1
1.5
2
high spec limit
low spec limit
Ideal reading


IRNET Carbon Dioxide sensor temperature compensation Range 0-5%vol
Readings (%vol)
Applied gas (%vol)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
high spec limit
low spec limit
Ideal reading

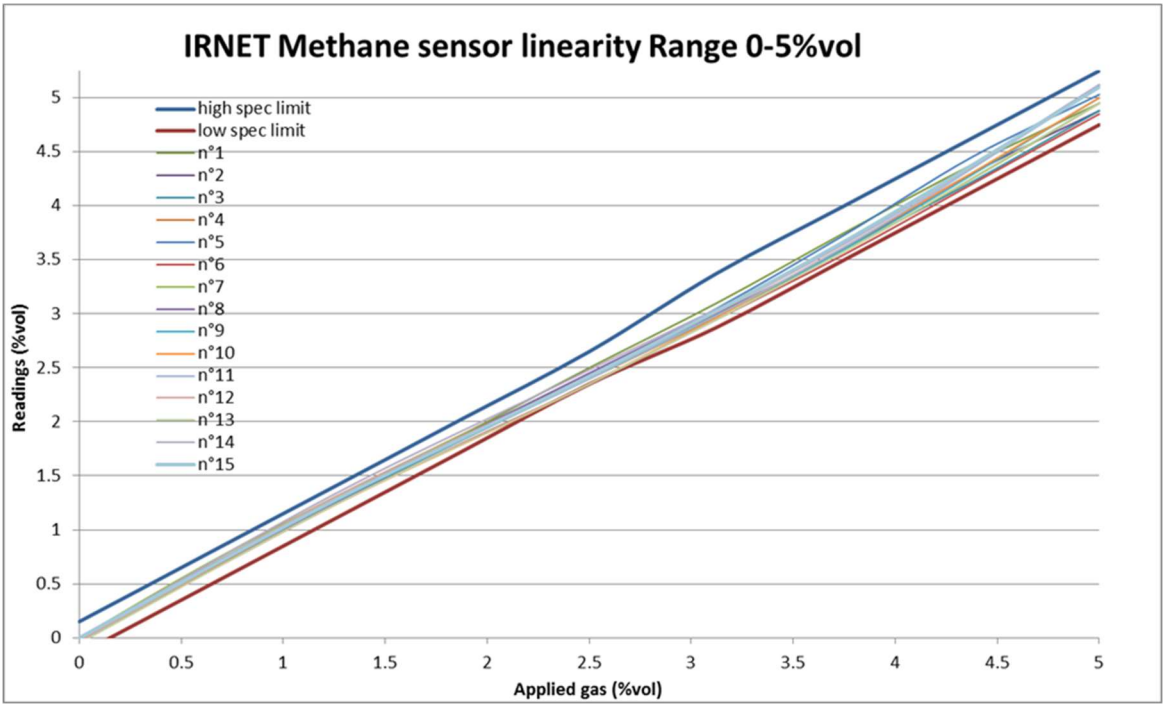
In the following graphs are showed the data measured on15 sensors of Methane and Propane applying 50% FS gas at different temperature (-40°C, -20°C, 0°C, 25°C, 40°C and 60°C).

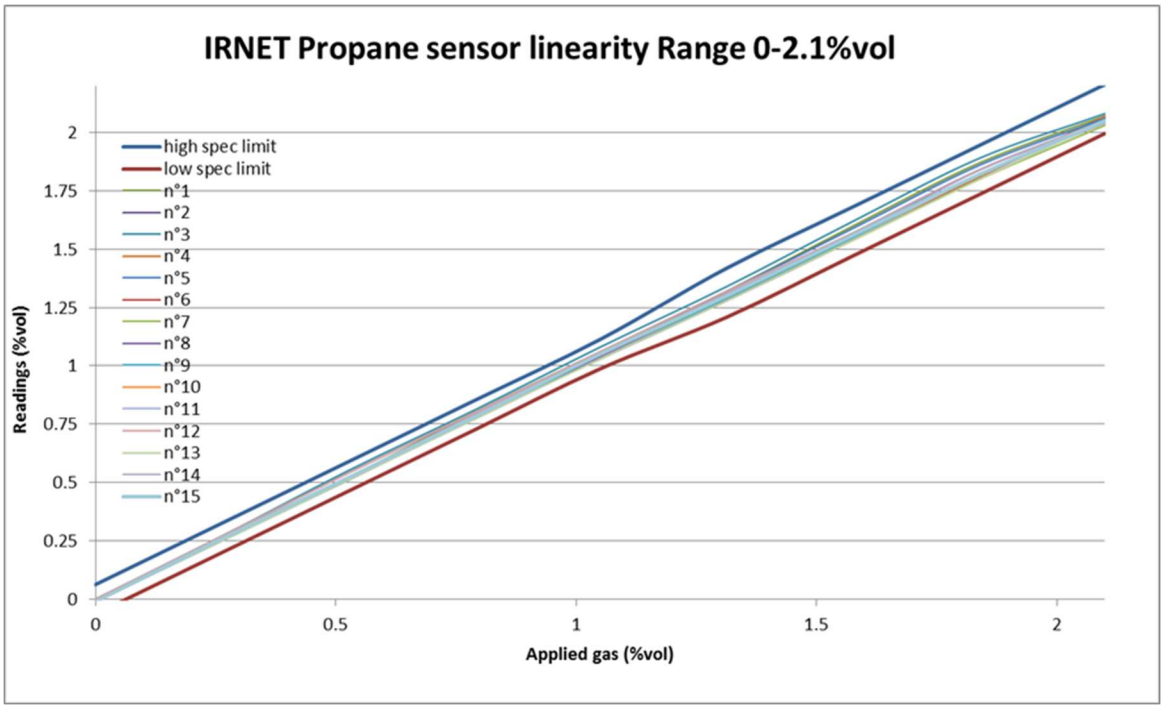


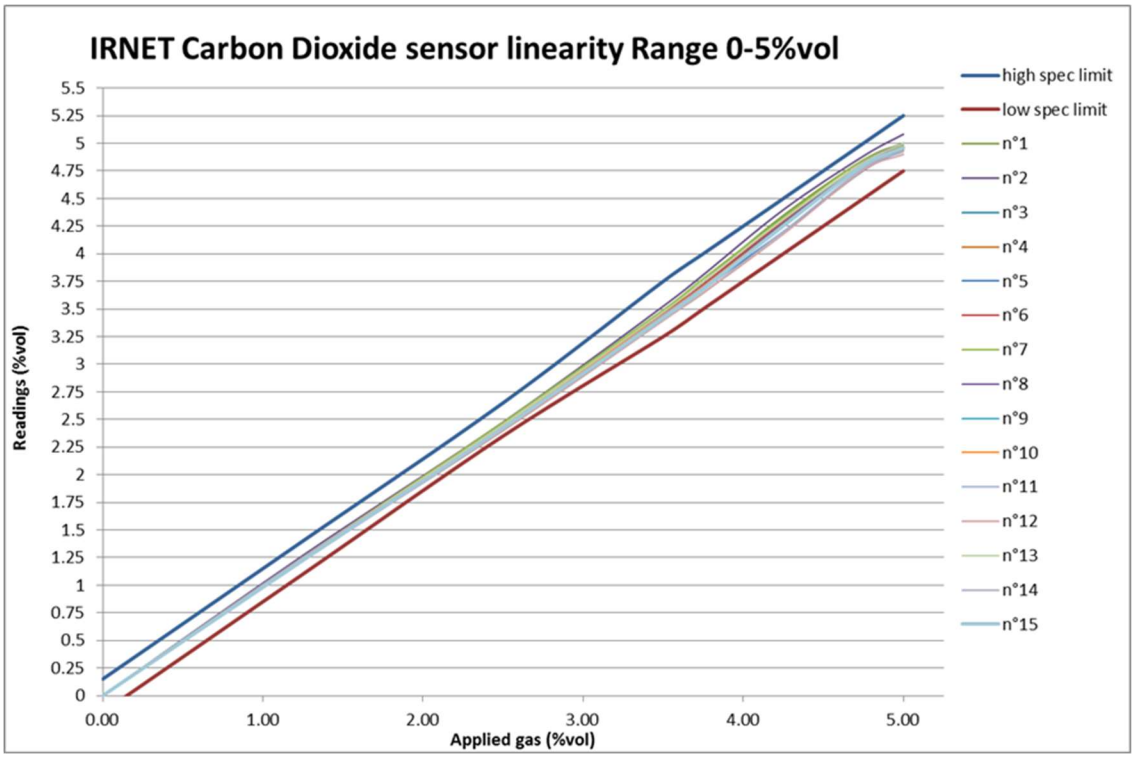


5.13 Linearity *

The linearity at room temperature, depends by the specific sensor that is used.
The following graphs show the linearity data for 15 sensors of Methane 5%vol, Propane 2.1%vol and CO2 5%vol.



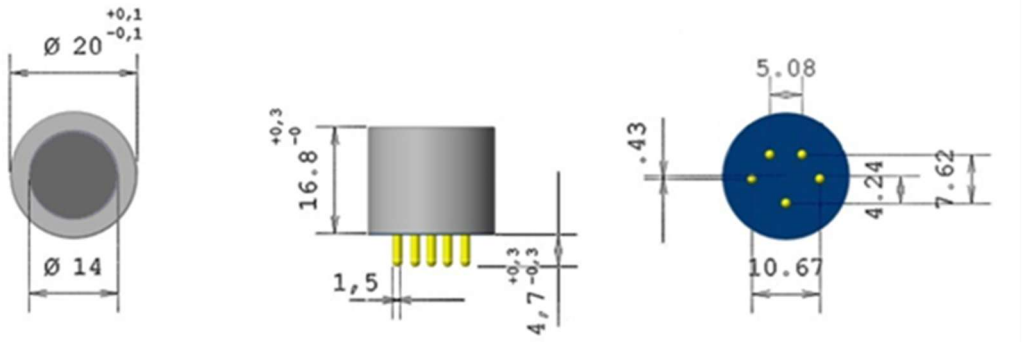




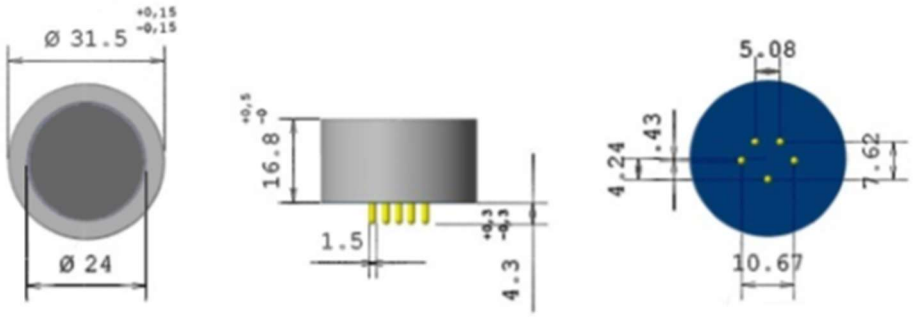
*Please refer to datasheet of individual sensors for full specifications.

6. Mechanical specifications

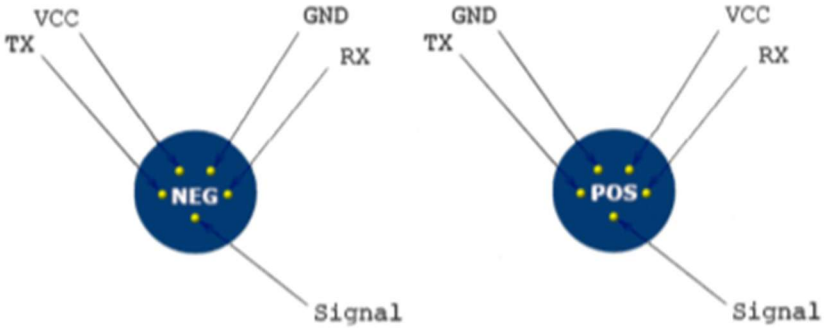
Mechanical specifications IRNET-P-20



Mechanical specifications IRNET-P-32



Pinout



All the dimensions in the figures are indicated in millimetres.
On request two pins RX and TX for MODBUS protocol communication can be cut off

7. Maintenance

Reparation or alteration on IRNET-P devices are exclusively reserved to the manufacturer and should not be performed by the customer. The manufacturer will guarantee that after a possible reparation, the product will work under the same safety conditions as when it was first released on the market.

All industrial gas detection systems, both for flammable and toxic gases, need to be periodically checked using a calibrated gas mix bottle. A small amount of zero drift can be compensated by re-zeroing the instrument rather than the sensor. The degree of drift that is acceptable should be determined by the end user. Please note that the subsequent change in gas reading will be greater than the change in zero reading.
N.E.T. recommends a maximum time of 1 year between calibration checks: however, this time span can vary significantly depending on the application and use of the sensor.
Depending on the specific application or installation, a time frame greater than 1 year between calibration checks may also be possible.
N.E.T suggests recording the calibration checks/verifications results to have them available during a possible future verification.

Before performing any tests on the sensors, Nitrogen or dry air must be administered for at least 5 minutes, after which the calibration procedure with the target gas can be initiated.
N.E.T. recommends keeping the gas flow rates below 500 SCCM (0.5 litres per minute).

To ensure a correct linearity and functionality of the sensor, the installation and power up must be performed in a clean environment.

For Carbon Dioxide sensors, the factory zero calibration is performed in Nitrogen, which means a low gas concentration reading (usually 400-600ppm) when exposed to air is normal; therefore, N.E.T. suggests performing the zero calibration on the detector using Nitrogen.

Hydrocarbon sensors should be tested in zero and span conditions maintaining the same level of humidity, as evaluating the functionality of zero and span at different humidity levels could affect the response of each sensor.
If the zero condition is tested in ambient air, the gas concentration should be applied through a nafion tube or any other method to maintain the same humidity level of zero condition; if the gas concentration is applied through a gas cylinder, then the zero condition should be checked applying Nitrogen or synthetic air to the sensor.

Applying dry hydrocarbon gas to a hydrocarbon sensor without application of N2 or synthetic air will cause a lower response than gas concentration applied.

For any anomalous conditions occurred during test operations, please contact N.E.T.

The sensor can be recalibrated by the customer only after signing an agreement with N.E.T. and using the appropriate “**IR Calibration kit**” or using the respective MODBUS calibration commands.
It is also possible to send the sensor back to N.E.T. to perform the recalibration based on a signed agreement.

8. Packaging & Warranty

The device should be kept in the supplied container until used. This will guarantee protection against dust and impact damage during transportation.

All IRNET-P sensors, except the IREF version are supplied with **three years** warranty from the date of production against defects in materials or production. This warranty however is not valid for articles that have been broken, repaired by a third person or not used according to the instructions contained in this document or supplied with the products, related to the storage, installation, operation, maintenance, or servicing of the products.

Please keep particular attention to:

- Power the sensor observing the correct voltage and polarity (positive or negative)
- Never solder directly on the pin, use PCB sockets
- Never cut or remove any of the pins.
- Use anti-static precautions when handling the sensor
- Never let water or other liquids to enter inside the sensor
- Never expose the sensor to corrosive gases.
- Avoid sudden temperature changes, above 1°C per minute, when testing the sensor
- The gas flow used for testing should be ≤500 SCCM.

The sensor calibration is guaranteed for one year from the selling date.
Defective products can be returned to N.E.T. Srl only after a previous agreement and with a description of the fault.
N.E.T. Srl has the right to replace or repair all the products that, according to his unquestionable judgement, are found to be defective, without being held responsible for any possible direct or indirect damages suffered by the Customer.
According to the above-mentioned warranty, shipping and packaging charges and any other incidental expenses for the products returned to N.E.T. Srl will be at the Customer's own risk and charged to him.
In case of product that have been recalibrated by the customer then calibration warranty is considered void also in case the sensor is inside the calibration warranty period of 1 year from the selling date.

N.E.T Srl reserves the right to change the technical specifications without notice when it causes a technical enhancement and improvements of the performances.
N.E.T Srl will directly contact the customer to inform of the changes in case these could affect the customer's use of the product.

N.E.T. has a policy of continuous development and improvement of its products. As such the specification for the device outlined in this manual may be changed without notice