NDIR SENSORS
for
Gas Composition Measurements

C series
(release 23/03/2023)

PRODUCT HIGHLIGHTS
High accuracy for High concentration measurements
Reference I.R. Channel for long-term measurements
Wide spectrum of detectable gases.
Easy to integrate in OEM systems

APPLICATION
Gas Purity Control
Gas Analysis
Environmental Monitoring

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Contents

Introduction

"C" series sensors are designed for High concentration Gas analysis for Industrial or environmental applications. They share the dual-channel scheme with "E" series sensors. The adoption of the same high quality components of "LS"- and "E"-series sensors produce high accuracy and stability of measurements, making these sensors indicated for high precision and high reliability applications.

List of available E sensors

DETECTABLE Gases:

Hydrocarbons	**HC** : [CH_4, C_2H_6, C_3H_8 , C_4H_{10} …]	Sensor C1
Ethanol	**C_2H_6O**	Sensor C1
Methane (max sensitivity)	**CH_4**	Sensor C5
Methane (low interference)	**CH_4**	Sensor C8
Carbon Monoxide	**CO**	Sensor C2
Carbon Dioxide	**CO_2**	Sensor C3
Acetylene	**C_2H_2**	Sensor C4
Ethylene	**C_2H_4**	Sensor C7
Nitrogen Oxide	**NO**	Sensor C6
Nitrogen Dioxide	**NO_2**	Sensor CA
Carbon Tetrafluoride	**CF_4**	Sensor C8
Sulfur Dioxide	**SO_2**	Sensor C9
Ammonia	**NH_3**	Sensor C7
Sulfur Exafluoride	**SF_6**	Sensor C7

Other gases available on request.

Sensor Specifications

Typical sensor measuring ranges and corresponding performances:

Gas	Sensor	Range	Repeatability	Accuracy (% of Full Scale)
CO_2	C3-9	0-100 (%Vol.)	0.2	0.1% (on 95-100 range)
CO_2	C3-9	0-20 (%Vol.)	0.2	1%
CO_2	C3-16	0- 1 (%Vol.) 0-10.000 (PPM)	0.02 20	1%
C_4H_{10} (R600)	C1-9	0-100 (%Vol.)	0.2	0.1% (on 95-100 range)
SF_6	C7-9	0-100 (%Vol.)	0.2	0.1% (on 95-100 range)
CO	C2			
SF_6	C7			
CH_4	C5			
CH_4	C8			
C_2H_2	C4			
C_2H_4	C7			
C_2H_6	C1			
C_3H_8 (R290)	C1			
NO_2	CA			
SO_2	C9			
C_2H_6O	C1			
CF_4	C8			
NH_3	C7			
Digital scale	0 - 9999			
Response time	0.5 - 30 (sec) [1]			
Recommended Gas flow	120 - 300 sccm			

Repeatability is expressed in absolute value and referred to a 10 sec statistic, **Accuracy** is expressed in percentage of the full-scale

Gas Purity Sensors (0-100%) are calibrated to give the highest Accuracy on the 95%-100% range. The specified accuracy is obtained provided that the Scale span Calibration is performed by the user.

[1] The sensor response time can be set on customer demand. A faster response time means a lower detector precision.

Operational Specifications

General Specifications

Measuring Principle	NDIR (Non dispersive Infra Red)
Measured Gas	See sensor table
Digital Measuring Range	0 - 9999
Measuring Accuracy	See sensor table
Measurement scale	PPM
Resolution	1 Digit = 1 PPM (typical)
Response time	1-30 s (*)
Warm-up Time	30 min
Operating temperature Range	0 ~ 55 °C non condensing
Storage Temperature Range	-20 ~ 85 °C
Operating Humidity Range	0 ~ 90% (non condensing)
Size	160 x 40 x 35 mm including gas connectors

(*) *Other measuring times available on request*

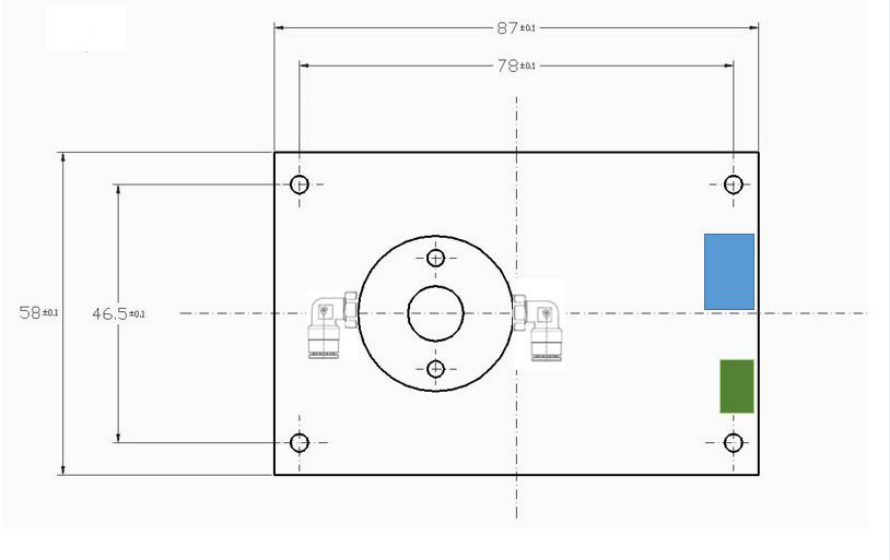
Electrical Specifications

Supply voltage	5V (+/- 5%)
Power consumption	Average 0.7 W (peak current <250 mA)
Communication Interface (ASCII data)	Standard UART 9600 (**)

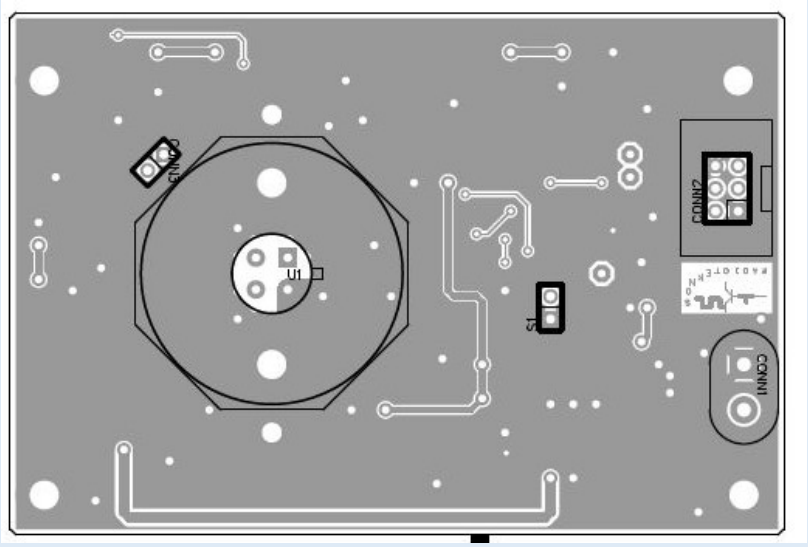
(**) *Baud-rate=9600 (it can be differently set on customer demand), Data bits=8, Parity=none, Stop bits=1.*

WARM-UP:
- The sensor can be used immediately after power-on. It will warm-up in 10-30 minutes. During this period, frequent calibration may be necessary to counteract I.R.-background variations. The optimal warm-up time should be determined depending on the different gas detectors and environmental conditions.
- To obtain precise measurements, we recommend waiting at least 40-50 minutes from the turn on.

Mechanical dimensions



Connectors



Connector 2

Pin #1: GND
Pin #2: P.S. +5V
Pin #3: UART RX (sensor)
Pin #4: UART TX (sensor)
Pin #5: 3.3V out
Pin #6: GND

Connector 1

Pin #1: GND
Pin #2: P.S. +5V

CAUTION:

- Avoid any liquid, moisture and dust to enter the optical cell. The optical cell should be protected by an appropriate filtering stage.
- Prevent not-grounded conductors to touch the aluminum body of the optical cell. Infrared components may be permanently damaged by ESD or any external voltage.

Sensor command list

(Commands are sent in plain ASCII code followed by <CR><LF>)

INPUT	COMMAND DESCRIPTION	SENSOR OUTPUT
M	**Sensor Model:**	Sensor answers with its type and serial number. (e.g. **D6-033** for sensor 18-6 s/n 033)
r	**Reset processor**: carries out diagnostics and sets parameters to factory values.	Sensor answers **rok** in case of positive diagnostics.
c	**Single Calibration: (precise –slow)** carries out a manual zero setting (to be done in clean air) and makes this setting active for the following measuring sessions. . In the standard setting the answer arrives after **10 seconds**.	Sensor answers **cok** at the end of the calibration procedure (lasts typically 30 seconds).
d	**Single Calibration: (fast)** carries out a manual zero setting (to be done in clean air) and makes this setting active for the following measuring sessions. . In the standard setting the answer arrives after **2 seconds**.	Sensor answers **dok** at the end of the calibration procedure (lasts typically 30 seconds).
cc	**Custom calibration:** Allows the user to store a calibration made on the measuring site with any custom chosen gas mixture. This calibration is stored in permanent memory and can be recalled by the command **rcc**. It becomes active for the following measuring sessions.	Sensor answers **ccok** at the end of the calibration procedure (lasts typically 30 seconds).
rcc	**Recall custom calibration:** Recalls the custom calibration carried out by the user, and makes this setting active for the following measuring sessions.	Sensor answers **rccok**
rcf	**Recall factory calibration:** Recalls the factory calibration carried out in clean atmospheric air, and makes this setting active for the following measuring sessions.	Sensor answers **rcfok**
l	**Single measurement: (fast)** gas detection command for a single measurement. In the standard setting the answer arrives after 1 **seconds**.	Sensor answers with a four digit string corresponding to the measured gas concentration. Concentrations are expressed in a scale specified in the sensor test-report (usually 0.1 , 1 or 10 PPM per digit). In case of abnormal signal levels the string may contain a warning code (**W01…W04).** (See "Error and Warning message List").
h	**Single measurement: (precise – slow)** gas detection command for a single measurement. In the standard setting the answer arrives after **5 seconds**.	Sensor answers with a four digit string corresponding to the measured gas concentration. Concentrations are expressed in a scale specified in the sensor test-report (usually 0.1 , 1 or 10 PPM per digit). In case of abnormal signal levels the string may contain a warning code (**W01…W04).** (See "Error and Warning message List").

start	**Continuous measurement mode:** This command allows a continuous measuring session, calling a sequence of "l" commands. the signal output from the sensor is displayed continuously every measuring cycle (standard 1 sec). This operating mode can be interrupted by the **stop** command.	Sensor answers **startok** followed by a series of four digit strings (always ended by a <CR><LF> sequence).These strings correspond to the measured gas concentrations. (Possible answers same as above.)
stop	**Terminate continuous meas. mode:** This command terminates the continuous measuring session activated by the command **start**.	Sensor answers **stopok**
ric	**Scale recalibration:** This command allows to correct the span of the sensor scale .	If called without a value, the sensor answers with the value in memory. If called followed by a value, the sensor will put in memory the new value. (please check the "Scale recalibration Procedure" in the following paragraph).

IMPORTANT NOTE: after the sensor is turned on, it is always necessary to define a current calibration before measuring. This can be done by any one the "c", "d", "cc", "rcc", "rcf" commands.

ERROR & WARNING Message List:

Error/Warning Message	Meaning	Counter-measure
E01	Low level H.W. fault.	Contact factory
E02	Very low Infrared signal	Contact factory
W01	Infrared detector signal is too low. (measurements can be performed anyway).	Sensor is still working. Please repeat one reset cycle. If the problem persists sensor needs revision.
W02	Calibration took place in a polluted environment or was performed too long ago.	Please perform a new calibration cycle in clean air.
W04	Measurements performed without a calibration (either with a "start" or "l" command call)	Please perform a calibration (calling a "c" , "cc", "rcc" or "rcf" command).

Scale span Calibration Procedure

In order to have a correct measure on the full scale the E-series gas sensors must be carefully calibrated at their start.

These are the steps to obtain a correct calibration of the sensor:

1) Let the sensor warm-up for at least 10-20 minutes (depending on the environmental temperature).

2) Feed the sensor with Nitrogen or clean dry air (usually clean air has a CO2 Concentration level of the order of 400 PPM) and send the command “c” (for zero calibration).

3) Call the command “ric 1000” (to set the span scale at the full-scale reference level). Please consider that the full-scale level may differ from the value 1000 in some sensors calibrated for specific ranges.

4) Feed the sensor with a nominal concentration equal to the full-scale (for instance a 1000 PPM of the gas to be detected) and perform a measurement. This can be done either using the “l” command or using the “start” command. This second command will perform a sequence of measurement, and this will help in determining the peak measurement value.

5) Read the peak measurement value (for instance 0989)

6) Call the command “ric 989” (in case the peak read value was 0989). This will set the span scale at the calibrated level.

7) Now you can perform test measurements with the full scale (for instance 1000 PPM of sample gas) or with any other calibrated mixture (for instance 500 PPM of sample gas) to check the correct calibration of the sensor.

In case there is no possibility to perform step number 2) (zero calibration in clean air) each time the sensor is turned on (or reset), alternative procedures are available.

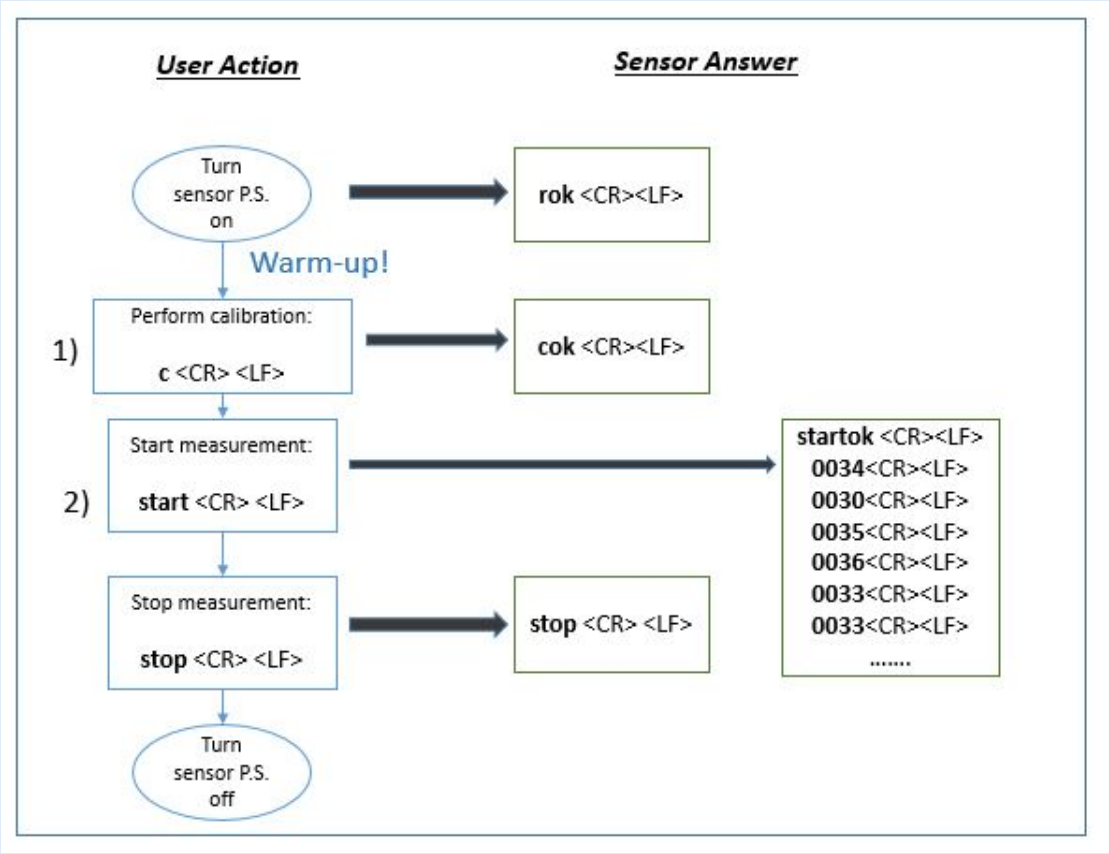
The first alternative consists in performing the actions of step number 2) only once with the sensor in its measuring location and environmental conditions. This can be done using the custom calibration command “cc” (constant memory) instead of command “c” (volatile memory) in step number 2) of the calibration procedure. A command “rcc” (recall custom calibration) is to be sent to the sensor each time it is switched on or reset.

A second alternative consists simply in sending an “rcf” (recall factory calibration) each time the sensor is switched on or reset. This command will make use of a factory zero calibration performed during the first sensor testing. This procedure is obviously less precise than performing a zero test in the actual sensor working conditions.

Standard Measuring Procedure

The above described commands are to be used in precise sequences in order to determine a correct measurement procedure. Standard measuring procedures are sketched in the flow-charts that follow.

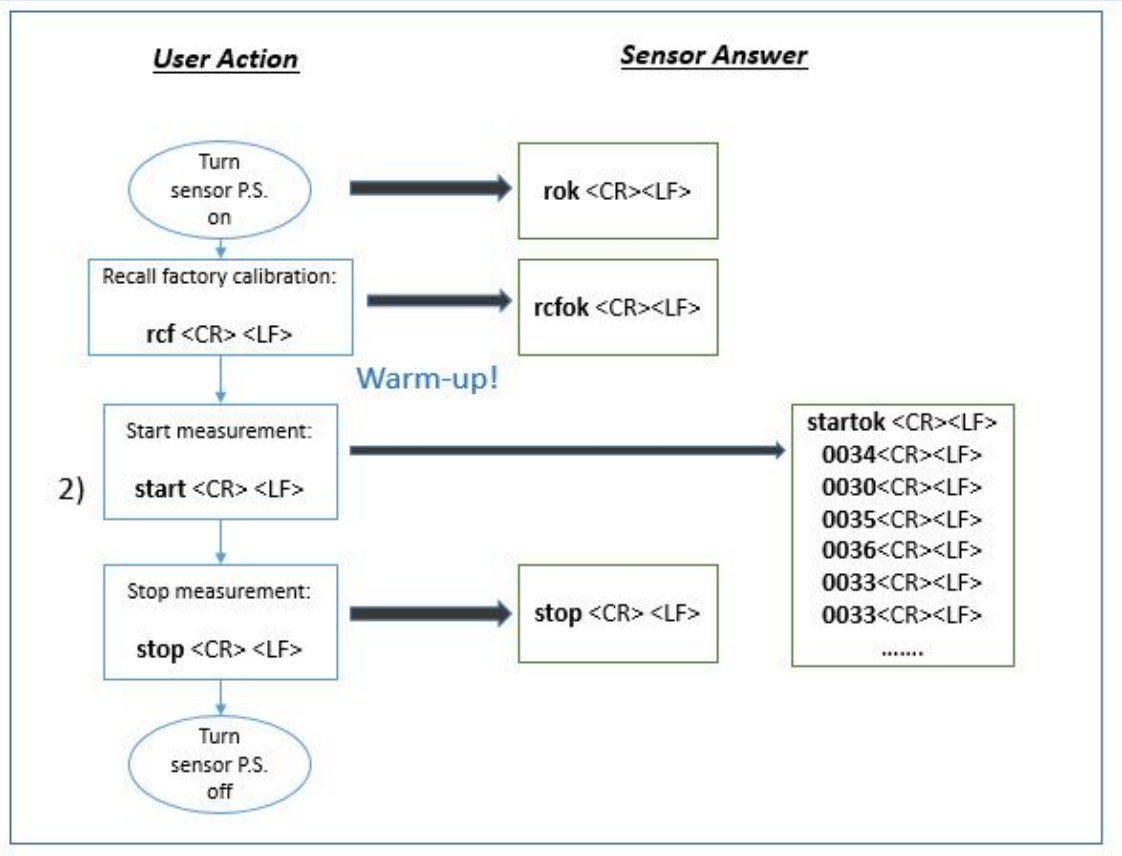
The first flow-chart shows the most common procedure, that determines a continuous operation of the gas-sensor.
Step nr.1) is a zero level setting. It has to be accomplished in a clean environment in which no trace of the gas under detection can be present, preferably after 30 minutes of sensor warm-up. The gas under test is detected during the procedure nr.2) that can thus be performed in the measuring environment.



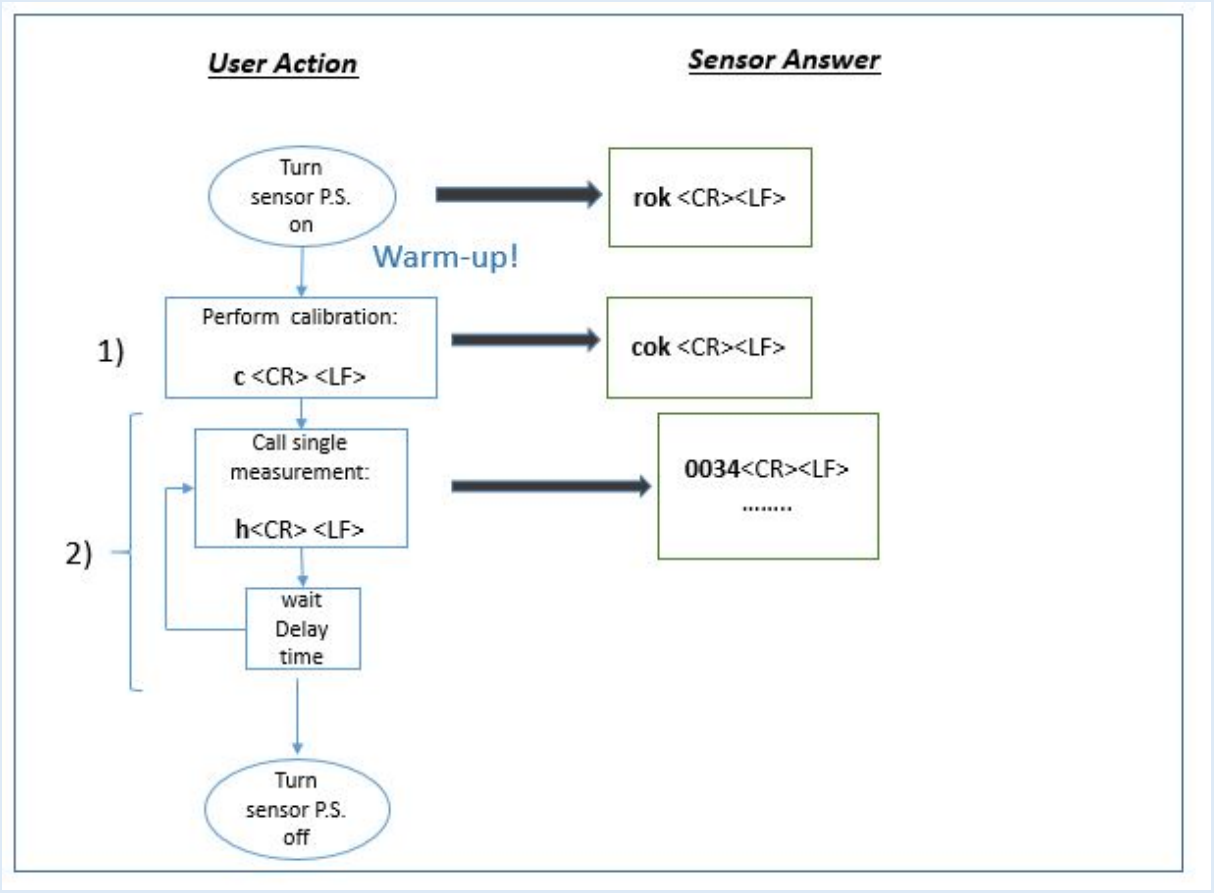
A command “d” can replace the command “c” if a faster calibration procedure is needed.

In case a calibration in a clean air is not possible, step nr.1) is to be replaced utilizing a zero calibration previously performed either by the factory (using command “rcf”) or by the customer (using command “rcc”). In this case, a zero has to be previously stored by the user using command “cc”.

In this second case the correct measurement procedure appears as explained in the following flow-chart:



An alternative measuring mode is possible, in which the user can set the measuring intervals at his convenience. In the case the single measuring command is adopted, either "**l**" (fast response - low precision) or "h" (slow response - high precision) can be used as detailed in the following flow-chart. This procedure allows the user to choose the measuring time [fast (1 seconds) or precise (5 seconds)] and interval (by calling the single measure after a user-defined delay).



Again the procedure nr.1) must be performed in a clean environment, after a suitable sensor warm-up (preferably 30 minutes). When this is not possible, a saved calibration has to be used as explained previously.

HC cross sensitivity table

Possible interferences may be encountered when detecting Hydrocarbons. The following table gives some hints to optimize the simultaneous detection of different HCs. Cross-sensitivities are indicated in red.

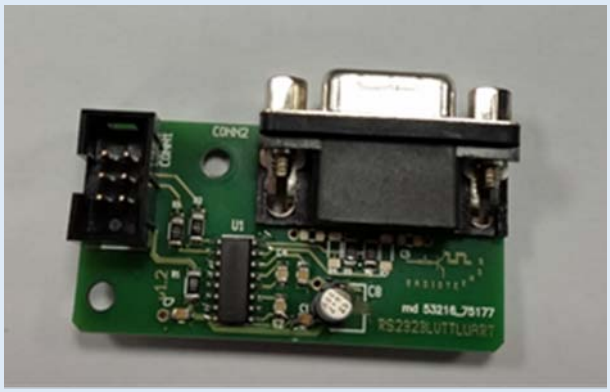
Sensor →	E5	E8	E1	E7
	For CH_4 **(A)**	For CH_4 **(B)**	For C_2H_6	For C_2H_4
MDC	**15 PPM**	**30 PPM**	**20 PPM**	**15 PPM**
Range→ Sensitivity ↓	0-2000 PPM	0-2000 PPM	0-2000 PPM	0-2000 PPM
To CH_4	**1 PPM = 1 digit**	**1 PPM = 1 digit**	***4 PPM = 1 digit***	≈0
To C_2H_6	***1PPM= 2 digit***	≈0	**1 PPM = 1 digit**	≈0
To C_2H_4	***1.5PPM= 1 digit***	≈0	***7.5PPM= 1 digit***	**1 PPM = 1 digit**

MDC = minimum detectable concentration

Available connection boards

Some standard conversion boards are available, such as:

- UART – RS232 Conversion board
- UART – USB Conversion board
- UART – Bluetooth Conversion board



Other interface options available on request.

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