GSS
Gas Sensing Solutions

CozIR®-A

Flexible Low Power CO₂ Sensor

DESCRIPTION

The CozIR®-A is a low power NDIR CO_2 sensor using state-of-the-art solid-state LED optical technology. The low power LEDs are manufactured in-house, giving GSS complete control of the CO_2 sensor signal chain.

The CozIR®-A's low power consumption is compatible with battery powered operation, allowing the sensor to be used in a wide variety of applications including wirelessly connected equipment.

The sensor is available in multiple versions with several user selectable options, including temperature and RH measurement capability.

The CozIR®-A also features a built-in auto-zero function that maintains CO_2 measurement accuracy over the lifetime of the product.
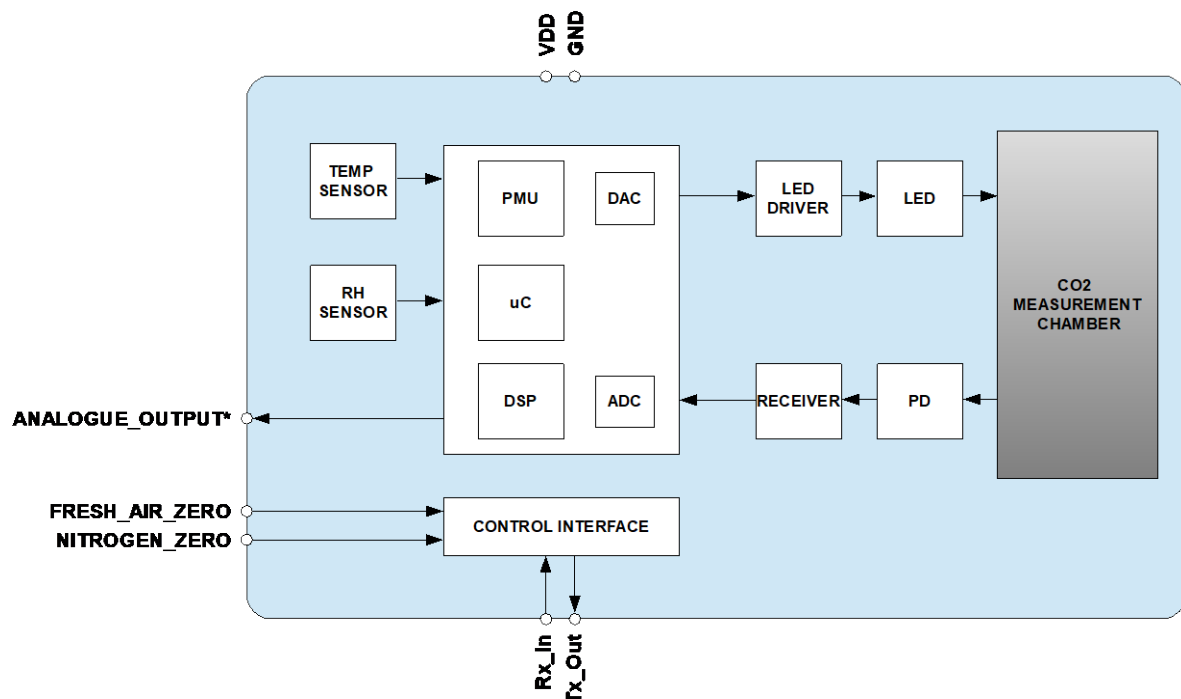
FEATURES

- Low power CO_2 sensor
- 30ppm typical measurement accuracy
- Solid state NDIR LED optical technology
- UART control and data interface
- Built-in auto-zeroing
- Optional Temperature and Relative Humidity sensing
- Optional Analogue (Voltage) output

APPLICATIONS

- Agriculture
- Livestock farming
- Healthcare
- Safety
- Aerospace
- Food packaging
- Food storage and transportation

BLOCK DIAGRAM

T, RH and *Optional

Alcom electronics

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Gas Sensing Solutions Ltd.

Production Data, Revision 4.8, 21 October 2021

Flexible Low Power CO₂ Sensor

TABLE OF CONTENTS

Gas Sensing Solutions Ltd.

Production Data, Revision 4.8, 21 October 2021

Flexible Low Power CO₂ Sensor

ORDERING INFORMATION

COZIR-A-X-XXX-X

X	Measurement Range
2000	2,000ppm
5000	5,000ppm
1	10,000ppm (1%)

X	Temperature and RH
H	Included
Blank	Not included

X	CO₂ Voltage Output
V	Included
Blank	Not included

X	Temperature Range
E	Extended, -25 to 55°C
Blank	Standard

X	Casing
U	Uncased
X	Cased

Notes:

1. Sensors are shipped individually

See separate data sheet for CozIR®-A evaluation kit options

Flexible Low Power CO₂ Sensor

PACKAGE DRAWING: CozIR®-A – Cased

Ø18.00
30.00°
7.00
Ø57
3 X 50 PCD
Ø3.10
3 POS.

17.25±0.25
1.40±0.10
Ø43.02
5.35
14.50
□0.64
2.54
5.00

10 9
8   7
6   5
4   3
2   1
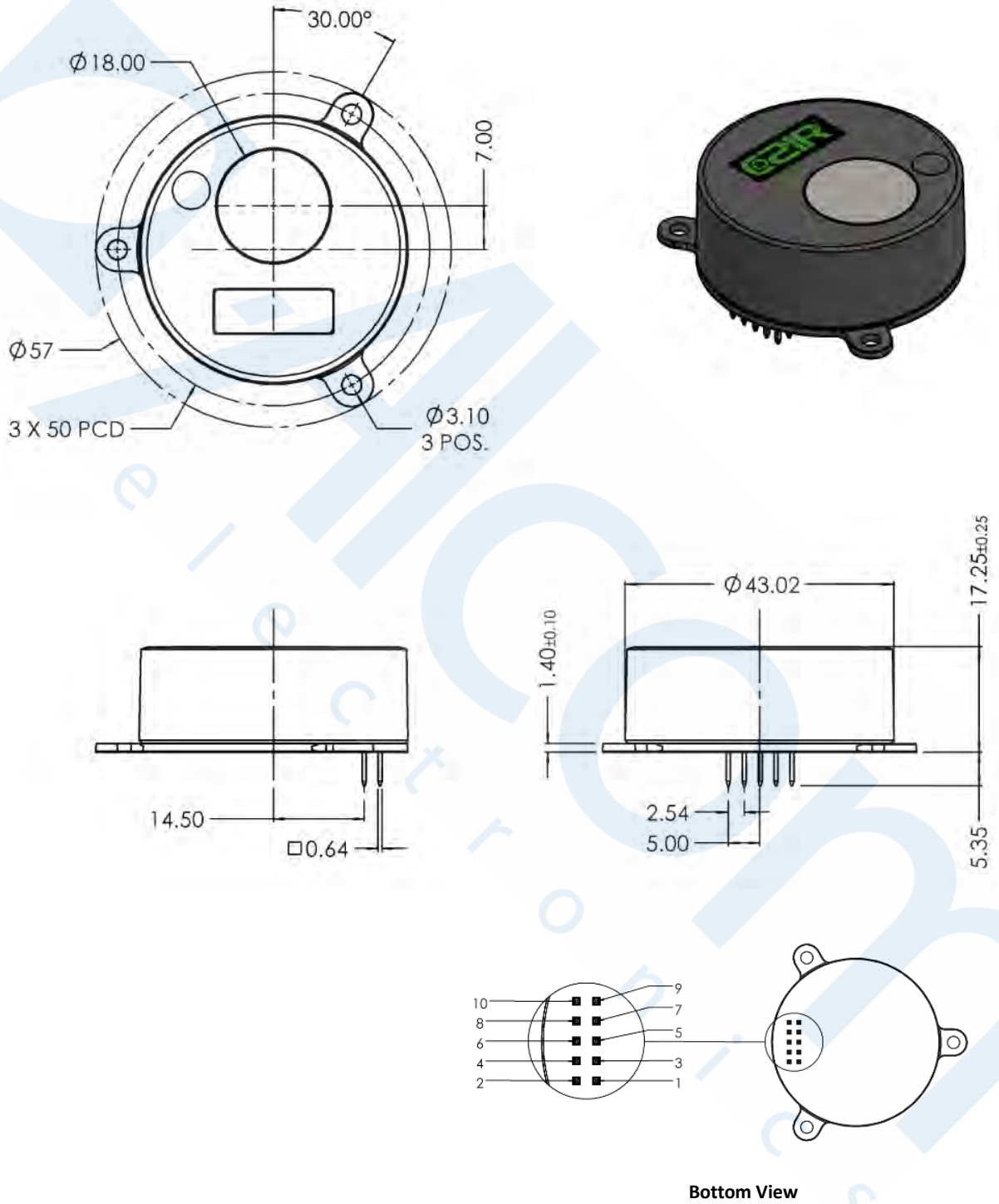
Bottom View

Weight = ~6g

Flexible Low Power CO₂ Sensor

PACKAGE DRAWING: CozIR®-A – Uncased

Ø18.00

Ø40.4±0.3

14.50

5.00

20 REF

□0.64

11.65±0.15

7.0±0.2

2.54

8.40

1.60

Ø38.80 'NO-GO ZONE BOTH SIDES
1.5 MAX COMPONENT HEIGHT

10
8
6
4
2

9
7
5
3
1
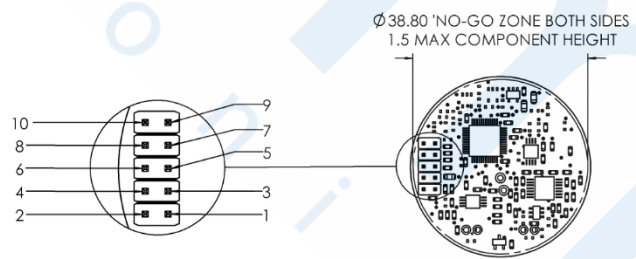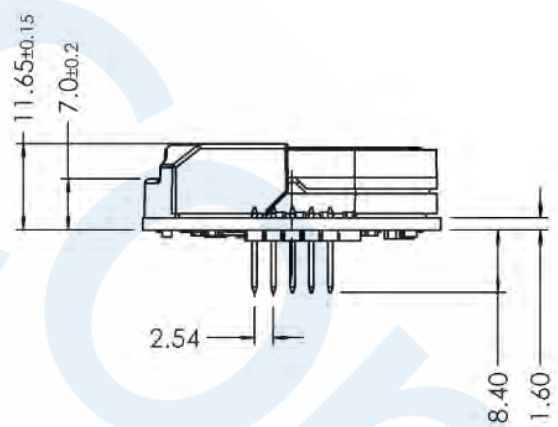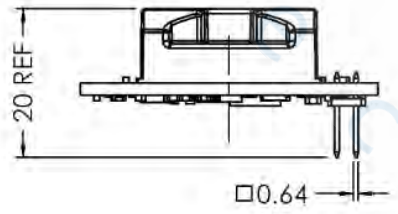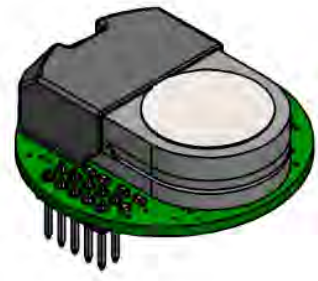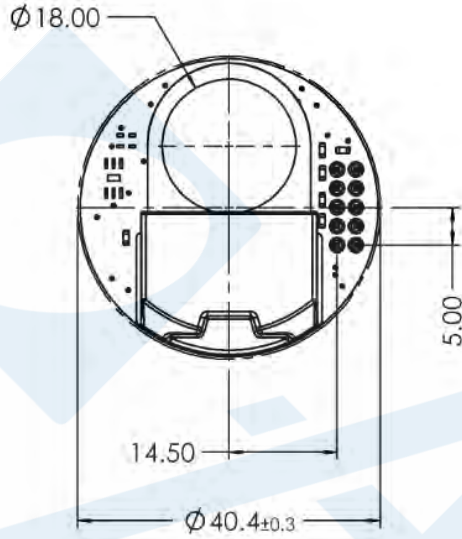
Bottom View

Weight = ~6g

Flexible Low Power CO_2 Sensor

PIN-OUT DESCRIPTION: CozIR®-A (Both Types)

PIN	NAME	TYPE	DESCRIPTION
1	GND	Supply	Sensor ground
2	NC	Unused	Do Not Connect
3	VDD	Supply	Sensor supply voltage
4	GND	Supply	Sensor ground
5	Rx_In	Digital Input	UART Receive Input
6	GND	Supply	Sensor ground
7	Tx_Out	Digital Output	UART Transmit Output
8	NITROGEN_ZERO	Digital Input	Set low to initiate a Zero in Nitrogen Zero Setting Cycle
9	ANALOGUE_OUTPUT	Analogue Output	CO_2 Level (Optional)
10	FRESH_AIR_ZERO	Digital Input	Set low to initiate a Zero in Fresh Air Zero Setting Cycle

Flexible Low Power CO$_2$ Sensor

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings are stress ratings only. Permanent damage to the CozIR®-A may be caused by continuously operating at or beyond these limits. The CozIR®-A functional operating limits and guaranteed performance specifications are given at the test conditions specified.

ESD Sensitive Device. This sensor uses ESD sensitive components. It is therefore generically susceptible to damage from excessive static voltages. Proper ESD precautions must be taken during handling and storage of this device.

CONDITION	MIN	MAX
Supply Voltages	-0.3V	+6.0V
Voltage Range Digital Inputs	GND -0.3V	5V
Operating Temperature Range (T$_a$)		
- Standard	0°C	+50°C
- Extended	-25°C	+55°C
Storage Temperature Range	-40°C	+70°C
Humidity Range (RH), Non-Condensing	0	95%
Operating Ambient Pressure Range	500mbar	2bar

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Supply	VDD	3.25	3.3	5.5	V
Ground	GND		0		V

Flexible Low Power CO$_2$ Sensor

PERFORMANCE CHARACTERISTICS

Test Conditions Unless Otherwise Specified

VDD = 3.3V, GND = 0V. CO$_2$ = 450ppm, RH = 0% non-condensing, T= 25°C, Pressure = 1013mbar

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
CO$_2$ measurement range			0		2,000	ppm
			0		5,000	ppm
			0		10,000	ppm
Accuracy		@25°C		±(30 +3% rdg)	±(50 +3% rdg)	ppm
		0°C to +55°C, after zeroing @25°C		±(30 +3% rdg)		ppm
CO$_2$ RMS Noise				-		ppm
Time to Valid Measurement After Power-On		Dependent on digital filter setting	0.3	3.3	6.5	secs
Response Time		From 0ppm to T$_{90}$ (half full-scale), default settings, limited by diffusion through membrane window		30		secs
Repeatability				±(30 +3% rdg)		ppm
Pressure Dependence		Per mbar deviation from 1013mbar, 950-1050mbar		0.14		%
Current Consumption		Peak current when sampling		15		mA
		Peak at turn-on		40		mA
		SLEEP Mode		0.01		mA

Flexible Low Power CO_2 Sensor

HUMIDTY PERFORMANCE CHARACTERISTICS - CozIR®-A Option

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Humidity measurement range			0		100	%
Accuracy		@25°C		±3		% RH
Repeatability		@25°C		±0.1		%
Response time		0-50%		<8		secs
Accuracy drift				0.25		% RH/Yr

TEMPERATURE PERFORMANCE CHARACTERISTICS - CozIR®-A Option

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Temperature measurement range			-25		55	°C
Accuracy		0-50°C		±0.5		°C
Repeatability		@25°C		±0.1		%
Response time		0-50%, @25°C, filter = 16		>10		s
Accuracy drift				0.02		°C / Yr

CO_2 ANALOGUE OUTPUT PERFORMANCE CHARACTERISTICS – CozIR®-A Option

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output voltage range[1,2]	ANALOGUE_OUTPUT		0		VDD	V
CO_2 level		0-1%, VDD = 3.3V		33		uV/ppm
Repeatability		@25°C		±0.1		%
Response time		From 0ppm to T_{90} default settings		0.5		secs

Notes

1. The output CO_2 accuracy is degraded where ANALOGUE_OUTPUT <50mV, or >VDD–50mV
2. ANALOGUE_OUTPUT accuracy specified with a resistive loading @ >100Kohm

Flexible Low Power CO_2 Sensor

ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Digital Input/Output						
Input HIGH Level			1.8			V
Input LOW Level					1.0	V
Output HIGH Level	I_{OH} = +1mA		2.6		3.0	V
Output LOW Level	I_{OL} = -1mA				0.4	V

POWER CONSUMPTION - CozIR®-A

Test Conditions Unless Otherwise Specified

VDD = 3.3V, GND = 0V. CO_2 = 450ppm, RH = 0% non-condensing, T= 25°C, Pressure = 1013mbar

SETTING	SYMBOL	TEST CONDITIONS	VDD		Total Power
			V	I (mA)	mW
OFF		No power applied		0	0
Active, K0 SLEEP mode, no measurement			3.3	0.01	0.03
Active, K1 mode whilst taking CO_2 2 measurements		Default settings	3.3	1	3.5
Additional with RH active		RH measurement on		+0.05	+0.2
Additional with T active		Temperature measurement on		+0.05	+0.2
Additional with CO_2 active		With analogue CO_2 output		+0.02	+0.1

Flexible Low Power CO$_2$ Sensor

INTERFACE TIMING – NITROGEN_ZERO and FRESH_AIR_ZERO
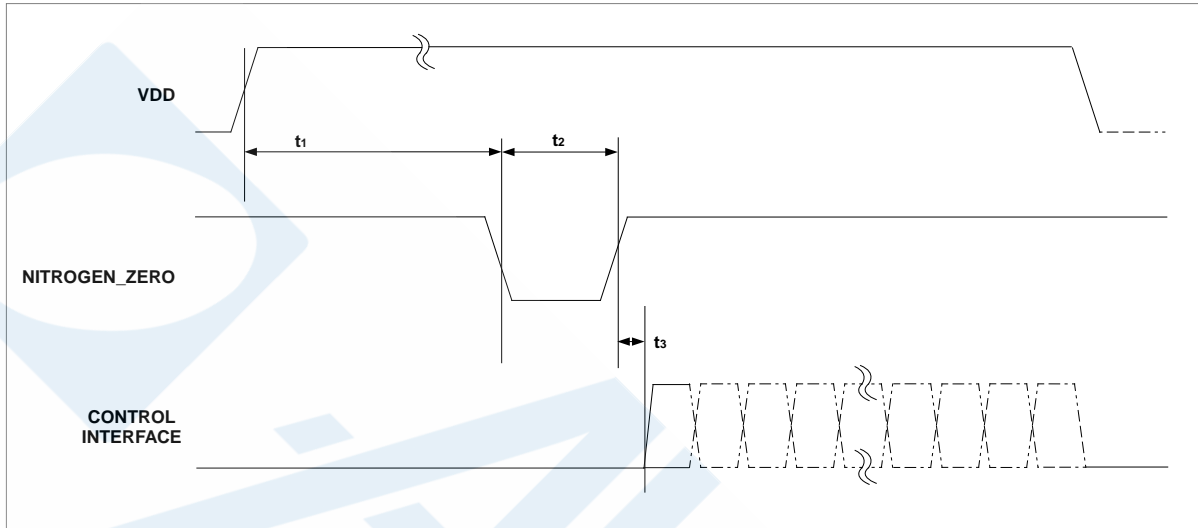
PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Power On to NITROGEN_ZERO Ready	t_1	Time to stable gas			ms
NITROGEN_ZERO Low Pulse-Width	t_2	3			s
Control Interface Setup Time	t_3	600			ns

Notes

1. The timing for FRESH_AIR_ZERO is identical to NITROGEN_ZERO
2. Ensure gas concentration is stable (t_1) before beginning zeroing process

CozIR®-A

Flexible Low Power CO₂ Sensor

METHOD OF OPERATION

After power is applied to the CozIR®-A, the sensor will automatically start to take CO_2 measurements using the Mode 1 default settings, where the sensor is pre-programmed to send CO_2 measurement data at 2 readings per second.

The measurement rate is fixed at 2 readings per second at a fixed 9600 baud rate. The sensor will return the previous CO_2 measurement results if the user requests more frequent measurements.

The CozIR®-A family has 3 potential modes of operation.

MODE K0 COMMAND MODE

In this mode, the sensor is in a SLEEP mode, waiting for commands. No measurements are made. There is no latency in command responses. All commands that report measurements or alter the zero-point settings are disabled in Mode 0. Mode 0 is NOT retained after power cycling.

MODE K1 STREAMING MODE

This is the factory default setting. Measurements are reported twice per second. Commands are processed when received, except during measurement activity, so there may be a time delay of up to 10ms in responding to commands.

MODE K2 POLLING MODE

In polling mode, the sensor only reports readings when requested. The sensor will continue to take measurements in the background, but the output stream is suppressed until data is requested. The sensor will always power up in streaming or polling mode, whichever mode was used before the power cycle.

Gas Sensing Solutions Ltd. **Production Data, Revision 4.8, 21 October 2021**

Page | 13   For regular updates, go to https://www.gassening.co.uk   Copyright © 2021 Gas Sensing Solutions Ltd.

Flexible Low Power CO₂ Sensor

DIGITAL FILTER

The CO_2 gas chamber is illuminated with a nominal 4.25um wavelength LED and the signal received using a photo-diode. The signal from the photo-diode is processed and filtered by the sensor to remove noise and provide an accurate CO_2 reading. High frequency noise coming from the sampling process is removed using a proprietary lowpass filter. The digital filter setting can be varied, allowing the user to reduce measurement noise at the expense of the measurement response time. The ideal digital filter setting is application specific and is normally a balance between CO_2 reading accuracy and response time. The CozIR®-A sensor will also output the raw unfiltered CO_2 measurement data. This data can be post processed using alternative filter algorithms.
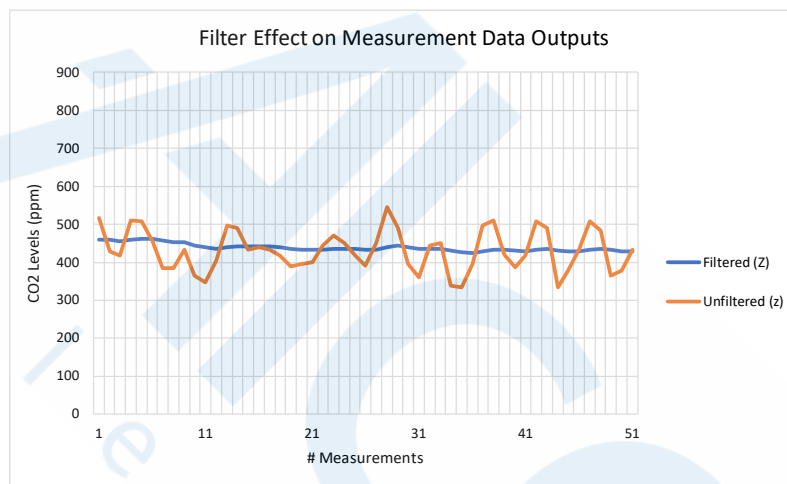
The graph above shows the effects of the filter on the CO_2 measurement data (Z or z). The unfiltered output is shown in orange and the filtered output shown in blue.
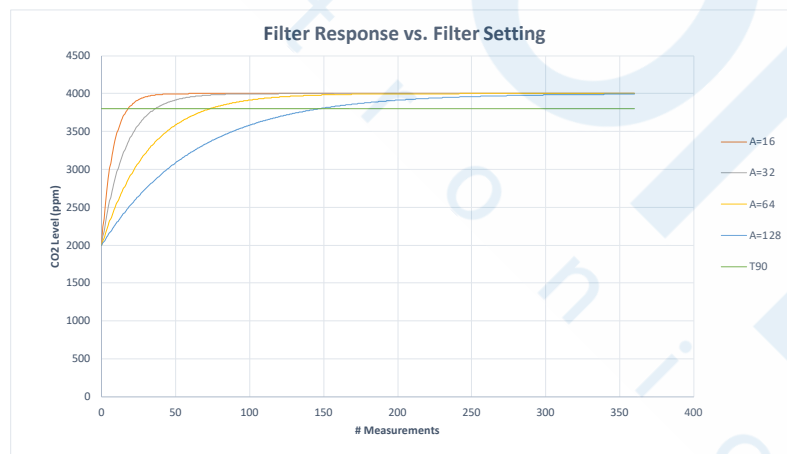
The graph above shows the effect of the filter on response times. Increasing the filter setting increases the measurement output response time. T_{90} is the time to 90% of reading. The CozIR®-A takes 2 readings per second.

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ZERO POINT SETTING

There are a several methods available to the user to set the zero point of the sensor. The recommended user method is zero-point setting in a known gas concentration. In all cases, the best zero is obtained when the gas concentration is stable, and the sensor is at a stabilised temperature.

Note that zero-point settings are not cumulative and only the latest zero-point setting is effective. For example, there is no benefit in zeroing in nitrogen, and then zeroing in a calibration gas. The sensor will store only the latest zero point.

To improve zeroing accuracy, the recommended digital filter setting is 32. See the 'A' command.

ZERO IN A KNOWN GAS CONCENTRATION

Place the sensor in a known gas concentration, power up the sensor and allow time for the sensor temperature to stabilise, and for the gas to be fully diffused into the sensor.

Send the *ZERO IN A KNOWN GAS CONCENTRATION* command X to the sensor. The sensor will be zeroed using the known gas concentration level sent by the user. The concentration value written to the sensor must be scaled dependent on the sensor CO_2 measurement range. The multiplier for the scaling factor is set according to the range of the sensor, see the '.' command.

ZERO IN NITROGEN

Place the sensor in nitrogen gas and allow time for the sensor temperature to stabilise and the gas to be fully diffused into the sensor. Send the *ZERO IN NITROGEN* command U to the sensor. The sensor is zeroed assuming a 0ppm CO_2 environment**.**

This function can also be enabled in hardware by pulling the NITROGEN_ZERO pin low for greater than 3 seconds (CozIR®-A Only).

ZERO IN FRESH AIR

If there is no calibration gas or nitrogen available, the sensor zero point can be set in fresh air. Ambient CO_2 concentrations in fresh air are typically 400ppm. The CO_2 concentration fresh air zero level is programmable over a range from 0ppm to the full scale of the sensor.

Place the sensor in a fresh air environment and allow time for the sensor temperature to stabilise, and for the fresh air to be fully diffused into the sensor. Power up the sensor, write the G command to the sensor. The concentration value written to the sensor must be scaled dependent on the sensor CO_2 measurement range. The sensor can use the default fresh air CO_2 concentration value of 400ppm, or the user can write a different fresh air value to the sensor if desired.

This function can also be enabled in hardware by pulling the FRESH_AIR_ZERO pin low for greater than 3 seconds.

ZERO POINT ADJUSTMENT

If the CO_2 concentration and the sensor reported concentration are known, the zero point can be adjusted using the known concentration to fine tune the zero point. For example, if the sensor has been in an environment that has been exposed to outside air, and the sensor reading is known at that time, the zero point can be fine-tuned to correct the reading. This is typically used to implement automated zeroing routines.

The known CO_2 concentration value and the reported CO_2 value from the sensor can be sent to the sensor using the **ZERO POINT ADJUSTMENT** command F.

AUTO-ZERO FUNCTION

The sensor has a built-in auto-zero function. To function correctly, the sensor must be exposed to typical background levels (400-450ppm) at least once during the auto-zero period. For example, many buildings will drop quickly to background CO_2 levels when unoccupied overnight or at weekends. The auto-zero function uses the information gathered during these periods to re-zero. The sensor will reset the 'zero' level every time it does an auto-zero.

Auto-zero is ENABLED by default. If the sensor is powered down, the auto-zero period settings are reset to the default value.

The auto-zero function works in the same way as the **ZERO IN FRESH AIR** command. The user can also independently adjust the CO_2 level used for auto-zeroing. Typically, it is set to the same value as the **ZERO IN FRESH AIR** value, but it can also be set at a different level if desired.

AUTO-ZERO INTERVALS

The auto-zero period can be programmed by the user. The sensor can be programmed to undertake an initial auto-zero after power-on. Thereafter, the auto-zero period can be set independently of the start-up auto-zero time. Note, the auto-zero timer is reset if the sensor is powered down.

AUTO-ZERO SETTINGS

By default, the sensor will automatically 'zero' using the lowest measured CO_2 level sampled during the auto-zero period. The sensor will re-zero to the pre-programmed level (default of 400ppm). The auto-zero reset value can be changed by the user.

Flexible Low Power CO₂ Sensor

ALTITUDE COMPENSATION

NDIR gas sensors detect the concentration of gas by measuring the degree of light absorption by the gas analyte. The degree of light absorption is then converted into a concentration reported by the sensor.

The absorption process is pressure dependent, and a change in pressure will cause a change in the reported gas concentration. As the pressure increases, the reported gas concentration also increases. As the pressure decreases, the reported concentration decreases. This effect takes place at a molecular level and is common to all NDIR gas sensors.

GSS sensors are calibrated at 1013mbar. The reading will vary by approximately 0.14% of reading for each mbar change in barometric pressure.

If the sensor is installed at an elevated altitude, the mean barometric pressure will be lower than 1013mbar. It is possible to configure the sensor to correct for this effect, by setting the altitude compensation value as part of the initial set up process. This will apply a permanent correction to the output of the sensor, depending on the altitude setting selected.

ALTITUDE COMPENSATION TABLE

Altitude (ft.)	Altitude (m)	Pressure (mbar)	Sea Level Difference	% Change per	CO₂ Measurement Change (%)	Compensation Value
0	0	1,013	0	0.14	0	8,192
500	153	995	18	0.14	3	8,398
1,000	305	977	36	0.14	5	8,605
1,500	458	960	53	0.14	7	8,800
2,000	610	942	71	0.14	10	9,006
2,500	763	925	88	0.14	12	9,201
3,000	915	908	105	0.14	15	9,396
3,500	1,068	891	122	0.14	17	9,591
4,000	1,220	875	138	0.14	19	9,775
4,500	1,373	859	154	0.14	22	9,958
5,000	1,525	843	170	0.14	24	10,142
6,000	1,830	812	201	0.14	28	10,497
7,000	2,135	782	231	0.14	32	10,841
8,000	2,440	753	260	0.14	36	11,174
9,000	2,745	724	289	0.14	40	11,506
10,000	3,050	697	316	0.14	44	11,816

Other altitude compensation values can be calculated using the following formula.

$$Compensation\ Value = 8192 + \left(\frac{Sea\ Level\ Difference * 0.14}{100}\right) * 8192$$

Flexible Low Power CO₂ Sensor

CONTROL INTERFACE

The CozIR®-A family of sensors are controlled by writing and reading from the sensor via its UART interface. The Rx_In and Tx_Out pins are normally high, suitable for direct connection to a TTL level UART. If the sensor is to be read by a true RS232 device (e.g. a PC), it is necessary to pass through a level converter to step up/down the voltage and invert the signal.

CONTROL INTERFACE TIMING - UART MODE

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Baud Rate			9600		Bits/s
Data Bits			8		
Parity			None		
Stop Bits			1		
Hardware Flow Control			None		

UART COMMAND PROTOCOL

All UART commands must be terminated with a carriage return and line feed <CR><LF>, hex 0x0D 0x0A. In this document, this is shown as '\r\n'. UART commands that take a parameter always have a space between the letter and the parameter. The sensor will respond with a '?' if a command is not recognised. The two most common causes are missing spaces or missing <CR><LF> terminators.

All command communications are in ASCII and are terminated by carriage return, line feed (0x0D 0x0A). This document uses the protocol "\r\n" to indicate the carriage return line feed. All responses from the sensor, including measurements, have a leading space (ASCII character 32, hex 0x20).

The character '#' represents an ASCII representation of a numeric character (0-9). Note there is a space between the first letter and any parameter. For example, the X command reads "X space 2000 carriage return line feed".

UART OPERATION

When initially powered, the sensor will immediately start to make measurements and transmit CO_2 readings when in K1 streaming mode, which is the default operational mode of the sensor.

The CO_2 measurement is reported as:

```
Z ##### z #####\r\n
```

where `Z #####` shows the filtered CO_2 concentration and z ##### shows the raw most recent measurement.

Note that all outputs from the sensor have a leading space.

UART INTERFACE SUMMARY

Syntax	Use	Example	Response	Comments
A ###\r\n	Set value of the digital filter	A 128\r\n	A 00128\r\n	See *"Digital Filter"*
a\r\n	Return the value of the digital filter	a\r\n	a 00128\r\n	See *"Digital Filter"*
F ##### #####\r\n	Fine Tune the zero-point setting	F 410 400\r\n	F 33000\r\n	See *"Zero Point Setting"*
G\r\n	Zero-point setting using fresh air	G\r\n	G 33000\r\n	See *"Zero Point Setting"*
H\r\n	Returns the relative humidity value	H\r\n	H 00551\r\n	Only if fitted as an option
K #\r\n	Switches the sensor between different modes	K 1\r\n	K 00001\r\n	
M ###\r\n	Sets the number of measurement data types output by the sensor	M 212\r\n	M 00212\r\n	See **"Measurement Data Outputs"**
P 8 ###\r\n P 9 ###\r\n	Sets value of CO_2 background concentration in ppm for auto-zeroing	P 8 1\r\n P 9 144\r\n	P 00008 00001\r\n P 00009 00144\r\n	Two-byte value, P 8 = MSB P 9 = LSB 400ppm in the example
P 10 ###\r\n P 11 ###\r\n	Sets value of CO_2 background concentration in ppm used for zero- point setting in fresh air.	P 10 1\r\n P 11 144\r\n	P 00010 00001\r\n P 00011 00144\r\n	Two-byte value, P 10 = MSB P 11 = LSB 400ppm in the example
Q\r\n	Reports the latest measurement data types, as defined by 'M'	Q\r\n	H 12345 T 12345 Z 00010 z 00010\r\n	Output is same format as data in K 1 streaming mode
S ####\r\n	Sets the pressure and concentration compensation value	S 8192\r\n	S 08192\r\n	See *"Altitude Compensation"*
s\r\n	Returns the altitude compensation value	s\r\n	s 08192\r\n	See *"Altitude Compensation"*
T\r\n	Returns the temperature value	T\r\n	T 01224\r\n	Only if fitted as an option
U\r\n	Zero-point setting using nitrogen	U\r\n	U 33000\r\n	See *"Zero Point Setting"*
u #####\r\n	Manual setting of the zero point.	u 32997\r\n	u 32997\r\n	See *"Zero Point Setting"*
X #####\r\n	Zero-point setting using a known gas concentration	X 2000\r\n	X 32997\r\n	See *"Zero Point Setting"*
Y\r\n	Return firmware version and sensor serial number	Y\r\n	Returns <u>two</u> lines	

Flexible Low Power CO₂ Sensor

Syntax	Use	Example	Response	Comments
Z\r\n	Return the most recent filtered CO_2 2 measurement in ppm	Z\r\n	Z 01521\r\n	
z\r\n	Return the most recent unfiltered CO_2 2 measurement in ppm	z\r\n	Z 01521\r\n	
@ #.# #.#\r\n	Set auto-zero ON, and sets the timing for initial and interval auto-zero periods	@ 1.0 8.0\r\n	@ 1.0 8.0\r\n	See *"Auto-Zero Function"* for details
@\r\n	Returns the auto-zero configuration	@\r\n	@ 1.0 8.0\r\n	See *"Auto-Zero Function"* for details
@ 0\n	Switch auto-zero OFF	@ 0\r\n	@ 0\r\n	See *"Auto-Zero Function"* for details
.\r\n	Returns the scaling factor multiplier required to convert the Z or z output to ppm	.\r\n	. 00001\r\n	Multiply by 1 in the example

---

Flexible Low Power CO₂ Sensor

CO₂ LEVEL MEASUREMENT VALUE - Z INFORMATION (0x5A)

Description	Reports the latest filtered CO_2 measurement
Syntax	ASCII Character 'Z', terminated by 0x0D 0x0A (CR & LF)
Example	Z\r\n
Response	Z 00521\r\n

This value needs to be multiplied by the appropriate scaling factor to derive the ppm value. See the '.' command.

CO₂ LEVEL MEASUREMENT VALUE - z INFORMATION (0x7A)

The sensor is also capable of reporting the real time unfiltered CO_2 measurement value.

Description	Reports the unfiltered CO_2 measurement
Syntax	ASCII Character 'Z', terminated by 0x0D 0x0A (CR & LF)
Example	z\r\n
Response	z 00521\r\n

'.' COMMAND (0x2E)

To calculate the measurement value in ppm, the 'Z' or 'z' value, they must be converted into ppm by using the '.' multiplier factor. This multiplier will depend on the full-scale measurement range of the sensor. The multiplier is related to the full-scale range of the sensor.

The multiplier must also be used when sending CO_2 concentration levels to the sensor, for example when setting the fresh air CO_2 concentration value. The '.' Command can also be used to read back the scaling factor.

For example, if the user wants to zero the sensor in a known concentration of gas (e.g. 450ppm), the value written to the sensor must be 450/scaling factor.

Description	Returns a number indicating what multiplier must be applied to the Z CO_2 measurement output to convert it into ppm.
Syntax	ASCII character '.', terminated by 0x0D 0x0A (CR & LF)
Example	.\r\n
Response	. 00001\r\n (this number is variable, usually 1)

Flexible Low Power CO₂ Sensor

Measurement Range of Sensor	CO₂ Measurement Scaling Factor (Z)	CO₂ Measurement Output Units	Example
0 – 1%	1	ppm	Z 00650 = 650ppm = 0.065%
0 – 60%	10	ppm/10	Z 01200 = 12000ppm = 1.2%
0 – 100%	100	ppm/100	Z 01500 = 15000ppm = 15%

TEMPERATURE MEASUREMENT VALUE - CozIR®-A Option

Command	Use	Example	Response	Comments
T\r\n	Returns the most recent temperature measurement.	T\r\n	T 01224\r\n	Where ##### is a 5-digit number. Temperature (°C) = (##### - 1000)/10. 22.4°C in the example

Description	Returns the most recent temperature measurement.
Syntax	ASCII character 'T', SPACE, decimal, terminated by 0x0D 0x0A (CR & LF)
Example	T\r\n
Response	T 01224\r\n (this number is variable)

HUMIDITY MEASUREMENT VALUE - CozIR®-A Option

Command	Use	Example	Response	Comments
H\r\n	Return the most recent humidity measurement.	H\r\n	H 00551\r\n	Where ##### is a 5-digit number. Humidity (%RH) = #####/10. 55.1% RH in the example

Description	Returns the most recent the humidity measurement.
Syntax	ASCII character 'H', SPACE, decimal, terminated by 0x0D 0x0A (CR & LF)
Example	H\r\n
Response	H 00551\r\n (this number is variable)

Note both temperature and humidity outputs are a factory fit option on the CozIR®-A only. If not fitted, sensor will return either T 01000 or H 00000.

To output temperature, humidity, and filtered CO₂, send "M 4164\r\n" (see *"Measurement Data Outputs"*).

Flexible Low Power CO₂ Sensor

The output format will have the form: *H 00345 T 01195 Z 00065\r\n*

This example indicates 34.5% RH, 19.5°C and 650ppm CO₂.

MEASUREMENT DATA OUTPUTS

The CozIR®-A family of sensors can be configured to provide CO_2, temperature, and humidity data as a single string of data. Up to five data fields can be transmitted, programmable by the user. The number of fields and the type of data to be transmitted is defined by the "Mask Value" setting.

The output data format is as follows. Each field is identified by the Data Field Identifier character, followed by a space, followed by the five-digit number indicating the value of the parameter.

Data Parameter	Data Field Identifier	Mask Value	Description
Humidity	H	4096	Humidity value of the environment around the sensor
D digitally filtered	d	2048	Reports a value related to the normalized LED signal strength (smoothed)
D unfiltered	D	1024	Reports a value related to the normalized LED signal strength
Zero Set Point	h	256	Reports the current zero value
Sensor Temperature (unfiltered)	V	128	Reports a value that varies inversely with the sensor temperature.
Temperature	T	64	Reports a true temperature value of the environment around the sensor, if optional temperature sensor is fitted
LED Signal (digitally filtered)	o	32	Reports a value that gives an indication of the LED signal strength (smoothed)
LED Signal (unfiltered)	O	16	Reports a value that gives an indication of the LED signal strength.
Sensor Temperature (filtered)	v	8	Reports a value that varies inversely with the sensor temperature. (smoothed)
CO₂ Output (Filtered)	Z	4	Filtered CO_2 reading
CO₂ Output (Unfiltered)	z	2	Raw CO_2 reading, unfiltered

Flexible Low Power CO$_2$ Sensor

UART Command	Use	Default	Range	Example	Response	Comments
M #####\r\n	Sets the number of measurement data types output by the sensor. ##### is the mask value	M 6\r\n		See **"Measurement Data Outputs"**	M 00006\r\n	Sets the number of measurement data types output by the sensor

The required mask value is the sum of the 'Mask Value' for each field required. To output filtered and unfiltered CO$_2$ data, set M=6.

To output the temperature, humidity, and CO$_2$ measurements, send: M 4164\r\n (4096 + 64 + 4 = 4164)

The output string will then be: H 12345 T 12345 Z 00010\r\n

M COMMAND

Description	Sets the type and number of data outputs
Syntax	ASCII character 'M', SPACE, up to 5 digit number, terminated by 0x0D 0x0A (CR & LF)
Example	M 04164\r\n
Response	M 04164\r\n

Q COMMAND

Description	Reports the latest output data fields defined by 'M'
Syntax	ASCII character 'Q', terminated by 0x0D 0x0A (CR & LF)
Example	Q\r\n
Response	H 12345 T 12345 Z 00010\r\n

K COMMAND

Command	Use	Default	Range	Example	Response	Comments
K #\r\n	Switches the sensor between different control modes	1		K 1\r\n	K 1\r\n	*See 'K' Commands*

K COMMAND (0x4B)

Description	Sets the control interface mode
Syntax	ASCII character 'K', SPACE, mode number, terminated by 0x0D 0x0A (CR & LF)

Flexible Low Power CO₂ Sensor

Example	K 1\r\n	
Response	K 00001\r\n	(this number is variable)

Flexible Low Power CO$_2$ Sensor

DIGITAL FILTER COMMANDS

Command	Use	Default	Range	Example	Response	Comments
A ###\r\n	Set value of the digital filter	16	0 - 65635	A 16\r\n	A 00016\r\n	
a\r\n	Return value of digital filter		0 - 65365	a\r\n	a 00016\r\n	

A COMMAND (0x41)

Description	Set the value for the digital filter
Syntax	ASCII character 'A', SPACE, decimal, terminated by 0x0D 0x0A (CR & LF)
Example	A 16\r\n
Response	A 00016\r\n (this number is variable)

a COMMAND (0x61)

Description	Set the value for the digital filter
Syntax	ASCII character 'A', SPACE, decimal, terminated by 0x0D 0x0A (CR & LF)
Example	A 16\r\n
Response	A 00016\r\n (this number is variable)

ZERO POINT SETTING COMMANDS

Command	Use	Default	Range	Example	Response	Comments
F ##### #####\r\n	Fine Tune the zero point		Range of sensor	F 410 400\r\n	F 33000\r\n	See *"Zero Point Setting"*
G\r\n	Zero-point setting using fresh air			G\r\n	G 33000\r\n	See *"Zero Point Setting"*
U\r\n	Zero-point setting using nitrogen			U\r\n	U 33000\r\n	See *"Zero Point Setting"*
u #####\r\n	Manual setting of the zero point			u 32997\r\n	u 32997\r\n	See *"Zero Point Setting"*
X #####\r\n	Zero-point setting using a known gas concentration		Range of sensor	X 2000\r\n	X 32997\r\n	See *"Zero Point Setting"*
P 8 ###\r\n P 9 #\r\n	Sets value of CO$_2$ background concentration	P 8 1\r\n P 9 144\r\n		P 8 1\r\n	P 00008 00001\r\n	Two-byte value, P 8 = MSB P 9 = LSB

Flexible Low Power CO₂ Sensor

Command	Use	Default	Range	Example	Response	Comments
	in ppm for auto-zeroing			P 9 144\r\n	P 00009 00144\r\n	400ppm in the example
P 10 ###\r\n P 11 #\r\n	Sets value of CO₂ background concentration in ppm used for zero- point setting in fresh air.	P 10 1\r\n P 11 144\r\n		P 10 1\r\n P 11 144\r\n	P 00010 00001\r\n P 00011 00144\r\n	Two-byte value, P 10 = MSB P 11 = LSB 400ppm in the example

F COMMAND (0x46)

Description	Sets the zero-point using a known reading and a known CO₂ concentration terminated by 0x0D 0x0A (CR & LF)
Syntax	ASCII character 'F', SPACE, then the reported gas concentration, SPACE, then the actual gas concentration, terminated by 0x0D 0x0A (CR & LF)
Example	F 410 400\r\n
Response	F 33000\r\n (the numbers are variable)

G COMMAND (0x47)

Description	Sets the zero point assuming the sensor is in fresh air (typically 400ppm CO₂, but level can be set by user – see P commands.)
Syntax	ASCII character 'G' terminated by 0x0D 0x0A (CR & LF)
Example	G\r\n
Response	G 33000\r\n (the number is variable)

U COMMAND (0x55)

Description	Sets the zero point assuming the sensor is in 0ppm CO₂ such as nitrogen.
Syntax	ASCII Character 'U' terminated by 0x0D 0x0A (CR & LF)
Example	U\r\n
Response	U 32767\r\n(the number is variable)

u COMMAND (0x75)

Description	Forces a specific zero set point value.
Syntax	ASCII character 'u', SPACE, then specific zero value, terminated by 0x0D 0x0A (CR & LF)
Example	u 32767\r\n
Response	u 32767\r\n

X COMMAND (0x58)

Description	Sets the zero point with the sensor in a known concentration of CO₂. Input value is scaled by CO₂ value multiplier, see '.' command.
Syntax	ASCII character 'X', SPACE, then the gas concentration, terminated by 0x0D (CR & LF)
Example	X 1000\r\n
Response	X 33000\r\n (the number is variable).

P COMMAND - CO₂ Level for Auto-Zeroing

Description	Sets the value of CO₂ in ppm used for auto-zeroing. Input value is scaled by CO₂ value multiplier, see '.' command.
Syntax	ASCII character 'P', SPACE, then 8, SPACE, then MSB terminated by 0x0D 0x0A (CR & LF) ASCII character 'P' then a space, then 9, then a space, then LSB terminated by 0x0D 0x0A (CR & LF)
Example	P 8 1\r\n P 9 144\r\n
Response	P 00008 00001\r\n P 00009 00144\r\n

The value is entered as a two-byte word, MSB first.

MSB = Integer (Concentration/256)
LSB = Concentration – (256*MSB)

In the above example, target CO₂ background concentration is 400ppm.

MSB = Integer (400/256) = 1
LSB = 400 – 256 = 144

P COMMAND – CO₂ Level for Zero-Point Setting

Description	Sets value of CO₂ in ppm for zero-point setting in fresh air. Input value is scaled by CO₂ value multiplier, see '.' command.
Syntax	ASCII character 'P', SPACE, then 10, SPACE, then MSB terminated by 0x0D 0x0A (CR & LF) ASCII character 'P', SPACE, then 11, SPACE, then LSB terminated by 0x0D 0x0A (CR & LF)
Example	P 10 7\r\n P 11 208\r\n
Response	P 00010 00007\r\n P 00011 00208\r\n

Flexible Low Power CO$_2$ Sensor

MSB = Integer (Concentration/256)
LSB = Concentration – (256*MSB)

In the above example, target zero-point CO$_2$ concentration is 2000ppm.

MSB = Integer (2000/256) = 7
LSB = 2000 – (256*MSB) = 208

AUTO-ZERO INTERVALS

UART Command	Use	Default	Range	Example	Response	Comments
@ #.# #.#\r\n	Auto-zero interval settings			@ 1.0 8.0\r\n	@ 1.0 8.0\r\n	See "Auto-zero" for details

@ COMMAND (0x40)

Description	Set the 'Initial Interval' and 'Regular Interval' for auto-zero events.
Syntax	ASCII character '@', SPACE, decimal, SPACE, decimal terminated by 0x0D 0x0A (CR & LF)
Example	@ 1.0 8.0\r\n
Response	@ 1.0 8.0\r\n (the number mirrors the input value)

Both the initial interval and regular interval are given in days. Both must be entered with a decimal point and one figure after the decimal point. In the above example, the auto-zeroing interval is set to 8 days, and the initial interval set to 1 day.

The CozIR®-A has auto-zero ENABLED by default. The default values are an initial interval of 1.0 day and an on-going interval of 8.0 days.

- To set auto-zero OFF, send @ 0\r\n

- To set auto-zero ON, send @ #.# #.#\r\n (integer numbers for initial period and regular period)

- To determine the auto-zeroing configuration, send @\r\n

- If the auto-zero function is OFF, @\r\n will return 0.

- If the auto-zero is ON, @\r\n will return 1.0 8.0 (for the default values).

ALTITUDE COMPENSATION

UART Command	Use	Default	Range	Example	Response	Comments
S #####\r\n	Sets the altitude compensation value	8192	0-65536	S 8192\r\n	S 08192\r\n	See *"Altitude Compensation"*
s\r\n	Returns the altitude compensation value			s\r\n	s 08192\r\n	See *"Altitude Compensation"*

S COMMAND (0x53)

Description	Set the 'Altitude Compensation' value
Syntax	ASCII character 'S', SPACE, decimal, terminated by 0x0D 0x0A (CR & LF)
Example	S 8192\r\n
Response	S 08192\r\n (the number mirrors the input value)

s COMMAND (0x73)

Description	Reports the 'Altitude Compensation' value.
Syntax	ASCII Character 's', terminated by 0x0D 0x0A (CR & LF)
Example	s\r\n
Response	s 8192\r\n

SERIAL NUMBER AND FIRMWARE VERSION

UART Command	Use	Default	Range	Example	Response	Comments
Y\r\n	Return firmware version and sensor serial number			Y\r\n	Returns <u>two</u> lines	

Gas Sensing Solutions Ltd. **Production Data, Revision 4.8, 21 October 2021**

Flexible Low Power CO$_2$ Sensor

Y COMMAND (0x59)

Description	The present version string for the firmware and serial number of the sensor.
Syntax	ASCII character 'Y', terminated by 0x0d 0x0a (CR & LF)
Example	Y\r\n
Response	Y,Aug 25 2021,14:19:56,LP15132 B 528148 00000 Where; Aug 25 2021,14:19:56 is the firmware compile date and time LP15132 is the firmware revision 528148 is the sensor ID

N.B. This command returns two lines split by a carriage return line feed and terminated by a carriage return line feed. This command requires that the sensor has been stopped (see 'K' command).

Flexible Low Power CO$_2$ Sensor

CONNECTION DIAGRAM FOR UART INTERFACE
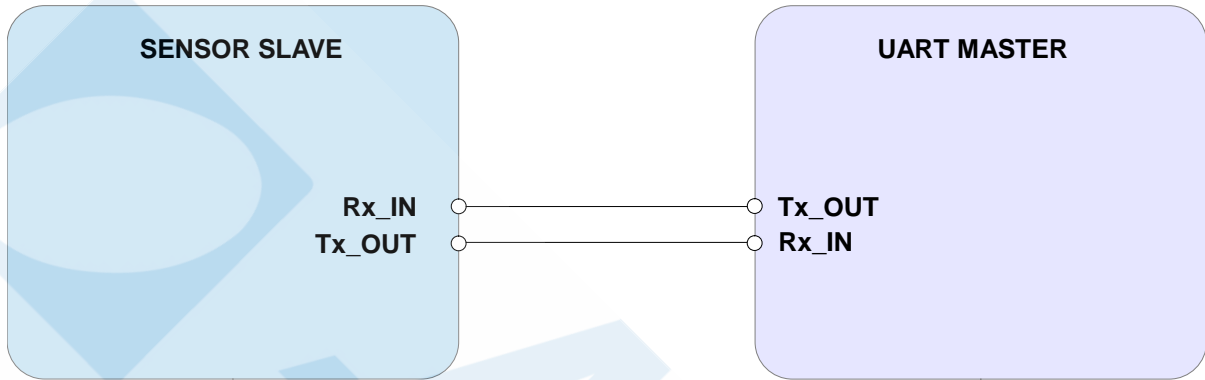
Flexible Low Power CO$_2$ Sensor

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Flexible Low Power CO₂ Sensor

REVISION HISTORY

DATE	RELEASE	DESCRIPTION OF CHANGES	PAGES
05/03/2020	4.0	First revision	All
13/05/2020	4.1	Updated auto-zero language	All
10/06/2020	4.2	ABSOLUTE MAXIMUM RATINGS	P.8
15/01/2021	4.3	INTERFACE TIMING – NITROGEN_ZERO and FRESH_AIR_ZERO	P.12
01/02/2021	4.4	ABSOLUTE MAXIMUM RATINGS	P.8
23/06/2021	4.5	@ COMMAND UPDATE	P.27
23/08/2021	4.6	Added Measure data outputs information	P.23
27/09/2021	4.7	Y Command	P.31
21/10/2021	4.8	@ COMMAND functionality	P.16,29

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