GSS
Gas Sensing Solutions

Low Power CO₂ Sensor

DESCRIPTION

The CozIR®-LP is a low power NDIR CO₂ 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 CO₂ sensor signal chain.

The CozIR®-LP'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 CozIR®-LP operation is configurable depending on user requirements. On power-up, the CozIR®-LP automatically starts taking measurements. Measurements can be streamed or output on request.

The CozIR®-LP also features a built-in auto-zero function that maintains CO₂ measurement accuracy over the lifetime of the product.
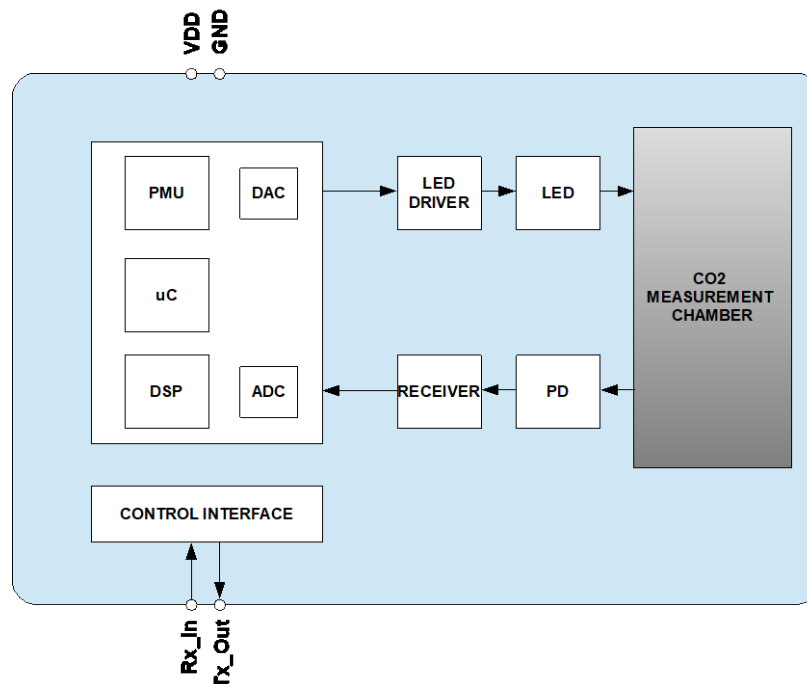
FEATURES

- Low power CO₂ sensor
- 30ppm typical measurement accuracy
- Solid state NDIR LED optical technology
- UART control and data interface
- Built-in auto-zeroing

APPLICATIONS

- Indoor Air Quality (IAQ)
- IoT and Smart Technology wireless equipment
- Air Quality and HVAC Systems
- Building Management Systems (BMS)
- Demand-Controlled Ventilation (DCV) systems
- Transport
- In-Cabin Air Quality

BLOCK DIAGRAM

Low Power CO_2 Sensor

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ORDERING INFORMATION

CozIR®-LP-X

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

See separate data sheet for CozIR®-LP evaluation kit options.

Notes:

1. Sensors are shipped individually or in trays
2. Tray quantity = 50

PACKAGE DRAWING
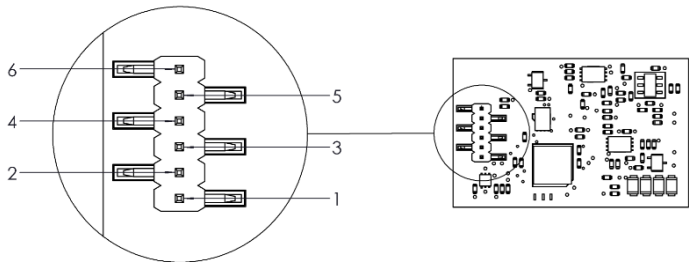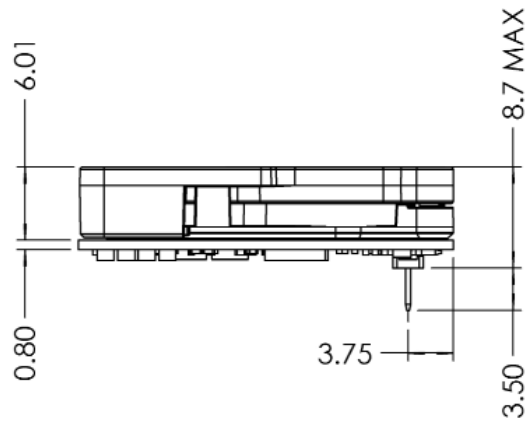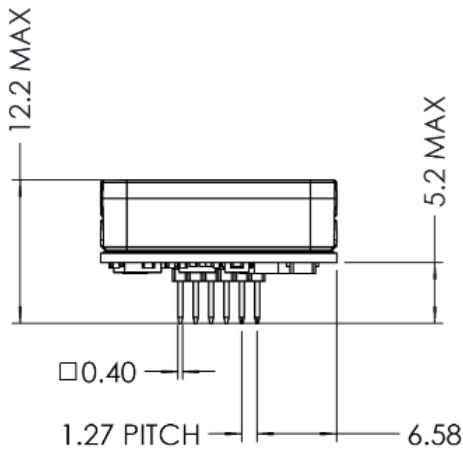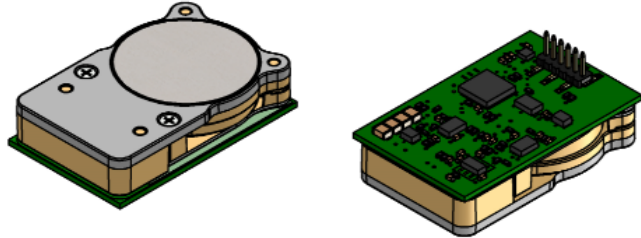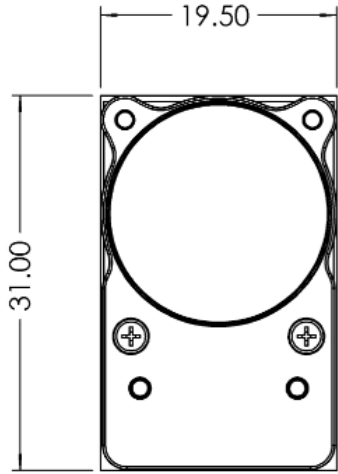
Bottom View

Weight = 2.5g

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PIN-OUT DESCRIPTION

PIN	NAME	TYPE	DESCRIPTION
1	GND	Supply	Sensor ground
2	VDD	Supply	Sensor supply voltage
3	Rx_In	Digital Input	UART Receive Input
4	Tx_Out	Digital Output	UART Transmit Output
5	NC	Unused	Do not connect
6	NC	Unused	Do not connect

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ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings are stress ratings only. Permanent damage to the CozIR®-LP may be caused by continuously operating at or beyond these limits. The CozIR®-LP 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)	0°C	+50°C
Storage Temperature Range	-40°C	+70°C
Humidity Range (RH), non-condensing	0	95%
Operating Pressure Range	500mbar	10bar

RECOMMENDED OPERATING CONDITIONS

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

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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%) of reading	±(45, +3%) of reading	ppm
		0°C to +50°C, after zeroing @25°C		±(30, +3%)		ppm
CO_2 RMS Noise		16 pulses per reading.		-		ppm
Time to Valid Measurement After Power-On		Dependent on number of pulses per reading	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%,		%
Pressure Dependence		Per mbar deviation from 1013mbar, 950-1050mbar		0.14		%
Current Consumption		Peak current when sampling, 16 pulses per reading		15		mA
		Peak at turn-on		40		mA
		SLEEP Mode		0.01		mA

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			V
Output LOW Level		I_{OL} = -1mA			0.4	V

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POWER CONSUMPTION

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, SLEEP mode, no measurement			3.3	0.01	0.03
Active, taking measurements		Default settings	3.3	1	3.5

The energy per reading is approximately 25mJ using default settings. Power consumption is strongly dependent on digital filter settings (# of pulses) and the measurement period.

$$Power\ (\mu W) = \frac{1.5625 * number\ of\ pulses\ per\ reading}{Measurement\ period\ in\ Seconds} * 1000$$

In a typical application where the user might want to take a reading every minute, the power requirement is approximately 417uW per reading. Power consumption can be lowered even further by reducing the number of pulses per reading or by increasing the measurement interval.

Current consumption varies depending on digital filter settings (# of pulses). A typical current consumption profile after power-on is shown below.
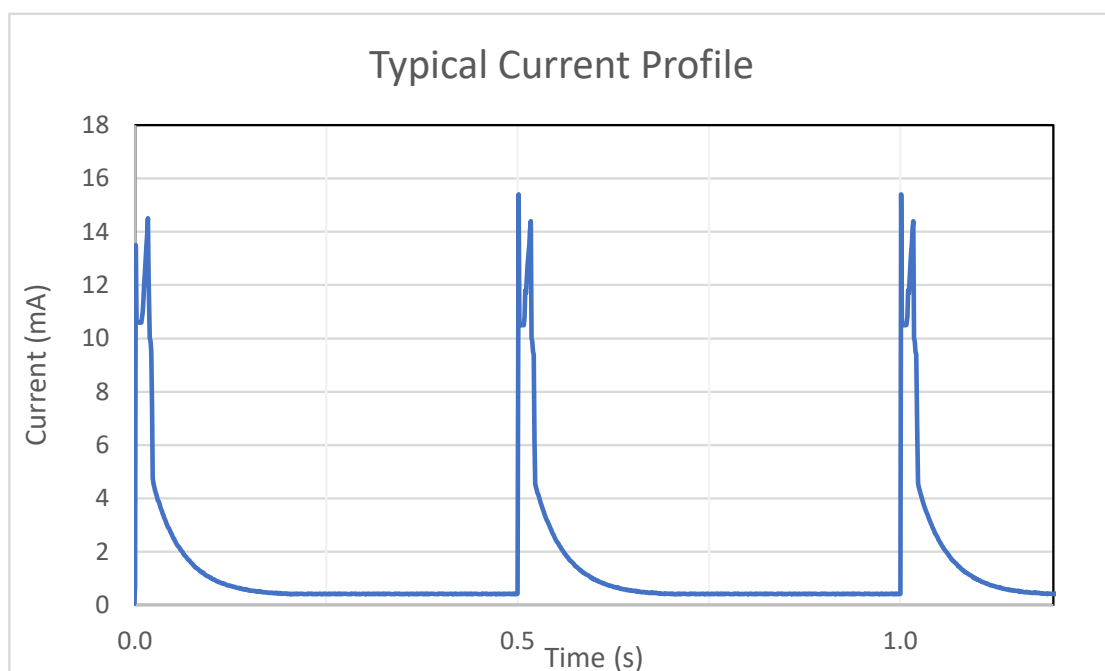
Low Power CO$_2$ Sensor

METHOD OF OPERATION

The CozIR®-LP is designed for low power applications where power is often at a premium. After power is applied to the CozIR®-LP, 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 9600 baud rate. The sensor will return the previous CO$_2$ measurement results if the user requests more frequent measurements.

The CozIR®-LP has 3 potential modes of operation.

MODE 0 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 1 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 2 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.

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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®-LP sensor will also output the raw unfiltered CO_2 measurement data. This data can be post processed using alternative filter algorithms.
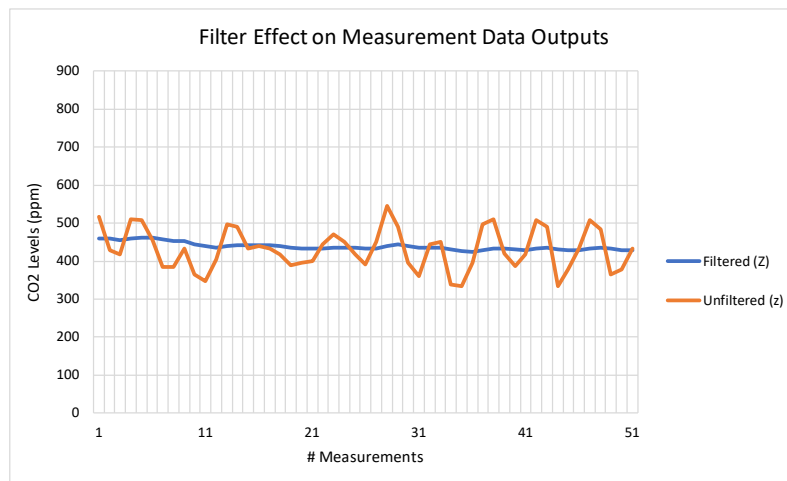
The graph above shows the effects of the filter on the CO_2 measurement data (Z). The unfiltered output (z) is shown in orange and the filtered output (Z) shown in blue.
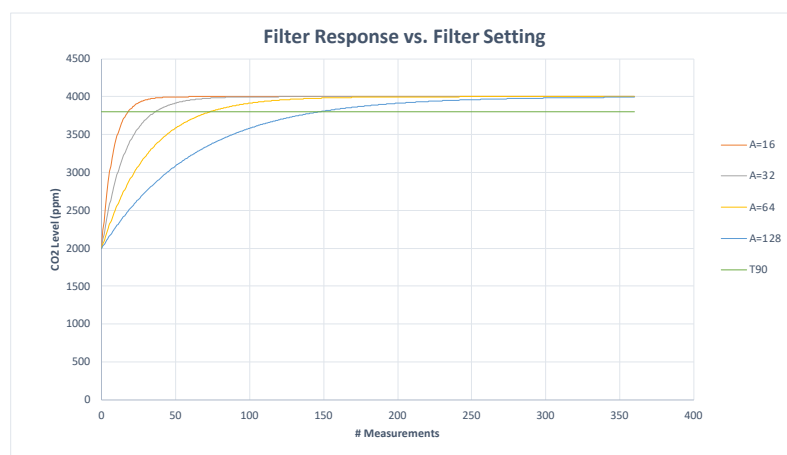
The graph above shows the effect of the filter on response times. Increasing the filter setting increases the measurement output response time. T_{90} is the time to 90% of reading. The CozIR®-LP takes 2 readings per second. The CozIR®-LP sensor will also output the raw unfiltered CO_2 measurement data. This data can be post processed using alternative filter algorithms.

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ZERO POINT SETTING

In all cases, the best zero is obtained when the gas concentration is stable, and the sensor is at a stabilised temperature. 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 regardless of what method is used. There are a several different methods available to the user to set the zero point of the sensor.

ZERO IN A KNOWN GAS CONCENTRATION

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

Power up the sensor, wait for the READY pin to indicate the sensor interface is active. Write the known concentration level to the sensor, then initiate the Zero in a Known Gas calibration method. The concentration must be in ppm**.**

ZERO IN NITROGEN

Place the sensor in the nitrogen gas and allow time for the sensor temperature to stabilise, and for the gas to be fully diffused into the sensor. Power up the sensor, wait for the READY pin to indicate the sensor interface is active. Initiate the Zero in Nitrogen command. The sensor is zero'd assuming a 0ppm CO$_2$ environment**.**

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. This 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, wait for the READY pin to indicate the sensor interface is active.

The user can initiate a Zero in Fresh Air zero cycle. The sensor can use the default fresh air CO$_2$ concentration value (400ppm), or the user can write a different fresh air value to the sensor if desired. The concentration must be in ppm**.**

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ZERO POINT ADJUSTMENT

If the CO_2 concentration and the sensor reported concentrations 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.

AUTO-ZERO FUNCTION

The sensor has a built-in auto-zero function. In order to function correctly, the sensor must be exposed to typical background levels (400-450ppm) at least once during the auto-zeroing 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 disabled by default. If the sensor is powered down, the auto-zeroing is reset to default values.

The auto-zero function works in the same way as the *ZERO IN FRESH AIR* command. Auto-zeroing is disabled by default, but can be enabled to operate automatically, or zeroing can be forced. 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 settings are reset if the sensor is powered down.

AUTO-ZERO LEVEL

The background concentration will depend on sensor location. Ambient levels are typically in the range of 400ppm - 450ppm. The factory default is set to 400ppm. The user can change the background ambient level used for auto-zeroing. The value is stored in the sensor.

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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.

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

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CONTROL INTERFACE

The CozIR®-LP is 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 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 (Fixed)			9,600		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).

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 transmit a CO₂ reading on receiving any character. The sensor will also output a reading based on receiving any character, used mostly when in K 2 mode.

The CO₂ measurement is reported as:

Z #####\r\n

where *Z #####* shows the CO₂ concentration.

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

Low Power CO₂ Sensor

METHOD OF OPERATION

After power is applied to the CozIR®-LP 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 9600 baud rate. The sensor will return the previous CO_2 measurement results if the user requests more frequent measurements. The CozIR®-LP has 3 potential modes of operation.

MODE 0 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 1 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 100ms in responding to commands.

MODE 2 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.

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

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MEASUREMENT DATA OUTPUTS

The CozIR®-LP sensor can be configured to provide filtered and unfiltered CO₂ data as a single string of data. The number of data sets being sent by the sensor is configurable using the 'M' command. Up to 5 different data sets can be transmitted in one string.

UART Command	Use	Default	Range	Example	Response	Comments
M #####\r\n	Sets the number of measurement data types output by the sensor. Set ##### to the mask value	M 00006\r\n		See **"Output Fields"**	M #####\r\n	Sets the number of measurement data types output by the sensor

Measurement Parameter	Field Identifier	Mask Value
CO₂ (Filtered)	Z	4
CO₂ (Unfiltered)	z	2

The CO₂ measurement string is reported as:

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

where

Z ##### shows the CO₂ concentration after digitally filtering

and

z ##### shows the instantaneous CO₂ concentration without any digital filtering.

The required mask value is the sum of the 'Mask Value' for each field required. To output filtered and unfiltered CO₂ data, set M=6.

Low Power CO₂ Sensor

UART INTERFACE SUMMARY

Syntax	Use	Example	Response	Comments
A ###\r\n	Set value of the digital filter, nPulse	A 128\r\n	A 00128\r\n	See **"Digital Filter"**
a\r\n	Return the value of the digital filter, nPulse	a\r\n	a 00128\r\n	See **"Digital Filter"**
F ##### #####\r\n	Fine Tune the zero point	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"*
K #\r\n	Switches the sensor between different modes	K 1\r\n	K 1\r\n	
M ###\r\n	Sets the number of measurement data types output by the sensor	M 6\r\n	M 6\r\n	See **"Output Fields"**
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		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		Two byte value, P 8 = MSB P 9 = 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\r\n	
S #####\r\n	Sets the altitude 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 01224\r\n	
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 calibration	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	

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Syntax	Use	Example	Response	Comments
Z\r\n	Return the most recent filtered CO$_2$ 2 measurement in ppm	Z\r\n	Z 00521\r\n	
z\r\n	Return the most recent unfiltered CO$_2$ 2 measurement in ppm	z\r\n	Z 00521\r\n	
@ ## ##\r\n	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 setting"** for details
@ r\n	Returns the Auto-zero configuration	@ 1.0 8.0\r\n	@ 1.0 8.0\r\n	See **"Auto-zero setting"** for details
@ #r\n	Switch Auto-zeroing on or off	@ 0\r\n	@ 0\r\n	See **"Auto-zero setting"** 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

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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 multiplier to get the ppm value.

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

CO₂ MEASUREMENT Z SCALING FACTOR – UART MODE

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

Measurement Range of Sensor	CO₂ Measurement Scaling Factor (Z)	CO₂ 2 Measurement Output Units	Example
0 – 1%	1	ppm	Z 00521 = 521ppm

'.' COMMAND (0x2E)

To calculate the measurement value in ppm, the 'Z' or 'z' value 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.

Description	Returns a number indicating what multiplier must be applied to the Z CO_2 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 always 1 for CozIR®-LP)

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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 of 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	Read the value of 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)

Low Power CO₂ Sensor

ZERO SETTING COMMANDS – UART MODE

Command	Use	Default	Range	Example	Response	Comments
F ##### #####\r\n	Fine Tune the zero point			F 410 390\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 (in ppm)			X 1000\r\n	X 32997\r\n	See *"Zero Point Setting"*
P 8 ###\r\n P 9 #\r\n	Sets value of CO₂ background concentration in ppm for auto-zeroing	P 8 1\r\n P 9 144\r\n		Two byte value P 8 = MSB P 9 = LSB 400ppm in the example	P 8 ###\r\n P 9 ###\r\n	
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		Two byte value P 8 = MSB P 9 = LSB 400ppm in the example	P 10 ###\r\n P 11 ###\r\n	

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F COMMAND (0x46)

Description	Sets the zero-point using a known reading and a known CO_2 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 41 39\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 CO_2, 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 CO_2 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. Input value is scaled by CO_2 value multiplier, see '.' command.
Syntax	ASCII character 'u', SPACE, then the gas concentration, 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 CO_2. Input value is scaled by CO_2 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).

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P COMMAND - CO₂ Level for Auto-Zeroing

Description	Sets the value of CO_2 in ppm used for auto-zeroing. Input value is scaled by CO_2 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 0\r\n P 9 40\r\n
Response	p 8 0\r\n p 9 40\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 CO_2 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 CO_2 in ppm for zero-point setting in fresh air.
Syntax	ASCII character 'P' then a space, then 10, then a space, then MSB terminated by 0x0D 0x0A (CR & LF) ASCII character 'P' then a space, then 11, then a 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

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

Low Power CO₂ Sensor

ALTITUDE COMPENSATION – UART MODE

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	Return 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 8192\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

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 Function" for details

@ COMMAND (0x2E)

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-zero interval is set to 8 days, and the initial interval set to 1 day.

To disable auto-zero, send @ *0\r\n.*

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To start an auto-zero immediately, send 65222\r\n.

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

SERIAL NUMBER AND FIRMWARE VERSION – UART MODE

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

Y COMMAND (0x59)

Description	The present version string for the firmware and serial number of sensor
Syntax	ASCII character 'Y', terminated by 0x0d 0x0a (CR & LF)
Example	Y\r\n
Response	Y,Jan 30 2013,10:45:03,AL17\r\n B 00233 00000\r\n

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).

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CONNECTION DIAGRAM FOR UART INTERFACE

SENSOR SLAVE		UART MASTER
Rx_IN ○———————○ Tx_OUT		
Tx_OUT ○———————○ Rx_IN		
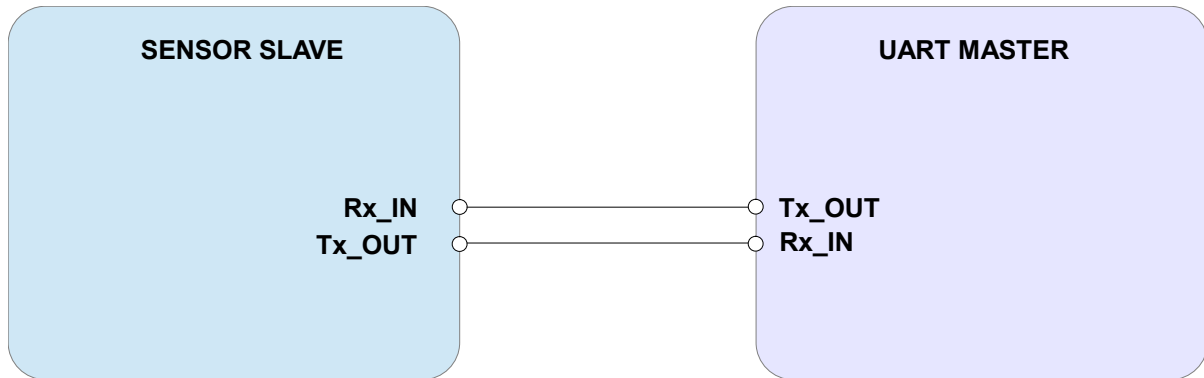
Low Power CO₂ Sensor

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Low Power CO₂ Sensor

REVISION HISTORY

DATE	RELEASE	DESCRIPTION OF CHANGES	PAGES
13/04/2020	4.0	First revision	All
13/05/2020	4.1	Updated power consumption graph, updated language for auto-zero function	P9, All
13/05/2020	4.2	Updated operating temperature	P7, P8

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