

## Ultra-Low Power CO<sub>2</sub> Sensor

### DESCRIPTION

The CozIR®-Blink is an ultra-low power NDIR CO<sub>2</sub> 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<sub>2</sub> sensor signal chain.

The CozIR®-Blink uniquely allows users to reduce power consumption of the CO<sub>2</sub> measurement to unprecedented levels. The CO<sub>2</sub> module is designed to be power cycled when not in use. The sensor is designed to allow the user to wake up the unit from a dormant state and take a reading, and then power down it completely. This reduces the power consumption of the sensor to zero when dormant. The power cycling function is particularly useful for battery powered or wireless interface applications where power is often at a premium.

The CozIR®-Blink also features a built-in auto-zero function that maintains CO<sub>2</sub> measurement accuracy over the lifetime of the product.

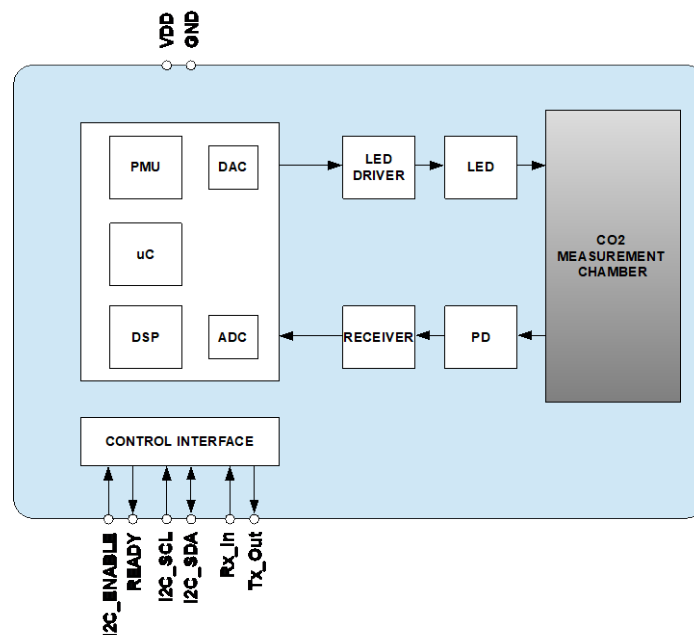
### FEATURES

- Ultra-low power CO<sub>2</sub> sensor
- 30ppm typical measurement accuracy
- Solid state NDIR LED optical technology
- UART or I<sup>2</sup>C control and data interface
- Power cycling compatible
- Built-in auto-zeroing

### APPLICATIONS

- Air Quality and HVAC
- Building management systems (BMS)
- Demand-Controlled Ventilation (DCV) systems
- IoT and Smart Technology wireless equipment
- Indoor Air Quality (IAQ) equipment

### BLOCK DIAGRAM



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### ORDERING INFORMATION

#### COZIR-BLINK-X

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

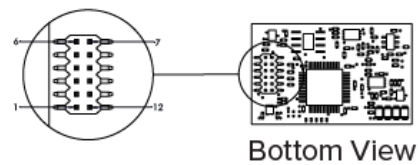
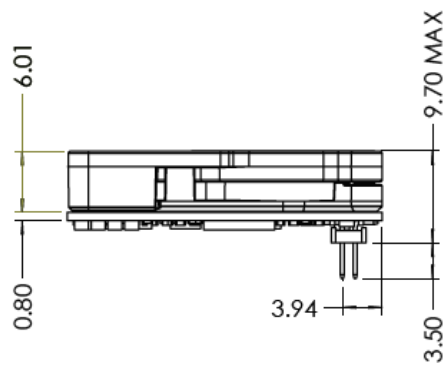
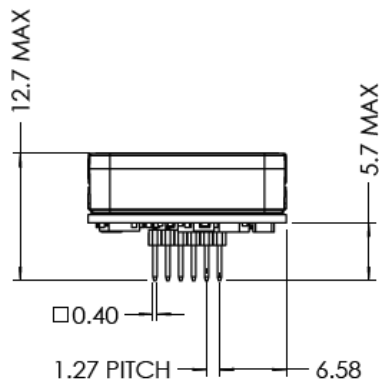
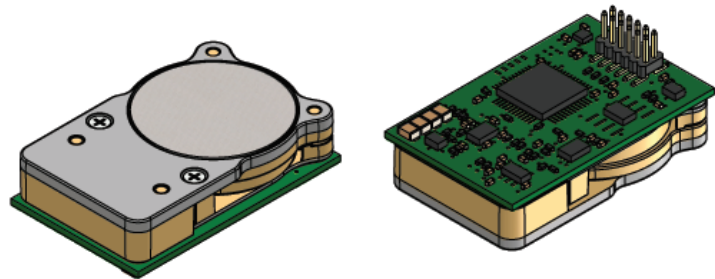
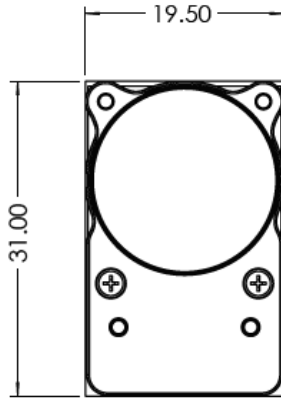
#### Notes:

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

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

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### PACKAGE DRAWING



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	READY	Digital Output	Data ready pin. Pulsed high when data ready
7	NC	Unused	Do not connect
8	NC	Unused	Do not connect
9	NC	Unused	Do not connect
10	I <sup>2</sup> C_ENABLE	Digital Input	Set low for I <sup>2</sup> C interface mode. Leave floating to select UART interface mode. Pin status detected at power on.
11	I2C_SCL	Digital Input	I <sup>2</sup> C serial clock input. Open drain, external 4.7kΩ resistor pulled high to VDD required
12	I2C_SDA	Digital Input/Output	I <sup>2</sup> C serial data input/output. Open drain, external 4.7kΩ resistor pulled high to VDD required

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### ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings are stress ratings only. Permanent damage to the CozIR®-Blink may be caused by continuously operating at or beyond these limits. The CozIR®-Blink 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 <sub>a</sub> )	0°C	+50°C
Storage Temperature Range	-40°C	+70°C
Humidity Range (RH), non-condensing	0	95%
Operating 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

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**PERFORMANCE CHARACTERISTICS**
**Test Conditions Unless Otherwise Specified**

VDD = 3.3V, GND = 0V. CO<sub>2</sub> = 450ppm, RH = 0% non-condensing, T= 25°C, Pressure = 1013mbar

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
CO <sub>2</sub> 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 auto-zero @25°C		±30, +3%, +0.1% per °C		ppm
CO <sub>2</sub> 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 <sub>50</sub> (half full-scale), default settings, limited by diffusion through membrane window		30		secs
Repeatability				±(30, +3%)		ppm
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
		OFF		0		mA

**ELECTRICAL CHARACTERISTICS**

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>Digital Input/Output</b>						
Input HIGH Level			1.8			V
Input LOW Level					1.0	V
Output HIGH Level		I <sub>OH</sub> = +1mA	2.6			V
Output LOW Level		I <sub>OL</sub> = -1mA			0.4	V



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### POWER CONSUMPTION

Test Conditions Unless Otherwise Specified

VDD = 3.3V, GND = 0V. CO<sub>2</sub> = 450ppm, RH = 0% non-condensing, T= 25°C, Pressure = 1013mbar

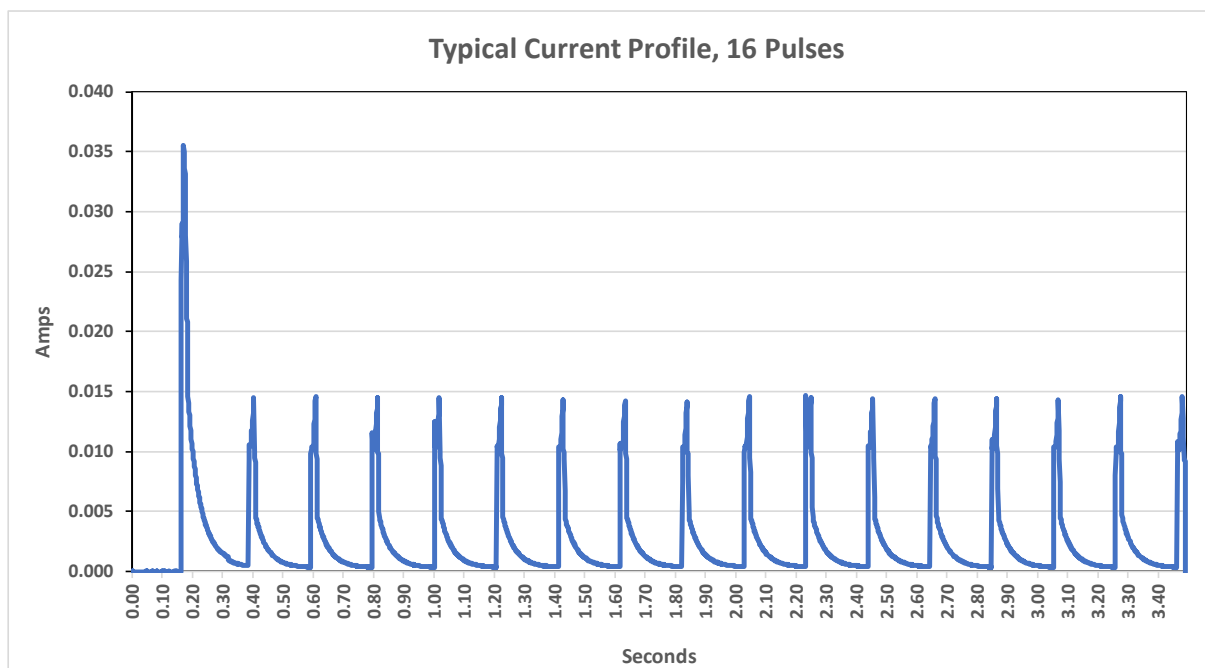
SETTING	SYMBOL	TEST CONDITIONS	VDD		Total Power
			V	I (mA)	mW
OFF		No power applied		0	0
Active, SLEEP mode, no measurement			3.3	0.01	0.03

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.

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

In a typical application where the user might want to take a reading every minute, the power requirement is 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 is shown below.



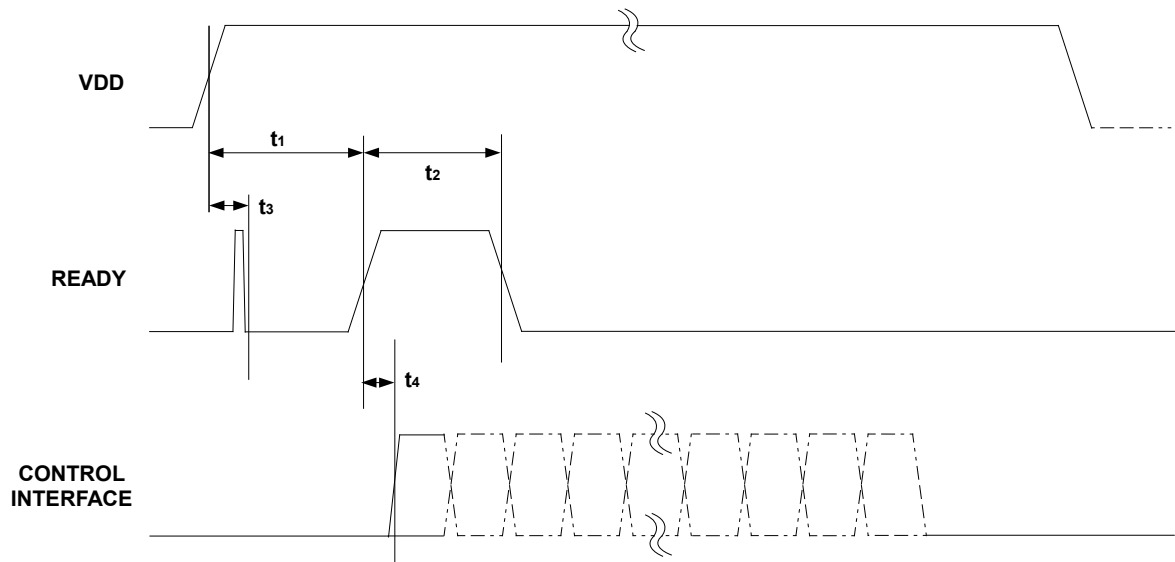
## Ultra-Low Power CO<sub>2</sub> Sensor

### METHOD OF OPERATION

The CozIR®-Blink is designed for ultra-low power applications where power is often at a premium. CozIR®-Blink is designed to be power cycled. When the sensor is switched on, a measurement is automatically initiated. Data can be read out once the READY pin is pulsed high. The sensor can then be subsequently switched off, saving power.

### DATA READY

After power is applied to the CozIR®-Blink, the sensor will automatically start to take CO<sub>2</sub> measurements using the configured settings. Once the READY flag has been pulsed high, the sensor will respond to requests for CO<sub>2</sub> data. The control interface is available on the rising edge of a valid READY pulse.



PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
READY Data Valid from Power On	t <sub>1</sub>	300	3300		ms
READY High Pulse-Width	t <sub>2</sub>		1		ms
READY Low from Power On	t <sub>3</sub>			5	ms
Control Interface Setup Time	t <sub>4</sub>	600			ns

## Ultra-Low Power CO<sub>2</sub> Sensor

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### MEASUREMENT CYCLE

The measurement cycle is the same in either UART or I<sup>2</sup>C connection mode.

- Apply power to the Sensor
- The sensor will automatically start taking measurements. The sensor takes a measurement using the configured number of pulses (*npulse*). The default setting is 16
- The measurement time is approximately 100ms + (200ms x *npulse*)
- The typical measurement time using the default setting *npulse* of 16 is 3,300ms
- The data READY flag is set low within 5ms of power on.
- When the measurement is complete, the data READY flag will be pulsed high for approximately 1ms with data available on the rising edge
- After the measurement is read by the host, the sensor will go into SLEEP mode, and will take no further measurements until the power is cycled again
- During SLEEP mode, the sensor will respond to commands, and can be re-configured but no further measurements will be taken
- A new measurement cycle will start the next time the sensor is power cycled
- Note when auto-calibration is used, the auto-calibration trigger event will extend the measurement time by ~2s
- The number of pulses (*npulse*) can be set and read by the user

All sensor settings are stored in non-volatile memory. The sensor should only be configured once. It should not be configured every power cycle as this consumes unnecessary power.

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### DIGITAL FILTER SETTING

The CO<sub>2</sub> gas chamber is illuminated with a nominal 4.25um wavelength LED and the signal received using a photodiode. The LED output is 'pulsed' several times per measurement reading. The signal from the photodiode is processed and filtered by the sensor to remove noise and provide an accurate CO<sub>2</sub> reading.

The number of 'pulses' used by the sensor is a balance between CO<sub>2</sub> reading accuracy and power consumption. The energy required per measurement is directly proportional to the number of pulses (*npulse*).

Higher values of *npulse* will reduce noise and improve resolution. A lower value of *npulse* reduces the energy per measurement. The user should carefully consider the compromise between power consumption and resolution to determine the optimum setting of *npulse* for the application. The factory default is 16 and the maximum value is 32.

The value of *npulse* is stored on the sensor and can be read by the host controller. If the value of *npulse* is changed, the sensor must be zero-calibrated.

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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 measurement is complete. Write the known concentration level to the sensor, then initiate the Zero in a Known Gas zeroing 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 measurement done. Initiate the Zero in Nitrogen command. The sensor is zeroed assuming a 0ppm CO<sub>2</sub> 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<sub>2</sub> 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 measurement done.

Once the initial CO<sub>2</sub> measurement has been completed, the user can initiate a new Zero in Fresh Air zeroing cycle. The sensor can use the default fresh air CO<sub>2</sub> concentration value (400ppm), or the user can write a different fresh air value to the sensor if desired. The concentration must be in ppm.

## Ultra-Low Power CO<sub>2</sub> Sensor

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### **ZERO POINT ADJUSTMENT (not available in I<sup>2</sup>C interface mode)**

If the CO<sub>2</sub> 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-zero period. For example, many buildings will drop quickly to background CO<sub>2</sub> 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-zeroing is enabled by default.

### **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.

### **AUTO-ZERO INTERVALS**

The auto-zero period is based on the number of power cycles. The CozIR®-Blink records the number of power cycles since the last auto-zero event. When it reaches a pre-defined threshold, auto-zero will be triggered. The number of cycles can be configured by the user.

For example, if the sensor is programmed to take a reading once every 5 minutes, with auto-zero to be set for every 7 days, set the auto-zero threshold to 2,016 (12 times per hour x 24 hours per day x 8 days). The auto-zero routine will trigger after 2,016 power cycles.

Note, an auto-zero operation will extend the time from power-on to when valid measurements are available (defined by status of READY flag) by approximately 2s.

The sensor default is auto-zero enabled. However, auto-zero can be disabled, or auto-zero can be forced. The auto-zero counter is reset automatically if the user forces an auto-zero directly. The auto-zero counter is available to be read back by the controller.

## Ultra-Low Power CO<sub>2</sub> 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	CO <sub>2</sub> 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.

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

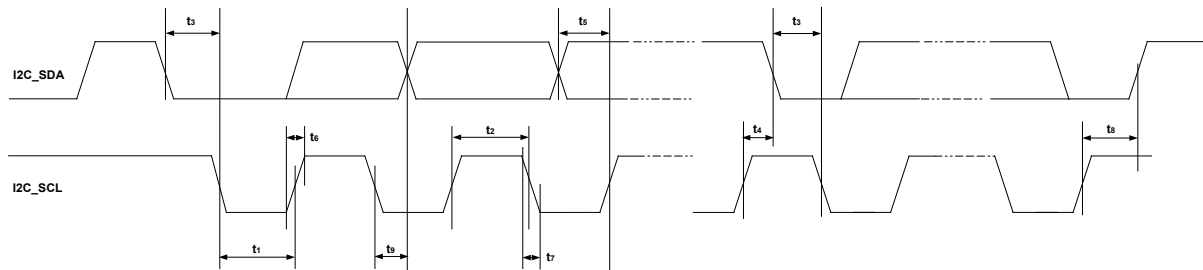
## Ultra-Low Power CO<sub>2</sub> Sensor

### SELECTION OF CONTROL INTERFACE

The CozIR®-Blink is controlled by writing to registers through a serial control interface. The control interface can be configured as a UART or 2-wire I<sup>2</sup>C interface.

Selection of the control interface is done via the I2C\_ENABLE pin. The state of the I2C\_ENABLE pin is sampled at power up only. The status cannot be changed after power up. Setting the I2C\_ENABLE pin low puts the CozIR®-Blink into I<sup>2</sup>C interface mode. Leaving the I2C\_ENABLE pin floating puts the CozIR®-Blink into UART control interface mode.

### CONTROL INTERFACE TIMING - I<sup>2</sup>C MODE



PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
I2C_SCL Frequency		0		100	kHz
I2C_SCL Low Pulse-Width	t <sub>1</sub>	4.7			us
I2C_SCL High Pulse-Width	t <sub>2</sub>	4.0			us
Hold Time (Start Condition)	t <sub>3</sub>	4.0			us
Setup Time (Start Condition)	t <sub>4</sub>	4.7			us
Data Setup Time	t <sub>5</sub>	250			ns
I2C_SDA, I2C_SCL Rise Time	t <sub>6</sub>			1000	ns
I2C_SDA, I2C_SCL Fall Time	t <sub>7</sub>			300	ns
Setup Time (Stop Condition)	t <sub>8</sub>	4.0			us
Data Hold Time	t <sub>9</sub>	0		5.0	us
Capacitive load for each bus line	-			400	pF



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### I<sup>2</sup>C INTERFACE MODE

The CozIR®-Blink supports software control via a 2-wire serial bus. Many devices can be controlled by the same bus, and each device has a unique 7-bit address (this is not the same as the 8-bit address of each register in the CozIR®-Blink). The CozIR®-Blink operates as a slave only device.

The controller indicates the start of data transfer with a high to low transition on I2C\_SDA while I2C\_SCL remains high (I<sup>2</sup>C Start condition). This indicates that a device address will follow. All devices on the 2-wire bus respond to the start condition and shift in the next eight bits on I2C\_SDA (7-bit address + Read/Write bit, MSB first). If the device address received matches the address of the CozIR-BLINK and the R/W bit is '0', indicating a write, then the CozIR®-Blink responds by pulling I2C\_SDA low on the next clock pulse (ACK). If the address is not recognised or the R/W bit is '1', the CozIR®-Blink returns to the idle condition and waits for a new start condition and valid address.

The CozIR®-Blink acknowledges the correct address by pulling I2C\_SDA low for one clock pulse. The master then sends the address of the register it wishes to read from or write to. Data is either read from or written to in 1 - 4 bytes, most significant byte (MSB) first.

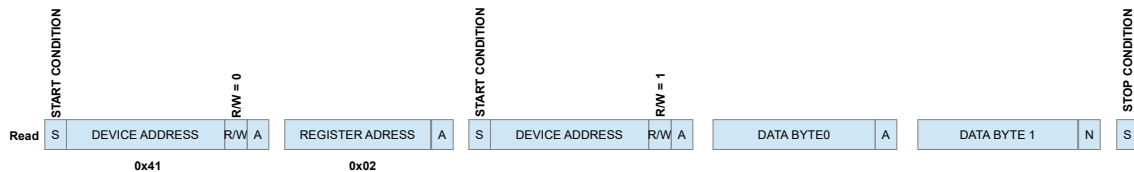
The transfer of data is complete when there is a low to high transition on I2C\_SDA while I2C\_SCLK is high. After receiving a complete address and data sequence the CozIR®-Blink returns to the idle state and waits for another start condition. If a start or stop condition is detected out of sequence at any point during data transfer (i.e. I2C\_SDA changes while I2C\_SCL is high), the device jumps to the idle condition.

***The CozIR®-Blink device address is 0x41.***

## Ultra-Low Power CO<sub>2</sub> Sensor

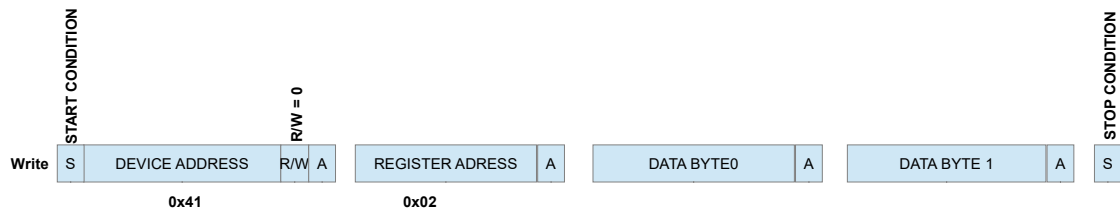
### WRITING TO AN I<sup>2</sup>C REGISTER

The controller (Master) sends a START condition to the sensor. The sensor acknowledges the controller by setting the R/W bit low, indicating it is expecting the controller to write to a register. The controller sends the register address that it wants to write to, and then 1-4 data bytes. Once the controller has completed the operation, it sends the STOP condition.



### READING FROM AN I<sup>2</sup>C REGISTER

The controller (Master) sends a START condition to the sensor. The sensor acknowledges the controller by setting the R/W bit high, indicating it is expecting the controller to read from a register. The controller sends the register address that it wants to read from, and then reads out 1-4 data bytes. Once the controller has completed the operation, it sends the STOP condition.



## Ultra-Low Power CO<sub>2</sub> Sensor

**I<sup>2</sup>C REGISTER MAP SUMMARY**

REGISTER	ADDRESS	DESCRIPTION	DEFAULT	RANGE	Size (bytes)	READ/WRITE
R2 (0x02)	00000010	CO <sub>2</sub> Level (ppm)	N/A	0 – 65535	2	READ only
R5 (0x05)	00000101	Sensor Control Settings			1	WRITE only
R12 (0x0C)	00001100	Auto-Zero Target	400ppm	0 to full scale	2	READ/WRITE
R18 (0x12)	00010010	Target value for CO <sub>2</sub> in fresh air (in ppm)	400ppm	0 to full scale	2	READ/WRITE
R20 (0x14)	00010100	Known CO <sub>2</sub> Concentration (in ppm)		0 to full scale	2	READ/WRITE
R26 (0x1A)	00011010	Auto-Zero Cycles	5000	0 – 39268	2	READ/WRITE*
R30 (0x1E)	00011110	Altitude Correction Value	8192	0 to 32768	2	READ/WRITE
R38 (0x26)	00100110	Serial Number	N/A		4	READ only
R42 (0x2A)	00101010	nPulse	16	1 – 32	1	READ/WRITE*
R78 (0x4E)	01001110	Auto-Zero Control			1	READ/WRITE*

\* indicates a sensor zero should be performed after the default values are changed.

## Ultra-Low Power CO<sub>2</sub> Sensor

### CO<sub>2</sub> LEVEL MEASUREMENT VALUE

REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R2 (0x02)	00000010	15:0		CO <sub>2</sub> level, in ppm		Read only

The measured CO<sub>2</sub> level is read from Register R2, 2 bytes, MSB first. The value is CO<sub>2</sub> level in ppm.

### CALIBRATION ZERO CONTROL

REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R5 (0x05)	00000101	0	Air Zero	Sets the zero point assuming the sensor is in 400ppm CO <sub>2</sub> . Write the measured CO <sub>2</sub> level into Register 18  00000000: No Zero 00000001: Zero	00000000	Write
		2	X Zero	Sets the zero point with the sensor in a known concentration of CO <sub>2</sub> . Write the target ppm concentration into Register 20.  00000000: No X Zero 00000010: X Zero	00000000	Write

### ZERO IN FRESH AIR

REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R18 (0x12)	00010010	15:0		Target value for CO <sub>2</sub> in fresh air	110010000	Read/Write

The target value for CO<sub>2</sub> in fresh air is stored in register 18. The default is 400ppm.

### ZERO IN A KNOWN GAS CONCENTRATION

REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R20 (0x14)	00010100	15:0	X Zero	CO <sub>2</sub> concentration (in ppm)		Read/Write

Stores the target ppm concentration of CO<sub>2</sub> gas. All CO<sub>2</sub> values are in ppm. CO<sub>2</sub> level is a two-byte value, MSB first.

## Ultra-Low Power CO<sub>2</sub> Sensor

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### AUTO-ZERO CYCLES

REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R26 (0x1A)	00011010	15:0		Number of power cycles between auto-zero events	1001110001000	Read/Write*

### ALTITUDE COMPENSATION

REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R30 (0x1E)	00011110	15:0	ALTITUDE	Altitude level compensation value	10000000000000	Read/Write

### SERIAL NUMBER

REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R38 (0x26)	00100110	31:0	SERIAL NUMBER	Unique sensor serial number, 32-digit code		Read only

### nPULSE

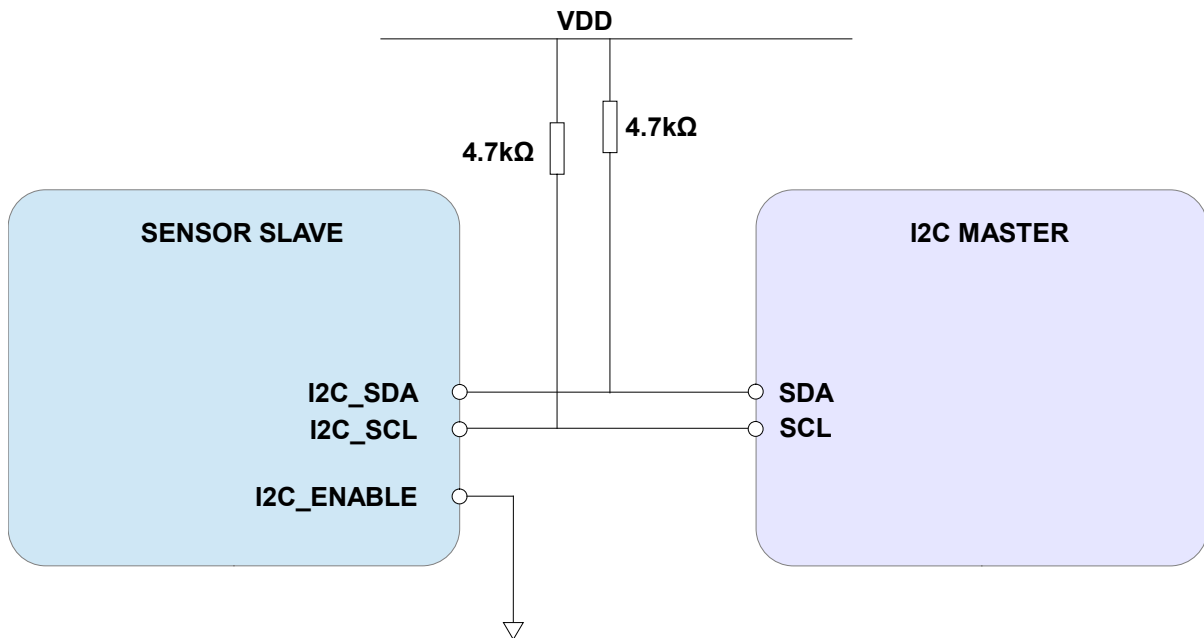
REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R42 (0x2A)	00101010	7:0	nPulse	Sets the number of pulses per reading	00010000	Read/Write

### AUTO-ZERO CONTROL

REGISTER	ADDRESS	BIT	LABEL	DESCRIPTION	DEFAULT	READ/WRITE
R78 (0x4E)	01001110	7:0	AUTO CAL	Auto-calibration control 00000000 = Disabled 00000010 = Enabled	00000010	Read/Write

## Ultra-Low Power CO<sub>2</sub> Sensor

### CONNECTION DIAGRAM FOR I<sup>2</sup>C INTERFACE



## Ultra-Low Power CO<sub>2</sub> Sensor

### UART INTERFACE MODE

Leaving the I<sup>2</sup>C\_ENABLE pin floating puts the CozIR®-Blink into UART control interface mode. The status of the I<sup>2</sup>C\_ENABLE is only sampled at power up.

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 use 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			38,400		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 CO<sub>2</sub> reading on receiving any character.

The CO<sub>2</sub> measurement is reported as:

Z #####\r\n

where Z ##### shows the CO<sub>2</sub> concentration.

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

***After the initial measurement, the sensor will cease to transmit another CO<sub>2</sub> reading until it has been power cycled.***

## Ultra-Low Power CO<sub>2</sub> Sensor

**UART INTERFACE SUMMARY**

Command	Use	Example	Response	Comments
A ###\r\n	Set value of nPulse	A 16\r\n	A 00016\r\n	See <b>"nPulse"</b>
a\r\n	Return the value of nPulse	a\r\n	a 00016\r\n	See <b>"nPulse"</b>
F #####\r\n	Fine tune the zero point	F 410 400\r\n	F 33000\r\n	See <b>"Zero Point Setting"</b>
G\r\n	Zero-point calibration using fresh air.	G\r\n	G 33000\r\n	See <b>"Zero Point Setting"</b>
P 8 ###\r\n P 9 ###\r\n	Sets value of CO <sub>2</sub> background concentration in ppm for auto-zero	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 <sub>2</sub> 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
S #####\r\n	Sets the altitude compensation value	S 8192\r\n	S 08192\r\n	See <b>"Altitude Compensation"</b>
s\r\n	Returns the altitude compensation value	s\r\n	s 08192\r\n	See <b>"Altitude Compensation"</b>
U\r\n	Zero-point setting using nitrogen.	U\r\n	U 33000\r\n	See <b>"Zero Point Setting"</b>
u #####\r\n	Manual setting of the zero point.	u 32997\r\n	u 32997\r\n	See <b>"Zero Point Setting"</b>
X #####\r\n	Zero-point setting using a known gas concentration	X 2000\r\n	X 32997\r\n	See <b>"Zero Point Setting"</b>
Y\r\n	Return firmware version and sensor serial number	Y\r\n	Returns <u>two</u> lines	
Z\r\n	Return the most recent CO <sub>2</sub> measurement.	Z\r\n	Z 01521\r\n	1521ppm in the example
@ #.#.#.#\r\n	Sets power cycle auto-zero count	@ 5000\r\n	@ 05000\r\n	See <b>"Auto-Zero Function"</b> for details
.\r\n	Return the multiplier required to convert the Z output to ppm	.\r\n	. 00001\r\n	Multiply by 1 in the example



## Ultra-Low Power CO<sub>2</sub> Sensor

Command	Use	Example	Response	Comments
*\r\n	Return configuration information.	*\r\n		

### CO<sub>2</sub> LEVEL MEASUREMENT VALUE - Z INFORMATION (0x5A)

<b>Description</b>	Reports the latest CO <sub>2</sub> measurement
<b>Syntax</b>	ASCII Character 'Z', terminated by 0x0D 0x0A (CR & LF)
<b>Example</b>	Z\r\n
<b>Response</b>	Z 00521\r\n     1521ppm in the example

The CO<sub>2</sub> reading will be in 2 bytes, MSB first, then LSB followed by a status byte.

In the above example, the sensor will respond as follows:-

Byte 1: 0x05

Byte 2: 0xF1

Byte 3: 0x5A

After reading the CO<sub>2</sub> value, the sensor should be powered down unless the sensor settings need to be modified.

### CO<sub>2</sub> 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	CO <sub>2</sub> Measurement Scaling Factor (Z)	CO <sub>2</sub> Measurement Output Units	Example
0 – 1%	1	ppm	Z 00631 = 631ppm

### '.' COMMAND (0x2E)

<b>Description</b>	Returns a number indicating what multiplier must be applied to the Z CO <sub>2</sub> measurement output to convert it into ppm.
<b>Syntax</b>	ASCII character '.', terminated by 0x0D 0x0A ( CR & LF )
<b>Example</b>	.\r\n
<b>Response</b>	. 00001\r\n     (this number is always 1 for CoZIR®-Blink)

## Ultra-Low Power CO<sub>2</sub> Sensor

### nPULSE SETTING – UART MODE

UART Command	Use	Default	Range	Example	Response	Comments
A ###\r\n	Set <i>npulse</i> , the number of pulses	16	0 - 32	A 16\r\n	A 00016\r\n	Lower npulse reduces power consumption.
a\r\n	Return <i>npulse</i> value	16	0 - 32	a\r\n	a 00016\r\n	

### A COMMAND (0x41)

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

### a COMMAND (0x61)

<b>Description</b>	Return the value for the number of pulses
<b>Syntax</b>	ASCII Character 'a' terminated by 0x0D 0x0A (CR & LF)
<b>Example</b>	a\r\n
<b>Response</b>	a 00016\r\n (this number is variable)

## Ultra-Low Power CO<sub>2</sub> Sensor

### ZERO POINT CALIBRATION COMMANDS – UART MODE

Command	Use	Default	Range	Example	Response	Comments
F ##### #####\r\n	Fine Tune the zero point			F 410 400\r\n	F 33000\r\n	See <b>“Zero Point Setting”</b>
G\r\n	Zero-point setting using fresh air			G\r\n	G 33000\r\n	See <b>“Zero Point Setting”</b>
U\r\n	Zero-point setting using nitrogen			U\r\n	U 33000\r\n	See <b>“Zero Point Setting”</b>
u #####\r\n	Manual setting of the zero point			u 32997\r\n	u 32997\r\n	See <b>“Zero Point Setting”</b>
X #####\r\n	Zero-point setting using a known gas concentration			X 2000\r\n	X 32997\r\n	See <b>“Zero Point Setting”</b>
P 8 ###\r\n P 9 #\r\n	Sets value of CO <sub>2</sub> background concentration in ppm for auto-zero	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 CO <sub>2</sub> 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	

### F COMMAND (0x46)

<b>Description</b>	Sets the zero-point using a known reading and known CO <sub>2</sub> concentration
<b>Syntax</b>	ASCII character 'F' then a space, then the reported gas concentration, then a space, then the actual gas concentration
<b>Example</b>	F 410 390\r\n
<b>Response</b>	F 33000\r\n (the numbers are variable)

### G COMMAND (0x47)

<b>Description</b>	Sets the zero point assuming the sensor is in fresh air (typically 400ppm CO <sub>2</sub> , but level can be set by user – see P commands.)
<b>Syntax</b>	ASCII character 'G'
<b>Example</b>	G\r\n
<b>Response</b>	G 33000\r\n (the number is variable)

## Ultra-Low Power CO<sub>2</sub> Sensor

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**U COMMAND (0x55)**

<b>Description</b>	Sets the zero point assuming the sensor is in 0ppm CO <sub>2</sub> such as nitrogen
<b>Syntax</b>	ASCII Character 'U' terminated by 0x0D 0x0A (CR & LF)
<b>Example</b>	U\r\n
<b>Response</b>	U 32767\r\n (the number is variable)

**u COMMAND (0x75)**

<b>Description</b>	Forces a specific zero set point value. Value in ppm.
<b>Syntax</b>	ASCII character 'u', SPACE, decimal, terminated by 0x0D 0x0A (CR & LF)
<b>Example</b>	u 32767\r\n
<b>Response</b>	u 32767\r\n

**X COMMAND (0x58)**

<b>Description</b>	Sets the zero point with the sensor in a known concentration of CO <sub>2</sub> . Value in ppm
<b>Syntax</b>	ASCII character 'X' then a space, then the gas concentration.
<b>Example</b>	X 1000\r\n
<b>Response</b>	X 33000\r\n (the number is variable)

**P COMMAND - CO<sub>2</sub> Level for Auto-Zero**

<b>Description</b>	Sets the value of CO <sub>2</sub> in ppm used for auto-zero
<b>Syntax</b>	ASCII character 'P' then a space, then 8, then a 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)
<b>Example</b>	P 8 1\r\n P 9 144\r\n
<b>Response</b>	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 CO<sub>2</sub> background concentration is 400ppm.

MSB = Integer (400/256) = 1

LSB = 400 – 256 = 144

## Ultra-Low Power CO<sub>2</sub> Sensor

### P COMMAND – CO<sub>2</sub> Level for Zero-Point Setting

<b>Description</b>	Sets value of CO <sub>2</sub> in ppm for zero-point setting in fresh air.
<b>Syntax</b>	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)
<b>Example</b>	P 10 7\r\n P 11 208\r\n
<b>Response</b>	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<sub>2</sub> concentration is 2000ppm.

MSB = Integer (2000/256) = 7

LSB = 2000 – (256\*MSB) = 208

### 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 “ <i>Altitude Compensation</i> ”
s\r\n	Return the altitude compensation value			s\r\n	s 08192\r\n	See “ <i>Altitude Compensation</i> ”

### S COMMAND (0x53)

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

### s COMMAND (0x73)

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

## Ultra-Low Power CO<sub>2</sub> Sensor

### AUTO-ZERO INTERVAL – UART MODE

UART Command	Use	Default	Range	Example	Response	Comments
@ #####\r\n	Auto-zero interval setting, # power cycles			@ 05760\r\n	@ 05760\r\n	See “Auto-Zero Settings”

### @ COMMAND (0x2E)

<b>Description</b>	Sets the number of power cycles between auto-zero events.
<b>Syntax</b>	ASCII character '@' then a space, then the number of power cycles, terminated by 0x0D 0x0A (CR & LF)
<b>Example</b>	@ ## ###\r\n
<b>Response</b>	@ 5760\r\n (this number is variable)

In the above example, if the sensor is powered up once every 2 minutes, and auto-calibration is once every 8 days, the power cycle auto-calibration counter should be set to 5760.

To read the auto-zeroing counter, send @\r\n. The sensor will respond with @ #####\r\n.

To disable auto-zeroing, send @ 0\r\n

To start an auto-zero immediately, send 65222\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 <u>two</u> lines	

### Y COMMAND (0x59)

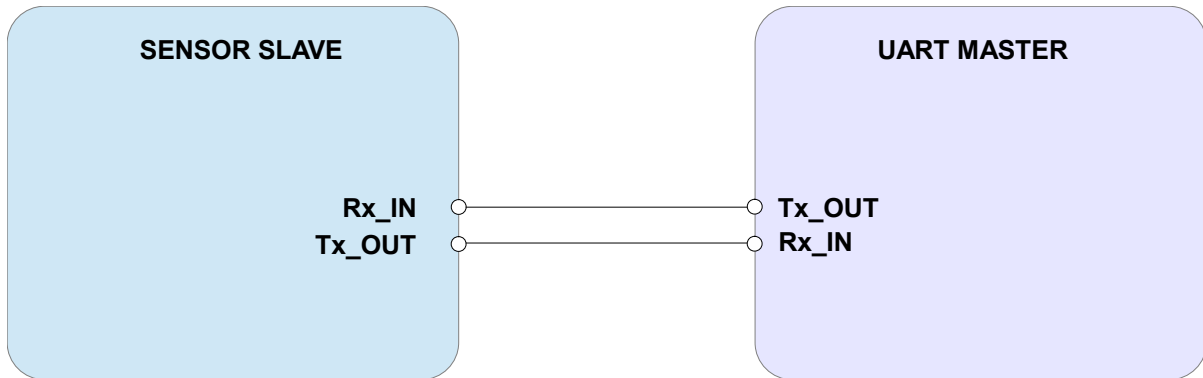
<b>Description</b>	The present version string for the firmware and serial number of the sensor.
<b>Syntax</b>	ASCII character 'Y', terminated by 0x0d 0x0a ( CR & LF )
<b>Example</b>	Y\r\n
<b>Response</b>	Y,Jan 30 2013,10:45:03,AL17\r\n B 00233 00000\r\n

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).

## Ultra-Low Power CO<sub>2</sub> Sensor

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### CONNECTION DIAGRAM FOR UART INTERFACE



## Ultra-Low Power CO<sub>2</sub> Sensor

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### IMPORTANT NOTICE

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## Ultra-Low Power CO<sub>2</sub> Sensor

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### REVISION HISTORY

DATE	RELEASE	DESCRIPTION OF CHANGES	PAGES
10/04/2020	4.0	First revision	All
14/04/2020	4.1	Block Diagram, Current Consumption Graph	1,8
17/04/2020	4.2	I <sup>2</sup> C REGISTER MAP SUMMARY	18
01/05/2020	4.3	Pin-out description	5
13/05/2020	4.4	Updated operating temperature	7, 8
14/05/2020	4.5	Updated auto-zero language	All