Small Footprint Low Power CO_2 Sensor

DESCRIPTION

The ExplorIR®-W is a small footprint low power NDIR CO_2 sensors using state-of-the-art solid-state LED optical technology. The low power LEDs are manufactured in-house, giving SST complete control of the CO_2 sensor signal chain.

The ExplorIR®-W is designed for applications that need to work reliably over a wide range of conditions and environments. The sensor is available in multiple versions with several user selectable options, including temperature and RH measurement capability. The sensor will measure CO_2 levels up to 100% concentration.

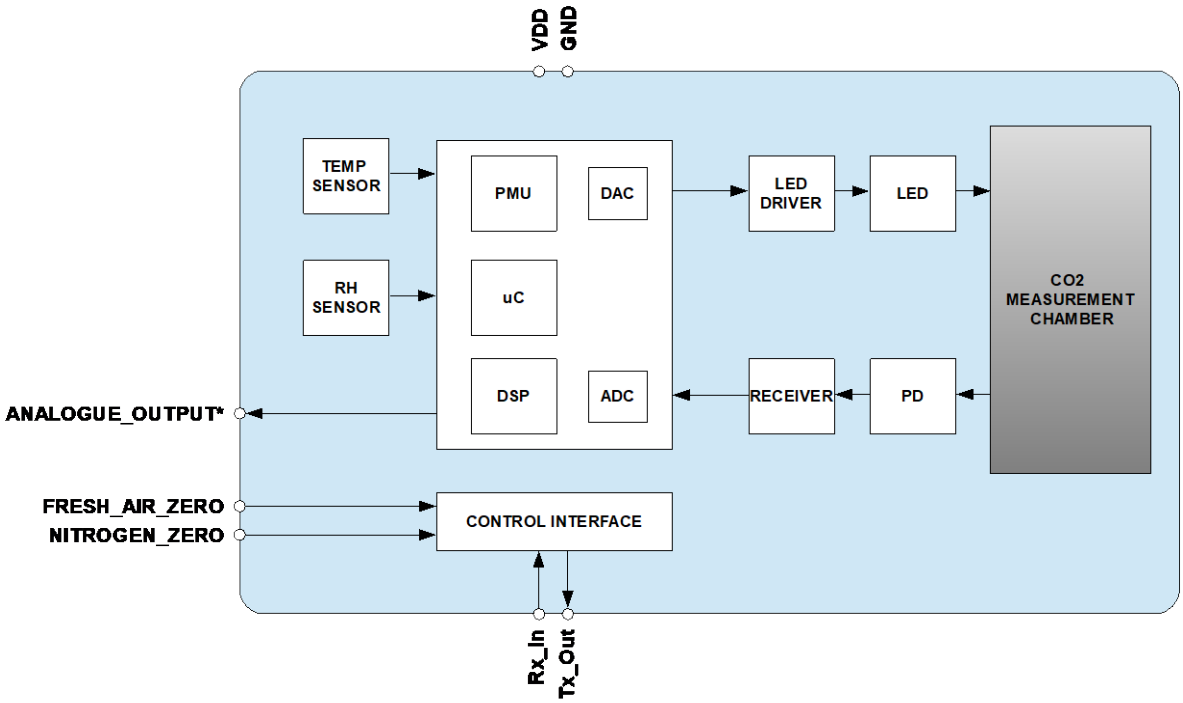
FEATURES

- Low power CO_2 sensor
- 70ppm typical measurement accuracy
- Measurement range up to 100%
- Solid state NDIR LED optical technology
- UART control and data interface
- Built-in auto-calibration

APPLICATIONS

- Agriculture
- Healthcare
- Safety
- Aerospace
- Food packaging
- Incubators
- Food storage and transportation

BLOCK DIAGRAM



T, RH and * Optional

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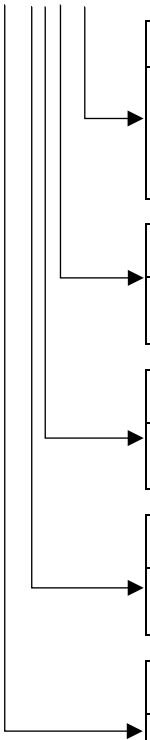
ORDERING INFORMATION

EXPLORIR-W-X-XXX-X



X	Measurement Range
5	0-5%
20	0-20%
60	0-60%
100	0-100%

X	Temperature and RH
H	Included
Blank	Not included

X	CO_2 Voltage Output
V	Included
Blank	Not included

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

X	Flow Adaptor
F	Included
X	Not included

Notes:

1. Sensors are shipped individually

See separate data sheet for ExplorIR®-W evaluation kit options

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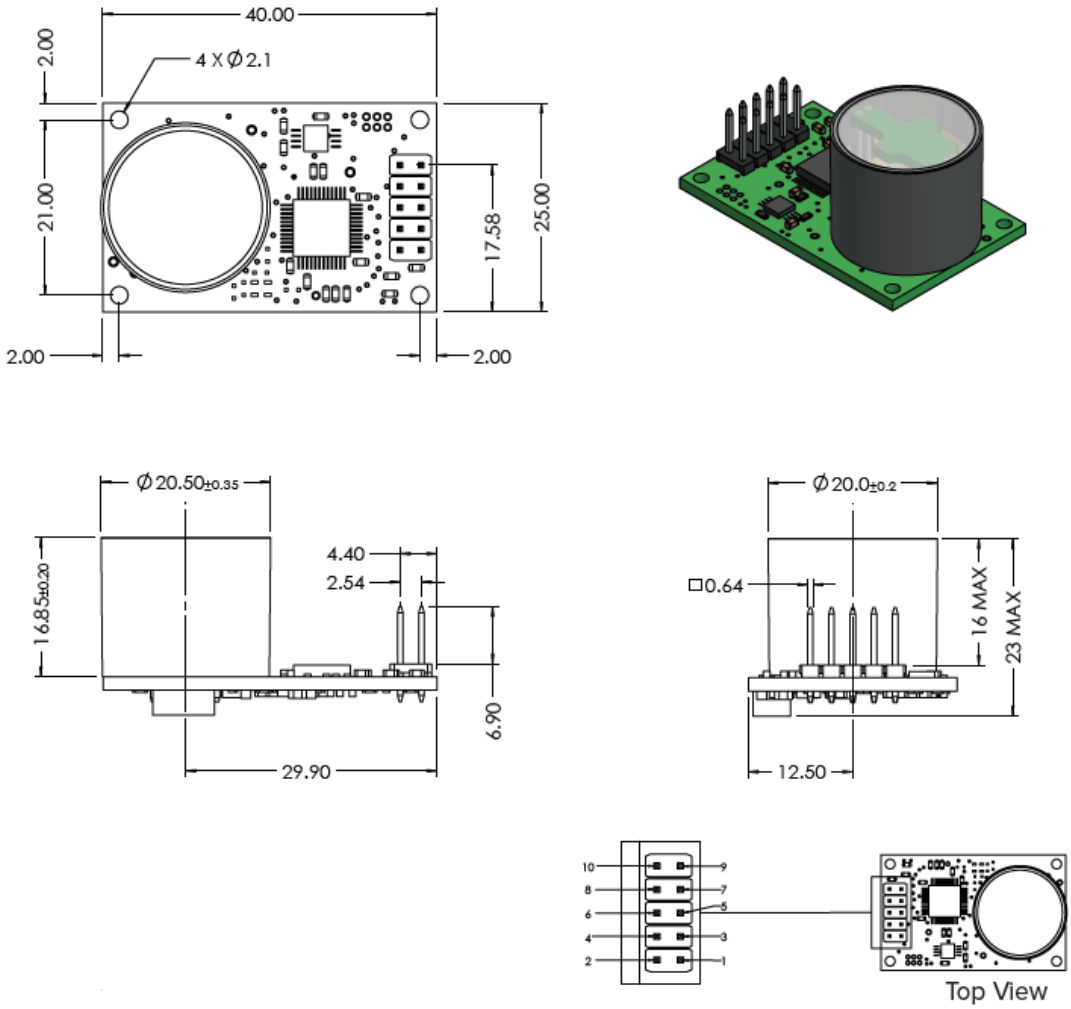
PACKAGE DRAWING: ExplorIR®-W



Weight = ~6g

PIN-OUT DESCRIPTION: ExplorIR®-W

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 Calibration 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 Calibration Cycle

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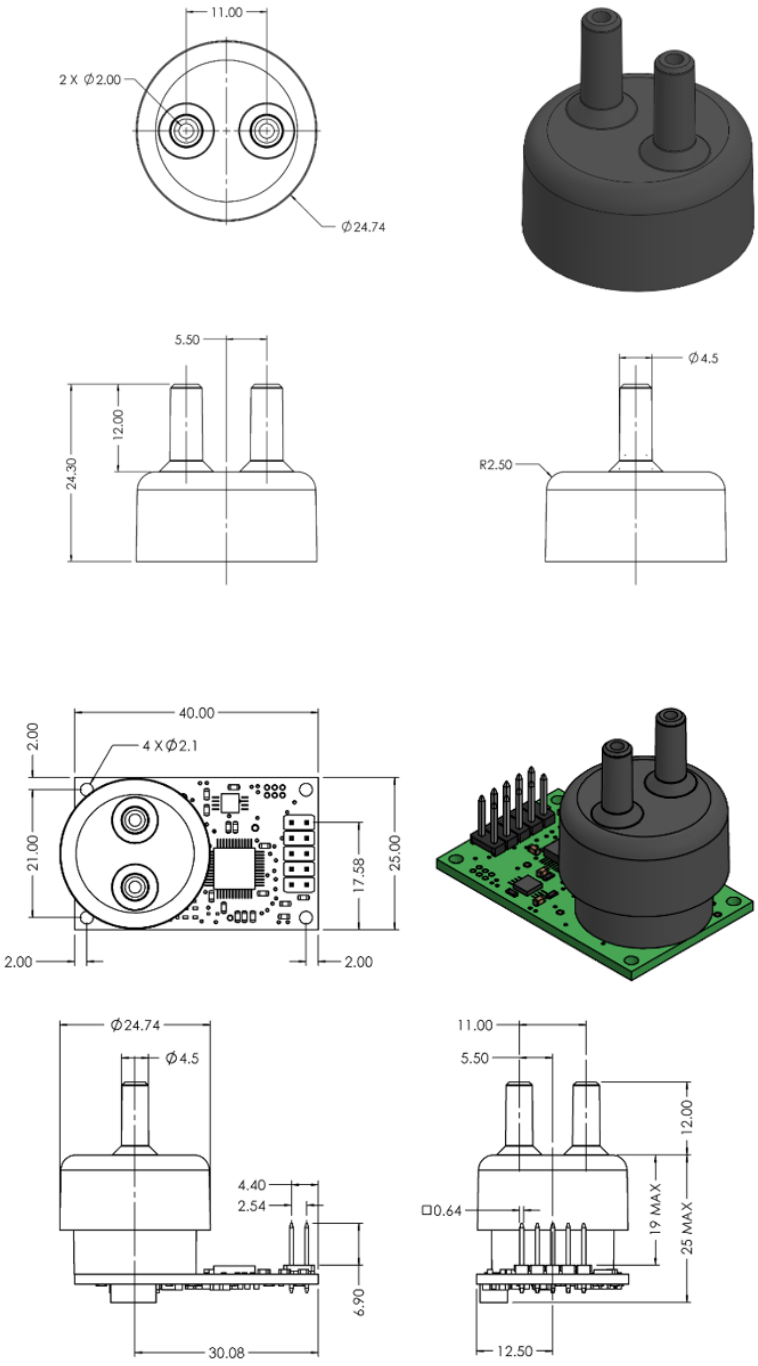
FLOW ADAPTOR DRAWING: ExplorIR®-W



Notes

1. The flow adaptor is sealed over the existing outer body of the sensor and replaces the membrane cover of the standard sensor
2. The flow adaptor seal is not pressure tested, contact SST if the sensor is required to operate in a pressurised environment

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ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings are stress ratings only. Permanent damage to the ExplorIR® may be caused by continuously operating at or beyond these limits. The ExplorIR® 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 - Extended	 0°C -25°C	 +50°C +55°C
Storage Temperature Range	-40°C	+70°C
Humidity Range (RH)	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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CO2 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		5	%
			0		20	%
			0		60	%
			0		100	%
Accuracy (Peak-Peak) 0-60%		@25°C		±70, +5%	±100, +5%	ppm
		0°C to +55°C, after auto-zero @25°C		±70, +5%, +0.1% per °C		ppm
		-25°C to +55°C, after auto-zero @25°C		±70, +5%, +0.1% per °C		ppm
Accuracy (Peak-Peak) 0-100%		@25°C		±300, +5%	±300, +5%	ppm
		0°C to +55°C, after auto-zero @25°C		±300, +5%, +0.1% per °C		ppm
		-25°C to +55°C, after auto-zero @25°C		±1000, +5%, +0.1% per °C		ppm
CO_2 RMS Noise		Digital filter setting 16		0		ppm
Time to Valid Measurement After Power-On		Digital filter setting 16, dependent on digital filter setting	1.0	1.2		secs
Response Time		From 0ppm to T_{50} default settings, limited by diffusion through membrane window		30		secs
Repeatability		@25°C, 0-60%		±70, +5%		ppm
		@25°C, 0-100%		±300, +5%		ppm
Current Consumption		Peak current when sampling		35		mA
		Peak at turn-on		40		mA
		SLEEP Mode (K2 polling)		0.01		mA

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HUMIDTY PERFORMANCE CHARACTERISTICS - ExplorIR®-W Option

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Humidity measurement range			0		100	%
Accuracy		@25°C		±3		% RH
Repeatability		@25°C		±1		%
Response time		0-50%		<8		secs
Accuracy drift				0.25		% RH/Yr

TEMPERATURE PERFORMANCE CHARACTERISTICS - ExplorIR®-W 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		>10		secs
Accuracy drift				0.03		%/Yr

CO_2 ANALOGUE OUTPUT PERFORMANCE CHARACTERISTICS – ExplorIR®-W Option

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output voltage range[1, 2]	ANALOGUE_OUTPUT		0		VDD	V
CO_2 level		0-10%		33		uV/ppm
		0-20%		16.5		uV/ppm
		0-60%		5.5		uV/ppm
		0-100%		3.3		uV/ppm
Repeatability		@25°C, 0-60%		±0.1		°C
		@25°C, 0-100%		±0.1		°C
Response time		From 0ppm to T_{50} 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

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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 - ExplorIR®-W

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 CO2 measurements		Default settings	3.3	1	3.5
With RH active		RH measurement on		+0.05	+0.2
With T active		Temperature measurement on		+0.05	+0.2
With CO_2 active		With analogue CO_2 output		+0.02	+0.1

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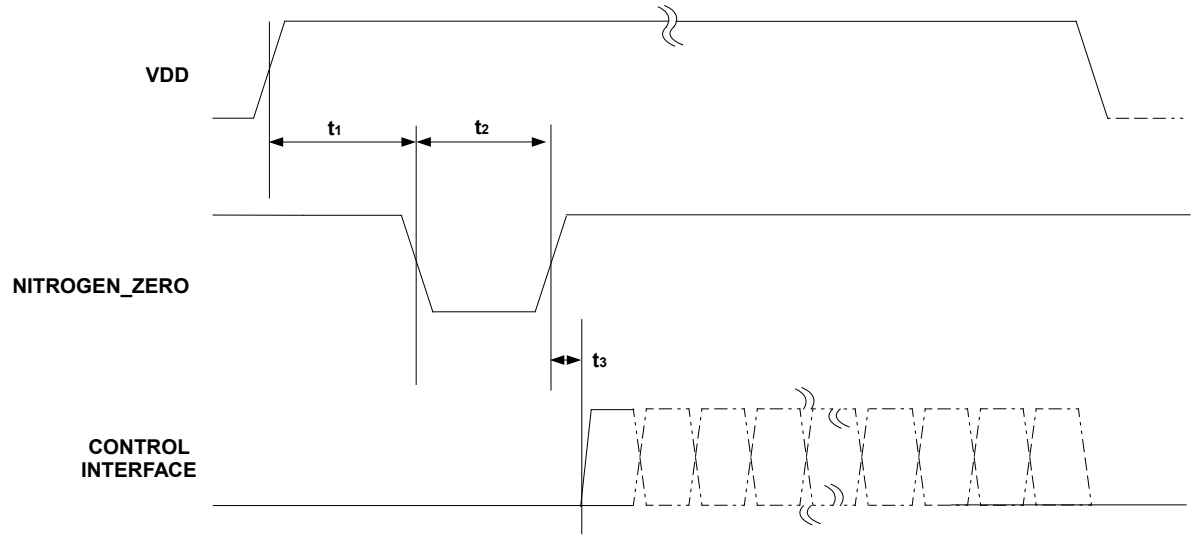
INTERFACE TIMING – NITROGEN_ZERO and FRESH_AIR_ZERO



PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Power On to NITROGEN_ZERO Ready	t_1	300			ms
NITROGEN_ZERO Low Pulse-Width	t_2	3			s
Control Interface Setup Time	t_3	600			ns

The timing for FRESH_AIR_ZERO is identical to NITROGEN_ZERO.

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METHOD OF OPERATION

After power is applied to the ExplorIR®-W, 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 ExplorIR®-W 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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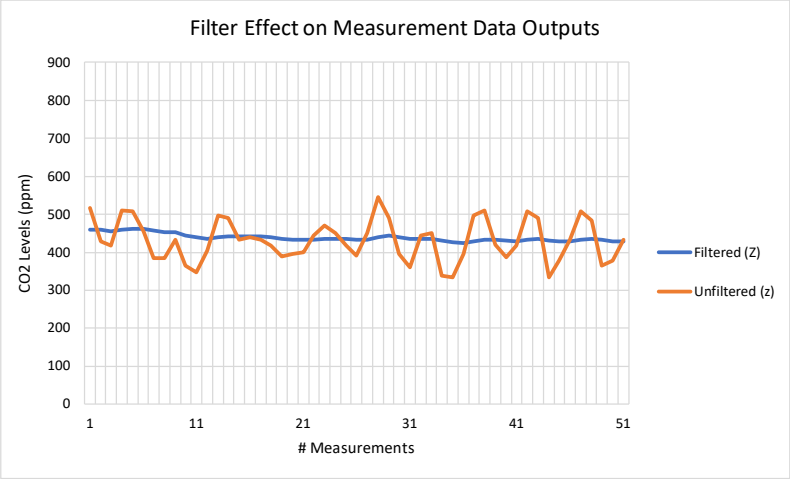
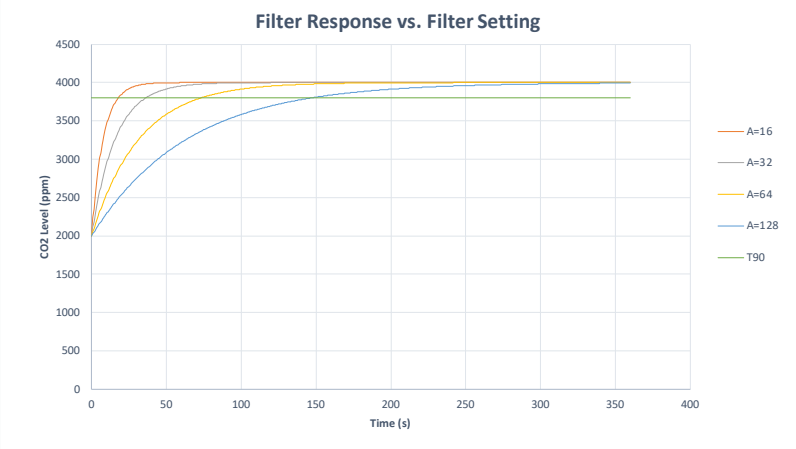
DIGITAL FILTER

The CO_2 gas chamber is illuminated with a nominal 4.25um wavelength LED and the signal received using a photodiode. The signal from the photodiode 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 ExplorIR®-W 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 ExplorIR®-W takes 2 readings per second.

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ZERO POINT CALIBRATION

There are a several methods available to the user to calibrate the zero point of the sensor. The recommended method is zero-point calibration 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 calibrations are not cumulative and only the latest zero-point calibration is effective. For example, there is no benefit in calibrating in nitrogen, and then calibrating in a calibration gas. The sensor will store only the latest zero point.

To improve calibration 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 zero'd using the known gas concentration level sent by the user. The concentration value written to the sensor must be scaled dependent on the sensor CO2 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 calibrated 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 (ExplorIR®-W 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 calibration 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 CO2 measurement range. 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.

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

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 calibration 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-CALIBRATION

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

The auto-calibration function works in the same way as the ***ZERO IN FRESH AIR*** command. Auto-calibration is disabled by default, but can be enabled to operate automatically, or calibration can be forced. The user can also independently adjust the CO_2 level used for auto-calibration. 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-CALIBRATION INTERVALS

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

AUTO-CALIBRATION SETTINGS

By default, the sensor will automatically 'zero' using the measured CO_2 level sampled during the auto-calibration period. The user can alter the behaviour of the sensor as a result of the auto-calibration process.

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PRESSURE AND CONCENTRATION LEVEL 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 converted into a concentration reported by the sensor.

The absorption process is pressure and gas concentration dependent. In general, 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.

SST sensors are calibrated at 1013mbar and 450ppm CO_2. The reading will vary due to pressure and CO_2 concentration. It is possible to correct for the effects of pressure and concentration by setting a compensation value. This will apply a permanent correction to the output of the sensor, depending on the compensation value. The compensation value needs to be written to the sensor and will overwrite the default 1013mbar and 450ppm CO_2 value. The new compensation value will be used for all subsequent measurements and will be retained after a power cycle.

ALTITUDE COMPENSATION TABLE

Altitude (ft.)	Altitude (m)	Pressure (mbar)	Sea Level Difference	% Change per	CO_2 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 compensation values can be calculated using the following formula.

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

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The pressure compensation values calculated above are only approximate and only valid for concentrations below 1%. For higher accuracy compensation, the sensor output must be adjusted for both pressure and concentration as the CO_2 level measured by the sensor is affected by both ambient pressure and gas concentration levels. To calculate the adjusted CO_2 level, use the following calculator.

The corrected CO_2 level (C2) = C1/(1+Y(1013-P)),

where,

C1 = Concentration reading from sensor

P = Pressure in mbar

Where concentration < 1500ppm.

$Y = 2.6661E\text{-}16\ C1^4 - 1.1146E\text{-}12\ C1^3 + 1.7397E\text{-}09\ C1^2 - 1.2556E\text{-}06\ C1 - 9.8754E\text{-}04$

Where concentration >1500ppm.

$Y = 2.37472E\text{-}30\ C1^6 - 2.70695E\text{-}25\ C1^5 + 1.24012E\text{-}20\ C1^4 - 2.91716E\text{-}16\ C1^3 + 3.62939E\text{-}12\ C1^2 - 1.82753E\text{-}08\ C1 - 1.35129E\text{-}03$

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CONTROL INTERFACE

The ExplorIR® 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 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).

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_2 reading on receiving any character.

The CO_2 measurement is reported as:

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

where `Z #####` shows the CO_2 concentration.

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

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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	F 410 400\r\n	F 33000\r\n	See ***"Zero Point Calibration"***
G\r\n	Zero-point calibration using fresh air	G\r\n	G 33000\r\n	See ***"Zero Point Calibration"***
H\r\n	Returns the relative humidity value		H 00551\r\n	
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 212\r\n	M 212\r\n	See **"Output Fields"**
P 8 ###\r\n P 9 #\r\n	Sets value of CO_2 background concentration in ppm for auto-calibration	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 calibration 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 pressure and concentration compensation value	S 8192\r\n	S 08192\r\n	See ***"Pressure and Concentration Compensation"***
s\r\n	Returns the pressure and concentration compensation value	s\r\n	s 08192\r\n	See ***"Pressure and Concentration Compensation"***
T\r\n	Returns the temperature value		T 01224\r\n	
U\r\n	Zero-point calibration using nitrogen	U\r\n	U 33000\r\n	See ***"Zero Point Calibration"***
u #####\r\n	Manual setting of the zero point.	u 32997\r\n	u 32997\r\n	See ***"Zero Point Calibration"***
X #####\r\n	Zero-point setting using a known gas calibration	X 2000\r\n	X 32997\r\n	See ***"Zero Point Calibration"***

Small Footprint Low Power CO_2 Sensor

Syntax	Use	Example	Response	Comments
Y\r\n	Return firmware version and sensor serial number	Y\r\n	Returns two lines	
Z\r\n	Return the most recent filtered CO2 measurement in ppm	Z\r\n	Z 01521\r\n	
z\r\n	Return the most recent unfiltered CO2 measurement in ppm	z\r\n	Z 01521\r\n	
@ #.# #.#\r\n	Sets the timing for initial and interval auto-calibration periods	@ 1.0 8.0\r\n	@ 1.0 8.0\r\n	See ***"Auto-calibration"*** for details
@ r\n	Returns the Autocalibration configuration	@ 1.0 8.0\r\n	@ 1.0 8.0\r\n	See ***"Auto-calibration"*** for details
@ #r\n	Switch Auto-calibration on or off	@ 0\r\n	@ 0\r\n	See ***"Auto-calibration"*** for details
.\r\n	Returns the scaling factor multiplier required to convert the Z or z output to ppm	.\r\n	. 00010\r\n	Multiply by 10 in the example

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 CO2 measurement output to convert it into ppm.
Syntax	ASCII character '.', terminated by 0x0D 0x0A (CR & LF)
Example	.\r\n
Response	. 00010\r\n (this number is variable, usually 10)

Measurement Range of Sensor	**CO_2 Measurement Scaling Factor (Z)**	**CO2 Measurement Output Units**	**Example**
0 – 60%	10	ppm/10	Z 01200 = 12000ppm = 1.2%
0 – 100%	100	ppm/100	Z 01500 = 15000ppm = 15%

Small Footprint Low Power CO_2 Sensor

TEMPERATURE MEASUREMENT VALUE - ExplorIR®-W 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 - ExplorIR®-W 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)C) = #####/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 ExplorIR®-W only. If not fitted, sensor will return either T 00000 or H 00000.

The sensor default data output is filtered CO_2 only. To output temperature, humidity and filtered CO_2, send "M 4164\r\n" (see ***"Output Fields"***).

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 CO_2.

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)

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)

Small Footprint Low Power CO_2 Sensor

ZERO POINT CALIBRATION 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 Calibration"***
G\r\n	Zero-point calibration using fresh air			G\r\n	G 33000\r\n	See ***"Zero Point Calibration"***
U\r\n	Zero-point calibration using nitrogen			U\r\n	U 33000\r\n	See ***"Zero Point Calibration"***
u #####\r\n	Manual setting of the zero point			u 32997\r\n	u 32997\r\n	See ***"Zero Point Calibration"***
X #####\r\n	Zero-point calibration using a known gas concentration		Range of sensor	X 2000\r\n	X 32997\r\n	See ***"Zero Point Calibration"***
P 8 ###\r\n P 9 #\r\n	Sets value of CO_2 background concentration in ppm for auto-calibration	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 calibration 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

F COMMAND (0x46)

Description	Calibrates 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	Calibrates 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	Calibrates 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	Calibrates 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).

P COMMAND - CO_2 Level for Auto-calibration

Description	Sets the value of CO_2 in ppm used for auto-calibration. 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 Calibration

Description	Sets value of CO_2 in ppm for zero-point calibration in fresh air. Input value is scaled by CO_2 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 10 7\r\n p 11 208\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

AUTO-CALIBRATION INTERVALS

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

@ COMMAND (0x2E)

Description	Set the 'Initial Interval' and 'Regular Interval' for auto-calibration 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-calibration interval is set to 8 days, and the initial interval set to 1 day.

To disable auto-calibration, send *@ 0\r\n*. To start an auto-calibration immediately, send 65222\r\n. To determine the auto-calibration configuration, send @\r\n.

PRESSURE AND CONCENTRATION COMPENSATION

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

S COMMAND (0x53)

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

MEASUREMENT DATA OUTPUTS

The ExplorIR®-W sensors can be configured to provide CO_2, temperature and humidity data as a single string of data.

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 04164\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
Humidity	H	4096
Temperature	T	64
CO_2 (Filtered)	Z	4
CO_2 (Unfiltered)	z	2

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.

M COMMAND

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

Q COMMAND

Description	Reports the output data fields
Syntax	ASCII character 'Q', SPACE, then Mask Value, terminated by 0x0D 0x0A (CR & LF)
Example	Q\r\n
Response	H 12345 T 12345 Z 00010\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 two lines	

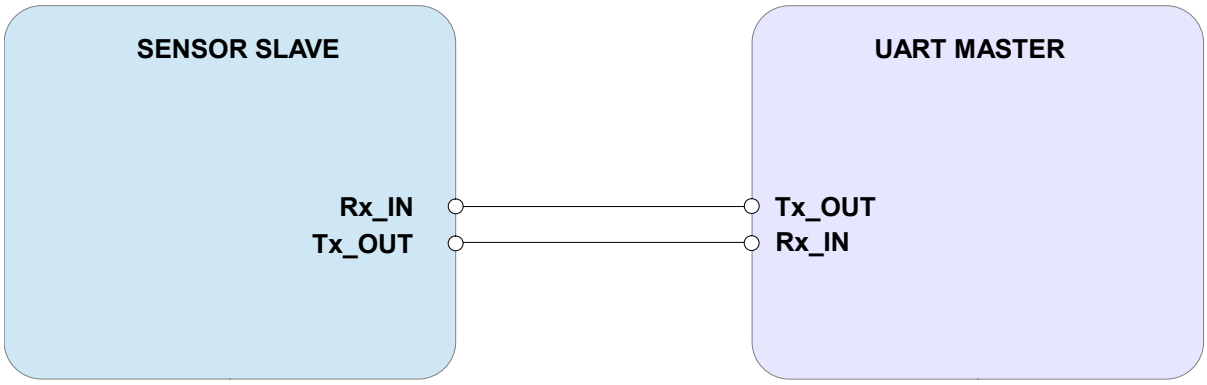
Y COMMAND (0x59)

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,Jan 30 2013,10:45:03,AL17\r\n* *B 127709 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).

Small Footprint Low Power CO_2 Sensor

CONNECTION DIAGRAM FOR UART INTERFACE



Small Footprint Low Power CO_2 Sensor

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Small Footprint Low Power CO_2 Sensor

REVISION HISTORY

DATE	RELEASE	DESCRIPTION OF CHANGES	PAGES
21/04/2020	4.0	First revision	All

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