CO_2 SENSORS – User Guide

This document describes the CO_2 sensor installation and operation processes.

The CO_2 family is a range of factory calibrated carbon dioxide sensors that measure CO_2 levels.

NOTE: This guide applies to the RS232 configuration and usage ONLY. If you wish to configure the voltage output then refer to *AN-0118, CO_2 Sensor Voltage Output Option*. The voltage output is a factory fit option; it is not present unless requested. Before selecting the voltage output, please consider:

- The voltage output is derived from the digital output (it is a PWM driven)
- A digital interface is required to configure the CO_2 sensor
- Even if the end application will use only a voltage interface, SST recommend using a digital interface (e.g. USB to serial cable) when evaluating the sensor

CONTENTS

1 DEFINITIONS

The following definitions apply to WARNINGS, CAUTIONS and NOTES used throughout this manual.

WARNING:

The warning symbol is used to indicate instructions that, if they are not followed, can result in minor, serious or even fatal injuries to personnel.

CAUTION:

The caution symbol is used to indicate instructions that, if they are not followed, can result in damage to the equipment (hardware and/or software), or a system failure occurring.

NOTE: Highlights an essential operating procedure, condition or statement.

In this manual:

\r\n

Is used to indicate carriage return <CR>, line feed <LF> characters, (0x0d,0x0a) which are required at the end of each string sent to the sensor, and are appended to all transmissions from the sensor.

`Z 12345\r\n`

Courier fixed pitch font is used to show commands sent to the sensor, and transmissions received from the sensor.

2 PRODUCT OVERVIEW

NOTE: Sensors are sold separately; refer to datasheets listed in REFERENCE DOCUMENTS for details.

2.1 Sensors

CozIR®A – Ambient – Cased

CozIR®-LP – Low Profile

SprintIR®-W

SprintIR®-6S

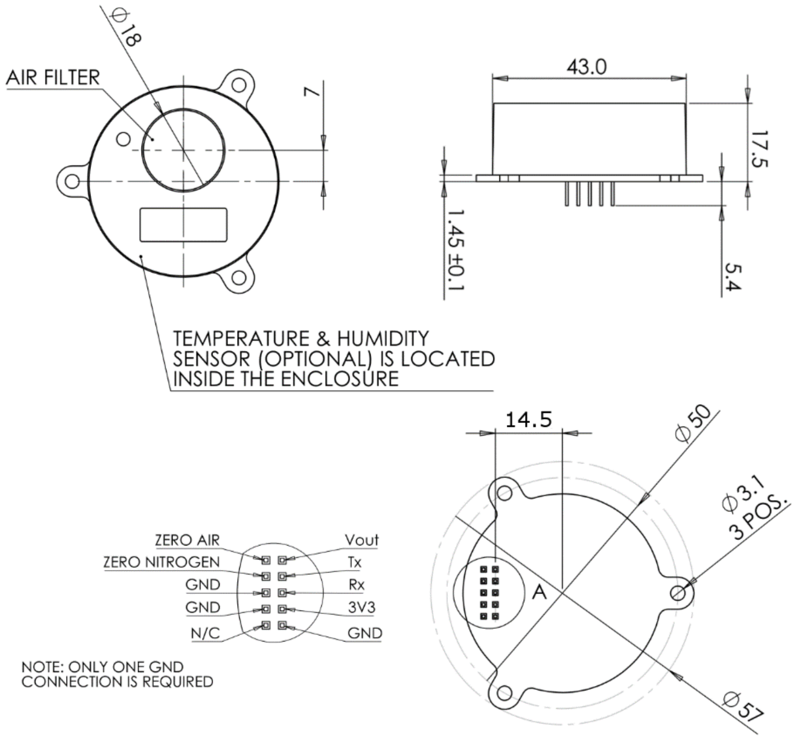
ExplorIR®-W

ExplorIR®-M

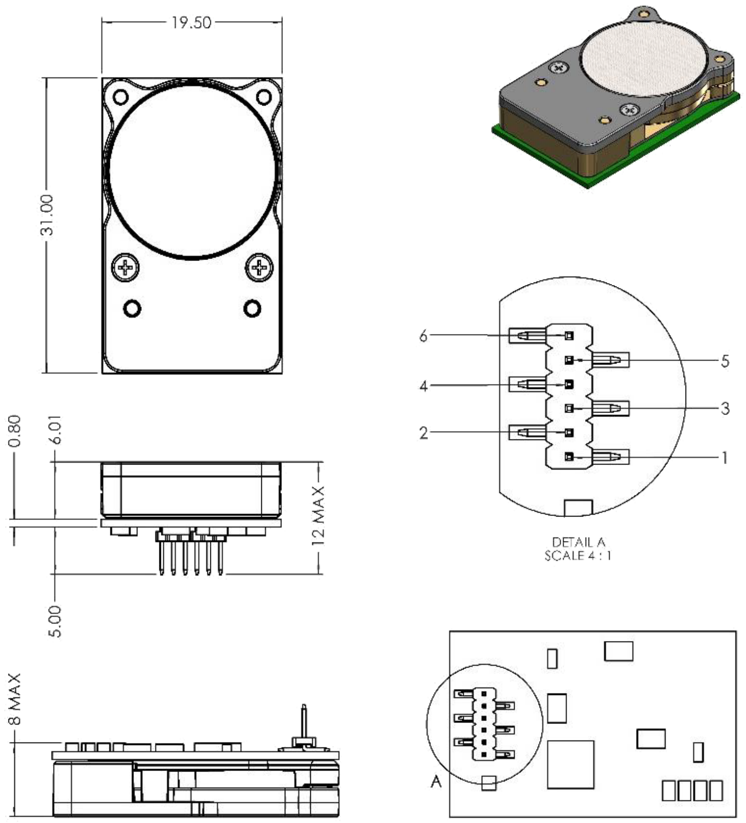
2.2 External Dimensions

Dimensions in mm unless otherwise stated; tolerance ±0.5mm.

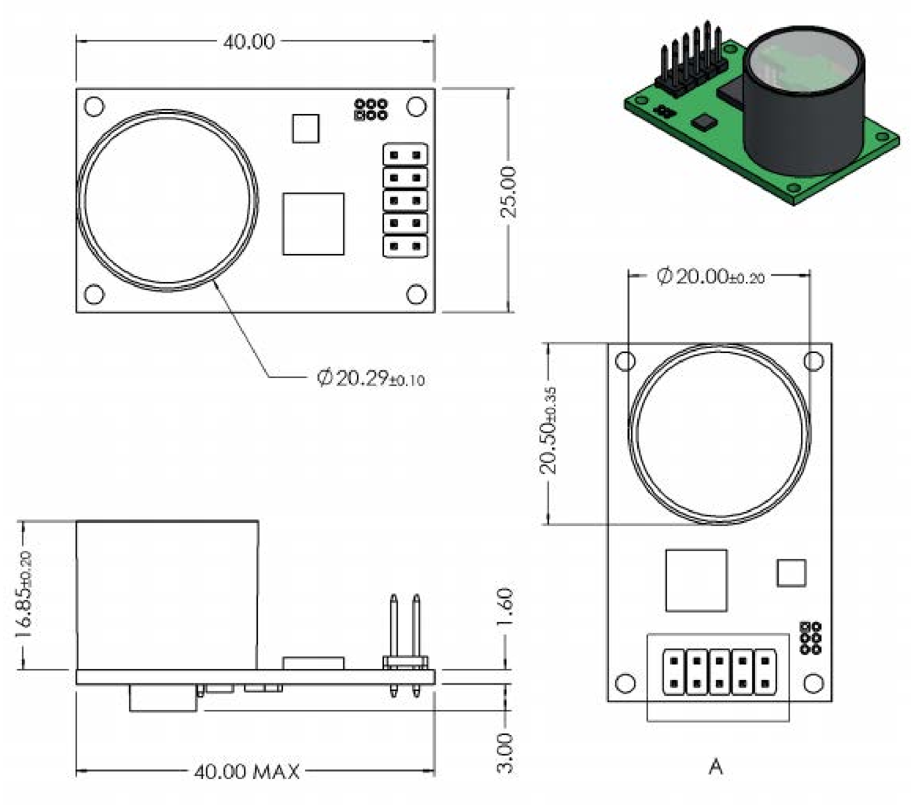
CozIR®A – Ambient

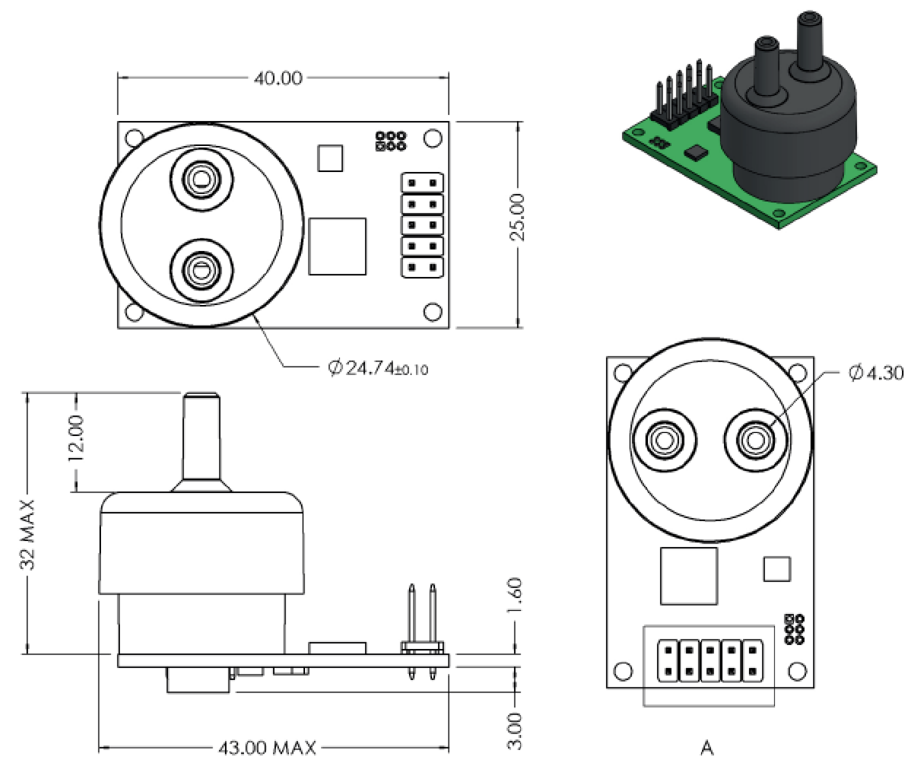


CozIR®-LP – Low Profile

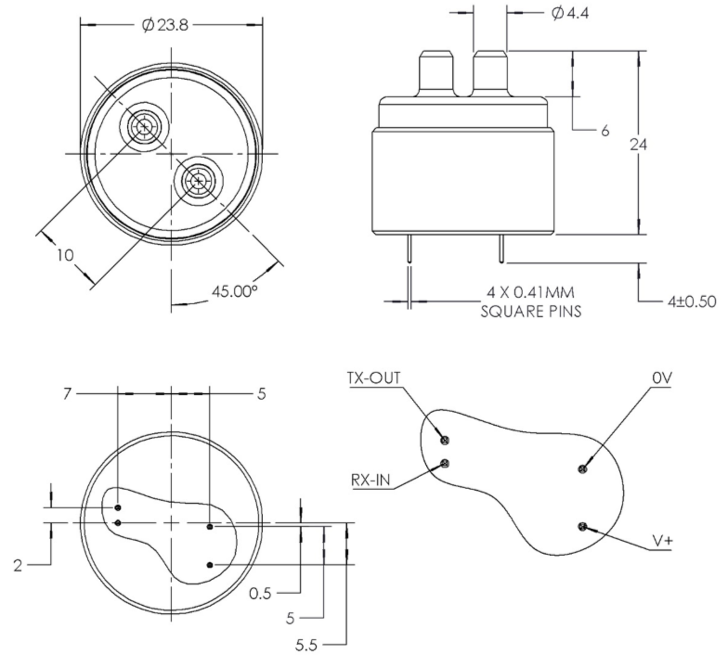


SprintIR®-W

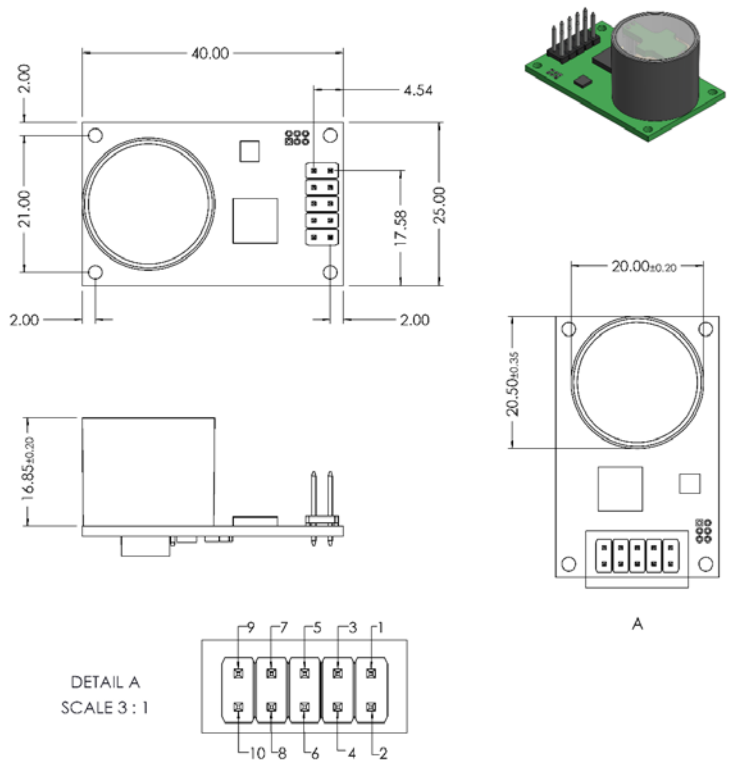

40.00
25.00
∅20.29±0.10
∅20.00±0.20
20.50±0.35
16.85±0.20
1.60
3.00
40.00 MAX
A


40.00
25.00
∅24.74±0.10
∅4.30
12.00
32 MAX
1.60
3.00
43.00 MAX
A

SprintIR®-6S



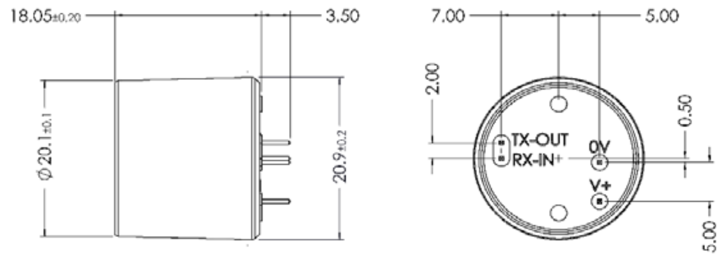
ExplorIR®-W

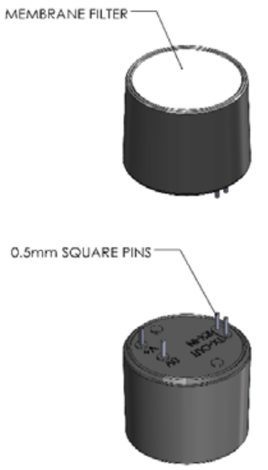


FUNCTION	PIN #	PIN #	FUNCTION
FRESH AIR ZERO	10	9	ANALOGUE OUTPUT
NITROGEN ZERO	8	7	SENSOR Tx (OUT)
GND	6	5	SENSOR Rx (IN)
GND	4	3	+3.3V
N/C	2	1	GND

ExplorIR®-M

CONNECTION	DESCRIPTION	COMMENTS
0V	GND CONNECTION	0V
V+	POSITIVE POWER SUPPLY	3V3 TO 5V
Tx-OUT	UART Tx FROM SENSOR	Voh WILL BE 3V. SENSOR OUTPUT.
Rx-IN	UART Rx TO SENSOR	USED FOR CONFIGURATION





3 INSTALLATION

To ensure the best performance from your equipment, it must be installed correctly.

CO_2 sensors should be treated as an electronic component and handled using the correct ESD handling precautions.

NOTE: The sensor must be securely fitted to a suitable mounting surface using the mounting holes provided; refer to Section 2.2 for details.

3.1 Electrical Connections

NOTE: Communication to and from the CO_2 sensor is via a serial connection.

The recommended supply voltage is $3.3V_{DC}$; refer to the product datasheet for the minimum and maximum allowable range.

Refer to Section 2.2 or datasheets for full details.

3.2 RS232 Setup (Serial Connection)

The Rx and Tx 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.

Sensors have different connector sizes.
NOTE: For all sensors, only GND, +3V3, Rx and Tx are required for bi-directions serial connection. All other pins should be left unconnected.

A starter kit is available to allow simple interfacing between the sensor and a PC. Contact technical@sstsensing.com for details.

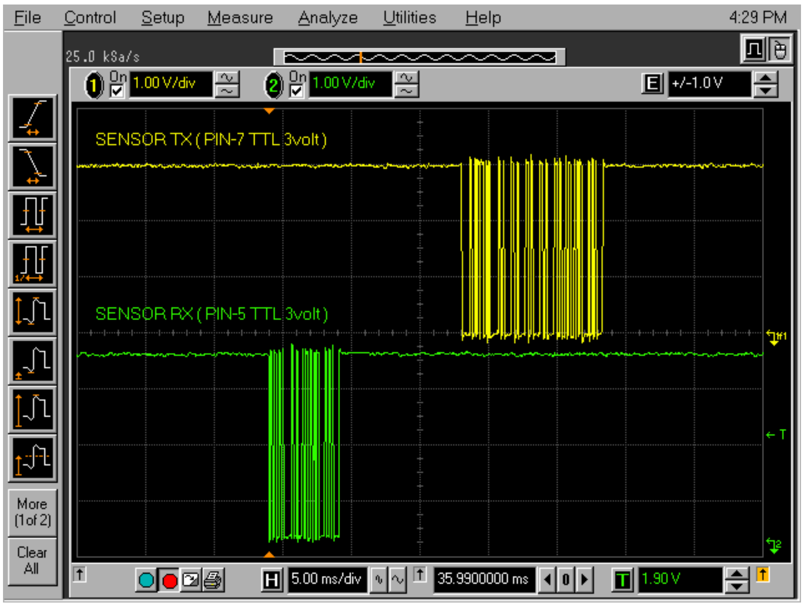


Figure 3-1 - Scope Trace Showing Command Sent to Sensor (Green) and Sensor Response (Yellow)

The following setup should be used when using the RS232 interface:

- **Baudrate:** 9600
- **Data Bits:** 8
- **Parity:** None
- **Stop Bits:** One
- **Format:** UART (normally high)
- **Flow Control:** None
- **Voltage Voh:** 3V (MISIR $V_{oh} = V_{supply}$)
- **Voltage Vih:** 3V – 5V

NOTE: If you connect to the sensor using HyperTerminal®, you must select the box "Send line ends with line feeds" under ASCII setup.

When initially powered, the sensor will immediately start to transmit readings (refer to 6.2 Mode 1; Streaming Mode on page 5-1).

3.3 Reading Format

3.3.1 CO_2 Measurement

The CO_2 measurement is reported as:

Z ##### z #####/r/n

where

Z ##### shows the CO_2 concentration after digitally filtering

and

z ##### shows the instantaneous CO_2 concentration without any digital filtering.

The concentration is reported in the following units:

Type	Range	Units	Example
COZIR-A & COZIR-LP	Up to 2%	ppm	Z 00631 = 631ppm
COZIR-W, SprintIR & ExplorIR-M	Up to 65%	ppm/10	Z 01200 = 12000ppm = 1.2%
COZIR-W-100, ExplorIR-100 & SprintIR-100	Up to 100%	ppm/100	Z 01500 = 150000ppm = 15%

NOTE: The same units must be used when sending concentration information to the sensor (for example, the X command and the F command). If in doubt, the '.' Command (see below) will indicate what multiplier should be applied to the Z output to convert to ppm.

```
Z 00842 z 00765
Z 00842 z 00738
Z 00842 z 00875
Z 00842 z 00858
Z 00842 z 00817
Z 00842 z 00839
Z 00842 z 00817
Z 00842 z 00828
Z 00842 z 00850
Z 00842 z 00875
Z 00842 z 00804
```

Sample output from a sensor with factory settings.

This is a COZIR-A, so the reported CO_2 reading is 842ppm.

The second figure shows the instantaneous (unfiltered) CO_2 reading.

Refer to 9.1 Digital Filter on page 9-1 for more details.

NOTE: All outputs from the sensor have a leading space.

3.3.2 Temperature Measurement (Optional)

NOTE: Factory fit option on COZIR versions only. Not available on COZIR-LP.

The temperature measurement is reported as:

T #####/r/n

where *#####* is a five-digit number.

To convert to °C, subtract 1000 and divide by 10.

For example, 23.5°C is represented as:

T 01235/r/n

NOTE: The temperature and humidity sensor is a factory fit option. If it is not fitted, the sensor will return "*T 01000*".

3.3.3 Humidity Measurement (Optional)

The humidity measurement is reported as:

H #####/r/n

Where *#####* is a five-digit number.

To convert to relative humidity (%), divide by 10.

For example, 55.1% RH is represented as:

H 00551/r/n

NOTE: The temperature and humidity sensor is a factory fit option. If it is not fitted, the sensor will return "*H 00000*".

3.3.4 Example of T, H and CO_2

When shipped, the sensor default output is CO_2 only. To output temperature, humidity and CO_2, send "*M 4164\r\n*" (refer to 6 OUTPUT FIELDS on page 6-1). The output format will have the form:

H 00345 T 01195 Z 00651\r\n

This example indicates 34.5% RH, 19.5°C and 651ppm CO_2.

4 COMMAND SUMMARY

Table 4-1 shows the RS232 command summary; for complete details of the commands and their correct usage, refer to APPENDIX A – COMMAND REFERENCE on page A-1.

Table 4-1 - RS232 Command Set

Command	Use	Example	Response	Comments
`A ###\r\n`	Set the digital Filter	A 16\r\n	A 00016\r\n	See "User Settings"
`a\r\n`	Return the digital filter setting	a\r\n	a 00016\r\n	See "User Settings"
`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`	Return most recent humidity measurement	H\r\n	H 00552\r\n	=55.2% in example. Humidity sensing is a factory fit option
`K #\r\n`	Selects the operating mode	K 1\r\n	K 00001\r\n	See "Operating Modes"
`M #####\r\n`	Sets the output fields	M 6\r\n	M 00006\r\n	See "Output Fields"
`P ### ###\r\n`	Sets a user configurable field in EEPROM	P 1 10\r\n	P 00001 00010\r\n	See "User Settings"
`p ###\r\n`	Reads a user configurable field from EEPROM	p 10\r\n	p 00010 00001\r\n	See "User Settings"
`Q\r\n`	Return most recent fields	Q\r\n		See "Command Reference"
`S #####\r\n`	Sets the span calibration value	S 8192\r\n	S 08192\r\n	See "Span Calibration"
`s\r\n`	Return the span calibration value	s\r\n	s 08192\r\n	See "Span Calibration"
`T\r\n`	Return the most recent temperature measurement	T\r\n	T 01225\r\n	22.5°C in example. Temperature sensing is a factory fit option
`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"
`Y\r\n`	Return firmware version and sensor serial number	Y\r\n		See "Command Reference" for details
`Z\r\n`	Return the most recent CO_2 measurement	Z\r\n	Z 01521\r\n	1521ppm in the example
`@ #.# #.#\r\n`	Auto calibration configuration	@ 1.0 8.0\r\n	@ 1.0 8.0\r\n	See "Autocalibration" for details
`.\r\n`	Return the multiplier required to convert the Z output to ppm	.\r\n	. 00100\r\n	Multiply by 100 in the example
`*\r\n`	Return configuration information	*\r\n		See "Command Reference" for details

All communications are performed using ASCII characters and are terminated by carriage return, line feed (ASCII characters 13 and 10). 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".

NOTE: All settings are stored in non-volatile memory, so the sensor only has to be configured once. It should NOT be configured every time it is powered up.

5 OPERATING MODES

There are three modes available; Command Mode, Streaming Mode and Polling Mode. Switch between the modes using the "*K*" command.

5.1 Mode 0; Command Mode

This is primarily intended for use when extracting larger chunks of information from the sensor (for example using the *Y* and *** commands).

In this mode, the sensor is stopped waiting for commands. No measurements are made, and the sensor will run through a warm-up cycle after exiting this command. There is no latency in command responses.

The power consumption is less than 3.5mW as no measurement activity takes place. Commands which report measurements or alter the zero-point setting are disabled in mode 0.

NOTE: Mode 0 is NOT retained after power cycling. The sensor will always power up in Streaming or Polling mode, whichever was the most recently used.

5.2 Mode 1; Streaming Mode

This is the factory default.

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.

The power consumption is 3.5mW (assuming one field of information is transmitted, and there is no temperature and humidity sensor).

5.3 Mode 2; Polling Mode

In polling mode, the sensor only reports readings when requested. The measurement cycle continues in the background, but the output stream is suppressed.

The power consumption depends on the frequency of polling, but is approximately the same as the streaming mode power consumption.

NOTE: The sensor will power up in the mode last used. If it was last used in K0 mode, it will power up in either K1 or K2 mode, depending on which was most recently used.

In Polling Mode, measurements can be accessed using the polling commands H, L, Q, T and Z (refer to APPENDIX A – COMMAND REFERENCE).

6 OUTPUT FIELDS

SST sensors can be configured to output up to five fields of information. Typically, the only fields of interest are the CO_2 concentration, Temperature (if fitted) and Humidity (if fitted).

This allows you to customise the output string transmitted by the sensor. Up to five values can be transmitted in the string. The format is always the same; each field is identified by a single character, followed by a space, followed by the five-digit number indicating the value of the parameter.

The output fields are set by sending a command in the format `M 12345\r\n` where `12345` represents a mask value which defines the output fields.

The mask value is created by adding the mask values for the parameters required (see Table 6-1).

The sensor outputs a maximum of five fields; if the mask setting represents more than five fields, only the first five (those with the highest mask values) will be output.

NOTE: SprintIR sensors have a limited time to transmit information, so no more than two fields should be selected for output.

Table 6-1 - Output Fields

Parameter	Field Identifier	Mask Value	Comments
Reserved		32768	Reserved
Reserved		16384	Reserved
Reserved		8192	Reserved
Humidity	**H**	**4096**	**Reports the humidity output of the Temperature & Humidity sensor (if fitted)**
D digitally filtered	d	2048	Reports a value related to the normalised LED signal strength (smoothed)
D unfiltered	D	1024	Reports a value related to the normalised LED signal strength
Reserved		512	Reserved
Zero Set Point	h	256	Reports a value related to the normalised LED signal strength
Sensor Temperature (unfiltered)	V	128	Reports a value which varies inversely with the sensor temperature
Temperature	**T**	**64**	**Reports the temperature output (if Temperature & Humidity sensor fitted)**
LED Signal (digitally filtered)	o	32	Reports a value which gives an indication of the LED signal strength (smoothed)
LED Signal (unfiltered)	O	16	Reports a value which gives an indication of the LED signal strength
Sensor Temperature (filtered)	v	8	Reports a value which varies inversely with the sensor temp (smoothed)
CO2 Output (Digitally Filtered)	**Z**	**4**	**Digitally filtered CO_2 reading**
CO2 Output (unfiltered)	**z**	**2**	**Instantaneous CO_2 reading**
Reserved		1	**Reserved**

NOTE: Most fields are for advanced use only and require specific guidance from SST Sensing Ltd. for their correct interpretation and use.

Measurement fields are indicated in **bold**. For example, to output the temperature, humidity and CO_2 measurements, send:

```
M 4164\r\n
```

The output string will be:

```
H 12345 T 12345 Z 00010\r\n
```

7 CALIBRATION

7.1 Zero-Point Calibration

There are a several methods to calibrate the zero point of the sensor. The recommended method is zero-point calibration in a known gas (refer to "X command" in APPENDIX A – COMMAND REFERENCE) which will give the most accurate zero setting.

In all cases, the best zero is obtained when the gas concentration is stable and the sensor is at a stabilised temperature.
NOTE: Zero-point calibrations are not cumulative – only the latest zero-point calibration is effective. For example, there is no benefit in zero-point calibrating in nitrogen, and then calibrating in a calibration gas. The sensor will store only the latest zero point.

7.1.1 Zero in a Known Gas Concentration (Recommended)

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.

Send command `X ###\r\n`

NOTE: The concentration must be in the same units as the sensor output (refer to 3.3 Reading Format on page 3-2).

For example, to set the zero point in a COZIR-A sensor when it is in a known gas concentration of 2000ppm:

Send:	`X 2000\r\n`
Response:	`X 32950\r\n`

7.1.2 Zero in Nitrogen

Place the sensor in a gas containing no CO_2 (typically nitrogen) and allow time for the sensor temperature to stabilise, and for the gas to be fully diffused into the sensor.

Send command `U\r\n`

The sensor will respond with an echo of the command and the new zero point, for example:

Send:	`U\r\n`
Response:	`U 32950\r\n`

7.1.3 Zero in Fresh Air (Assumed to be 400ppm)

If there is no calibration gas and no nitrogen available, the sensor zero point can be set in fresh air. The sensor is programmed to assume that fresh air is 400ppm (this value is user configurable, refer to 9 USER SETTINGS on page 9-1).

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.

Send command   *G\r\n*

The sensor will respond with an echo of the command and the new zero point, for example:

Send: *G\r\n*
Response: *G 32950\r\n*

7.1.4 Fine Tune the Zero Point

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. This is similar in operation to the "*X* command" (see page 7-1) but can operate on historic data. For example, if the sensor has been in an environment in which it is known to have 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 command takes two parameters, separated by a space. The first parameter is the reading reported by the sensor. The second is the corrected reading. Both parameters must be in the same units as the sensor output (refer to 3.3 Reading Format on page 3-2).

The sensor will respond with an echo of the command and the new zero point, for example:

Send: *F 400 380\r\n*
Response: *F 32950\r\n*

In this example, the sensor zero point would be corrected so that a reading of 400ppm, would now be reported as 380ppm.

7.1.5 Zero Point Adjustment

The precise zero point can be fine-tuned by sending a zero point to the sensor.
NOTE: This is NOT recommended for general use.

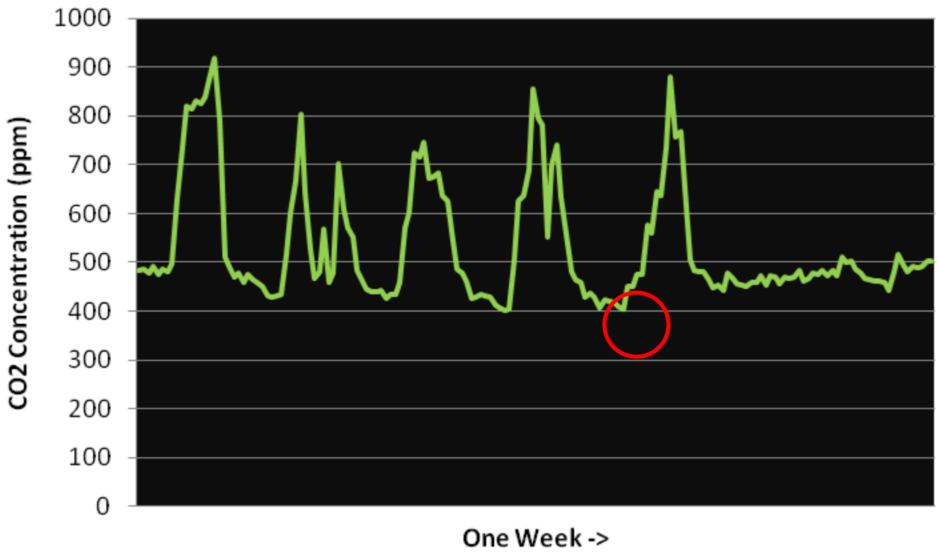
Send command   *u #####\r\n*   where *#####* is the new zero point.

7.2 Auto-Calibration

All CO_2 sensors are fully calibrated prior to shipping from the factory. Over time, the zero point of the sensor needs to be calibrated to maintain the long-term stability of the sensor.

In many applications, this can happen automatically using the built-in auto-calibration function.

This technique can be used in situations in which sensors will 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 at these periods to recalibrate.



This recording from a sensor shows a typical one week recording in an office environment. The auto-calibration function uses the low point (circled) and uses it to recalibrate the zero point.

The auto-calibration function environmental requirements are:

- **Exposure to Fresh Air;** The sensor must 'see' fresh air at least once during the auto-calibration period. You do not need to know when the fresh air will be sensed, just that it will be sensed at some point during the period.
- **Continuously Powered;** The auto-calibration information is deleted when the sensor is switched OFF. This ensures that each installation is unaffected by any previous history of the sensor. For auto-calibration to function, it MUST be power on for the whole of the auto-calibration period.

7.2.1 Setting the Auto Calibration Parameters

Three parameters are required to enable the auto-calibration routine:

1. **Auto-Calibration Interval;** This determines how often the auto-calibration takes place.
2. **Background Concentration;** Typically, 400 – 450ppm; this is the level the sensor will use as background.
3. **Initial Auto-calibration Interval;** It is possible for the first auto-calibration to take place more quickly than the regular auto-calibration event. This can be useful to stabilise quickly after installation.

NOTE: The auto-calibration timers are reset when the power to the sensor is interrupted. At power ON, the sensor will always time an initial auto-calibration interval first, then settle into the regular auto-calibration cycle.

The regular auto-calibration timer is reset automatically if the user calibrates the sensor using the *U*, *G*, *X*, *F* or *u* commands.

7.2.2 Setting the Auto Calibration Intervals

The auto-calibration intervals are set using the '@' command. This command allows the auto-calibration periods to be set, interrogated or disabled.

To set the auto-calibration intervals, the command structure is

```
@ initialinterval regularinterval\r\n
```

Where 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, for example:

Send:	`@ 1.0 8.0\r\n`
Response:	`@ 1.0 8.0\r\n`

Will set the auto-calibration interval to 8 days, and the initial interval to 1 day.

NOTE: There is a space between the @ and the first number, and a space between the two numbers. In hex, the example above reads:

40 20 31 2E 30 20 38 2E 30 0D 0A

7.2.3 Reading the Auto Calibration Settings

To determine the current auto-calibration settings:

Send:	`@ \r\n`
Response:	`@ 1.0 8.0\r\n`

If auto-calibration is enabled, the sensor will respond with the format above showing the initial and regular auto-calibration intervals. If auto-calibration is disabled, the sensor will respond with:

Send:	`@ \r\n`
Response:	`@ 0\r\n`

7.2.4 Disabling the Auto Calibration Function

To disable the auto-calibration:

Send:	`@ 0\r\n`
Response:	`@ 0\r\n`

That is, @ followed by a space followed by a zero terminated with `0x0d 0x0a`

7.2.5 Setting the Background Concentration

The background concentration depends somewhat on the area the sensor is installed. Typically, a figure between 400ppm and 450ppm is used; the factory default is 400ppm.

To set the background concentration, send:

```
P 8 x\r\n
P 9 y\r\n
```

Where x and y depend on the concentration you want to set, refer to Table 7-1 below:

Table 7-1 - Concentration Values

Concentration	X	Y
380	1	124
400	1	144
425	1	169
450	1	194

NOTE: This is stored as a two-byte value; the high byte being stored in location 8 and the low byte in location 9. The value represents the concentration.

To calculate other values,

x = int (concentration/256)
y = the remainder after dividing concentration/256

8 ALTITUDE COMPENSATION

IMPORTANT! This feature was introduced in sensors manufactured after July 2013 using firmware version AL17 or higher. The firmware version can be identified by sending the *Y* or *** command.

Altitude compensation applies a permanent correction to the sensor response, so should only be used when it is known that the sensor will be operating at altitude permanently.

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

The absorption process is pressure dependant, so that 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.

In normal use, close to 1013mbar, the reading will vary by 0.1% of reading for each mbar change in barometric pressure (the sensors are calibrated at 1013mbar).

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 when installing. This will apply a permanent correction to the output of the sensor, depending on the altitude setting selected. To apply this correction:

1. Select the appropriate code from Table 8-1 below (intermediate values can be interpolated).
2. Send `S ####\r\n` to the sensor, where *####* is the code from the table below.

For example, to correct the sensor for permanent installation at 305m elevation:

Send: `S 8494\r\n`
Response: `S 08494\r\n`

Table 8-1 - Altitude Codes

Altitude (ft)	Altitude (m)	Barometric Pressure (mbar)	Code
-1000	-305	1050	7906
0	0	1013	8192
1000	305	976	8497
2000	610	942	8803
3000	915	908	9134
4000	1219	875	9483
5000	1524	843	9851
6000	1823	812	10238
7000	2133	781	10660
8000	2438	752	11090

The current setting can be determined by sending a lower-case *s*:

Send: `s\r\n`
Response: `s 08494\r\n`

9 USER SETTINGS

9.1 Digital Filter

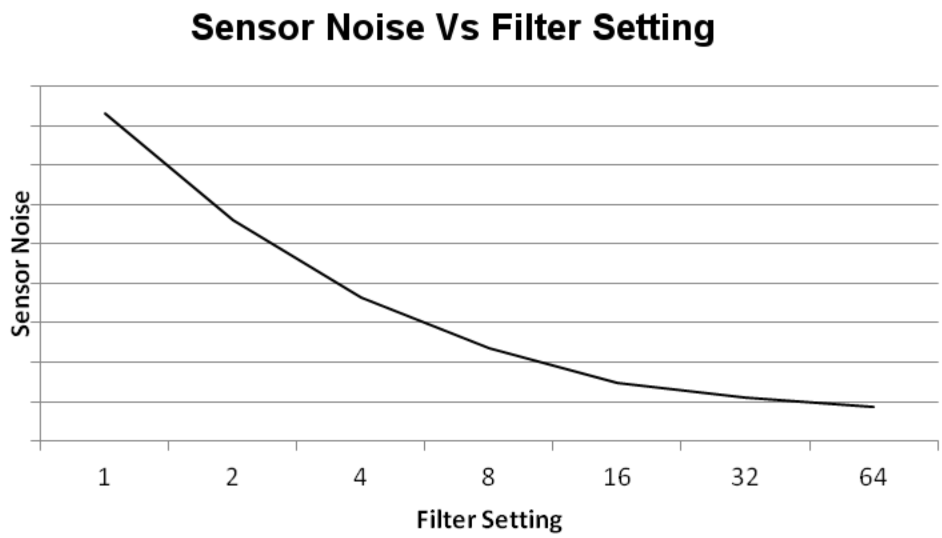
9.1.1 Customising the Sensor Response

The CO_2 measurement is passed through a digital filter to condition the signal. The characteristics of the filter can be altered by the user to tune the sensor performance to specific applications.

The filter operates as a low pass filter; increasing the filter parameter reduces measurement noise, but slows the response. There is a trade-off between noise (resolution) and speed of response.

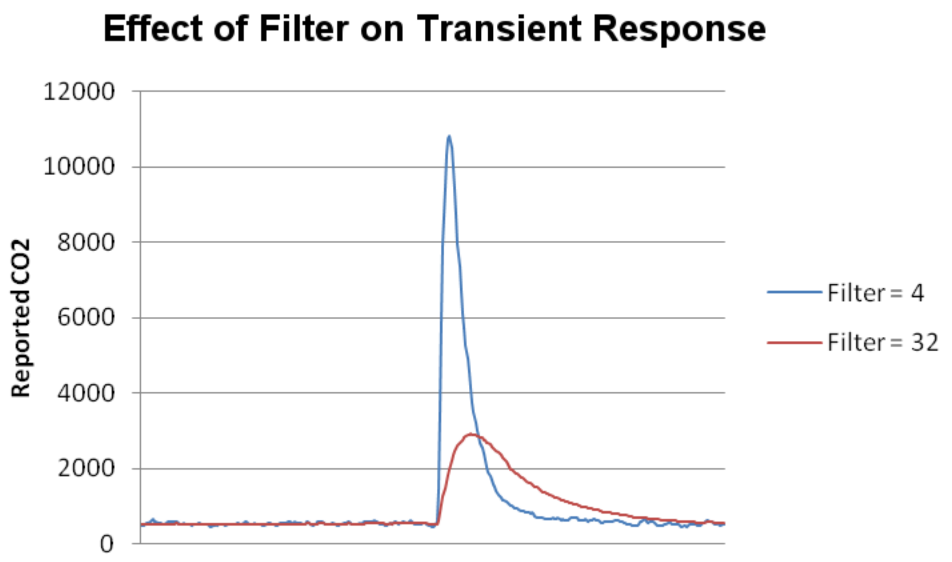
The filter can be set to a value between 1 and 65535 although settings higher than 64 are not recommended for normal use. A low value will result in the fastest response to changes in gas concentration, a high value will result in a slower response.
NOTE: The response is also determined by the diffusion rate into the sensor; default setting is 32.

This following chart shows the effect of changing the filter setting:



Increasing the filter setting has a beneficial impact on noise, so improves the sensor resolution. It also slows the sensor response to transients. This can be used to improve the detection of average CO_2 conditions. In building control, for example, a fast response to breathing near the sensor is undesirable. If the transient response is important either for speed of response or because the shape of the transient is required, a low filter setting should be used.

The following chart shows the same transient event capture using a filter setting of 4, and using a filter setting of 32.



9.1.2 Setting the Digital Filter

To change the setting, send *A ###\r\n* where *###* is the required filter setting. For most applications, a filter setting of 32 is recommended.

Send: *A 32\r\n*
Response: *A 00032\r\n*

If the filter is set to zero, a smart filter mode will be used in which the filter response is altered to suit the prevailing conditions. This is useful if there is a combination of steady state conditions, with some periods of rapidly changing concentrations.

9.1.3 Reading the Digital Filter Setting

The current setting for the digital filter can be determined by sending *a\r\n*

Send: *a\r\n*
Response: *a 00032\r\n*

9.2 EEPROM

Some user settings can be altered in the internal EEPROM. These settings can be set by using the parameter setting command "P", and read using a lower case "p".

There are also 32 bytes of user EEPROM storage available.

9.2.1 Setting EEPROM

To set an EEPROM location, send *P ### ###\r\n* where the first parameter is the address, and the second is the value.

NOTE: Two byte values must be set one byte at a time.

For example, to change the default value of the ambient gas concentration used for ambient calibration (i.e. the assumed CO_2 concentration in fresh air) to 380ppm;

Send:	*P 10 1\r\n*
Response:	*P 00010 00001\r\n*
Send:	*P 11 124\r\n*
Response:	*P 00011 00124\r\n*

9.2.2 Reading EEPROM

To read a parameter value from an EEPROM location, send *p #####\r\n* where *#####* is the address of the parameter.

NOTE: Two byte values must be read one byte at a time.

For example, to read the value of the ambient gas concentration used for ambient calibration (i.e. the assumed CO_2 concentration in fresh air);

Send:	*p 10\r\n*
Response:	*p 00010 00001\r\n*
Send:	*p 11\r\n*
Response:	*p 00011 00124\r\n*

9.2.3 EEPROM Settings

Most of the EEPROM settings are two byte values, indicated by HI and LO in the variable name, refer to Table 9-1 below. Contact technical@sstsensing.com before altering the default values.

Table 9-1 - EEPROM Settings

Location	Name	Purpose	Default Value
0	AHHI	Reserved	0
1	ANLO_	Reserved	0
2	ANSOURCE	Reserved	0
3	ACINITHI	Auto-calibration Preload. This preloads the auto-calibration timer so that the first auto-calibration occurs after a shorter time	87
4	ACINITLO	Low byte of above	192
5	ACHI	Auto-calibration Interval. Sets the time interval between auto-calibrations	94
6	ACLO	Low byte of above	128
7	ACONOFF	Switches auto-calibration ON/OFF	0
8	ACPPMHI	Auto-calibration Background Concentration. This determines what background CO_2 level is assumed for auto-calibration.	1
9	ACPPMLO	Low byte of above	194
10	AMBHI	Ambient Concentration (for *G* command). This determines what background CO_2 level is assumed for ambient calibration using the *G* command.	1
11	AMBLO	Low byte of above	194
12	BCHI	Buffer clear time. This will clear any incomplete commands from the serial buffer after a fixed period of inactivity. The time is in half second increments	0
13	BCLO	Low byte of above	8
14		Reserved	0
15		Reserved	0
16	ACALDIV	Divider for proportional autocalibration	1
17	ACALTHHI	Threshold for autocalibration	0
18	ACALTHLO	Low Byte of Above	0
200 – 231		User EEPROM	255

9.2.3.1 Auto-Calibration Settings (locations 3-7)

These are included now to maintain compatibility with previous firmware versions. We recommend using the *@* command to set auto-calibration timings.

9.2.3.2 User EEPROM

Locations 200 to 231 can be used to store user values. Each location is a single byte. These locations are not used by the sensor.

For example, to store the number 42 in the first user EEPROM location:

Send: `P 200 42\r\n`
Response: `P 00200 00042\r\n`

and to read it:

Send: `p 200\r\n`
Response: `p 00200 00042\r\n`

NOTE: The EEPROM is only guaranteed for 100,000 write cycles.

APPENDIX A – COMMAND REFERENCE

This gives the complete command set for the COZIR, SprintIR, and ExplorIR sensors and illustrates use of some of the more commonly used options.

Key points to note are:

- In all cases, commands are terminated with a carriage return, line feed ("\r\n")
- Commands are case sensitive
- The commands use all use ASCII characters. Each command lists the ASCII letter and includes the hex code for avoidance of doubt
- Always check for a correct response before sending another command
- If a command is unrecognized, the sensor will respond with a "?"

WARNING:

This document is provided to give a complete reference of the command set and outputs from the COZIR™ sensor. It is intended for advanced users only. If in doubt, please contact technical@sstsensing.com prior to use.

A-1 CUSTOMISATION

A COMMAND (0x41) *USER CONFIGURATION*

Example:	A 128\r\n
Description:	Set the value for the digital filter
Syntax:	ASCII character 'A', SPACE, decimal, terminated by 0x0d 0x0a (CR & LF)
Response:	A 00032\r\n

a COMMAND (0x61) *INFORMATION*

Example:	a\r\n
Description:	Return the value for the digital filter
Syntax:	ASCII Character 'a' terminated by 0x0d 0x0a (CR & LF)
Response:	a 00032\r\n

M COMMAND (0x4D) *USER CONFIGURATION*

Example:	M 212\r\n
Description:	Determines which values are going to be returned by the unit
Syntax:	"M", SPACE, followed by an up-to 5-digit number, each bit of which dictates which item will be returned by the sensor, terminated by 0x0d 0x0a (CR & LF)
Response:	M 212\r\n (see "Output Fields" for details)

P COMMAND (0x50) *USER CONFIGURATION*

Example: P 10 1\r\n
Description: Sets a user configurable parameter
Syntax: "P", SPACE, followed by an up to 2-digit number, SPACE followed by an up to 3-digit number, terminated by 0x0d 0x0a (CR & LF)
Response: P 00001 00010\r\n (see "User Settings" for details)

p COMMAND (0x70) *USER CONFIGURATION*

Example: p 10\r\n
Description: Returns a user configurable parameter
Syntax: "P", SPACE, followed by an up-to 2-digit number, terminated by 0x0d 0x0a (CR & LF)
Response: P 10 1\r\n (see "User Settings" for details)

A-2 INFORMATION

Y COMMAND (0x59) *INFORMATION*

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

NOTE: This command requires that the sensor has been stopped (see 'K' command).

** COMMAND (0x59)* *INFORMATION*

Example: *\r\n
Description: Returns a number of fields of information giving information about the sensor configuration and behaviour
Syntax: ASCII character '*', terminated by 0x0d 0x0a (CR & LF)
Response: Contact SST for details

. COMMAND (0x2E) *INFORMATION*

Example: .\r\n
Description: Returns a number indicating what multiplier must be applied to the Z or z output to convert it into ppm
Syntax: ASCII character '.', terminated by 0x0d 0x0a (CR & LF)
Response: . 00001\r\n" (this number is variable)

A-3 SWITCHING BETWEEN MODES

For discussion of different modes of operation, see the section “Operating Modes”.

K COMMAND (0x4B) *USER CONFIGURATION*

Example: K 1
Description: Switches the sensor between the operating modes
Syntax: ASCII character "K", SPACE, followed by the mode number, terminated by 0x0d 0x0a (CR & LF)
Response: K 1\r\n (the number mirrors the input value)

A-4 ZEROING AND CALIBRATION

See examples of each of the zero and calibration commands in the following section.

U COMMAND (0x55) *CALIBRATION – USE WITH CARE*

Example: U\r\n
Description: Calibrates the zero-point assuming the sensor is in 0ppm CO_2
Syntax: ASCII Character 'U' terminated by 0x0d 0x0a (CR & LF)
Response: U 32767\r\n (the number is variable)

G COMMAND (0x47) *CALIBRATION – USE WITH CARE*

Example: G\r\n
Description: Calibrates the zero-point assuming the sensor is in 400ppm CO_2
Syntax: ASCII character 'G'
Response: G 33000\r\n (the number is variable)

F COMMAND (0x46) *CALIBRATION – USE WITH CARE*

Example: F 410 390\r\n
Description: Calibrates the zero-point using a known reading and known CO_2 concentration.
Syntax: ASCII character 'F' then a space, then the reported gas concentration then a space then the actual gas concentration.
Response: F 33000\r\n (the numbers are variable)

X COMMAND (0x58) *CALIBRATION – USE WITH CARE*

Example: X 1000\r\n
Description: Calibrates the zero point with the sensor in a known concentration of CO_2
Syntax: ASCII character 'X' then a space, then the gas concentration
Response: X 33000\r\n (the number is variable)

S COMMAND (0x53) *CALIBRATION – USE WITH CARE*

Example: S 8192\r\n
Description: Set the 'Altitude Compensation' value in EEPROM
Syntax: ASCII character 'S', SPACE, decimal, terminated by 0x0d 0x0a (CR & LF)
Response: S 8192\r\n (the number mirrors the input value)

s COMMAND (0x73) *INFORMATION*

Example: s\r\n
Description: Reports the Altitude Compensation value in EEPROM. See “Altitude Compensation”
Syntax: ASCII Character 's', terminated by 0x0d 0x0a (CR & LF)
Response: s 8193\r\n

u COMMAND (0x75) *USE ONLY WITH SST GUIDANCE*

Example: u 32767\r\n
Description: Send a zero-set point
Syntax: ASCII character 'u', SPACE, decimal, terminated by 0x0d 0x0a (CR & LF)
Response: u 32767\r\n

NOTE: For advanced use only. Contact SST before using this command.

There are three variants of the autocalibration configuration command:

@ COMMAND (0x40) *INFORMATION*

Example: @\r\n"
Description: Return the autocalibration settings
Syntax: ASCII character '@'terminated by 0x0d 0x0a (CR & LF)
Response: @ 1.0 8.0\r\n (if autocalibration is enabled)
@ 0\r\n (if autocalibration is disabled)

@ COMMAND (0x40) *CALIBRATION – USE WITH CARE*

Example: @ 0\r\n
Description: Switch off the autocalibration function
Syntax: ASCII character '@' followed by a SPACE followed by a zero terminated by 0x0d 0x0a (CR & LF)
Response: “@ 0\r\n”

@ COMMAND (0x40) *CALIBRATION – USE WITH CARE*

Example: @ 1.0 8.0\r\n
Description: Set the Autocalibration timing
Syntax: See “Autocalibration” section
Response: @ 1.0 8.0\r\n (the number mirrors the input value)

A-5 POLLING COMMANDS

H COMMAND (0x48) *INFORMATION*

Example: H\r\n
Description: Reports the humidity measurement from the temperature and humidity sensor (if fitted). Divide by 10 to get the %RH.
Syntax: ASCII Character 'H', terminated by 0x0d 0x0a (CR & LF)
Response: H 00551\r\n

T COMMAND (0x54) *INFORMATION*

Example: T\r\n
Description: Reports the humidity measurement from the temperature and humidity sensor (if fitted). Subtract 1000 and divide by 10 to get the temperature in ^{o}C.
Syntax: ASCII Character 'T', terminated by 0x0d 0x0a (CR & LF)
Response: T 01224\r\n

Z COMMAND (0x5A) *INFORMATION*

Example: Z\r\n
Description: Reports the latest CO2 measurement in ppm
Syntax: ASCII Character 'Z', terminated by 0x0d 0x0a (CR & LF)
Response: Z 00512\r\n

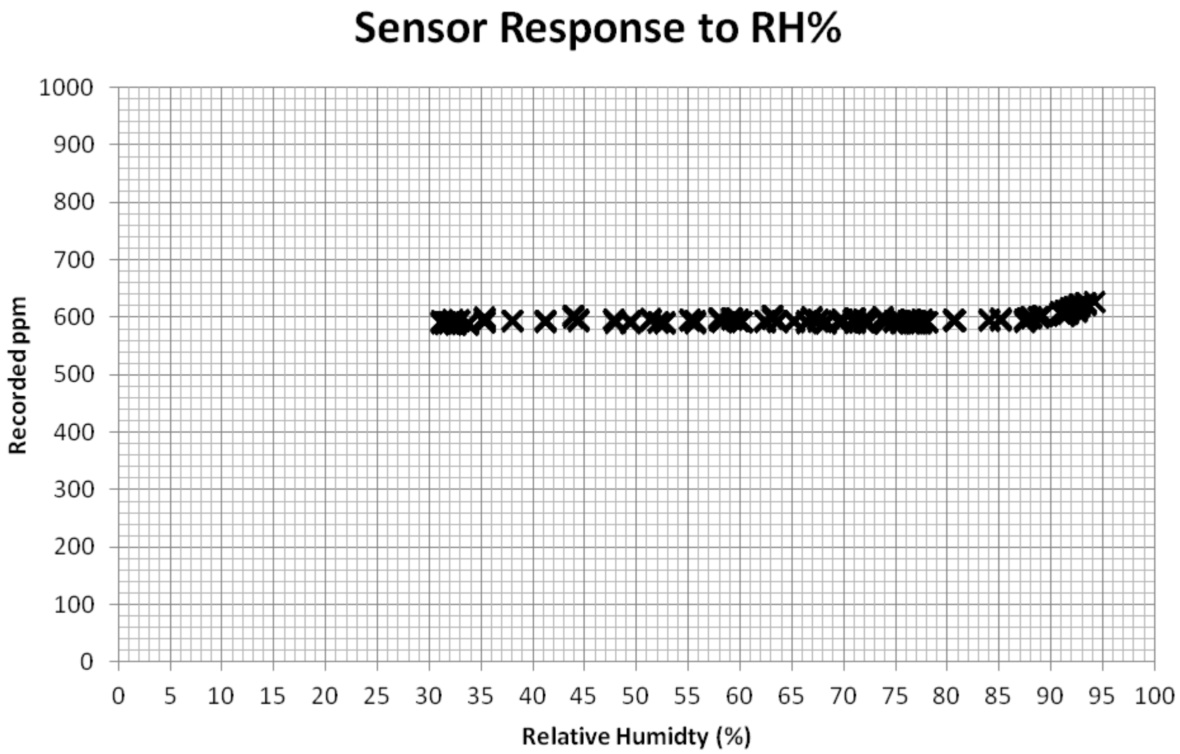
Q COMMAND (0x51) *INFORMATION*

Example: Q\r\n
Description: Reports the latest measurement fields as defined by the most recent 'M' command.
Syntax: ASCII Character 'Q', terminated by 0x0d 0x0a (CR & LF)

APPENDIX B – HUMIDITY CROSS SENSITIVITY

Cross sensitivity was tested in an environmental chamber with controlled temperature and humidity. The CO_2 concentration was not independently controlled, so reflects the background CO_2 level in the factory during the measurement run.

NOTE: There was no change in CO_2 reading between 30% and 90% RH. Between 90% and 95% there was evidence of a slight (30ppm) increase in reading



REFERENCE DOCUMENTS

Other documents in the CO_2 product range are listed below; this list is not exhaustive, always refer to the SST website for the latest information.

Part Number	Title
AN-0118	CO_2 Sensor – Voltage Output Option
AN-0126	CO_2 Sensor – Power Consumption
DS-0002	CO_2 Sensors – SprintIR Datasheet
DS-0113	CO_2 Sensors – COZIR Datasheet
DS-0115	CO_2 Sensors – ExplorIR-W Datasheet
DS-0147	CO_2 Sensors – ExplorIR-M Datasheet
DS-0148	CO_2 Sensors – COZIR LP Datasheet
DS-0149	CO_2 Sensors – SprintIR-6S Datasheet
QS-003	CO_2 Sensors – Quick Start Guide

CAUTION

Do not exceed maximum ratings and ensure sensor(s) are operated in accordance with their requirements.
Carefully follow all wiring instructions. Incorrect wiring can cause permanent damage to the device.
Do NOT use chemical cleaning agents.

Failure to comply with these instructions may result in product damage.

INFORMATION

As customer applications are outside of SST Sensing Ltd.'s control, the information provided is given without legal responsibility. Customers should test under their own conditions to ensure that the equipment is suitable for their intended application.

For technical assistance or advice, please email: technical@sstsensing.com

SST SENSING LIMITED, 5 HAGMILL CRESCENT, SHAWHEAD INDUSTRIAL ESTATE, COATBRIDGE, UK, ML5 4NS
www.sstsensing.com | e: sales@sstsensing.com | t: +44 (0)1236 459 020 | f: +44 (0)1236 459 026