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COZIR™ Software User's Guide

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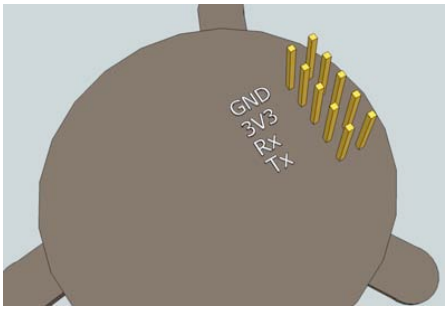
1 Serial Format and Connection

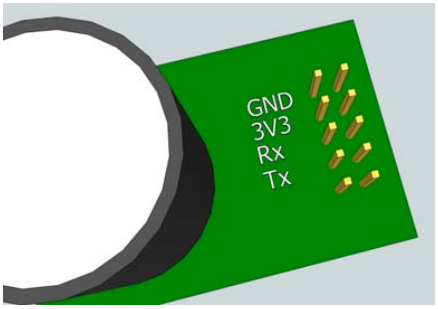
1.1 Connection

Communication to and from the COZIR™ sensor is via a serial connection. Pins are shown looking at the connector of the sensor.



COZIR-A

GND	N/C
3V3	N/C
Rx	N/C
Tx	Zero
N/C	Ambient



COZIR-W

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 (eg a PC) it is necessary to pass through a level converter to step up/down the voltage and invert the signal.

A starter kit is available to allow simple interfacing between the sensor and a PC. Contact AirTest (support@AirTest.com) for details.

Connection to the sensor is via a 10 way, 0.1” pitch connector. In practice, only the first 4 pins are required (GND, 3V3, Rx and Tx) so a 4 way connector can be used.

When powered, the sensor will immediately start to transmit readings (see Mode 1 in "***Operating Modes")***

Parameter	Value
Baud Rate	9600
Data Bits	8
Parity	None
Stop Bits	1
Format	UART (normally high)
Hardware Flow Control	None
Voltage V_h	3V

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

1.2 Reading Format

The reported CO_2 output is presented 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	Up to 2%	ppm	Z 00631 = 631ppm
COZIR-W	Up to 65%	ppm/10	Z 01200 = 12000ppm = 1.2%
COZIR-W-100	Up to 100%	ppm/100	Z 01500 = 150000ppm = 15%

Note that the same units must be used when sending concentration information to the sensor (X command, F command).

From firmware version AL14 (released February 2012), users can confirm the units using the '.' command. This will respond with the multiplication factor required to covert the reading to ppm.

Note that all output from the sensor has a leading space.
From version AL14 (released end Q1 2012)

2 Command Summary

For complete details of the commands and their correct usage, please refer to the **Command Reference.**

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 the example. Not available on all models.
K #\r\n	Selects the operating mode	K 1\r\n	K 00001\r\n	See ***"Operating Modes"***
L\r\n	Return the most recent light measurement	L\r\n	L 02900\r\n	Not available on all models.
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 ###	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 the example. Not available on all models.
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 CO2 measurement.	Z\r\n	Z 01521\r\n	1521ppm in the example for COZIR-A. Check 1.2 Reading Format for others.
*\r\n	Return configuration information.	*\r\n		See the "***Command Reference"*** for details
.\r\n	Return multiplier to convert Z to ppm	.\r\n	. 00010\r\n	See the "***Command Reference"*** for details

All communications are in ASCII, have a leading space(ASCII character 32), 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.

The character '#' represents an ASCII representation of a numeric character (0-9).

Note that there is a space between the first letter and any parameter. For example, the X command reads "X space 2000 carriage return line feed".

3 Operating Modes

The COZIR™ sensor can be operated in three different modes. Users can switch between the modes using the "K" command.

3.1 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.

3.2 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).

3.3 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.

In Polling Mode, measurements can be accessed using the polling commands H, L, Q, T and Z (see ***"Command Reference"***).

4 Output Fields

The COZIR™ sensor can be configured to output up to five fields of information. Typically, the only fields of interest are the CO2 concentration and Temperature/Humidity (if fitted).
This allows users 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 an single character, followed by a space, followed by the five digit number indicating the value of the parameter.
The output fields can be set by sending a command of 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 below).
The sensor will output 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.

Parameter	Field Identifier	Mask Value	Comments
Unused		65535	
Unused		32768	
Unused		16384	
Light	L	8192	Reports the output of the Light Sensor (if Fitted).
Humidity	H	4096	Reports the humidity output of the Temperature and Humidity Sensor (if Fitted).
D digitally filtered	D	2048	Reports a value related to the normalized LED signal strength (smoothed)
D unfiltered	d	1024	Reports a value related to the normalized LED signal strength
D recent maximum		512	Reports the recent highest normalized LED signal strength
Zero Set Point		256	Reports a value related to the normalized 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 of the Temperature and Humidity Sensor (if 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 temperature. (smoothed)
CO2 Output (Digitally Filtered)	Z	4	Digitally filtered CO2 reading
CO2 Output (not filtered)	z	2	Instantaneous CO2 reading
None		1	Reserved

Note that most fields are for advanced use only and require specific guidance from GSS engineering for their correct interpretation and use.
For example, to output the temperature, humidity and CO2 measurements, send:
M 4164\r\n
The output string will then be:
H 12345 T 12345 Z 00010\r\n

5 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 (see X command) 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 stabilized temperature.

5.1 Zero in a known gas concentration (recommended)

Place the sensor in a known gas concentration and allow time for the sensor temperature to stabilize, and for the gas to be fully diffused into the sensor.
Send the command "X ###\r\n"
The concentration must be in the same units as the sensor output (see ***"Reading Format".*** The sensor will respond with an echo of the command and the new zero point.
For example, to set the zero point in a COZIR-A when the sensor is in a known gas concentration of 2000ppm

send: *X 2000\r\n*
response: *X 32950\r\n*

5.2 Zero in Nitrogen

Place the sensor in a gas containing no CO2 (typically nitrogen). and allow time for the sensor temperature to stabilize, and for the gas to be fully diffused into the sensor.
Send the 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*

5.3 Zero in Fresh Air (assumed to be 450ppm)

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 450ppm (this value is user configurable – see *"User Settings"*).

Place the sensor in a fresh air environment and allow time for the sensor temperature to stabilize, and for the fresh air to be fully diffused into the sensor.
Send the 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*

5.4 Fine Tune the Zero Point

If the CO2 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 above) but can operate on historic data. For example, if the sensor has been

in an environment in which it is know 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 (see ***"Reading Format"***)

The sensor will respond with an echo of the command and the new zero point.

For example,

send:	*F 400 380\r\n*
response:	*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.

5.5 Zero Point Adjustment

The precise zero point can be fine-tuned by sending a zero point to the sensor. This is not recommended for general use.
Send the command "u #####\r\n" where ##### is the new zero point.

5.6 Auto Zero Point Calibration

The sensor can be configured to zero automatically using fresh air as the calibration source. Contact GSS Ltd for details.

6 Span Calibration

NB Span calibration must only be performed AFTER the unit has been correctly zeroed.
NB The COZIR™ Sensor should not require span calibration. GSS does not recommend using the span calibration procedure.
Span calibration allows users to fine tune readings to ensure that the sensor gives exactly the correct reading when presented with a gas of know concentration. Typically, span calibration should not be required, however it may become necessary if he unit has suffered shock (mechanical or thermal) sufficient to cause a local distortion of the optical elements. It can also be used to fine tune the unit to give the most accurate readings around a specific concentration of interest.

Procedure:

- Switch on the unit and allow to warm up for at least two minutes.
- Present the sensor with a known gas for calibration. The gas should be in the general range which the sensor is to be used to measure.
- Allow the sensor reading (filtered output) to settle.
- Read the existing Span Calibration Factor by sending "s\r\n". The factory default is 8192.
- Work out the span calibration factor by using the formula
- Span Calibration Factor = (Known Gas Concentration x Existing Span Calibration Factor)/Sensor Reading
- Now programme the span calibration factor into the unit by sending the following command

  S ####\r\n

  where

  #### is Span Calibration Factor
  \r\n is Line Feed, Carriage Return

Example

1. If the known gas is 2000ppm, the sensor reading is 1950ppm and the current Span Calibration Factor is 8192, then:

   Span Calibration Factor = (2000 x 8192)/1950 = 8402

   The command line is:

   S 8402\r\n

2. If the existing span calibration factor was 8205, the calculation would be:

   Span Calibration Factor = (2000x8205)/1950 = 8415

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7 User Settings

7.1 Digital Filter

The CO2 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 can be set to a value between 1 and 256 (see below for smart filter). A low value will result in the fastest response to changes in gas concentration, a high value will result in a slower response. Note that the response is also determined by the diffusion rate into the sensor. The default setting is 32.

To change the setting, type "A ###\r\n" where ### is the required filter setting.

For most applications, a filter setting of 32 is recommended.
Eg

A 32 \r\n

The filter works as a low pass filter - increasing the parameter reduces measurement noise, but slows the response.

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.

7.2 User Options – EEPROM Settings

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".

7.2.1 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 that 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 (ie the assumed CO_2 concentration in fresh air) to 380ppm, send

send: *P 10 1\r\n*
response: *P 00010 00001\r\n*
send: *P 11 124\r\n*
response: *P 00011 00124\r\n*

7.2.2 Reading EEPROM

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

Note that 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 (ie the assumed CO_2 concentration in fresh air)send:

send: *p 10\r\n*
response: *p 00010 00001\r\n*
send: *p 11\r\n*
response: *p 00011 00124\r\n*

7.2.3 EEPROM Settings

Most of the EEPROM settings are two byte values, indicated by HI and LO in the variable name in the following table. We recommend contacting GSS before altering the default values.

Location	Name	Purpose	Default Value
0	AHHI	Reserved	0
1	ANLO_	Reserved	0
2	ANSOURCE	Reserved	0
3	ACINITHI	Autocalibration Preload. This preloads the autocalibration timer so that the first autocalibration occurs after a shorter time.	87
4	ACINITLO	Low byte of above.	192
5	ACHI	Autocalibration Interval. Sets the time interval between autocalibrations.	94
6	ACLO	Low byte of above.	128
7	ACONOFF	Switches Autocalibration ON/OFF	0
8	ACPPMHI	Autocalibration Background Concentration. This determines what background CO_2 level is assumed for autocalibration.	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

8 Command Set

This gives the complete command set for the COZIR™ sensor 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 GSS engineering prior to use.

8.1 Customisation

A COMMAND (0x41) ***USER CONFIGURATION***

Eg: "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***

Eg: "a\r\n"

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

M COMMAND (0x4D) ***USER CONFIGURATION***

Eg: "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: Eg "M 212\r\n" (see *“Output Fields”* for details)

P COMMAND (0x50) **USER CONFIGURATION**

Eg: "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: Eg "P 00001 00010\r\n" (see *"User Settings"* for details)

p COMMAND (0x70) **USER CONFIGURATION**

Eg: "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: Eg "P 10 1\r\n" (see *"User Settings"* for details)

8.2 Information

Y COMMAND (0x59) **INFORMATION**

Eg:"Y\r\n"

Description: the present version string for the firmware
Syntax: ASCII character 'Y', terminated by 0x0d 0x0a (CR & LF)
Response: Y May 30 2008 10:45:03 CA08 B 00233

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

**** COMMAND (0x59)*** **INFORMATION**

Eg:"*\r\n"

Description: Returns a number of fields of information giving information about the sensor configuration and behavior.
Syntax: ASCII character '*', terminated by 0x0d 0x0a (CR & LF)
Response: Contact GSS for details.

. COMMAND (0x59) **INFORMATION**

Eg:".\r\n"

Description: Returns the multiplier required to convert the CO2 reading to ppm..
Syntax: ASCII character '.', terminated by 0x0d 0x0a (CR & LF)
Response: eg . 00010\r\n This would indicate that the Z output must be multiplied by 10.

8.3 Switching between Modes

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

K COMMAND (0x4B) **USER CONFIGURATION**

Eg: "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 #\r\n" where # is the mode number.

8.4 Zeroing and Calibration

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

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

Eg: "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***

Eg: "G\r\n"

Description : Calibrates the zero point assuming the sensor is in 450ppm CO_2.
Syntax: ASCII character 'G'
Response: "G 33000\r\n" (the number is variable).

F COMMAND (0x46) CALIBRATION – USE WITH CARE

Eg: "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***

Eg: "X 1000\r\n"

Description : Calibrates the zero point with the sensor in a known concentration ofCO_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***

Eg: "S 8193\r\n"

Description: Set the 'Span' value in EEPROM
Syntax: ASCII character 'S', SPACE, decimal, terminated by 0x0d 0x0a (CR & LF)
Response: "S 8193\r\n" (the number mirrors the input value).

s COMMAND (0x73) ***INFORMATION***

Eg: "s\r\n"

Description: Reports the set 'Span' value in EEPROM Nominally 8192 = a multiplier of 1.
Syntax: ASCII Character 's', terminated by 0x0d 0x0a (CR & LF)
Response: “S 8193\r\n”

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

Eg: "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"

NB For advanced use only. Contact GSS before using this command.

8.5 Polling Commands

H COMMAND (0x48) ***INFORMATION***

Eg: "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”

L COMMAND (0x4C) ***INFORMATION***

Eg: "L\r\n"

Description: Reports the light measurement from the light sensor (if fitted).
Syntax: ASCII Character 'L', terminated by 0x0d 0x0a (CR & LF)
Response: “L 02221\r\n”

T COMMAND (0x54) ***INFORMATION***

Eg: "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 ºC.
Syntax: ASCII Character 'T', terminated by 0x0d 0x0a (CR & LF)
Response: “T 01224\r\n”

Z COMMAND (0x5A) ***INFORMATION***

Eg: "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***

Eg: "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)
Response: “H 12345 T 12345 Z 00010\r\n”