

# C1 & C2 ANALOGUE VOLTAGE OPTION

## Voltage Output Option

Before selecting the voltage output option, please consider:

- ✚ The voltage output is derived from the digital output (it is a PWM driven).
- ✚ A digital interface is required to configure the sensors.
- ✚ Even if the end application will use only a voltage interface, we recommend that users and designers use a digital interface (for example, the USB to serial cable, part number 2112BC12USB) when evaluating the sensor.
- ✚ The voltage output is for CO2 measurement only. The optional temperature and humidity outputs are only available as digital (UART) outputs.

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## 1 Introduction

The C1 and C2 sensors have an optional voltage output in addition to the standard digital (UART) output. We would recommend that a digital sensor is utilised where possible.

The output voltage output is proportional to the CO<sub>2</sub> concentration.

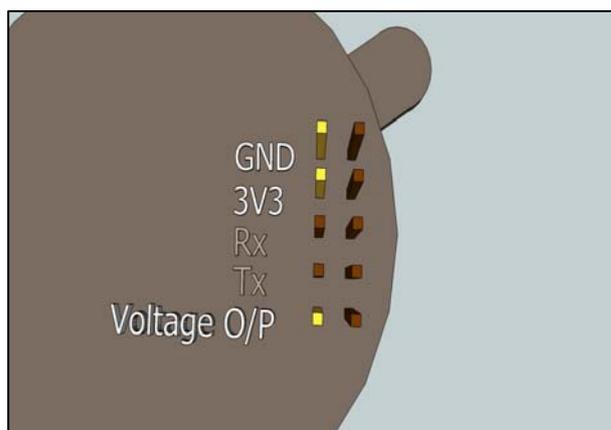
Key points to note are:

- The maximum voltage output (full scale) will always be that applied to pin 3 of the 10 way connector.
- Care must be exercised in selecting the load resistance connected between the voltage output (pin 9) and GND (pin 1).
- The voltage output pin (pin 9) is an output pin only. Take care not to feed any voltage/current into the voltage output pin.
- The voltage output is a factory fit option. It is not present unless requested.
- The supply voltage should be 3.3V +/- 0.1V. The sensor can operate at higher voltages, however the offset voltage becomes problematic outside the standard operating voltage range.

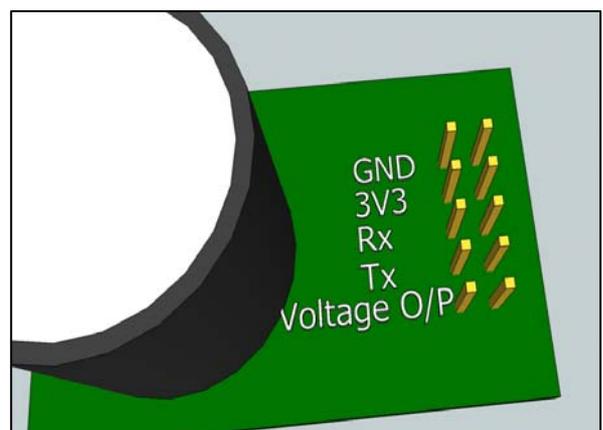
## 2 Voltage Output

### 2.1 Connections

The voltage output is available on pin 9 of the sensor. Power and ground must be applied to pins 1 and 3.



**C1 Connections, part no. 2112BC1-V**



**C2 Connections, part no. 2112BC2-V**

## 2.2 Load Impedance

The C1 and C2 voltage output pins have an internal resistance of approximately 150Ω. The internal capacitance between the voltage output pin and 0V is 220nF. This gives the output a single order high frequency roll off at about 4.8kHz.

To avoid loading issues affecting the measurement, it is essential to ensure that load connected to the voltage output pin (9) is greater than 10kΩ and preferably greater than 100kΩ.

Load Resistance	Loading Error
4k7	3%
10k	1.5%
100k	0.1%
500k	0.03%

## 3 Output Voltage

The voltage output is provided by Pulse Width Modulation (PWM) of the sensor supply voltage. This means that all voltage outputs are relative to the supply voltage. For example, if the supply voltage is 3.4V, then the full scale output from the voltage pin will also be 3.4V, the half scale voltage will be 1.7V etc.

To convert a voltage into a CO<sub>2</sub> concentration:

$$\text{Concentration} = FS * V_{out} / V_{supply}$$

Where

$$\begin{aligned} FS &= \text{Full Scale Concentration} \\ V_{out} &= \text{voltage output (at pin 9)} \\ V_{supply} &= \text{supply voltage (at pin 3)} \end{aligned}$$

All voltages relative to GND (pin 1)

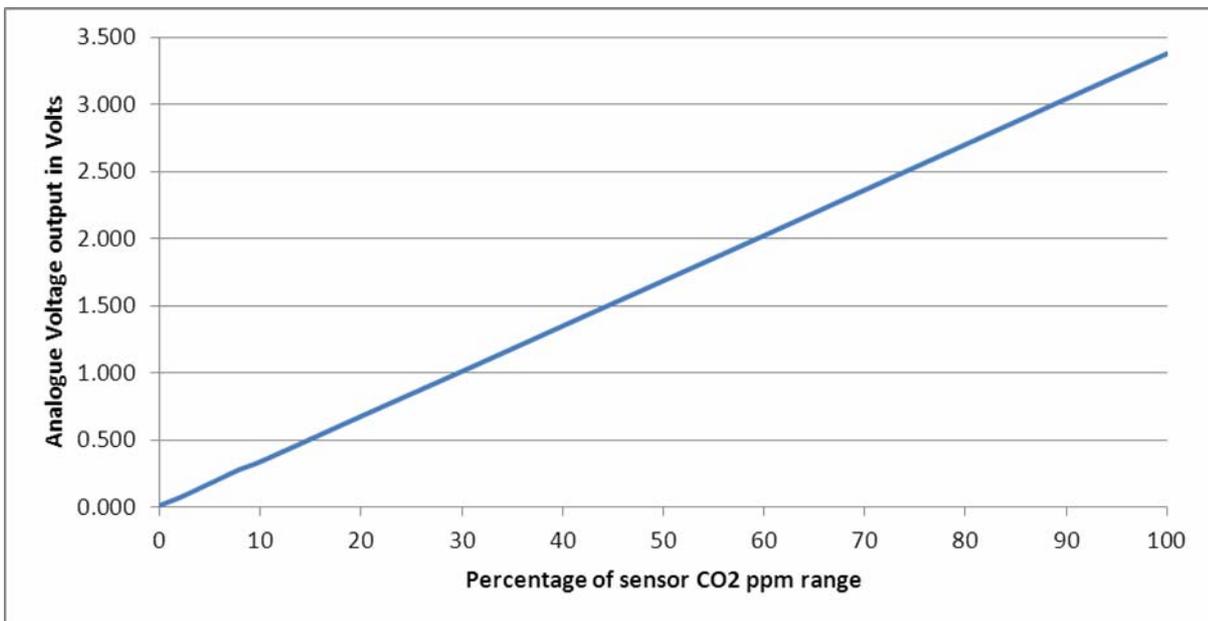
Note that there is a slight zero offset (see below), which should be taken into account for readings below 10% of the Full Scale.

### 3.1 Linearity of the Voltage Output

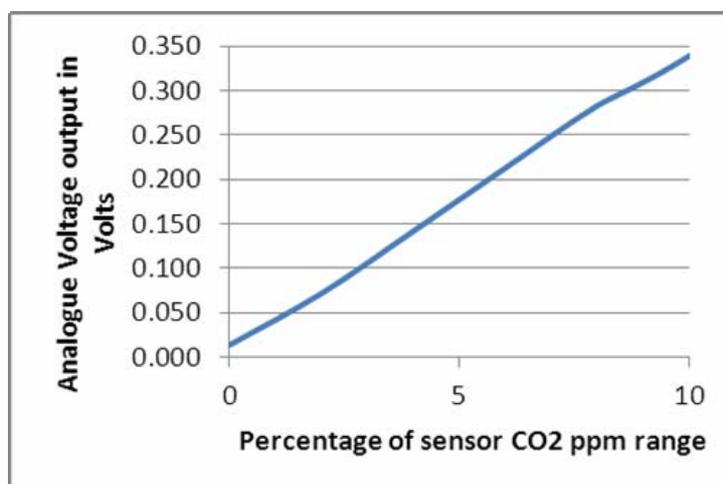
Figure 2 shows a typical plot of output voltage (at pin 9) vs CO<sub>2</sub> concentration.

- Note that the output voltage is linearly dependent on the CO<sub>2</sub> concentration measured by the sensor.
- Note also that for CO<sub>2</sub> concentrations less than 10% of full scale, the sensor output voltage is affected by the output Operation Amplifier offset voltage (~14mV). See below:

**Output Linearity – this graph assumes a supply voltage of 3.3V**



**Effect of zero offset close to 0 – this graph assumes a supply voltage of 3.3V**



### 3.2 Noise on the Voltage Output

The typical noise present on the voltage output is as follows with the voltage output at half full scale:

- 140µVrms measured in a 20kHz bandwidth.
- 450µVrms measured in a 10MHz bandwidth.
- In a 10MHz bandwidth, the highest noise voltage amplitude is at least 70dB below the desired DC output voltage.

## 4 Digital outputs

The digital (serial) Rx and Tx connections are still available and active when the voltage output is fitted. This allows the sensor to be calibrated and configured over the serial connections.

## 5 Zero Point Calibration

The serial communication options are also available (see the *C1 & C2 Sensor Manual*).

The sensor requires periodic zero point calibration. In many cases, this can be done automatically using the built in auto-calibration option (the sensor must be able to 'see' fresh air at some point with auto-calibration option). Additionally, two zero calibration pins are available:

### Nitrogen Zero (Pin 8)

This pin is normally high. Hold it low for 1.5s to trigger a nitrogen zero. This assumes that the sensor is free from any CO<sub>2</sub>.

### Ambient Zero (Pin 10)

This pin is normally high. Hold it low for 1.5s to trigger an ambient zero. This assumes that the sensor is in fresh air (default setting is 450ppm).

## 6 Ordering Information

**The voltage output is a factory fit option and must be specified by the customer at the time of ordering. The customer must also specify the full scale range required. Sensors with voltage output have a "V" appended to the product code.**

**For example: part number 2112BC1-V has an analogue voltage output.**

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