# C20 User Instructions

Getting Started

The C20 can be run using just four connections - +5V, 0V, Serial In, Serial Out. Once powered up, it will immediately start to transmit CO_2 readings twice per second. This can be read directly by connecting to a microcontroller, or can be connected to a PC using a suitable serial driver chipset.

The sensor outputs actual CO_2 readings, compensated for temperature in the range -25C and +55C.

Development Kit
For a really quick start, we strongly recommend the C20 Development Kit. This comprises one C20 CO_2 sensor mounted on a development board with a display, voltage regulator, serial driver, and standard 9 pin D type socket for connection directly to a PC, and an interface programme to allow some configuration of the C20.
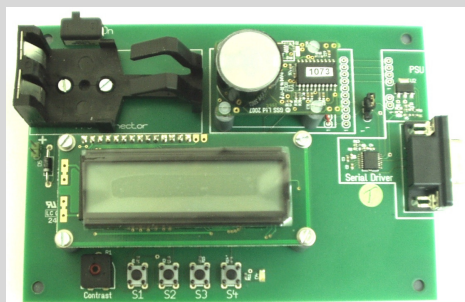
C20 Connections

The C20 can be connected using the Molex locking socket, or by connection to four plated through holes.

Rx   Tx

Molex 10-way
Connector. Pin 1

Alternative 0V   0V   +5V
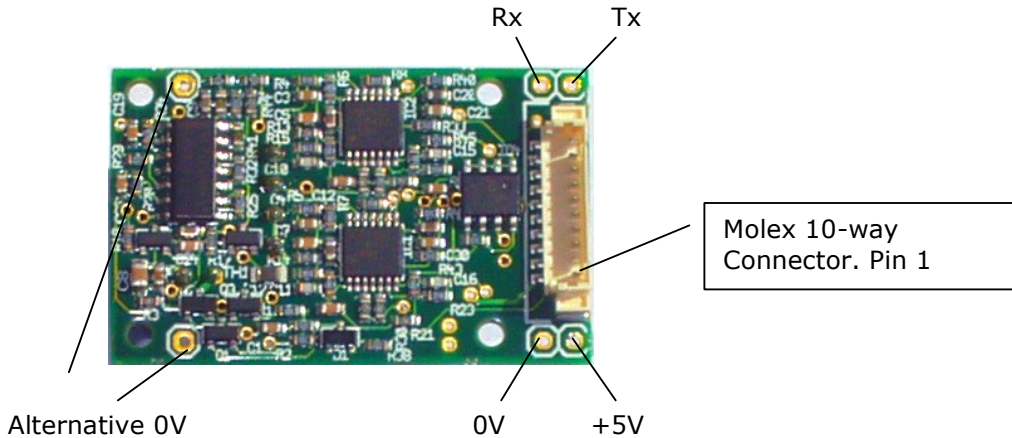
Molex Socket

Connection to the sensor is via a Molex 533981071 locking header plug. The mating part is Molex 51021-1000. At the time of writing, the Farnell order codes for the mating connector and crimped cables are 873-3124 and 112-5276.

The pin connections are:

Pin	Use	Comments
1	+5V	Positive supply 4.7v to 5.5v
2	GND	0V
3	Zero	Pull low to zero the unit
4	N/C	Factory calibration use only
5	Serial Transmit	NB inverted
6	Serial Receive	NB inverted
7	N/C	Factory calibration use only
8	N/C	Factory calibration use only
9	Air Zero	Pull Low to zero the unit in ambient air.
10	GND	0V

Through Hole Connections

As an alternative to the Molex connector, the C20 can be operated by connecting to the through plated holes located either side of the Molex connector. These can accommodate standard 0.1" pitch pin headers, or soldered connections.

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Communications

Serial Protocol

The format is set as follows:
9600 baud
8 bit
no parity
1 stop bit
There is no hardware flow control.

Output Format

Each output record consists of a number of field characters followed by their value and terminated with a \r\n (carriage return, line feed).

Z ##### z ##### \r \n

For example:

Z 00017 z 00020 \r\n

This would indicate a reading of 170ppm on the high resolution output and 200ppm on the fast response output.

Other data fields can be accessed by configuring the unit. These fields include ADC outputs of PCB and gas head temperature sensors, and an optical signal strength output (see *advanced features*).

Zeroing

The zero for the sensor should be set periodically. It is stored in non-volatile memory, so does not need to be set every time the unit is switched on.

Zeroing in Nitrogen (recommended)
- Flow Nitrogen (or another gas free of CO2) over the sensor for 30s.
- Pull pin 3 low for at least 1s.
- The sensor will respond by sending "N #####" where ##### is a 5 digit number.

If nitrogen is not available, it is possible to calibrate in ambient air (preferably 'outside' air.

Zeroing in Ambient Air (assumed to be 450ppm) *(Not available on all models).*
1. Place the unit in ambient air (preferably fresh 'outside' air) and allow it to stabilise for 30s
2. Pull pin 9 low for at least 1s.
3. The sensor will respond by sending "A #####" where ##### is a 5 digit number.

Advanced Features

Software Zeroing

The C20 sensor can be zeroed remotely by sending a zero command over the serial link. The serial protocol is the same as for receiving data from the sensor.

The command format is an upper case "U".

U \r\n

The C20 sensor will respond by:

N ##### \r\n

The five digit number must not be used as a CO2 reading.

Output Options

The serial output from the unit can be altered to give different fields. To alter the output fields, send an 'M' command followed by the total of the mask value for each output required.

Field	Mask Value	Output	Description
Fast Reponse CO2	2	z #####	In ppm/10
Filtered CO2	4	Z #####	In ppm/10
LED Signal Strength	32	O #####	ADC Output – Not Calibrated
PCB Temperature Sensor	64	T #####	ADC Output – Not calibrated
Gas Cell Temperature Sensor	128	V #####	ADC Output – Not calibrated

Eg

M 2 \r\n   Fast Output Only   z #####
M 6 \r\n   Fast and Filtered Output   Z ##### z #####

Filter Response

The filter response can be tuned to optimise for a particular application. This is done by passing a parameter (1 to 128) to the unit using the 'A' command.
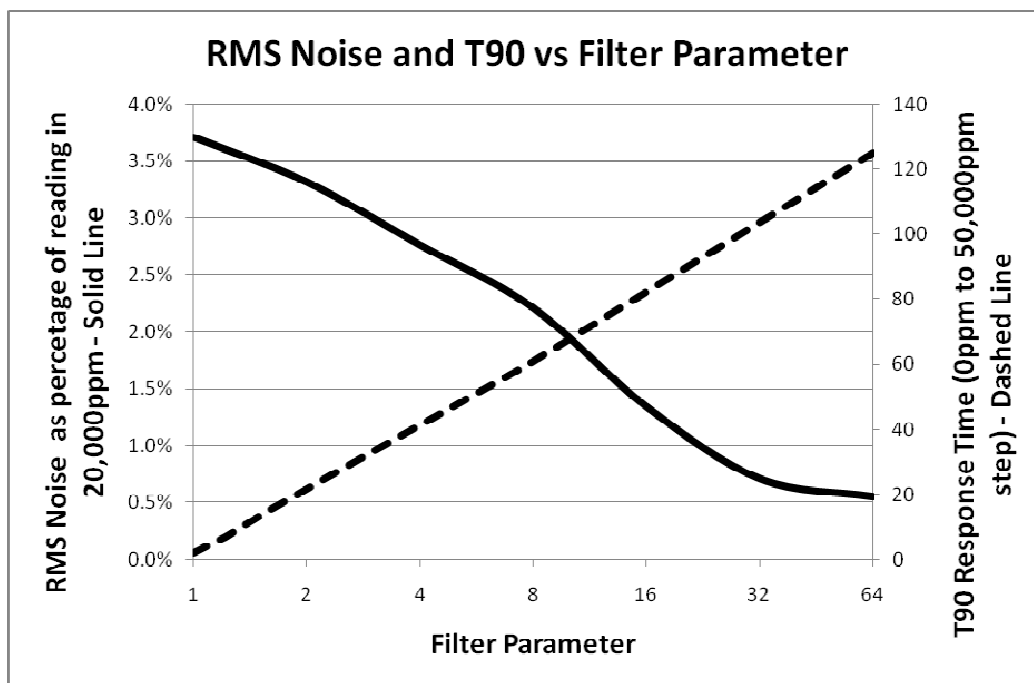
Eg

A 32 \r\n

The filter works broadly as a low pass filter - increasing the parameter reduces the noise, but slows the response. The filter parameter must be a power of two – 2,4,8,16 etc. Other values will be interpreted as the next lowest power of two.

The following graph show the trade-off between signal to noise and speed of response for various values of the filter parameter.

RMS Noise and T90 vs Filter Parameter

(Graph: RMS Noise as percetage of reading in 20,000ppm – Solid Line (left axis, 0.0% to 4.0%) and T90 Response Time (0ppm to 50,000ppm step) – Dashed Line (right axis, 0 to 140), versus Filter Parameter (1, 2, 4, 8, 16, 32, 64))

Span Calibration

The C20 is fully factory calibrated before shipping. The C20 span (full scale reading) can be calibrated by using a calibration gas source. The process is as follows:

1) Ensure that the C20 is correctly zeroed using a nitrogen (or zero gas) source.
2) Immerse the gas sensor in a gas of known concentration (eg a calibration gas).
3) Allow the gas reading to settle and record the measured gas concentration.
4) Now calculate the calibration factor using the formula

    CF = (AGC * 8192)/MGC (round to nearest integer)

    Where

    CF= Calibration Factor
    AGC = Actual Gas Concentration
    MGC = Measured Gas Concentration

5) Finally, enter the correction factor into the C20 using the command

    S ##### \r\n where #### is the Correction factor calculated in step 4.

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For example, if the calibration gas is 10,000ppm, and the reading is 10,200ppm, the value to be entered would be

(10000*8192/10200) = 8031

i.e. S 8031\r\n

Draft Specifications

Item	Value	Comments
Detection limits	200ppm	
Noise at zero	20ppm	Filter setting at 32
Warm Up	120s	For full accuracy.
Temperature Range	-25C to 55C	
Storage Temp	-30C to +70C	
Supply Voltage	5v	3.3v version available. 5v preferred.
Supply Current	20mA	Average at 5v. Peak is 220mA
Range	Up to 65%	Available as 5%, 20% and 65%
Output	TTL Level RS232	9600,n,8,1
Cross Sensitivity CO CH4	None Low	100% CH4 reads as 100ppm CO2