CCS801 Ultra-low power multi-gas sensor for indoor air quality

Technology Advantage

Cambridge CMOS Sensors (CCS) micro-hotplate technology provides a unique silicon platform for the CCS80x range of Metal Oxide (MOX) gas sensors. These devices enable sensor miniaturisation, have ultra-low power consumption and provide fast response times due to the ability to heat the micro-hotplate very quickly.

The Micro-hotplates are fabricated using a robust silicon dioxide membrane and include an embedded tungsten heater acting as a heating element for the MOX based sensing material. The micro-hotplate can be used to heat the MOX sensing material up to 500°C and the electrical resistance of the MOX sensor can be monitored to detect the target gas. Through enabling fast heater cycling times, temperature modulation techniques can be used to reduce the device power consumption and implement advanced gas sensing methods.

Software including advanced algorithms and an example Android app are available for Indoor Air Quality monitoring.

Product Overview

CCS801 is an ultra-low power MOX multi-gas sensor for monitoring indoor air quality including Carbon Monoxide (CO) and a wide range of Volatile Organic Compounds (VOCs). CCS801 can be used as an equivalent carbon dioxide (eCO_2) sensor to represent eCO_2 levels in real world environments, where the main cause of VOCs is from humans.

The sensitivity of CCS801 to a target gas is optimised by adapting the supply voltage (V_H) of the integrated micro-heater, and the gas concentration can be correlated to the change in resistance of the MOX sensing layer (R_S).

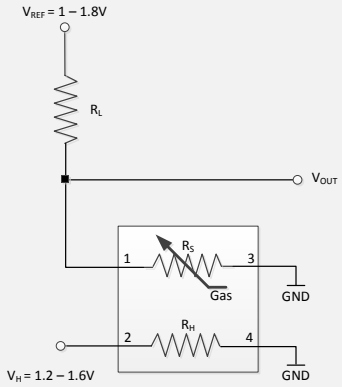
V_H can be set using a low-dropout (LDO) regulator or operated in pulsed PWM mode to reduce power consumption. The sensor resistance (R_S) is determined using a series load resistor (R_L), a reference voltage (V_{REF}), and an output voltage (V_{OUT}) read by an Analogue-to-Digital Converter (ADC).

Miniaturisation

The CCS801 multi-gas sensor is supported in a compact 2 mm x 3 mm DFN (Dual Flat No lead) package as standard. Other package options may be available on request. The inherent design of this sensor enables ultra-low power consumption for battery operated portable handheld devices.

Key Benefits

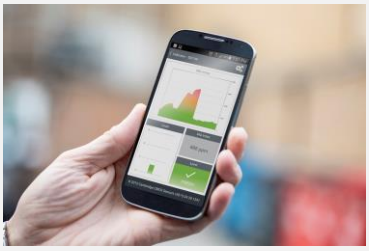
- Ultra-low power consumption - ideal for battery operated devices
- High sensitivity
- Fast heating time <25ms for quick response
- Compact 2mm x 3mm DFN package for small form factor designs



Recommended Sensor Configuration

Applications

- Total VOC sensor for Indoor air quality monitoring
- Alcohol breathalyser
- Toxic gas (CO) detection



Email: sales@ccmoss.com Telephone: +44 1223 395 551 Date Issued: 04 Jun 2015

Electrical characteristics

Parameters	Comments / Conditions	Min	Typical	Max	Units
Absolute maximum Heater voltage (V_H)	50% Relative humidity and 25°C ambient temperature			1.8	V
Recommended operating temperature		-5		+50	°C
Heater voltage (V_H) to set operating temperature for target gas	Carbon monoxide		1.3		V
	Ethanol		1.4		V
	VOCs		1.5		V
Average power consumption (P_{AV}) for three target gases	Powered at V_H for target gases in pulse mode[1]		1.3		mW
			1.6		mW
			1.8		mW
Peak power consumption (P_{DC}) for three target gases	Powered at V_H for target gases when DC powered		30		mW
			33		mW
			37		mW
Heater resistance (R_H)	V_H = 1.4V @ 50% RH	50	58	66	Ω
Reference voltage (V_{REF})[2]		1.0	1.8		V
Load resistance (R_L)			200		KΩ
Typical sensor resistance in air (R_S=R0)	V_H = 1.4V @ 50% RH	0.1	0.5	1.0	MΩ
Lifetime	V_H = 1.6V @ 20% duty cycle	>5			years

Note:

1. Based on a 0.5s heater ON, 9.5s heater OFF period. Timing will vary depending on application and use case requirements

2. The reference voltage (V_{REF}) needs to cover the input range of the ADC.

Sensor performance

Gas type	Test condition	Typical Sensitivity Range[1,2]
Carbon Monoxide (CO)	R0 / R_{100ppm}	2 -3
Ethanol (C_2H_5OH)	R0 / R_{100ppm}	5 – 10
Toluene (C_7H_8)	R0 / R_{100ppm}	4 – 7

Note:

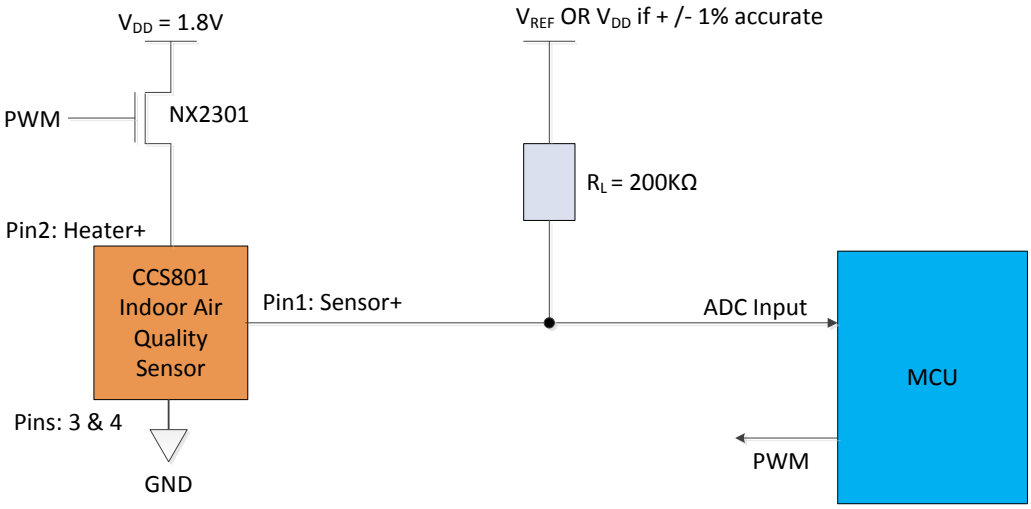
1. Defined as the sensor's resistance in air (R0) divided by the sensor's resistance at a specific gas concentration level at 50% relative humidity and 25°C ambient temperature. Typical values given for each target gas.

2. A minimum burn-in time of 24hrs is recommended to ensure sensor performance is consistent over longer period of time

Recommended basic application circuit

For more information refer to application note CC-000018-AN on CCS80x hardware design guidelines.

The recommended basic application circuit for CCS801 is shown below.



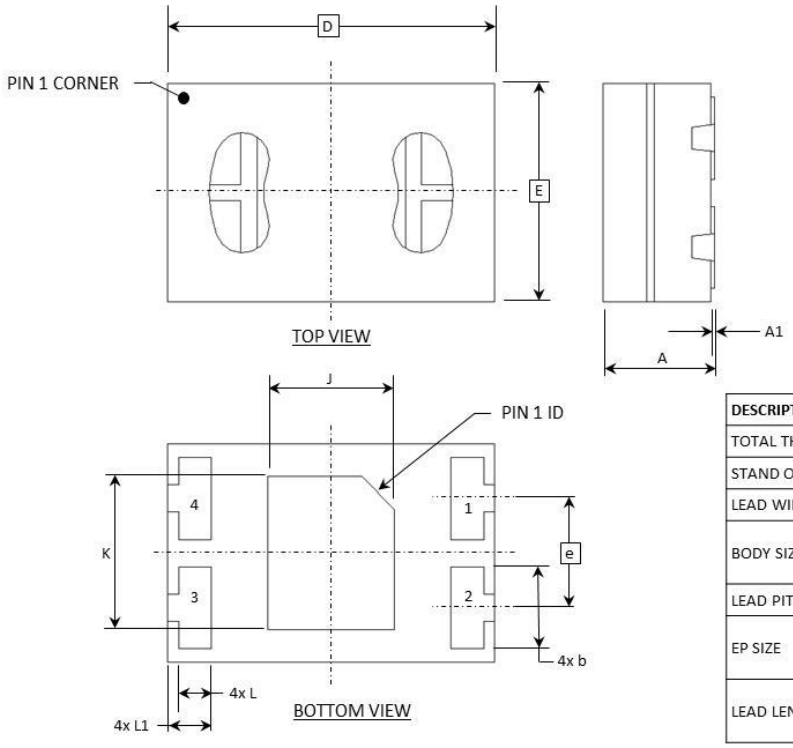
Notes:

1. The sensor can be operated in pulsed mode to reduce overall power consumption. This assumes a PWM output from the MCU is available to drive an external MOSFET switch (p-channel). The PWM must operate with a minimum frequency of 10 kHz. The following table illustrates PWM duty cycle requirements to enable VH in the range 1.3 – 1.5V for CCS801:

Target Heater Voltage (V_H)	Supply Voltage (V)				
	1.5V	1.8V	2.5V	3V	3.3V
1.30	75%	52%	27%	19%	15%
1.40	87%	60%	31%	22%	18%
1.50	100%	69%	36%	25%	21%

2. An ADC input is required on the MCU to measure the sensor resistance.

DFN package outline and pin assignment



Pin	Function
1	Sensor+, V_{OUT}
2	Heater+, V_H
3	Sensor, 0V
4	Heater, 0V

ALL DIMENSIONS ARE IN MM

DESCRIPTION	SYMBOL	MIN	NOM	MAX
TOTAL THICKNESS	A	0.95	1.0	1.05
STAND OFF	A1	0	0.035	0.05
LEAD WIDTH	b	0.7	0.75	0.8
BODY SIZE	D	3 BSC		
	E	2 BSC		
LEAD PITCH	e	1.0 BSC		
EP SIZE	J	1.06	1.16	1.26
	K	1.3	1.4	1.5
LEAD LENGTH	L	0.25	0.3	0.35
	L1	0.35	0.4	0.45

Ordering Information

Part Number	Description	Package	MOQ
CCS801B-COPR	Volume production of CCS801 Multi-gas sensor for Indoor Air Quality Monitoring	2x3mm DFN	5000
CCS801B-COPS	Sample of CCS801 Multi-gas sensor for Indoor Air Quality Monitoring	2x3mm DFN	100

Note:

1. Refer to JEDEC J-STD020 lead-free standard for maximum soldering profile
2. Refer to application note CC-000090-AN on device assembly guidelines