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The technical content of this Cambridge CMOS Sensors (CCS) document is still valid.

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CCS803 Ultra-low power gas sensor for Ethanol detection

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 heating element to heat the MOX based sensing material. The MOX sensing material can be heated up to 500°C to allow the electrical resistance of the MOX sensor to be monitored to detect the target gas. By exploiting the fast heater cycling times, temperature modulation techniques can be used to reduce the device power consumption and implement advanced gas sensing methods.

Software libraries containing proprietary algorithms and example Android application are available for alcohol breathalyser use case.

Product Overview

The CCS803 is an ultra-low power MOX gas sensor for monitoring Ethanol.

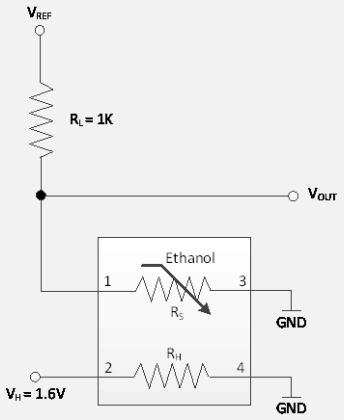
For CCS803 a supply voltage (V_H) is provided to the integrated micro-heater and the gas concentration can be correlated to the change in resistance of the MOX sensing layer (RS).

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 typically 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). The reference voltage (V_{REF}) must only be enabled during the sensor reading.

CCS803 is supported in a compact 2 mm x 3 mm DFN (Dual Flat No lead) package as standard.

Key Benefits

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



Recommended Sensor Configuration

Applications

- Detection of Ethanol
- Alcohol breathalyser in consumer devices

Electrical characteristics

Parameters	Conditions	Min	Typ	Max	Units
Maximum target heater voltage (V_H) [1]				1.8	V
Recommended ambient operating temperature		-5		50	°C
Recommended ambient operating humidity	Non-Condensing	15		95	%RH
Storage temperature range		-40		125	°C
Recommended heater voltage (V_H)		1.4	1.6		V
Average power consumption (P_{AV}) [1.2]			10.2		mW
Heater resistance (R_H)	V_H = 1.6V	50	58	66	Ω
Load resistance (R_L)			1		kΩ
Sensor resistance in clean air (R_a)	V_H = 1.6V @ 50% RH	0.1	1.0	10	kΩ

Notes:

1. When V_H is produced by PWM of a V_{DD} voltage above 1.8V the duty cycle (%) must not exceed $1.8V^2$ / V_{DD}^2
2. Based on 30s heater on time which includes a 20s warm-up period and a 10s measurement window performed once in a 2min period for Alcohol breath analysis. Refer to application note CC-000614-AN for more details.

Sensor Performance

Gas type	Test condition	Typical Sensitivity Range [1,2]
Ethanol (C_2H_5OH)	Ra / R_{100ppm}	5 – 10

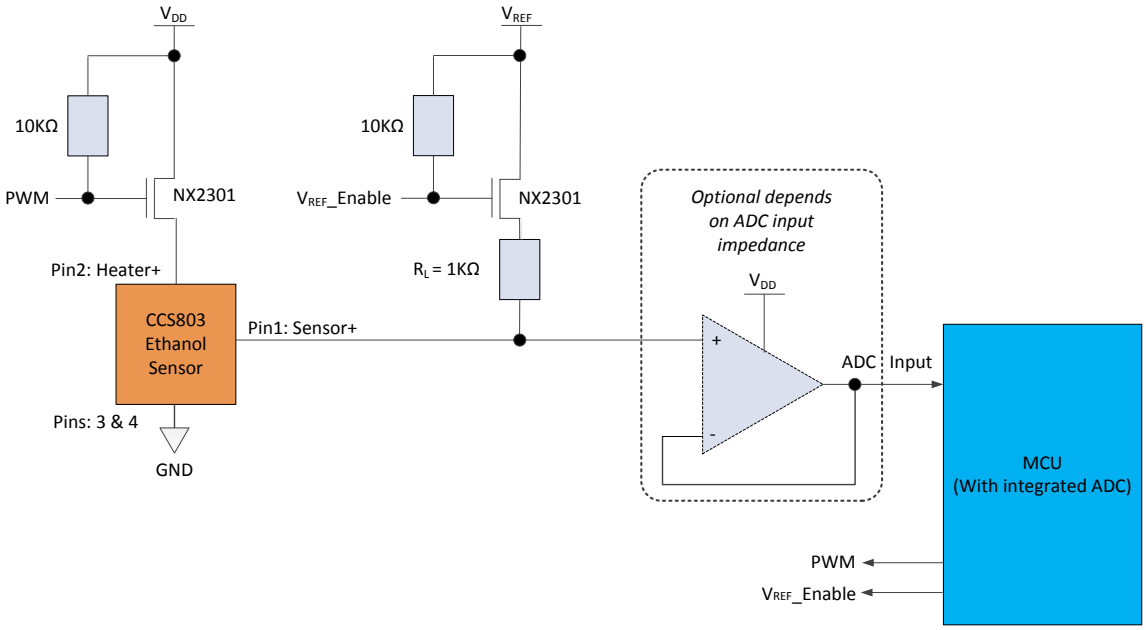
Notes:

1. Defined as the sensor's resistance in air (Ra) divided by the sensor's resistance at a specific gas concentration level at 50% relative humidity and 25°C ambient temperature.

2. Operating a new sensor in constant power mode at V_H in the first 24 hours is recommended to ensure sensor performance is stabilised.

Recommended Application Circuit

The recommended application circuit for CCS803 is shown below.



Notes:

1. The sensor can be operated in pulsed mode to reduce overall power consumption. In this case the Heater V_H is only driven for a fraction of the time at regular intervals under the control of the MCU.

2. An equivalent V_H can be produced more efficiently with a PWM than with a linear regulator if a PWM output from the MCU is available to drive an external MOSFET switch (p-channel). If not driven the MOSFET input should be pulled high.

3. The PWM must operate with a minimum frequency of 10 kHz. The following table illustrates PWM duty cycle requirements to enable V_H in the range 1.4 – 1.6V for CCS803, other duty cycles can be calculated using the equation V_H^2 / V_{DD}^2:

Target Heater Voltage (V_H)	Supply Voltage (V)				
	1.5V	1.8V	2.5V	3V	3.3V
1.40	87%	60%	31%	22%	18%
1.50	100%	69%	36%	25%	21%
1.60	-	79%	50%	28%	24%

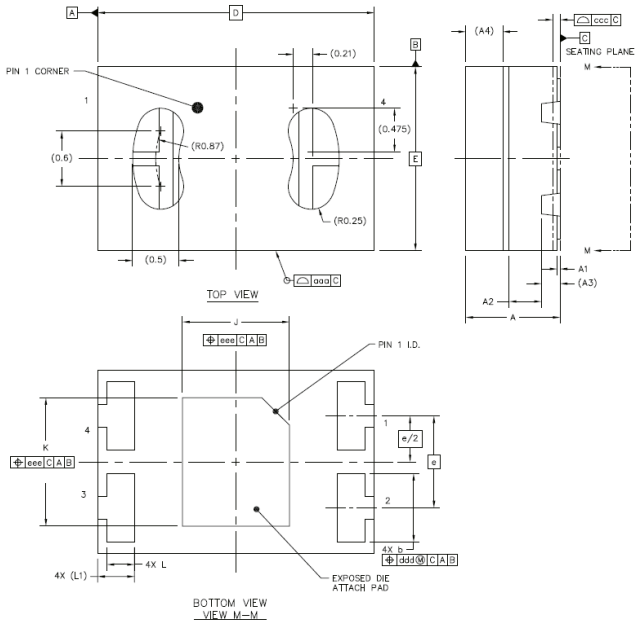
4. An ADC input is required on the MCU to measure the sensor resistance, the recommended ADC reference voltage (V_{REF}) depends on what voltage range the ADC supports. Control of the sensor bias (V_{REF}) [e.g. by using an external MOSFET switch (p-channel)] is required to power the sensor bias only when needed for the ADC measurements, ensuring that all reference voltages are stable for the measurement.

5. A minimum load resistor (R_L) value of 1kΩ is recommended.

Pin Assignment

Pin No	Name	Description
1	Sensor+	Sensor output (V_{OUT})
2	Heater+	Heater Input (V_H)
3	Sensor-	Connect to Ground or 0V
4	Heater-	Connect to Ground or 0V

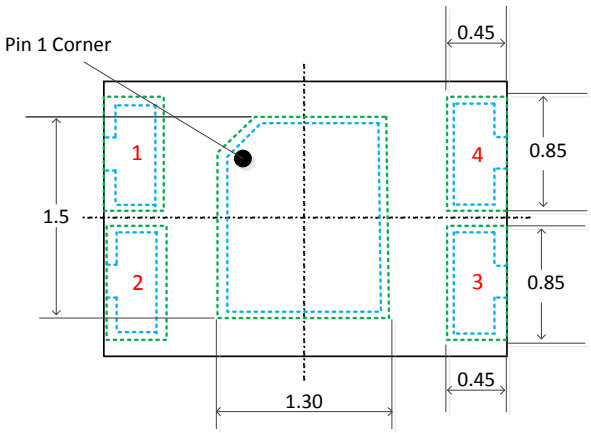
DFN package outline



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

The recommended package footprint or landing pattern for CCS803 is shown below:



Top View

Note:

1. All dimensions are in mm
2. PCB land pattern in Green dash lines
3. Pin numbers are in Red
4. Add 0.05mm all around the nominal lead width and length for the PCB land pattern

Ordering Information

Part Number	Description	Package	MOQ
CCS803A-COPR	CCS803 Ultra-low power gas sensor for ethanol detection	2x3mm DFN	5000
CCS803A-COPS	Sample of CCS803 Ultra-low power gas sensor for ethanol detection	2x3mm DFN	100

Notes:

1. Refer to JEDEC J-STD020 lead-free standard for typical soldering reflow profile
2. Refer to application note CC-000090-AN on device assembly guidelines
3. Refer to application note CC-000018-AN on CCS80x hardware design guidelines.

