User manual for CCS_EVK02 CCS800 evaluation kit

Evaluation kit for the CCS800 product family of ultra-low power gas sensors

Cambridge CMOS Sensors Technology Advantage

Our patented CMOS MEMS Micro-hotplates technology provides a unique silicon platform for our Metal Oxide (MOX) gas sensors and enables sensor miniaturisation, significantly lower power consumption and ultra-fast response times.

Our Micro-hotplates are located inside a high reliability silicon membrane and act as heating elements for a MOX based sensing material. The MOX resistance changes on reaction to the target gases and operates at a temperature of between 150°C to 400°C. Through enabling fast cycle times, advanced temperature modulation techniques can be used to ensure maximum sensitivity, stability and gas selectivity, and minimise measurement times.

Advanced algorithms support the MOX gas sensors family, for maximum sensitivity, selectivity, drift compensation, and for self-calibration; enabling easy and timely integration into a wide range of applications.

Product Overview

The CCS_EVK02 evaluation kit is designed to allow easy test and development with our CCS800 product family of ultra-low power MOX sensors for monitoring indoor air quality including Carbon Monoxide (CO) and a wide range of Volatile Organic Compounds (VOCs).

The evaluation kit includes the following:

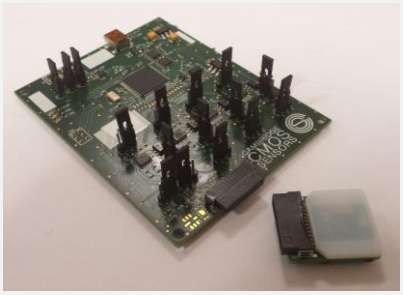
- Main processor board
- Sensor daughter board (fitted with CCS803 as standard)
- USB to mini-USB cable
- Windows based software for set-up, measurement and logging results (CCS_EV02)
- User guide

Software Interface

The CCS_EVK02 evaluation kit includes software to evaluate different modes of operation (DC or pulsed mode), and fully select different configuration options for driving and monitoring our CCS800 devices

Key Benefits

- Direct connection to PC via USB with simple software GUI for easy setup and data logging
- Develop low-level firmware and software algorithms for gas sensing specific to application
- Determine effects of temperature and humidity on the gas sensor
- Evaluate power consumption for different drive scenarios
- Perform gas air-flow analysis



CCS_EVK02 Evaluation kit
(Shown with optional plastics)

Applications

- Indoor air quality monitoring
- Carbon Monoxide or Toxic gas alarm
- Alcohol breathalyser

CCS_EVK02 software GUI

Email: sales@ccmoss.com Telephone: +44 1223 395 551 Date Issued: 09 Dec 2014

Hardware overview

The CCS_EVK02 evaluation kit is design to allow easy test and development with our CCS800 product family of ultra-low power gas sensors. The evaluation kit can be operated using a number of different interfaces and data can be collected from the main processor board through I^2C or USB to enable ease of integration in consumer applications such as smartphones, tablets and wearable devices.

This evaluation kit contains a main processor board, a sensor daughter board and a USB to mini-USB cable.

The sensitivity of CCS800 product family 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 PWM mode to reduce power consumption. The sensor resistance (R_s) is determined using a series load resistor (R_L) and an Analogue-to-Digital Converter (ADC).

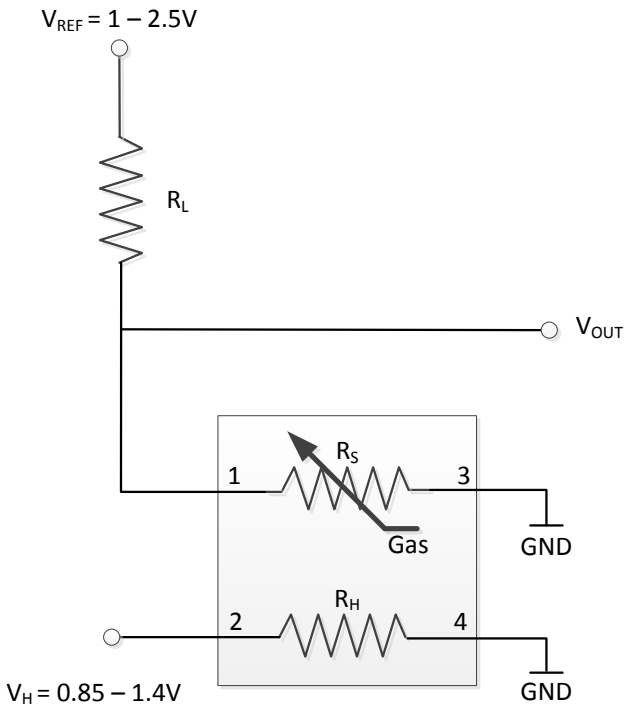


Figure 1: CCS801 sensor configuration

Main processor board

The main processor board as shown in figure 2 below allows control and measurement of the sensor daughter boards which can support different MOX gas sensors from CCS800 product family.

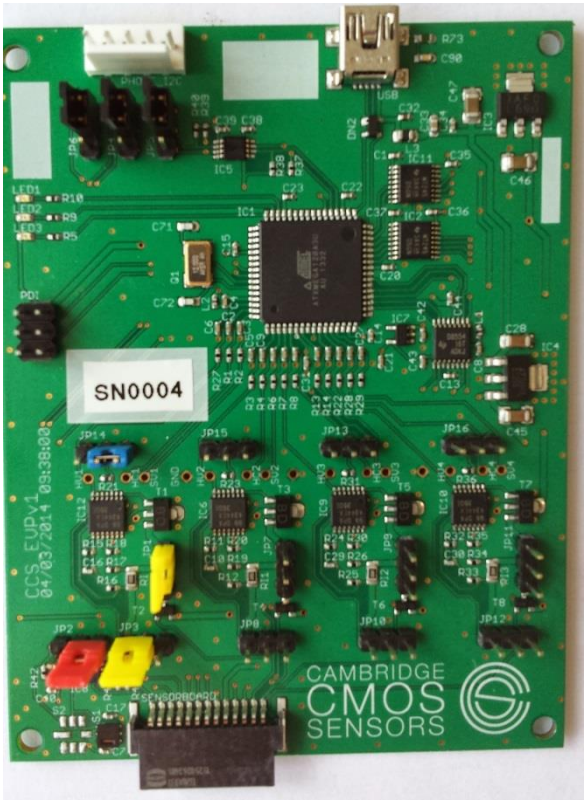


Figure 2: CCS_EVK02 main processor board

The MCU on the main processor board will be programmed to drive the supply voltage (V_H) of the integrated micro-heater and measure the change in resistance of the MOX sensing layer (R_s) of the CCS800 sensor on the sensor daughter board via an integrated ADC. A schematic and BOM for the main processor board is available in Appendix I.

Jumpers on the main processor board are colour coded and allow flexible operation as shown in table 1 below

Jumper	Function	Option 1 (Pins 1:2)	Option 2 (Pins 2:3)
JP1	Sensor 1 heater drive select	DC voltage	PWM
JP2	Sensor daughter board VRefs	DAC0 output	2.048V
JP3	Heater 1 voltage sense	Main processor board CS	Sensor daughter board heater
JP4	I2C clock select	Dev Kit I2C	Sensor daughter board I2C
JP5	I2C data select	Dev Kit I2C	Sensor daughter board I2C
JP6	Phone alarm select	Main processor board alarm	Sensor daughter board alarm
JP14	Heater 1 DC voltage select	EDAC1	DAC1

Note(s):

1. The main processor board has been designed to support multiple heater and sensor voltages for future dual and quad sensor devices on our roadmap.
2. JP7 – 13 and JP15 and JP16 are not required for the CCS801, CCS802 and CCS803 gas sensors

Table 1: Jumper setting for CCS_EVK02 main processor board

The following tables indicate the pin-out for the I2C connector and USB connector on the main processor board.

Pin	Function	Description
1	Alarm	Alarm from MCU – Phone Wake Up
2	I2C Clock	I2C Clock, driven by phone master
3	I2C Data	I2C Data
4	1.8V	Phone Power
5	GND	Ground

Table 2: Pin-out for I2C connector on main processor board

Pin(s)	Function	Description
1	USB Power	USB Power
2	D-	USB Data +
3	D+	USB Data -
4, 5	GND	Ground
6	Screen	Cable Screen

Table 3: Pin-out for Mini-USB connector on main processor board

Sensor Daughter board

The sensor daughter board as shown in figure 3 will also support an EEPROM for storing configuration and calibration settings. There will also be the option to drive the heater with a DC voltage or control the heater power through PWM to the gate of an external MOSFET device. A schematic and BOM for the sensor daughter board is available in Appendix II.

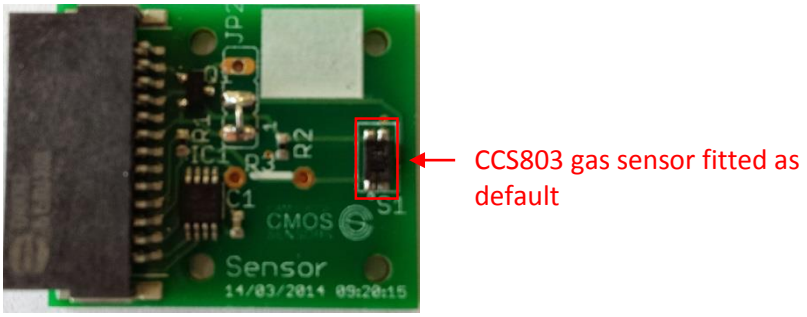


Figure 3: CCS_EVK02 sensor daughter board (no plastics)

Optional plastic cover with screws for the sensor daughter board is available on request.

Table 4 below indicates the pin-out for the Harting connector on the sensor daughter board.

Pin(s)	Function	Description
1	I2C SDA	I2C data line
2	I2C SCL	I2C clock line
3	EEPROM VDD	Supply voltage for EEPROM
4	ALARM	Alarm output for future use
5	VRef	Sense voltage
6, 8, 10,12, 14	GND	Ground
7	Sensor1	Sensor 1 analog Output
15	Heater 1 Power	Power connection to heater 1
19	Heater 1 ADC	Analog output to heater1 current sense
23	Heater 1 FET Gate	PWM - Ptype heater FET gate for sensor 1
8,9,10,11,12,13,14,16,17, 18,20,21,22,23,24,25,26	NC	Not connected[1]

Note:
1. The connector on the main processor board has been designed to support multiple heater and sensor voltages for future dual and quad sensor devices on our roadmap.

Table 4: Pin-out for connector on sensor daughter board

Software overview

The CCS_EVK02 evaluation kit includes a simple software GUI to fully evaluate functionality of our CCS800 gas sensors by enabling different configuration options for driving and monitoring our devices. The main features of this software are:

- Monitoring sensor resistance, sensor current, sensor voltage, Heater resistance, Heater voltage, Heater current, Heater power viewing and (long term) logging functions.
- Heater voltage cycle definition and programming

Installation

The CCS_EVK02 software is delivered as a setup program. Please install the software by running the setup program and following the directions in the setup program. You will need administrator rights to install the software.

Prerequisites

The CCS_EVK02 software will work under Windows XP or higher. After plugging in the CCS_EVK02 evaluation kit for the first time, Windows will identify the board and configure the drivers automatically.

Starting CCS_EV02 Software

Please connect the CCS_EVK02 evaluation kit to the computer before starting the software. The CCS_EVK02 software will automatically detect the CCS_EVK02 evaluation kit.

All settings in the software are automatically stored when closing the software. When starting the software the last settings are loaded.

> ***Important: In order to save any measurement data, the log file has to be activated before taking the measurements!***

The firmware on the CCS_EVK02 evaluation kit has to match the software. The software will upgrade the firmware on the CCS_EVK02 evaluation kit if it detects an older version of the firmware on the CCS_EVK02 evaluation kit.

Using CCS_EVK02 Software

The main software window is divided in three tabs as follows

The Measurement tab

The measurement tab as shown in figures 4.1 and 4.2 consists of a graph area and allows users to select several use case mode including:

- Carbon monoxide alarm
- Alcohol Breathalyzer
- Sensor refresh and factory test

These modes contain default value for heater voltage pulse setting and the measurement rate.

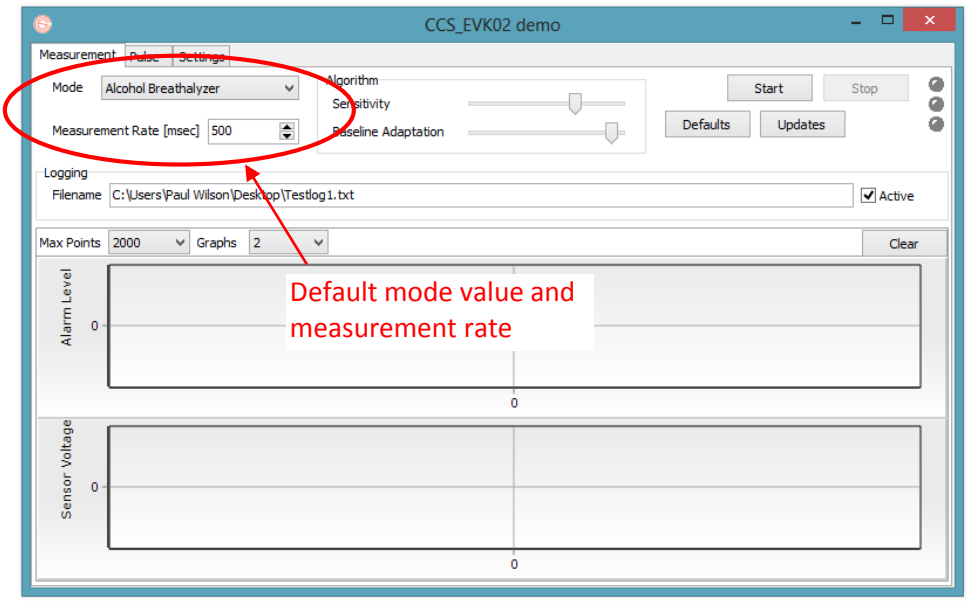
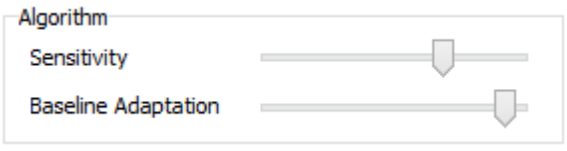


Figure 4.1: CCS_EVK02 software GUI measurement tab

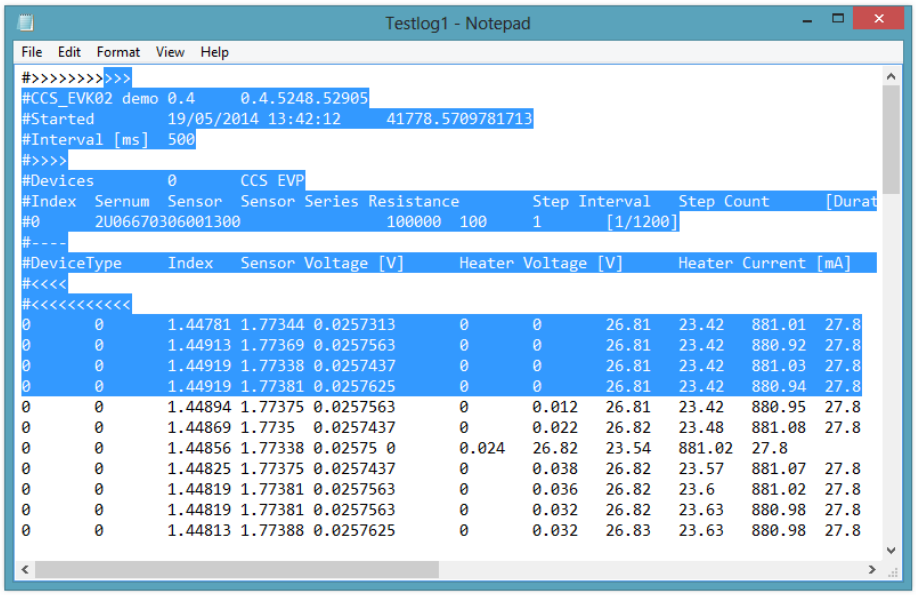
Algorithm parameters for changing sensitivity and baseline adaption levels can also be adjusted by the user as shown below:



Each mode has different settings for these parameters.

Test data can be logged in a user defined txt file and location per below:

Example of test log is shown below:



Pressing the start button will start a measurement. Pressing the stop button will stop a measurement.

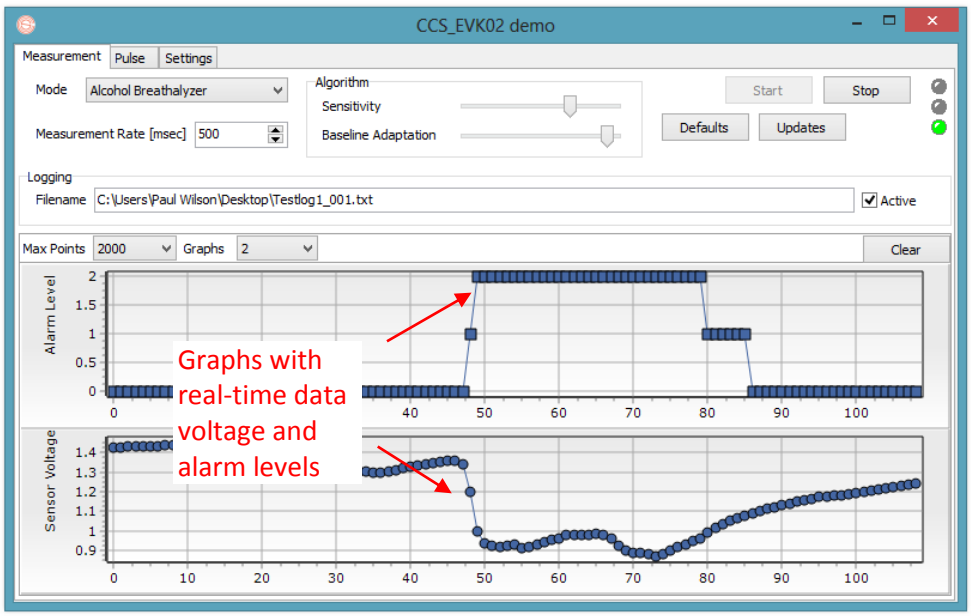


Figure 4.2: CCS_EVK02 software GUI measurement tab

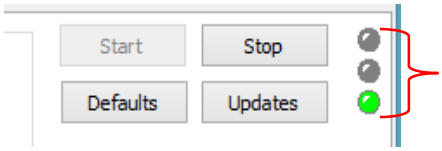
Graphs can be zoomed by dragging a box into the desired area. Double clicking or dragging a box from lower

right to upper left will undo the zoom. Holding the right mouse button allows to shift a zoomed graph. The Max Points parameter controls the number of measurements shown in the graphs.

To reset timing parameters and sensitivity / baseline adaptation their default settings, press the defaults button.

Pressing the updates button brings up a dialog which checks for new updates of the software.

The traffic light in the top right corner indicates a relative alarm level. If green this indicates a low concentration level for target gas and vice versa for red.



Traffic light indicating relative alarm / concentration of target gas

The pulse tab

The pulse tab as shown in figure 5 defines how the heater voltage is set-up and cycled. Each step has a set duration (Step Interval), the duration of every heater step is set in number of step interval units, and the total number of cycle intervals is defined in count. For each cycle interval, the duration and the heater voltage can be set. The graph in the top right, below shows a summary of a programmed heater voltage waveform.

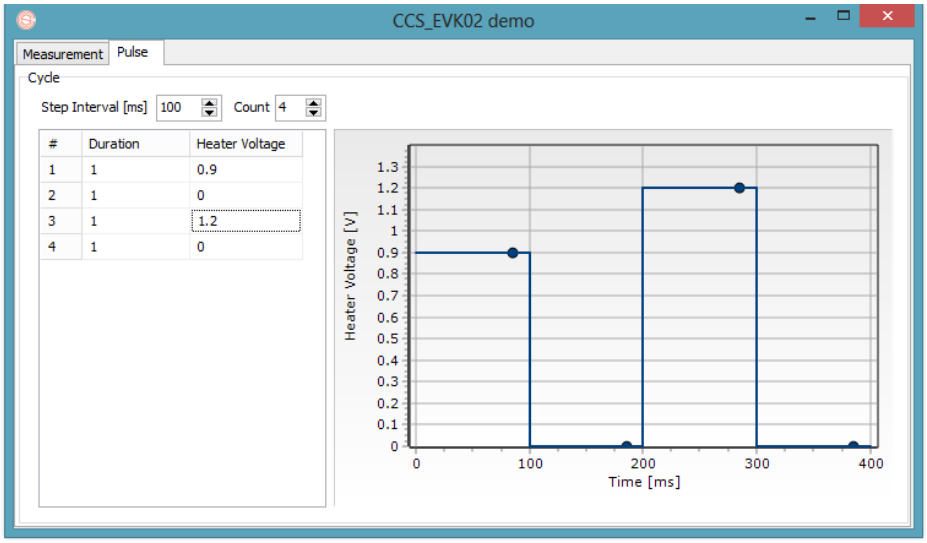


Figure 5: CCS_EVK02 software GUI pulse tab

Attention: Do not set heater voltages in excess of 2.5V as this will damage the sensor!

The Settings tab

The Settings tab as shown in figure 6 defines what additional sensors are active during measurements including a separate temperature & humidity sensor and a pressure sensor.

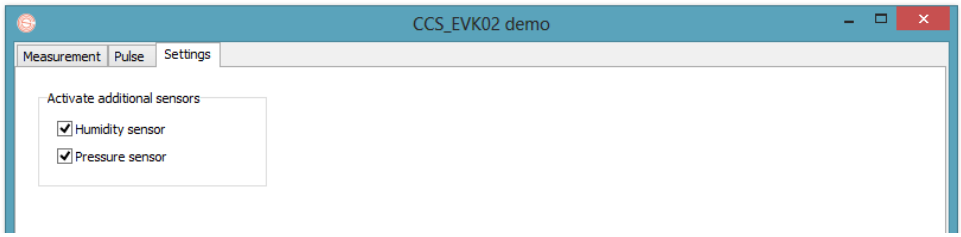


Figure 6: CCS_EVK02 software GUI settings tab

Technical Specification

The technical specification for the CCS_EVK02 evaluation kit is shown in table 5 below:

Operating Condition	
Supply voltage	5V, 400mA, DC. – Directly PC USB interface
Power consumption	<1W
Ambient temperature	0°C to 40°C
Ambient humidity	0 to 95% RH non condensing
Interface	
Digital interface	USB 2.0 and I2C
Devices supported	CCS801, CCS802 and CCS803
Software requirements	CCS_EVK02 (requires Windows XP SP3 or later)
Physical	
Main processor board dimensions	77mm by 100mm
Sensor daughter board dimensions	23mm by 27mm
Weight	122g

Table 5: CCS_EVK02 technical specification

Ordering Information

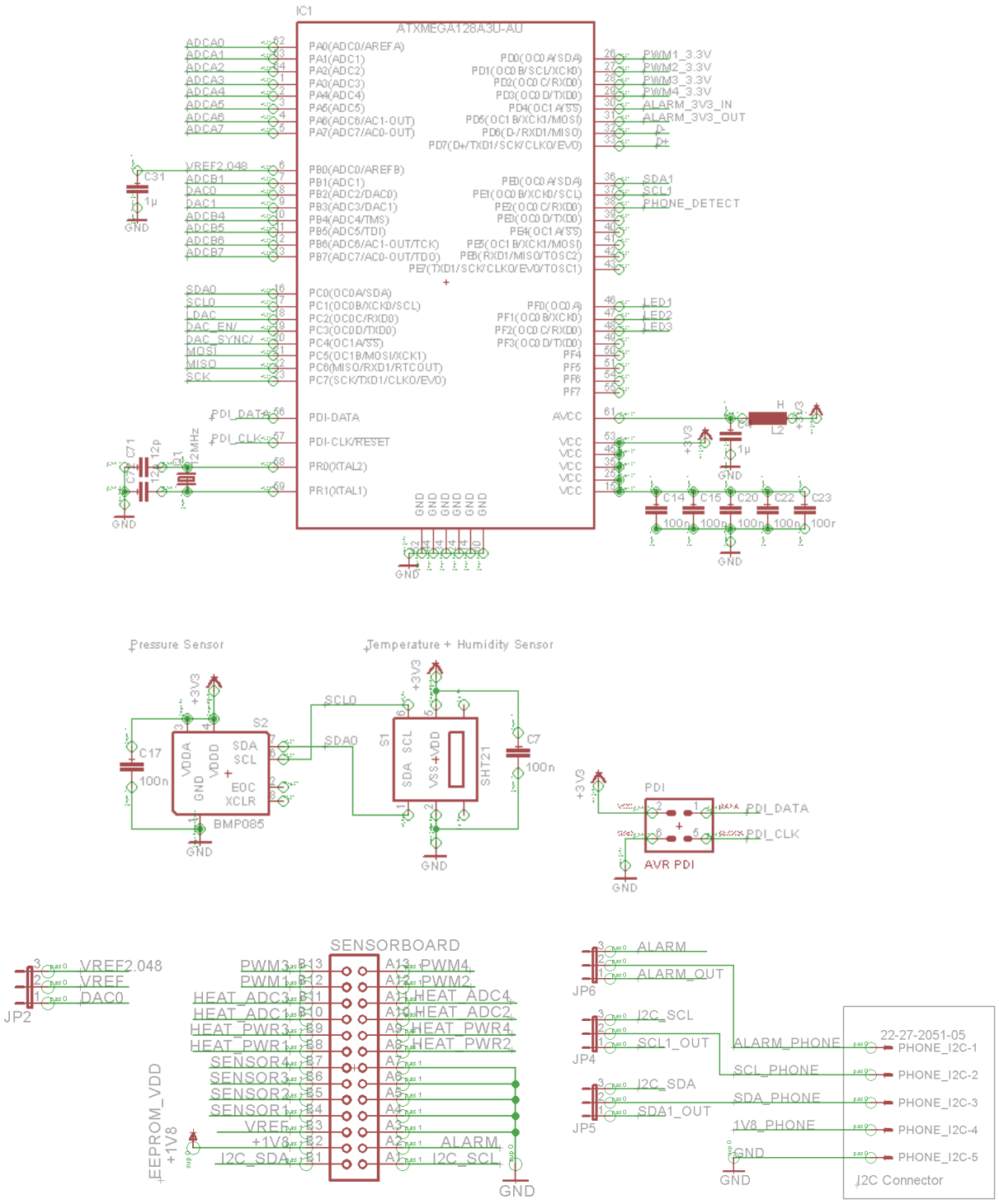
Additional CCS800 sensor daughter boards are available to order as follows:

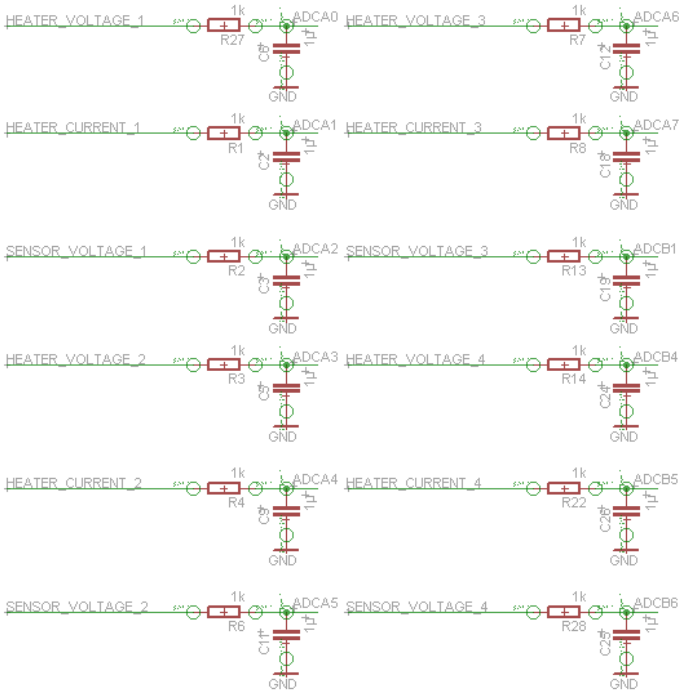
Product Description	Target Gases	Part Number
CCS801 daughter board	VOCs, CO and Ethanol	CCS_EVK02_801SB
CCS802 daughter board	CO	CCS_EVK02_802SB
CCS803 daughter board	Ethanol	CCS_EVK02_803SB

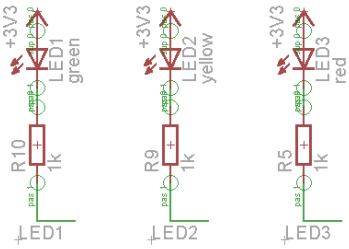
Table 6: Ordering Information

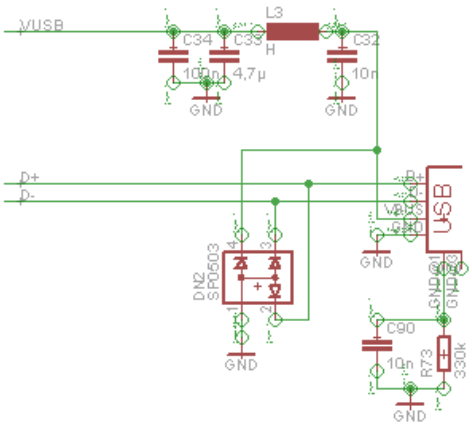
Appendix I – Main processor board schematics and BOM

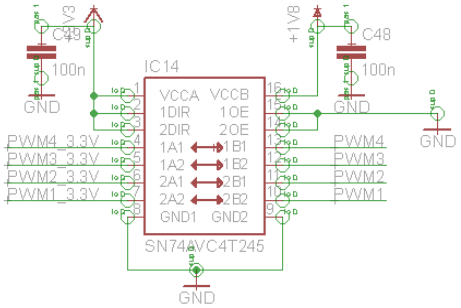
Schematics and BOM for the main processor board are shown figure 7 and table 7 below:

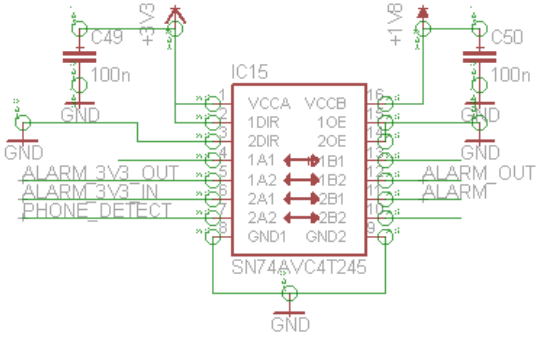


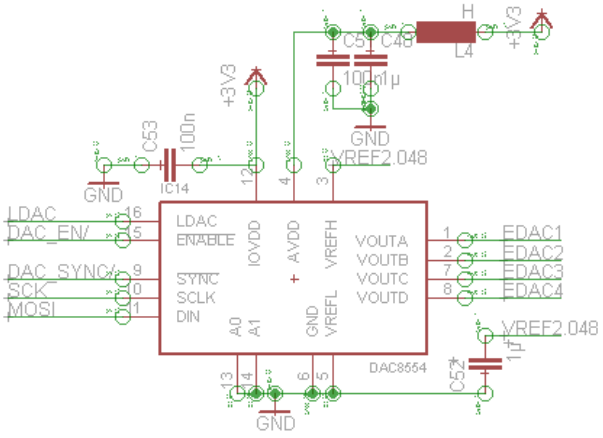


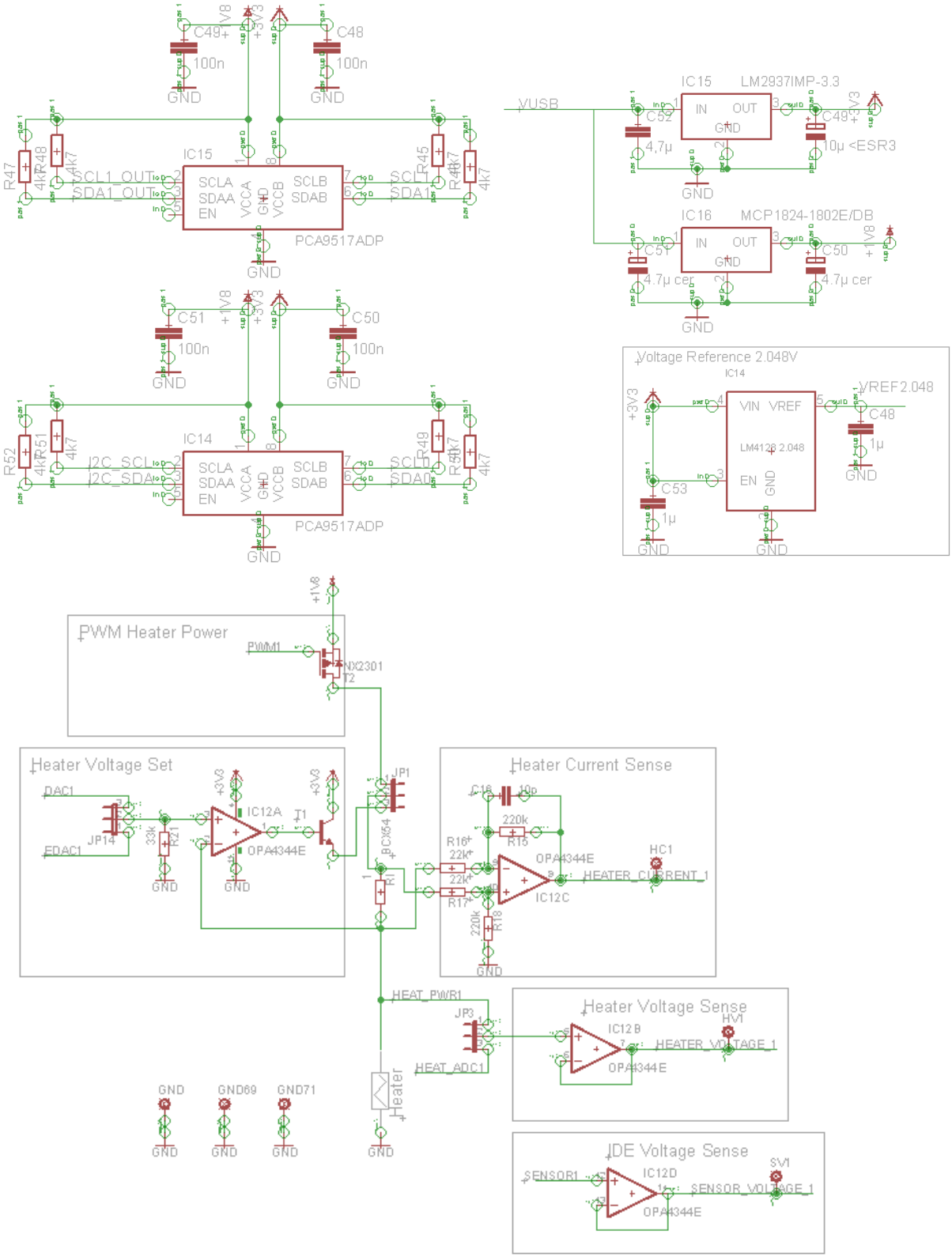












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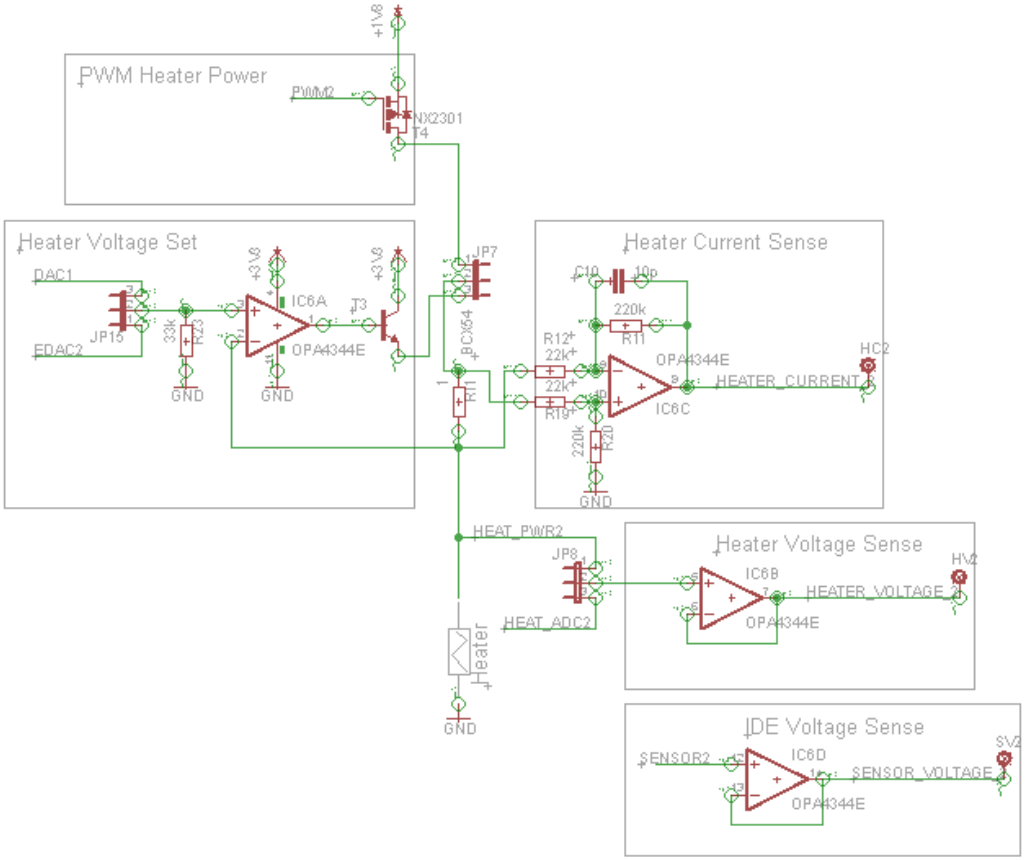

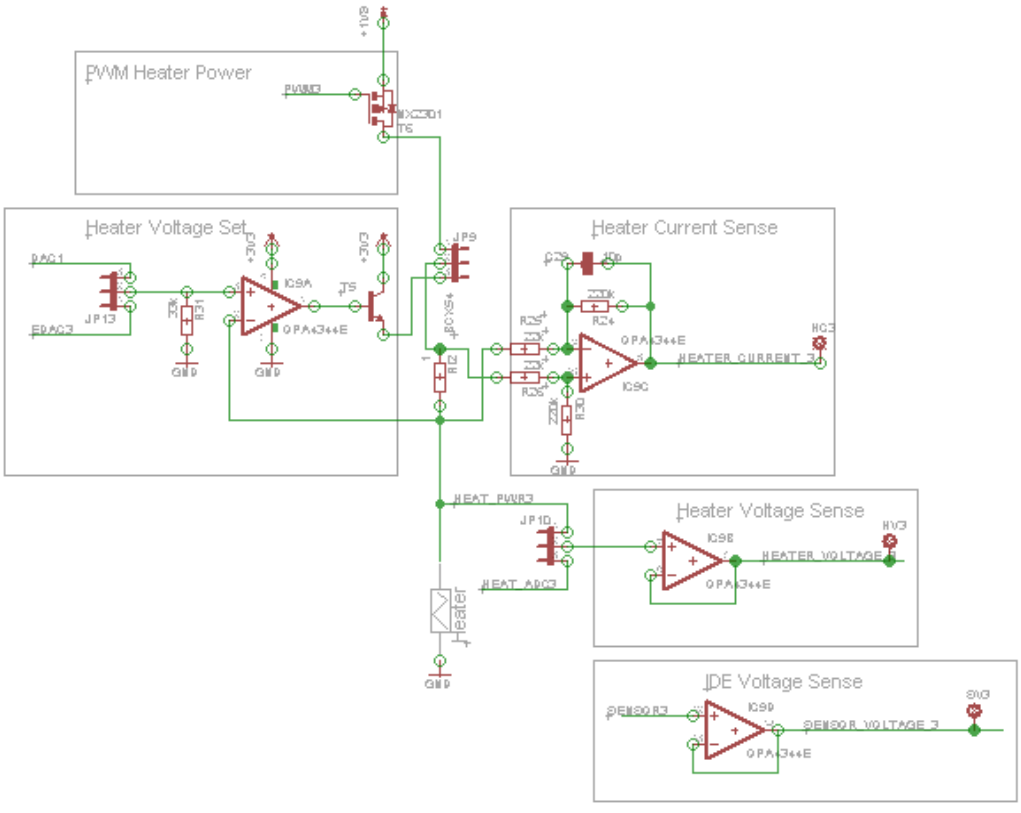

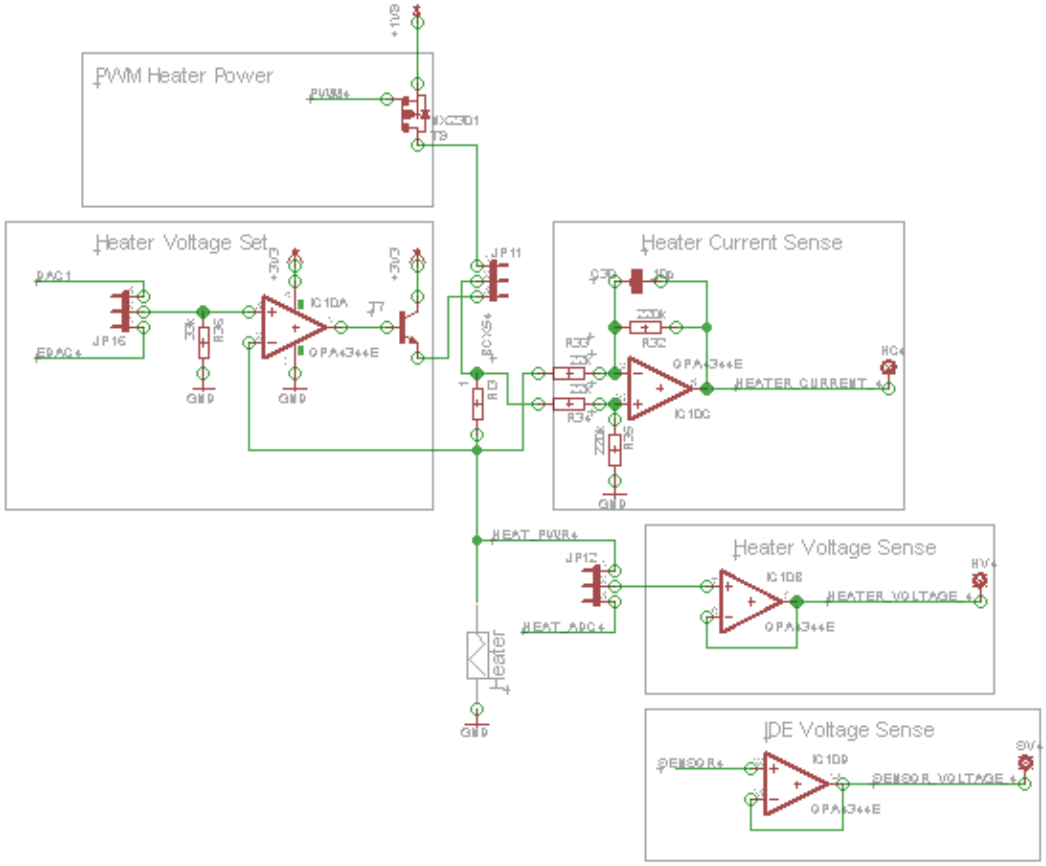

Figure 7: Schematic(s) for main processor board

Ref	Manufacturer	Part number	Description
SENSORBOARD	Harting	15 25 026 2601 000	Sensor board connector
JP1 – JP16	WURTH ELEKTRONIK	61300311121	Various coloured jumpers
RI, RI1, RI2, RI3	BOURNS	CR0805-FX-1R00ELF	1Ω Resistor in 0805 package
C1,C7,C13,C14,C15,C17,C20,C22, C23,C32,C33, C34, C35, C36, C37, C38,C39, C40, C41,C44	MULTICOMP	MC0402X104K100CT	100nF Capacitor in 0402 package
C90	MULTICOMP	MC0603B103K160CT	10nF Capacitor in 0603 package
C10, C16, C29, C30	MULTICOMP	MCCA000091	10pF Capacitor in 0402 package
Q1	AKER	C6S-12.000-12-3030-X	CRYSTALCTS406 12 MHz Crystal
C71, C72	MULTICOMP	MC0402N120J500CT	12pF Capacitor
R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R13, R14,R22, R27, R28, R29	WELWYN	ASC0402-1K0FT10	1K Resistor in 0402 package
C2,C3,C4,C5,C6,C8,C9, C11,C12,C18,C19,C21,C24, C25,C26,C27,C31,C42,C43	MULTICOMP	MCCA000506	1uF Capacitor in 0402 package
PHONE_I2C	MOLEX	22-27-2051	Connector for phone I2C
R11, R15, R18, R20, R24, R30, R32, R35	MULTICOMP	MCMR04X2203FTL	220k Resistor in 0402 package
R12, R16, R17, R19, R25, R26, R33, R34	VISHAY DRALORIC	CRCW040222K0FKEAHP	22k Resistor in 0402 package
R73	KOA	SG73S1JTTD3303F	330k Resistor in 0603 package
R21, R23, R31, R36	YAGEO (PHYCOMP)	RC0402JR-0733KL	33k Resistor in 0402 package
C45, C28	MULTICOMP	MCCA000563	4,7uF Capacitor in 1206 package
C46, C47		MCCA000603	10uF Capacitor in 1206 package
R37 – R44		MCMR04X4701FTL	4k7 Resistor in 0402 package
IC1	Atmel	ATXMEGA128A3U	Processor in a TQFP64 package
T1, T3, T5, T7	MULTICOMP	BCX54	NPN Transistor in SOT-89 package
IC13	TEXAS INSTRUMENTS	DAC8554IPWG4	DAC IC
L1, L2	WURTH ELEKTRONIK	742843122	500mA and 0.38 Ohm
L3	TDK	MLP2012S4R7MT	4.7uH Inductor
IC3	TEXAS INSTRUMENTS	LM2937IMP-3.3	3.3V LDO
IC7		LM4128BMF-2.5/NOPB	Voltage Reference IC
IC4	LINEAR TECHNOLOGY	LT1129CST-5#PBF	Adjustable LDO
T2, T4, T6, T8	NXP	NX2301P	P Type Mosfet
IC6, IC9, IC10, IC12	TEXAS INSTRUMENTS	OPA4344EA/250	Op Amp
IC5, IC8	NXP	PCA9517ADP	I2C bus repeater
S1	SENSIRION	SHT21	Temperature and Humidity Sensor
IC2, IC11	TEXAS INSTRUMENTS	SN74AVC4T245PW	Voltage Level Shifter
DN2	LITTELFUSE	SP0503BAHTG	USB protection diodes
USB	FCI	10033526-N3212MLF	Mini USB Connector
LED1	WURTH ELEKTRONIK	150060GS75000	Green LED in a 0603 package
LED3		150060RS75000	Red LED in a 0603 package
LED2		150060YS75000	Yellow LED in a 0603 package

Table 7: Bill-of-Materials (BOM) for sensor daughter board

Appendix II – Sensor daughter board schematics and BOM

A schematic and BOM for the sensor daughter board is shown figure 8 and table 7 below:

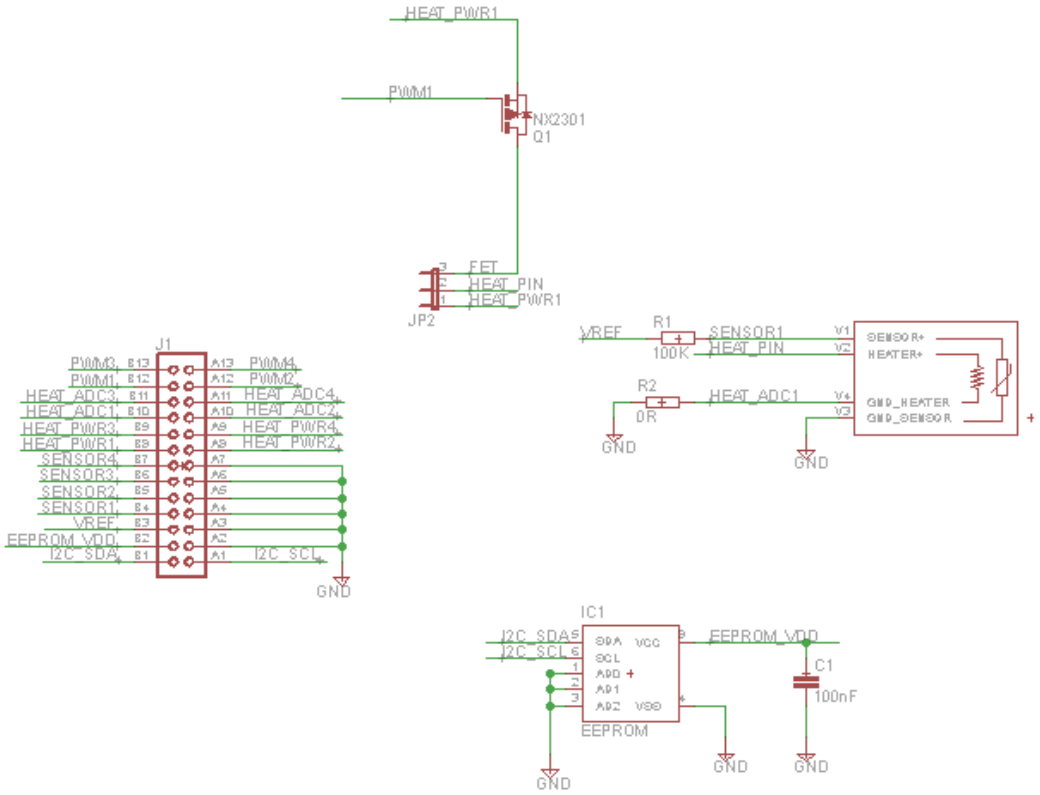

Figure 8: Schematic for CCS801 sensor daughter board

Ref	Manufacturer	Part number	Description
J1	HARTING	15 15 026 2601 000	Male surface mount connector
IC1	MICROCHIP	24AA02-I/MS	EEPROM with I2C address 1010000
Q1	NXP	NX2301	P Type Mosfet in SOT23 package
R1	MULTICOMP	MCMR04X1003FTL	100KΩ Resistor in 0402 package
R2	MULTICOMP	MCMR04X000 PTL	0Ω Resistor in 0402 package
S1	CCS	CCS801	Ultra-low power multi gas sensor
C1	MULTICOMP	MC0402X104K100CT	100nF capacitor in 0402 package
JP1	WURTH ELEKTRONIK	61300311121	Jumper to select between DC and FET heater drive

Table 8: Bill-of-Materials (BOM) for sensor daughter board