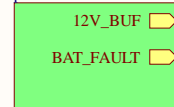
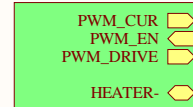


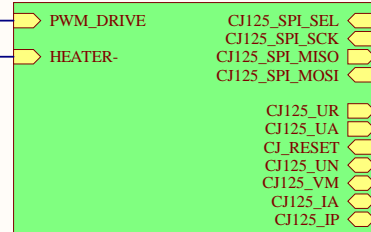
U_power
power.SchDoc



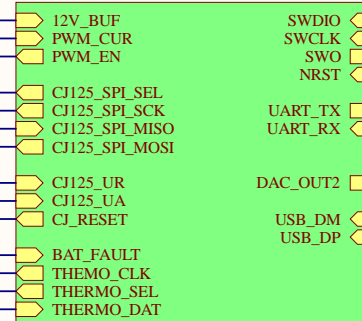
U_heater
heater.SchDoc



U_cj125
sensor.schDoc



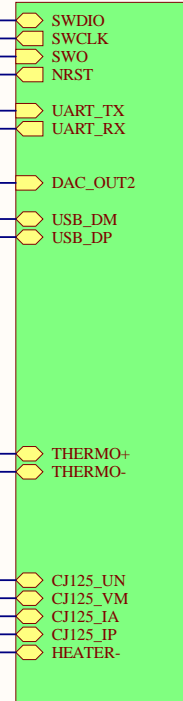
U_microcontroller
microcontroller.SchDoc



U_thermocouple
thermocouple.SchDoc

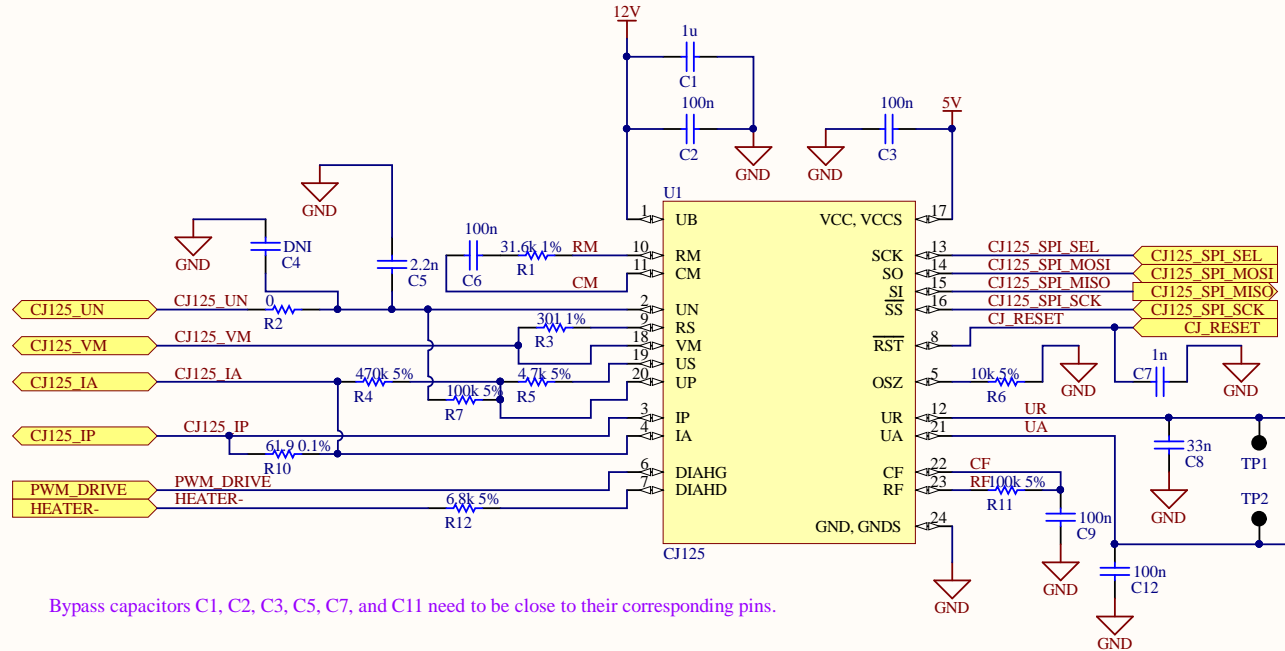


U_breakout
breakout.SchDoc



Note:
All capacitors are rated for 50V unless otherwise noted.
All resistors are rated for 1/10W unless otherwise noted.

CJ125



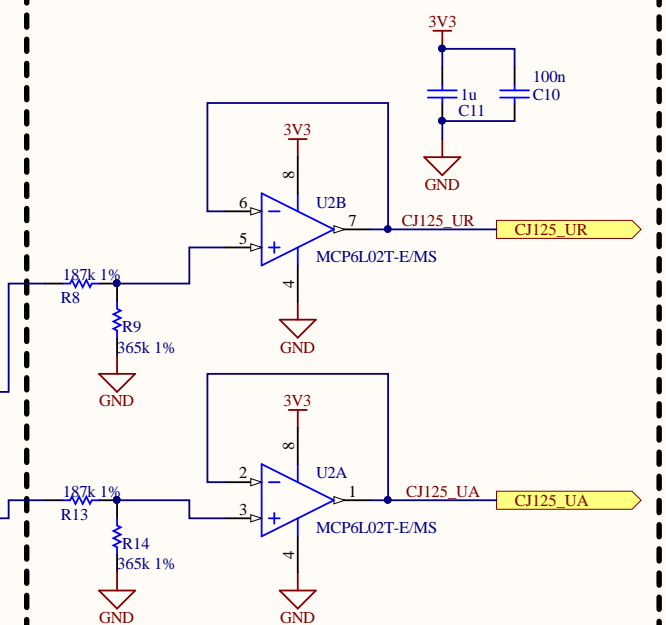
Bypass capacitors C1, C2, C3, C5, C7, and C11 need to be close to their corresponding pins.

Guard ring connected to the UA pin and enclosing the CF pin and C9 is recommended to prevent interference with the the RC filter connected to CF and RF. A guard ring is traditionally used to protect high impedance nodes in a circuit from surface leakage currents. The guard ring is a ring of copper driven by a low-impedance source to the same voltage as the high impedance node. The guard ring prevents current from the GND,GNDS pin from flowing to the filter pins. The guard ring won't drive current to the filter because they are at a very similar voltage potential.

- The 10k Ohm R6 sets the internal oscillator to 192kHz.
- The 31.6k Ohm R1 sets the current for Ri measurement to $\pm 79\mu\text{A}$.
- The 100nF C6 acts as a DC filter for the Ri measurement current.
- The 301 Ohm R3 is the calibration value for the optimal nernst resistance.
- The 61.9 Ohm R10 is a current sense resistor for measuring lambda.
- The 6.8k Ohm R12 sets the current input to DIAHD.
- The 470k Ohm R4 compensates parasitic effects of the lambda sensor.
- The 100k Ohm R7 is used for leakage detection. When the sensor is cold, the R7 makes the voltages at pins UN and UP equal.
- The 4.7k Ohm R5 is used to feed the nernst cell reference voltage into the pump current control circuit.

- The 100k Ohm R11 and 100nF C9 create a RC lowpass filter with a cutoff frequency of 15.915Hz to filter out the switching currents in the lambda measurement.
- The 100nF C12 adds additional filtering fo the lambda measurement. The UA pin has an output resistance of 100 Ohms creating a RC filter with a cutoff of 15.915kHz.
- The 33nF C8 filters the resistance measurement. UR has an output resistance of 15k Ohm creating a RC filter with a cutoff of 321.5Hz.

Analog Buffer



100nF capacitor need to be within 2mm the VDD pin
1uF capacitor need to be within 100mm the VDD pin

The 187k Ohm and 365k Ohm create a resistor divider that scales by $365/(187+365) = 0.66123$.

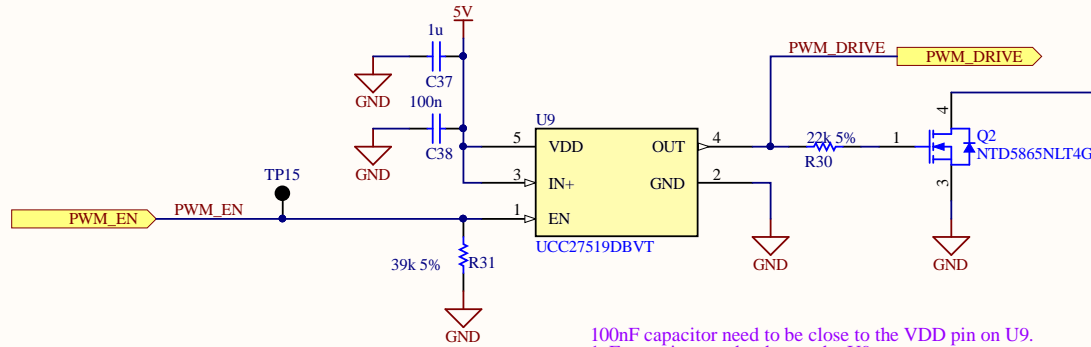
The maximum expected input of 5V scales down to 3.306V to be read by the microcontroller ADC.

The MCP6L02 acts as a unity gain buffer to provide the ADCs with low impedance inputs.

The MCP6L02 has 1MHz bandwidth, rail-to-rail input and output swing, 1.8V to 6.0V supply operation, and consuming 85uA per amplifier.

Title: Sensor Controller			
Project: Lambda Oxygen Sensor Interface			
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MOSFET Drive



100nF capacitor need to be close to the VDD pin on U9.
1uF capacitor need to be nearby U9.

UCC27519DBVT has an internal 200kOhm pull-up.

If PWM_EN input is floating the EN voltage will be $VDD * 39k\Omega / (39k\Omega + 200k\Omega)$.

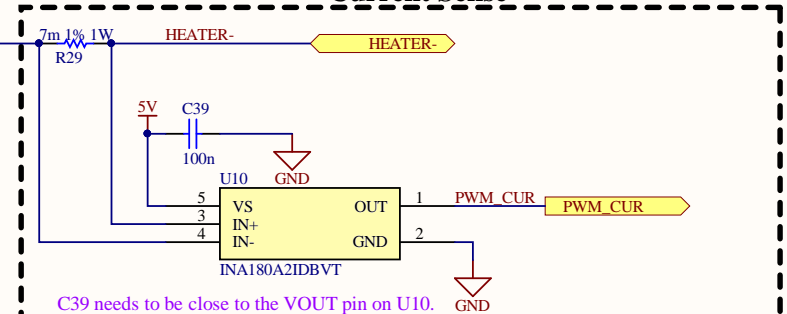
If VDD is 5V, EN will see 815.9mV. The enable is high when EN is at least 1V.

R30 limits the current driving the MOSFET to prevent spikes when switching.

UCC27519 has a propagation delay of 17ns and requires a VDD of at least 4.5V.

NTD5865NLT4G has a 60V drain-source voltage, 20V gate-source voltage, drain current of 46A, gate threshold of 2V, and on resistance of 16mOhms.

Current Sense



C39 needs to be close to the VOUT pin on U10.

Current Sense Output = Battery Voltage / (Heater Resistance + 7mOhm + 16mOhm) * 7mOhm * 50V/V

For the maximum battery voltage of 16.2V and minimum heater resistance of 1.8Ohms, the current sense output is 3.110V

The 5V supply is used for VS because it is easier to route then the 3V3. The microcontroller ADC is 5V tolerant.

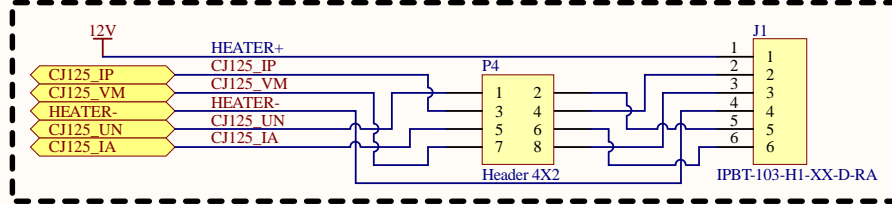
INA180A2 has common-mode range of -0.2 V to +26 V. Operates with VDD of 2.7V to 5.5V. 210kHz bandwidth.

Title: Sensor Heater Control

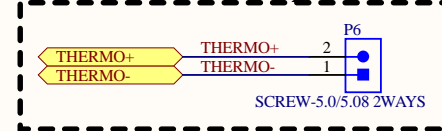
Project: Lambda Oxygen Sensor Interface

Date: 12/18/2018 Time: 11:26:27 AM Sheet 5 of 7 File: heater.SchDoc

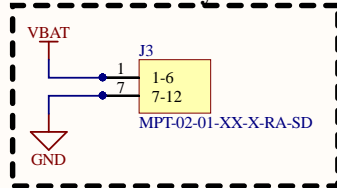
Sensor



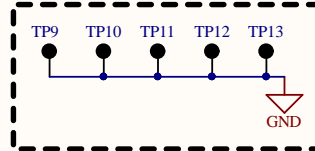
Thermocouple



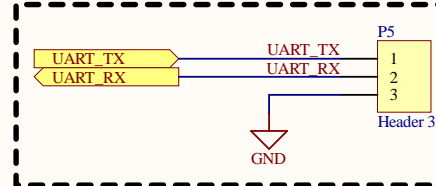
Battery



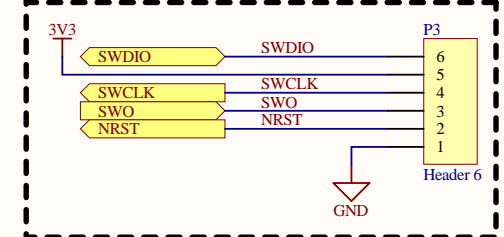
Ground Test Points



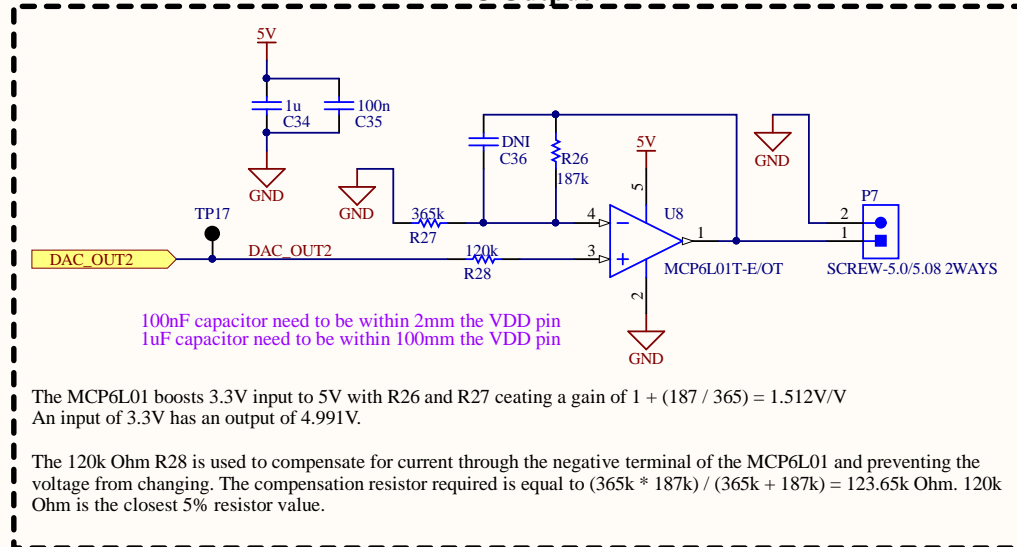
UART



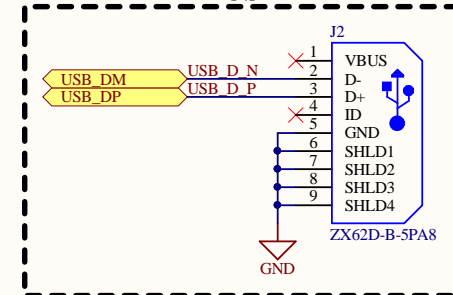
SWD



DAC Output



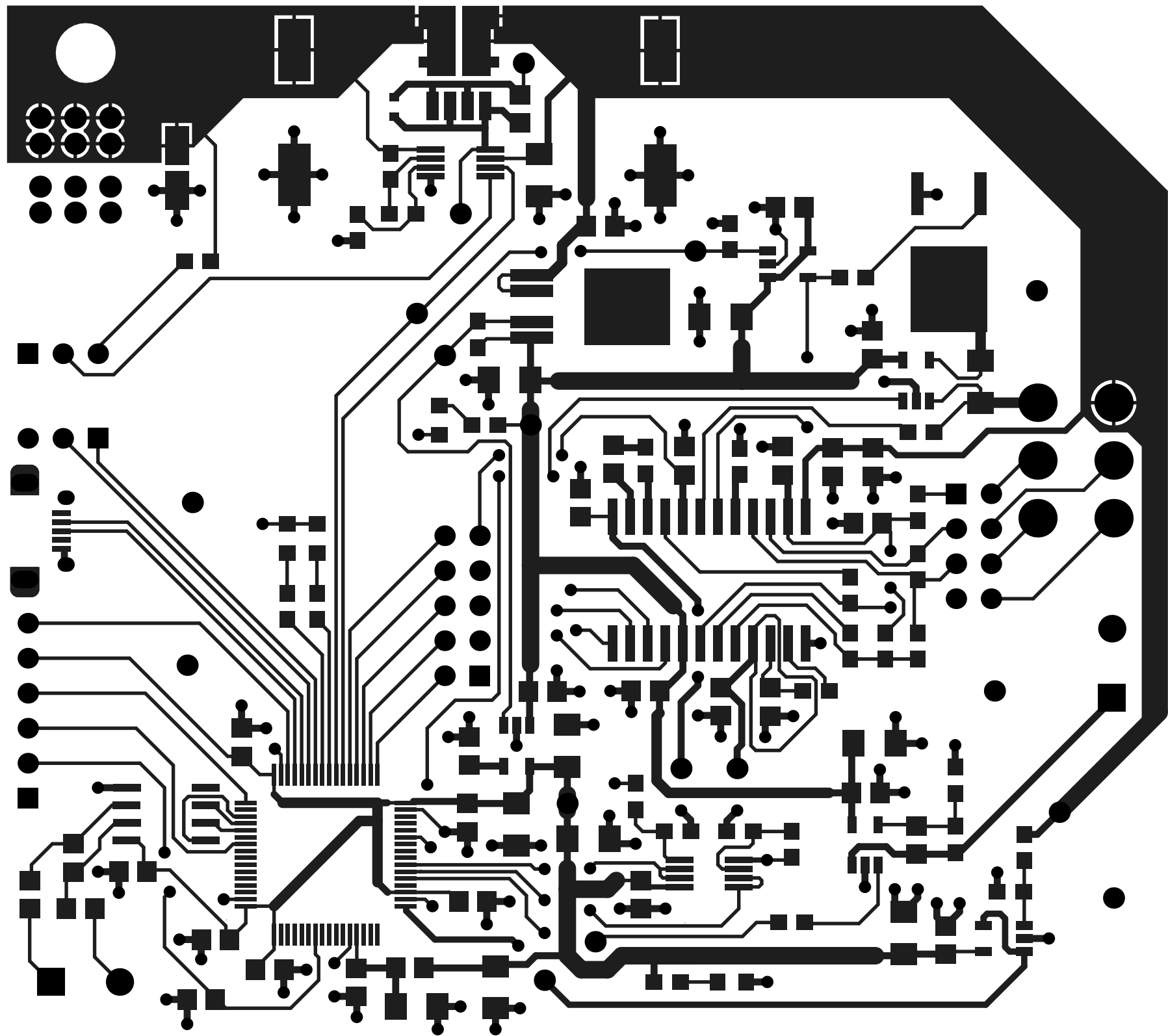
USB

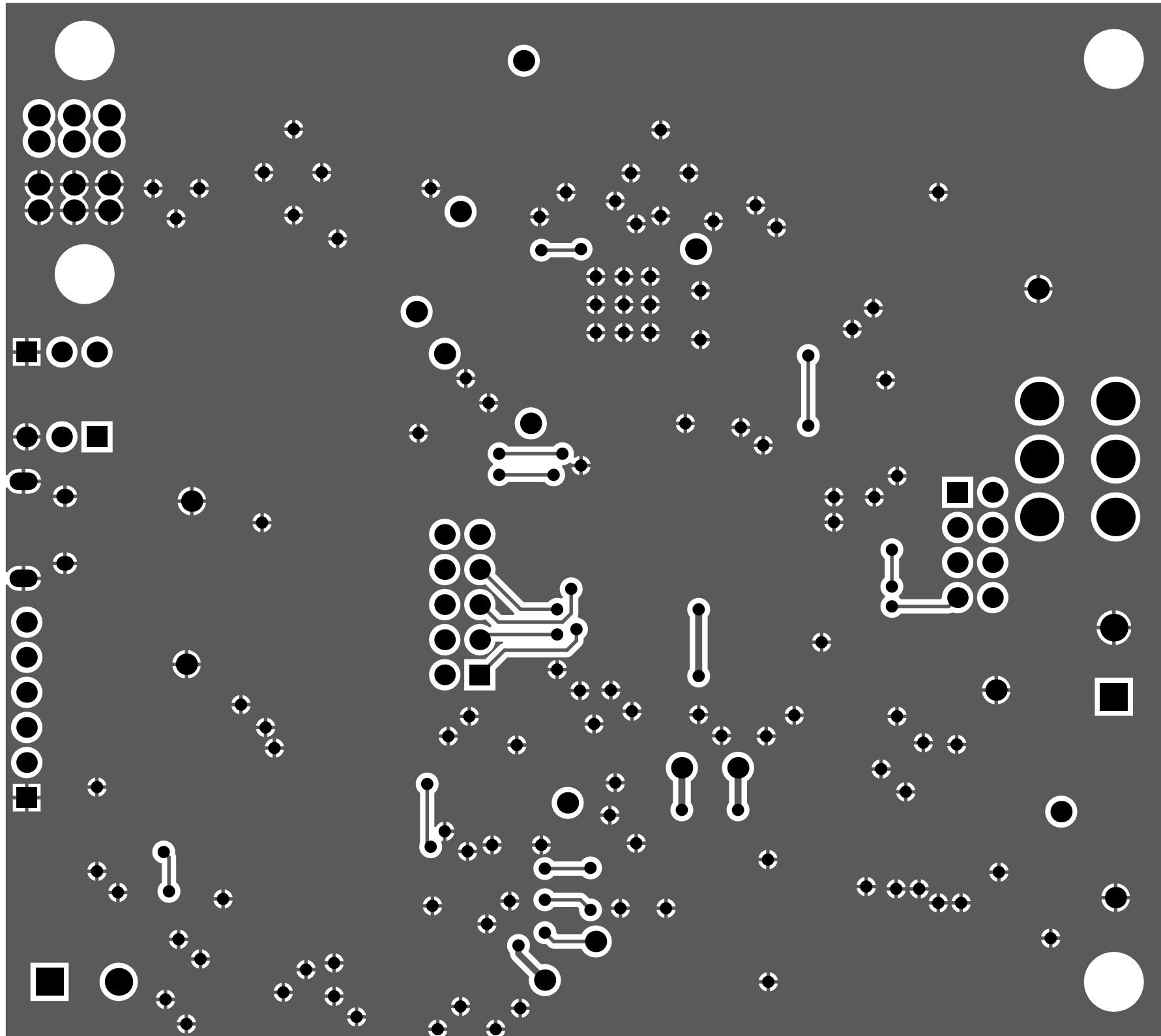


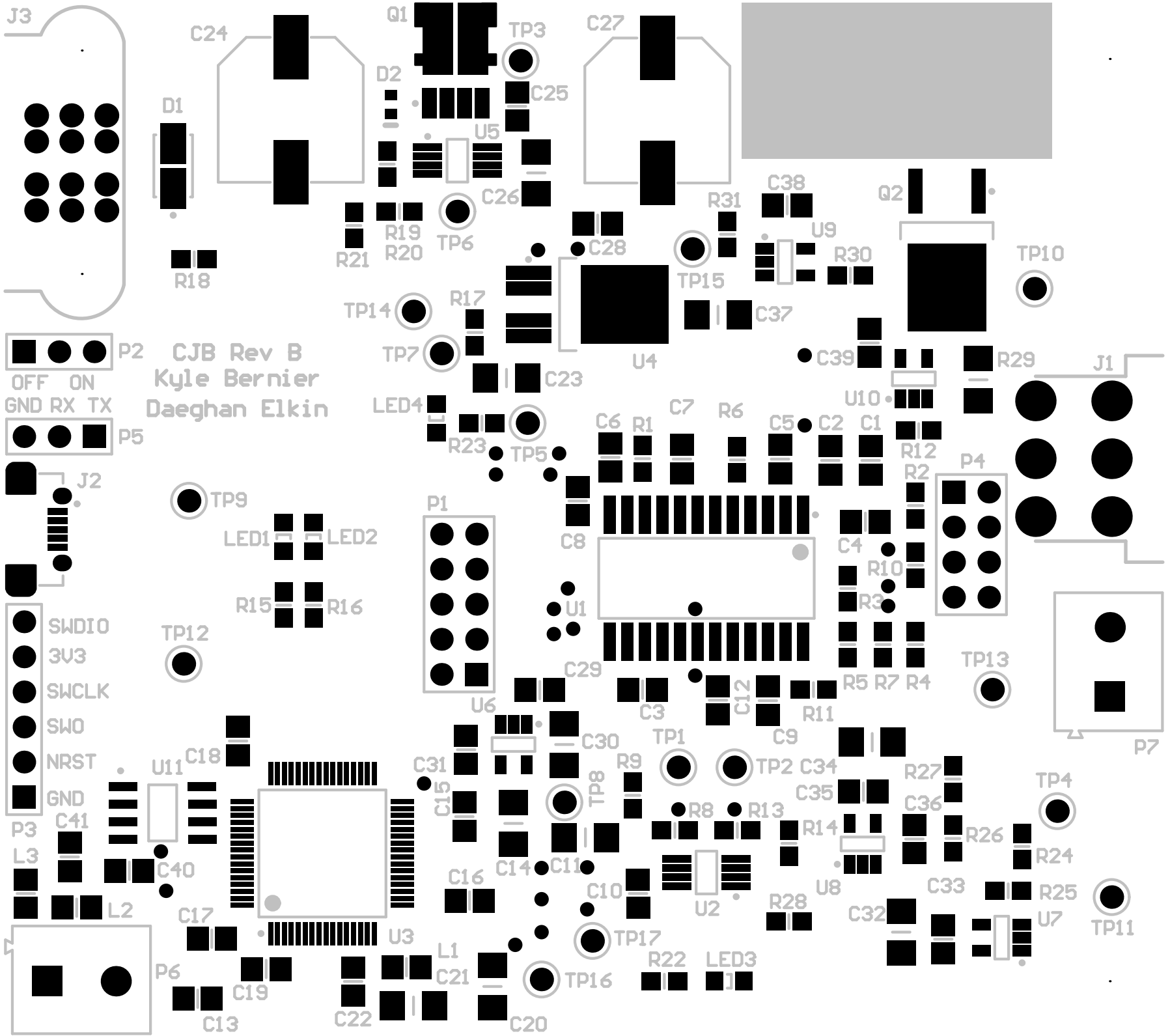
Title: Pin Breakout

Project: Lambda Oxygen Sensor Interface

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CJB Rev B
Kyle Bernier
Daeghan Elkin

P2
OFF ON
GND RX TX
P5

SWDIO
3V3
SWCLK
SWO
NRST
GND
P3
L3
L2

P6

