

Coffee Bean Roaster

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Project Overview and Name ~1 min

- Our project aims for implementing a functional precision temperature control for equipment like a Coffee Bean Roaster, by recycling simple popcorn maker with built in heater, fan, and AC power distribution.
- The project will dive into recreating thermocouple module, AC or DC heat fan dimmer/control board, wall plug AC/DC converter, additional app/GUI control on screen display.
- Major challenges would be precise feedback control of temperature in the chamber, additional serial peripheral interface bus may be required if multiple thermocouple is desired.
- ESP32, K-Type Thermocouple, 16x4 LCD
- Overall circuit designs (filter types, power regulator type, power source, microcontroller used, important sensors, actuators or ICs, data buses used)

BOM ~30 sec

Coffee Bean Roaster BOM

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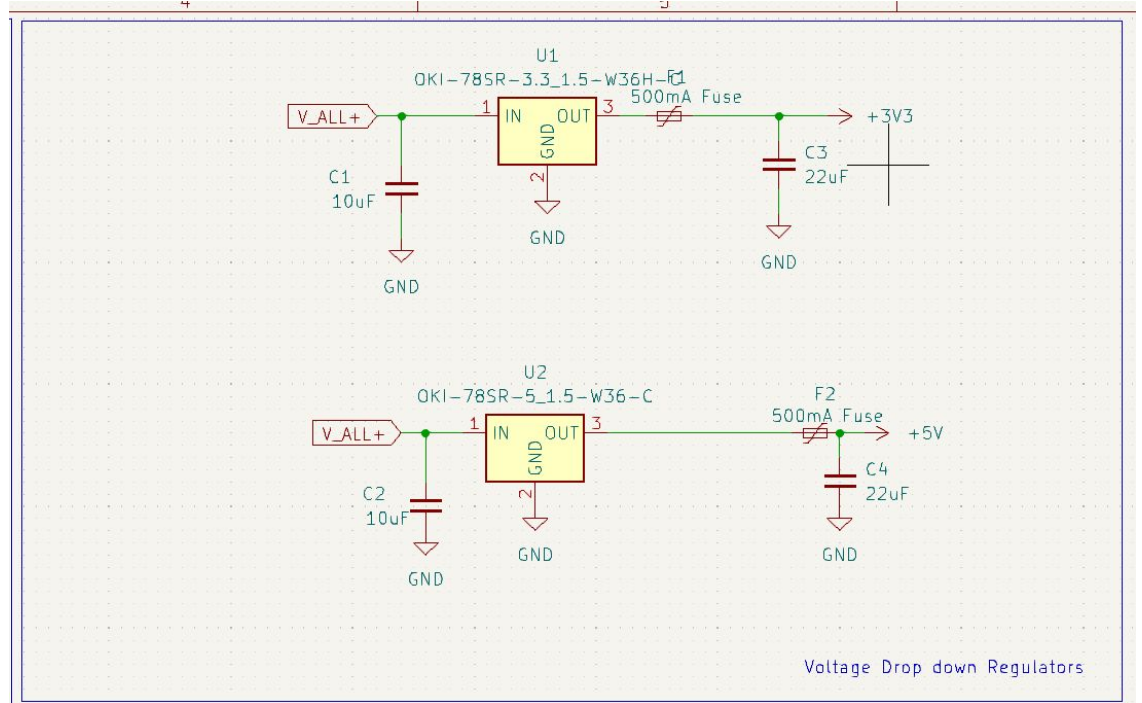
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Schematic ~2 min

Voltage drop down module:
DC-DC Converters

24V to 3.3V

24V to 5V

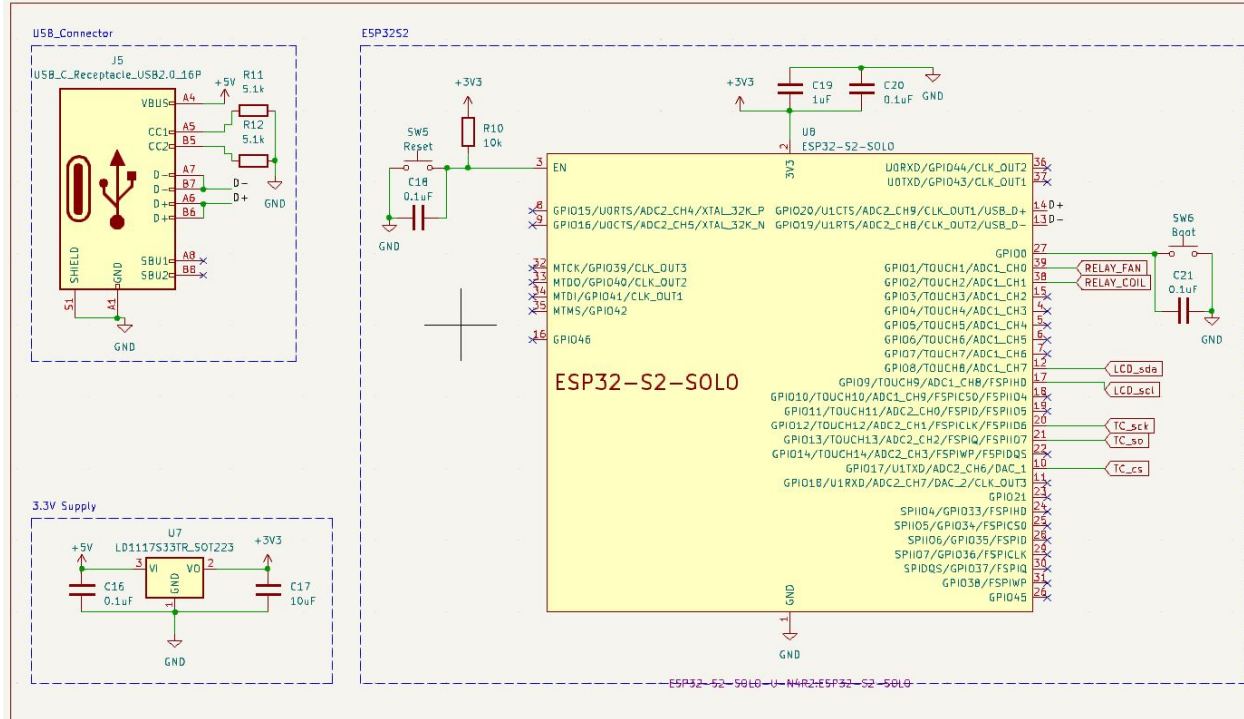


Schematic ~2 min

USB C receptacle

USB Voltage drop down:
-LDO linear Regulator

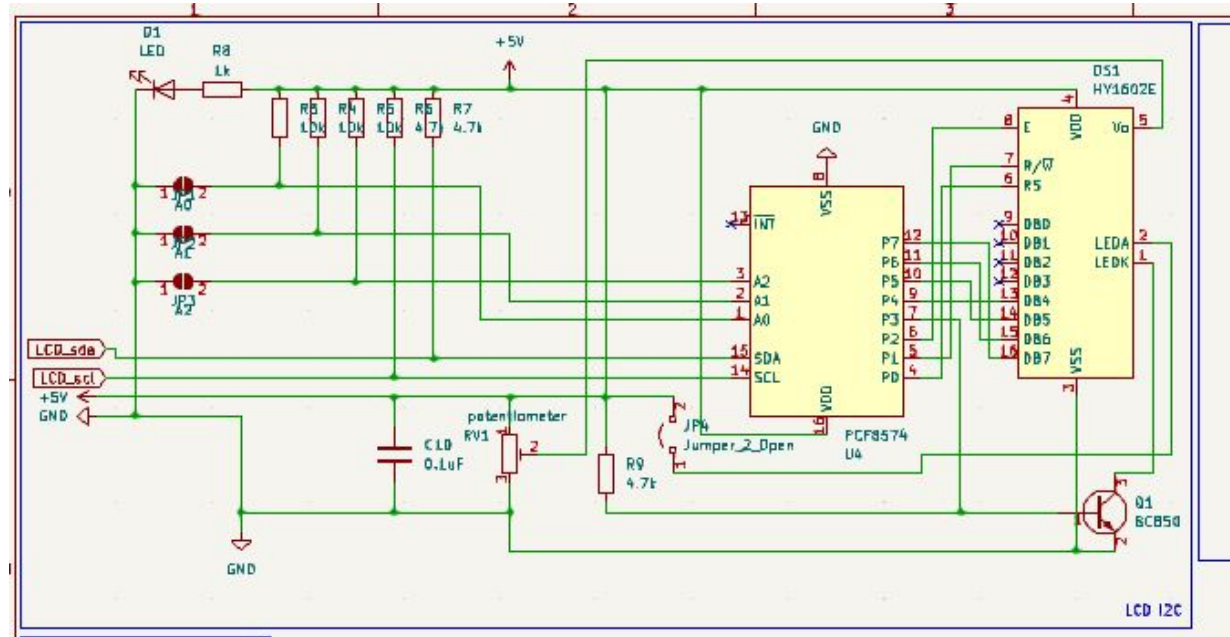
ESP32-S2-SOLO:
assigned GPIO:
-thermocouple: SO, SCK,CS
-LCD I2C: sda,scl
-Fan relay
-Heater relay
-Boot button
-Reset button



Schematic ~2 min

LCD I2C:

Generic 20x4 LCD display, replicate I2C board with IO expander



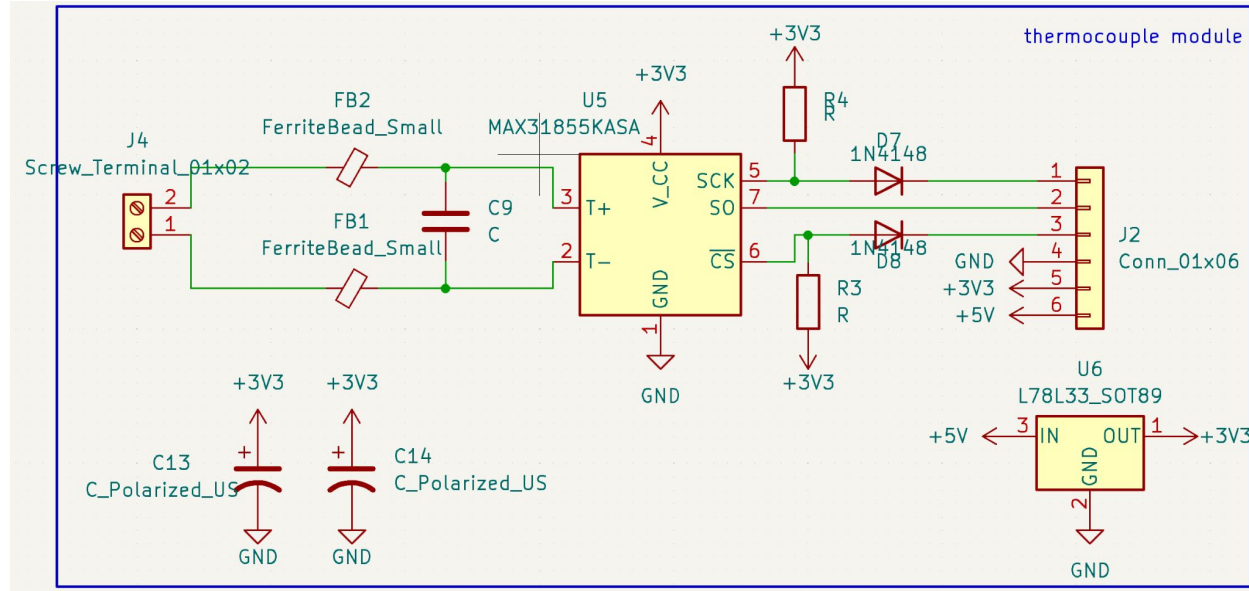
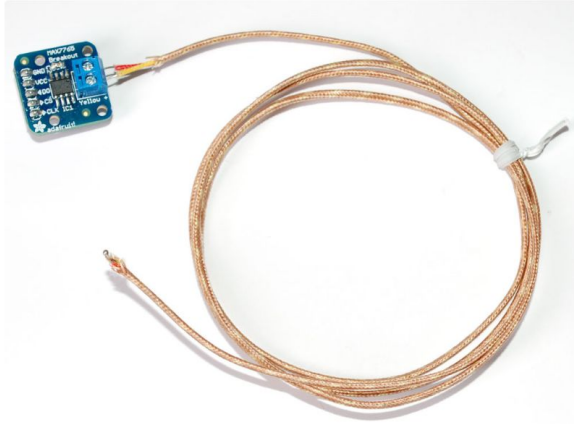
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Schematic ~2 min

Thermocouple module:

MAX31855 IC, screw terminal connected to k-type thermocouple

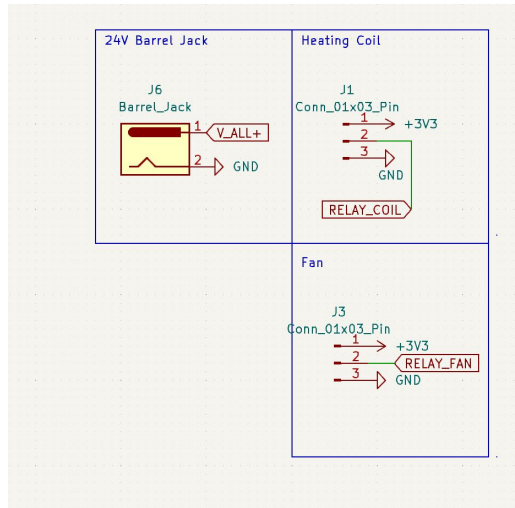


Schematic ~2 min

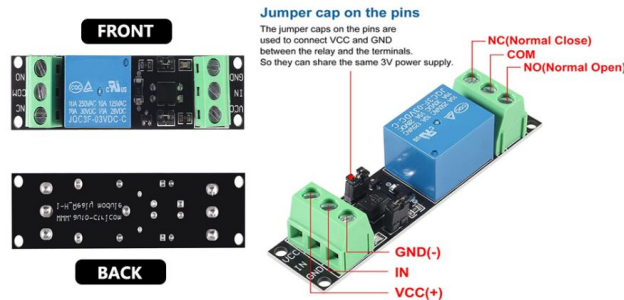
Additional COTS components not included in schematics:

-3V AC relays for Heater and Fan

-AC/DC converter Barrel Jack → Output 24V 1A, 100 ~ 240 VDC Input



1 Channel 3V/3.3V Power Relay Module



Power interface:

VCC: Connect to the positive pole of the power supply (5.3V)

GND: Connect to the negative pole of the power supply

IN: high level control relay pull-in

Load interface:

NO: Normally open interface of the relay, the relay is suspended before pull-in, and shorted to COM after pull-in

COM: Relay common interface

NC: Normally closed interface of the relay, the relay is short-circuited with COM before pull-in, and hangs up after pull-in



Trace Widths

24V 1A DC input:

32 mil trace width, 32 mil via inner diameter, 64 mil via outer diameter:

Calculator Tools

Parameters

Current (I):	1	A
Temperature rise (ΔT):	10.0	°C
Conductor length:	3965	mil
Copper resistivity:	1.72e-08	Ω·m

If you specify the maximum current, then the trace widths will be calculated to suit.

If you specify one of the trace widths, the maximum current it can handle will be calculated. The width for the other trace to also handle this current will then be calculated.

The controlling value is shown in bold.

The calculations are valid for currents up to 35 A (external) or 17.5 A (internal), temperature rises up to 100 °C, and widths of up to 400 mils (10 mm).

The formula, from IPC 2221, is

$$I = K \cdot \Delta T^{0.44} \cdot (W \cdot H)^{0.725}$$

where:

- I is maximum current in A
- ΔT is temperature rise above ambient in °C
- W is width in mils
- H is thickness (height) in mils

External Layer Traces

Trace width (W):	12.0325	mil
Trace thickness (H):	1	oz/ft²
Cross-section area:	16.296	mil²
Resistance:	0.164762	Ω
Voltage drop:	0.164762	V
Power loss:	0.164762	W

Internal Layer Traces

Trace width (W):	31.3019	mil
Trace thickness (H):	1	oz/ft²
Cross-section area:	42.3931	mil²
Resistance:	0.0633349	Ω
Voltage drop:	0.0633349	V
Power loss:	0.0633349	W

Reset to Defaults

Trace Widths

3.3V and 5V (VUSB) nets, 500mA max:

12.5 mil trace width, 25 mil via inner diameter, 12.5 mil via outer diameter:

+3V3 net

5V net

Calculator Tools

- General system design
 - Regulators
 - Power, current and isolation
 - Electrical Spacing
 - Via Size
 - Track Width
 - Fusing Current
 - Cable Size
 - High speed
 - Wavelength
 - RF Attenuators
 - Transmission Lines
 - Memo
 - E-Series
 - Color Code
 - Board Classes
 - Galvanic Corrosion

Parameters

Current (I): 0.5 A

Temperature rise (ΔT): 10.0 °C

Conductor length: 103059 mil

Copper resistivity: 1.72e-08 Ω·m

External Layer Traces

Trace width (W): 4.62533 mil

Trace thickness (H): 1 oz/ft²

Cross-section area: 6.26422 mil²

Resistance: 11.1407 Ω

Voltage drop: 5.57036 V

Power loss: 2.78518 W

Internal Layer Traces

Trace width (W): 12.0325 mil

Trace thickness (H): 1 oz/ft²

Cross-section area: 16.296 mil²

Resistance: 4.28252 Ω

Voltage drop: 2.14126 V

Power loss: 1.07063 W

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Calculator Tools

- General system design
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Parameters

Current (I): 0.5 A

Temperature rise (ΔT): 10.0 °C

Conductor length: 98719 mil

Copper resistivity: 1.72e-08 Ω·m

External Layer Traces

Trace width (W): 4.62533 mil

Trace thickness (H): 1 oz/ft²

Cross-section area: 6.26422 mil²

Resistance: 10.6716 Ω

Voltage drop: 5.33578 V

Power loss: 2.66789 W

Internal Layer Traces

Trace width (W): 12.0325 mil

Trace thickness (H): 1 oz/ft²

Cross-section area: 16.296 mil²

Resistance: 4.10218 Ω

Voltage drop: 2.05109 V

Power loss: 1.02554 W

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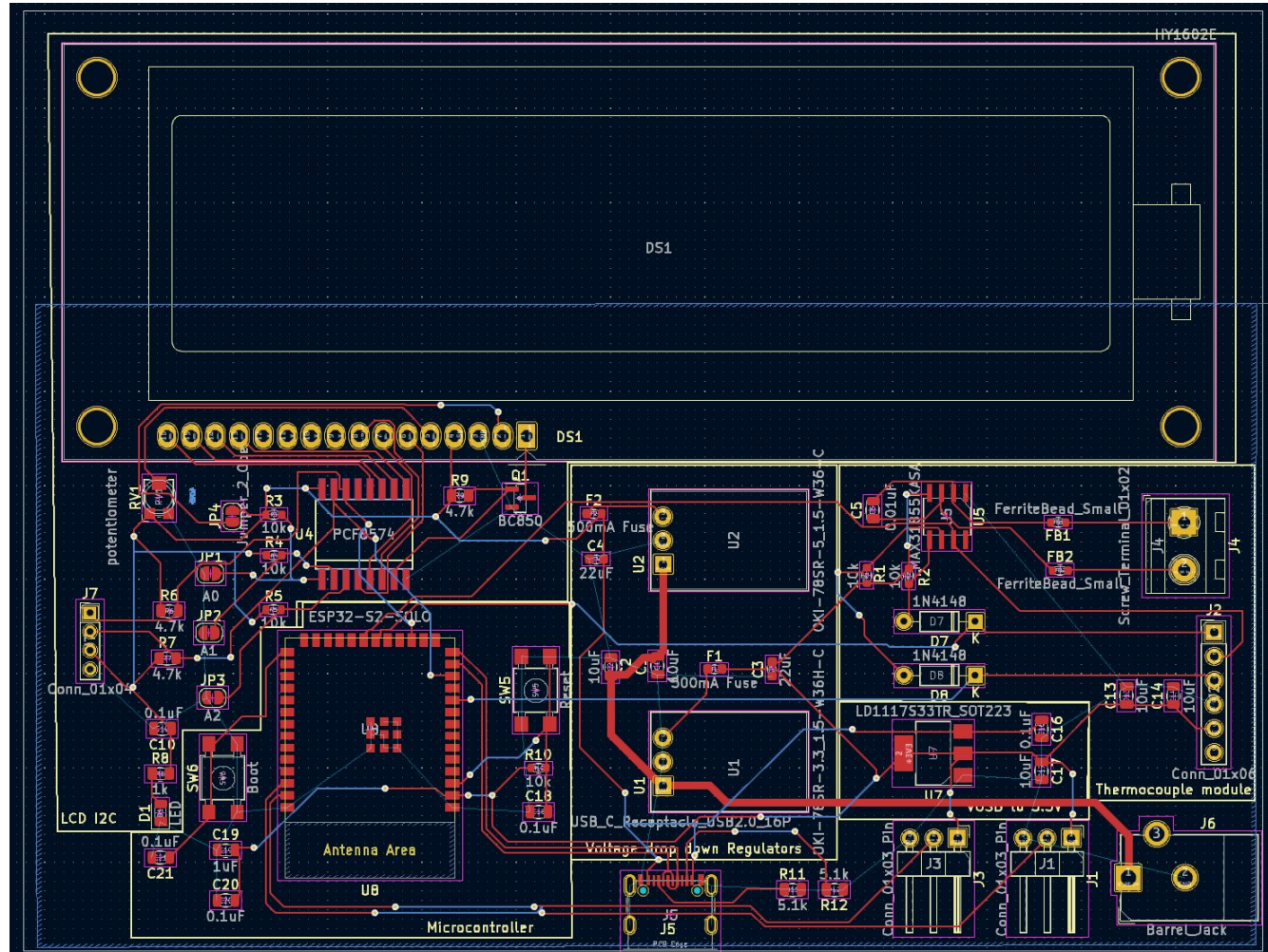
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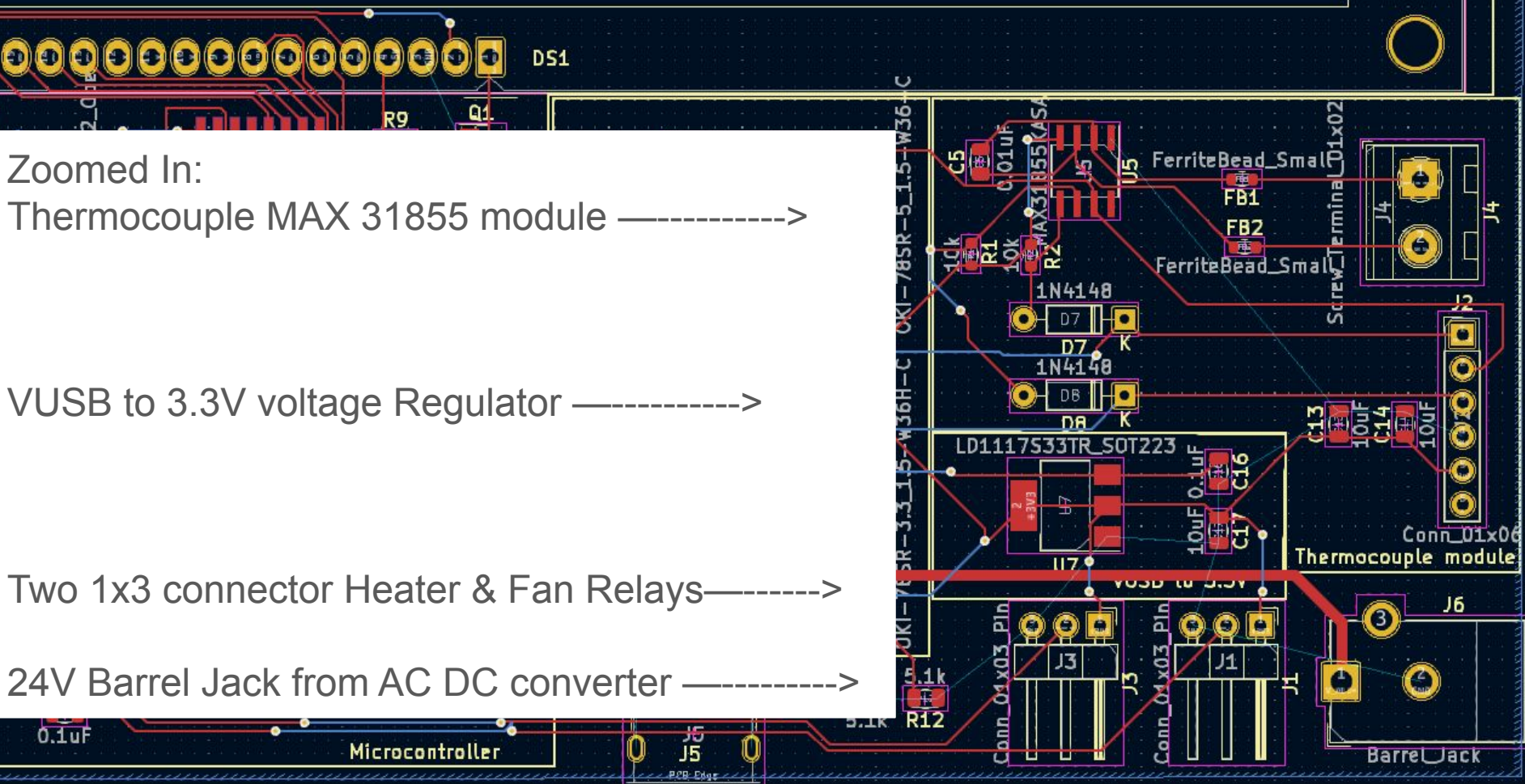


Zoomed In:
Thermocouple MAX 31855 module ----->

VUSB to 3.3V voltage Regulator ----->

Two 1x3 connector Heater & Fan Relays ----->

24V Barrel Jack from AC DC converter ----->



Zoomed In:
24V DC to 5V DC DC converter —>

24V DC to 3.3V DC DC converter —>

