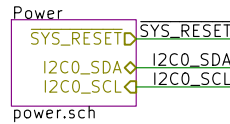
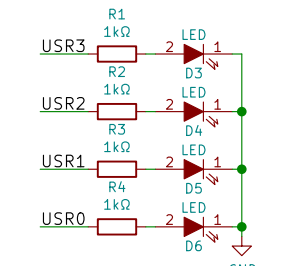


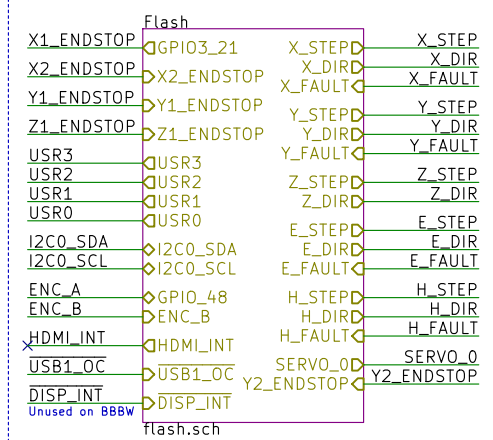
Power



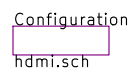
User LEDs



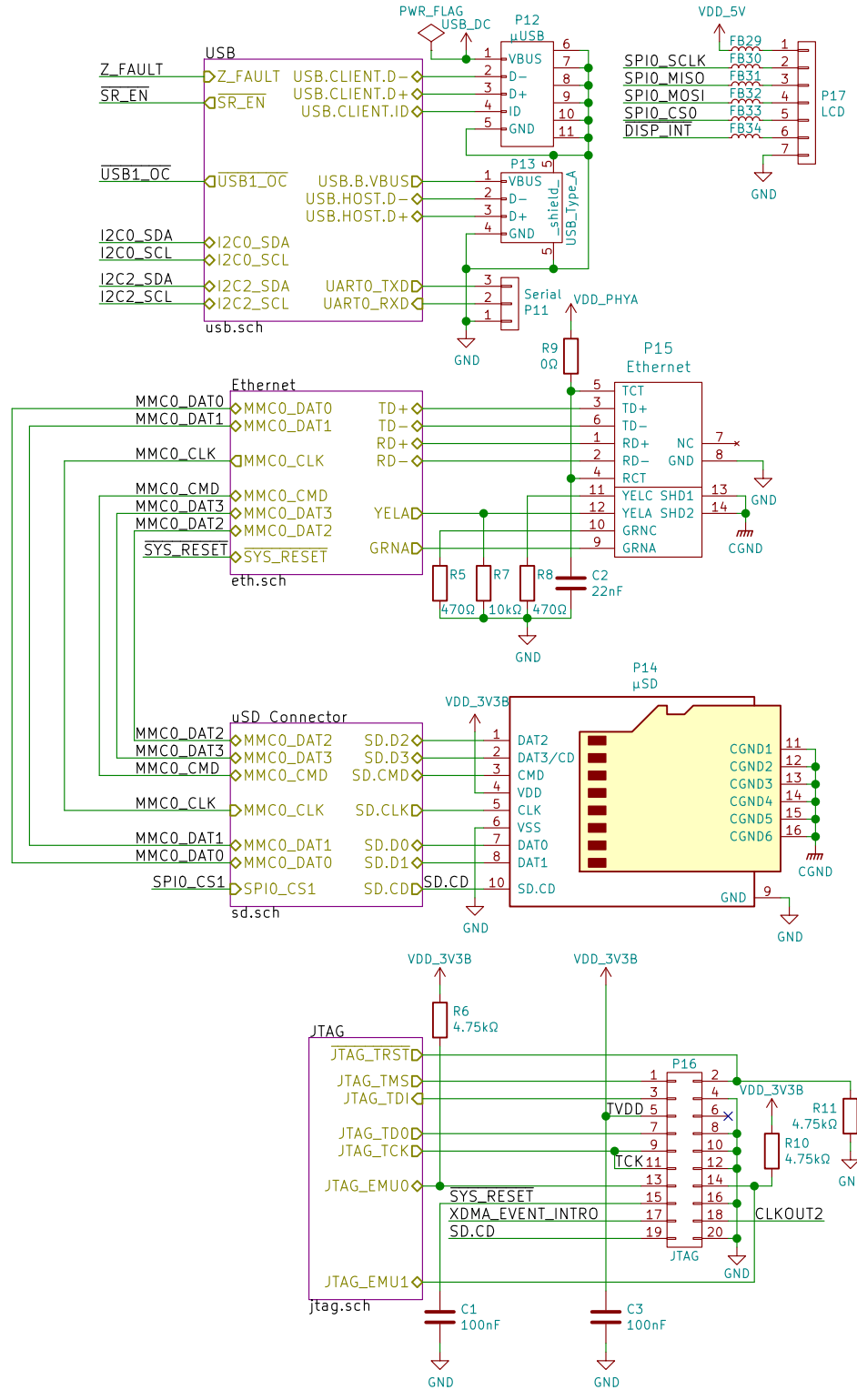
eMMC



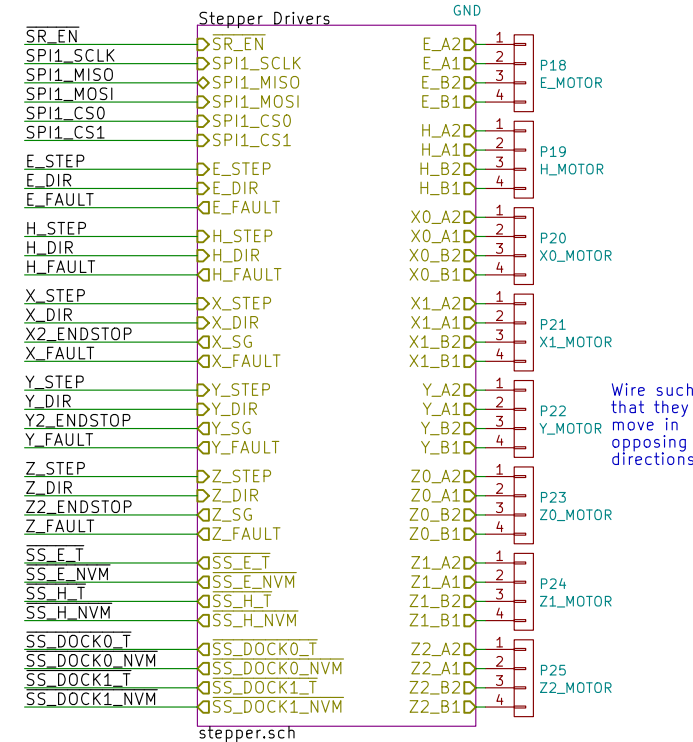
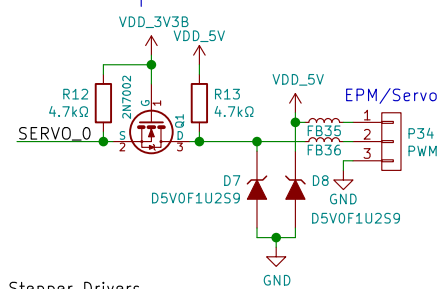
Boot Configuration



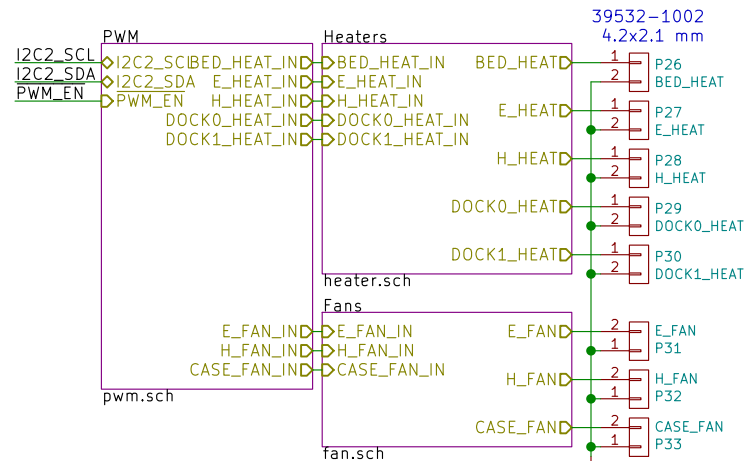
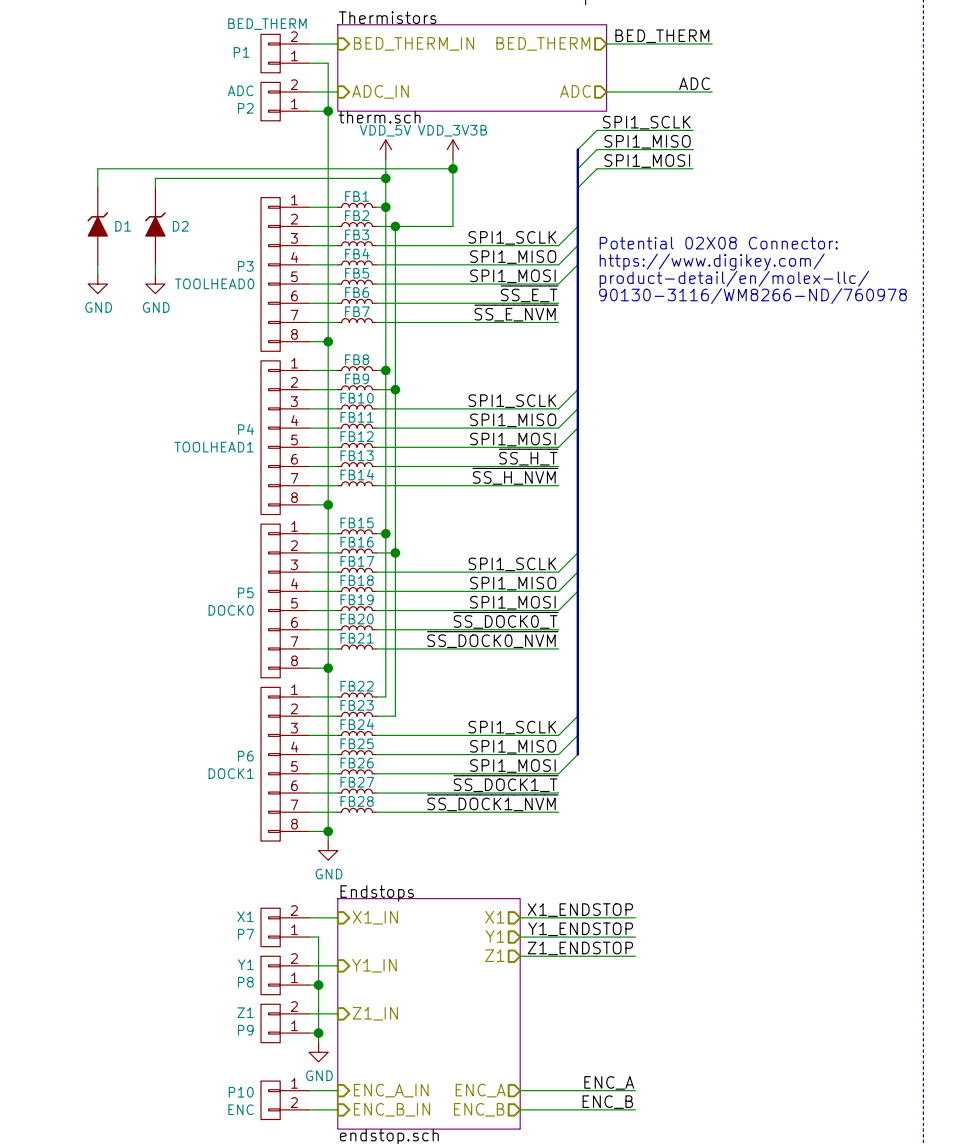
Interfaces

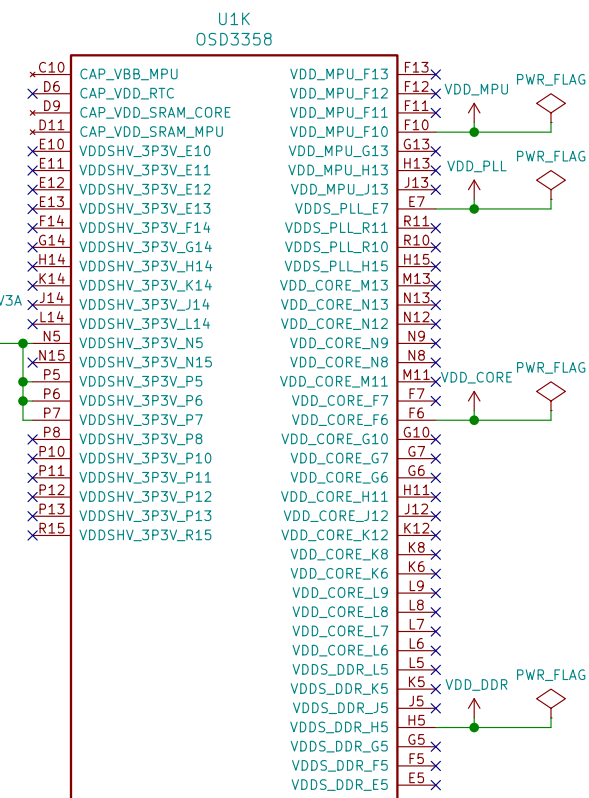
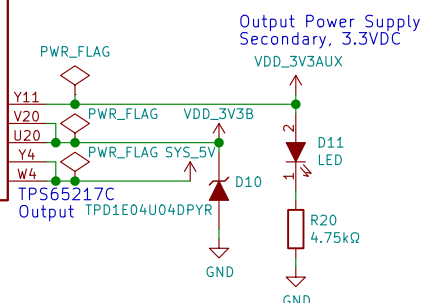
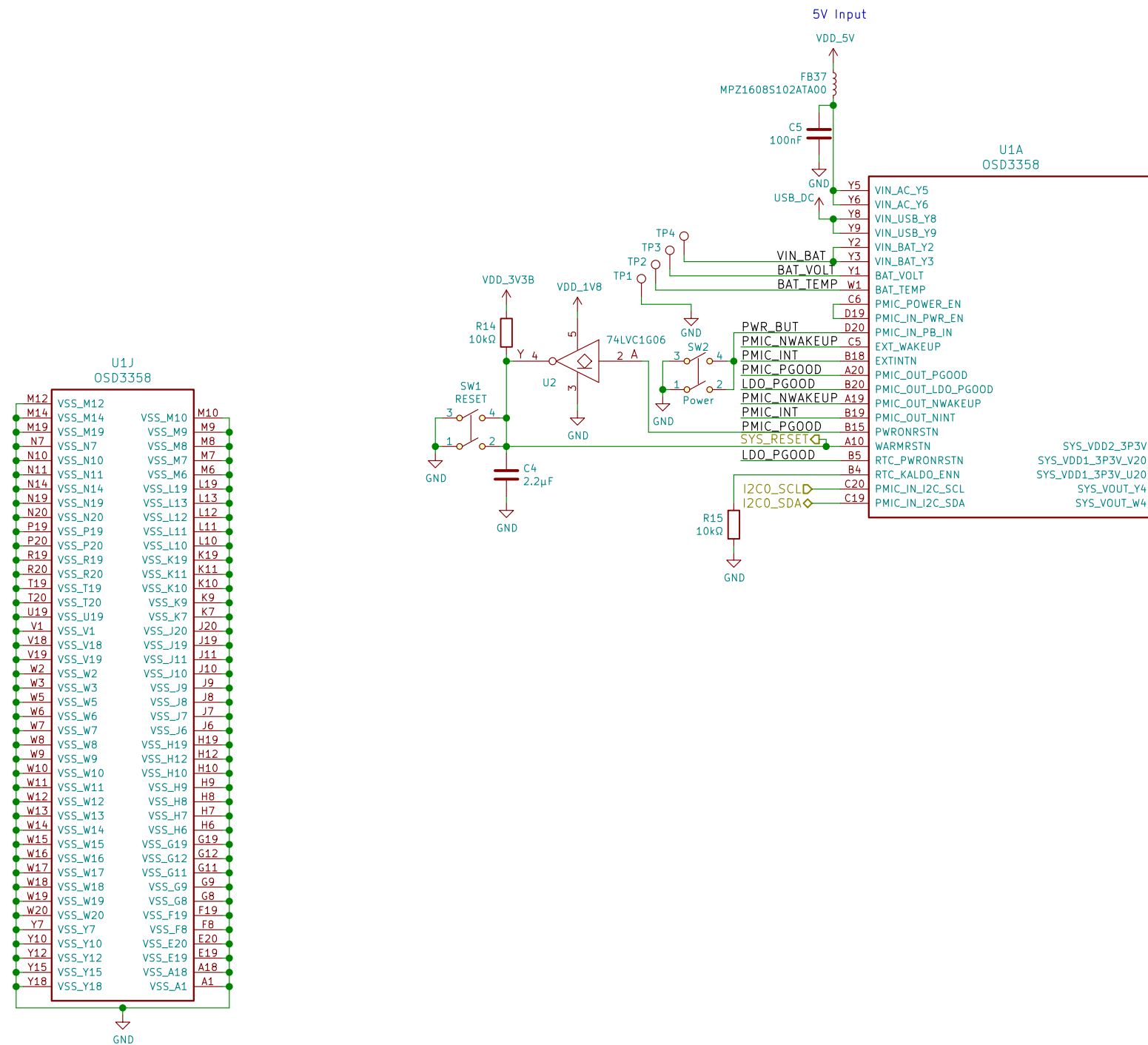
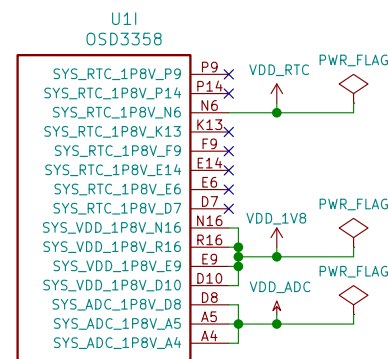
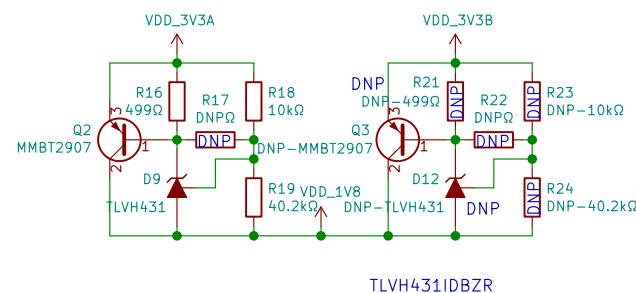
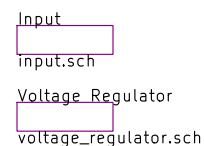


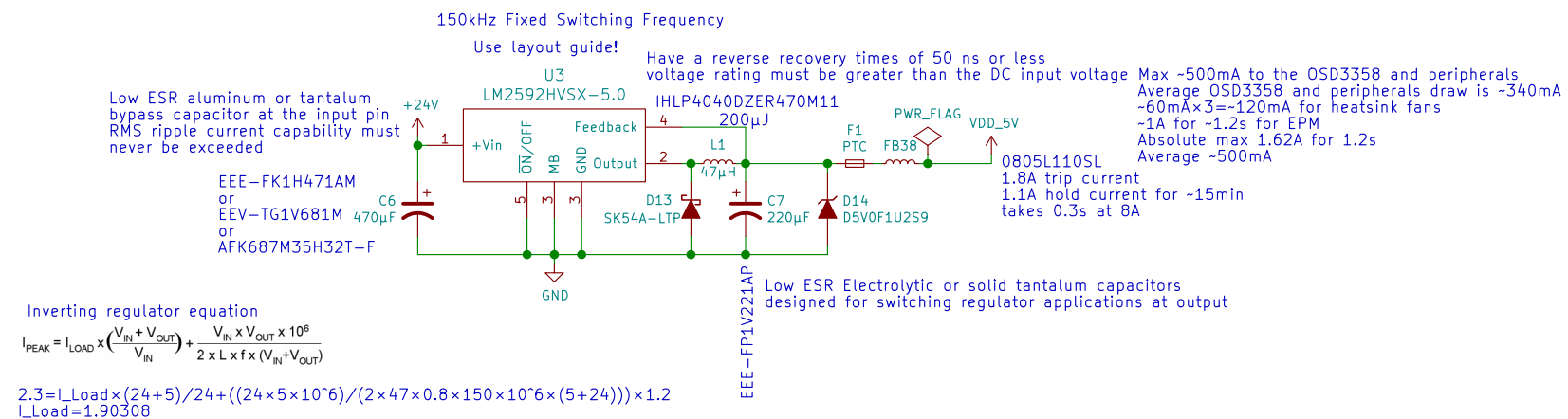
Output



Feedback Input







Sheet: /Power/Voltage Regulator/
File: voltage_regulator.sch

Title:

Size: A3

Date:

Rev:

Size: AS	Date:
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Voltage Drop Calculator by Gerald Newton <http://www.electricalnrg.com>

The following calculator calculates the voltage drop, and voltage at the end of the wire for American Wire Gauge from 4/0 AWG, aluminum or copper wire. (Note: this only calculates the voltage drop, consult the above table for rules-of-thumb, or your local or national electrical code or your electrician to decide what is legal!) Note that the voltage drop does not depend on the input voltage, just on the resistance of the wire and the load in amps.

Select Copper or Aluminum **Copper**

Select American Wire Gauge (AWG) Size
16 AWG

Select Voltage
24 VDC or 1-phase AC

Enter 1-way circuit length in feet (the calculation is for the round trip distance)
1.80446

Enter Load in amps
13.5

Click to Calculate

Voltage drop
0.203

Voltage at load end of circuit
23.797

Per Cent voltage drop
0.85

Wire cross section in circular mils
2560

PCB Calculator

Regulators

Trace Width

Electrical Spacing

TransLine

RF Antennators

Parameters

Current

13.5

A

Temperature rise

23

deg C

Conductor length

550

mm

Resistivity

1.72e-8

Ohm-meter

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 can be calculated.

If you specify the width for the other trace also to also handle this current will then be calculated.

The controlling value is shown in bold.

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

The formula, from IPC 2221, is

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

where:

I = maximum current in amps

δT = temperature rise above ambient in deg C

W,H = width and thickness in mils

Color Code

Board Classes

External layer traces

Trace width

6.46155

mm

Trace thickness

0.03556

mm

Cross-section area

0.229773

mm x mm

Resistance

0.0411711

Ohm

Voltage drop

0.55581

Volt

Power loss

7.50344

Watt

Internal layer traces

Trace width

16.8093

mm

Trace thickness

0.03556

mm

Cross-section area

0.597739

mm x mm

Resistance

0.0158263

Ohm

Voltage drop

0.213655

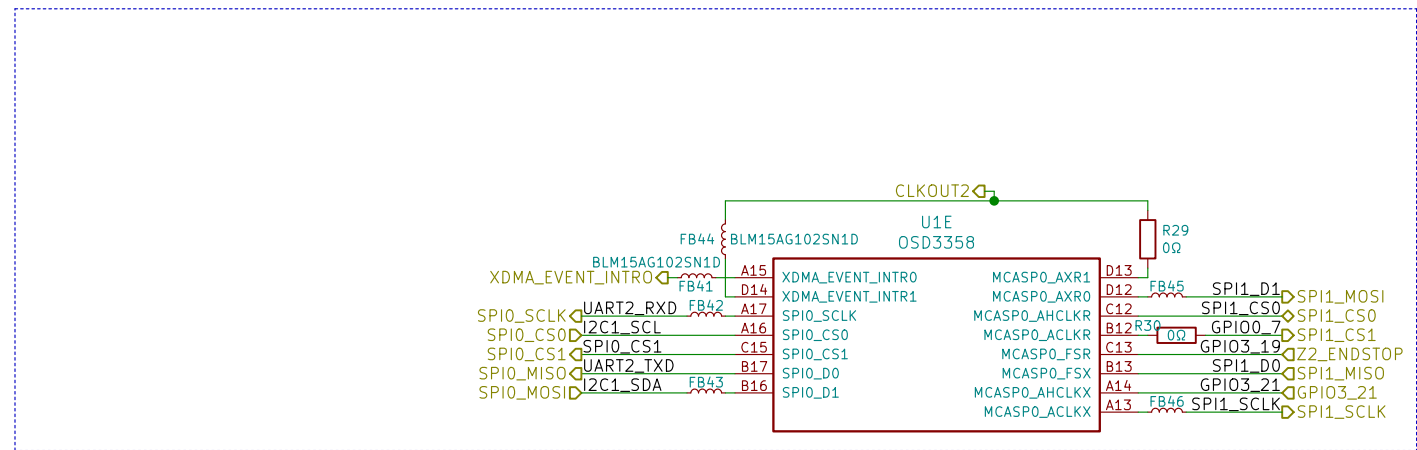
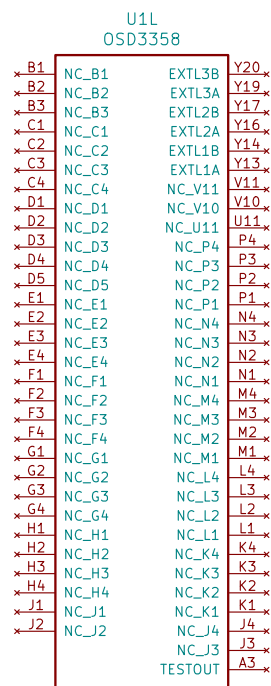
Volt

Power loss

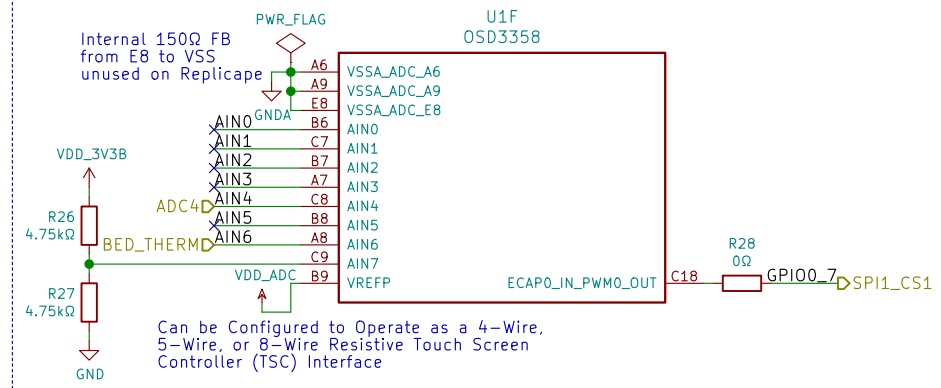
2.88434

Watt

Unused



Analog I/O



Sheet: /Microprocessor/
File: mpu.sch

Title:

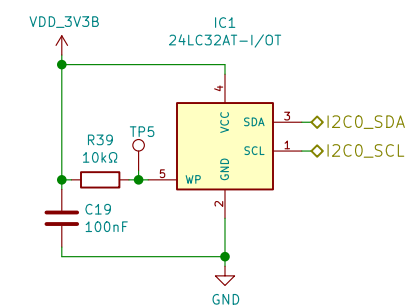
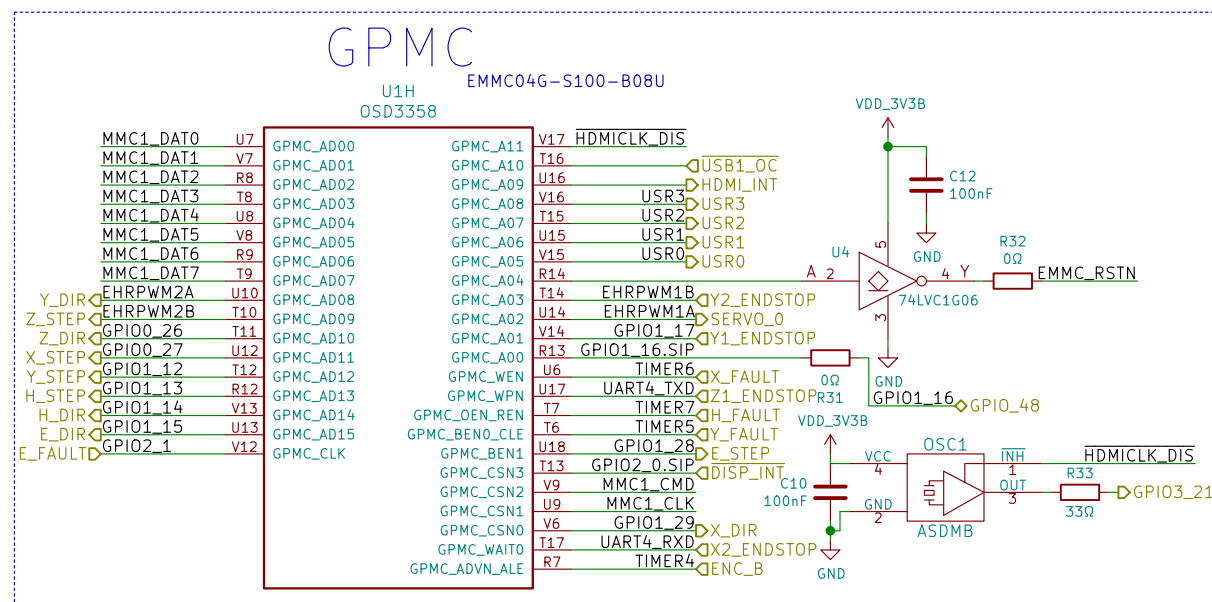
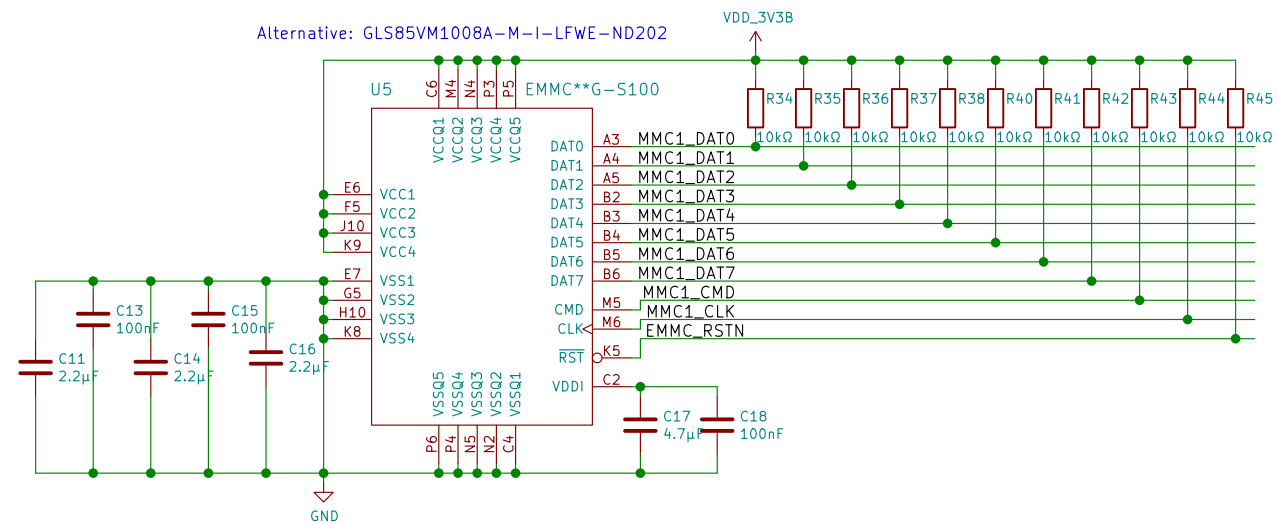
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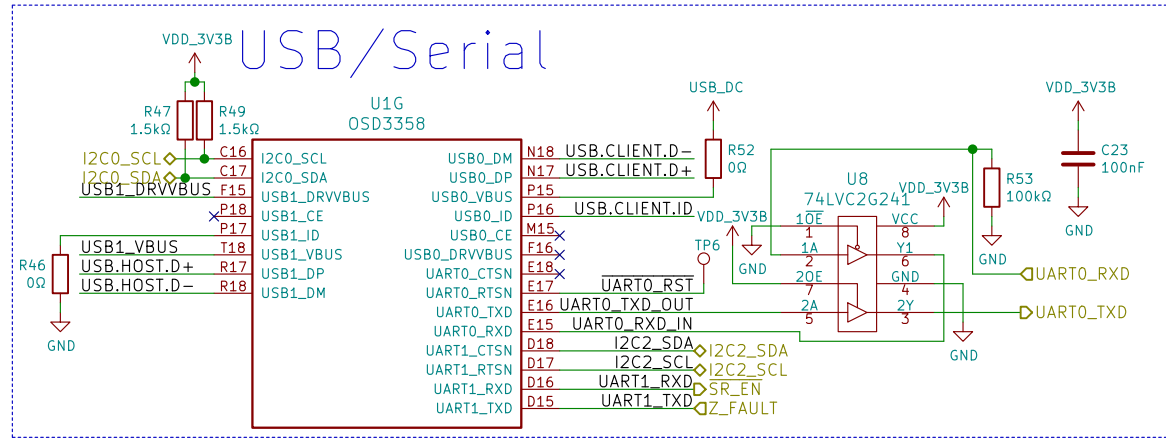
Date:

Rev:

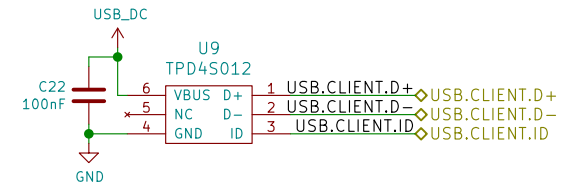
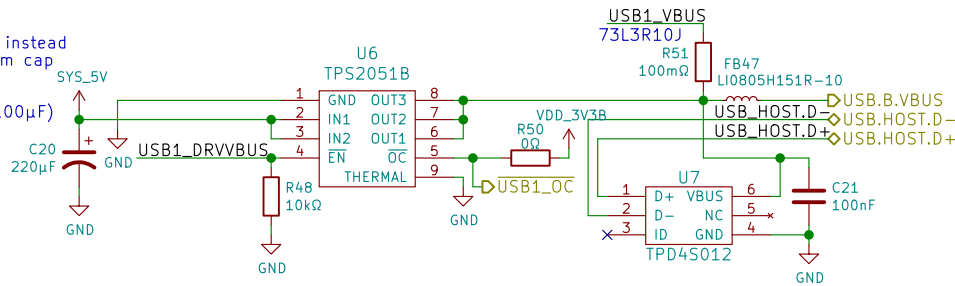
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Used a tantalum cap instead of the large aluminium cap TAJD227M010RNJ instead of AVE107M06D16T-F (100µF)



Sheet: /USB/
File: usb.sch

Title:

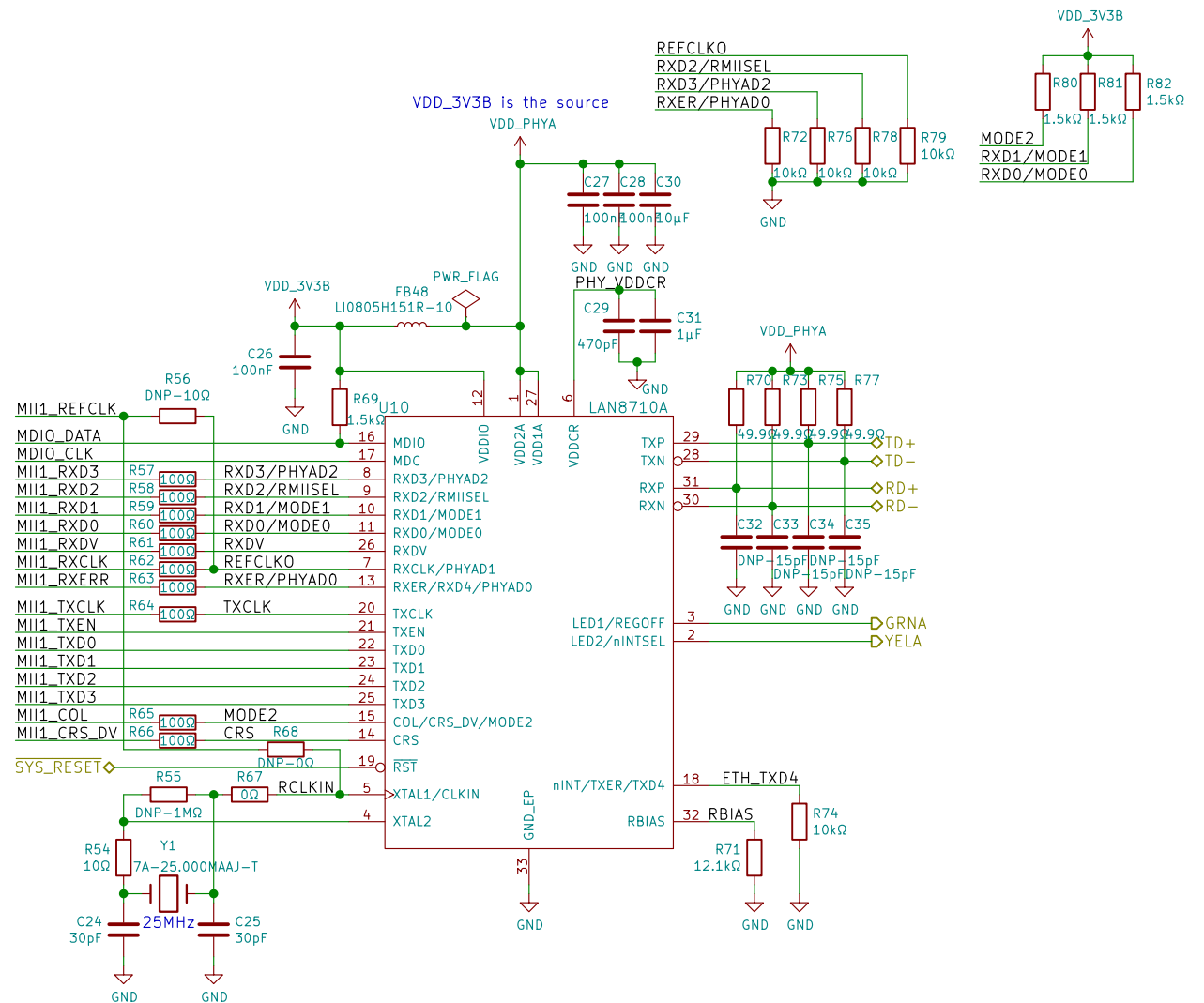
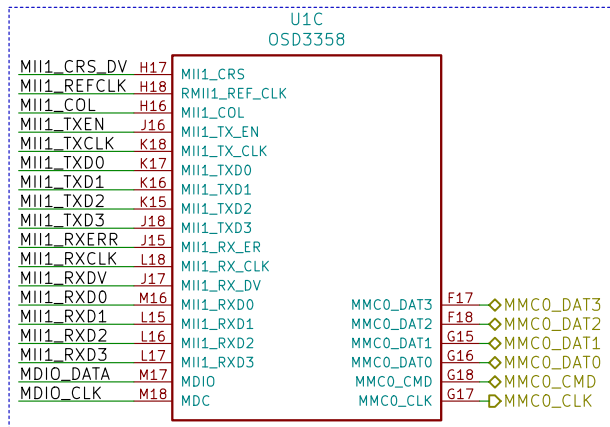
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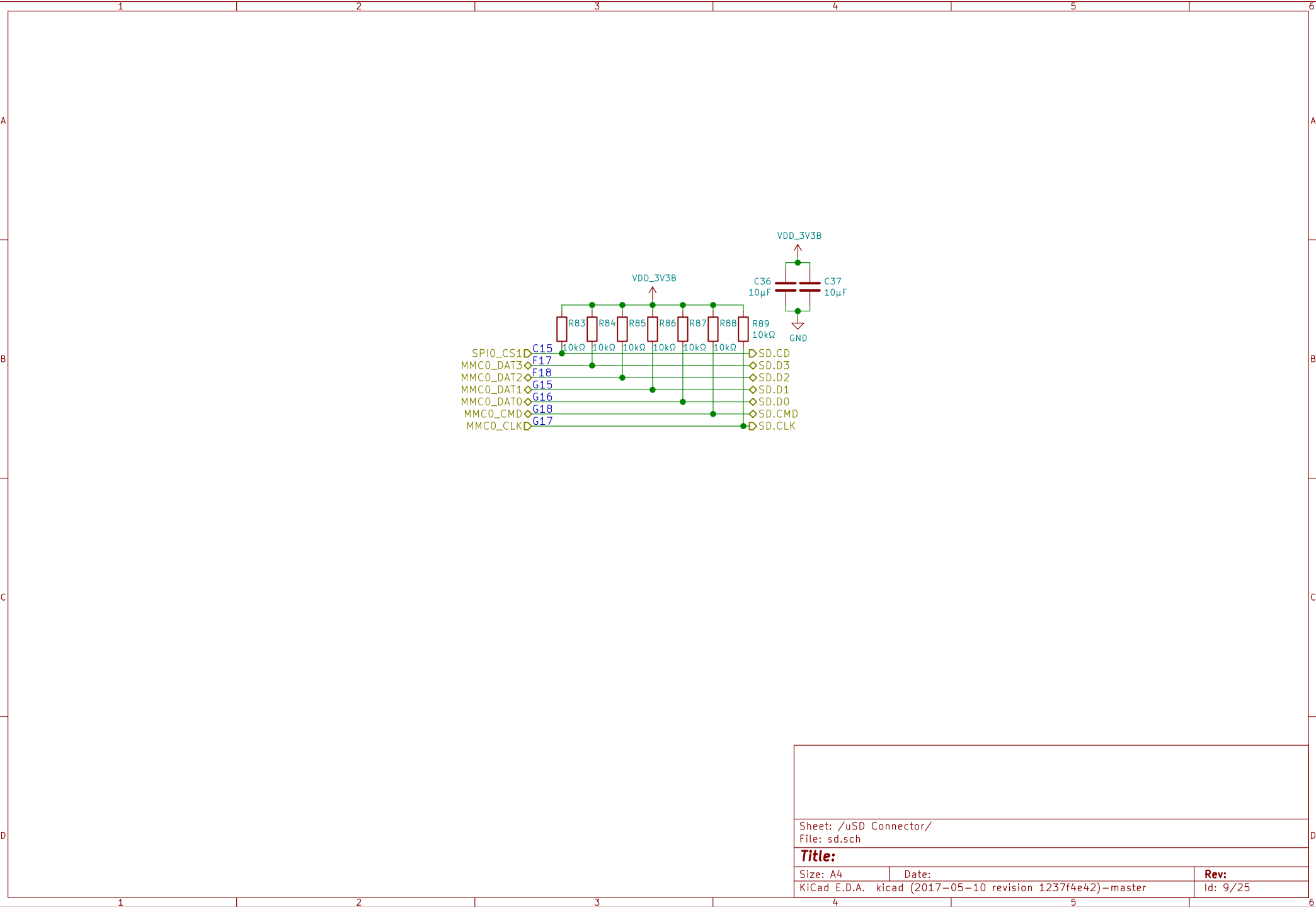
Date:

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Rev:

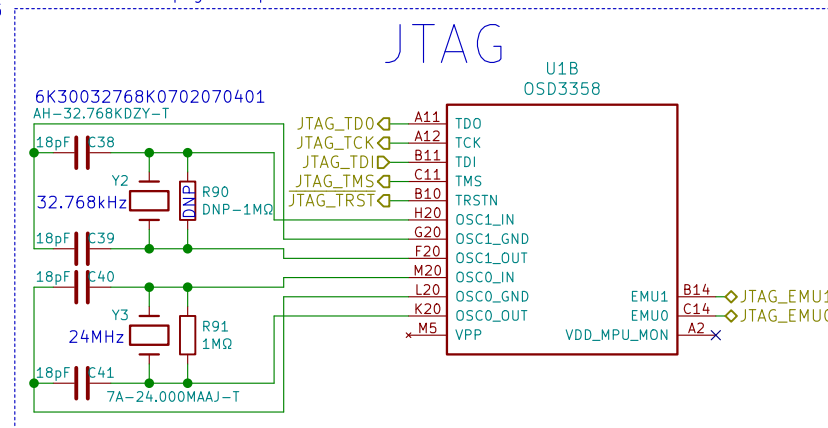
Id: 7/25





Sheet: /uSD Connector/ File: sd.sch		
Title:		
Size: A4	Date:	Rev:
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<https://www.digikey.com/products/en/crystals-oscillators-resonators/crystals/171?k=&keyword=&pv46=14783&FV=8c0011%2C22c0060%2C8640003%2C1f140000%2Cffe000ab%2C402f3e&mnonly=0&newproducts=0&ColumnSort=0&page=1&quantity=0&ptm=0&fid=0&pageSize=25>



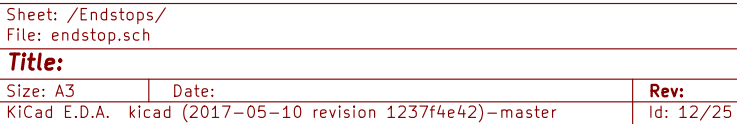
Sheet: /JTAG/
File: jtag.sch

Title:

Size: A4 Date: KiCad E.D.A. kicad (2017-05-10 revision 1237f4e42)-master

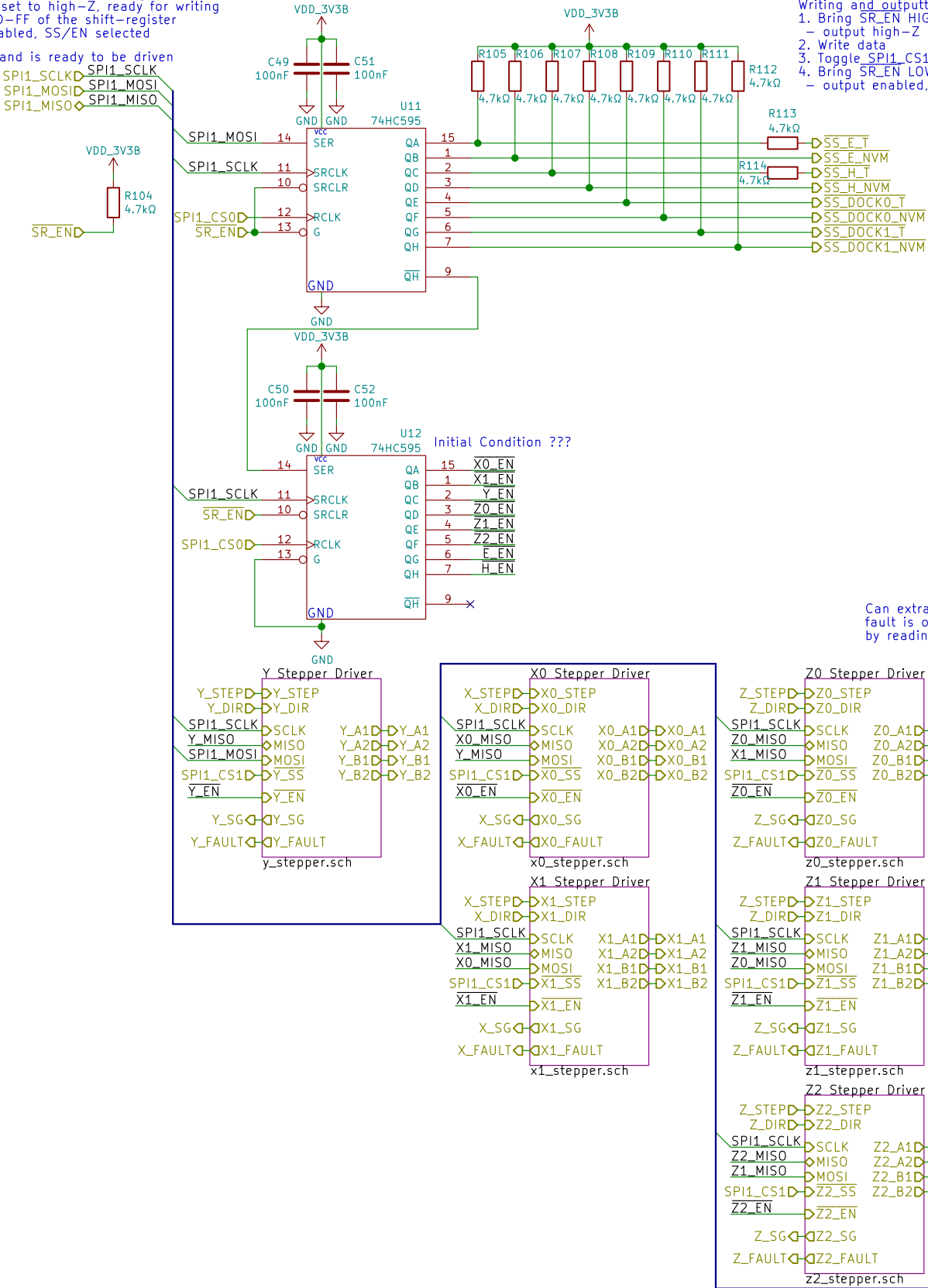
Rev:
Id: 10/25





When $\overline{SR_EN}$ transitions from LOW to HIGH each D-FF of the shift-register come out of their reset states and the output is set to high-Z, ready for writing
When $\overline{SR_EN}$ transitions from HIGH to LOW each D-FF of the shift-register goes into their reset states and the output is enabled, SS/EN selected

SPI1_CS1 captures the data in the shift register and is ready to be driven by the second stage of D-FFs



- Writing and outputting data:
1. Bring $\overline{SR_EN}$ HIGH
- output high-Z (pull-ups)
 2. Write data
 3. Toggle SPI1_CS1_0|-|-
 4. Bring $\overline{SR_EN}$ LOW
- output enabled, disable specific motors/ready to configure

Series resistor for reading temp whilst docking/undocking

Can extract which fault is occurring via SPI by reading DRV_STATUS reg

Place sense resistors and all filter capacitors as close as possible to the related IC pins. Use a solid common GND for all GND connections, also for sense resistor GND. Connect 5VOUT filtering capacitor directly to 5VOUT and GNDA pin. See layout hints for more details. Low ESR electrolytic capacitors are recommended for VS filtering.

place a ceramic filtering capacitor (470nF) as close as possible (1–2mm) to VCC pin with GND return going to ground plane.

100

JS reg

```
Rsense = 220mOhm;
Vsense = 1 : 15.775726mA res : 236.635888mA range : 0.26818734A to 0.504823228A
Vsense = 0 : 28.483949mA res : 427.259243mA range : 0.484227141A to 0.911486384A
```

Sense input tolerance / motor current full scale tolerance -using internal reference	I_{con}	$I_{scale_analog}=0$, $vsense=0$	-5	+5	%
Sense input tolerance / motor current full scale tolerance -using external reference voltage	I_{con}	$I_{scale_analog}=1$, $V_{AN}=2V$, $vsense=0$ $V_{in} = 2.379759519V$	-2	+2	%

vsense	Allows control of the sense resistor <i>voltage range</i> for full scale current.	0	$V_{FS} = 0.32 \text{ V}$	Vsrtl=325mV
		1	$V_{FS} = 0.18 \text{ V}$	

$$I_{rms} = (CS+1)/32 \times V_{fs}/(R_{sense}+20m\Omega) \times 1/\sqrt{2}$$

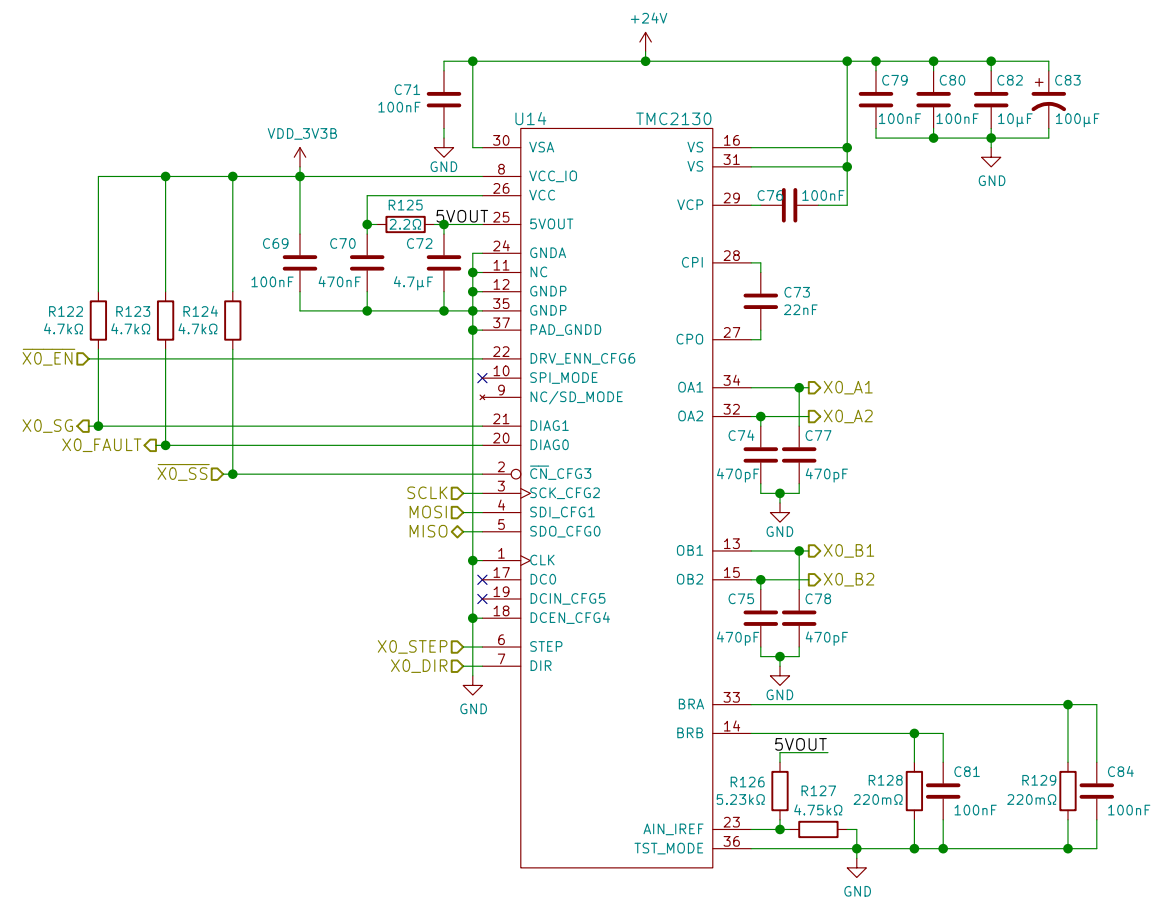
CS is the current scale setting as set by IHOLD IRUN and coolStep
VFS is the full scale voltage as determined by vsense control bit

When *I_scale_analog* is enabled for analog scaling of V_{FS} , the resulting voltage V_{FS}' is calculated by:

$$V'_{FS} = V_{FS} * \frac{V_{AIN}}{2.5V}$$

AIN_IREF=1-2.4V

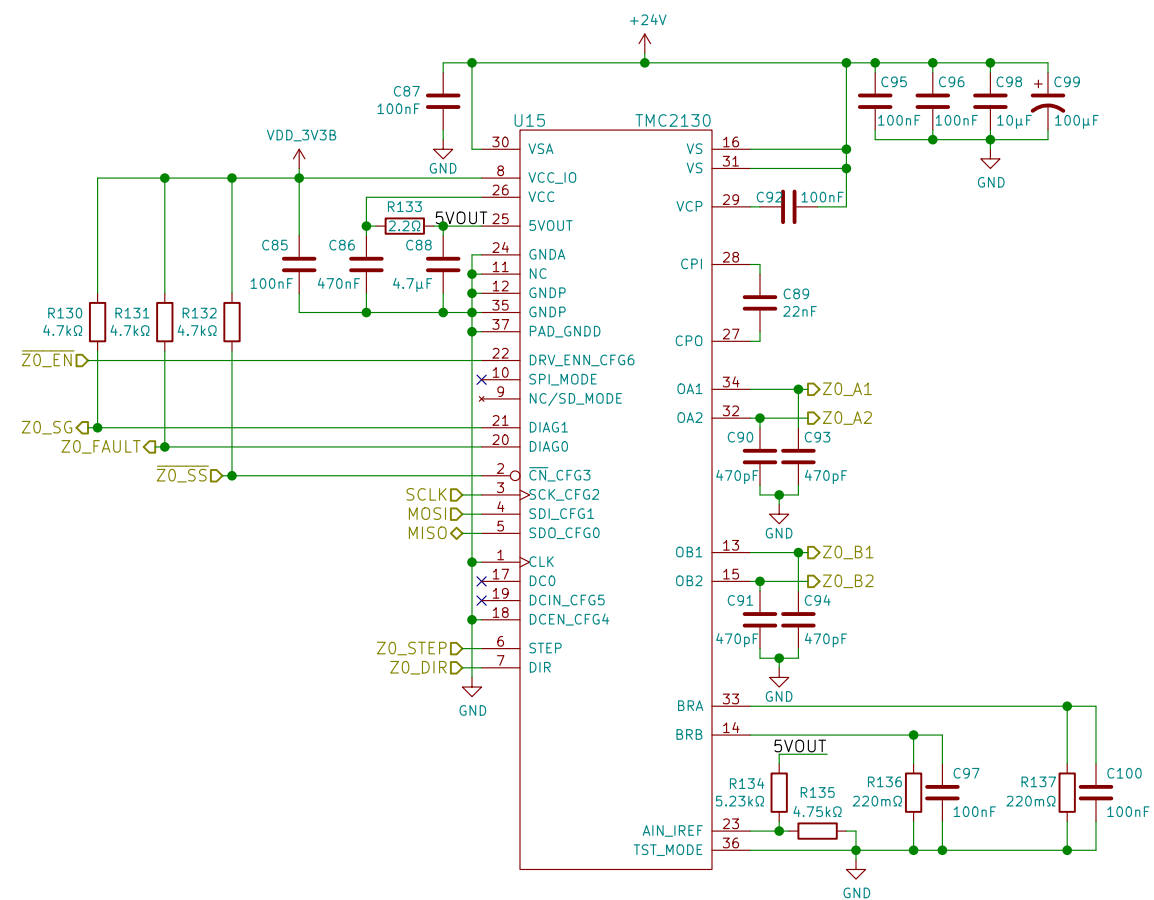
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Sheet: /Stepper Drivers/X0 Stepper Driver/
File: x0_stepper.sch

Title:

Size: A3	Date:	Rev:
KiCad E.D.A.	kiCad (2017-05-10 revision 1237f4e42)-master	Id: 15/25



Sheet: /Stepper Drivers/Z0 Stepper Driver/
File: z0_stepper.sch

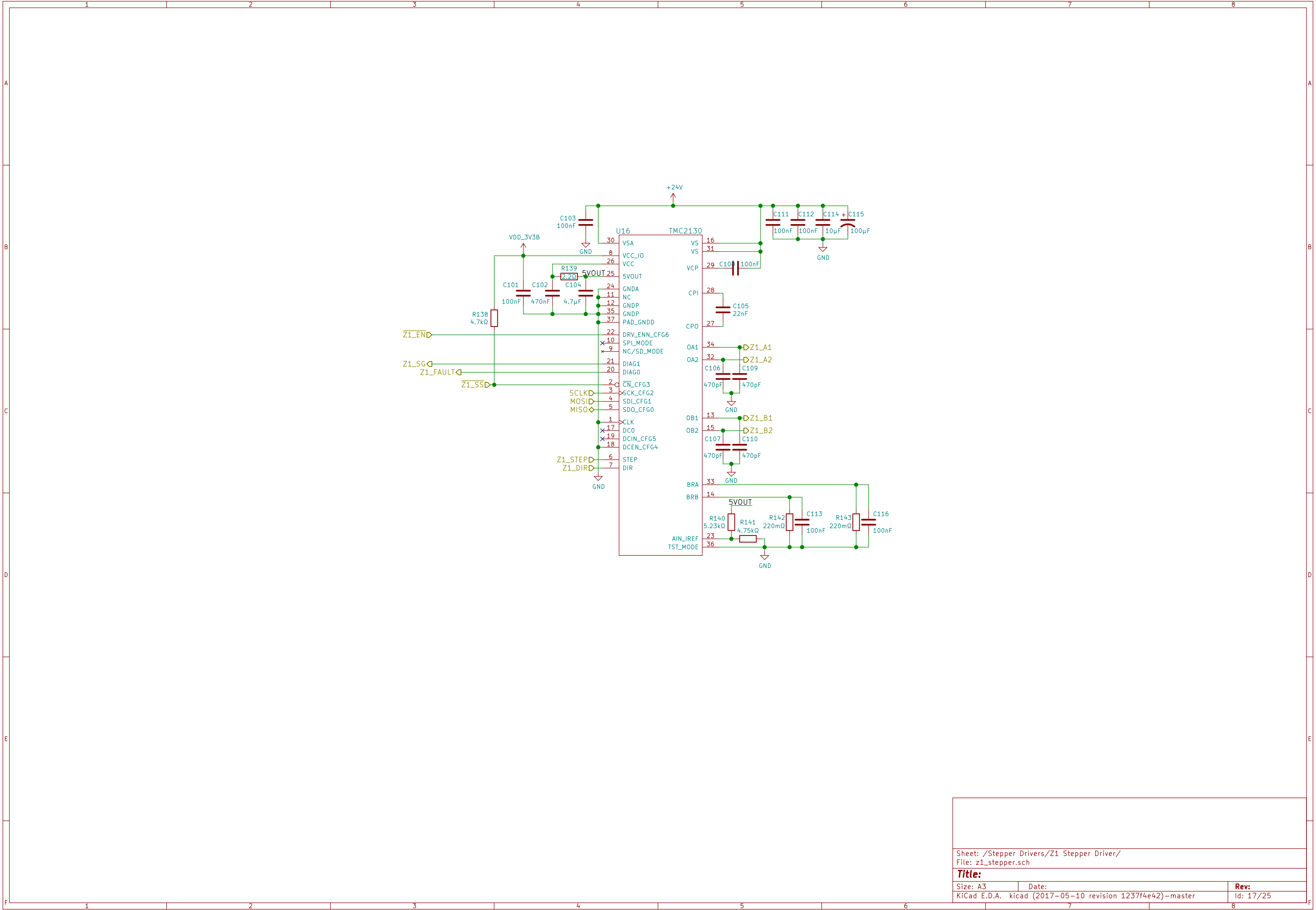
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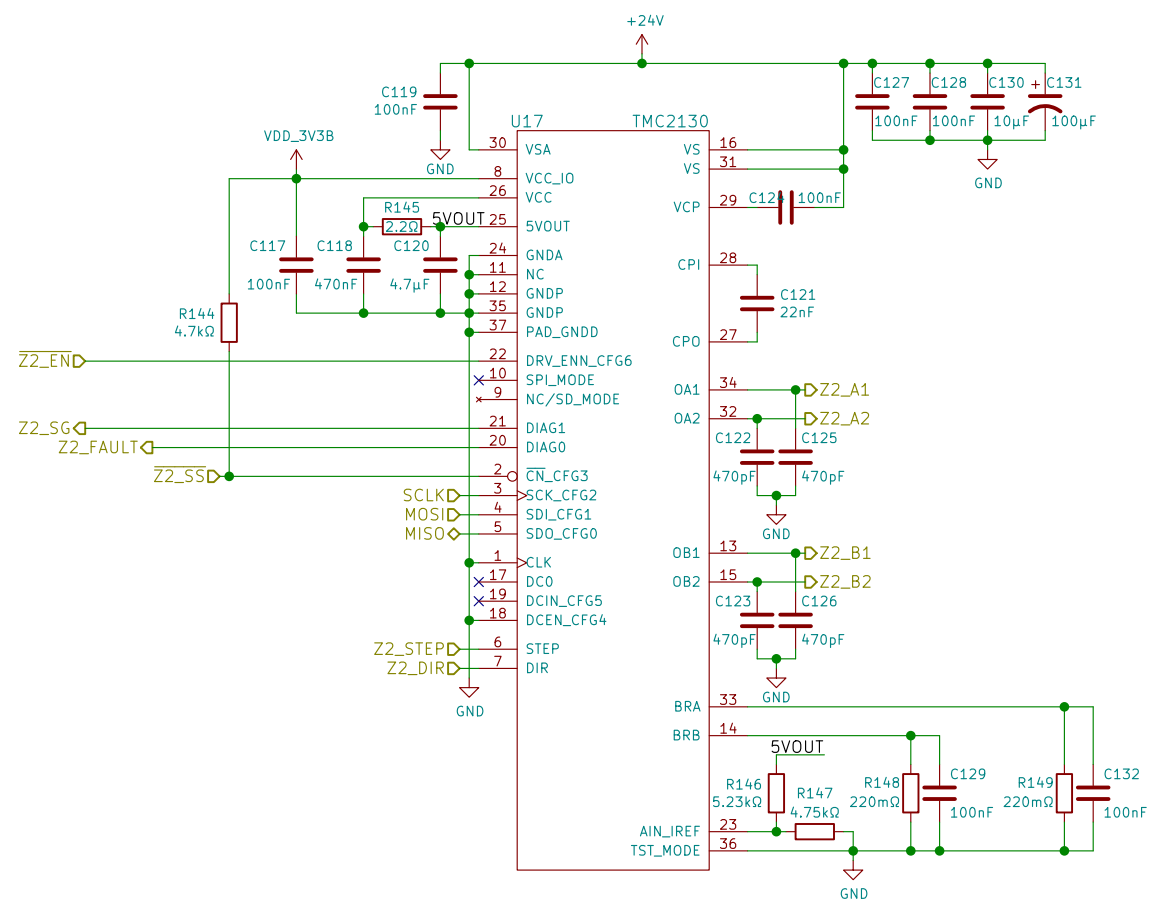
Size: A3

Date:

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Rev:
Id: 16/25





Sheet: /Stepper Drivers/Z2 Stepper Driver/
File: z2_stepper.sch

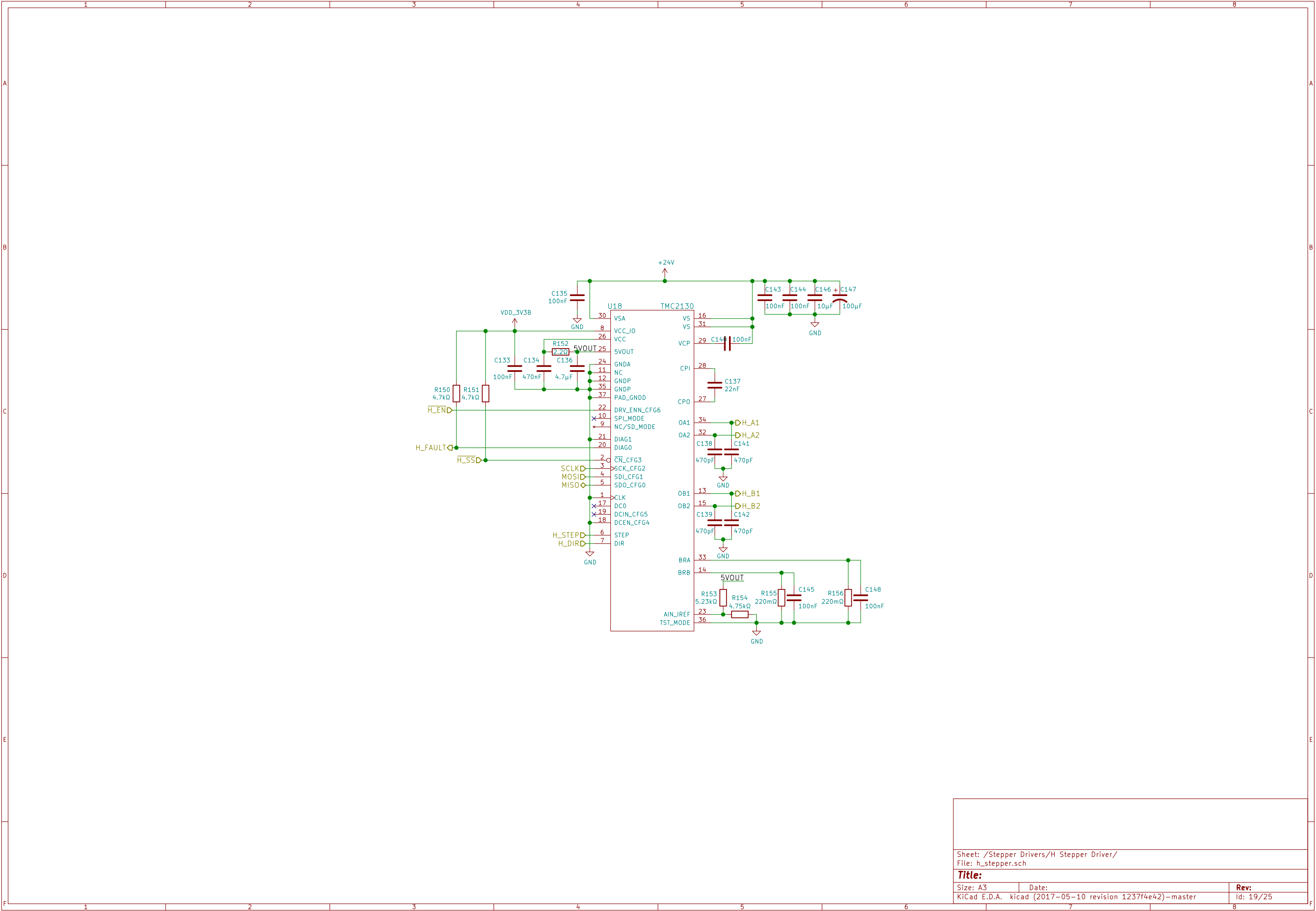
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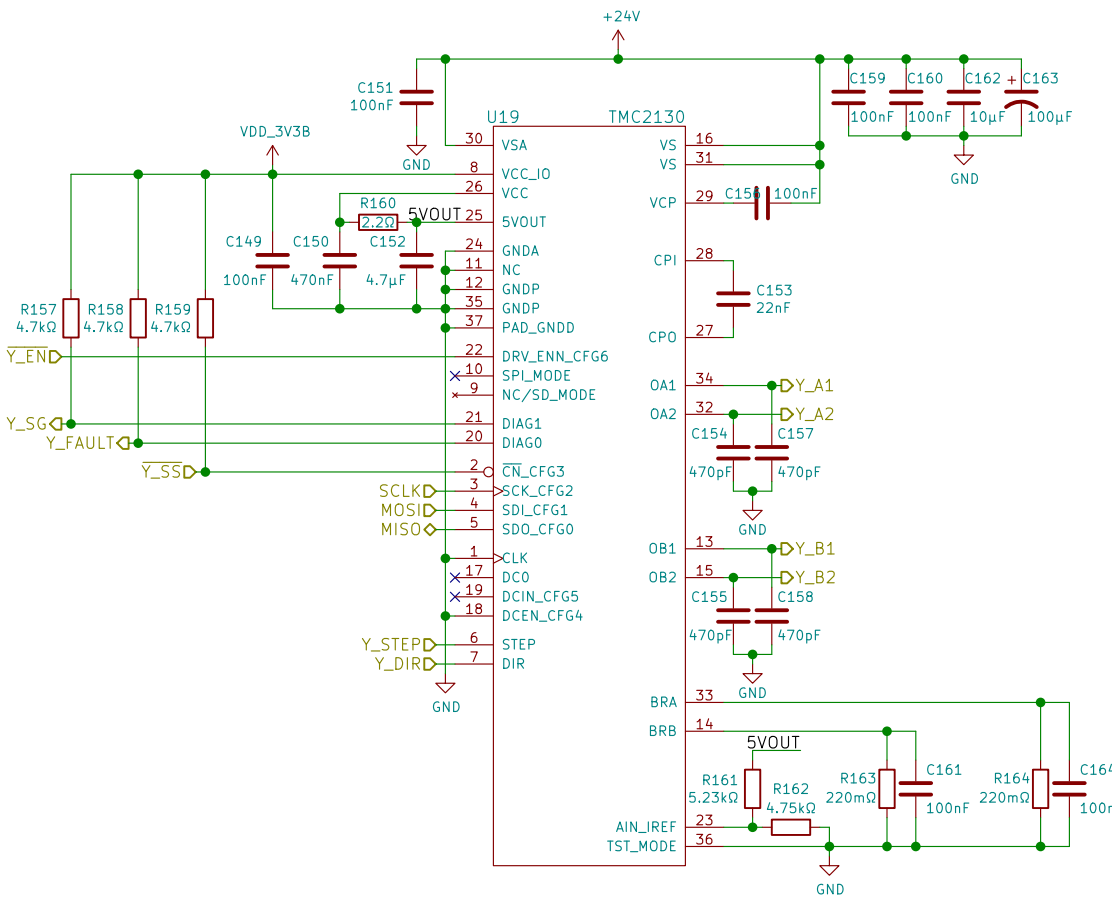
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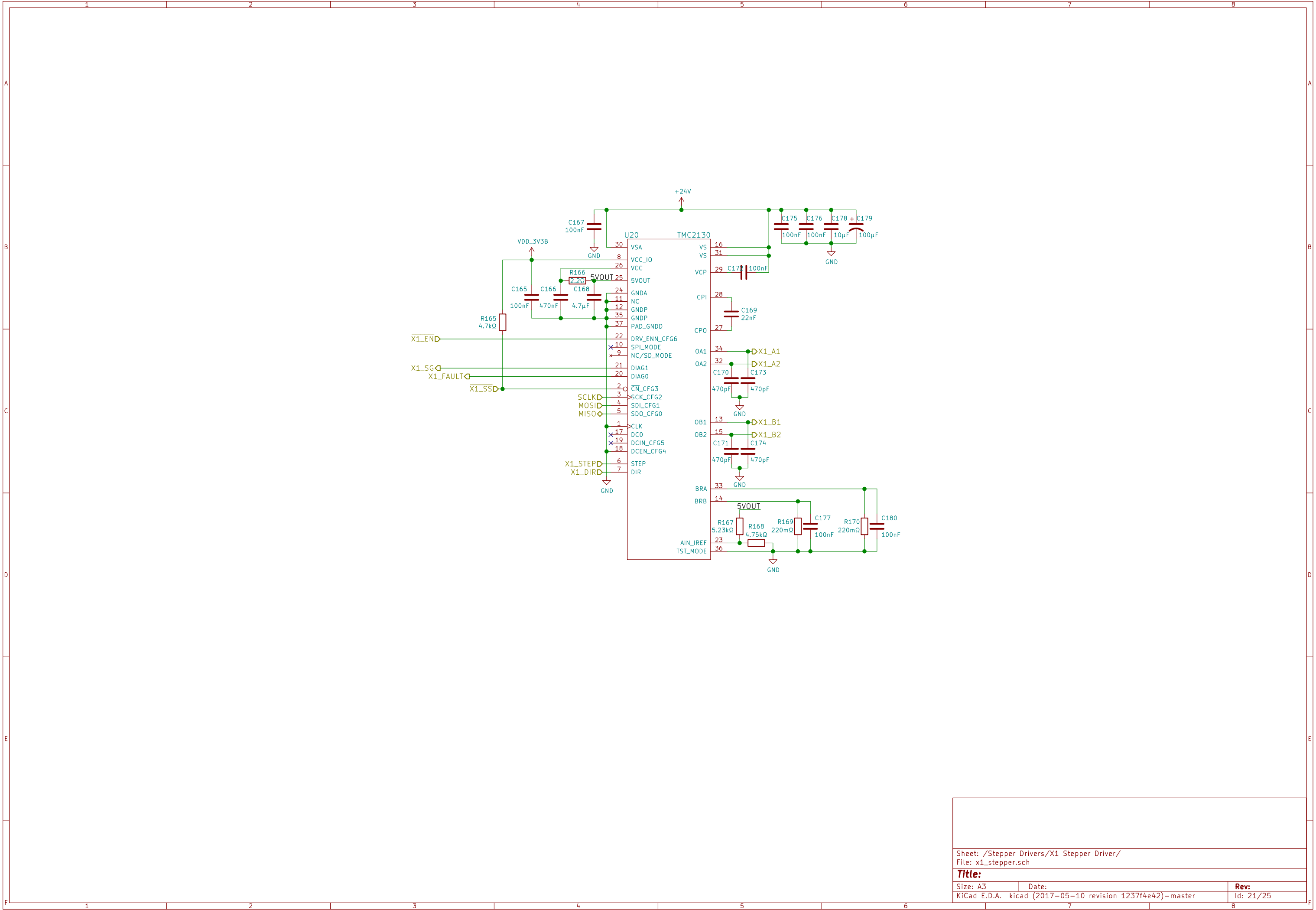
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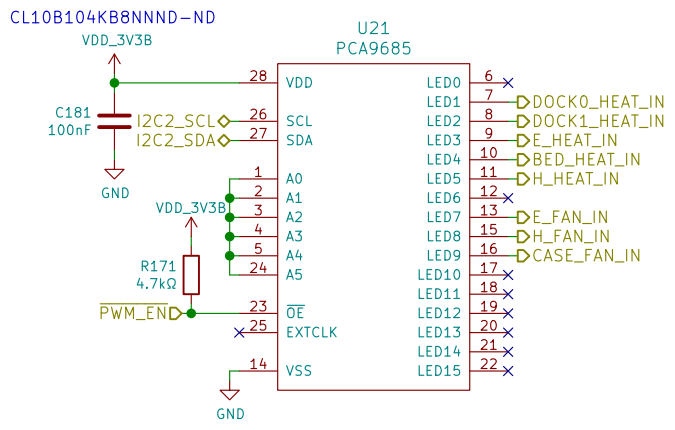
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Rev:
Id: 18/25

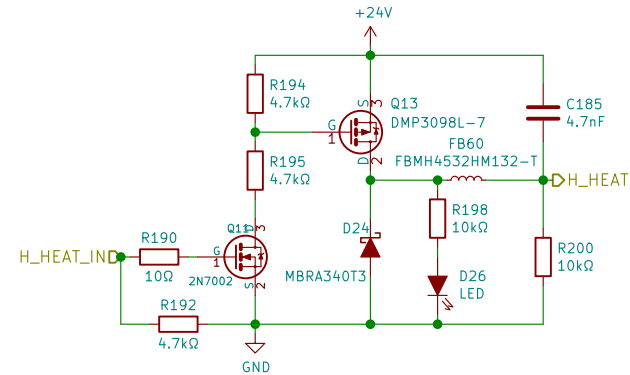
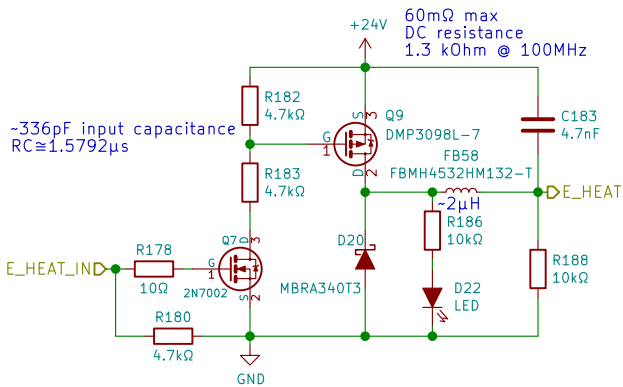
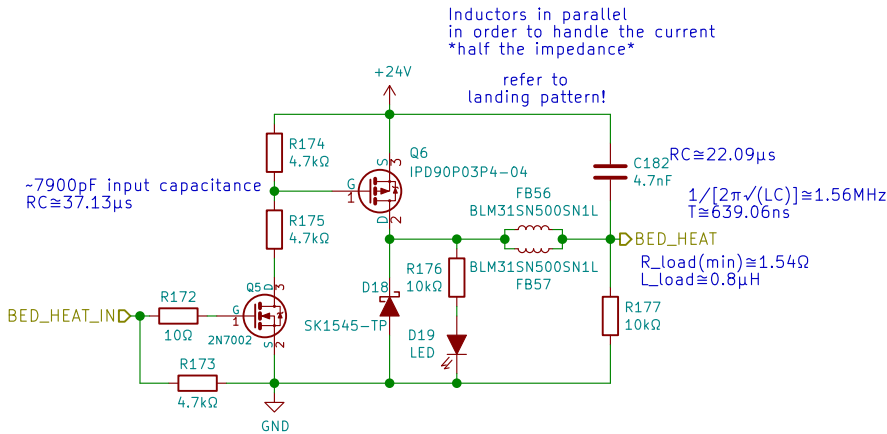








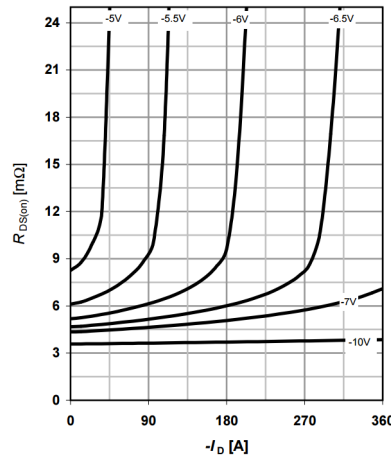
Sheet: /PWM/ File: pwm.sch		
Title:		
Size: A4	Date:	Rev:
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6 Typ. drain-source on-state resistance

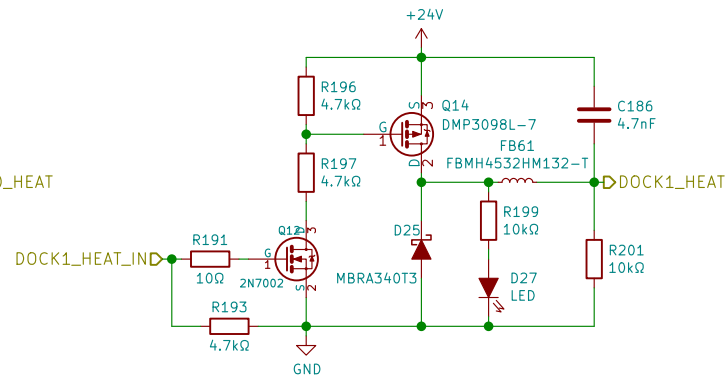
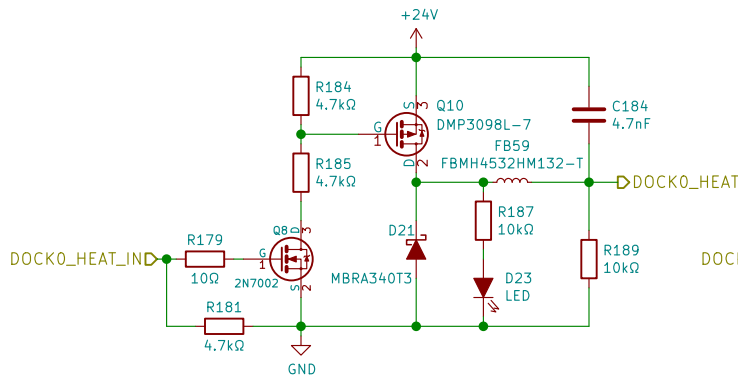
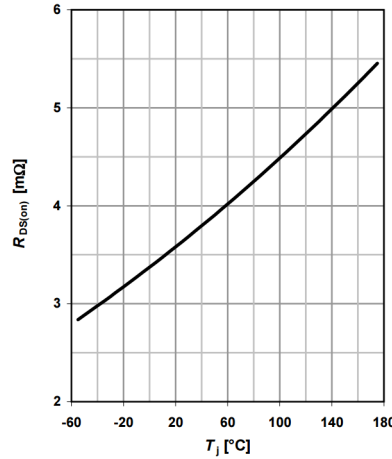
$$R_{\text{DS(on)}} = f(I_D); T_J = 25^\circ\text{C}$$

parameter: V_{GS}



8 Typ. drain-source on-state resistance

$$R_{\text{DS(on)}} = f(T_J); I_D = -90\text{ A}; V_{\text{GS}} = -10\text{ V}$$



Sheet: /Heaters/
File: heater.sch

Title:

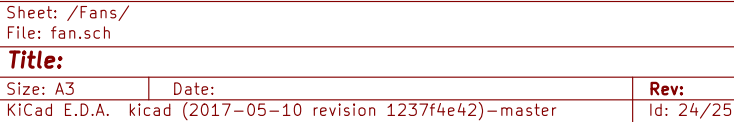
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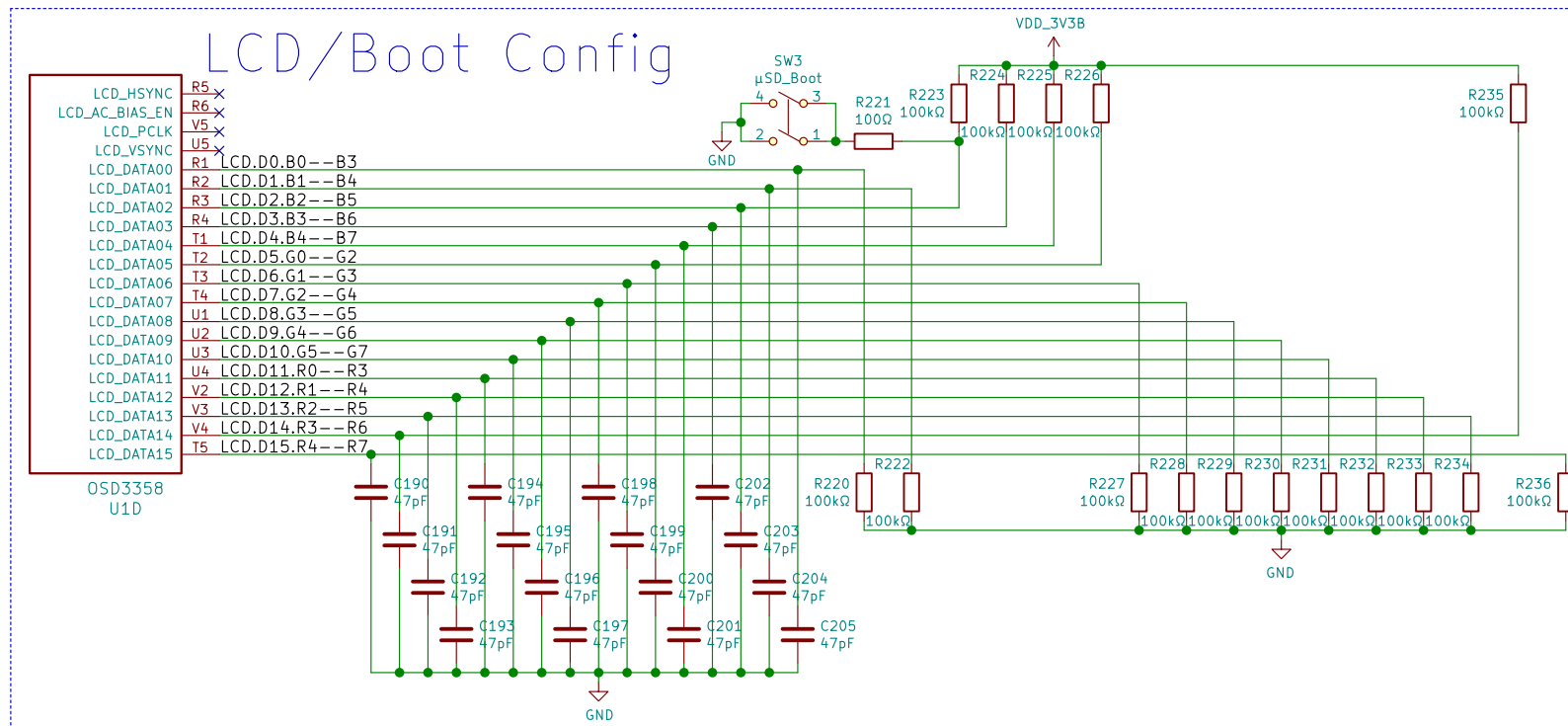
Date:

Rev:

KiCad E.D.A. kicad (2017-05-10 revision 1237f4e42)-master

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Sheet: /Configuration/
File: hdmi.sch

Title:

Size: A4

Date:

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Rev:

Id: 25/25