Power

Power
SYS_RESET
I2C0_SDA
I2C0_SCL
power.sch

User LEDs

USR3 R1 1kΩ LED D3
USR2 R2 1kΩ LED D4
USR1 R3 1kΩ LED D5
USR0 R4 1kΩ LED D6
GND

eMMC

Flash
X2_ENDSTOP
Y1_ENDSTOP
Z1_ENDSTOP
USR3
USR2
USR1
USR0
I2C0_SDA
I2C0_SCL
ENC_A
ENC_B
HDMI_INT
USB1_OC
DISP_INT
Unused on BBBW
GPIO_48
X_STEP X_DIR X_FAULT
Y_STEP Y_DIR Y_FAULT
Z_STEP Z_DIR
E_STEP E_DIR E_FAULT
H_STEP H_DIR H_FAULT
SERVO_0
Y2_ENDSTOP
flash.sch

Boot Configuration

Configuration
hdmi.sch

Interfaces

USB
Z_FAULT
SR_EN
USB1_OC
I2C0_SDA
I2C0_SCL
SIP_I2C0_SCL
I2C2_SDA
I2C2_SCL
USB.CLIENT.D−
USB.CLIENT.D+
USB.CLIENT.ID
USB.B.VBUS
USB.HOST.D−
USB.HOST.D+
UART0_TXD
UART0_RXD
usb.sch
PWR_FLAG
USB_DC
P12 µUSB
P13 USB_Type_A
Serial P11
VDD_PHYA
R9 0Ω
P15 Ethernet
Ethernet
MMC0_DAT0
MMC0_DAT1
MMC0_CLK
MMC0_CMD
MMC0_DAT3
MMC0_DAT2
SYS_RESET
TD+ TD− RD+ RD− YELA GRNA
R5 470Ω
R7 10kΩ
R8 470Ω
C2 22nF
eth.sch
P14 µSD
µSD_Connector
DAT2 DAT3/CD CMD VDD CLK VSS DAT0 DAT1
CGND1 CGND2 CGND3 CGND4 CGND5 CGND6
SD.D2 SD.D3 SD.CMD SD.CLK SD.D0 SD.D1 SD.CD
SPI0_CS1
sd.sch
VDD_3V3B
JTAG
JTAG_TRST
JTAG_TMS
JTAG_TDI
JTAG_TDO
JTAG_TCK
JTAG_EMU0
JTAG_EMU1
TVDD TCK
R6 4.75kΩ
R10 4.75kΩ
R11 4.75kΩ
C1 100nF
C3 100nF
P16 JTAG
jtag.sch
VDD_5V
SPI0_SCLK
SPI0_MISO
SPI0_MOSI
SPI0_CS0
DISP_INT
FB29 FB30 FB31 FB32 FB33 FB34
LCD P17

Microprocessor

XDMA_EVENT_INTRO
PWM_EN
CLKOUT2
SPI0_SCLK
SPI0_MISO
SPI0_MOSI
SPI0_CS0
SPI0_CS1
LCD
µSD
GPIO3_21
Z2_ENDSTOP
BED_THERM
ADC4
SPI1_SCLK
SPI1_MISO
SPI1_MOSI
SPI1_CS0
SPI1_CS1
X1_ENDSTOP
Z2_ENDSTOP
BED_THERM
ADC
Shift Registers
Stepper Drivers
mpu.sch

Feedback Input

Thermistors
BED_THERM
P1
ADC
P2
BED_THERM_IN
ADC_IN
therm.sch
VDD_5V VDD_3V3B
D1 D2
GND GND
TOOLHEAD0 P3
TOOLHEAD1 P4
DOCK0 P5
DOCK1 P6
FB1 FB2 FB3 FB4 FB5 FB6 FB7
FB8 FB9 FB10 FB11 FB12 FB13 FB14
FB15 FB16 FB17 FB18 FB19 FB20 FB21
FB22 FB23 FB24 FB25 FB26 FB27 FB28
SPI1_SCLK
SPI1_MISO
SPI1_MOSI
SS_E_T
SS_E_NVM
SS_H_T
SS_H_NVM
SS_DOCK0_T
SS_DOCK0_NVM
SS_DOCK1_T
SS_DOCK1_NVM
Potential 02X08 Connector:
https://www.digikey.com/product-detail/en/molex-llc/90130-3116/WM8266-ND/760978
Endstops
X1 P7
Y1 P8
Z1 P9
X1_IN
Y1_IN
Z1_IN
X1_ENDSTOP
Y1_ENDSTOP
Z1_ENDSTOP
P10 ENC
ENC_A_IN
ENC_B_IN
ENC_A
ENC_B
endstop.sch

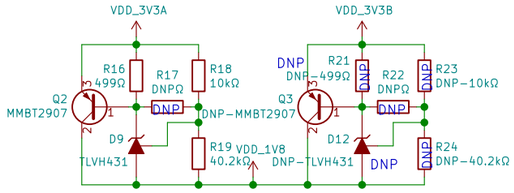
Output

VDD_3V3B
VDD_5V
R12 4.7kΩ
R13 4.7kΩ
2N7002
SERVO_0
EPM/Servo
FB35 FB36
PWM P34
D7 D8
D5V0F1U2S9
GND
Stepper Drivers
SR_EN
SPI1_SCLK
SPI1_MISO
SPI1_MOSI
SPI1_CS0
SPI1_CS1
E_STEP E_DIR E_FAULT
H_STEP H_DIR H_FAULT
X_STEP X_DIR X2_ENDSTOP X_FAULT
Y_STEP Y_DIR Y2_ENDSTOP Y_FAULT
Z_STEP Z_DIR Z2_ENDSTOP Z_FAULT
SS_E_T
SS_E_NVM
SS_H_T
SS_H_NVM
SS_DOCK0_T
SS_DOCK0_NVM
SS_DOCK1_T
SS_DOCK1_NVM
E_A2 E_A1 E_B2 E_B1 P18 E_MOTOR
H_A2 H_A1 H_B2 H_B1 P19 H_MOTOR
X0_A2 X0_A1 X0_B2 X0_B1 P20 X0_MOTOR
X1_A2 X1_A1 X1_B2 X1_B1 P21 X1_MOTOR
Y_A2 Y_A1 Y_B2 Y_B1 P22 Y_MOTOR
Z0_A2 Z0_A1 Z0_B2 Z0_B1 P23 Z0_MOTOR
Z1_A2 Z1_A1 Z1_B2 Z1_B1 P24 Z1_MOTOR
Z2_A2 Z2_A1 Z2_B2 Z2_B1 P25 Z2_MOTOR
Wire such that they move in opposing directions
stepper.sch
39532-1002 4.2x2.1 mm
PWM
I2C2_SCL
I2C2_SDA
PWM_EN
Heaters
BED_HEAT_IN
E_HEAT_IN
H_HEAT_IN
DOCK0_HEAT_IN
DOCK1_HEAT_IN
BED_HEAT P26 BED_HEAT
E_HEAT P27 E_HEAT
H_HEAT P28 H_HEAT
DOCK0_HEAT P29 DOCK0_HEAT
DOCK1_HEAT P30 DOCK1_HEAT
heater.sch
pwm.sch
Fans
E_FAN_IN
H_FAN_IN
CASE_FAN_IN
E_FAN P31 E_FAN
H_FAN P32 H_FAN
CASE_FAN P33 CASE_FAN
fan.sch

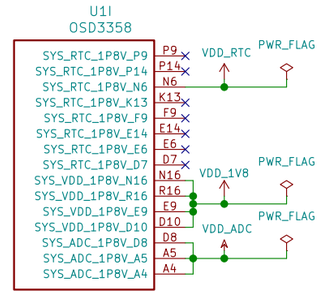
Aleph Objects Inc.
Sheet: /
File: KiMBo.sch
Title: KiMBo
Size: A3 | Date: 2017−03−17 | **Rev:**
KiCad E.D.A. kicad 4.0.6 | Id: 1/25

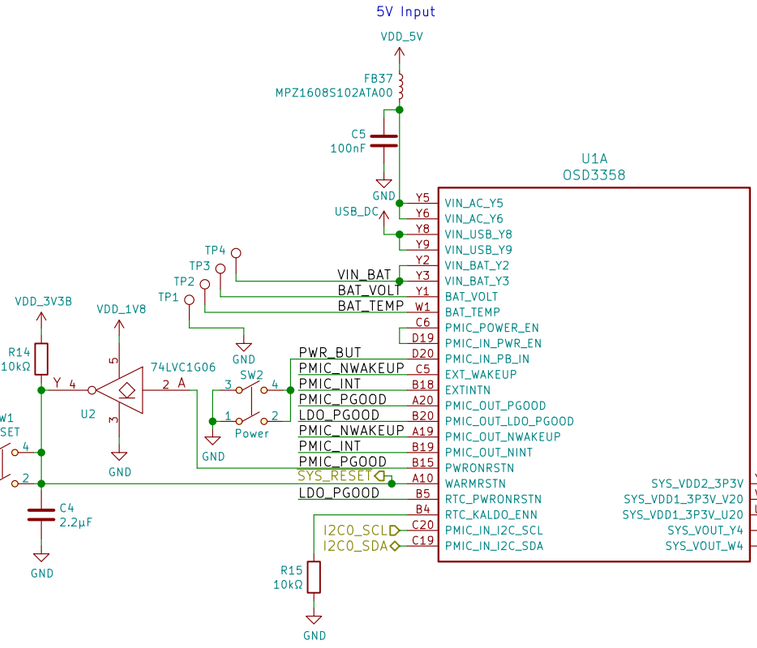
Input
input.sch

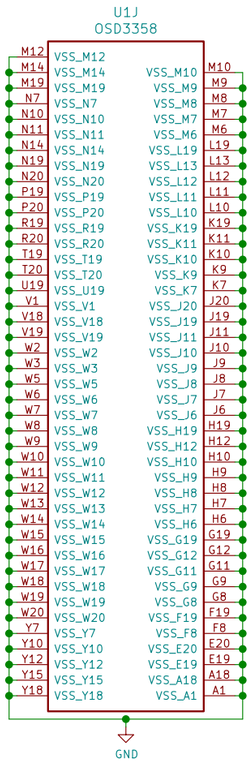
Voltage Regulator
voltage_regulator.sch

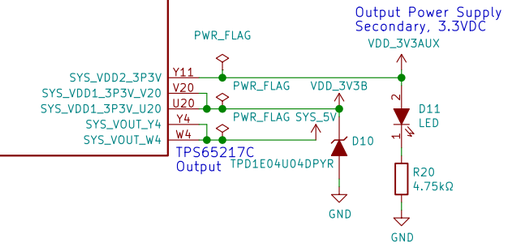


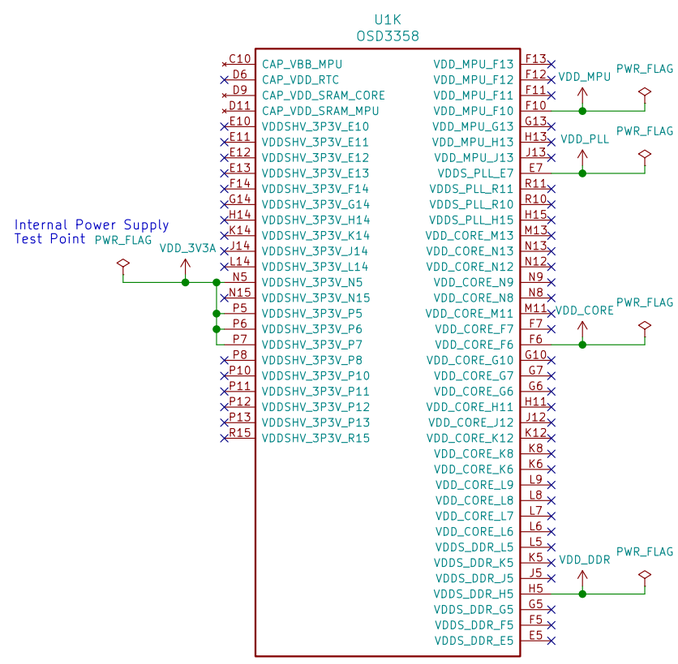
TLVH431IDBZR











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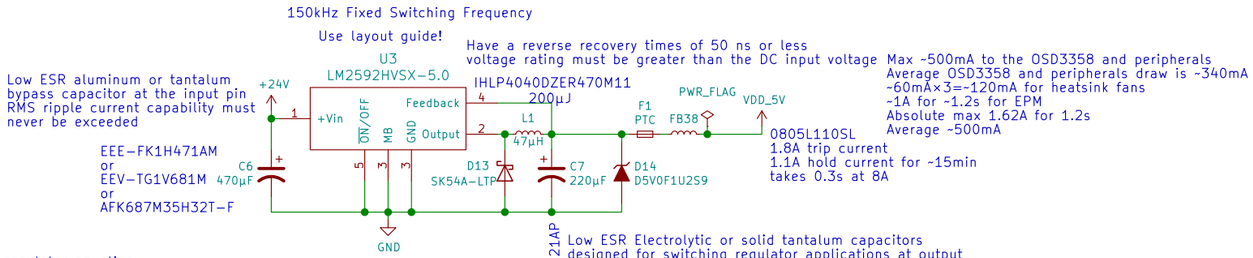
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 2/25

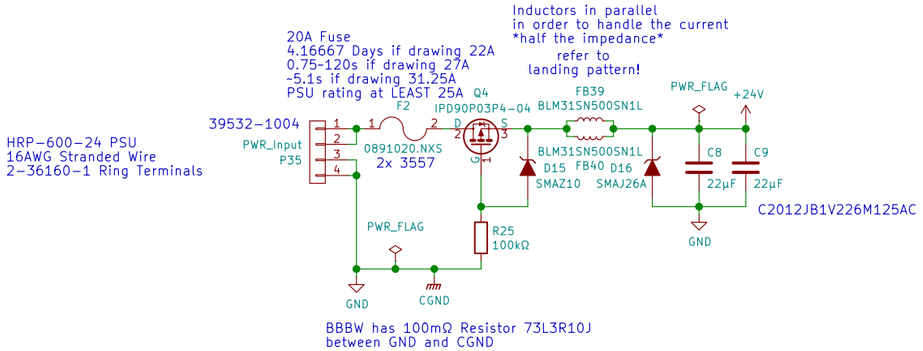


Inverting regulator equation

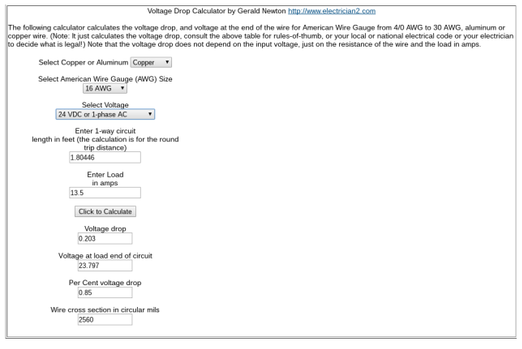
$$I_{PEAK} = I_{LOAD} \times \left(\frac{V_{IN} + V_{OUT}}{V_{IN}}\right) + \frac{V_{IN} \times V_{OUT} \times 10^6}{2 \times L \times f \times (V_{IN}+V_{OUT})}$$

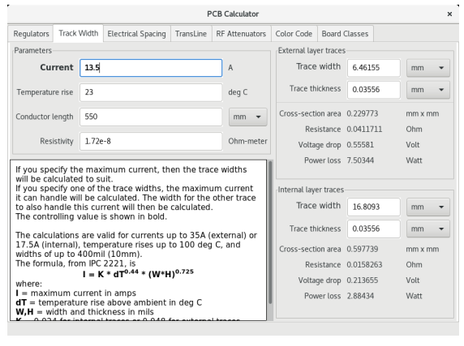
2.3=I_Load×(24+5)/24+((24×5×10^6)/(2×47×0.8×150×10^6×(5+24)))×1.2
I_Load=1.90308

Sheet: /Power/Voltage Regulator/		
File: voltage_regulator.sch		
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 3/25



AWG	Diameter		Turns of wire, without insulation		Area		Copper wire							
							Resistance/length[6]	Ampacity,[7] at 20 °C insulation material temperature rating, or 16 AWG and smaller for single unbundled wires in equipment[8]			Fusing current[9][10]			
								60 °C	75 °C	90 °C	Preece[11][12][13][14]	Onderdonk[15][14]		
	(in)	(mm)	(per in)	(per cm)	(kcmil)	(mm²)	(mΩ/m[6])	(mΩ/ft[6])	(A)			~10 s	1 s	32 ms
16	0.0508	1.291	19.7	7.75	2.58	1.31	13.17	4.016	22*free air	13*enclosed	18	117 A	398 A	2.2 kA



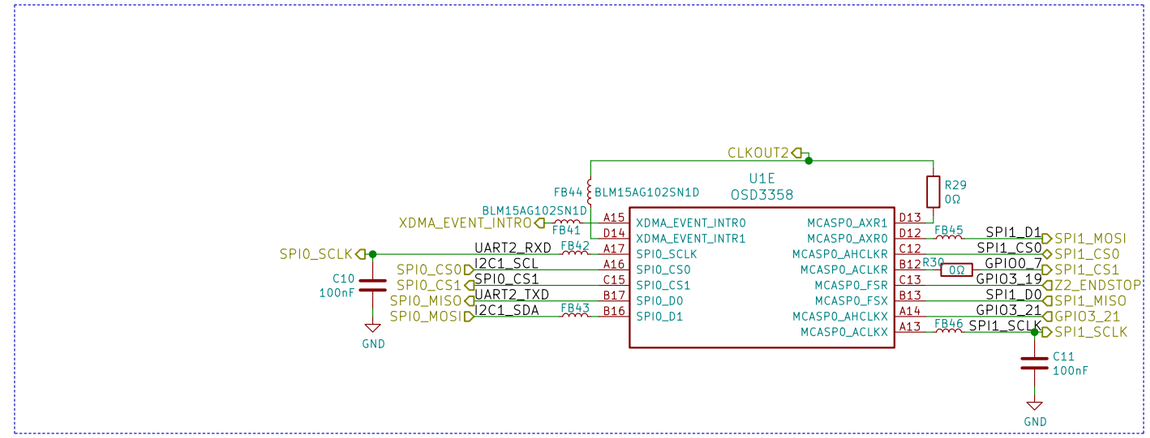


Sheet: /Power/Input/	
File: input.sch	
Title:	
Size: A3	Date:
KiCad E.D.A. kicad 4.0.6	Id: 4/25

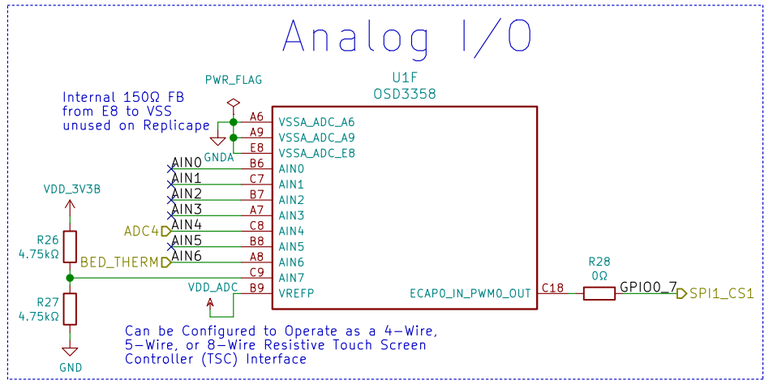
Unused

U1L
OSD3358

B1	NC_B1	EXTL3B	Y20
B2	NC_B2	EXTL3A	Y19
B3	NC_B3	EXTL2B	Y17
C1	NC_C1	EXTL2A	Y16
C2	NC_C2	EXTL1B	Y14
C3	NC_C3	EXTL1A	Y13
C4	NC_C4	NC_V11	V11
D1	NC_D1	NC_V10	V10
D2	NC_D2	NC_U11	U11
D3	NC_D3	NC_P4	P4
D4	NC_D4	NC_P3	P3
D5	NC_D5	NC_P2	P2
E1	NC_E1	NC_P1	P1
E2	NC_E2	NC_N4	N4
E3	NC_E3	NC_N3	N3
E4	NC_E4	NC_N2	N2
F1	NC_F1	NC_N1	N1
F2	NC_F2	NC_M4	M4
F3	NC_F3	NC_M3	M3
F4	NC_F4	NC_M2	M2
G1	NC_G1	NC_M1	M1
G2	NC_G2	NC_L4	L4
G3	NC_G3	NC_L3	L3
G4	NC_G4	NC_L2	L2
H1	NC_H1	NC_L1	L1
H2	NC_H2	NC_K4	K4
H3	NC_H3	NC_K3	K3
H4	NC_H4	NC_K2	K2
J1	NC_J1	NC_K1	K1
J2	NC_J2	NC_J4	J4
		NC_J3	J3
		TESTOUT	A3



Analog I/O



Sheet: /Microprocessor/		
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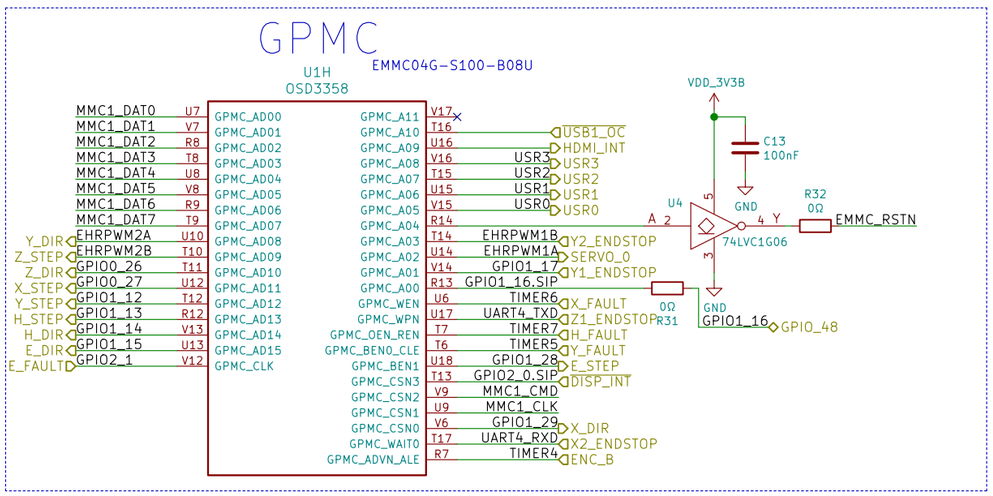
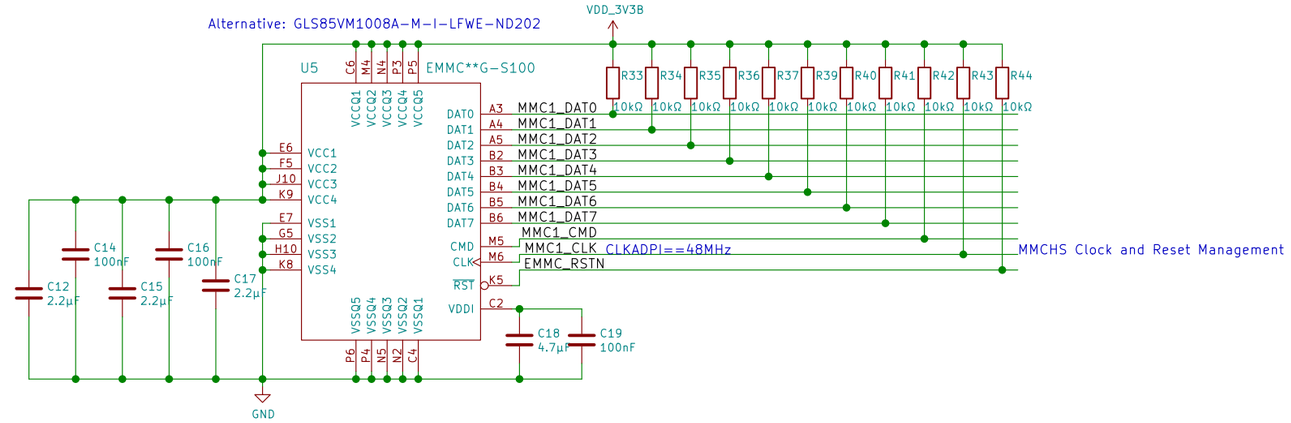
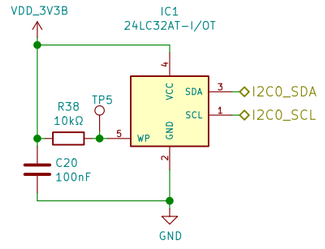
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 5/25





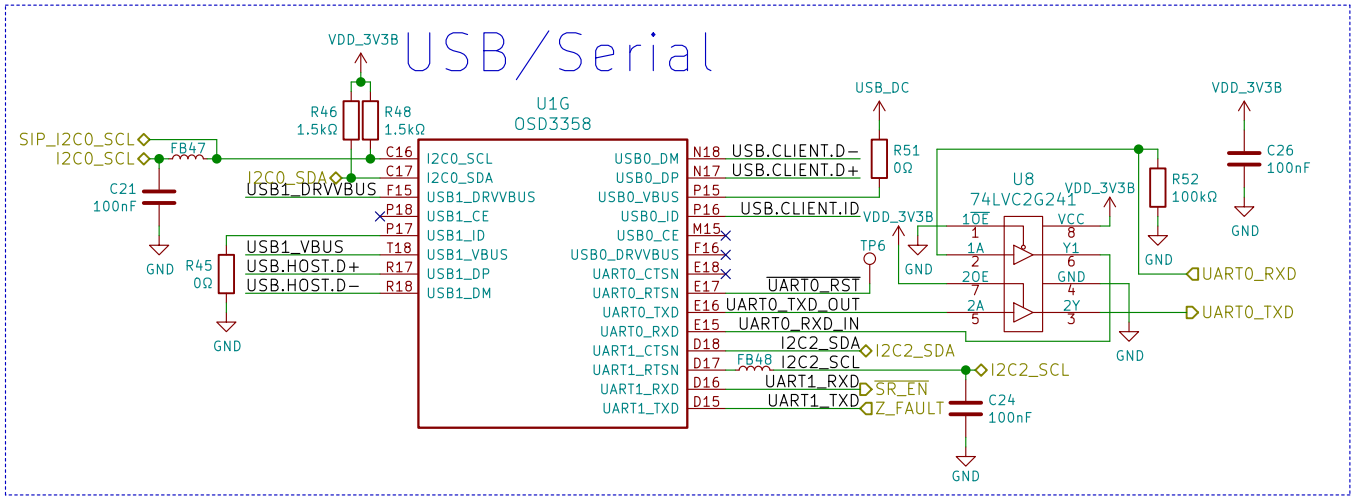


Removed OSC1, description for BBB (it is not applicable to Cimarron):

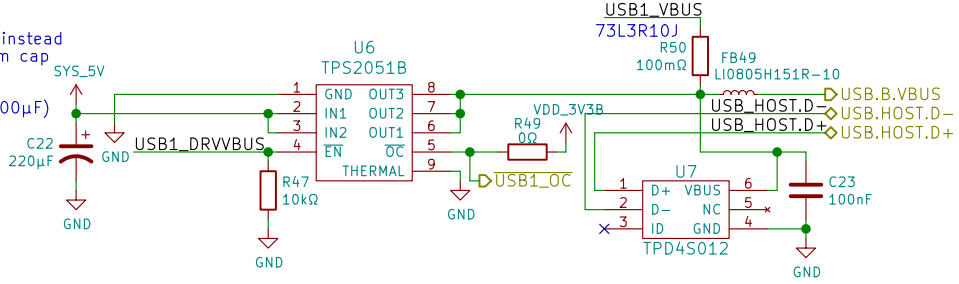
GPIO3_21 has a 24.576 MHZ clock on it.

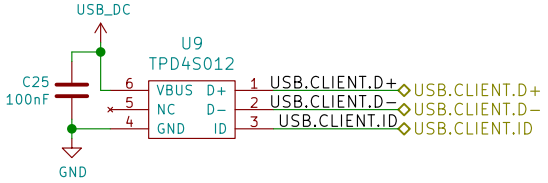
o This is required by the HDMI Framer for Audio purposes.
We needed to run a clock into the processor to generate the
correct clock frequency. The pin on the processor was already
routed to the expansion header. In order not to remove this
feature on the expansion header, it was left connected. In order
to use the pin as a GPIO pin, you need to disable the clock. While
this disables audio to the HDMI, the fact that you want to use
this pin for something else, does the same thing.

Sheet: /Flash/ File: flash.sch		
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 6/25



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

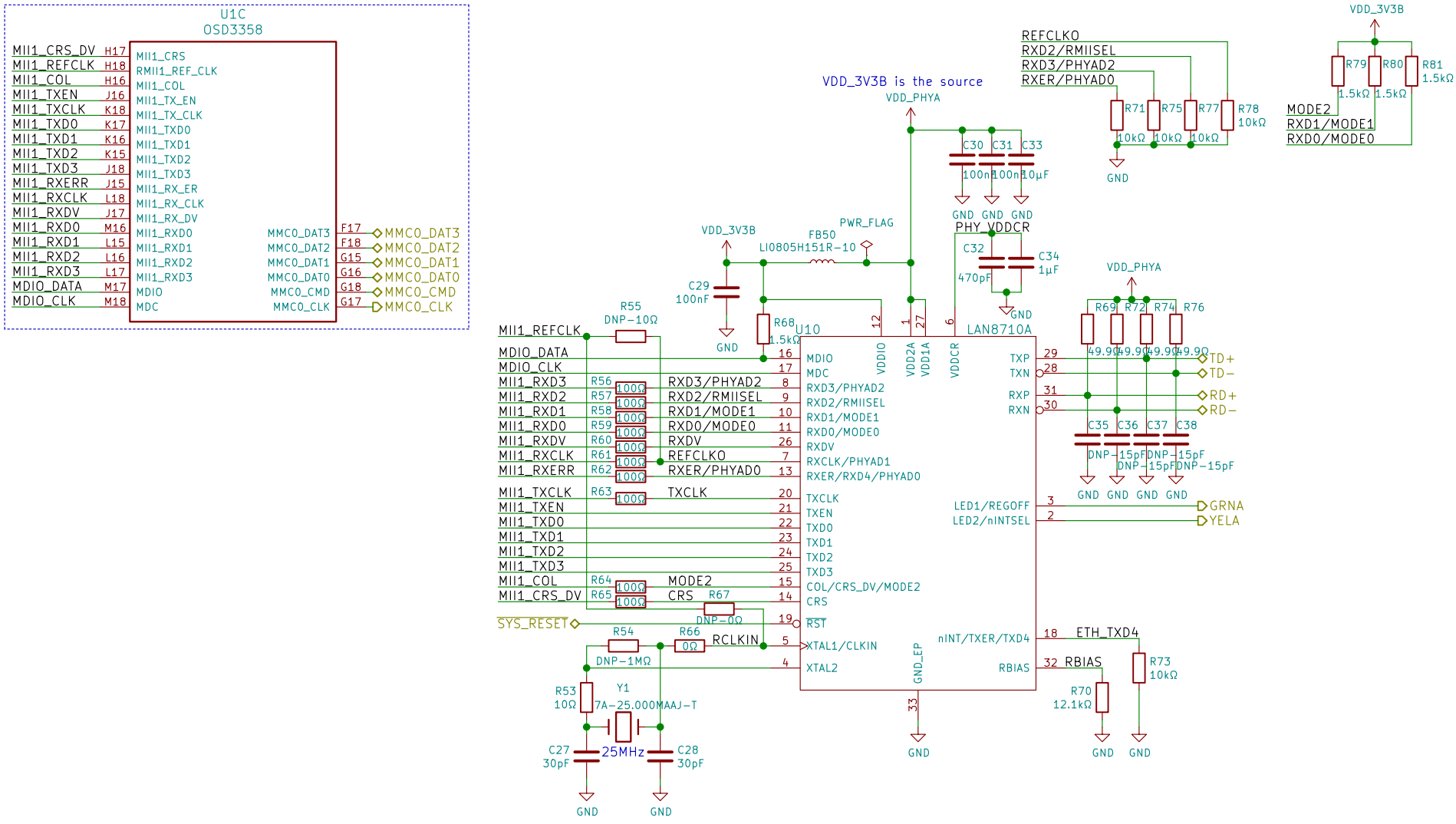


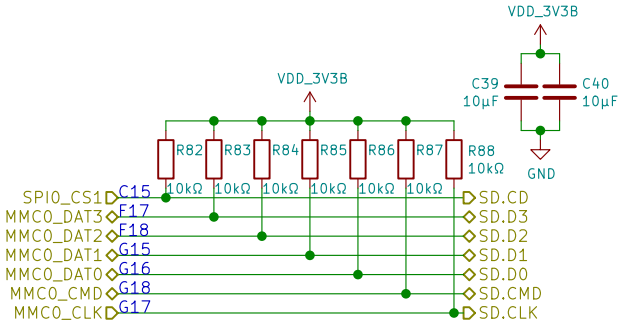


Sheet: /USB/
File: usb.sch

Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 7/25


U1C
OSD3358
MII1_CRS_DV H17
MII1_REFCLK H18
MII1_COL H16
MII1_TXEN J16
MII1_TXCLK K18
MII1_TXD0 K17
MII1_TXD1 K16
MII1_TXD2 K15
MII1_TXD3 J18
MII1_RXERR J15
MII1_RXCLK L18
MII1_RXDV J17
MII1_RXD0 M16
MII1_RXD1 L15
MII1_RXD2 L16
MII1_RXD3 L17
MDIO_DATA M17
MDIO_CLK M18
MII1_CRS
RMII1_REF_CLK
MII1_COL
MII1_TX_EN
MII1_TX_CLK
MII1_TXD0
MII1_TXD1
MII1_TXD2
MII1_TXD3
MII1_RX_ER
MII1_RX_CLK
MII1_RX_DV
MII1_RXD0
MII1_RXD1
MII1_RXD2
MII1_RXD3
MDIO
MDC
MMC0_DAT3 F17
MMC0_DAT2 F18
MMC0_DAT1 G15
MMC0_DAT0 G16
MMC0_CMD G18
MMC0_CLK G17
MMC0_DAT3
MMC0_DAT2
MMC0_DAT1
MMC0_DAT0
MMC0_CMD
MMC0_CLK
VDD_3V3B is the source
VDD_PHYA
C30 100n
C31 100n
C33 10µF
GND GND GND
REFCLKO
RXD2/RMIISEL
RXD3/PHYAD2
RXER/PHYAD0
R71 10kΩ
R75 10kΩ
R77 10kΩ
R78 10kΩ
GND
VDD_3V3B
R79 1.5kΩ
R80 1.5kΩ
R81 1.5kΩ
MODE2
RXD1/MODE1
RXD0/MODE0
VDD_3V3B
C29 100nF
GND
FB50
LI0805H151R-10
PWR_FLAG
PHY_VDDCR
C32 470pF
C34 1µF
GND
VDD_PHYA
R69 49.9Ω
R72 49.9Ω
R74 49.9Ω
R76 49.9Ω
R55 DNP-10Ω
R68 1.5kΩ
U10
LAN8710A
MII1_REFCLK
MDIO_DATA
MDIO_CLK
MII1_RXD3 R56 100Ω RXD3/PHYAD2
MII1_RXD2 R57 100Ω RXD2/RMIISEL
MII1_RXD1 R58 100Ω RXD1/MODE1
MII1_RXD0 R59 100Ω RXD0/MODE0
MII1_RXDV R60 100Ω RXDV
MII1_RXCLK R61 100Ω REFCLKO
MII1_RXERR R62 100Ω RXER/PHYAD0
MII1_TXCLK R63 100Ω TXCLK
MII1_TXEN
MII1_TXD0
MII1_TXD1
MII1_TXD2
MII1_TXD3
MII1_COL R64 100Ω MODE2
MII1_CRS_DV R65 100Ω CRS
R67 DNP-0Ω
SYS_RESET
R54 DNP-1MΩ
R66 0Ω RCLKIN
R53 10Ω
Y1 7A-25.000MAAJ-T
25MHz
C27 30pF
C28 30pF
GND GND
MDIO
MDC
RXD3/PHYAD2
RXD2/RMIISEL
RXD1/MODE1
RXD0/MODE0
RXDV
RXCLK/PHYAD1
RXER/RXD4/PHYAD0
TXCLK
TXEN
TXD0
TXD1
TXD2
TXD3
COL/CRS_DV/MODE2
CRS
RST
XTAL1/CLKIN
XTAL2
VDDIO
VDD2A
VDD1A
VDDCR
GND_EP
nINT/TXER/TXD4
RBIAS
TXP
TXN
RXP
RXN
LED1/REGOFF
LED2/nINTSEL
C35 DNP-15pF
C36 DNP-15pF
C37 DNP-15pF
C38 DNP-15pF
GND GND GND GND
TD+
TD−
RD+
RD−
GRNA
YELA
ETH_TXD4
R73 10kΩ
RBIAS
R70 12.1kΩ
GND GND
GND
Sheet: /Ethernet/
File: eth.sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. kicad 4.0.6
Id: 8/25



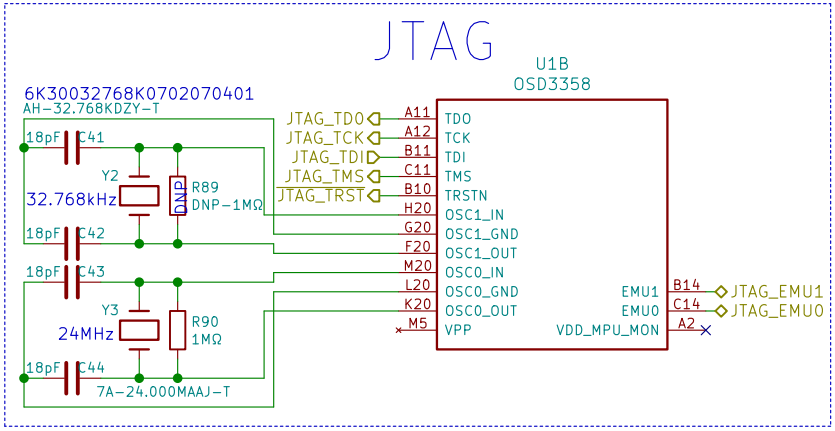
Sheet: /uSD Connector/
File: sd.sch

Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 9/25

https://www.digikey.com/products/en/crystals-oscillators-resonators/crystals/171?k=&pkeyword=&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

8.1.6.6 Spread Spectrum Clocking (SSC)



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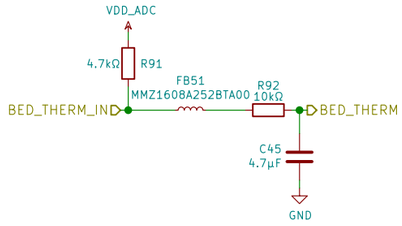
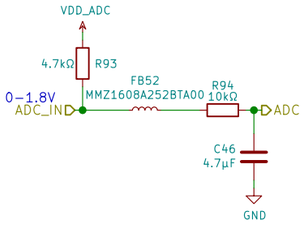
Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 10/25





Sheet: /Thermistors/
File: therm.sch

Title:

Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 11/25

TAZ 6 X&Y homing feedrate:
100µsteps/mm * 30mm/sec = 3000µsteps/sec
1/(3kHz) = 333.33µs

V_IH = 0.65*VDDS_DDR

RC_rise=183.3µs T_rise(20% to 80%) ≅ 1.4τ ≅ 256.62µs

256.62µs < 333.33µs

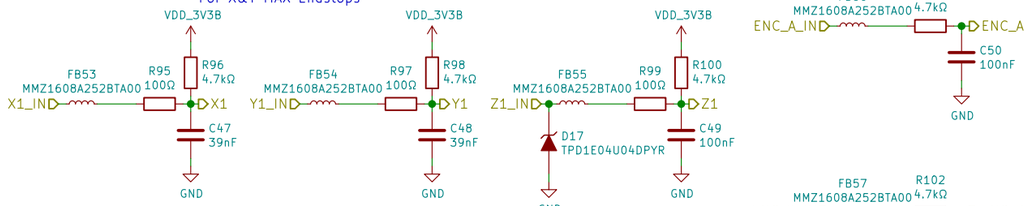
TAZ 6 Z homing feedrate:
1600µsteps/mm * 12mm/sec = 19200µsteps/sec
1/(19.2kHz) = 52.0833µs

V_IL=0.35*VDDS_DDR

RC_fall=10µs T_rise(80% to 20%) ≅ 1.4τ ≅ 14µs

14µs < 52.0833µs

Use TMC2130
Back-EMF Detection
DRV_STATUS Register
For X&Y MAX Endstops



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Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 12/25

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

SPI0_CS1 captures the data in the shift register and is ready to be driven by the second stage of D-FFs

$\overline{SR\_EN}$ (D16) reset state:
State of the terminal after the active low PWRONRSTn terminal transitions from low to high...
High-impedance with an active pullup resistor

Writing and outputting data:
1. Bring $\overline{SR\_EN}$ HIGH
 - output high-Z (pull-ups)
2. Write data
3. Toggle SPI0_CS1 _|‾|_
4. Bring $\overline{SR\_EN}$ LOW
 - output enabled, disable specific motors/ready to configure

Series resistor for reading temp whilst docking/undocking

Initial Condition ???
May not be needed, check section 6.6!!!

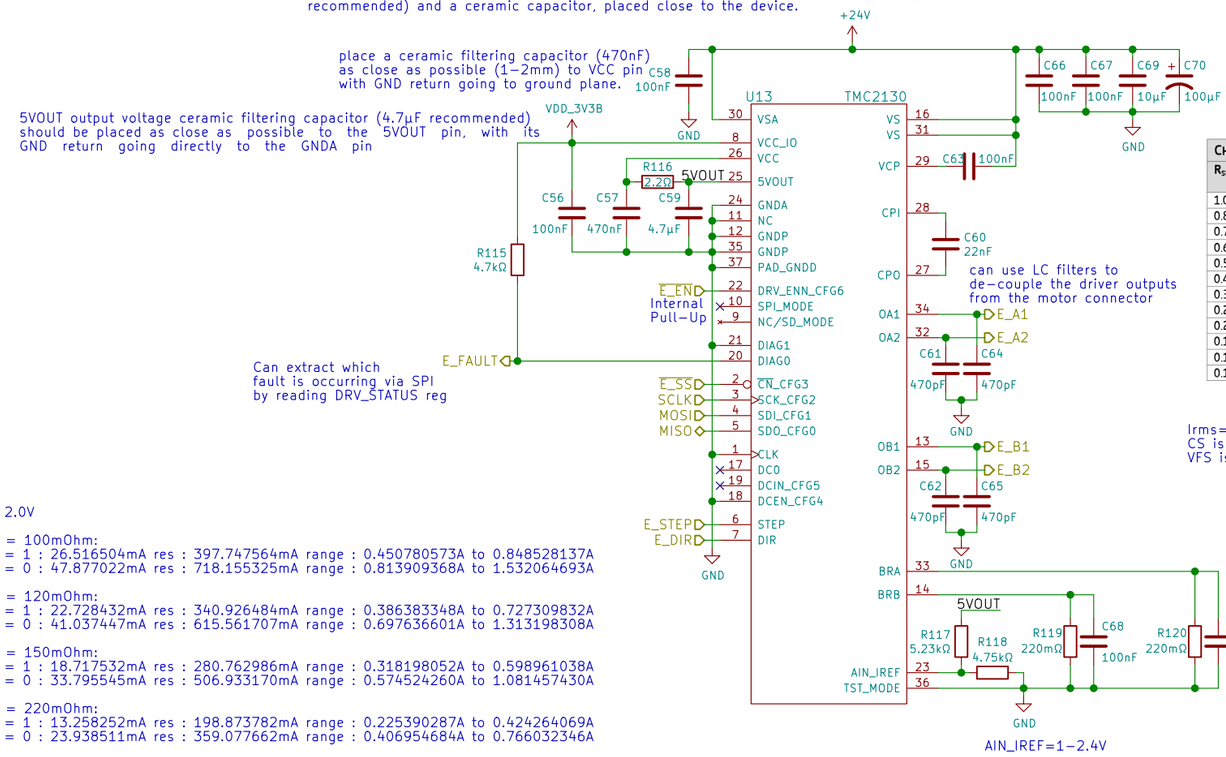
Can extract which fault is occurring via SPI by reading DRV_STATUS reg

Sheet: /Stepper Drivers/	
File: stepper.sch	
Title:	
Size: A3	Date:
KiCad E.D.A. kicad 4.0.6	Id: 13/25

See Chapter 29 of the datasheet for layout

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.

A 100nF filtering capacitor should be placed as close as possible to the VSA pin to ground plane. The motor supply pins VS should be decoupled with an electrolytic capacitor (47µF or larger is recommended) and a ceramic capacitor, placed close to the device.



CHOICE OF R_{SENSE} AND RESULTING MAX. MOTOR CURRENT		
R_{SENSE} [Ω]	*RMS current [A] (CS=31, vsense=0)*	*RMS current [A] (CS=31, vsense=1)*
1.00	0.23	0.12
0.82	0.27	0.15
0.75	0.30	0.17
0.68	0.33	0.18
0.50	0.44	0.24
0.47	0.47	0.26
0.33	0.66	0.36
0.27	0.79	0.44
0.22	0.96	0.53
0.15	1.35	0.75
0.12	1.64	0.91
0.10	1.92*)	1.06

Irms=(CS+1)/32 × Vfs/(Rsense+20mΩ) × 1/√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

Vain = 2.0V

Rsense = 100mOhm:
Vsense = 1 : 26.516504mA res : 397.747564mA range : 0.450780573A to 0.848528137A
Vsense = 0 : 47.877022mA res : 718.155325mA range : 0.813909368A to 1.532064693A

Rsense = 120mOhm:
Vsense = 1 : 22.728432mA res : 340.926484mA range : 0.386383348A to 0.727309832A
Vsense = 0 : 41.037447mA res : 615.561707mA range : 0.697636601A to 1.313198308A

Rsense = 150mOhm:
Vsense = 1 : 18.717532mA res : 280.762986mA range : 0.318198052A to 0.598961038A
Vsense = 0 : 33.795545mA res : 506.933170mA range : 0.574524260A to 1.081457430A

Rsense = 220mOhm:
Vsense = 1 : 13.258252mA res : 198.873782mA range : 0.225390287A to 0.424264069A
Vsense = 0 : 23.938511mA res : 359.077662mA range : 0.406954684A to 0.766032346A

Vain = 2.4V

Rsense = 220mOhm:
Vsense = 1 : 15.909903mA res : 238.648538mA range : 0.270468344A to 0.509116882A
Vsense = 0 : 28.726213mA res : 430.893195mA range : 0.488345621A to 0.919238816A

Vain = 2.379759519V

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

Bit 0 of GCONF:
I_scale_analog
0: Normal operation, use internal reference voltage
1: Use voltage supplied to AIN as current reference

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

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

Choose sense resistors in a way, that normal IRUN is 16 to 31 for best microstep performance.

For best precision, choose the sense resistors in a way that the desired maximum current is reached with AIN in the range 2V to 2.4V

Sense input tolerance / motor current full scale tolerance -using internal reference	I_{COIL}	*I_scale_analog*=0, *vsense*=0	-5		+5	%
Sense input tolerance / motor current full scale tolerance -using external reference voltage	I_{COIL}	*I_scale_analog*=1, V_{AIN}=2V, *vsense*=0	-2		+2	%

Vain = 2.379759519V

The sense resistor voltage range can be selected by the vsense bit in CHOPCONF. The low sensitivity setting (high sense resistor voltage, vsense=0) brings *best and most robust current regulation*, while high sensitivity (low sense resistor voltage, vsense=1) reduces power dissipation in the sense resistor. The high sensitivity setting reduces the power dissipation in the sense resistor by nearly half.

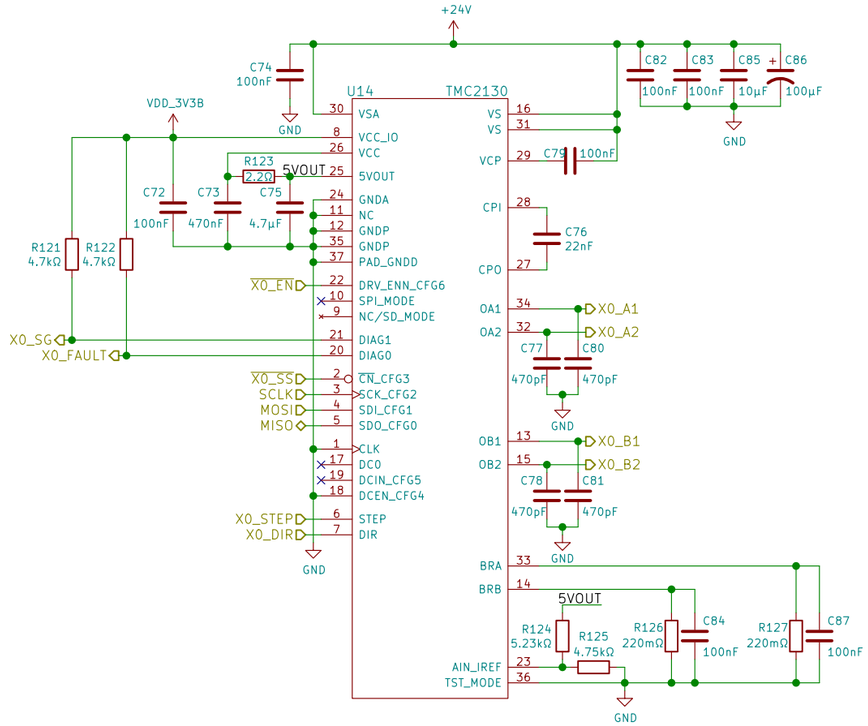
vsense	Allows control of the sense resistor *voltage range* for full scale current.	0	V_{FS} = 0.32 V
		1	V_{FS} = 0.18 V

Vsrtl=325mV

Sheet: /Stepper Drivers/E Stepper Driver/
File: e_stepper.sch

Title:

Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad 4.0.6		Id: 14/25



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File: x0_stepper.sch

Title:

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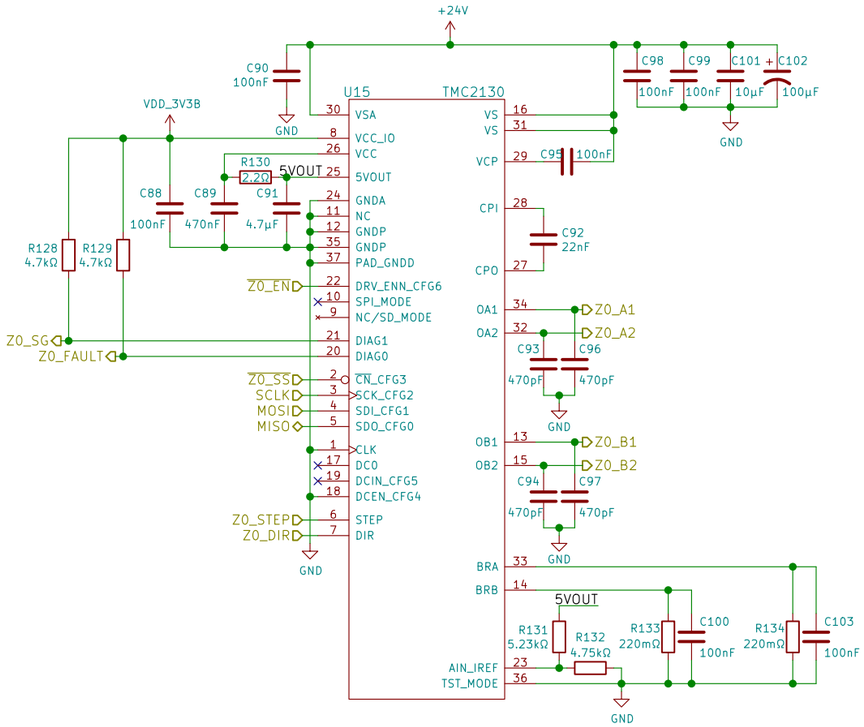

Sheet: /Stepper Drivers/Z0 Stepper Driver/		
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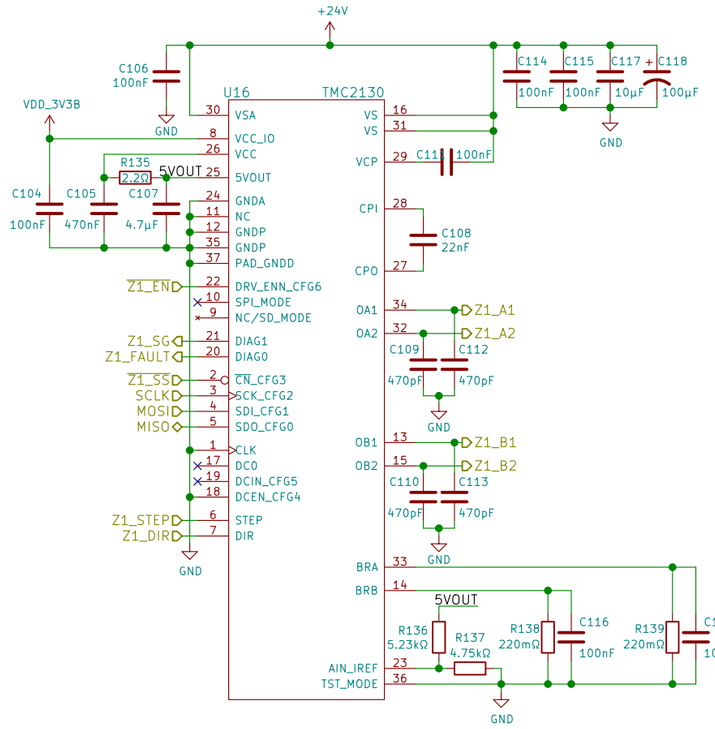

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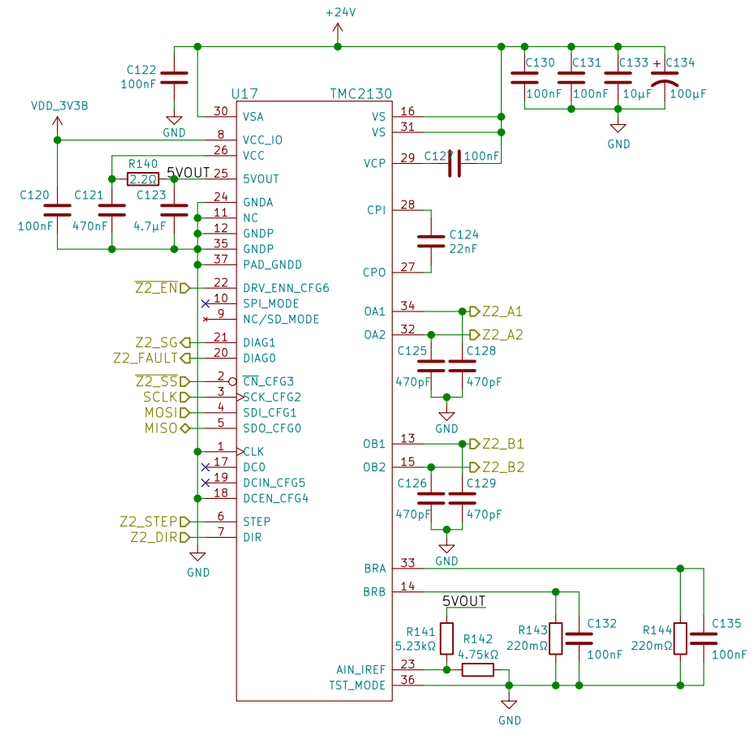

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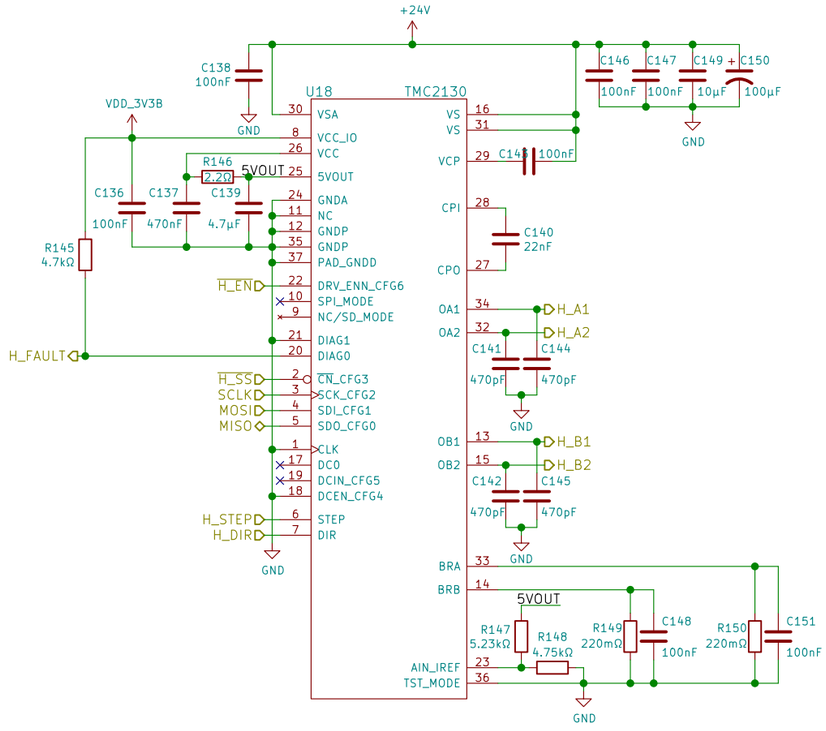

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File: h_stepper.sch

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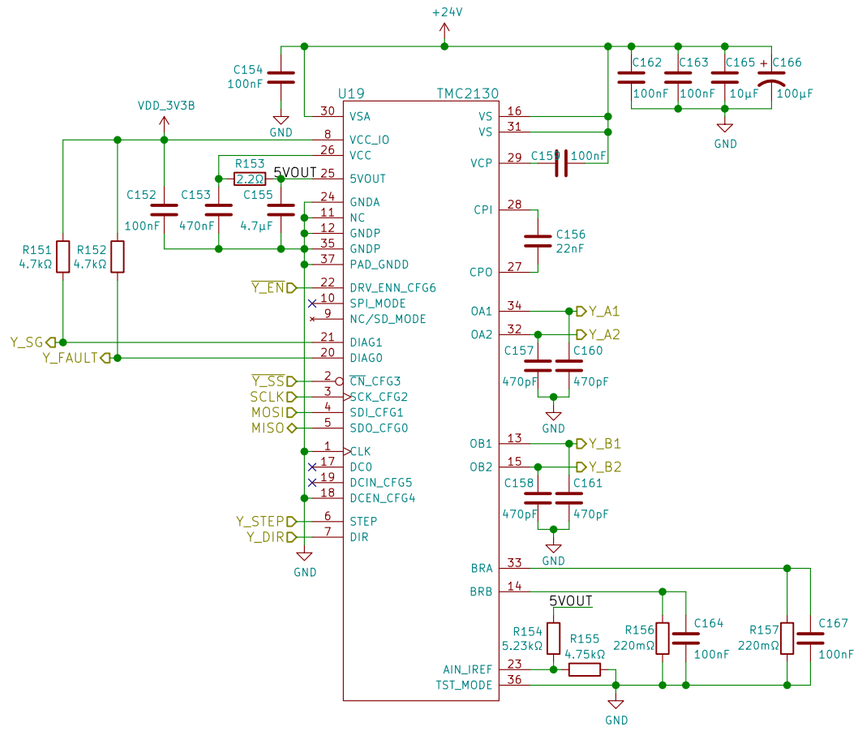

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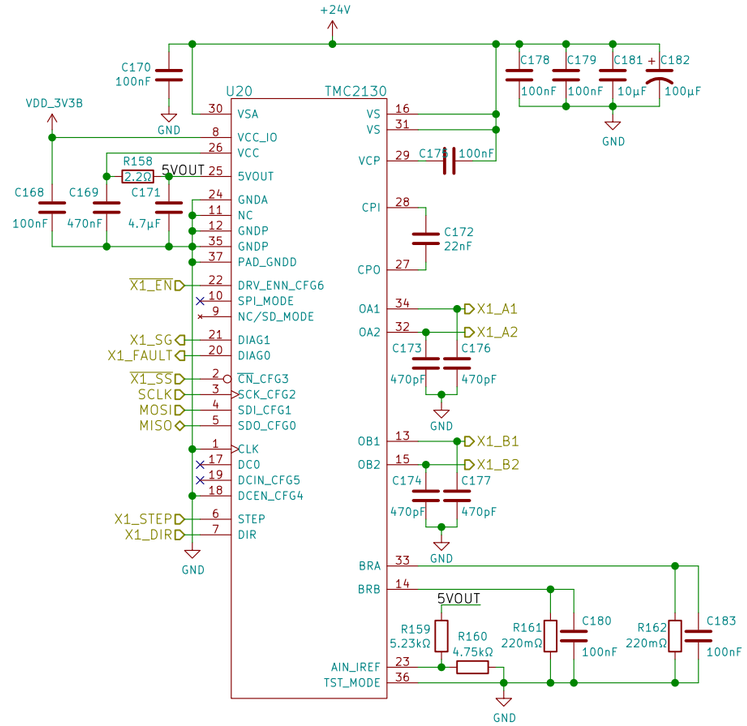

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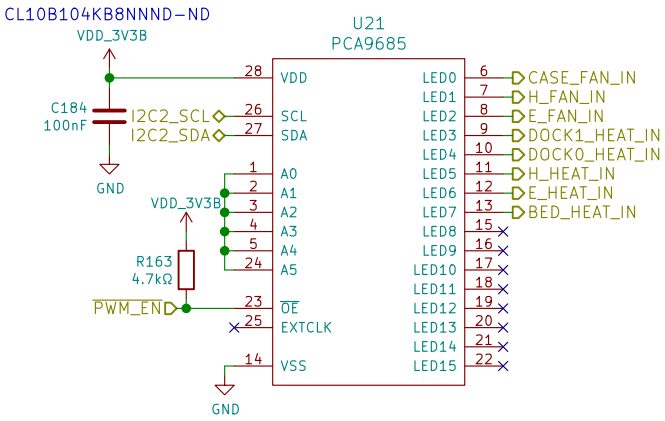

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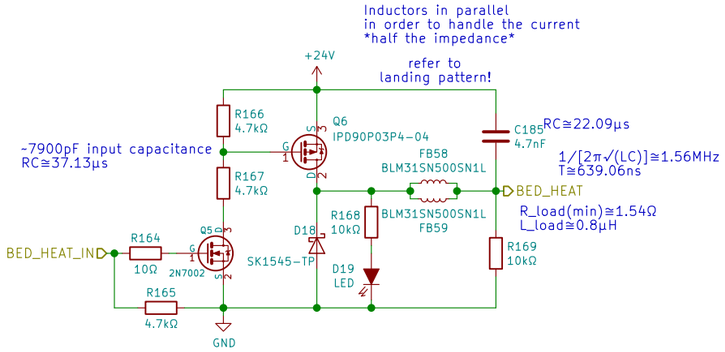
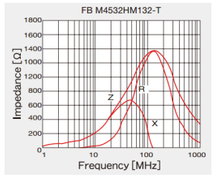
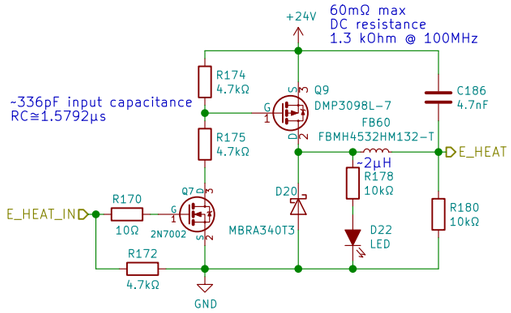
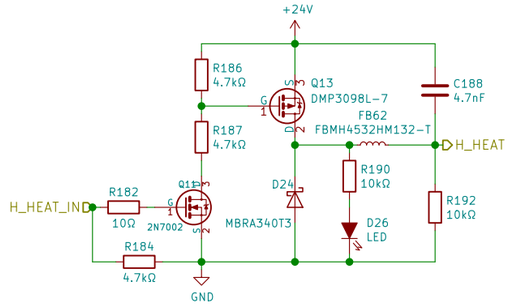
Size: A4 | Date: | **Rev:**

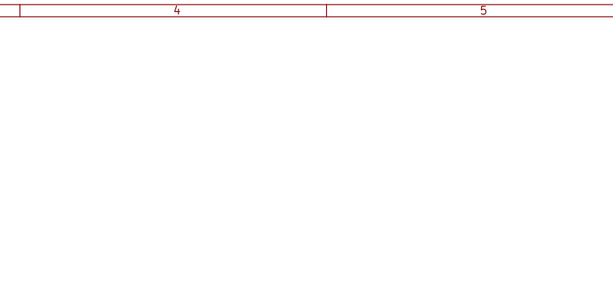
KiCad E.D.A. kicad 4.0.6 | Id: 22/25

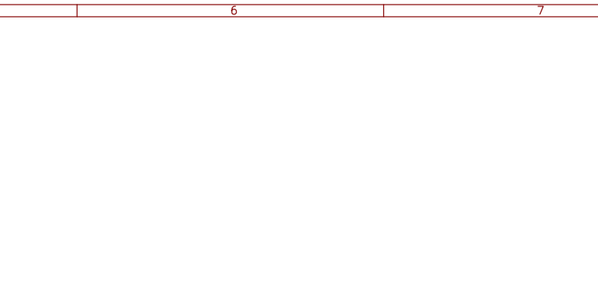








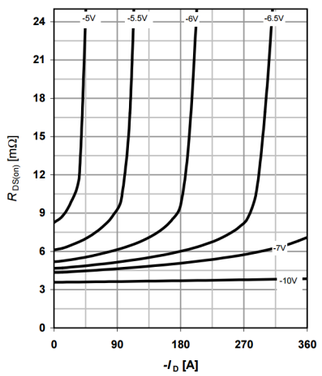




6 Typ. drain-source on-state resistance

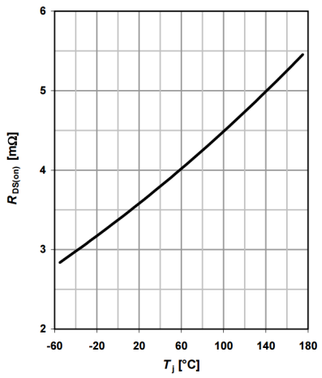
$R_{DS(on)} = (I_D)$; $T_j = 25$ °C

parameter: V_{GS}



8 Typ. drain-source on-state resistance

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



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Size: A3	Date:	**Rev:**
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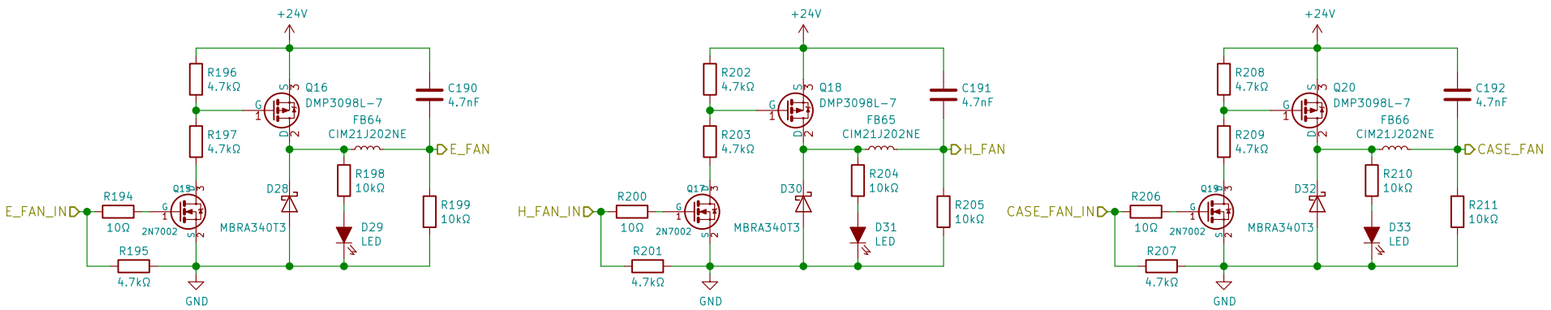

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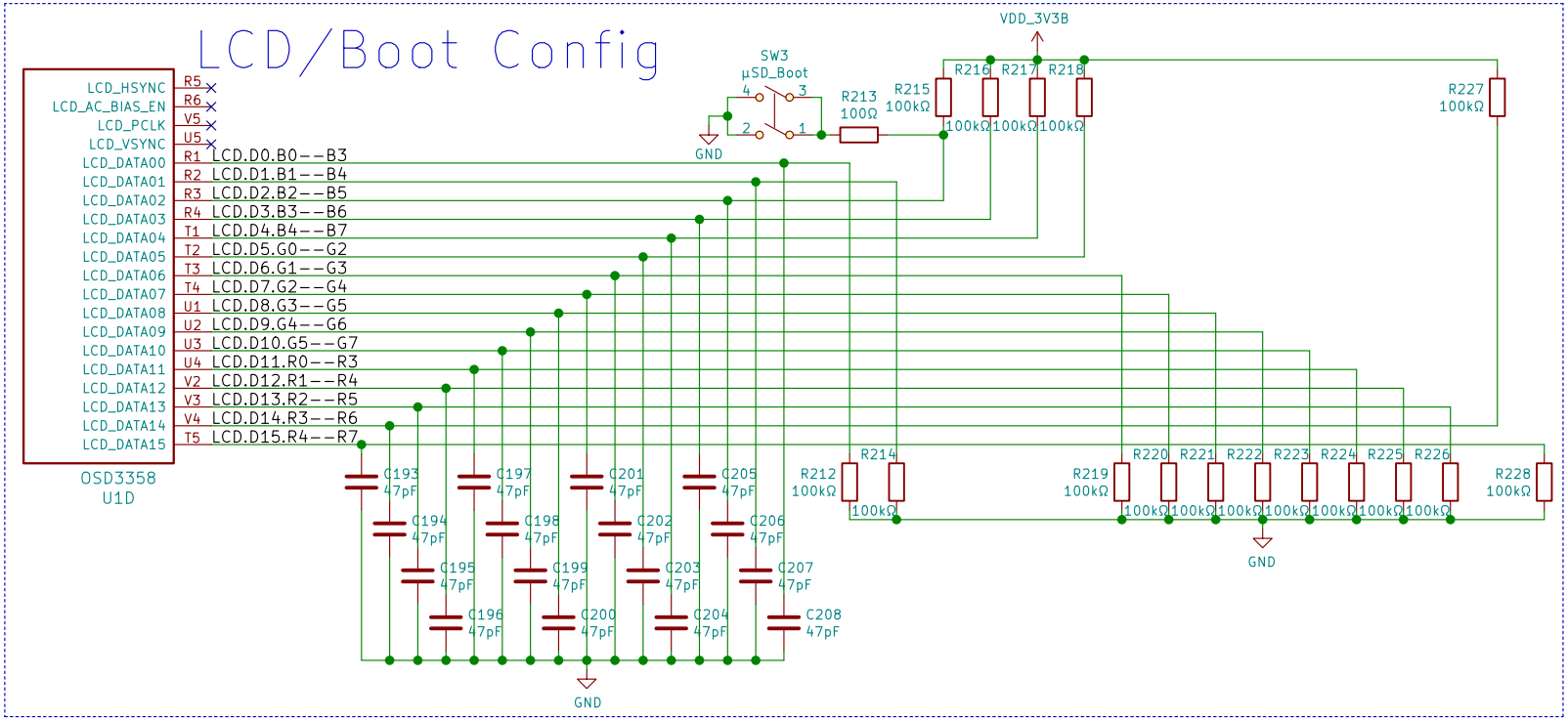

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