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
X1_ENDSTOP GPIO3_21
X2_ENDSTOP X2_ENDSTOP
Y1_ENDSTOP Y1_ENDSTOP
Z1_ENDSTOP Z1_ENDSTOP
USR3 USR3
USR2 USR2
USR1 USR1
USR0 USR0
I2C0_SDA I2C0_SDA
I2C0_SCL I2C0_SCL
ENC_A GPIO_48
ENC_B ENC_B
HDMI_INT HDMI_INT
USB1_OC USB1_OC
DISP_INT DISP_INT
Unused on BBBW
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 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
3V3_FILTERED SPI0_SCLK SPI0_MISO SPI0_MOSI SPI0_CS0 DISP_INT
P17 LCD
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
eth.sch
R5 470Ω R7 10kΩ R8 470Ω C6 22nF
P14 µSD
µSD Connector
MMC0_DAT2 MMC0_DAT3 MMC0_CMD MMC0_CLK MMC0_DAT1 MMC0_DAT0 SPI0_CS1
SD.D2 SD.D3 SD.CMD SD.CLK SD.D0 SD.D1 SD.CD
DAT2 DAT3/CD CMD VDD CLK VSS DAT0 DAT1 SD.CD
CGND1 CGND2 CGND3 CGND4 CGND5 CGND6 CGND
sd.sch
JTAG
JTAG_TRST JTAG_TMS JTAG_TDI JTAG_TDO JTAG_TCK JTAG_EMU0 JTAG_EMU1
TVDD TCK SYS_RESET XDMA_EVENT_INTRO SD.CD CLKOUT2
P16 JTAG
R6 4.75kΩ R10 4.75kΩ R11 4.75kΩ
C5 100nF C7 100nF
jtag.sch

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 SPI1_SCLK SPI1_MISO SPI1_MOSI SPI1_CS0 Shift Registers SPI1_CS1 Available
mpu.sch

Feedback Input

VDD_3V3B FB1 3V3_FILTERED C1 100nF C3 10nF D2
BED_THERM P9 P10 ADC
Thermistors
BED_THERM_IN ADC_IN
BED_THERM ADC
therm.sch
VDD_5V FB2 C2 100nF C4 10nF D1
P1 TOOLHEAD0 FB3 SS_TOOLHEAD0_T FB4 SS_TOOLHEAD0_NVM
P2 TOOLHEAD1 FB5 SS_TOOLHEAD1_T FB6 SS_TOOLHEAD1_NVM
P3 DOCK0 FB7 SS_DOCK0_T FB8 SS_DOCK0_NVM
P4 DOCK1 FB9 SS_DOCK1_T FB10 SS_DOCK1_NVM
SCLK DI DO
SCLK FB12 SPI1_SCLK
DI FB11 MMZ1608A252BTA00 SPI1_MISO
DO FB13 SPI1_MOSI
MMZ1608A252BTA00
Potential 02X08 Connector:
https://www.digikey.com/product-detail/en/molex-llc/90130-3116/WM8266-ND/760978
Endstops
P5 X1 P6 Y1 P7 Z1 P8 ENC
X1_IN Y1_IN Z1_IN ENC_A_IN ENC_B_IN
X1 Y1 Z1 ENC_A ENC_B
X1_ENDSTOP Y1_ENDSTOP Z1_ENDSTOP ENC_A ENC_B
endstop.sch

Output

VDD_3V3B VDD_5V
R12 4.7kΩ 2N7002 R13 4.7kΩ
SERVO_0
EPM/Servo
FB19 FB20 P35 PWM
D7 D5V0F1U2S9 D8 D5V0F1U2S9
GND
Stepper Drivers
SR_EN SPI1_SCLK SPI1_MISO SPI1_MOSI SPI1_CS0
E_STEP E_DIR E_FAULT
H_STEP H_DIR H_FAULT
X_STEP X_DIR X_ENDSTOP X_FAULT
Y_STEP Y_DIR Y2_ENDSTOP Y_FAULT
Z_STEP Z_DIR Z2_ENDSTOP Z_FAULT
SS_TOOLHEAD0_T SS_TOOLHEAD0_NVM SS_TOOLHEAD1_T SS_TOOLHEAD1_NVM
SS_DOCK0_T SS_DOCK0_NVM SS_DOCK1_T SS_DOCK1_NVM
E_A1 E_A2 E_B1 E_B2 P18 E_MOTOR
H_A1 H_A2 H_B1 H_B2 P19 H_MOTOR
X0_A1 X0_A2 X0_B1 X0_B2 P20 X0_MOTOR
X1_B2 X1_B1 X1_A2 X1_A1 P21 X1_MOTOR
Y_A1 Y_B1 P22 Y0_MOTOR Moves in opposing directions
Y_B2 Y_A2 P23 Y1_MOTOR
Z0_A1 Z0_A2 Z0_B1 Z0_B2 P24 Z0_MOTOR
Z1_A1 Z1_A2 Z1_B1 Z1_B2 P25 Z1_MOTOR
Z2_A1 Z2_A2 Z2_B1 Z2_B2 P26 Z2_MOTOR
stepper.sch
39532-1002 4.2x2.1 mm
PWM
I2C2_SCL I2C2_SDA PWM_EN
Heaters
BED_HEAT E_HEAT H_HEAT DOCK0_HEAT DOCK1_HEAT
BED_HEAT E_HEAT H_HEAT DOCK0_HEAT DOCK1_HEAT
P27 BED_HEAT P28 E_HEAT P29 H_HEAT P30 DOCK0_HEAT P31 DOCK1_HEAT
heater.sch
pwm.sch
Fans
E_FAN H_FAN CASE_FAN
E_FAN H_FAN CASE_FAN
P32 E_FAN P33 H_FAN P34 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 (2016-12-15 revision b13c7e4)-master | Id: 1/25

Input
input.sch

Voltage_Regulator
voltage_regulator.sch

U1I
OSD3358

SYS_RTC_1P8V_P9 P9
SYS_RTC_1P8V_P14 P14
SYS_RTC_1P8V_N6 N6
SYS_RTC_1P8V_K13 K13
SYS_RTC_1P8V_F9 F9
SYS_RTC_1P8V_E14 E14
SYS_RTC_1P8V_E6 E6
SYS_RTC_1P8V_D7 D7
SYS_VDD_1P8V_N16 N16
SYS_VDD_1P8V_R16 R16
SYS_VDD_1P8V_E9 E9
SYS_VDD_1P8V_D10 D10
SYS_ADC_1P8V_D8 D8
SYS_ADC_1P8V_A5 A5
SYS_ADC_1P8V_A4 A4

VDD_RTC
VDD_1V8
VDD_ADC
PWR_FLAG

VDD_3V3A
VDD_3V3B
R16 499Ω
R17 DNPΩ
R18 10kΩ
Q2 MMBT2907
DNP
DNP-MMBT2907
D9 TLVH431
R19 40.2kΩ
VDD_1V8
DNP-TLVH431
R21 DNP-499Ω
R22 DNPΩ
R23 DNP-10kΩ
Q3
D12
R24 DNP-40.2kΩ
TLVH431IDBZR

5V Input
VDD_5V
FB21 MPZ1608S102ATA00
C9 100nF
GND
USB_DC

U1A
OSD3358

VIN_AC_Y5 Y5
VIN_AC_Y6 Y6
VIN_USB_Y8 Y8
VIN_USB_Y9 Y9
VIN_BAT_Y2 Y2
VIN_BAT_Y3 Y3
BAT_VOLT Y1
BAT_TEMP W1
PMIC_POWER_EN C6
PMIC_IN_PWR_EN D19
PMIC_IN_PB_IN D20
EXT_WAKEUP C5
EXTINTN B18
PMIC_OUT_PGOOD A20
PMIC_OUT_LDO_PGOOD B20
PMIC_OUT_NWAKEUP A19
PMIC_OUT_NINT B19
PWRONRSTN B15
WARMRSTN A10
RTC_PWRONRSTN B5
RTC_KALDO_ENN B4
PMIC_IN_I2C_SCL C20
PMIC_IN_I2C_SDA C19

TP1
TP2
TP3
TP4
VIN_BAT
BAT_VOLT
BAT_TEMP
PWR_BUT
PMIC_NWAKEUP
PMIC_INT
PMIC_PGOOD
LDO_PGOOD
PMIC_NWAKEUP
PMIC_INT
PMIC_PGOOD
SYS_RESET
LDO_PGOOD
I2C0_SCL
I2C0_SDA

VDD_3V3B
VDD_1V8
R14 10kΩ
U2 74LVC1G06
SW1 RESET
SW2 Power
C8 2.2µF
R15 10kΩ
GND

U1J
OSD3358

VSS_M12 M12
VSS_M14 M14
VSS_M19 M19
VSS_N7 N7
VSS_N10 N10
VSS_N11 N11
VSS_N14 N14
VSS_N19 N19
VSS_N20 N20
VSS_P19 P19
VSS_P20 P20
VSS_R19 R19
VSS_R20 R20
VSS_T19 T19
VSS_T20 T20
VSS_U19 U19
VSS_V1 V1
VSS_V18 V18
VSS_V19 V19
VSS_W2 W2
VSS_W3 W3
VSS_W5 W5
VSS_W6 W6
VSS_W7 W7
VSS_W8 W8
VSS_W9 W9
VSS_W10 W10
VSS_W11 W11
VSS_W12 W12
VSS_W13 W13
VSS_W14 W14
VSS_W15 W15
VSS_W16 W16
VSS_W17 W17
VSS_W18 W18
VSS_W19 W19
VSS_W20 W20
VSS_Y7 Y7
VSS_Y10 Y10
VSS_Y12 Y12
VSS_Y15 Y15
VSS_Y18 Y18
VSS_M10 M10
VSS_M9 M9
VSS_M8 M8
VSS_M7 M7
VSS_M6 M6
VSS_L19 L19
VSS_L13 L13
VSS_L12 L12
VSS_L11 L11
VSS_L10 L10
VSS_K19 K19
VSS_K11 K11
VSS_K10 K10
VSS_K9 K9
VSS_K7 K7
VSS_J20 J20
VSS_J19 J19
VSS_J11 J11
VSS_J10 J10
VSS_J9 J9
VSS_J8 J8
VSS_J7 J7
VSS_J6 J6
VSS_H19 H19
VSS_H12 H12
VSS_H10 H10
VSS_H9 H9
VSS_H8 H8
VSS_H7 H7
VSS_H6 H6
VSS_G19 G19
VSS_G12 G12
VSS_G11 G11
VSS_G9 G9
VSS_G8 G8
VSS_F19 F19
VSS_F8 F8
VSS_E20 E20
VSS_E19 E19
VSS_A18 A18
VSS_A1 A1
GND

Internal Power Supply
Test Point PWR_FLAG
VDD_3V3A

U1K
OSD3358

CAP_VBB_MPU C10
CAP_VDD_RTC D6
CAP_VDD_SRAM_CORE D9
CAP_VDD_SRAM_MPU D11
VDDSHV_3P3V_E10 E10
VDDSHV_3P3V_E11 E11
VDDSHV_3P3V_E12 E12
VDDSHV_3P3V_E13 E13
VDDSHV_3P3V_F14 F14
VDDSHV_3P3V_G14 G14
VDDSHV_3P3V_H14 H14
VDDSHV_3P3V_K14 K14
VDDSHV_3P3V_J14 J14
VDDSHV_3P3V_L14 L14
VDDSHV_3P3V_N5 N5
VDDSHV_3P3V_N15 N15
VDDSHV_3P3V_P5 P5
VDDSHV_3P3V_P6 P6
VDDSHV_3P3V_P7 P7
VDDSHV_3P3V_P8 P8
VDDSHV_3P3V_P10 P10
VDDSHV_3P3V_P11 P11
VDDSHV_3P3V_P12 P12
VDDSHV_3P3V_P13 P13
VDDSHV_3P3V_R15 R15
VDD_MPU_F13 F13
VDD_MPU_F12 F12
VDD_MPU_F11 F11
VDD_MPU_F10 F10
VDD_MPU_G13 G13
VDD_MPU_H13 H13
VDD_MPU_J13 J13
VDDS_PLL_E7 E7
VDDS_PLL_R11 R11
VDDS_PLL_R10 R10
VDDS_PLL_H15 H15
VDD_CORE_M13 M13
VDD_CORE_N13 N13
VDD_CORE_N12 N12
VDD_CORE_N9 N9
VDD_CORE_N8 N8
VDD_CORE_M11 M11
VDD_CORE_F7 F7
VDD_CORE_F6 F6
VDD_CORE_G10 G10
VDD_CORE_G7 G7
VDD_CORE_G6 G6
VDD_CORE_H11 H11
VDD_CORE_J12 J12
VDD_CORE_K12 K12
VDD_CORE_K8 K8
VDD_CORE_K6 K6
VDD_CORE_L9 L9
VDD_CORE_L8 L8
VDD_CORE_L7 L7
VDD_CORE_L6 L6
VDDS_DDR_L5 L5
VDDS_DDR_K5 K5
VDDS_DDR_J5 J5
VDDS_DDR_H5 H5
VDDS_DDR_G5 G5
VDDS_DDR_F5 F5
VDDS_DDR_E5 E5

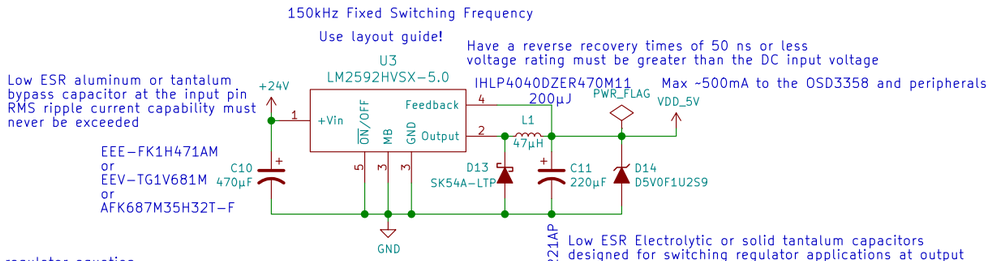
VDD_MPU
VDD_PLL
VDD_CORE
VDD_DDR
PWR_FLAG

Output Power Supply
Secondary, 3.3VDC
PWR_FLAG
VDD_3V3AUX
SYS_VDD2_3P3V Y11
SYS_VDD1_3P3V_V20 V20
SYS_VDD1_3P3V_U20 U20
SYS_VOUT_Y4 Y4
SYS_VOUT_W4 W4
PWR_FLAG
PWR_FLAG
VDD_3V3B
SYS_5V
TPS65217C
Output TPD1E04U04DPYR
D10
D11 LED
R20 4.75kΩ
GND

Sheet: /Power/
File: power.sch

Title:

Size: A3 | Date: | Rev:
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master | Id: 2/25

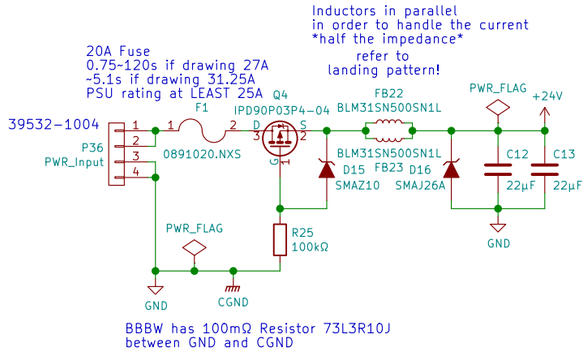


Inverting regulator equation

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

$2.3 = I\_Load \times (24+5)/24 + ((24 \times 5 \times 10\hat{}6)/(2 \times 47 \times 0.8 \times 150 \times 10\hat{}6 \times (5+24))) \times 1.2$
$I\_Load = 1.90308$

Sheet: /Power/Voltage Regulator/		
File: voltage_regulator.sch		
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master		Id: 3/25



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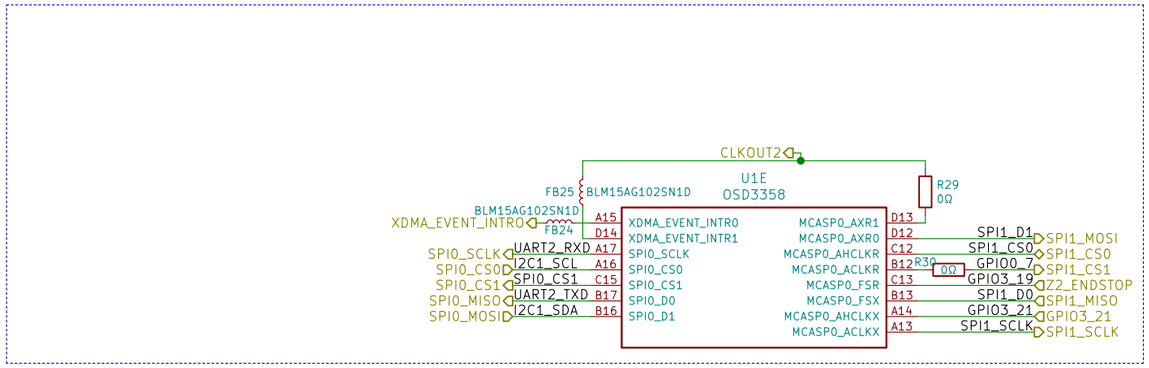
File: input.sch		
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master		Id: 4/25

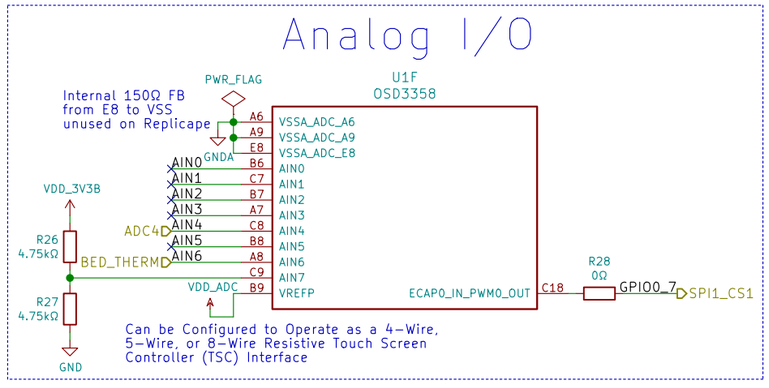
Unused

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



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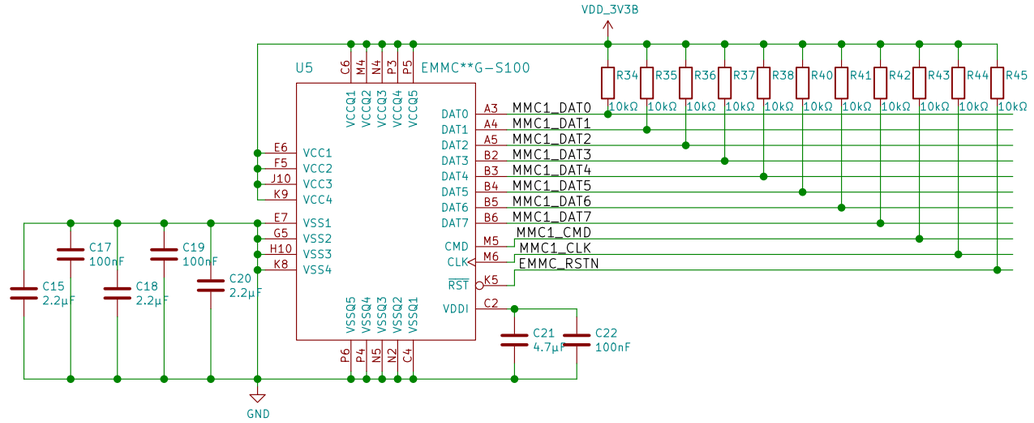
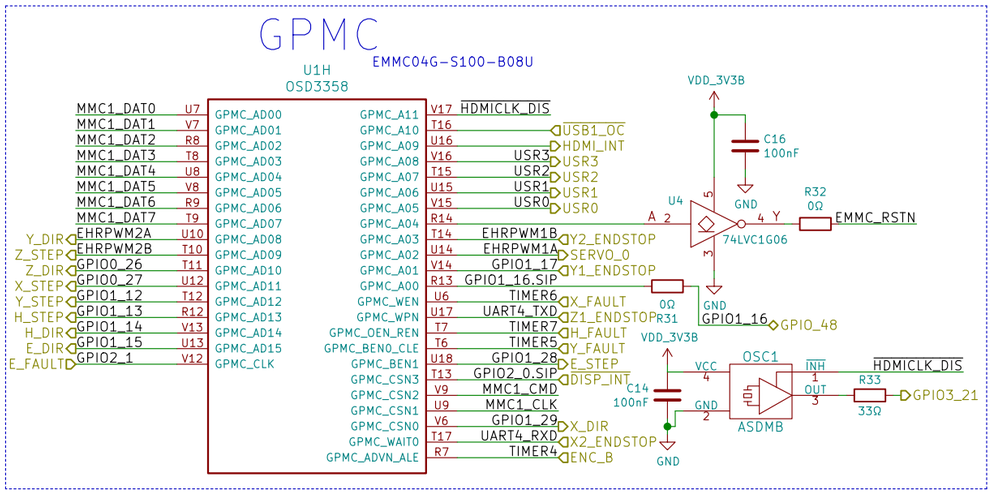
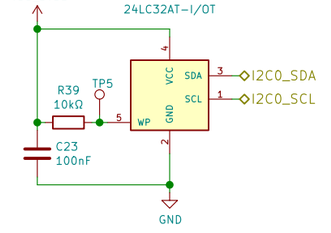
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master		Id: 5/25



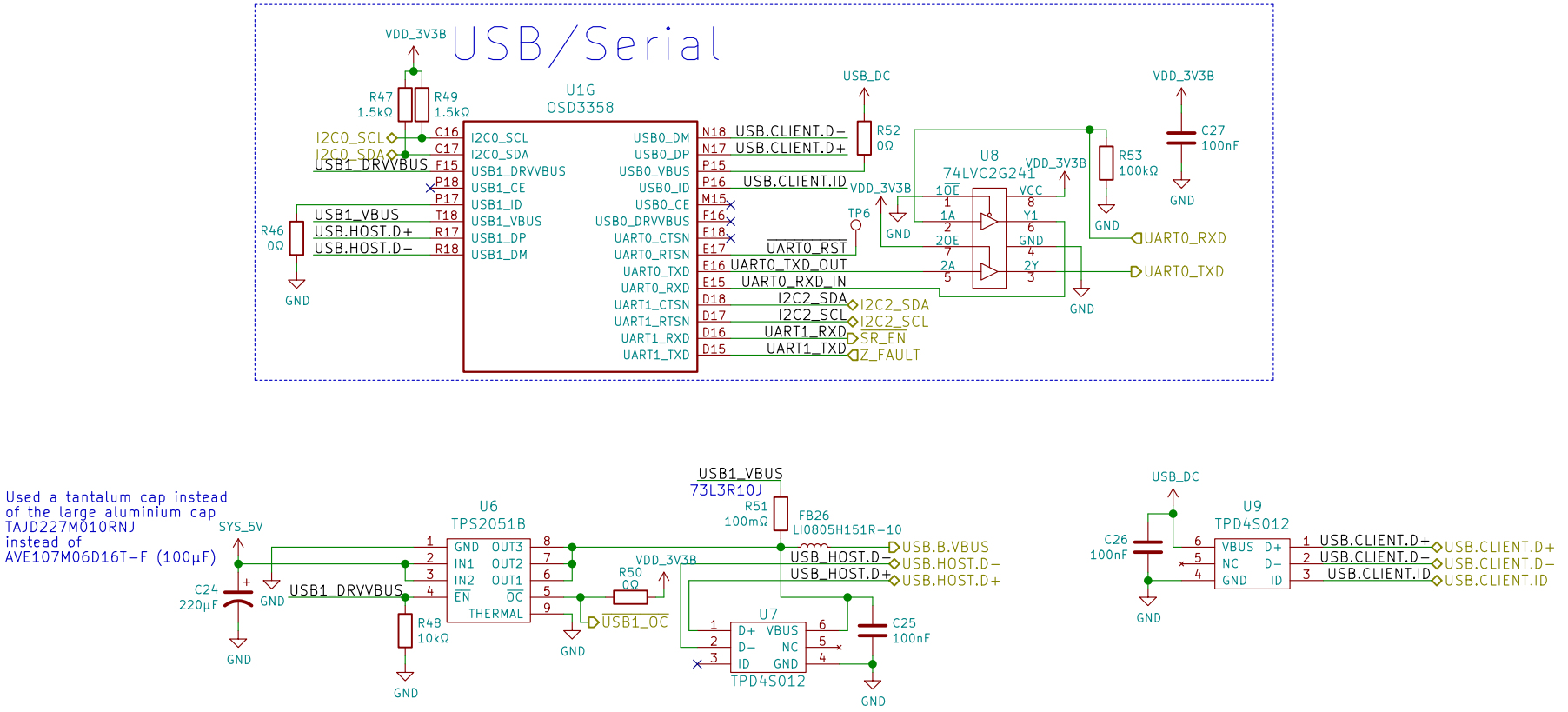




Sheet: /Flash/
File: flash.sch

Title:

Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master		Id: 6/25



Sheet: /USB/ File: usb.sch		
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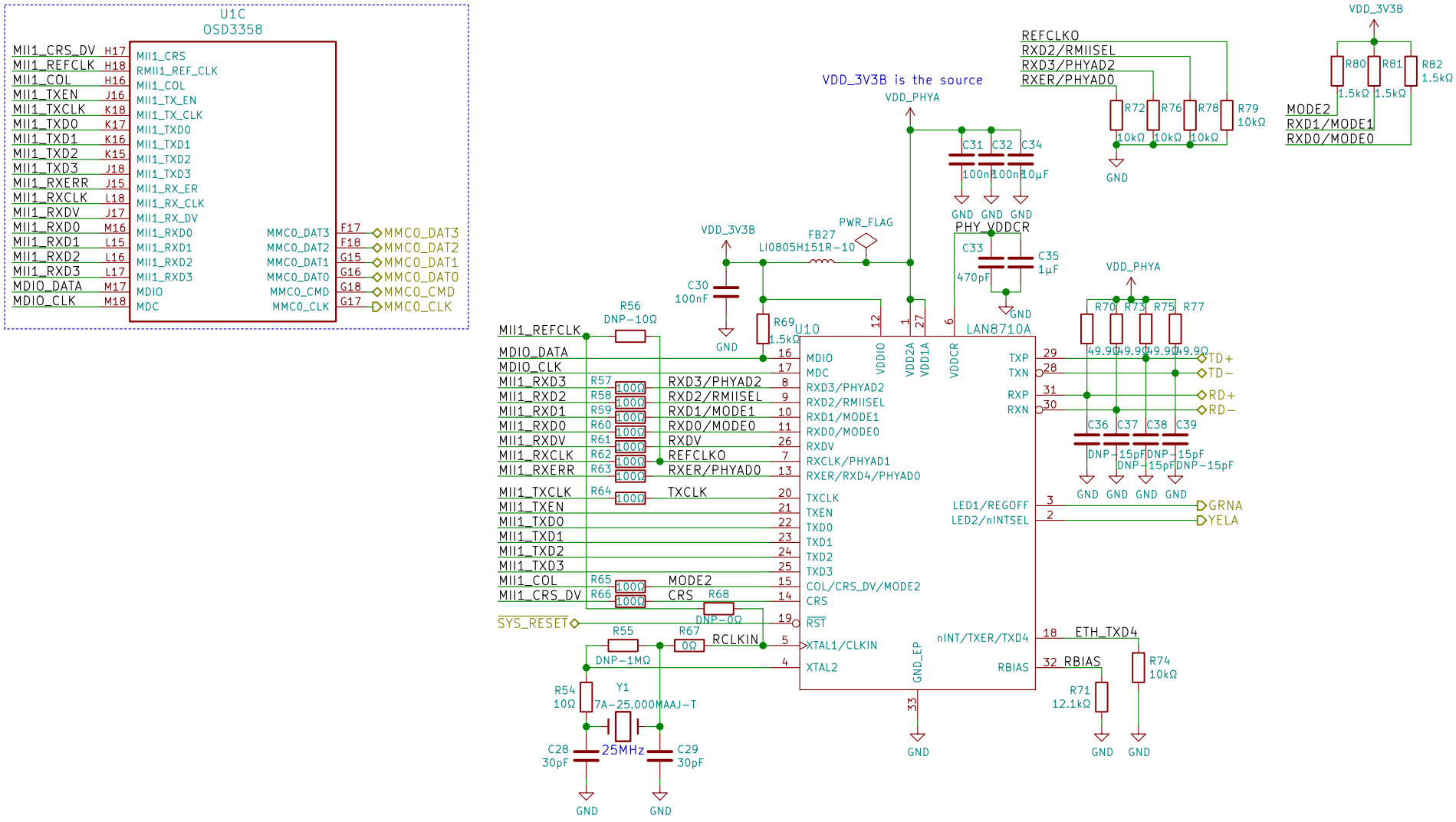
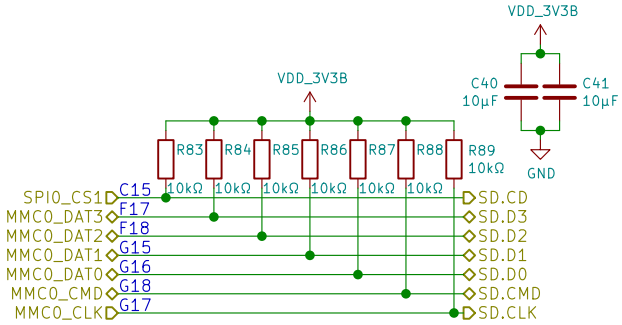
Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad (2016−12−15 revision b13c7e4)−master		Id: 7/25


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
REFCLKO
RXD2/RMIISEL
RXD3/PHYAD2
RXER/PHYAD0
R72 10kΩ
R76 10kΩ
R78 10kΩ
R79 10kΩ
GND
VDD_3V3B
R80 1.5kΩ
R81 1.5kΩ
R82 1.5kΩ
MODE2
RXD1/MODE1
RXD0/MODE0
C31 100nF
C32 100nF
C34 10µF
GND GND GND
VDD_3V3B
C30 100nF
GND
FB27
LI0805H151R-10
PWR_FLAG
PHY_VDDCR
C33 470pF
C35 1µF
GND
R69 1.5kΩ
R56 DNP-10Ω
U10
LAN8710A
MII1_REFCLK
MDIO_DATA
MDIO_CLK
MII1_RXD3 R57 100Ω RXD3/PHYAD2
MII1_RXD2 R58 100Ω RXD2/RMIISEL
MII1_RXD1 R59 100Ω RXD1/MODE1
MII1_RXD0 R60 100Ω RXD0/MODE0
MII1_RXDV R61 100Ω RXDV
MII1_RXCLK R62 100Ω REFCLKO
MII1_RXERR R63 100Ω RXER/PHYAD0
MII1_TXCLK R64 100Ω TXCLK
MII1_TXEN
MII1_TXD0
MII1_TXD1
MII1_TXD2
MII1_TXD3
MII1_COL R65 100Ω MODE2
MII1_CRS_DV R66 100Ω CRS
R68 DNP-0Ω
SYS_RESET
R55 DNP-1MΩ
R67 0Ω RCLKIN
R54 10Ω
Y1 7A-25.000MAAJ-T
25MHz
C28 30pF
C29 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
LED1/REGOFF
LED2/nINTSEL
TXP
TXN
RXP
RXN
12
1
27
6
16
17
8
9
10
11
26
7
13
20
21
22
23
24
25
15
14
19
5
4
33
18
32
3
2
29
28
31
30
VDD_PHYA
R70 49.9Ω
R73 49.9Ω
R75 49.9Ω
R77 49.9Ω
TD+
TD−
RD+
RD−
C36 DNP-15pF
C37 DNP-15pF
C38 DNP-15pF
C39 DNP-15pF
GND GND GND GND
GRNA
YELA
ETH_TXD4
R74 10kΩ
RBIAS
R71 12.1kΩ
GND GND
GND
Sheet: /Ethernet/
File: eth.sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master
Id: 8/25



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Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master		Id: 9/25

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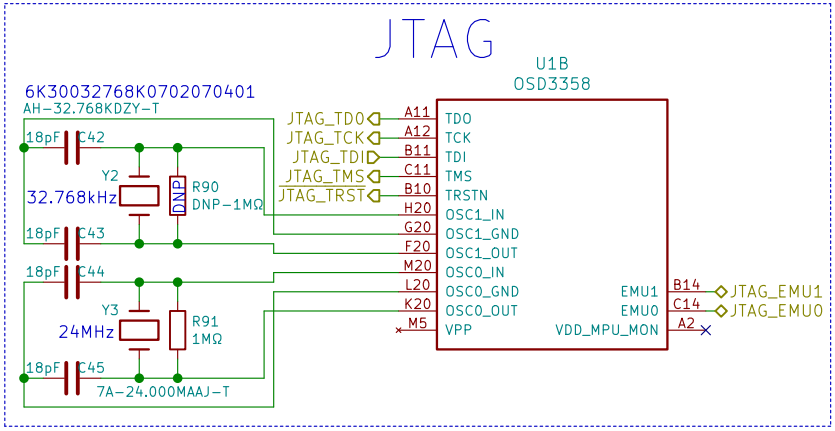

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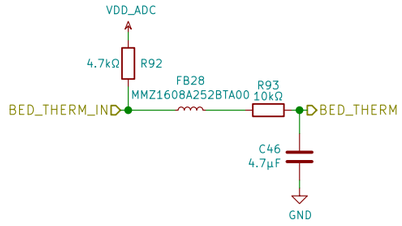
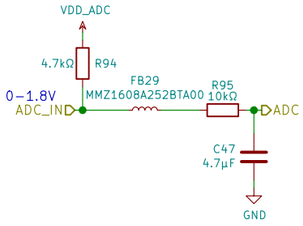




Sheet: /Thermistors/
File: therm.sch

Title:

Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master		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

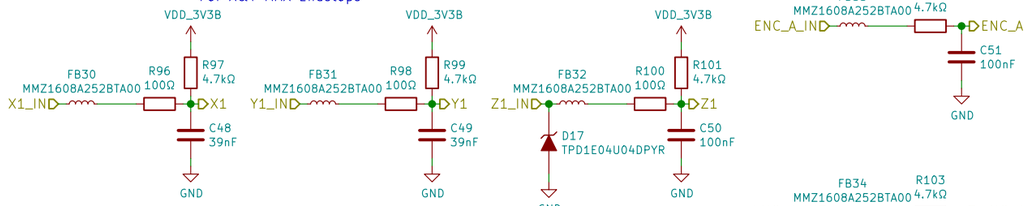
TAZ 6 Z homing feedrate:
1600µsteps/mm * 12mm/sec = 19200µsteps/sec
1/(19.2kHz) = 52.0833µs

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



Sheet: /Endstops/		
File: endstop.sch		
Title:		
Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master		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

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 _|‾|_
4. Bring $\overline{SR\_EN}$ LOW
   - output enabled, disable specific motors/ready to configure

Series resistor for reading temp whilst docking/undocking

Initial Condition ???

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

Sheet: /Stepper Drivers/
File: stepper.sch

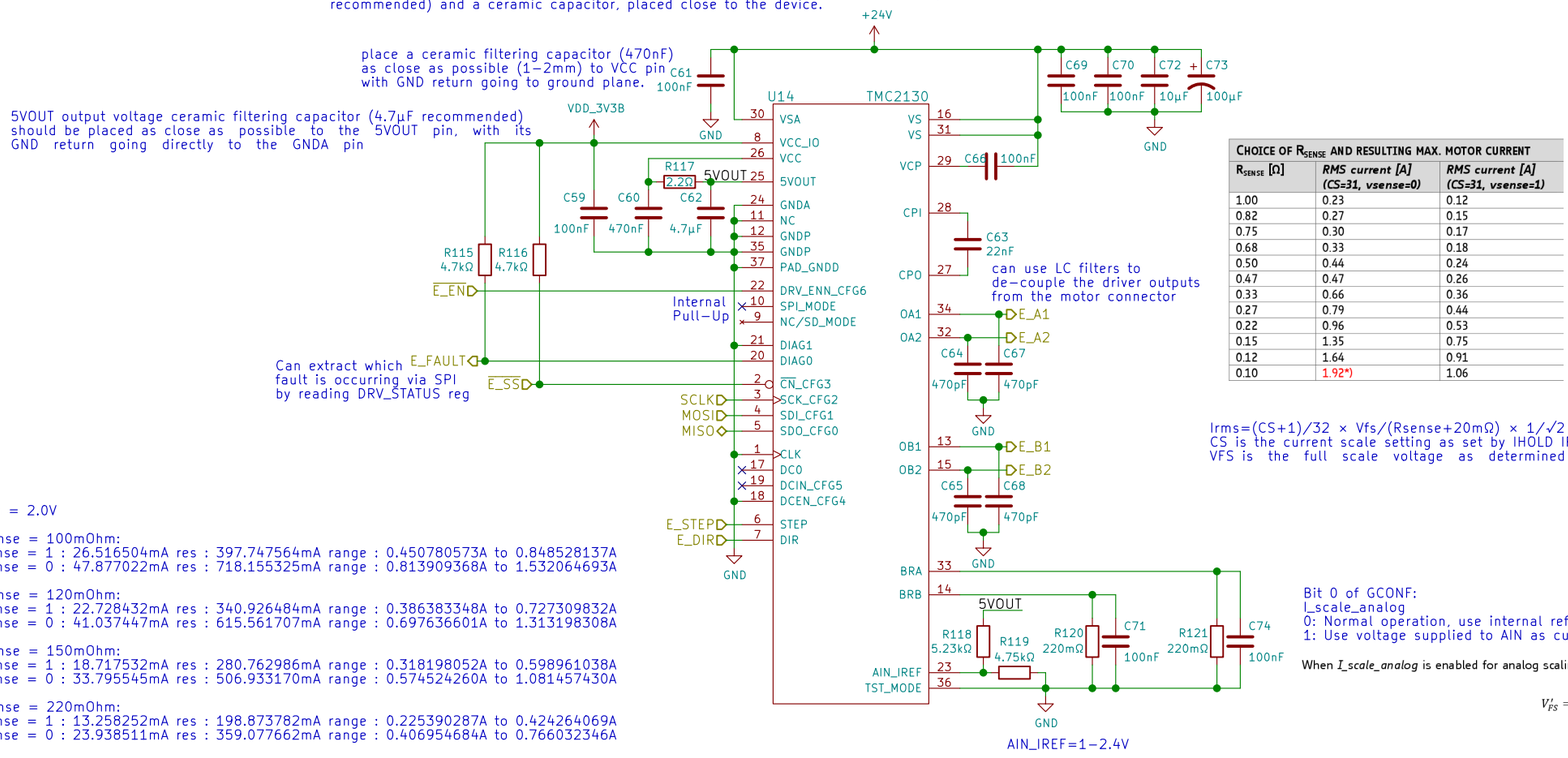
Title:

Size: A3 | Date: | Rev:
KiCad E.D.A. kicad (2016-12-15 revision b13c7e4)-master | 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.

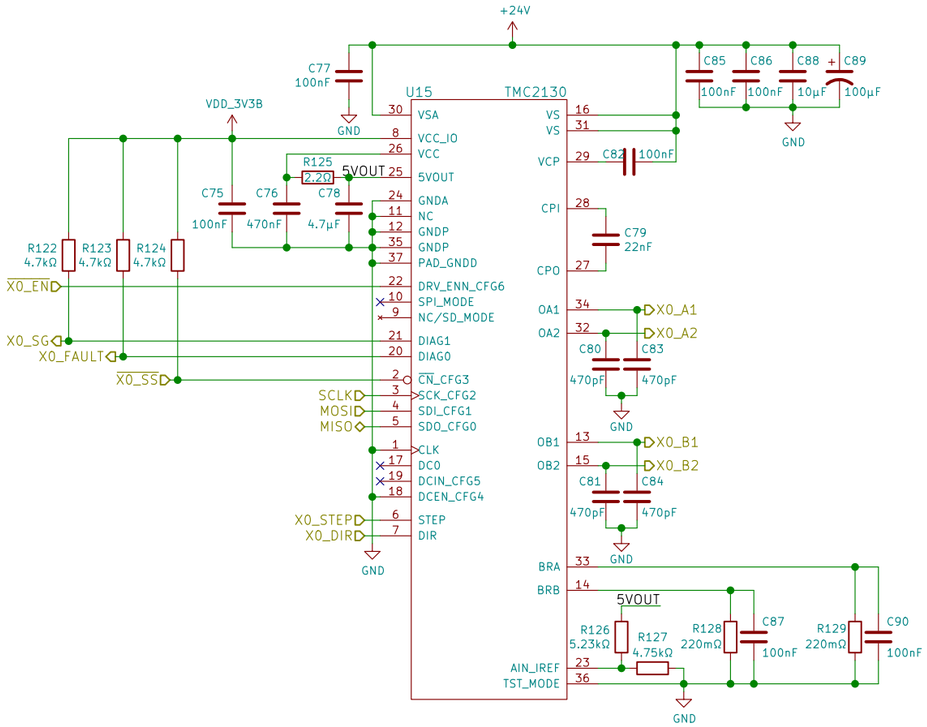
vsense	Allows control of the sense resistor *voltage range* for full scale current.	0	V_{FS} = 0.32 V
		1	V_{FS} = 0.18 V

Vsrtl=325mV

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

Title:

Size: A3	Date:	**Rev:**
KiCad E.D.A. kicad (2016–12–15 revision b13c7e4)–master		Id: 14/25



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File: x0_stepper.sch

Title:

Size: A3	Date:	**Rev:**
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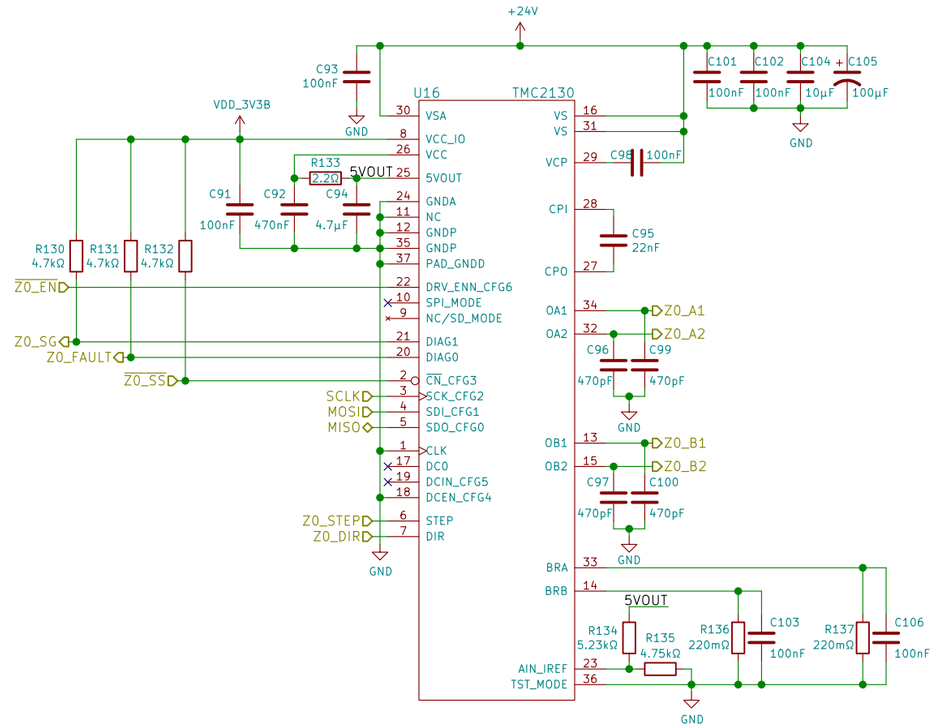

Sheet: /Stepper Drivers/Z0 Stepper Driver/		
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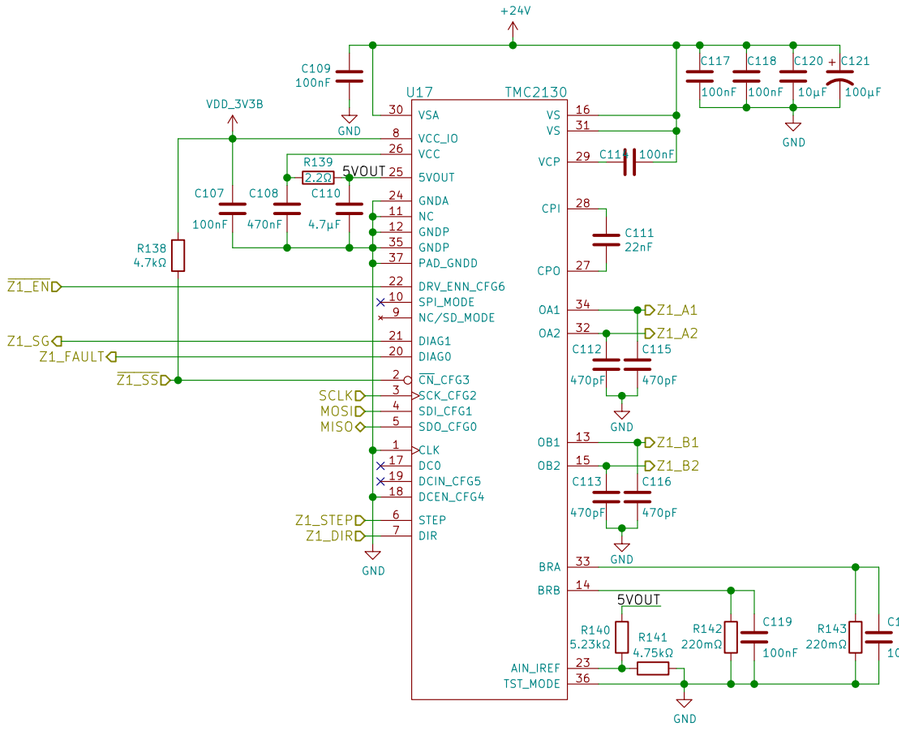

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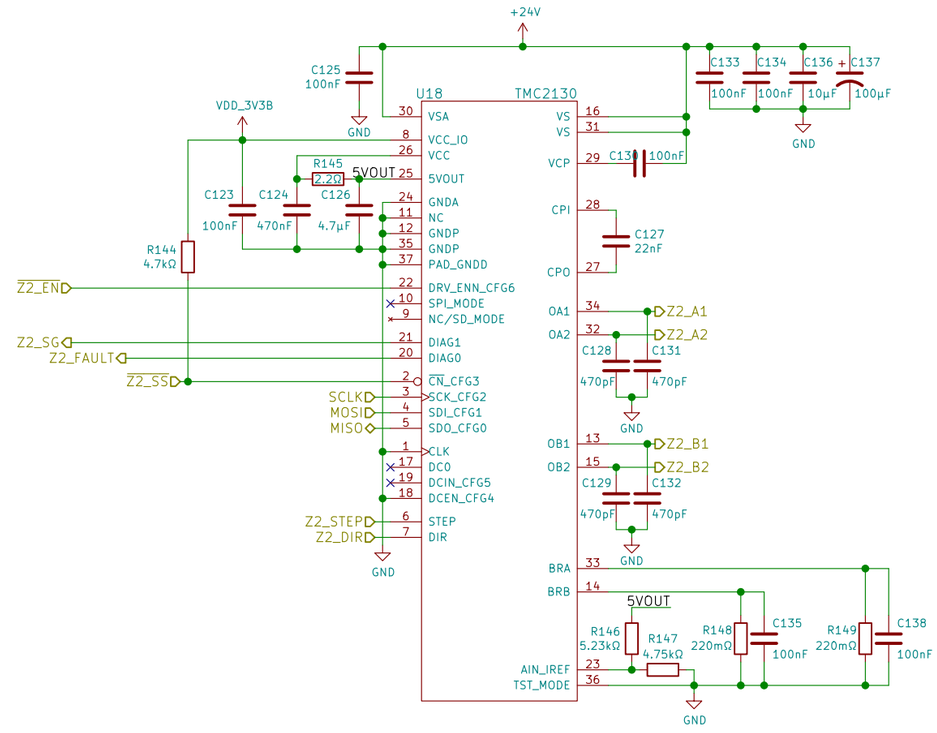

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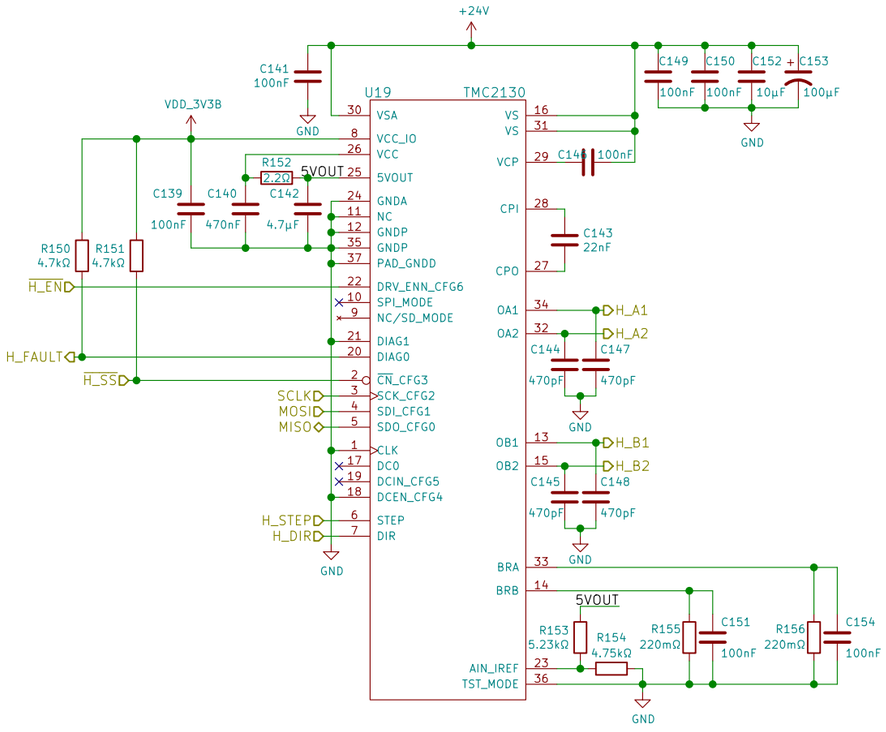

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File: h_stepper.sch		
Title:		
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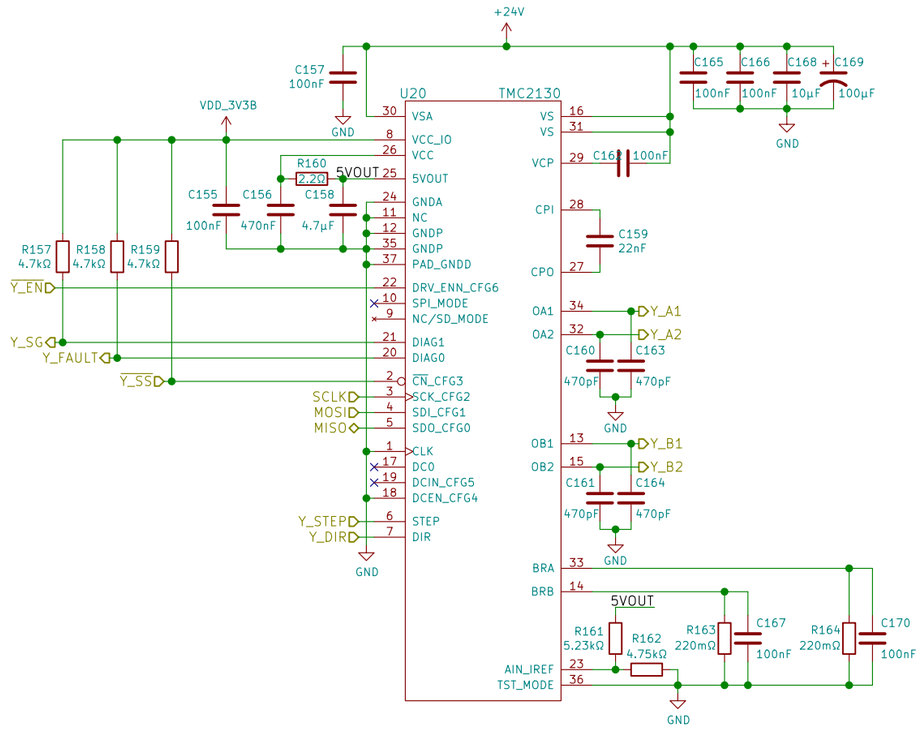

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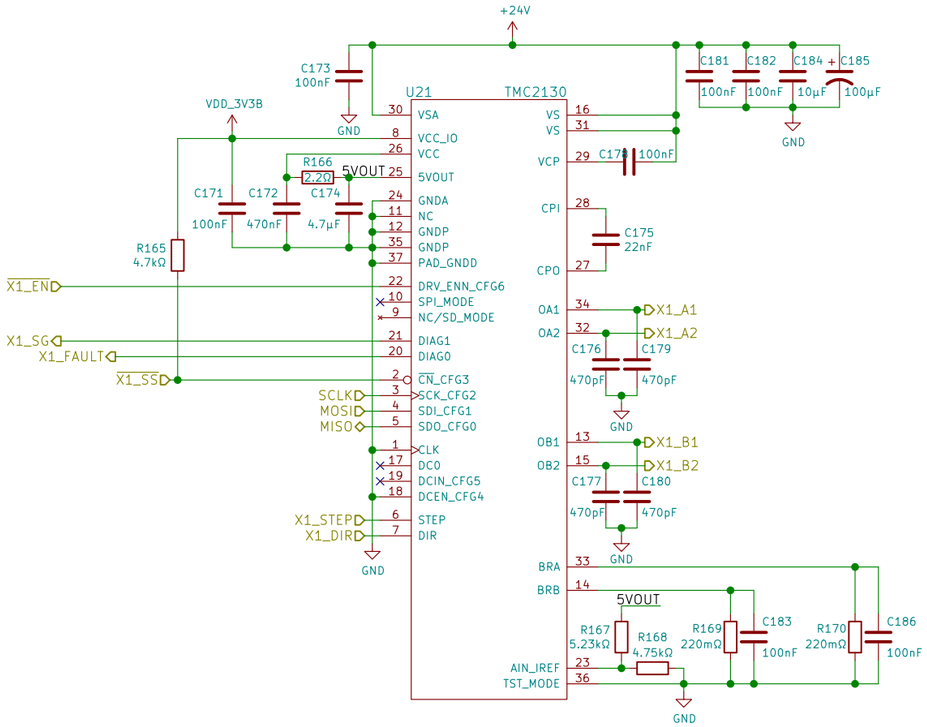

Sheet: /Stepper Drivers/X1 Stepper Driver/
File: x1_stepper.sch

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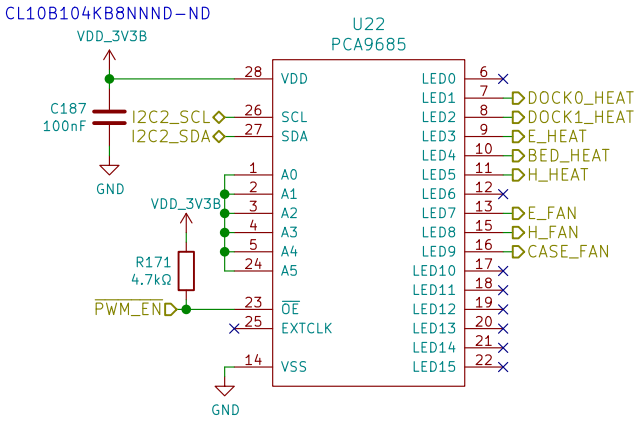

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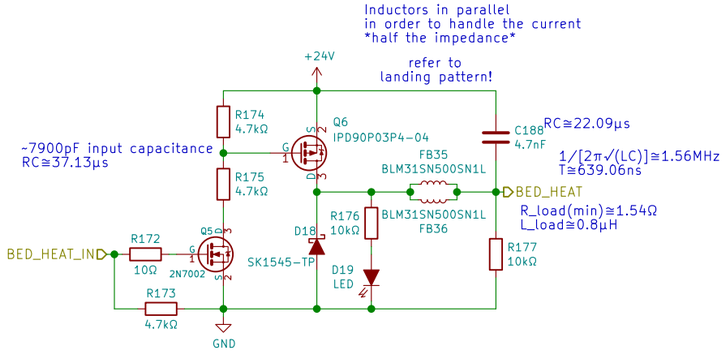
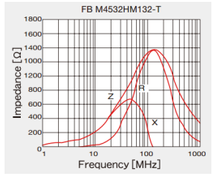
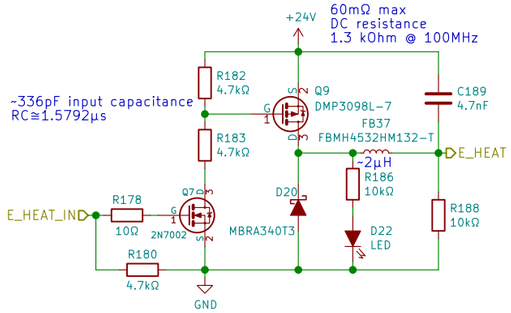
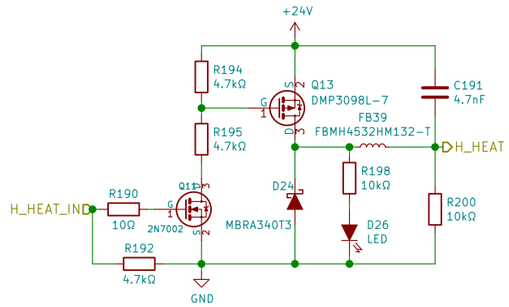
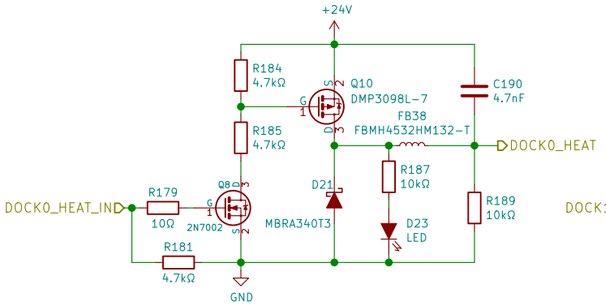
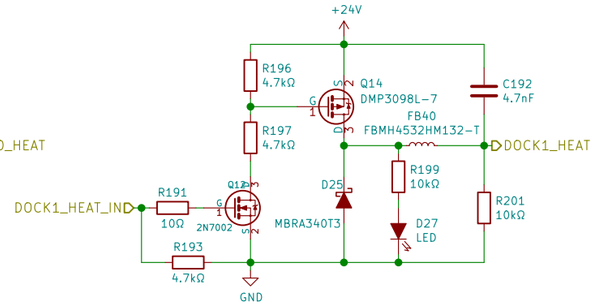








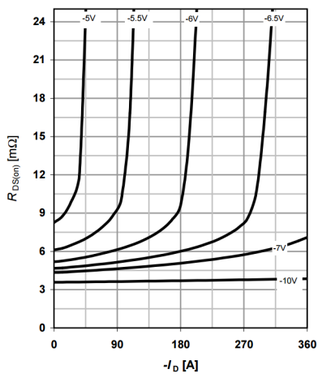




6 Typ. drain-source on-state resistance

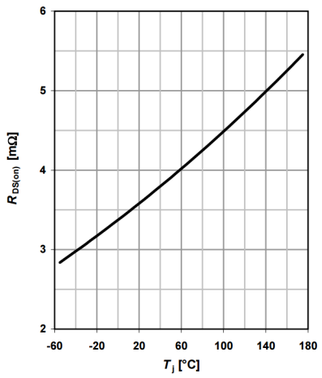
$R_{DS(on)} = (I_D)$; $T_j = 25$ °C

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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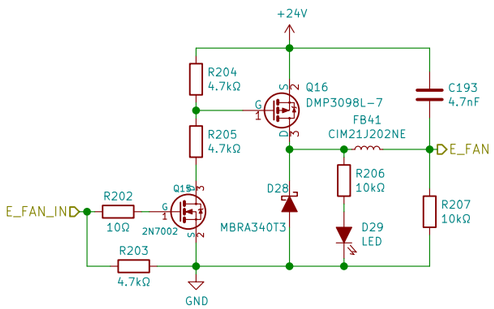

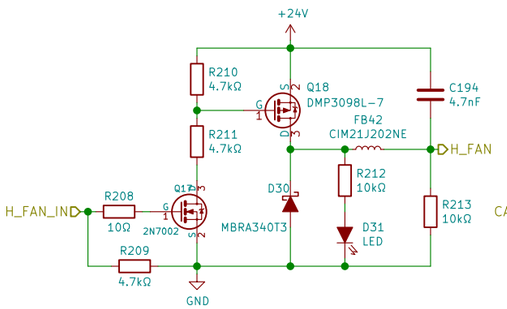

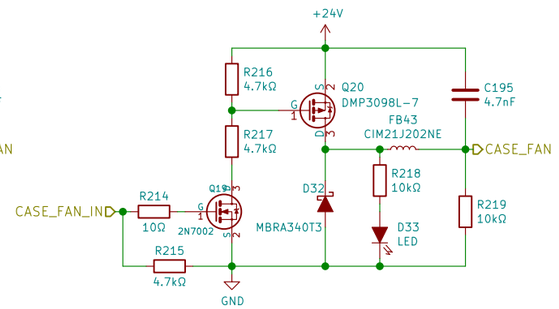

Sheet: /Fans/
File: fan.sch

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Size: A3	Date:	**Rev:**
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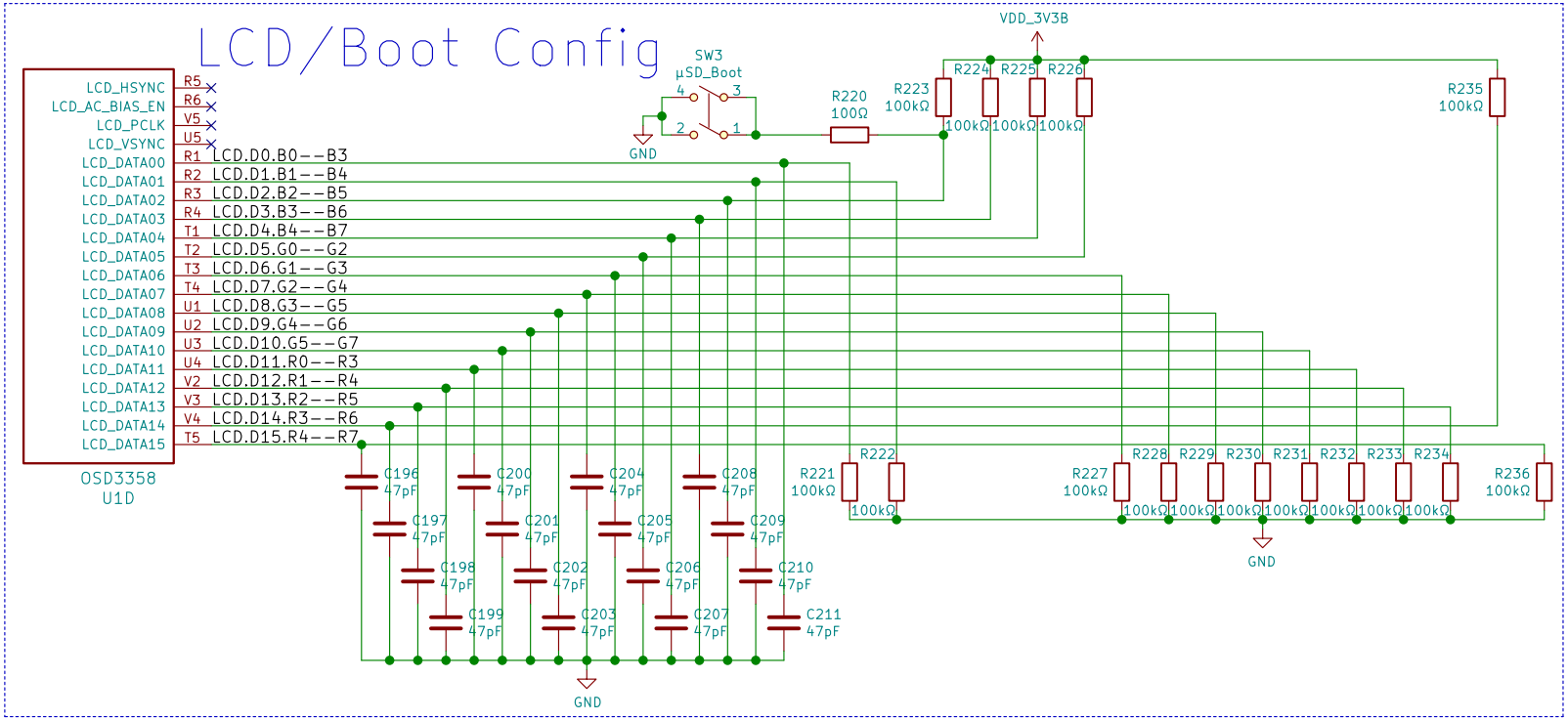

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