Input

CAN and Power Input

X1
Conn_01x04_2.5mm_JST_S04B-XASK-1
1 VBUS_24V
2
3 CAN+
4 CAN-
GND

Input protection

VBUS_24V
F2
2A
PWR_FLAG +24V
F1
SMF30CA
GND
U1
PESD2CANFD24L-TR
CAN-
CAN+
GND

Drawer Encoder Sensor Input

X3
Conn_01x08_2.5mm_JST_S04B-XASK-1
8 Drawer_1_A-
7 Drawer_1_A+
6 Drawer_1_B-
5 Drawer_1_B+
4 Drawer_1_N-
3 Drawer_1_N+
2
1
GND +5V

Drawer Closed Sensor Input

Ext_Switch_Sensing_Drawer_1
Sense_Input_Drawer_Closed_1
Sense_Input Switch
File: Ext_Switch_Sensing.kicad_sch
X2
Conn_01x02_2.5mm_JST_S02B-XASS-1N-BN
GND

CAN Communication

+3V3
CAN_Communication
+3V3
CAN+ CAN+
CAN- CAN-
CAN_EN_High_Speed_Mode EN_High_Speed_Mode
TWAI_TX CAN_Transmit_Data_Input
CAN_Receive_Data_Output TWAI_RX
GND
GND
File: CAN_Communication.kicad_sch

Power Stage

+24V
Power Stage
+24V +5V
GND +3V3
+5V
+3V3
GND
File: power_stage.kicad_sch

Onboard LED Control

+3V3 +24V
LED_Control
+24V
+3V3
+3V3
R1
10K
Enable_LED_VDD Enable_LED_VDD
SCL SCL
SDA SDA
ADDR0
ADDR1
GND
GND
File: Led_Control.kicad_sch

Lock Control and Sense

Lock_Control_And_Sense

Lock_1_Close_Control	Lock_1_Close_Control	Lock_1_VDD_Closed	Lock_1_VDD_Close
Lock_2_Close_Control	Lock_2_Close_Control	Lock_2_VDD_Closed	Lock_2_VDD_Close
Lock_3_Close_Control	Lock_3_Close_Control	Lock_3_VDD_Closed	Lock_3_VDD_Close
Lock_4_Close_Control	Lock_4_Close_Control	Lock_4_VDD_Closed	Lock_4_VDD_Close
Lock_5_Close_Control	Lock_5_Close_Control	Lock_5_VDD_Closed	Lock_5_VDD_Close
Lock_6_Close_Control	Lock_6_Close_Control	Lock_6_VDD_Closed	Lock_6_VDD_Close
Lock_7_Close_Control	Lock_7_Close_Control	Lock_7_VDD_Closed	Lock_7_VDD_Close
Lock_8_Close_Control	Lock_8_Close_Control	Lock_8_VDD_Closed	Lock_8_VDD_Close
Lock_1_Open_Control	Lock_1_Open_Control	Lock_1_VDD_Opened	Lock_1_VDD_Open
Lock_2_Open_Control	Lock_2_Open_Control	Lock_2_VDD_Opened	Lock_2_VDD_Open
Lock_3_Open_Control	Lock_3_Open_Control	Lock_3_VDD_Opened	Lock_3_VDD_Open
Lock_4_Open_Control	Lock_4_Open_Control	Lock_4_VDD_Opened	Lock_4_VDD_Open
Lock_5_Open_Control	Lock_5_Open_Control	Lock_5_VDD_Opened	Lock_5_VDD_Open
Lock_6_Open_Control	Lock_6_Open_Control	Lock_6_VDD_Opened	Lock_6_VDD_Open
Lock_7_Open_Control	Lock_7_Open_Control	Lock_7_VDD_Opened	Lock_7_VDD_Open
Lock_8_Open_Control	Lock_8_Open_Control	Lock_8_VDD_Opened	Lock_8_VDD_Open
Sense_Lock_1	Sense_Lock_1		
Sense_Lock_2	Sense_Lock_2		
Sense_Lock_3	Sense_Lock_3		
Sense_Lock_4	Sense_Lock_4		
Sense_Lock_5	Sense_Lock_5		
Sense_Lock_6	Sense_Lock_6		
Sense_Lock_7	Sense_Lock_7		
Sense_Lock_8	Sense_Lock_8		

File: Lock_Control_And_Sense.kicad_sch

ESP32

ESP32_WROOM_32
+3V3 +5V
+5V
+3V3
GND
GND

IO2	Drawer_1_Encoder_B
IO4_TWAI_RX	TWAI_RX
IO5_SPI_CS_TWAI_TX	TWAI_TX
IO12_TDI	JTAG_TDI
IO13_TCK	JTAG_TCK
IO14_TMS	JTAG_TMS
IO15_TDO	JTAG_TDO
EN_ESP32	EN_ESP32
IO16_UART2_RX	UART2_RX
IO17_UART2_TX	
IO18_SPI_SCK	SPI_SCK
IO19_SPI_SO	SPI_SO
IO23_SPI_SI	SPI_SI
IO33	SPI_CS
IO21_SDA	SDA
IO22_SCL	SCL
IO25_DAC_1	Drawer_DAC_VREF
IO26_DAC_2	Drawer_1_Encoder_A
IO32	LED_D_in
I34	pe_1_-INT
I35	Sense_Lock_8
I36	pe_0_-INT
I39	pe_2_-INT

R2
1K
UART2_RX

pe_0_-INT	pe_0_-INT
pe_0_IO0_0	Drawer_1_STDBY_TMC2209
pe_0_IO0_1	Sense_Lock_3
pe_0_IO0_2	Lock_2_Open_Control
pe_0_IO0_3	Lock_2_Close_Control
pe_0_IO0_4	Sense_Lock_2
pe_0_IO0_5	Lock_1_Open_Control
pe_0_IO0_6	Lock_1_Close_Control
pe_0_IO0_7	Sense_Lock_1
pe_0_IO1_0	Drawer_1_-EN_TMC2209
pe_0_IO1_1	Lock_3_Open_Control
pe_0_IO1_2	Lock_3_Close_Control
pe_0_IO1_3	Drawer_1_DIR
pe_0_IO1_4	Drawer_1_SPREAD
pe_0_IO1_5	Drawer_1_DIAG
pe_0_IO1_6	Drawer_1_STEP
pe_0_IO1_7	Drawer_1_INDEX
pe_1_-INT	pe_1_-INT
pe_1_IO0_0	
pe_1_IO0_1	
pe_1_IO0_2	
pe_1_IO0_3	
pe_1_IO0_4	
pe_1_IO0_5	
pe_1_IO0_6	Lock_8_Close_Control
pe_1_IO0_7	Lock_8_Open_Control
pe_1_IO1_0	CAN_EN_High_Speed_Mode
pe_1_IO1_1	Lock_7_Close_Control
pe_1_IO1_2	Lock_7_Open_Control
pe_1_IO1_3	
pe_1_IO1_4	
pe_1_IO1_5	Sense_Lock_7
pe_1_IO1_6	Lock_6_Open_Control
pe_1_IO1_7	Lock_6_Close_Control
pe_2_-INT	pe_2_-INT
pe_2_IO0_0	pe_2_IO0_0
pe_2_IO0_1	Sense_Input_Drawer_Closed_1
pe_2_IO0_2	Lock_4_Close_Control
pe_2_IO0_3	pe_2_IO0_3
pe_2_IO0_4	pe_2_IO0_4
pe_2_IO0_5	Sense_Lock_5
pe_2_IO0_6	Lock_4_Open_Control
pe_2_IO0_7	Enable_LED_VDD
pe_2_IO1_0	Sense_Lock_6
pe_2_IO1_1	pe_2_IO1_1
pe_2_IO1_2	Drawer_1_Encoder_N
pe_2_IO1_3	
pe_2_IO1_4	Sense_Lock_4
pe_2_IO1_5	Lock_5_Close_Control
pe_2_IO1_6	pe_2_IO1_6
pe_2_IO1_7	Lock_5_Open_Control

File: ESP32_WROOM_32.kicad_sch

Electrical Drawer with Encoder

+24V
TMC2209
+3V3
+24V
+3V3
Drawer_1_-EN_TMC2209 ENN_TMC2209
Drawer_1_STDBY_TMC2209 STDBY_TMC2209
GND
MS1_AD0
MS1_AD1
UART2_RX PDN_UART
Drawer_1_SPREAD SPREAD
Drawer_1_DIR DIR
Drawer_1_STEP STEP
Drawer_DAC_VREF DAC_Vref
GND
GND
File: TMC2209.kicad_sch

OA1D Drawer_1_OA1
OA2D Drawer_1_OA2
OB1D Drawer_1_OB1
OB2D Drawer_1_OB2
DIAGD Drawer_1_DIAG
INDEXD Drawer_1_INDEX

+5V
Differential_Line_Receiver
+5V
Drawer_1_A+ A+
Drawer_1_A- A-
Drawer_1_B+ B+
Drawer_1_B- B-
Drawer_1_N+ N+
Drawer_1_N- N-
GND
GND
File: Differential_Line_Receiver.kicad_sch

AD Drawer_1_Encoder_A
BD Drawer_1_Encoder_B
ND Drawer_1_Encoder_N

Output

Locks

Lock_1_VDD_Open
Lock_1_VDD_Close
Conn_01x03_3.0mm_Molex_Micro_Fit
X4
GND

Lock_2_VDD_Open
Lock_2_VDD_Close
Conn_01x03_3.0mm_Molex_Micro_Fit
X5
GND

Lock_3_VDD_Open
Lock_3_VDD_Close
Conn_01x03_3.0mm_Molex_Micro_Fit
X6
GND

Lock_4_VDD_Open
Lock_4_VDD_Close
Conn_01x03_3.0mm_Molex_Micro_Fit
X7
GND

Lock_5_VDD_Open
Lock_5_VDD_Close
Conn_01x03_3.0mm_Molex_Micro_Fit
X8
GND

Lock_6_VDD_Open
Lock_6_VDD_Close
Conn_01x03_3.0mm_Molex_Micro_Fit
X9
GND

Lock_7_VDD_Open
Lock_7_VDD_Close
Conn_01x03_3.0mm_Molex_Micro_Fit
X10
GND

Lock_8_VDD_Open
Lock_8_VDD_Close
Conn_01x03_3.0mm_Molex_Micro_Fit
X11
GND

JTAG Debugging

J1
Conn_02x03_Odd_Even
JTAG_TDO 1 2 JTAG_TMS
JTAG_TCK 3 4
EN_ESP32 5 6 JTAG_TDI
GND

SPI

J2
+5V
Conn_02x04_Odd_Even
+3V3
1 2
3 4
GND SPI_SI 5 6 SPI_CS
SPI_SO 7 8 SPI_SCK
GND

Electrical Drawer

Drawer_1_OB1 1
Drawer_1_OB2 2
Drawer_1_OA1 3
Drawer_1_OA2 4
X12
Conn_01x04_2.5mm_JST_S04B-XASK-1

LED Output

+5V
C1
100u_80V
GND
LED_D_in
330
R3
1 LED_Din 3
X13
Conn_01x03_2.5mm_JST_S04B-XASK-1

Spare Port Expander pins

J3
Conn_02x05_Odd_Even
pe_2_IO0_0 1 2
pe_2_IO0_3 3 4
pe_2_IO0_4 5 6
pe_2_IO1_1 7 8
pe_2_IO1_6 9 10
GND

Mounting Holes

M3

H1 MountingHole	H9 MountingHole
H2 MountingHole	H10 MountingHole
H3 MountingHole	H11 MountingHole
H4 MountingHole	H12 MountingHole
H5 MountingHole	H13 MountingHole
H6 MountingHole	H14 MountingHole
H7 MountingHole	H15 MountingHole
H8 MountingHole	H16 MountingHole

4mm

H17 MountingHole	H25 MountingHole
H18 MountingHole	H26 MountingHole
H19 MountingHole	H27 MountingHole
H20 MountingHole	H28 MountingHole
H21 MountingHole	H29 MountingHole
H22 MountingHole	H30 MountingHole
H23 MountingHole	H31 MountingHole
H24 MountingHole	H32 MountingHole

M3 with big bot Pad

H33 MountingHole
H34 MountingHole
H35 MountingHole
H36 MountingHole
H37 MountingHole
H38 MountingHole
H39 MountingHole
H40 MountingHole

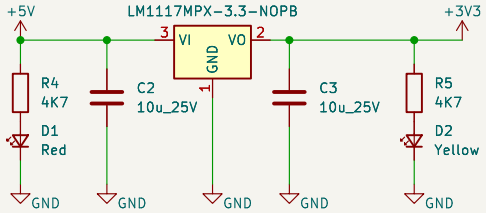
M2 for cable ties

H41 MountingHole
H42 MountingHole
H43 MountingHole
H44 MountingHole
H45 MountingHole
H46 MountingHole

Sheet: /
File: Partial_Drawer_Controller_v1_hotfix.kicad_sch
Title:
Size: A3 | Date: | **Rev:**
KiCad E.D.A. 8.0.6 | Id: 1/68

Input

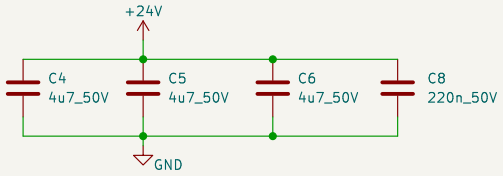
5V to 3.3V



24V to 5V

Input Capacitor

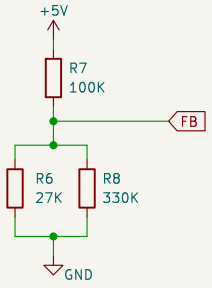
A minimum of 10 µF of ceramic capacitance is required on the input of the LMR33630.
This must be rated for at least the maximum input voltage that the application requires; preferably twice the maximum input voltage. This capacitance can be increased to help reduce input voltage ripple and maintain the input voltage during load transients. In addition, a small case size, 220-nF ceramic capacitor must be used at the input, as close a possible to the regulator. This provides a high frequency bypass for the control circuits internal to the device. For this example a 4.7-µF, 50-V, X7R (or better like C0G) ceramic capacitor is chosen. The 220 nF must also be rated at 50 V with an X7R or C0G dielectric.
Please mind that the small capacitor should have a smaller footprint to have smaller ESL.
https://www.signalintegrityjournal.com/articles/1589-the-myth-of-three-capacitor-values



Reference Voltage

Ouput Voltage Set-Point:
R1 = R2 / (V_Out/1V) - 1)
R1 = 100k / (5V - 1V)
= 25k

Please mind:
R2 is recommended to be app. 100kΩ
For R1 = 24.9k is chosen as recommended in the datasheet.
27k||330k = 27k*330k / (27k+330k)
= 24,958



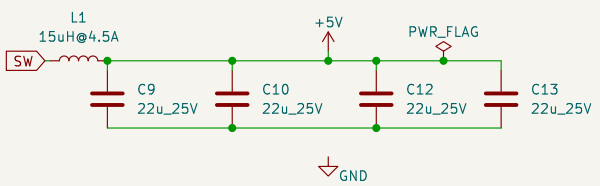
Output Filter

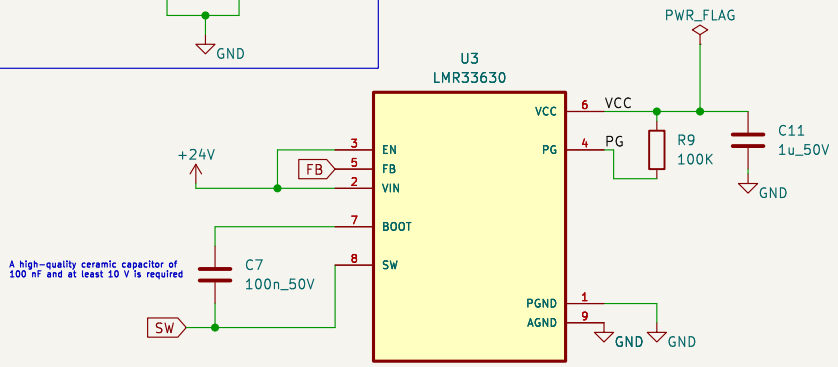
Inductor Selection
The parameters for selecting the inductor are the inductance and saturation current. The inductance is based on the desired peak-to-peak ripple current and is normally chosen to be in the range of 20% to 40% of the maximum output current. Experience shows that the best value for inductor ripple current is 30% of the maximum load current. Note that when selecting the ripple current for applications with much smaller maximum load than the maximum available from the device, the maximum device current should be used. Equation 4 can be used to determine the value of inductance. The constant K is the percentage of inductor current ripple. For this example, K = 0.3 was chosen.
L = ((VIN - VOut) x (VOut / VIn)) / (fSW x K x IOutMax)
= (24V - 5V) x (5V / 24V) / (400kHz x 0.3 x 2.3A)
= 14.34µH
Therefore we take the next available standard inductor value of 15uH.

For this example, a ΔVOUT ≤ 250 mV for an output current step of ΔIOUT = 2 A is required. Equation 6 gives a minimum value of 52 µF and a maximum ESR of 0.11 Ω.
More output capacitance can be used to improve the load transient response.
Ceramic capacitors can easily meet the minimum ESR requirements. In some cases, an aluminum electrolytic capacitor can be placed in parallel with the ceramics to help build up the required value of capacitance. In general, use a capacitor of at least 10 V for output voltages of 3.3 V or less and a capacitor of 16 V or more for output voltages of 5 V and above.

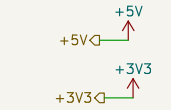
For the capacitor we use 4 x 25V 22uF X5R ±10% 1206 Multilayer Ceramic Capacitors MLCC (CL31A226KAHNNNE).
If you check the specifactions under
https://product.samsungsem.com/micc/CL31A226KAHNNN.do

You can find, that the DC Bias at 5V DC is -37.96% of the original capacity, so
Co = 4 x 22uF x 0.62 = 54.56µF
To find out the RESR of the capacitor we can check the graph given in the above link and check the ESR value at the self-resonant frequency where the impedance |Z| is minimal.
This is at least what they did with the capacitor they took in the datasheet. The link to the capacitor of the datasheet can be found here:
https://product.tdk.com/en/search/capacitor/ceramic/micc/info?part_no=C3216X5R0J476M160AC
Following this procedure, the ESR value for ONE CL31A226KAHNNNE is something like:
RESR,1xC = 3.82mOhm = 0.00382 Ohm





Output

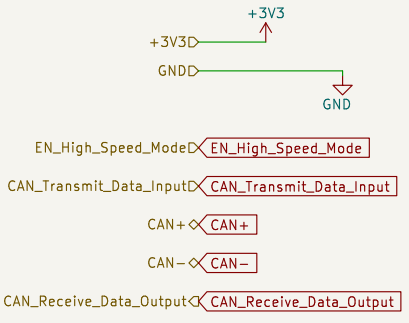


Sheet: /Power Stage/
File: power_stage.kicad_sch

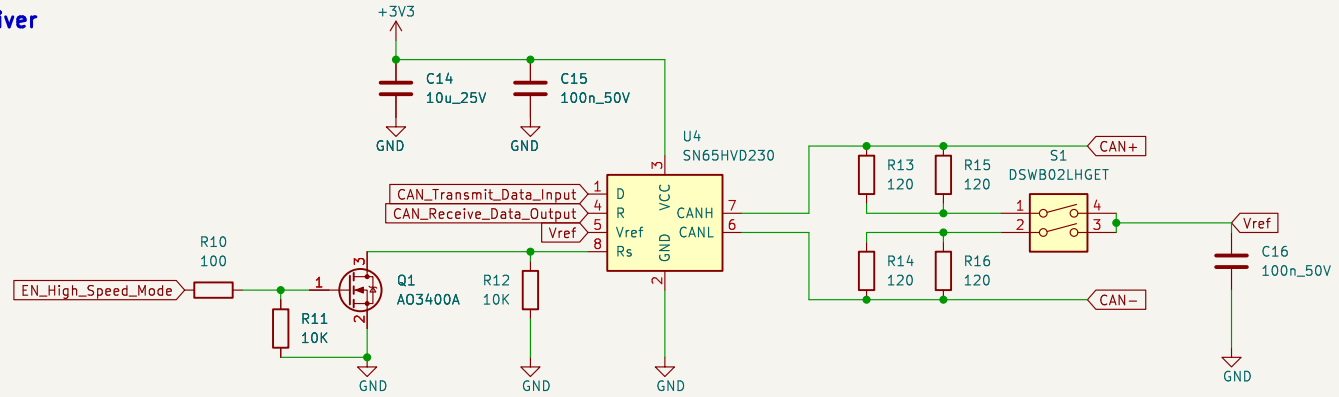
Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 2/68

Input/Output

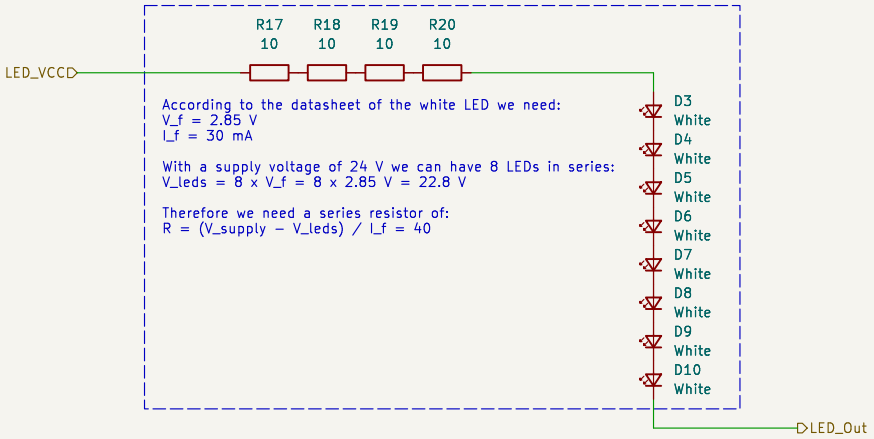


CAN Transceiver



The RS pin (pin 8) on the SN65HVD230 and SN65HVD231 provides three different modes of operation: high speed mode, slope control mode, and low−power mode. The high speed mode of operation is selected by connecting the RS pin to ground, allowing the transmitter output transistors to switch on and off as fast as possible with no limitation on the rise and fall slopes. The rise and fall slopes can also be adjusted by connecting a resistor in series between the RS pin and ground. The slope will be proportional to the pin's output current. With a resistor value of 10 kΩ the device will have a slew rate of ~15 V/µs, and with a resistor value of 100 kΩ the device will have a slew rate of ~2 V/µs.

Sheet: /CAN_Communication/		
File: CAN_Communication.kicad_sch		
Title:		
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 3/68



Sheet: /LED_Control/8xLED_White1/		
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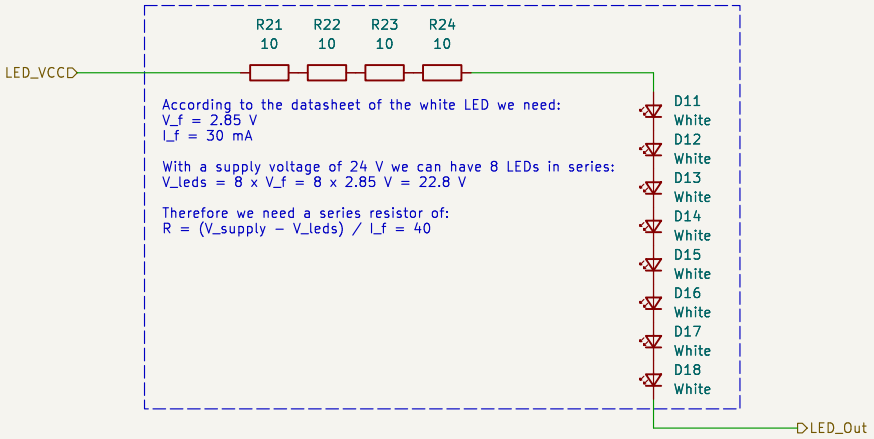
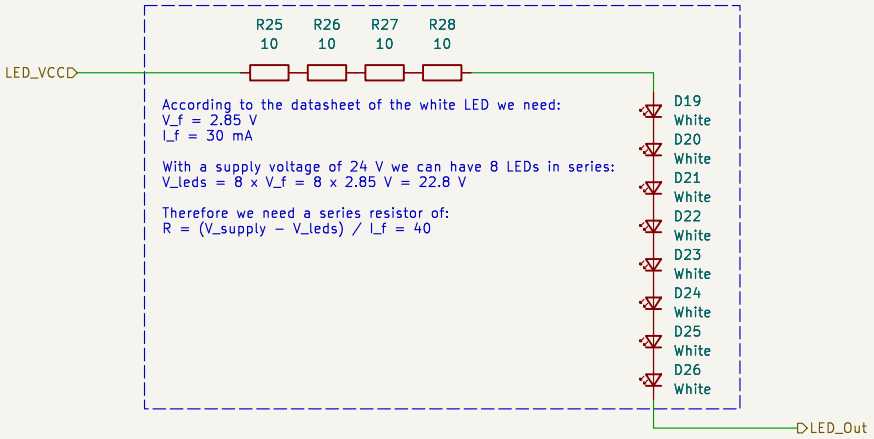
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 4/68

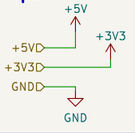


Sheet: /LED_Control/8xLED_White2/		
File: 8xLED_White.kicad_sch		
Title:		
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 5/68

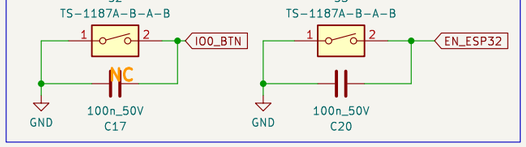


Sheet: /LED_Control/8xLED_White3/		
File: 8xLED_White.kicad_sch		
Title:		
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 6/68

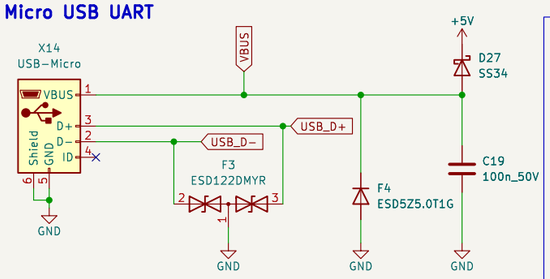
Input

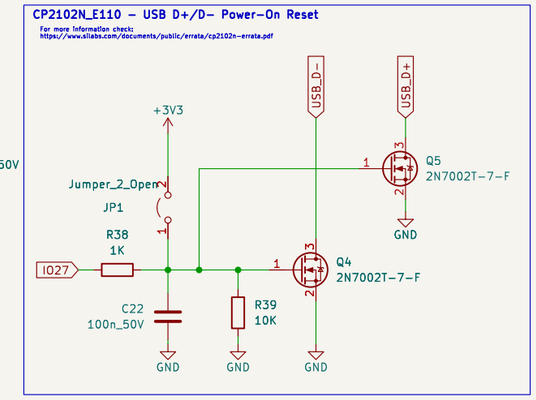


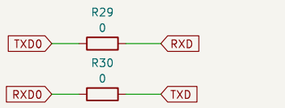
Switches

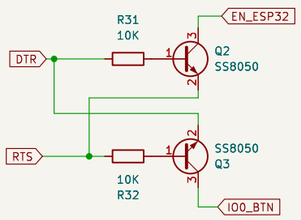


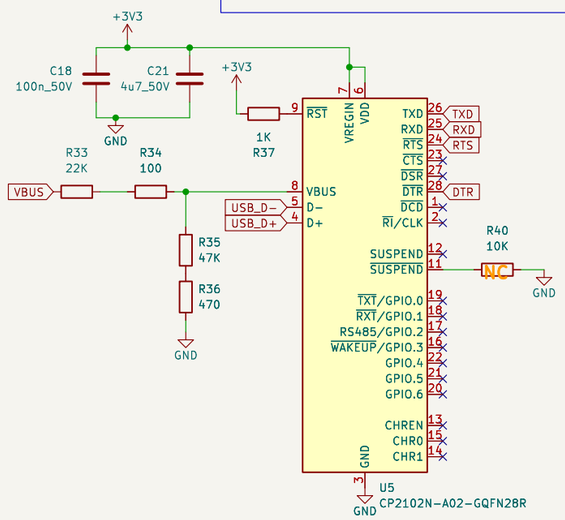
Micro USB UART



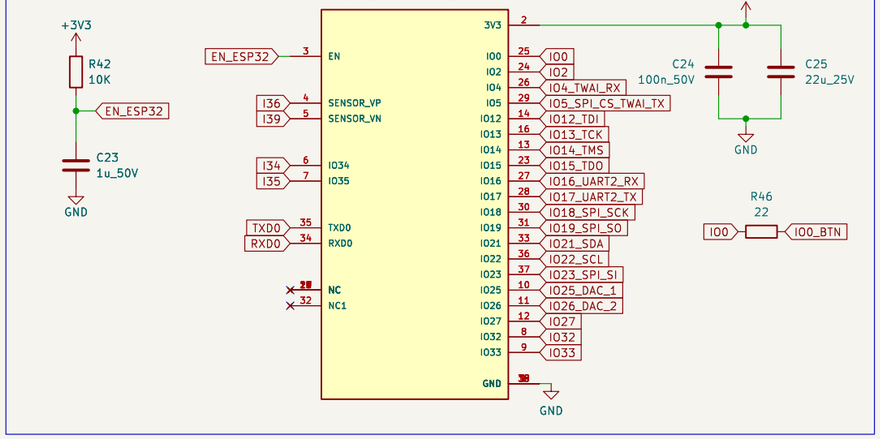




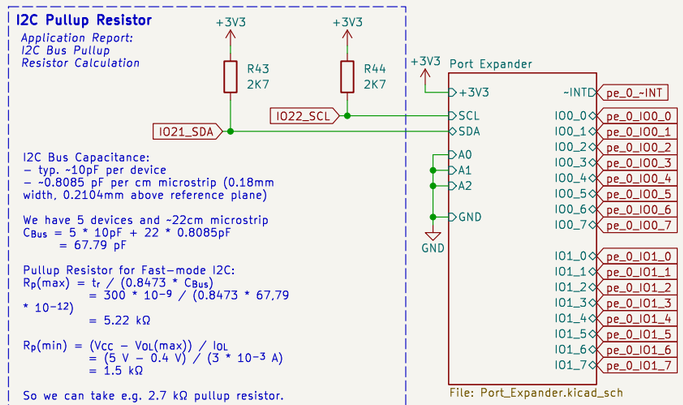


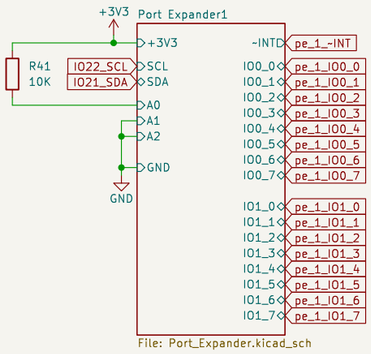


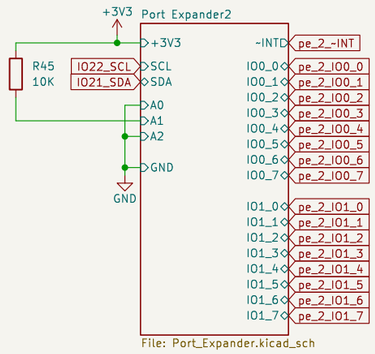
ESP32 Module



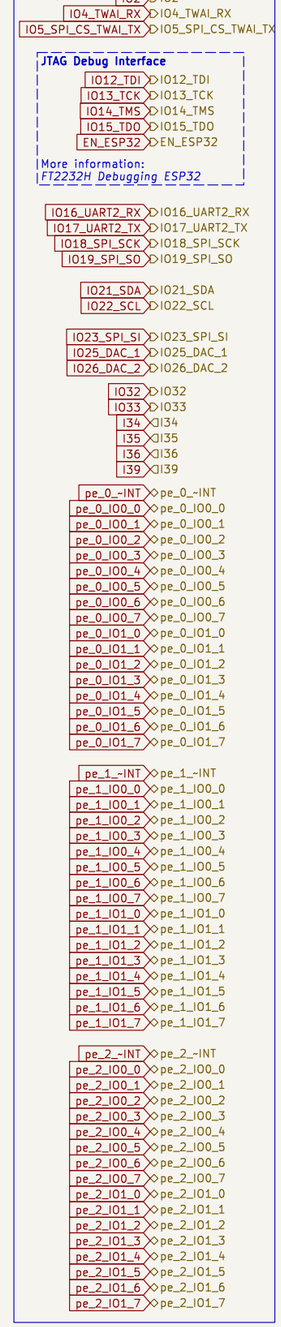
Port Expander







Output



Datasheets & References:
https://www.espressif.com/sites/default/files/documentation/esp32-wroom-32e_esp32-wroom-32ue_datasheet_en.pdf
https://dl.espressif.com/dl/schematics/esp32_devkitc_v4-sch.pdf
https://www.youtube.com/watch?v=S_pOYV-JlfU&t=4185s

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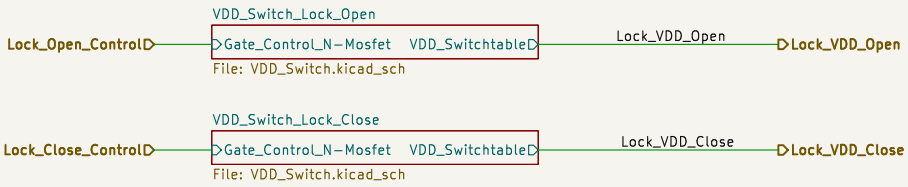
KiCad E.D.A. 8.0.6		Id: 7/68



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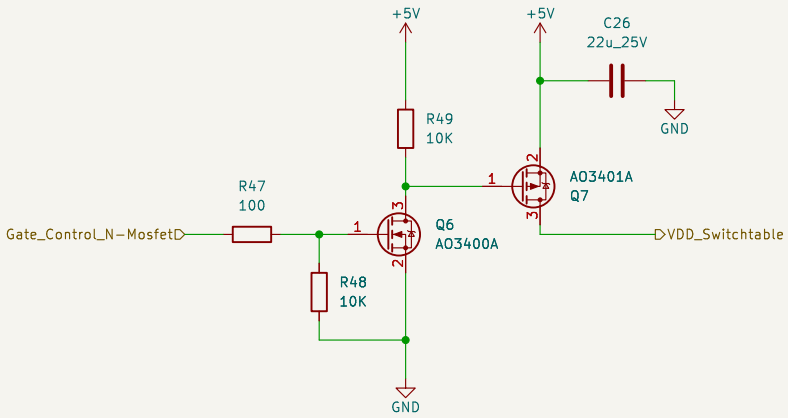

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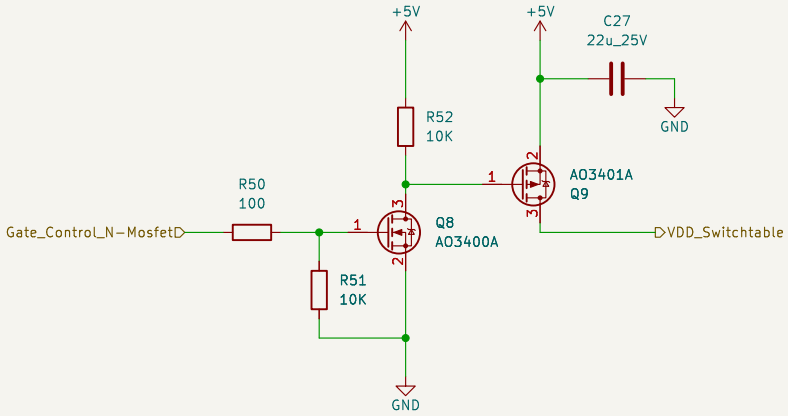

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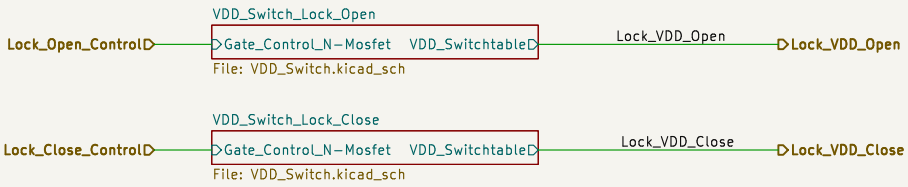

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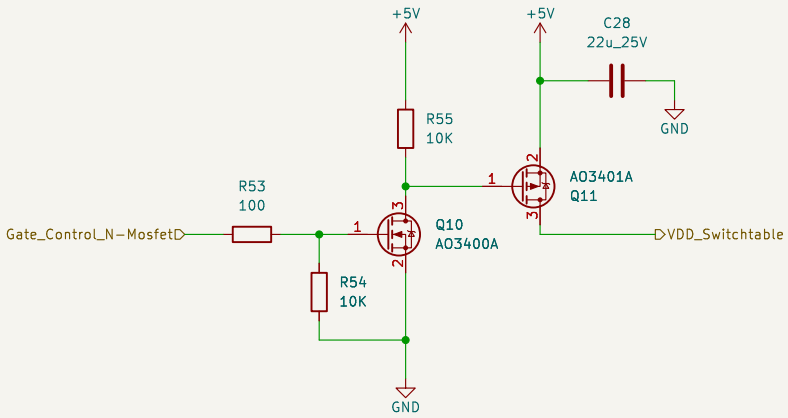

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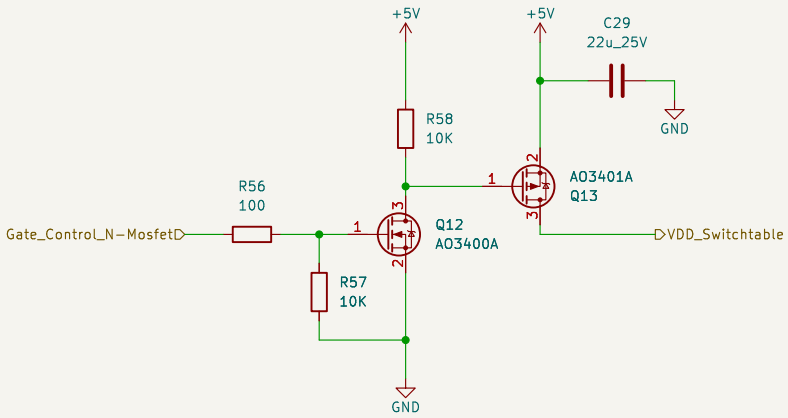
KiCad E.D.A. 8.0.6		Id: 12/68



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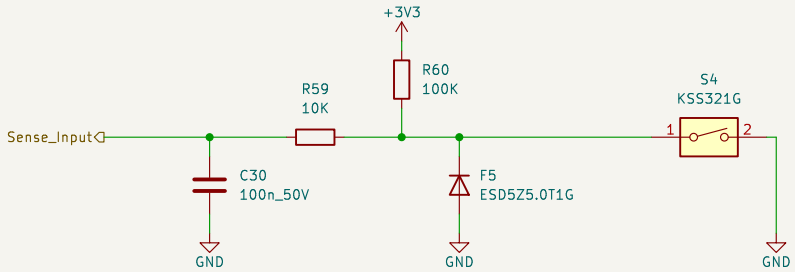

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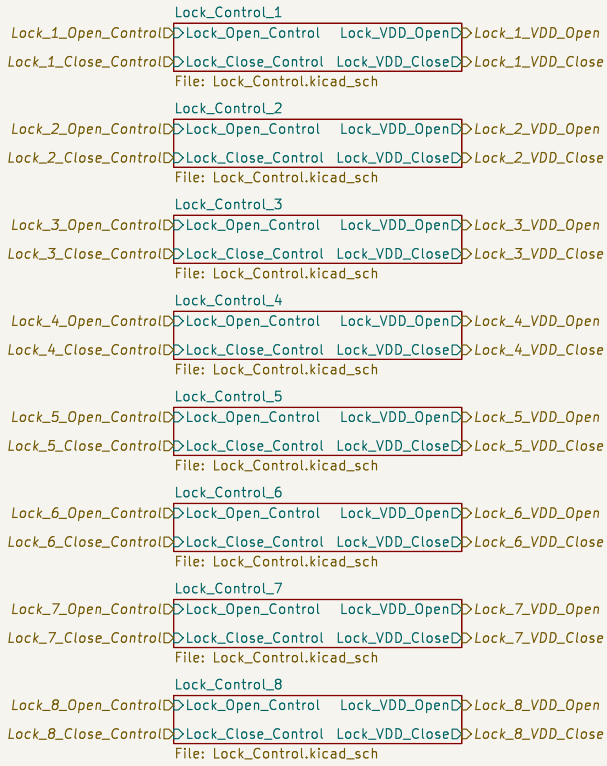
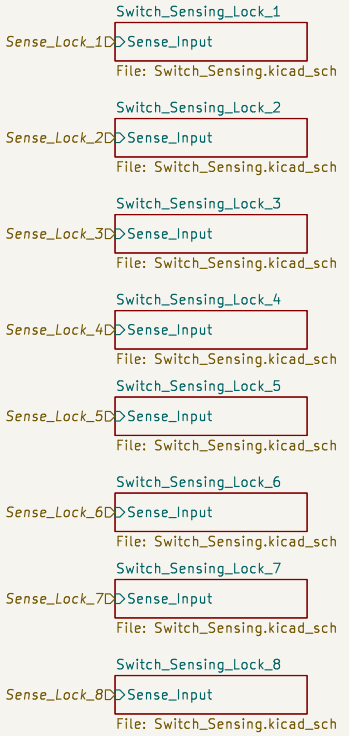
KiCad E.D.A. 8.0.6		Id: 14/68

Lock Control



Switch Sensing



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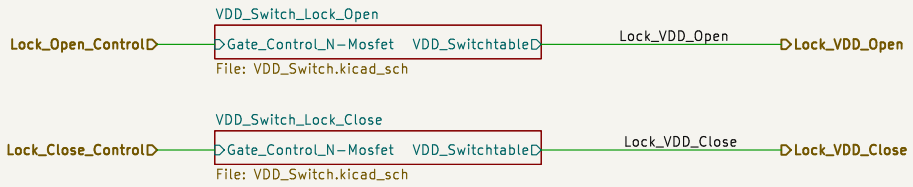

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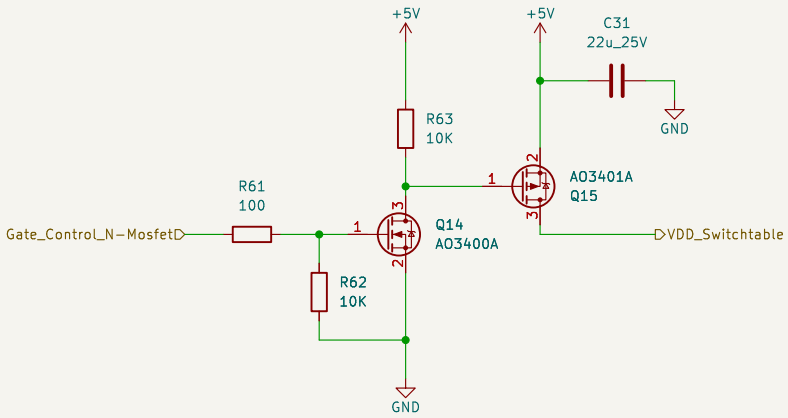

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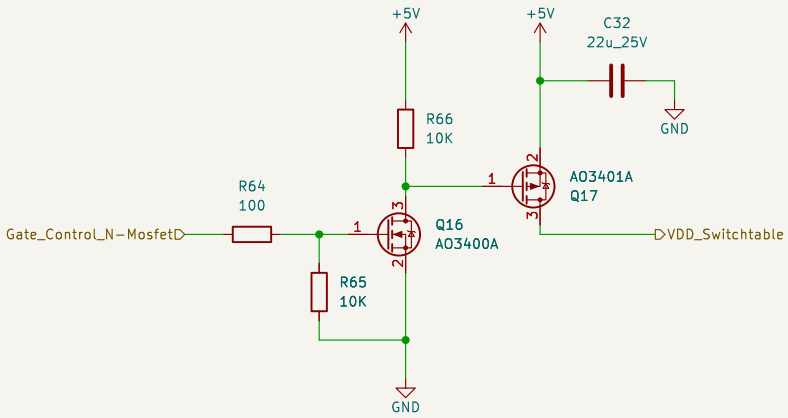

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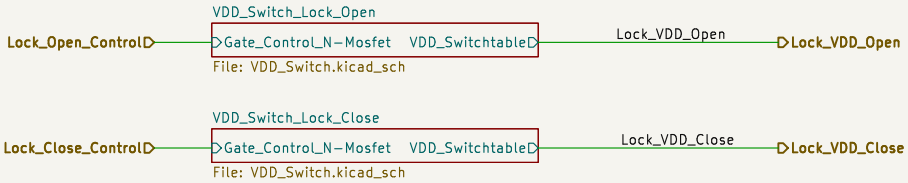

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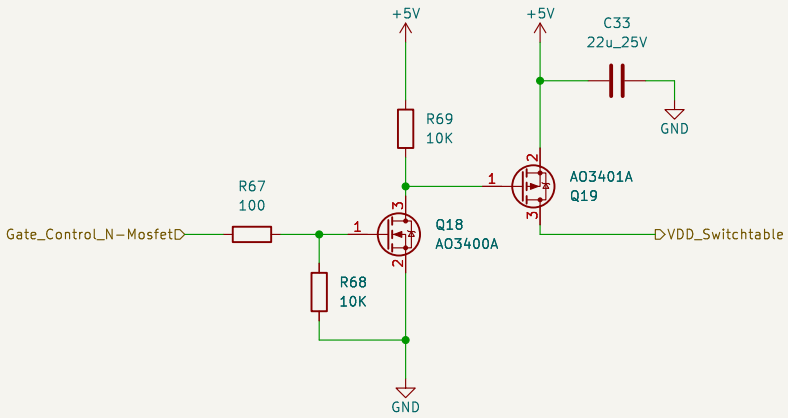

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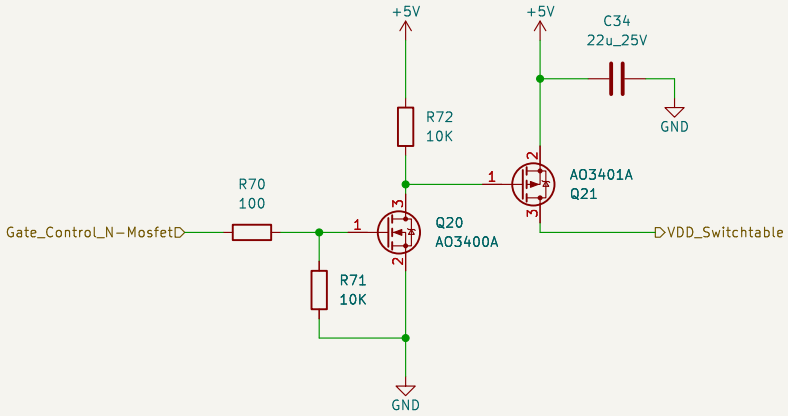

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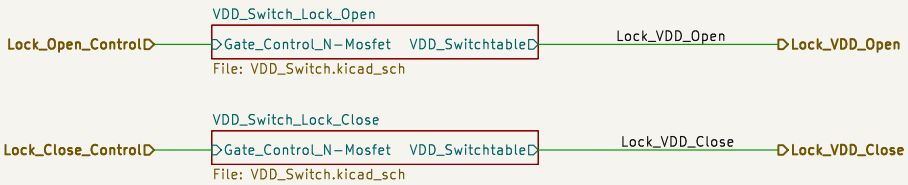

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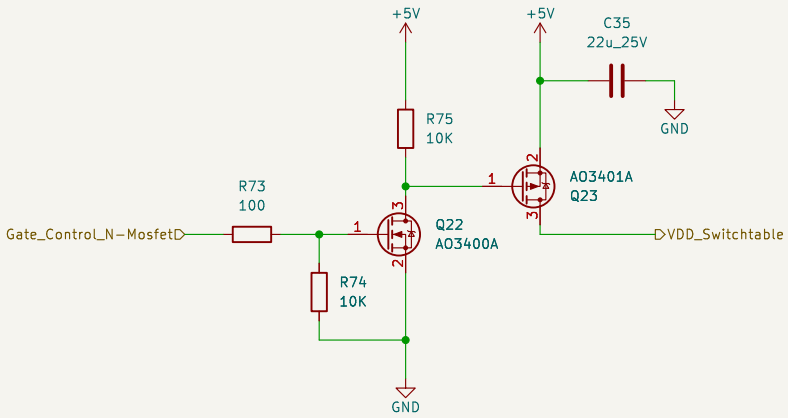

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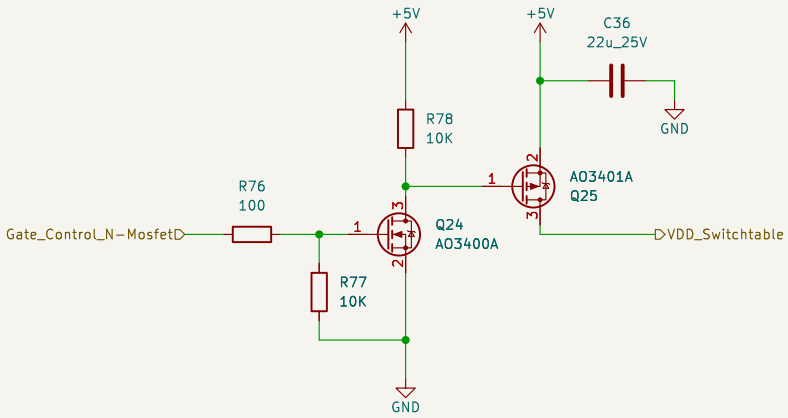

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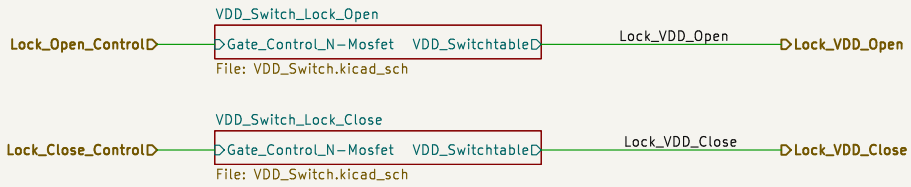

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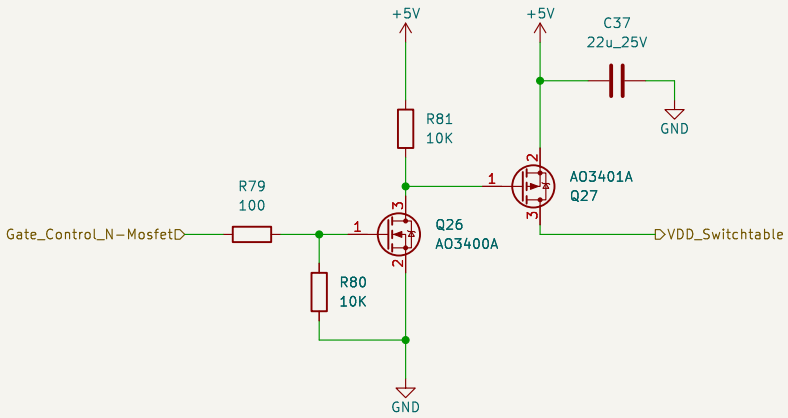

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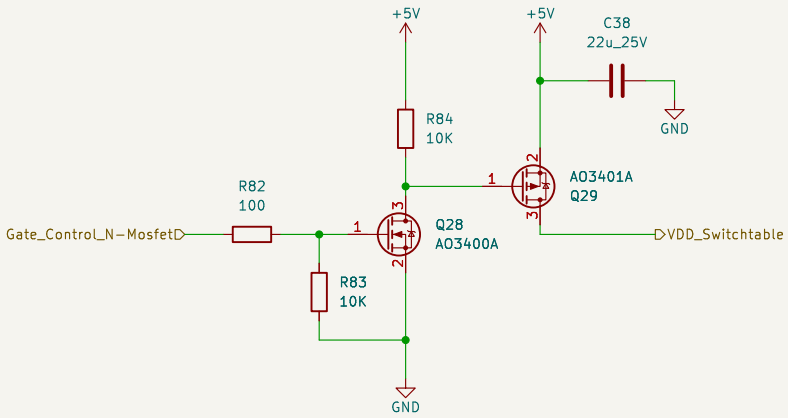

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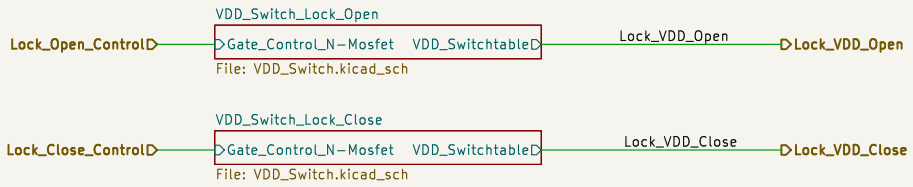

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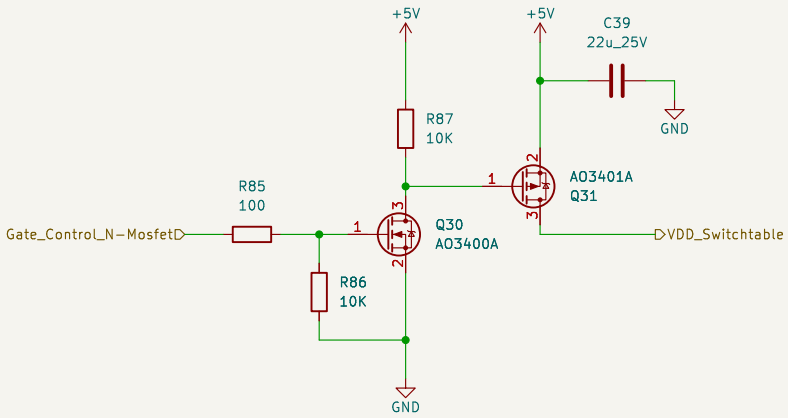

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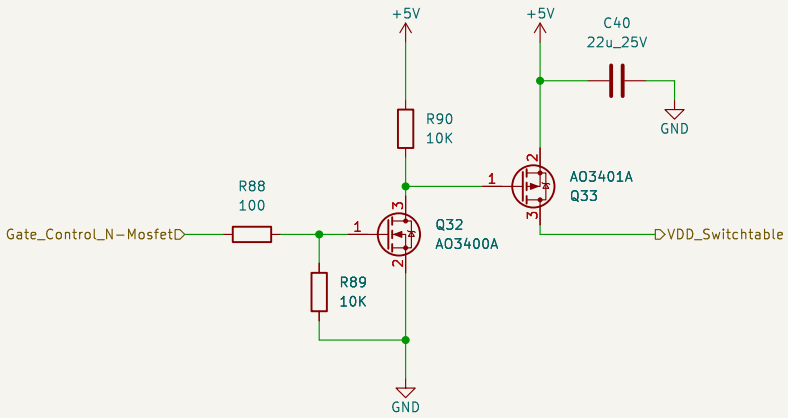

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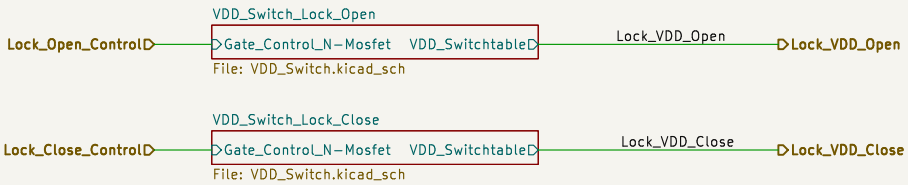

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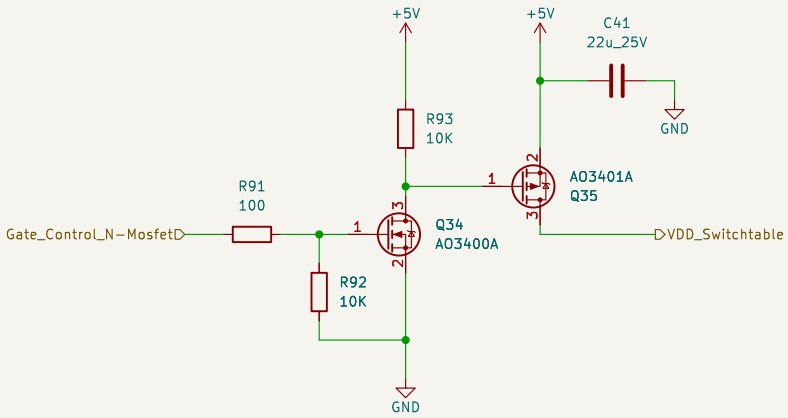

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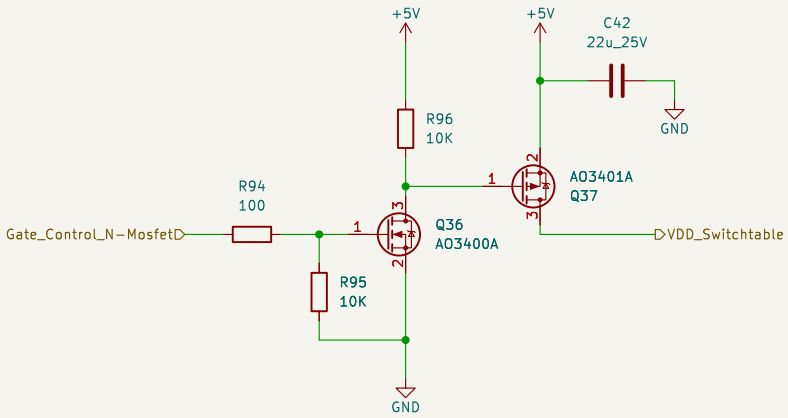

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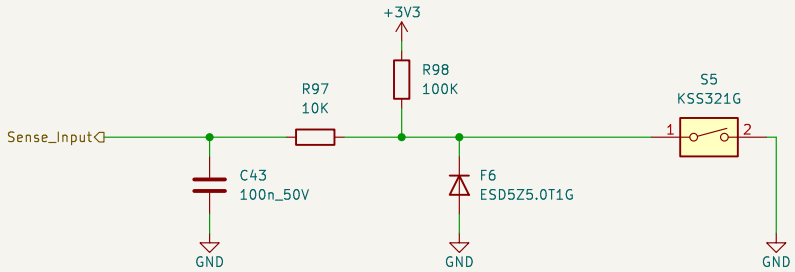

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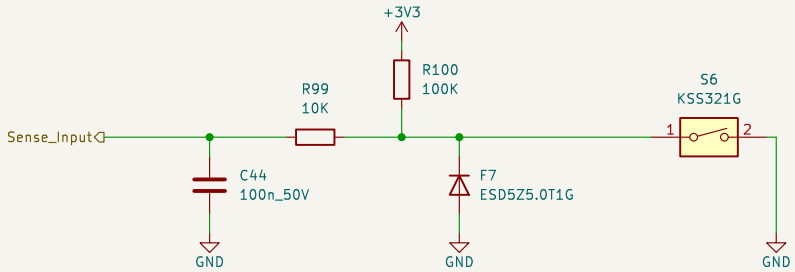

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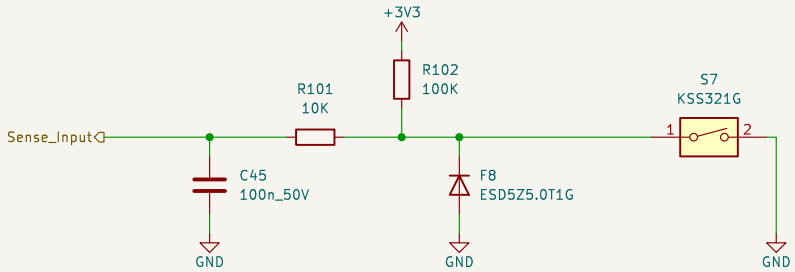

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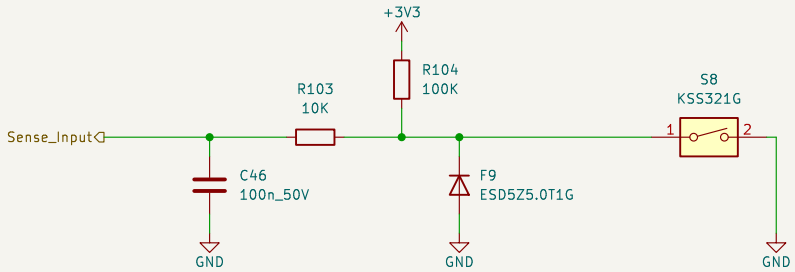

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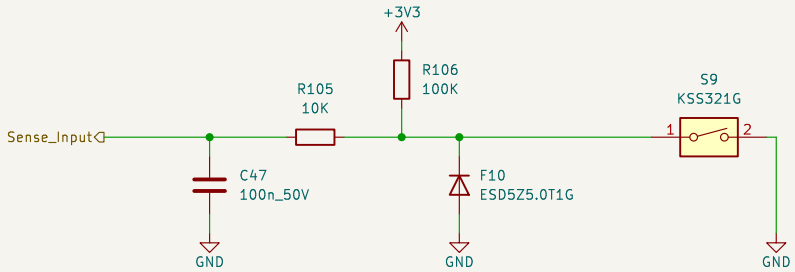

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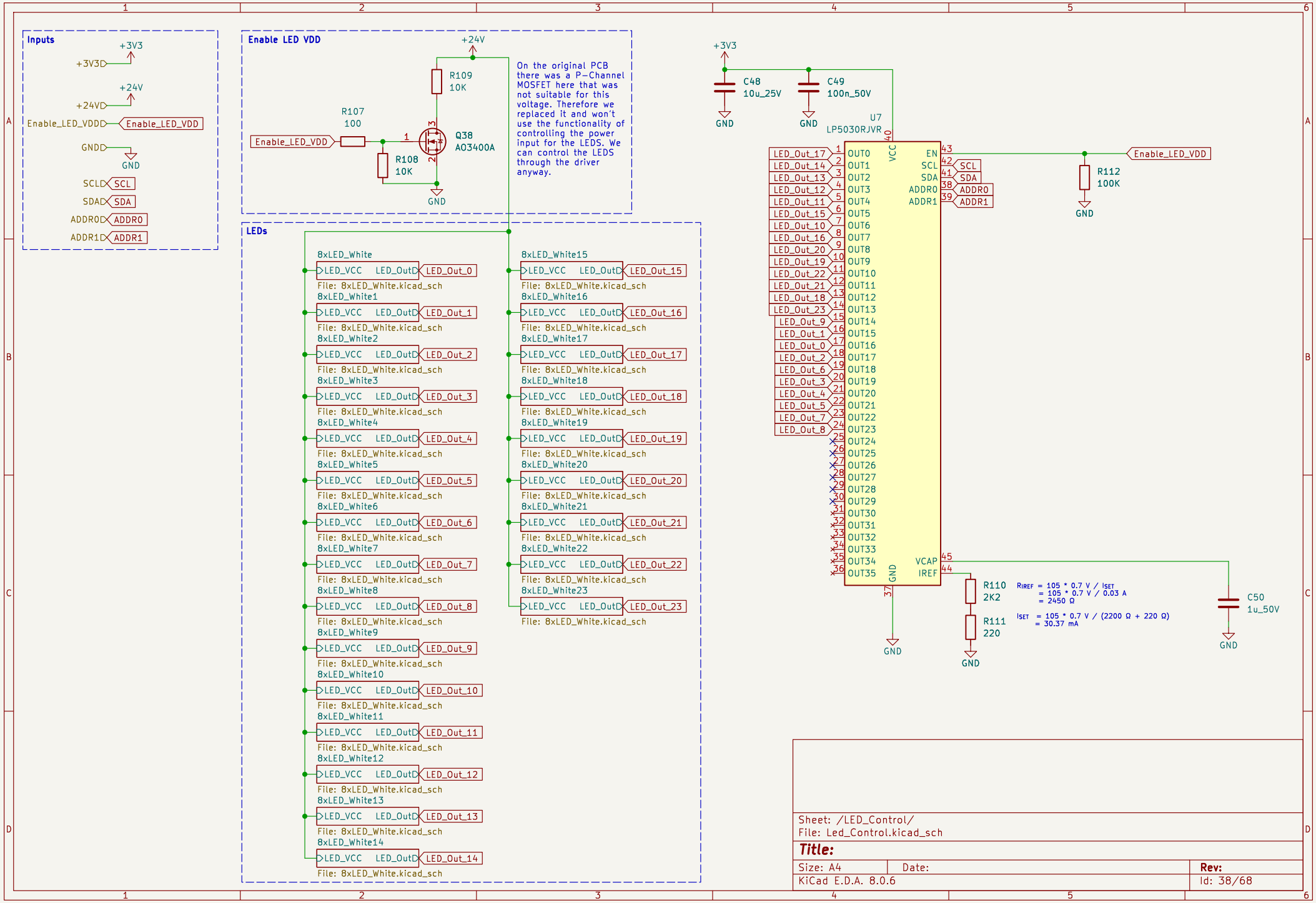
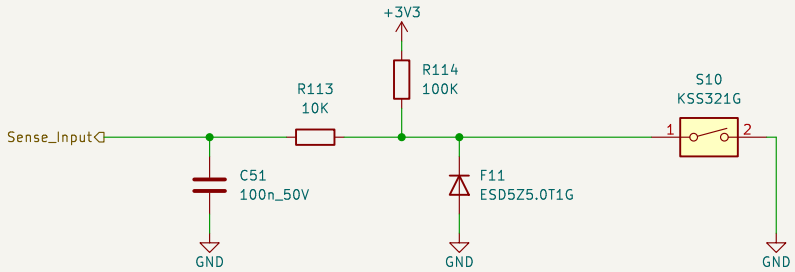
KiCad E.D.A. 8.0.6		Id: 38/68


Inputs
+3V3
+24V
Enable_LED_VDD
GND
SCL
SDA
ADDR0
ADDR1
Enable LED VDD
R109
10K
R107
100
R108
10K
Q38
AO3400A
On the original PCB there was a P-Channel MOSFET here that was not suitable for this voltage. Therefore we replaced it and won't use the functionality of controlling the power input for the LEDS. We can control the LEDS through the driver anyway.
LEDs
8xLED_White
8xLED_White1
8xLED_White2
8xLED_White3
8xLED_White4
8xLED_White5
8xLED_White6
8xLED_White7
8xLED_White8
8xLED_White9
8xLED_White10
8xLED_White11
8xLED_White12
8xLED_White13
8xLED_White14
8xLED_White15
8xLED_White16
8xLED_White17
8xLED_White18
8xLED_White19
8xLED_White20
8xLED_White21
8xLED_White22
8xLED_White23
File: 8xLED_White.kicad_sch
C48
10u_25V
C49
100n_50V
U7
LP5030RJVR
R112
100K
R110
2K2
R111
220
C50
1u_50V
IREF = 105 * 0.7 V / ISET
= 105 * 0.7 V / 0.03 A
= 2450 Ω
ISET = 105 * 0.7 V / (2200 Ω + 220 Ω)
= 30.37 mA
Sheet: /LED_Control/
File: Led_Control.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 8.0.6
Id: 38/68



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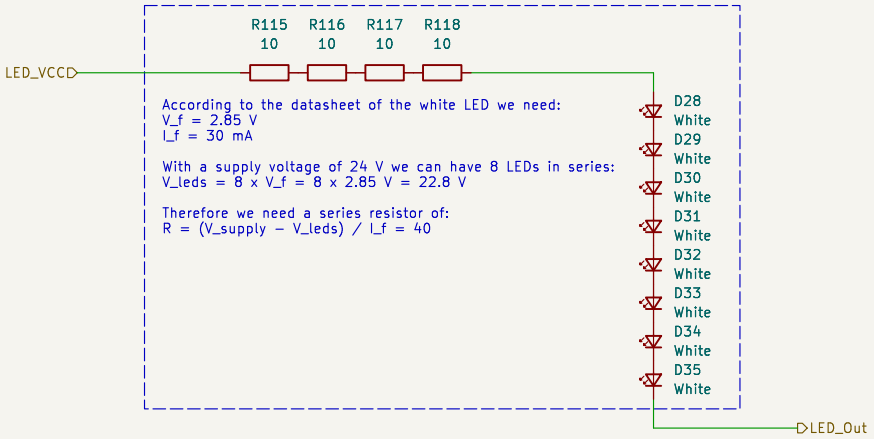
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 39/68



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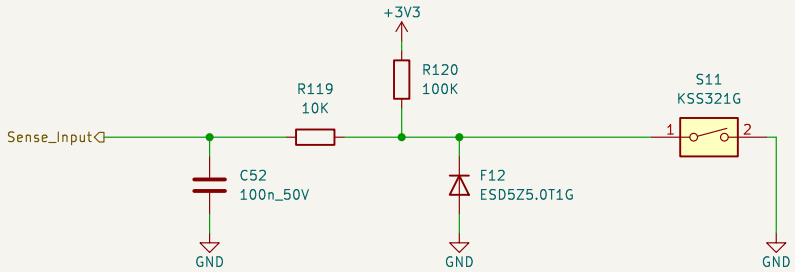
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 39/68



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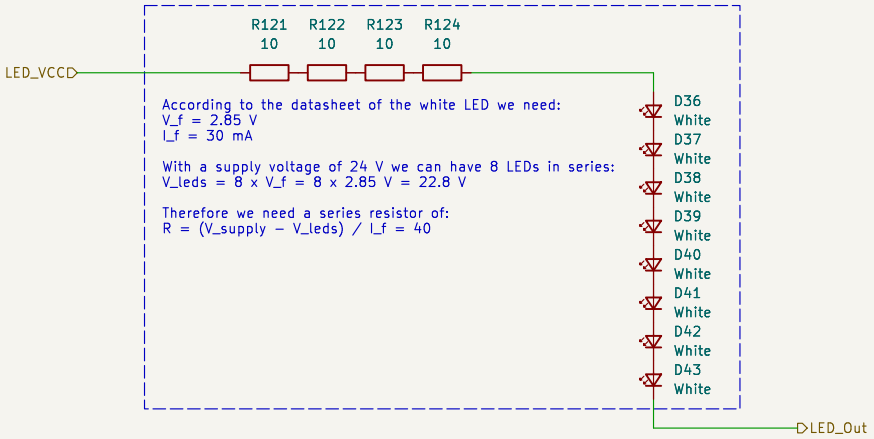
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 40/68



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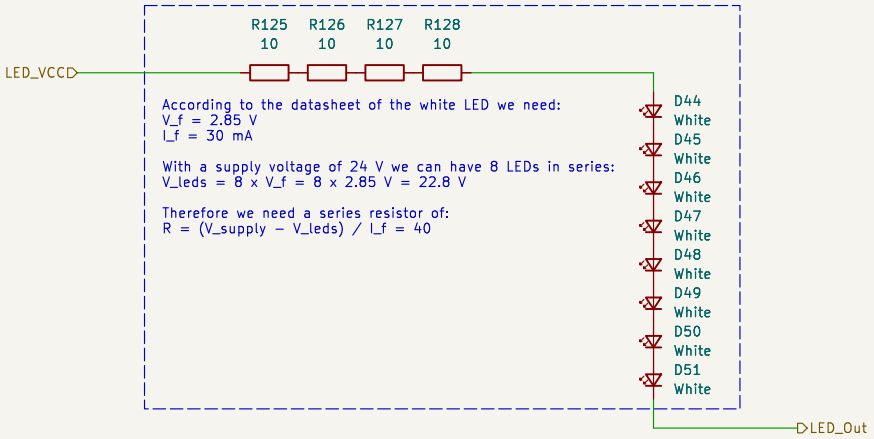
KiCad E.D.A. 8.0.6		Id: 41/68



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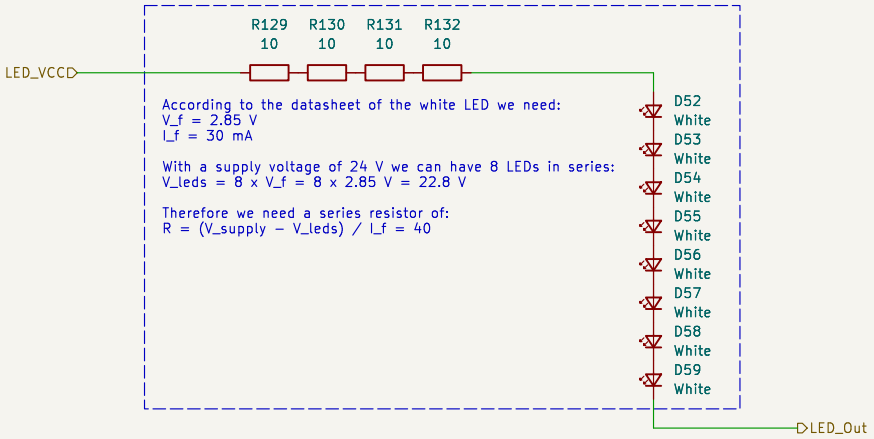
KiCad E.D.A. 8.0.6		Id: 42/68



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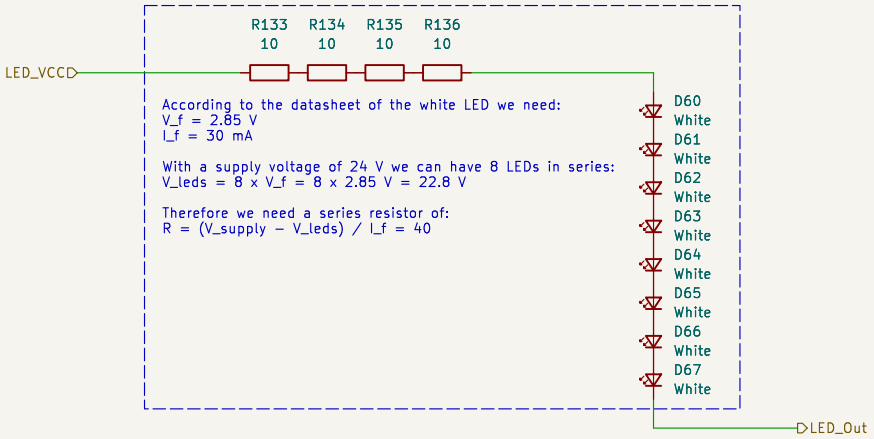
KiCad E.D.A. 8.0.6		Id: 43/68



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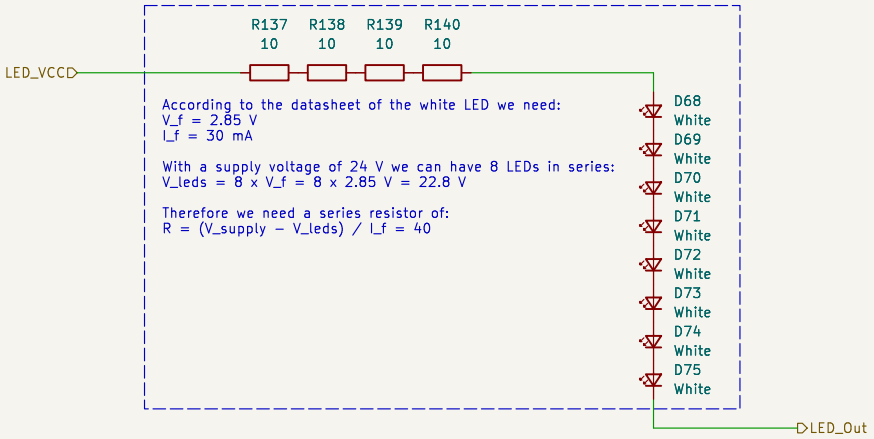
KiCad E.D.A. 8.0.6		Id: 44/68



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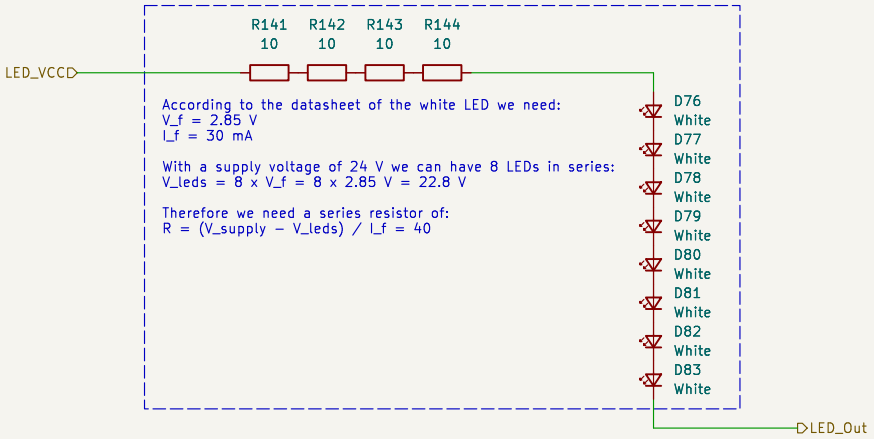

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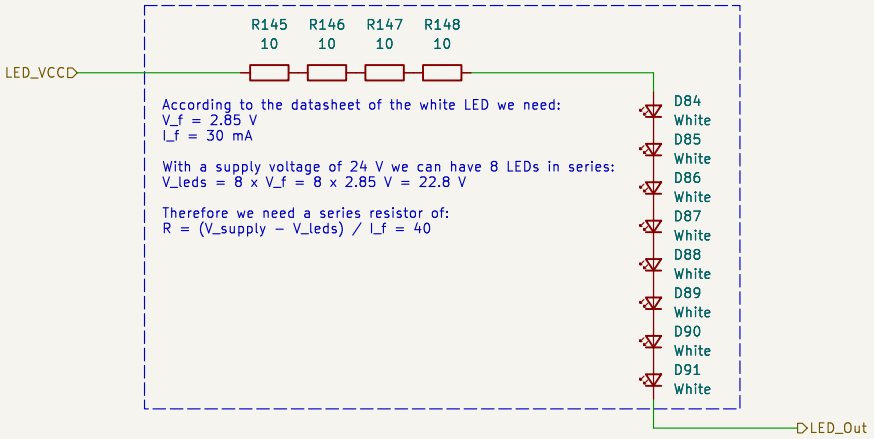
KiCad E.D.A. 8.0.6		Id: 46/68



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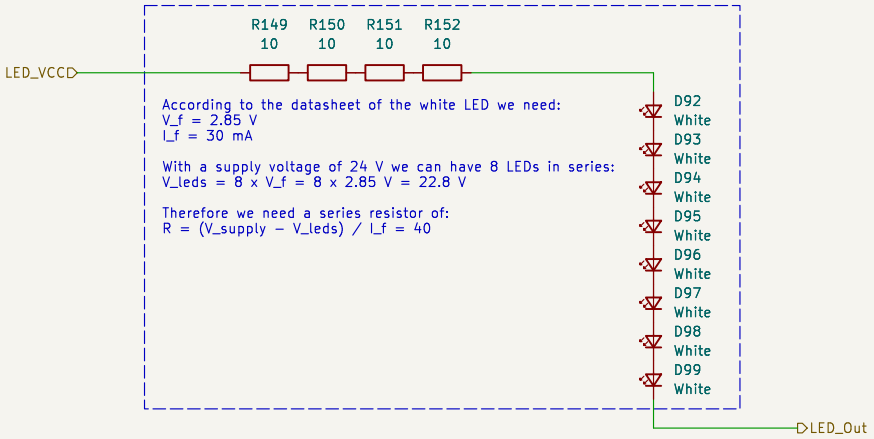
KiCad E.D.A. 8.0.6		Id: 47/68



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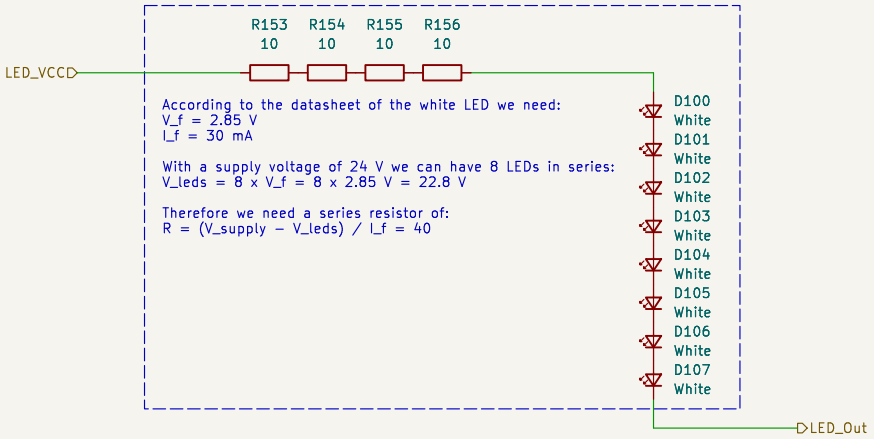
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 48/68



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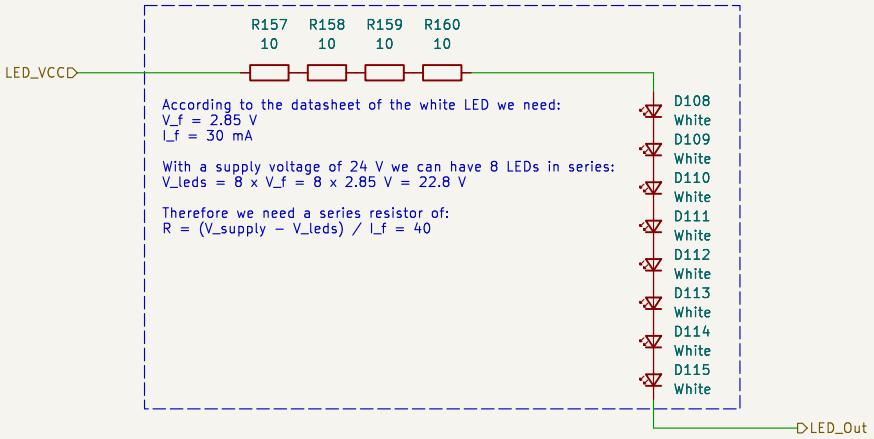
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 49/68



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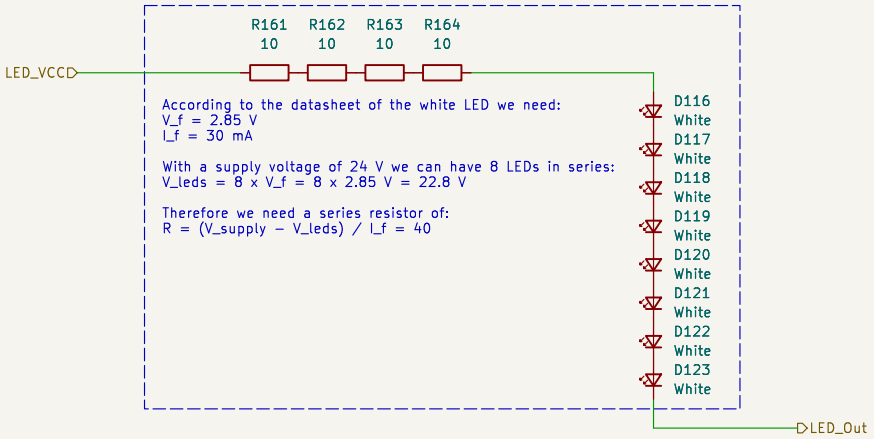
KiCad E.D.A. 8.0.6		Id: 50/68



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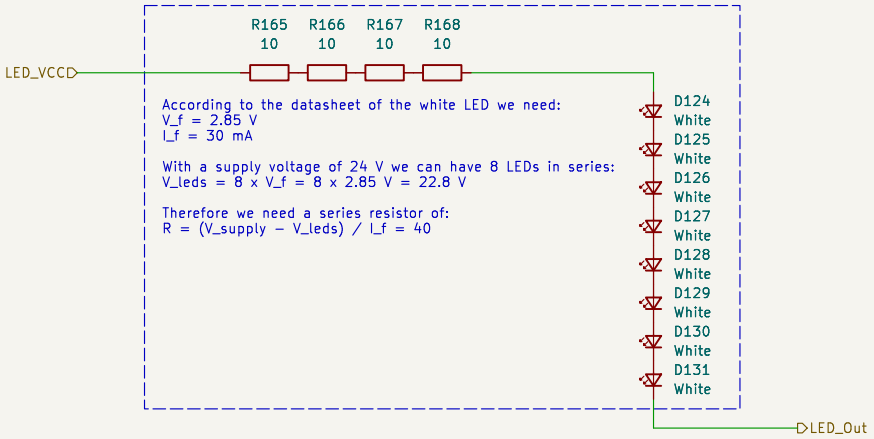
KiCad E.D.A. 8.0.6		Id: 51/68



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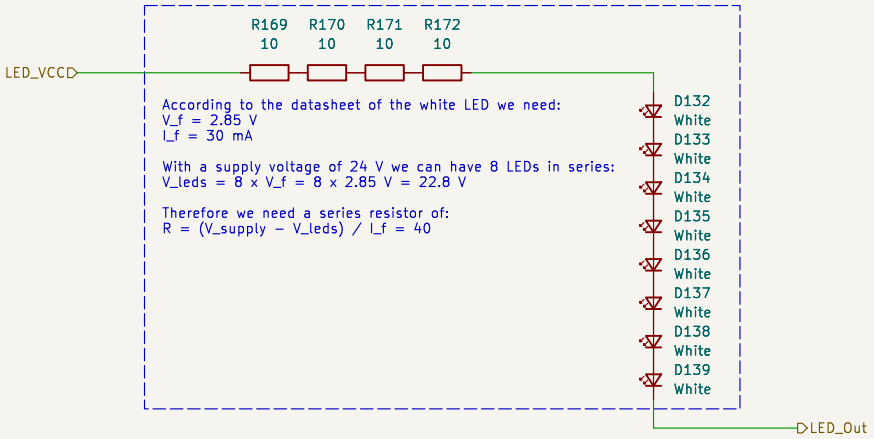
KiCad E.D.A. 8.0.6		Id: 52/68



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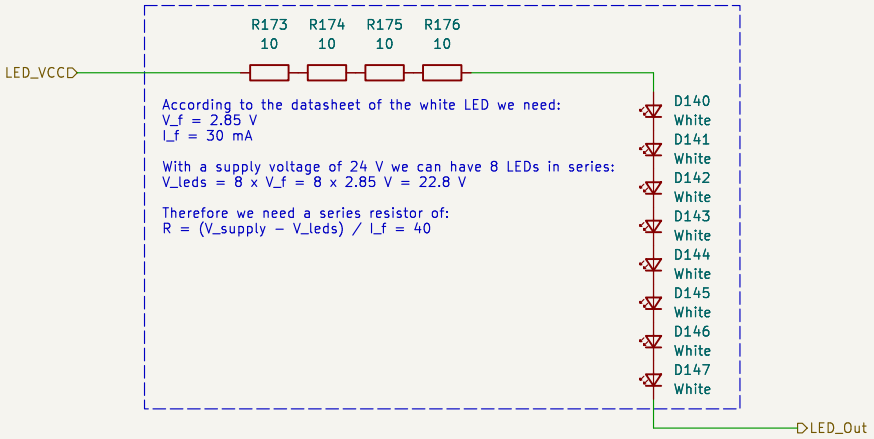
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 53/68



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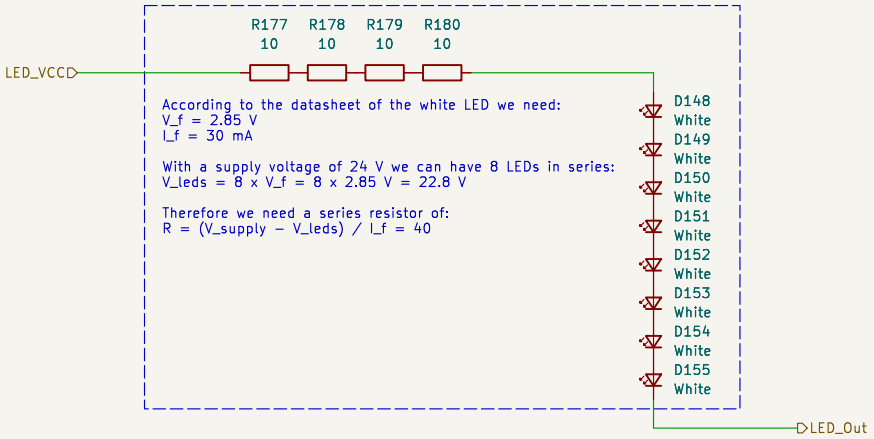
KiCad E.D.A. 8.0.6		Id: 54/68



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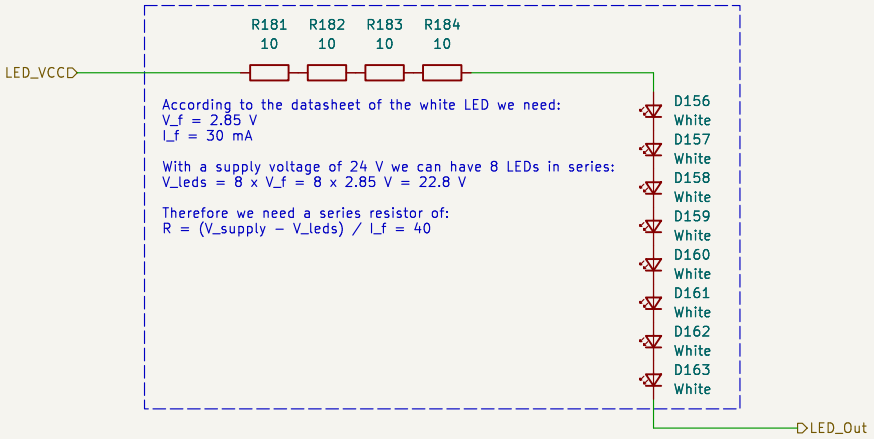
KiCad E.D.A. 8.0.6		Id: 55/68



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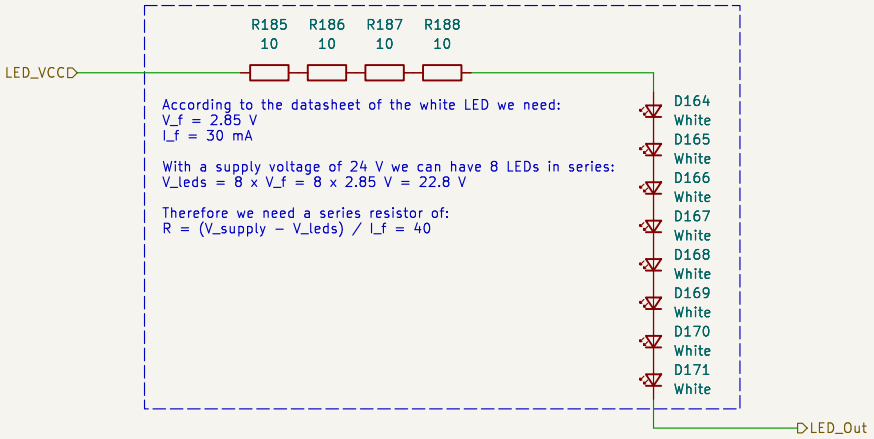
KiCad E.D.A. 8.0.6		Id: 56/68



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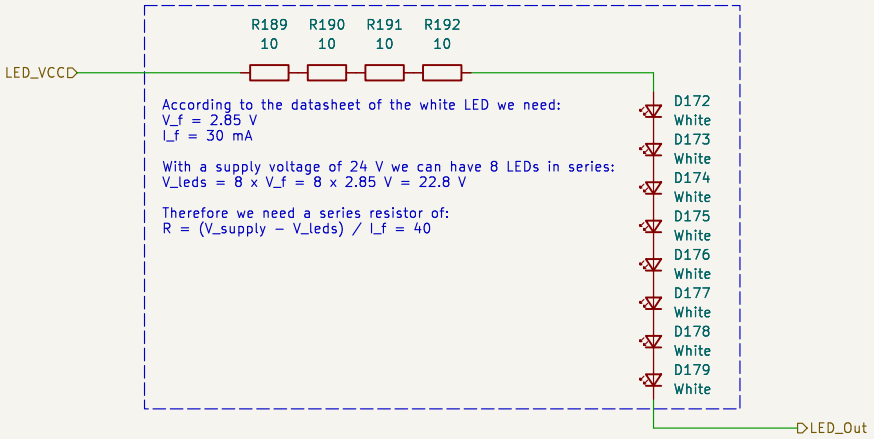
KiCad E.D.A. 8.0.6		Id: 57/68



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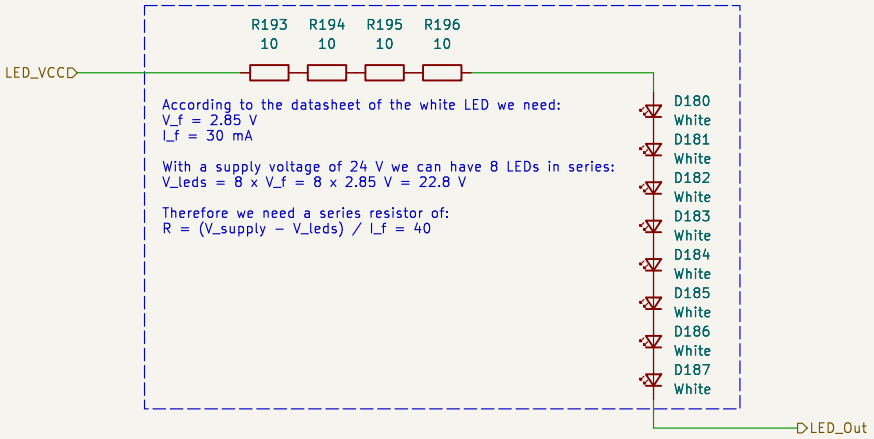
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 58/68



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Size: A4	Date:	**Rev:**
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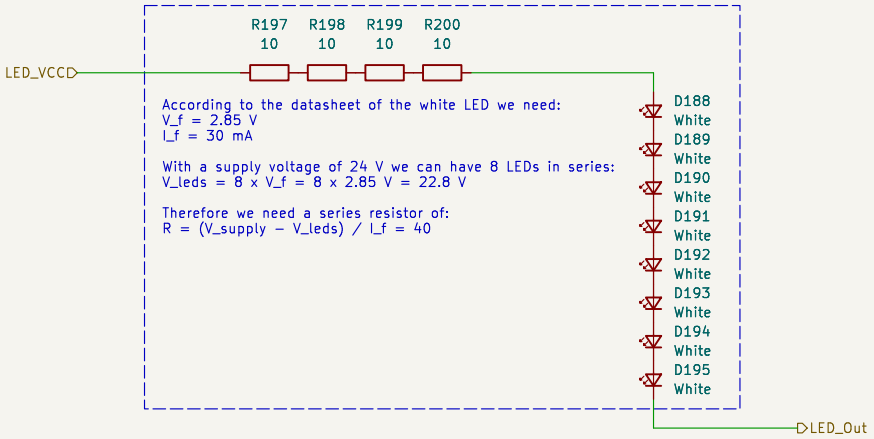

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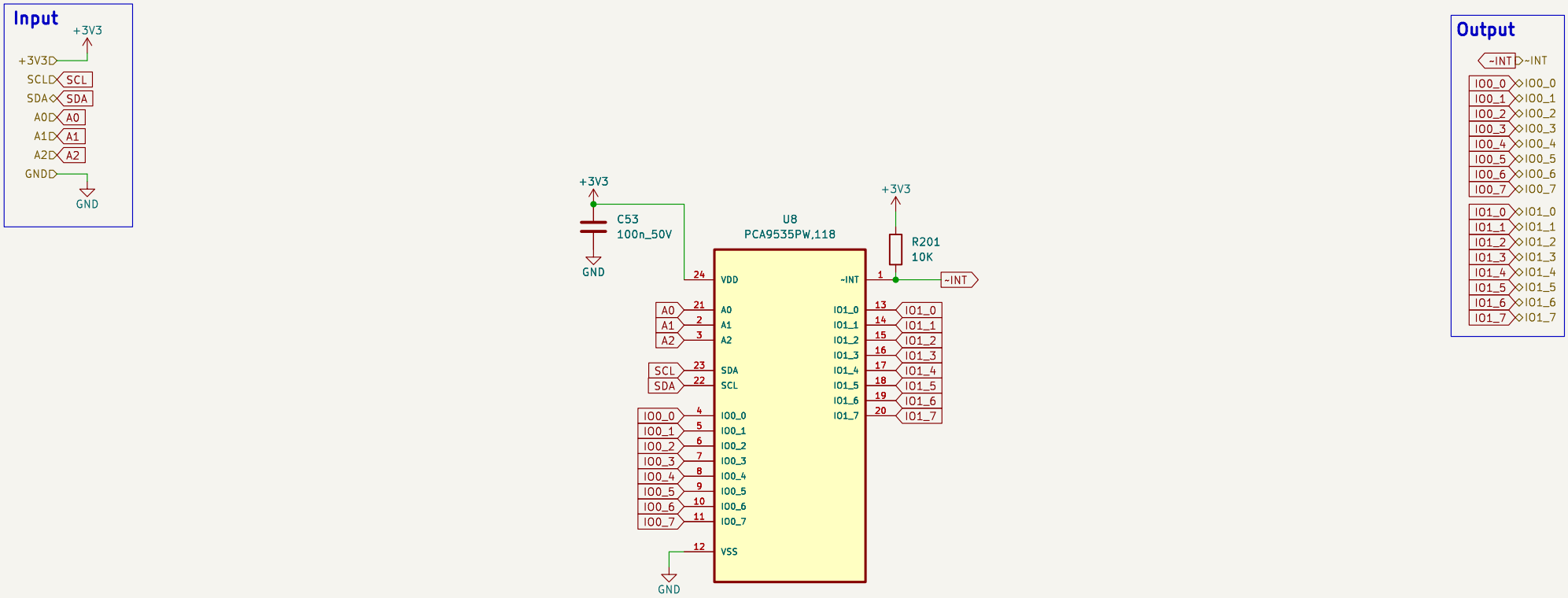
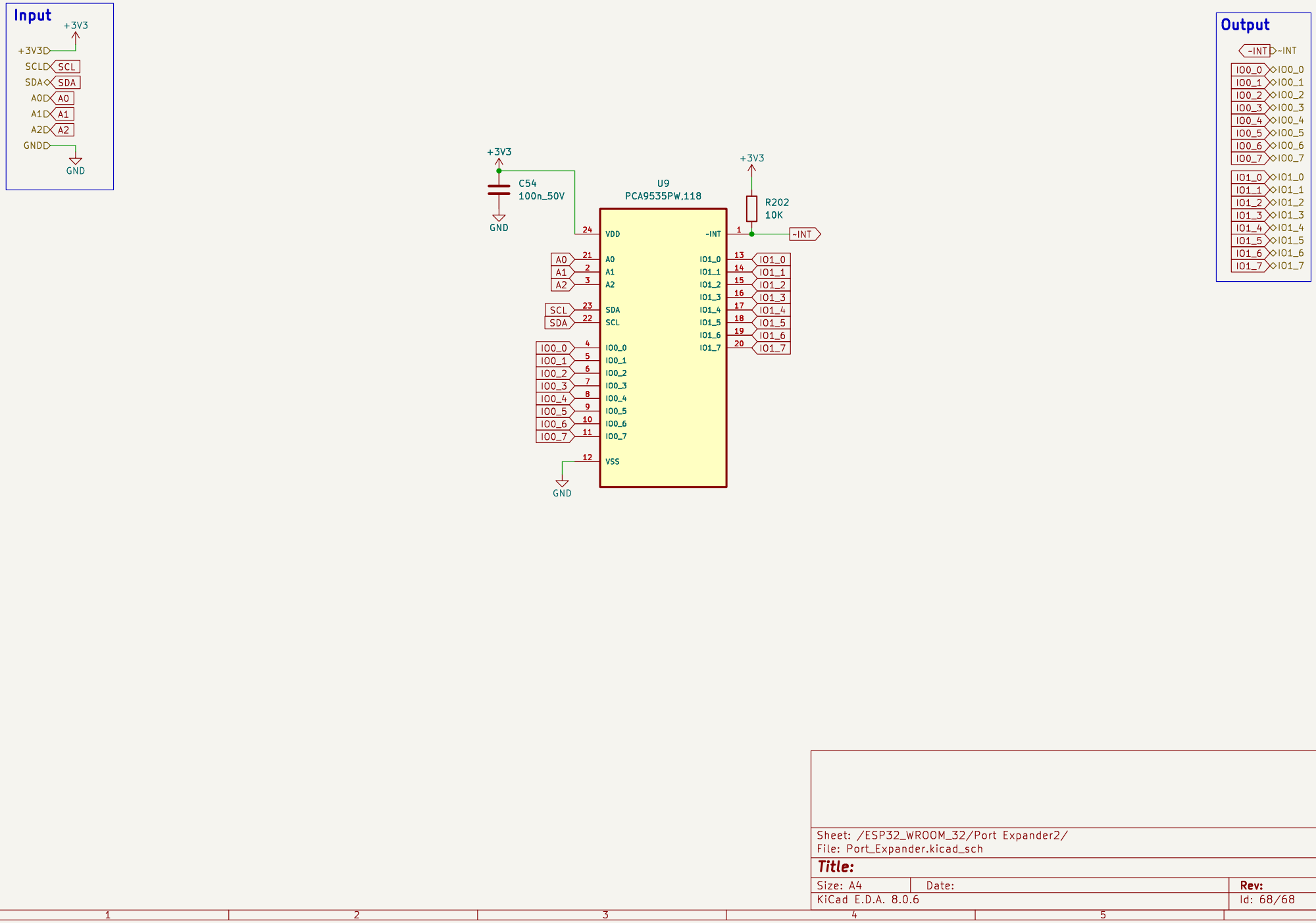
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 60/68

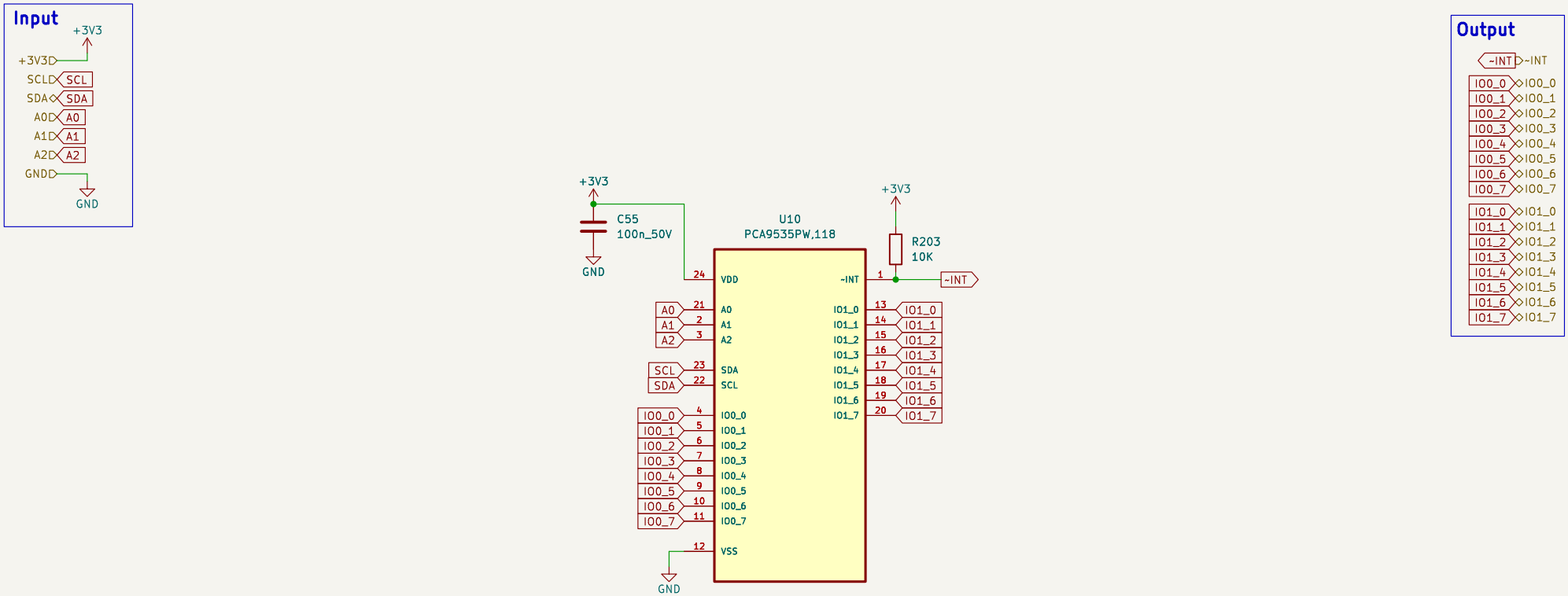


Sheet: /ESP32_WROOM_32/Port Expander1/
File: Port_Expander.kicad_sch

Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 67/68


Input
+3V3
+3V3
SCL
SDA
A0
A1
A2
GND
GND
Output
~INT
~INT
IO0_0
IO0_1
IO0_2
IO0_3
IO0_4
IO0_5
IO0_6
IO0_7
IO1_0
IO1_1
IO1_2
IO1_3
IO1_4
IO1_5
IO1_6
IO1_7
+3V3
C54
100n_50V
GND
U9
PCA9535PW,118
+3V3
R202
10K
~INT
VDD
~INT
A0
A1
A2
SDA
SCL
IO0_0
IO0_1
IO0_2
IO0_3
IO0_4
IO0_5
IO0_6
IO0_7
IO1_0
IO1_1
IO1_2
IO1_3
IO1_4
IO1_5
IO1_6
IO1_7
VSS
GND
Sheet: /ESP32_WROOM_32/Port Expander2/
File: Port_Expander.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 8.0.6
Id: 68/68

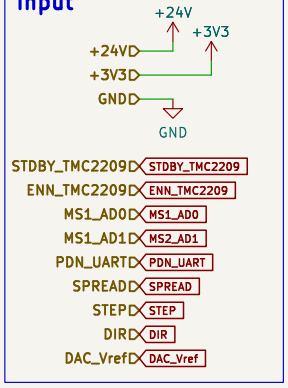


Sheet: /ESP32_WROOM_32/Port Expander/
File: Port_Expander.kicad_sch

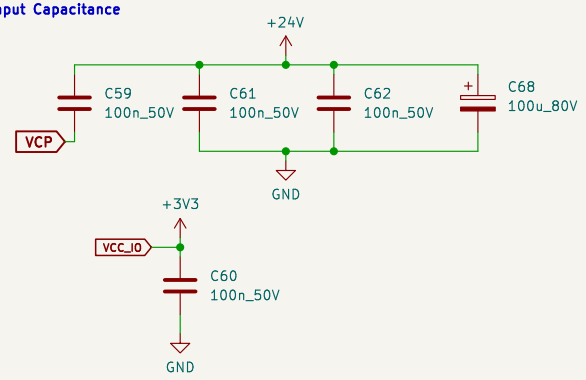
Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 69/68

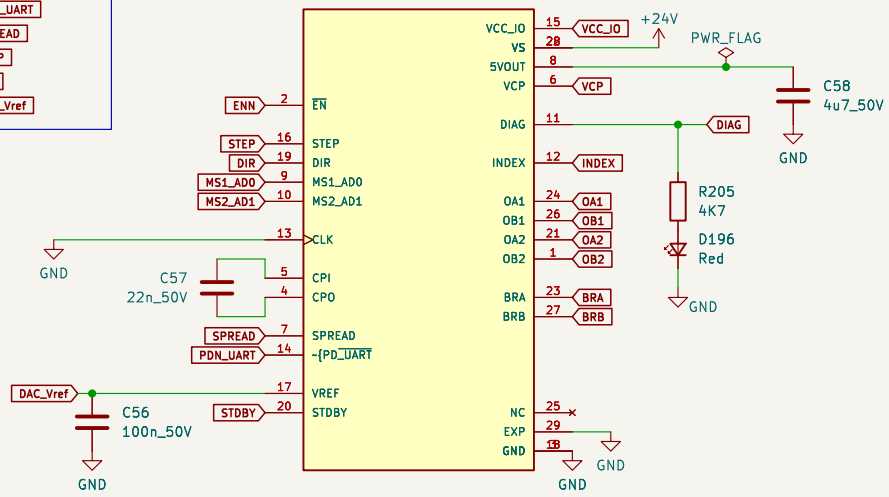
Input



Input Capacitance



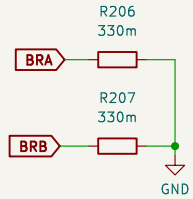
Output



Sense Resistor

Sense resistors should be carefully selected. The full motor current flows through the sense resistors. Due to chopper operation the sense resistors see pulsed current from the MOSFET bridges. Therefore, a low-inductance type such as film or composition resistors is required to prevent voltage spikes causing ringing on the sense voltage inputs leading to unstable measurement results. Also, a low-inductance, low-resistance PCB layout is essential. Any common GND path for the two sense resistors must be avoided, because this would lead to coupling between the two current sense signals. A massive ground plane is best.
The sense resistor needs to be able to conduct the peak motor coil current in motor standstill conditions, unless standby power is reduced. Under normal conditions, the sense resistor conducts less than the coil RMS current, because no current flows through the sense resistor during the slow decay phases. A 0.5W type is sufficient for most applications up to 1.2A RMS current.

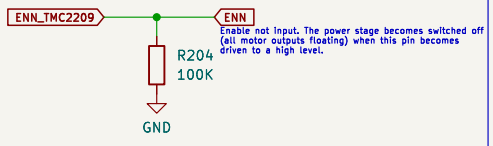
Be sure to use a symmetrical sense resistor layout and short and straight sense resistor traces of identical length. Well matching sense resistors ensure best performance.
A compact layout with massive ground plane is best to avoid parasitic resistance effects.

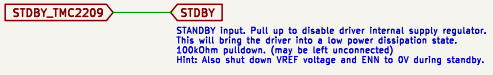


According to the datasheet:
330mΩ resistor results in 0.66A max motor current

Low Power Standby

Battery powered applications, and mains powered applications conforming to standby energy saving rules, often require a standby operation, where the power-supply remains on, but current draw goes down to a low value. The TMC2209/2226 support standby operation of roughly 2mW (at 12V supply). or <1mW at 5V supply using a dedicated pin STANDYBY. Pull up STANDBY to VCC_IO to go to low power standby. VCC_IO may be dropped down to 1.5V during standby. A high level on STANDBY will disable the internal 5V regulator and at the same time switches off all internal units. Prior to going to STANDBY, stop the motor, and allow it to enter standstill current, or switch off the motor completely. When in STANDBY, inputs ENN and VREF have to be driven to a low level. VCC_IO shall remain active in standby mode. All driver registers are reset to their power-up defaults after leaving standby mode.



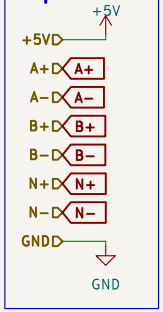


Sheet: /TMC2209/
File: TMC2209.kicad_sch

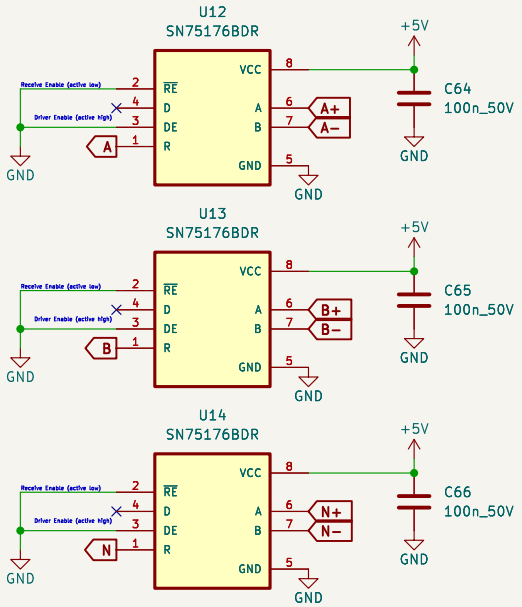
Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 72/68

Input

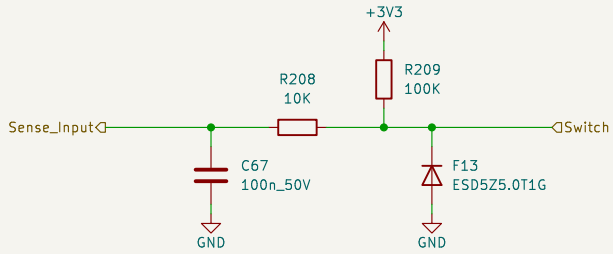


Differential Line Receiver



Output

Sheet: /Differential_Line_Receiver/		
File: Differential_Line_Receiver.kicad_sch		
Title:		
Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 74/68



Sheet: /Ext_Switch_Sensing_Drawer_1/
File: Ext_Switch_Sensing.kicad_sch

Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 75/68