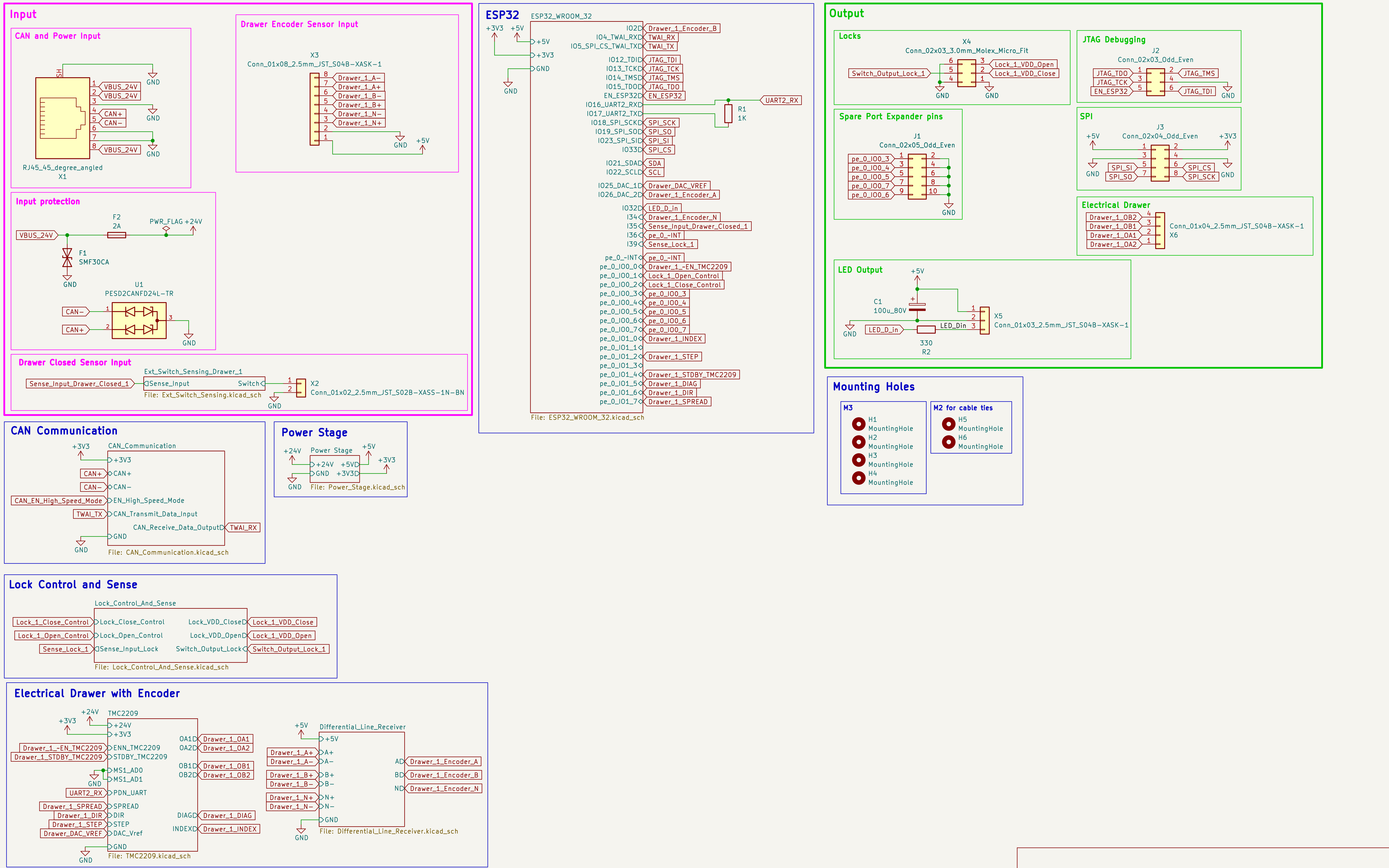

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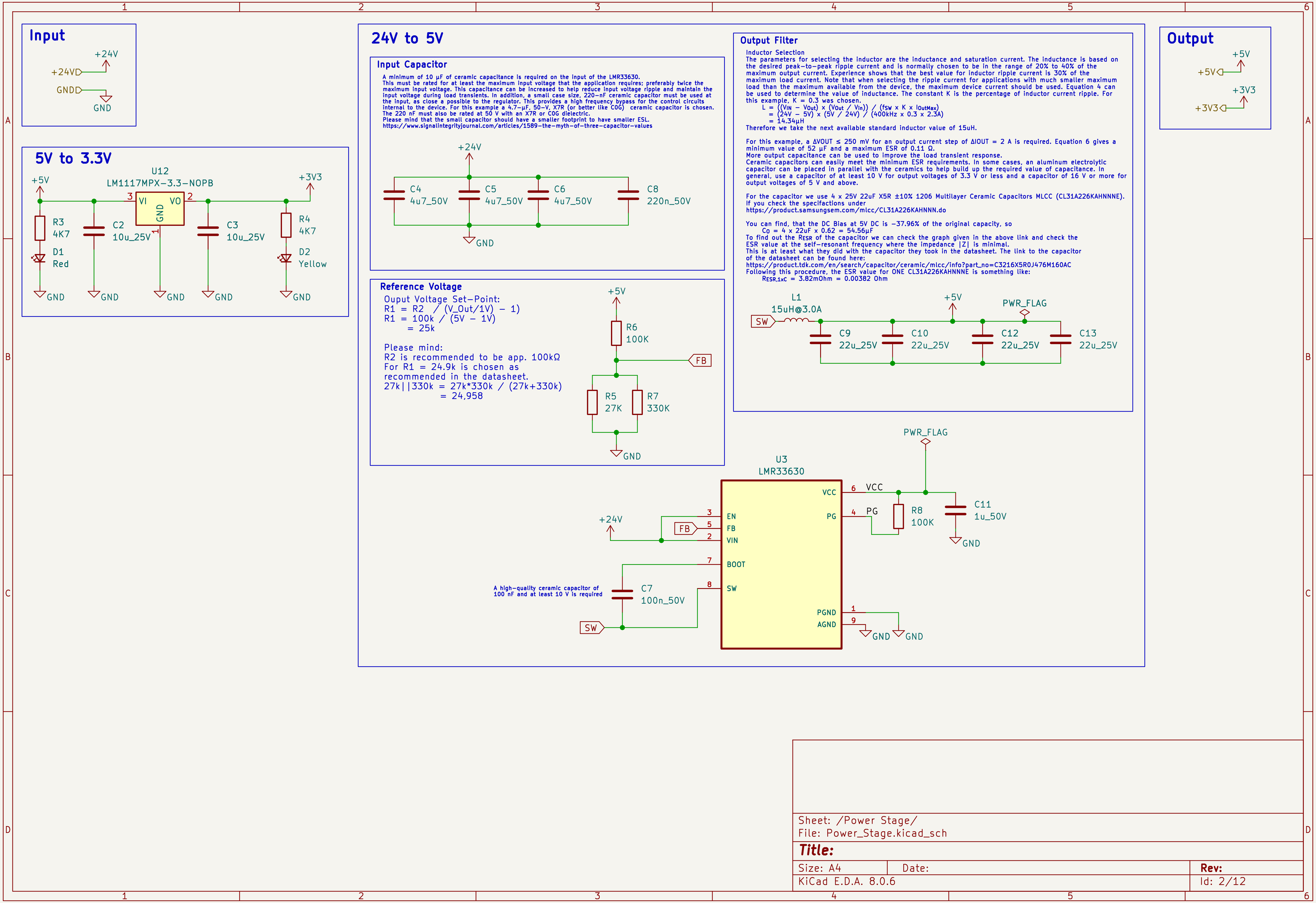
Input
+24V
+24V
GND
GND
5V to 3.3V
U12
LM1117MPX-3.3-NOPB
+5V
+3V3
VI
VO
GND
R3
4K7
D1
Red
C2
10u_25V
C3
10u_25V
R4
4K7
D2
Yellow
GND
GND
GND
GND
GND
24V to 5V
Input Capacitor
A minimum of 10 µF of ceramic capacitance is required on the input of the LMR33630.
This must be rated for at least the maximum 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
+24V
C4
4u7_50V
C5
4u7_50V
C6
4u7_50V
C8
220n_50V
GND
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
+5V
R6
100K
FB
R5
27K
R7
330K
GND
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 specfications under
https://product.samsungsem.com/mlcc/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/mlcc/info?part_no=C3216X5R0J476M160AC
Following this procedure, the ESR value for ONE CL31A226KAHNNNE is something like:
RESR,1xC = 3.82mOhm = 0.00382 Ohm
L1
15uH@3.0A
SW
+5V
PWR_FLAG
C9
22u_25V
C10
22u_25V
C12
22u_25V
C13
22u_25V
Output
+5V
+5V
+3V3
+3V3
U3
LMR33630
PWR_FLAG
VCC
PG
VCC
PG
EN
FB
VIN
BOOT
SW
PGND
AGND
R8
100K
C11
1u_50V
GND
+24V
FB
A high-quality ceramic capacitor of 100 nF and at least 10 V is required
C7
100n_50V
SW
GND
GND
Sheet: /Power Stage/
File: Power_Stage.kicad_sch
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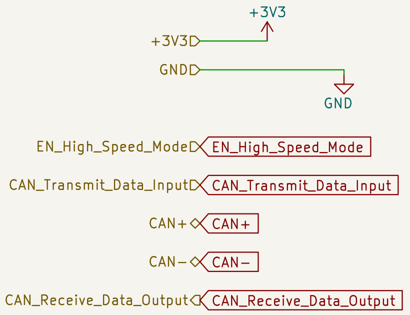
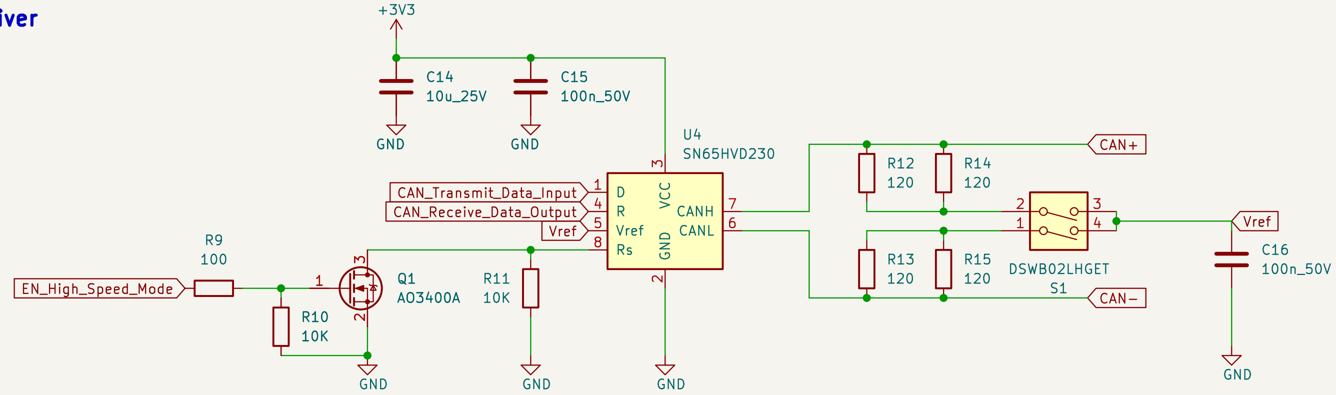
Input/Output



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/
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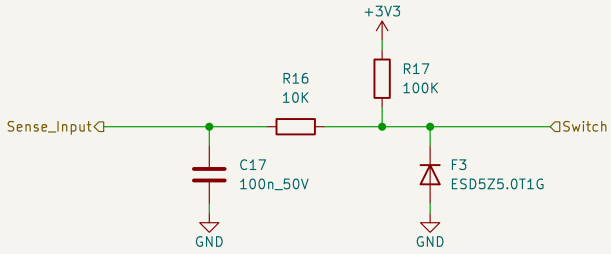

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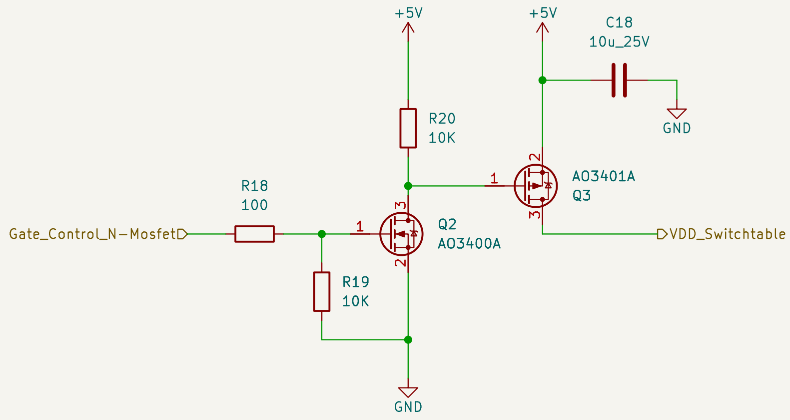

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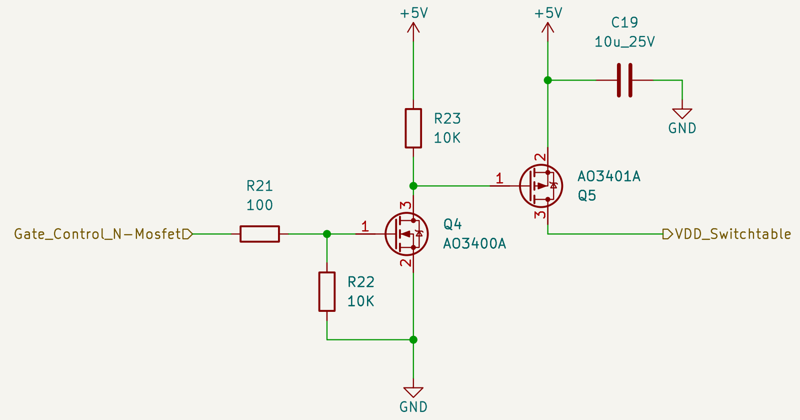
Size: A4	Date:	Rev:
KiCad E.D.A. 8.0.6		Id: 5/12



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Size: A4	Date:	**Rev:**
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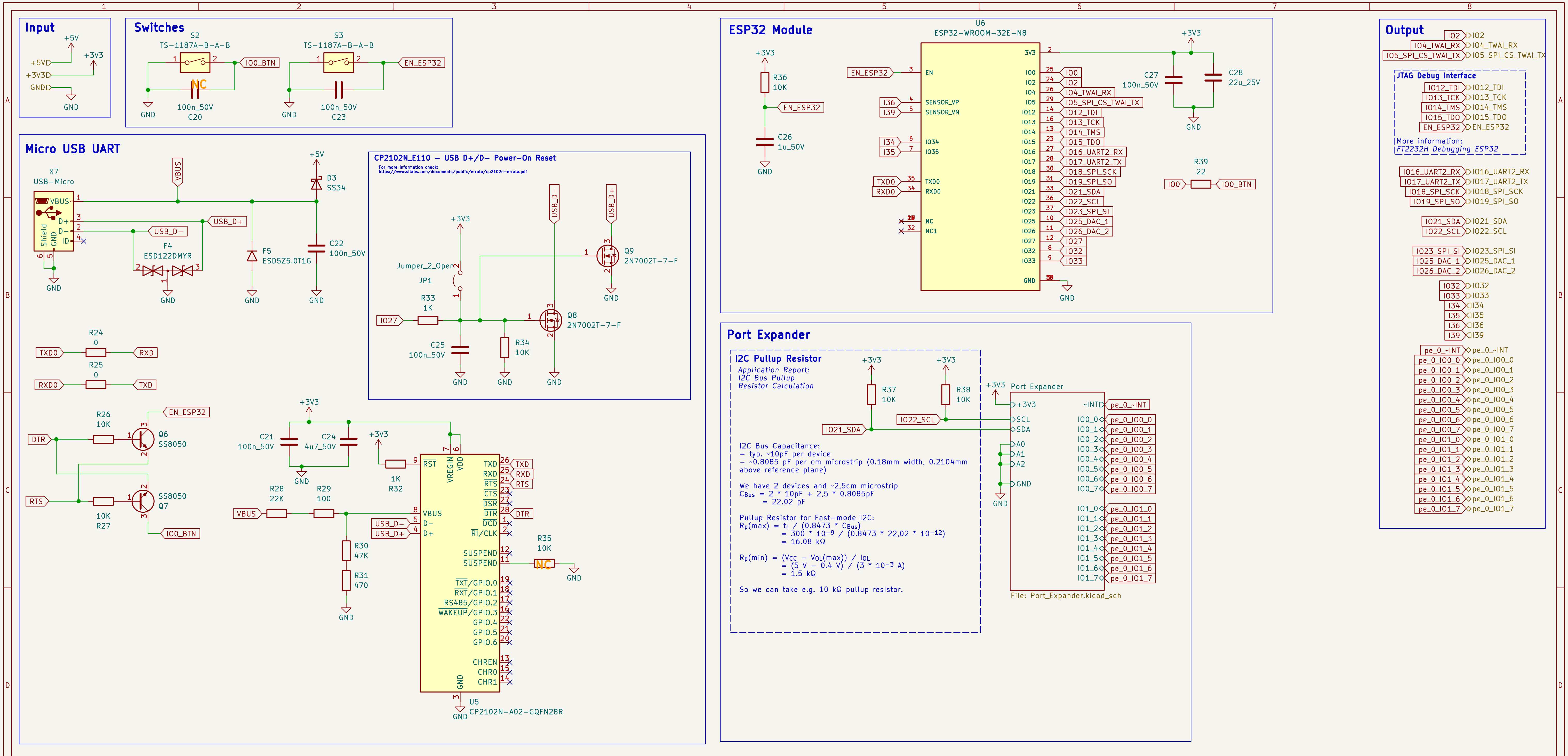

Datasheets & References:
https://www.espressif.com/sites/default/files/documentation/esp32-wroom-32e_esp32-wroom-32ue_datasheet_en.pdf
https://dl.espressif.com/dl/schematics/esp32_devkitc_v4-sch.pdf
https://www.youtube.com/watch?v=S_p0YV-JlfU&t=4185s

Sheet: /ESP32_WROOM_32/
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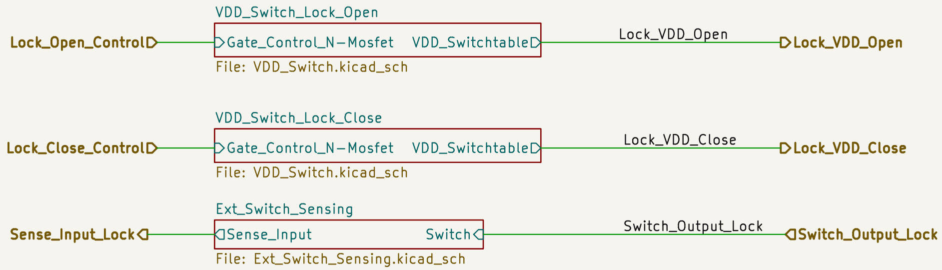
Size: A3 Date: Rev:

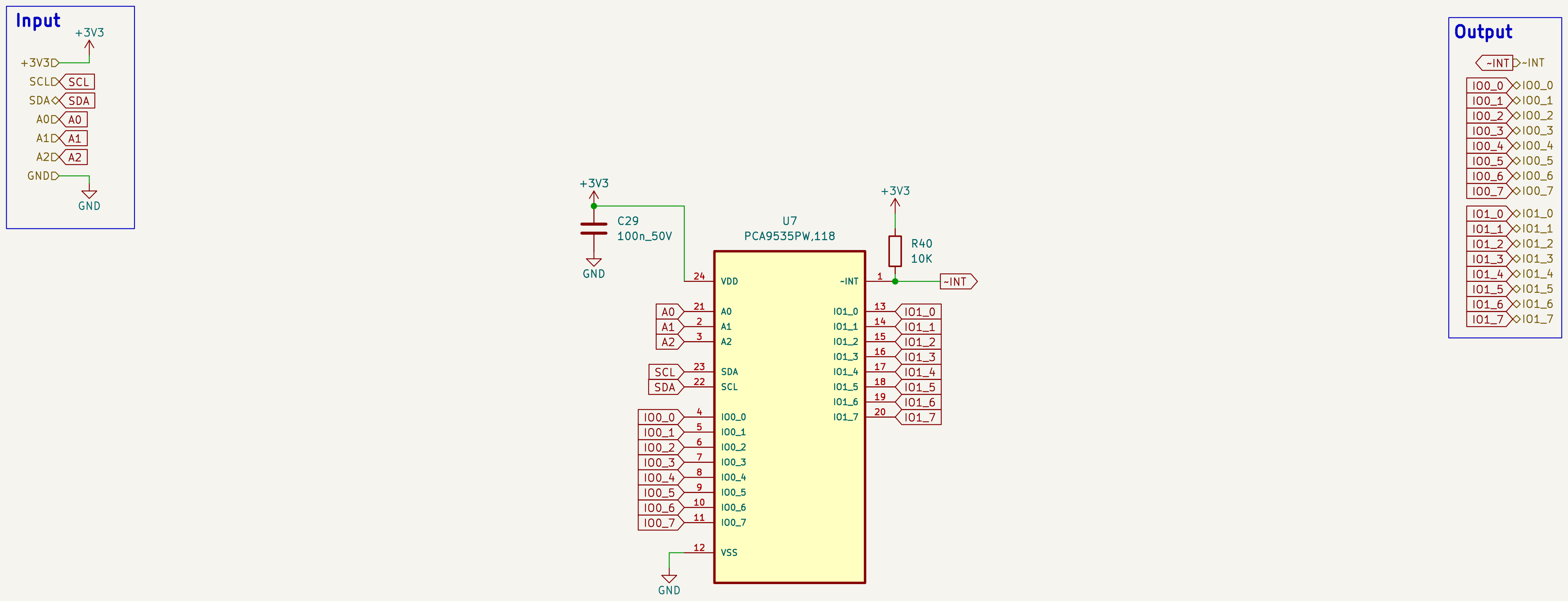
KiCad E.D.A. 8.0.6 Id: 7/12



Sheet: /Lock_Control_And_Sense/
File: Lock_Control_And_Sense.kicad_sch

Title:

Size: A4	Date:	**Rev:**
KiCad E.D.A. 8.0.6		Id: 15/12



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

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

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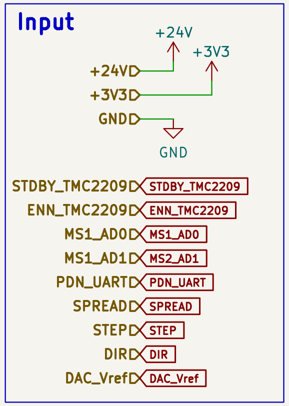
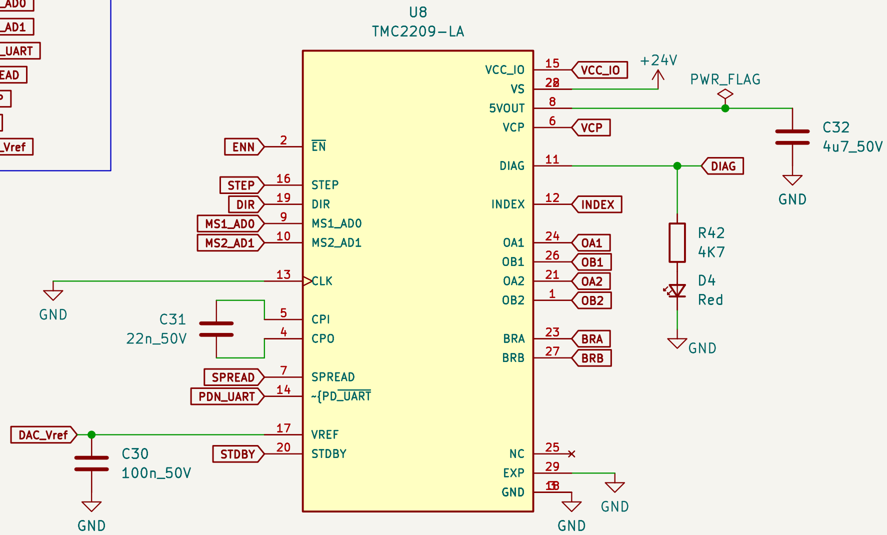
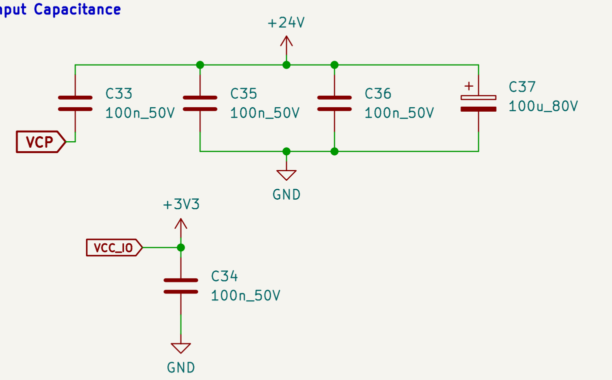
Input

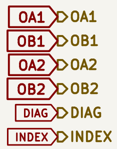




Input Capacitance



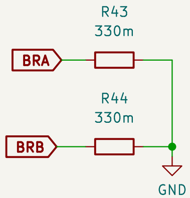
Output



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.

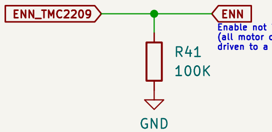
Be sure to use a symmetrical sense resistor layout and short and straight sense resistor traces of identical length. Well matching sense resistors ensure best performance.
A compact layout with massive ground plane is best to avoid parasitic resistance effects.



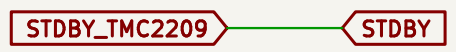
According to the datasheet:
330mΩ resistor results in 0.66A max motor current

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.



Enable not input. The power stage becomes switched off (all motor outputs floating) when this pin becomes driven to a high level.



STANDBY input. Pull up to disable driver internal supply regulator.
This will bring the driver into a low power dissipation state.
100kOhm pulldown. (may be left unconnected)
Hint: Also shut down VREF voltage and ENN to 0V during standby.

Sheet: /TMC2209/		
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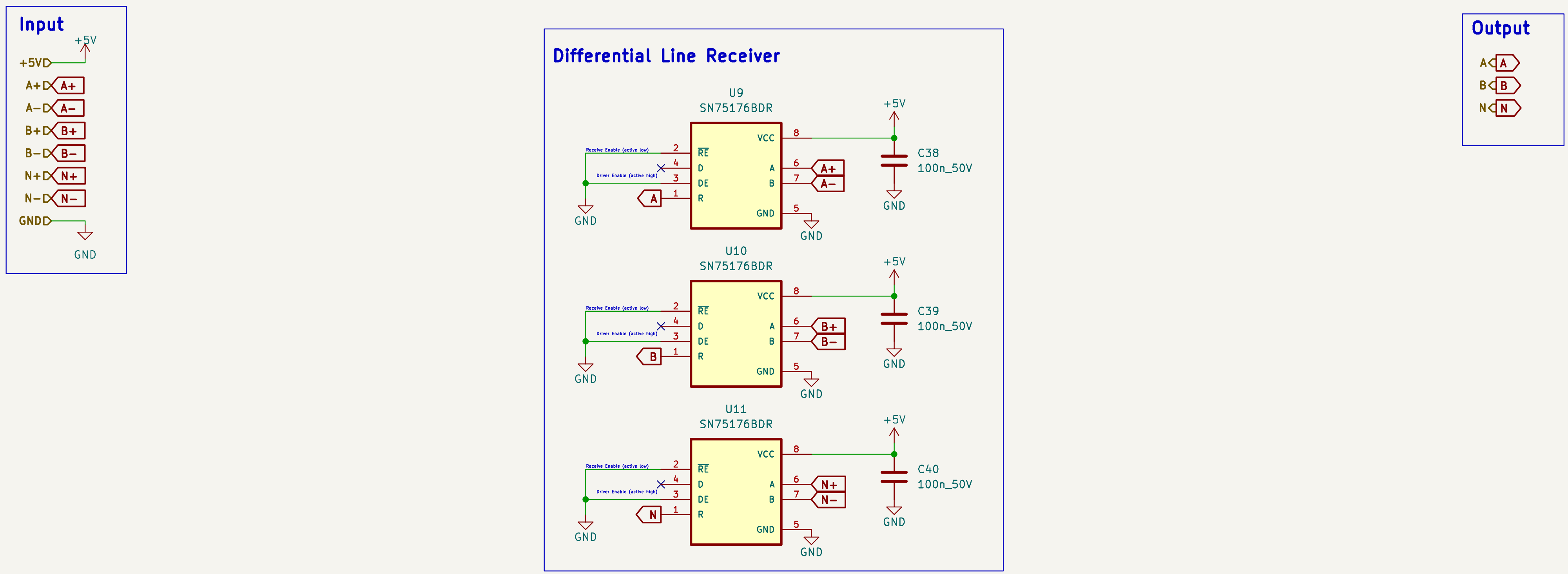

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Size: A4	Date:	**Rev:**
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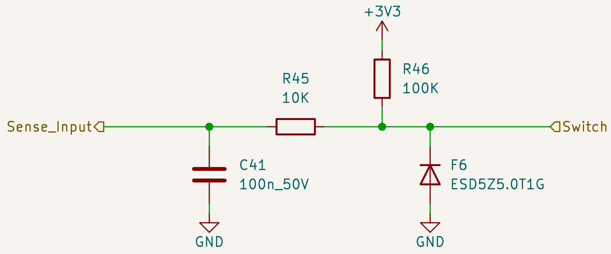

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KiCad E.D.A. 8.0.6		Id: 75/12