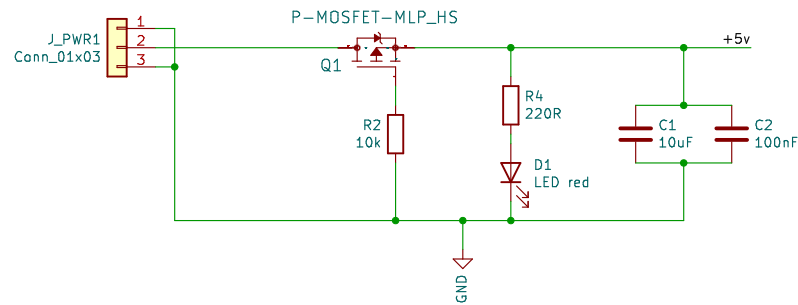


## Common Power Supply (where applicable)

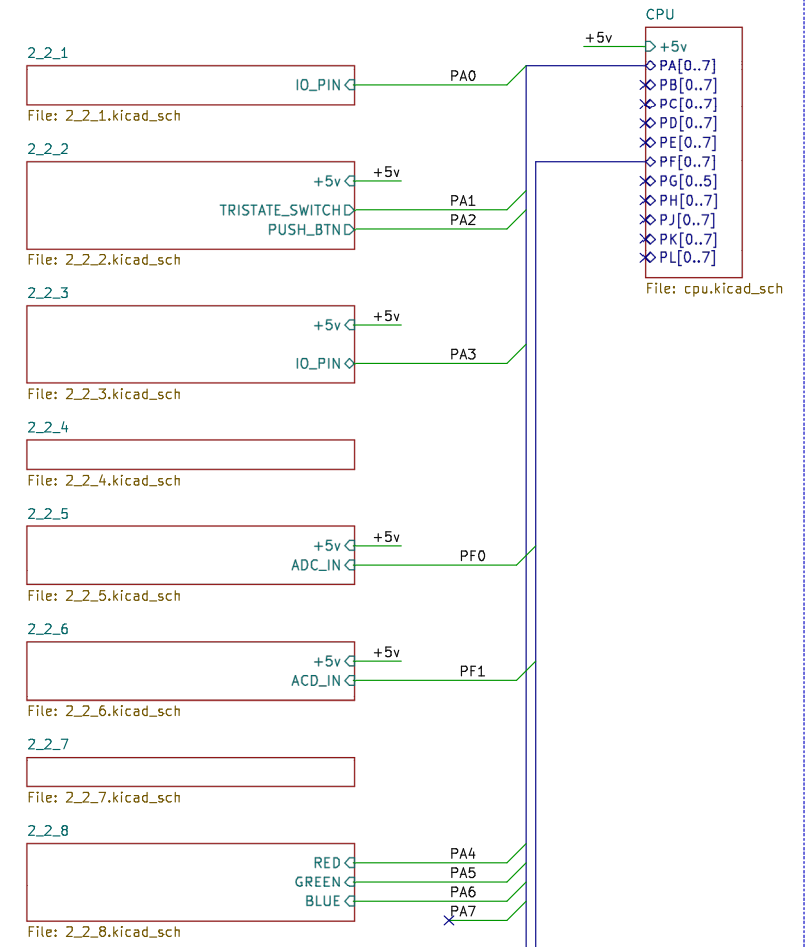


## PB171 Project

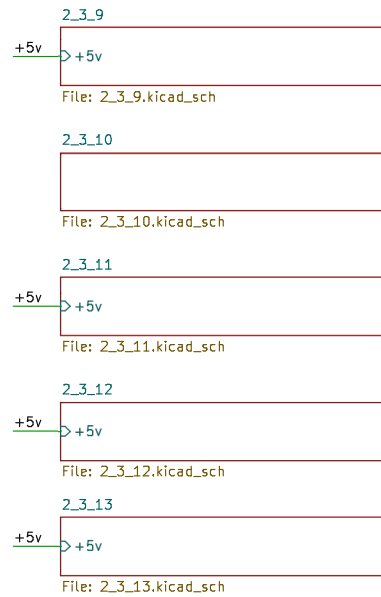
CPU: ATmega2560-16A

## BASIC SCHEMATICS

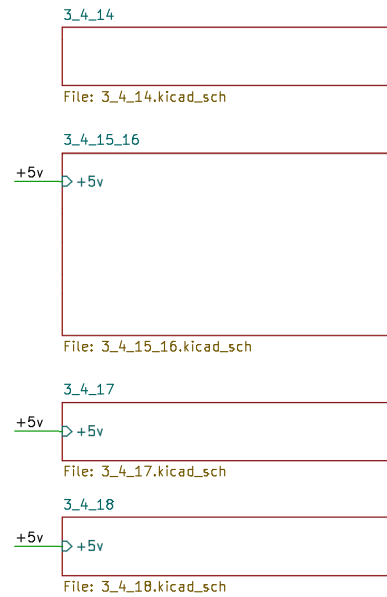
The following exercises were connected to a single CPU, where applicable.



## HIGH POWER CONSUMPTION



## PERIPHERALS



The power supply is 5 V.  
Please specify a link to the datasheet of the used LED and the used CPU.

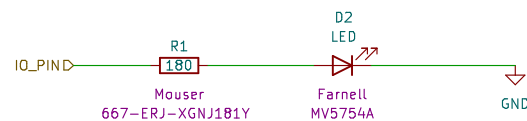
Sheet: /  
File: hw.kicad\_sch

### Title: PB171: Assignment

Size: A4 Date: 2021-04-07  
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32

Rev: 1  
Id: 1/25

Draw schematics of the circuit with one LED driven by the CPU. The power supply is 5 V. Please specify a link to the datasheet of the used LED and the used CPU.



At standard temperature (25deg C):

[1; p.355]: Voltage on any Pin except RESET with respect to Ground:  $-0.5V$  to  $VCC+0.5V$ .  
[1; p.355]: DC Current per I/O Pin:  $40.0mA$

Assuming  $VCC = 5V$ , the upper voltage bound on PA0 is  $5.5V$ .

[2; p.3]: LED Diode Continuous Forward Current:  $20.0mA$   
[2; p.3]: LED Diode Forward Voltage: typical  $2V$ , maximum  $2.5V$

$$R = (V_{PA0} - V_F) / I_F = (5.5 - 2) / 0.020 = 175 \text{ Ohm}$$

At the same time, the maximum amount of power that can enter the resistor is  $5.5V \cdot 0.0040A = 0.022 \text{ W}$ , so we'd need a resistor with a power rating of ca  $1/40W$  or higher.

[1] <https://ww1.microchip.com/downloads/en/DeviceDoc/ATmega640-1280-1281-2560-2561-Datasheet-DS40002211A.pdf>  
[2] <http://www.farnell.com/datasheets/1498852.pdf>

Regarding the data-sheet of the ATmega2560, each I/O port is tested with  $20mA$ .

The maximum current for the combination of port registers is the following:

J0-J7 + A0-A7 + G2 <  $200mA$   
C0-C7 + G0-G1 + D0-D7 + L0-L7 <  $200mA$   
G3-G4 + B0-B7 + H0-B7 <  $200mA$   
E0-E7 + G5 <  $100mA$   
F0-F7 + K0-K7 <  $100mA$

Sheet: /2\_2\_1/  
File: 2\_2\_1.kicad\_sch

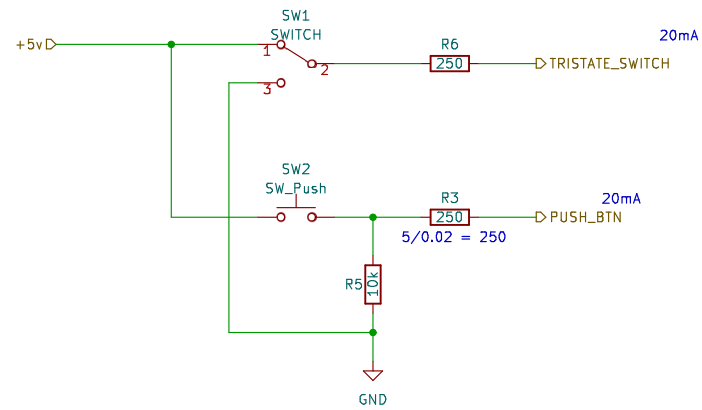
**Title: Basic Schematic 1**

Size: A4  
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32

Date:  
Id: 2/25

Rev:

Draw schematics of the circuit with one switch and one button connected to the CPU as two input devices connected to two separate pins.



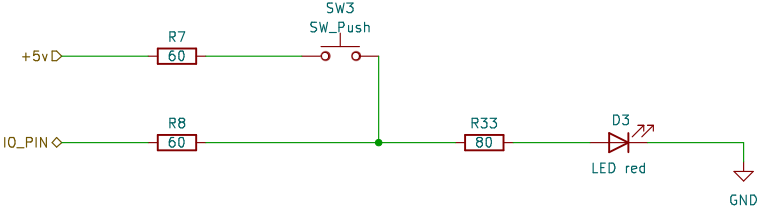
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File: 2\_2\_2.kicad\_sch

### Title: Basic Schematic 2

Size: A4 Date:  
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32

Rev:  
Id: 3/25

Draw schematics of the circuit with one button and one LED connected to any IO pin on the CPU.  
If the IO pin is set as output, the LED is driven by the CPU.  
If the IO pin is set as input, the CPU is able to read the state of the button and the LED indicates the state of the button, too.



Sheet: /2\_2\_3/  
File: 2\_2\_3.kicad\_sch

**Title: Basic Schematic 3**

Size: A4      Date:  
KiCad E.D.A.    kicad 5.99.0-1.20210404git80728f8.fc32

**Rev:**  
Id: 4/25

## PORTS

8-bit (except for G which is 6-bit) bi-directional I/O port with internal pull-up resistors (selected for each bit).

The port output buffers have symmetrical drive characteristics with both high sink and source capability.

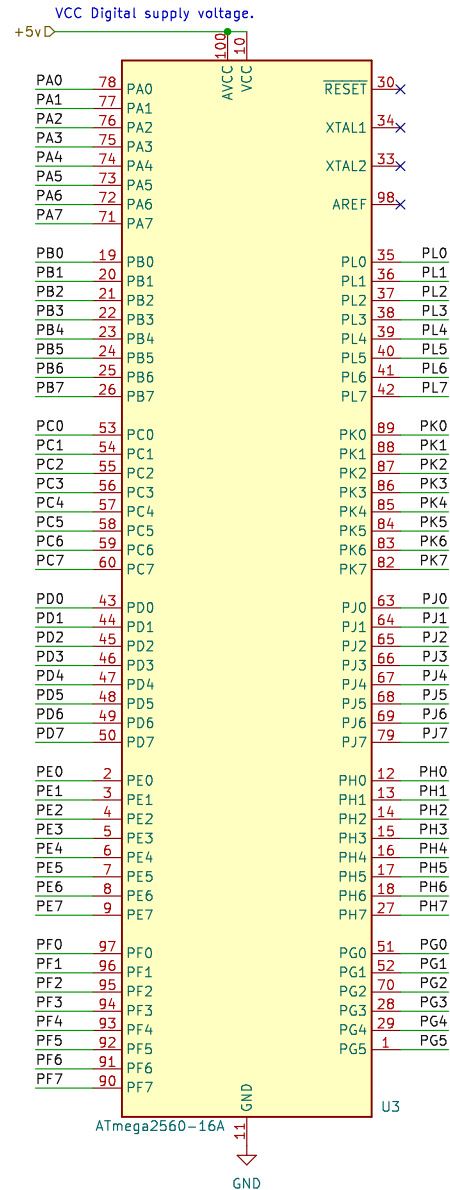
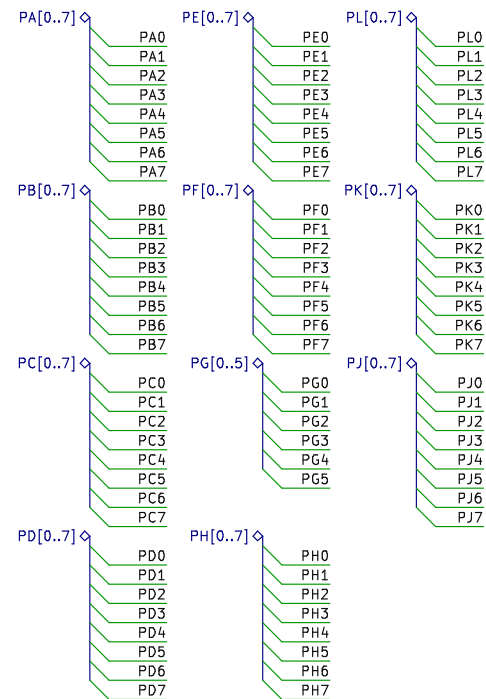
As inputs, port pins that are externally pulled low will source current if the pull-up resistors are activated.

The port pins are tri-stated when a reset condition becomes active, even if the clock is not running.

Ports F and K serve as analog inputs to the ADC, or as an 8-bit bi-directional I/O port, if the ADC is not used.

If the JTAG interface is enabled, the pull-up resistors on pins PF7(TDI), PF5(TMS), and PF4(TCK) will be activated even if a reset occurs.

Port F also serves the functions of the JTAG interface.



ATmega2560-16A

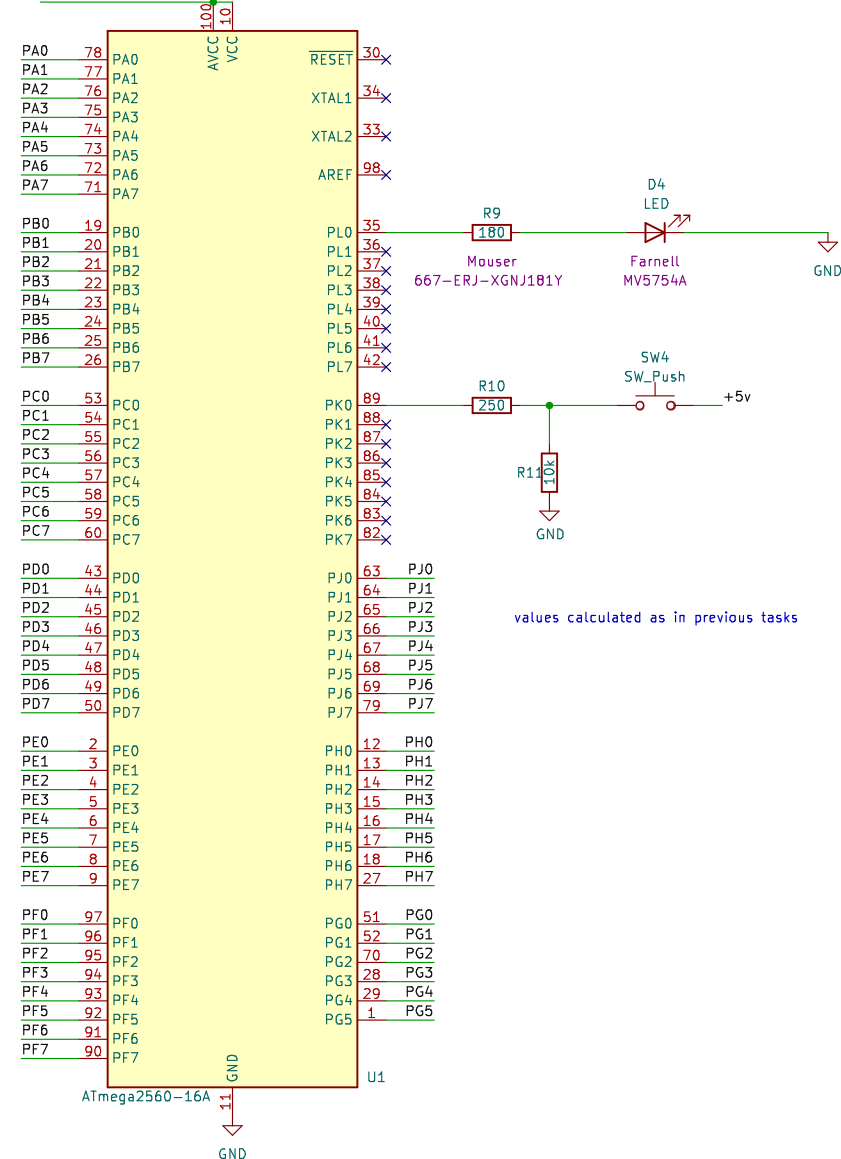
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File: cpu.kicad\_sch

**Title: Basic Schematics Shared CPU**

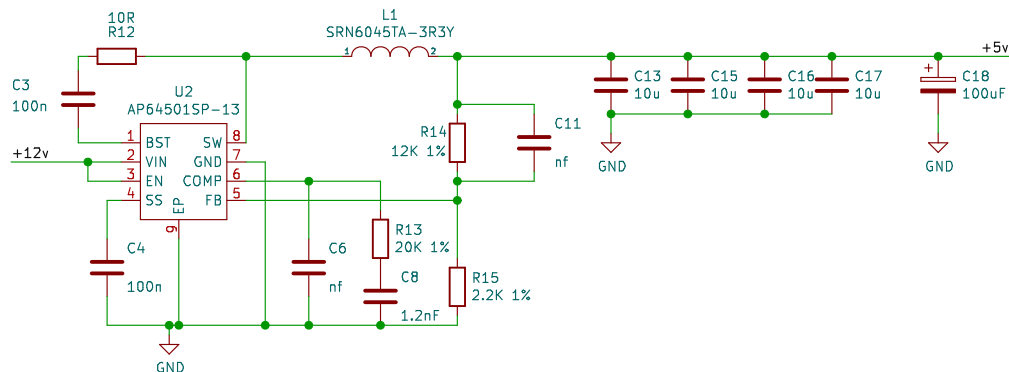
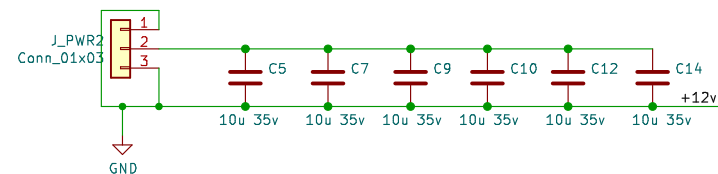
Size: A4 Date:  
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32

Rev:  
Id: 5/25

+5v VCC Digital supply voltage.



values calculated as in previous tasks



<https://www.diodes.com/assets/Datasheets/AP64501.pdf>

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File: 2\_2\_4.kicad\_sch

### Title: Basic Schematic 4

Size: A4

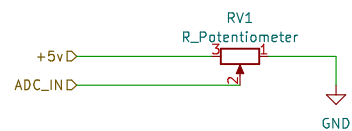
Date:

KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32

Rev:

Id: 6/25

Draw schematics of the circuit with one potentiometer connected as an analog input to the CPU. The CPU usually has several AD converters, you can use any of them.



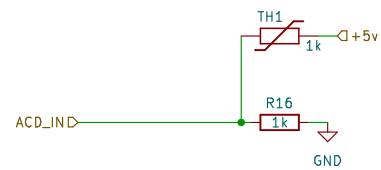
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Date:  
Id: 7/25

**Rev:**

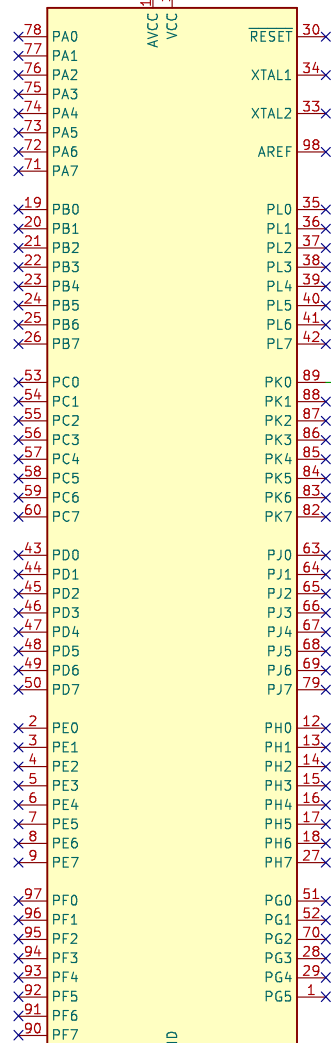


THERMISTOR PTC 1K OHM 1% 0603  
<https://www.vishay.com/docs/33017/tfpt.pdf>  
TFPT0603L1001FV

Sheet: /2_2_6/		
File: 2_2_6.kicad_sch		
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Size: A4	Date:	Rev:
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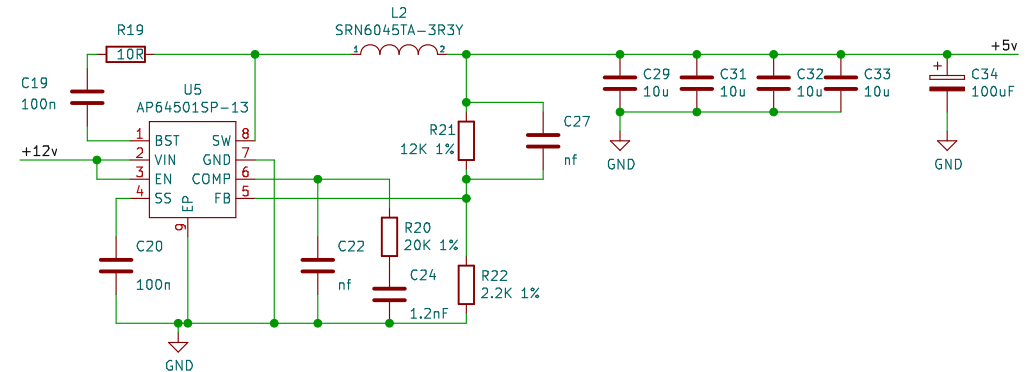
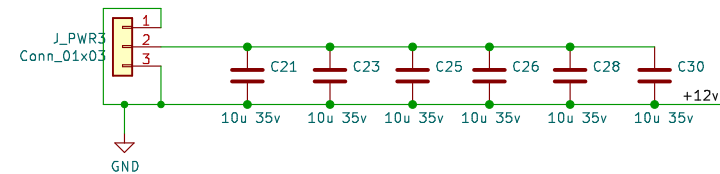


+5v VCC Digital supply voltage.



ATmega2560-16A

GND



<https://www.diodes.com/assets/Datasheets/AP64501.pdf>

<https://search.murata.co.jp/Ceramy/image/img/A01X/G101/ENG/GRM155R71C104KA88-01.pdf>

<https://www.bourns.com/docs/Product-Datasheets/SRN6045TA.pdf>

[https://fscdn.rohm.com/en/products/databook/datasheet/passive/resistor/chip\\_resistor/mc](https://fscdn.rohm.com/en/products/databook/datasheet/passive/resistor/chip_resistor/mc)

[https://fscdn.rohm.com/en/products/databook/datasheet/passive/resistor/chip\\_resistor/mc](https://fscdn.rohm.com/en/products/databook/datasheet/passive/resistor/chip_resistor/mc)

<https://www.murata.com/en-global/products/productdetail.aspx?partno=GRM21BC8YA106ME1>

<https://cz.mouser.com/datasheet/2/315/ABE0000C49-947552.pdf>

Sheet: /2\_2\_7/

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**Title: Basic Schematic 7**

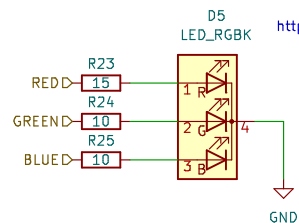
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Date:

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Rev:

Id: 9/25



<https://docs.broadcom.com/docs/ASMG-PT00-DS100>

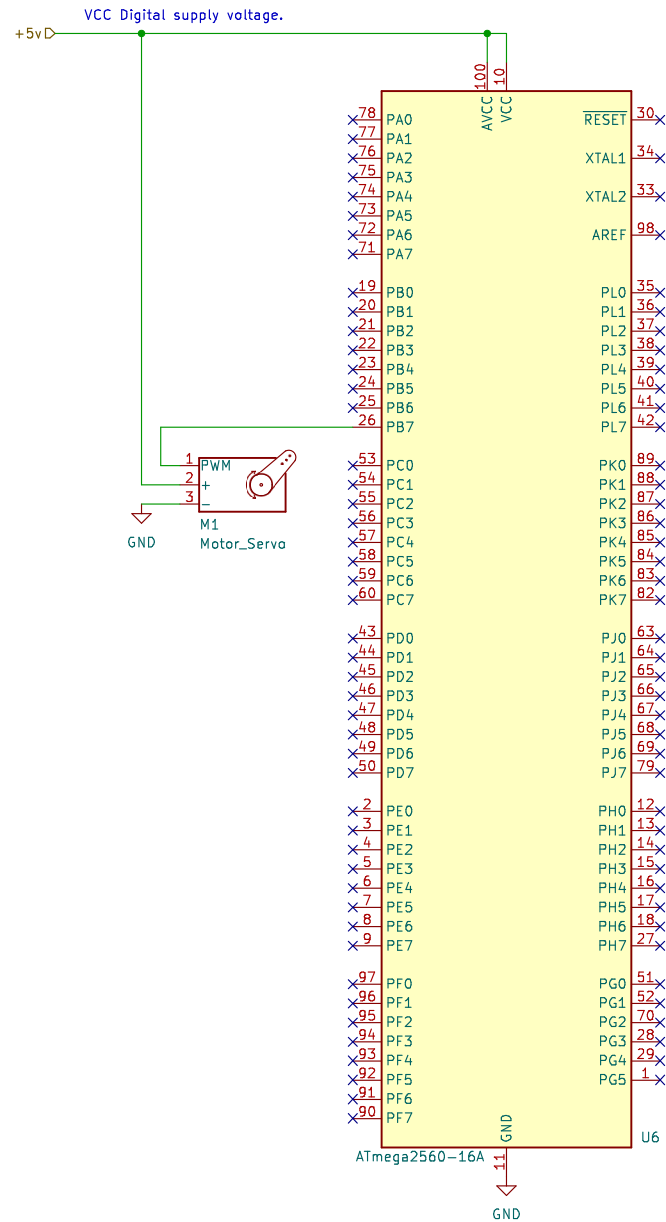
DC Forward Current 200mA  
Forward Voltages (typical values at standard conditions):  
Red Vf from 1.8, typical 2.2V, max 2.8V  
 $R_r = (5V - 1.8V) / 0.2A = 16 \text{ ohm}$   
 $R_r = (5V - 2.2V) / 0.2A = 14 \text{ ohm}$   
 $R_r = (5V - 2.8V) / 0.2A = 11 \text{ ohm}$   
Green Vf from 2.8, typical 3.1V, max 3.7V  
 $R_r = (5V - 2.8V) / 0.2A = 11 \text{ ohm}$   
 $R_r = (5V - 3.1V) / 0.2A = 9.5 \text{ ohm}$   
 $R_r = (5V - 3.7V) / 0.2A = 6.5 \text{ ohm}$   
Blue Vf from 2.8, typical 3.0V, max 3.7V  
 $R_r = (5V - 2.8V) / 0.2A = 11 \text{ ohm}$   
 $R_r = (5V - 3.0V) / 0.2A = 10 \text{ ohm}$   
 $R_r = (5V - 3.7V) / 0.2A = 6.5 \text{ ohm}$

Sheet: /2\_2\_8/  
File: 2\_2\_8.kicad\_sch

**Title: Basic Schematic 8**

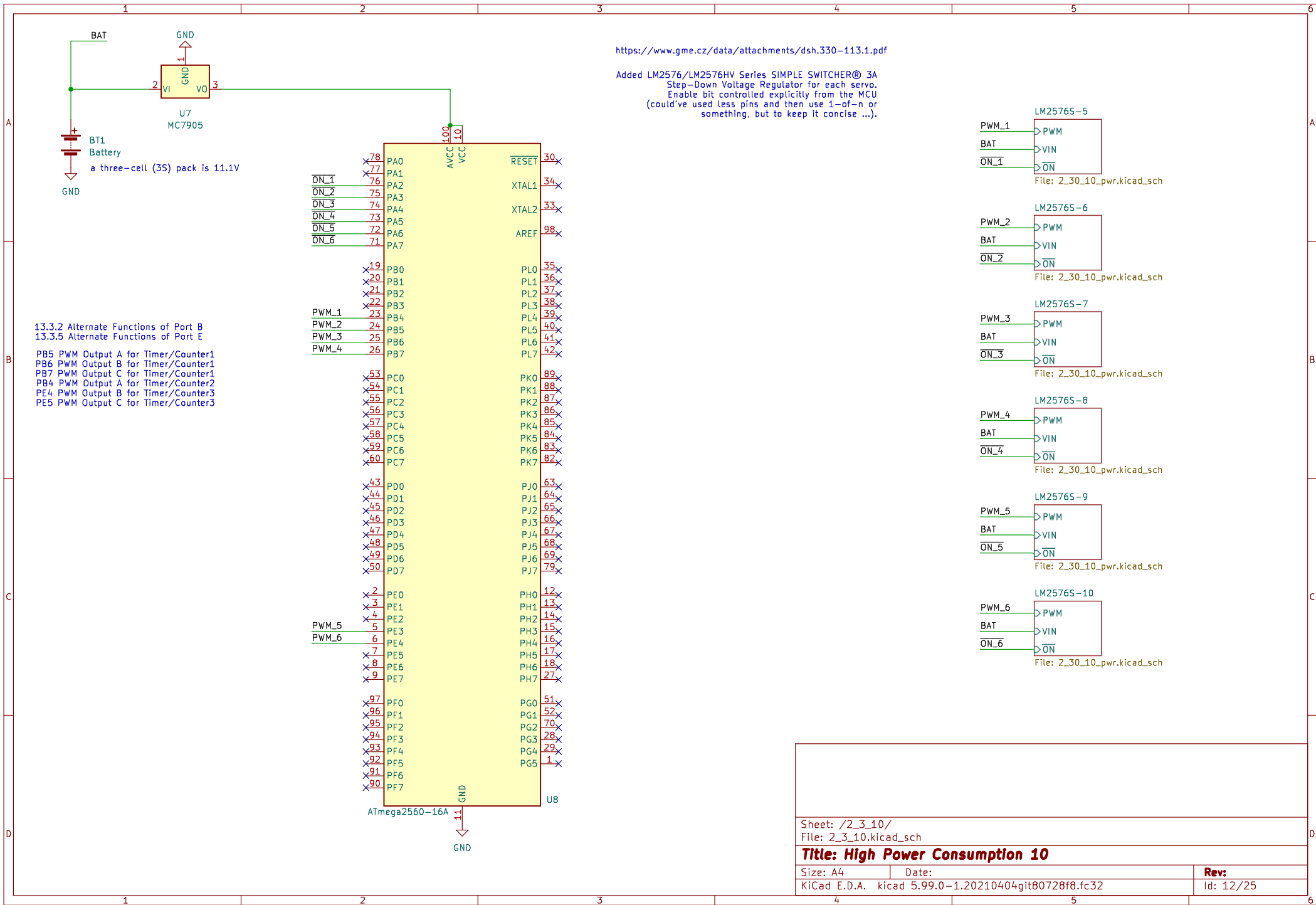
Size: A4 Date:  
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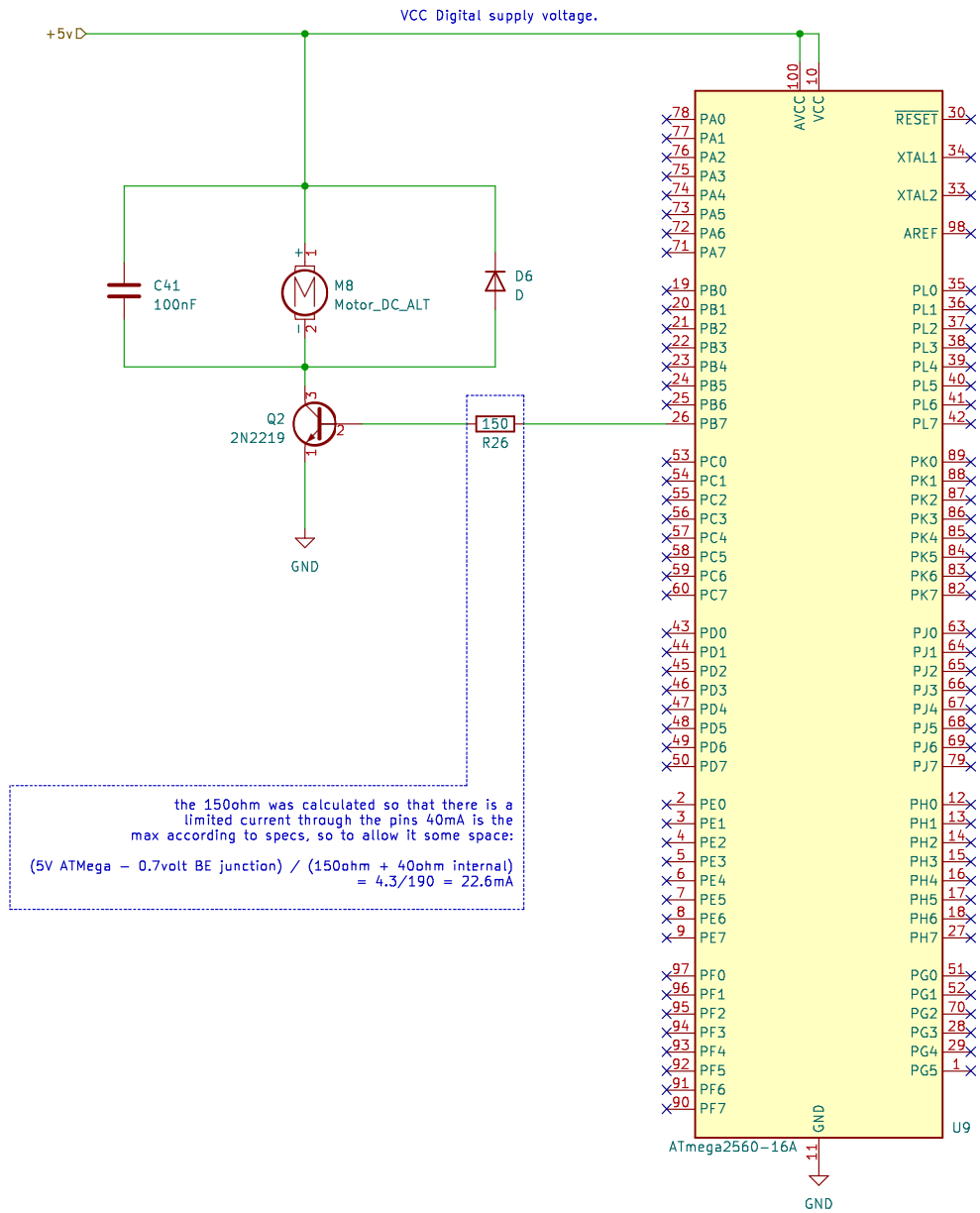
Rev:  
Id: 10/25



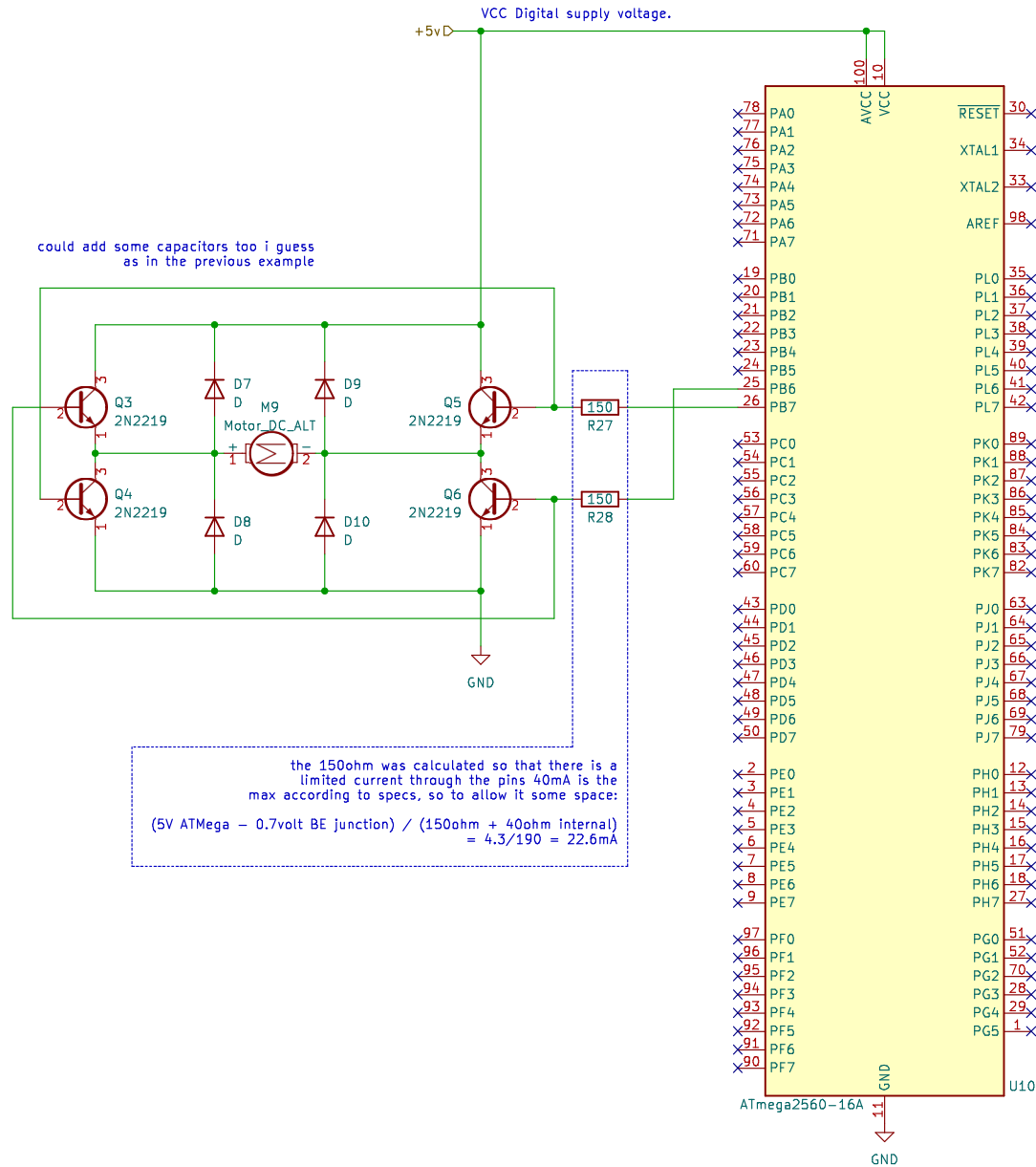
[https://cz.mouser.com/datasheet/2/240/Littelfuse\\_GDT\\_SG\\_Datasheet\\_pdf-319337.pdf](https://cz.mouser.com/datasheet/2/240/Littelfuse_GDT_SG_Datasheet_pdf-319337.pdf)

Sheet: /2_3_9/		
File: 2_3_9.kicad_sch		
<b>Title: High Power Consumption 9</b>		
Size: A4	Date:	Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32		Id: 11/25





the 150ohm was calculated so that there is a limited current through the pins 40mA is the max according to specs, so to allow it some space:  
$$(5V \text{ ATmega} - 0.7\text{volt BE junction}) / (150\text{ohm} + 40\text{ohm internal}) = 4.3/190 = 22.6\text{mA}$$



Sheet: /2\_3\_12/

File: 2\_3\_12.kicad\_sch

# Title: High Power Consumption 12

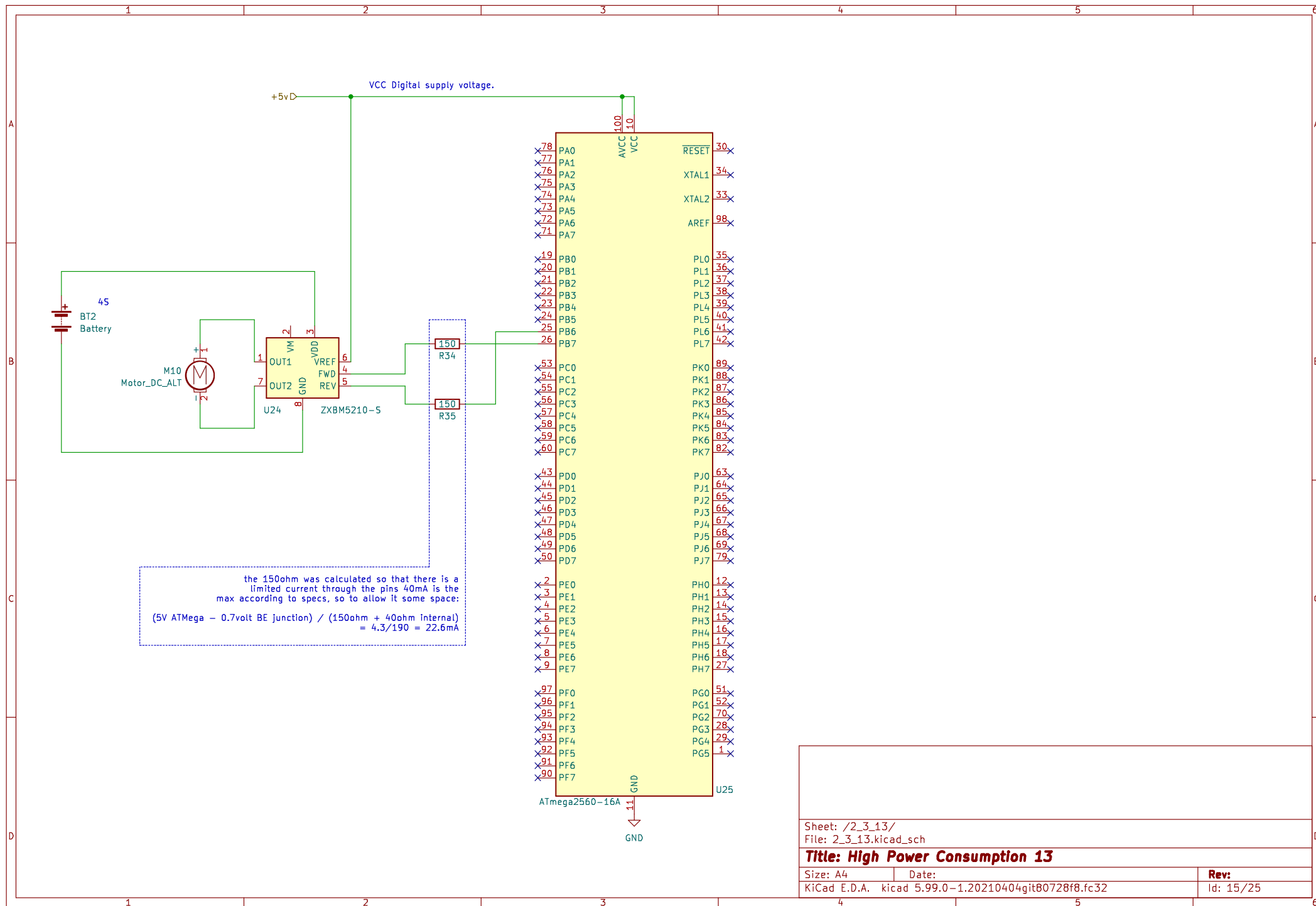
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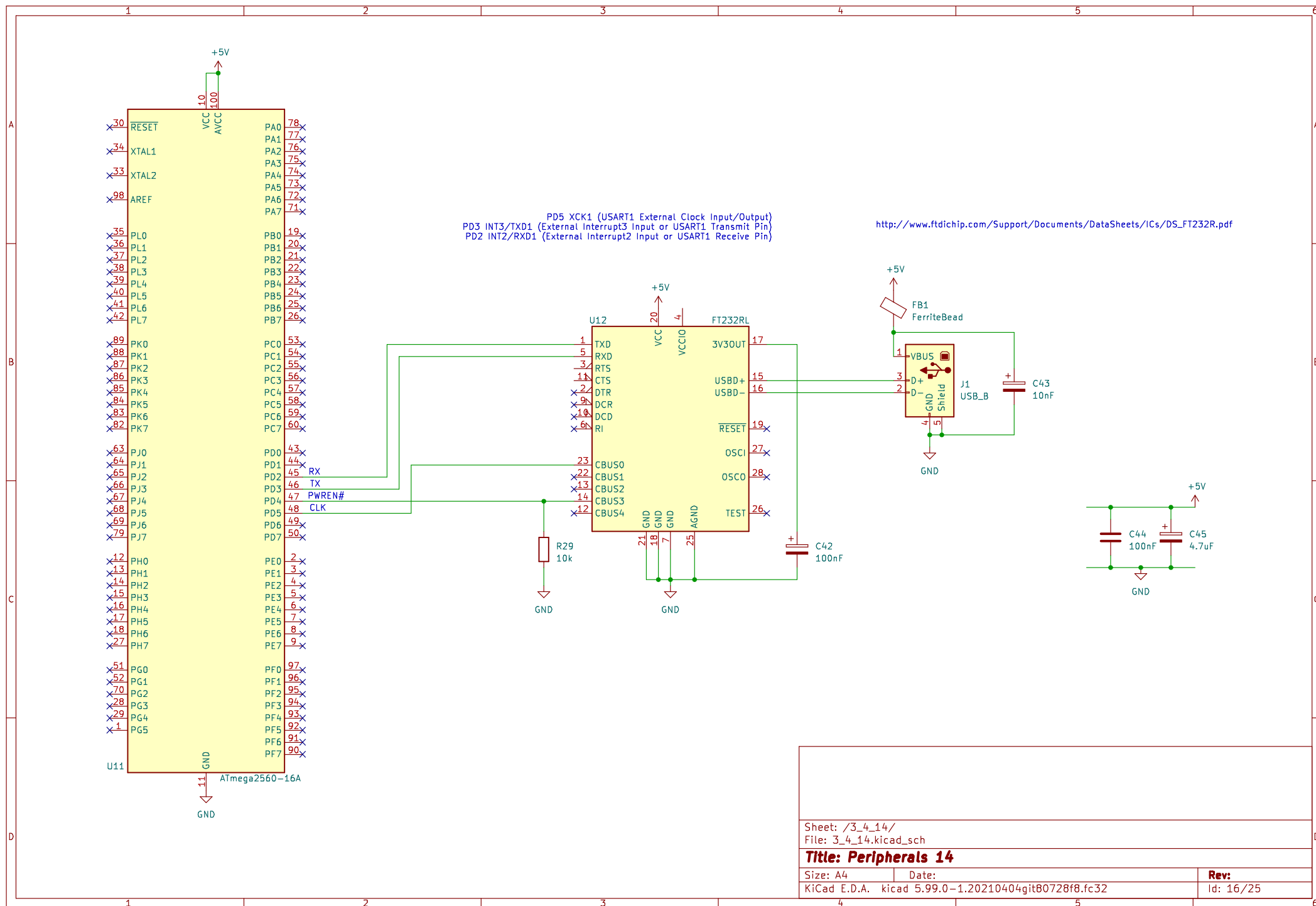
Date:

Rev:

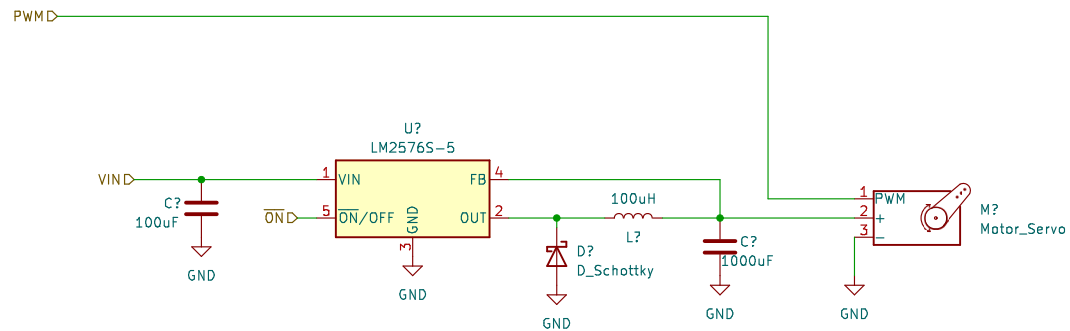
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Id: 14/25









Sheet: /2\_3\_10/LM2576S-6/  
File: 2\_30\_10\_pwr.kicad\_sch

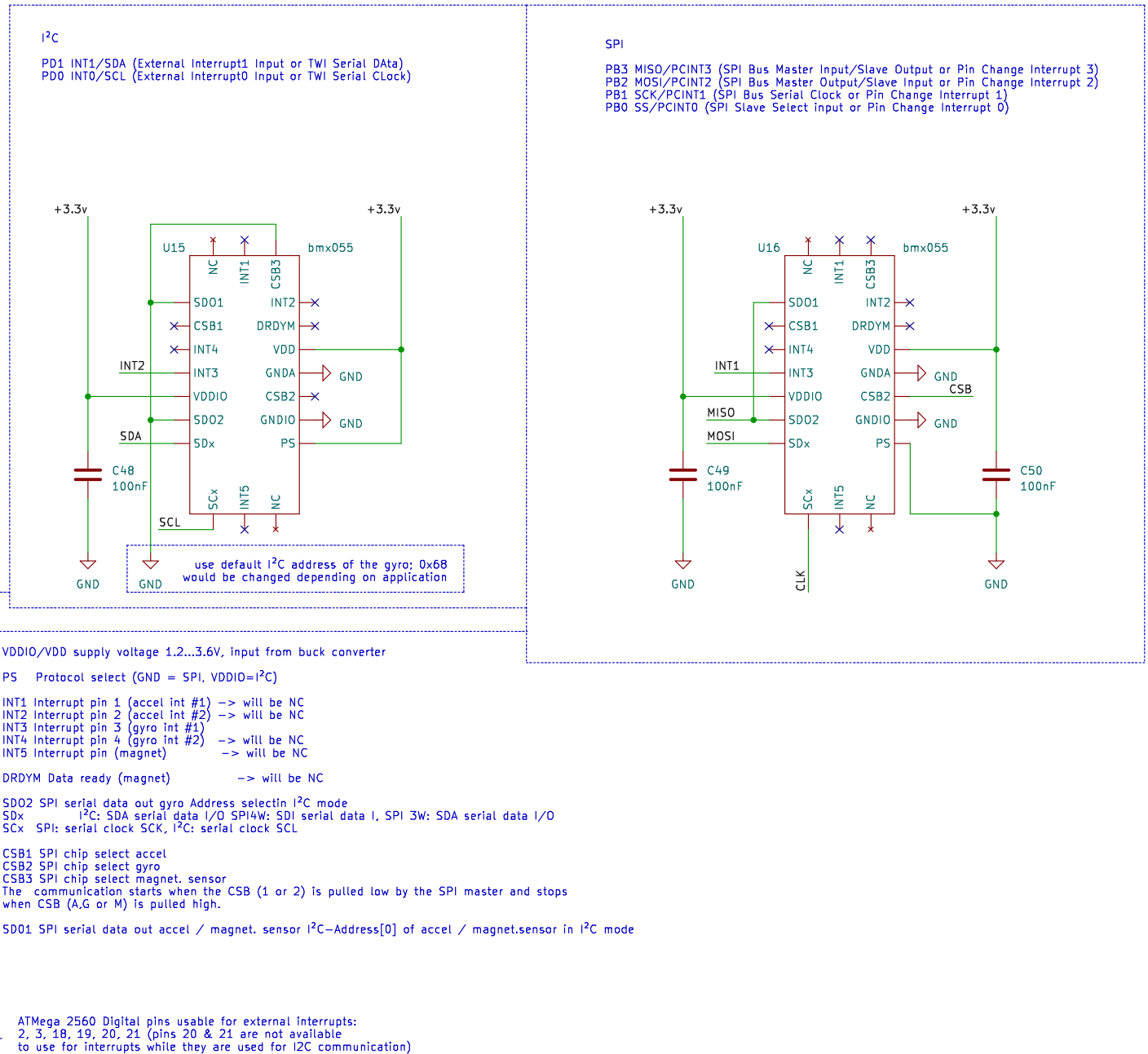
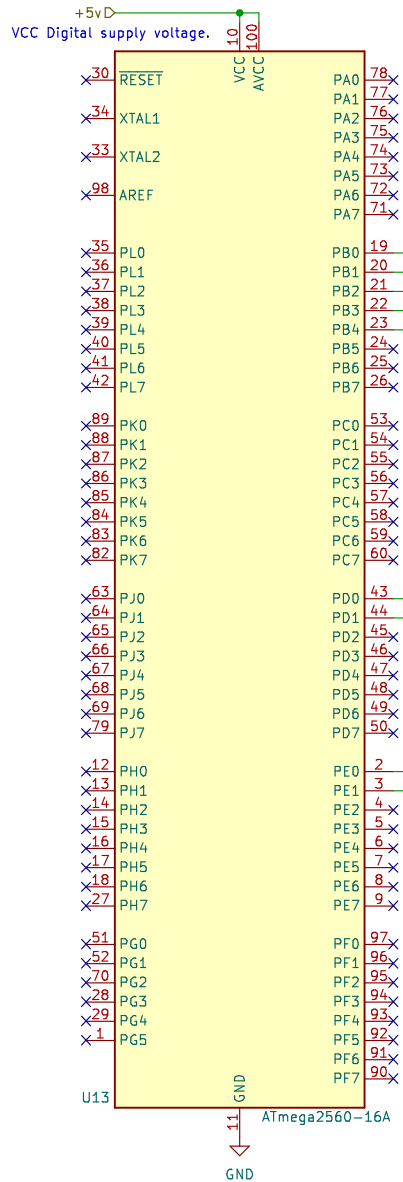
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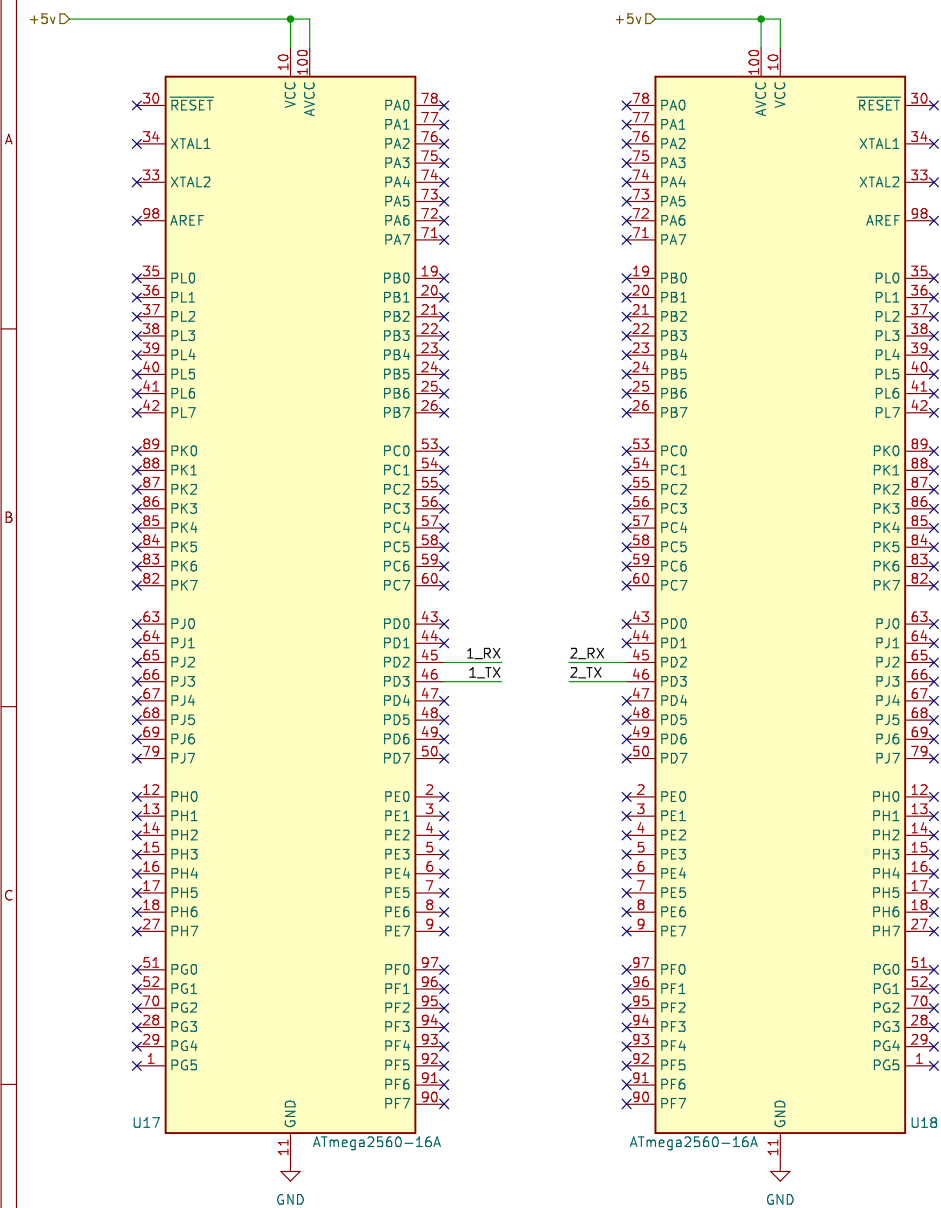
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Rev:

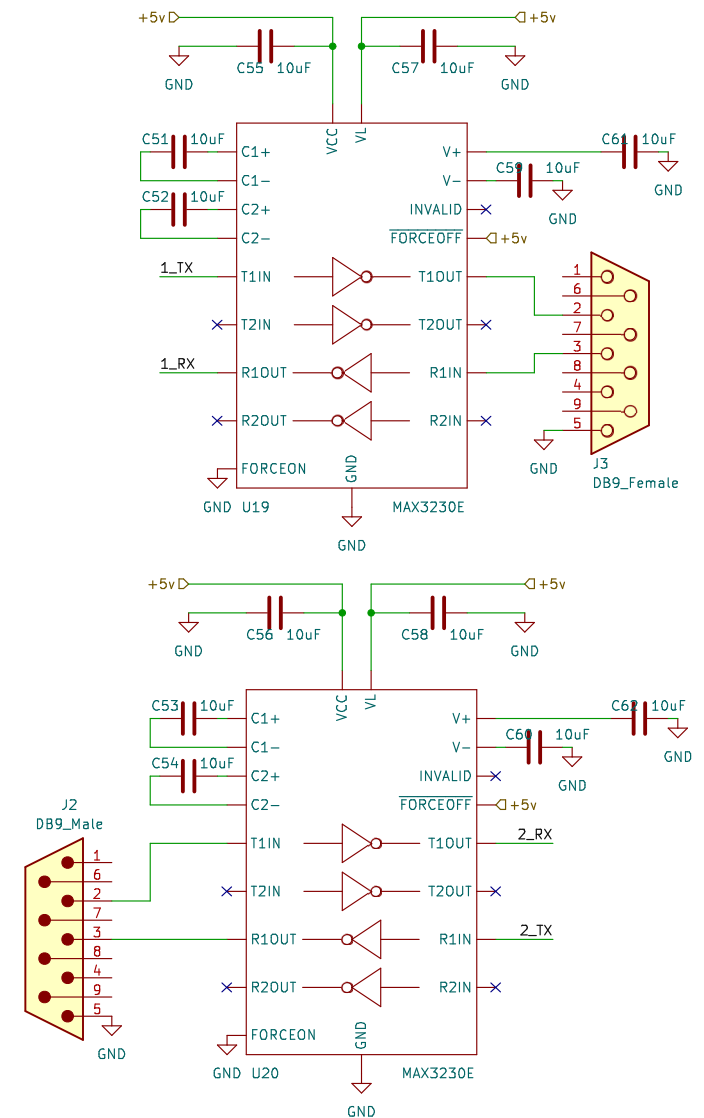
Id: 17/25



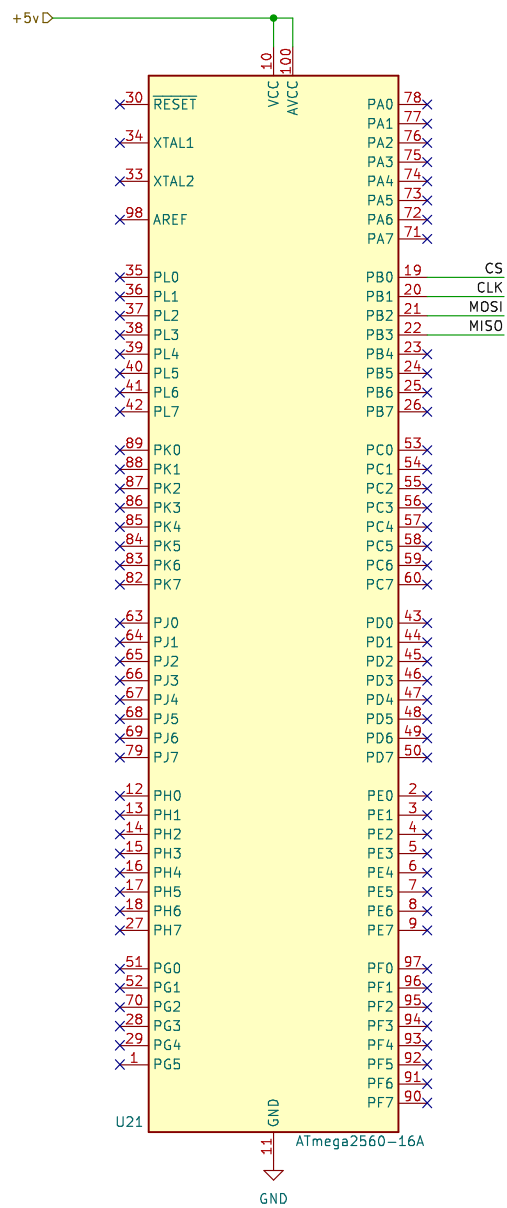
I am using the same input for power, but that's just to save space. In reality they'd have separate power inputs.



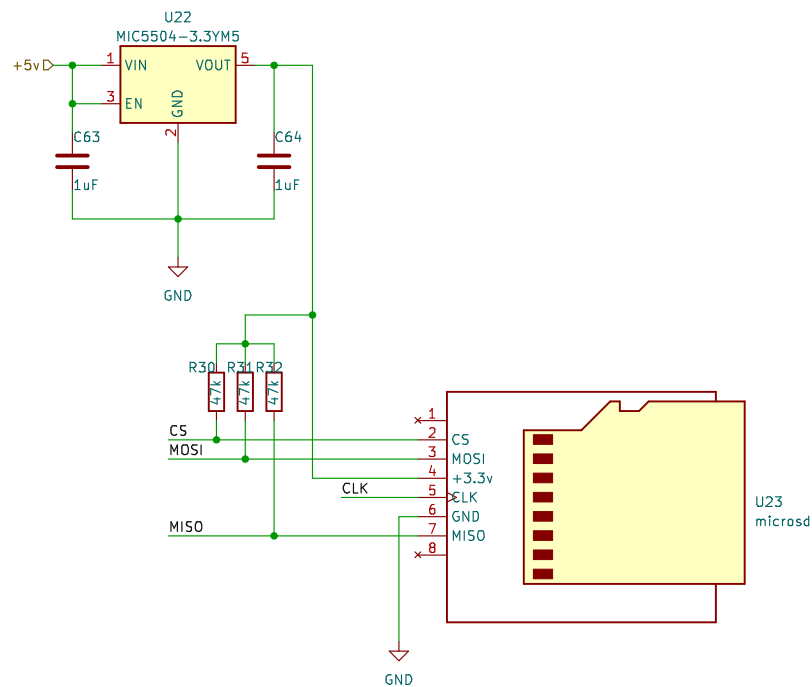
<https://cz.mouser.com/datasheet/2/256/MAX3230AE-1389211.pdf>



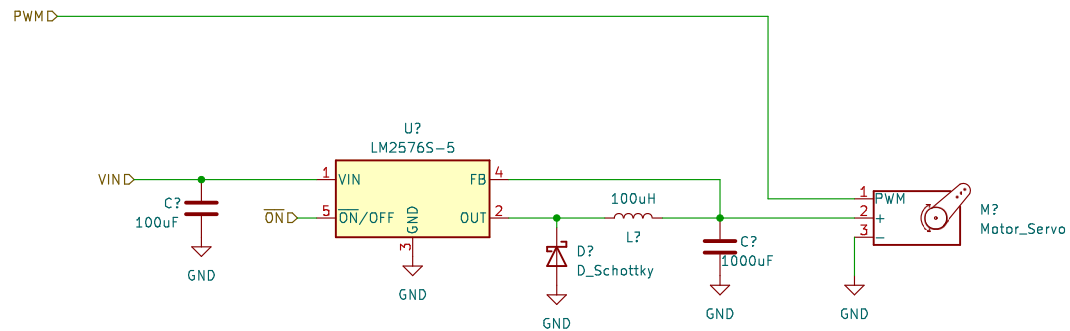
Sheet: /3_4_17/	
File: 3_4_17.kicad_sch	
<b>Title: Peripherals 17</b>	
Size: A4	Date:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32	
Rev: 19/25	



<https://ww1.microchip.com/downloads/en/DeviceDoc/MIC5501-02-03-04-300mA-Single-Output-LDO-in-Small-Packages-DS20006006B.pdf>



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<b>Title: Peripherals 18</b>		
Size: A4	Date:	Rev:
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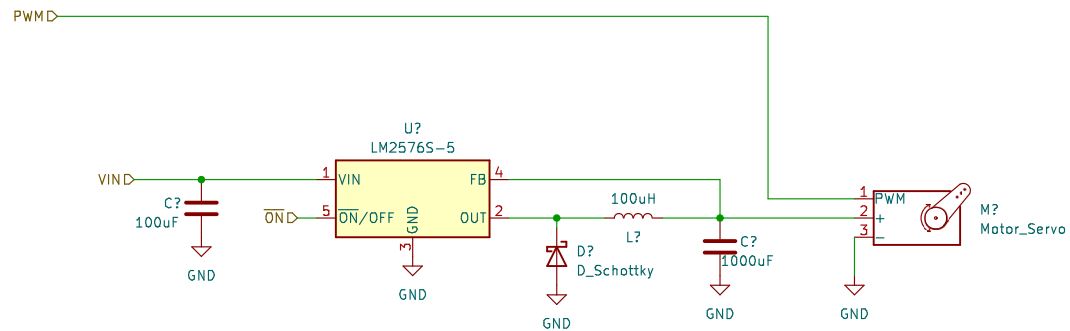
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Date:

Rev:

Id: 20/25



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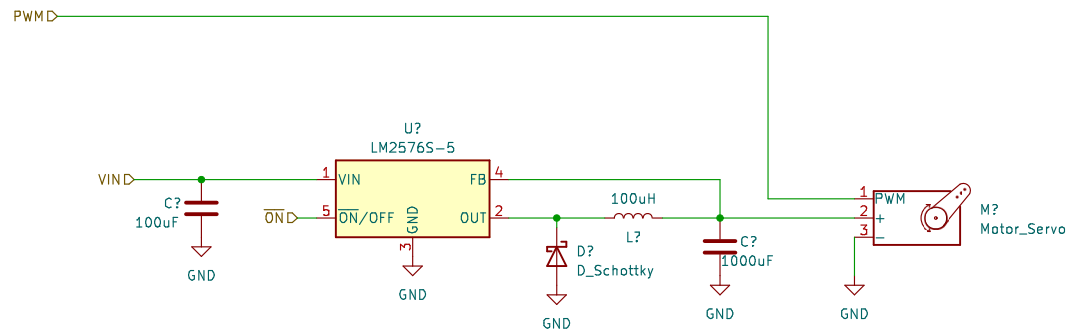
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Date:

Rev:

Id: 21/25



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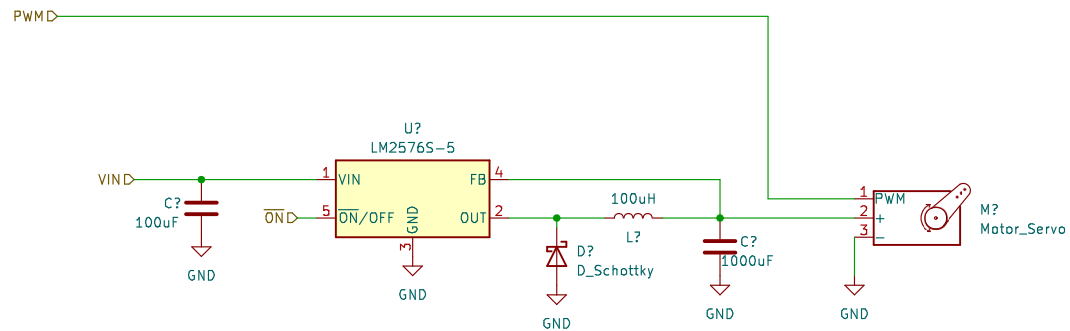
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Date:

Rev:

Id: 22/25



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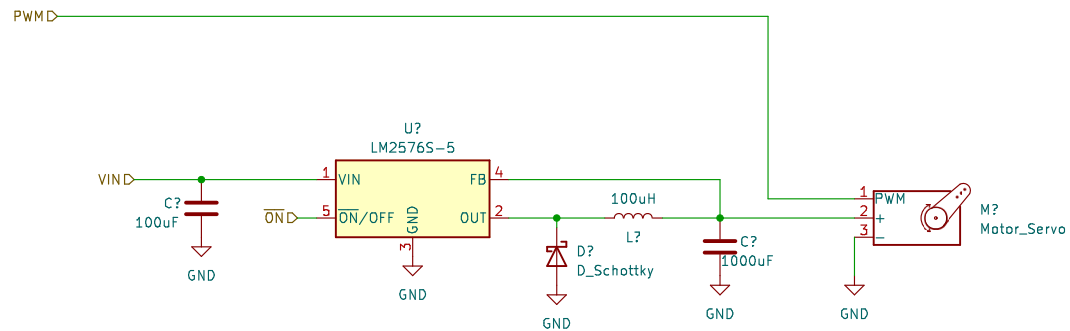
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Date:

Rev:

Id: 23/25





Sheet: /2\_3\_10/LM2576S-10/  
File: 2\_30\_10\_pwr.kicad\_sch

**Title:**

Size: A4  
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Date:

Rev:

Id: 24/25