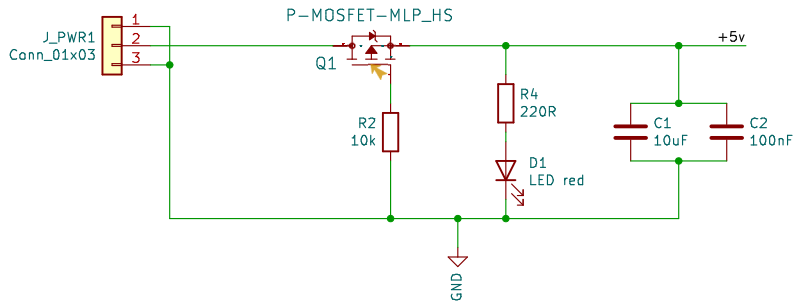
Common Power Supply (where applicable)

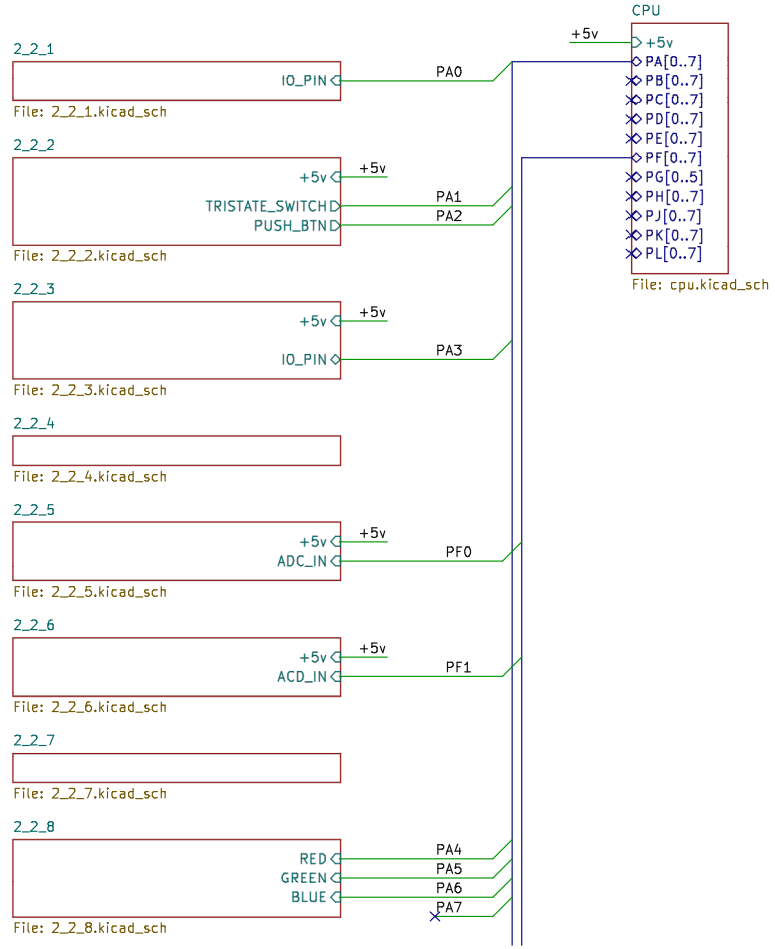


PB171 Project

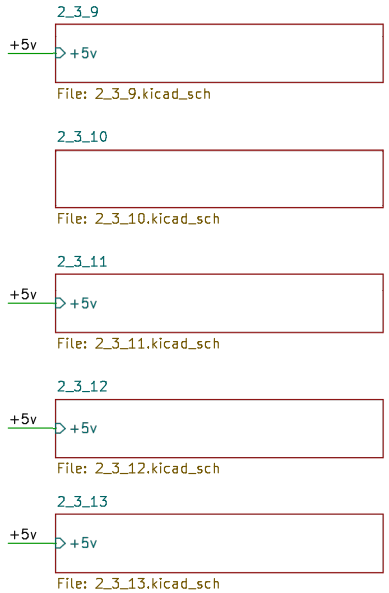
CPU: ATmega2560-16A

BASIC SCHEMATICS

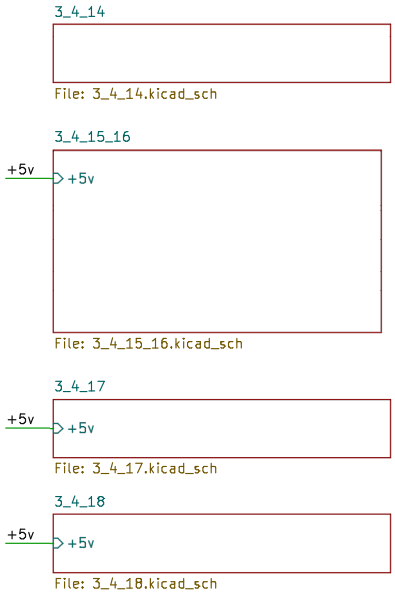
The following exercises were connected to a single CPU, where applicable.



HIGH POWER CONSUMPTION



PERIPHERALS



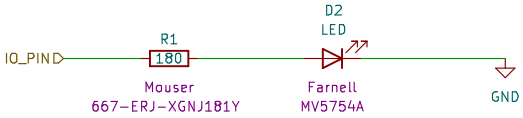
The power supply is 5 V.
Please specify a link to the datasheet of the used LED and the used CPU.

Sheet: /
File: hw.kicad_sch

Title: PB171: Assignment

Size: A4	Date: 2021-04-07	**Rev: 1**
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32		Id: 1/19

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 Ohm

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

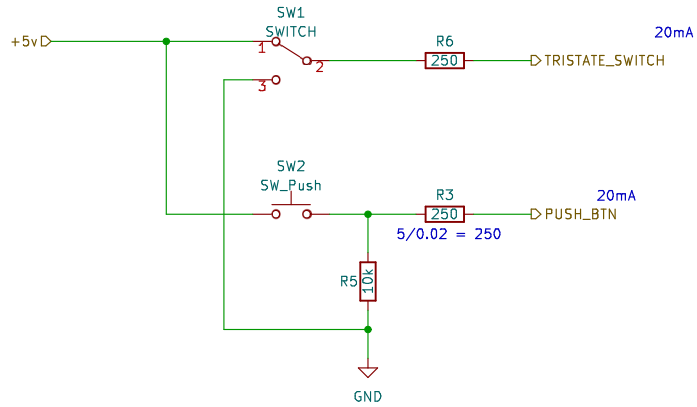
[1] https://ww1.microchip.com/downloads/en/DeviceDoc/ATmega640-1280-1281-2560-2561-Datasheet-DS40002211A.pdf
[2] http://www.farnell.com/datasheets/1498852.pdf
--

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	Date:	**Rev:**
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32		Id: 2/19

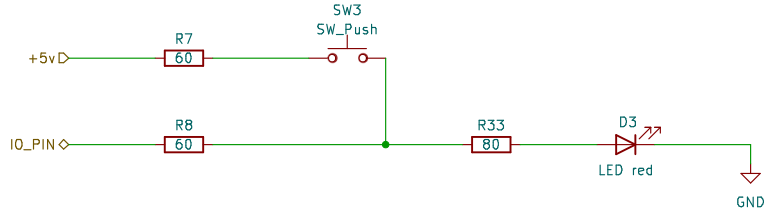
Draw schematics of the circuit with one switch and one button connected to the CPU as two input devices connected to two separate pins.



Sheet: /2_2_2/		
File: 2_2_2.kicad_sch		
Title: Basic Schematic 2		
Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad 5.99.0-1.20210404gitb0728f8.fc32		Id: 3/19

Draw schematics of the circuit with one button and one LED connected to any IO pin onthe CPU.
If the IO pin is set as output, the LED is driven by the CPU.

If the IO pin isset 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:	**Rev:**
KiCad E.D.A. kicad 5.99.0-1.20210404gitb0728f8.fc32		Id: 4/19

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.

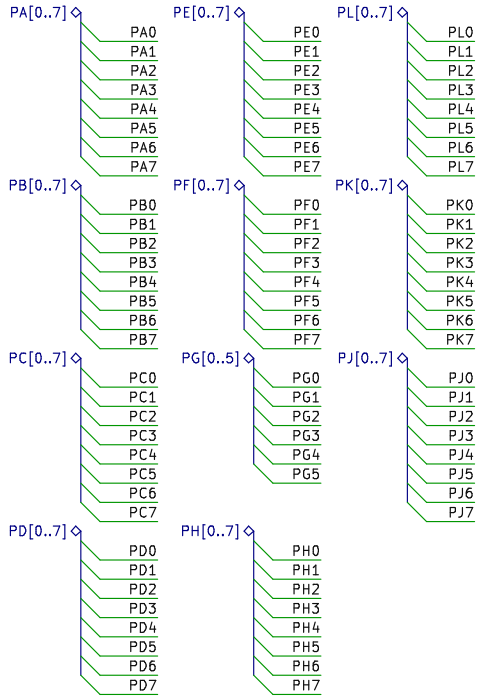
As inputs, port pins that are externally pulled low will source current if the pull-up resistors are activated.

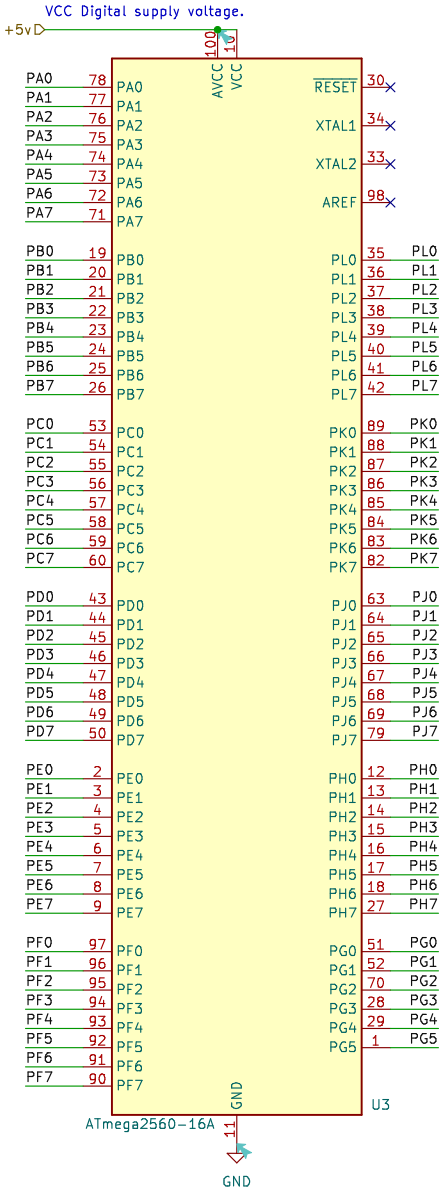
The port pins are tri-stated when a reset condition becomes active, even if the clock is not running.

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 beactivated even if a reset occurs.

Port F also serves the functions of the JTAG interface.



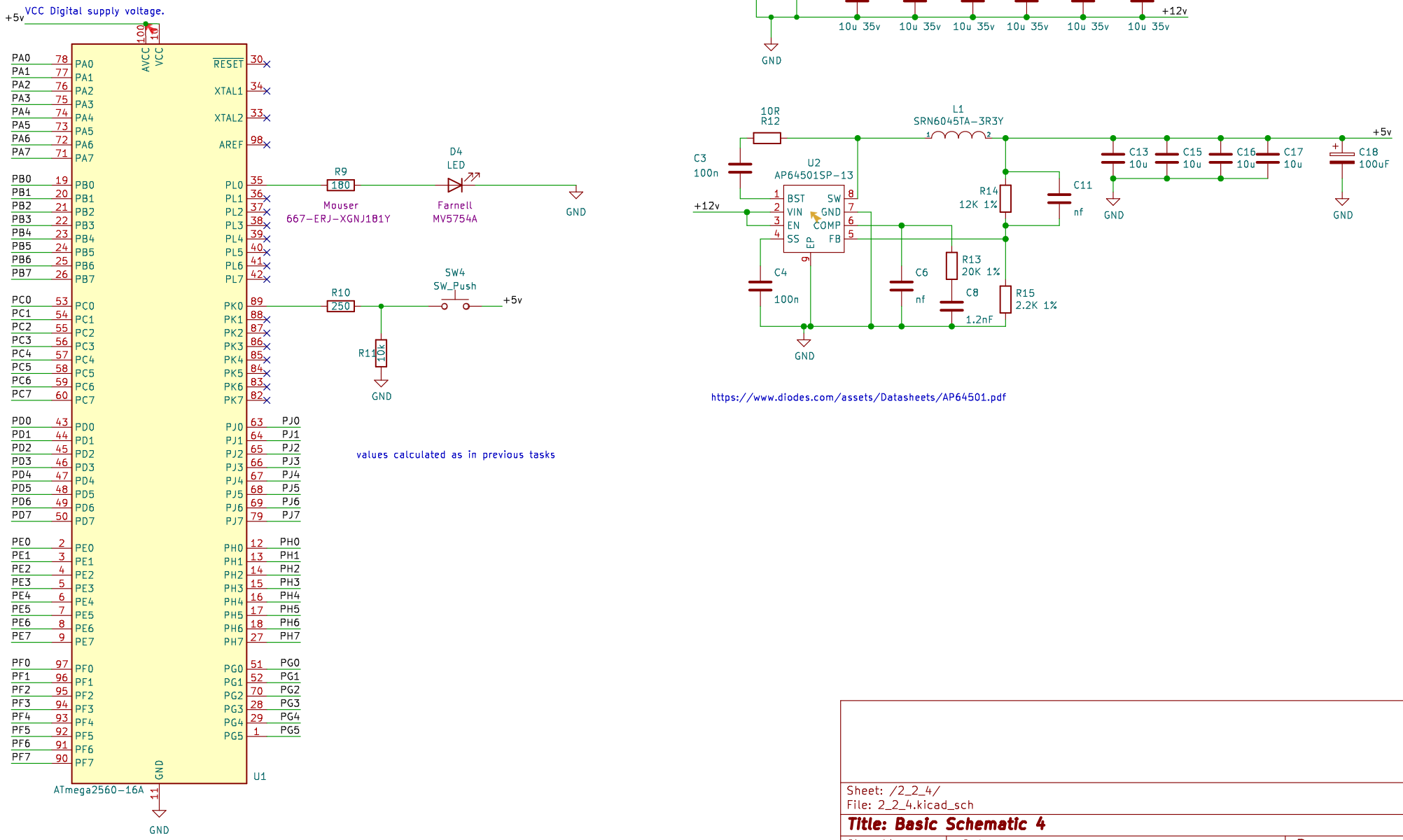


ATmega2560-16A

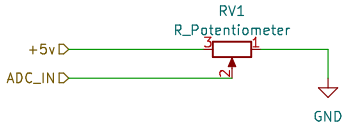
Sheet: /CPU/
File: cpu.kicad_sch

Title: Basic Schematics Shared CPU

Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32		Id: 5/19


+5v
VCC Digital supply voltage.
AVCC
VCC
GND
RESET
XTAL1
XTAL2
AREF
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7
PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7
PC0 PC1 PC2 PC3 PC4 PC5 PC6 PC7
PD0 PD1 PD2 PD3 PD4 PD5 PD6 PD7
PE0 PE1 PE2 PE3 PE4 PE5 PE6 PE7
PF0 PF1 PF2 PF3 PF4 PF5 PF6 PF7
PL0 PL1 PL2 PL3 PL4 PL5 PL6 PL7
PK0 PK1 PK2 PK3 PK4 PK5 PK6 PK7
PJ0 PJ1 PJ2 PJ3 PJ4 PJ5 PJ6 PJ7
PH0 PH1 PH2 PH3 PH4 PH5 PH6 PH7
PG0 PG1 PG2 PG3 PG4 PG5
U1
ATmega2560-16A
R9
180
Mouser
667-ERJ-XGNJ1B1Y
D4
LED
Farnell
MV5754A
R10
250
R11
10k
SW4
SW_Push
values calculated as in previous tasks
J_PWR2
Conn_01x03
C5 C7 C9 C10 C12 C14
10u 35v
+12v
10R
R12
L1
SRN6045TA-3R3Y
C3
100n
U2
AP64501SP-13
BST SW
VIN GND
EN COMP
SS FB
EP
R14
12K 1%
C11
nf
C13 C15 C16 C17
10u
C18
100uF
C4
100n
C6
nf
R13
20K 1%
C8
1.2nF
R15
2.2K 1%
https://www.diodes.com/assets/Datasheets/AP64501.pdf
Sheet: /2_2_4/
File: 2_2_4.kicad_sch
Title: Basic Schematic 4
Size: A4
Date:
Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32
Id: 6/19

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



Sheet: /2_2_5/
File: 2_2_5.kicad_sch

Title: Basic Schematic 5

Size: A4	Date:	**Rev:**
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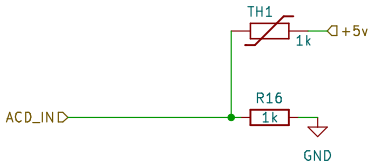


THERMISTOR PTC 1K OHM 1% 0603

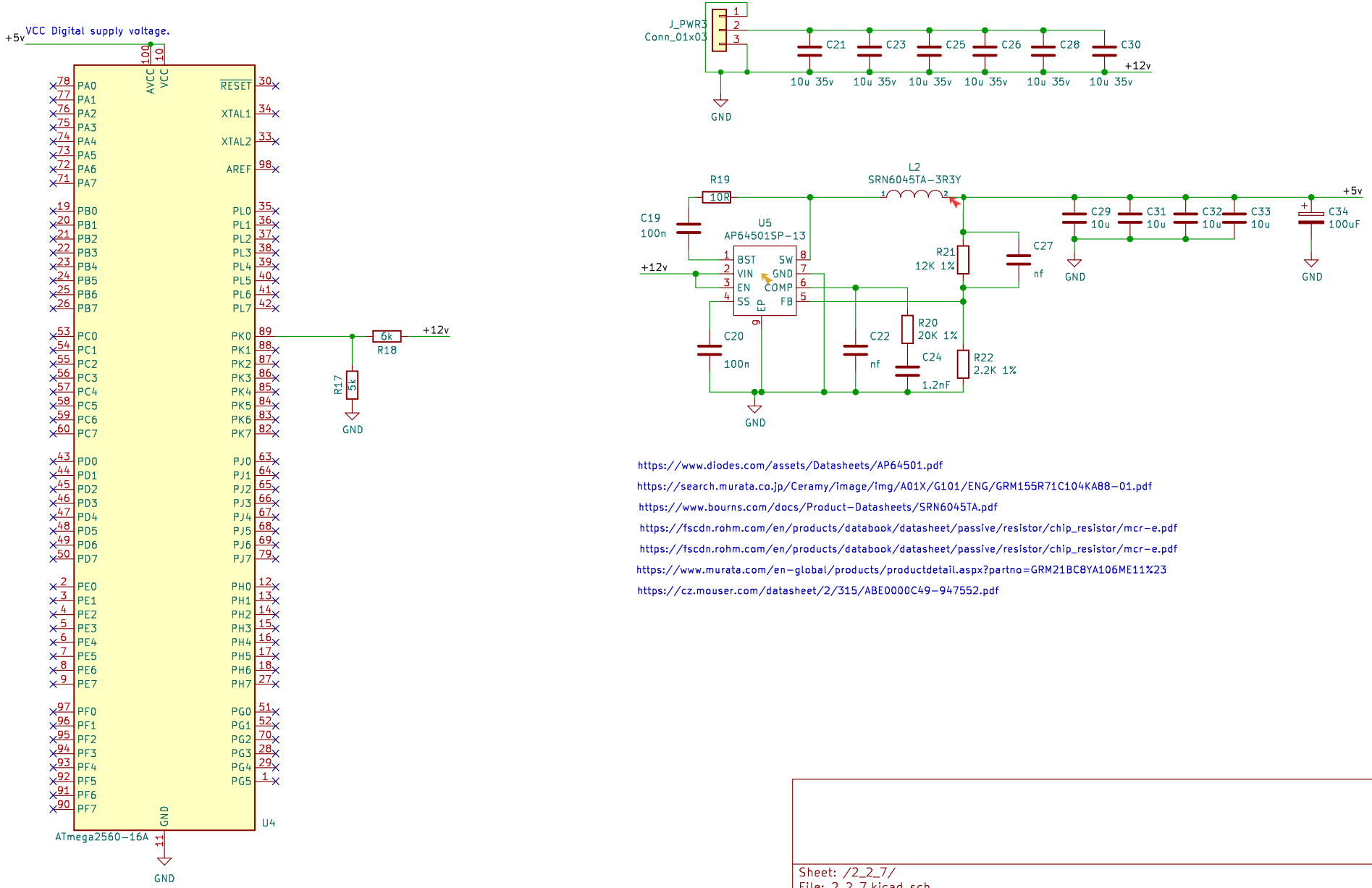
https://www.vishay.com/docs/33017/tfpt.pdf

TFPT0603L1001FV

Sheet: /2_2_6/
File: 2_2_6.kicad_sch

Title: Basic Schematic 6

Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32		Id: 8/19



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/mcr-e.pdf

https://fscdn.rohm.com/en/products/databook/datasheet/passive/resistor/chip_resistor/mcr-e.pdf

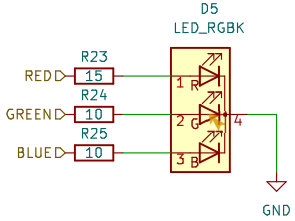
https://www.murata.com/en-global/products/productdetail.aspx?partno=GRM21BC8YA106ME11%23

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

Sheet: /2_2_7/
File: 2_2_7.kicad_sch

Title: Basic Schematic 7

Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad 5.99.0-1.20210404gitB0728f8.fc32		Id: 9/19



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
Rr = (5V - 1.8V) / 0.2A = 16 ohm
Rr = (5V - 2.2V) / 0.2A = 14 ohm
Rr = (5V - 2.8V) / 0.2A = 11 ohm

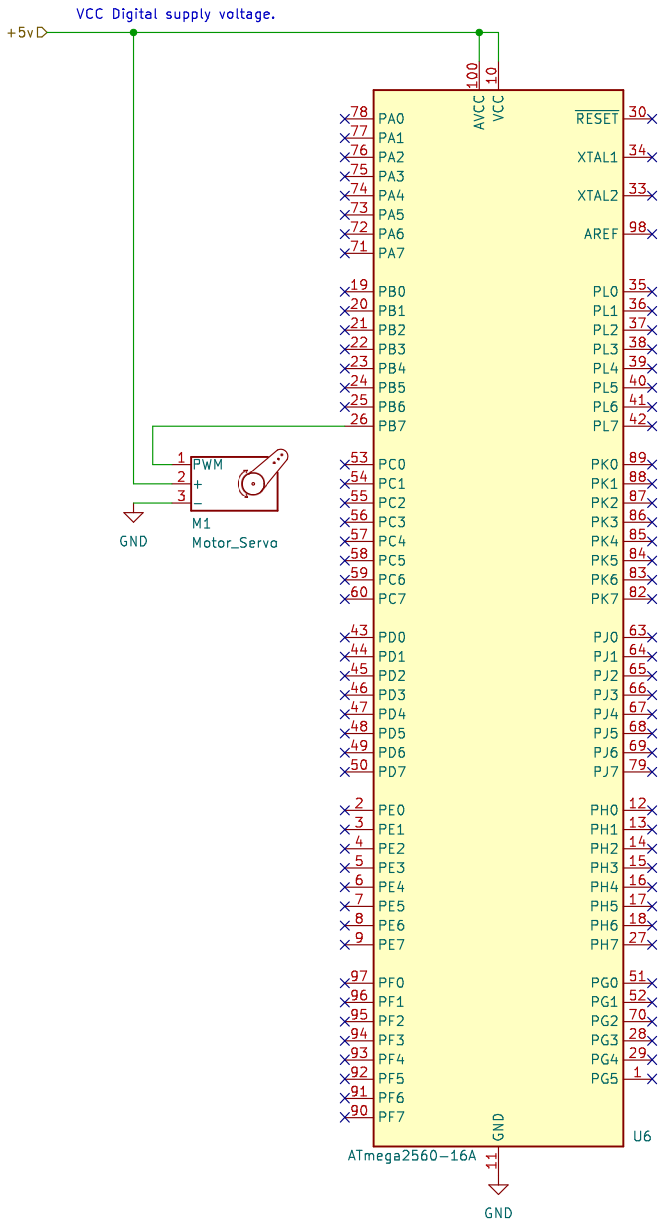
Green Vf from 2.8, typical 3.1V, max 3.7V
Rr = (5V - 2.8V) / 0.2A = 11 ohm
Rr = (5V - 3.1V) / 0.2A = 9.5 ohm
Rr = (5V - 3.7V) / 0.2A = 6.5 ohm

Blue Vf from 2.8, typical 3.0V, max 3.7V
Rr = (5V - 2.8V) / 0.2A = 11 ohm
Rr = (5V - 3.0V) / 0.2A = 10 ohm
Rr = (5V - 3.7V) / 0.2A = 6.5 ohm

Sheet: /2_2_8/
File: 2_2_8.kicad_sch

Title: Basic Schematic 8

Size: A4	Date:	**Rev:**
KiCad E.D.A. kicad 5.99.0-1.20210404gitB0728f8.fc32		Id: 10/19

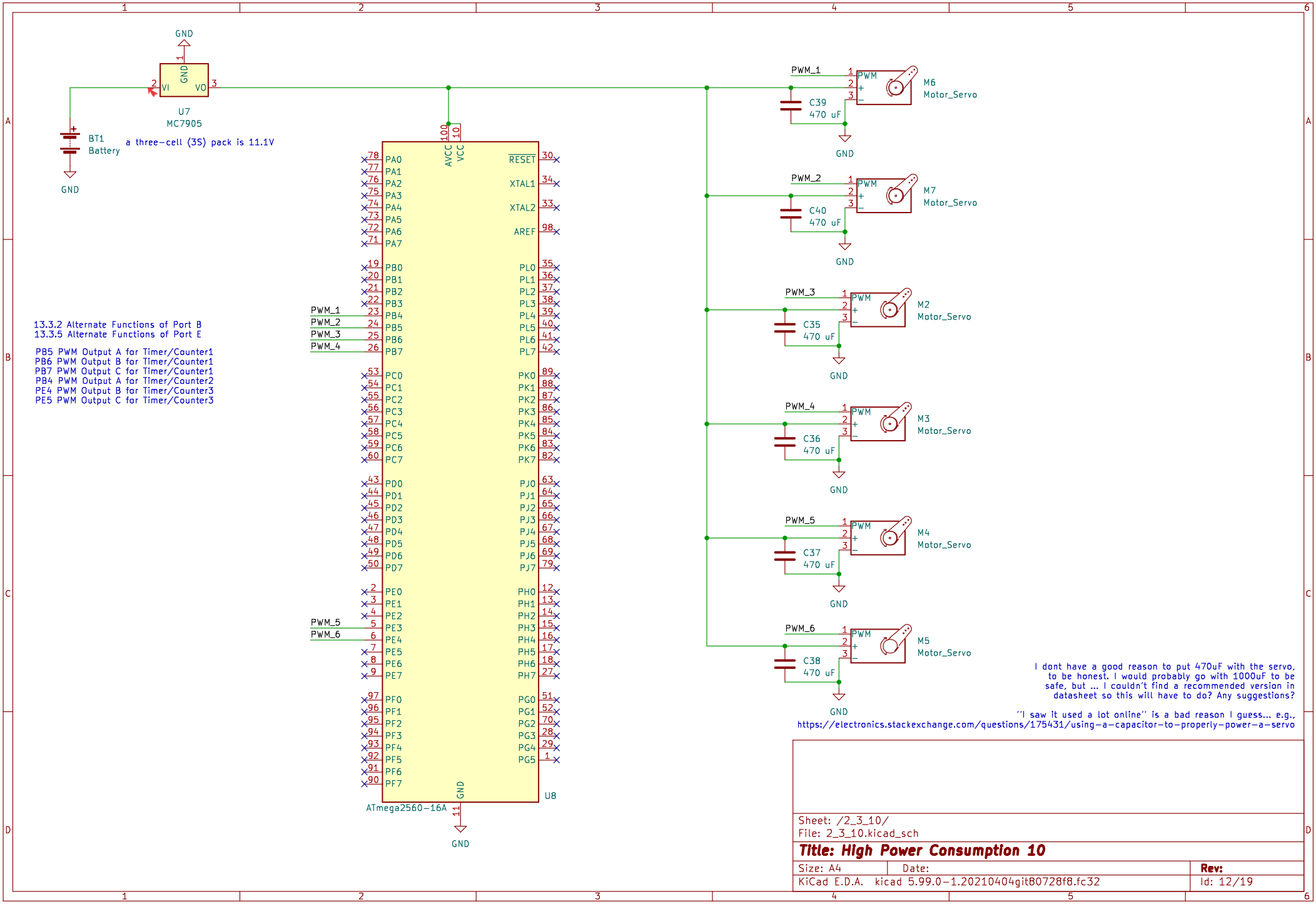


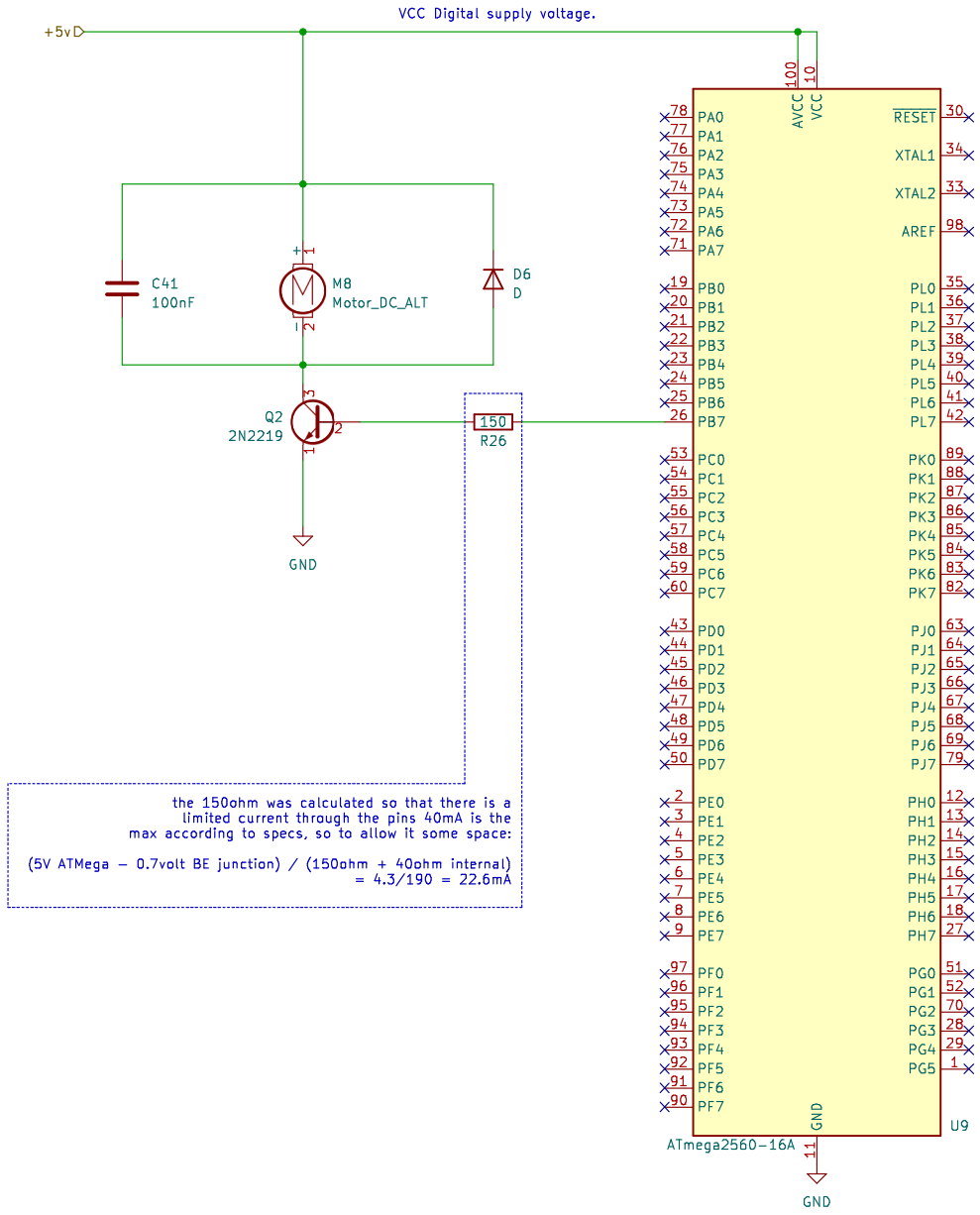
https://cz.mouser.com/datasheet/2/240/Littelfuse_GDT_SG_Datasheet_pdf-319337.pdf

Sheet: /2_3_9/
File: 2_3_9.kicad_sch

Title: High Power Consumption 9

Size: A4	Date:	Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32		Id: 11/19

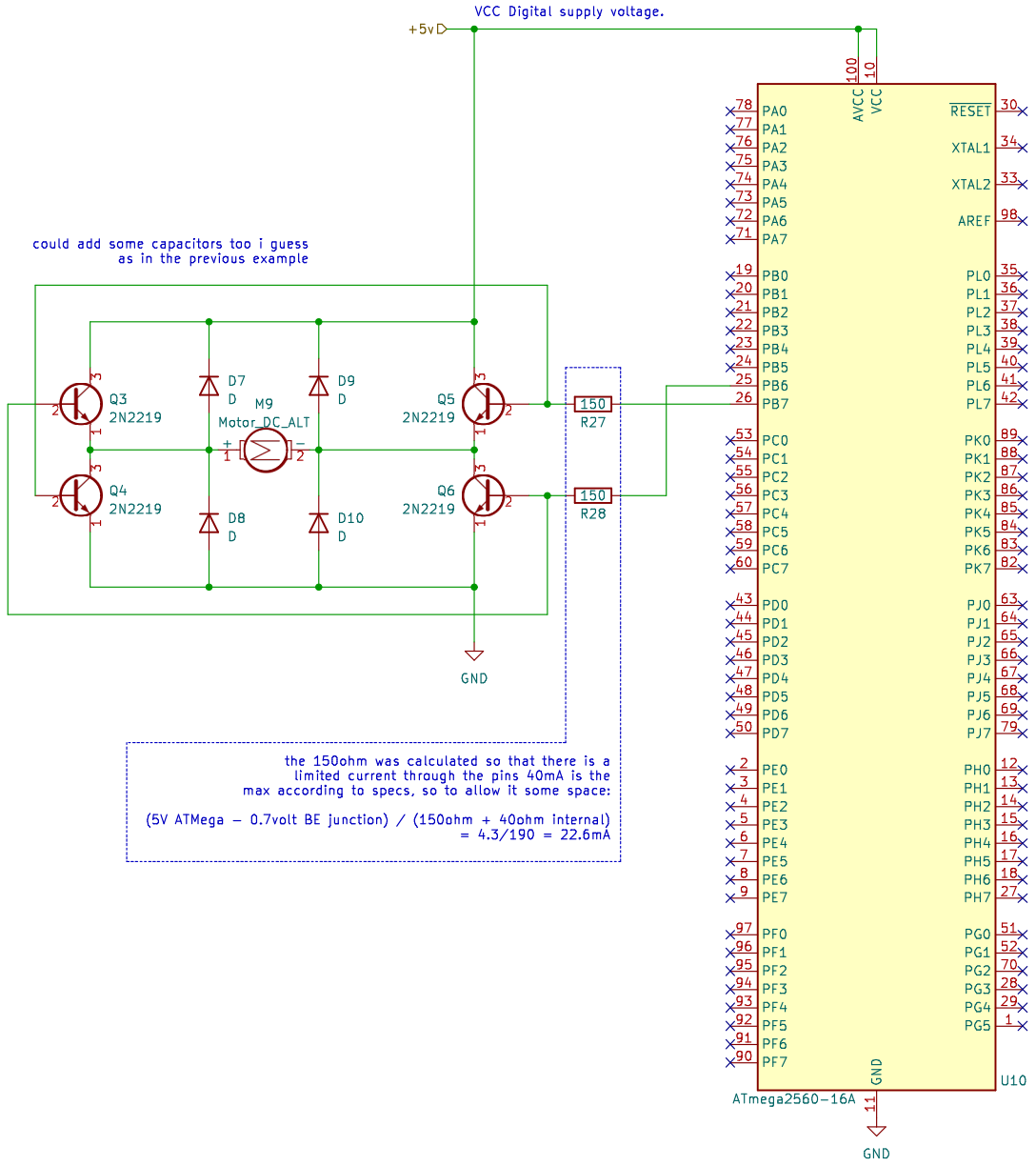

GND
U7
MC7905
VI
VO
BT1
Battery
a three-cell (3S) pack is 11.1V
GND
13.3.2 Alternate Functions of Port B
13.3.5 Alternate Functions of Port E
PB5 PWM Output A for Timer/Counter1
PB6 PWM Output B for Timer/Counter1
PB7 PWM Output C for Timer/Counter1
PB4 PWM Output A for Timer/Counter2
PE4 PWM Output B for Timer/Counter3
PE5 PWM Output C for Timer/Counter3
AVCC
VCC
RESET
XTAL1
XTAL2
AREF
PWM_1
PWM_2
PWM_3
PWM_4
PWM_5
PWM_6
ATmega2560-16A
U8
C39
C40
C35
C36
C37
C38
470 uF
M6
M7
M2
M3
M4
M5
Motor_Servo
I dont have a good reason to put 470uF with the servo, to be honest. I would probably go with 1000uF to be safe, but ... I couldn't find a recommended version in datasheet so this will have to do? Any suggestions?
"I saw it used a lot online" is a bad reason I guess... e.g., https://electronics.stackexchange.com/questions/175431/using-a-capacitor-to-properly-power-a-servo
Sheet: /2_3_10/
File: 2_3_10.kicad_sch
Title: High Power Consumption 10
Size: A4
Date:
Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32
Id: 12/19



Sheet: /2_3_11/
File: 2_3_11.kicad_sch

Title: High Power Consumption 11

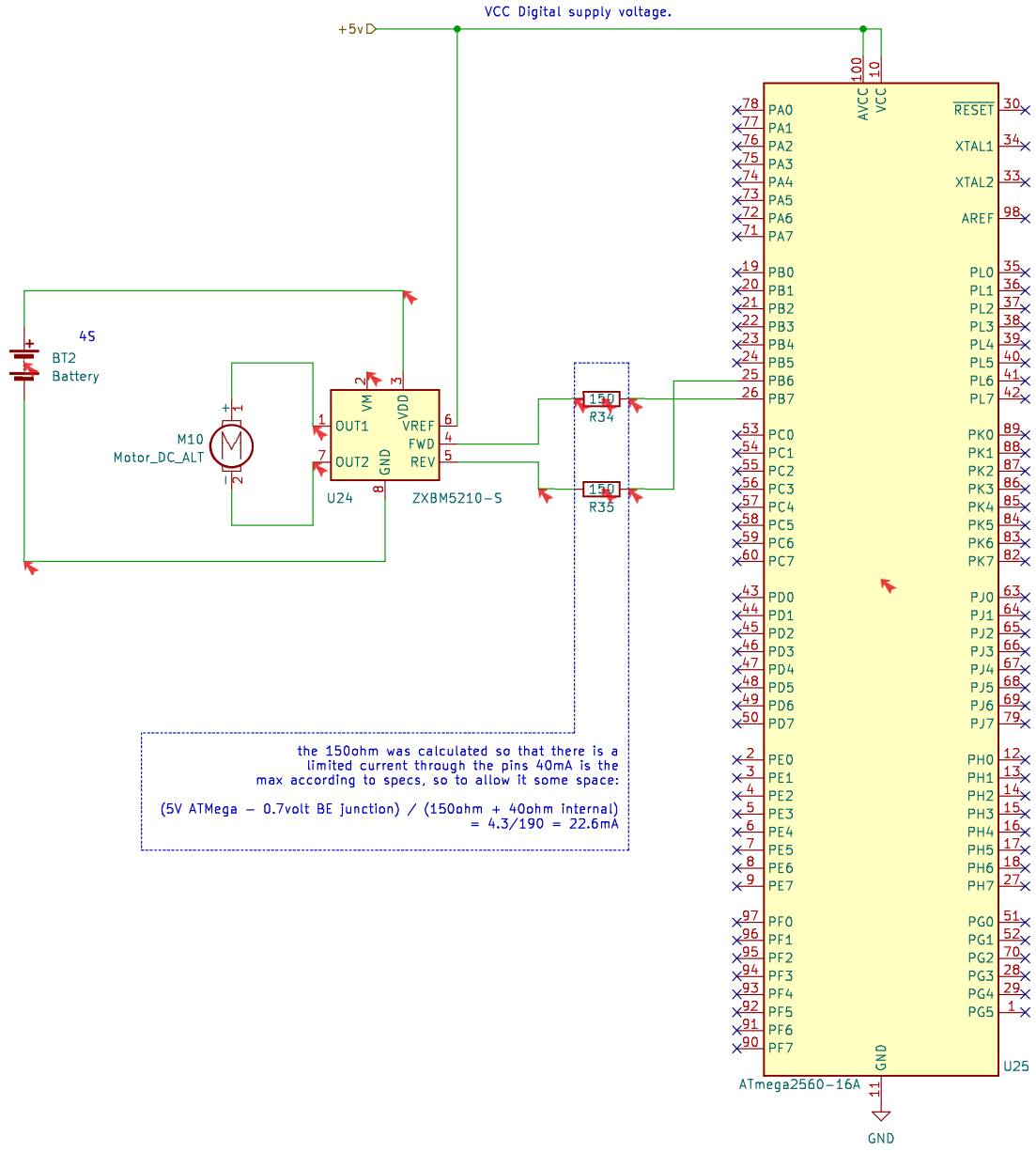
Size: A4	Date:	Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32		Id: 13/19



Sheet: /2_3_12/
File: 2_3_12.kicad_sch

Title: High Power Consumption 12

Size: A4	Date:	Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404gitB0728f8.fc32		Id: 14/19



Sheet: /2_3_13/
File: 2_3_13.kicad_sch

Title: High Power Consumption 13

Size: A4	Date:	Rev:
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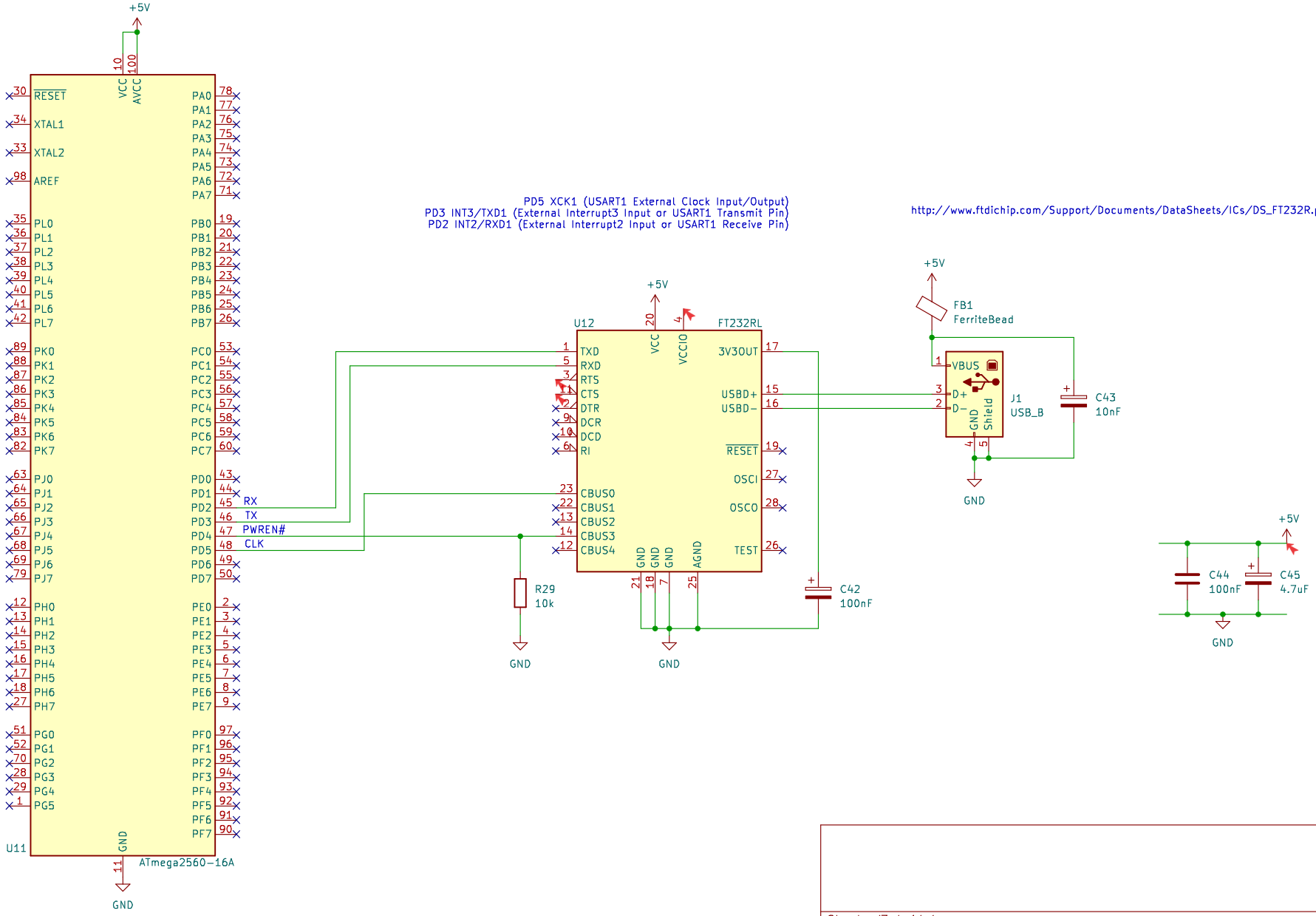
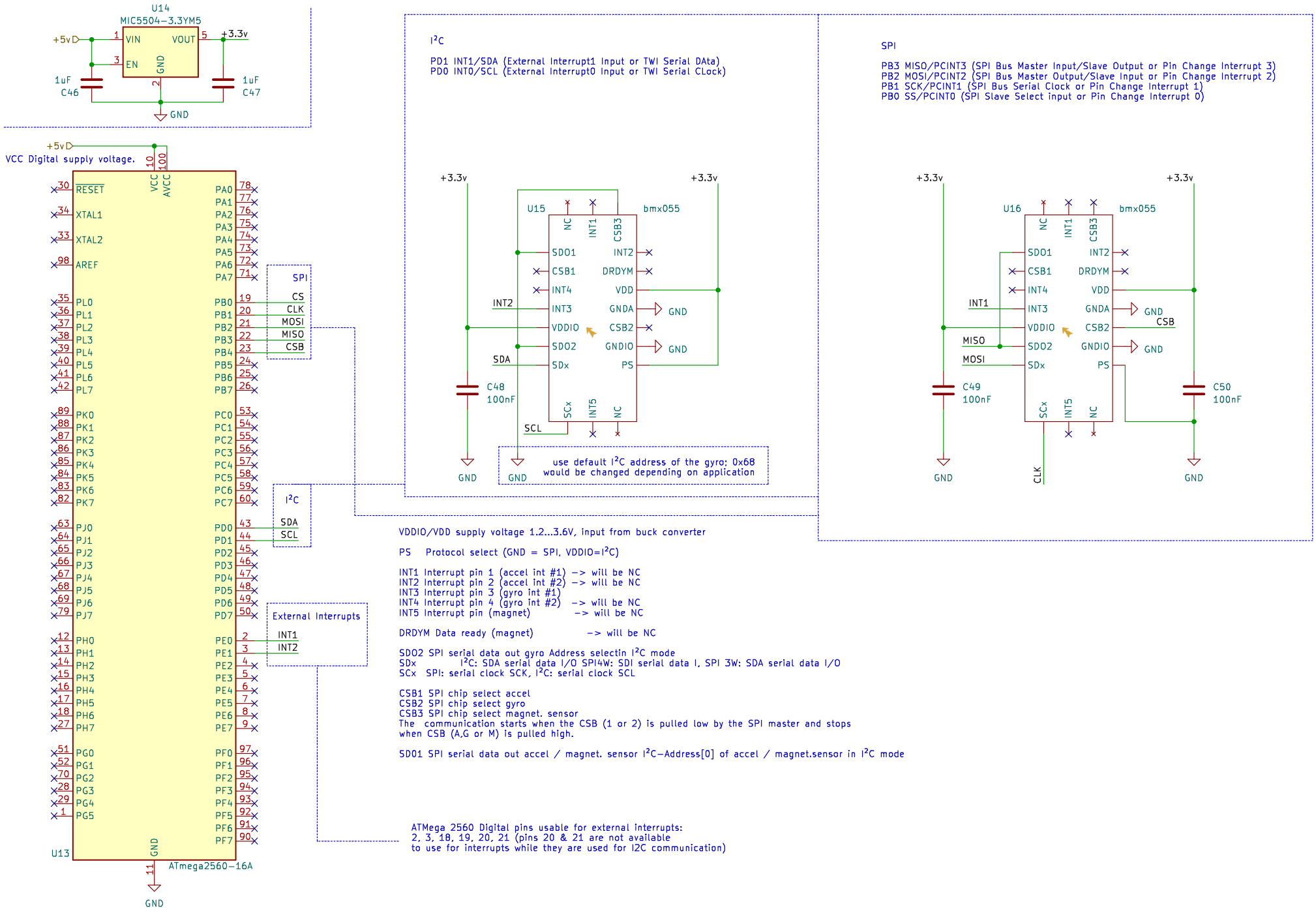
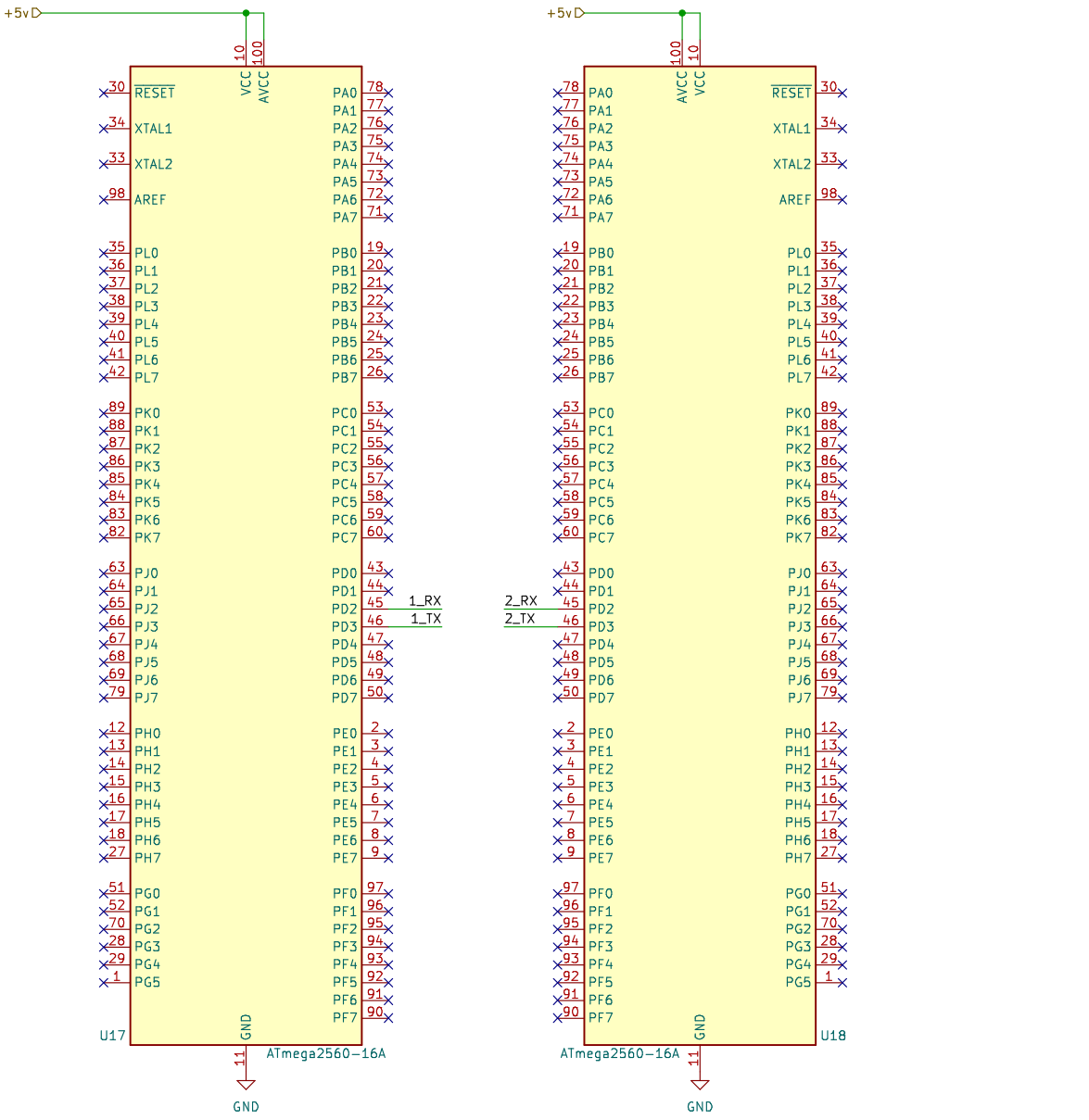
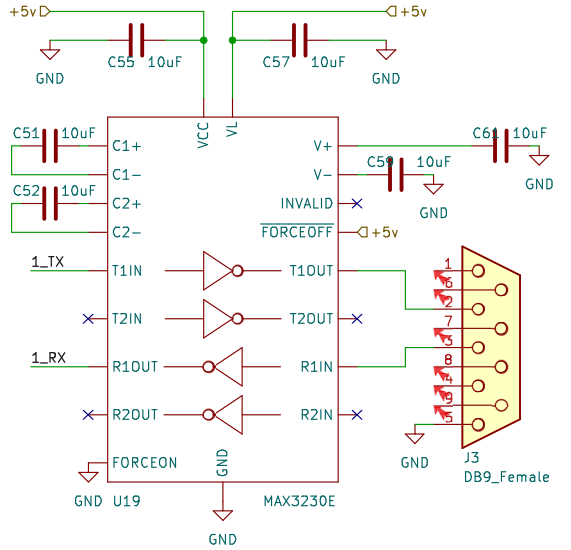
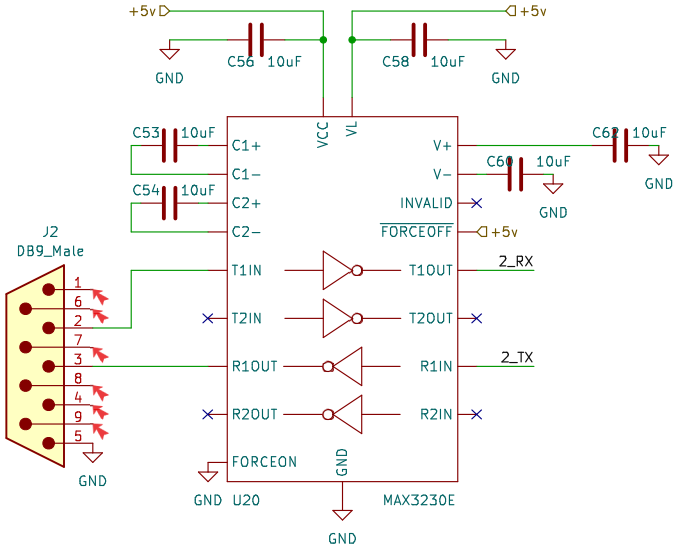

+5V
U11
ATmega2560-16A
RESET
XTAL1
XTAL2
AREF
PL0
PL1
PL2
PL3
PL4
PL5
PL6
PL7
PK0
PK1
PK2
PK3
PK4
PK5
PK6
PK7
PJ0
PJ1
PJ2
PJ3
PJ4
PJ5
PJ6
PJ7
PH0
PH1
PH2
PH3
PH4
PH5
PH6
PH7
PG0
PG1
PG2
PG3
PG4
PG5
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PB0
PB1
PB2
PB3
PB4
PB5
PB6
PB7
PC0
PC1
PC2
PC3
PC4
PC5
PC6
PC7
PD0
PD1
PD2
PD3
PD4
PD5
PD6
PD7
PE0
PE1
PE2
PE3
PE4
PE5
PE6
PE7
PF0
PF1
PF2
PF3
PF4
PF5
PF6
PF7
VCC
AVCC
GND
RX
TX
PWREN#
CLK
PD5 XCK1 (USART1 External Clock Input/Output)
PD3 INT3/TXD1 (External Interrupt3 Input or USART1 Transmit Pin)
PD2 INT2/RXD1 (External Interrupt2 Input or USART1 Receive Pin)
http://www.ftdichip.com/Support/Documents/DataSheets/ICs/DS_FT232R.pdf
U12
FT232RL
TXD
RXD
RTS
CTS
DTR
DCR
DCD
RI
CBUS0
CBUS1
CBUS2
CBUS3
CBUS4
3V3OUT
USBD+
USBD-
RESET
OSCI
OSCO
TEST
VCCIO
AGND
R29
10k
C42
100nF
FB1
FerriteBead
J1
USB_B
VBUS
D+
D-
Shield
C43
10nF
C44
100nF
C45
4.7uF
Sheet: /3_4_14/
File: 3_4_14.kicad_sch
Title: Peripherals 14
Size: A4
Date:
Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32
Id: 16/19


U14
MIC5504-3.3YM5
+5v
VIN
VOUT
+3.3v
EN
GND
1uF
C46
1uF
C47
GND
+5v
VCC Digital supply voltage.
VCC
AVCC
RESET
XTAL1
XTAL2
AREF
PL0
PL1
PL2
PL3
PL4
PL5
PL6
PL7
PK0
PK1
PK2
PK3
PK4
PK5
PK6
PK7
PJ0
PJ1
PJ2
PJ3
PJ4
PJ5
PJ6
PJ7
PH0
PH1
PH2
PH3
PH4
PH5
PH6
PH7
PG0
PG1
PG2
PG3
PG4
PG5
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PB0
PB1
PB2
PB3
PB4
PB5
PB6
PB7
PC0
PC1
PC2
PC3
PC4
PC5
PC6
PC7
PD0
PD1
PD2
PD3
PD4
PD5
PD6
PD7
PE0
PE1
PE2
PE3
PE4
PE5
PE6
PE7
PF0
PF1
PF2
PF3
PF4
PF5
PF6
PF7
U13
ATmega2560-16A
SPI
CS
CLK
MOSI
MISO
CSB
I²C
SDA
SCL
External Interrupts
INT1
INT2
I²C
PD1 INT1/SDA (External Interrupt1 Input or TWI Serial DAta)
PD0 INT0/SCL (External Interrupt0 Input or TWI Serial CLock)
U15
bmx055
NC
INT1
CSB3
SDO1
CSB1
INT4
INT2
INT3
VDDIO
SDO2
SDx
SCx
INT5
INT2
DRDYM
VDD
GNDA
GNDIO
PS
GND
SDA
SCL
C48
100nF
use default I²C address of the gyro: 0x68
would be changed depending on application
SPI
PB3 MISO/PCINT3 (SPI Bus Master Input/Slave Output or Pin Change Interrupt 3)
PB2 MOSI/PCINT2 (SPI Bus Master Output/Slave Input or Pin Change Interrupt 2)
PB1 SCK/PCINT1 (SPI Bus Serial Clock or Pin Change Interrupt 1)
PB0 SS/PCINT0 (SPI Slave Select input or Pin Change Interrupt 0)
U16
bmx055
INT1
MISO
MOSI
CSB
C49
100nF
C50
100nF
CLK
VDDIO/VDD supply voltage 1.2...3.6V, input from buck converter
PS Protocol select (GND = SPI, VDDIO=I²C)
INT1 Interrupt pin 1 (accel int #1) -> will be NC
INT2 Interrupt pin 2 (accel int #2) -> will be NC
INT3 Interrupt pin 3 (gyro int #1)
INT4 Interrupt pin 4 (gyro int #2) -> will be NC
INT5 Interrupt pin (magnet) -> will be NC
DRDYM Data ready (magnet) -> will be NC
SDO2 SPI serial data out gyro Address selectin I²C mode
SDx I²C: SDA serial data I/O SPI4W: SDI serial data I, SPI 3W: SDA serial data I/O
SCx SPI: serial clock SCK, I²C: serial clock SCL
CSB1 SPI chip select accel
CSB2 SPI chip select gyro
CSB3 SPI chip select magnet. sensor
The communication starts when the CSB (1 or 2) is pulled low by the SPI master and stops
when CSB (A,G or M) is pulled high.
SDO1 SPI serial data out accel / magnet. sensor I²C-Address[0] of accel / magnet.sensor in I²C mode
ATMega 2560 Digital pins usable for external interrupts:
2, 3, 18, 19, 20, 21 (pins 20 & 21 are not available
to use for interrupts while they are used for I2C communication)

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





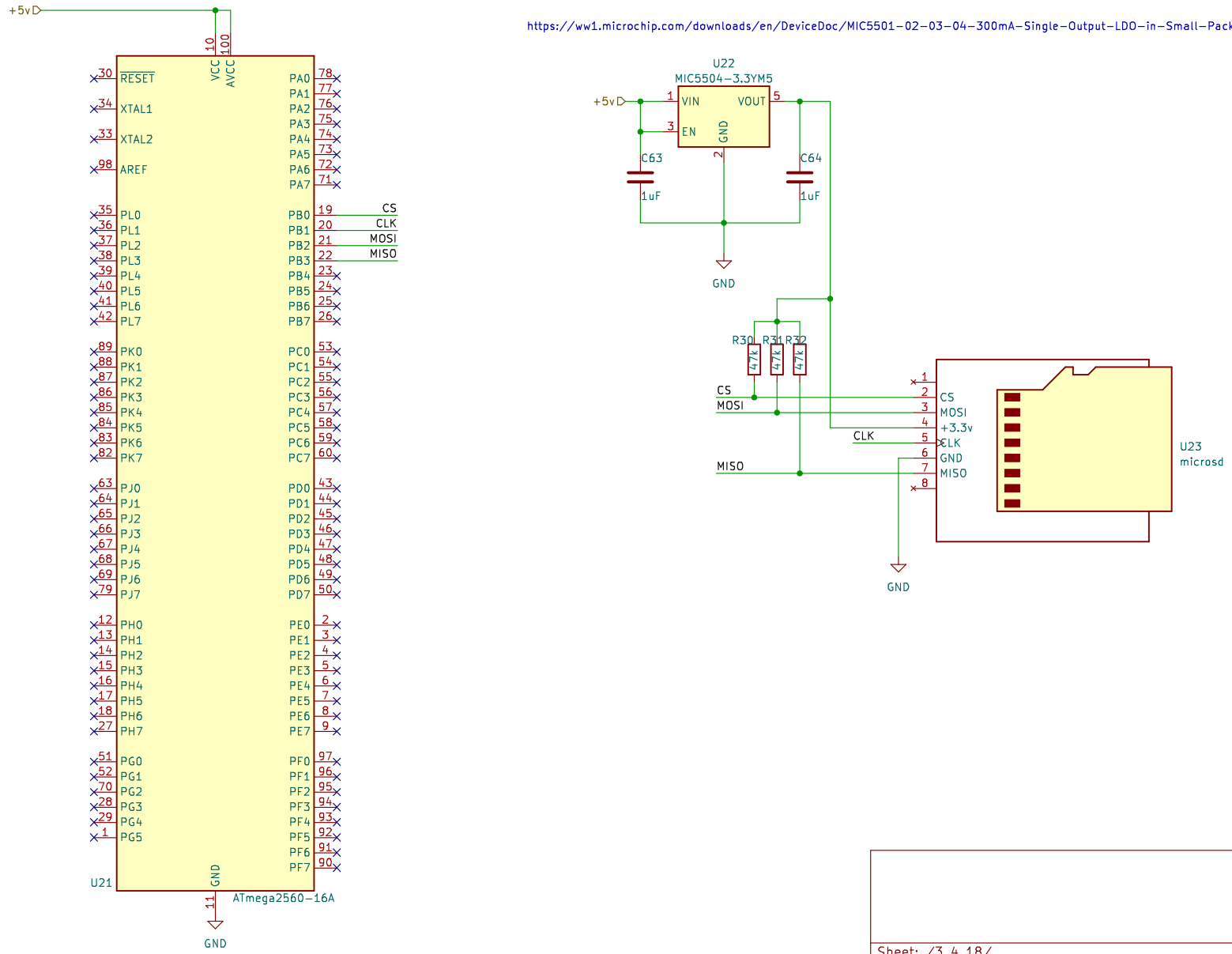


https://cz.mouser.com/datasheet/2/256/MAX3230AE-1389211.pdf

Sheet: /3_4_17/
File: 3_4_17.kicad_sch

Title: Peripherals 17

Size: A4	Date:	Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32		Id: 19/19


+5v
VCC
AVCC
RESET
XTAL1
XTAL2
AREF
PL0
PL1
PL2
PL3
PL4
PL5
PL6
PL7
PK0
PK1
PK2
PK3
PK4
PK5
PK6
PK7
PJ0
PJ1
PJ2
PJ3
PJ4
PJ5
PJ6
PJ7
PH0
PH1
PH2
PH3
PH4
PH5
PH6
PH7
PG0
PG1
PG2
PG3
PG4
PG5
PA0
PA1
PA2
PA3
PA4
PA5
PA6
PA7
PB0
PB1
PB2
PB3
PB4
PB5
PB6
PB7
PC0
PC1
PC2
PC3
PC4
PC5
PC6
PC7
PD0
PD1
PD2
PD3
PD4
PD5
PD6
PD7
PE0
PE1
PE2
PE3
PE4
PE5
PE6
PE7
PF0
PF1
PF2
PF3
PF4
PF5
PF6
PF7
CS
CLK
MOSI
MISO
GND
U21
ATmega2560-16A
https://ww1.microchip.com/downloads/en/DeviceDoc/MIC5501-02-03-04-300mA-Single-Output-LDO-in-Small-Packages-DS20006006B.pdf
U22
MIC5504-3.3YM5
VIN
VOUT
EN
C63
1uF
C64
1uF
R30
R31
R32
47k
+3.3v
U23
microsd
Sheet: /3_4_18/
File: 3_4_18.kicad_sch
Title: Peripherals 18
Size: A4
Date:
Rev:
KiCad E.D.A. kicad 5.99.0-1.20210404git80728f8.fc32
Id: 20/19