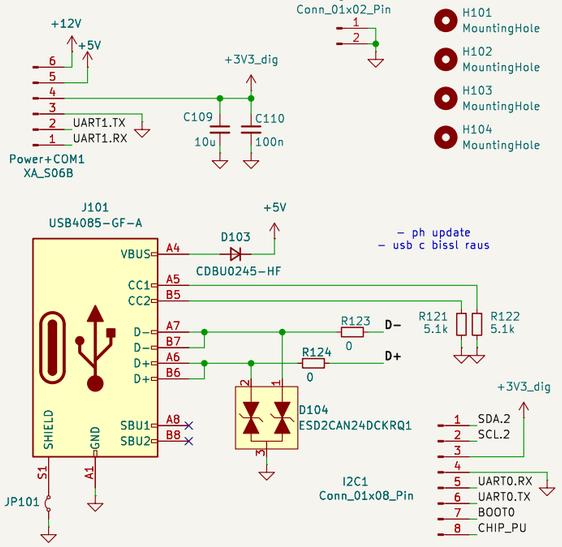
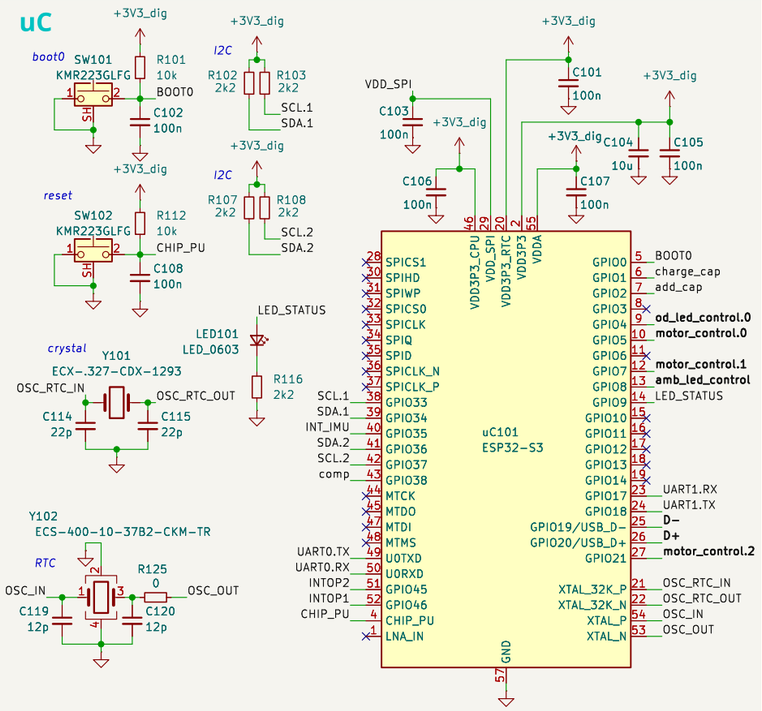
Phenobottle Sensorboard

This PCB does sensor readout as well as motor/light control for the phenobottle.

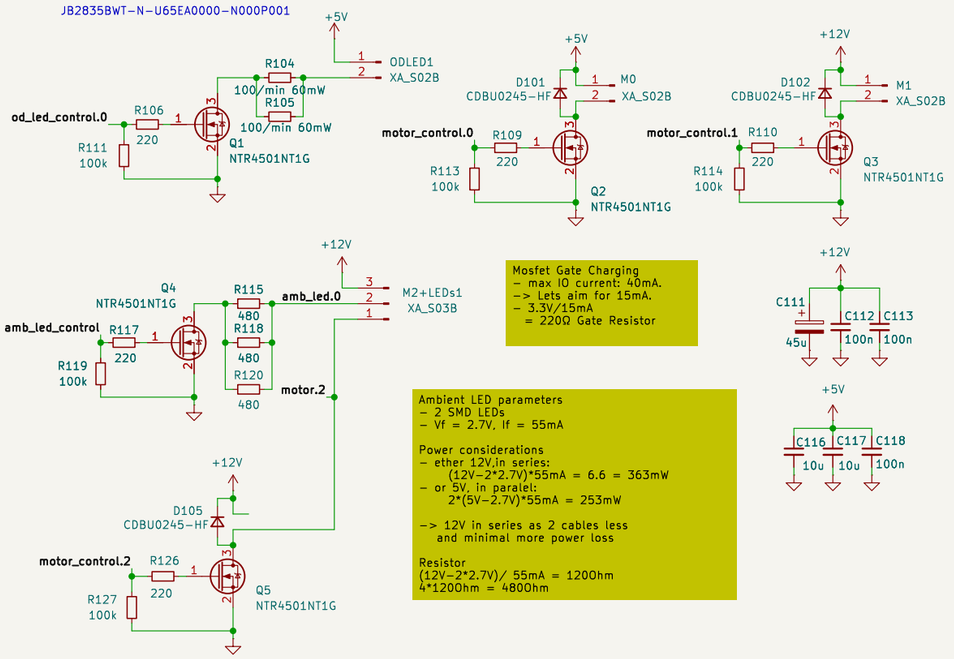
IO external



uC

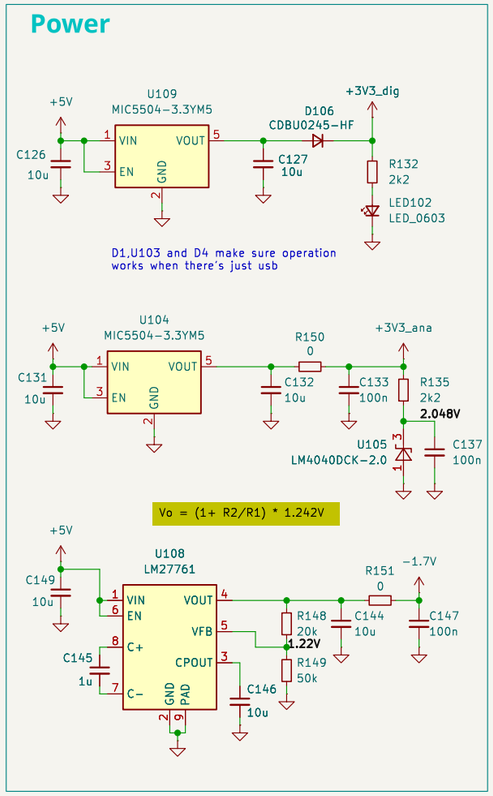


Mosfet Driver [Motors & LEDs]



Analog

Power



ADC

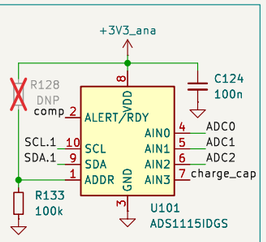
Adress: 72 or 73

TIA: Range: 0.256V
I_pd=ADC2/10MEG

pH: Range: 2.048V
pH=7+(ADC1–1.024V)
*9.64853*10^4/(T[K]*19.143)

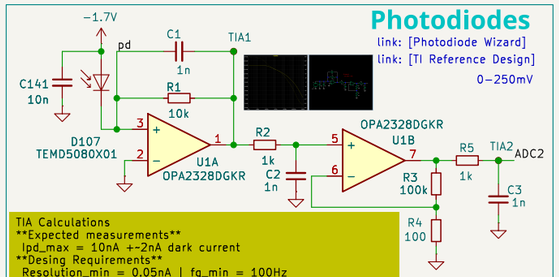
NTC: Range: 2.048V
volt_dif = ADC0*(1.0/gain)+voffset
Rntc = R_dif*((Vref/volt_dif)–1)
Temp[K]= 1.0/(1.0/NTC_T0+(1.0/NTC_B)
*log(Rntc/NTC_R0))

Current Integrator
i_photodiode=C*delta_v/delta_t

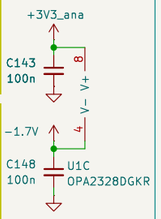


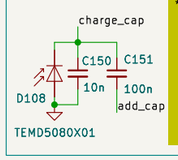
Photodiodes

link: [Photodiode Wizard]
link: [TI Reference Design]



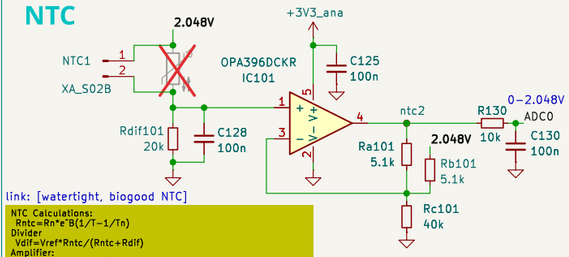
TIA Calculations
Expected measurements
Ipd_max = 10nA +–2nA dark current
Desing Requirements
Resolution_min = 0.05nA | fg_min = 100Hz
ADC:
N_bit = 16bit | ADC_Vmax = 256mV
ADC_Resolution = ADC_Vmax/2^N_bit~4uV
min_Gain = ADC_Resolution / Resolution_min = 4uV / 0.1nA
= 80kOhm = 98,06dB
Dual stage design:
Gain: 10k*100k/100 = 10MEG
2x LP at 159,1kHz
1x LP at 15,9kHz





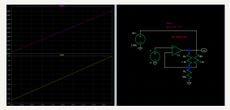
Current Integrator
Concept
.uC charges Cap to 3.3v
.uC pin goes High Impedance
.photodiode discharges Cap.
.ADC measures discharge time
–>i_photodiode=C*delta_v/delta_t
add_cap can be pulled low
to add the additional cap
Trades Time for accuracy
but has sub–nA potential
and doesn't care for noise

NTC

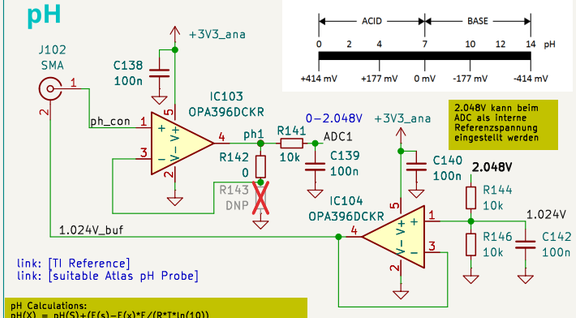


link: [watertight, biogood NTC]

NTC Calculations:
Rntc=Rn*e^B(1/T–1/Tn)
Divider
Vdif=Vref*Rntc/(Rntc+Rdif)
Amplifier:
if low accuracy suffisicates:
Ra=0Ohm; Rb,Rc=DNP
else
Vref = 2.048V
Gain = 1.0/(Rc||Rb/(Rc||Rb + Ra))= 2,1
Voffset = 2.048V * Rc||Ra/(Rc||Ra + Rb) = 0.96
RC filter:
fg=1.6kHz as response is slow
Temp:
volt_dif = ADC0*(1.0/gain)+voffset; #volt before amplifier
Rntc = R_dif*((Vref/volt_dif)–1);
Temp[K]= 1.0/(1.0/NTC_T0+(1.0/NTC_B)*log(Rntc/NTC_R0));
Temp[°C] = Temp[K]– 273.15;



pH



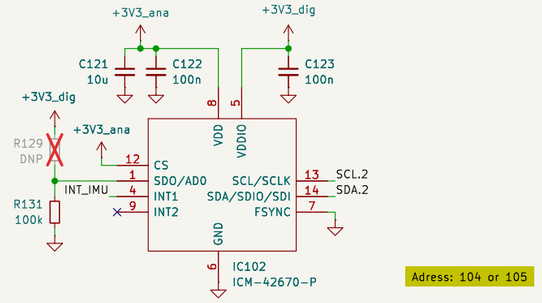
link: [TI Reference]
link: [suitable Atlas pH Probe]

pH Calculations:
pH(X) = pH(S)+(E(s)–E(x)*F/(R*T*ln(10))
= 7+V_electrode*9.6485309*10^4/(T[K]*19.143)
Can be positiv or negativ –> second opamp creates offset

818mV/14pH –> 59.1mV/pH

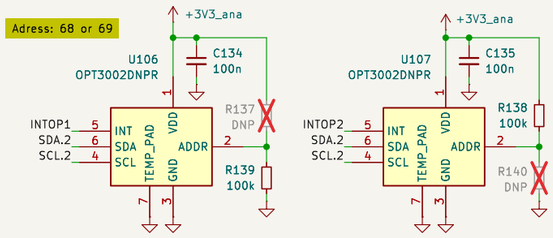
Gain for full range:
1.024V/414mV = 2,47
RC filter fg=1.6kHz as it measures mostly dc

Imu



Light Sensor

Adress: 68 or 69



SpaceLabs | Fynn Gewiese

Sheet: /
File: Phenobottle Sensorboard.kicad_sch

Title: Phenobottle Sensorboard

Size: A3	Date: 2025–01–20	**Rev: V1**
KiCad E.D.A. 9.0.1		Id: 1/1