

PCB Manufacturing Constraints

- Size 54.1 x 75.2 mm, 6 Layer
- 0.15 mm Track Width
- 0.15 mm Copper Clearance
- 0.38 mm Edge Clearance
- 0.35 mm Toolsize / non plated Hole
- 0.25 mm Plated Hole (End-)Size
- 0.125 mm Annular Ring
- 2.54 mm milling radius
- Solder Paste Pads are optimized for a 70 - 110 um Stencil

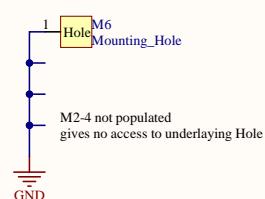
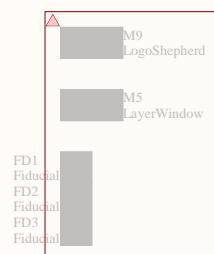
Assembly (v2.4)

- 2 Variations, recorder / emulator are self-contained and optional
- with Emu > X parts, X unique
- with Mech-15 contains assembly notes / Pick and Place
- marking origin of part: cross (+) on assembly notes layer
- marking pad 1 of ICs: chamfered edge and circle (assembly notes) and filled triangle (silk)
- marking cathode of diodes: "C" or chamfered edge (assembly notes) and filled triangle (silk)
- Mech-2 contains Top Part Designators
- smallest part 0402
- smallest pitch 0.35 mm, XSON8
- only top layer populated

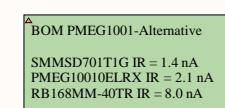
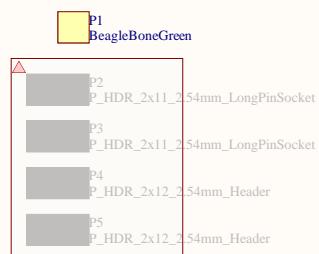
Manual Assembly

- Mech-13 contains info about non-reflow parts (8 items)

Misc



BOM-Additions



External-BOM

- USB-Stick 256 GB
- Ethernet Cables
- POE-Adapter
- uSD-Card (for flashing)

Calibration Resistors

1k-0603-0.05% 667-ERA-3ARW102V
100R-0603-0.05% 754-RG1608N-101-W-T1

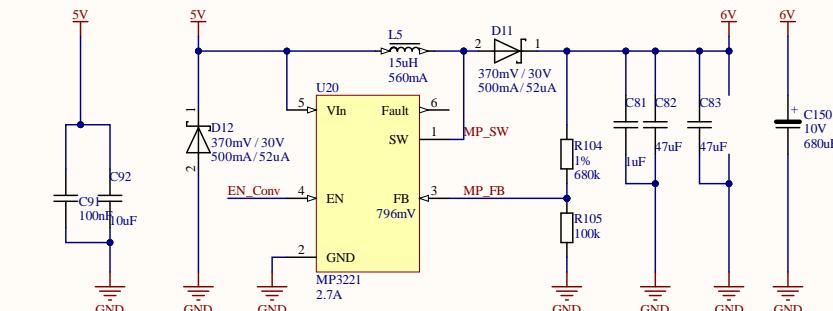
Pinheader Connection BBone Variants

- 2x23 Header > 7731-802-4LF 1.3 €
- 2x23 LongPinSocket
- Samtec SSQ-123-23-G-D or 03-G-D 6 € (Default in BOM)
- Major League SSHQ-123-D-10-G-LF 3 €
- 2x16 LongPinSocket & 2x12 Header
- Samtec SSQ-111-03-G-D 3 €
- Amphenol 10129381-924003BLF 0.4 €

Title Shepherd - Overview NES Lab / TU Dresden		
Size A4	Number	Revision
Date: 9.23.2022		Sheet of shepherd_v2.PriPcb
File: C:\Users\...\overview.SchDoc		Drawn By: Ingmar

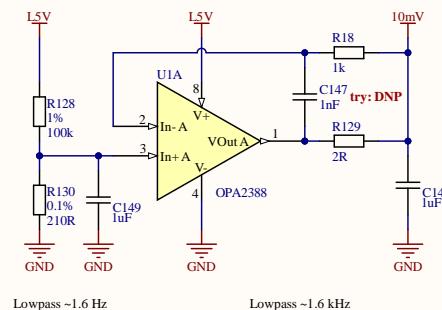
1 2 3 4 5 6

BoostConverter



V_{out} 6.2088 V, 1% range is [6.102; 6.318] V
 I_{out} [36; 166] mA
 $dV_{out} <= 9.2 - 42 \mu V$ (min/max load) Output-Ripple
 $L_{Opt} = 20 \mu H$

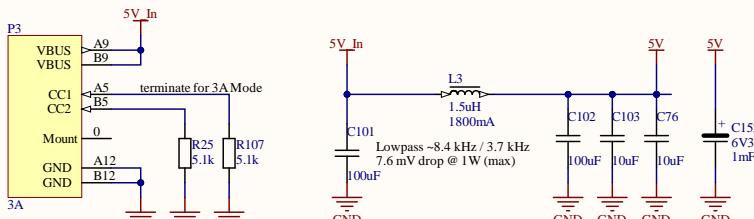
Reference-Offset



Lowpass ~1.6 Hz

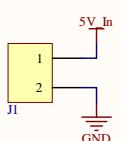
Lowpass ~1.6 kHz

External Power Input

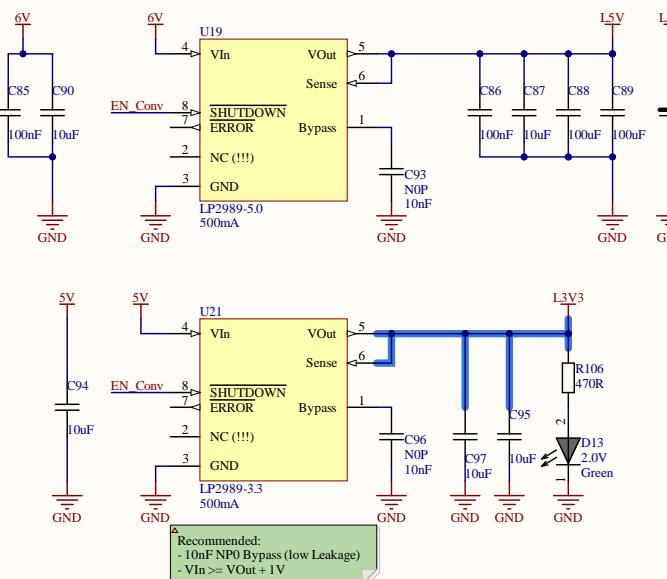


terminate for 3A Mode

MAX 5V



LowNoise LDOs

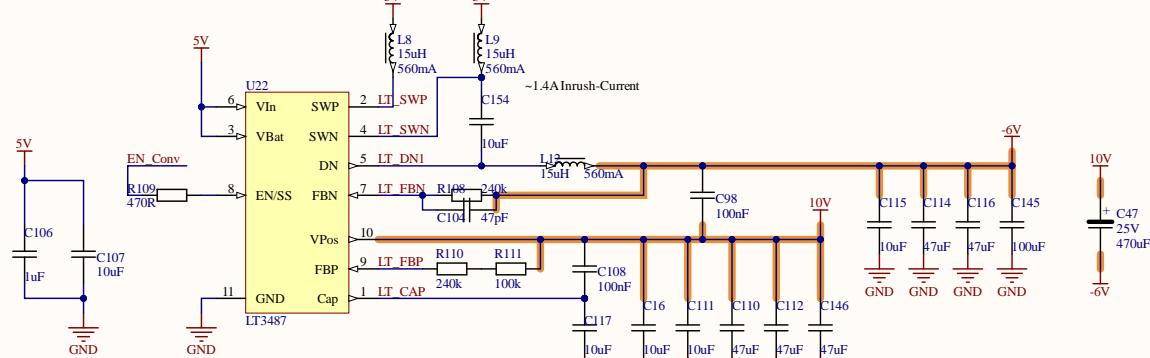


Δ Consumption:
- Disabled < 2 mA
- Enabled 67 mA @ 5.1 V (Emu & Rec)
- BB 390 mA during boot, 170 to 240 mA later

Shepherd ON 272 mW (Emu only)
18mW @ 3V 144mW @ 5V
36mW @ 6V 37mW @ 16V
Shepherd ON 401 mW (Emu & Rec)
18mW @ 3V 198mW @ 5V
36mW @ 6V 101mW @ 16V
Shepherd MAX 1121mW (both targets drain 50mA)
20mW @ 3V 795mW @ 5V
36mW @ 6V 101mW @ 16V

Main Voltages:
A5V/L5V -> 5.000 V Should be Spot On
L3V3 -> 3.300 V Should be Spot On
6V -> 5.38 V [5.29; 5.47] V with 1% Res
10V -> 9.73 V [9.56; 9.90] V with 1% Res
-6V -> -6 V, [5.94; 6.06] V with 1% Res

Boost & Inverter

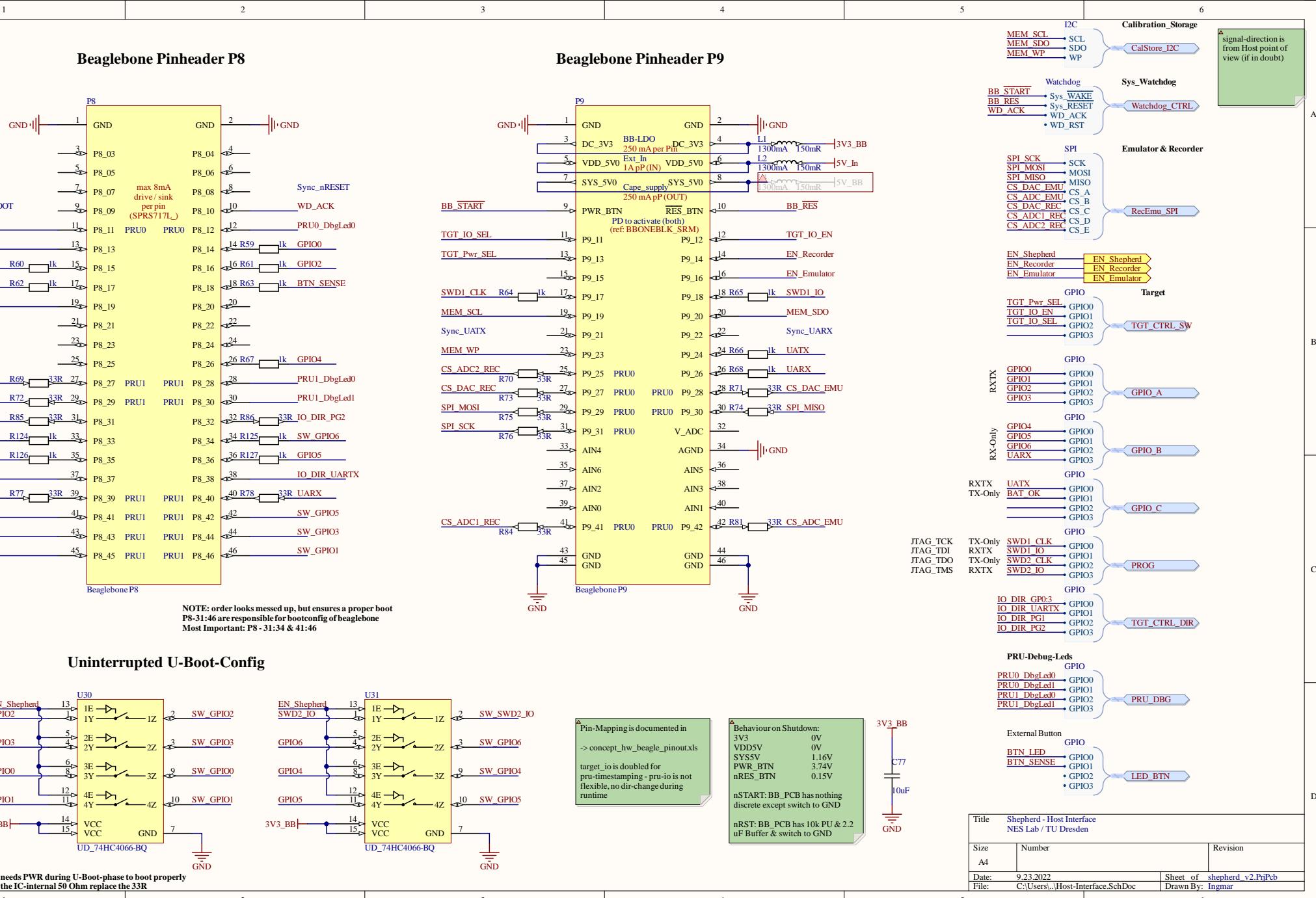


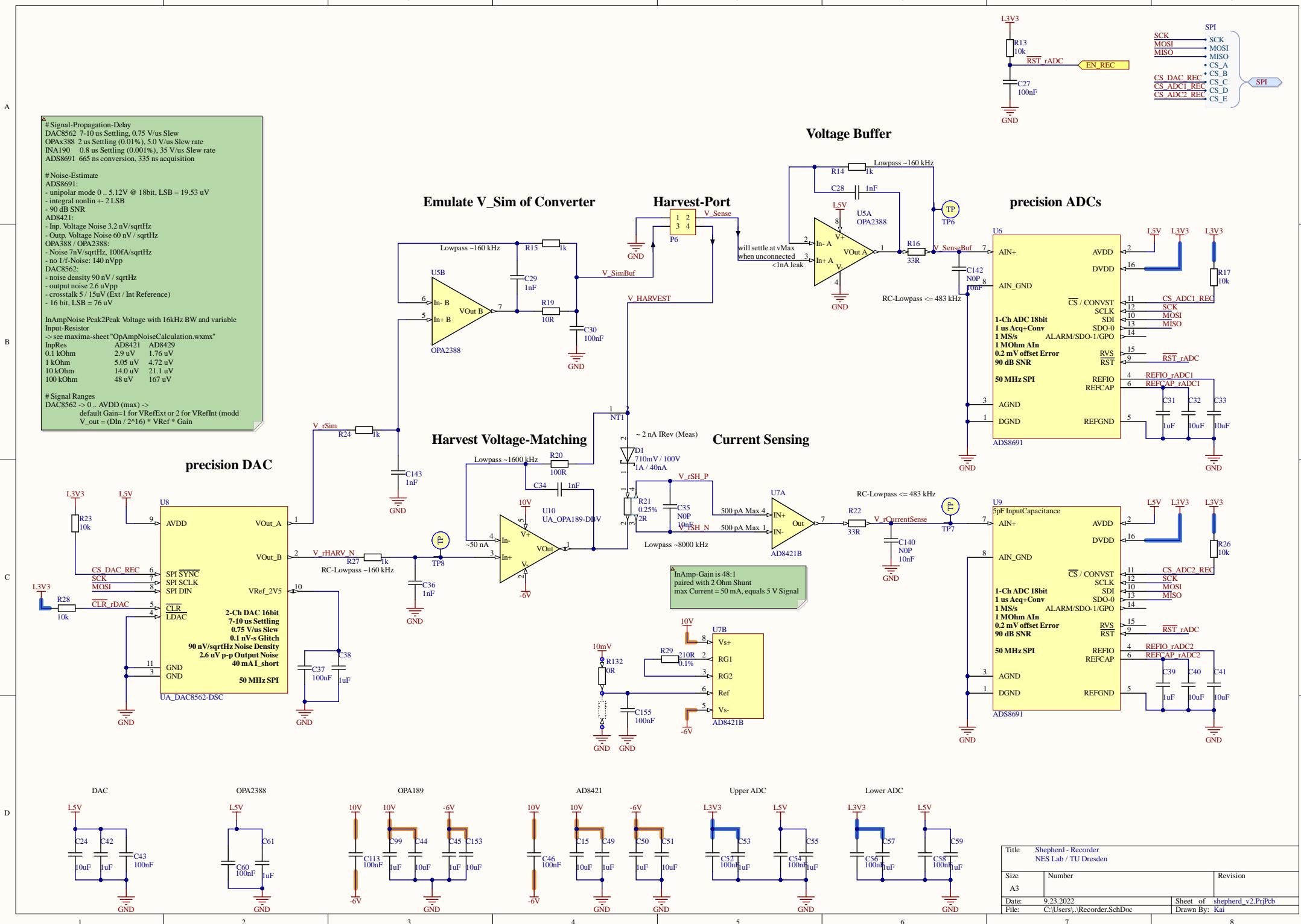
$R_1 = (V_p - 1.23V) / 25\mu A$
 $R_1 = 350.8 \text{ k}\Omega \text{m} (10V)$
 $340\text{k}\Omega \text{m} > 9.73V @ 1\%$
 $R_2 = V_n / 25\mu A$
 $R_2 = 240 \text{ k}\Omega \text{m} (-6V)$
Regulator drives at least 50mA on both Outputs

Title Shepherd - Power Supplies
NES Lab / TU Dresden

Size	Number	Revision
Date:	9.23.2022	Sheet of shepherd_v2.PriPcb
File:	C:\Users\...\PowerSupplies.SchDoc	Drawn By: Ingmar

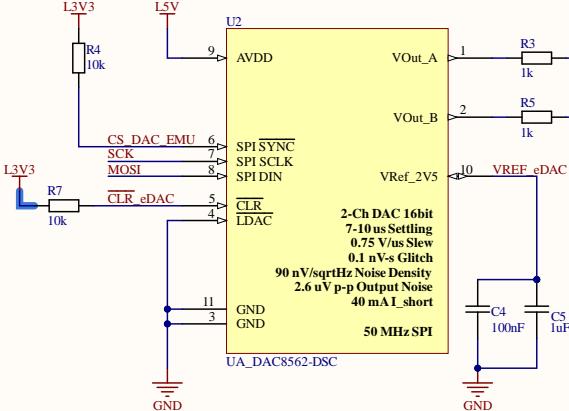
1 2 3 4 5 6



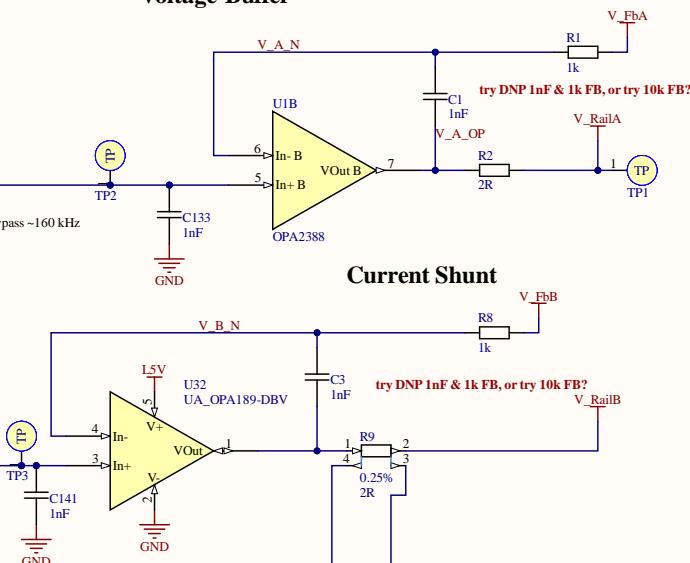


1 2 3 4 5 6

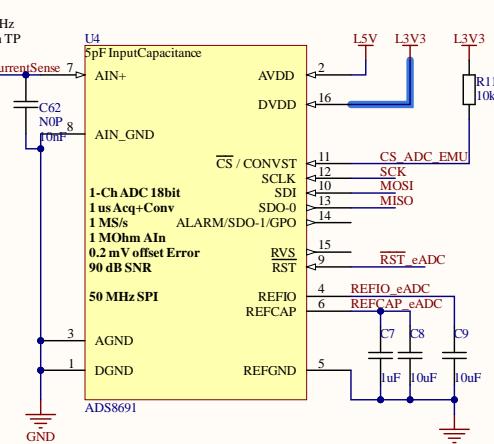
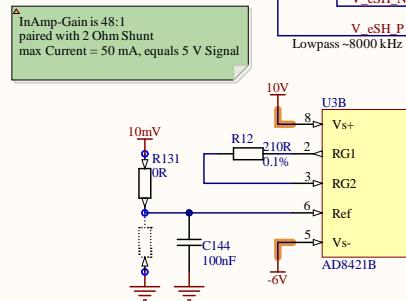
precision DAC



Voltage-Buffer

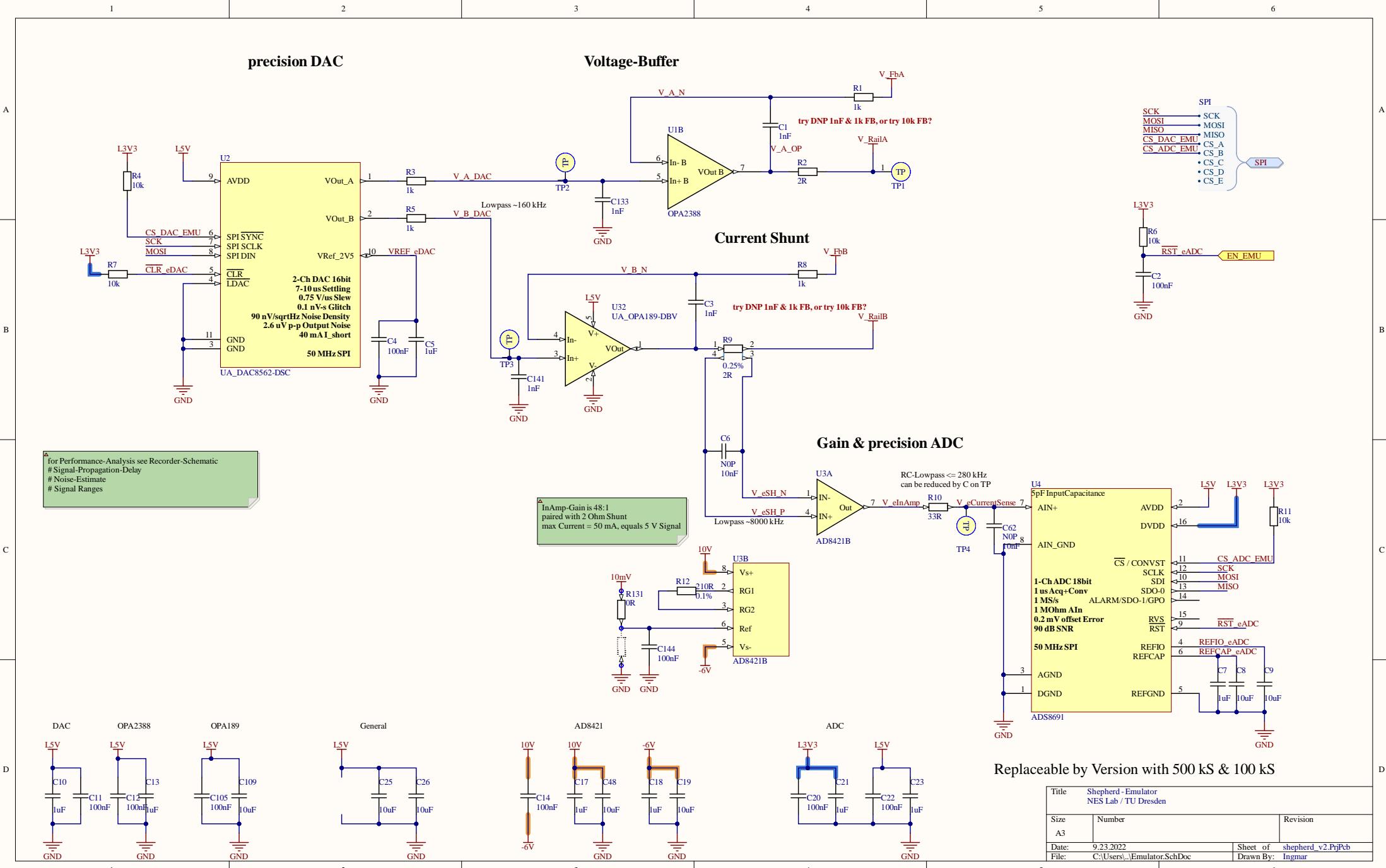


Gain & precision ADC

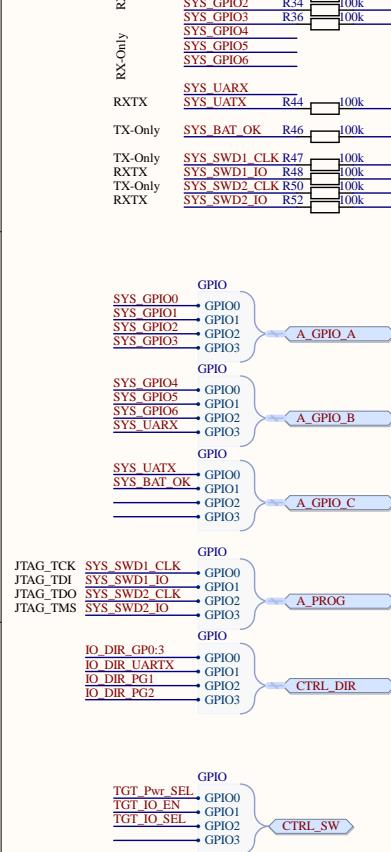
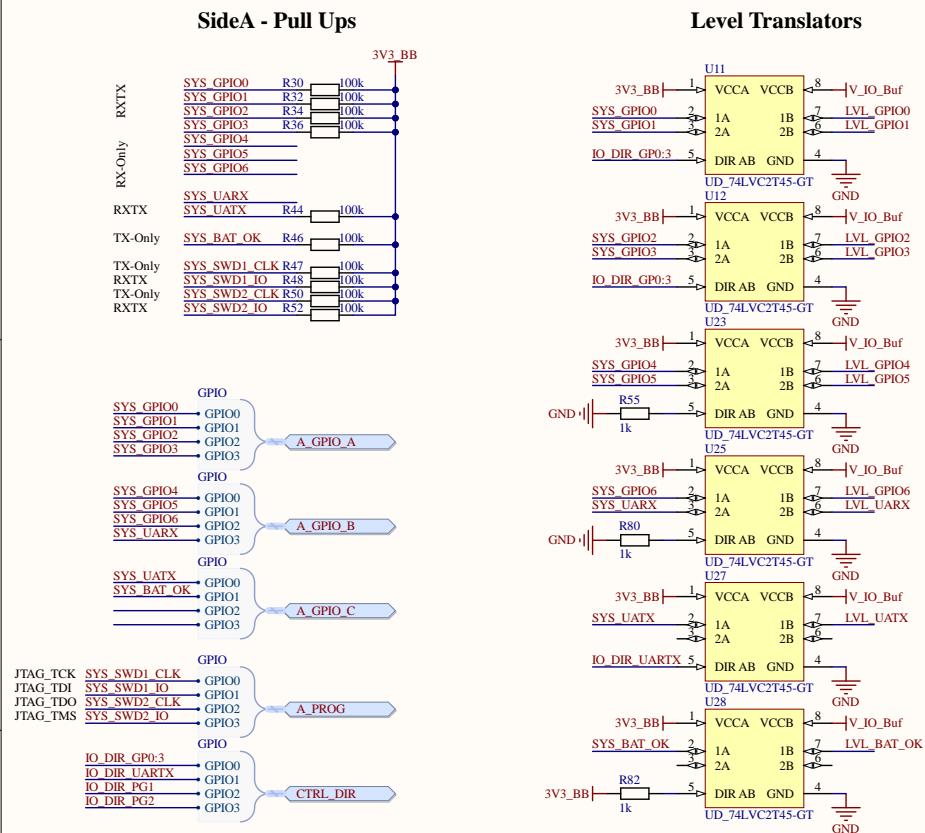
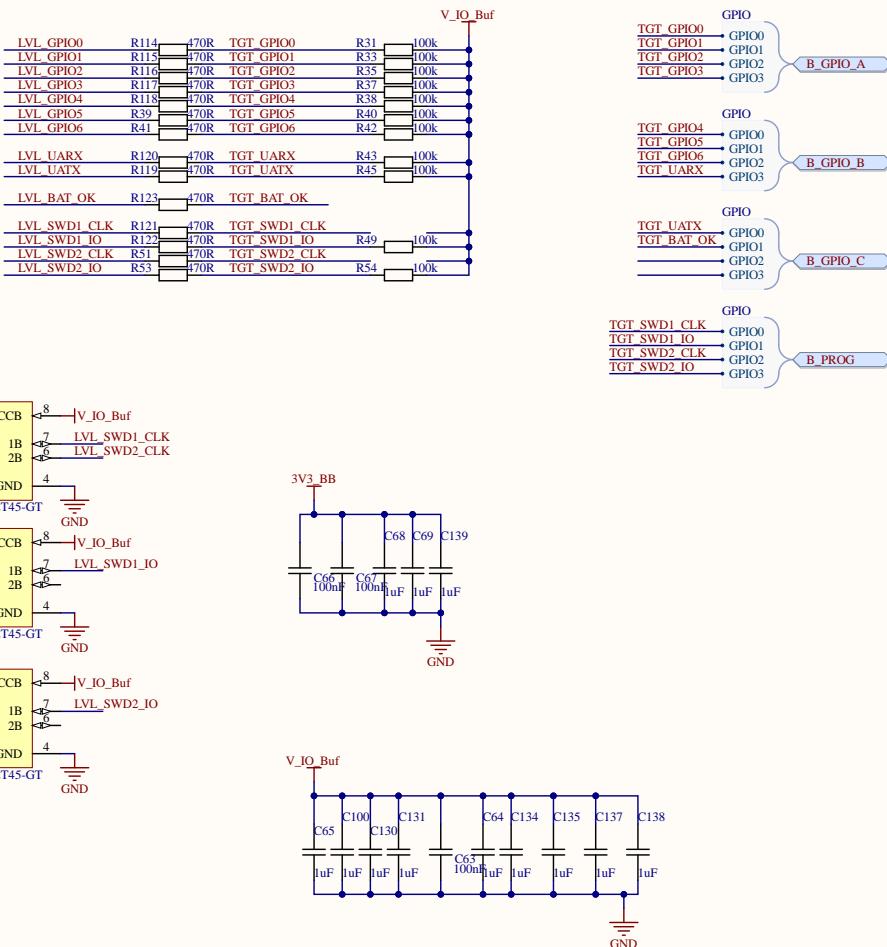
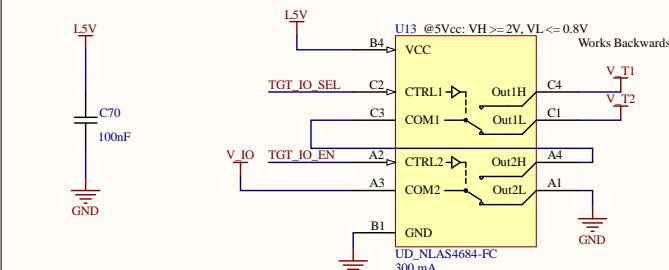
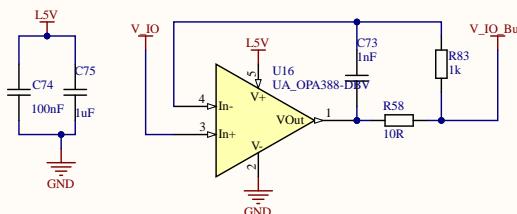


Replaceable by Version with 500 kS & 100 kS

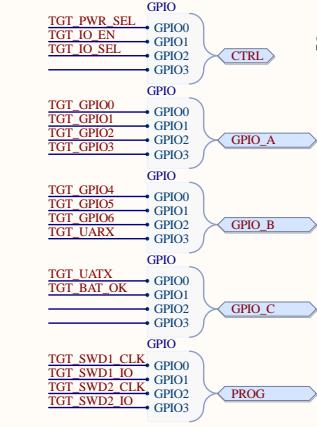
Title Shepherd-Emulator NES Lab / TU Dresden		
Size A3	Number	Revision
Date: 9.23.2022		Sheet of shepherd_v2.PjPcb
File: C:\Users\...\Emulator.SchDoc		Drawn By: Ingmar



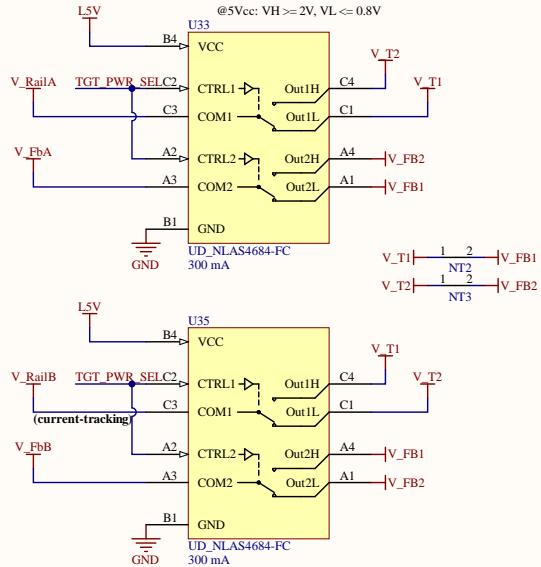
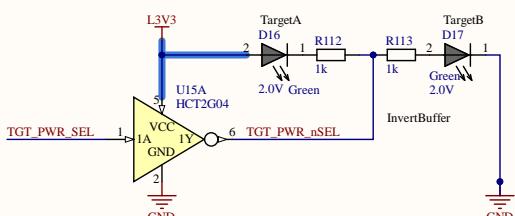
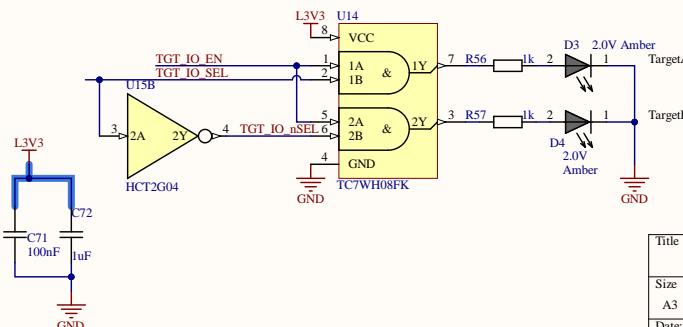
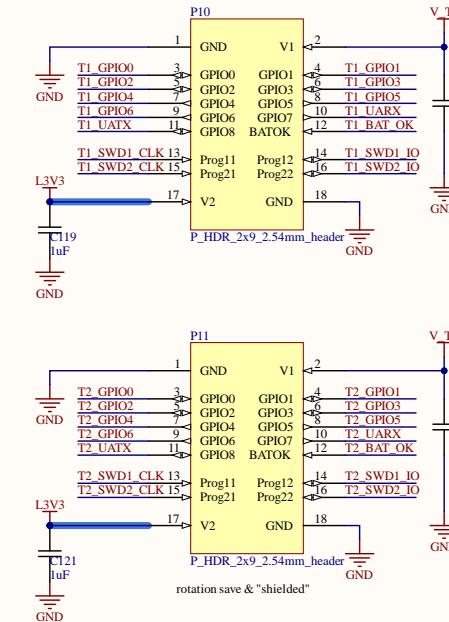
1 2 3 4 5 6

SideA - Pull Ups**Level Translators****SideB - Pull Ups****IO-Voltage - Reverse Routing Switch****IO-Voltage - Buffer**Title Shepherd - Level Translators
NES Lab / TU Dresden

Size	Number	Revision
A3		
Date:	9.23.2022	Sheet of shepherd_v2.PnjPcb
File:	C:\Users\...\LevelTranslators.SchDoc	Drawn By: Ingmar

Signal Switches

SEL Tar1 Tar2
0 VA VB
1 VB VA
only VB has current-tracking
> so SEL=0 enables tracking of Target 1
only VB has current-tracking
> so SEL=1 enables tracking of Target 2

Power Switches**LED-Feedback for PWR-State****LED-Feedback for IO-State****Target Ports**

Programming-Hints:

- Equalize DACs before switching
- unused GPIO should be switched to Input (target and bbone)
- level translators can be switched to other target for low leakage

Leakage Analysis (max per Pin):

NLAS4684	1-2 nA
NXS0101	1 uA
LSF010x	1-5 uA

Max Current:

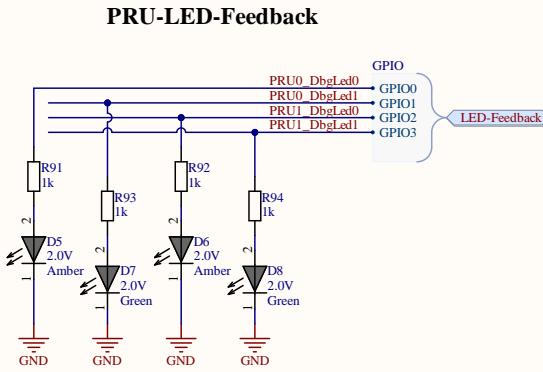
Target Switches	300mA
3V3 (unmonitored)	250mA
V_Target -> OPA#388 VoltageBuffers source	30-60mA, current measurement up to 50mA

Programming Target:

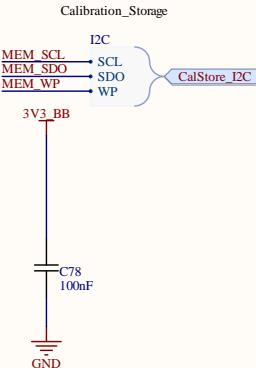
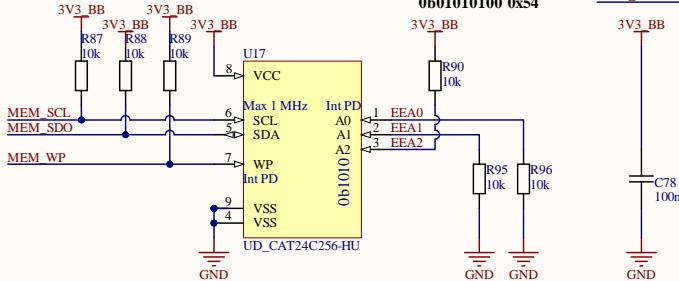
SWD	-> nRF52, STM32L4
SBW	-> MSP430, MSP432, CC430
SBW-TDIO	-TCK (nRST/NMI)

Title Shepherd - Target Interface NES Lab / TU Dresden		
Size A3	Number	Revision
Date: 9.23.2022	Sheet of shepherd_v2.PnjPcb	
File: C:\Users\...\Targets.SchDoc	Drawn By: Ingmar	

A



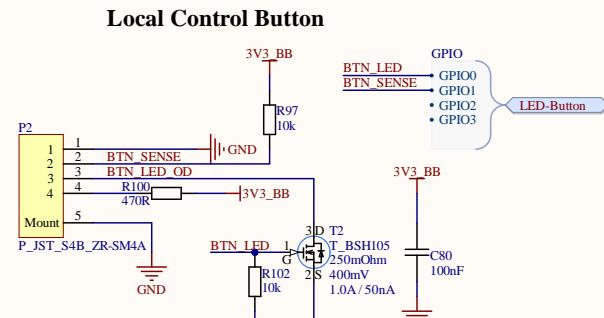
Calibration-EEPROM



TODO:
Separate into smaller Individual Schem

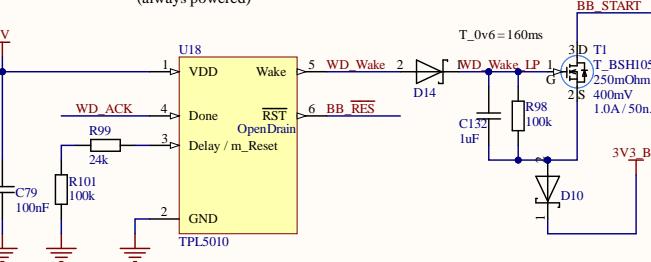
Possible Changes:
- LED Button could be designed with just 3 Leads, or even 2
- One LED per PRU is enough

B



Watchdog

(always powered)



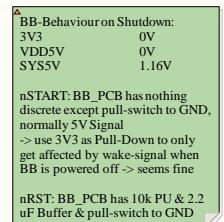
Watchdog - Advantages:
- nodes are in remote rooms, often without access
- Fallback if we can't control POE-Power of ports (most likely)
- with a WD the BB can shut down and be woken up periodically
- routine: BB asks server for tasks, waits or goes to sleep if NOP

TPL5000 Watchdog behaviour:
- time-delay is configured via resistor (100ms .. 2h)
- "wake" is triggered for 31 ms on timer-match => LowPass to 150 ms
- wake only reaches BB if 3V3_BB is at GND-Level (BB Shutdown)
- system has to confirm wake by triggering "done"
- if "done" is not triggered before next "wake" a reset occurs

R_Delay	T_Delay
057 kOhm	10 min
077 kOhm	20 min
092 kOhm	30 min
125 kOhm	60 min
150 kOhm	90 min
170 kOhm	120 min

A RTC (i.e. PCF2129 with Linux-Drivers) with alarm-timer and watchdog would be preferred, but both functions are only triggered ONCE without interaction. So if the BB gets woken but fails to boot then it will never be a reset.

C



to change 60 to 20 min: add a second 100k over first one



Title Shepherd - Misc		Revision
Size	Number	
Date: 9.23.2022		Sheet of shepherd_v2.PriPcb
File: C:\Users\...\Misc.SchDoc		Drawn By: Ingmar

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