Hearing Aid

Power

VDD_1V2D	
VDD_1V8D	
PMIC_ISET	
PMIC_CHGD	
PMIC_ERRD	
BATT_VOLTAGED	

MCU

PMIC_ISET	VDD_1V8C
PMIC_CHG	
PMIC_ERR	CTRL_RESETD
BATT_VOLTAGE	CTRL_IRQD
	CTRL_GPIOD
SPI_SCKD	
SPI_MISOD	
SPI_MOSID	
SPI_CSD	
I2S_MCLKD	
I2S_DOUTD	
I2S_DIND	
I2S_BCLKD	
I2S_FSYNCD	

Audio

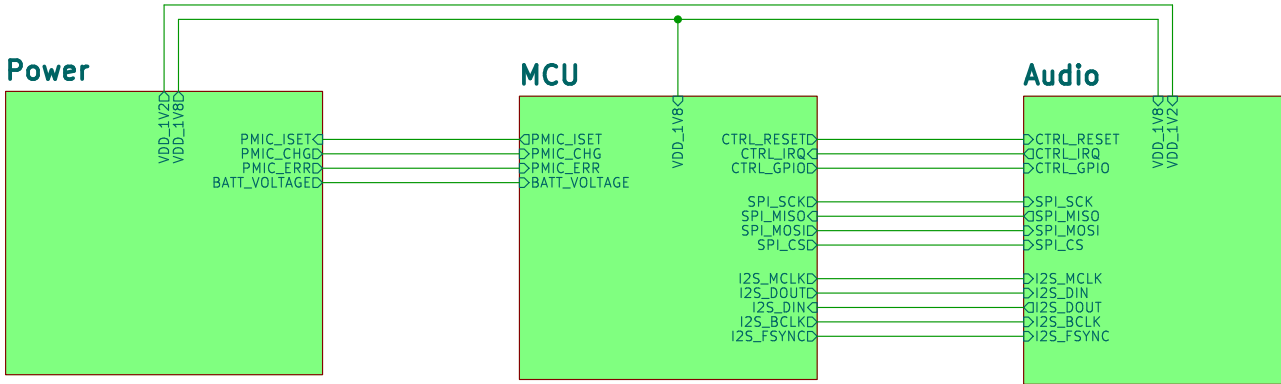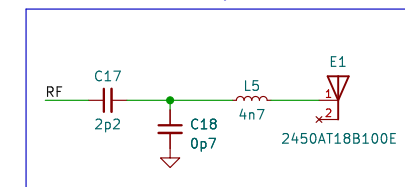|	
CTRL_RESET	VDD_1V8C
CTRL_IRQ	VDD_1V2C
CTRL_GPIO	
SPI_SCK	
SPI_MISO	
SPI_MOSI	
SPI_CS	
I2S_MCLK	
I2S_DIN	
I2S_DOUT	
I2S_BCLK	
I2S_FSYNC	

This device is intended to capture audio from two microphones,
clean up the signal using a dedicated DSP chip and an MCU,
apply compression and send the amplfied mono audio directly
into a hearing aid compatible RIC (receiver in canal / earpiece).
The device runs off a Li-ion battery and can be charged at 5V.
Other features include Bluetooth control and Bluetooth LE Audio.

MCU

nRF5340 Microcontroller

PWR_FLAG +1V8

VDD_1V8▷

+1V8

C1 100n C2 100n C3 100n C4 100n C5 100n C6 100n C7 1u

A3 VDD
D2 VDD
H11 VDD
K1 VDD
L5 VDD
L11 VDD

U1

+1V8

Primary power input

B7 VDD
B6 DCC

L1 10u

C8 1u C9 1u C10 2n2

+1V8

Primary power input

B10 VDD
A9 DCCD

L4 10u

A7 DECD

+1V8

E11 VDD
D11 DCCH
B12 VDDH
B11 VBUS

No capacitor used because VDDH not used

C11 DECUSB
B5 DECN
B8 DECA

C15 100n C16 1u

B4 DECR
B1 DECRF

NRF5340-CLAA-R

XC2 A2 XC2
XC1 A1 XC1
ANT D1 ANT

Y1 32Mhz

L2 2n2   L3 2n2   RF

C11 0p7   C12 N.C.

nRESET G2 RESET
SWDCLK F2 SWDCLK
SWDIO F1 SWDIO

D− A11
D+ A12

P0.00/XL1 F11
P0.01/XL2 F12
P0.02/NFC1 G11 BUTTON1
P0.03/NFC2 H12 BUTTON2
P0.04/AIN0 G10 BUTTON3
P0.05/AIN1 F10 BATT_VOLTAGE ▷BATT_VOLTAGE
P0.06/AIN2 H10
P0.07/AIN3 J10   5.5V scaled to 1.8V for ADC

P0.08/TRACEDATA3/SCK L12 SPI_MISO ▷SPI_MISO
P0.09/TRACEDATA2/MOSI J9 SPI_MOSI ▷SPI_MOSI
P0.10/TRACEDATA1/MISO J8 SPI_SCK ▷SPI_SCK
P0.11/TRACEDATA0/CSN J7 SWO
P0.12/TRACECLK/DCX J6 I2S_MCLK ▷I2S_MCLK
P0.13/I00 K10 I2S_DOUT ▷I2S_DOUT
P0.14/I01 K9 I2S_BCLK ▷I2S_BCLK
P0.15/I02 L9 I2S_DIN ◁I2S_DIN
P0.16/I03 K8 I2S_FSYNC ▷I2S_FSYNC
P0.17/SCK L7 SPI_CS ▷SPI_CS
P0.18/CSN K7 CTRL_RESET ◁CTRL_RESET
P0.19 J5 CTRL_IRQ ◁CTRL_IRQ
P0.20 K5 CTRL_GPIO ◁CTRL_GPIO
P0.21 J4 PMIC_ERR ◁PMIC_ERR
P0.22 K4 PMIC_CHG ◁PMIC_CHG
P0.23 H3 PMIC_ISET ◁PMIC_ISET
P0.24 K2

D10 P1.00
E10 P1.01
J11 P1.02/I2C
K12 P1.03/I2C
K3 P1.04
L3 P1.05
J3 P1.06
G3 P1.07
F3 P1.08
H2 P1.09
E4 P1.10
C6 P1.11
C7 P1.12
C8 P1.13
C9 P1.14
C10 P1.15

P0.25/AIN4 L1
P0.26/AIN5 J2
P0.27/AIN6 H1
P0.28/AIN7 E3
P0.29 E2
P0.30 C4
P0.31 C5

C13 1u

C14 1u

VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS VSS AVSS AVSS AVSS
D12 A5 B2 B9 C2 E5 E6 E7 E8 F5 F6 F7 F8 G6 G7 G8 G5 K11 K6

Bluetooth Chip Antenna

RF   C17 2p2   L5 4n7   E1

C18 0p7

2450AT18B100E

User Buttons

BUTTON1   SW1   Volume Up

BUTTON2   SW2   Volume Down

BUTTON3   SW3   Power / Misc.

Debug Interface

+1V8   VTref (VCC pin) used for sensing the VDD voltage, not for powering the board

J1

1 VCC
RESET   3 RESET
SWCLK   4 SWDCLK
SWDIO   2 SWDIO
SWO   6 SWO

C19 100n

5 GND

TC2030-NL

Audio

Headphone Out

J2
1 — HEADPHONE_OUTP
2 — HEADPHONE_OUTN

Conn_01x02_Pin

D1 PESD5V0V1BDSF
D2 PESD5V0V1BDSF
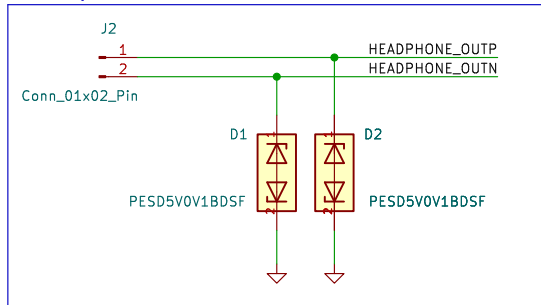
ESD protection diodes

PDM Digital Microphones

U2 IM69D130_PDM
MIC_PDM_POWER — 2 VDD
C20 100n
4 SELECT
5 GND
DATA 1 — MIC_PDM_DATA
CLOCK 3 — MIC_PDM_CLOCK
R1 100

U3 IM69D130_PDM
MIC_PDM_POWER — 2 VDD
C21 100n
4 SELECT
5 GND
DATA 1 — MIC_PDM_DATA
CLOCK 3 — MIC_PDM_CLOCK
R2 100
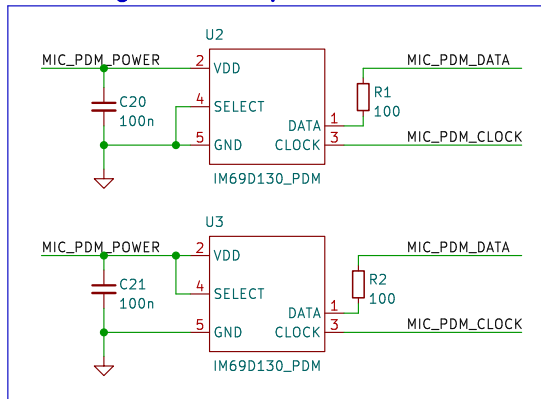
One mic is configured to output on left channel
and other on right via SELECT pin config.
This way they can share the same stereo stream

Digital Signal Processor (DSP)

VDD_1V2 — VDD_1V8

Audio Core Voltage

GPIO, Microphone and Analog Voltage

C22 1u   C23 1u   C24 100n   C25 1u

U4 CS47L63-CWZR

VDD_D (G1, L7), VDD_A (A11), VDD_IO (L3), VDD_LDO (D10)

A9 OUTP — HEADPHONE_OUTP
B8 OUTN — HEADPHONE_OUTN

Headphone out
can drive a
32 ohm load

R3 22   R4 22
C26 200n   C27 200n

D4 IN1LP_1
C5 IN1LN_1
E5 IN1LP_2
E3 IN1LN_2
A5 IN1RP
B4 IN1RN
C3 IN2LP
D2 IN2LN
B2 IN2RP
A3 IN2RN

MIC_PDM_DATA — E1 IN1_PDMDATA
MIC_PDM_CLOCK — F4 IN1_PDMCLK
MIC_PDM_POWER — B6 MICBIAS1B
A1 IN2_PDMDATA
C1 IN2_PDMCLK
A7 MICBIAS1C
D6 MICBIAS1A

MIC_PDM_POWER is cleaner
than input supply

D8 VREF1_FILT
C11 VREF2_FILT
C7 LDO_FILT

G11 SPI1_MISO/I2C1_SCL — SPI_MISO
G9 SPI1_MOSI/I2C1_SDA — SPI_MOSI
H10 SPI1_SCK — SPI_SCK
H8 SPI1_SS — SPI_CS
J1 SPI2_MISO/I2C2_SCL/GPIO11
H4 SPI2_MOSI/I2C2_SDA/GPIO12
H2 SPI2_SCK/GPIO10
G3 SPI2_SS/GPIO9 — CTRL_GPIO

VDD_1V8
R5 100k

F10 IRQ — CTRL_IRQ
F8 RESET — CTRL_RESET
L9 MCLK1 — I2S_MCLK
L5 MCLK2
J7 AS1_DOUT/GPIO1 — I2S_DOUT
J9 ASP1_DIN/GPIO2 — I2S_DIN
K10 ASP1_BCLK/GPIO3N — I2S_BCLK
J11 ASP1_FSYNC/GPIO4 — I2S_FSYNC
J5 ASP2_DOUT/GPIO5
J3 ASP2_DIN/GPIO6
K2 ASP2_BCLK/GPIO7
K6 ASP2_FSYNC/GPIO8

GND_A (B10, C9), GND_D (F2, K4, K8, E7), GND_SUB

NC (E9, E11, F6, G5, G7, H6, L1, L11)

C28 2u2   C29 10u

SPI is used for the control
interface to setup the audio

CTRL is used for interrupting
the MCU, resetting the DSP
and voltage negotiation

I2S is used for full duplex
digital audio streaming

Yote
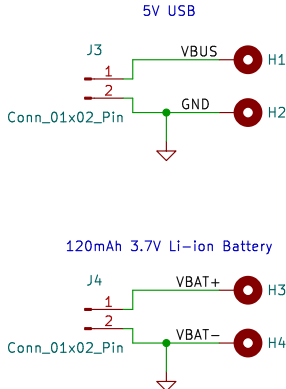Sheet: /Audio/
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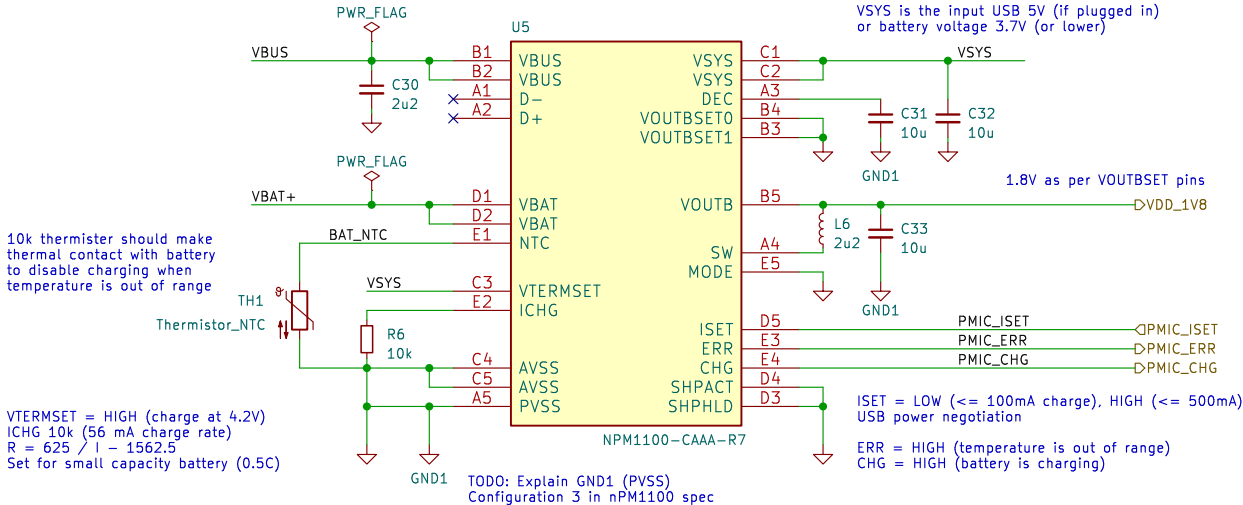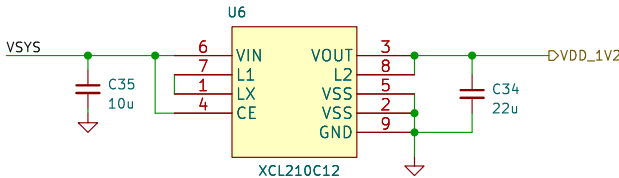KiCad E.D.A. kicad 7.0.1-3b83917a11~172~ubuntu20.04.1   Id: 3/4
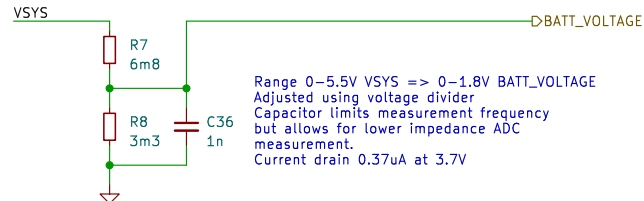
Power Supply

Power Connectors

5V USB

J3
1
2
Conn_01x02_Pin

VBUS — H1
GND — H2

120mAh 3.7V Li-ion Battery

J4
1
2
Conn_01x02_Pin

VBAT+ — H3
VBAT− — H4

Battery Charger and 1.8V Converter

PWR_FLAG

VBUS

C30
2u2

U5

B1	VBUS	VSYS	C1
B2	VBUS	VSYS	C2
A1	D−	DEC	A3
A2	D+	VOUTBSET0	B4
		VOUTBSET1	B3

VSYS is the input USB 5V (if plugged in)
or battery voltage 3.7V (or lower)

VSYS

C31 10u   C32 10u

GND1

PWR_FLAG

VBAT+

D1	VBAT	VOUTB	B5
D2	VBAT		
E1	NTC	SW	A4
		MODE	E5

1.8V as per VOUTBSET pins

VDD_1V8

L6 2u2   C33 10u

GND1

10k thermister should make
thermal contact with battery
to disable charging when
temperature is out of range

BAT_NTC

TH1
Thermistor_NTC

VSYS

| C3 | VTERMSET |
| E2 | ICHG |

R6
10k

C4	AVSS	ISET	D5
C5	AVSS	ERR	E3
A5	PVSS	CHG	E4
		SHPACT	D4
		SHPHLD	D3

NPM1100−CAAA−R7

PMIC_ISET — PMIC_ISET
PMIC_ERR — PMIC_ERR
PMIC_CHG — PMIC_CHG

VTERMSET = HIGH (charge at 4.2V)
ICHG 10k (56 mA charge rate)
R = 625 / I − 1562.5
Set for small capacity battery (0.5C)

GND1

TODO: Explain GND1 (PVSS)
Configuration 3 in nPM1100 spec

ISET = LOW (<= 100mA charge), HIGH (<= 500mA)
USB power negotiation

ERR = HIGH (temperature is out of range)
CHG = HIGH (battery is charging)

1.2V DC/DC Converter

VSYS

C35
10u

U6

6	VIN	VOUT	3
7	L1		8
1	LX	VSS	5
4	CE	VSS	2
		GND	9

VDD_1V2

C34
22u

XCL210C12

Battery Voltage Measurement

VSYS

R7
6m8

BATT_VOLTAGE

R8
3m3

C36
1n

Range 0−5.5V VSYS => 0−1.8V BATT_VOLTAGE
Adjusted using voltage divider
Capacitor limits measurement frequency
but allows for lower impedance ADC
measurement.
Current drain 0.37uA at 3.7V