EmCraft System On Module

NXP i.MX 8M Quad Applications Processor with DDR4 LPRAM and eMMC
Connectors: 4x dual row 80 pin 0.4mm pitch headers (P1..P4)

Note:
Leave annotation
as P1, P2, P3, P4

Note:
Some I2C devices
require SDA/SCL
to be high before
powering them

3V3_OUT is sourced
from PMIC's 3A NVCC_3P3/
BUCK6 and is supplying the
SoC's H7 ball "NVCC_I2C"

Alternate
Functions:
CAPTOUCH_RST
SAI6_TXD0
SAI6_TXFS/RXFS
SAI6_TXC/RXC
SAI6_RXD0

Spare GPIO:
GPIO1_IO05 (was CSI_P2_PWDN)
GPIO5_IO18 (PWM4/CLKO2/I2C3_SCL)

GPIO that can be swapped around:
GPIO1_IO05 (was CSI_P2_PWDN)
GPIO1_IO12 (was IR_CAP)
GPIO3_IO19 (was LED1)
GPIO3_IO20
GPIO3_IO25
GPIO5_IO03 (was PWM3)
GPIO5_IO04 (was PWM2)
GPIO5_IO05 (was PWM1)
GPIO5_IO18 (PWM4/CLKO2/I2C3_SCL)

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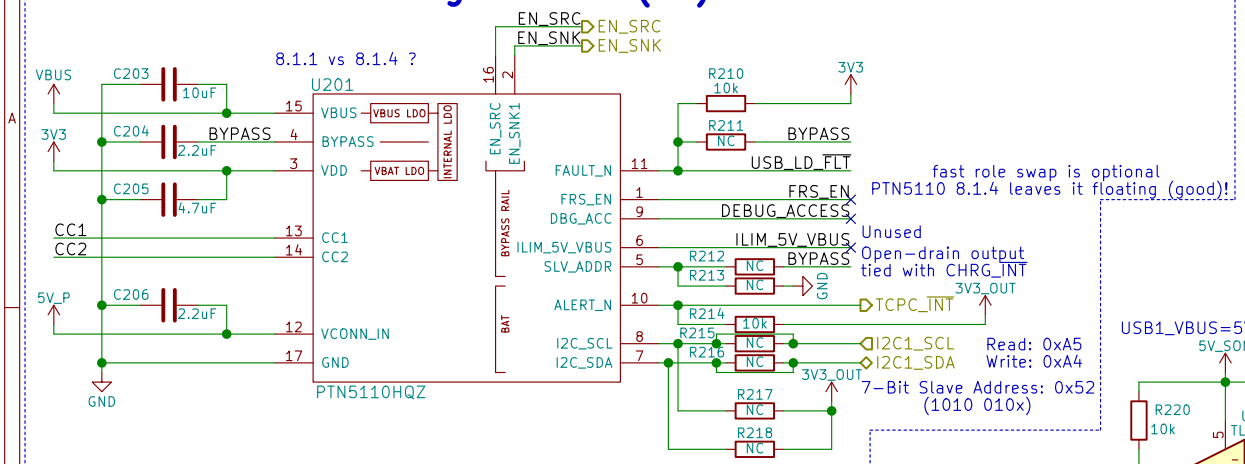
Sheet: /
File: dvk-mx8m-bsb.sch

Title: Librem 5 Dev Kit

Size: A3	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 1/24

USB-C TCPC – Config Channel (CC) and PD Role Controller



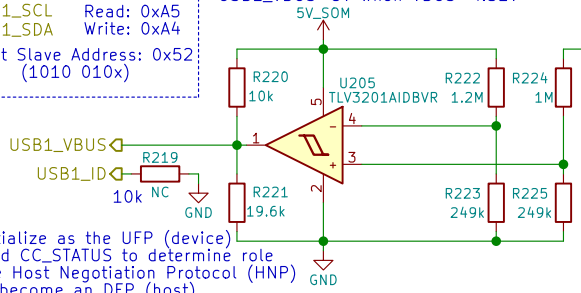
fast role swap is optional
PTN5110 8.1.4 leaves it floating (good)!

Unused

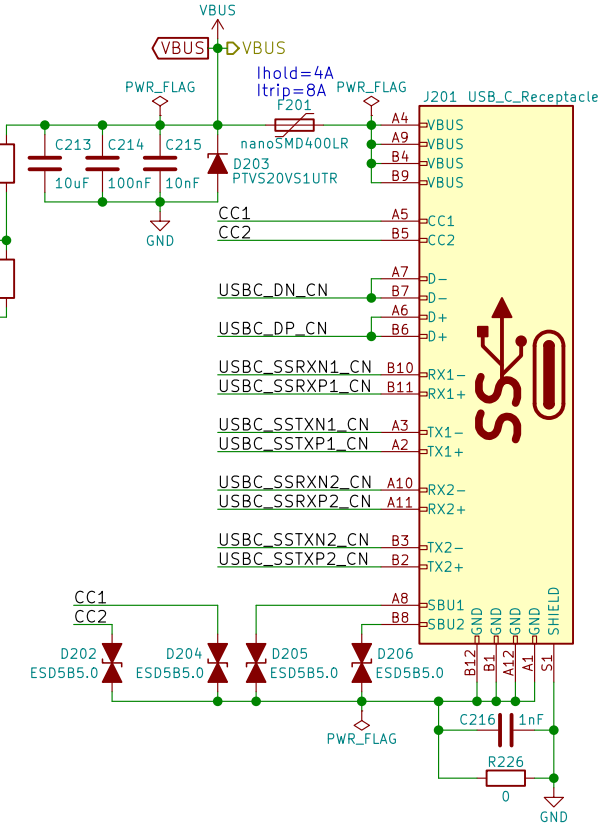
Open-drain output
tied with CHRG_INT

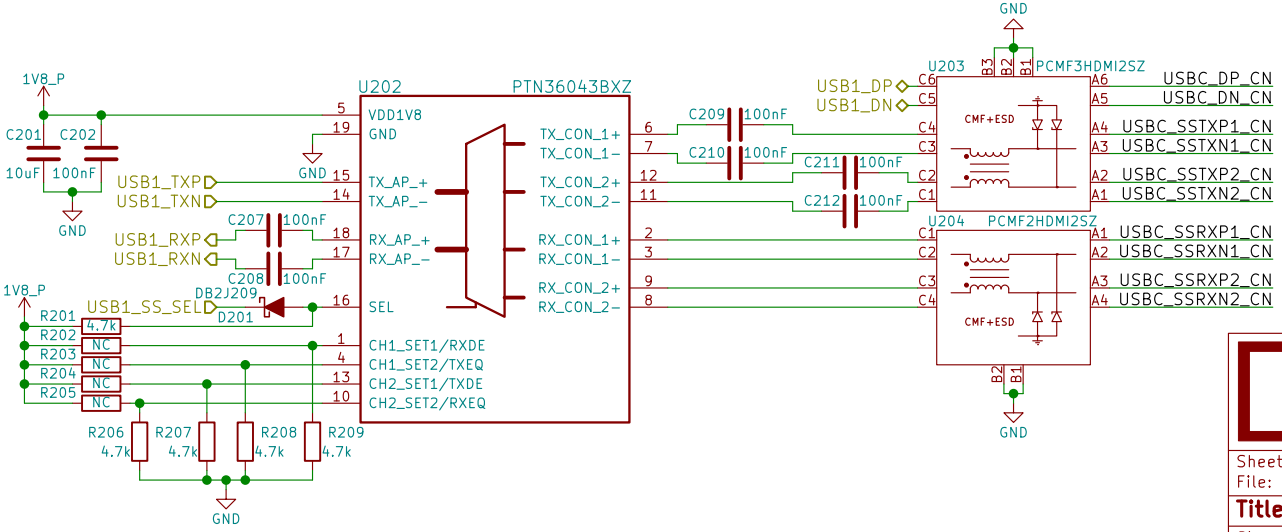
Read: 0xA5
Write: 0xA4
7-Bit Slave Address: 0x52
(1010 010x)

"Under dead battery operation, PTN5110 applies voltage clamps to both CC pins so that the system may receive power as a Sink. To support platforms with buck-boost configuration, PTN5110 asserts EN_SNK1 pin based on validity of VBUS voltage (facilitates 5 V VBUS sinking)."



Initialize as the UFP (device)
read CC_STATUS to determine role
use Host Negotiation Protocol (HNP)
to become an DFP (host)
∴USB ID is effectively unused
⇒Legacy devices would "wait" for this
⇒If CC initializes as UFP then no HNP needed





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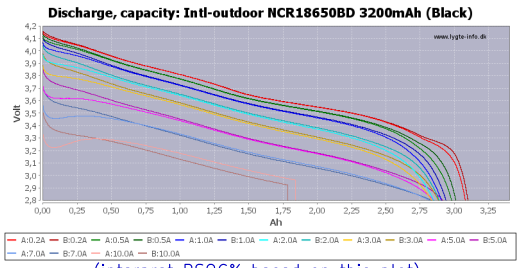
Purism

Sheet: /USB-C/
File: usb-c.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 2/24

Battery Charge Controller



(interpret RSOC% based on this plot)

Drawing ~333.33mA, or consuming <1.2W, should give close to 10 hours going from 100% to 0% charge

use AUTO_DPDM_EN to auto-detect IINLIM

1.658≤ILIM≤2.063
ILIM(nom)≅1.859A
3.9≤VIN≤14

7-bit Slave Address: 0x6B (1101 011x)

U301 BQ25896

I(Lsat)=7A

Default LOW: adapter source

sink current ~5mA

Read: 0xD7
Write: 0xD6

Ihold=3.5A
Itrip=6.3A
Ttrip(max)=5s@8A

Vrwm(max)=5.0V
Vbr(min)=6.2V
Pd=150mW

Vf(max)=1.1V

3.5~4.25V

~110uF

0.18mA~0.95mA

VBAT(DPL)=2.15~2.5V

NCR18650B meets requirements

VBAT(ovp_default)=REG06[7:2]=4.208V (reduce to 4.192V [010110])
Worst Case:
VBAT(default_max_ovp)=(REG06[7:2]×1.005)×1.04=4.3982016V
BQ29705 provides 4.425V as OVP!

ICHG(default)=REG[6:0]=2048mA (reduce to ~1.6A [0011001])

reference design: http://www.ti.com/lit/ug/sluuba2b/sluuba2b.pdf

may want to include BQ29705 protection as in:
http://www.ti.com/lit/ug/tiducl1/tiducl1.pdf
schematic: http://www.ti.com/lit/df/tidrp70/tidrp70.pdf
(PTC may be good enough)

This disables charging
but maybe not VBUS->VOUT
if PTN5110HQ's FAULT_STATUS[6]==1
(Force Off VBUS bit) then set EN_HiZ=1
EN_HiZ may be auto-set when in hiccup

Reading PTN5110HQ's CC_STATUS and POWER_STATUS registers will tell TCPM (i.MX8M) when to set EN_HiZ

Also, reading PTN5110HQ's CC_STATUS and POWER_STATUS registers will tell TCPM (i.MX8M) when to set OTG_CONFIG=1
(this will also happen when PTN5110HQ sets EN_SRC HIGH)

BC1.2 is not mandated by PD spec
ICO used to determine max current
Also negotiated from CC pins (I2C)

Battery holder gives ~1mm clearance underneath the battery
Thermistor is 1.1±0.15mm thick, should fit fine with stack-up

Battery holder seems to fit up to ~68.88mm long batteries
need to test 18650 protected cells which are ~69.35mm long

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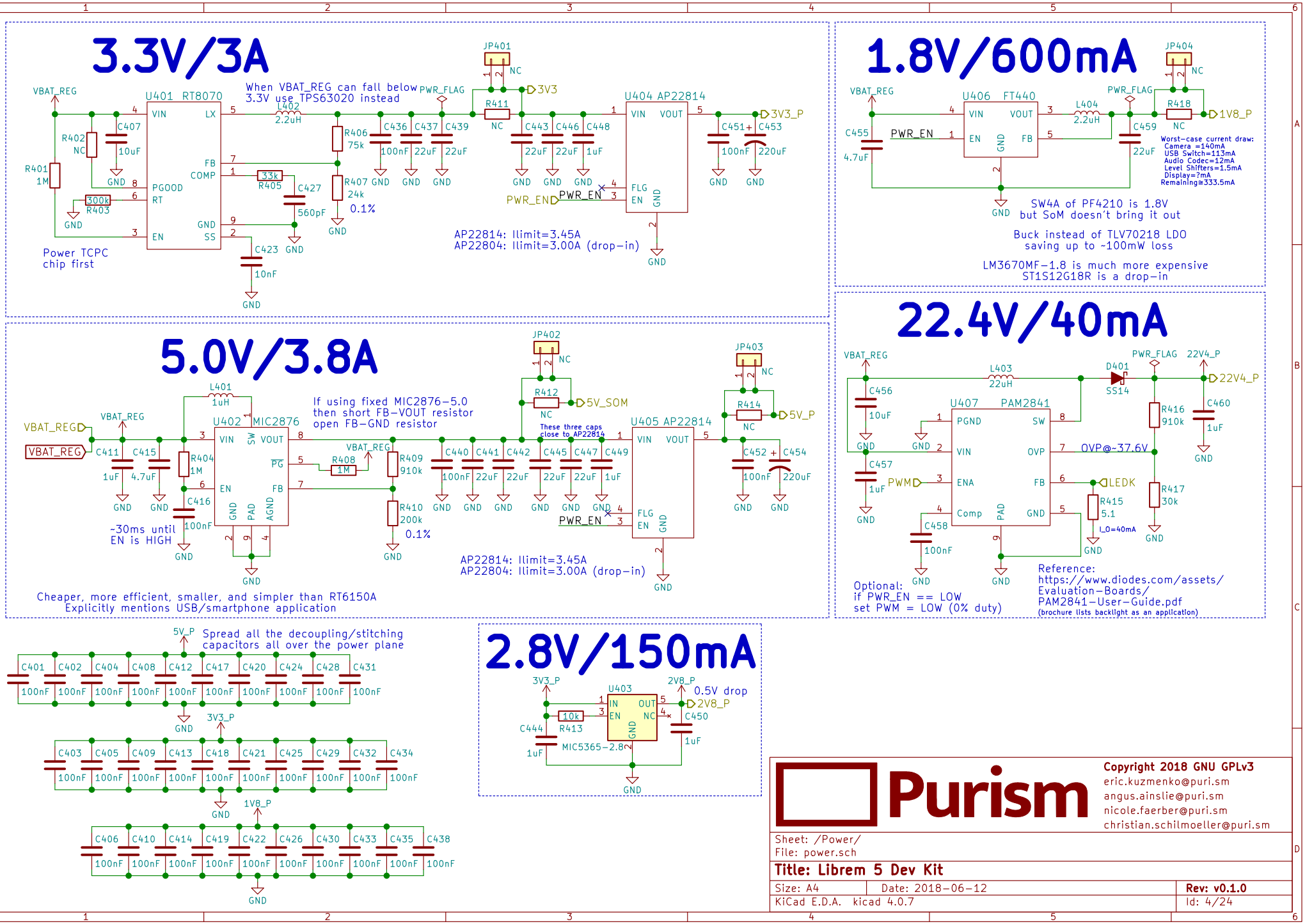
Sheet: /Battery/
File: battery.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 3/24


3.3V/3A
When VBAT_REG can fall below 3.3V use TPS63020 instead
Power TCPC chip first
AP22814: Ilimit=3.45A
AP22804: Ilimit=3.00A (drop-in)
1.8V/600mA
SW4A of PF4210 is 1.8V but SoM doesn't bring it out
Buck instead of TLV70218 LDO saving up to ~100mW loss
LM3670MF-1.8 is much more expensive
ST1S12G18R is a drop-in
Worst-case current draw:
Camera =140mA
USB Switch=113mA
Audio Codec=12mA
Level Shifters=1.5mA
Display=7mA
Remaining≥333.5mA
5.0V/3.8A
If using fixed MIC2876-5.0 then short FB-VOUT resistor open FB-GND resistor
~30ms until EN is HIGH
Cheaper, more efficient, smaller, and simpler than RT6150A
Explicitly mentions USB/smartphone application
AP22814: Ilimit=3.45A
AP22804: Ilimit=3.00A (drop-in)
22.4V/40mA
Optional: if PWR_EN == LOW set PWM = LOW (0% duty)
Reference: https://www.diodes.com/assets/Evaluation-Boards/PAM2841-User-Guide.pdf
(brochure lists backlight as an application)
Spread all the decoupling/stitching capacitors all over the power plane
2.8V/150mA
0.5V drop
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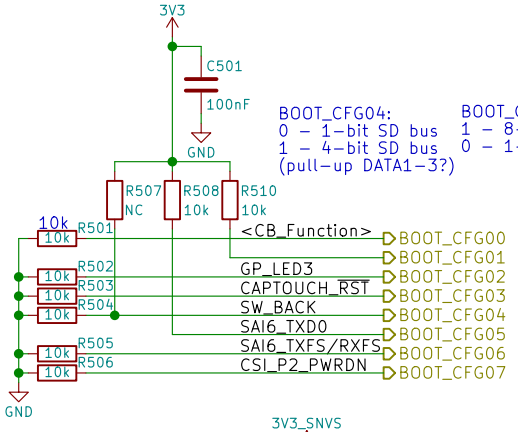
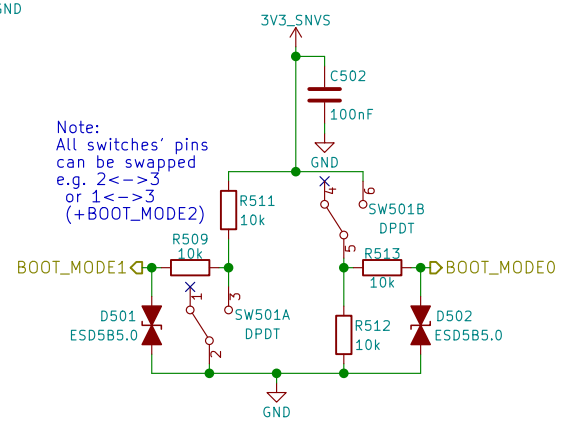
Sheet: /Power/
File: power.sch
Title: Librem 5 Dev Kit
Size: A4
Date: 2018-06-12
Rev: v0.1.0
KiCad E.D.A. kicad 4.0.7
Id: 4/24





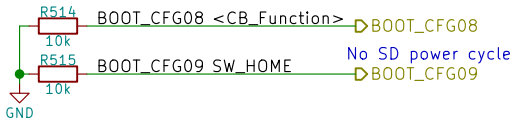
2–>1: eMMC
2–>3: USB (Serial Downloader)

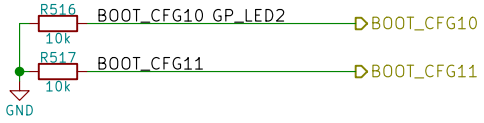
BOOT_MODE[1:0]	Boot Type
00	Boot From Fuses
01	Serial Downloader
10	Internal Boot
11	Reserved

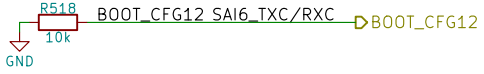
Only eMMC

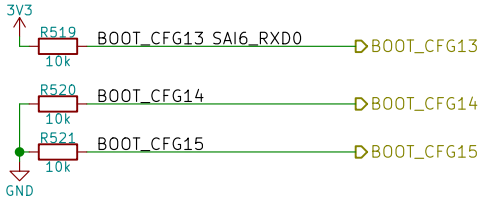
BOOT_CFG[14:12]	Boot device
001	SD/eSD
010	MMC/eMMC
011	NAND

Fuse	Config	Definition	GPIO[1]	Shipped value	Settings
BOOT_CFG[11:10]	OEM	USDHC port selection	Yes	00	00 - USDHC-1 01 - USDHC-2 10 - USDHC-3 else - reserved









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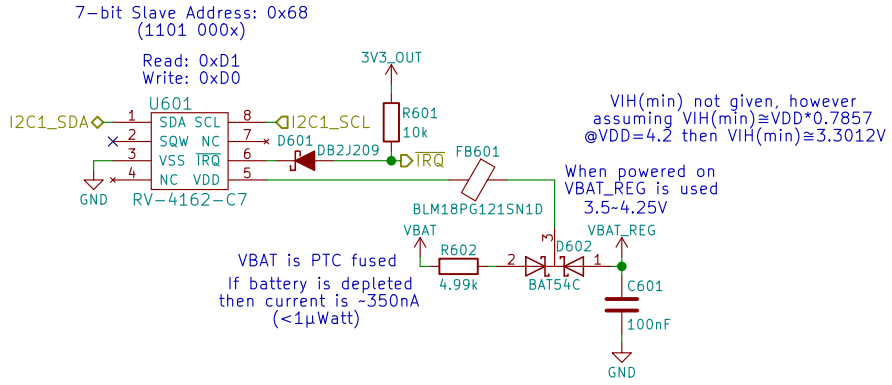
Sheet: /Boot Config/
File: boot.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018–06–12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 5/24



Note:
Datasheet says slave address is 0xD0
with a R/W bit appended, since 0xD must
be 4-bits wide the actual 7-bit address is
0x68 (110 1000), and becomes 0xD0 during a
write operation (1101 0000)

Reference:
https://github.com/HIO-Project/linux-imx6-nano-imx_3.10.17_1.0.1_ga/
blob/8848e94b2f889fe44f6736e2d4c98851a2282275/arch/arm/boot/dts/
imx6qdl-mtp.dtsi#L351

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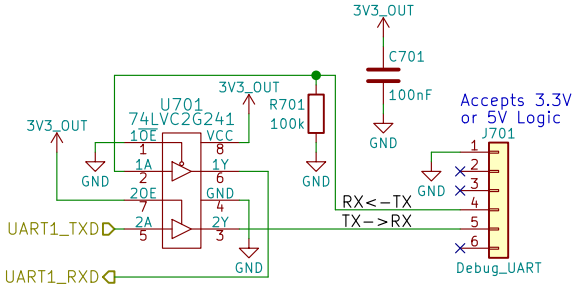
Sheet: /RTC/
File: rtc.sch

Title: Librem 5 Dev Kit

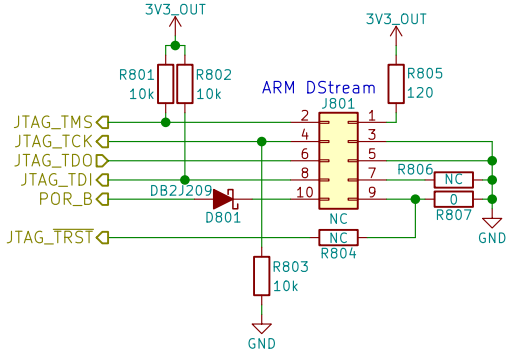
Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 6/24



Sheet: /UART Debug/
File: uart.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 7/24



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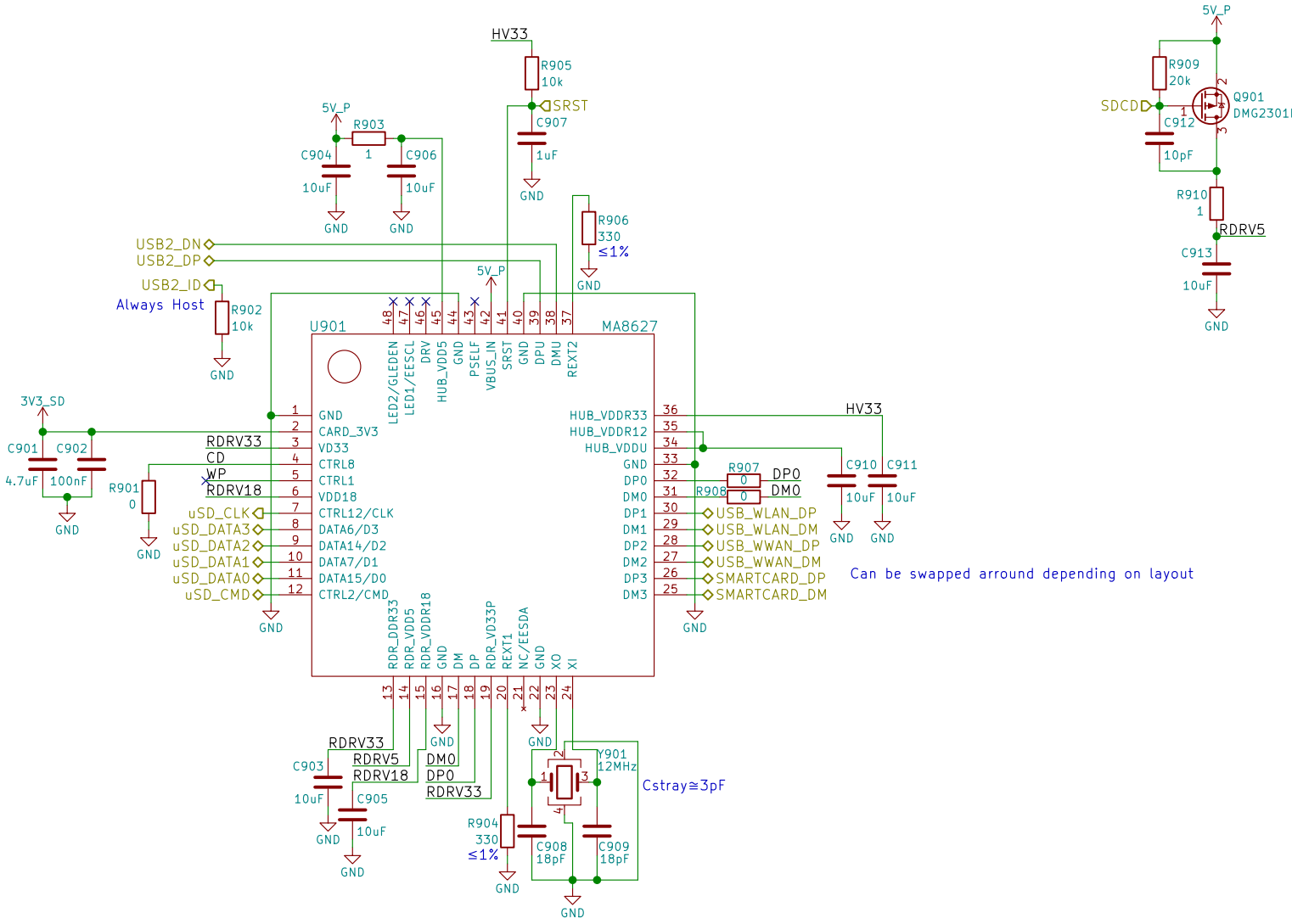
Sheet: /JTAG/
File: jtag.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 8/24



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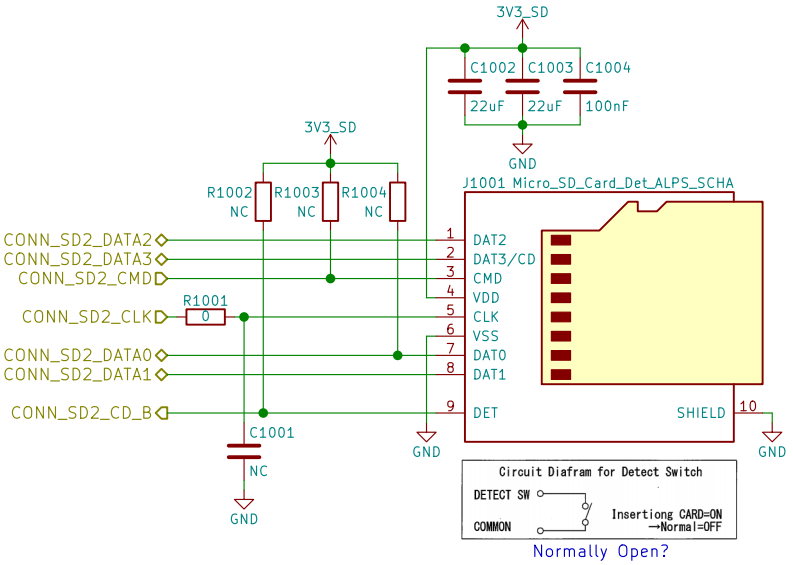
Sheet: /USB Hub + SDIO Bridge/
File: usb_hub_sdio.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 9/24



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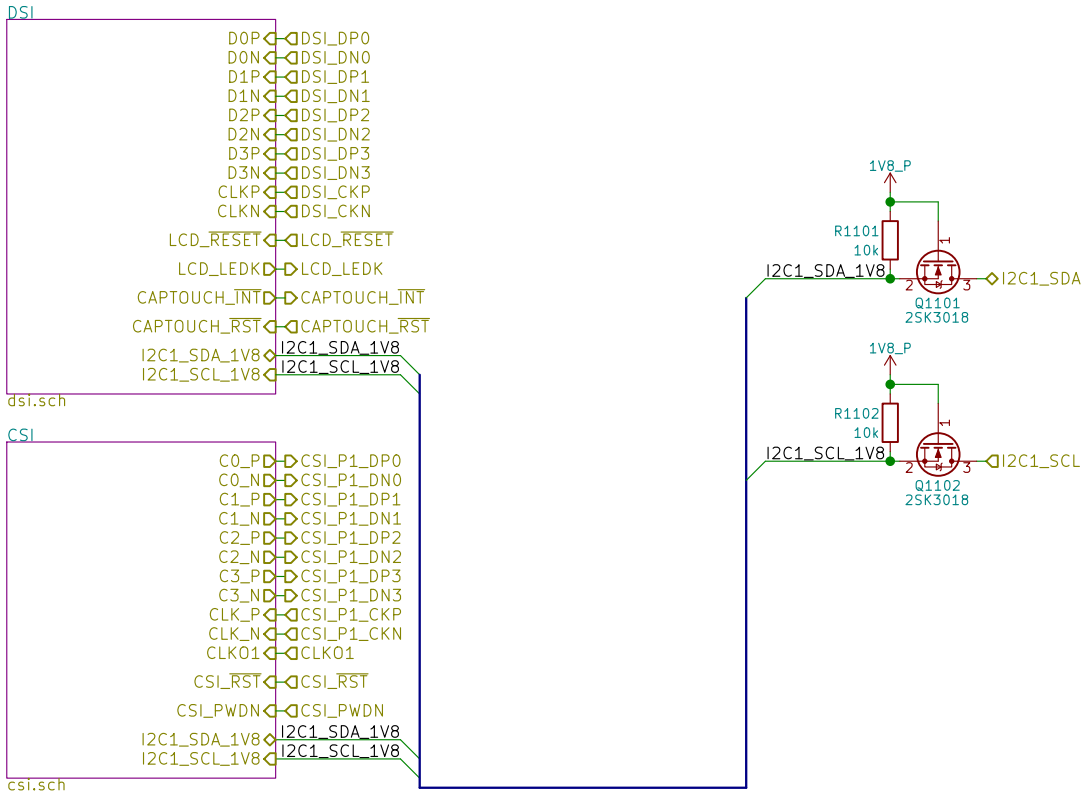
Sheet: /uSD Card/
File: sd.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 10/24



Purism

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Sheet: /MIPI/
File: mipi.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 11/24

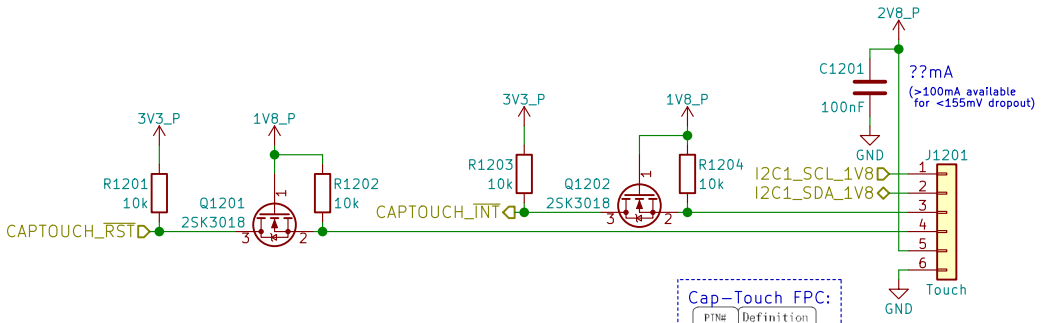
LCD PN:
Shenzhen Jinghong Electronics Co., Ltd.
JH057N00900

Note:
No power-up sequence is given in the spec sheet

7-bit Slave Address: 0x5D
(1011 101x)

Read: 0xBB
Write: 0xBA

Cap-Touch Controller IC PN:
Goodix GT5688



Cap-Touch FPC:

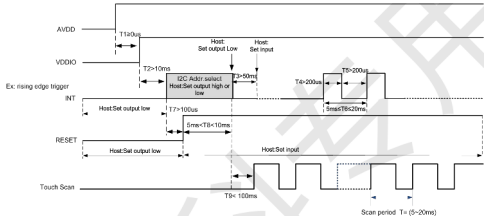
PIN#	Definition
1	SCL
2	SDA
3	INT
4	RESET
5	VDD2.85
6	GND

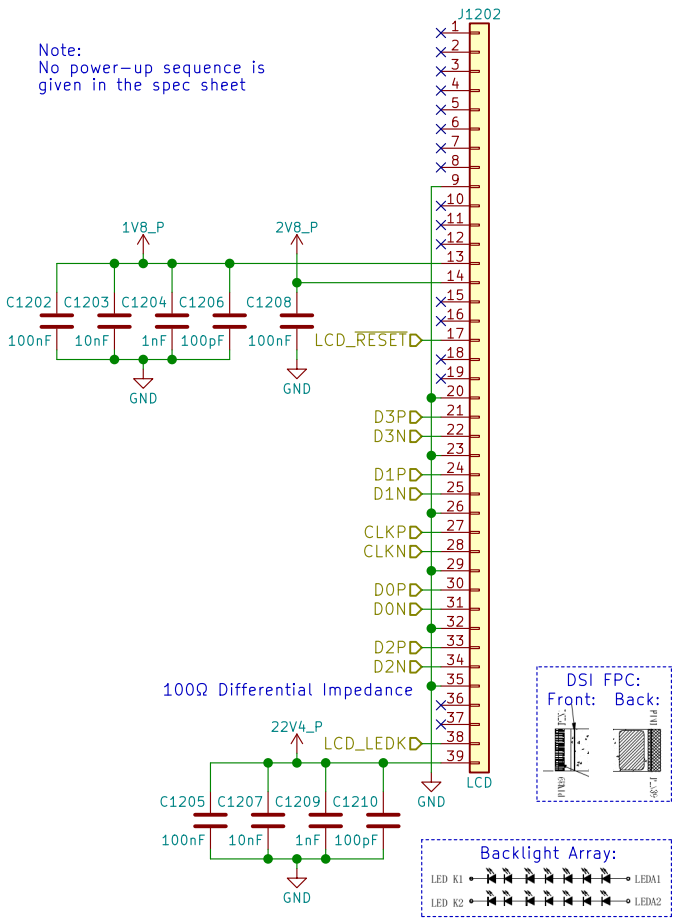
Front: Back:

The upper 7 bits are the address,
and bit 0 is used to select read or write.
GT5688 has two slave device addresses to choose from:

INT	7-Bit Address	8-Bit Write Address	8-Bit Read Address
LOW	0x5D	0xBA	0xBB
HIGH	0x14	0x28	0x29

Every time you power on or reset, you need to use the INT pin to set the I2C address:





DSI FPC:
Front: Back:

Backlight Array:

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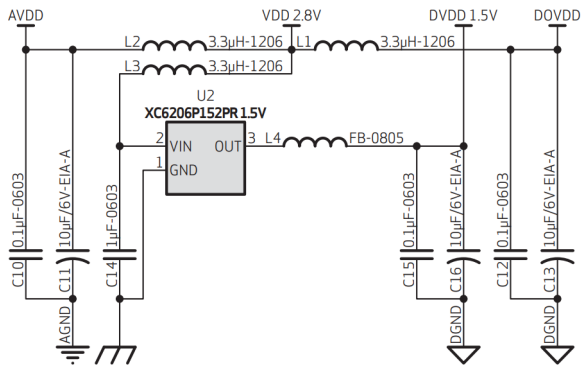
Purism

Sheet: /MIPI/DSI/
File: dsi.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 12/24

Using Internal DVDD 1.5V Regulator:



2.7 POWER UP SEQUENCE

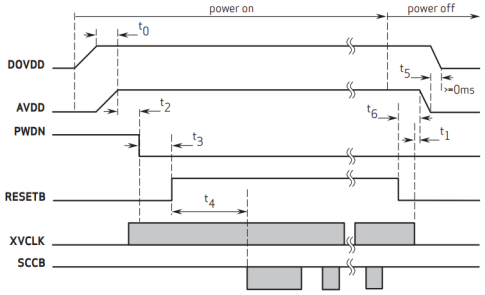
Based on the system power configuration (1.8V or 2.8V for I/O power, using external DVDD or internal DVDD, requiring access to the I2C during power up period or not), the power up sequence will differ. If 1.8V is used for I/O power, using the internal DVDD is preferred. If 2.8V is used for I/O power, due to a high voltage drop at the internal DVDD regulator, there is a potential heat issue. Hence, for a 2.8V power system, OmniVision recommends using an external DVDD source. Due to the higher power down current when using an external DVDD source, OmniVision strongly recommends cutting off all powers, including the external DVDD, when the sensor is not in use in the case of 2.8V I/O and external DVDD.

2.7.1 POWER UP WITH INTERNAL DVDD

For powering up with the internal DVDD and I2C access during the power ON period, the following conditions must occur:

1. when DOVDD and AVDD are turned ON, make sure DOVDD becomes stable before AVDD becomes stable
2. PWDN is active high with an asynchronized design (does not need clock)
3. PWDN pin tied to digital ground if it is not controlled.
4. if PWDN pin is controlled as below, for PWDN to go low, power must first become stable (AVDD to PWDN ≥ 5 ms)
5. RESETB is active low with an asynchronized design
6. master clock XVCLK should provide at least 1 ms before host accesses the sensor's registers
7. host can access I2C bus (if shared) during entire period. 20ms after RESETB goes high, host can access the sensor's registers to initialize sensor

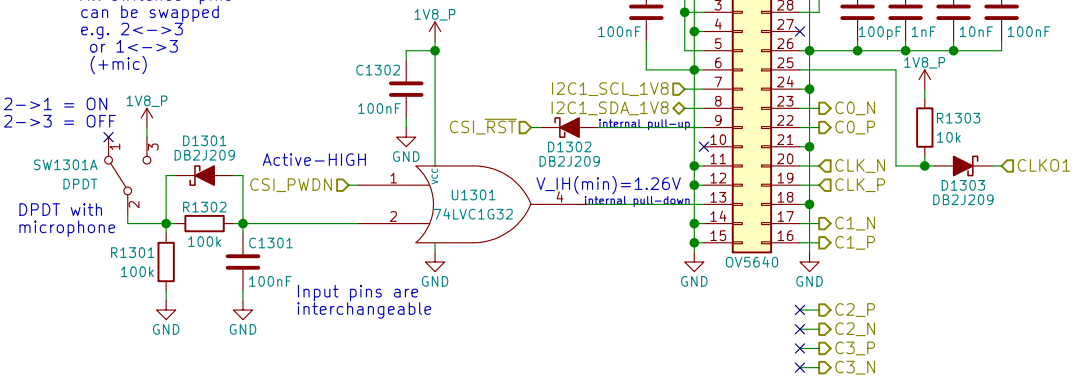
figure 2-3 power up timing with internal DVDD



note
- t_0 ≥ 0ms, delay from DOVDD stable to AVDD stable, it is recommended to power up AVDD shortly after DOVDD has been powered up
- t_1 ≥ 0ms, delay from XVCLK off to AVDD off
- t_2 ≥ 5ms, delay from AVDD stable to sensor power up stable, PWDN can be pulled low after this point, XVCLK can be turned on after power on
- t_3 ≥ 1ms, delay from sensor power up stable to RESETB pull up
- t_4 ≥ 20ms, delay from RESETB pull high to SCCB initialization
- t_5 ≥ 0ms, delay from AVDD off to DOVDD off
- t_6 ≥ 0ms, delay from RESETB pull low to AVDD off

S640_DS_2_2

Note:
All switches' pins can be swapped
e.g. 2<->3
or 1<->3
(+mic)



Camera PN:
Truly CO8725-B5SA-E

7-bit Slave Address: 0x78
(1111 000x)

Read: 0xF1
Write 0xF0

OV5640 CMOS Image Sensor Datasheet:
https://cdn.sparkfun.com/datasheets/Sensors/LightImaging/OV5640_datasheet.pdf

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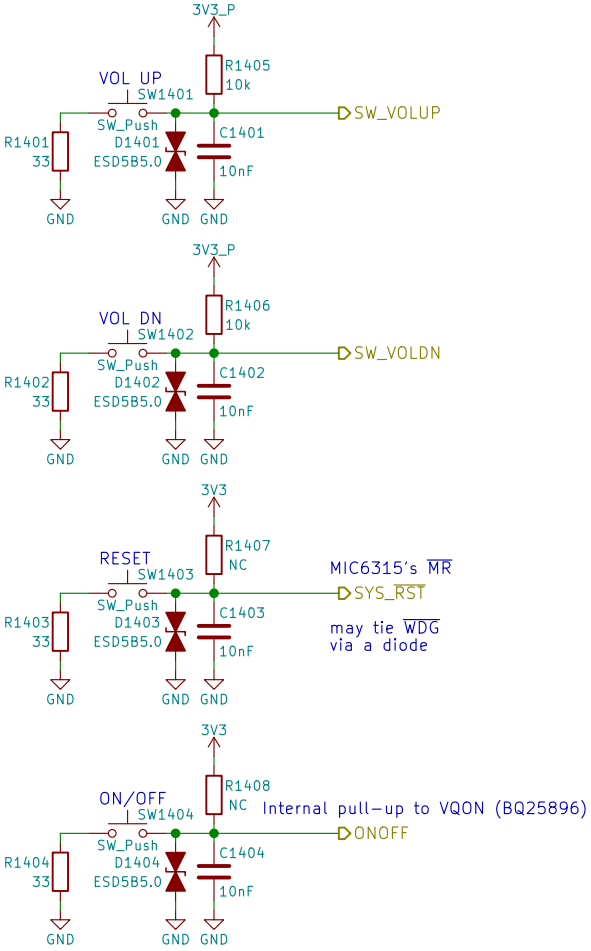
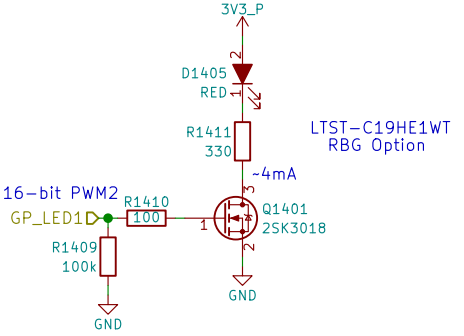
Sheet: /MIPI/CSI/
File: csi.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 13/24



Use PWM2_PWMSAR to set the compare value (duty cycle)
Use PWM2_PWMCR[15:4] to set the PRESCALER (frequency)
Use PWM2_PWMPR to set the top of the counter (frequency)



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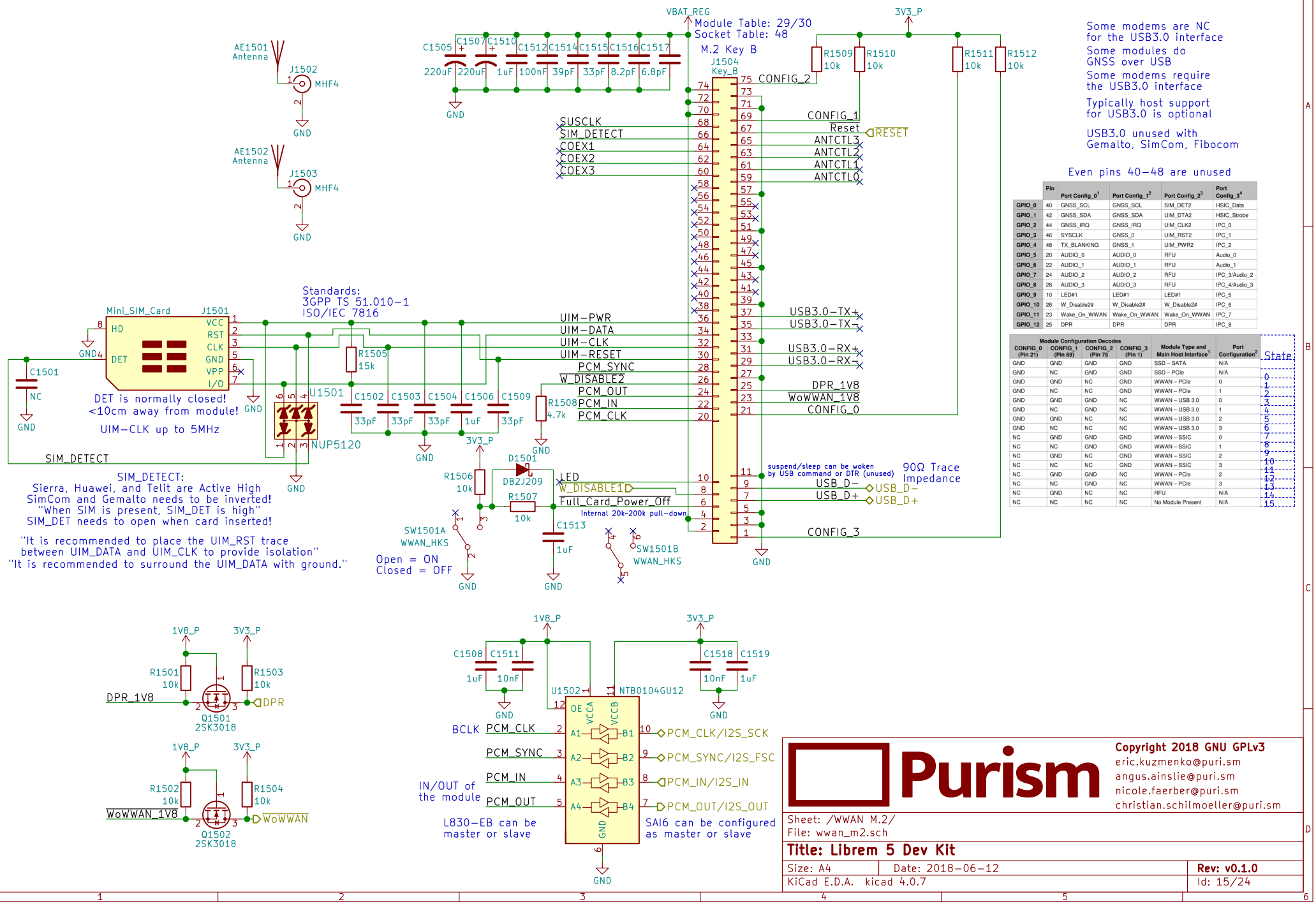
Sheet: /Buttons & LED/
File: buttons_led.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 14/24



	Pin	Port Config_0[1]	Port Config_1[2]	Port Config_2[3]	Port Config_3[4]
GPIO_0	40	GNSS_SCL	GNSS_SCL	SIM_DET2	HSIC_Data
GPIO_1	42	GNSS_SDA	GNSS_SDA	UIM_DTA2	HSIC_Strobe
GPIO_2	44	GNSS_IRQ	GNSS_IRQ	UIM_CLK2	IPC_0
GPIO_3	46	SYSCLK	GNSS_0	UIM_RST2	IPC_1
GPIO_4	48	TX_BLANKING	GNSS_1	UIM_PWR2	IPC_2
GPIO_5	20	AUDIO_0	AUDIO_0	RFU	Audio_0
GPIO_6	22	AUDIO_1	AUDIO_1	RFU	Audio_1
GPIO_7	24	AUDIO_2	AUDIO_2	RFU	IPC_3/Audio_2
GPIO_8	28	AUDIO_3	AUDIO_3	RFU	IPC_4/Audio_3
GPIO_9	10	LED#1	LED#1	LED#1	IPC_5
GPIO_10	26	W_Disable2#	W_Disable2#	W_Disable2#	IPC_6
GPIO_11	23	Wake_On_WWAN	Wake_On_WWAN	Wake_On_WWAN	IPC_7
GPIO_12	25	DPR	DPR	DPR	IPC_8

Module Configuration Decodes						State
CONFIG_0 (Pin 21)	CONFIG_1 (Pin 69)	CONFIG_2 (Pin 75)	CONFIG_3 (Pin 1)	Module Type and Main Host Interface[1]	Port Configuration[2]	
GND	GND	GND	GND	SSD – SATA	N/A	
GND	NC	GND	GND	SSD – PCIe	N/A	
GND	GND	NC	GND	WWAN – PCIe	0	0
GND	NC	NC	GND	WWAN – PCIe	1	1
GND	GND	GND	NC	WWAN – USB 3.0	0	2
GND	NC	GND	NC	WWAN – USB 3.0	1	3
GND	GND	NC	NC	WWAN – USB 3.0	2	4
GND	NC	NC	NC	WWAN – USB 3.0	3	5
NC	GND	GND	GND	WWAN – SSIC	0	6
NC	NC	GND	GND	WWAN – SSIC	1	7
NC	GND	NC	GND	WWAN – SSIC	2	8
NC	NC	NC	GND	WWAN – SSIC	3	9
NC	GND	GND	NC	WWAN – PCIe	2	10
NC	NC	GND	NC	WWAN – PCIe	3	11
NC	GND	NC	NC	RFU	N/A	12
NC	NC	NC	NC	No Module Present	N/A	13
						14
						15

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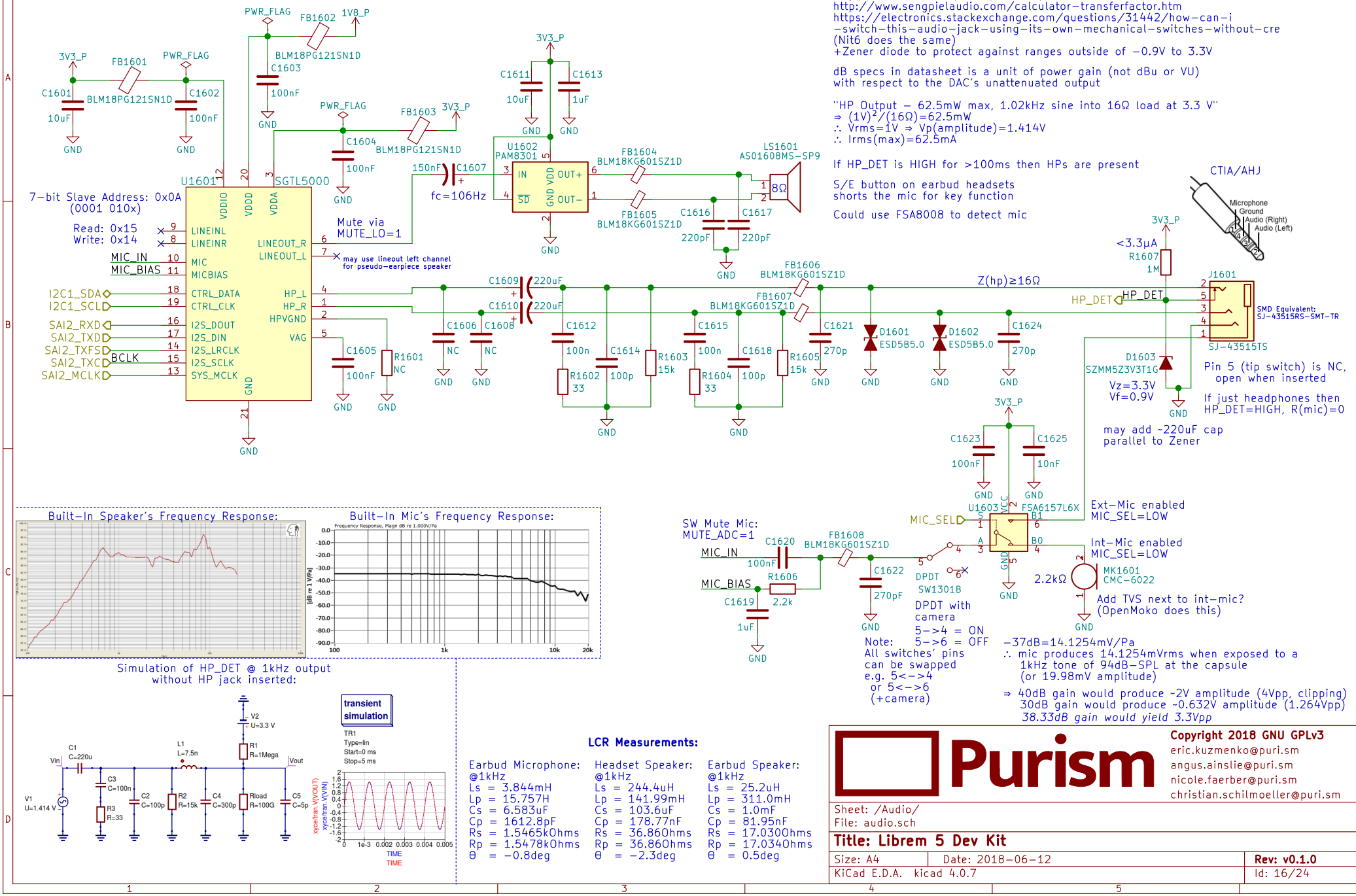
Sheet: /WWAN M.2/
File: wwan_m2.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 15/24


Reference:
http://www.52rd.com/S_txt/2011_3/TXT26685.htm
http://www.sengpielaudio.com/calculator-transferfactor.htm
https://electronics.stackexchange.com/questions/31442/how-can-i-switch-this-audio-jack-using-its-own-mechanical-switches-without-cre
(Nit6 does the same)
+Zener diode to protect against ranges outside of -0.9V to 3.3V
dB specs in datasheet is a unit of power gain (not dBu or VU)
with respect to the DAC's unattenuated output
"HP Output - 62.5mW max, 1.02kHz sine into 16Ω load at 3.3 V"
⇒ (1V)²/(16Ω)=62.5mW
∴ Vrms=1V ⇒ Vp(amplitude)=1.414V
∴ Irms(max)=62.5mA
If HP_DET is HIGH for >100ms then HPs are present
S/E button on earbud headsets
shorts the mic for key function
Could use FSA8008 to detect mic
U1601
SGTL5000
7-bit Slave Address: 0x0A
(0001 010x)
Read: 0x15
Write: 0x14
Mute via
MUTE_LO=1
may use lineout left channel
for pseudo-earpiece speaker
U1602
PAM8301
LS1601
AS01608MS-SP9
8Ω
fc=106Hz
CTIA/AHJ
Microphone
Ground
Audio (Right)
Audio (Left)
<3.3µA
Z(hp)≥16Ω
J1601
SMD Equivalent:
SJ-43515RS-SMT-TR
SJ-43515TS
Pin 5 (tip switch) is NC,
open when inserted
If just headphones then
HP_DET=HIGH, R(mic)=0
D1603
SZMM5Z3V3T1G
Vz=3.3V
Vf=0.9V
may add ~220uF cap
parallel to Zener
U1603
FSA6157L6X
Ext-Mic enabled
MIC_SEL=LOW
Int-Mic enabled
MIC_SEL=LOW
MK1601
CMC-6022
Add TVS next to int-mic?
(OpenMoko does this)
SW Mute Mic:
MUTE_ADC=1
DPDT
SW1301B
DPDT with
camera
5->4 = ON
Note: 5->6 = OFF
All switches' pins
can be swapped
e.g. 5<->4
or 5<->6
(+camera)
-37dB=14.1254mV/Pa
∴ mic produces 14.1254mVrms when exposed to a
1kHz tone of 94dB-SPL at the capsule
(or 19.98mV amplitude)
⇒ 40dB gain would produce ~2V amplitude (4Vpp, clipping)
30dB gain would produce ~0.632V amplitude (1.264Vpp)
38.33dB gain would yield 3.3Vpp
Built-In Speaker's Frequency Response:
Built-In Mic's Frequency Response:
Simulation of HP_DET @ 1kHz output
without HP jack inserted:
transient
simulation
LCR Measurements:
Earbud Microphone:
@1kHz
Ls = 3.844mH
Lp = 15.757H
Cs = 6.583uF
Cp = 1612.8pF
Rs = 1.5465kOhms
Rp = 1.5478kOhms
θ = -0.8deg
Headset Speaker:
@1kHz
Ls = 244.4uH
Lp = 141.99mH
Cs = 103.6uF
Cp = 178.77nF
Rs = 36.860hms
Rp = 36.860hms
θ = -2.3deg
Earbud Speaker:
@1kHz
Ls = 25.2uH
Lp = 311.0mH
Cs = 1.0mF
Cp = 81.95nF
Rs = 17.0300hms
Rp = 17.0340hms
θ = 0.5deg
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Copyright 2018 GNU GPLv3
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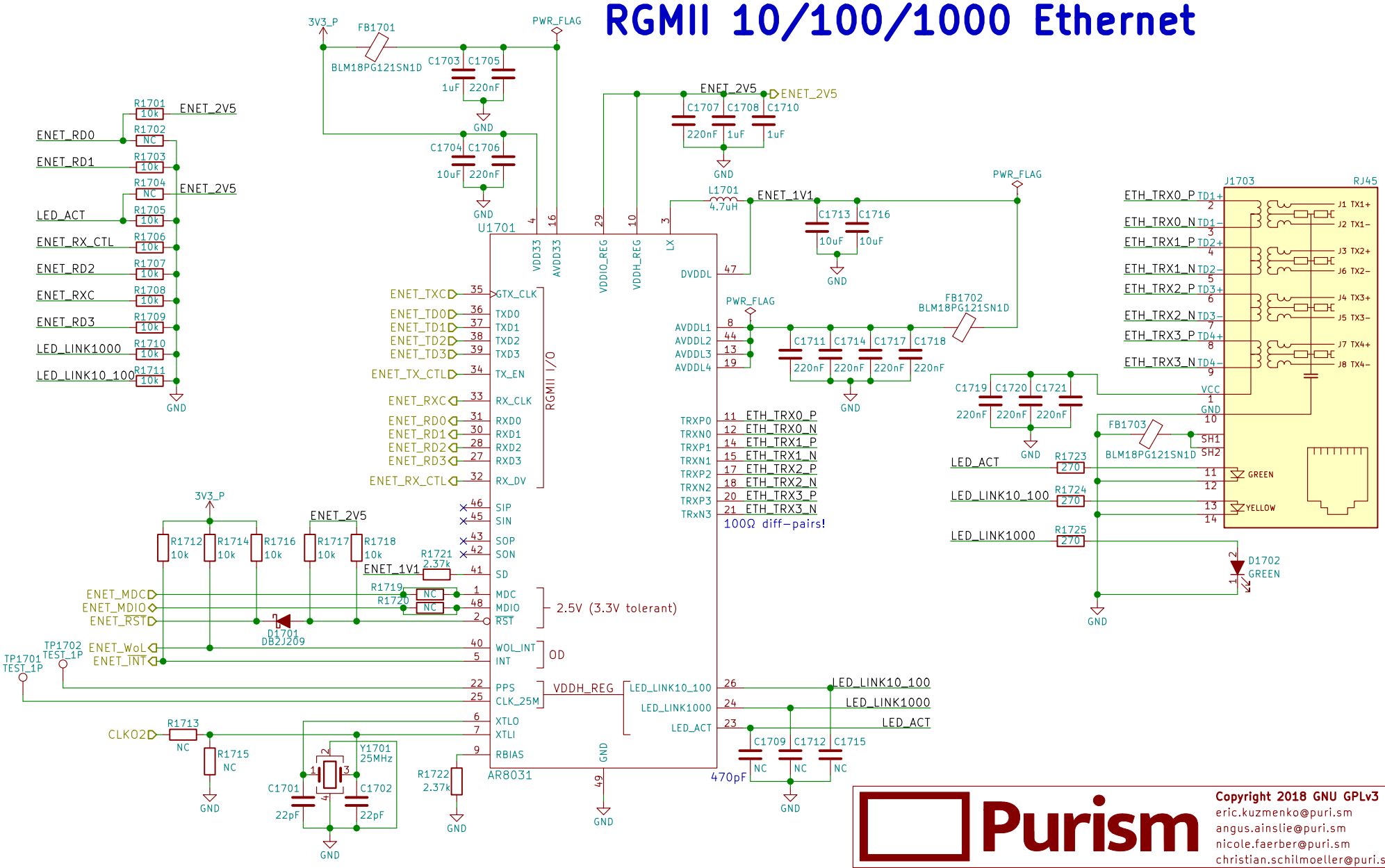
christian.schilmoeller@puri.sm
Sheet: /Audio/
File: audio.sch
Title: Librem 5 Dev Kit
Size: A4
Date: 2018-06-12
Rev: v0.1.0
KiCad E.D.A. kicad 4.0.7
Id: 16/24

RGMII 10/100/1000 Ethernet



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Sheet: /Ethernet/
File: ethernet.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 17/24

Module: Table 23
Socket: Table 46

RS9116 NC:
RTS, CTS, BT_HOST_WAKE

RS9116 datasheet says
no WIFI_WAKE
but the schematic has it

RedPine RS9116 MB0
Requires 5V on
Pin 54 if USB used

M.2 Key E

AE1801 Antenna
AE1802 Antenna
J1801 MHF4
J1802 MHF4

R1802 NC
JP1801 NC
C1809 6.8pF
C1810 8.2pF
C1811 33pF
C1812 39pF
C1813 100nF
C1814 1uF
C1816 220uF
C1817 220uF

J1803 Key_E

USB_WLAN_DP
USB_WLAN_DN
WIFI_CLK
WIFI_CMD
WIFI_DATA0
WIFI_DATA1
WIFI_DATA2
WIFI_DATA3
WIFI_WAKE
M2_PCM_CLK
M2_PCM_SYNC
M2_PCM_IN
M2_PCM_OUT
SoC's IN/OUT
BT_HOST_WAKE
BT_UART_RXD
SoC's RX
Module's TX
SoC's TX
Module's RX
BT_UART_TXD
BT_UART_RTS
BT_UART_CTS
i.MX8M in DCE mode (POR state)
has CTS output, RTS input

R1801 100k
D1801 DB2J209
WIFI_RST
W_DISABLE1
D1802 DB2J209
VIH=2.31V

RedPine RS9116
has 100k pull-up to
3.3V making SDIO_RST
~2.55V when HIGH

6.2 M.2 Signal Directions
UARTn_UFCR[DCEDTE]=0 on POR

TX output
RX input
CTS output
RTS input
⇒TX→RX
RX←TX
CTS→CTS
RTS←RTS

C1815 100nF

Pin 54 on RS9116 is
USB_VBUS Sink

RS9116 SUSCLK
is a GPIO (unused)
SUSCLK
R1803 10k
W_DISABLE2
W_DISABLE1
M2_I2C_SDA
M2_I2C_SCL

U1803A 74AUP2G08
U1803B 74AUP2G08

Leave BT_DISABLE
LOW for RS9116
BT_DISABLE
WIFI_DISABLE

Input pins are
interchangeable

D1803 DB2J209
R1805 100k
R1807 100k
C1818 100nF
SW1801A WLAN_HKS
SW1801B WLAN_HKS
Open = ON
Closed = OFF

Note:
All switches' pins
can be swapped
e.g. 2<->3
or 1<->3

R1804 10k
M2_I2C_SDA
Q1801 2SK3018
I2C2_SDA

R1806 10k
M2_I2C_SCL
Q1802 2SK3018
I2C2_SCL

RS9116 is an I2C master
⇒its SCL is an output
(ok bc only device on I2C2)

C1801 1uF
C1802 10nF
C1803 10nF
C1804 1uF
U1801 NTB0104GU12

BT_UART_RXD
BT_UART_TXD
BT_UART_RTS
BT_UART_CTS

RS9116 does not
use RTX & CTS

RX, TX, RTS, CTS
of the SoC

internal 10k pull-up

C1805 1uF
C1806 10nF
C1807 10nF
C1808 1uF
U1802 NTB0104GU12

BCLK
M2_PCM_CLK
M2_PCM_SYNC
M2_PCM_IN
M2_PCM_OUT

BT_PCM_CLK
BT_PCM_SYNC
BT_PCM_IN
BT_PCM_OUT

configure as slave

IN, OUT
of the SoC

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Sheet: /WLAN+BT M.2/
File: wifi_bt_m2.sch

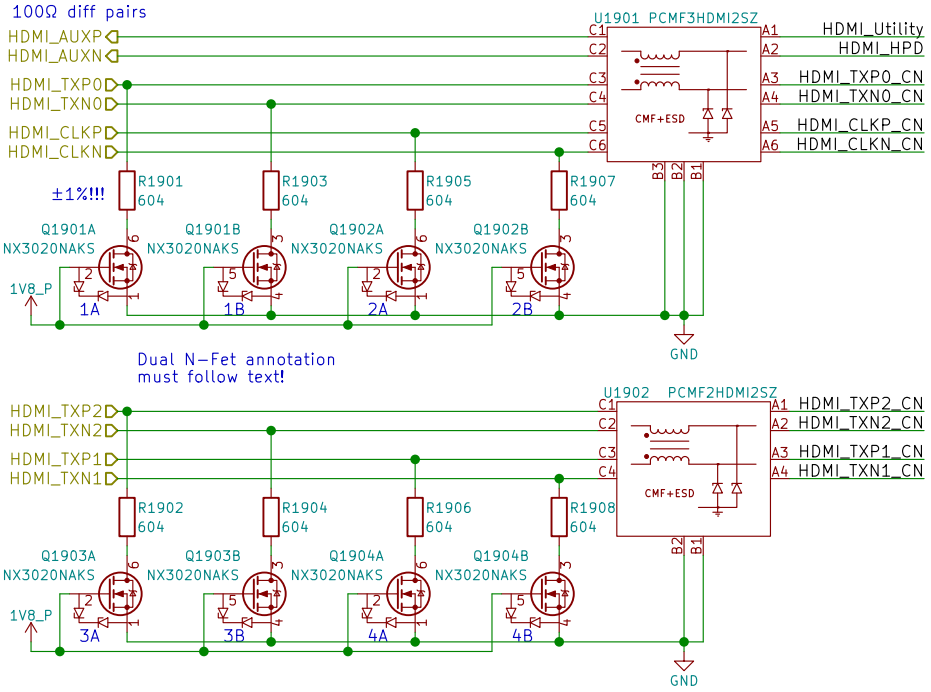
Title: Librem 5 Dev Kit

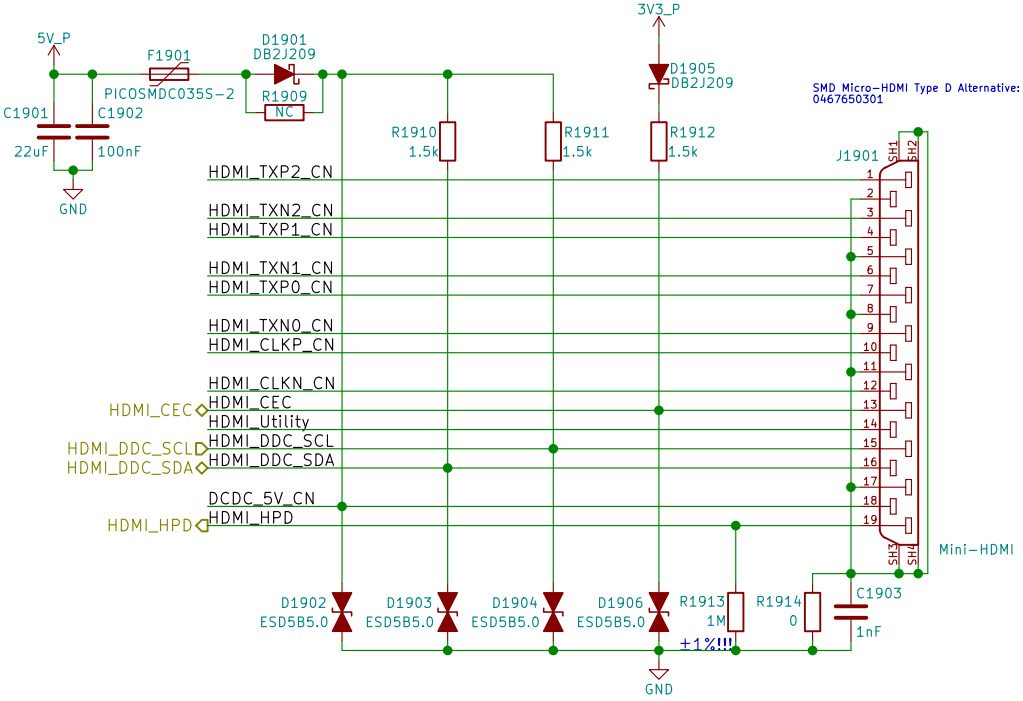
Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 18/24

TUSB1046 can be used for DP over USB-C

Layout Note:
May need swap some signals
due to micro-HDMI pinout diff
depending on pin location/routing

100Ω diff pairs





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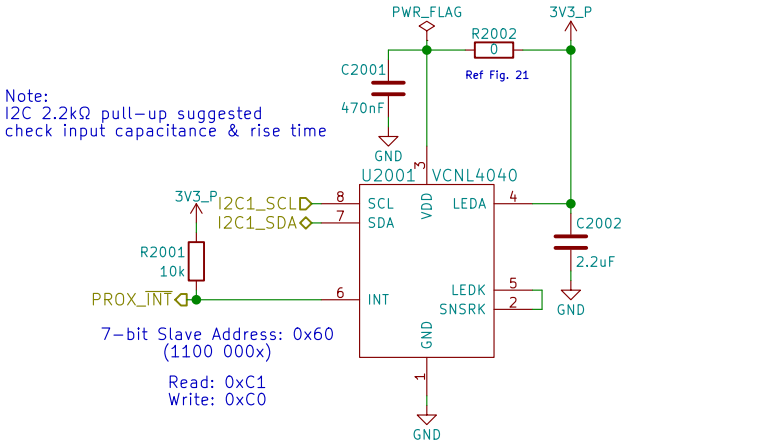
Sheet: /HDMI/
File: hdmi.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 19/24

Proximity & Ambient Light



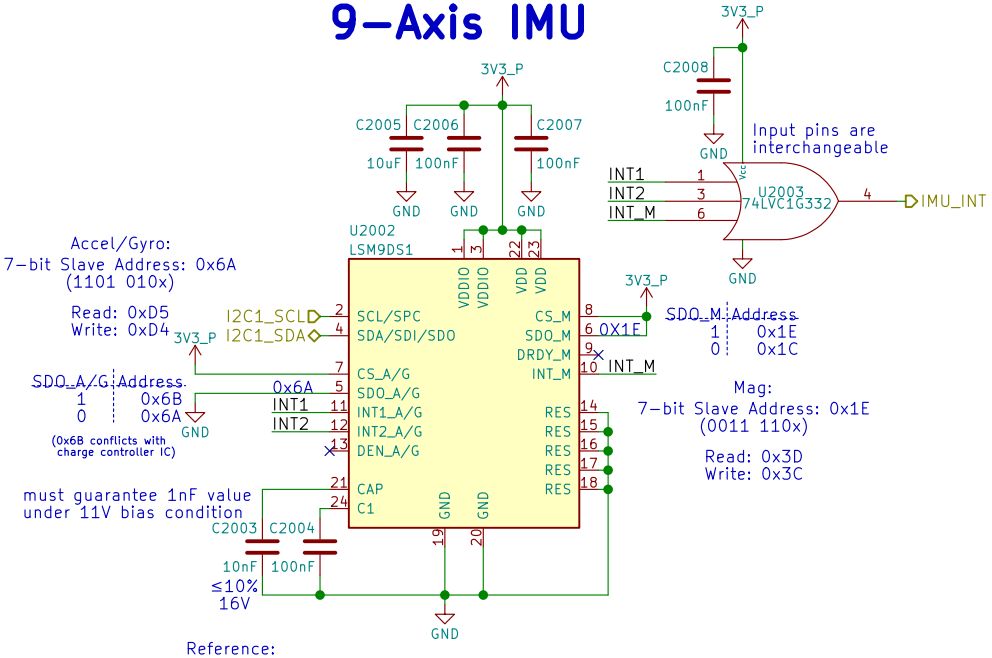
Note:
I2C 2.2kΩ pull-up suggested
check input capacitance & rise time

7-bit Slave Address: 0x60
(1100 000x)

Read: 0xC1
Write: 0xC0

Reference:
https://www.vishay.com/docs/84307/designingvcnl4040.pdf
http://www.vishay.com/docs/84931/vcnl4040sensorboardfiles.pdf

9-Axis IMU



Accel/Gyro:
7-bit Slave Address: 0x6A
(1101 010x)

Read: 0xD5
Write: 0xD4

must guarantee 1nF value
under 11V bias condition
≤10%
16V

Mag:
7-bit Slave Address: 0x1E
(0011 110x)

Read: 0x3D
Write: 0x3C

Reference:
http://www.st.com/en/evaluation-tools/steval-mki159v1.html

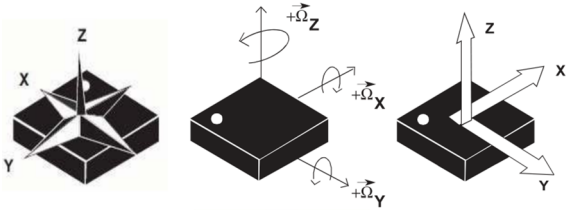


Table 19. Accelerometer and gyroscope SAD+Read/Write patterns

Command	SAD[6:1]	SAD[0] = SA0	R/W	SAD+R/W
Read	110101	0	1	11010101 (D5h)
Write	110101	0	0	11010100 (D4h)
Read	110101	1	1	11010111 (D7h)
Write	110101	1	0	11010110 (D6h)

Table 20. Magnetic sensor SAD+Read/Write patterns

Command	SAD[6:2]	SAD[1] = SDO/SA1	SAD[0]	R/W	SAD+R/W
Read	00111	0	0	1	00111001 (39h)
Write	00111	0	0	0	00111000 (38h)
Read	00111	1	0	1	00111101 (3Dh)
Write	00111	1	0	0	00111100 (3Ch)

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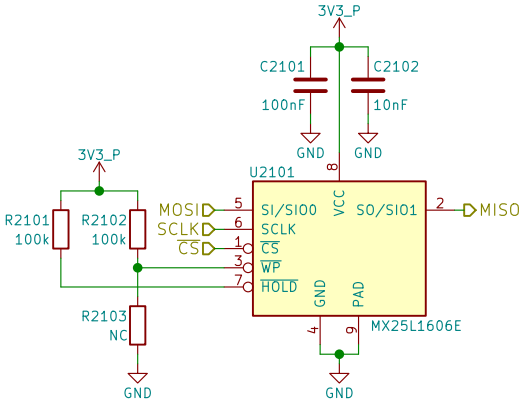
Sheet: /Sensors/
File: sensors.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 20/24



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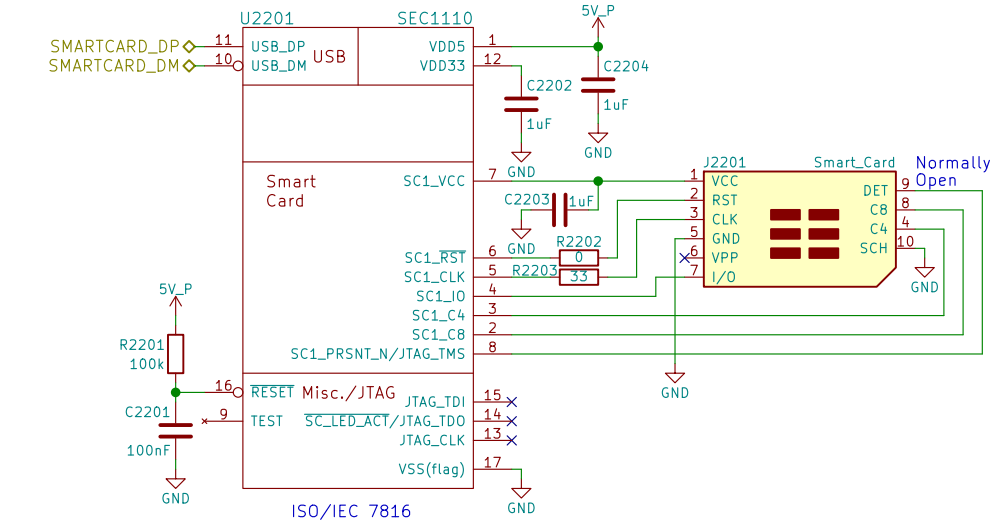
Sheet: /SPI Flash/
File: flash.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 21/24



Reference:
http://www.microchip.com/DevelopmentTools/ProductDetails.aspx?PartNO=EVB-SEC1110

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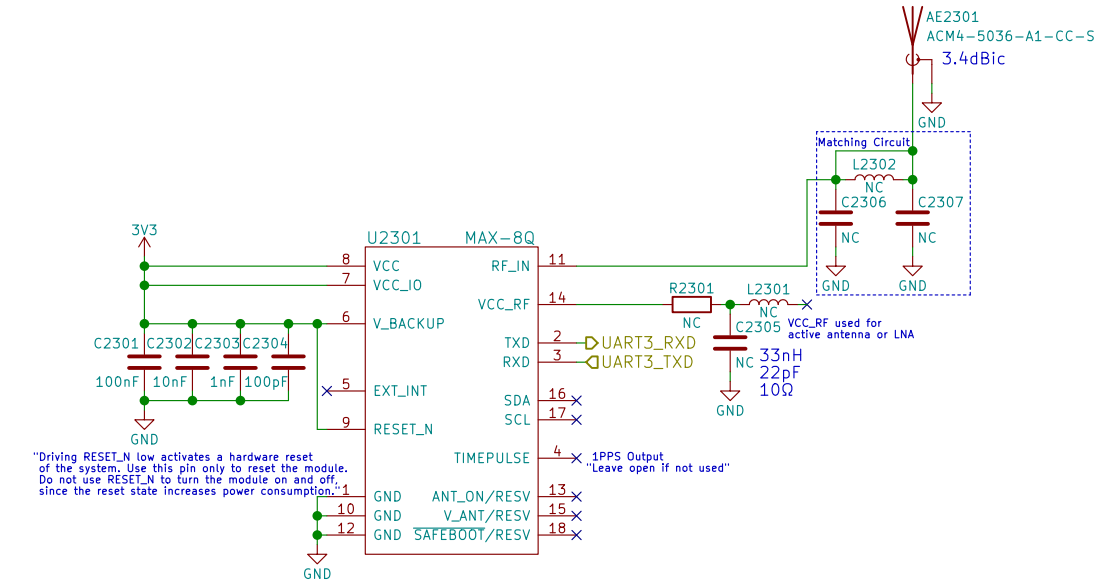
Sheet: /Smart Card/
File: smartcard.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 22/24



Reference:
https://www.u-blox.com/sites/default/files/MAX-8-M8-FW3_HardwareIntegrationManual_%28UBX-15030059%29.pdf

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Sheet: /GNSS/
File: gnss.sch

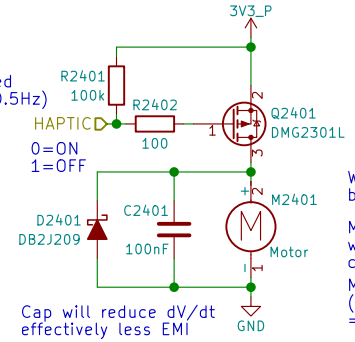
Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
KiCad E.D.A. kicad 4.0.7		Id: 23/24

PWM pins occupied:
GPIO1_IO01 – LCD Backlight
GPIO1_IO13 – LED
GPIO1_IO14 – Ethernet (CLKO_25MHz)
GPIO1_IO15 – CSI (CLKO2)

PWM needed?
Only needs to be toggled
ON 1 sec, OFF 1 sec (0.5Hz)

Can MUX as either
GPIO or PWM2
swapping with LED



When the motor is off
both terminals are at GND

Motor will have wire leads
with a 2-pin Molex or Boom Precision
connector installed (by request)!

Metal housing is floating
(not connected to either pin)
⇒ could connect housing to GND

Cap will reduce dV/dt
effectively less EMI

Cheaper Motor Connector:
https://lcsc.com/product-detail/1-25T-Connectors_1-25T-1-2AW_C10832.html

Motor Source:
https://www.alibaba.com/product-detail/Coin-motor-vibration-dc-motor
cellphone_1994583657.html?spm=a2700.8443308.0.0.5aa13e5f1wxHgs

Motor Datasheet:
https://cloud.puri.sm/s/z8JR6DJ4KrJYzoW

Motor PN:
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Purism

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Sheet: /Haptic Motor/
File: haptic.sch

Title: Librem 5 Dev Kit

Size: A4	Date: 2018-06-12	**Rev: v0.1.0**
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