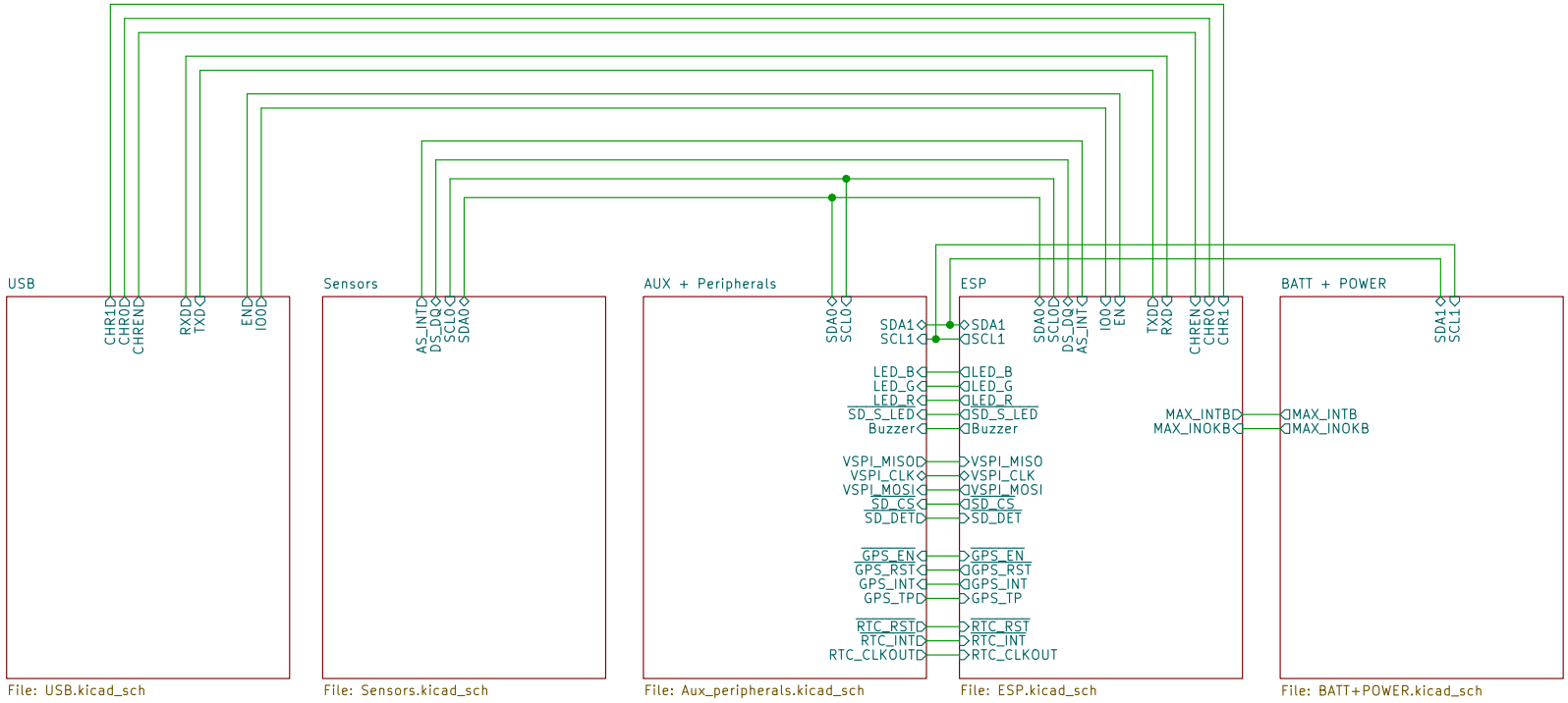

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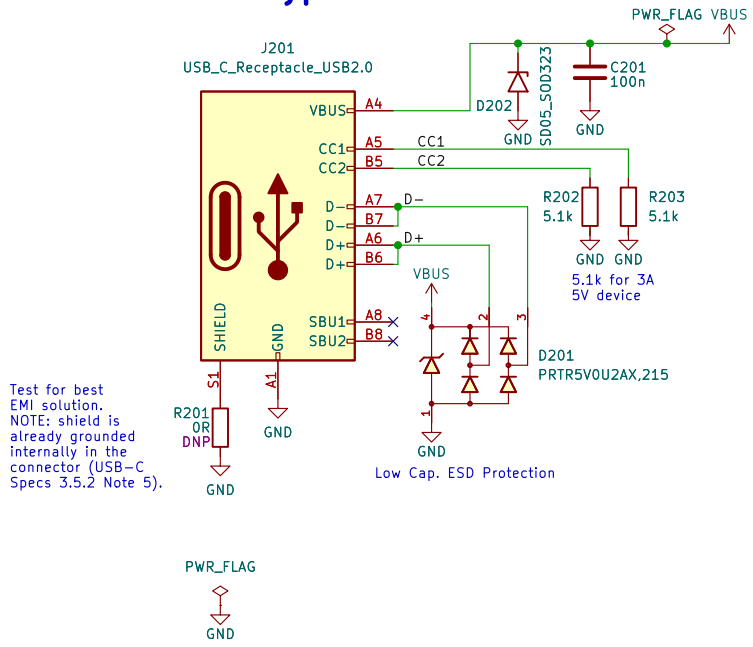
Sheet: /

File: LAITS-HW.kicad_sch

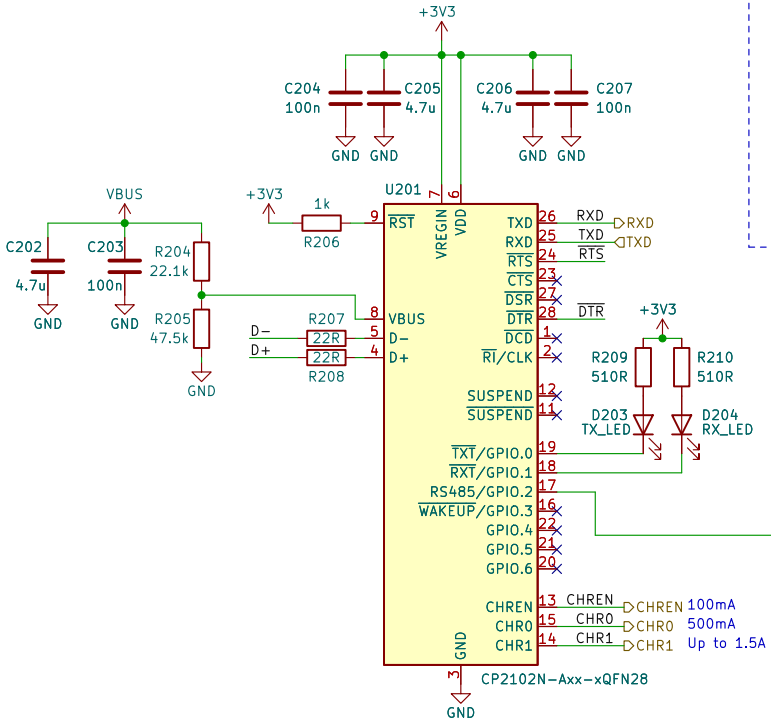
Title: LAITS (Light Analysis Iot porTable Spectrometer)

Size: A4	Date: 2022-08-12	**Rev: 1.0.3**
KiCad E.D.A. kicad 6.0.7-1.fc36		Id: 1/6

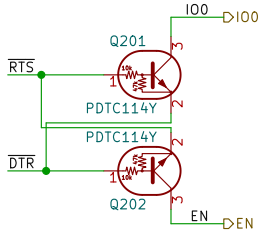
USB Type C

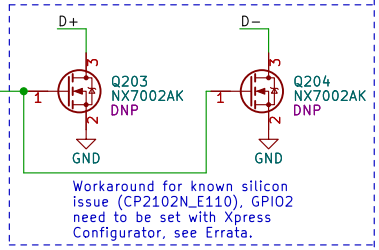


USB to UART



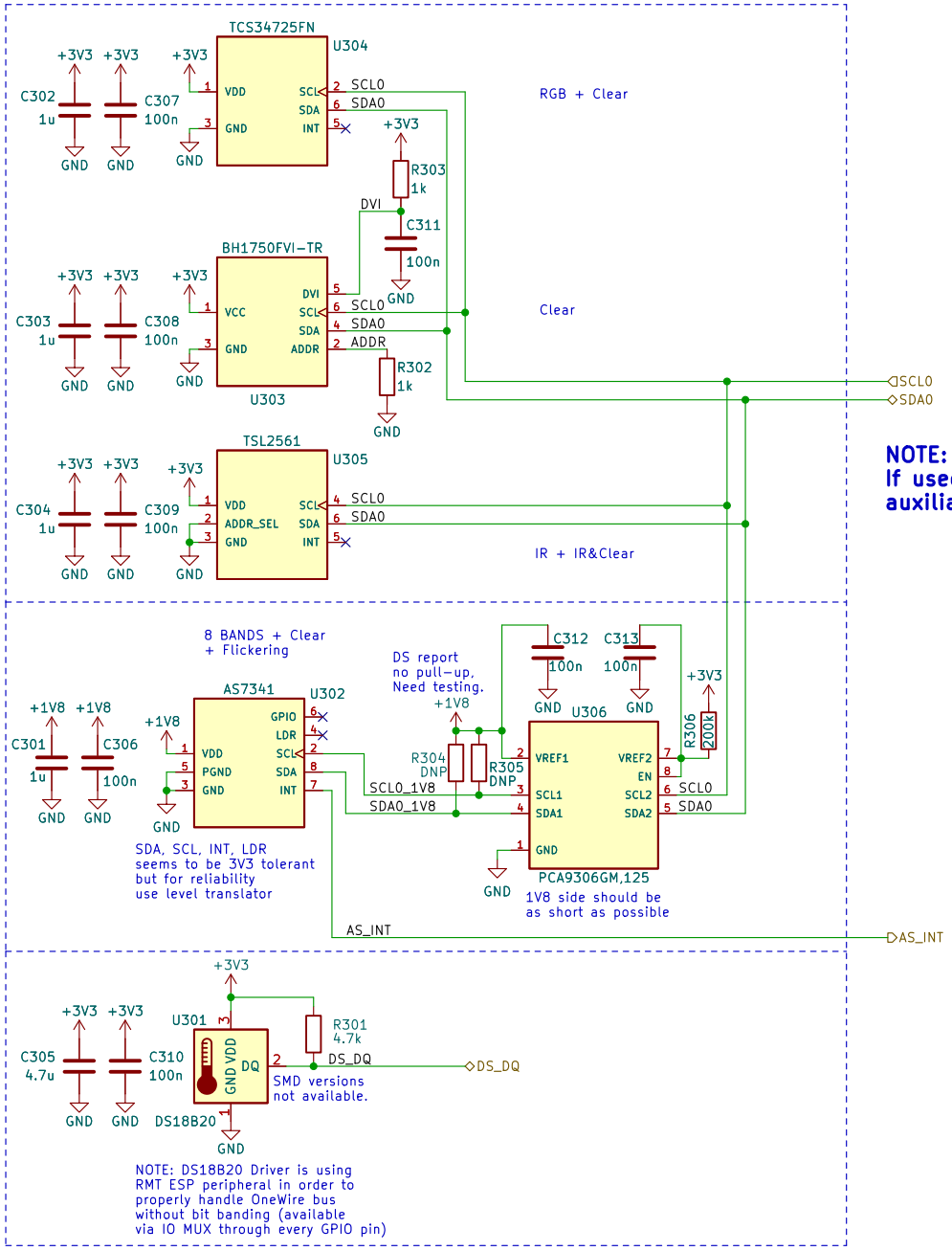
Bootloader Mode from USB





Simone Tollardo		
Sheet: /USB/		
File: USB.kicad_sch		
Title: PS + USB		
Size: A4	Date: 2022−08−12	**Rev: 1.0.3**
KiCad E.D.A. kicad 6.0.7−1.fc36		Id: 2/6

SENSORS



NOTE: AS7341 can replace TCS, BH and TSL.
If used do not place TCS, BH, TSL and their auxiliary components.

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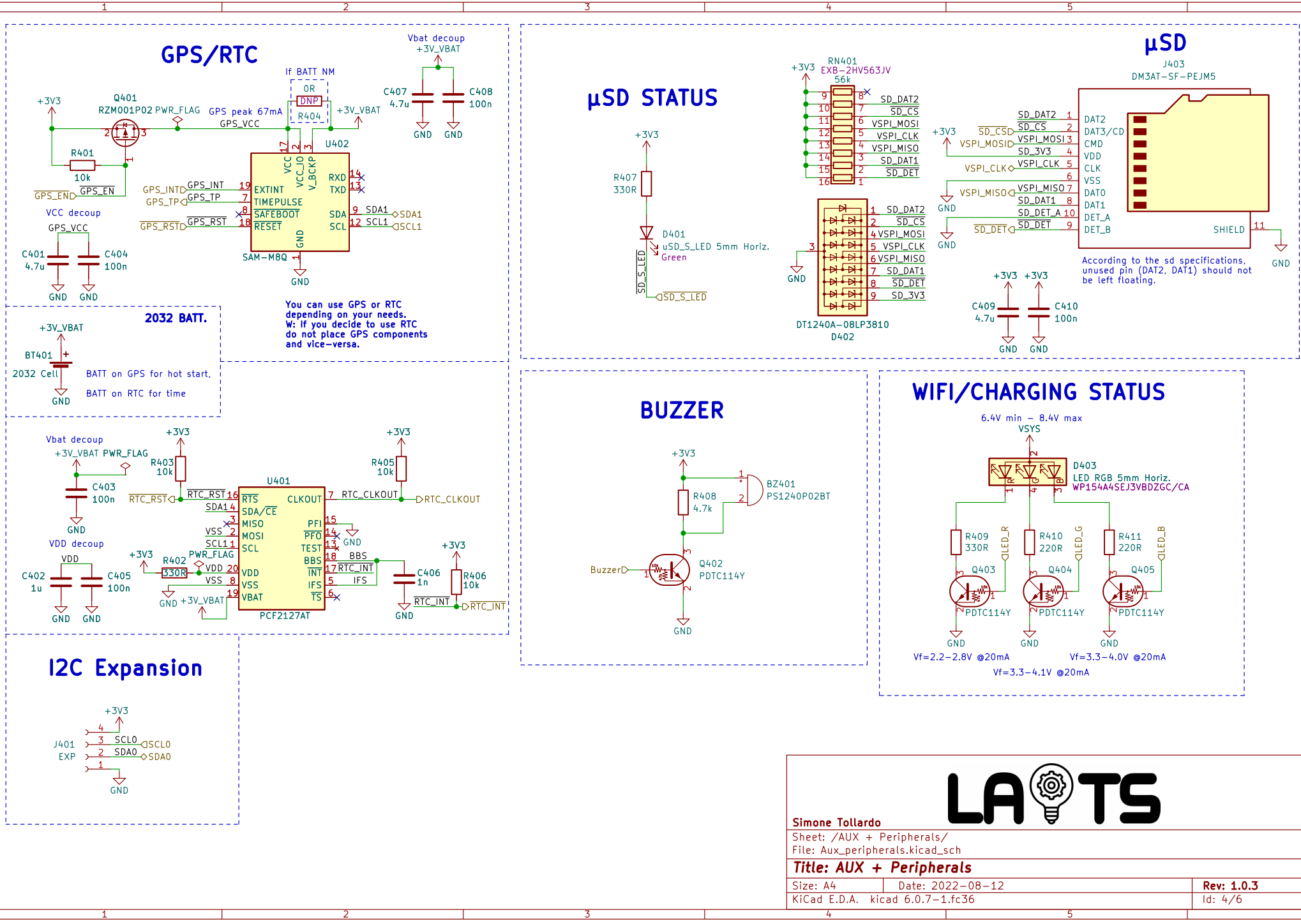
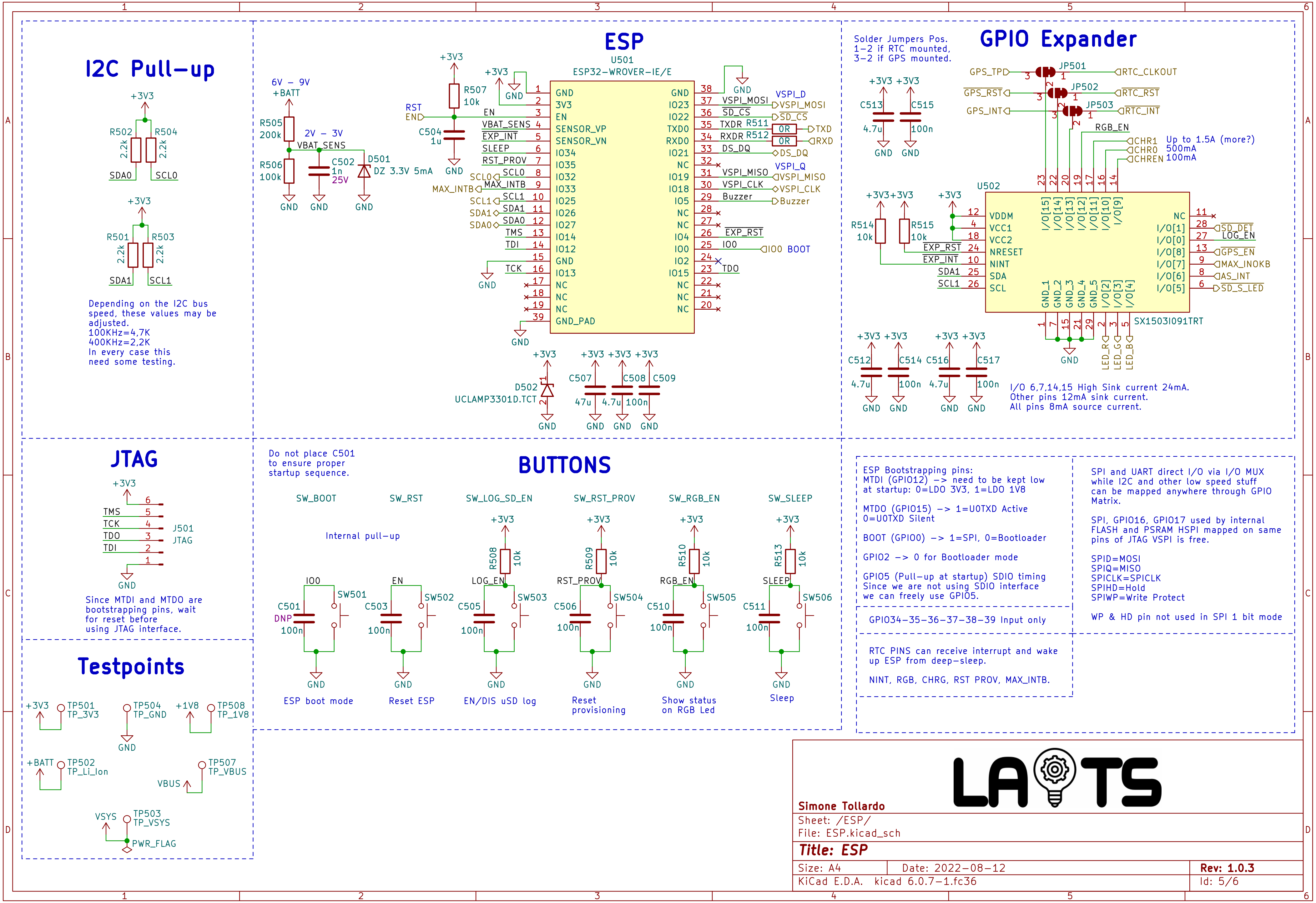
Sheet: /Sensors/
File: Sensors.kicad_sch

Title: Sensors

Size: A4	Date: 2022-08-12	**Rev: 1.0.3**
KiCad E.D.A. kicad 6.0.7-1.fc36		Id: 3/6


GPS/RTC
Vbat decoup
+3V_VBAT
If BATT NM
0R
DNP
R404
C407
4.7u
C408
100n
GND
+3V3
Q401
RZM001P02
PWR_FLAG
GPS peak 67mA
GPS_VCC
+3V_VBAT
R401
10k
GPS_EN
U402
VCC
VCC_IO
V_BCKP
GPS_INT
GPS_TP
GPS_RST
EXTINT
TIMEPULSE
SAFEBOOT
RESET
RXD
TXD
SDA
SCL
SDA1
SCL1
GND
SAM-M8Q
VCC decoup
C401
4.7u
C404
100n
You can use GPS or RTC depending on your needs.
W: If you decide to use RTC do not place GPS components and vice-versa.
2032 BATT.
BT401
2032 Cell
BATT on GPS for hot start,
BATT on RTC for time
Vbat decoup
PWR_FLAG
C403
100n
VDD decoup
C402
1u
C405
100n
R403
10k
R405
10k
U401
RTC_RST
SDA1
VSS
SCL1
RTS
SDA/CE
MISO
MOSI
SCL
CLKOUT
PFI
PFO
TEST
BBS
INT
IFS
TS
VDD
VSS
VBAT
RTC_CLKOUT
RTC_INT
BBS
IFS
R402
330R
VDD
VSS
C406
1n
R406
10k
PCF2127AT
I2C Expansion
J401
EXP
SCL0
SDA0
µSD STATUS
R407
330R
D401
uSD_S_LED 5mm Horiz.
Green
SD_S_LED
RN401
EXB-2HV563JV
56k
SD_DAT2
SD_CS
VSPI_MOSI
VSPI_CLK
VSPI_MISO
SD_DAT1
SD_DET
SD_3V3
DT1240A-08LP3810
D402
µSD
J403
DM3AT-SF-PEJM5
DAT2
DAT3/CD
CMD
VDD
CLK
VSS
DAT0
DAT1
DET_A
DET_B
SHIELD
According to the sd specifications, unused pin (DAT2, DAT1) should not be left floating.
C409
4.7u
C410
100n
BUZZER
R408
4.7k
BZ401
PS1240P02BT
Buzzer
Q402
PDTC114Y
WIFI/CHARGING STATUS
6.4V min - 8.4V max
VSYS
D403
LED RGB 5mm Horiz.
WP154A4SEJ3VBDZGC/CA
R409
330R
R410
220R
R411
220R
LED_R
LED_G
LED_B
Q403
Q404
Q405
PDTC114Y
Vf=2.2-2.8V @20mA
Vf=3.3-4.0V @20mA
Vf=3.3-4.1V @20mA
Simone Tollardo
Sheet: /AUX + Peripherals/
File: Aux_peripherals.kicad_sch
Title: AUX + Peripherals
Size: A4
Date: 2022-08-12
Rev: 1.0.3
KiCad E.D.A. kicad 6.0.7-1.fc36
Id: 4/6


I2C Pull-up
+3V3
R502 2.2k
R504 2.2k
SDA0
SCL0
R501 2.2k
R503 2.2k
SDA1
SCL1
Depending on the I2C bus speed, these values may be adjusted.
100KHz=4,7K
400KHz=2,2K
In every case this need some testing.
ESP
U501
ESP32-WROVER-IE/E
6V - 9V
+BATT
R505 200k
R506 100k
2V - 3V
VBAT_SENS
C502 1n 25V
D501 DZ 3.3V 5mA
R507 10k
RST
EN
C504 1u
GND
SENSOR_VP
SENSOR_VN
TXD0
RXD0
VSPI_D
VSPI_MOSI
SD_CS
TXD
RXD
DS_DQ
VSPI_Q
VSPI_MISO
VSPI_CLK
Buzzer
EXP_RST
IO0 BOOT
TDO
TMS
TDI
TCK
SLEEP
RST_PROV
MAX_INTB
EXP_INT
R511 0R
R512 0R
D502 UCLAMP3301D.TCT
C507 47u
C508 4.7u
C509 100n
GPIO Expander
Solder Jumpers Pos.
1-2 if RTC mounted,
3-2 if GPS mounted.
GPS_TPD
GPS_RST
GPS_INT
JP501
JP502
JP503
RTC_CLKOUT
RTC_RST
RTC_INT
RGB_EN
CHR1
CHR0
CHREN
Up to 1.5A (more?)
500mA
100mA
C513 4.7u
C515 100n
U502
SX1503I091TRT
R514 10k
R515 10k
SD_DET
LOG_EN
GPS_EN
MAX_INOKB
AS_INT
SD_S_LED
LED_R
LED_G
LED_B
C512 4.7u
C514 100n
C516 4.7u
C517 100n
I/O 6,7,14,15 High Sink current 24mA.
Other pins 12mA sink current.
All pins 8mA source current.
JTAG
J501
JTAG
Since MTDI and MTDO are bootstrapping pins, wait for reset before using JTAG interface.
Testpoints
TP501 TP_3V3
TP504 TP_GND
TP508 TP_1V8
TP502 TP_Li_Ion
TP507 TP_VBUS
TP503 TP_VSYS
PWR_FLAG
BUTTONS
Do not place C501 to ensure proper startup sequence.
SW_BOOT
SW_RST
SW_LOG_SD_EN
SW_RST_PROV
SW_RGB_EN
SW_SLEEP
Internal pull-up
C501 DNP 100n
SW501
C503 100n
SW502
R508 10k
C505 100n
SW503
R509 10k
C506 100n
SW504
R510 10k
C510 100n
SW505
R513 10k
C511 100n
SW506
ESP boot mode
Reset ESP
EN/DIS uSD log
Reset provisioning
Show status on RGB Led
Sleep
ESP Bootstrapping pins:
MTDI (GPIO12) -> need to be kept low at startup: 0=LDO 3V3, 1=LDO 1V8
MTDO (GPIO15) -> 1=U0TXD Active 0=U0TXD Silent
BOOT (GPIO0) -> 1=SPI, 0=Bootloader
GPIO2 -> 0 for Bootloader mode
GPIO5 (Pull-up at startup) SDIO timing
Since we are not using SDIO interface we can freely use GPIO5.
GPIO34-35-36-37-38-39 Input only
RTC PINS can receive interrupt and wake up ESP from deep-sleep.
NINT, RGB, CHRG, RST PROV, MAX_INTB.
SPI and UART direct I/O via I/O MUX while I2C and other low speed stuff can be mapped anywhere through GPIO Matrix.
SPI, GPIO16, GPIO17 used by internal FLASH and PSRAM HSPI mapped on same pins of JTAG VSPI is free.
SPID=MOSI
SPIQ=MISO
SPICLK=SPICLK
SPIHD=Hold
SPIWP=Write Protect
WP & HD pin not used in SPI 1 bit mode
Simone Tollardo
Sheet: /ESP/
File: ESP.kicad_sch
Title: ESP
Size: A4
Date: 2022-08-12
Rev: 1.0.3
KiCad E.D.A. kicad 6.0.7-1.fc36
Id: 5/6

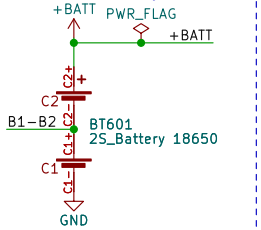
Battery Management

Energy Distribution Priority

- With a valid external power source at CHGIN:
  - The external power source is the primary source of energy.
  - The battery is the secondary source of energy.
  - Energy delivery to SYS has the highest priority.
  - Any remaining energy from the power source that is not required by the system is available to the battery charger.
- With no valid external power source at CHGIN:
  - The battery is the primary source of energy.
  - When OTG mode is enabled, energy delivery to SYS has the highest priority.
  - Any remaining energy from the battery that is not required by the system is available to power the CHGIN.

WARNING, NO REVERSE POLARITY PROTECTION!

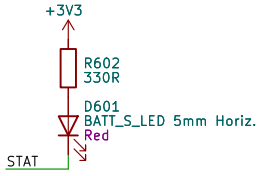
Battery

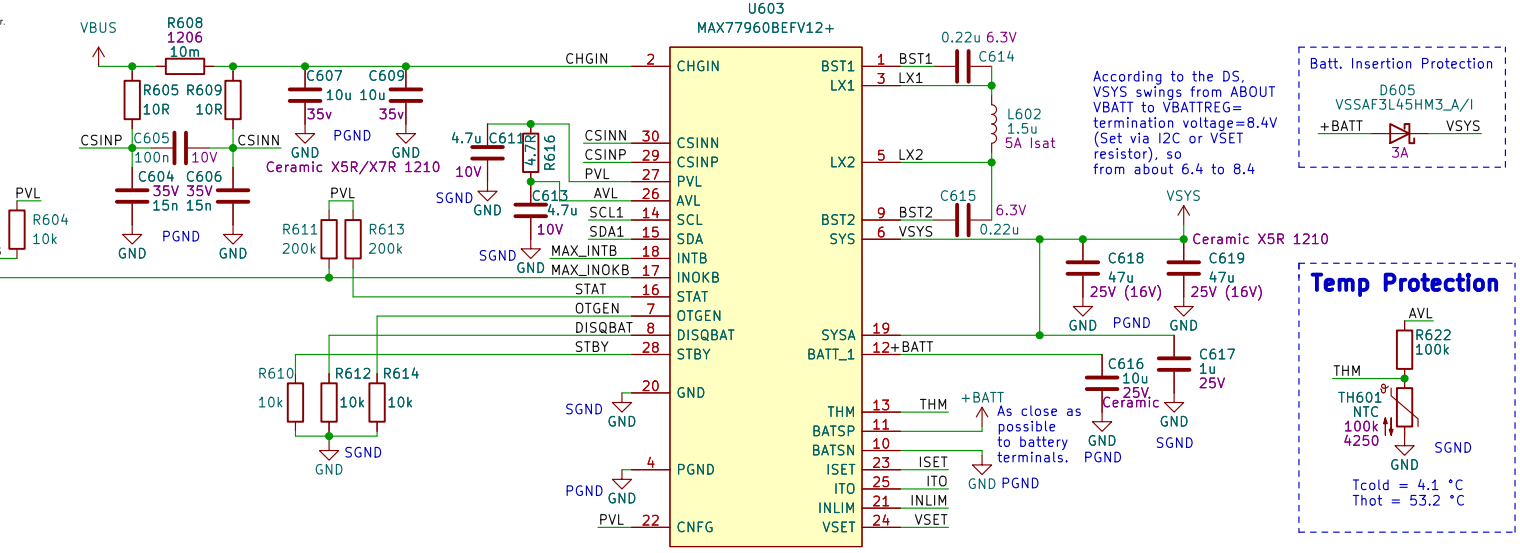


2S1P 18650 Li-Ion.

Battery Charge LED

Led off charge off,
Led blinking charge on,
Led on when top-off treshold reached.





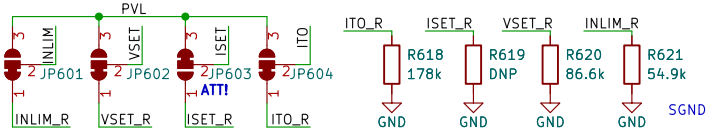
According to the DS, VSYS swings from ABOUT VBATT to VBATTREG= termination voltage=8.4V (Set via I2C or VSET resistor), so from about 6.4 to 8.4

Batt. Insertion Protection

Temp Protection

Tcold = 4.1 °C
Thot = 53.2 °C

If at least one has no valid resistor value (ISET) charging is disabled by default and need to be set by I2C (choosen for safety reasons). ==>

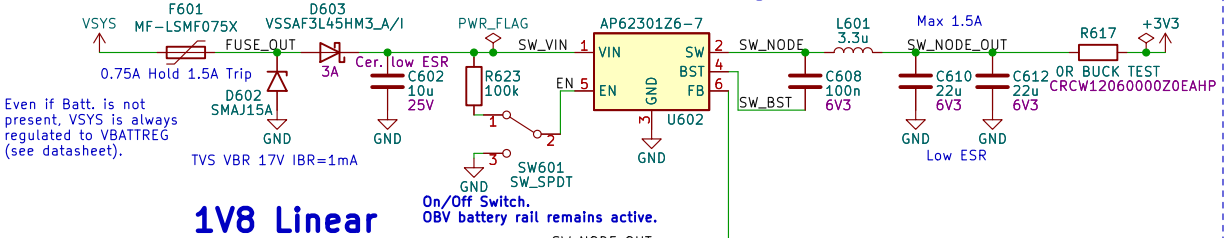


USB BC 1.2 Imax = 1.5A.

According to the DS of CP2102N, implementing USB BC 1.2, 1.5A is the TOTAL MAX CURRENT drawn from USB 5V rail.

There are also some proprietary protocols (e.g. Apple, Samsung and Blackberry chargers) that allows to draw more than 1.5A without USB C PD, but they are not implemented on CP2102N.

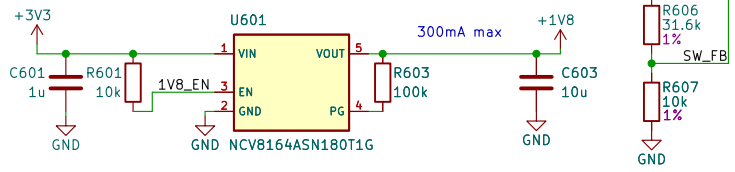
3V3 Switching



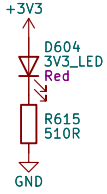
Even if Batt. is not present, VSYS is always regulated to VBATTREG (see datasheet).

1V8 Linear

Needed only if AS7341 used.



PDmax=(Tjmax-Ta)/RθJA)=
(125-20)/158=0.66 W
PD=Vin(Ignd(Iout))+Iout(Vin-Vout)=
3.3(0)+300m(3.3-1.8)=0.45 W



3V3 Peripherals MAX absolute ratings:
- ESP32 = 500mA (min required by DS)
- GPIO Expander = 300mA (with all pin max output)
- CP2102N = 50mA
- 4 Sensors = 10mA
- GPS/RTC = 70mA/50mA
- Buzzer = 35mA

TOT < 1.5A -> Real probably < 0.7A

The regulator always priorities the system, the remaining power will be delivered to battery if charging. So, if charging at 1.5A and system is using 1A, battery charger will get only 0.5A.
If Input power is not enough to power the system, battery will output current to system. So, if available input power is 0.5A and system is using 1A, if battery are charged they will deliver the remaining 0.5A, otherwise the DCDC will detect a failure.
For this reason the ESP32 has as input CHREN, CHR0 and CHR1 and it should go to power save mode (disable wifi and other peripherals) if power is not enough.

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Sheet: /BATT + POWER/
File: BATT+POWER.kicad_sch

Title: BATT

Size: A4	Date: 2022-08-12	**Rev: 1.0.3**
KiCad E.D.A. kicad 6.0.7-1.fc36		Id: 6/6