

PROJECT:

LoRa Comms Payload: Cubesat Carrier

PART OF THE MASTER'S THESIS:

"Development of a LoRa-based communications payload for CubeSat"

MASTER'S DEGREE IN ELECTRONIC SYSTEMS ENGINEERING
POLYTECHNIC UNIVERSITY OF VALENCIA
ACADEMIC COURSE 2023/2024

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DEPARTMENT OF ELECTRONIC ENGINEERING

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DEPARTMENT OF COMMUNICATIONS

DEVELOPED IN PROUD COLLABORATION WITH:



Notes:
This board provides mechanical and electrical support for the LoRa gateway modules. It consists of a PCI-104 board with two mPCIe sockets where the modules are inserted. The on-board microcontroller arbitrates these modules and acts as an intermediary between the modules and the rest of the satellite, with which it communicates using SpaceCAN.

Title: Cover and block diagram

Prj: Estigia Comms Payload - Cubesat carrier

Date: 2024-08-11 13:33:56 **Last modified:** 2024-08-11

Size: A4 **Sheet** 1 of 8

File: 1_cover.SchDoc

Author: Juan Del Pino Mena

Approved: *

Prj. revision: 0.4

Variant: [No Variations]

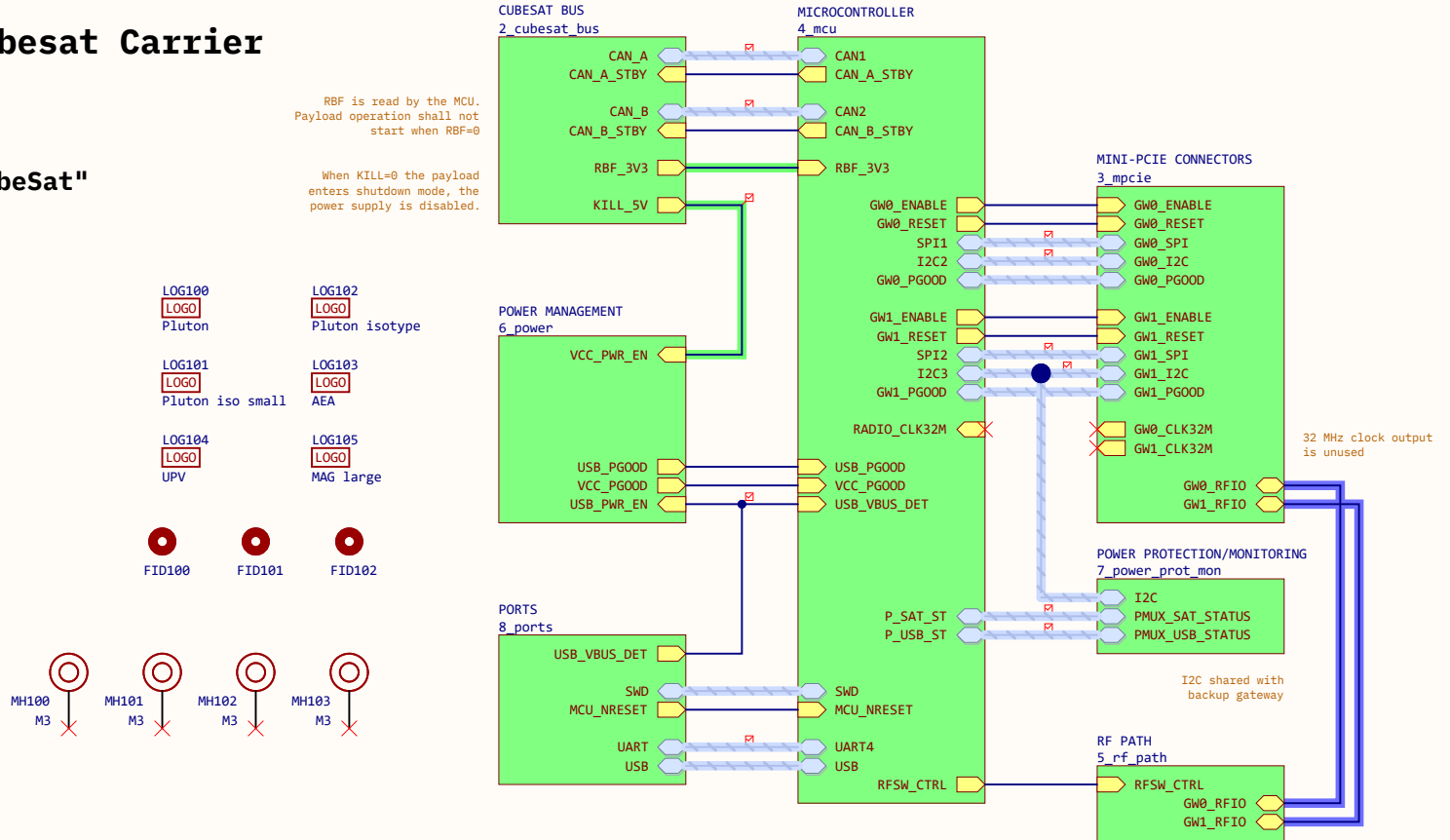
Altium version: 24.3.1.35

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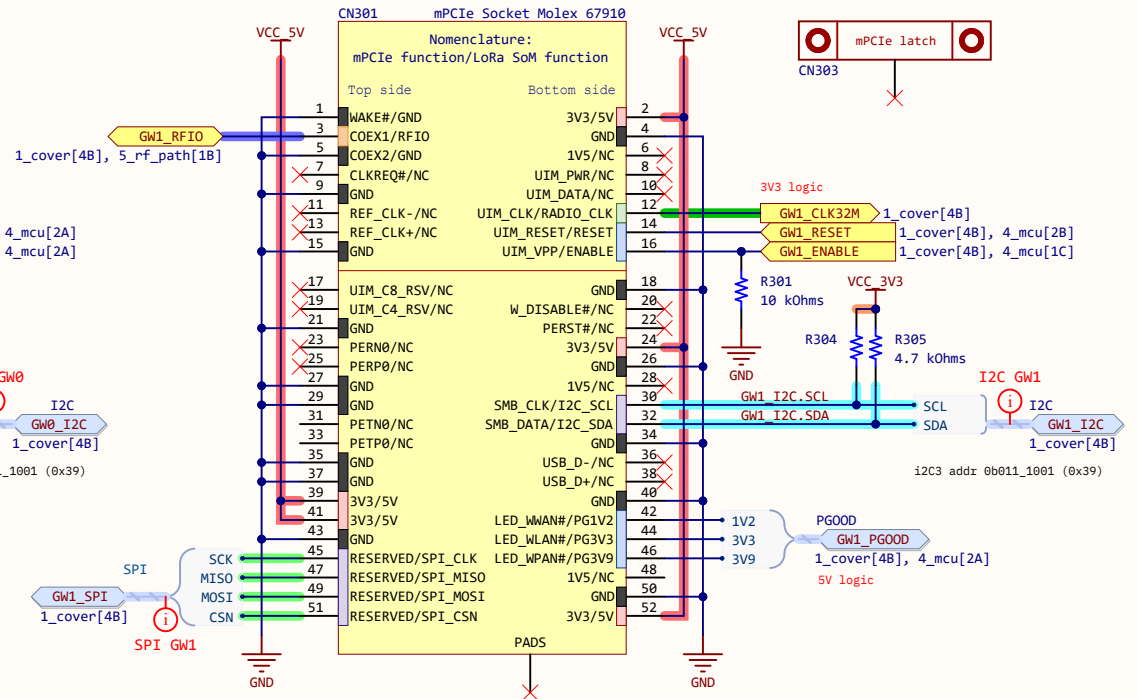
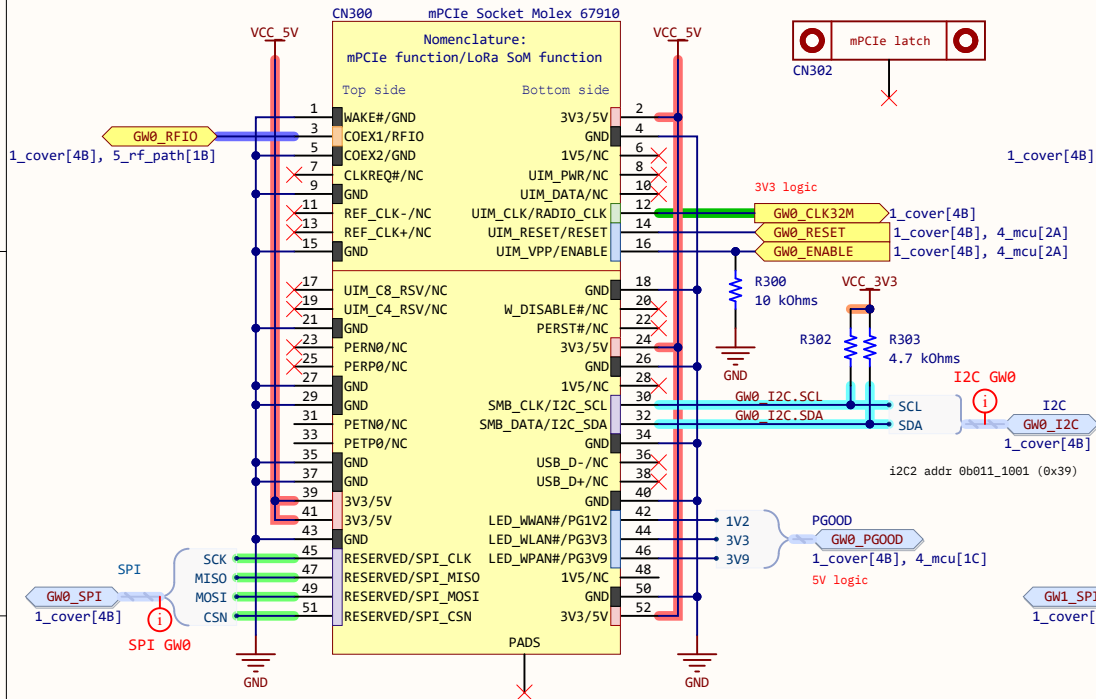
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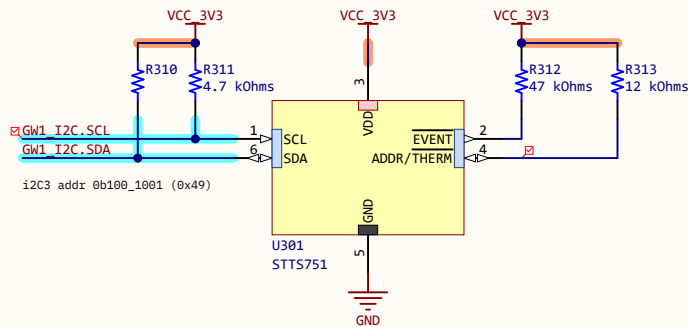
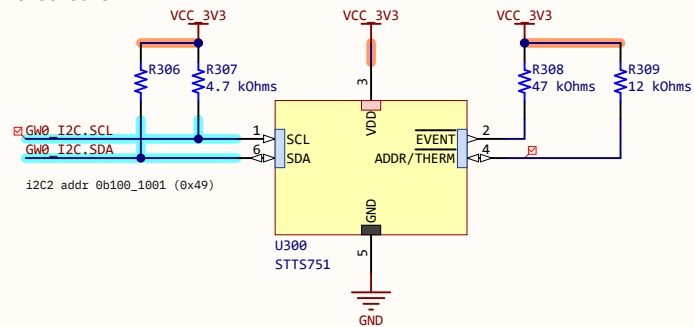
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Spain



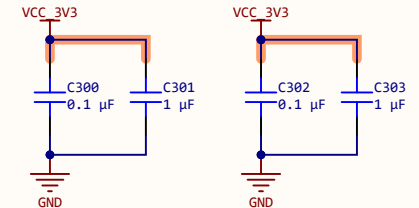
Gateways mPCIe sockets



Temperature sensors



Decoupling caps



To be distributed throughout the board

Notes:

Title: **Mini-PCIe connectors**

Prj: Estigia Comms Payload - Cubesat carrier

Date: 2024-08-11 13:33:57

Last modified:	2024-08-11
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Size: A4

Sheet 3 of 8

File: 3_mpcie.SchDoc

Author:	Juan Del Pino Mena
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Approved:	*
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Prj. revision:	0.4
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Variant:	[No Variations]
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Altium version:	24.3.1.35
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License:	--
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Git Hash: 8e980d747e300d217102f3d6dbc5ec10b92cd1fb [Locally Modified]
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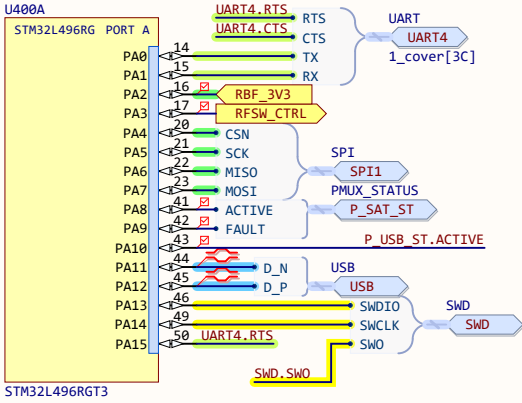
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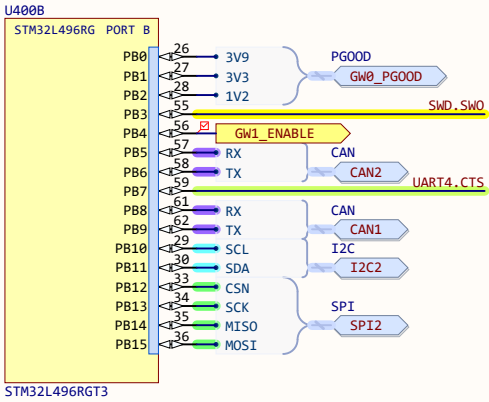


I/O Ports

PORT A



PORT B

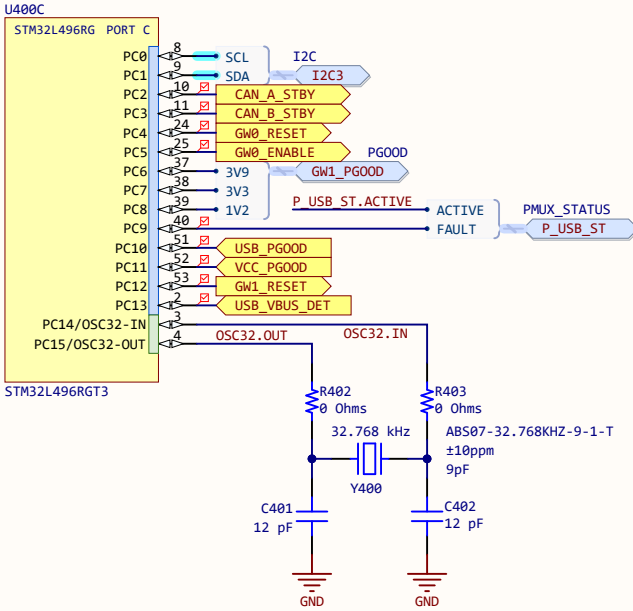


CAN A = CAN 1
CAN B = CAN 2

Altium warns about "net connection problems" when a bi-directional pin is connected to a input or output port. Ignore warning.

Many interfaces are defined and made available into the sheet symbol, so this sheet can be re-used easily between designs. Some peripherals are used both by the Carrier and EGSE, whereas others are only used in one of them.

PORT C

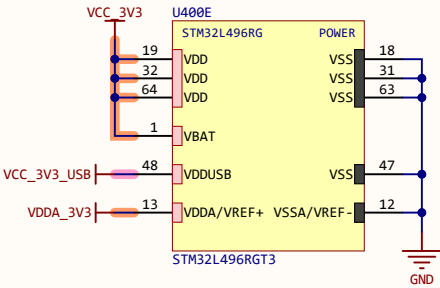


CAUTION! GW0 and GW1 can be enabled simultaneously but cannot be active at the same time!. See 5_if_path

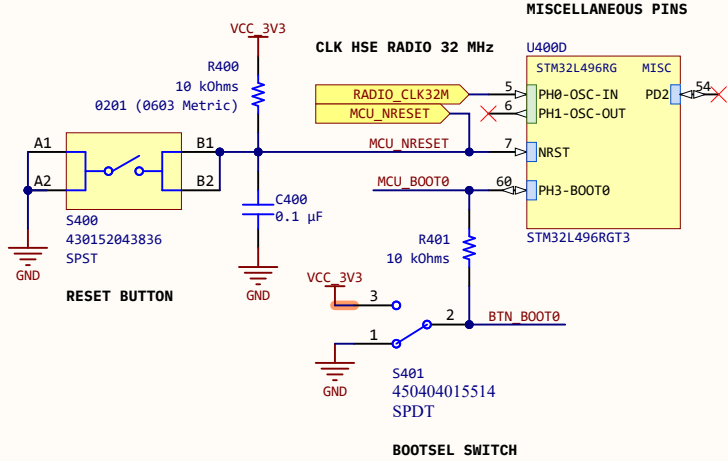
RESET signals are strongly pulled down in the mPCIe modules, but ENABLE signals are weakly pulled low.

CLK LSE 32.768 kHz
This MCU should use the MSI clock

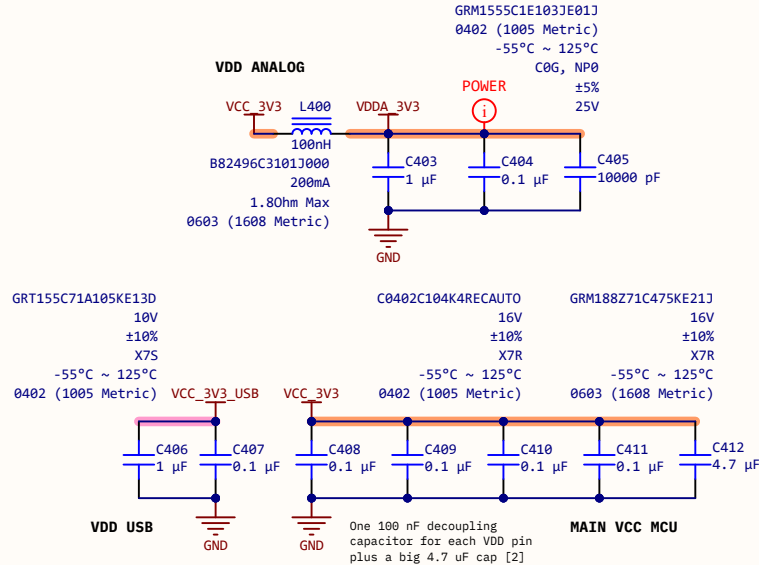
POWER PINS



Reset button and boot selection dip switch



Filtering & decoupling



Notes:

- [1] STMicroelectronics Inc. STM32L496xx Datasheet, DS11585, Rev 17, 11-2022
- [2] STMicroelectronics Inc. Getting started with STM32L4/L4+ hardware dev., AN4555, Rev 9, 11-2022
- [3] STMicroelectronics Inc. Oscillator design guide for STM32 MCUs, AN2687, Rev 19, 04-2023

Title: **Microcontroller**

Prj: Estigia Comms Payload - Cubesat carrier

Date: 2024-08-11 13:33:57 Last modified: 2024-08-11

Size: A4 Sheet 4 of 8

File: 4_mcu.SchDoc

Author: Juan Del Pino Mena

Approved: *

Prj. revision: 0.4

Variant: [No Variations]

Altium version: 24.3.1.35

License: --

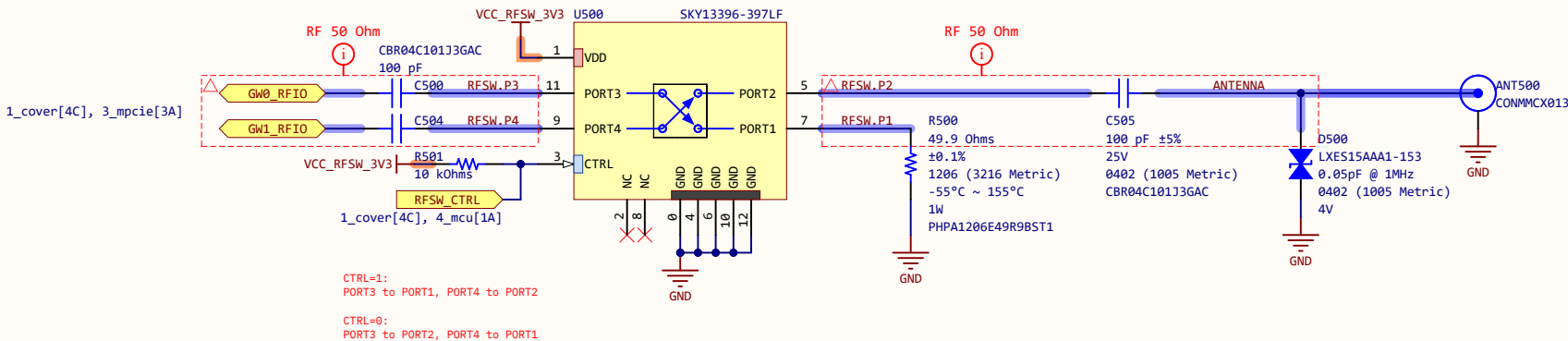
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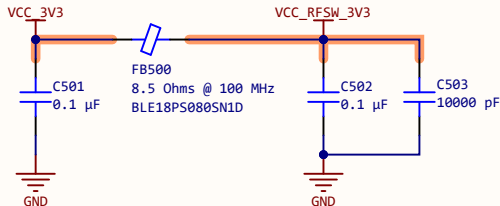
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RF connectors, switch and load



Decoupling capacitors and supply filtering



Notes:

Selects which module has access to the antenna, and connects the other one to a 50-ohm load.

[1] Skyworks Inc. SKY13396-397LF 400 MHz RO 3000 MHz DPDT Switch Module, 201475H, 7-2017

Title: RF path selection

Prj: Estigia Comms Payload - Cubesat carrier

Date: 2024-08-11 13:33:58 **Last modified:** 2024-08-11

Size: A4 **Sheet** 5 of 8

File: 5_rf_path.SchDoc

Author: Juan Del Pino Mena

Approved: *

Prj. revision: 0.4

Variant: [No Variations]

Altium version: 24.3.1.35

License: --

Git Hash: 8e980d747e300d217102f3d6dbc5ec10b92cd1fb [Locally Modified]

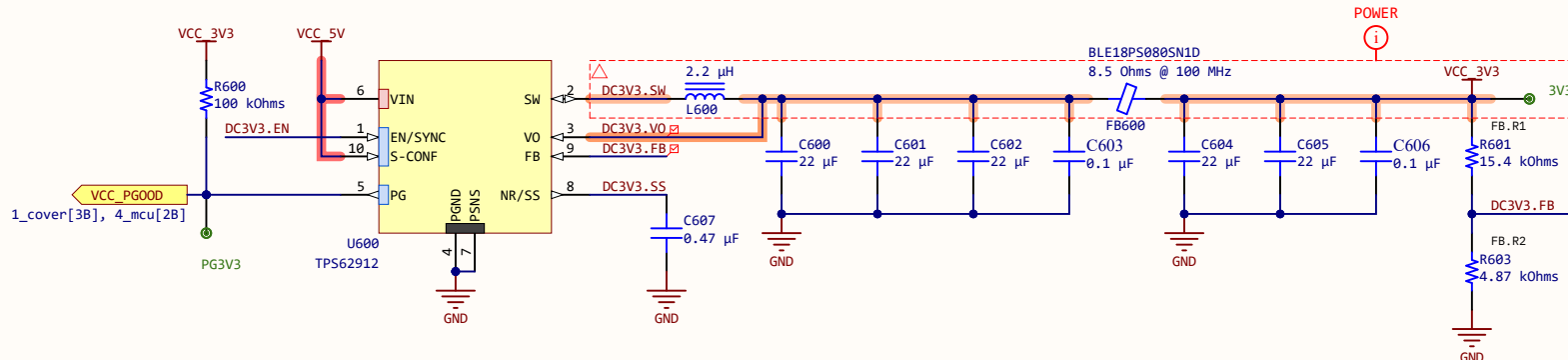
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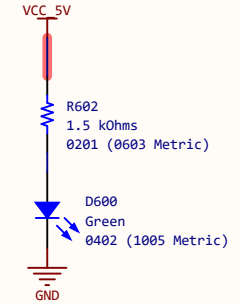


Low noise DC/DC converter - 3.3 V for MCU, CAN

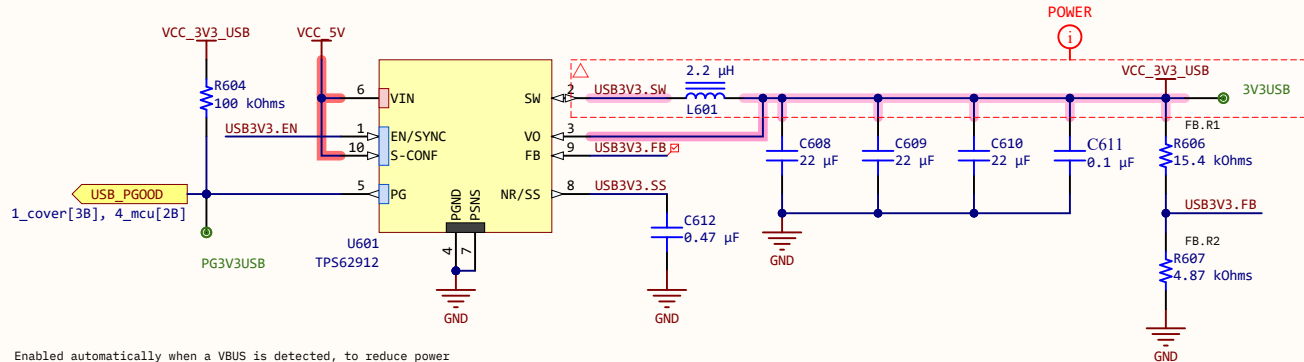


Main power supply

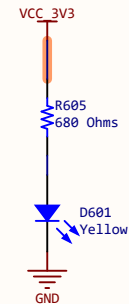
Power LED indicator



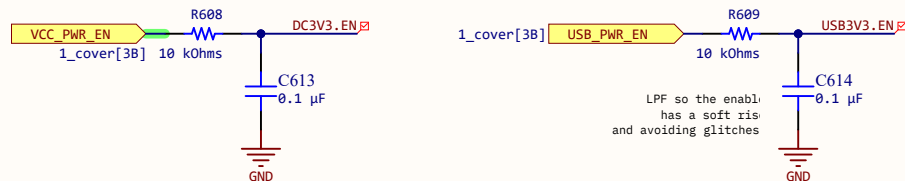
DC/DC converter - dirty 3.3 V for the MCU-USB peripheral



Enabled automatically when a VBUS is detected, to reduce power consumption. This supply is isolated from the rest to reduce noise.

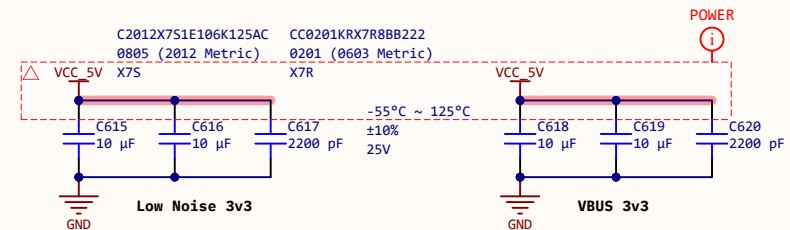


Enable input



Power supply tied to the global killswitch. When KILL=0, the payload enters shutdown mode: the power supply is disabled and all the components in the board are shut down.

Decoupling capacitors



Notes:

- [1] Texas Instruments Inc. TPS62912/3 datasheet, SLVSFP4B, 03-2021
[2] Texas Instruments Inc. INA232 datasheet, SB05AA2, 12-2022

Title: **Power management**

Prj: Estigia Comms Payload - Cubesat carrier

Date: 2024-08-11 13:33:58

Last modified: 2024-08-11

Size: A4

Sheet 6 of 8

File: 6_power.SchDoc

Author: Juan Del Pino Mena

Approved: *

Prj. revision: 0.4

Variant: [No Variations]

Altium version: 24.3.1.35

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Git Hash: 8e980d747e300d217102f3d6dbc5ec10b92cd1fb [Locally Modified]

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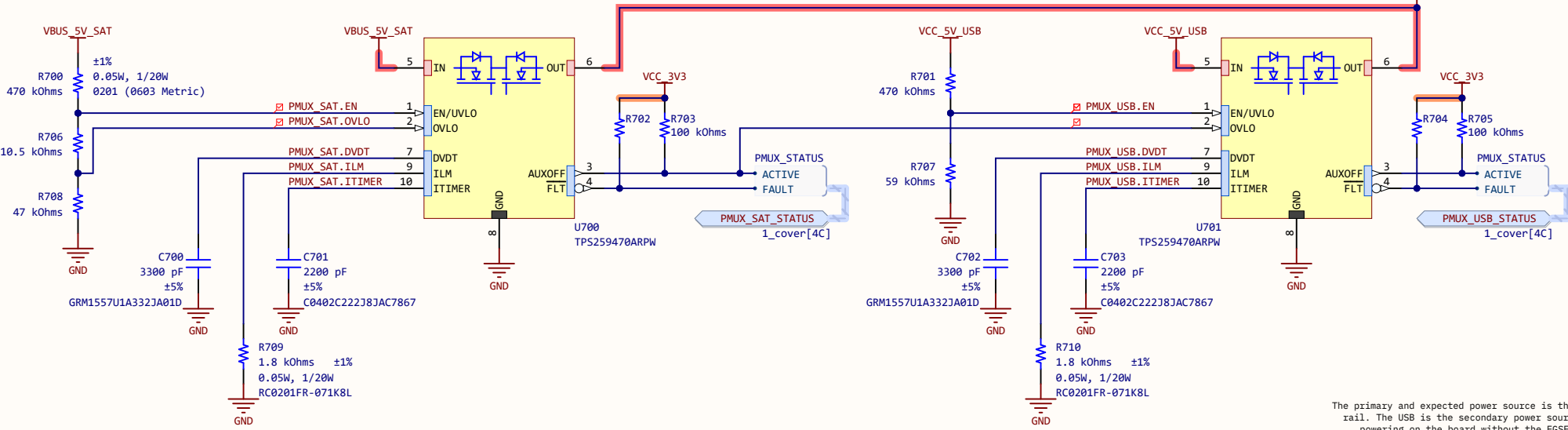


eFuse and power multiplexor

Priority power muxing, reverse current/polarity protection, over-current, over-voltage protection.

POWER FROM CUBESAT BUS
(PRIORITY)

POWER FROM USB
(SECONDARY)



The primary and expected power source is the Cubesat bus rail. The USB is the secondary power source and allows powering on the board without the EGSE, for example

Voltage, current and power monitor

R_SHUNT selection (early power budget estimation)

Carrier power consumption: 0.33 W (max)
LoRa SoM power consumption: 4.62 W (tx); 0.58 W (rx)
Expected total power consumption: [0.9 W, 5 W]
Thus, at V_{cc} = 5 V : current consumption: [0.18 A, 1 A]

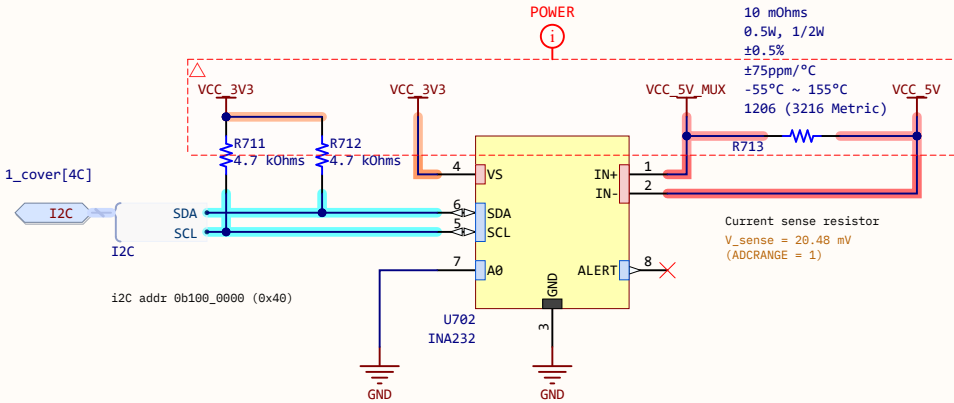
Account for an instantaneous peak current consumption of double the maximum: I_{peak} = 2 A

For minimum voltage drop, V_{sense} = 20.48 mV (INA232 cfg)

R_{shunt} < V_{sense} / I_{peak} = 10.24 mOhm

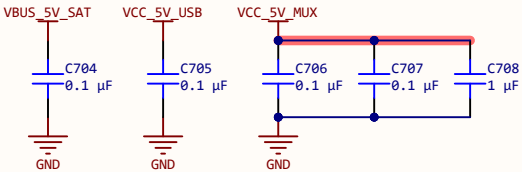
Power dissipated on R_{shunt}: 42 mW

R_{shunt} = 10 mOhm, tolerance <=0.5 %, power >= 0.1 W

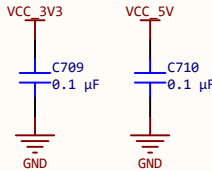


Decoupling capacitors

TPS259470A



INA232



Notes:

Title:

Prj: Estigia Comms Payload - Cubesat carrier

Date: 2024-08-11 13:33:58

Size: A4

File: 7_power_prot_mon.SchDoc

Last modified: 2024-08-11

Sheet 7 of 8

Author: Juan Del Pino Mena

Approved: *

Prj. revision: 0.4

Variants: [No Variations]

Altium version: 24.3.1.35

License: --

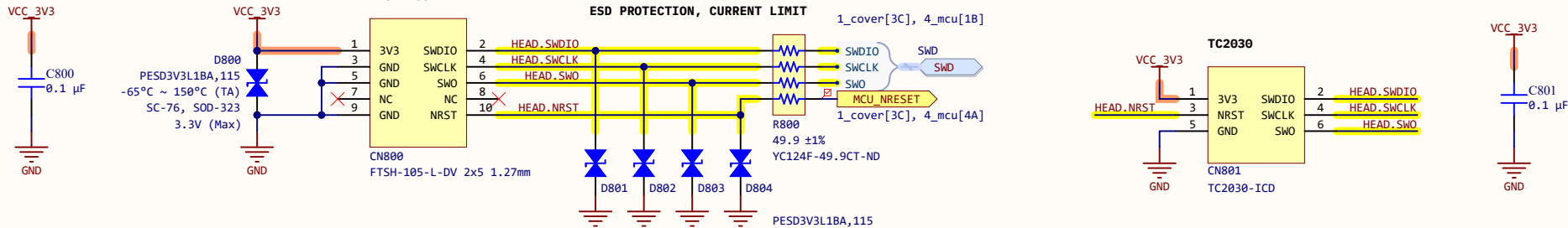
Git Hash: 8e980d747e300d217102f3d6dbc5ec10b92cd1fb [Locally Modified]

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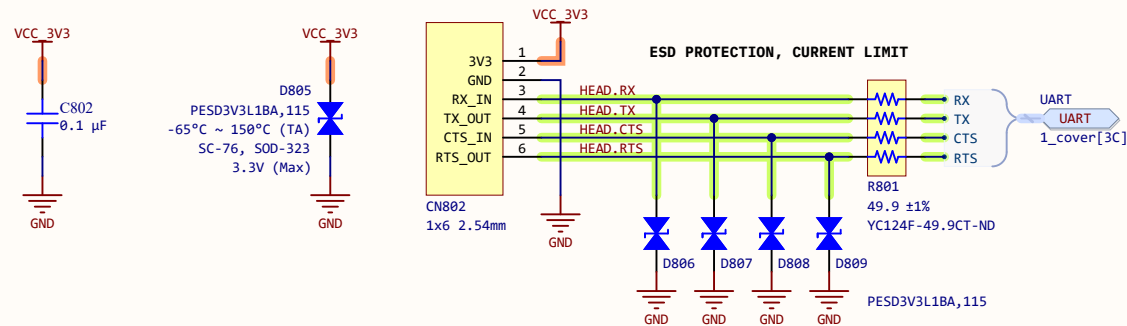


SWD



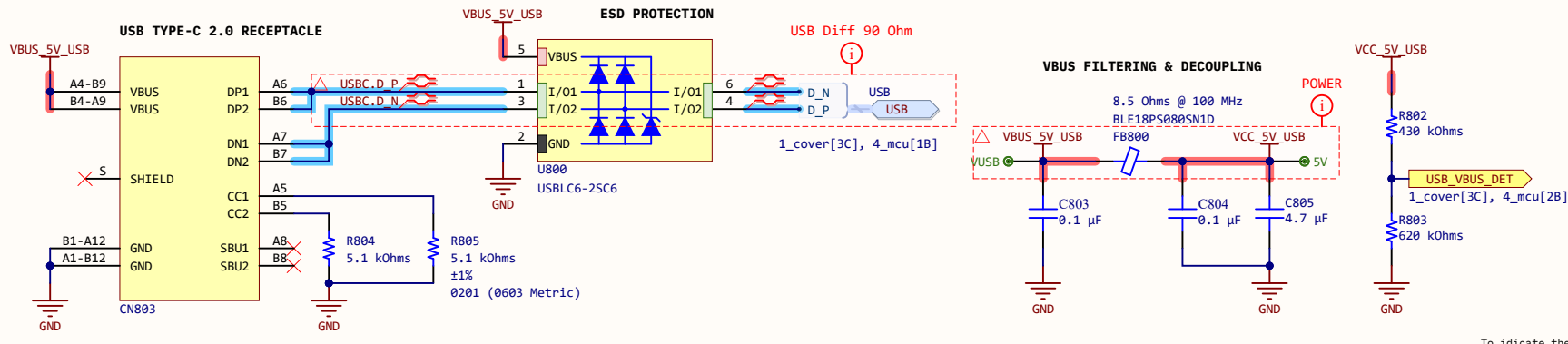
FTSH-105 and TC2030 share nets and ESD protections
(there are 2 possibilities for the same SWD interface!)

UART



CAUTION: UART SIGNALS ALREADY CROSSED!
Compatible serial adapter pinout:
1:3V3, 2:GND, 3:TXD, 4:RXD, 5:RTS, 6:CTS

USB



USB-C 2.0 interface. Pull down resistors on CC pins make the connector behave electrically as an USB type B, device only, which sinks up to 15 W (5V, 3A max).

This USB can be used for both power and comms

To indicate the microcontroller when to enable the USB peripheral

Notes:

- Miscellaneous connectors: Debug, UART, USB. With ESD protections.
- [1] STMicroelectronics Inc. STLINK-V3MINIE debugger/programmer User Manual, UM2910, Rev 3, 04-2024
 - [2] Tag-connect, ARM-CTX (20-pin ARM to TC2030) adapter for SWD datasheet.
 - [3] Tag-connect, TC2030-IDC datasheet, Rev B, 05-2019
 - [4] STMicroelectronics Inc. AN4879, Rev 6,

Title: **Miscellaneous ports**

Prj: Estigia Comms Payload - Cubesat carrier

Date: 2024-08-11 13:33:59 Last modified: 2024-08-11

Size: A4 Sheet 8 of 8

File: 8_ports.SchDoc

Author: Juan Del Pino Mena

Approved: *

Prj. revision: 0.4

Variant: [No Variations]

Altium version: 24.3.1.35

License: --

Git Hash: 8e980d747e300d217102f3d6dbc5ec10b92cd1fb [Locally Modified]

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