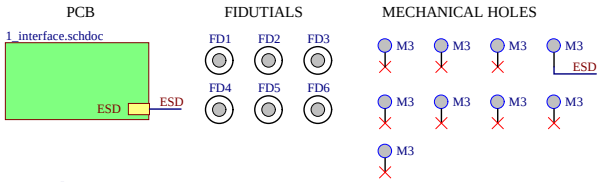
Rev	Description	Date	Author
0.1	- Initial release - Update beacon radio output - General updates for compliance with the SpaceLab hardware development standards	28-Aug-2020	Andre M. P. Mattos
0.2	- Added variant types for test and flight models, draftsman source and PDF output - Updated schematic templates - Updating battery monitor and minor fixes	16-Jun-2021	Yan C. de Azeredo

Revision History



PCB Elements

EPS2 Hardware:

- Drawn by: André M. P. Mattos (updates from FloripaSat-I EPS)
- Based on FloripaSat-I OBDH designed by: Sara V. Martinez
- Reviewers: Kleber Gouveia and Yan C. Azeredo
- Support: Gabriel M. Marcelino

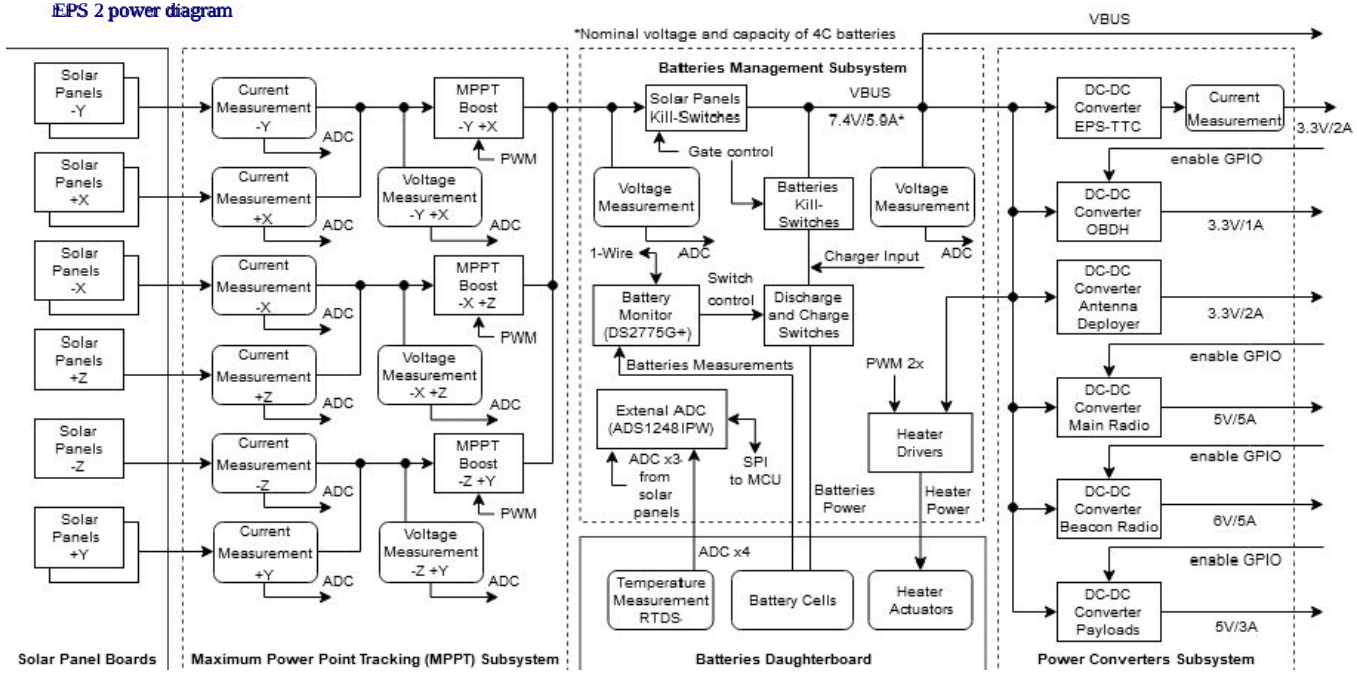
Project Contributions

Github repository: https://github.com/spacelab-ufsc/eps2

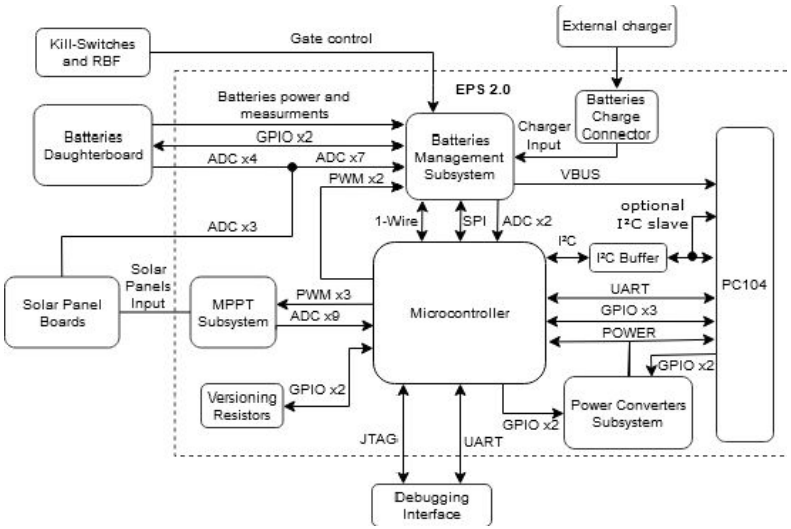
More info about SpaceLab: https://spacelab.ufsc.br/

Project Information

EPS 2 power diagram



EPS 2 MCU diagram

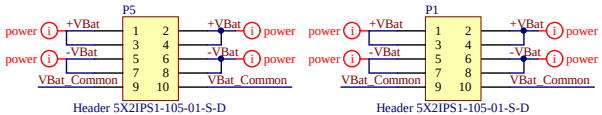


SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *Block diagram*			
Engineer: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *1* of *11*	Size: A3

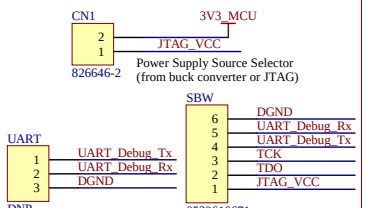
SOLAR PANNELS POWER INTERFACES

+Y — Panel+Y — PGND — Header 4_PicoBlade
-Y — Panel-Y — PGND — Header 4_PicoBlade
+X — Panel+X — PGND — Header 4_PicoBlade
-X — Panel-X — PGND — Header 4_PicoBlade
+Z — Panel+Z — PGND — Header 4_PicoBlade
-Z — Panel-Z — PGND — Header 4_PicoBlade

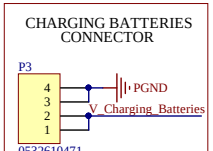
BATTERY BOARD POWER INTERFACES



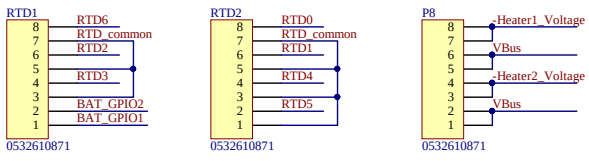
DEBUG AND PROGRAMMING INTERFACES



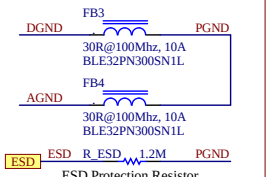
CHARGING BATTERIES CONNECTOR



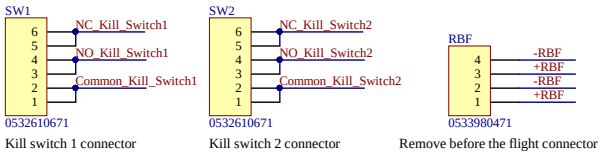
BATTERY BOARD SENSORS AND CONTROL INTERFACES



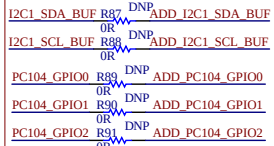
GROUNDING



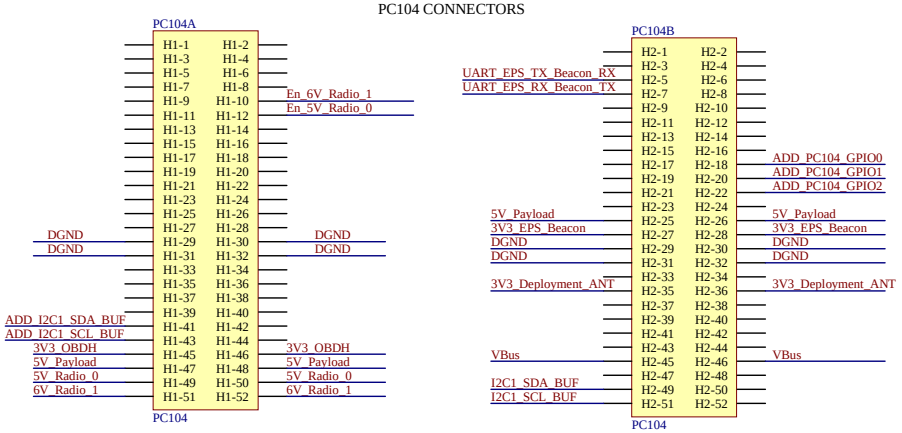
EXTERNAL SWITCHES INTERFACES



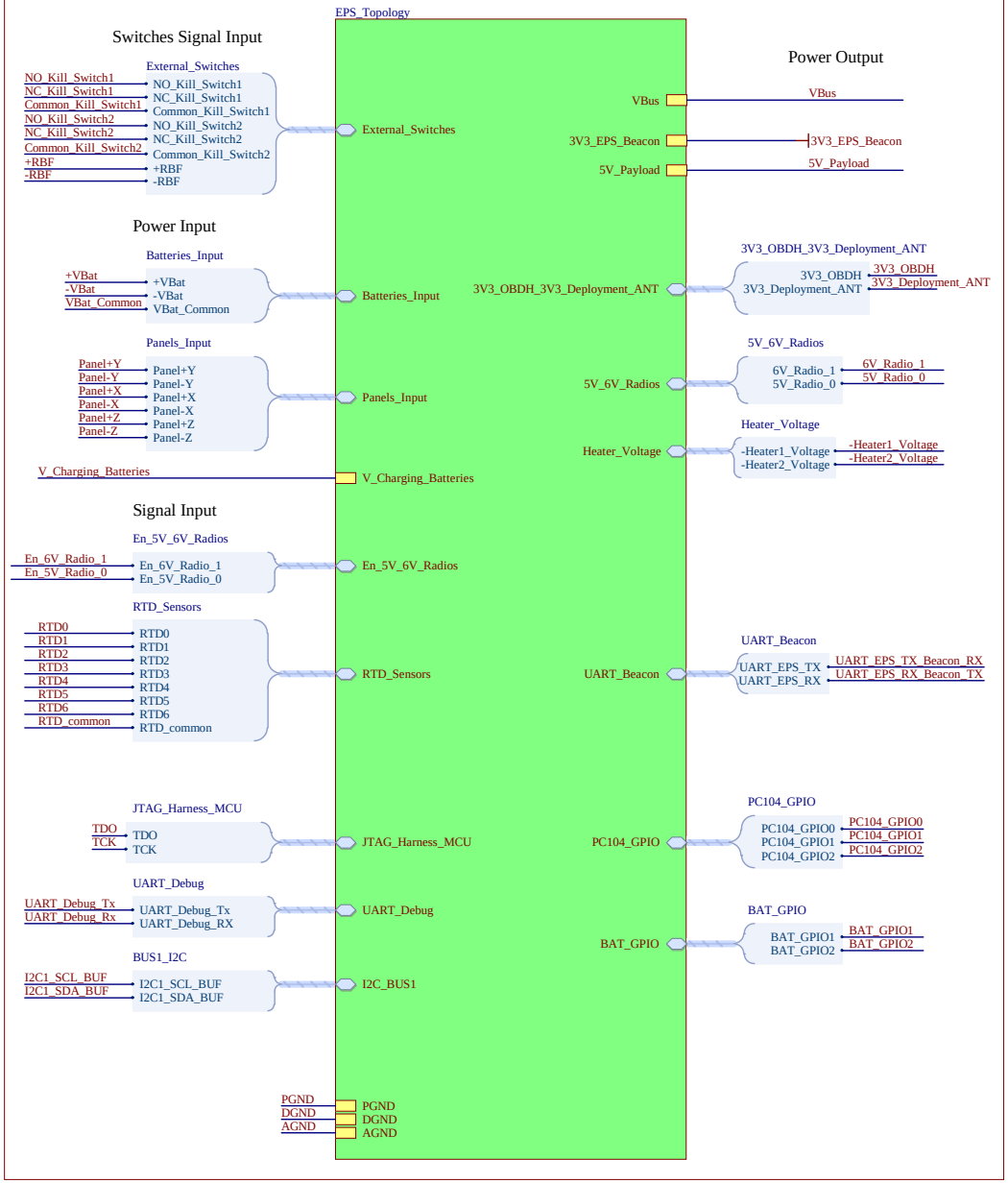
ADDITIONAL INTERFACES



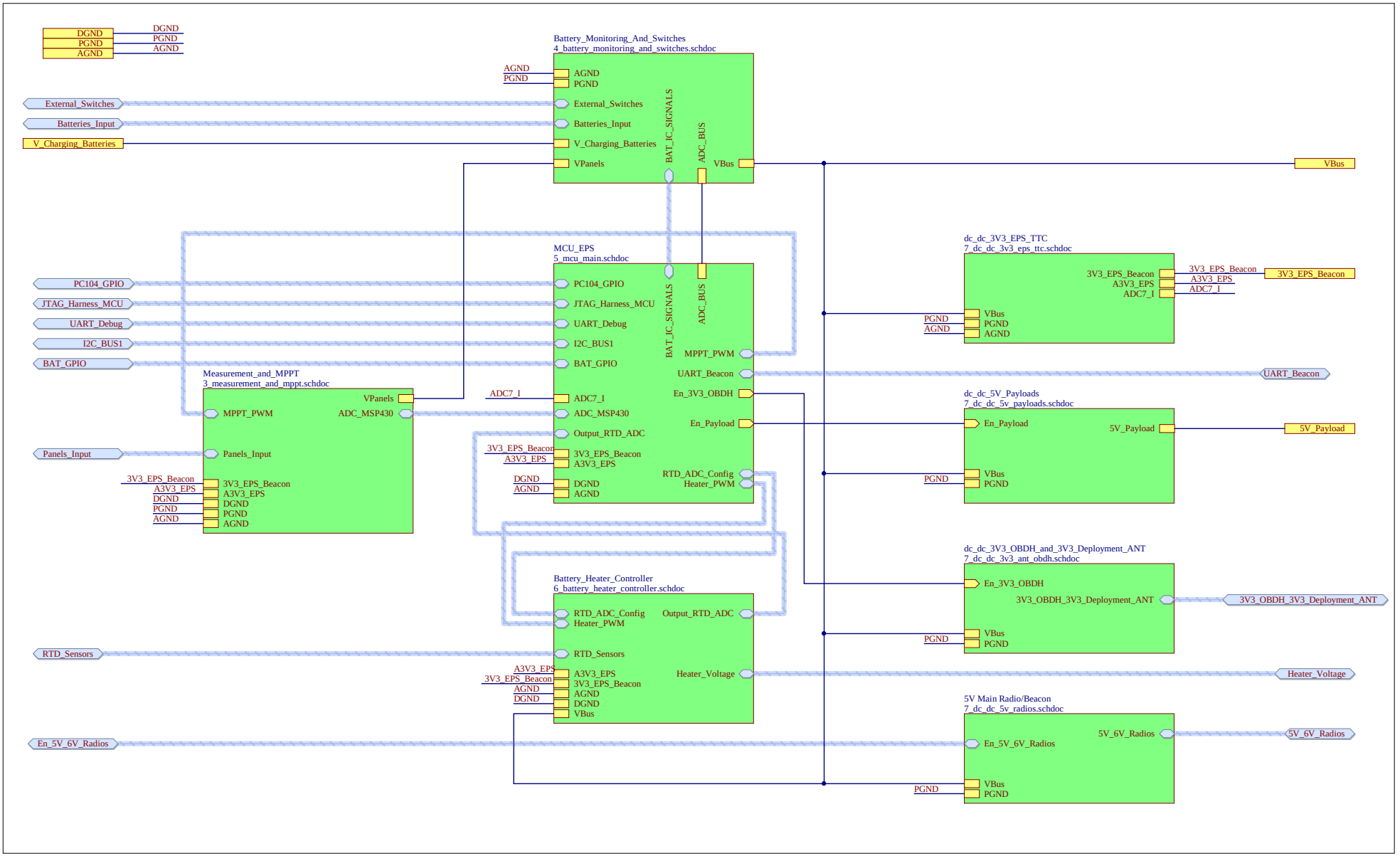
PC104 CONNECTORS



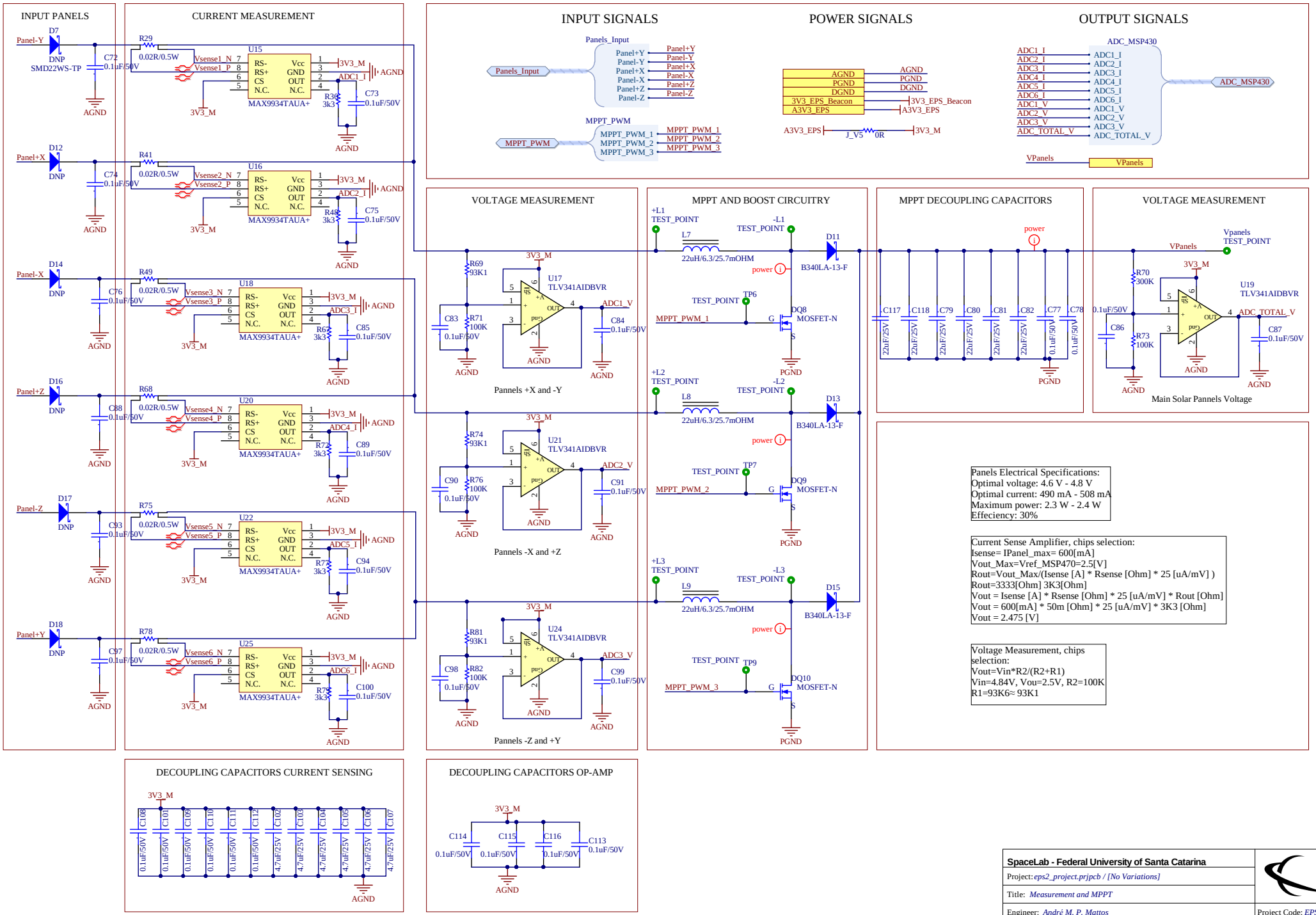
ELECTRICAL POWER SYSTEM TOPOLOGY INTERFACES



SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *EPS Interface*			
Engineer: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *2* of *11*	Size: A3



SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *EPS Topology*			
Engineer: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *3* of *11*	Size: A3


INPUT PANELS
CURRENT MEASUREMENT
INPUT SIGNALS
POWER SIGNALS
OUTPUT SIGNALS
VOLTAGE MEASUREMENT
MPPT AND BOOST CIRCUITRY
MPPT DECOUPLING CAPACITORS
VOLTAGE MEASUREMENT
Pannels +X and -Y
Pannels -X and +Z
Pannels -Z and +Y
Main Solar Pannels Voltage
DECOUPLING CAPACITORS CURRENT SENSING
DECOUPLING CAPACITORS OP-AMP
Panels Electrical Specifications:
Optimal voltage: 4.6 V - 4.8 V
Optimal current: 490 mA - 508 mA
Maximum power: 2.3 W - 2.4 W
Effeciency: 30%
Current Sense Amplifier, chips selection:
Isense= IPanel_max= 600[mA]
Vout_Max=Vref_MSP470=2.5[V]
Rout=Vout_Max/(Isense [A] * Rsense [Ohm] * 25 [uA/mV])
Rout=3333[Ohm] 3K3[Ohm]
Vout = Isense [A] * Rsense [Ohm] * 25 [uA/mV] * Rout [Ohm]
Vout = 600[mA] * 50m [Ohm] * 25 [uA/mV] * 3K3 [Ohm]
Vout = 2.475 [V]
Voltage Measurement, chips selection:
Vout=Vin*R2/(R2+R1)
Vin=4.84V, Vou=2.5V, R2=100K
R1=93K6≈ 93K1
SpaceLab - Federal University of Santa Catarina
Project: eps2_project.prjpcb / [No Variations]
Title: Measurement and MPPT
Engineer: André M. P. Mattos
Project Code: EPS2
Date: 16/06/2021
Revision: v0.2
Sheet 4 of 11
Size: A3

SEPARATION SWITCHES

Q3 MOSFET-P-SI4403CDY-T1-GE3

VPanels
Panels Power

Q4

RBF: Remove before the flight
+VBat +RBF -RBF

Launch Swich (Partnumber: DH2C-B1PA)
+VBat NO_Kill_Switch1
R35 NC_Kill_Switch1 Common_Kill_Switch1
100K 1/10W
PGND

Solar Panels Separation Switch

Q5
Q6

VBus_TP
TEST_POINT

RBF: Remove before the flight
+VBat +RBF -RBF

Launch Swich (Partnumber: DH2C-B1PA)
+VBat NO_Kill_Switch2
R85 NC_Kill_Switch2 Common_Kill_Switch2
100K 1/10W
PGND

Batteries Separation Switch

RBF	Switch(NC)	Switch(NO)	MOSFET	EPS POWER
1	X	X	OPEN	Cut-off
0	1	0	CLOSE	ON
0	0	1	OPEN	Cut-off (launch moment)

VOLTAGE MEASUREMENT

PGND
VBUS_LED
DNP
R31 1k
Load Power
VBus

3V3_M
R45 300K
C121 0.1uF/50V
C120 0.1uF/50V
R86 100K
U26 TLV341AIDBVR
ADC_BUS
C119 0.1uF/50V
AGND

Bus Voltage Measurement, chips selection:
Vout=Vin*R2/(R2+R1)
Vin=10V, Vou=2.5V, R2=100K
R1=300K

BATTERY MONITOR CIRCUITRY

Charger Connector Input
power
V_Charging_Batteries

Condition for charging batteries:
ICR18650-30B
- Charging Voltage: 8.8V
- Temperature: 25℃
- Standard Charging Current: 1475mA
- Standard Charging Time : 3 hours

Monitor bypass jumper (Do not solder!)
R93 0R DNP

C37 1000pF/50V
C38 1000pF/50V

U6 FDS6898AZ
+VBat

CC TEST_POINT
DC TEST_POINT

R37 1k
R38 470R
R39 1k
R40 1k
R33 150R
R34 1k

U7 DS2777G+
I2C0_SDA R42 150R
PIO R44 150R
R43 1k
VBat_Common

3SMAJ5919B-TP
DNP
C40 0.1uF/50V
C39 0.47uF/50V
C41 0.1uF/50V
D5 D6 D8

V_sense0_N
V_sense0_P
RSense1 0.01R/0.5W
R92 150R
I2C0_SCL
R46 0R
R47 0R
Bat2-
-VBat

Rsenser for battery monitoring:
(Datasheet : DS2775, pag 17)
Rsense=10mOhms (LVK12R010DER)
Current Range: ± 5.12A
ACR Resolution = 625µAh
ACR Range = ±40.96Ah

Battery Monitoring

External_Switches
NO_Kill_Switch1
NC_Kill_Switch1
Common_Kill_Switch1
NO_Kill_Switch2
NC_Kill_Switch2
Common_Kill_Switch2
+RBF
-RBF

Batteries_Input
+VBat
-VBat
VBat_Common

AGND
PGND
V_Charging_Batteries
VPanels

VBus

Bidirectional

BAT_IC_SIGNALS
PIO
I2C0_SCL
I2C0_SDA

ADC_BUS

SpaceLab - Federal University of Santa Catarina	
Project: *eps2_project.prjpcb / [No Variations]*	
Title: *Batteries Monitor and Power Switches*	
Engineer: *André M. P. Mattos*	Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*
Sheet *5* of *11*	Size: A3

ADC_MSP430

ADC_MSP430
ADC1_I
ADC2_I
ADC3_I
ADC4_I
ADC5_I
ADC6_I
ADC1_V
ADC2_V
ADC3_V
ADC_TOTAL_V

Output_RTD_ADC

Output_RTD_ADC
RTD_DOUT
RTD_DRDY

JTAG_Harness_MCU

JTAG_Harness_MCU
TDO
TCK

PC104_GPIO

PC104_GPIO
PC104_GPIO0
PC104_GPIO1
PC104_GPIO2

BAT_GPIO

BAT_GPIO
BAT_GPIO1
BAT_GPIO2

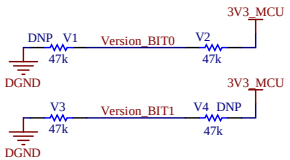
ADC_BUS
ADC7_I

A3V3_EPS
AGND

3V3_EPS_Beacon
DGND

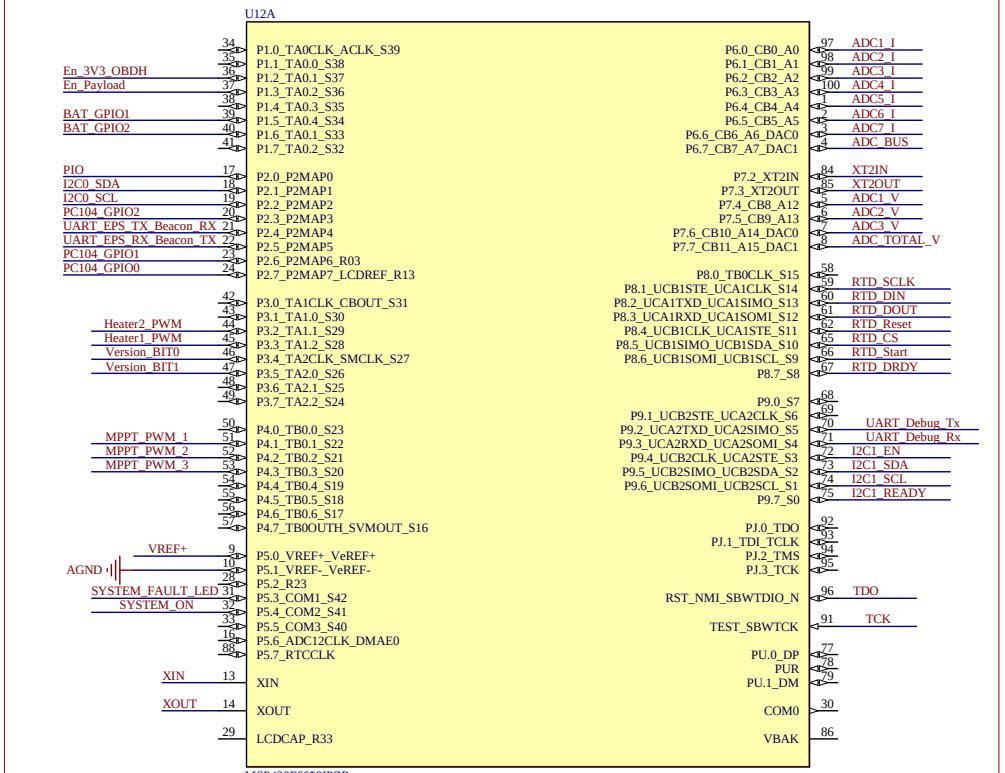
3V3_EPS_Beacon
J_V3
0R
3V3_MCU

VERSIONING RESISTORS

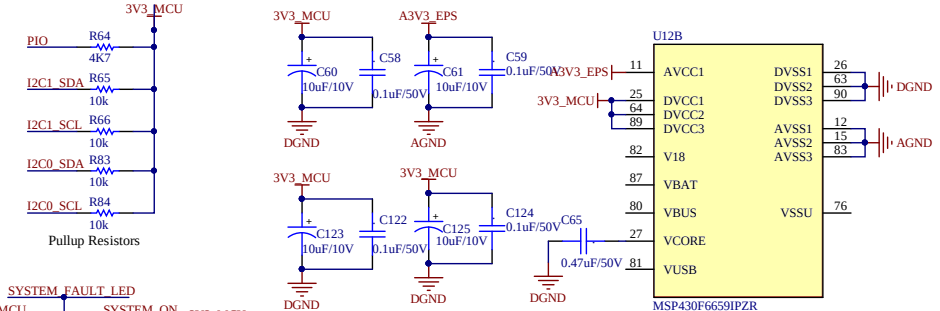


Configuration for version v0.2

MICROCONTROLLER CIRCUITRY (MCU)



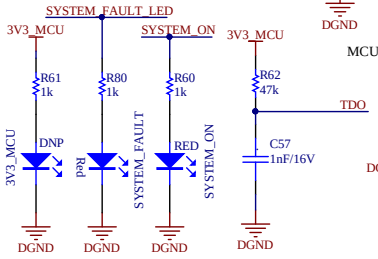
MCU Signals



Pullup Resistors

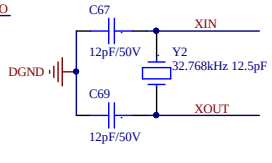
MCU Decoupling Capacitors

MCU Power

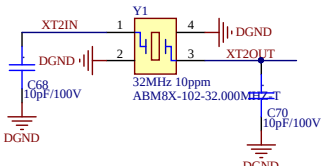


System LEDs

Reset and JTAG pullup



Auxiliary Crystal



Main Crystal

MPPT_PWM
MPPT_PWM_1
MPPT_PWM_2
MPPT_PWM_3
MPPT_PWM

RTD_ADC_Config
RTD_SCLK
RTD_DIN
RTD_CS
RTD_Reset
RTD_Start
RTD_ADC_Config

Heaters_PWM
Heater1_PWM
Heater2_PWM
Heater_PWM

UART_Debug
UART_Debug_Tx
UART_Debug_Rx
UART_Debug

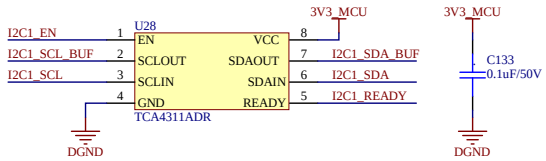
UART_Beacon
UART_EPS_TX_Beacon_RX
UART_EPS_RX_Beacon_TX
UART_Beacon

BAT_IC_SIGNALS
PIO
I2C0_SCL
I2C0_SDA
BAT_IC_SIGNALS

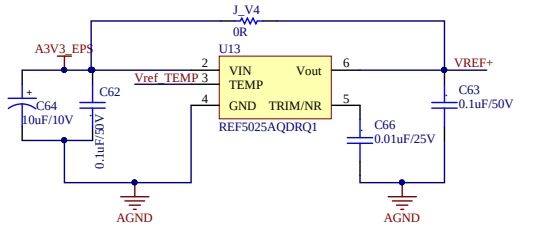
BUS1_I2C
I2C1_SCL_BUF
I2C1_SDA_BUF
I2C_BUS1

En_Payload
En_3V3_OBDH

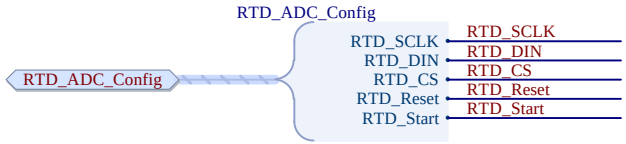
I2C BUFFER CIRCUIT

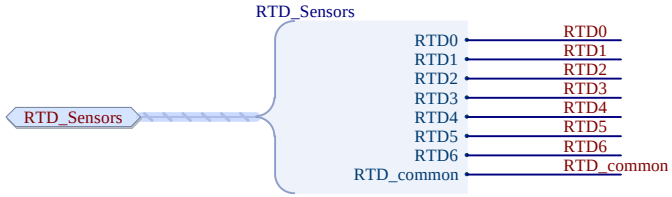


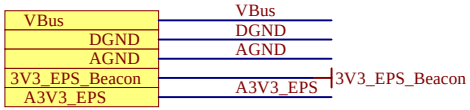
VOLTAGE REFERENCE CIRCUIT

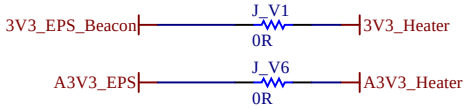


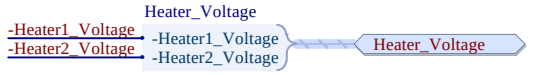
SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *EPS MCU Main*			
Engineer: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *6* of *11*	Size: A3



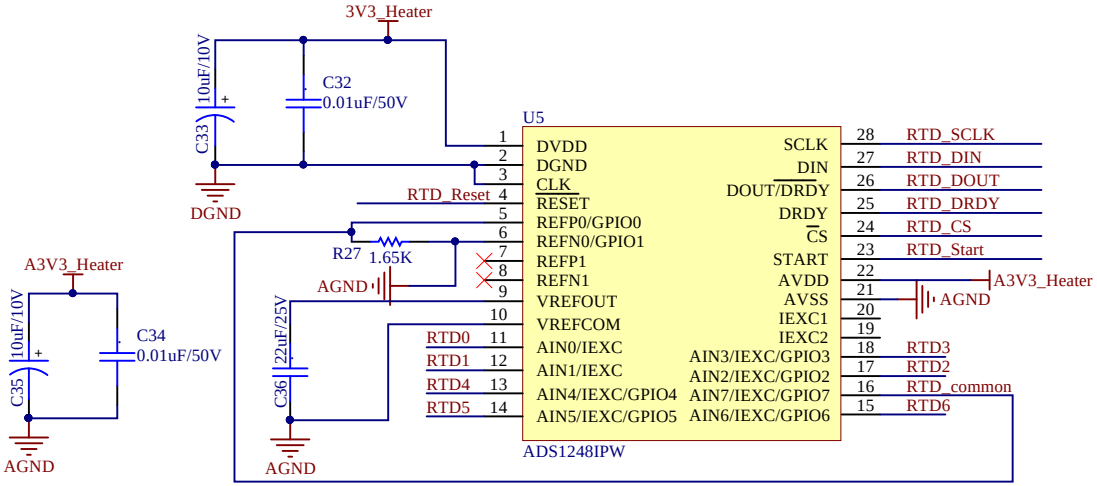








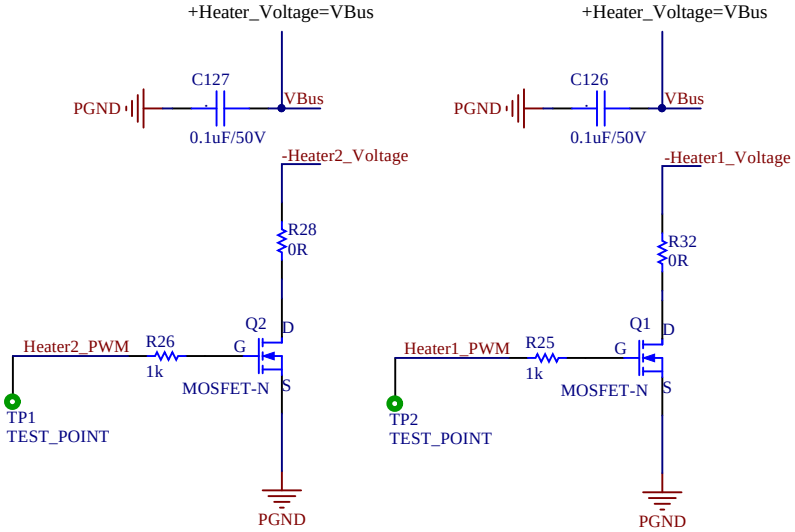
HEATERS SENSORS (RTD)



Decoupling capacitors

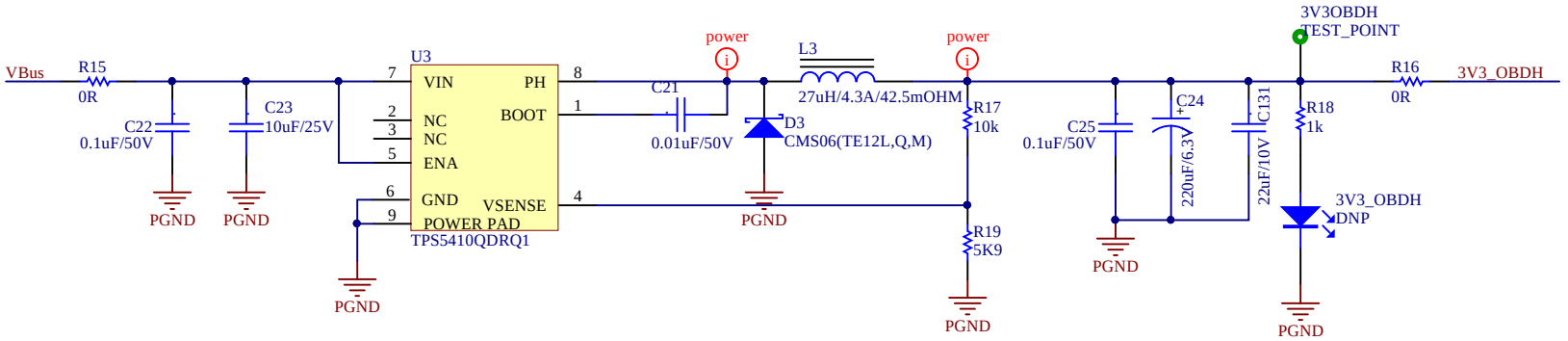
Analog-to-Digital Converter (for temperature acquisition through external thermocouples)

HEATERS ACTUATORS (PWM)



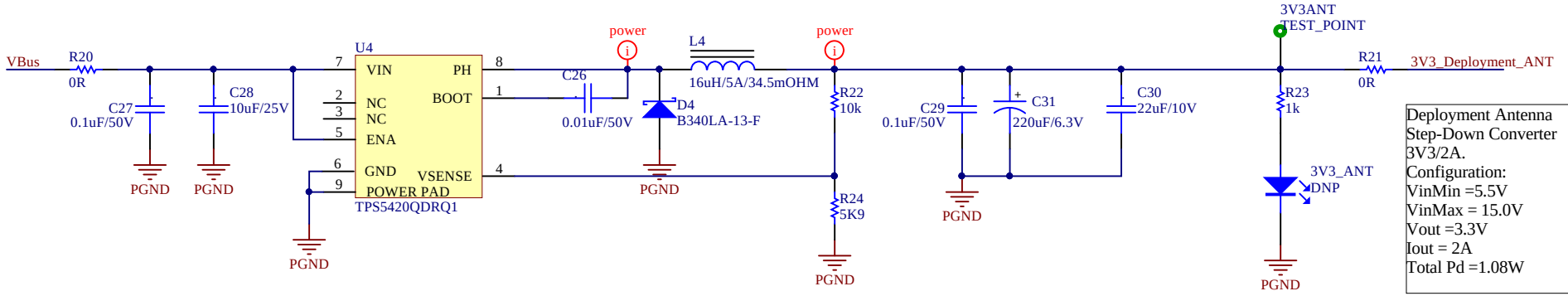
SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *Batteries Heater Controller and RTD ADC*			
Designed by: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *7* of *11*	Size: A4

OBDH STEP-DOWN CONVERTER 3V3/1A



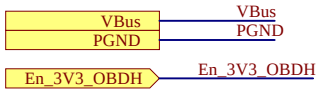
OBDH Digital dc/dc converter 3V3/1A.
Configuration:
VinMin = 6.5V
VinMax = 15.0V
Vout = 3.3V
Iout = 1A
Pd = 0.58W

ANTENNA DEPLOYER STEP-DOWN CONVERTER 3V3/2A



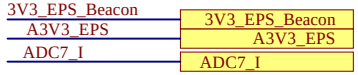
Deployment Antenna Step-Down Converter 3V3/2A.
Configuration:
VinMin =5.5V
VinMax = 15.0V
Vout =3.3V
Iout = 2A
Total Pd =1.08W

Input

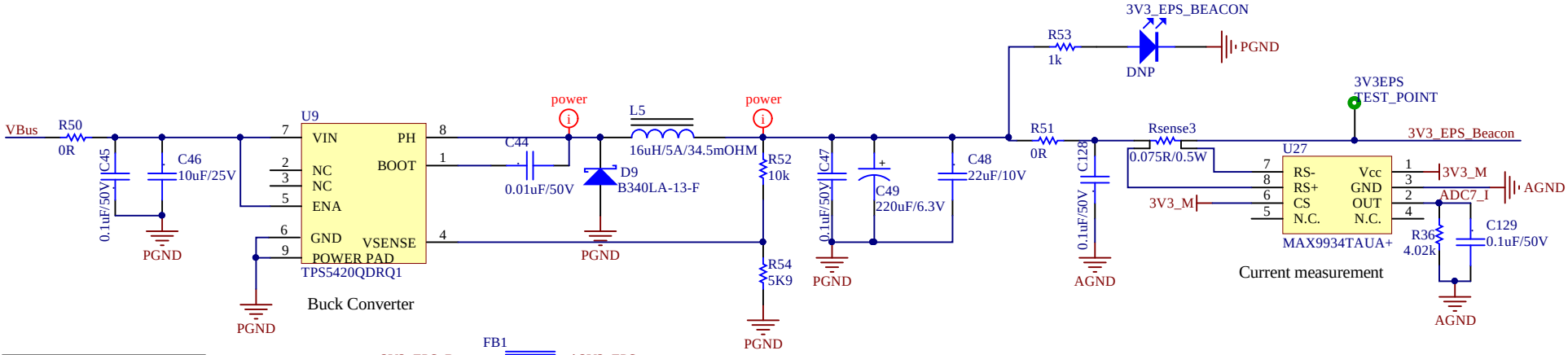


Output

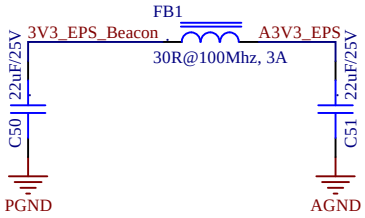
SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *OBDH and Antenna Deployment Step-Down (3V3/1A and 3V3/2A)*			
Designed by: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *8* of *11*	Size: A4



EPS/BEACON STEP-DOWN CONVERTER 3V3/2A

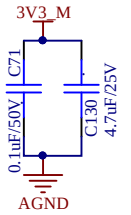


Beacon/EPS Digital dc/dc converter 3V3/2A:
Configuration:
VinMin =5.5V
VinMax = 15V
Vout = 3.3V
Iout = 2A
Footprint = 81.0 mm2
Total Pd = 1.21W



High frequency noise reduction ferrite bread

Current Sense Amplifier, chips selection:
I_EPS_Beacon=300[mA]
Vout_Max=Vref_MSP470=2.5[V]
Rout=Vout_Max/(Isense [A] * Rsense [Ohm] * 25 [uA/mV])
Rout=4065[Ohm] 4.02 k[Ohm]
Vout = Isense [A] * Rsense [Ohm] * 25 [uA/mV] * Rout [Ohm]
Vout = 300[mA] * 82m [Ohm] * 25 [uA/mV] * 4.02 k [Ohm]
Vout = 2.4723 [V]



SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *EPS/Beacon Step-Down Converter (3V3/2A)*			
Designed by: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *9* of *11*	Size: A4

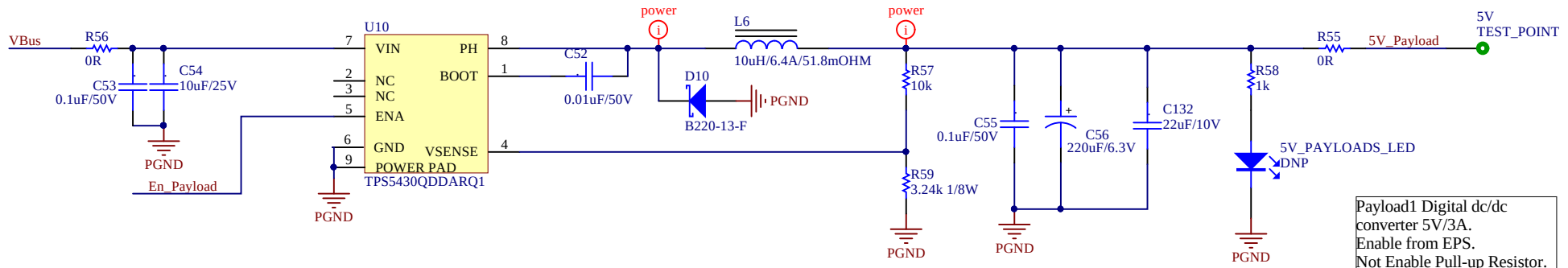
Input

VBus
PGND
En_Payload

Output

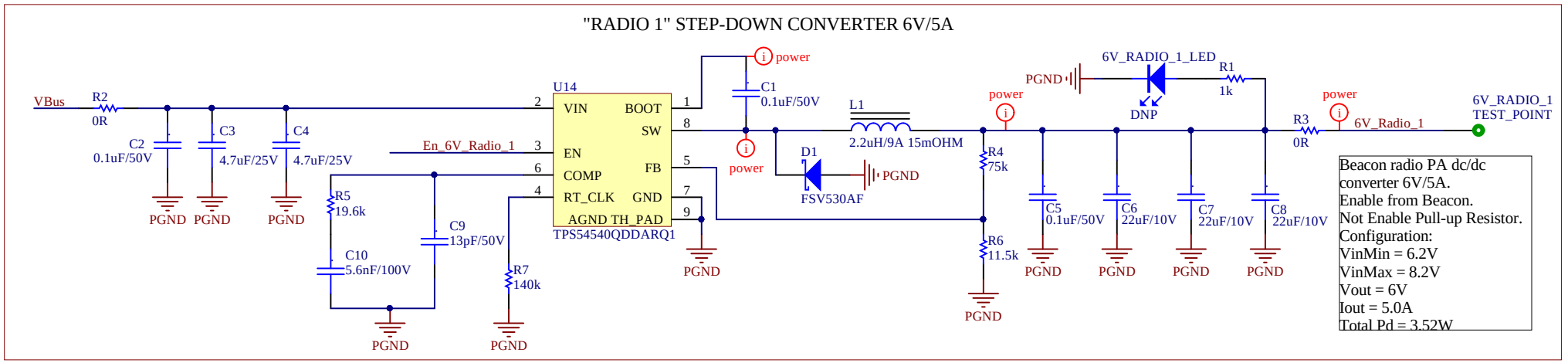
5V_Payload

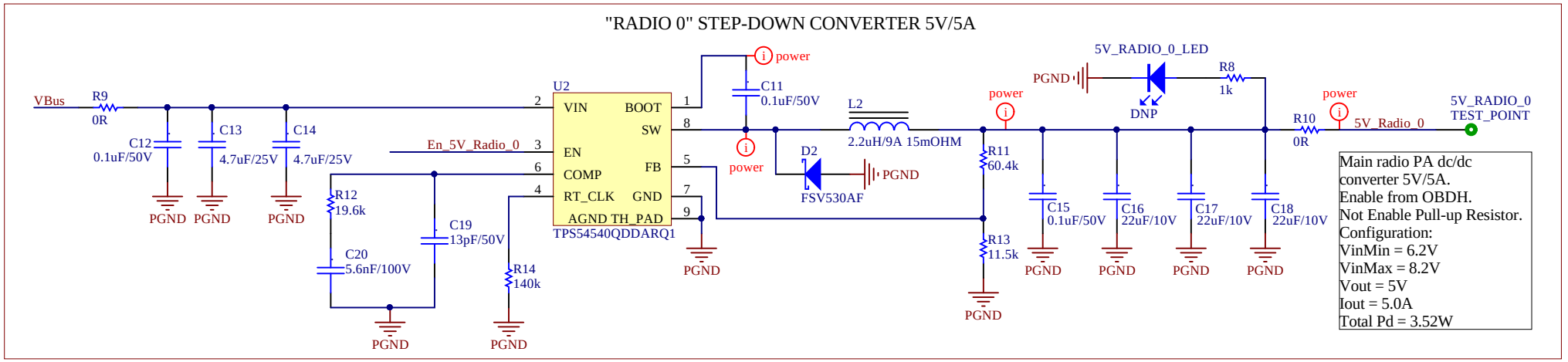
PAYLOAD STEP-DOWN CONVERTER 5V/3A

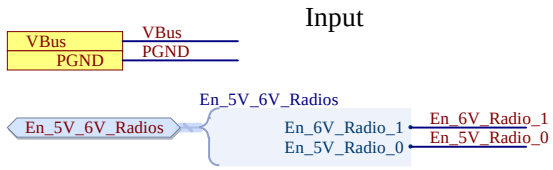


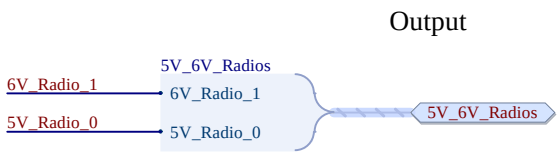
Payload1 Digital dc/dc converter 5V/3A.
Enable from EPS.
Not Enable Pull-up Resistor.
Configuration:
VinMin = 6.2V
VinMax = 8.4V
Vout = 5.0V
Iout = 3.0A
Total Pd = 1.83W

SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *Payloads Step-Down Converters (5V/3A)*			
Designed by: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *10* of *11*	Size: A4









SpaceLab - Federal University of Santa Catarina			
Project: *eps2_project.prjpcb / [No Variations]*			
Title: *Beacon and Main Radio Step-Down Converters (6V/3A and 5V/3A)*			
Designed by: *André M. P. Mattos*			Project Code: *EPS2*
Date: 16/06/2021	Revision: *v0.2*	Sheet *11* of *11*	Size: A4