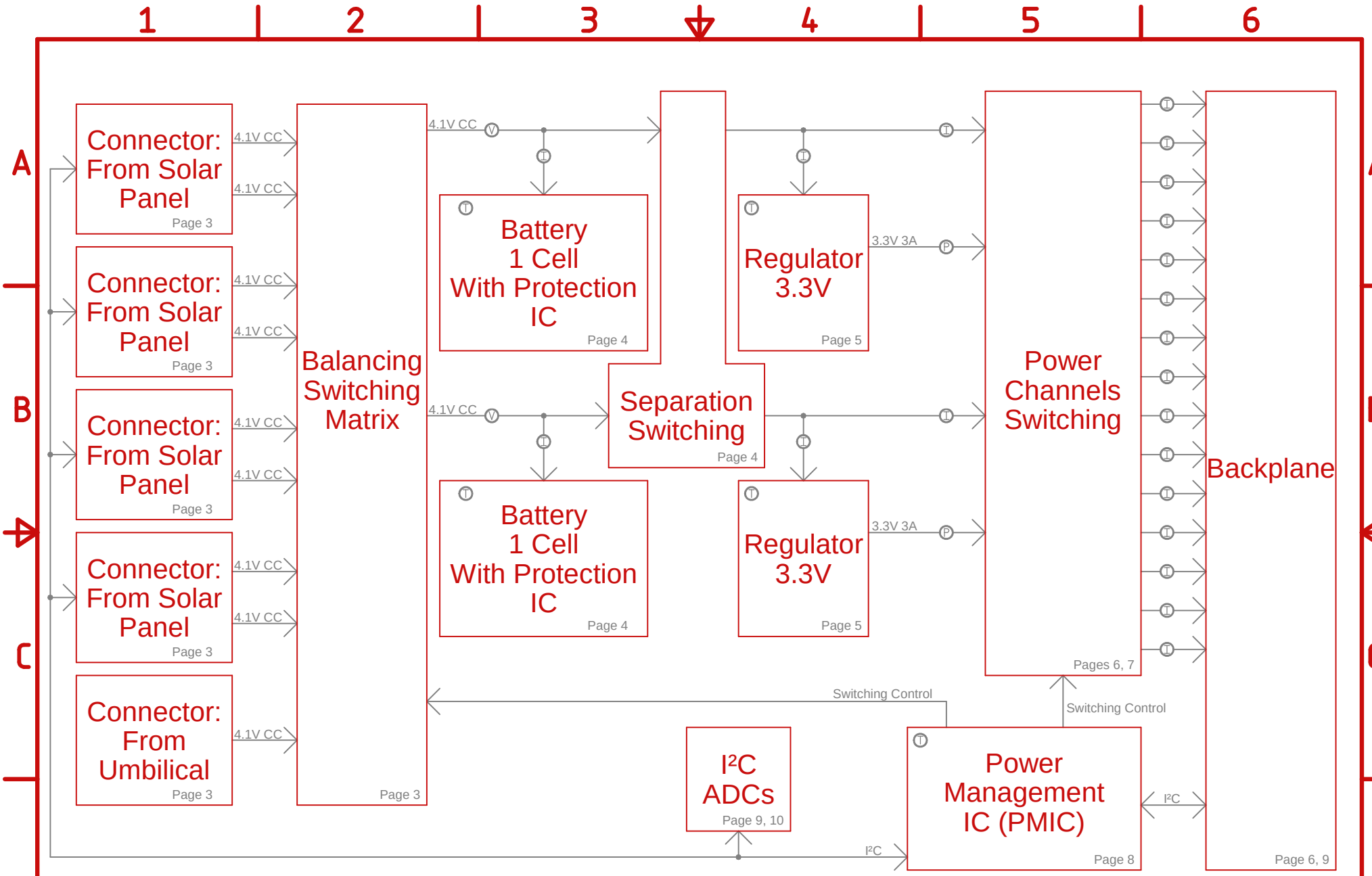
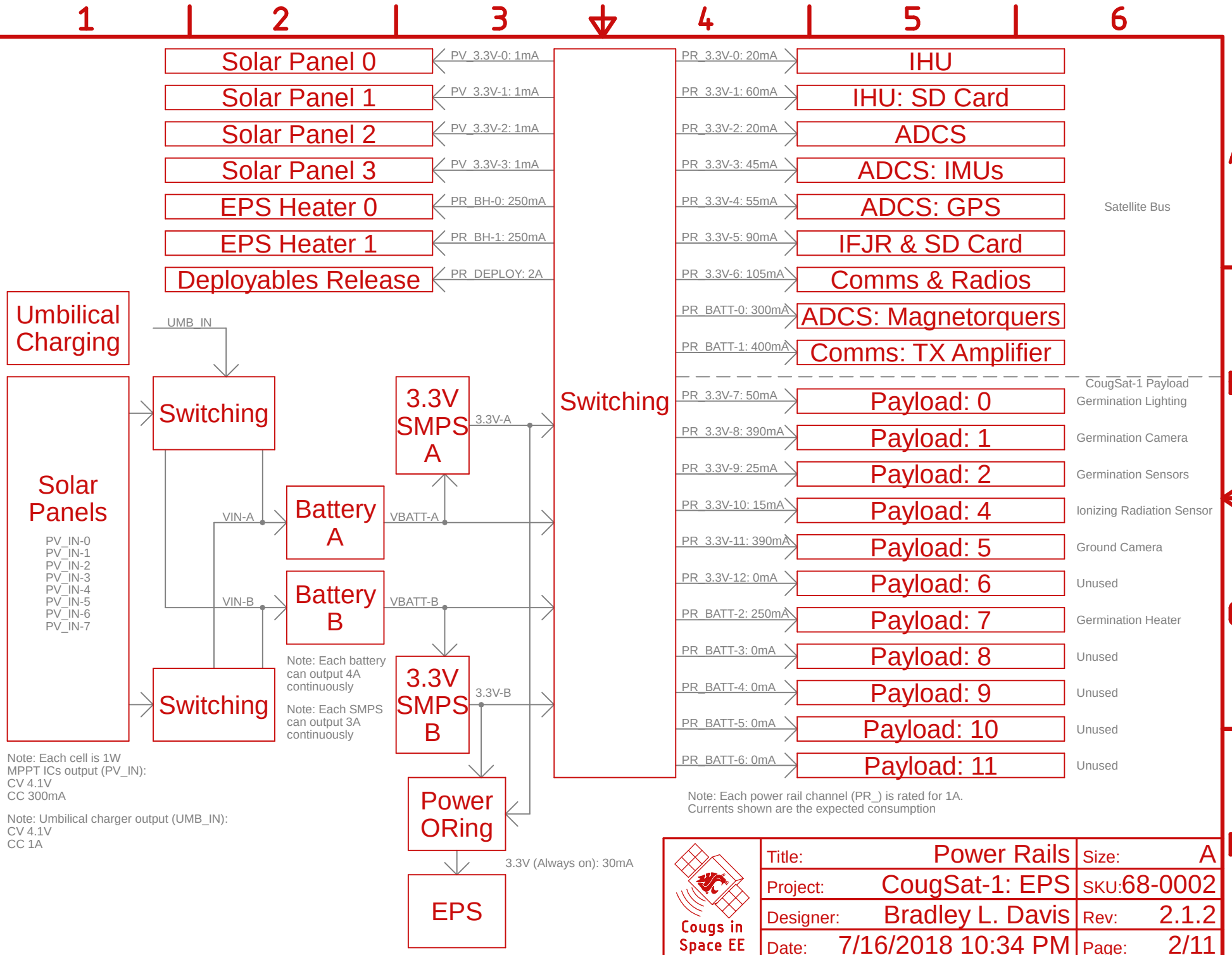
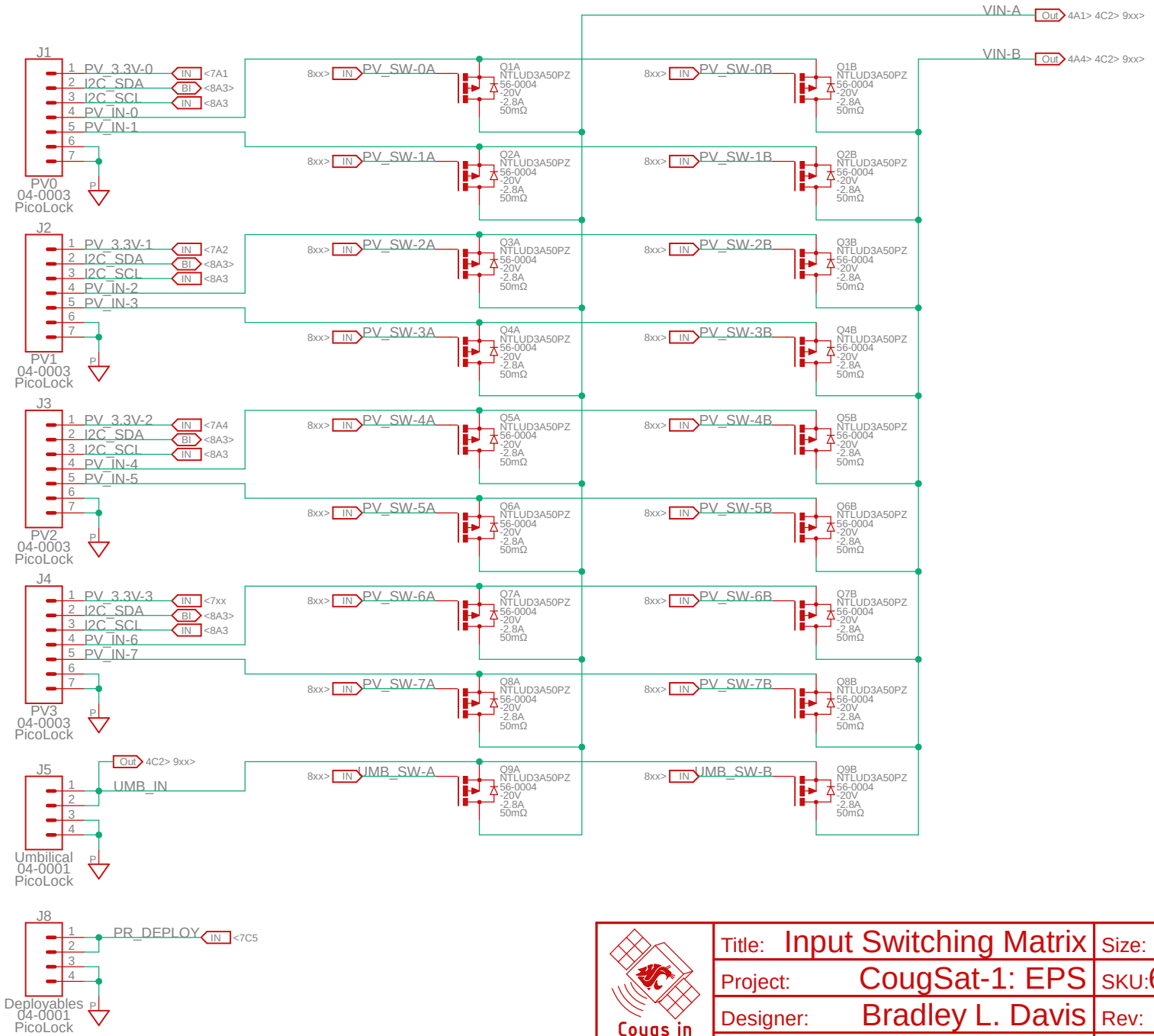


Cougs in Space EE

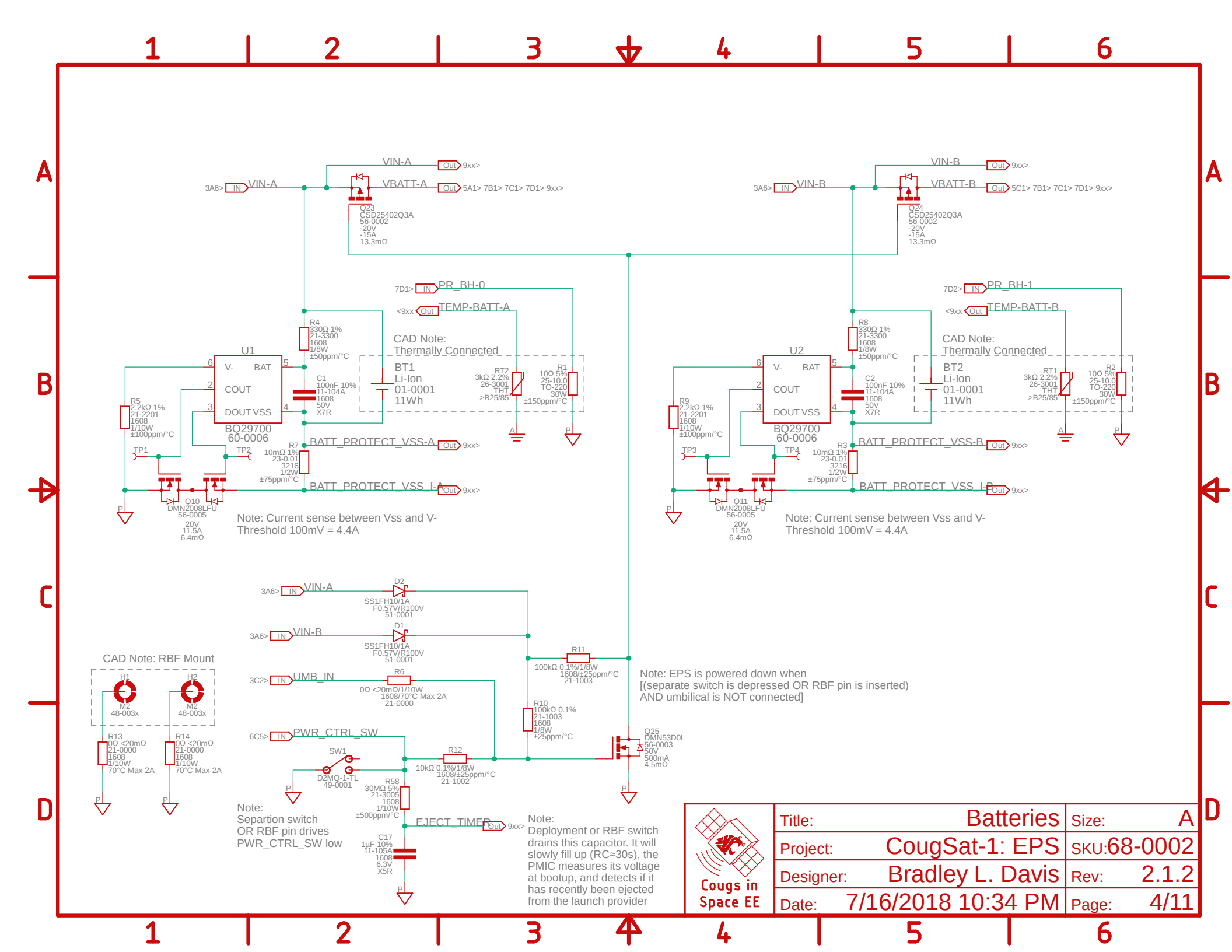
Title:	Block Diagram	Size:	A
Project:	CougSat-1: EPS	SKU:	68-0002
Designer:	Bradley L. Davis	Rev:	2.1.2
Date:	7/16/2018 10:34 PM	Page:	1/11

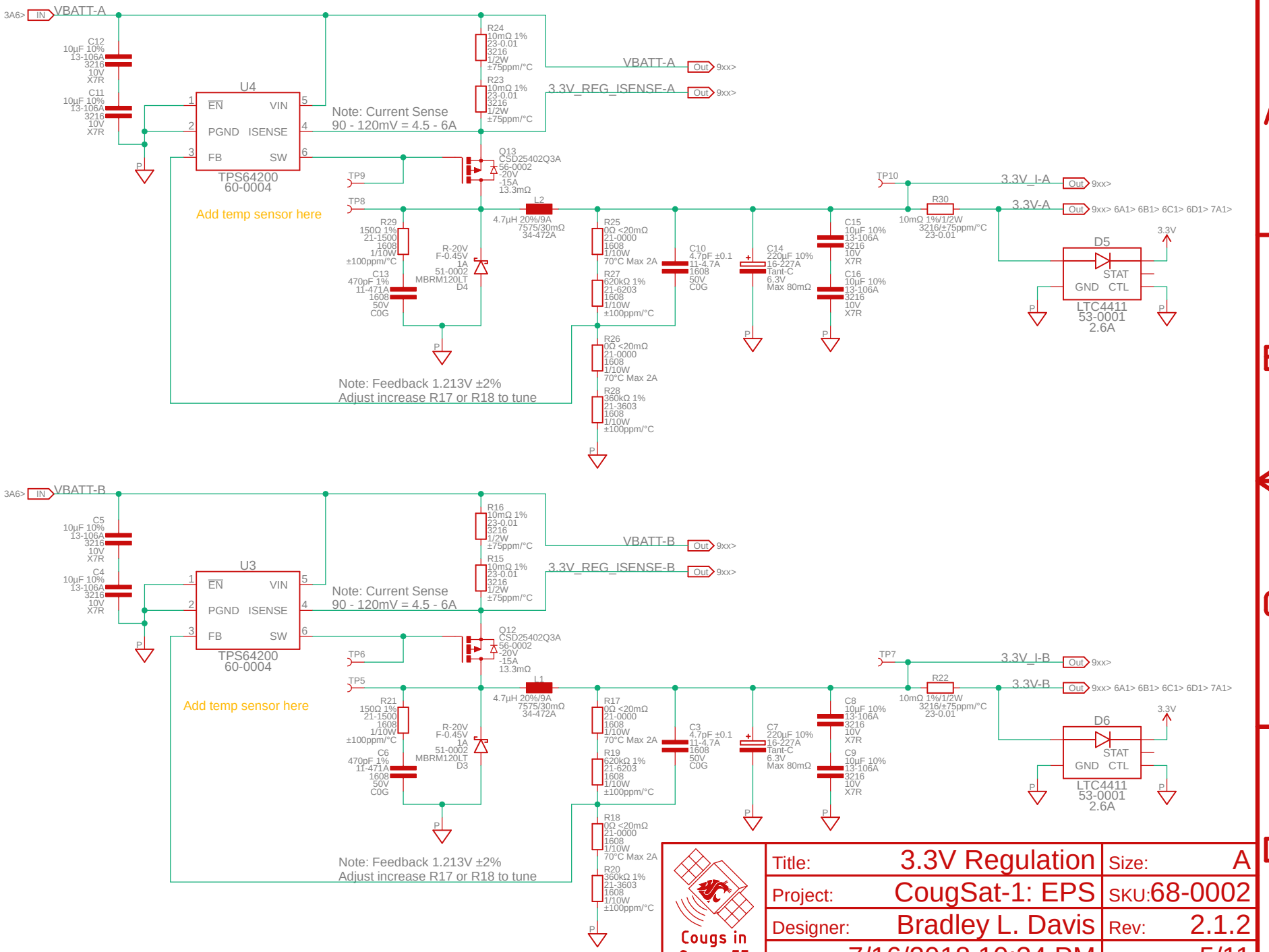

Solar Panel 0
Solar Panel 1
Solar Panel 2
Solar Panel 3
EPS Heater 0
EPS Heater 1
Deployables Release
PV_3.3V-0: 1mA
PV_3.3V-1: 1mA
PV_3.3V-2: 1mA
PV_3.3V-3: 1mA
PR_BH-0: 250mA
PR_BH-1: 250mA
PR_DEPLOY: 2A
Umbilical Charging
UMB_IN
Solar Panels
PV_IN-0
PV_IN-1
PV_IN-2
PV_IN-3
PV_IN-4
PV_IN-5
PV_IN-6
PV_IN-7
Switching
Switching
VIN-A
VIN-B
Battery A
Battery B
VBATT-A
VBATT-B
3.3V SMPS A
3.3V SMPS B
3.3V-A
3.3V-B
Note: Each battery can output 4A continuously
Note: Each SMPS can output 3A continuously
Note: Each cell is 1W
MPPT ICs output (PV_IN):
CV 4.1V
CC 300mA
Note: Umbilical charger output (UMB_IN):
CV 4.1V
CC 1A
Switching
Power ORing
3.3V (Always on): 30mA
EPS
PR_3.3V-0: 20mA
PR_3.3V-1: 60mA
PR_3.3V-2: 20mA
PR_3.3V-3: 45mA
PR_3.3V-4: 55mA
PR_3.3V-5: 90mA
PR_3.3V-6: 105mA
PR_BATT-0: 300mA
PR_BATT-1: 400mA
PR_3.3V-7: 50mA
PR_3.3V-8: 390mA
PR_3.3V-9: 25mA
PR_3.3V-10: 15mA
PR_3.3V-11: 390mA
PR_3.3V-12: 0mA
PR_BATT-2: 250mA
PR_BATT-3: 0mA
PR_BATT-4: 0mA
PR_BATT-5: 0mA
PR_BATT-6: 0mA
IHU
IHU: SD Card
ADCS
ADCS: IMUs
ADCS: GPS
IFJR & SD Card
Comms & Radios
ADCS: Magnetorquers
Comms: TX Amplifier
Satellite Bus
CougSat-1 Payload
Payload: 0
Payload: 1
Payload: 2
Payload: 4
Payload: 5
Payload: 6
Payload: 7
Payload: 8
Payload: 9
Payload: 10
Payload: 11
Germination Lighting
Germination Camera
Germination Sensors
Ionizing Radiation Sensor
Ground Camera
Unused
Germination Heater
Unused
Unused
Unused
Unused
Note: Each power rail channel (PR_) is rated for 1A.
Currents shown are the expected consumption
Cougs in Space EE
Title: Power Rails
Size: A
Project: CougSat-1: EPS
SKU:68-0002
Designer: Bradley L. Davis
Rev: 2.1.2
Date: 7/16/2018 10:34 PM
Page: 2/11

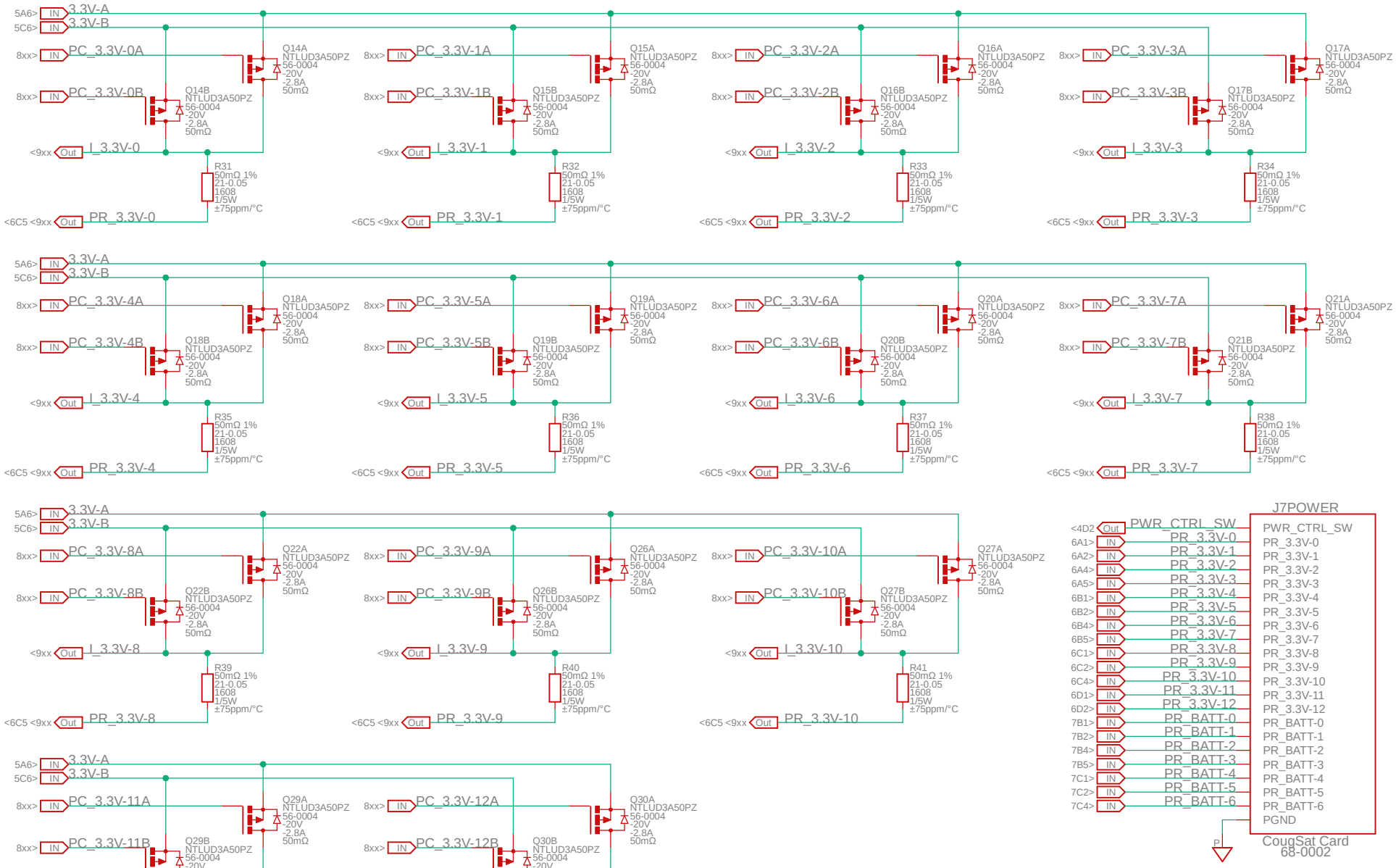


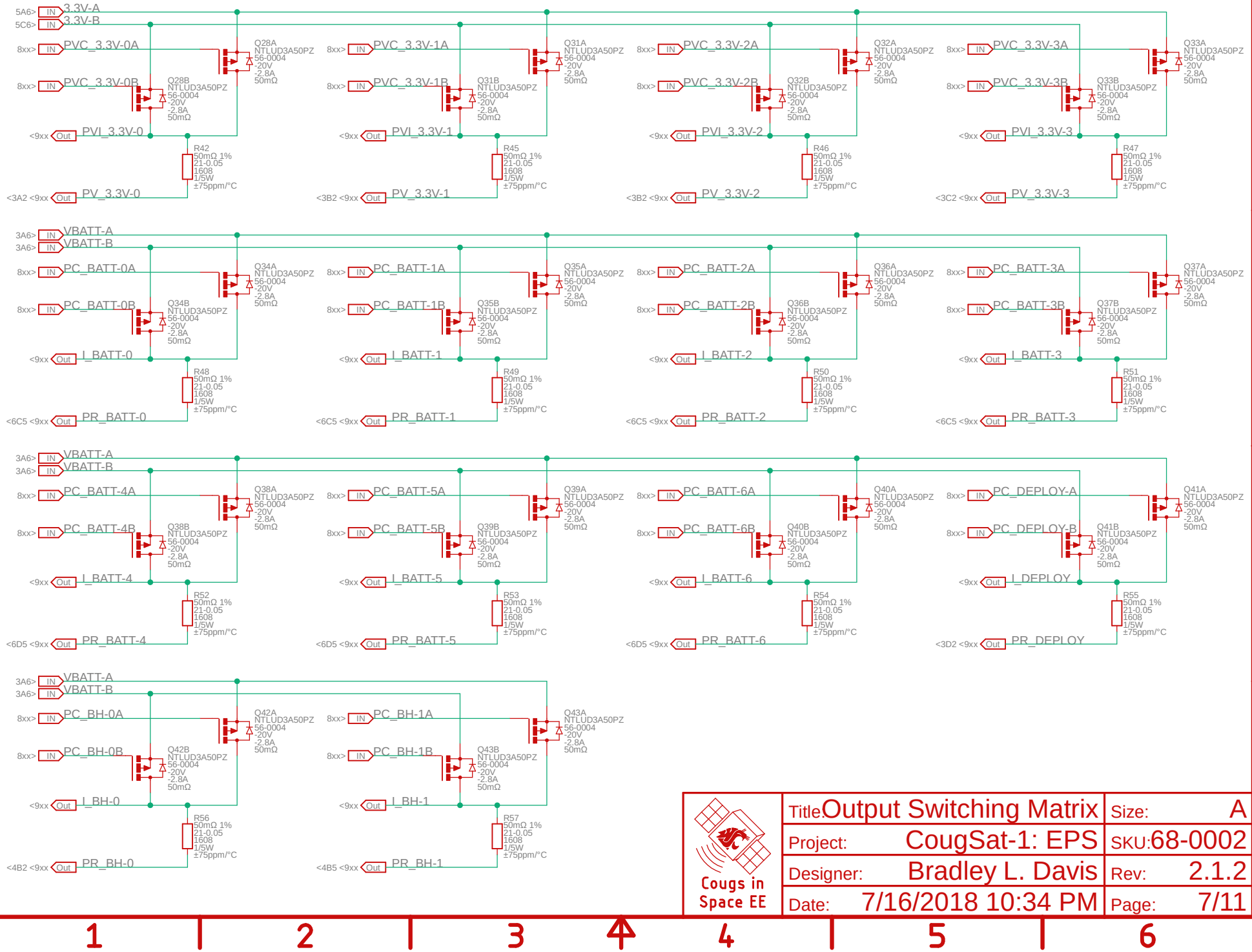
Cougs in Space EE

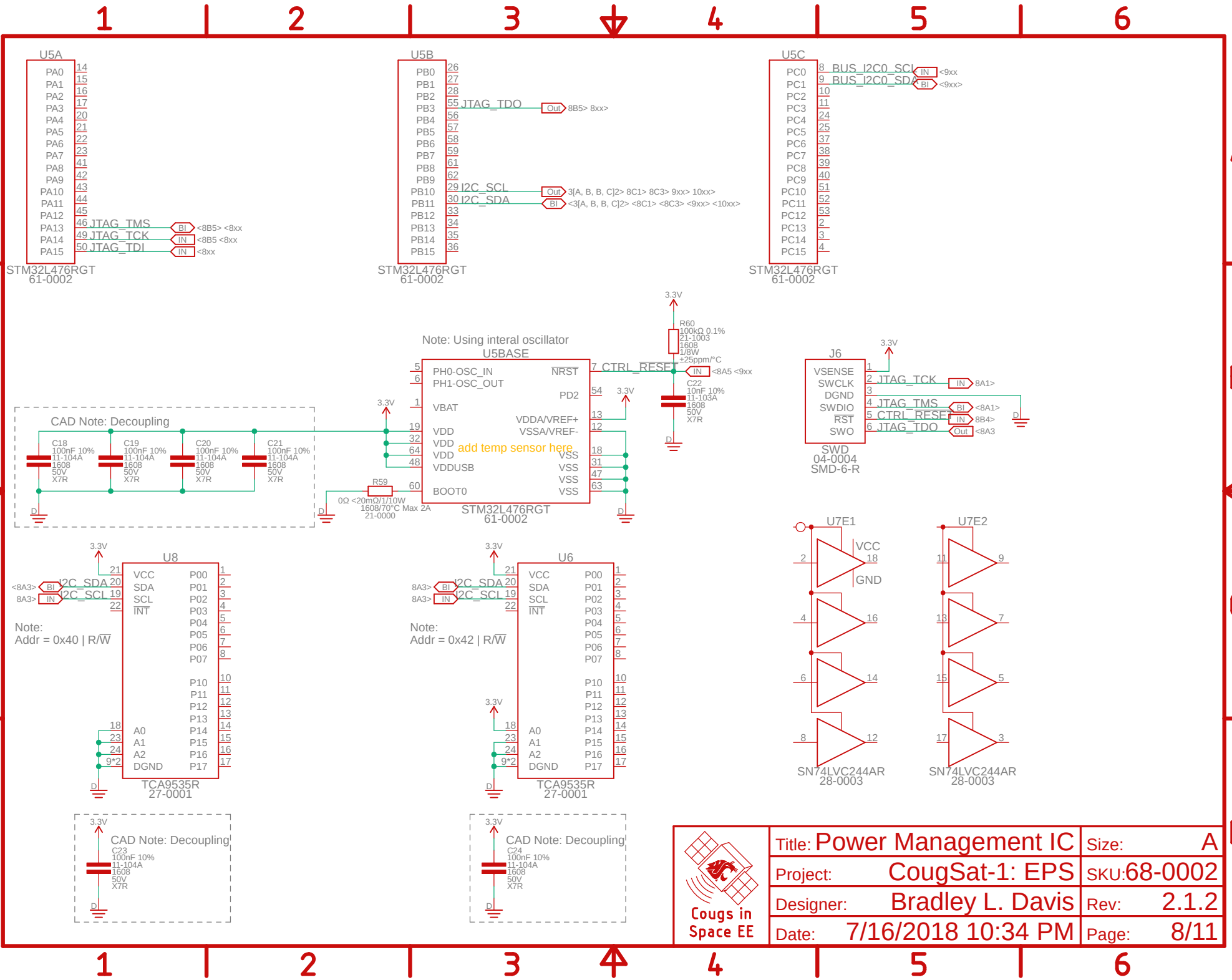
Title:	Input Switching Matrix	Size:	A
Project:	CougSat-1: EPS	SKU:	68-0002
Designer:	Bradley L. Davis	Rev:	2.1.2
Date:	7/16/2018 10:34 PM	Page:	3/11


VIN-A
VBATT-A
Q23
CSD25402Q3A
56-0002
-20V
-15A
13.3mΩ
VIN-B
VBATT-B
Q24
CSD25402Q3A
56-0002
-20V
-15A
13.3mΩ
PR_BH-0
TEMP-BATT-A
PR_BH-1
TEMP-BATT-B
U1
U2
BQ29700
60-0006
CAD Note:
Thermally Connected
BT1
Li-Ion
01-0001
11Wh
BT2
Li-Ion
01-0001
11Wh
BATT_PROTECT_VSS-A
BATT_PROTECT_VSS_I-A
BATT_PROTECT_VSS-B
BATT_PROTECT_VSS_I-B
Note: Current sense between Vss and V-
Threshold 100mV = 4.4A
CAD Note: RBF Mount
Note:
Separtion switch
OR RBF pin drives
PWR_CTRL_SW low
Note:
Deployment or RBF switch
drains this capacitor. It will
slowly fill up (RC≈30s), the
PMIC measures its voltage
at bootup, and detects if it
has recently been ejected
from the launch provider
Note: EPS is powered down when
[(separate switch is depressed OR RBF pin is inserted)
AND umbilical is NOT connected]
Cougs in Space EE
Title: Batteries
Size: A
Project: CougSat-1: EPS
SKU:68-0002
Designer: Bradley L. Davis
Rev: 2.1.2
Date: 7/16/2018 10:34 PM
Page: 4/11


VBATT-A
U4
TPS64200
60-0004
Note: Current Sense
90 - 120mV = 4.5 - 6A
Add temp sensor here
Note: Feedback 1.213V ±2%
Adjust increase R17 or R18 to tune
VBATT-A
3.3V_REG_ISENSE-A
3.3V_I-A
3.3V-A
LTC4411
53-0001
2.6A
VBATT-B
U3
TPS64200
60-0004
Note: Current Sense
90 - 120mV = 4.5 - 6A
Add temp sensor here
Note: Feedback 1.213V ±2%
Adjust increase R17 or R18 to tune
VBATT-B
3.3V_REG_ISENSE-B
3.3V_I-B
3.3V-B
LTC4411
53-0001
2.6A
Cougs in Space EE
Title: 3.3V Regulation
Size: A
Project: CougSat-1: EPS
SKU:68-0002
Designer: Bradley L. Davis
Rev: 2.1.2
Date: 7/16/2018 10:34 PM
Page: 5/11


3.3V-A
3.3V-B
PC_3.3V-0A
PC_3.3V-0B
I_3.3V-0
PR_3.3V-0
Q14A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q14B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R31 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-1A
PC_3.3V-1B
I_3.3V-1
PR_3.3V-1
Q15A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q15B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R32 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-2A
PC_3.3V-2B
I_3.3V-2
PR_3.3V-2
Q16A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q16B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R33 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-3A
PC_3.3V-3B
I_3.3V-3
PR_3.3V-3
Q17A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q17B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R34 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-4A
PC_3.3V-4B
I_3.3V-4
PR_3.3V-4
Q18A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q18B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R35 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-5A
PC_3.3V-5B
I_3.3V-5
PR_3.3V-5
Q19A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q19B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R36 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-6A
PC_3.3V-6B
I_3.3V-6
PR_3.3V-6
Q20A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q20B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R37 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-7A
PC_3.3V-7B
I_3.3V-7
PR_3.3V-7
Q21A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q21B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R38 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-8A
PC_3.3V-8B
I_3.3V-8
PR_3.3V-8
Q22A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q22B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R39 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-9A
PC_3.3V-9B
I_3.3V-9
PR_3.3V-9
Q26A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q26B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R40 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-10A
PC_3.3V-10B
I_3.3V-10
PR_3.3V-10
Q27A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q27B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R41 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-11A
PC_3.3V-11B
I_3.3V-11
PR_3.3V-11
Q29A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q29B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R43 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
PC_3.3V-12A
PC_3.3V-12B
I_3.3V-12
PR_3.3V-12
Q30A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q30B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R44 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
J7POWER
PWR_CTRL_SW
PR_3.3V-0
PR_3.3V-1
PR_3.3V-2
PR_3.3V-3
PR_3.3V-4
PR_3.3V-5
PR_3.3V-6
PR_3.3V-7
PR_3.3V-8
PR_3.3V-9
PR_3.3V-10
PR_3.3V-11
PR_3.3V-12
PR_BATT-0
PR_BATT-1
PR_BATT-2
PR_BATT-3
PR_BATT-4
PR_BATT-5
PR_BATT-6
PGND
CougSat Card 68-0002
Cougs in Space EE
Title: Output Switching Matrix
Size: A
Project: CougSat-1: EPS
SKU: 68-0002
Designer: Bradley L. Davis
Rev: 2.1.2
Date: 7/16/2018 10:34 PM
Page: 6/11


5A6> IN 3.3V-A
5C6> IN 3.3V-B
8xx> IN PVC_3.3V-0A
8xx> IN PVC_3.3V-0B
<9xx Out PVI_3.3V-0
<3A2 <9xx Out PV_3.3V-0
Q28A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q28B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R42 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PVC_3.3V-1A
8xx> IN PVC_3.3V-1B
<9xx Out PVI_3.3V-1
<3B2 <9xx Out PV_3.3V-1
Q31A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q31B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R45 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PVC_3.3V-2A
8xx> IN PVC_3.3V-2B
<9xx Out PVI_3.3V-2
<3B2 <9xx Out PV_3.3V-2
Q32A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q32B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R46 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PVC_3.3V-3A
8xx> IN PVC_3.3V-3B
<9xx Out PVI_3.3V-3
<3C2 <9xx Out PV_3.3V-3
Q33A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q33B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R47 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
3A6> IN VBATT-A
3A6> IN VBATT-B
8xx> IN PC_BATT-0A
8xx> IN PC_BATT-0B
<9xx Out I_BATT-0
<6C5 <9xx Out PR_BATT-0
Q34A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q34B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R48 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PC_BATT-1A
8xx> IN PC_BATT-1B
<9xx Out I_BATT-1
<6C5 <9xx Out PR_BATT-1
Q35A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q35B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R49 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PC_BATT-2A
8xx> IN PC_BATT-2B
<9xx Out I_BATT-2
<6C5 <9xx Out PR_BATT-2
Q36A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q36B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R50 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PC_BATT-3A
8xx> IN PC_BATT-3B
<9xx Out I_BATT-3
<6C5 <9xx Out PR_BATT-3
Q37A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q37B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R51 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
3A6> IN VBATT-A
3A6> IN VBATT-B
8xx> IN PC_BATT-4A
8xx> IN PC_BATT-4B
<9xx Out I_BATT-4
<6D5 <9xx Out PR_BATT-4
Q38A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q38B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R52 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PC_BATT-5A
8xx> IN PC_BATT-5B
<9xx Out I_BATT-5
<6D5 <9xx Out PR_BATT-5
Q39A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q39B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R53 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PC_BATT-6A
8xx> IN PC_BATT-6B
<9xx Out I_BATT-6
<6D5 <9xx Out PR_BATT-6
Q40A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q40B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R54 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PC_DEPLOY-A
8xx> IN PC_DEPLOY-B
<9xx Out I_DEPLOY
<3D2 <9xx Out PR_DEPLOY
Q41A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q41B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R55 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
3A6> IN VBATT-A
3A6> IN VBATT-B
8xx> IN PC_BH-0A
8xx> IN PC_BH-0B
<9xx Out I_BH-0
<4B2 <9xx Out PR_BH-0
Q42A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q42B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R56 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
8xx> IN PC_BH-1A
8xx> IN PC_BH-1B
<9xx Out I_BH-1
<4B5 <9xx Out PR_BH-1
Q43A NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
Q43B NTLUD3A50PZ 56-0004 -20V -2.8A 50mΩ
R57 50mΩ 1% 21-0.05 1608 1/5W ±75ppm/°C
Cougs in Space EE
Title: Output Switching Matrix
Size: A
Project: CougSat-1: EPS
SKU: 68-0002
Designer: Bradley L. Davis
Rev: 2.1.2
Date: 7/16/2018 10:34 PM
Page: 7/11


U5A
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7 PA8 PA9 PA10 PA11 PA12 PA13 PA14 PA15
JTAG_TMS JTAG_TCK JTAG_TDI
STM32L476RGT
61-0002
U5B
PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7 PB8 PB9 PB10 PB11 PB12 PB13 PB14 PB15
JTAG_TDO
I2C_SCL
I2C_SDA
STM32L476RGT
61-0002
U5C
PC0 PC1 PC2 PC3 PC4 PC5 PC6 PC7 PC8 PC9 PC10 PC11 PC12 PC13 PC14 PC15
BUS_I2C0_SCL
BUS_I2C0_SDA
STM32L476RGT
61-0002
CAD Note: Decoupling
C18 C19 C20 C21
100nF 10%
11-104A
1608
50V
X7R
Note: Using interal oscillator
U5BASE
PH0-OSC_IN
PH1-OSC_OUT
VBAT
VDD
VDDUSB
BOOT0
NRST
PD2
VDDA/VREF+
VSSA/VREF-
VSS
add temp sensor here
CTRL_RESET
R59
0Ω <20mΩ/1/10W
1608/70°C Max 2A
21-0000
R60
100kΩ 0.1%
21-1003
1608
1/8W
±25ppm/°C
C22
10nF 10%
11-103A
1608
50V
X7R
STM32L476RGT
61-0002
J6
VSENSE
SWCLK
DGND
SWDIO
RST
SWO
JTAG_TCK
JTAG_TMS
CTRL_RESET
JTAG_TDO
SWD
04-0004
SMD-6-R
U8
VCC
SDA
SCL
INT
A0
A1
A2
DGND
P00 P01 P02 P03 P04 P05 P06 P07
P10 P11 P12 P13 P14 P15 P16 P17
I2C_SDA
I2C_SCL
Note:
Addr = 0x40 | R/W
TCA9535R
27-0001
U6
Note:
Addr = 0x42 | R/W
TCA9535R
27-0001
U7E1
U7E2
VCC
GND
SN74LVC244AR
28-0003
CAD Note: Decoupling
C23
C24
100nF 10%
11-104A
1608
50V
X7R
Cougs in Space EE
Title: Power Management IC
Size: A
Project: CougSat-1: EPS
SKU:68-0002
Designer: Bradley L. Davis
Rev: 2.1.2
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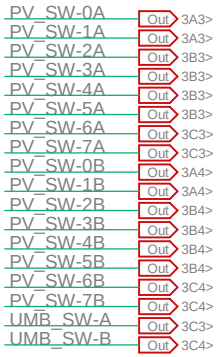
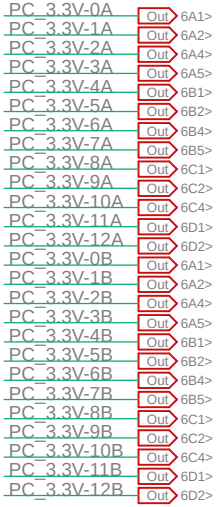
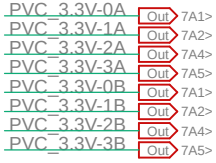
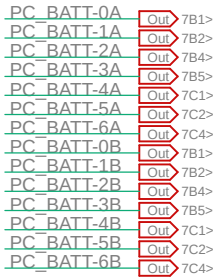
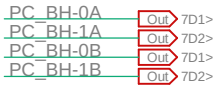






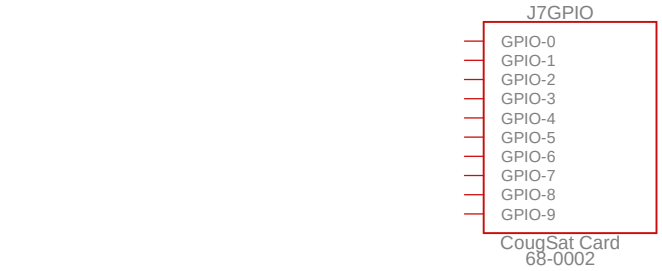


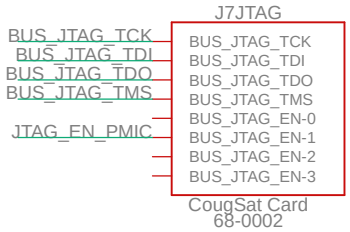


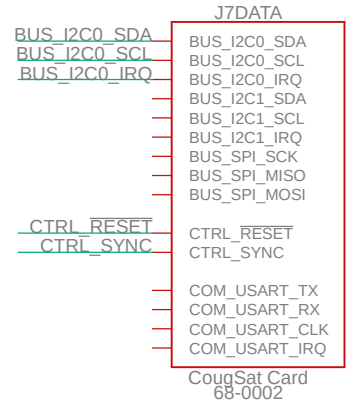
Note: Fix all off sheet designators linked to this sheet

Note: All signals above are GPIO, connect to any GPIO bank, whichever is best for routing, don't use PD2

Note: Interrupt pins, place on different pin numbers (same port okay), ease for routing







Cougs in Space EE

Title:	Backplane Digital & ADCs	Size:	A
Project:	CougSat-1: EPS	SKU:	68-0002
Designer:	Bradley L. Davis	Rev:	2.1.2
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Note: 35 differential/8 = 5
5V+5T=10Single/16 = 1

Differential ADC voltage reference is 1.024V
At 16b, 7.81µV/LSB
Maximum input is ±512mV

Cougs in Space EE	Title:	ADCs	Size: A
	Project:	CougSat-1: EPS	SKU:68-0002
	Designer:	Bradley L. Davis	Rev: 2.1.2
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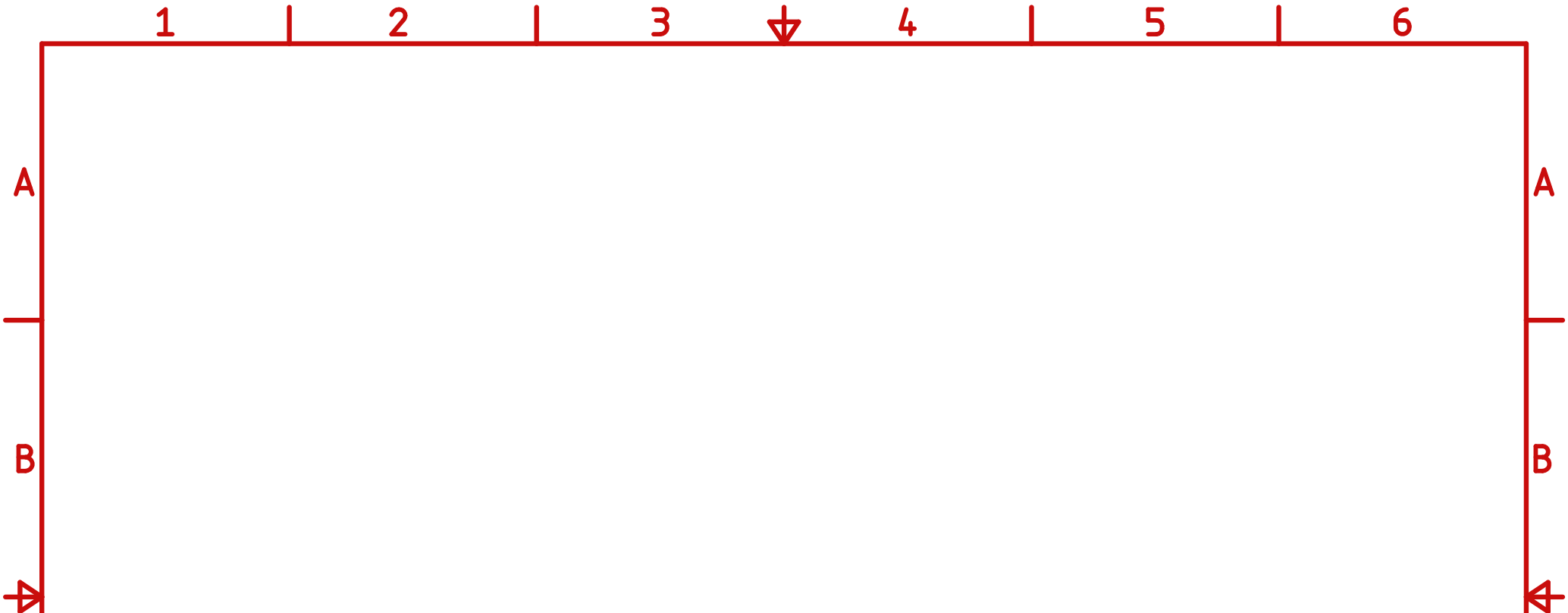
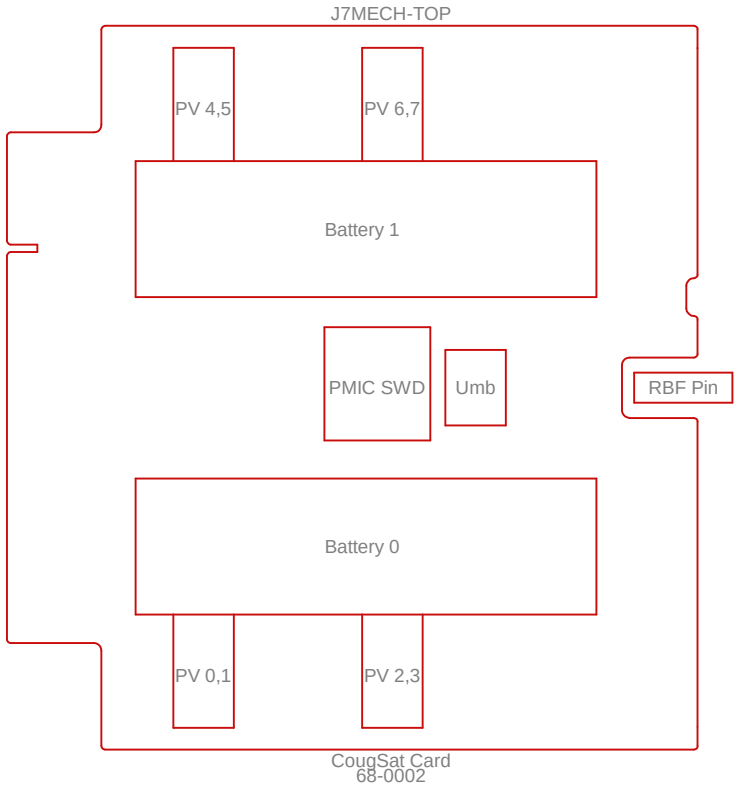
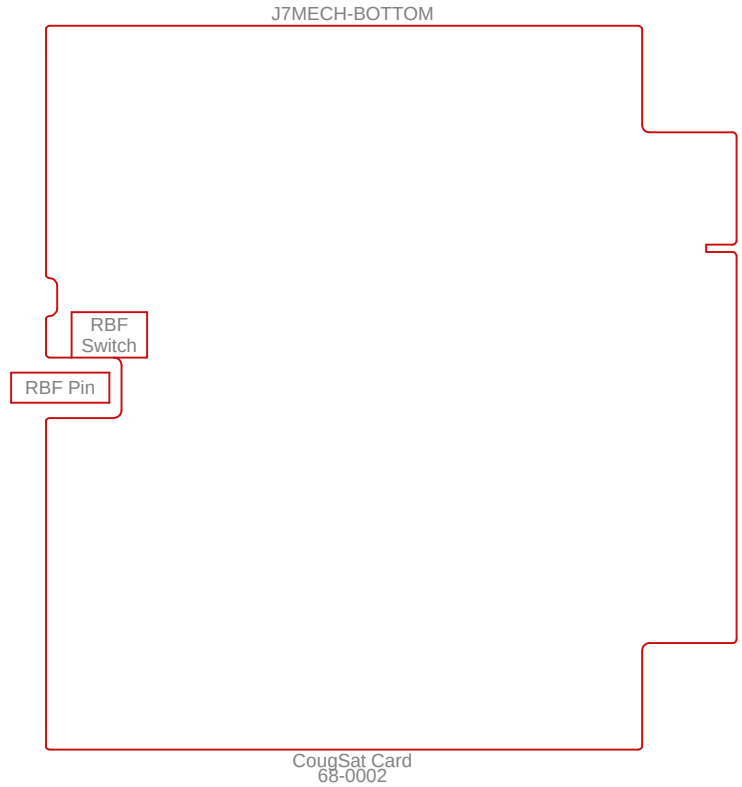
Note: Fix all off sheet designators linked to this sheet


1
2
3
4
5
6
A
B





Cougs in Space EE	Title:	Mechanical	Size: A
	Project:	CougSat-1: EPS	SKU:68-0002
	Designer:	Bradley L. Davis	Rev: 2.1.2
	Date:	7/16/2018 10:34 PM	Page: 11/11