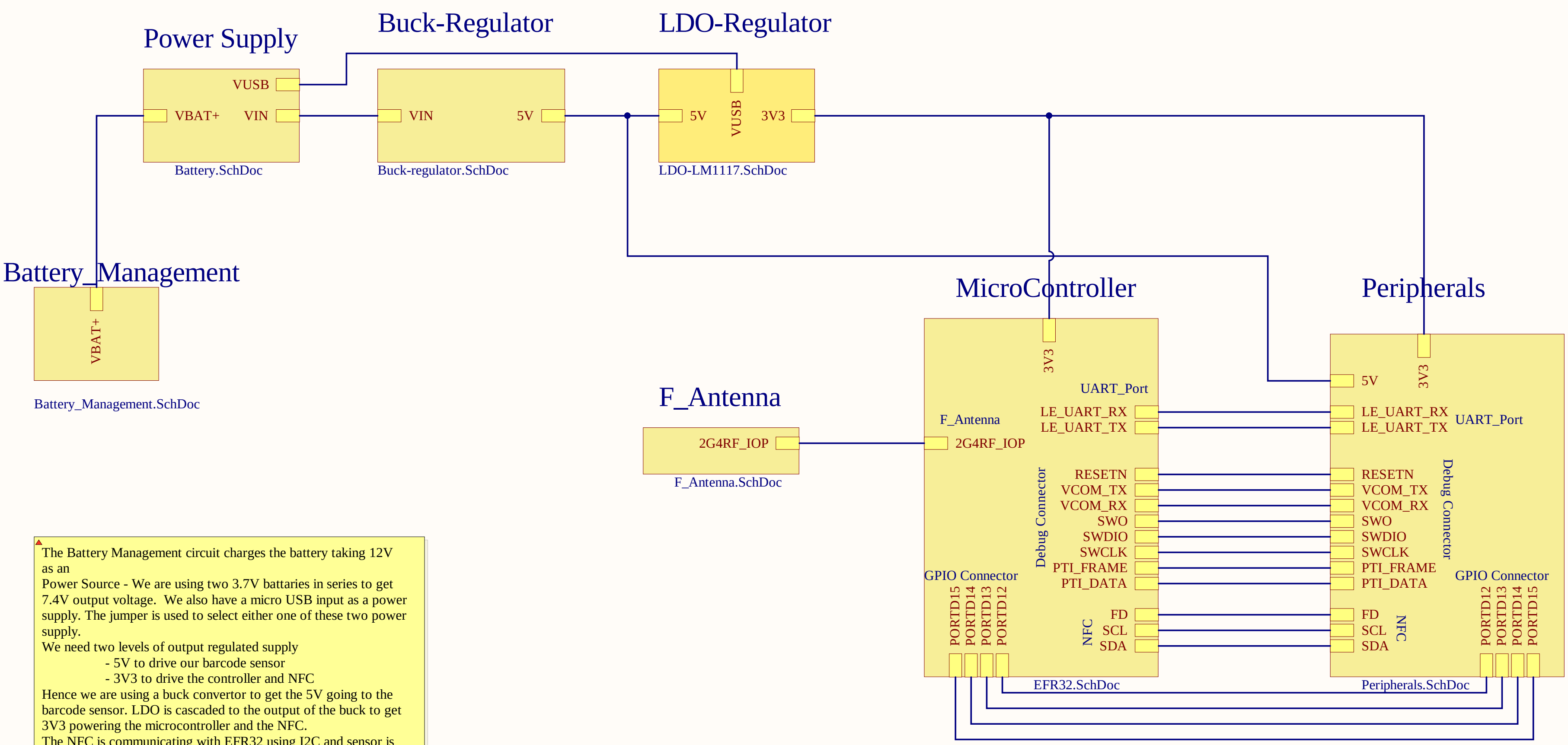
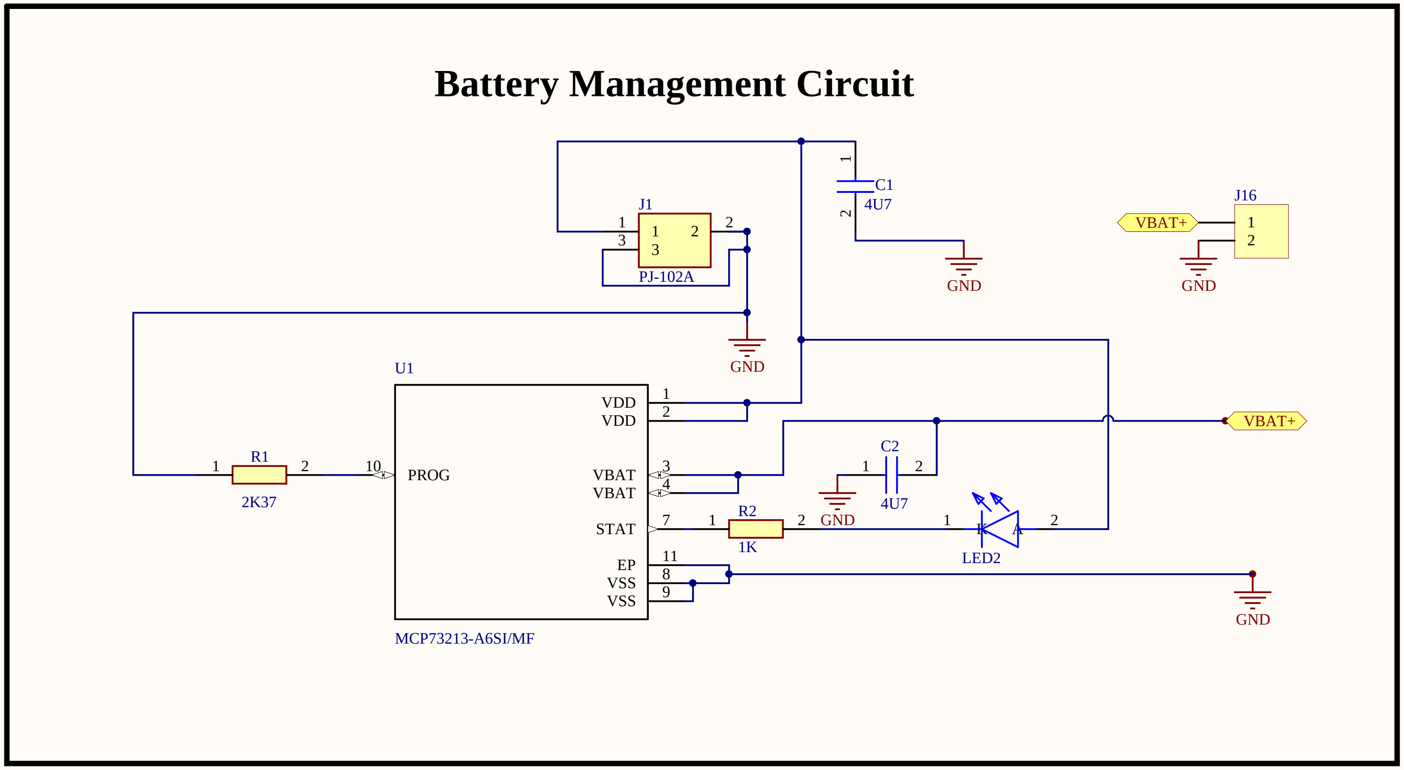
Block Diagram



The Battery Management circuit charges the battery taking 12V as an
Power Source - We are using two 3.7V battaries in series to get 7.4V output voltage. We also have a micro USB input as a power supply. The jumper is used to select either one of these two power supply.
We need two levels of output regulated supply
- 5V to drive our barcode sensor
- 3V3 to drive the controller and NFC

Hence we are using a buck convertor to get the 5V going to the barcode sensor. LDO is cascaded to the output of the buck to get 3V3 powering the microcontroller and the NFC.
The NFC is communicating with EFR32 using I2C and sensor is communicating using UART.

Title *Block Diagram*			*Team - Ashwathama* *Colorado Boulder* *Author : Siddhant Jajoo* *Self Checkout Shopping Cart*
Size: A4	Number: 1	Revision: 1.0	
Date: 11/19/2019	Time: 6:02:46 PM	Sheet 0 of 7	
File: C:\LPEDT\Schematics\MicroController\Block_Diagram.SchDoc			



MCP73213 takes 12V as an input and provides 8.2V for charging the battery.
R1 is used to program the constant output charging current which is set to 500mA with R1 = 2.37K
LED is used as a indicator to that the circuit is charging the battery.

Title: *Battery Management Circuit*			*Team- Ashwathama* *Colorado Boulder* *Author- Satya Mehta* *Self Checkout Shopping Cart*
Size: A4	Number: 1	Revision: 1.0	
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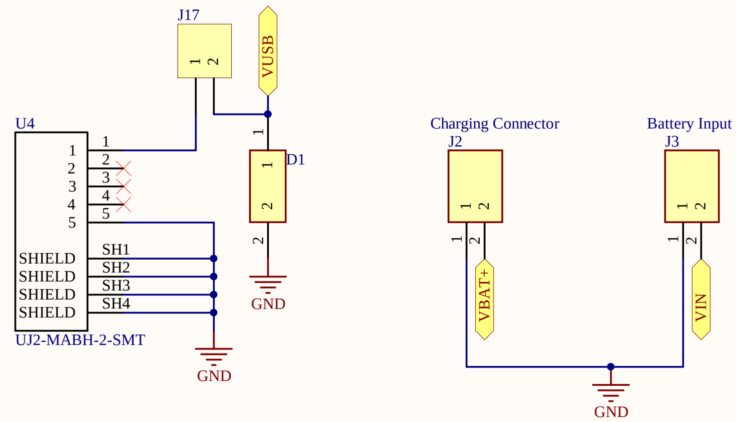
File: C:\LPEDT\Schematics\MicroController\Battery_Management.SchDoc			

Battery Connector



We have used a jumper for providing an option to choose between the USB power supply and battery power supply.
We have a charging conector to charge the bttery

Title **Battery Connector**			*Team Ashwathama* *Colorado Boulder* *Author- Satya Mehta* *Self Checkout Shopping Cart*
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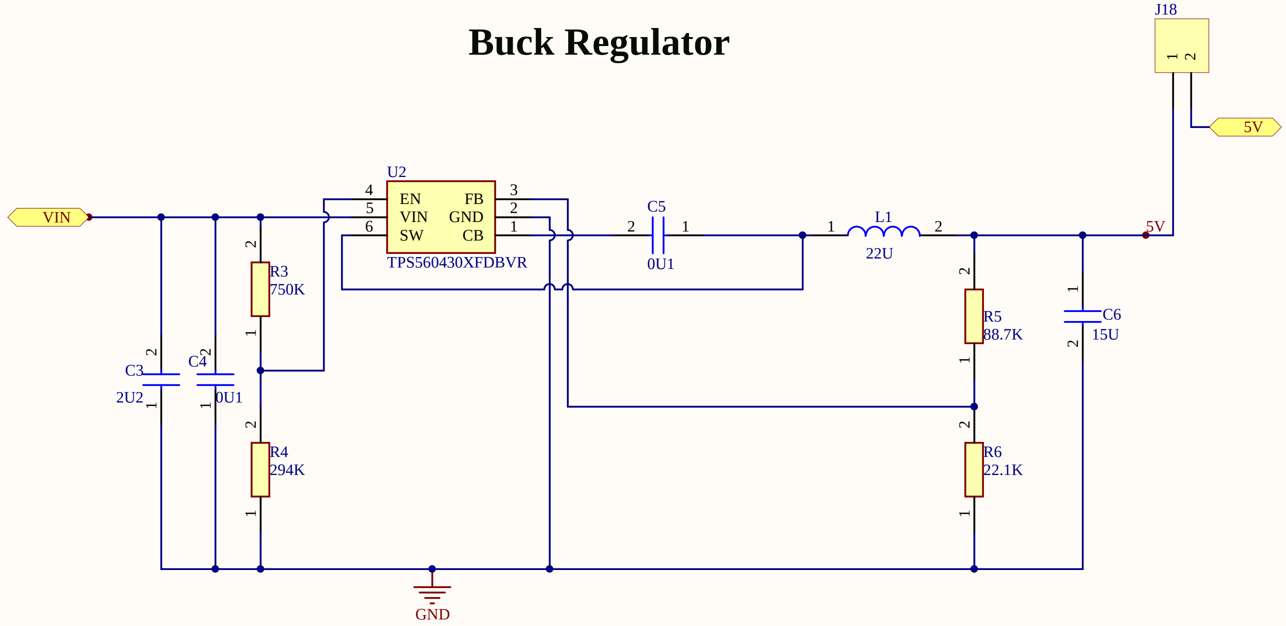
Buck Regulator



Rfbt = (Vout-Vref)/Vref * Rfbb
Choose the value of RFBB to be 22.1 kΩ. With the desired output voltage set to 5 V and the VREF = 1.0 V, the RFBT value can then be calculated . The formula yields to a value 88.4 kΩ, a standard value of 88.7 kΩ is selected.
Ripple Current = (Vout * (Vinmax – Vout)) / (Vinmax * L * Fsw)
Lmin = ((Vinmax – Vout)/(Iout*Kind)) * (Vout/(Vinmax * fsw
KIND is a coefficient that represents the amount of inductor ripple current relative to the maximum output current of the device. A reasonable value of KIND should be 20% to 60%
Fsw is switching frequency which is 1.1MHz.
Vout is 5V
Vinmax is 7.4V
Hence, substituting in ripple current equation. Ripple current comes to around 67mA.
Choosing L as 22uH. (widely available and given by webench designer studio)
Therefore, Kind is Ripple Current/Maximum current which is 33.5% and it is in the range of the 20% to 60%.
Therefore the selected inductor is valid.

Output capacitance is usually limited by transient performance specifications if the system requires tight voltage
regulation with presence of large current steps and fast slew rate. When a large load step happens, output capacitors provide the required charge before the inductor current can slew up to the appropriate level. The regulator’s control loop usually needs 8 or more clock cycles to regulate the inductor current equal to the new load level. The output capacitance must be large enough to supply the current difference for 8 clock cycles to maintain the output voltage within the specified range.

As per the data sheet the Capacitor equation is
Cout > ½*(8*(Ioh-Iol))/fsw*(delVoutShoot)
• KIND = Ripple ratio of the inductor current (ΔiL / IOUT) • IOL = Low level output current during load transient • IOH = High level output current during load transient • VOUT_SHOOT = Target output voltage overshoot or undershoot
Voutshoot is 5% of output voltage. Which is 250mV.
Ioh = 150mA
IoL = 2uA
Fsw = 1.1Mhz
substituting in above equation. Capacitor value should be more than 2.9uF. Webench simulation provided 15uF capacitor. Hence we are sticking to it and not changing any value.

Title *Buck Regulator*			*Team- Ashwathama* *Colorado Boulder* *Author- Satya Mehta* *Self Checkout Shopping Cart*
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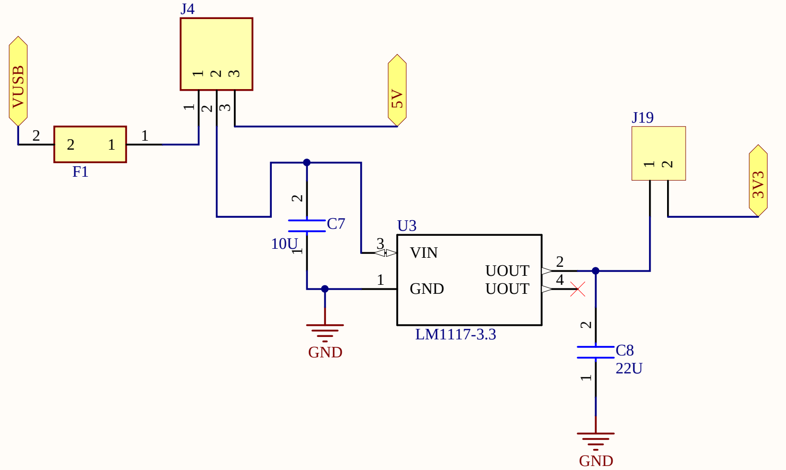
Date: 11/19/2019	Time: 6:02:46 PM	Sheet 3 of 7	
File: C:\LPEDT\Schematics\MicroController\Buck-regulator.SchDoc			

LDO Regulator



Title *LDO Regulator*			*Team Ashwathama* *Colorado Boulder* *Author- Satya Mehta* *Self Checkout Shopping Cart* *
Size: A4	Number: 1	Revision: 1.0	
Date: 11/19/2019	Time: 6:02:47 PM	Sheet 4 of 7	
File: C:\LPEDT\Schematics\MicroController\LDO-LM1117.SchDoc			

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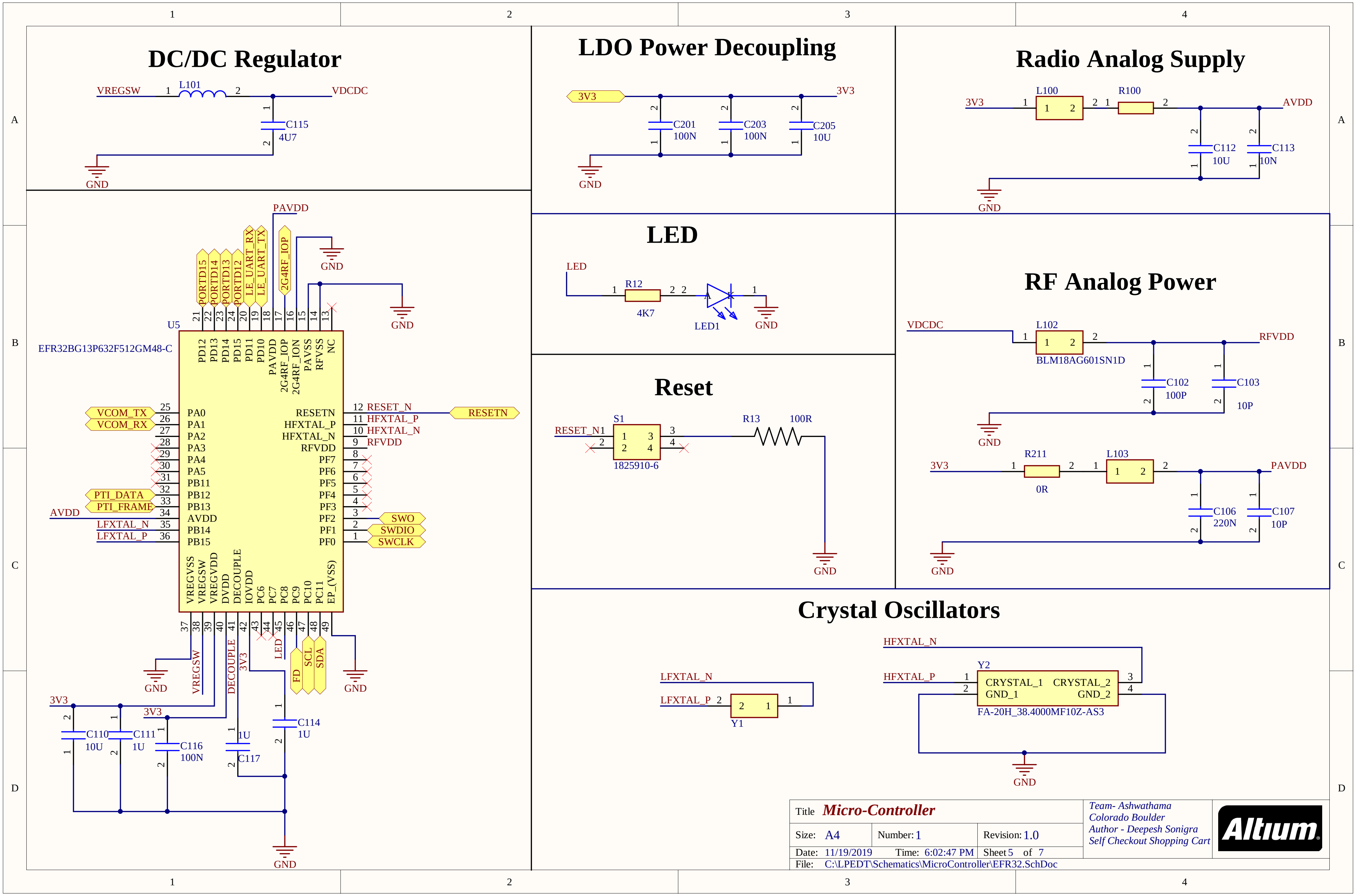
DC/DC Regulator
VREGSW
L101
VDCDC
C115
4U7
GND
LDO Power Decoupling
3V3
C201
100N
C203
100N
C205
10U
GND
Radio Analog Supply
L100
R100
AVDD
C112
10U
C113
10N
GND
LED
R12
4K7
LED1
GND
Reset
RESET_N
S1
1825910-6
R13
100R
GND
RF Analog Power
VDCDC
L102
BLM18AG601SN1D
RFVDD
C102
100P
C103
10P
GND
R211
0R
L103
PAVDD
C106
220N
C107
10P
GND
U5
EFR32BG13P632F512GM48-C
PAVDD
PORTD15
PORTD14
PORTD13
PORTD12
LE_UART_RX
LE_UART_TX
2G4RF_IOP
PD12
PD13
PD14
PD15
PD11
PD10
PAVDD
2G4RF_IOP
2G4RF_ION
PAVSS
RFVSS
NC
VCOM_TX
VCOM_RX
PA0
PA1
PA2
PA3
PA4
PA5
PB11
PTI_DATA
PTI_FRAME
PB12
PB13
AVDD
LFXTAL_N
LFXTAL_P
PB14
PB15
RESETN
HFXTAL_P
HFXTAL_N
RFVDD
PF7
PF6
PF5
PF4
PF3
PF2
PF1
PF0
SWO
SWDIO
SWCLK
VREGVSS
VREGSW
VREGVDD
DVDD
DECOUPLE
IOVDD
PC6
PC7
PC8
PC9
PC10
PC11
EP_(VSS)
LED
FD
SCL
SDA
C110
10U
C111
1U
C116
100N
C117
1U
C114
1U
Crystal Oscillators
LFXTAL_N
LFXTAL_P
Y1
HFXTAL_N
HFXTAL_P
Y2
CRYSTAL_1
CRYSTAL_2
GND_1
GND_2
FA-20H_38.4000MF10Z-AS3
Title Micro-Controller
Size: A4
Number: 1
Revision: 1.0
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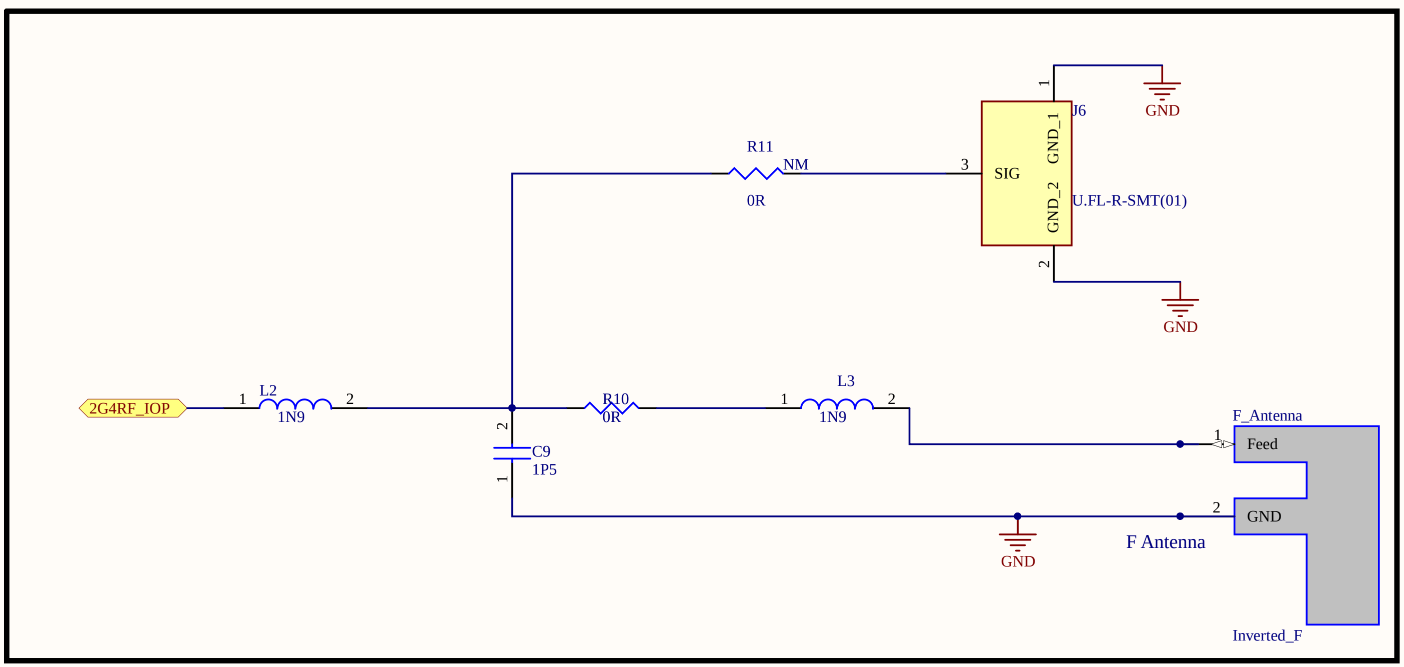
File: C:\LPEDT\Schematics\MicroController\EFR32.SchDoc
Team- Ashwathama
Colorado Boulder
Author - Deepesh Sonigra
Self Checkout Shopping Cart
Altium

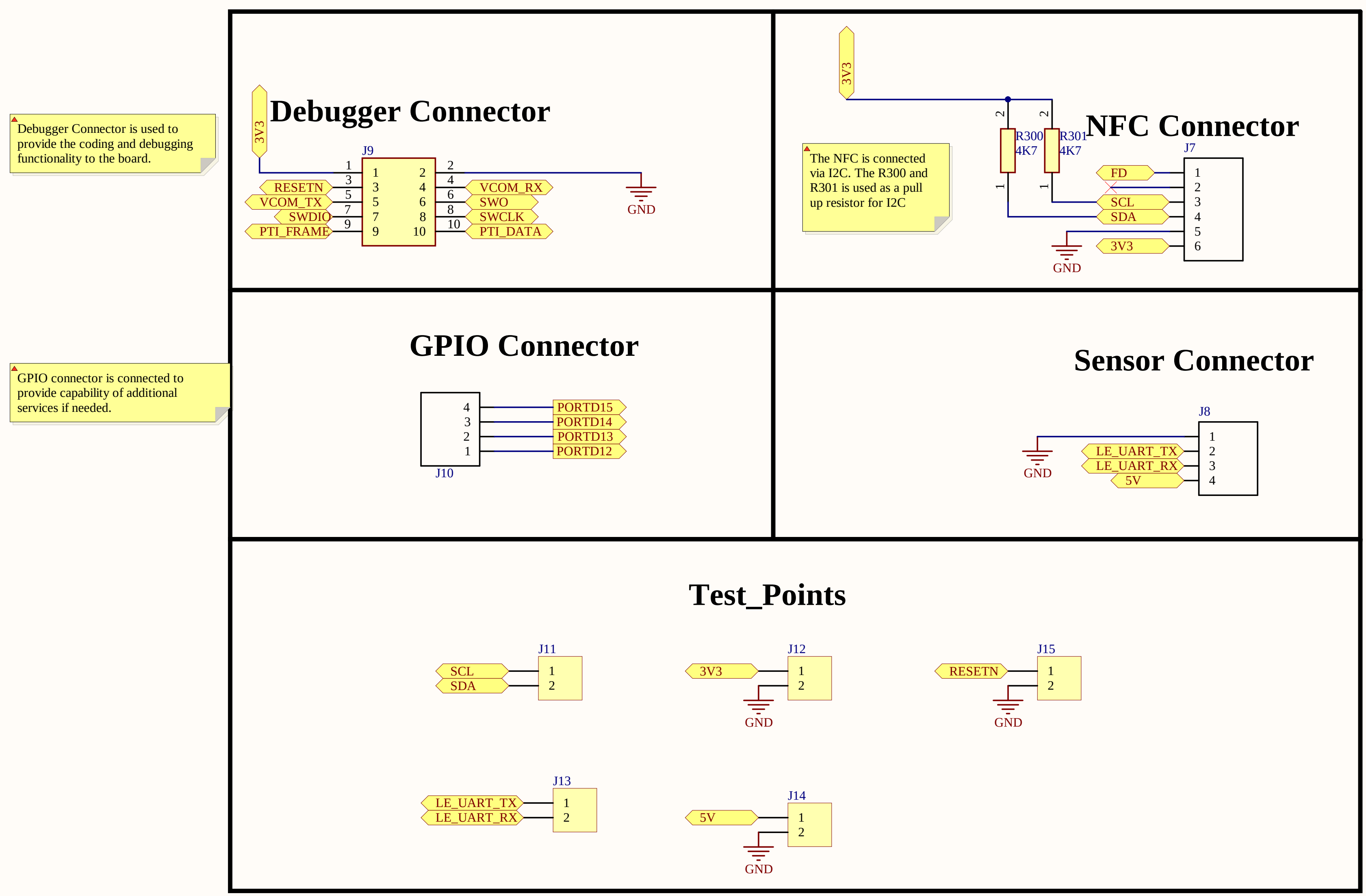
F Antenna



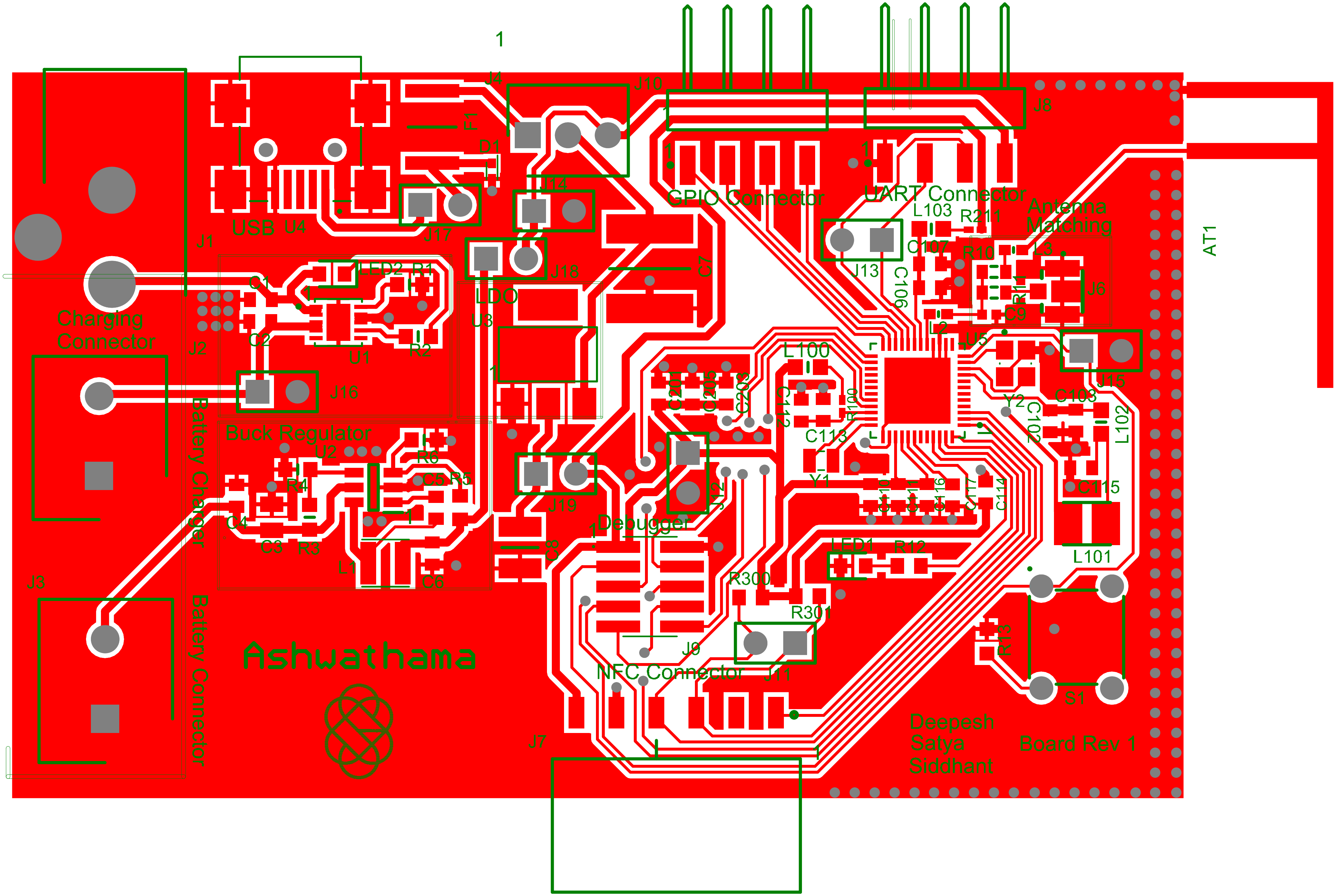
We have a backup UFL connector for the bluetooth antenna. The resistor R11 is not mounted initially to disconnect the UFL connector circuit. If the F antenna design fails we will remove R10 and mount R11 to switch to UFL connector.

Title **F-Antenna**			*Team- Ashwathama* *Colroado Boulder* *Author- Deepesh Sonigra* *Self Checking Shopping Cart* *
Size: A4	Number: 1	Revision: 1.0	
Date: 11/19/2019	Time: 6:02:47 PM	Sheet 6 of 7	
File: C:\LPEDT\Schematics\MicroController\F_Antenna.SchDoc			

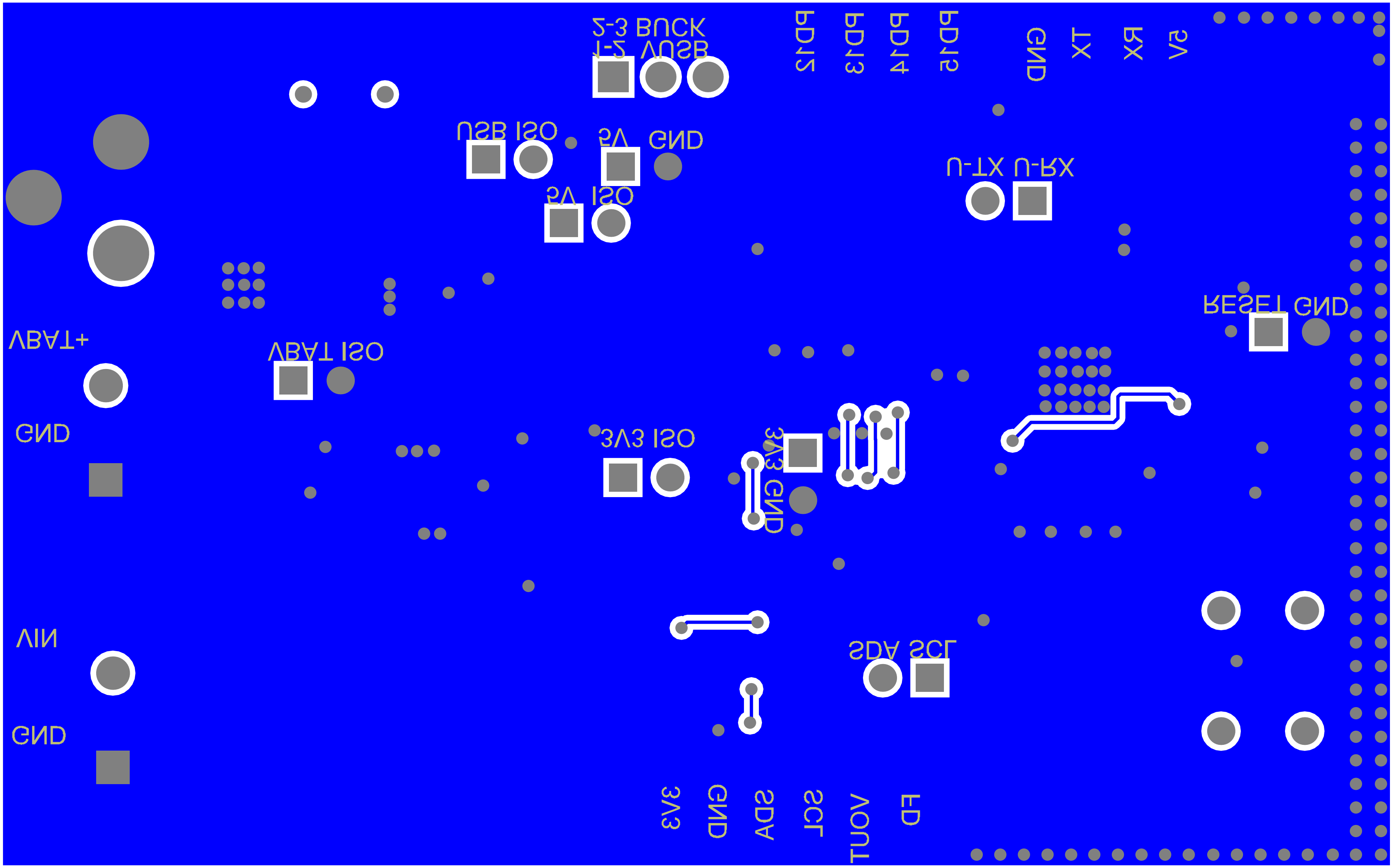
Altium

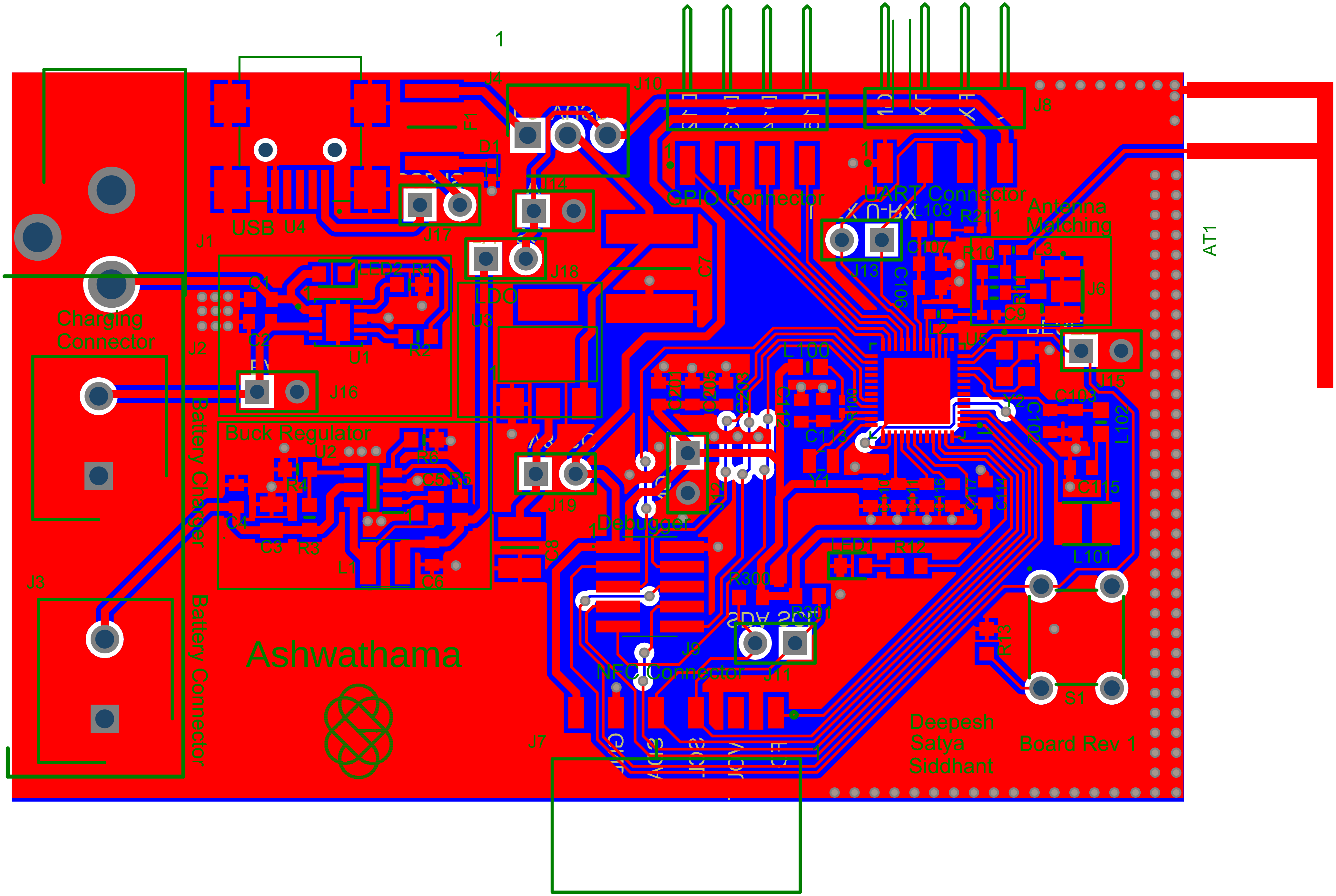


Title *Peripheral Connectors*			*Team Ashwathama* *Colorado Boulder* *Author- Deepesh Sonigra* *Self Checkout Shopping Cart* *
Size: A4	Number: 1	Revision: 1.0	
Date: 11/19/2019	Time: 6:02:47 PM	Sheet 7 of 7	
File: C:\LPEDT\Schematics\MicroController\Peripherals.SchDoc			



USB
U4
J1
Charging
Connector
J2
J3
Battery Charger
Battery Connector
C1
C2
LED2
R1
R2
U1
J16
J17
J18
J14
J4
F1
D1
J10
GPIO Connector
UART Connector
J8
LDO
U3
C7
C8
J19
Buck Regulator
U2
R6
R5
C5
R4
C4
C3
R3
L1
C6
Ashwathama
J13
L103
R211
C107
R10
C106
L3
R14
C9
L2
J6
Antenna
Matching
AT1
J15
U5
L100
C204
C205
C203
C112
R100
C113
Y1
Y2
C103
C102
L102
C115
C110
C111
C116
C117
C114
L101
J12
Debugger
LED1
R12
R300
R301
J9
J11
NFC Connector
R13
S1
J7
Deepesh
Satya
Siddhant
Board Rev 1


2-3 BUCK
1-2 VUSB
PD12
PD13
PD14
PD15
GND
TX
RX
5V
USB ISO
5V GND
5V ISO
U-TX U-RX
RESET GND
VBAT+
VBAT ISO
GND
3V3 ISO
3V3 GND
VIN
SDA SCL
GND
3V3
GND
SDA
SCL
VOUT
PE



USB
U4
J1
J2
J3
J4
F1
D1
Charging Connector
Battery Charger
Battery Connector
Buck Regulator
U2
LDO
U3
U1
LED2
R1
R2
C1
C2
C3
C4
C5
C6
C7
R3
R4
R5
R6
L1
J16
J17
J18
J14
J19
J10
GPIO Connector
J8
UART Connector
J13
L103
R211
C107
C106
R10
L3
J6
C9
L2
U5
Antenna Matching
AT1
L100
C113
Y1
Y2
C103
L102
C115
L101
J15
Debugger
LED1
R12
R300
R301
J9
NFC Connector
J11
J7
S1
Ashwathama
Deepesh
Satya
Siddhant
Board Rev 1