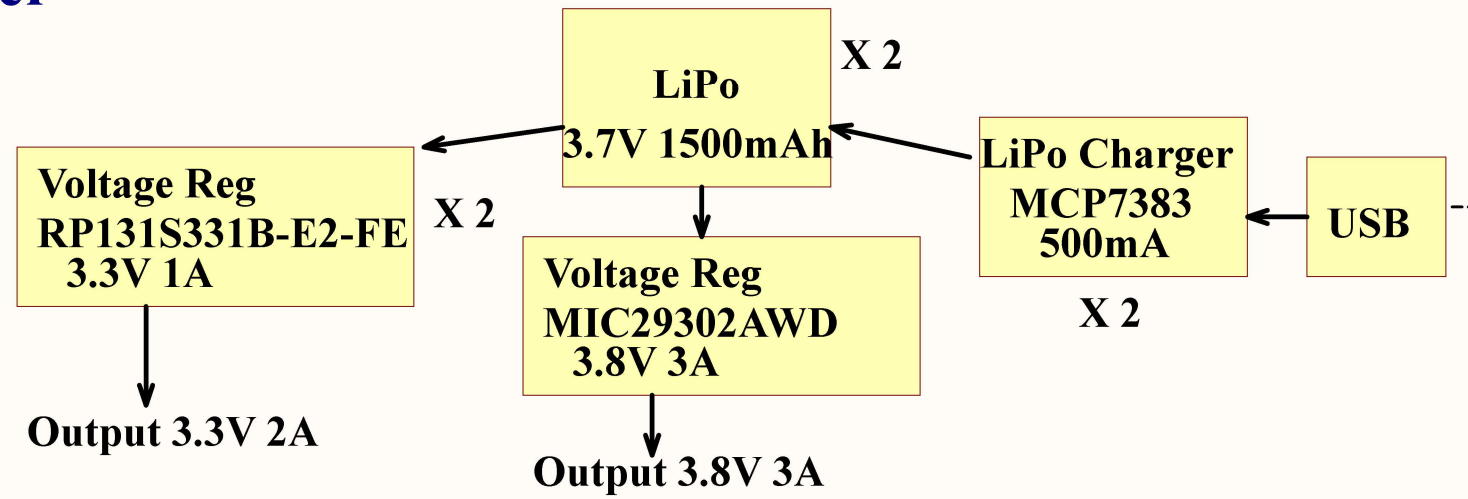
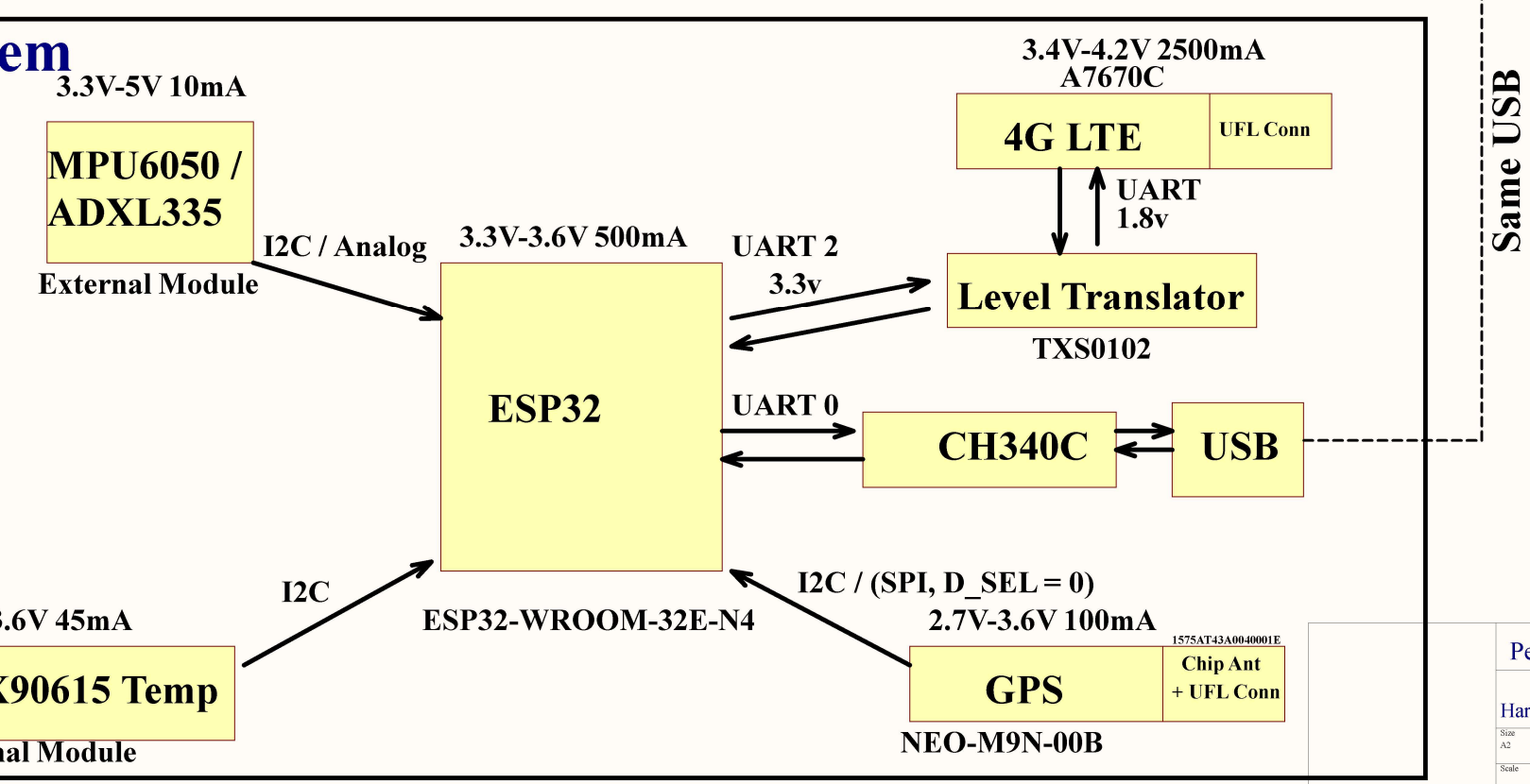
Pet Pulse

Power



System

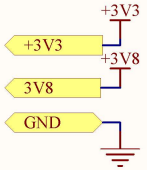


Pet Pulse [01] Block Diagram

Hardware designer : Naman Tanwar

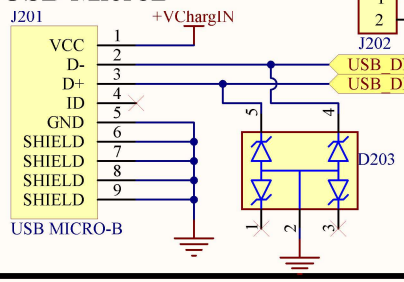
Size	FCSM No.	DWG No.	Rev
A2			
Scale		Sheet	

Port

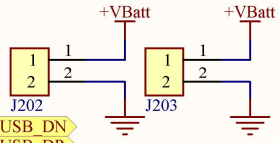


Connectors

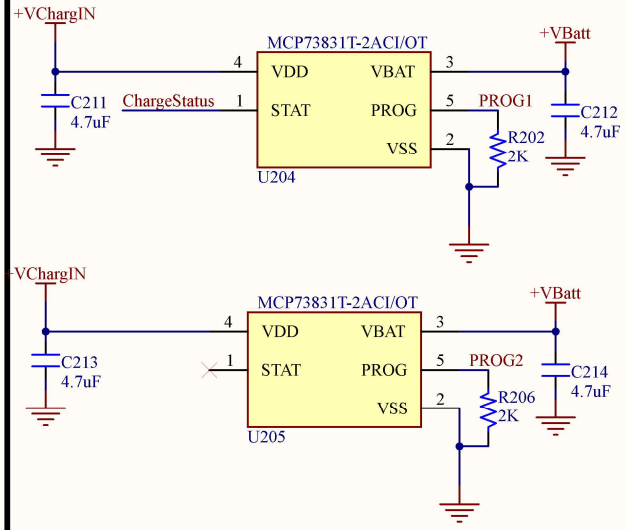
USB MicroB



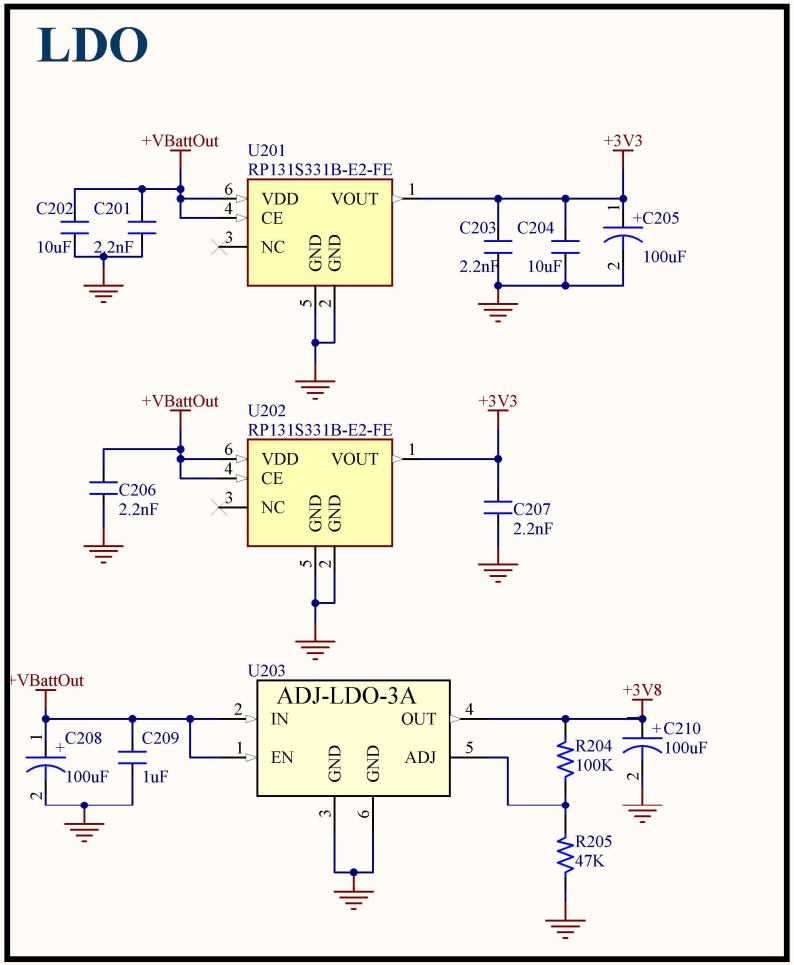
JST- LiPo Batt x2



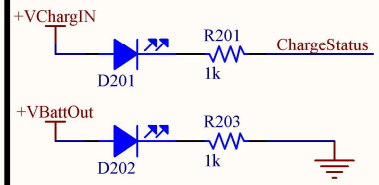
LiPo Charger



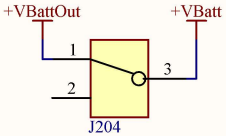
LDO



Indicator LEDs



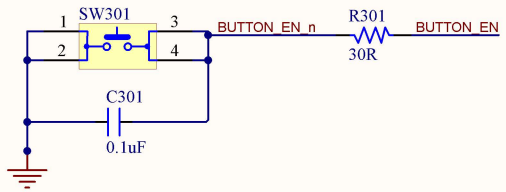
Switch



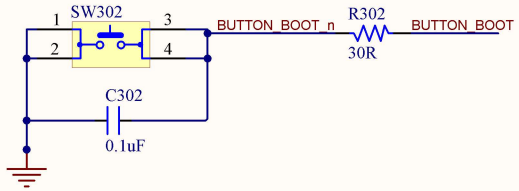
Title	Pet Pulse [02] LDO and LiPo circuit	
Size A4	Number	Revision
Date: 8-23-2023	Sheet of	
File: E:\Altium Projects\..\[02] LDO and LiPo Circuit.SchDoc	Drawn By:	

ESP32

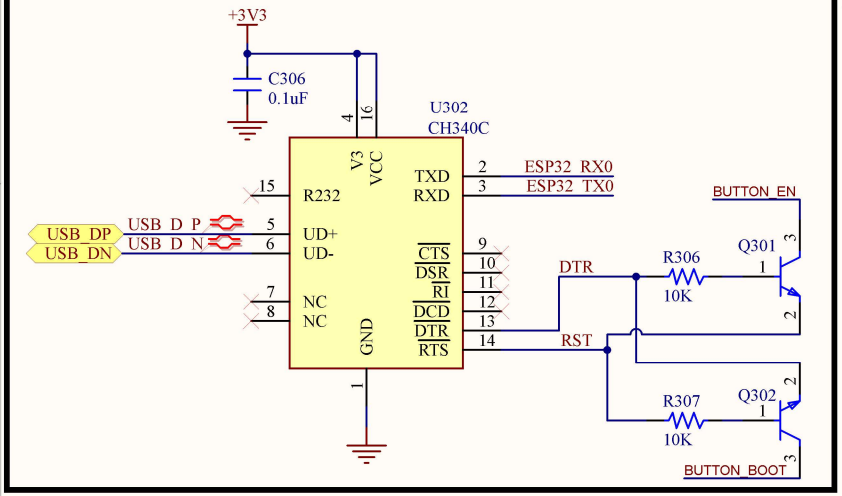
Enable



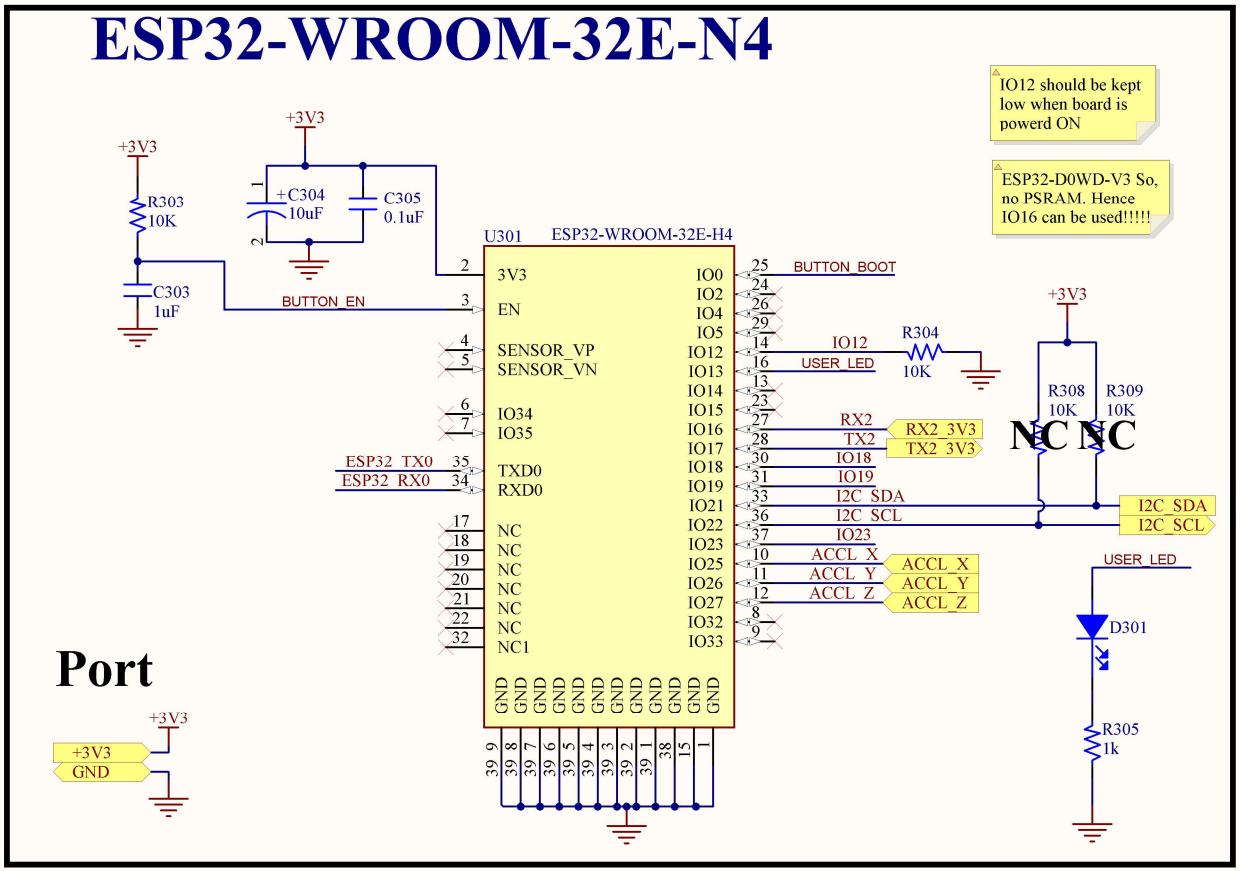
Boot



Programmer



ESP32-WROOM-32E-N4



Port

Pg.11, ESP32 Series Datasheet

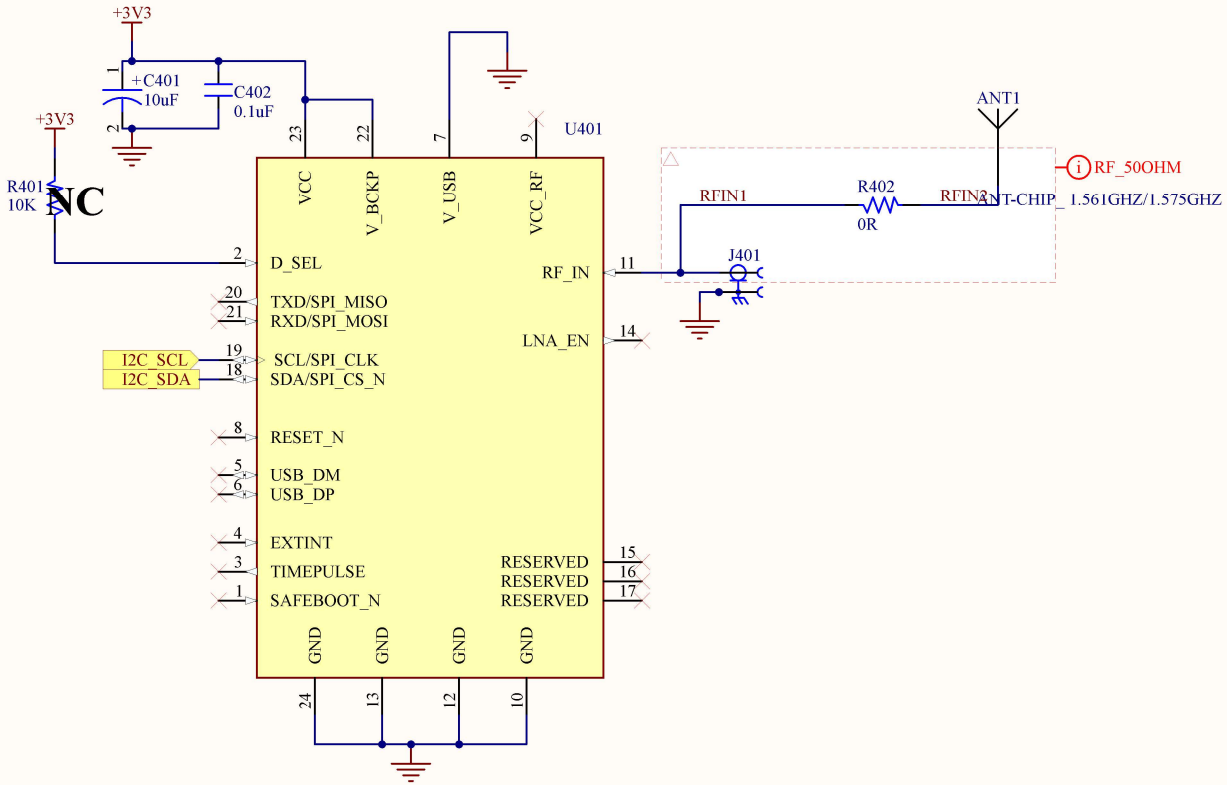
Table 1-1. ESP32 Series Comparison

Ordering code[1]	Core	Chip Revision[2]	In-Package Flash/PSRAM	Package	VDD_SDIO Voltage
ESP32-D0WD-V3	Dual core	v3.0/v3.1[4]	—	QFN 5*5	1.8 V/3.3 V
ESP32-D0WDR2-V3	Dual core	v3.0/v3.1[4]	2 MB PSRAM	QFN 5*5	3.3 V
ESP32-U4WDH	Dual core[3]	v3.0/v3.1[4]	4 MB flash (80 MHz)	QFN 5*5	3.3 V
ESP32-D0WDQ6-V3 (NRND)	Dual core	v3.0/v3.1[4]	—	QFN 6*6	1.8 V/3.3 V
ESP32-D0WD (NRND)	Dual core	v1.0/v1.1[5]	—	QFN 5*5	1.8 V/3.3 V
ESP32-D0WDQ6 (NRND)	Dual core	v1.0/v1.1[5]	—	QFN 6*6	1.8 V/3.3 V
ESP32-S0WD (NRND)	Single core	v1.0/v1.1[5]	—	QFN 5*5	1.8 V/3.3 V

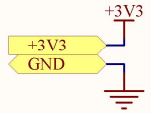
Title	Pet Pulse [03] ESP32	
Size: A4	Number	Revision
Date: 8-23-2023	Sheet of	
File: E:\Altium Projects\..\[03] ESP32.SchDoc	Drawn By:	

GPS

NEO-M9N-00B GPS



Port



Pin no.	Name	I/O	Description
1	SAFEBOOT_N	I	SAFEBOOT_N (used for FW updates and reconfiguration, leave open)
2	D_SEL	I	Interface select (open or VCC = UART + I2C; GND = SPI)
3	TIMEPULSE	O	TIMEPULSE (1 PPS)

4.3 NEO-M9N minimal design

The minimal electrical circuit for NEO-M9N operation using the UART1 interface is shown in Figure 31 below.

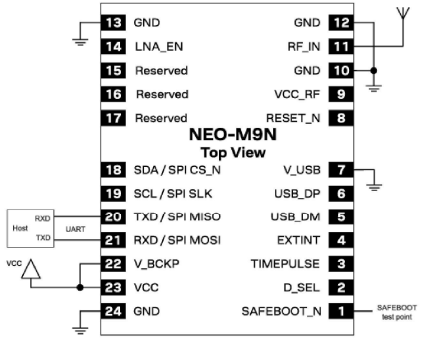
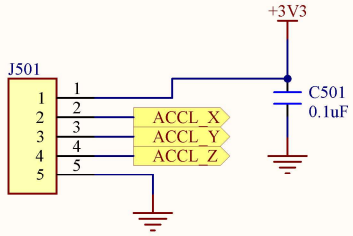


Figure 31: Minimal NEO-M9N design

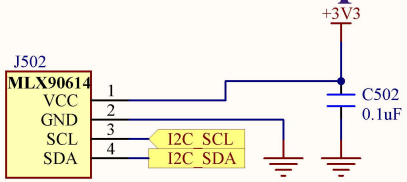
Title	Pet Pulse [04] GPS	
Size: A4	Number:	Revision:
Date: 8-23-2023		Sheet of
File: E:\Altium Projects\..\[04] GPS.SchDoc		Drawn By:

EXTERNAL MODULES

ADXL335 Accelerometer

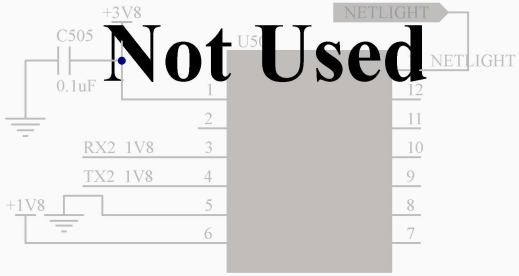


MLX90615 Temp Sensor

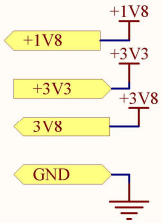


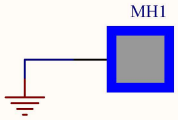
LTE EXT Module A7670C

Not Used



Port

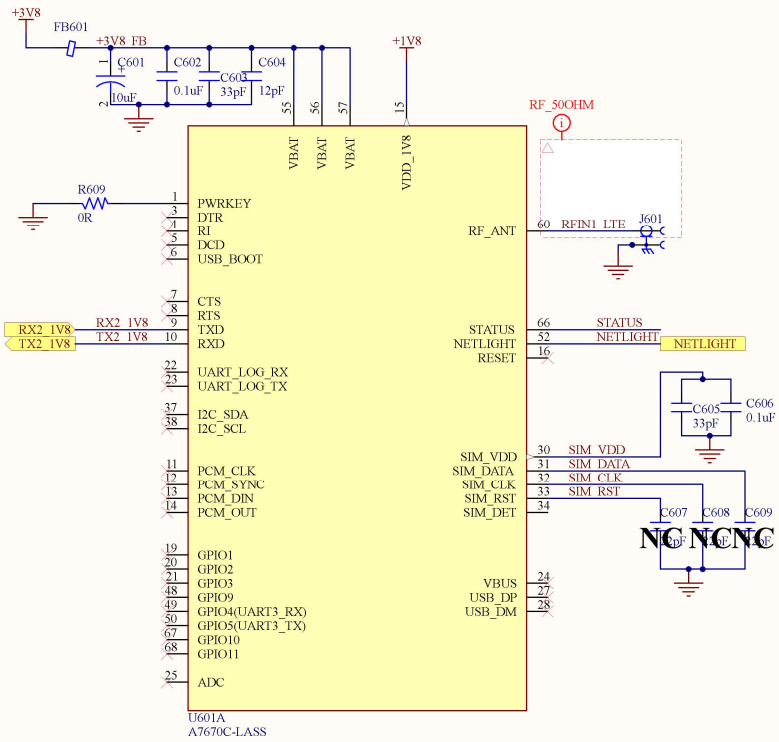




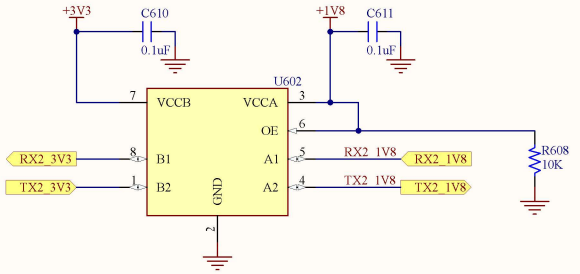
Title: Pet Pulse [05] External Modules		
Size: A4	Number:	Revision:
Date: 8-23-2023	Sheet of	
File: E:\Altium Projects\..\[05] External Modules.SchDoc	Drawn By:	

LTE

A7670C



UART Level Translation



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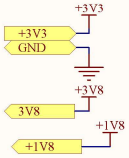
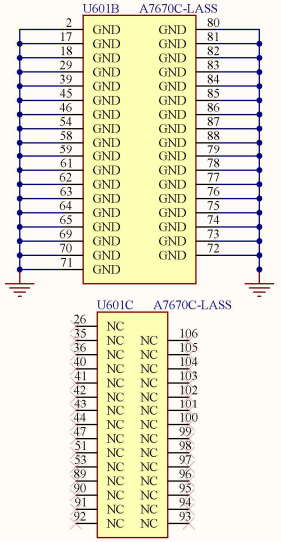
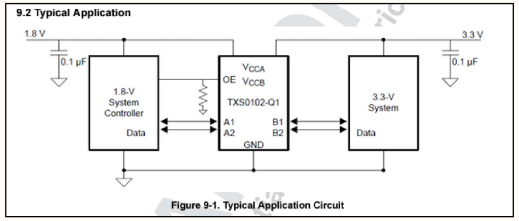


GND & NC

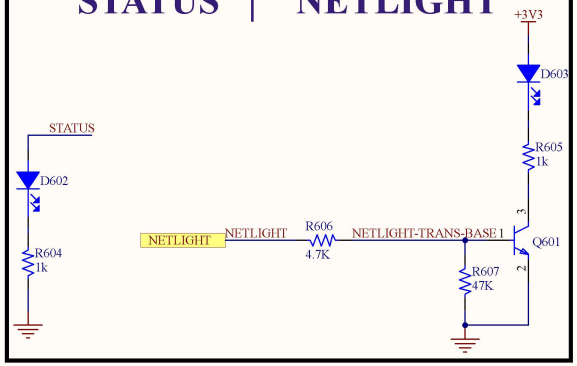


Chip Antenna

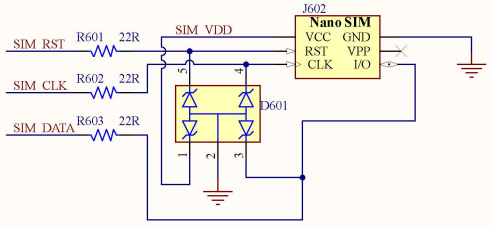
Not Used



STATUS | NETLIGHT



Nano SIM



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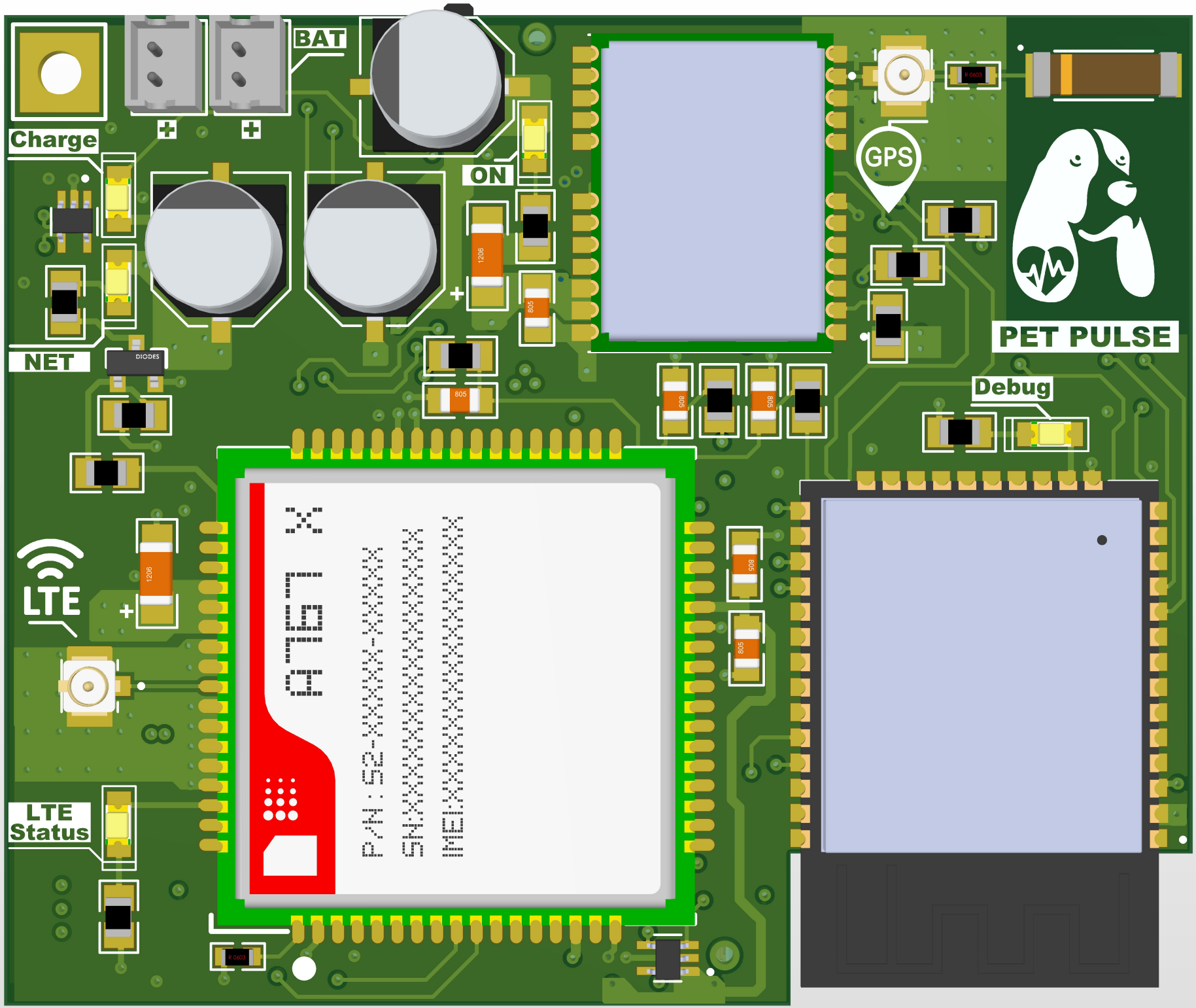
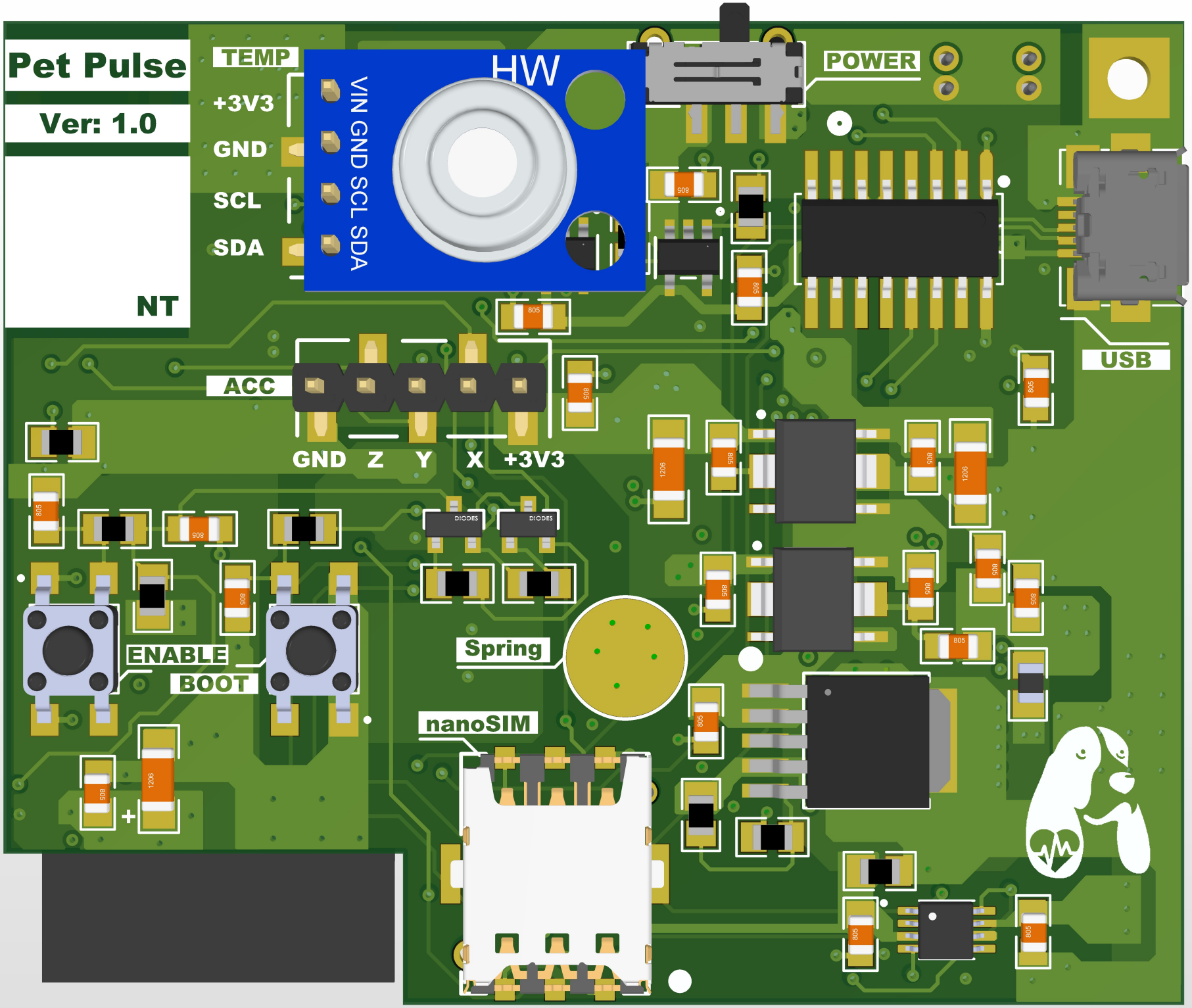
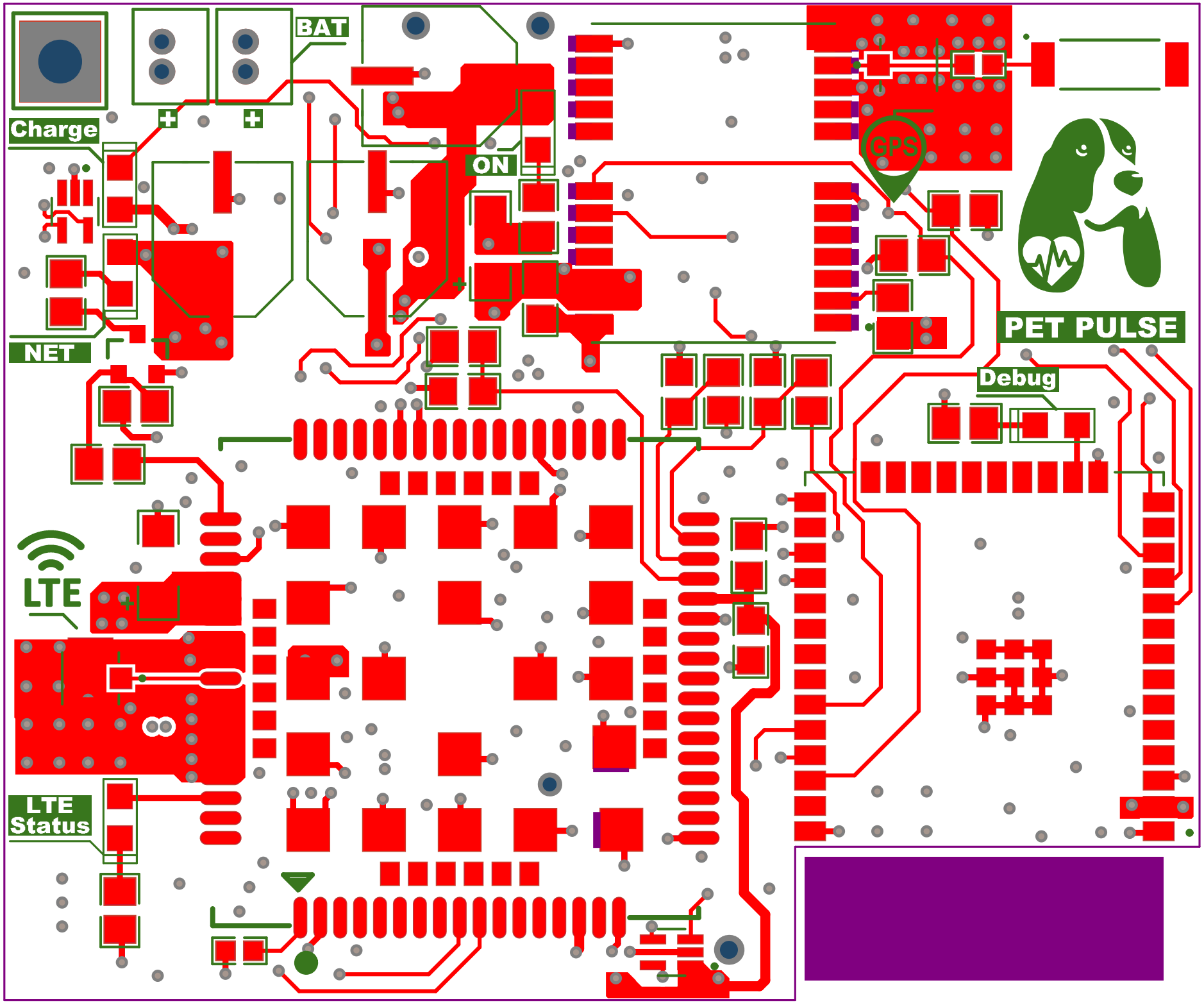
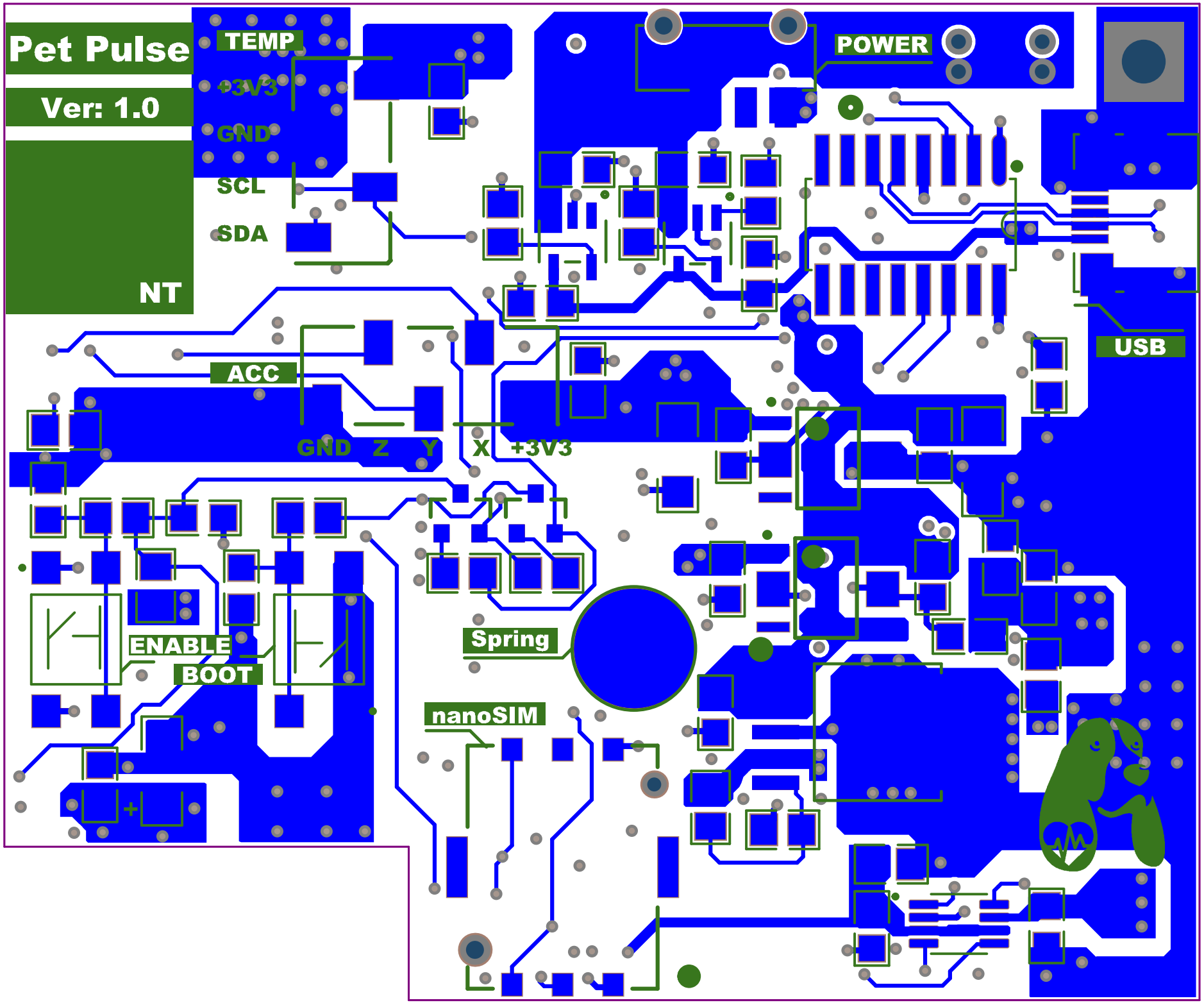
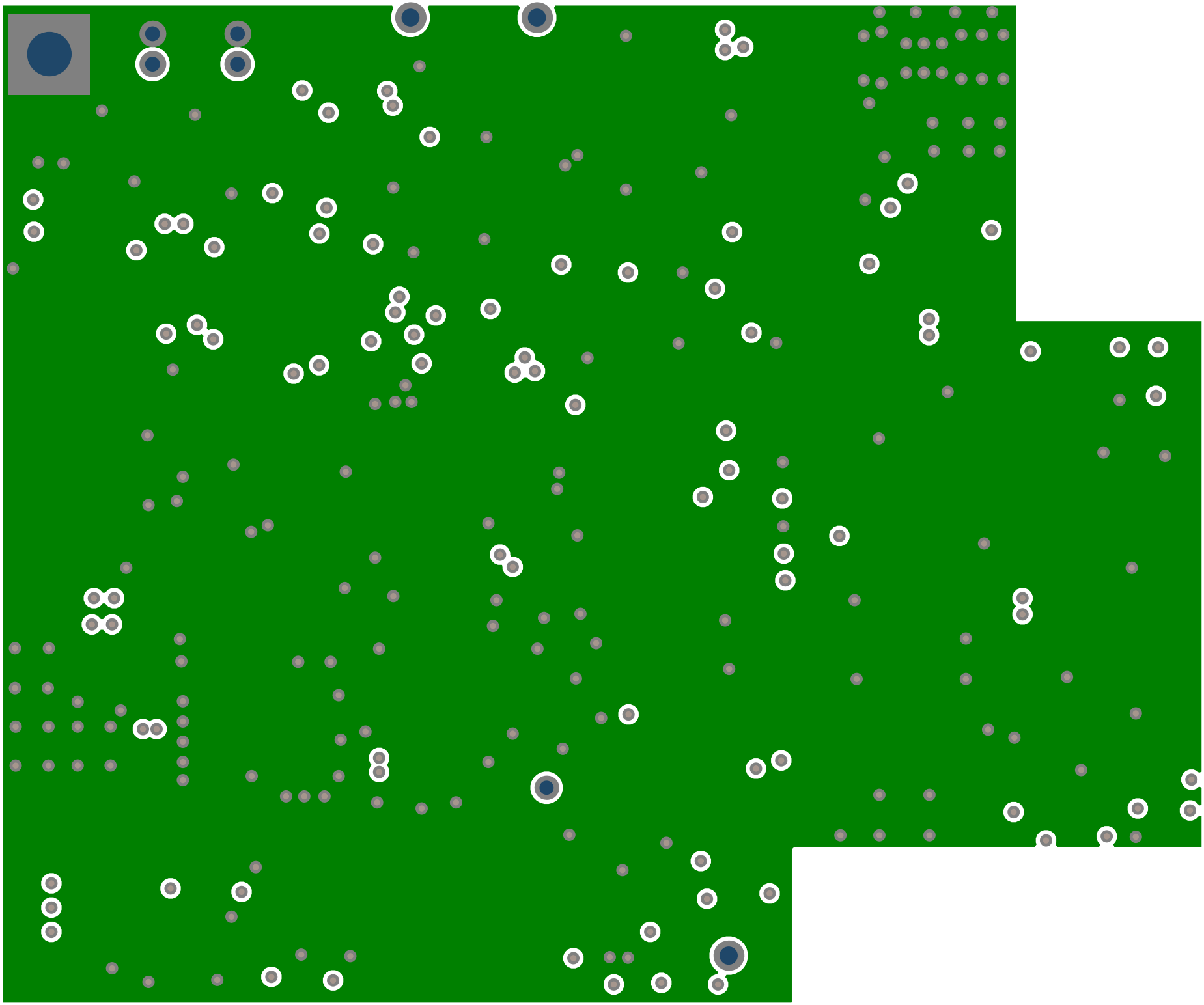
Date: 8-23-2023	Sheet of	
File: E:\Altium Projects\...\[06] LTE - A7670C.SchDoc	Drawn By:	

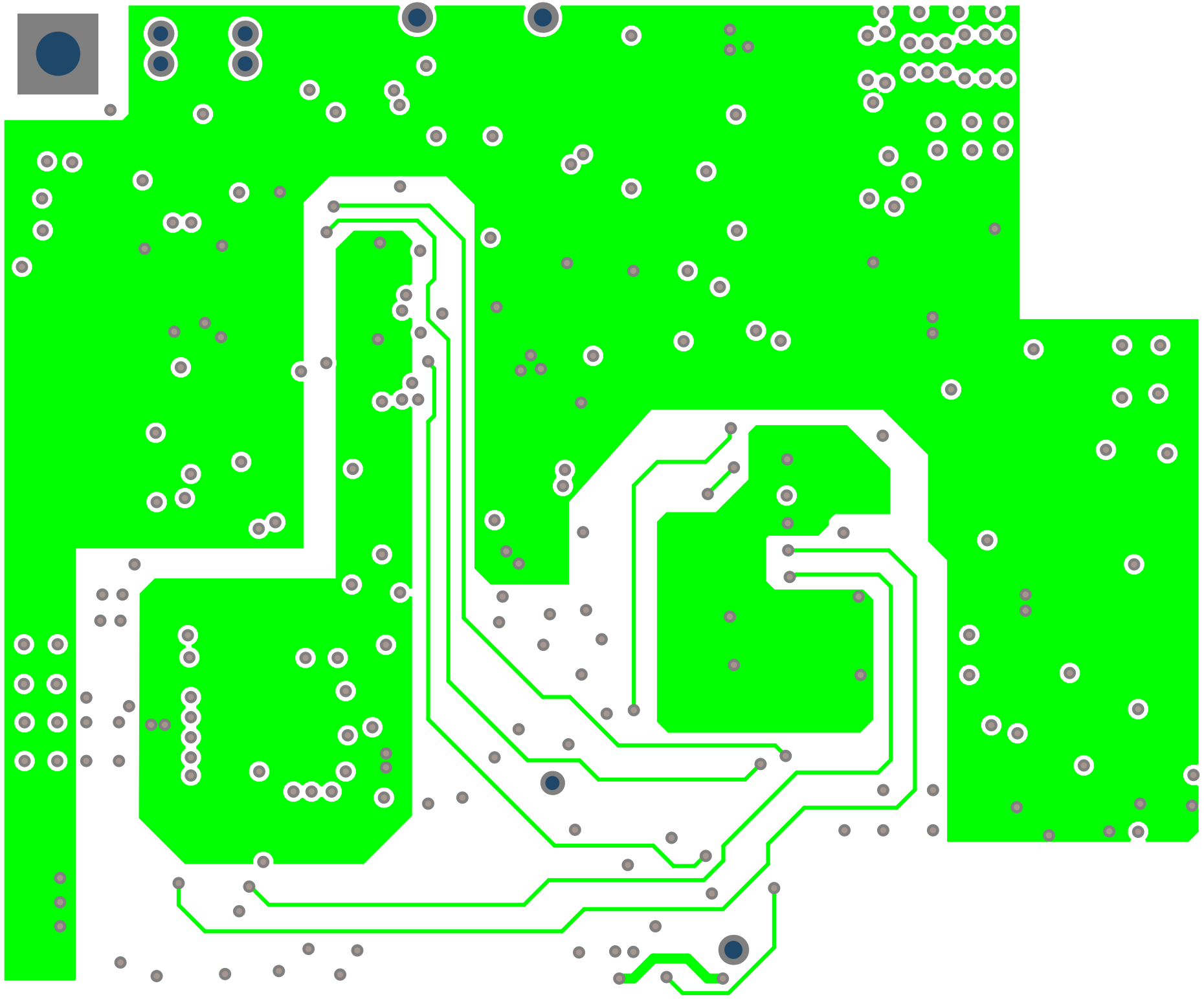

BAT
Charge
ON
GPS
NET
PET PULSE
Debug
LTE
LTE Status
DIODES
P/N:SQ-XXXXX-XXXXX
SN:XXXXXXXXXXXX
IMEI:XXXXXXXXXXXXX


Pet Pulse
Ver: 1.0
NT
TEMP
+3V3
GND
SCL
SDA
VIN GND SCL SDA
HW
POWER
USB
ACC
GND Z Y X +3V3
ENABLE
BOOT
Spring
nanoSIM

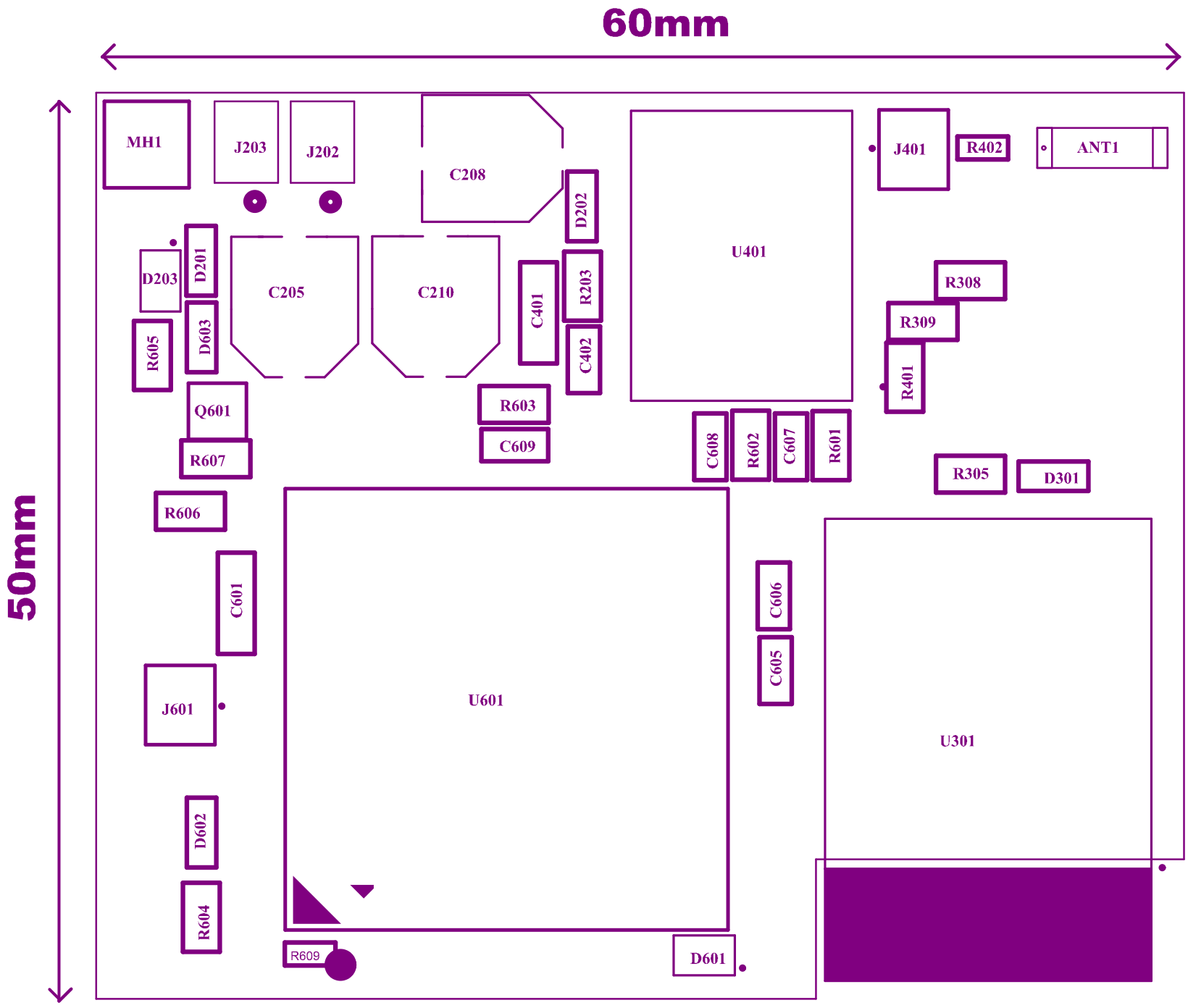

BAT
Charge
ON
GPS
NET
PET PULSE
Debug
LTE
LTE
Status


Pet Pulse
Ver: 1.0
NT
TEMP
+3V3
GND
SCL
SDA
POWER
USB
ACC
GND Z Y X +3V3
ENABLE
BOOT
Spring
nanoSIM

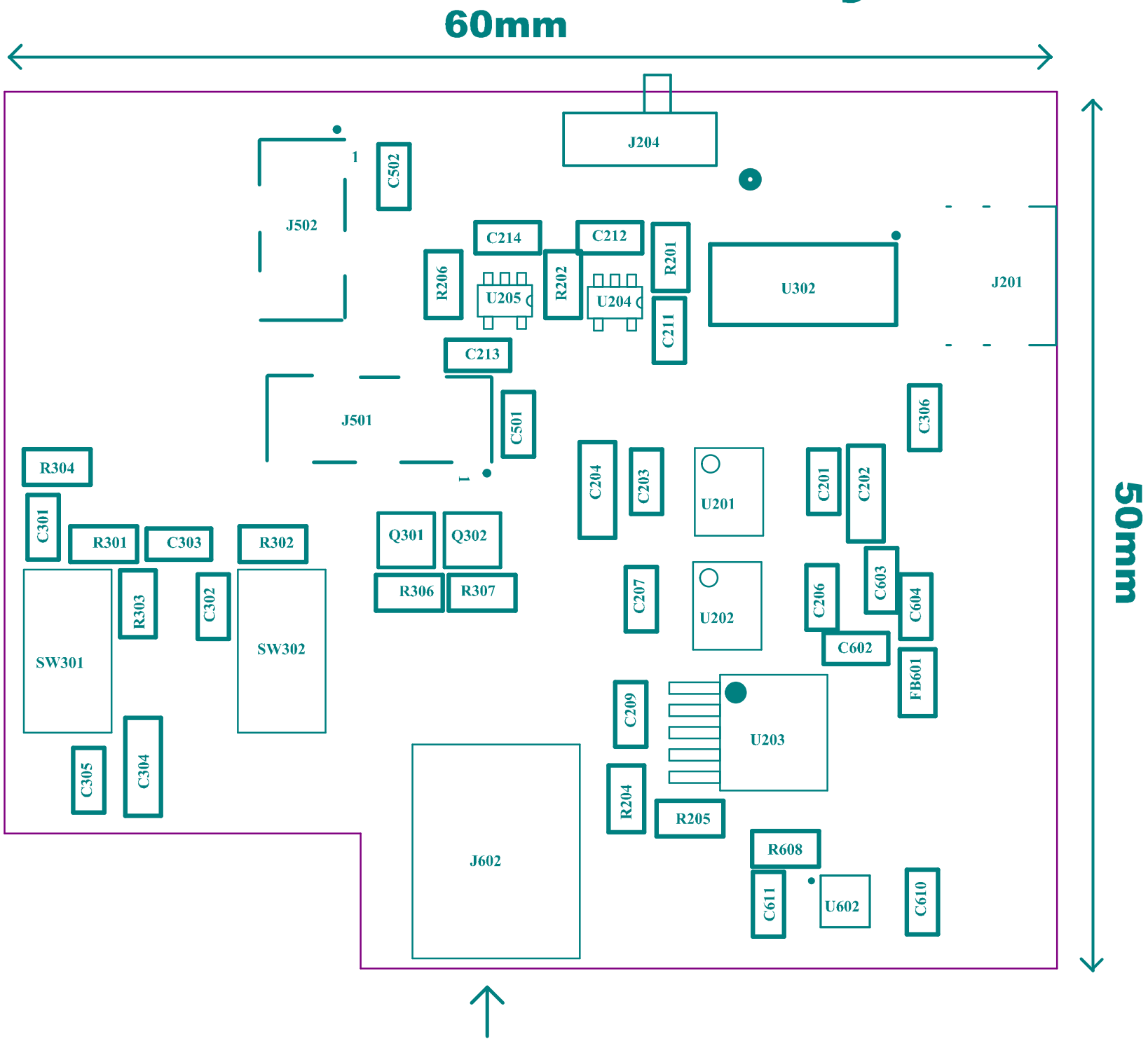




PCB Top Assembly

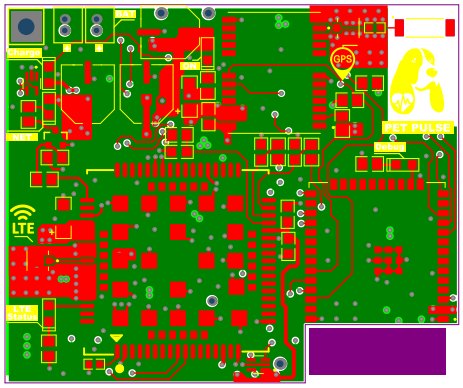


PCB Bottom Assembly

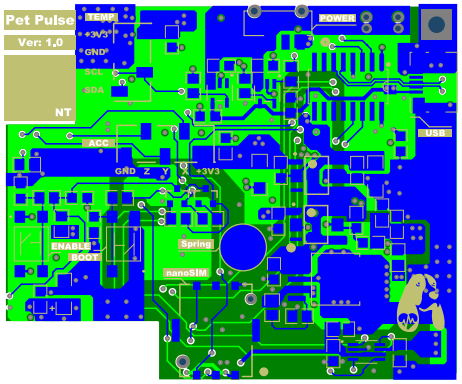


Actual Size of PCB

Top



Bottom


Pet Pulse
Ver: 1.0
TEMP
+3V3
GND
SCL
SDA
NT
POWER
USB
ACC
GRD
Z
Y
+3V3
ENABLE
BOOT
Spring
nanoSIM

❖ 4-Layer Board Stackup: (Based on LionCircuits capabilities)

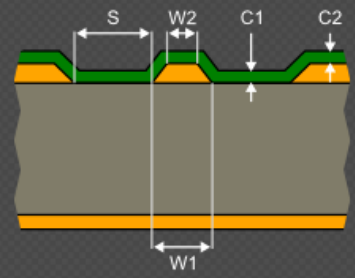
#	Name	Material	Type	Weight	Thickness	Dk	Df
	Top Overlay		Overlay				
	Top Solder	Solder Resist	Solder Mask		0.01016mm	3.5	
1	Top Layer		Signal	1oz	0.035mm		
	Dielectric 2	PP-2116	Prepreg		0.12mm	4.5	0.02
2	Layer 1	CF-004	Signal	1oz	0.035mm		
	Dielectric 1	FR-4_NP-140	Dielectric		1.165mm	4.4	
3	Layer 2	CF-004	Signal	1oz	0.035mm		
	Dielectric 3	PP-2116	Prepreg		0.12mm	4.5	0.02
4	Bottom Layer		Signal	1oz	0.035mm		
	Board Layer Stac...	Solder Resist	Solder Mask		0.01016mm	3.5	
	Board Layer Stac...		Overlay				

❖ Single Coplanar 50 Ohm Impedance:

+ Add | Delete | SC50 (RF50) | D90 (DIFF90)

#	Name	Material	Type	Top Ref	Bottom Ref	Width (W1)	Impedance (Z0)	Deviation	Delay (Tp)
	Top Overlay		Overlay						
	Top Solder	Solder Resist	Solder Mask						
1	Top Layer		Signal		2 - Layer 1	0.1944mm	50.01	0.02%	5.84339ns/m
	Dielectric 2	PP-2116	Prepreg						
2	Layer 1	CF-004	Signal	1 - Top Layer	3 - Layer 2	0.09439mm	50	0%	7.1324ns/m
	Dielectric 1	FR-4_NP-140	Dielectric						
3	Layer 2	CF-004	Signal	2 - Layer 1	4 - Bottom...	0.09439mm	50	0%	7.1324ns/m
	Dielectric 3	PP-2116	Prepreg						
4	Bottom Layer		Signal	3 - Layer 2		0.1944mm	50.01	0.02%	5.84339ns/m
	Board Layer Stac...	Solder Resist	Solder Mask						
	Board Layer Stac...		Overlay						

Transmission Line

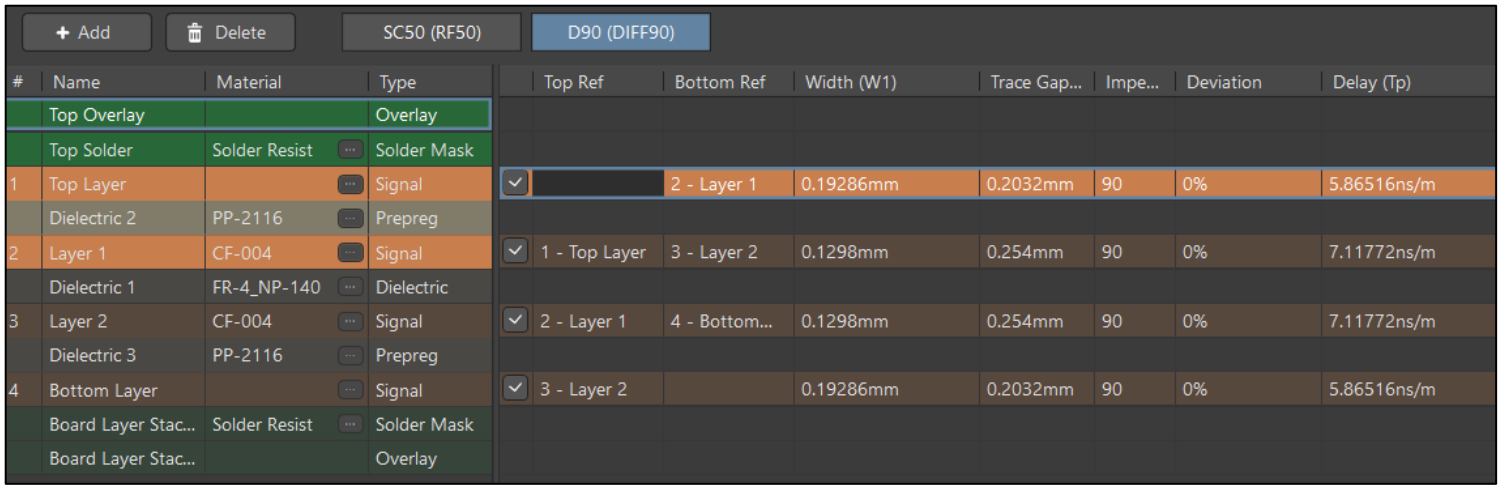


Simulated with SIMBEOR® software

Use Solder Mask	☐
Trace Inverted	☐
Etch [?]	0
Clearance (S)	0.2mm
Width (W1)	0.1944mm
Width (W2)	0.1944mm
Covering (C1)	0.01016mm
Covering (C2)	0.01016mm
Impedance (Zo)	50.01
Deviation	0.02%
Delay (Tp)	5.84339ns/m
Inductance	292.19597nH/m
Capacitance	116.85506pF/m

(For Top Layer- Single Coplanar)

❖ Differential Pair 90 Ohm Impedance:



#	Name	Material	Type	Top Ref	Bottom Ref	Width (W1)	Trace Gap...	Impe...	Deviation	Delay (Tp)
	Top Overlay		Overlay							
	Top Solder	Solder Resist	Solder Mask							
1	Top Layer		Signal		2 - Layer 1	0.19286mm	0.2032mm	90	0%	5.86516ns/m
	Dielectric 2	PP-2116	Prepreg							
2	Layer 1	CF-004	Signal	1 - Top Layer	3 - Layer 2	0.1298mm	0.254mm	90	0%	7.11772ns/m
	Dielectric 1	FR-4_NP-140	Dielectric							
3	Layer 2	CF-004	Signal	2 - Layer 1	4 - Bottom...	0.1298mm	0.254mm	90	0%	7.11772ns/m
	Dielectric 3	PP-2116	Prepreg							
4	Bottom Layer		Signal	3 - Layer 2		0.19286mm	0.2032mm	90	0%	5.86516ns/m
	Board Layer Stac...	Solder Resist	Solder Mask							
	Board Layer Stac...		Overlay							

❖ Controlled Impedance Trace Width data from LionCircuits

4 Layer- 1.6 mm-STD- STACKUP	90 DIFF		100 DIFF		50 SE
	Trace Width(mils	Trace Spacing(mils	Trace Width(mils)	Trace Spacing(mils	Trace Width(mils)
TOP/BOT	7.6	8	6	8	8
IN Layer 3	5	10	5.5	20	-
All Layer 1Oz copper					
Top/BOT- Soldermask Coated					

4 Layer- 1 mm-STD- STACKUP		90 DIFF		100 DIFF		50 SE
		Trace Width(mils)	Trace Spacing(mil	Trace Width(mils)	Trace Spacing(mil	Trace Width(mils)
TOP/BOT		7.6	8	6	8	8
IN Layer 3		5.2	10	5.5	20	-
All layer 1Oz Copper						
Top/BOT- Soldermask Coated						

2 Layer- 0.8 mm- 1oz copper		90 DIFF		100 DIFF		50 SE
		Trace Width(mils)	Trace Spacing(mil	Trace Width(mils)	Trace Spacing(mil	Trace Width(mils)
TOP/BOT		30.5	8	24	8	58

Name	Description	Designator	Quantity	Manufacturer Part Number
ANT-CHIP_ 1.561GHZ/1.575GHZ		ANT1	1	1575AT43A0040E
2.2nF	2200pF ±10% 50V Ceramic Capacitor C0G, NP0 0805 (2012 Metric)	C201, C203, C206, C207	4	CC0805KRX7R9BB222
10uF	10µF ±10% 50V Ceramic Capacitor X7R 1206 (3216 Metric)	C202, C204	2	CL31B106KBHNNNE
100uF	100µF 25V Aluminum Electrolytic Capacitors Radial, Can - SMD 1000 Hr	C205, C208, C210	3	UWT1E101MCL1GS
1uF	1µF ±5% 50V Ceramic Capacitor X7R 0805 (2012 Metric)	C209, C303	2	CC0805JKX7R9BB105
4.7uF	4.7µF ±10% 50V Ceramic Capacitor X5R 0805 (2012 Metric)	C211, C212, C213, C214	4	GRM21BR61H475KE51L
0.1uF	0.1µF ±10% 50V Ceramic Capacitor X7R 0805 (2012 Metric)	C301, C302, C305, C306, C402, C501, C502, C602, C606, C610, C611	11	CL21B104KBCNNNC
10uF	10µF Molded Tantalum Capacitors 16V 1206 (3216 Metric) 3Ohm	C304, C401, C601	3	TAJA106K016SNJ
33pF	33pF ±5% 50V Ceramic Capacitor C0G/NPO 0805 (2012 Metric)	C603, C605	2	CC0805JRNPO9BN330
12pF	12pF ±5% 50V Ceramic Capacitor C0G, NP0 0805 (2012 Metric)	C604	1	CC0805JRNPO9BN120
22pF	22pF ±5% 50V Ceramic Capacitor C0G, NP0 0805 (2012 Metric)	C607, C608, C609	3	CC0805JRNPO9BN220
LED 0805 ORANGE	Orange LED 0805 Vf = 2V, 20mA	D201, D202, D301, D602, D603	5	LOR976-PS-1
ESDA6V1W5	Tvs Diode Array 3V reverse standoff, 6.1V reverse breakdown. SOT-323	D203, D601	2	ESDA6V1W5
MPZ2012S221AT000	Ferrite bead 220 Ohms @ 100 MHz 0805 (2012 Metric) 3A 40mOhm	FB601	1	MPZ2012S221AT000
USB MICRO-B	USB - micro B USB 2.0 Receptacle Connector 5 Position Surface Mount,	J201	1	10118192-0001LF
1x2 JST	Connector Header Through Hole 2 position 0.059" (1.50mm)	J202, J203	2	B2B-ZR (LF)(SN)
SW1_SlideSW_SMD_SPDT_450405020524	Slide Switch SPDT Surface Mount	J204	1	450405020524
CON_UFL-SMD-T	U.FL (UMCC) Connector Jack, Male Pin 50Ohm Surface Mount Solder	J401, J601	2	
1X5 Berg Male	1X5 Berg Strip SMD Male Conn 2.54mm	J501	1	10129380-905001ALF
1X4 Berg Male With MLX90614 3D Body	1X4 Berg Strip SMD Male Conn 2.54mm with 3D body of MLX90614 IR T	J502	1	10129380-904001ALF
SIM8051-6-0-14-01-A	6 Position Card Connector NANO SIM Surface Mount, Right Angle Gold	J602	1	SIM8051-6-0-14-01-A
MMBT3904-7-F	TRANS NPN 40V 0.2A SMD SOT23-3	Q301, Q302, Q601	3	MMBT3904-7-F
1k	RES 1K OHM 5% 1/8W 0805	R201, R203, R305, R604, R605	5	RC0805JR-131KL
2K	2 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Moistur	R202, R206	2	RC0805FR-072KL
100K	100 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Auton	R204	1	WR08X1003FTL
47K	47 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Moistu	R205, R607	2	RC0805FR-0747KL
30R	30 Ohms ±5% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Moistur	R301, R302	2	RC0805JR-0730RL
10K	10 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Autom	R303, R304, R306, R307, R308, R309, R401, R608	8	WR08X1002FTL
0R	0 Ohms 0603 (1608 Metric)	R402, R609	2	RMCF0603ZT0R00
22R	22 Ohms ±5% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Moistur	R601, R602, R603	3	RC0805JR-0722RL
4.7K	4.7 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Moistu	R606	1	RC0805FR-074K7L
SW1_SMD_TL3305AF260QG	Tactile Switch SPST SMD	SW301, SW302	2	TL3305AF260QG
RP131S331B-E2-FE	LDO 3.3V Output 1A 6-HSOP-J	U201, U202	2	RP131S331B-E2-FE
MIC29302AWD	Linear Voltage Regulator IC Positive Adjustable 1 Output 3A TO-252-5	U203	1	MIC29302AWD
MCP73831T-2ACI/OT	Charger IC Lithium Ion/Polymer SOT-23-5	U204, U205	2	MCP73831T-2ACI/OT
ESP32-WROOM-32E-H4	Rx Txrx Mod Wifi Trace Ant SMD	U301	1	ESP32-WROOM-32E-H4
CH340C	USB Bridge, USB to UART USB 2.0 UART Interface	U302	1	CH340C
IC_GPS/GNSS_NEO-M9N-00B	M9 RF Receiver BeiDou, Galileo, GLONASS, GNSS, GPS -167dBm Module	U401	1	NEO-M9N-00B
A7670C-LASS		U601	1	Self-Procurred
TXS0102DCTR	2-Bit Bidirectional Voltage-Level Shifter for Open-Drain and Push-Pull A	U602	1	TXS0102DCTR

Bill Of Material (BOM) With Extra margin of Components and Self-Procured Components Removed

	Description	Designator	Quantity	Manufacturer Part Number
ANT-CHIP_ 1.561GHZ/1.575GHZ		ANT1	3	1575AT43A0040E
2.2nF	2200pF ±10% 50V Ceramic Capacitor C0G, NP0 0805 (2012 Met	C201, C203, C206, C207	10	CC0805KRX7R9BB222
10uF	10µF ±10% 50V Ceramic Capacitor X7R 1206 (3216 Metric)	C202, C204	3	CL31B106KBHNNNE
100uF	100µF 25V Aluminum Electrolytic Capacitors Radial, Can - SMD	C205, C208, C210	4	UWT1E101MCL1GS
1uF	1µF ±5% 50V Ceramic Capacitor X7R 0805 (2012 Metric)	C209, C303	3	CC0805JKX7R9BB105
4.7uF	4.7µF ±10% 50V Ceramic Capacitor X5R 0805 (2012 Metric)	C211, C212, C213, C214	5	GRM21BR61H475KE51L
0.1uF	0.1µF ±10% 50V Ceramic Capacitor X7R 0805 (2012 Metric)	C301, C302, C305, C306, C402, C501, C502, C602, C606, C610, C611	13	CL21B104KBCNNNC
10uF	10µF Molded Tantalum Capacitors 16V 1206 (3216 Metric) 3Oh	C304, C401, C601	4	TAJA106K016SNJ
33pF	33pF ±5% 50V Ceramic Capacitor C0G/NPO 0805 (2012 Metric)	C603, C605	3	CC0805JRNPO9BN330
12pF	12pF ±5% 50V Ceramic Capacitor C0G, NP0 0805 (2012 Metric)	C604	2	CC0805JRNPO9BN120
22pF	22pF ±5% 50V Ceramic Capacitor C0G, NP0 0805 (2012 Metric)	C607, C608, C609	4	CC0805JRNPO9BN220
LED 0805 ORANGE	Orange LED 0805 Vf = 2V, 20mA	D201, D202, D301, D602, D603	6	LOR976-PS-1
ESDA6V1W5	Tvs Diode Array 3V reverse standoff, 6.1V reverse breakdown.	D203, D601	3	ESDA6V1W5
MPZ2012S221AT000	Ferrite bead 220 Ohms @ 100 MHz 0805 (2012 Metric) 3A 40m	FB601	2	MPZ2012S221AT000
USB MICRO-B	USB - micro B USB 2.0 Receptacle Connector 5 Position Surface	J201	3	10118192-0001LF
1x2 JST	Connector Header Through Hole 2 position 0.059" (1.50mm)	J202, J203	3	B2B-ZR (LF) (SN)
SW1_SlideSW_SMD_SPDT_450405020524	Slide Switch SPDT Surface Mount	J204	2	450405020524
1X5 Berg Male	1X5 Berg Strip SMD Male Conn 2.54mm	J501	1	10129380-905001ALF
1X4 Berg Male With MLX90614 3D Body	1X4 Berg Strip SMD Male Conn 2.54mm with 3D body of MLX90	J502	1	10129380-904001ALF
SIM8051-6-0-14-01-A	6 Position Card Connector NANO SIM Surface Mount, Right Ang	J602	2	SIM8051-6-0-14-01-A
MMBT3904-7-F	TRANS NPN 40V 0.2A SMD SOT23-3	Q301, Q302, Q601	5	MMBT3904-7-F
1k	RES 1K OHM 5% 1/8W 0805	R201, R203, R305, R604, R605	6	RC0805JR-131KL
2K	2 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) I	R202, R206	3	RC0805FR-072KL
100K	100 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metri	R204	3	WR08X1003FTL
47K	47 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric)	R205, R607	4	RC0805FR-0747KL
30R	30 Ohms ±5% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) I	R301, R302	4	RC0805JR-0730RL
10K	10 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric)	R303, R304, R306, R307, R308, R309, R401, R608	10	WR08X1002FTL
0R	0 Ohms 0603 (1608 Metric)	R402, R609	5	RMCF0603ZT0R00
22R	22 Ohms ±5% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) I	R601, R602, R603	5	RC0805JR-0722RL
4.7K	4.7 kOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric	R606	3	RC0805FR-074K7L
SW1_SMD_TL3305AF260QG	Tactile Switch SPST SMD	SW301, SW302	3	TL3305AF260QG
RP131S331B-E2-FE	LDO 3.3V Output 1A 6-HSOP-J	U201, U202	2	RP131S331B-E2-FE
MIC29302AWD	Linear Voltage Regulator IC Positive Adjustable 1 Output 3A TO-	U203	2	MIC29302AWD
MCP73831T-2ACI/OT	Charger IC Lithium Ion/Polymer SOT-23-5	U204, U205	3	MCP73831T-2ACI/OT
ESP32-WROOM-32E-H4	Rx Txrx Mod Wifi Trace Ant SMD	U301	1	ESP32-WROOM-32E-H4
IC_GPS/GNSS_NEO-M9N-00B	M9 RF Receiver BeiDou, Galileo, GLONASS, GNSS, GPS -167dBm	U401	1	NEO-M9N-00B
TXS0102DCTR	2-Bit Bidirectional Voltage-Level Shifter for Open-Drain and Pus	U602	2	TXS0102DCTR
NC2SWLF.015 0.2OZ	No-Clean Wire Solder Sn99.3Cu0.7 (99.3/0.7) Tube, 0.2 oz (5.66g)		1	NC2SWLF.015 0.2OZ
LTE ANT	829MHz, 2.2GHz LTE Flat Patch RF Antenna 698MHz ~ 960MHz, 1.71GHz ~ 2.69GHz 4.84dBi, 4.84dBi IPEX MHF Adhesive		1	YF0028AA