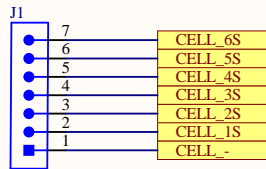


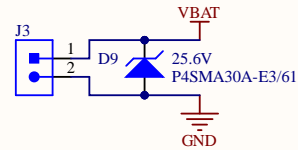
Title	Battery Manager
Size:	Letter
Drawn By:	Ayesha Ebrahim
Date:	2020-08-09
Sheet	of 6
File:	C:\Users\ayesh\Documents\GitHub\MarsRover2020-PCB\Projects\Battery Management System\Rev1\SH3 - BATTERY M



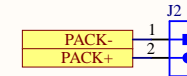
## Battery Balancing



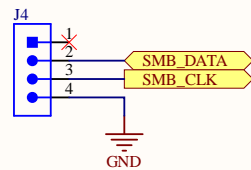
## Battery In



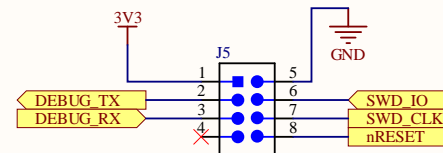
## Pack Out



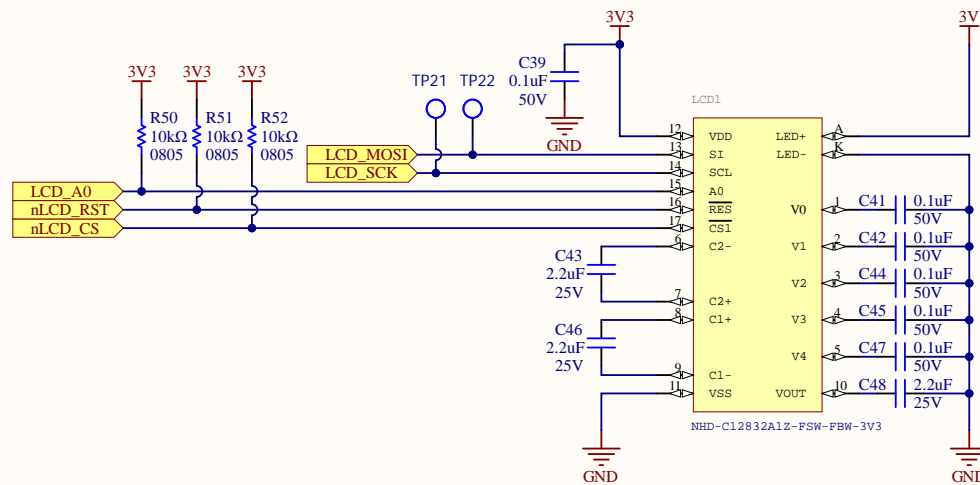
## EV2400



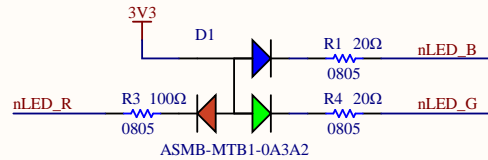
## Debug/Programing



# LCD



## Test LEDs

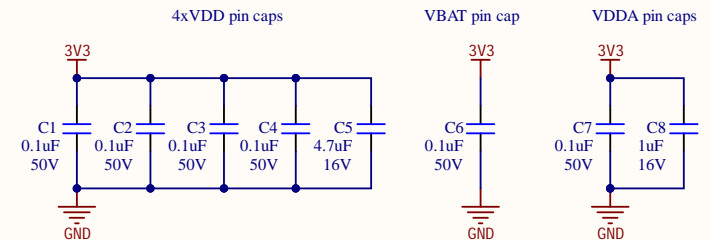


**Current Calculations**

Green LED voltage drop: 2.2V  
 $I = (3.3 - 2.2V) / 100 = 11mA$

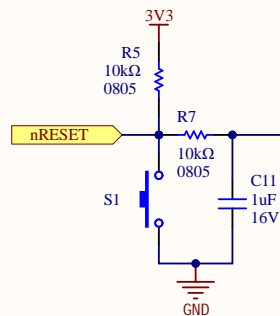
RGB LED voltage drops:  
 - Red: 2.1V:  $I = (3.3 - 2.1V) / 100 = 12mA$   
 - Blue: 3.1V:  $I = (3.3 - 3.1V) / 20 = 10mA$   
 - Green: 3.1V:  $I = (3.3 - 3.1V) / 20 = 10mA$

## Decoupling Caps

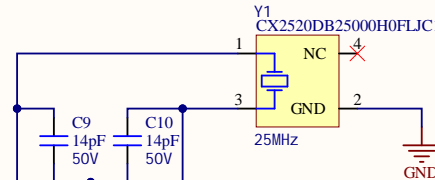


## STM32F446RET6

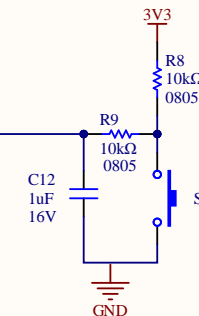
## Reset Button



**For Debounce Circuit:**  
 $T = RC \rightarrow C = T/R$   
 $C = 10ms / 10kOhms = 1\mu F$



## Test Button



**For Debounce Circuit:**  
 $T = RC \rightarrow C = T/R$   
 $C = 10ms / 10kOhms = 1\mu F$

## GND Test Point



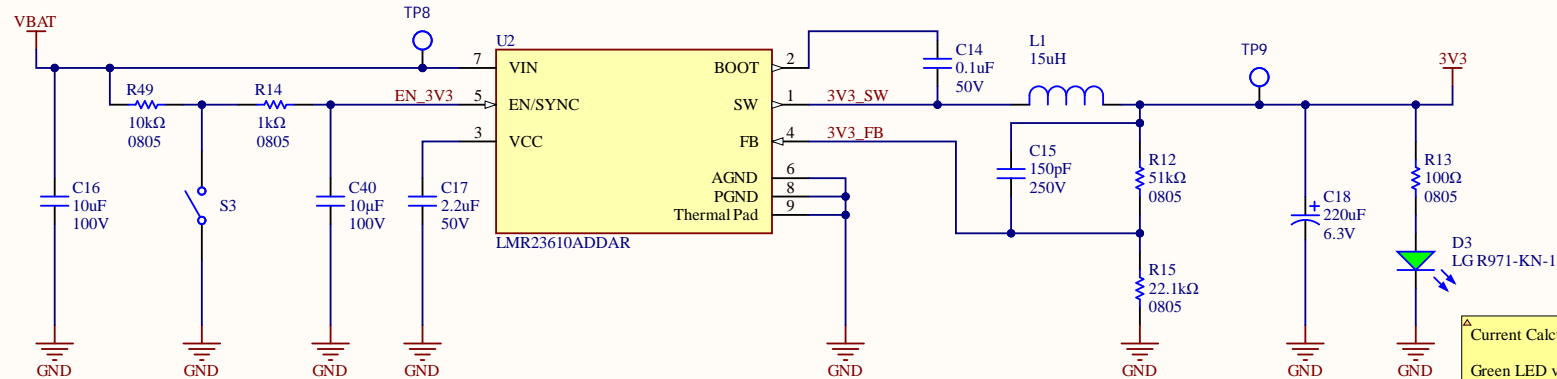
## Battery Voltage to 3V3 Buck @ 1A Max

Designed for 15V-25.2V input

Route for 0.5A in

Inductor: SRN6045-150M  
15uH, 20%, 95.8mOhm DCR (max)  
1.9A (rms), 2.3A (sat), 4.5mm tall

Route for 1A out



For Debounce Circuit:

$$T=RC \rightarrow C= T/R$$

$$C= 10ms/1kOhms= 10uF$$

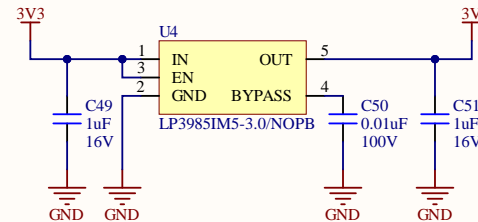
Current Calculations

$$\text{Green LED voltage drop: } 2.2V$$

$$I = (3.3-2.2V)/100 = 11mA$$

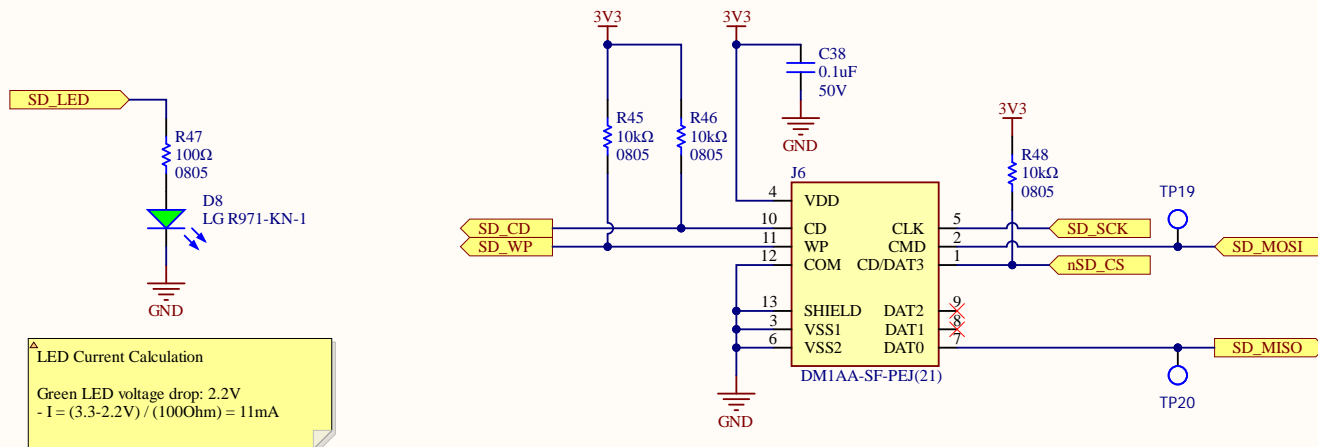
Max expected power on output = 1.65W  
Max current = 0.5A  
Expected Efficiency at 1A > 87.7%

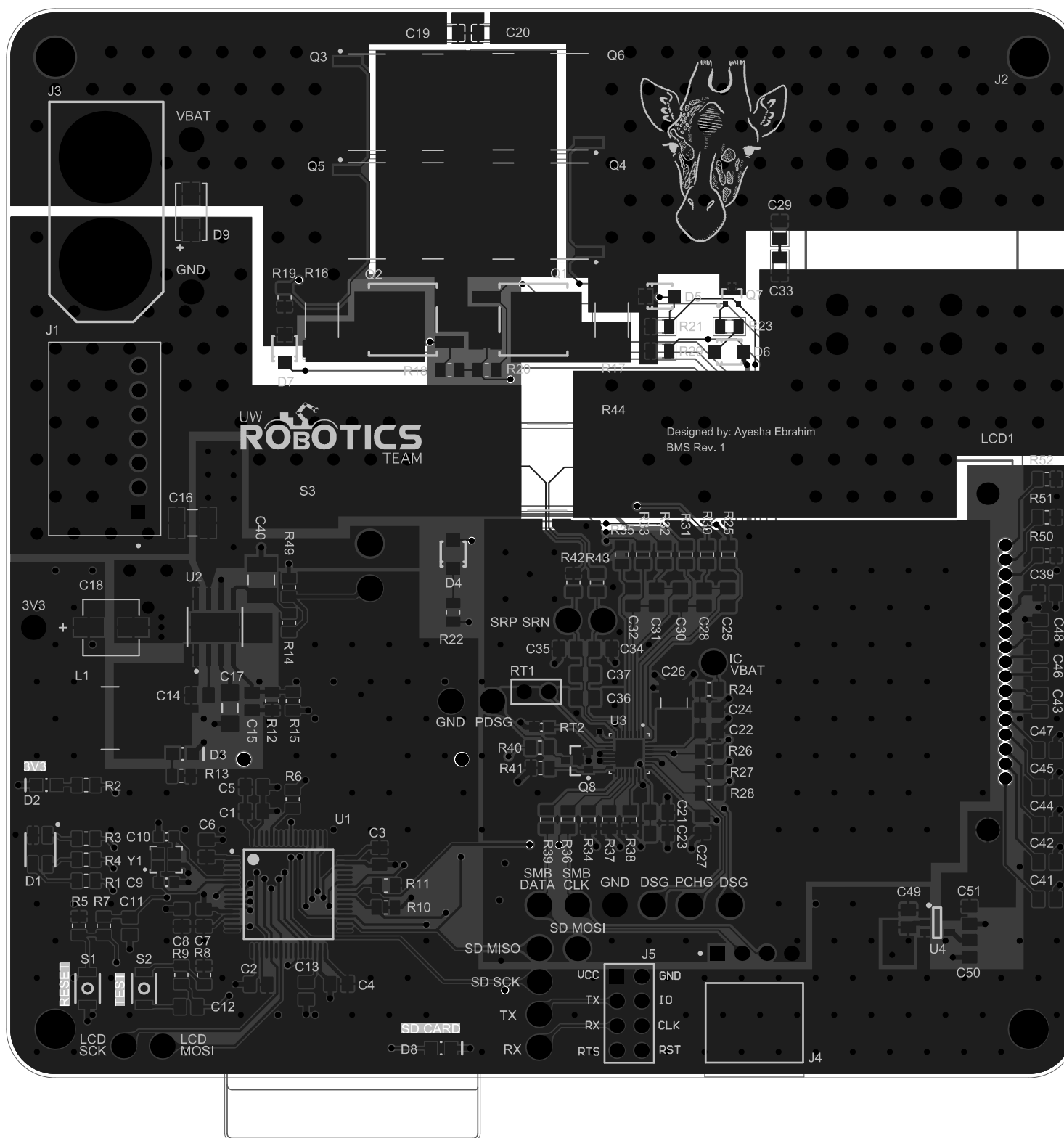
## 3V3 to 3V LDO @ 150mA Max



Title	Power
Size: Letter	Drawn By: Ayesha Ebrahimi
Date: 2020-08-09	Sheet 5 of 6
File: C:\Users\ayesh\Documents\GitHub\MarsRover2020-PCB\Projects\Battery Management System\Rev1\SH1 - POWER.Sch	

# SD Card Connector





Comment	Description	Designator	Footprint	Libref	Quantity
CAP_0.1uF_50V_0805	CAP CER 0.1uF 50V X7R 0805	C1, C4, C7, C14, C19, C20, C25, C28, C29, C30, C31, C32, C33, C34, C35, C37, C38, C39, C41, C42, C44, C45, C47	CAPC2012X140N	CAP_0.1uF_50V_0805	23
CAP_1uF_16V_0805	CAP CER 1uF 16V X7R 0805	C8, C11, C12, C49, C51	CAPC2012X140N	CAP_1uF_16V_0805	5
CL10C1408B8NNNC	Cap Ceramic 14pF 50V C0G 5% SMD 0603 125C Cardboard T/R	C9, C10	CAPC0603160855_N	CL10C1408B8NNNC	2
CAP_4.7uF_16V_0805	CAP CER 4.7uF 16V X5R 0805	C13	CAPC2012X140N	CAP_4.7uF_16V_0805	1
CAP_150pF_250V_0805	CAP CER 150pF 250V COG/NPO 0805	C15	CAPC2012X140N	CAP_150pF_250V_0805	1
CAP_10uF_100V_1210	CAP CER 10uF 100V X7S 1210, CAP CER 10uF 100V X7S 10% 1210	C16, C40	CAPC1210(3225)	CAP_10uF_100V_1210	2
CAP_2.2uF_50V_1206	CAP CER 2.2uF 50V X7E 1206	C17	CAPC1206(3216)	CAP_2.2uF_50V_1206	1
CAP_220uF_6.3V_5M	CAP ALUM POLY 220uF 20% 6.3V SMD	C18	PCAP_SVP_BA_P900	CAP_220uF_6.3V_5M	1
CAP_100pF_50V_0805	CAP CER 100pF 50V COG/NPO 0805	C21, C22, C23, C24, C36	CAPC2012X140N	CAP_100pF_50V_0805	5
CAP_2.2uF_100V_1210	CAP CER 2.2uF 100V X7E 1210	C26	CAPC1210(3225)	CAP_2.2uF_100V_1210	1
CAP_0.01uF_100V_0805	CAP CER 1000pF 100V X7E 0805	C27, C50	CAPC2012X140N	CAP_0.01uF_100V_0805	2
CAP_2.2uF_25V_0805	CAP CER 2.2uF 25V X7R 0805	C43, C46, C48	CAPC2012X140N	CAP_2.2uF_25V_0805	3
LED_RGB	LED RGB DIFFUSED 4Pin, CC SMD	D1	LED_RGB	LED_RGB	1
DIO_LED_G	LED GREEN DIFFUSED 0805 SMD	D2, D3, D8	LED_0805_LINE	DIO_LED_G	3
B0540W-7-F	DIODE SCHOTTKY 40V 500MA SOD123	D4, D7	SOD-123_FLAT	DIO_SCHOTTKY_40V_500mA	2
DIO_ZENER_16V	DIODE ZENER 16V 500MW SOD123	D5	SOD-123_FLAT	DIO_ZENER_16V	1
1N4148W-7-F	DIODE GEN PURP 100V 300MA SOD123	D6	SOD-123_FLAT	DIO_100V_300mA	1
P4SMA30A-E3/61	TVS DIODE, 400W, 25.4V, UNI, DO-214AC	D9	DO-214AC_UNI	P4SMA30A-E3/61	1
CON_7M_TH_RA	CONN HEADER RH SIDE THS 2.54MM	J1	IST_57B-WH-AU(F)506	CON_7M_TH_RA	1
SCREW_TERM_115A	CONN TERM BLOCK 2POS 10MM 1.8MM	J2	MOLEX 0399200302	SCREW_TERM_115A	1
XT90	HIGH QUALITY GOLD PLATED XT90 MA	J3	XT90	XT90	1
CON_4M_TH_RA	CONN HEADER R/A 4POS 2.54MM	J4	MOLEX 22-05-3041_V	CON_4M_TH_RA	1
HEADER_4X2	CONN HEADER VERT 8POS 2.54MM	J5	HEADER_2X4	HEADER_4X2	1
SD_CARD_CON	12 - 9 + 3, Position Card Connector Secure Digital - SD Surface Mount, Right Angle Gold	J6	HRS_DM1AA-SF-PE(21)	SD_CARD_CON	1
SRW045-152M	FIXED IND 15uH 1.0A 45 8MMx4MM SMD	L1	IND_BOURNS_SRW045	IND_15uH_1.0A	1
NHD-C128D2A12-F30W-FBW-3V3	LCD C00 GRAPHIC 128X32	LC.D1	NHD-C128D2A12-F30W-FBW3V3	NHD-C128D2A12-F30W-FBW-3V3	1
MOUNTING_HOLES	6cm x 6cm	MH1, MH2, MH3, MH4	MOUNTING_HOLE	MOUNTING_HOLES	4
PMOS_40V_40A	MOSFET P-CH 40V 40A TO252	Q1, Q2	D-PAK	PMOS_40V_40A	2
NMOS_100V_210A	MOSFET N-CH 100V 210A POWER56	Q3, Q4, Q5, Q6	B-HP50F	NMOS_100V_210A	4
NMOS_60V_310mA	NMOS N-CH 60V 110mA SOT-23	Q7	SOT323	NMOS_60V_310mA	1
NMOS_50V_200mA	NMOS N-CH 50V 200mA 1.2V DRIVE SOT-23-3	Q8	SOT23-3	NMOS_50V_200mA	1
RES_20u_0805	RES SMD 20 OHM 1% 1/BW 0805	R1, R4	RES2012X60N	RES_20u_0805	2
RES_100u_0805	RES SMD 100 OHM 1% 1/BW 0805	R2, R3, R24, R25, R30, R31, R32, R33, R35, R36, R39, R42, R43, R47	RES2012X60N	RES_100u_0805	14
RES_10k_0805	RES SMD 10K OHM 1% 1/BW 0805	R5, R6, R7, R8, R9, R23, R27, R34, R37, R38, R45, R46, R48, R49, R50, R51, R52	RES2012X60N	RES_10k_0805	17
RES_1k_0805	RES SMD 1K OHM 1% 1/BW 0805	R10, R11, R26, R28	RES2012X60N	RES_1k_0805	4
RES_51k_0805	RES SMD 51K OHM 1% 1/BW 0805	R12	RES2012X60N	RES_51k_0805	1
RES_22_1k_0805	RES SMD 22.1K OHM 1% 1/BW 0805	R14	RES2012X60N	RES_22_1k_0805	1
RES_22_1k_0805	RES SMD 22.1K OHM 1% 1/BW 0805	R15	RES2012X60N	RES_22_1k_0805	1
RES_200u_2512	RES 200 OHM 5% 1W 2512	R16, R17	RES06032525N	RES_200u_2512	2
RES_10k_0805	RES SMD 10K OHM 1% 1/BW 0805	R18, R19, R20, R21, R40, R41	RES2012X60N	RES_10k_0805	6
RES_510u_0805	RES SMD 510 OHM 1% 1/BW 0805	R22	RES2012X60N	RES_510u_0805	1
RES_1_1k_0805	RES SMD 1.1K OHM 1% 1/BW 0805	R29	RES2012X60N	RES_1_1k_0805	1
RES_1m_0805	RES 0.001 OHM 1% 10W 5931	R44	RES-5931	RES_1m_0805	1
THERM_10K_FREE_HA	THERMISTOR NTC 10K OHM 1% B3950 100K 0.5W	RT1	HDR102_PTH	THERM_10K_FREE_HA	1
THERM_10K_0603	THERMISTOR NTC 10K OHM 0603	RT2	RES060310K00_N	THERM_10K_0603	1
SW_TACTILE	Tactile Switch (Grip)	S1, S2	831U-1000P	SW_TACTILE	2
GF-123-0054	SWITCH SLIDE SPST 500mA (DC) 8.5A (AC) 120V	S3	GF1230054	GF-123-0054	1
TESTPOINT_LOOP	Loop testpoint through-hole pad	TP1, TP2, TP3, TP4, TP5, TP6, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP22	TESTPOINT_LOOP	TESTPOINT_LOOP	21
STM32F446RET6	ARM Cortex-M4 32-bit MCU w/ 1M 512-KB Flash, 128-KB Internal RAM, 50 I/Os, 64-Pin LQFP, -40 to 85 degC, Tray	U1	STM1LQFP4_L	MCU_STM32F446RET6	1
LMR2310A02AAR	IC REG BUCK ADJUSTABLE 1A 850PAW	U2	B-SD PowerPad	BUCK_1-20VOUT_1A	1
BO40280R5MT	POWER MANAGEMENT IC: Battery Multi-Function Controller IC: Lithium Ion Polymer 32 VOLT (4x4)	U3	BO40280R5MT	BATT_MANAGER	1
LP3985MS-3.0/NOPB	IC REG LINEAR 3V 150MA SOT23-5	U4	SOT23-5	LP3985MS-3.0/NOPB	1
CRYSTAL_25MHZ	CRYSTAL 25.0000MHZ 12PF SMD	V1	SOIC254P1016440-4N	CRYSTAL_25MHZ	1