Power Swap – Buck-Boost

Specifications

	Min	Max
Supply Voltage	3	4.2
Current		500mA
Output Voltage		3.3

- Constant output voltage over a range of input voltage
- Max 500mA

Description

The Power Swap – Buck Boost module provides a convenient way to supply a constant 3.3V from a lithium ION battery. The module is based on the TPS63030 High Efficiency Single Inductor Buck-Boost Converter With 1-A Switches.

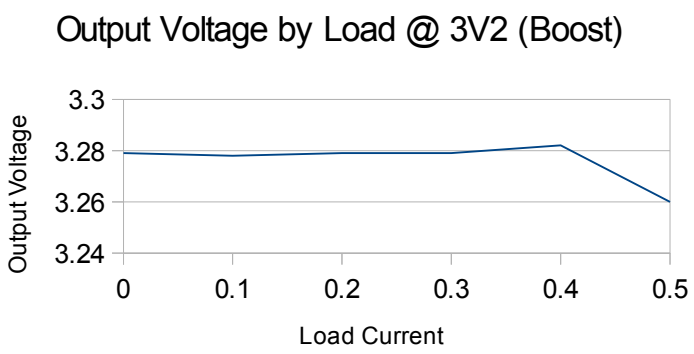
Test Results

Constant Supply

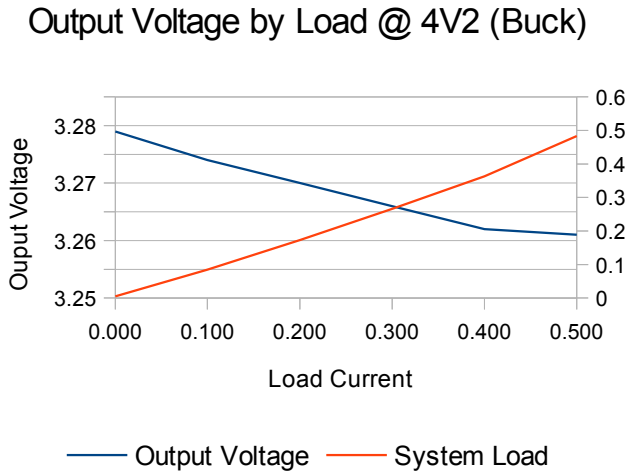
The test results show the behaviour of the system with a constant supply voltage and varied load from 0 through to 500mA. The system load represents the current drawn by the system as reported on the laboratory power supply.

Input Voltage3.2V

Load Current	Output Voltage	System Load
0.000	3.279	0.005
0.100	3.278	0.113
0.200	3.279	0.230
0.300	3.279	0.375
0.400	3.282	0.530



Load Current	Output Voltage	System Load
0.000	3.279	0.005
0.100	3.274	0.085
0.200	3.270	0.173
0.300	3.266	0.266
0.400	3.262	0.363
0.500	3.261	0.483



System Test

The results show the behaviour of a full system test. This is the Power Swap Buck-Boost module being supplied by the Full Charge Ahead (FCA) module, which is also charging a Lithium ION battery. An active load will be simulated using the Current Sink or Swim (CSoS) module.

The idea is to ascertain how the system will behave over time under load with no charge and then again with a constant charge from the FCA module.

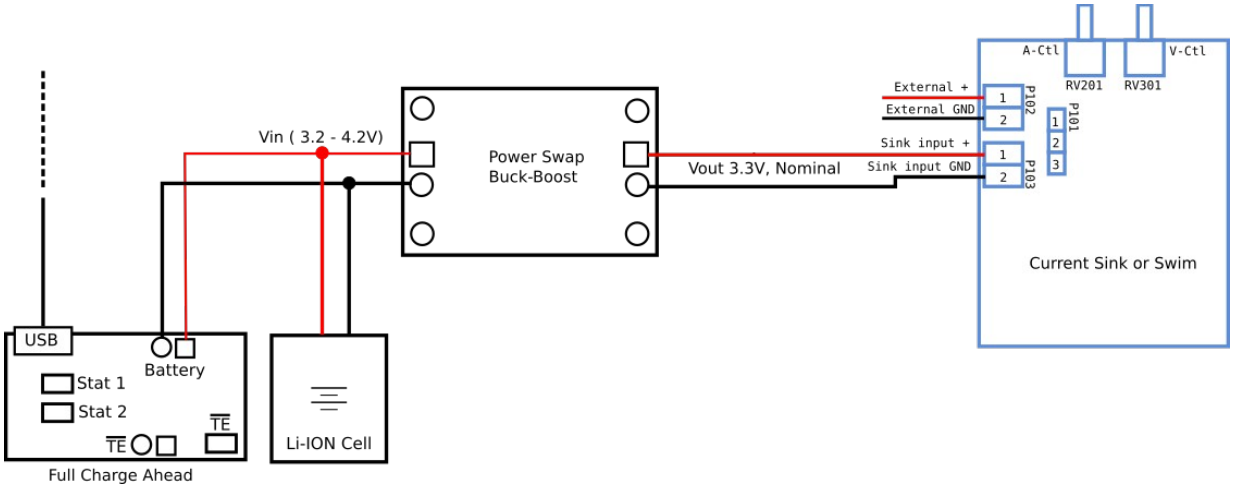
Set up

The modules are interconnected as per the diagram below. The CSoS acts as an active load drawing current from the Li-ION cell via the Power Swap Buck-Boost module. It is expected that the CSoS is delivered the required current at a constant voltage of 3.3V.

Expected Behaviour

When the system is supplied from an external source i.e. 5V supply via the USB connector, it is expected that there should be no variation in the behaviour of the system. Once the 5V supply is removed (on a fully charged system) no immediate change is expected from the perspective of the active load. The system will deliver the required current at the constant 3.3V.

After some time, the Lithium-ION cell will reduce its output voltage in the range from 4.2V down to about 3.2V before shutting off entirely. During this, the Power Swap Buck-Boost module will switch from Buck mode to Boost mode to continue to deliver the required current at 3.3V.

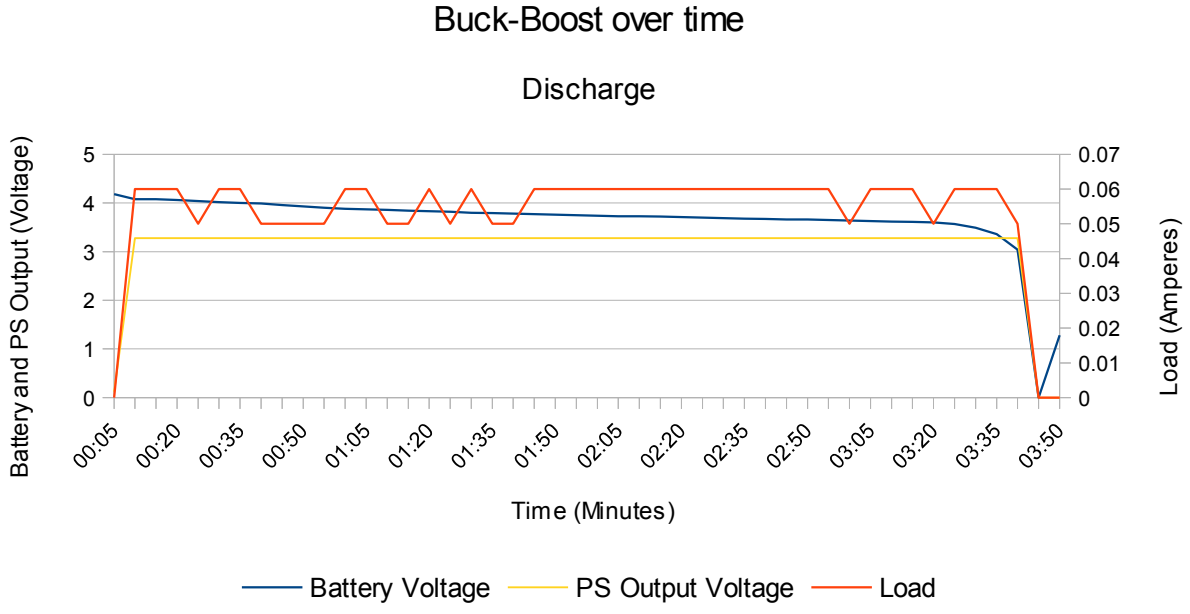


Results

Discharge

A constant load of approximately 60mA is applied using the CSoS. The battery voltage and Power Swap output voltage is measured at 5minute intervals.

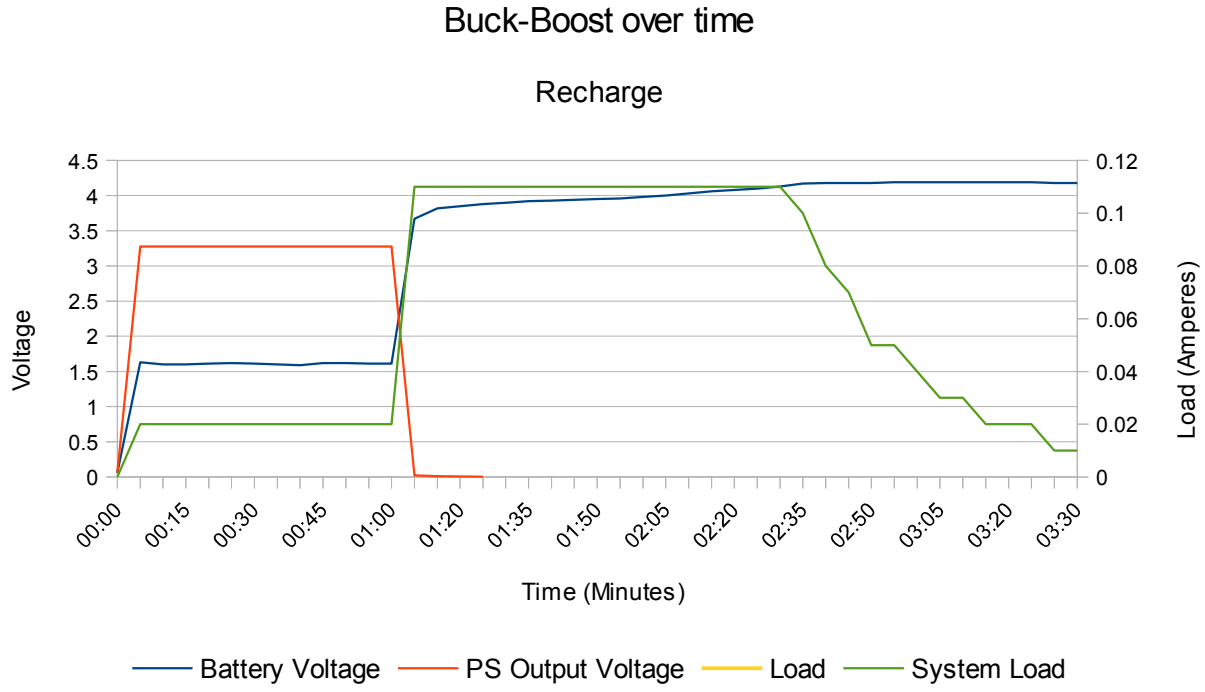
Time	Battery Voltage	PS Output Voltage	Load
00:00	4.180	0.121	0.000
00:05	4.080	3.279	0.060
00:10	4.080	3.279	0.060
00:15	4.060	3.279	0.060
00:20	4.040	3.279	0.050
00:25	4.020	3.279	0.060
00:30	4.000	3.279	0.060
00:35	3.990	3.279	0.050
00:40	3.960	3.279	0.050
00:45	3.930	3.279	0.050
00:50	3.900	3.278	0.050
00:55	3.880	3.278	0.060
01:00	3.870	3.279	0.060
01:05	3.860	3.279	0.050
01:10	3.840	3.278	0.050
01:15	3.830	3.279	0.060
01:20	3.820	3.279	0.050
01:25	3.800	3.278	0.060
01:30	3.790	3.278	0.050
01:35	3.780	3.278	0.050
01:40	3.770	3.278	0.060
01:45	3.760	3.278	0.060
01:50	3.750	3.278	0.060
01:55	3.740	3.278	0.060
02:00	3.730	3.279	0.060
02:05	3.730	3.278	0.060
02:10	3.720	3.278	0.060
02:15	3.710	3.278	0.060
02:20	3.700	3.279	0.060
02:25	3.690	3.278	0.060
02:30	3.680	3.279	0.060
02:15	3.670	3.278	0.060
02:20	3.660	3.278	0.060
02:25	3.660	3.278	0.060
02:30	3.650	3.279	0.060
02:15	3.640	3.278	0.050
02:20	3.630	3.279	0.060
02:25	3.620	3.278	0.060
02:30	3.610	3.278	0.060
02:15	3.600	3.278	0.050
02:20	3.570	3.279	0.060
02:25	3.490	3.278	0.060
02:30	3.360	3.278	0.060
02:15	3.040	3.278	0.050
02:20	0.000	0.000	0.000
02:25	1.280	0.000	0.000
02:30	1.300	0.000	0.000



Recharge

The USB supply was added to the system. It was found that neither the CSoS or Power Swap could be connected to the system to enable the battery to be charged.

Time	Battery Voltage	PS Output Voltage	Load	System Load
00:00	0.061	0.061	0.000	0.000
00:05	1.630	3.278		0.020
00:10	1.600	3.276		0.020
00:15	1.600	3.278		0.020
00:20	1.610	3.275		0.020
00:25	1.620	3.278		0.020
00:30	1.610	3.275		0.020
00:35	1.600	3.274		0.020
00:40	1.590	3.276		0.020
00:45	1.620	3.277		0.020
00:50	1.620	3.278		0.020
00:55	1.610	3.276		0.020
01:00	1.610	3.278		0.020
01:05	3.670	0.021		0.110
01:10	3.820	0.009		0.110
01:15	3.850	0.006		0.110
01:20	3.880	0.005		0.110
01:25	3.900			0.110
01:30	3.920			0.110
01:35	3.930			0.110
01:40	3.940			0.110
01:45	3.950			0.110
01:50	3.960			0.110
01:55	3.980			0.110
02:00	4.000			0.110
02:05	4.030			0.110
02:10	4.060			0.110
02:15	4.080			0.110
02:20	4.100			0.110
02:25	4.130			0.110
02:30	4.170			0.100
02:35	4.180			0.080
02:40	4.180			0.070
02:45	4.180			0.050
02:50	4.190			0.050
02:55	4.190			0.040
03:00	4.190			0.030
03:05	4.190			0.030
03:10	4.190			0.020
03:15	4.190			0.020
03:20	4.190			0.020
03:25	4.180			0.010
03:30	4.180			0.010

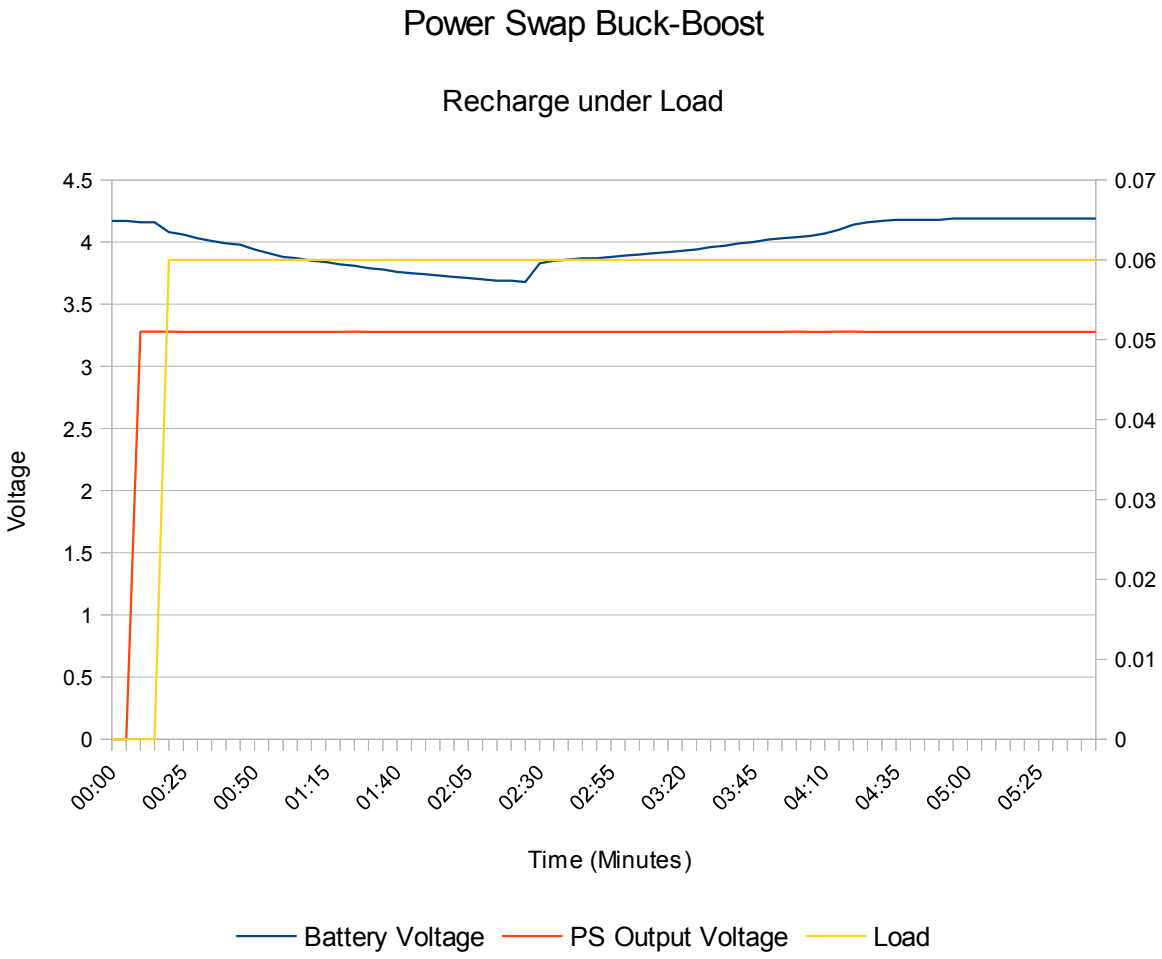


Recharge Under Load

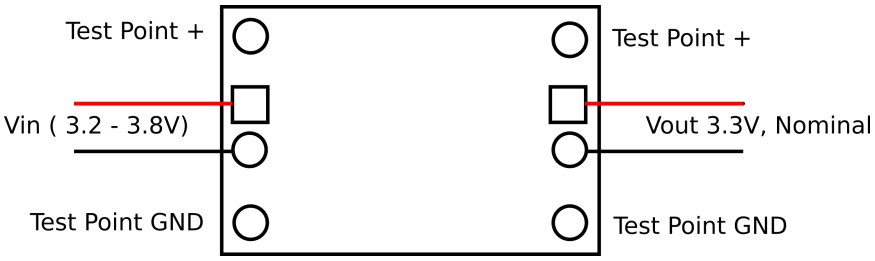
It was found during the recharge that the a completely depleted battery can not be effectively charged with the FCA with the Power Swap or CSoS connected. A further test is performed here to check the behaviour of the system when the batter is not completely depleted.

The results show that it is possible for the FCA to charge the battery and supply the System. However, the FCA will not indicate that the battery is fully charged – only when removing the Power Swap from the system will the FCA indicate a fully charged battery.

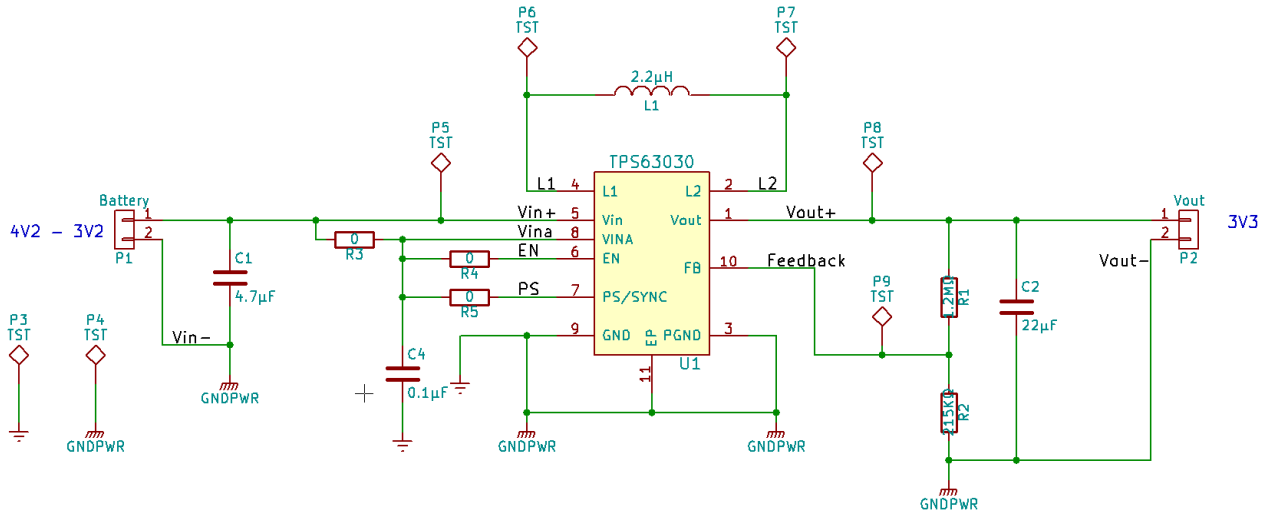
Time	Battery Voltage	PS Output Voltage	Load	
00:00	4.170	0.000	0.000	
00:05	4.170	0.000	0.000	
00:10	4.160	3.279	0.000	
00:15	4.160	3.279	0.000	
00:20	4.080	3.279	0.060	
00:25	4.060	3.278	0.060	
00:30	4.030	3.278	0.060	
00:35	4.010	3.278	0.060	
00:40	3.990	3.278	0.060	
00:45	3.980	3.278	0.060	
00:50	3.940	3.278	0.060	
00:55	3.910	3.278	0.060	
01:00	3.880	3.278	0.060	
01:05	3.870	3.278	0.060	
01:10	3.850	3.278	0.060	
01:15	3.840	3.278	0.060	
01:20	3.820	3.278	0.060	
01:25	3.810	3.279	0.060	
01:30	3.790	3.278	0.060	
01:35	3.780	3.278	0.060	
01:40	3.760	3.278	0.060	
01:45	3.750	3.278	0.060	
01:50	3.740	3.278	0.060	
01:55	3.730	3.278	0.060	
02:00	3.720	3.278	0.060	
02:05	3.710	3.278	0.060	
02:10	3.700	3.278	0.060	
02:15	3.690	3.278	0.060	
02:20	3.690	3.278	0.060	
02:25	3.680	3.278	0.060	
02:30	3.830	3.278	0.060	
02:35	3.850	3.278	0.060	
02:40	3.860	3.278	0.060	
02:45	3.870	3.278	0.060	
02:50	3.870	3.278	0.060	
02:55	3.880	3.278	0.060	
03:00	3.890	3.278	0.060	
03:05	3.900	3.278	0.060	
03:10	3.910	3.278	0.060	
03:15	3.920	3.278	0.060	
03:20	3.930	3.278	0.060	
03:25	3.940	3.278	0.060	
03:30	3.960	3.278	0.060	
03:15	3.970	3.278	0.060	
03:20	3.990	3.278	0.060	
03:25	4.000	3.278	0.060	
03:30	4.020	3.278	0.060	
03:15	4.030	3.278	0.060	
03:20	4.040	3.279	0.060	
03:25	4.050	3.278	0.060	
03:30	4.070	3.278	0.060	
03:15	4.100	3.279	0.060	
03:20	4.140	3.279	0.060	
03:25	4.160	3.278	0.060	
03:30	4.170	3.278	0.060	
03:35	4.180	3.278	0.060	
03:40	4.180	3.278	0.060	
03:45	4.180	3.278	0.060	
03:50	4.180	3.278	0.060	
03:55	4.190	3.278	0.060	
04:00	4.190	3.278	0.060	
04:05	4.190	3.278	0.060	
04:10	4.190	3.278	0.060	
04:15	4.190	3.278	0.060	
04:20	4.190	3.278	0.060	


Power Swap Buck-Boost
Recharge under Load
Voltage
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
00:00
00:25
00:50
01:15
01:40
02:05
02:30
02:55
03:20
03:45
04:10
04:35
05:00
05:25
Time (Minutes)
Battery Voltage
PS Output Voltage
Load

Connection


Test Point +
Vin (3.2 - 3.8V)
Test Point GND
Test Point +
Vout 3.3V, Nominal
Test Point GND

Schematic


P6
TST
P7
TST
2.2µH
L1
P5
TST
P8
TST
TPS63030
L1
4
L1
L2
2
L2
Battery
1
2
P1
4V2 – 3V2
Vin+
5
Vin
Vout
1
Vout+
Vout
1
2
P2
3V3
Vina
8
VINA
EN
6
EN
FB
10
Feedback
Vout–
C1
4.7µF
R3
0
R4
0
R5
0
PS
7
PS/SYNC
9
GND
EP
PGND
3
U1
11
P9
TST
2.2MΩ
R1
C2
22µF
P3
TST
P4
TST
Vin–
GNDPWR
C4
0.1µF
GNDPWR
GNDPWR
GNDPWR
215kΩ
R2
GNDPWR