





## DOCUMENTATION:

The EZ-PD USB-C Power Bank schematic, PCB layout, Gerber files, and BOM can be found at <http://www.cypress.com/documentation/reference-designs/ez-pd-ccg3-usb-type-c-power-bank-solution>

## TEST EQUIPMENTS:

Digital Multimeters (DMM) – Fluke

DC Power Supply – Agilent A3624A

Electronic Load – Kikusui

Infrared Camera – Flir i7

Lenovo 45W USB-C AC-DC Adapter

Apple 29W USB-C AC-DC Adapter

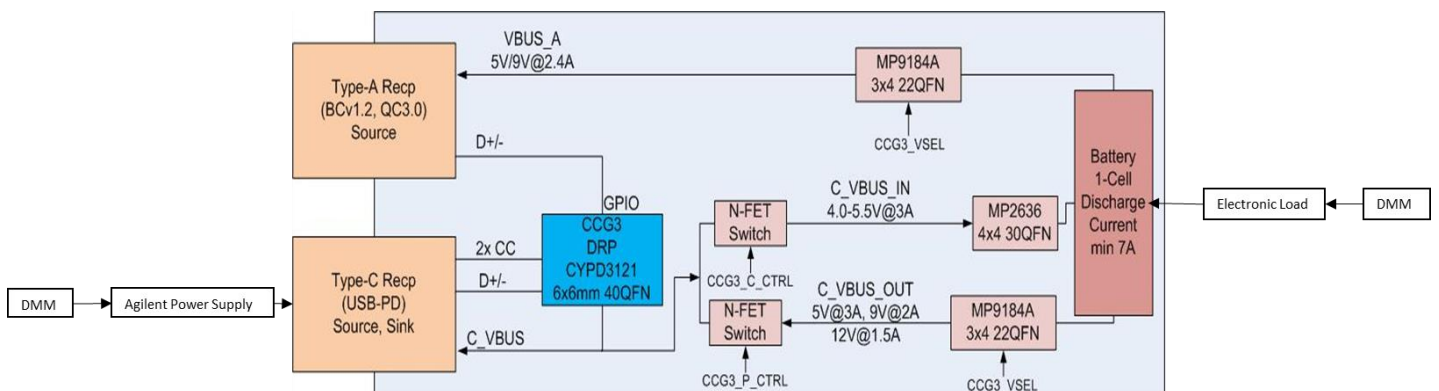
Custom Li-Ion 18650 Battery: **3.6V 18.2Ah (66wh, 7A rate, 7S/S, ICR18650B4).**

## STANDBY CURRENT:

Parameter	Test Conditions	Typ	Unit
I <sub>sb</sub>	V <sub>batt</sub> =3.5V, all ports unattached	2	mA

## CHARGE MODE EFFICIENCY on the USB Type-C Port:

### Charging Measurement Set Up:



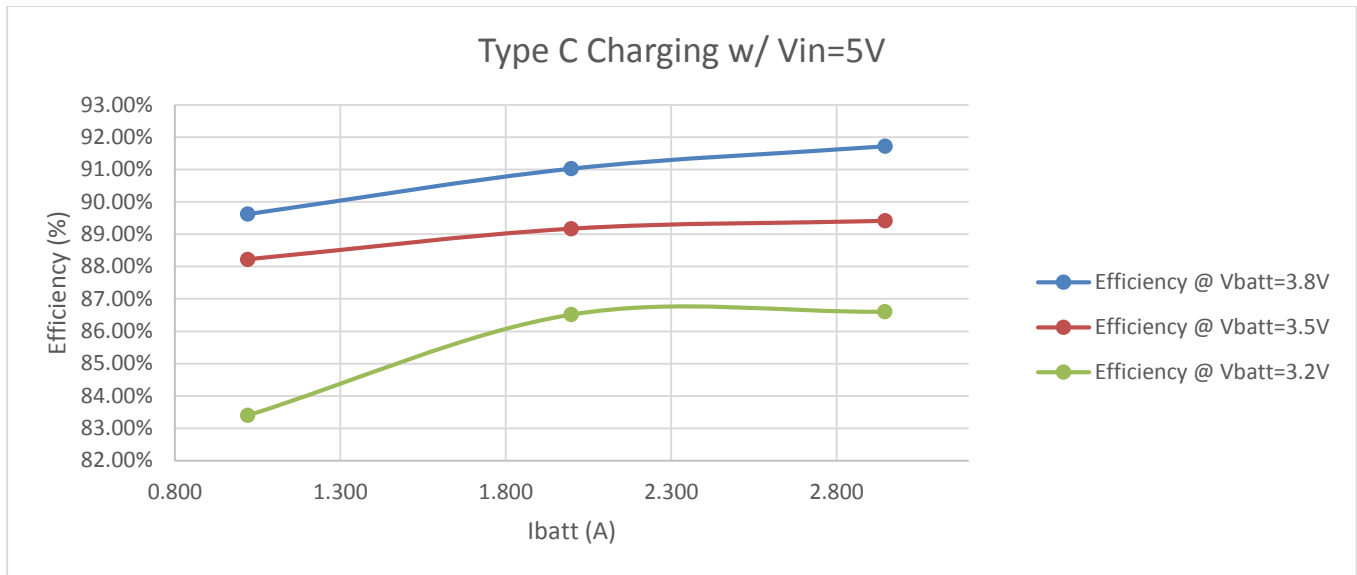


Figure 1: Charging Efficiency @ USB Type-C VBUSin = 5V

Vin=5V, Vbatt=3.2V

Vin (V)	Iin (A)	Vbatt (V)	Ibatt (A)	Eff (%)
4.978	0.796	3.240	1.020	83.40%
4.966	1.496	3.217	1.998	86.52%
4.949	2.196	3.195	2.946	86.61%

Vin=5V, Vbatt=3.5V

Vin (V)	Iin (A)	Vbatt (V)	Ibatt (A)	Eff (%)
4.984	0.813	3.522	1.020	88.66%
4.962	1.577	3.519	1.998	89.85%
4.970	2.332	3.512	2.947	89.30%

Vin=5V, Vbatt=3.8V

Vin (V)	Iin (A)	Vbatt (V)	Ibatt (A)	Eff (%)
4.990	0.910	3.990	1.020	89.63%
4.964	1.720	3.890	1.998	91.03%
4.930	2.470	3.790	2.947	91.72%

**Note:** Vin is USB Type-C VBUSin

## DISCHARGE EFFICIENCY –TYPE C PORT:

### Type C Discharge Measurement Set Up:

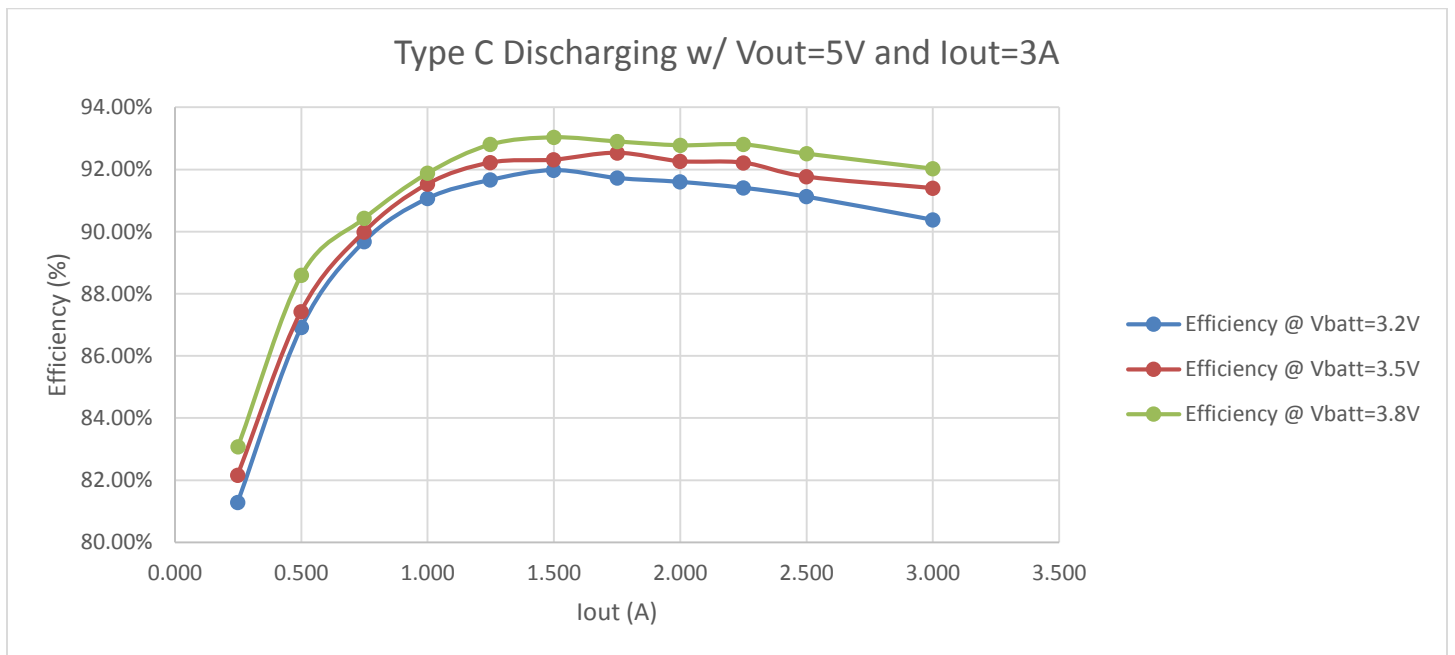
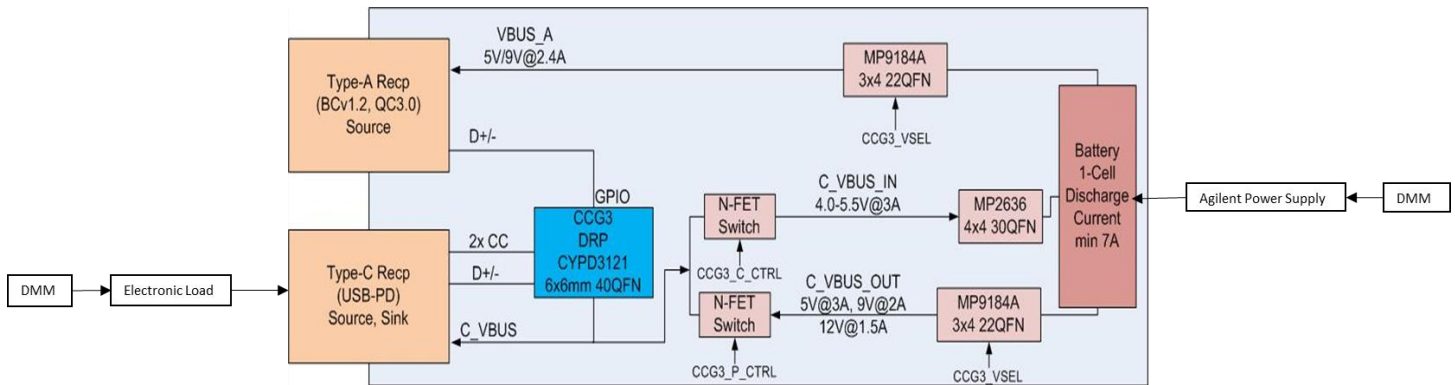


Figure 2: USB Type C Discharging VBUSout=5V and Iout=3A

Vbatt=3.2V, Vbus=5V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.200	0.492	5.160	0.248	81.28%
3.200	0.926	5.151	0.500	86.92%
3.200	1.342	5.142	0.749	89.68%
3.200	1.760	5.134	0.999	91.07%
3.200	2.181	5.126	1.248	91.66%
3.200	2.606	5.117	1.499	91.98%
3.200	3.046	5.109	1.750	91.73%
3.200	3.478	5.100	1.999	91.60%
3.200	3.916	5.091	2.250	91.41%
3.200	4.356	5.083	2.499	91.13%
3.200	5.252	5.065	2.999	90.38%

Vbatt=3.5V, Vbus=5V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.500	0.445	5.160	0.248	82.16%
3.500	0.840	5.151	0.499	87.43%
3.500	1.223	5.143	0.749	89.99%
3.500	1.601	5.134	0.999	91.53%
3.500	1.982	5.126	1.248	92.22%
3.500	2.374	5.117	1.499	92.31%
3.500	2.760	5.108	1.750	92.54%
3.500	3.157	5.100	1.999	92.27%
3.500	3.549	5.091	2.250	92.22%
3.500	3.954	5.082	2.499	91.77%
3.500	4.750	5.065	3.000	91.40%

Vbatt=3.8V, Vbus=5V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.800	0.407	5.160	0.249	83.08%
3.800	0.765	5.151	0.500	88.60%
3.800	1.121	5.143	0.749	90.43%
3.800	1.469	5.134	0.999	91.88%
3.800	1.814	5.126	1.248	92.81%
3.800	2.171	5.117	1.500	93.04%
3.800	2.532	5.108	1.750	92.91%
3.800	2.893	5.100	2.000	92.78%
3.800	3.248	5.091	2.250	92.81%
3.800	3.614	5.082	2.500	92.51%
3.800	4.345	5.065	3.000	92.03%

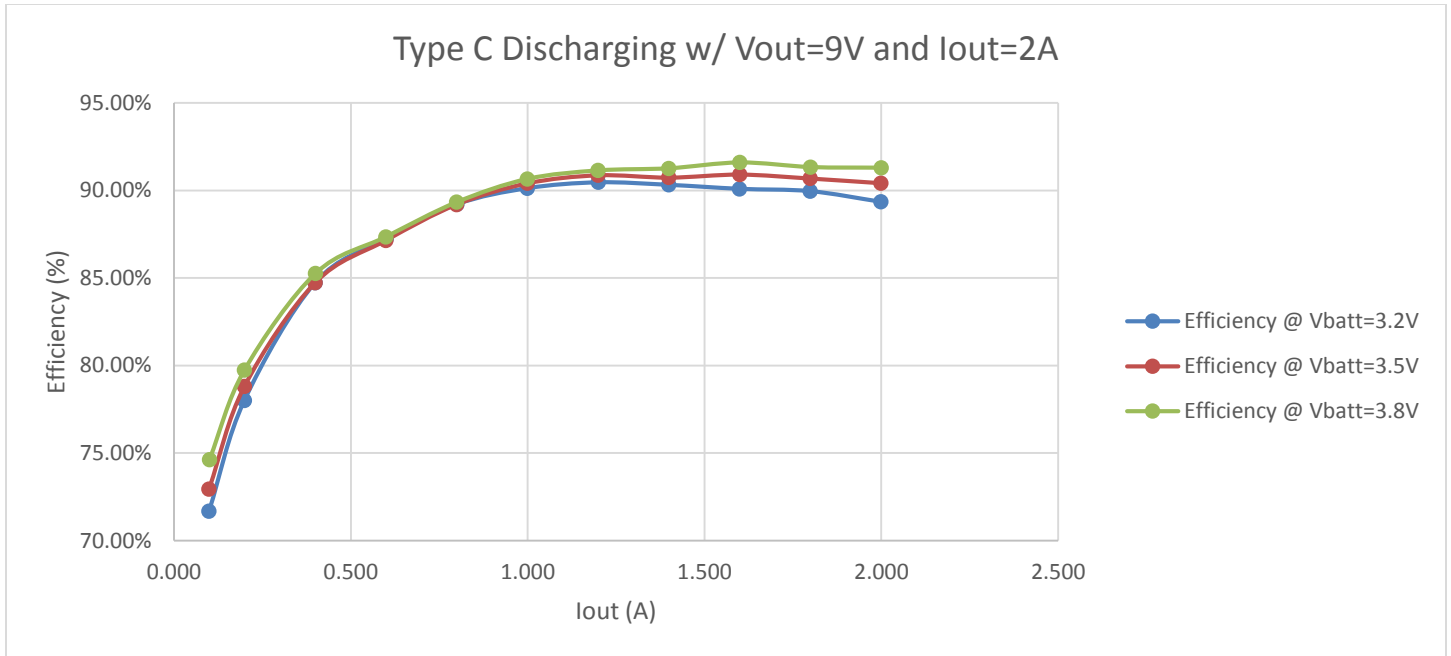


Figure 3: USB Type C Discharging VBUSout=9V and Iout=2A

Vbatt=3.2V, Vbus=9V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.200	0.394	9.130	0.099	71.69%
3.200	0.727	9.120	0.199	78.01%
3.200	1.342	9.120	0.399	84.74%
3.200	1.958	9.110	0.600	87.24%
3.200	2.550	9.100	0.800	89.22%
3.200	3.152	9.100	0.999	90.13%
3.200	3.768	9.090	1.200	90.47%
3.200	4.395	9.080	1.399	90.32%
3.200	5.036	9.080	1.599	90.09%
3.200	5.668	9.070	1.799	89.96%
3.200	6.334	9.060	1.999	89.35%

Vbatt=3.5V, Vbus=9V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.500	0.354	9.130	0.099	72.95%
3.500	0.658	9.120	0.199	78.81%
3.500	1.227	9.120	0.399	84.73%
3.500	1.789	9.110	0.599	87.15%
3.500	2.329	9.100	0.799	89.20%
3.500	2.873	9.100	0.999	90.41%
3.500	3.427	9.090	1.199	90.87%
3.500	4.000	9.080	1.399	90.74%
3.500	4.566	9.080	1.600	90.91%

3.500	5.141	9.070	1.799	90.68%
3.500	5.723	9.060	1.999	90.42%

Vbatt=3.8V, Vbus=9V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.800	0.322	9.130	0.100	74.62%
3.800	0.599	9.120	0.199	79.73%
3.800	1.126	9.120	0.400	85.26%
3.800	1.644	9.110	0.599	87.35%
3.800	2.142	9.100	0.799	89.33%
3.800	2.639	9.100	0.999	90.65%
3.800	3.147	9.090	1.199	91.14%
3.800	3.663	9.080	1.399	91.26%
3.800	4.174	9.080	1.600	91.59%
3.800	4.704	9.070	1.800	91.33%
3.800	5.223	9.060	2.000	91.30%

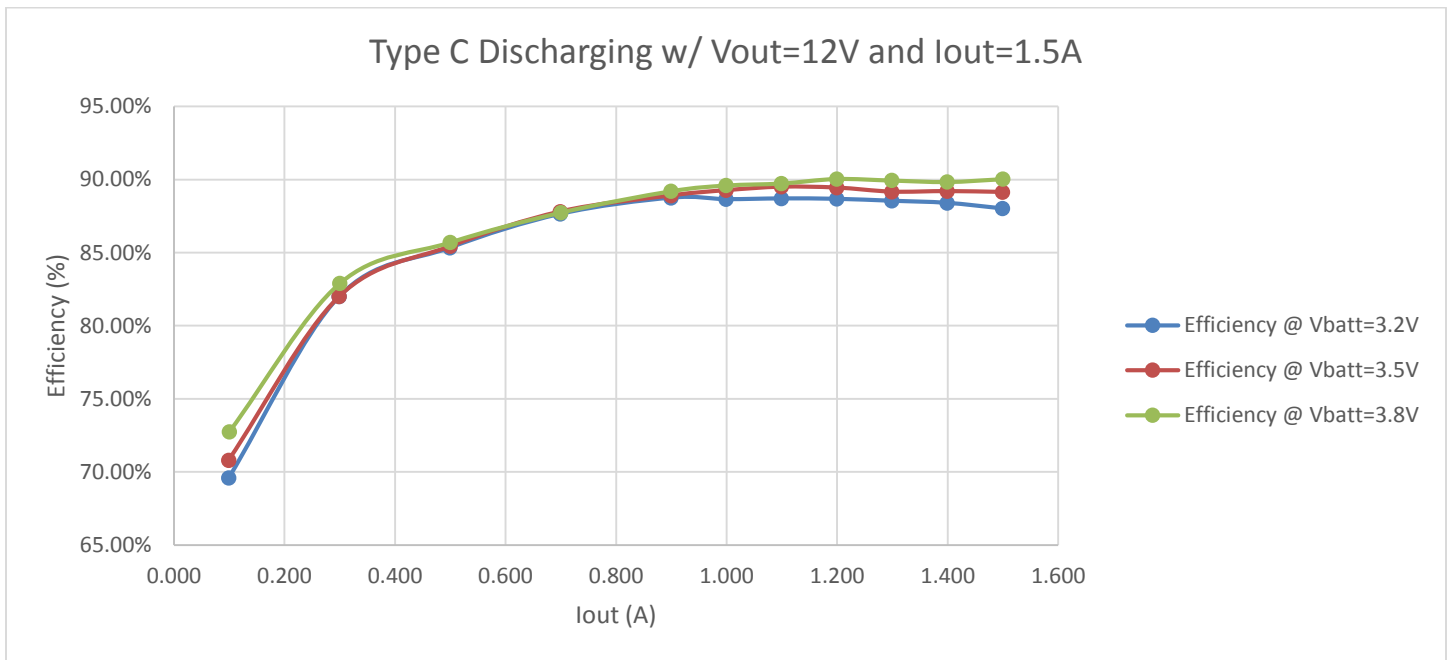


Figure 4: USB Type C Discharging VBUSout=12V and Iout=1.5A

Vbatt=3.2V, Vbus=12V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.200	0.542	12.190	0.099	69.58%
3.200	1.388	12.180	0.299	81.99%
3.200	2.224	12.170	0.499	85.33%
3.200	3.033	12.170	0.699	87.65%
3.200	3.849	12.160	0.899	88.76%
3.200	4.282	12.160	0.999	88.65%

3.200	4.708	12.160	1.099	88.70%
3.200	5.138	12.160	1.199	88.68%
3.210	5.553	12.150	1.299	88.54%
3.210	5.990	12.150	1.399	88.40%
3.200	6.466	12.150	1.499	88.02%

Vbatt=3.5V, Vbus=12V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.500	0.487	12.190	0.099	70.80%
3.500	1.269	12.180	0.299	82.00%
3.510	2.029	12.170	0.500	85.44%
3.510	2.760	12.170	0.699	87.81%
3.510	3.503	12.160	0.899	88.91%
3.500	3.888	12.160	0.999	89.27%
3.490	4.278	12.160	1.099	89.51%
3.500	4.657	12.160	1.199	89.45%
3.500	5.057	12.150	1.299	89.17%
3.500	5.444	12.150	1.399	89.21%
3.500	5.837	12.150	1.499	89.15%

Vbatt=3.8V, Vbus=12V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.800	0.441	12.190	0.100	72.74%
3.800	1.160	12.180	0.300	82.89%
3.800	1.870	12.180	0.500	85.70%
3.800	2.555	12.170	0.700	87.74%
3.800	3.225	12.160	0.899	89.20%
3.800	3.568	12.160	0.999	89.60%
3.800	3.919	12.160	1.099	89.74%
3.800	4.261	12.160	1.199	90.04%
3.800	4.618	12.150	1.299	89.94%
3.800	4.979	12.150	1.399	89.84%
3.800	5.327	12.150	1.500	90.03%



## DISCHARGE EFFICIENCY – TYPE A PORT:

### Type A Discharge Measurement Set Up:

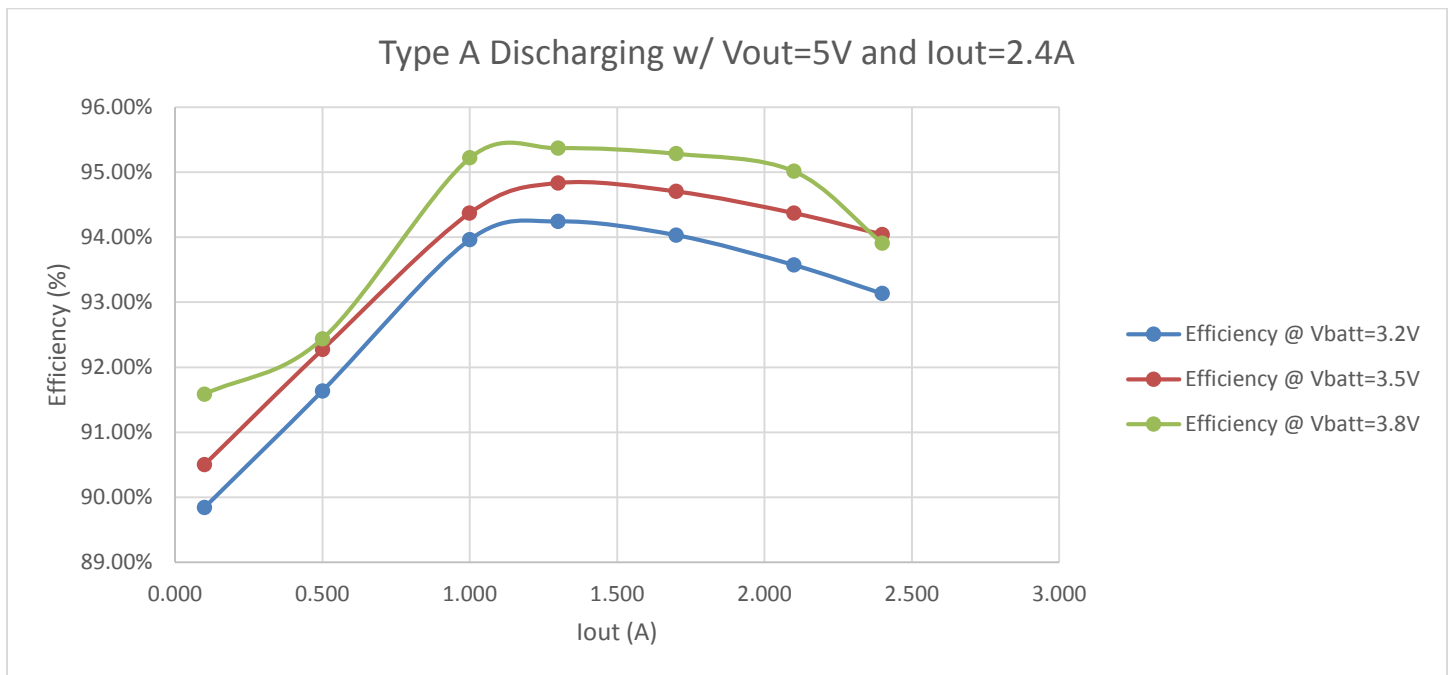
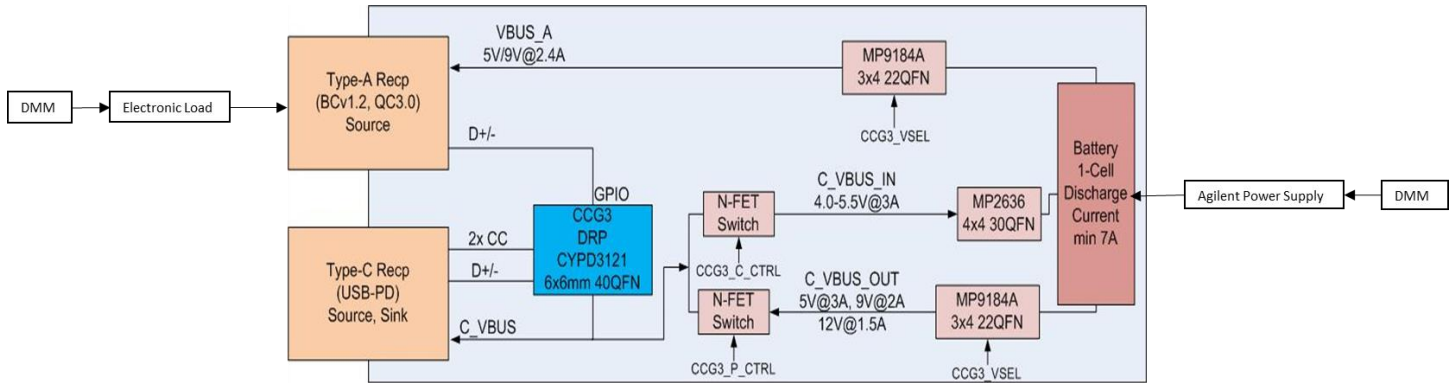


Figure 5: USB Type A Discharging VBUSout=5V and Iout=2.4A

Vbatt=3.2V, Vbus=5V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.200	0.184	5.290	0.100	89.84%
3.200	0.902	5.290	0.500	91.64%
3.200	1.756	5.280	1.000	93.96%
3.200	2.276	5.280	1.300	94.24%
3.200	2.983	5.280	1.700	94.03%
3.200	3.703	5.28	2.1	93.57%
3.200	4.252	5.280	2.400	93.13%

Vbatt=3.5V, Vbus=5V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.500	0.167	5.290	0.100	90.50%
3.500	0.819	5.290	0.500	92.27%
3.500	1.597	5.280	0.999	94.37%
3.500	2.068	5.280	1.300	94.83%
3.500	2.708	5.280	1.700	94.70%
3.500	3.357	5.280	2.1	94.37%
3.500	3.850	5.280	2.4	94.04%

Vbatt=3.8V, Vbus=5V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.800	0.152	5.290	0.100	91.59%
3.800	0.753	5.290	0.500	92.44%
3.800	1.462	5.290	1.000	95.22%
3.800	1.894	5.280	1.300	95.37%
3.800	2.479	5.28	1.700	95.28%
3.800	3.071	5.280	2.1	95.01%
3.800	3.551	5.280	2.400	93.91%

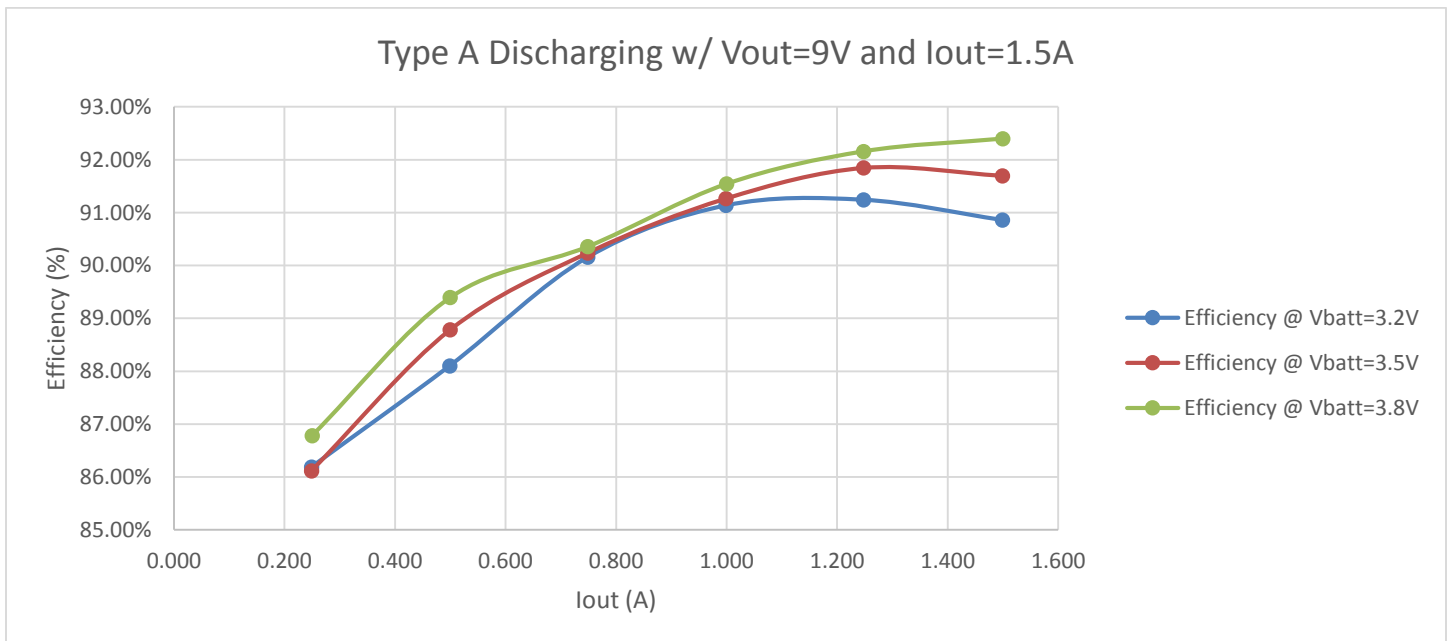


Figure 6: USB Type A Discharging VBUSout=9V and Iout=1.5A

Vbatt=3.2V, Vbus=9V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.200	0.836	9.260	0.249	86.19%
3.200	1.639	9.260	0.499	88.10%

3.200	2.404	9.260	0.749	90.16%
3.2	3.172	9.26	0.999	91.14%
3.2	3.958	9.260	1.248	91.24%
3.2	4.774	9.260	1.499	90.86%

Vbatt=3.5V, Vbus=9V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.500	0.765	9.260	0.249	86.12%
3.500	1.490	9.260	0.500	88.78%
3.500	2.196	9.260	0.749	90.24%
3.500	2.896	9.26	0.999	91.27%
3.500	3.595	9.260	1.248	91.85%
3.500	4.325	9.260	1.499	91.70%

Vbatt=3.8V, Vbus=9V

Vbatt (V)	Ibatt (A)	Vbus (V)	Ibus(A)	Eff (%)
3.800	0.702	9.260	0.250	86.78%
3.800	1.363	9.260	0.500	89.39%
3.800	2.020	9.260	0.749	90.36%
3.800	2.662	9.260	1	91.54%
3.800	3.300	9.260	1.248	92.16%
3.800	3.956	9.260	1.500	92.40%

## THERMAL:

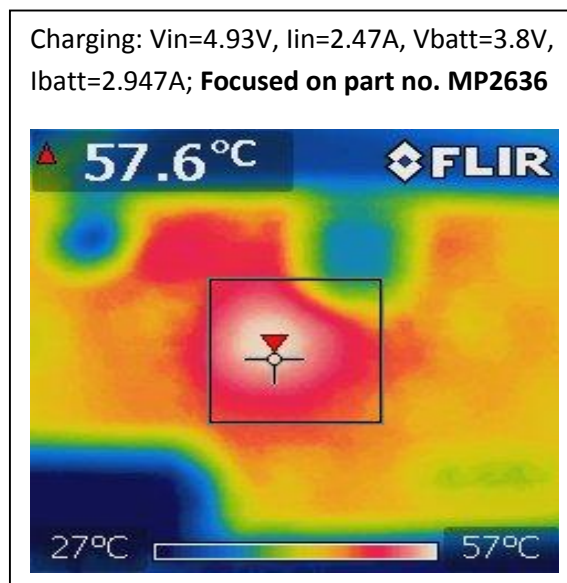


Figure 7: Thermals on MP2636

Discharging Type C:  $V_{batt}=3.2V$ ,  
 $I_{batt}=6.466A$ ,  $V_{bus}=12.15V$ ,  $I_{bus}=1.5A$ ;  
**Focused on part no. MP9184A**

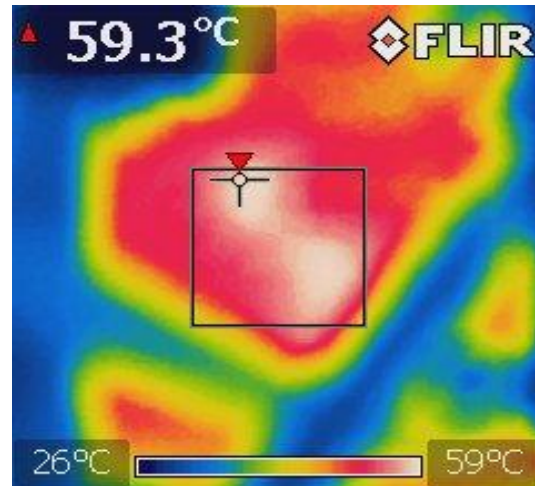


Figure 8: Thermals on MP9184A (Type-C)

Discharging Type A:  $V_{batt}=3.2V$ ,  
 $I_{batt}=4.774A$ ,  $V_{bus}=9.26V$ ,  $I_{bus}=1.5A$ ;  
**Focused on part no. MP9184A**

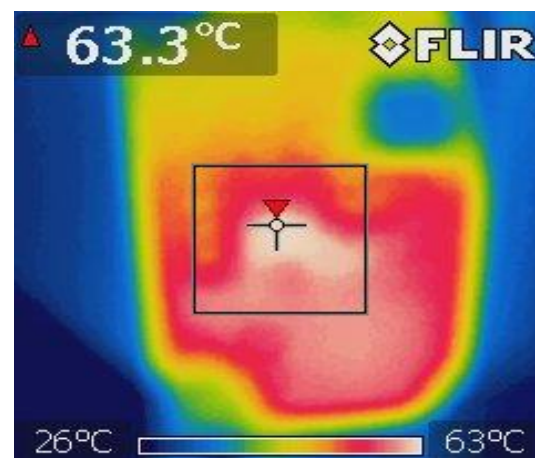


Figure 9:: Thermals on MP9184A (Type-A)