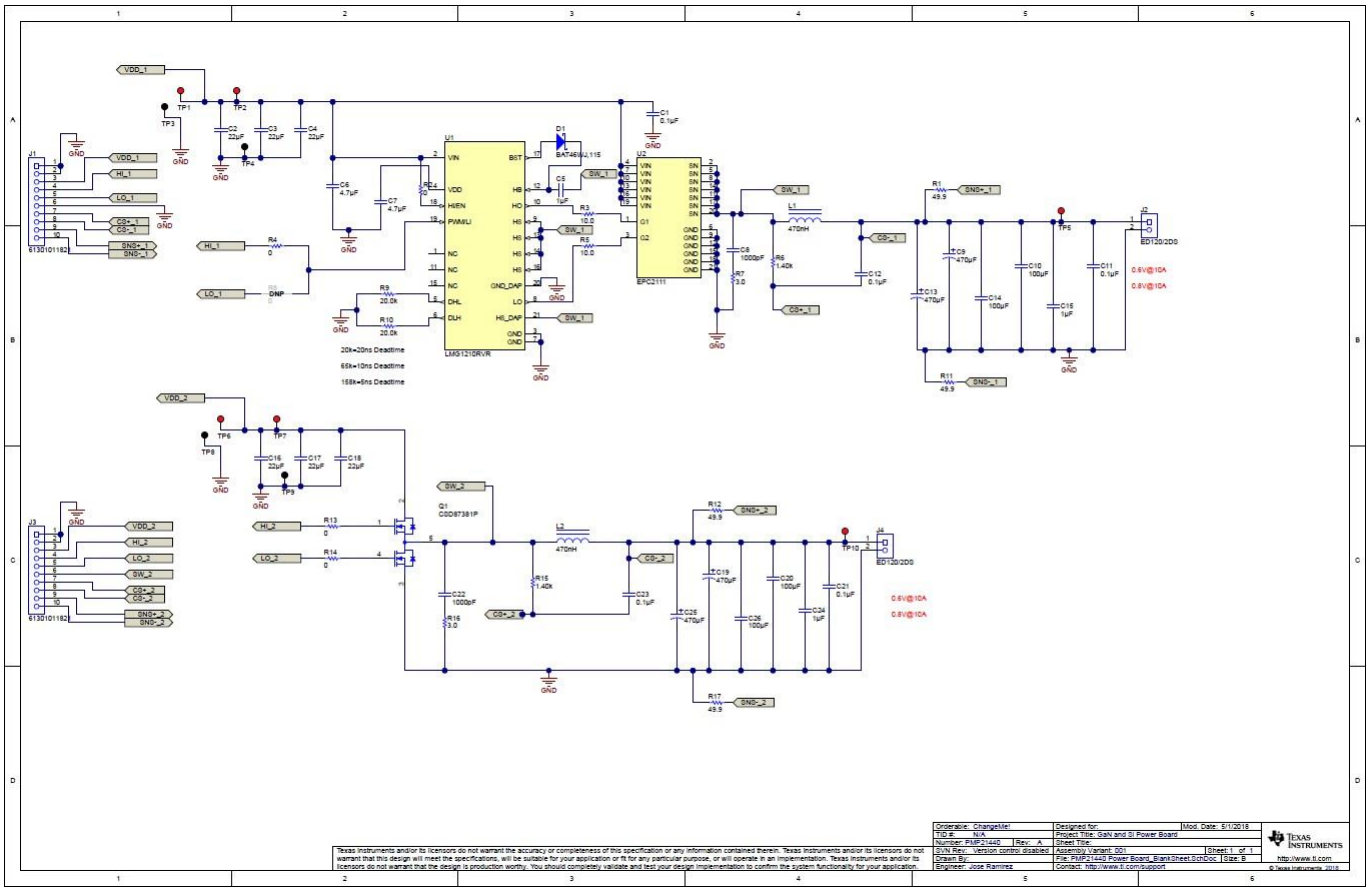
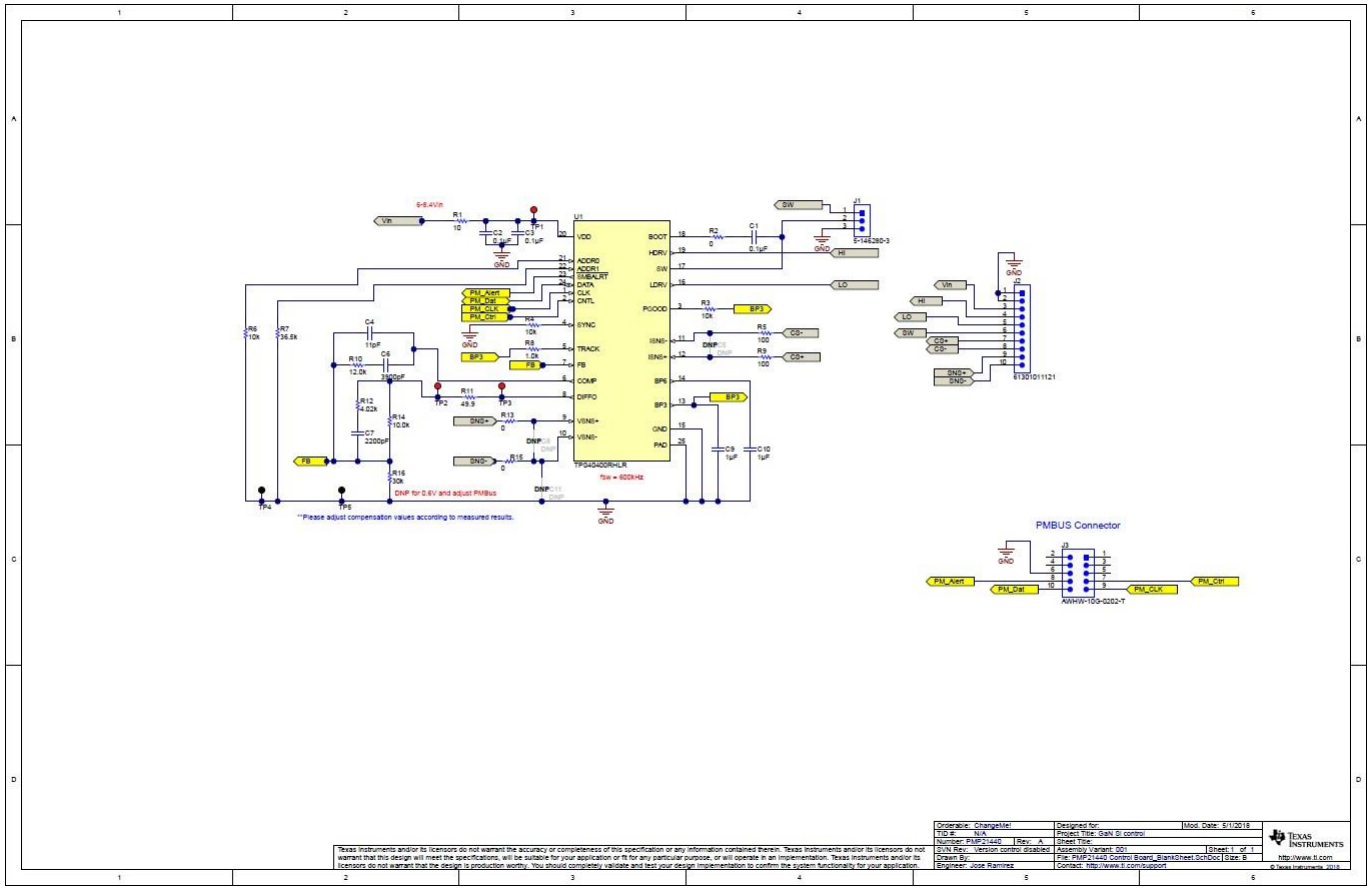
Test Report: PMP21440
Comparison:0.8V/8W GaN vs Si Power Supply Reference Design

Description

This reference design provides customers with a comparison study on the usage of GaN vs SI in power supply designs.
This specific design uses TPS40400 controller to drive CSD87381 for the silicon power supply and LMG1210 with EPC2111 for the GaN power supply to provide 0.8V/10A. This design compares the silicon and GaN power stages and illustrates the design tradeoffs and necessary optimizations when designing with GaN.





1 Test Prerequisites

1.1 Voltage and Current Requirements

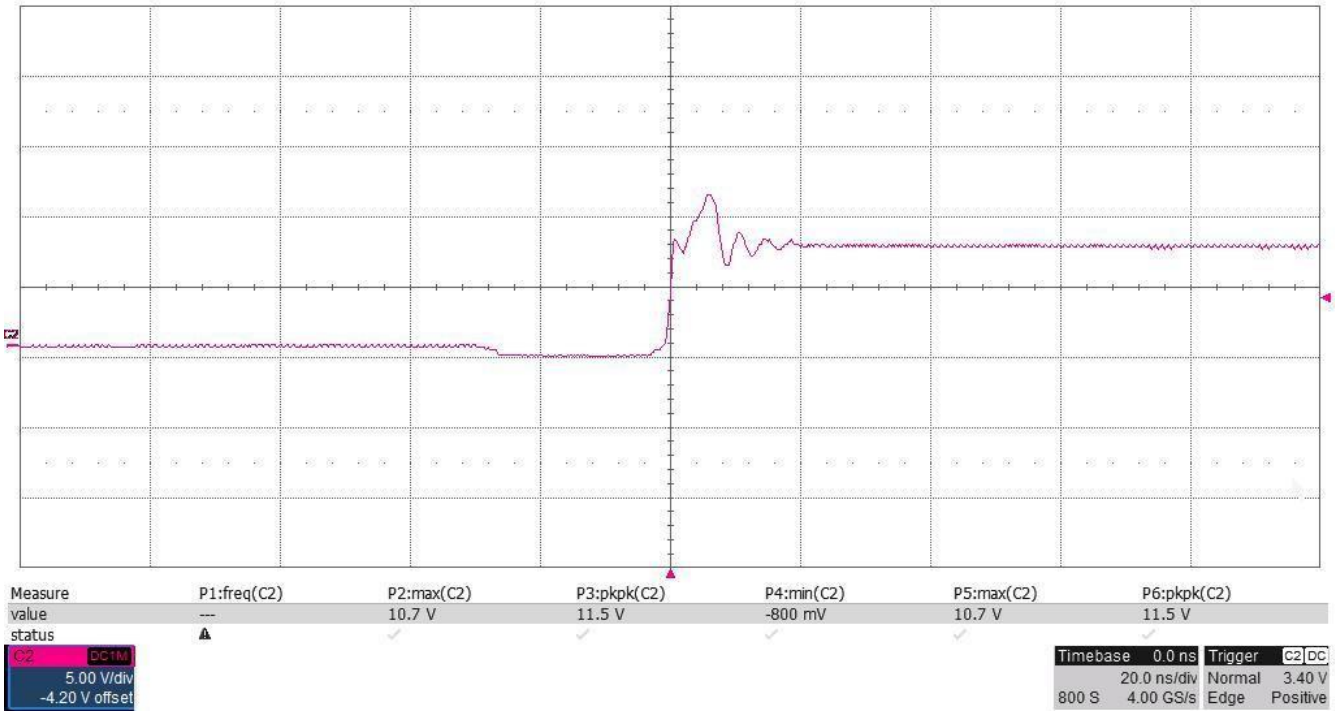
Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Vin	7V
Vout	0.8V
Iout	10A

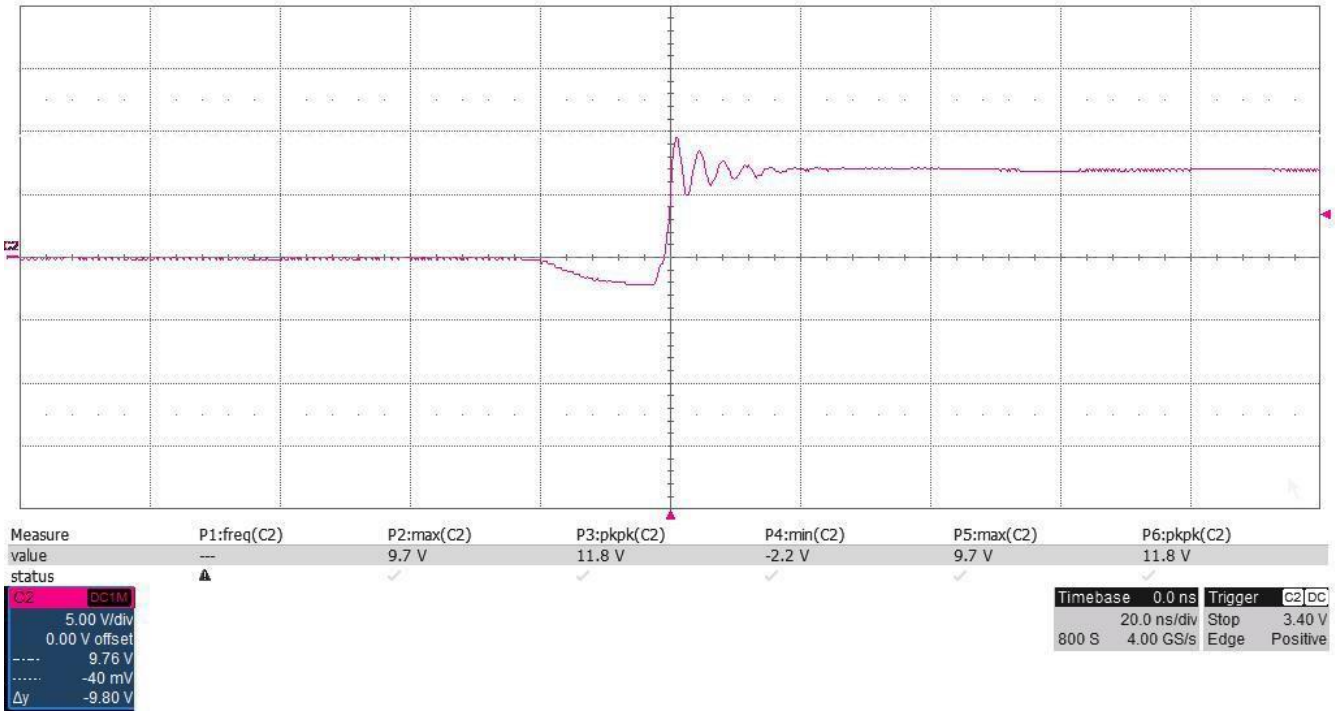
2 Test Data

2.1 Switching Waveforms

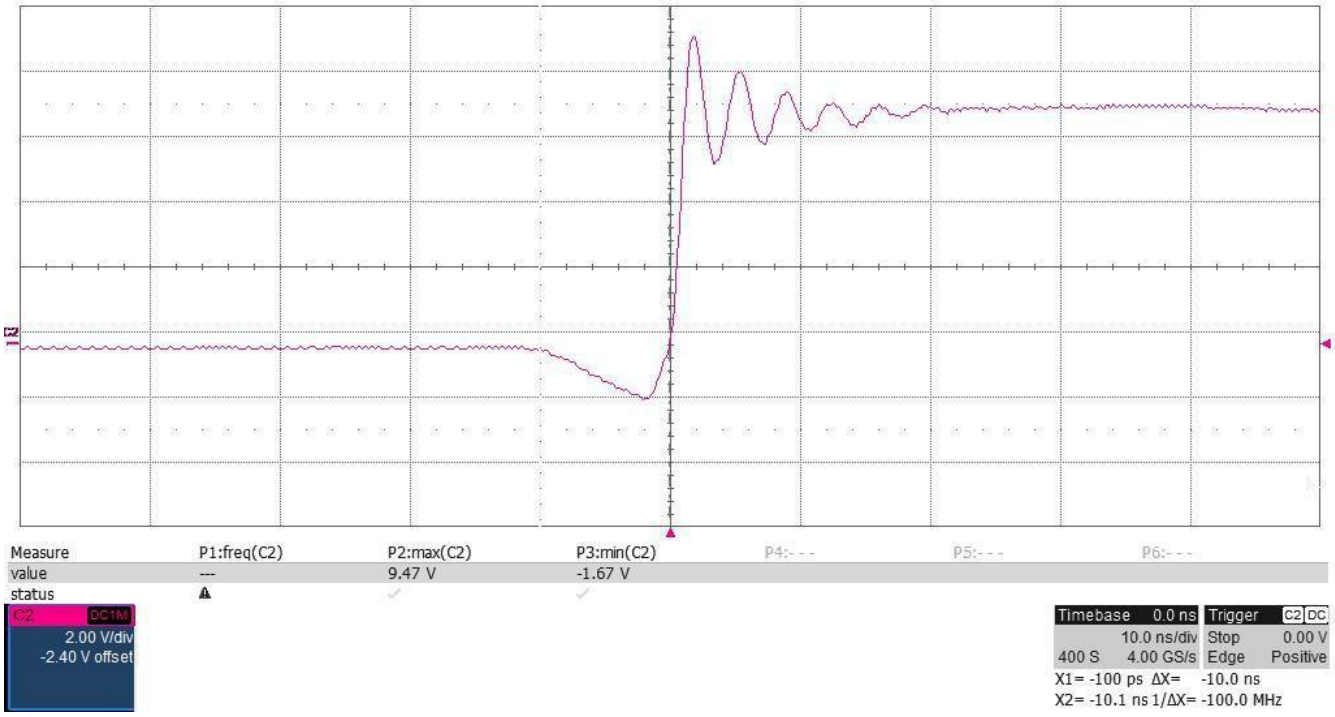
CSD87381P FET switch node. Dead time set to 25ns
(5V/div)



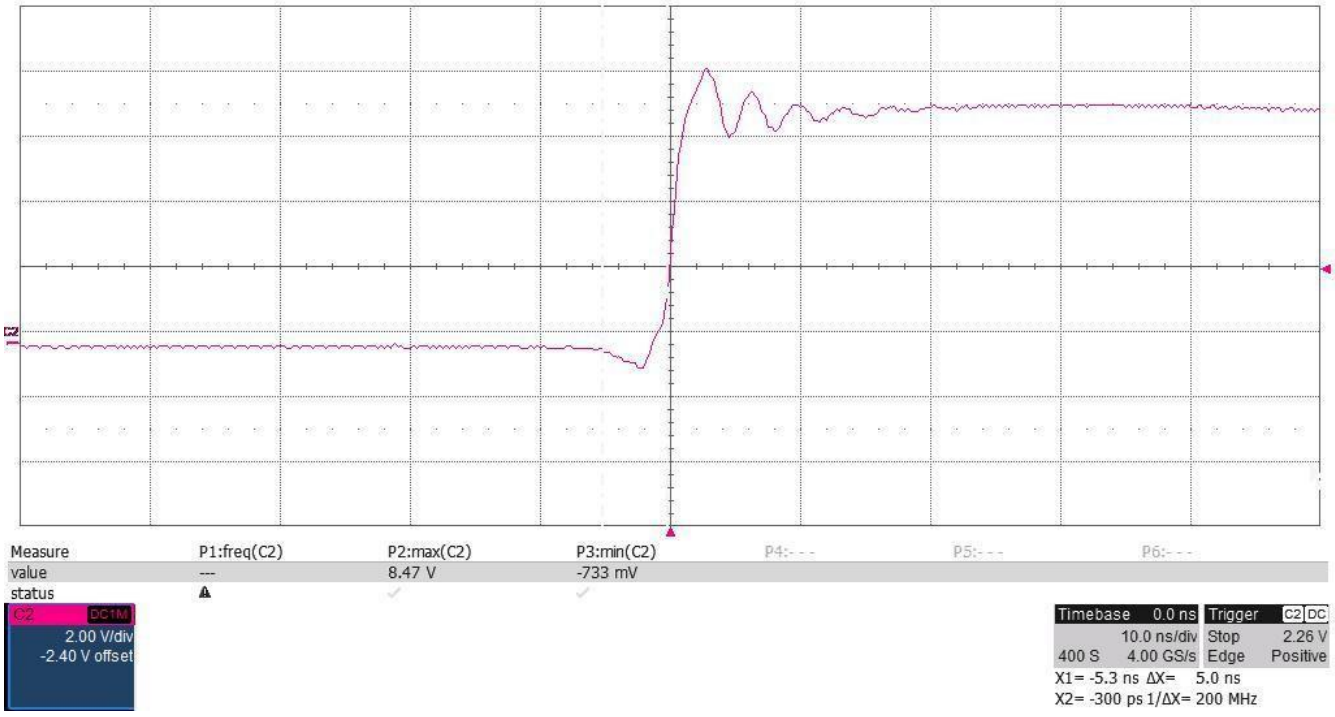
EPC2111 FET with LMG1210 GaN driver set to 20ns
(5V/div)



EPC2111 FET with LMG1210 GaN driver set to 10ns
(2V/div)

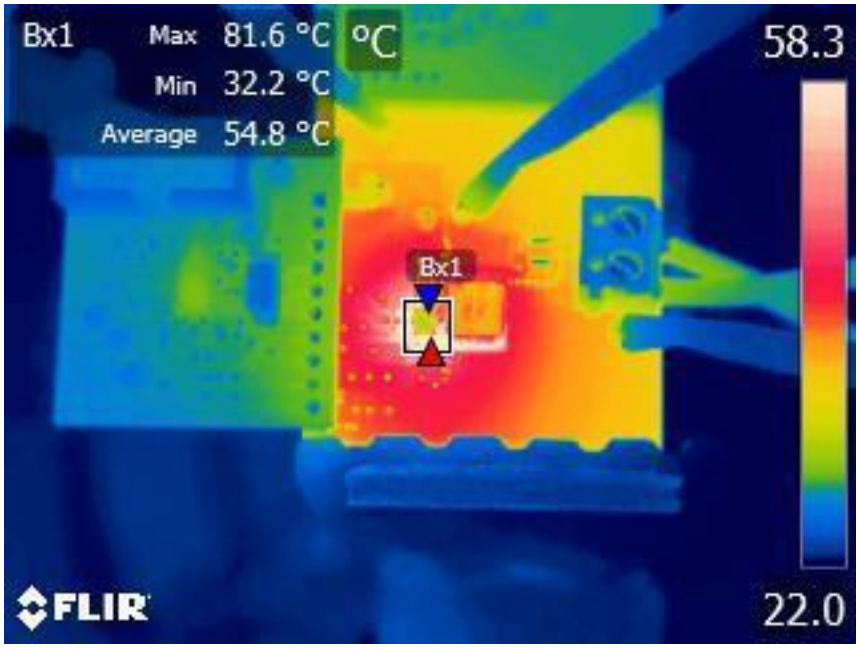


EPC2111 FET with LMG1210 GaN driver set to 5ns
(2V/div)

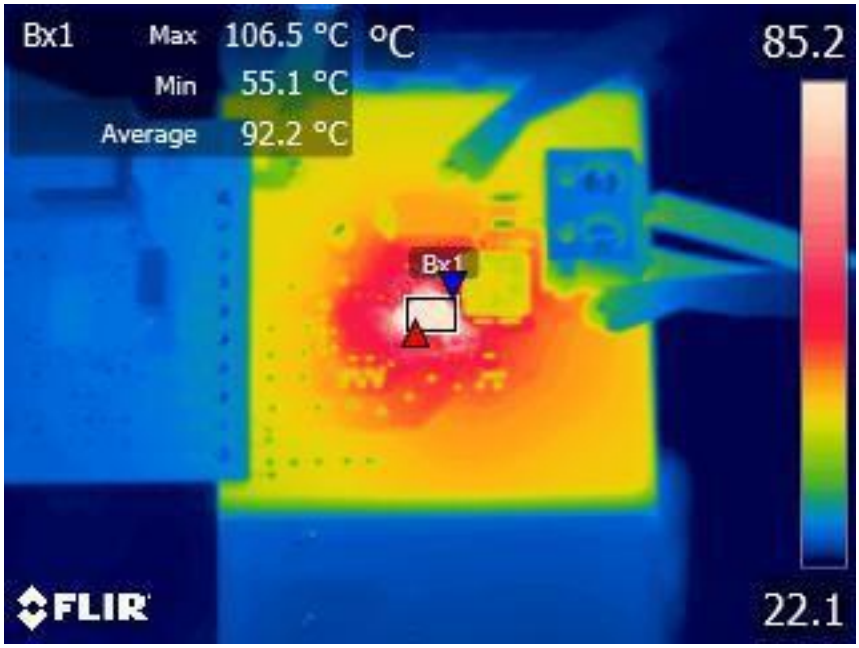


2.2 Thermal Images

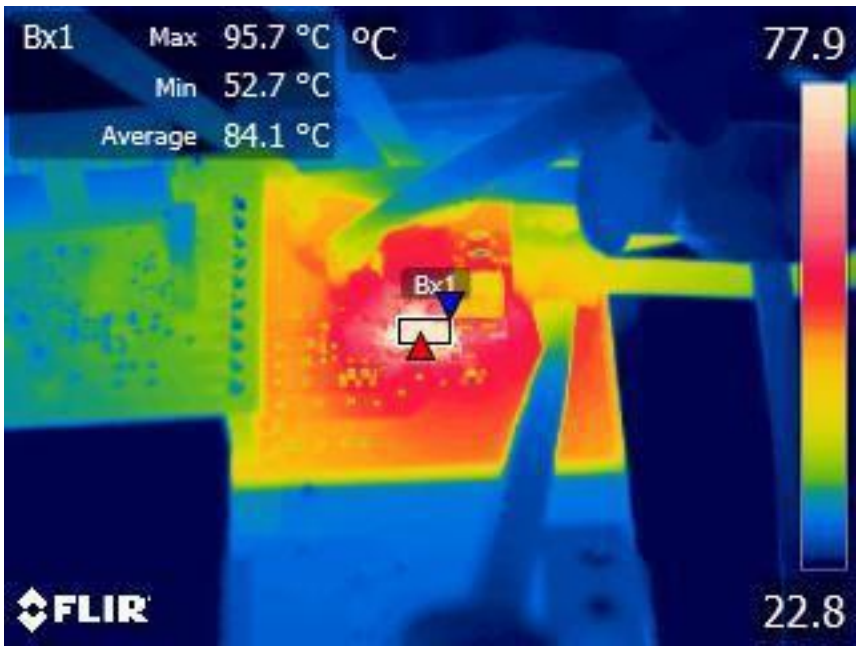
CSD87381P FET- 7Vin, 0.8Vout 10A



EPC2111 FET with LMG1210 GaN driver set to 20ns- 7Vin, 0.8Vout 10A

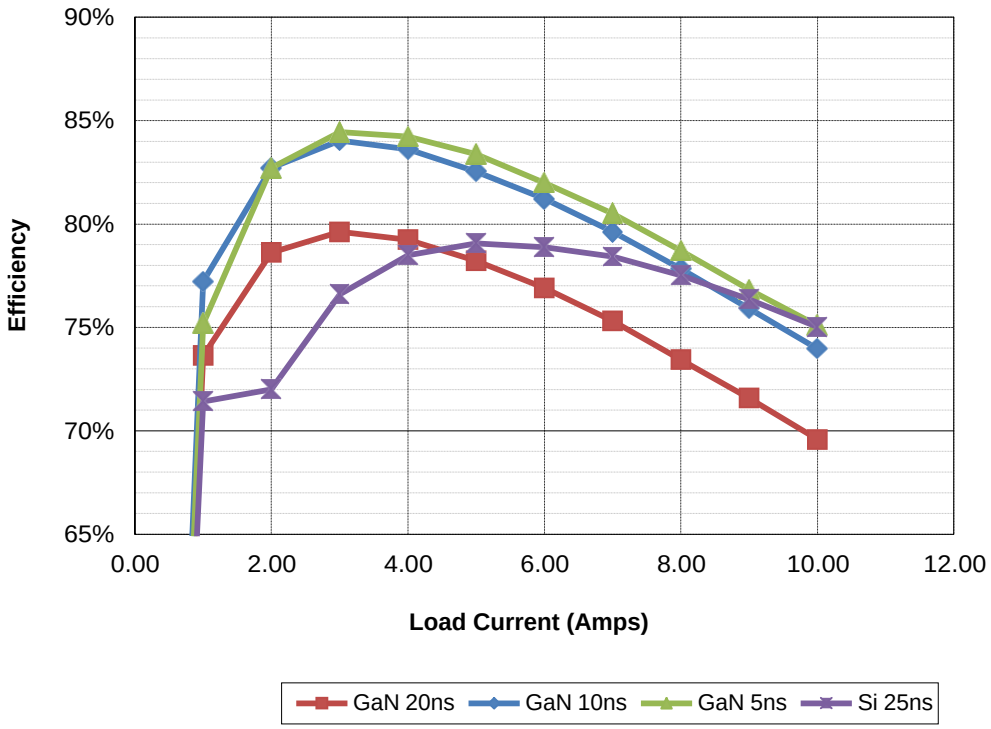


EPC2111 FET with LMG1210 GaN driver set to 10ns- 7Vin, 0.8Vout 10A



EPC2111 FET with LMG1210 GaN driver set to 5ns- 7Vin, 0.8Vout 10A

2.3 Efficiency Curves



2.4 Efficiency Data

Si 25ns

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	7.0	0.03100	0.2170	0.00	0.22	0.0%
1.000	0.800	7.0	0.1600	1.1200	0.80	0.32	71.4%
2.000	0.799	7.0	0.317	2.2190	1.60	0.62	72.0%
3.000	0.799	7.0	0.447	3.1290	2.40	0.73	76.6%
4.000	0.798	7.0	0.581	4.0670	3.19	0.88	78.5%
5.000	0.797	7.0	0.720	5.0400	3.99	1.06	79.1%
6.000	0.796	7.0	0.865	6.0550	4.78	1.28	78.9%
7.000	0.796	7.0	1.015	7.1050	5.57	1.53	78.4%
8.000	0.795	7.0	1.172	8.2040	6.36	1.84	77.5%
9.000	0.794	7.0	1.337	9.3590	7.15	2.21	76.4%
10.000	0.793	7.0	1.510	10.5700	7.93	2.64	75.0%

GaN 20ns

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	7.0	0.03600	0.2520	0.00	0.25	0.0%
1.000	0.799	7.0	0.1550	1.0850	0.80	0.29	73.6%
2.000	0.798	7.0	0.290	2.0300	1.60	0.43	78.6%
3.000	0.797	7.0	0.429	3.0030	2.39	0.61	79.6%
4.000	0.796	7.0	0.574	4.0180	3.18	0.83	79.2%
5.000	0.795	7.0	0.726	5.0820	3.98	1.11	78.2%
6.000	0.794	7.0	0.885	6.1950	4.76	1.43	76.9%
7.000	0.793	7.0	1.053	7.3710	5.55	1.82	75.3%
8.000	0.791	7.0	1.231	8.6170	6.33	2.29	73.4%
9.000	0.790	7.0	1.419	9.9330	7.11	2.82	71.6%
10.000	0.789	7.0	1.620	11.3400	7.89	3.45	69.6%

GaN 10ns

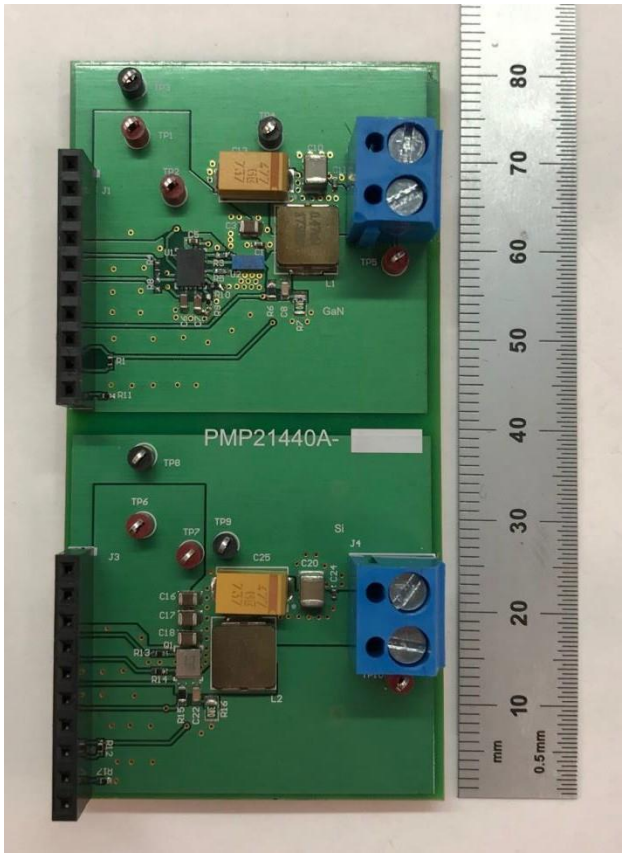
Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	7.0	0.02600	0.1820	0.00	0.18	0.0%
1.000	0.800	7.0	0.1480	1.0360	0.80	0.24	77.2%
2.000	0.799	7.0	0.276	1.9320	1.60	0.33	82.7%
3.000	0.798	7.0	0.407	2.8490	2.39	0.46	84.0%
4.000	0.796	7.0	0.544	3.8080	3.18	0.62	83.6%
5.000	0.795	7.0	0.688	4.8160	3.98	0.84	82.5%
6.000	0.794	7.0	0.838	5.8660	4.76	1.10	81.2%
7.000	0.793	7.0	0.996	6.9720	5.55	1.42	79.6%
8.000	0.792	7.0	1.163	8.1410	6.34	1.81	77.8%
9.000	0.790	7.0	1.338	9.3660	7.11	2.26	75.9%
10.000	0.789	7.0	1.524	10.6680	7.89	2.78	74.0%

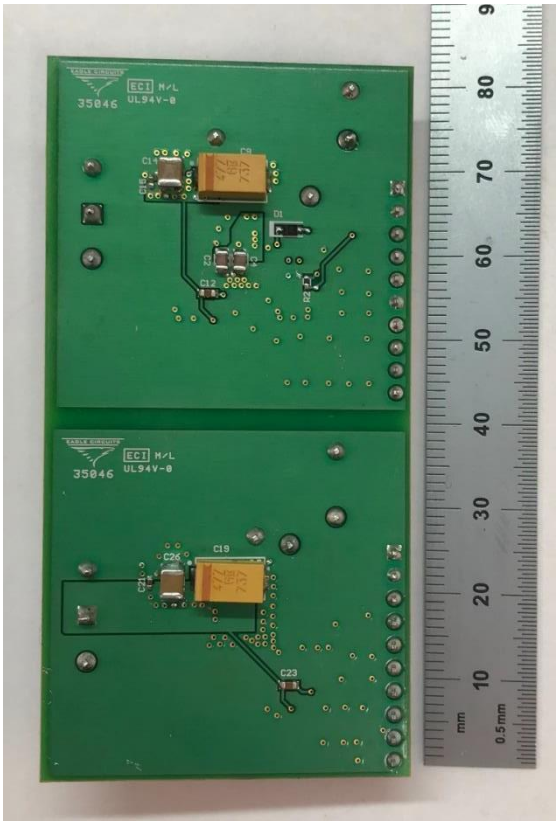
GaN 5ns

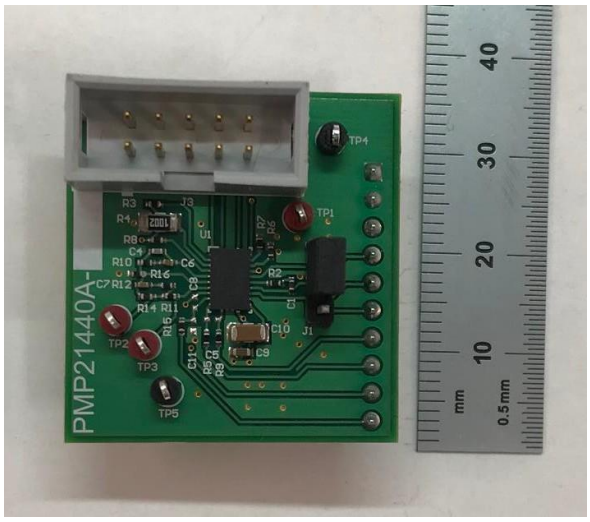
Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	7.0	0.03300	0.2310	0.00	0.23	0.0%
1.000	0.800	7.0	0.1520	1.0640	0.80	0.26	75.2%
2.000	0.799	7.0	0.276	1.9320	1.60	0.33	82.7%
3.000	0.798	7.0	0.405	2.8350	2.39	0.44	84.4%
4.000	0.796	7.0	0.540	3.7800	3.18	0.60	84.2%
5.000	0.795	7.0	0.681	4.7670	3.98	0.79	83.4%
6.000	0.794	7.0	0.830	5.8100	4.76	1.05	82.0%
7.000	0.793	7.0	0.985	6.8950	5.55	1.34	80.5%
8.000	0.792	7.0	1.150	8.0500	6.34	1.71	78.7%
9.000	0.790	7.0	1.322	9.2540	7.11	2.14	76.8%
10.000	0.789	7.0	1.501	10.5070	7.89	2.62	75.1%

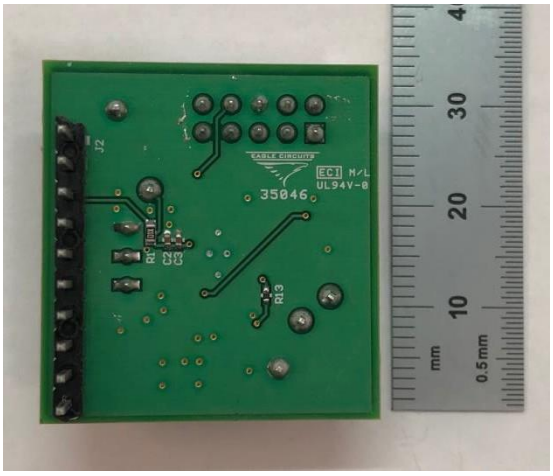
2.5 Dimensions

The photos below show the PMP21440.



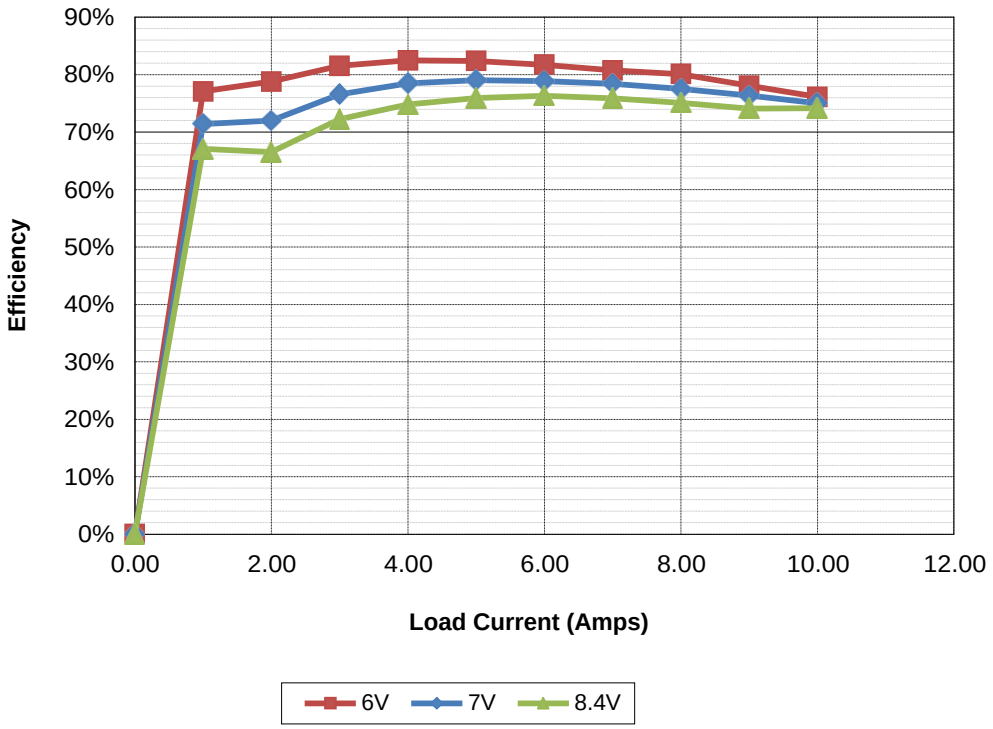






2.6 Additional Efficiency

Si 6V-8.4V 25ns

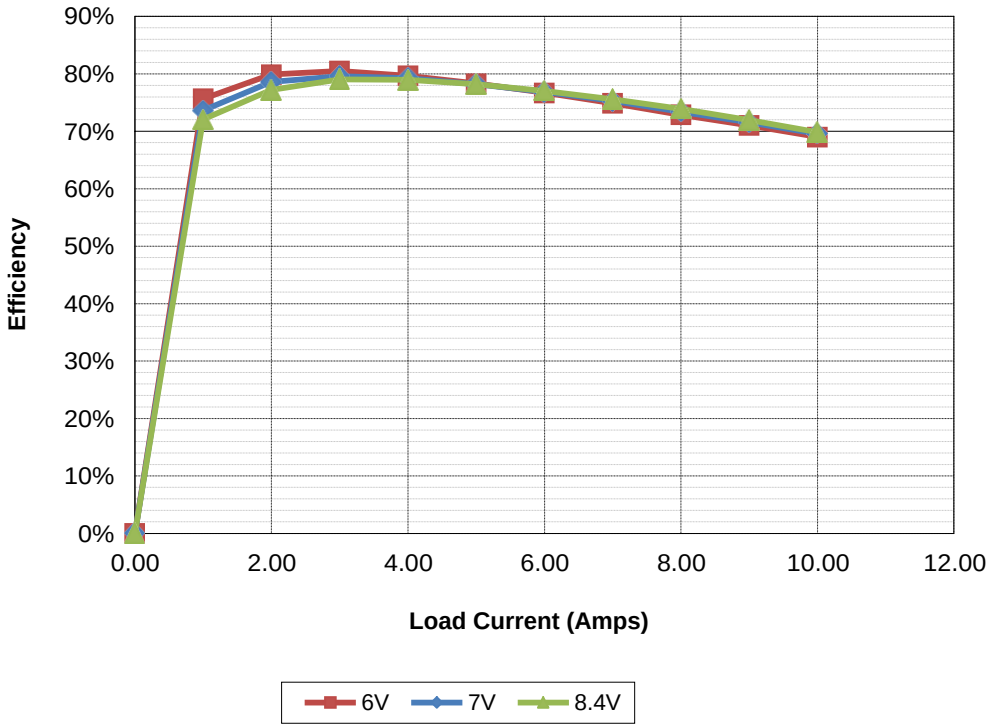


Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	6.0	0.03600	0.2160	0.00	0.22	0.0%
1.000	0.800	6.0	0.1730	1.0380	0.80	0.24	77.1%
2.000	0.799	6.0	0.338	2.0280	1.60	0.43	78.8%
3.000	0.799	6.0	0.490	2.9400	2.40	0.54	81.5%
4.000	0.798	6.0	0.645	3.8700	3.19	0.68	82.5%
5.000	0.797	6.0	0.806	4.8360	3.99	0.85	82.4%
6.000	0.797	6.0	0.975	5.8500	4.78	1.07	81.7%
7.000	0.796	6.0	1.150	6.9000	5.57	1.33	80.8%
8.000	0.795	6.0	1.323	7.9380	6.36	1.58	80.1%
9.000	0.794	6.0	1.525	9.1500	7.15	2.00	78.1%
10.000	0.793	6.0	1.736	10.4160	7.93	2.49	76.1%

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	7.0	0.03100	0.2170	0.00	0.22	0.0%
1.000	0.800	7.0	0.1600	1.1200	0.80	0.32	71.4%
2.000	0.799	7.0	0.317	2.2190	1.60	0.62	72.0%
3.000	0.799	7.0	0.447	3.1290	2.40	0.73	76.6%
4.000	0.798	7.0	0.581	4.0670	3.19	0.88	78.5%
5.000	0.797	7.0	0.720	5.0400	3.99	1.06	79.1%
6.000	0.796	7.0	0.865	6.0550	4.78	1.28	78.9%
7.000	0.796	7.0	1.015	7.1050	5.57	1.53	78.4%
8.000	0.795	7.0	1.172	8.2040	6.36	1.84	77.5%
9.000	0.794	7.0	1.337	9.3590	7.15	2.21	76.4%
10.000	0.793	7.0	1.510	10.5700	7.93	2.64	75.0%

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	8.4	0.03300	0.2772	0.00	0.28	0.0%
1.000	0.800	8.4	0.1420	1.1928	0.80	0.39	67.1%
2.000	0.799	8.4	0.286	2.4024	1.60	0.80	66.5%
3.000	0.799	8.4	0.395	3.3180	2.40	0.92	72.2%
4.000	0.798	8.4	0.508	4.2672	3.19	1.08	74.8%
5.000	0.797	8.4	0.625	5.2500	3.99	1.27	75.9%
6.000	0.796	8.4	0.745	6.2580	4.78	1.48	76.3%
7.000	0.796	8.4	0.874	7.3416	5.57	1.77	75.9%
8.000	0.795	8.4	1.008	8.4672	6.36	2.11	75.1%
9.000	0.794	8.4	1.148	9.6432	7.15	2.50	74.1%
10.000	0.793	8.4	1.273	10.6932	7.93	2.76	74.2%

GaN 6-8.4V20ns

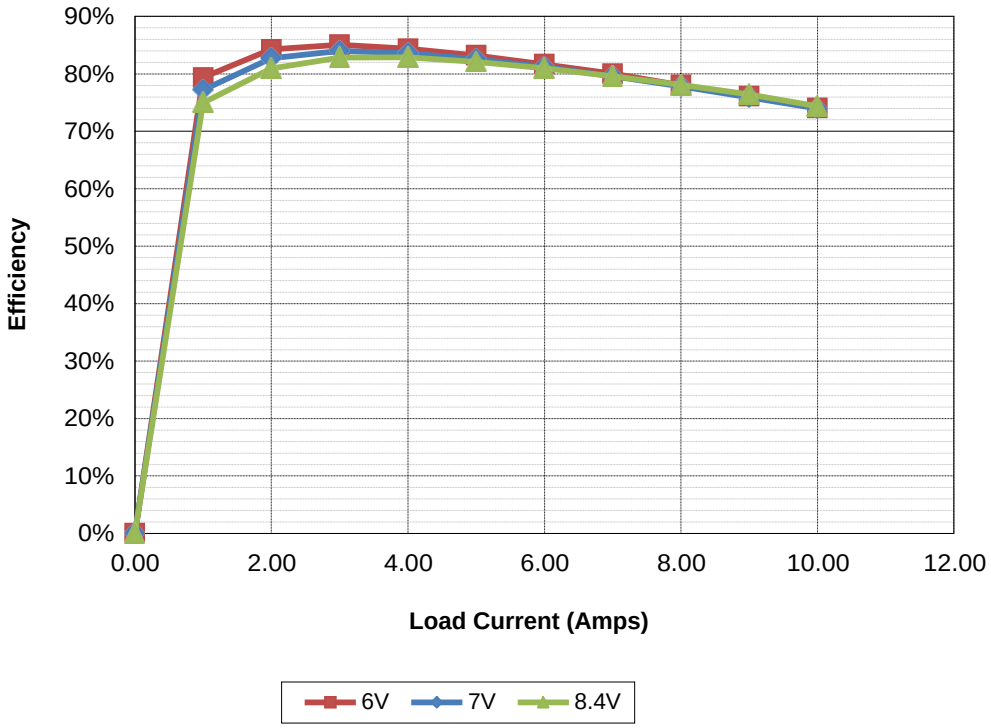


Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	6.0	0.03800	0.2280	0.00	0.23	0.0%
1.000	0.799	6.0	0.1760	1.0560	0.80	0.26	75.7%
2.000	0.798	6.0	0.333	1.9980	1.60	0.40	79.9%
3.000	0.797	6.0	0.495	2.9700	2.39	0.58	80.5%
4.000	0.796	6.0	0.666	3.9960	3.18	0.81	79.7%
5.000	0.795	6.0	0.846	5.0760	3.98	1.10	78.3%
6.000	0.793	6.0	1.034	6.2040	4.76	1.45	76.7%
7.000	0.792	6.0	1.234	7.4040	5.54	1.86	74.9%
8.000	0.791	6.0	1.447	8.6820	6.33	2.35	72.9%
9.000	0.790	6.0	1.668	10.0080	7.11	2.90	71.0%
10.000	0.788	6.0	1.903	11.4180	7.88	3.54	69.0%

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	7.0	0.03600	0.2520	0.00	0.25	0.0%
1.000	0.799	7.0	0.1550	1.0850	0.80	0.29	73.6%
2.000	0.798	7.0	0.290	2.0300	1.60	0.43	78.6%
3.000	0.797	7.0	0.429	3.0030	2.39	0.61	79.6%
4.000	0.796	7.0	0.574	4.0180	3.18	0.83	79.2%
5.000	0.795	7.0	0.726	5.0820	3.98	1.11	78.2%
6.000	0.794	7.0	0.885	6.1950	4.76	1.43	76.9%
7.000	0.793	7.0	1.053	7.3710	5.55	1.82	75.3%
8.000	0.791	7.0	1.231	8.6170	6.33	2.29	73.4%
9.000	0.790	7.0	1.419	9.9330	7.11	2.82	71.6%
10.000	0.789	7.0	1.620	11.3400	7.89	3.45	69.6%

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.800	8.4	0.03300	0.2772	0.00	0.28	0.0%
1.000	0.799	8.4	0.1320	1.1088	0.80	0.31	72.1%
2.000	0.798	8.4	0.246	2.0664	1.60	0.47	77.2%
3.000	0.797	8.4	0.360	3.0240	2.39	0.63	79.1%
4.000	0.796	8.4	0.480	4.0320	3.18	0.85	79.0%
5.000	0.795	8.4	0.605	5.0820	3.98	1.11	78.2%
6.000	0.794	8.4	0.736	6.1824	4.76	1.42	77.1%
7.000	0.793	8.4	0.874	7.3416	5.55	1.79	75.6%
8.000	0.791	8.4	1.019	8.5596	6.33	2.23	73.9%
9.000	0.790	8.4	1.176	9.8784	7.11	2.77	72.0%
10.000	0.789	8.4	1.345	11.2980	7.89	3.41	69.8%

GaN 6-8.4V10ns

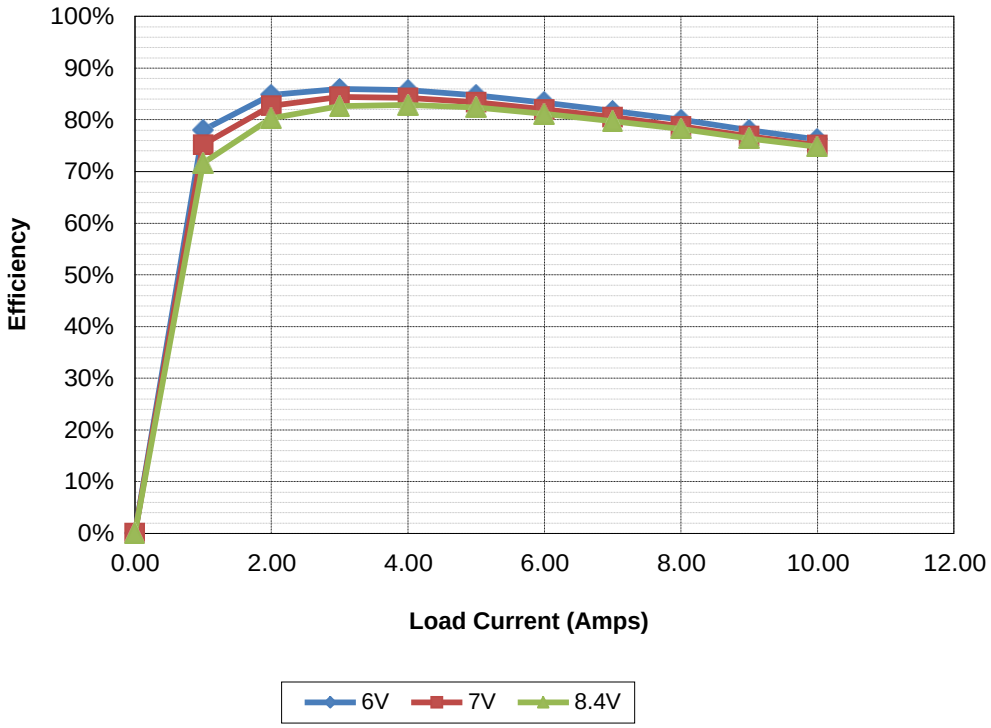


Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	6.0	0.02600	0.1560	0.00	0.16	0.0%
1.000	0.800	6.0	0.1680	1.0080	0.80	0.21	79.4%
2.000	0.799	6.0	0.316	1.8960	1.60	0.30	84.3%
3.000	0.798	6.0	0.469	2.8140	2.39	0.42	85.1%
4.000	0.796	6.0	0.629	3.7740	3.18	0.59	84.4%
5.000	0.795	6.0	0.796	4.7760	3.98	0.80	83.2%
6.000	0.794	6.0	0.972	5.8320	4.76	1.07	81.7%
7.000	0.793	6.0	1.156	6.9360	5.55	1.39	80.0%
8.000	0.792	6.0	1.353	8.1180	6.34	1.78	78.0%
9.000	0.790	6.0	1.557	9.3420	7.11	2.23	76.1%
10.000	0.789	6.0	1.775	10.6500	7.89	2.76	74.1%

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	7.0	0.02600	0.1820	0.00	0.18	0.0%
1.000	0.800	7.0	0.1480	1.0360	0.80	0.24	77.2%
2.000	0.799	7.0	0.276	1.9320	1.60	0.33	82.7%
3.000	0.798	7.0	0.407	2.8490	2.39	0.46	84.0%
4.000	0.796	7.0	0.544	3.8080	3.18	0.62	83.6%
5.000	0.795	7.0	0.688	4.8160	3.98	0.84	82.5%
6.000	0.794	7.0	0.838	5.8660	4.76	1.10	81.2%
7.000	0.793	7.0	0.996	6.9720	5.55	1.42	79.6%
8.000	0.792	7.0	1.163	8.1410	6.34	1.81	77.8%
9.000	0.790	7.0	1.338	9.3660	7.11	2.26	75.9%
10.000	0.789	7.0	1.524	10.6680	7.89	2.78	74.0%

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.800	8.4	0.02500	0.2100	0.00	0.21	0.0%
1.000	0.800	8.4	0.1270	1.0668	0.80	0.27	75.0%
2.000	0.799	8.4	0.235	1.9740	1.60	0.38	81.0%
3.000	0.798	8.4	0.344	2.8896	2.39	0.50	82.8%
4.000	0.797	8.4	0.458	3.8472	3.19	0.66	82.9%
5.000	0.796	8.4	0.577	4.8468	3.98	0.87	82.1%
6.000	0.794	8.4	0.700	5.8800	4.76	1.12	81.0%
7.000	0.793	8.4	0.830	6.9720	5.55	1.42	79.6%
8.000	0.792	8.4	0.966	8.1144	6.34	1.78	78.1%
9.000	0.791	8.4	1.109	9.3156	7.12	2.20	76.4%
10.000	0.789	8.4	1.263	10.6092	7.89	2.72	74.4%

GaN 5ns 6V-8.4V



Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	6.0	0.03200	0.1920	0.00	0.19	0.0%
1.000	0.800	6.0	0.1710	1.0260	0.80	0.23	78.0%
2.000	0.799	6.0	0.314	1.8840	1.60	0.29	84.8%
3.000	0.798	6.0	0.464	2.7840	2.39	0.39	86.0%
4.000	0.797	6.0	0.620	3.7200	3.19	0.53	85.7%
5.000	0.796	6.0	0.783	4.6980	3.98	0.72	84.7%
6.000	0.794	6.0	0.953	5.7180	4.76	0.95	83.3%
7.000	0.793	6.0	1.132	6.7920	5.55	1.24	81.7%
8.000	0.792	6.0	1.320	7.9200	6.34	1.58	80.0%
9.000	0.790	6.0	1.520	9.1200	7.11	2.01	78.0%
10.000	0.790	6.0	1.728	10.3680	7.90	2.47	76.2%

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	7.0	0.03300	0.2310	0.00	0.23	0.0%
1.000	0.800	7.0	0.1520	1.0640	0.80	0.26	75.2%
2.000	0.799	7.0	0.276	1.9320	1.60	0.33	82.7%
3.000	0.798	7.0	0.405	2.8350	2.39	0.44	84.4%
4.000	0.796	7.0	0.540	3.7800	3.18	0.60	84.2%
5.000	0.795	7.0	0.681	4.7670	3.98	0.79	83.4%
6.000	0.794	7.0	0.830	5.8100	4.76	1.05	82.0%
7.000	0.793	7.0	0.985	6.8950	5.55	1.34	80.5%
8.000	0.792	7.0	1.150	8.0500	6.34	1.71	78.7%
9.000	0.790	7.0	1.322	9.2540	7.11	2.14	76.8%
10.000	0.789	7.0	1.501	10.5070	7.89	2.62	75.1%

Iout	Vout	Vin	Iin	Pin	Pout	Losses	Efficiency
0.000	0.801	8.4	0.03400	0.2856	0.00	0.29	0.0%
1.000	0.800	8.4	0.1330	1.1172	0.80	0.32	71.6%
2.000	0.799	8.4	0.237	1.9908	1.60	0.39	80.3%
3.000	0.798	8.4	0.345	2.8980	2.39	0.50	82.6%
4.000	0.797	8.4	0.458	3.8472	3.19	0.66	82.9%
5.000	0.796	8.4	0.575	4.8300	3.98	0.85	82.4%
6.000	0.794	8.4	0.699	5.8716	4.76	1.11	81.1%
7.000	0.793	8.4	0.829	6.9636	5.55	1.41	79.7%
8.000	0.792	8.4	0.964	8.0976	6.34	1.76	78.2%
9.000	0.790	8.4	1.108	9.3072	7.11	2.20	76.4%
10.000	0.789	8.4	1.256	10.5504	7.89	2.66	74.8%

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