Design PMP20292 Test Results

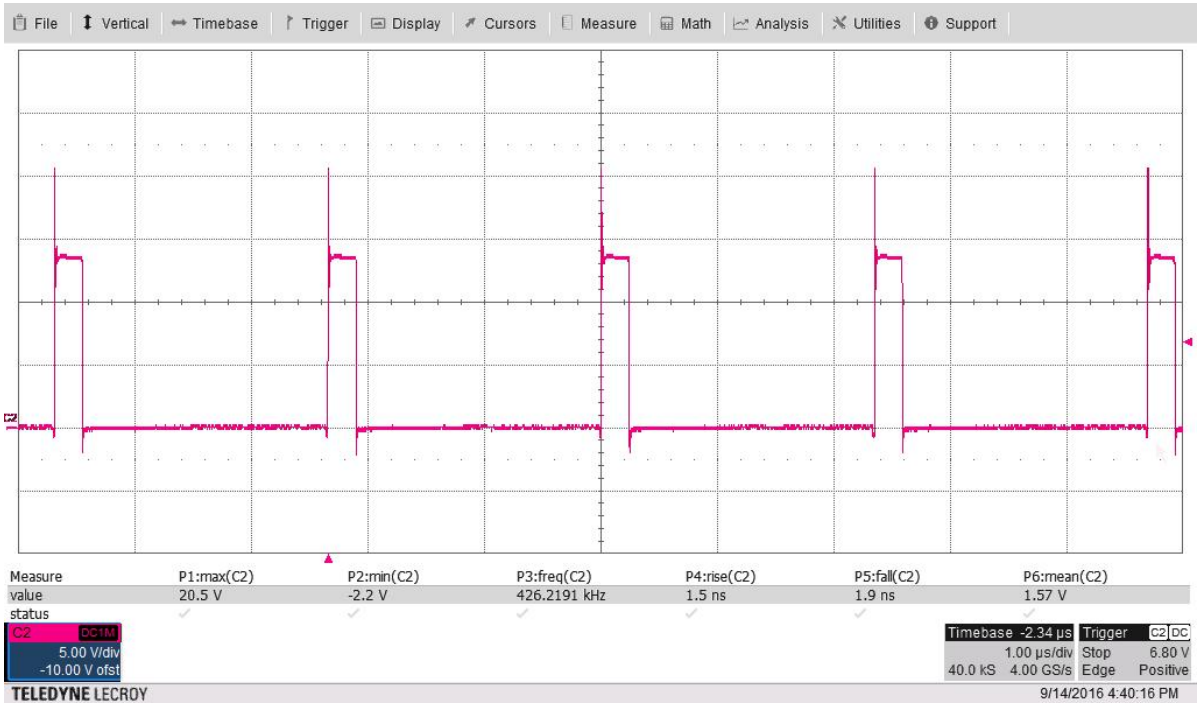
PMP20292 2xTPS546C20A 1200mV 60A Test Report:
425kHz per phase.
Board have two types of dynamic loads:

a) Self contained timer U501, driver U502 and switch Q500 with 11 parallel load resistors, R528 & R529 to control turn and turn off speeds. (See pages 8 & 9 below.)
b) Signal generator driven Q540 with 10 mOhm R542 to ground to allow scope to show both Vout and Iout at same time (See page 10 below.)

All testing at 12Vin unless otherwise mentioned

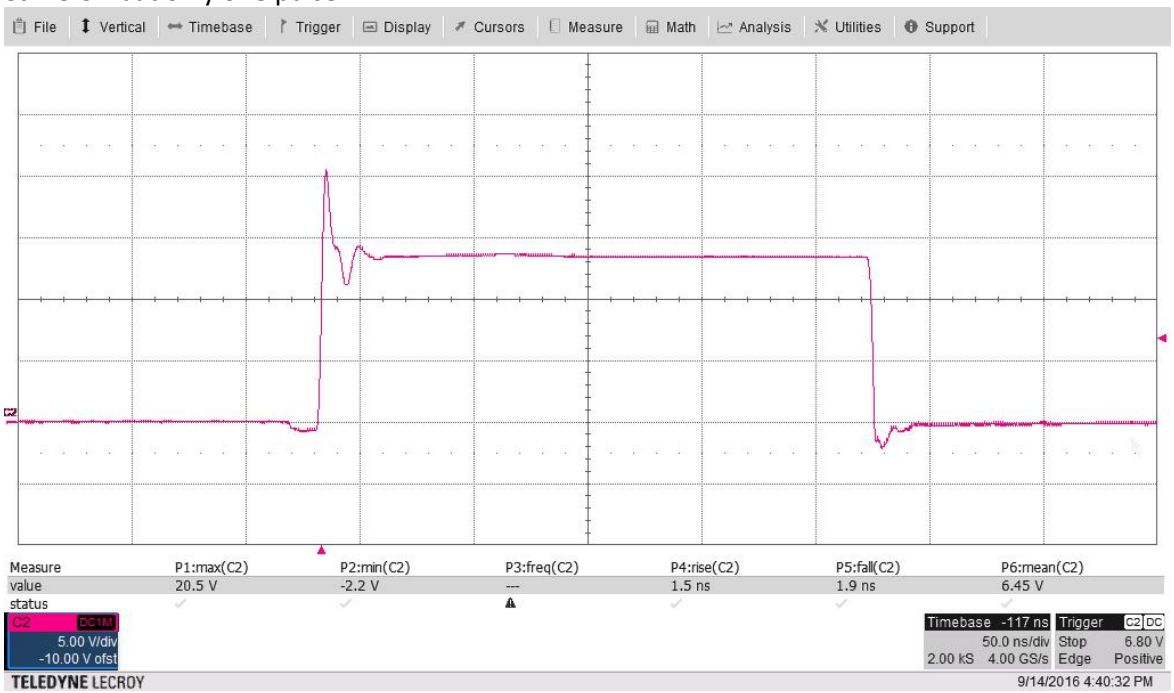
Main SW waveforms on both TPS546C20A's 13.2Vin max 60A load

U1



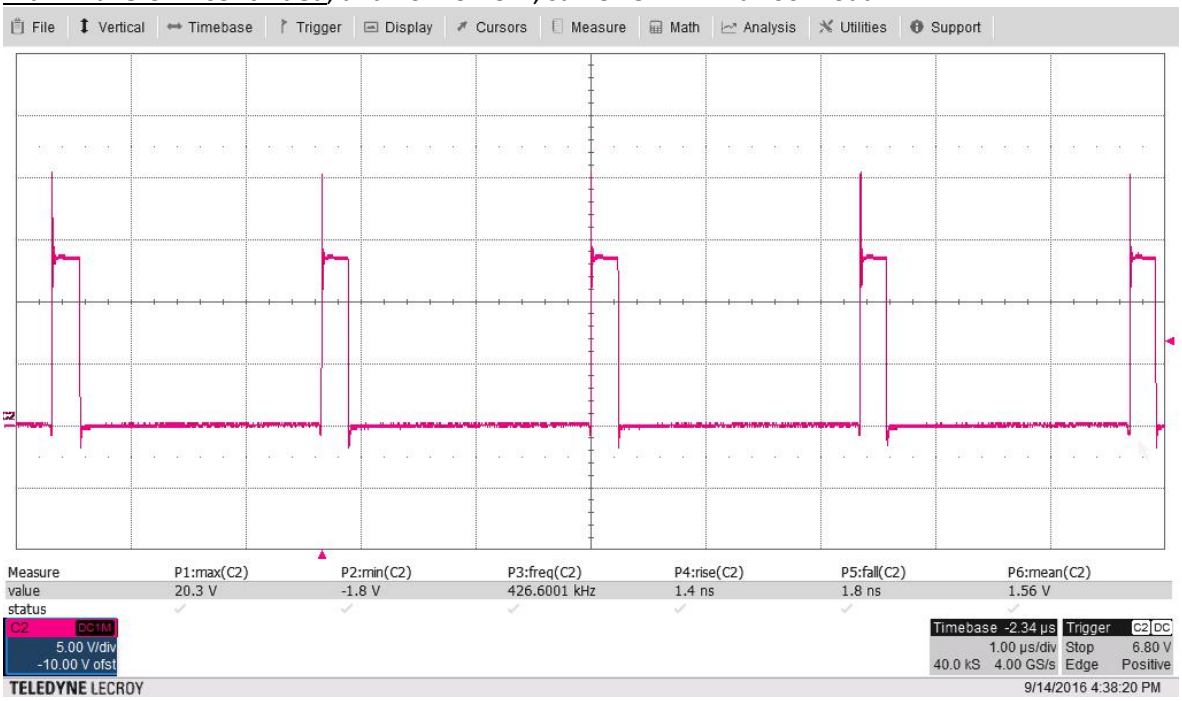
Q

Same U1 but only one pulse



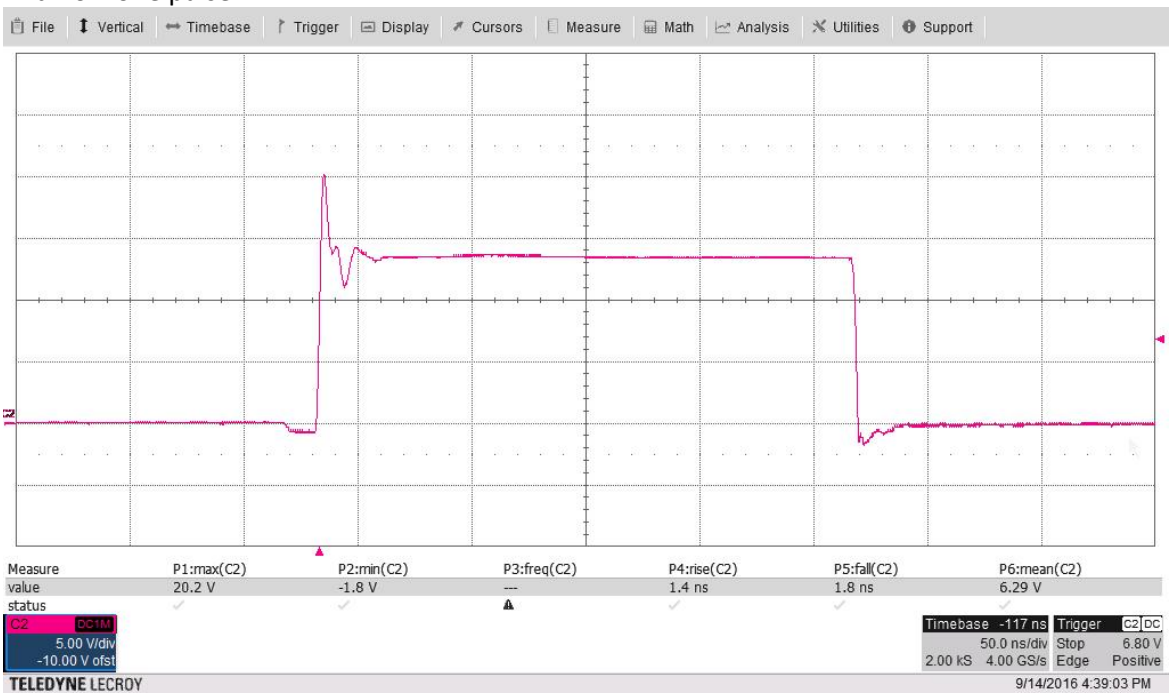
Q

Main waveform continued, and now U2-SW, same 13.2Vin max 60A load



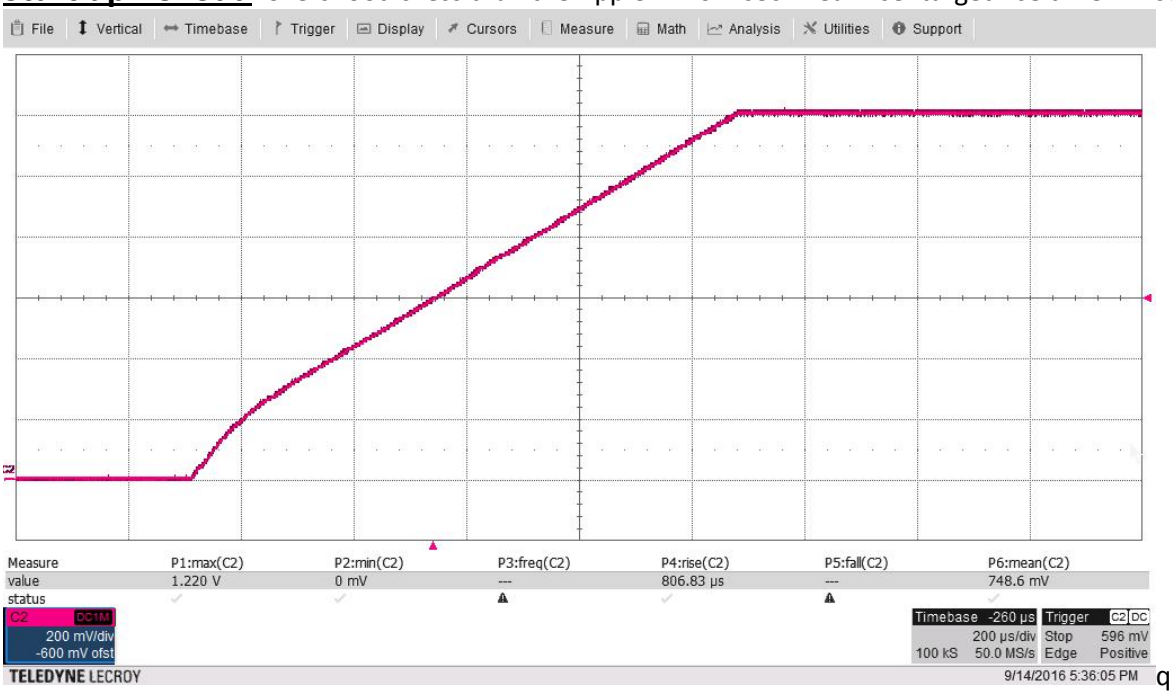
Q

And now one pulse



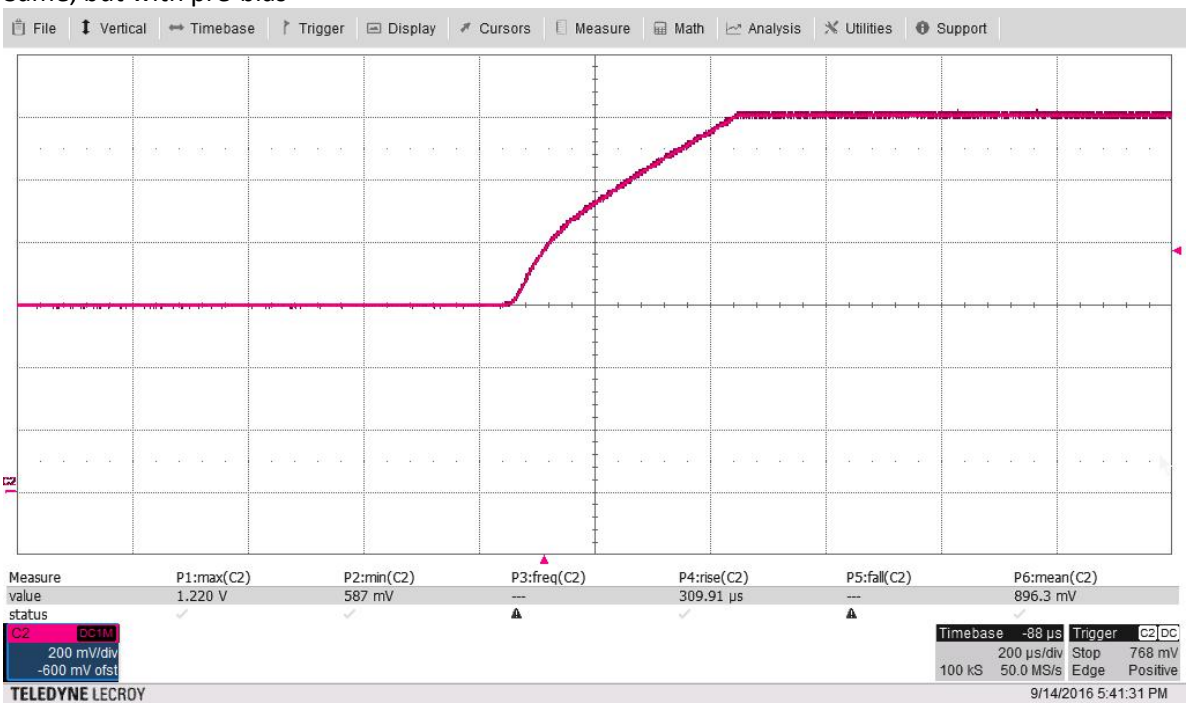
Q

Start up no load: overshoot is less than the ripple: ~1.0 msec linear rise: target rise time 1 msec



q

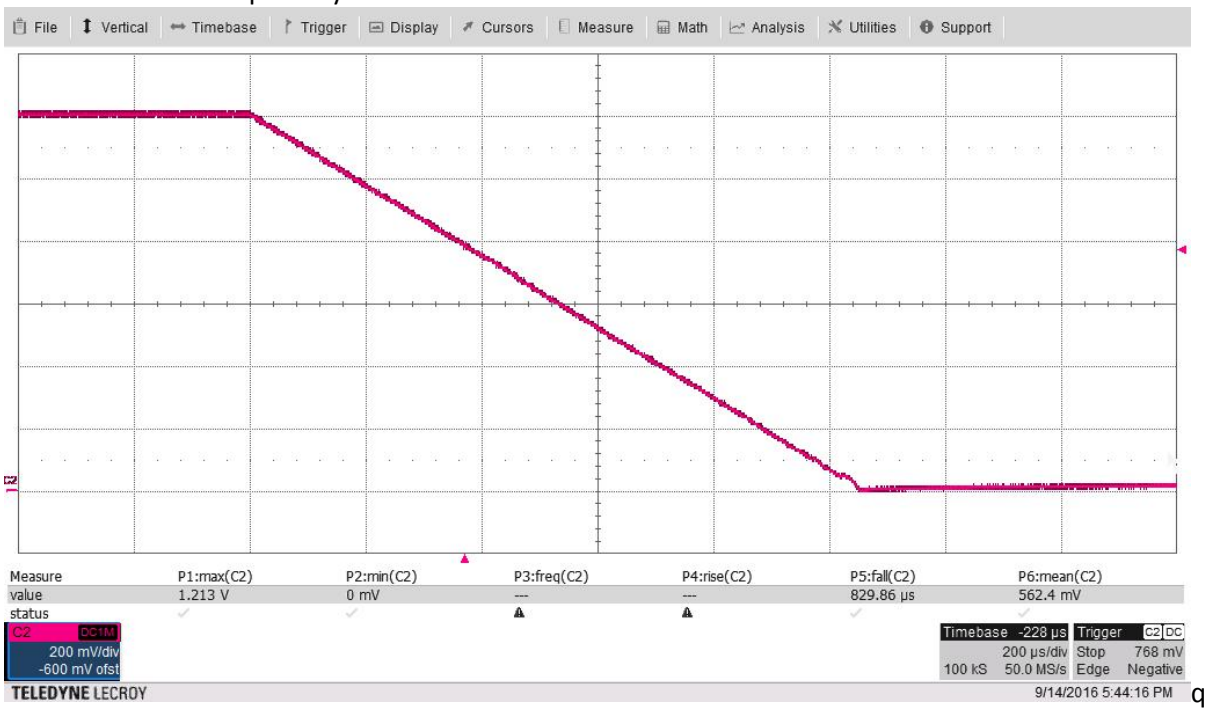
Same, but with pre-bias



Q

Controlled turn off "Soft Off"

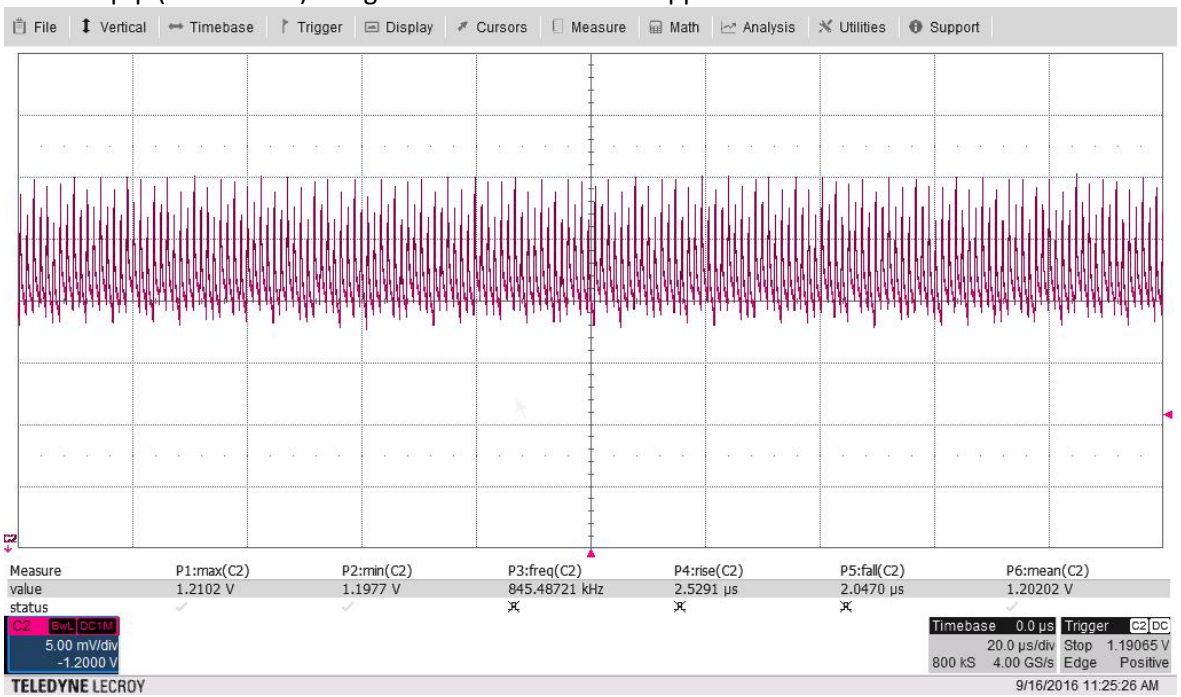
Disable thru control pin very similar



q

Q

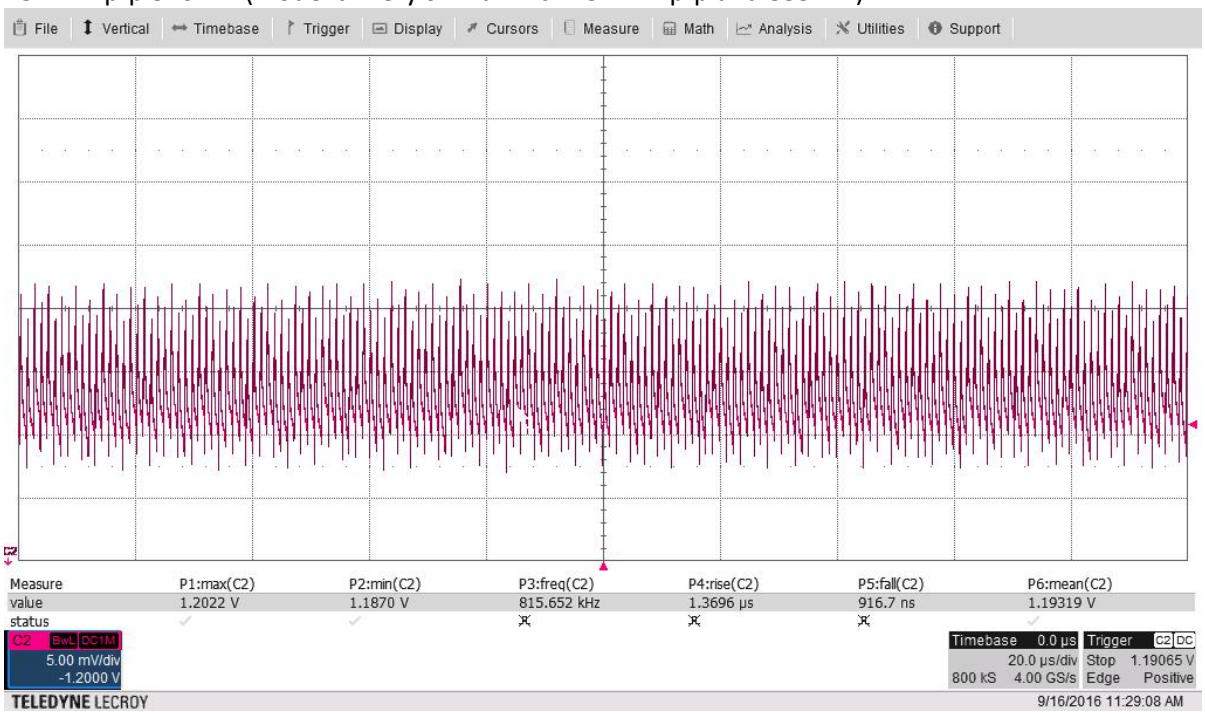
Output Ripple at no & full load: 12.0 Vin: 1.2 Vout with no load model t3:
12.5 mV p-p (20MHz BW) using J502 to measure Vout ripple



Q

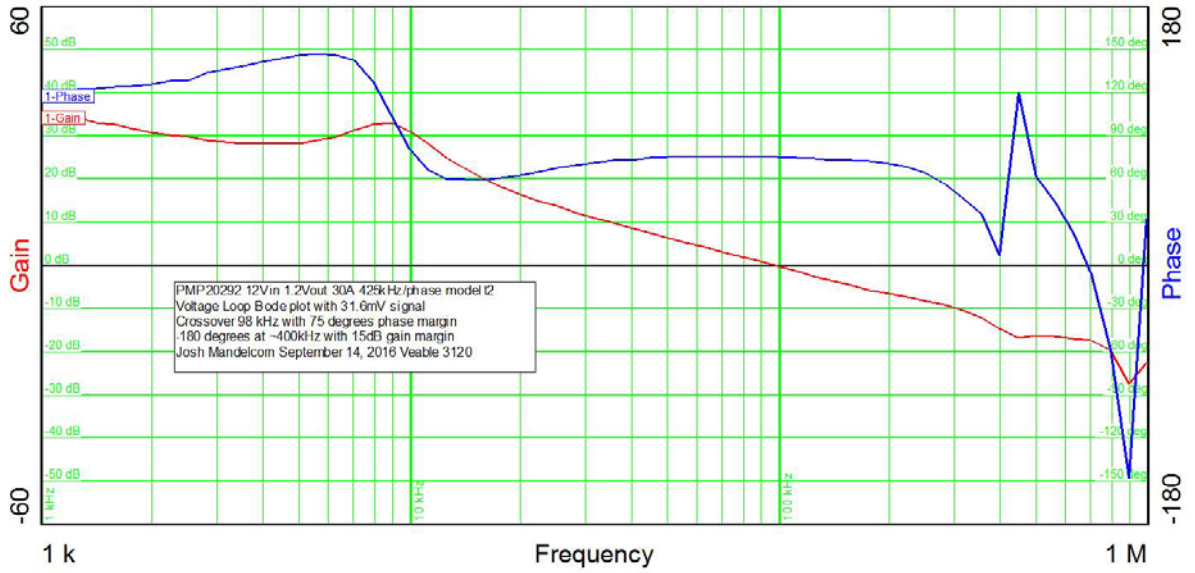
And now with full 60A load off output:

15.2mV p-p 816kHz (model t2 very similar with 15.1mV p-p and 835kHz)



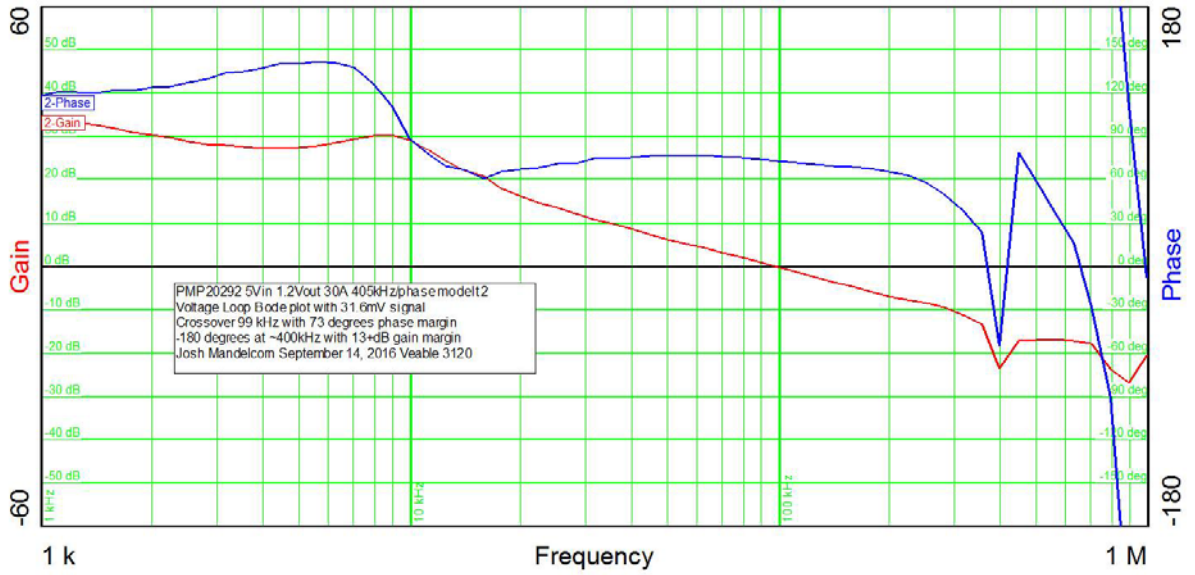
Bode Plots

12 Vin model t2



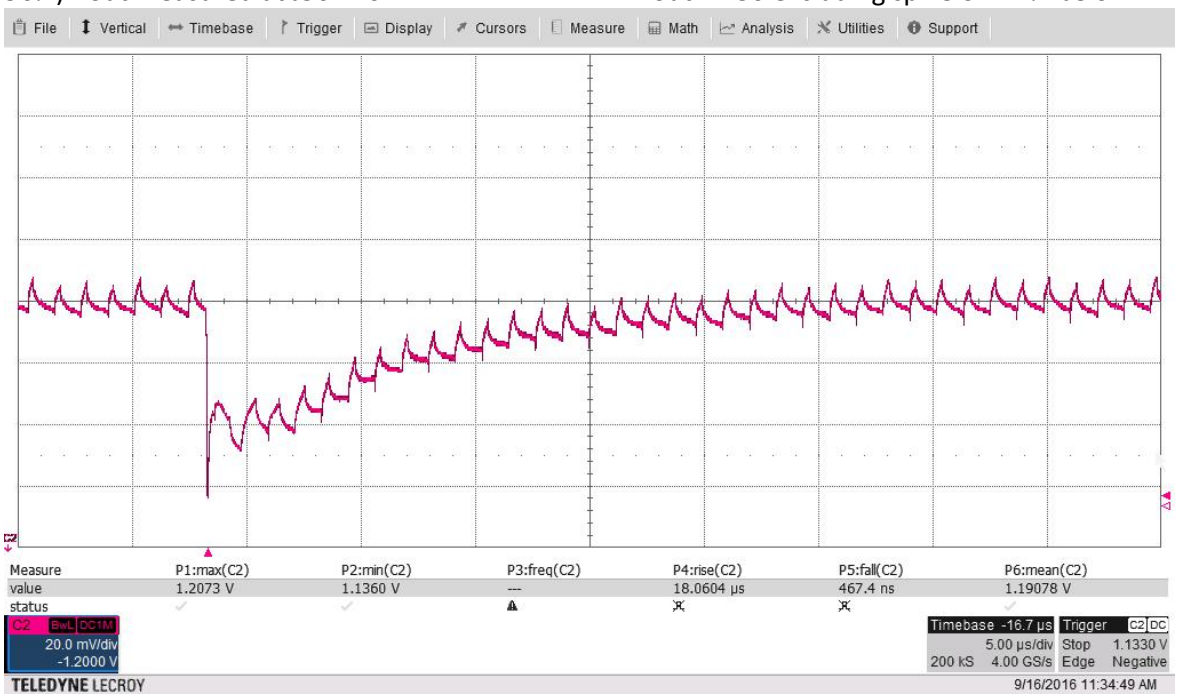
Q

And **5Vin**

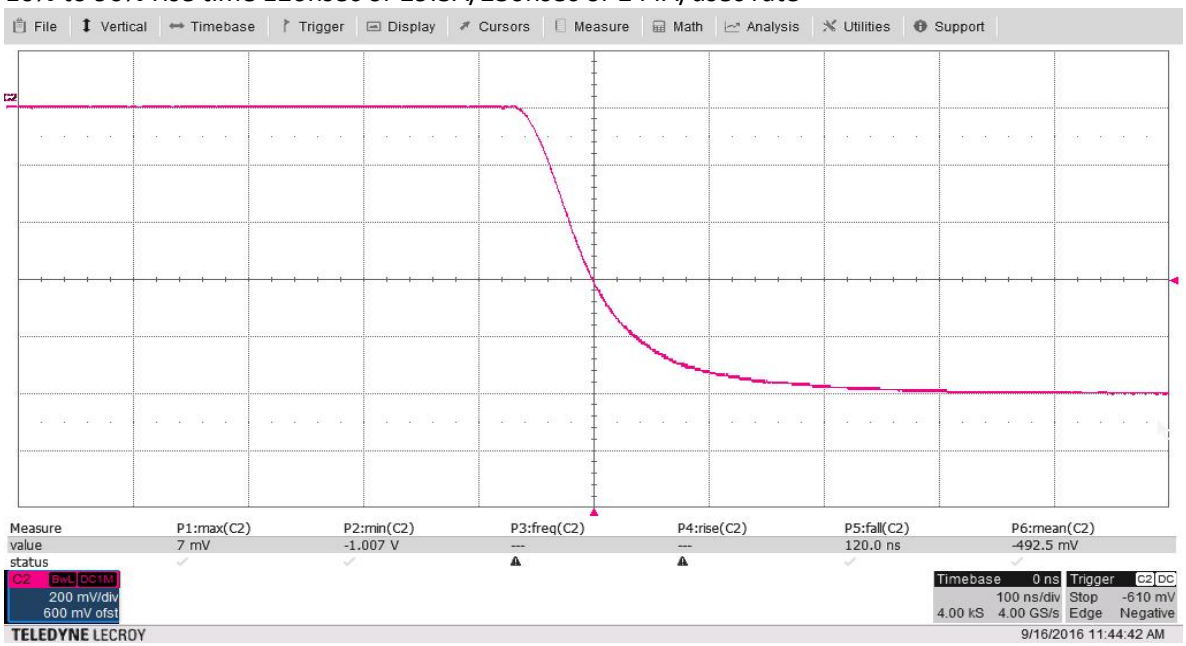


Vin has very little effect on loop gain

Step load response: using U501 / U502 / Q500 on board dynamic load (model t3)
12V 1.2Vout and 21A static load 37A additional load applied (21A to 58A) with 120 nsec rise time (10%-90%) Vout measured at J502 20 MHz BW Min Vout 1.150 excluding spike or 4.2% below 1.2V

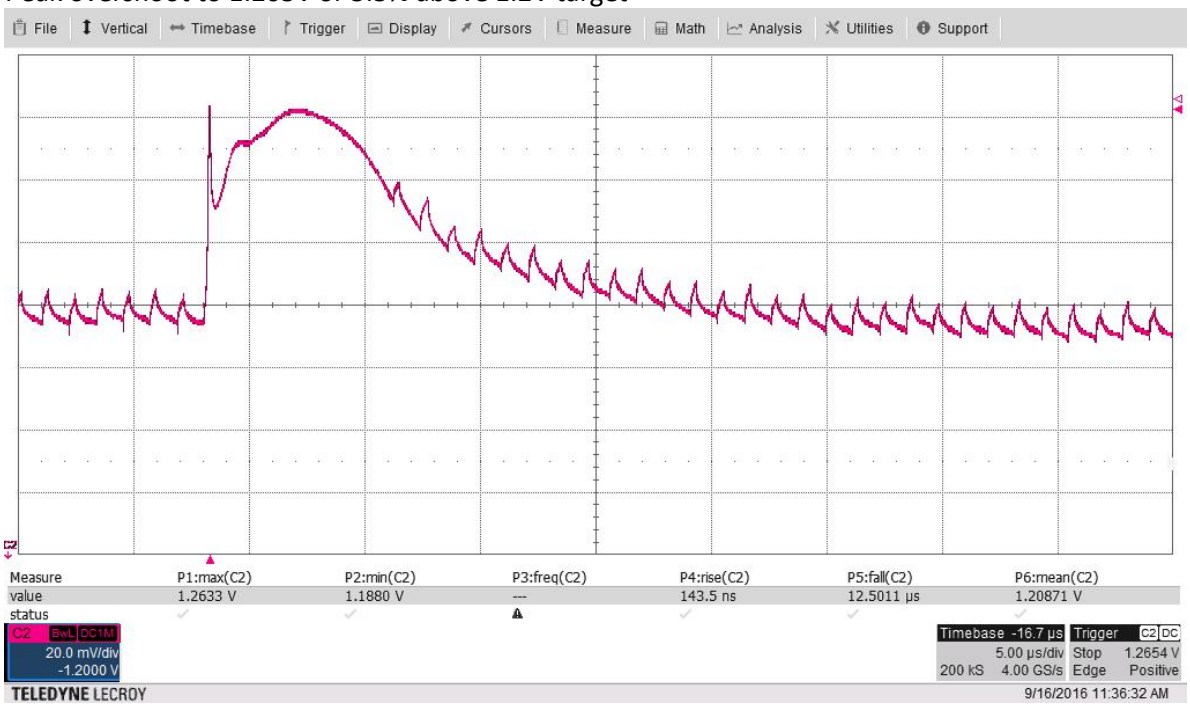


Q
Waveform across 300 mOhm dynamic load tied to Vout: 1.00V applied with 120 nsec 10% to 90% rise time: Close in tip & barrel on R505 (furthest of 11 parallel load resistors to drain of Q500)
200 MHz BW measurement: 1.00V/0.3 ohm = 3.33A times 11 resistors = 36.7A step
10% to 90% rise time 120nsec or 29.3A/236nsec or 244A/usec rate

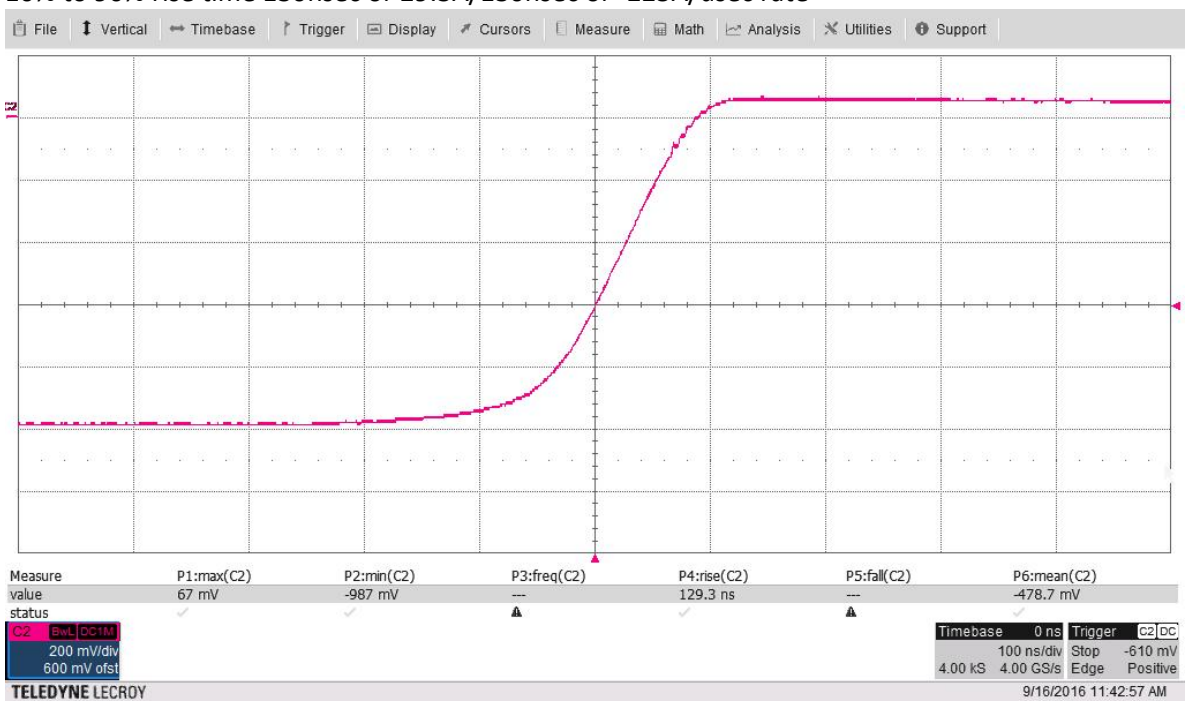


R528 now at 75 ohms sets speed of turn on and can be changed to get faster or slower turn on.

Load dump response: using U501 / U502 / Q500 on board dynamic load (model t3)
12Vin 1.2V from 58A to 21A in with 130 nsec 90% to 10% fall time. Vout measured at J502 20 MHz BW
Peak overshoot to 1.263V or 5.3% above 1.2V target

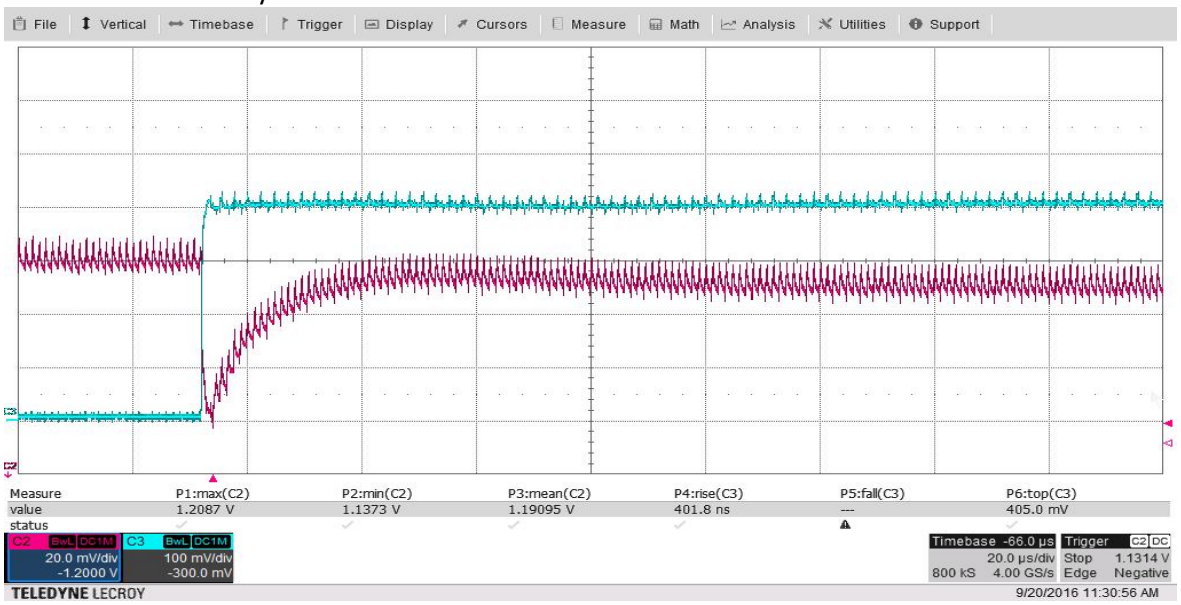


Q
Waveform across 300 mOhm dynamic load tied to Vout: 1.00V removed in ~ 100nsec
Close in tip & barrel on R505 (furthest of 11 parallel load resistors to drain of Q500)
200 MHz BW measurement: 1.00V/0.3 ohm = 3.33A times 11 resistors = 37A dump
10% to 90% rise time 130nsec or 29.3A/130nsec or -225A/usec rate

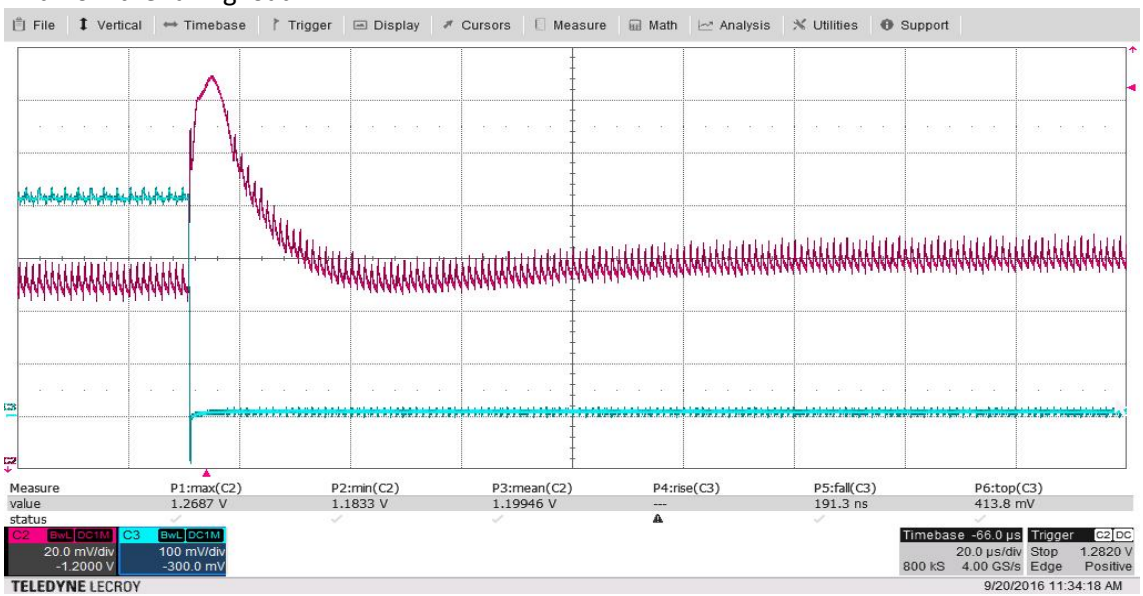


R529 now at 249 ohms sets speed of turn off and can be changed to get faster or slower turn off.

Dynamic load testing with Ryan type test load (Q540 CSD16325 & R542 10mOhms driven by **Signal Generator**): 12Vin 400kHz setting, Voltage sense at J502 red trace on scope, current sense at J541 green trace on scope at 1A per 10mV based upon R542 resistor value of 10mOhms model t2
Signal generator Tektronix AFG3102 Function: Pulse 40Hz, Delay zero ns, +/-1.250V on signal generator display but actually +/- 2.5V, width 1.00ms, leading 5nsec trailing 1.0 nusec, R540 at 1 ohm, R541 at 10k
21A static load 40A dynamic load:



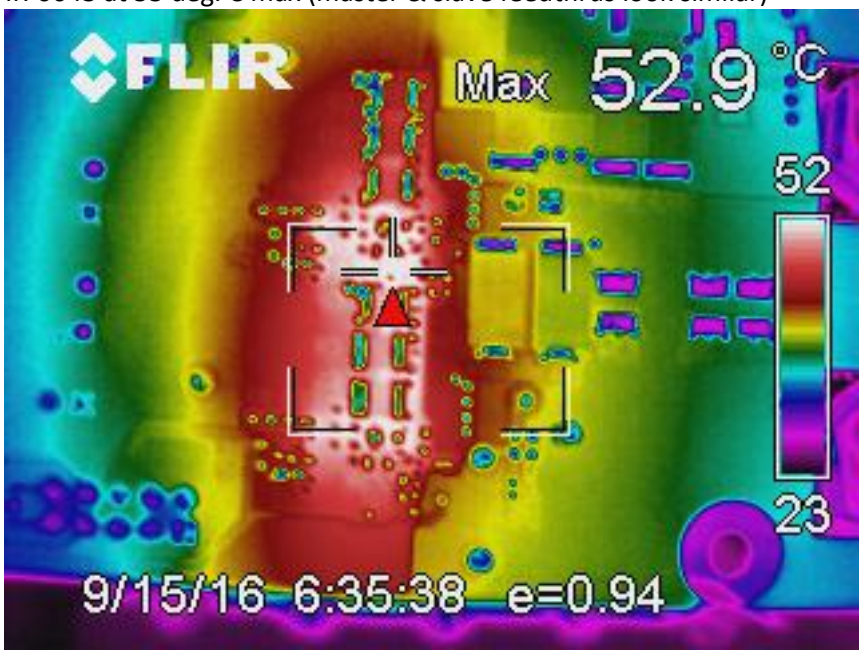
400mV/10mOhm is 40A dynamic load or 61A total including external 21A static load
10% to 90% rise time is 400usec or 80% of 40A or 32/0.4usec for 80A/usec
Undershoot to 1.1373V or 5.2% below nominal 1.2V
And now the falling load:



90% to 10% fall time is 191 nsec or 80% of 40A or 32/0.191usec for -167A/usec
Overshoot to 1.2687V or 5.7% above nominal 1.2V
Q

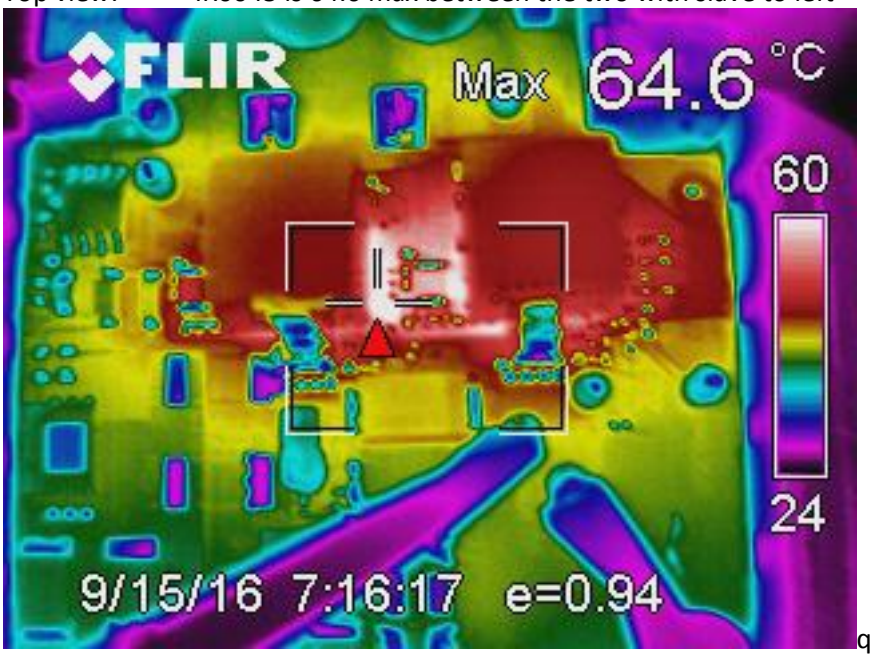
Thermal images: Full load with Fan: Model t1

Upsides down testing & view
11.99Vin 6.85Ain 1.201Vout 60.06A
Slave GUI 30.8A & 71 deg. C
Master GUI 30.0A & 68 deg. C
IR-0043 at 53 deg. C max (master & slave feedthrus look similar)



Q

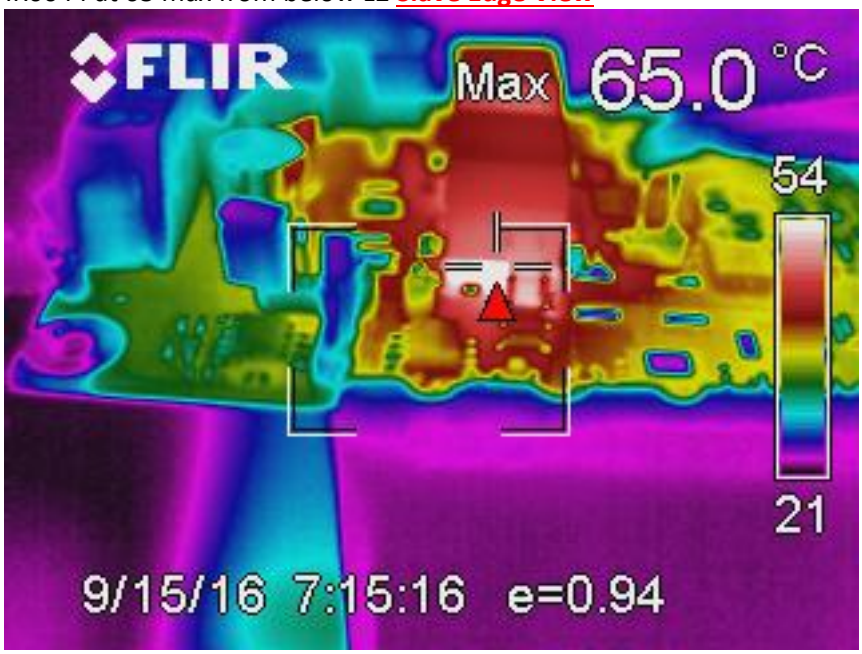
Back to right side up with fan stabilizes at 11.995Vin 6.85Ain 1.201Vout 60.06A
Master 71 deg. And 30.0A on GUI Slave 72 deg & 30.8A on GUI
Top view: IR0045 is 64.6 max between the two with slave to left



q

Thermal images: Full load with Fan: Model t1 (continued)

Right side up with fan stabilizes at 11.995Vin 6.85Ain 1.201Vout 60.06A
Master 71 deg. And 30.0A on GUI Slave 72 deg & 30.8A on GUI
Now looking at slave edge vs. master edge to see which is hotter:
IR0044 at 65 max from below L2 **Slave Edge View**



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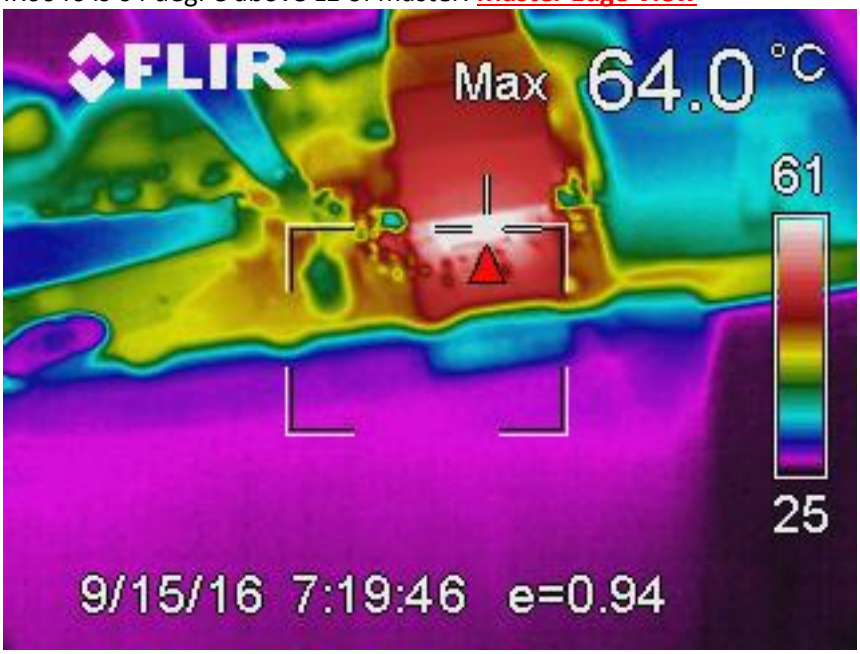
IR0046 is 64 deg. C above L1 of master: **Master Edge View**

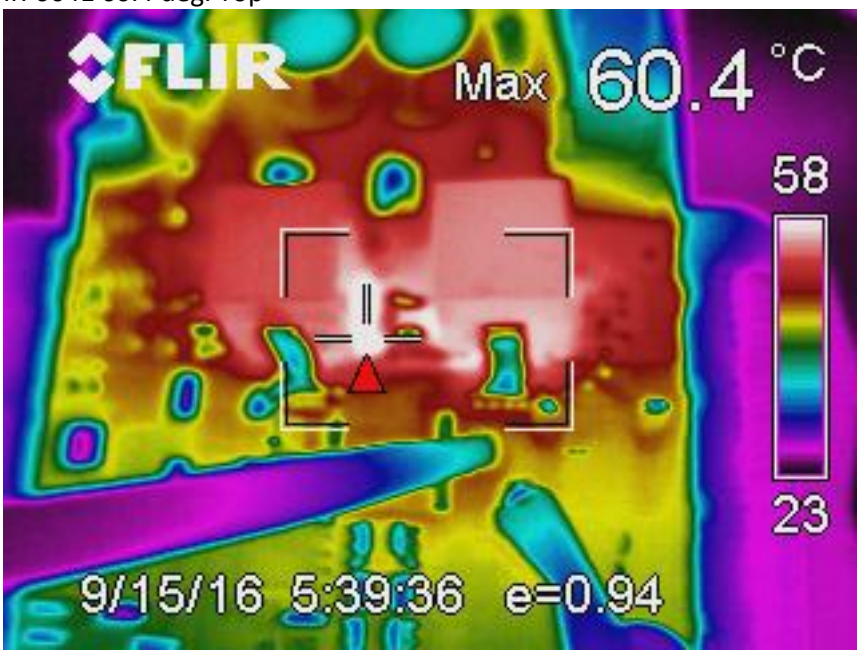


Hence, slave is 1 degree C hotter than master on both GUI & thermal images on edges.
With fan and inductors on top GUI reading 7 degrees C hotter than what I can capture on edges.

Model t1 thermal images continued:

No fan: 12.00Vin 3.884Ain 1.201Vout 35.01A
35A load master 17.1A 66 deg. C
Slave 18.2A 67 deg. C

IR-0041 60.4 deg. Top



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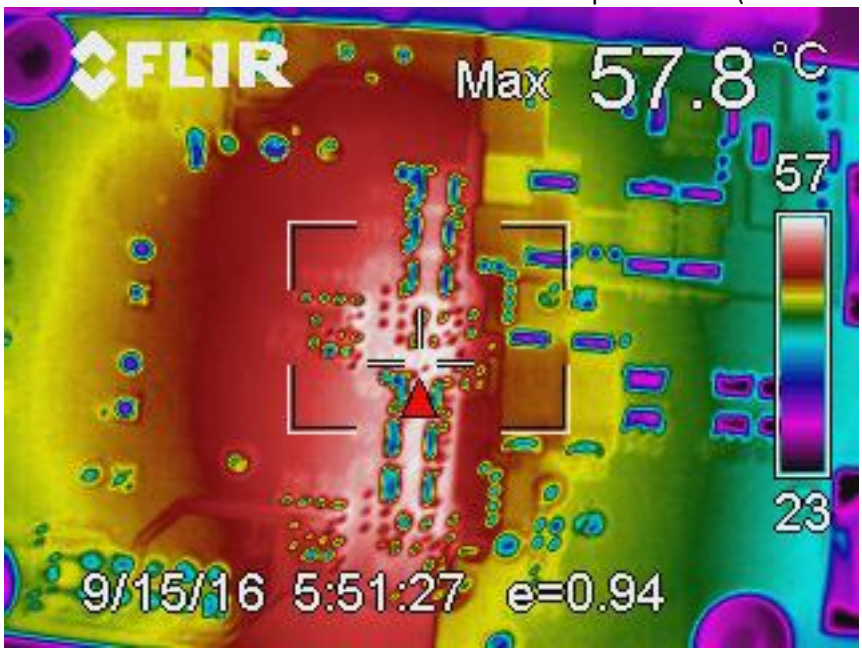
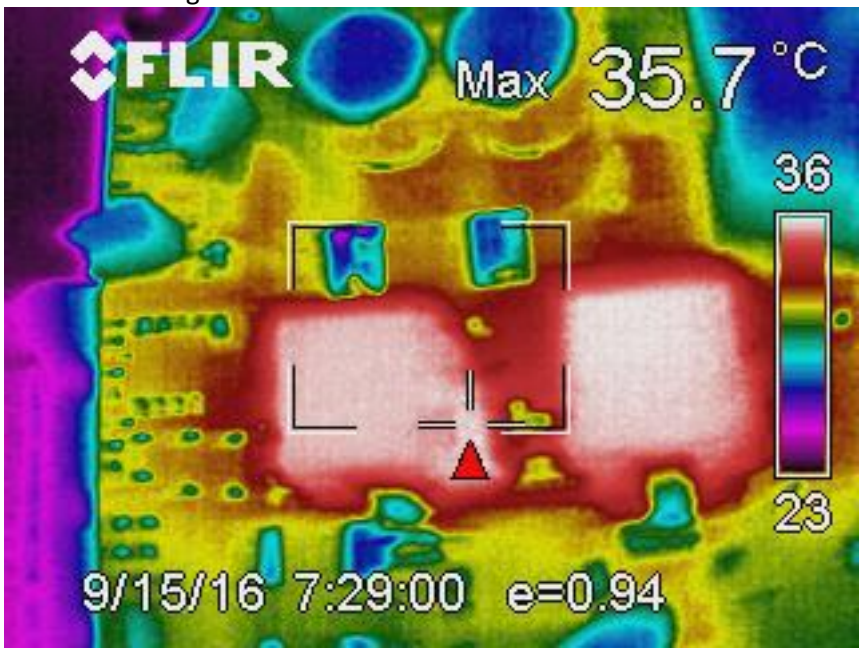
IR-0042 with 58 max bottom GUI 67 & 69 when upside down (17.1 & 18.2A same)



Q

Model t1 thermal images continued: No fan & No load:

Finally, no load and no fan with 12.0Vin 105mA in 1.2Vout model t1 IR0047 is 36 deg. C with no load no fan Both FETs read 35 on GUI



Q

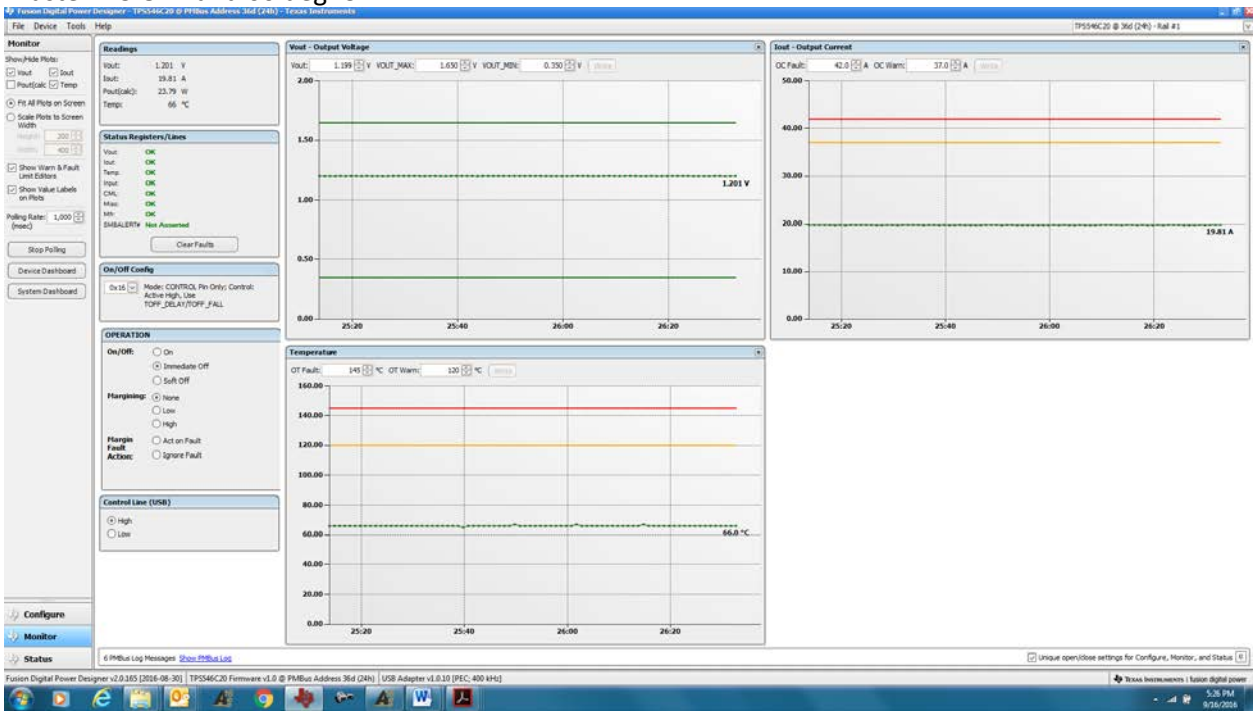
Thermal images: 40A load with No Fan: Model t2

GUI Images:

Model t2: 5Vin 40A no fan 5.006Vin 10.61ain 1.203Vout 40.07A

Slave: 67 deg. C and 19.25A

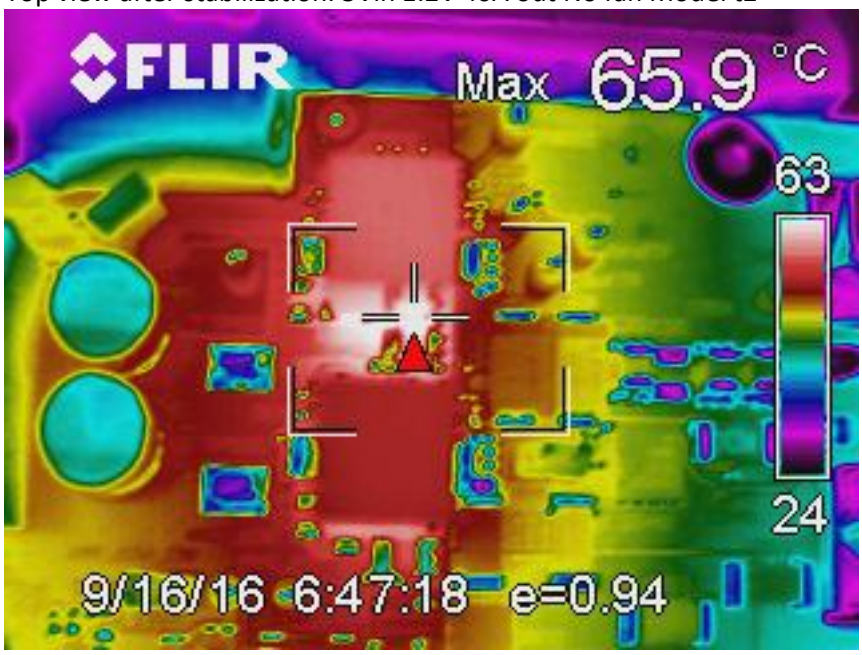
Master: 19.81A and 66 deg. C



Q

Thermal images: 40A load with No Fan: Model t2

Top view after stabilization: 5Vin 1.2V 40A out No fan Model t2



Q

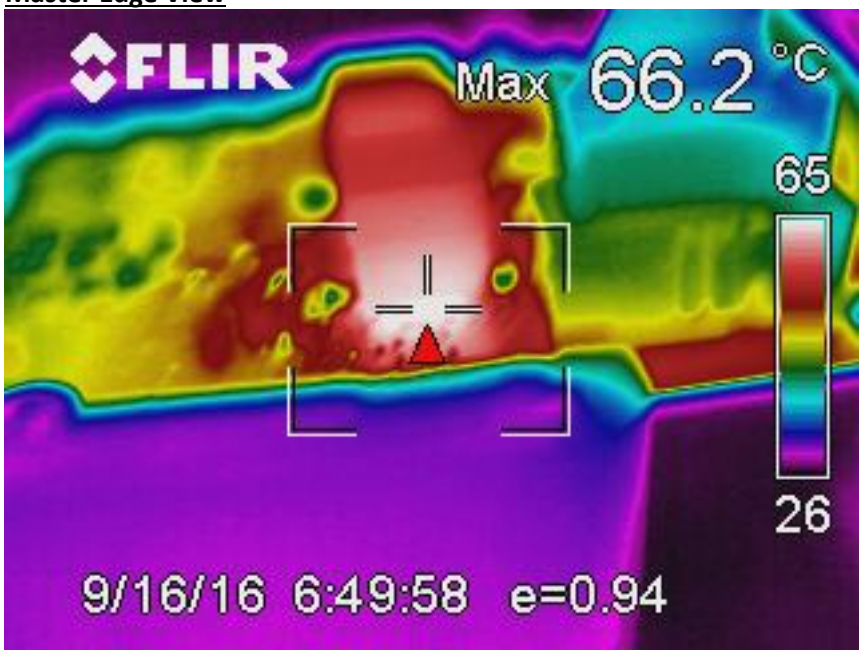
Thermal images: 40A load with No Fan: Model t2

Top side views after stabilization: 5Vin 1.2V 40A out No fan Model t2

Slave Edge View

Q

Master Edge View



Q

This points to master and slave TPS546C20As being within one degree Celsius of each other; except on the GUI the slave is one degree hotter 67 vs. 66 but with the Thermal Camera pictures on this page showing master to be one degree Celsius hotter than slave (66 vs. 65).

Efficiency data Model t3 5Vin

with ~1-2 Meter per second airflow model t3

Vin V	Iin A	Vout	Iout A	eff %	loss W
5.007	0.088	1.202	0.000	0.000	0.442
5.007	0.563	1.202	1.972	84.059	0.450
5.006	1.055	1.202	3.979	90.560	0.499
5.006	1.555	1.202	5.986	92.434	0.589
5.006	2.058	1.202	7.988	93.228	0.698
5.006	2.561	1.202	9.998	93.779	0.797
5.006	3.321	1.202	13.007	94.080	0.984
5.005	3.576	1.202	14.011	94.123	1.052
5.005	4.089	1.202	16.017	94.092	1.209
5.005	4.606	1.202	18.023	94.008	1.381
5.005	5.126	1.202	20.029	93.869	1.573
5.005	5.651	1.202	22.038	93.691	1.784
5.004	6.179	1.202	24.046	93.494	2.012
5.004	6.711	1.202	26.050	93.262	2.263
5.004	7.248	1.202	28.057	93.011	2.535
5.004	7.789	1.202	30.064	92.755	2.824
5.004	8.334	1.202	32.070	92.478	3.136
5.004	8.884	1.202	34.080	92.194	3.470
5.003	9.438	1.202	36.086	91.896	3.827
5.003	9.997	1.203	38.096	91.594	4.204
5.003	10.561	1.203	40.106	91.280	4.607
5.003	11.130	1.203	42.116	90.958	5.035
5.002	11.704	1.203	44.121	90.619	5.493
5.002	12.284	1.203	46.131	90.283	5.971
5.002	12.867	1.203	48.141	89.952	6.467
5.002	13.457	1.203	50.154	89.608	6.995
5.002	14.055	1.203	52.163	89.239	7.565
5.001	14.660	1.203	54.178	88.863	8.166
5.001	15.272	1.203	56.184	88.464	8.811
5.001	15.888	1.203	58.197	88.086	9.467
5.001	16.508	1.203	60.209	87.710	10.146

Q

Efficiency data continued:

Efficiency data Model t3 8Vin

with ~1-2 Meter per second airflow model t3

Vin V	Iin A	Vout	Iout A	eff %	loss W
8.004	0.100	1.202	0.000	0.000	0.797
8.003	0.400	1.202	1.975	74.087	0.830
8.003	0.710	1.202	3.981	84.188	0.899
8.003	1.024	1.202	5.985	87.795	1.000
8.003	1.340	1.202	7.991	89.555	1.120
8.003	1.654	1.202	9.996	90.737	1.226
8.003	1.969	1.202	12.002	91.525	1.336
8.003	2.285	1.202	14.008	92.037	1.457
8.003	2.604	1.202	16.015	92.342	1.596
8.003	2.925	1.202	18.021	92.526	1.749
8.003	3.247	1.202	20.027	92.621	1.918
8.002	3.572	1.202	22.035	92.633	2.106
8.002	3.899	1.202	24.040	92.598	2.310
8.002	4.228	1.202	26.045	92.516	2.532
8.002	4.559	1.202	28.053	92.408	2.770
8.002	4.893	1.202	30.059	92.263	3.029
8.002	5.229	1.202	32.065	92.097	3.307
8.002	5.568	1.202	34.076	91.916	3.602
8.002	5.909	1.202	36.082	91.711	3.919
8.001	6.253	1.202	38.090	91.498	4.254
8.001	6.599	1.202	40.098	91.273	4.608
8.001	6.948	1.202	42.107	91.031	4.986
8.001	7.301	1.202	44.114	90.773	5.390
8.001	7.655	1.202	46.125	90.514	5.810
8.001	8.013	1.202	48.135	90.245	6.254
8.001	8.375	1.202	50.145	89.962	6.726
8.001	8.739	1.202	52.158	89.668	7.224
8.000	9.106	1.202	54.170	89.380	7.737
8.000	9.478	1.202	56.179	89.059	8.296
8.000	9.853	1.202	58.190	88.737	8.878
8.000	10.233	1.202	60.204	88.406	9.491

Q

Efficiency data continued:

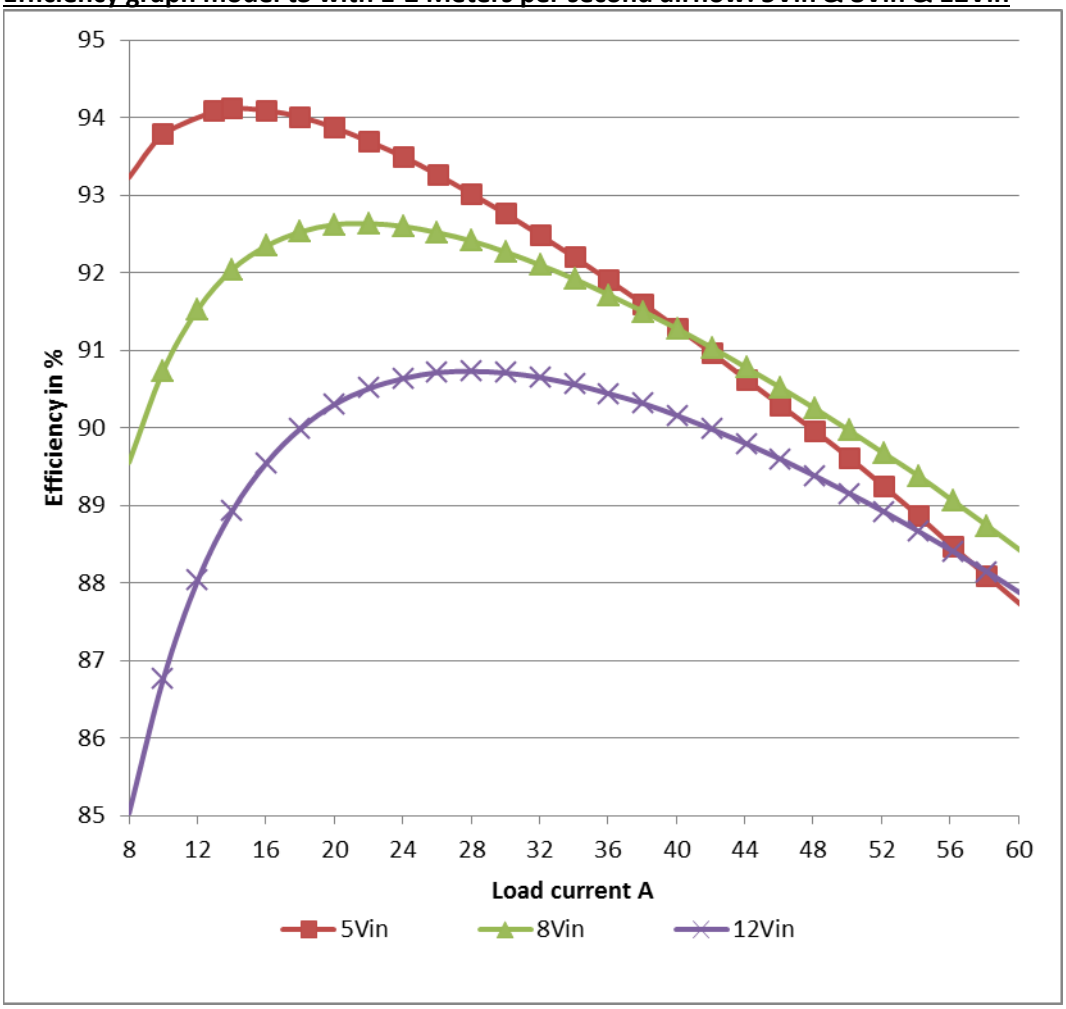
Efficiency data Model t3 12Vin

with ~1-2 Meter per second airflow model t3

Vin V	Iin A	Vout	Iout A	eff %	loss W
12.003	0.105	1.202	0.000	0.000	1.262
12.003	0.308	1.202	1.985	64.465	1.315
12.003	0.518	1.202	3.989	77.142	1.420
12.003	0.730	1.202	5.993	82.245	1.555
12.003	0.942	1.202	7.997	85.031	1.692
12.003	1.154	1.202	10.003	86.766	1.834
12.003	1.366	1.202	12.008	88.031	1.962
12.003	1.578	1.202	14.013	88.921	2.098
12.003	1.791	1.202	16.021	89.545	2.248
12.002	2.006	1.202	18.027	89.990	2.410
12.002	2.221	1.202	20.032	90.303	2.585
12.002	2.438	1.202	22.038	90.507	2.778
12.002	2.656	1.202	24.043	90.636	2.986
12.002	2.875	1.202	26.048	90.714	3.205
12.002	3.097	1.202	28.055	90.728	3.446
12.002	3.319	1.202	30.063	90.707	3.702
12.002	3.543	1.202	32.067	90.649	3.976
12.002	3.769	1.202	34.076	90.557	4.271
12.002	3.996	1.202	36.083	90.439	4.585
12.002	4.224	1.202	38.092	90.311	4.912
12.002	4.455	1.202	40.101	90.154	5.265
12.002	4.687	1.202	42.108	89.980	5.637
12.001	4.921	1.202	44.116	89.793	6.028
12.001	5.157	1.202	46.125	89.594	6.440
12.001	5.395	1.202	48.136	89.378	6.877
12.001	5.635	1.202	50.148	89.150	7.337
12.001	5.876	1.202	52.158	88.916	7.816
12.001	6.120	1.202	54.171	88.665	8.326
12.001	6.366	1.202	56.184	88.407	8.857
12.001	6.614	1.202	58.194	88.141	9.413
12.001	6.866	1.202	60.211	87.856	10.006

Q

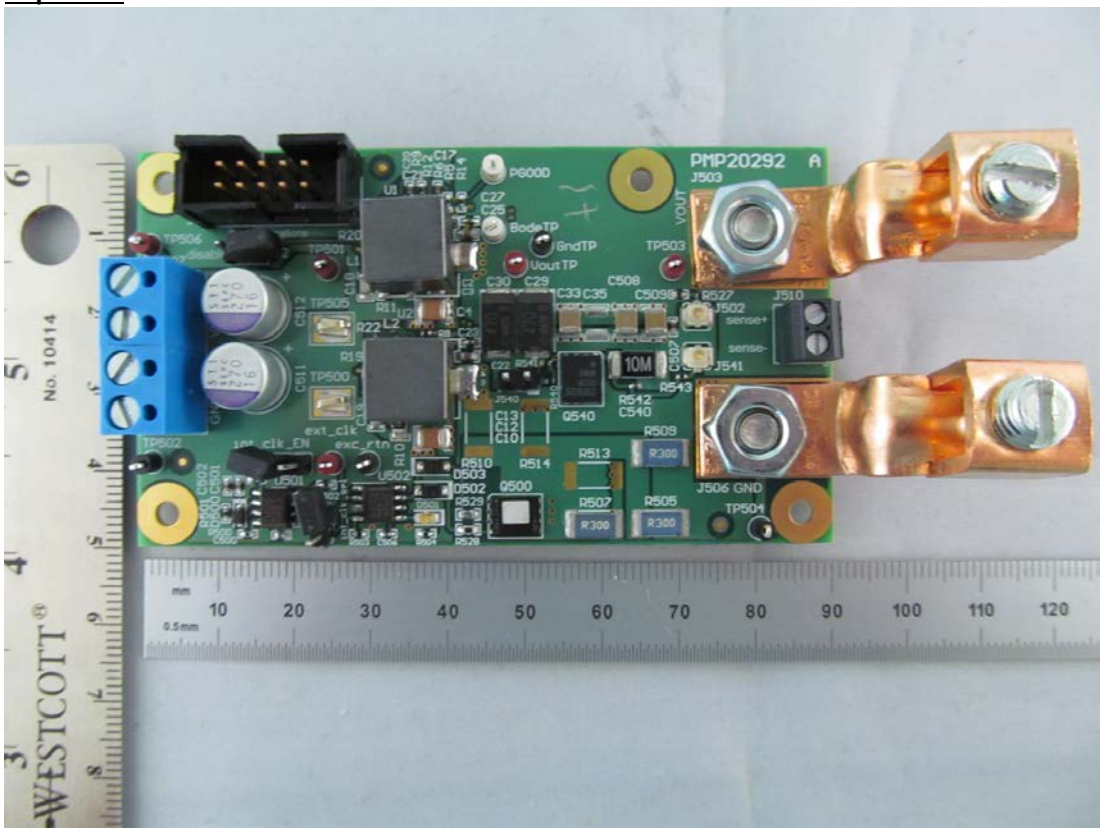
Efficiency graph model t3 with 1-2 Meters per second airflow: 5Vin & 8Vin & 12Vin



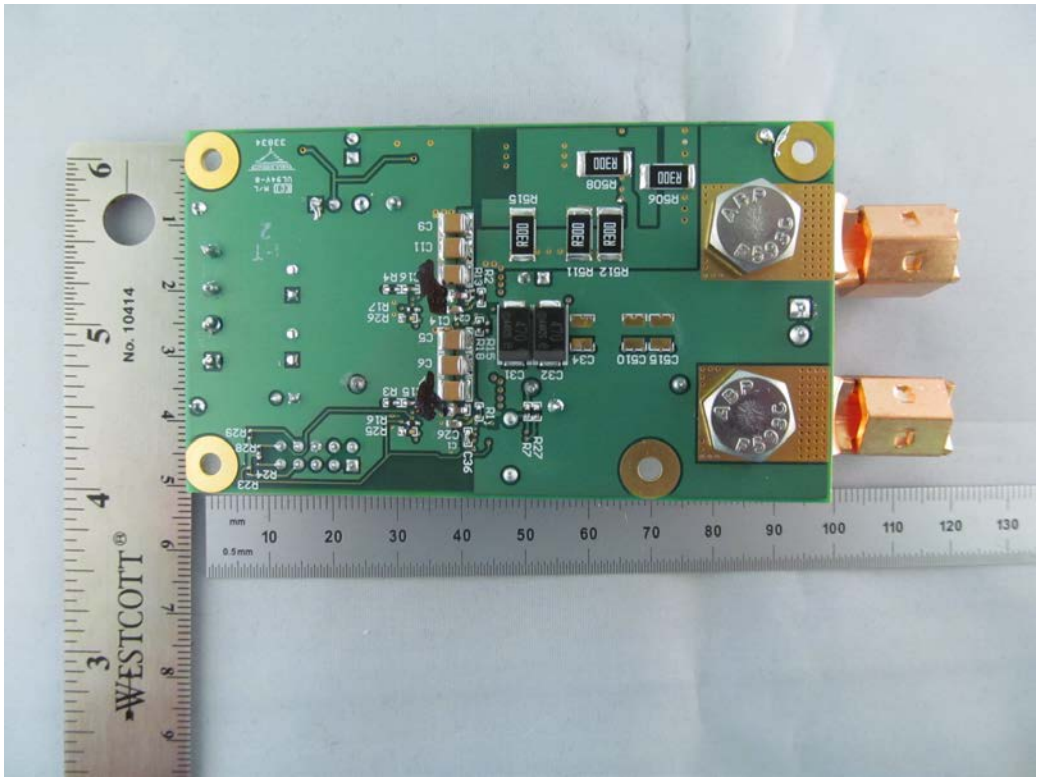
Q

Board assembly images:

Top view:

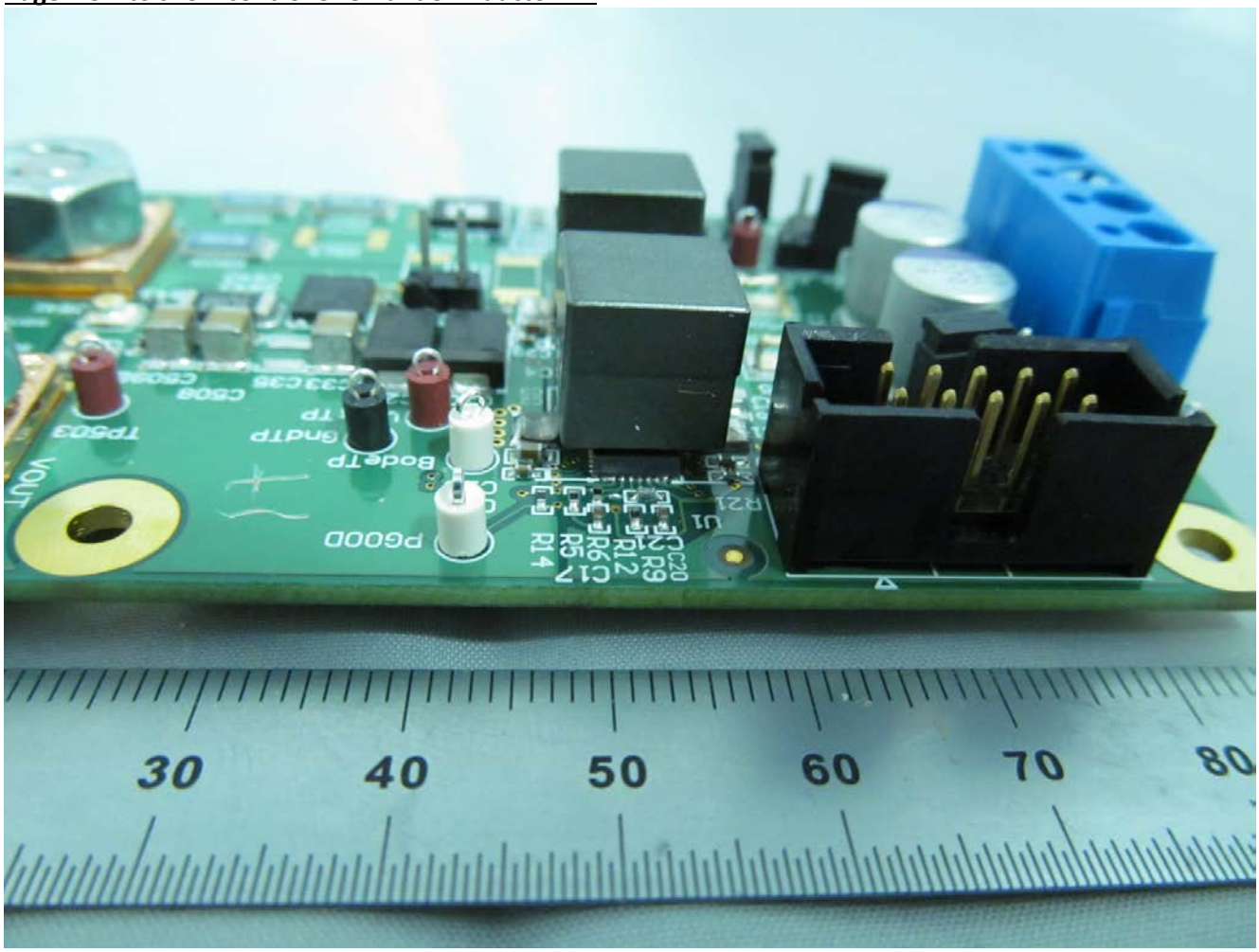


Bottom view:



Board images continued:

Edge view to show controller U1 under inductor L1:



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