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Notes:
To allow 10 A out of the BQ24745 converter instead of 8 A, the Battery current sense (R17 in schematic) was changed from 10 mOhms to 8 mOhms. Hence, battery current limit settings from the BQ24745 GUI need to be multiplied by 1.25. Input current sense R1 is at standard 10 mOhms. Hence, GUI input current settings are correct.

Q7 must be mounted with metal tab away from J5.
Q7 silkscreen on rev A PCB is not clear enough.

Limitations: Currents above 8A charging off 24Vin will need airflow as Q5 rises 50 deg. C above ambient at 8A current and no fan.

For lower charging voltage applications, such as single Li-ion cells:
"Fixed" current limit of about 3 A for Vout below 4 V in the BQ24745 becomes about 3.75 A. This protection limit was put in for multi-cell applications that the BQ24745 targeted; but does limit charging current during most of the recharge of single Li-ion cell applications where battery voltage is below 4V. Increasing current limit in such applications beyond this 3.75A will have limited effect in speeding up overall charging, as most of current limited charging occurs with battery less than 4V. For the testing shown here 5A was targeted to show transition out of the "3.75A mode".

When Vout less than 4V charging limited to 3A/(0.8) or 3.75A nominal and 3.70A on model t1. When battery V rose slightly above 4.0V, charging current increased to full 4.1A / (0.8) or 5A.

Battery discharge FET Q7 conduction verified on all 3 models with load resistance connected to J5 adjusted to target about 5 A:

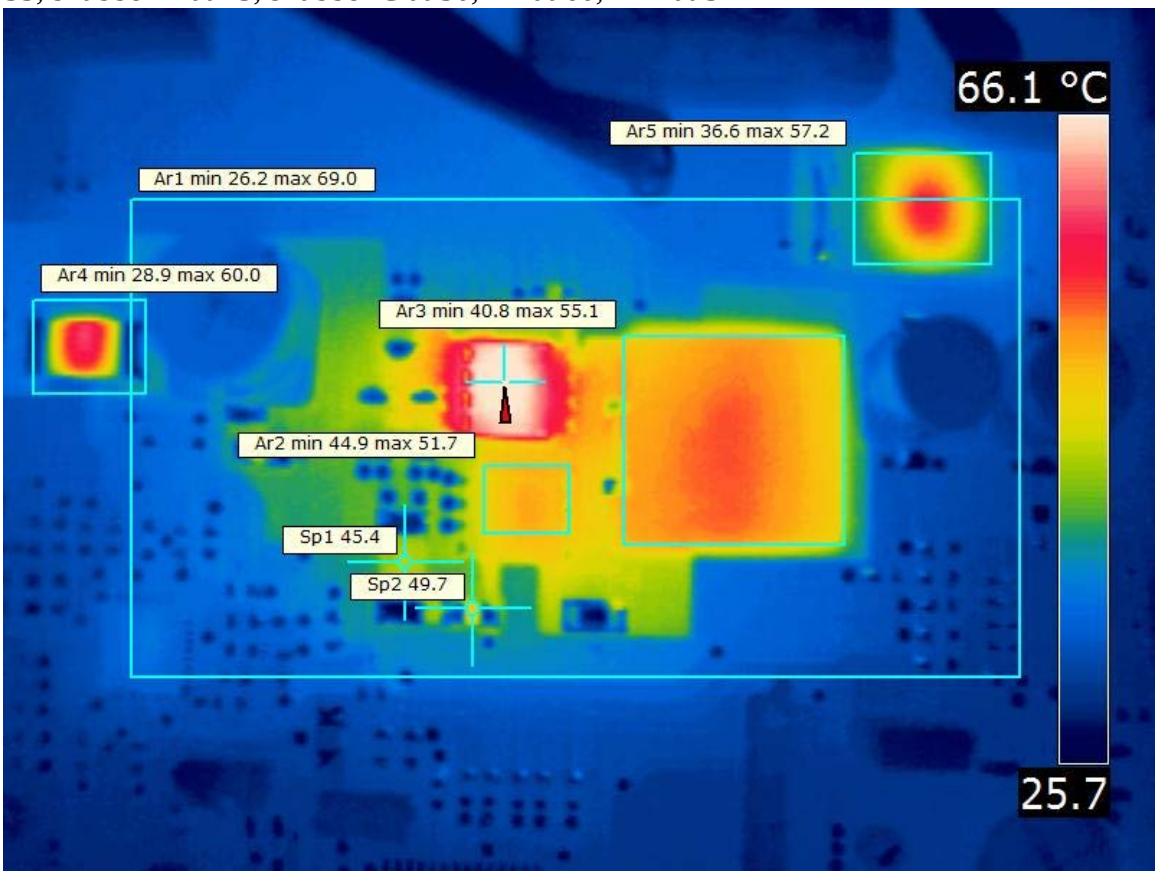
Battery discharge on model t1: 5.23A at 131mV across Q7.
Battery discharge on model t2: 5A at 120mV across Q7.
Battery discharge on model t3: 5.1A at 120mV across Q7.

BQ24745 converter with ~200 LFM airflow:
Efficiency and Losses: model t2: 24.0 Vin, Vout set at 12.6V
For efficiency & loss calculations I have subtracted out from the measured Iin values shown here, the 26mA drawn by 5V4A converter off the 24V
forced air about 200 LFM *italicized with R9 = 24.9*, else R9 = 15. R9 is gate drive resistor.

Vin Volts	Iin A	Vout Volts	Iout A	% Effi ciency	Losses in W	comments
24.09	*0.002*	*all*	*off*			*5V inhibited*
24.09	*0.028*	*only*	*5V on*			
24.09	*0.030*	*<1V*	*0*			*I chrg set 0*
24.09	*0.0455*	*4.215*	*0*			*4.208Vset*
24.09	*0.0605*	*12.62*	*0*			*12.608 set*
24.025	*5.420*	*12.227*	*9.968*	94.0	7.712	
24.07	5.455	12.347	9.968	94.2	7.601	
24.07	5.433	12.296	9.965	94.1	7.617	Ir469 69 max on Q5
24.08	5.437	12.503	9.814	94.2	7.592	
24.09	5.305	12.615	9.516	94.4	7.127	
24.06	5.023	12.618	9.006	94.5	6.590	
24.09	4.730	12.617	8.501	94.7	6.062	
24.07	4.457	12.618	8.009	94.8	5.597	
24.06	4.862	11.052	9.870	93.8	7.271	
24.03	4.374	10.008	9.750	93.4	6.904	
24.07	3.900	9.021	9.616	93.0	6.501	
24.07	3.902	12.617	7.019	94.9	4.737	
24.05	3.341	12.618	6.009	95.1	3.904	
24.04	2.7905	12.617	5.006	95.0	3.298	
24.095	2.234	12.618	4.002	94.9	2.705	
24.045	1.6957	12.618	3.003	94.4	2.256	
24.035	1.1520	12.6175	2.0035	93.4	1.784	
24.085	0.6060	12.620	1.0013	90.5	1.333	
24.08	0.3295	12.622	0.5013	86.6	0.981	
24.11	0.0605	12.622	0	0.0	0.832	
24.11	0.0277	off				

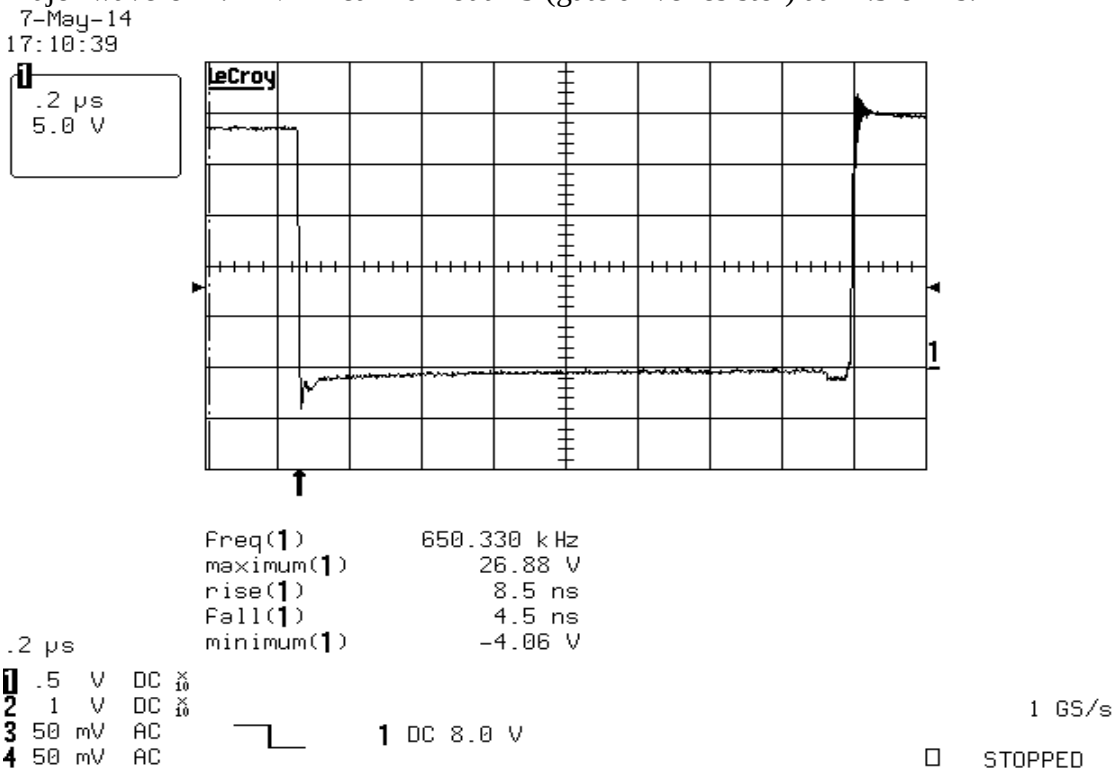
Model t2: (models t1& t3 went for software integration) 305kHz actual vs. 300kHz target at 10A out

Thermal Image at near max current with airflow:
PMP9668A model t2 charger 305kHz 24.07Vin 12.296Vout 9.965Aout 7.617W diss in charger ~200 LFM airflow 21-23 deg. C ambient Q5 at 69, Q6 at 52, inductor top 55, snubber R at 45, snubber C at 50, R1 at 60, R17 at 57



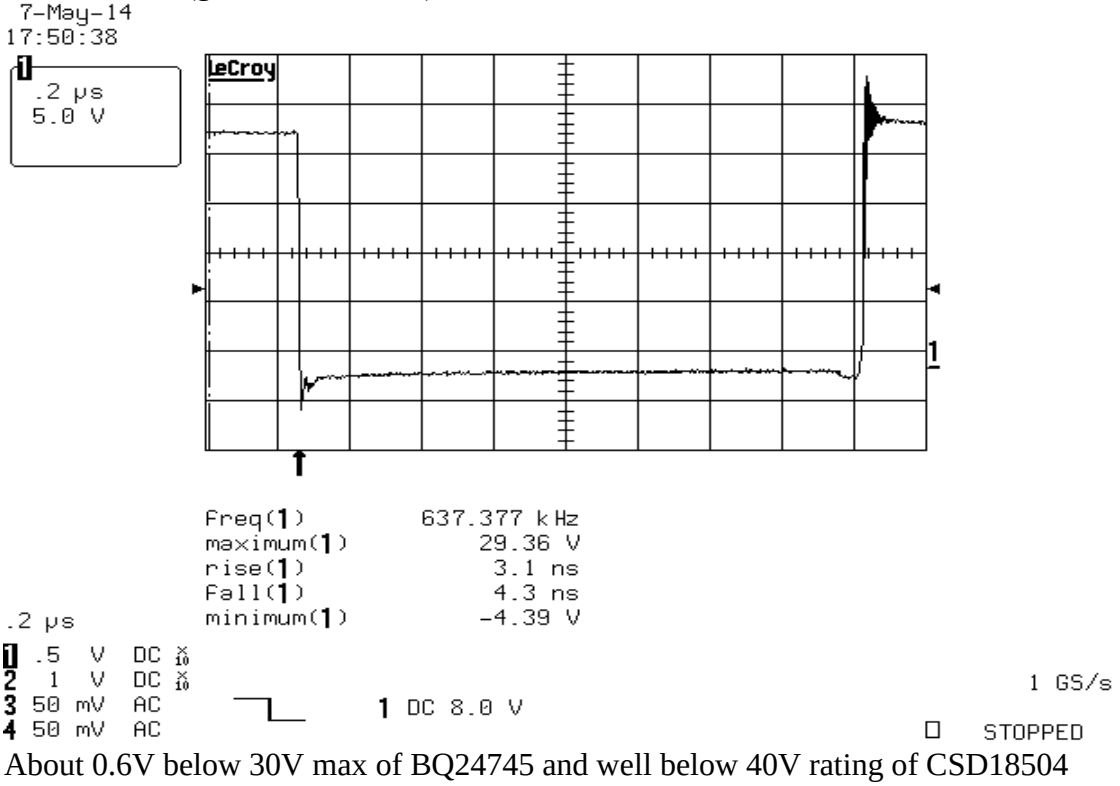
Q

Major waveform: 24Vin near 10A out R9 (gate drive resistor) at 24.9 ohms:



About 3V below 30V max of BQ24745 and well below 40V rating of CSD18504

Same, but R9 (gate drive resistor) at 15 ohms:



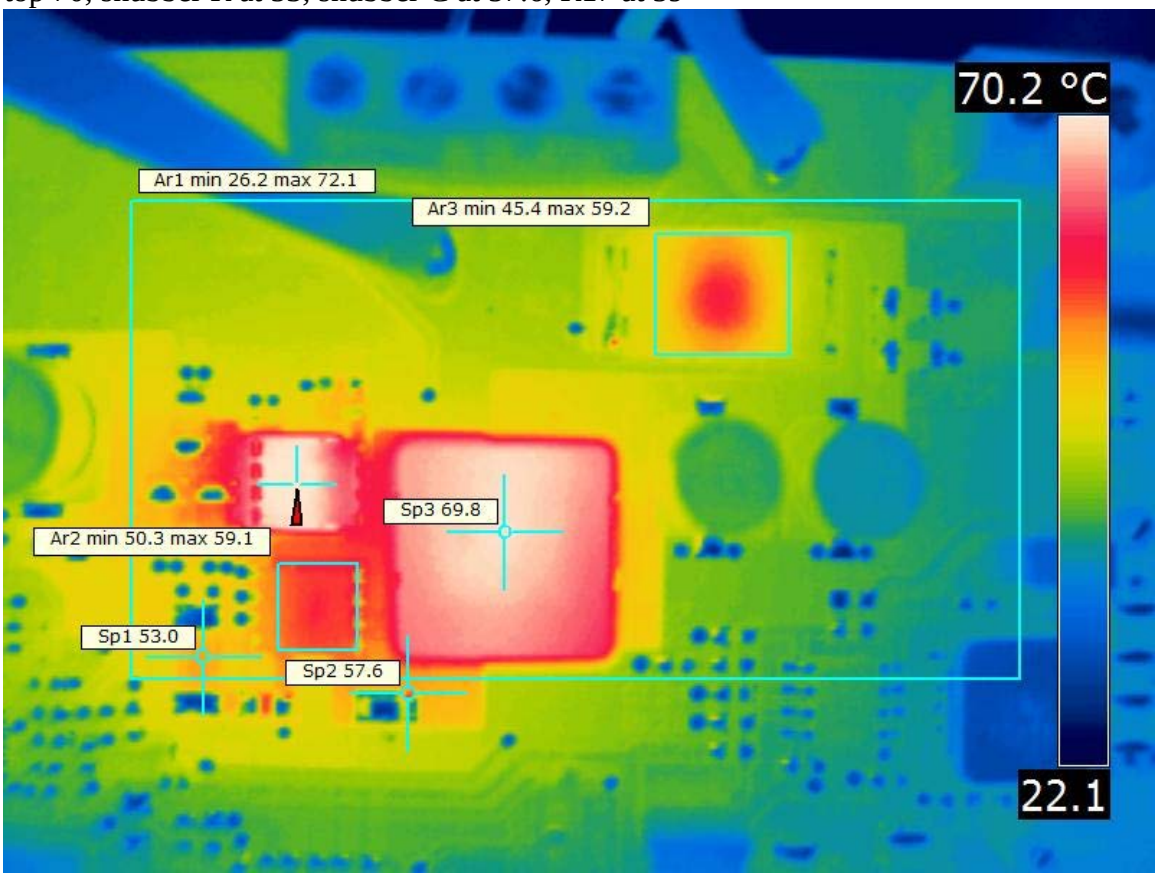
About 0.6V below 30V max of BQ24745 and well below 40V rating of CSD18504

BQ24745 converter with no forced airflow: 8 A max here
Efficiency and Losses: model t2: 24.0 Vin, Vout set at 12.6V
For efficiency & loss calculations I have subtracted out from the measured Iin values shown here, the 26mA drawn by 5V4A converter off the 24V
No forced air R9 = 15 max I will target 8A or 6400mA divided by 0.8

Vin Volts	Iin A	Vout Volts	Iout A	% Effi ciency	Losses in W	comments
24.06	4.3155	12.453	7.847	94.7	5.487	IR470 20 min 72max
24.07	4.200	12.001	7.916	94.6	5.468	
24.07	3.871	11.012	7.916	94.2	5.378	
24.10	3.532	10.010	7.916	93.8	5.255	
24.02	3.100	9.003	7.669	93.5	4.793	
24.05	4.346	12.439	7.911	94.7	5.491	Vds on Q6 28.6Vmax
24.05	4.284	12.604	7.702	94.8	5.329	
24.07	4.171	12.619	7.4985	94.8	5.147	
24.06	3.898	12.621	7.007	94.9	4.725	
24.04	3.343	12.621	6.007	95.1	3.926	
24.09	2.784	12.621	5.004	95.1	3.285	
24.01	2.245	12.621	4.007	94.9	2.706	
24.065	1.6952	12.621	3.002	94.3	2.281	
24.005	1.1530	12.621	2.0015	93.4	1.793	
24.05	0.6071	12.622	1.0014	90.4	1.336	
24.08	0.3290	12.623	0.4995	86.4	0.991	
24.10	0.0604	12.623	0	0.0	0.829	

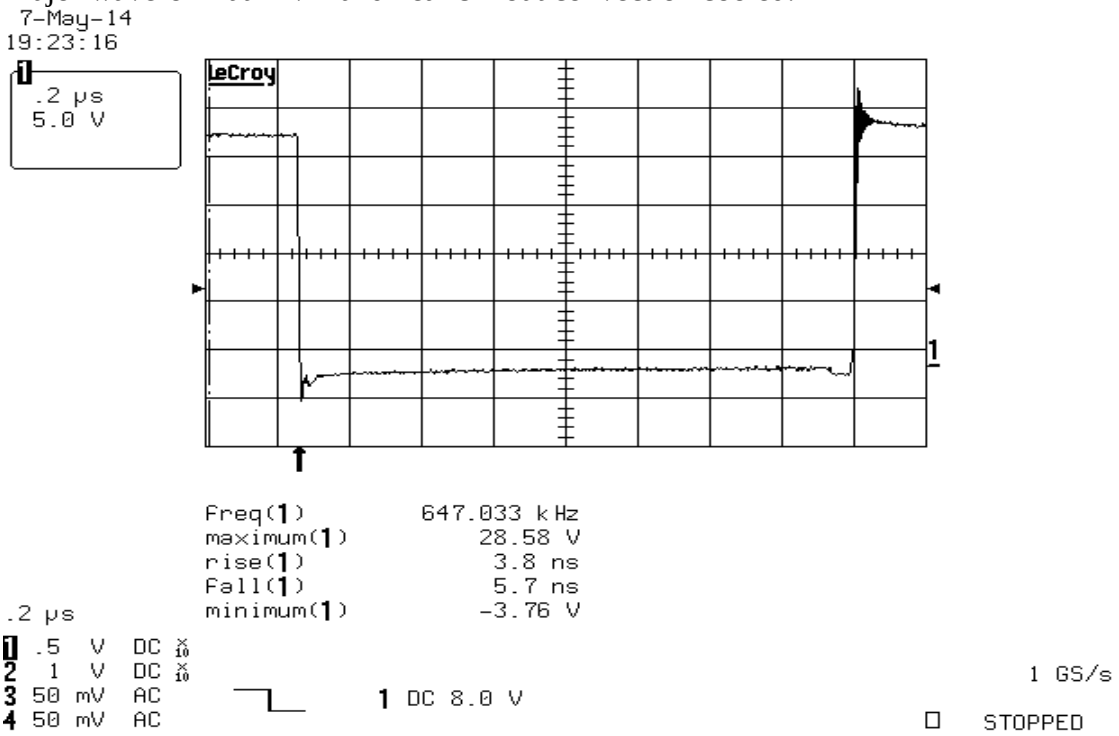
Model t2: (model t1 went for software integration) 305kHz actual vs. 300kHz target at 8A out

PMP9668A model t2 charger 305kHz 24.06Vin 12.453Vout 7.847Aout 5.487W dissipation in charger convection only 21-23 deg. C ambient Q5 at 72, Q6 at 59, inductor top 70, snubber R at 53, snubber C at 57.6, R17 at 59



q

Major waveform at 24vin and near 8A out convection cooled:



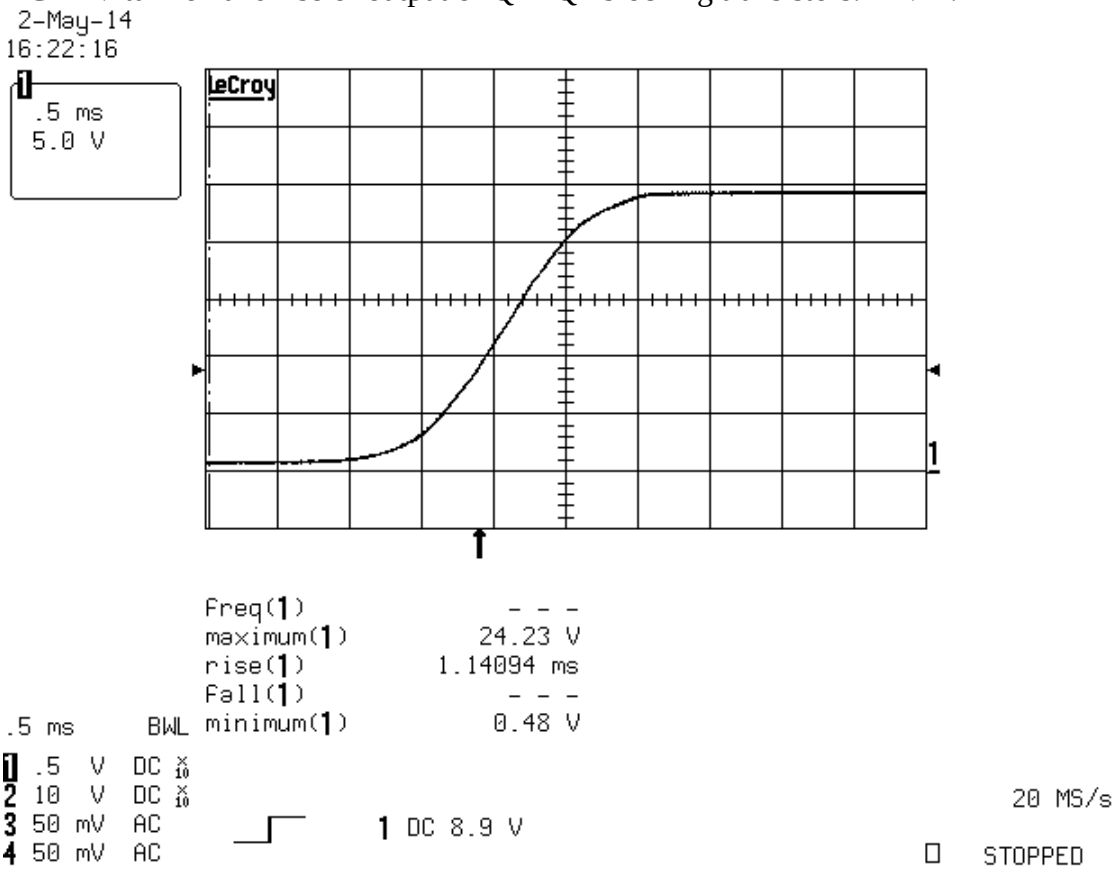
About 1.5V below 30V max of BQ24745 and well below 40V rating of CSD18504

Efficiency and Losses: model t2: 24.0 Vin, Vout set at 4.208V
For efficiency & loss calculations I have subtracted out from the measured Iin values shown here, the 26mA drawn by 5V4A converter off the 24V
No forced air R9 = 15 max I will target 5A or 4096mA divided by 0.8

Vin Volts	Iin A	Vout Volts	Iout A	% Effi ciency	Losses in W	comments
24.09	0.044	4.215	0	0.0	0.434	
24.06	0.997	4.159	5.035	89.6	2.422	Max Iin 52 degC hotspot
24.06	0.990	4.100	5.065	89.5	2.427	
24.06	0.969	3.997	5.074	89.4	2.408	
24.06	0.935	3.838	5.076	89.1	2.389	Falling drops as Vout drops below 3.83V
24.01	0.6375	3.552	3.646	88.2	1.732	3A/0.8 mode
24.02	0.552	3.006	3.647	86.8	1.672	3A/0.8 mode
23.99	0.942	3.861	5.079	89.2	2.365	Just b4 3A/0.8 mode
24.01	0.707	3.998	3.643	89.1	1.786	3A/0.8 mode
24.03	0.487	2.592	3.648	85.4	1.622	3A/0.8 mode
24.025	0.9855	4.201	4.928	89.8	2.349	
24.03	0.9063	4.213	4.507	89.8	2.166	
24.04	0.8099	4.213	4.007	89.6	1.963	
24.06	0.6186	4.214	3.006	88.8	1.591	
24.075	0.4313	4.214	2.000	86.4	1.330	
24.09	0.2407	4.215	1.002	81.7	0.949	
24.06	0.1558	4.215	0.5000	67.5	1.015	
24.07	0.0433	4.214	0	0.0	0.416	
24.05	0.238	1.397	2.042	56.0	2.246	

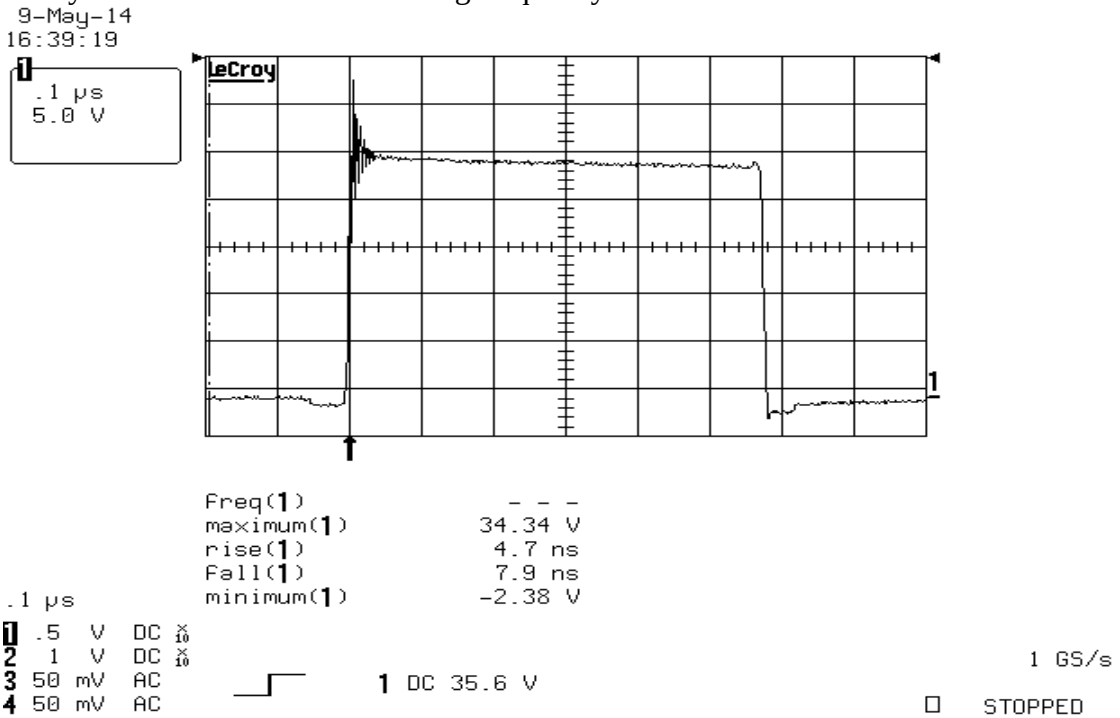
Model t2: (model t1 went for software integration) 305kHz actual vs. 300kHz target at 5A out
Enters 3A/0.8 mode on Vout falling below 3.84V and exits it at 4.03V rising.
Short circuit current for Vout less than 2.49V falling or 2.7V rising is in 1.3 to 2.1A range.

ACDRV turn on and rise of output of Q1 –Q2 blocking transistors: 24Vin:



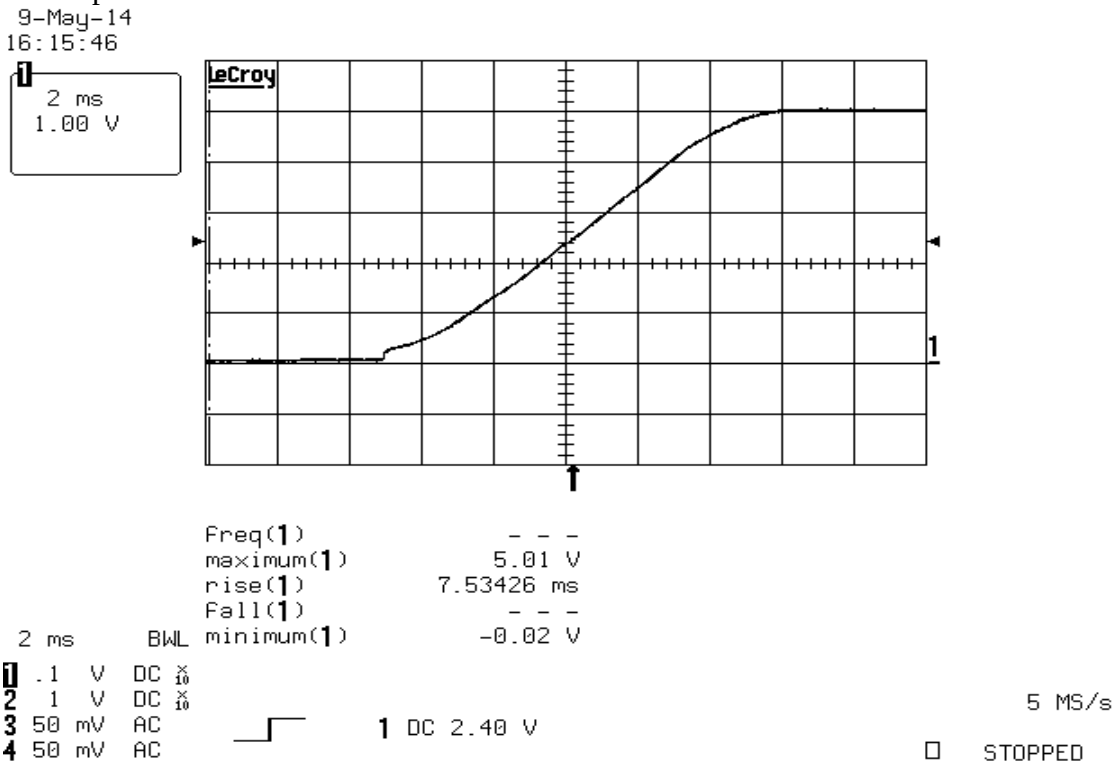
Qq

5V4A testing: R107 updated from zero to 5.1 to reduce peak Vds stress on Q102 from nearly 39V to under 35V: Switching frequency 376kHz



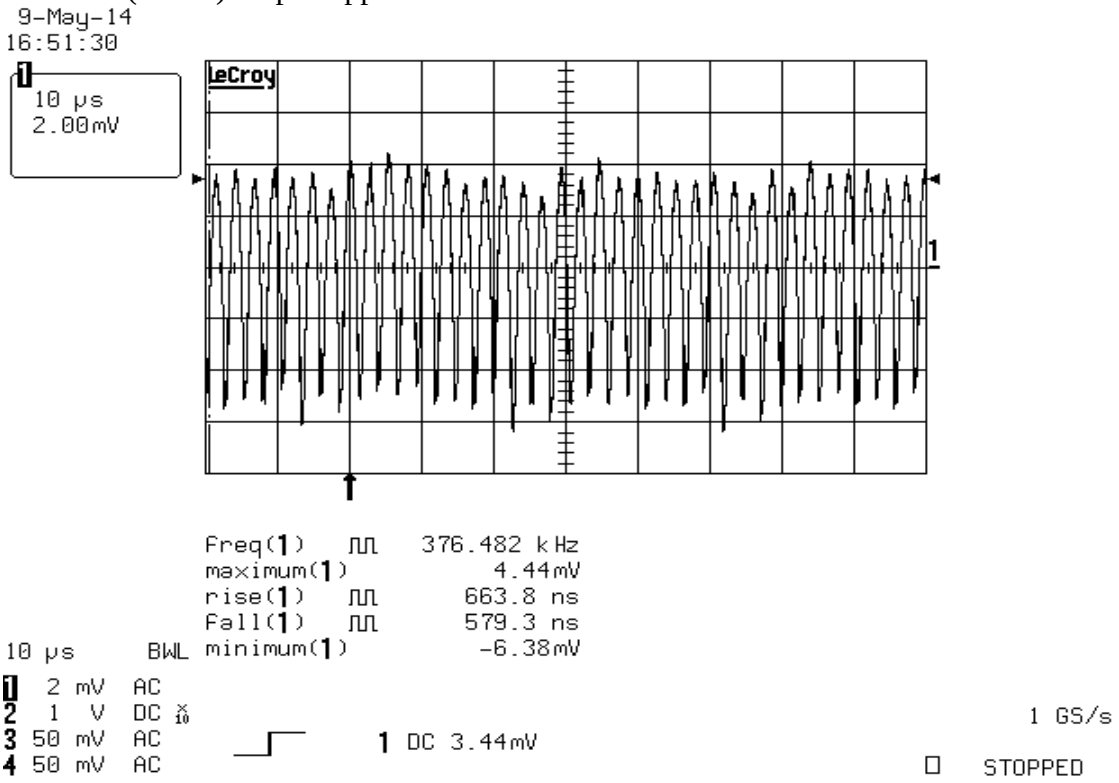
Q

5V output from Enable 24Vin no load



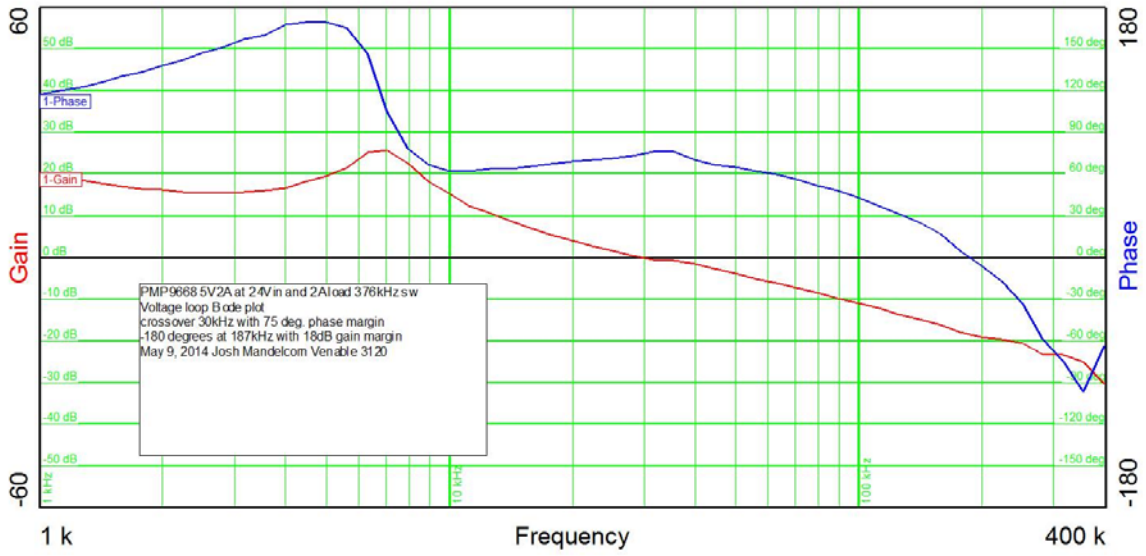
~10 msec rise with no overshoot

5V4A testing (cont.)
Full load (4.08A) output ripple of 24Vin



Q

Bode plot of 5V4A control loop done at 2A load of 24Vin



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5V4A efficiency & losses: 24Vin, 376kHz switching on model t2 after R107 changed to 5.1 ohms; 2mA of input current already subtracted out as due to other circuits
No fans; full load hotspot just under 50 degrees C per Thermal camera
Converter is fixed frequency without light load reduced frequency / conduction.

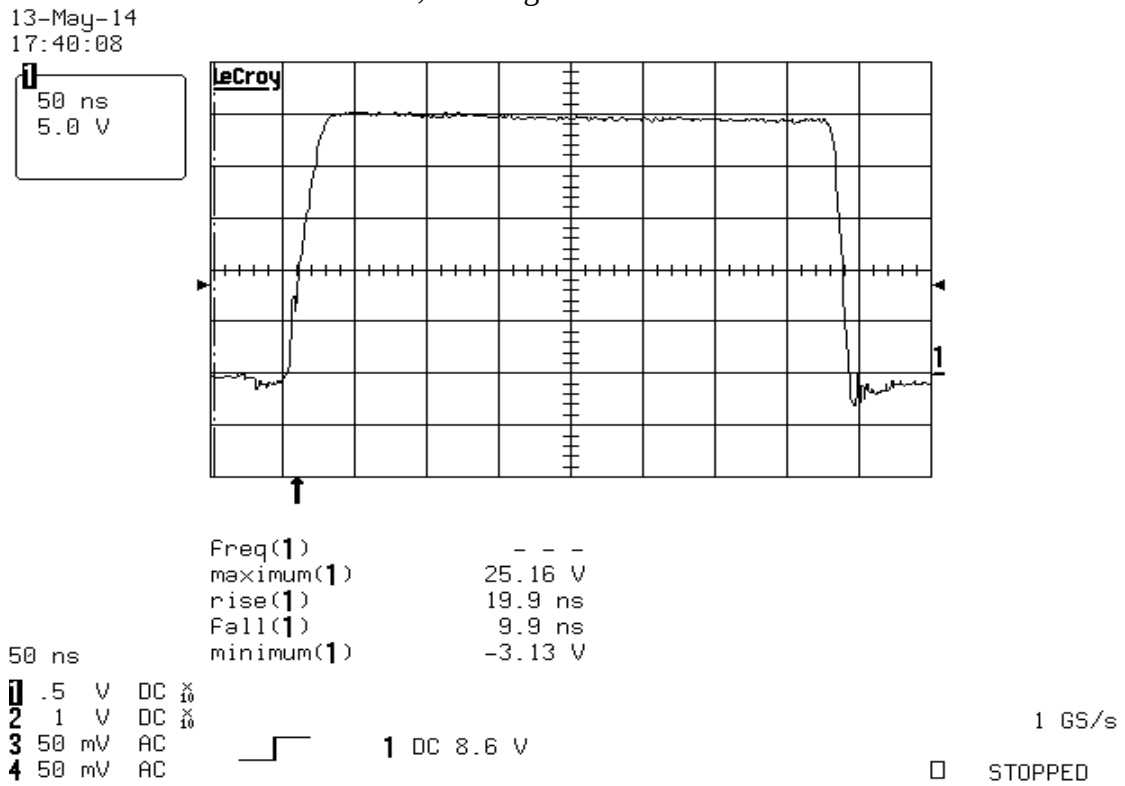
Vin Volts	Iin A	Vout Volts	Iout A	% Effi ciency	Losses in W	comments
24.08	0.9327	4.928	4.084	89.6	2.333	
24.05	0.6832	4.924	3.000	89.9	1.659	
24.07	0.4587	4.918	2.001	89.1	1.200	
24.09	0.2413	4.920	1.001	84.7	0.888	
24.10	0.1342	4.957	0.500	76.6	0.756	
24.11	0.0252	4.960	0	N/A	0.608	

Q

5V or 12V at 2A aux output off 24Vin:
efficiency & losses: 24Vin, 583kHz switching on model t2 with other converters inhibited; 2mA of input current already subtracted out as due to other circuits (mostly BQ24745 and related circuits)
No fans; full load hotspot on TPS54335DDA 45 degrees C per Thermal camera, inductor top about 30 degrees C pointing to low core losses in Vishay part
Converter is with light load reduced frequency / conduction.

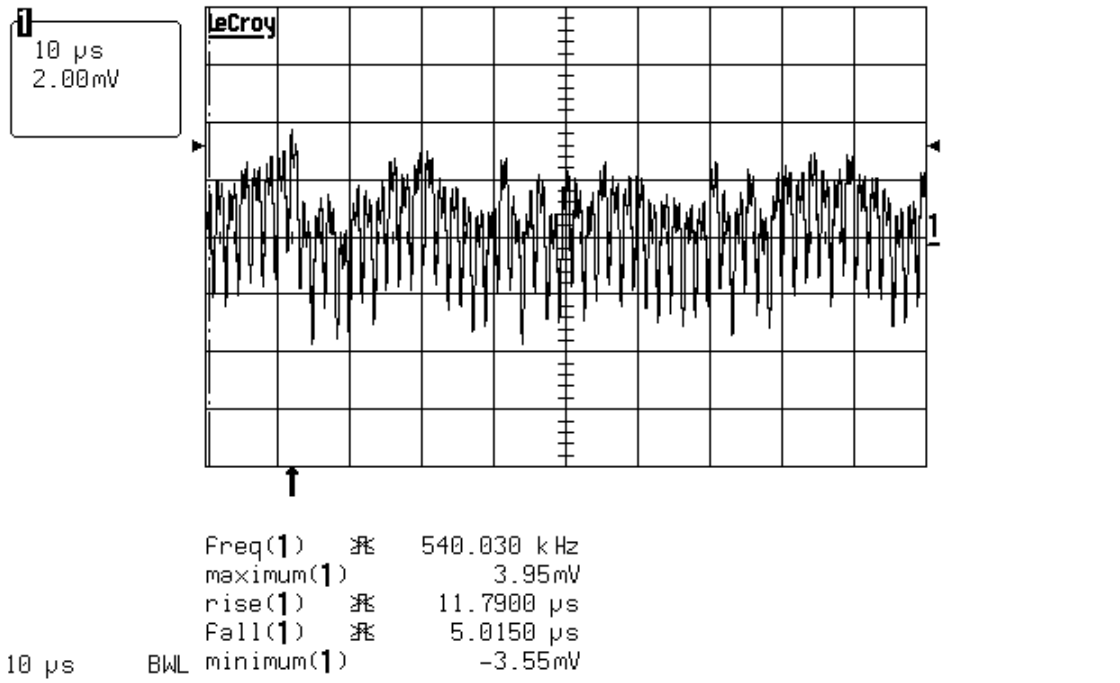
Vin Volts	Iin A	Vout Volts	Iout A	% Effi ciency	Losses in W	comments
24.06	1.0598	11.884	2.0145	93.9	1.558	
24.09	0.7850	11.892	1.501	94.4	1.061	
24.03	0.5238	11.900	1.001	94.6	0.675	
24.055	0.2635	11.908	0.5001	94.0	0.383	
24.08	0.0004	11.918	0	N/A	0.010	
24.03	0.4747	4.975	2.013	87.8	1.392	
24.05	0.3495	4.978	1.500	88.8	0.938	
24.06	2.330	4.982	1.000	88.9	0.624	
24.07	0.1169	4.985	0.5026	89.0	0.308	
24.08	0.0003	4.991	0	N/A	0.007	

Q
Major waveform 24Vin 5Vout at 2A 583kHz operation:
12Vout at 2A similar waveform, but longer on time



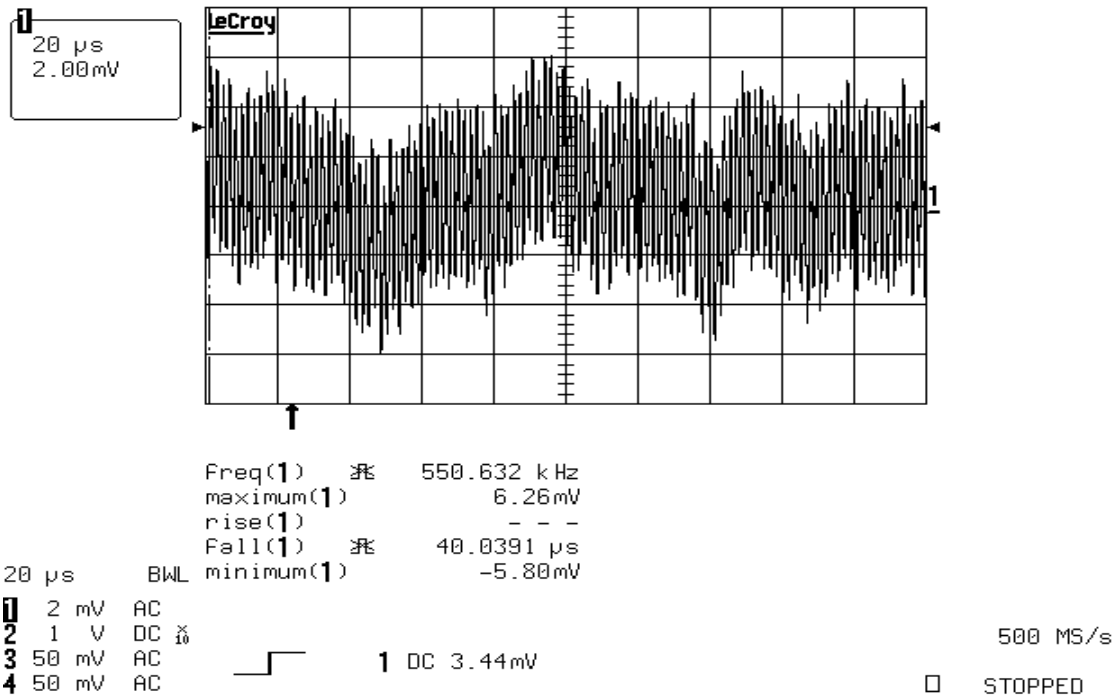
Qq

5V 2A output ripple at full load at output cap – 24Vin: TPS54335DDA

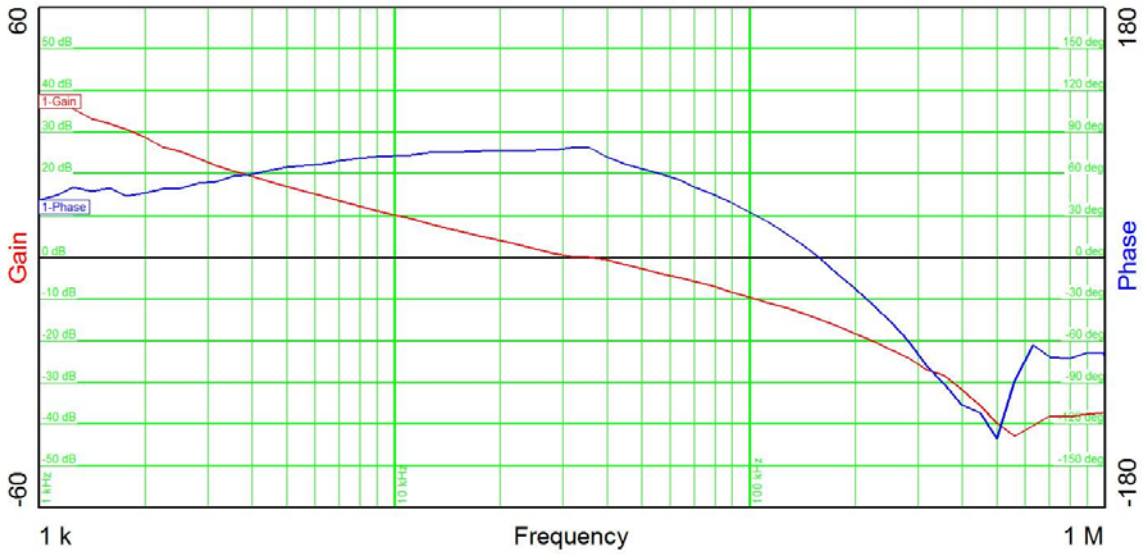


Qq

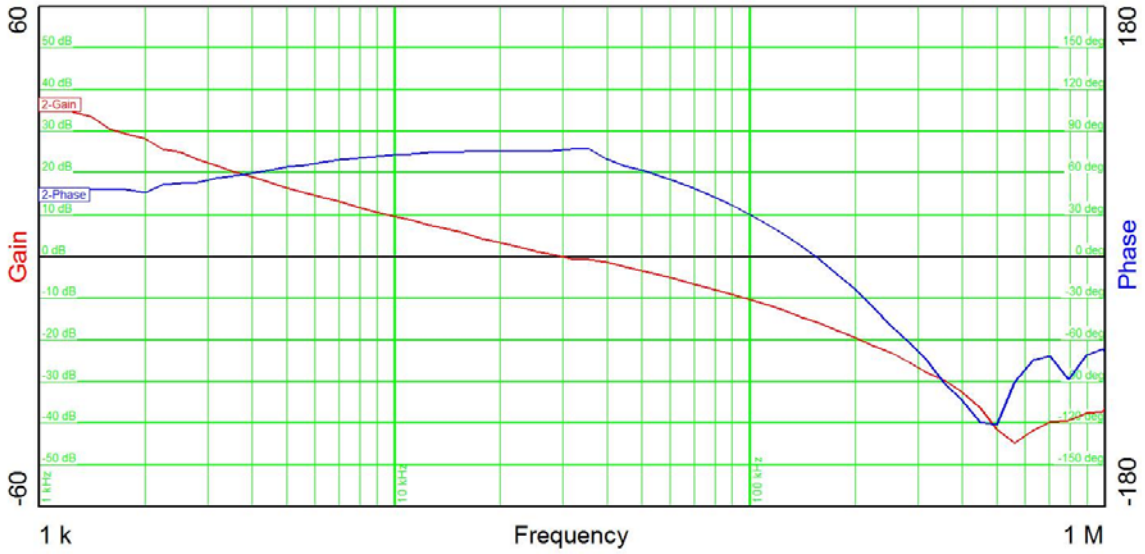
12V 2A output ripple at full load at output cap – 24Vin:



Bode plots: 24Vin 583kHz actual switching frequency TPS54335DDA
5V setting load 1 A

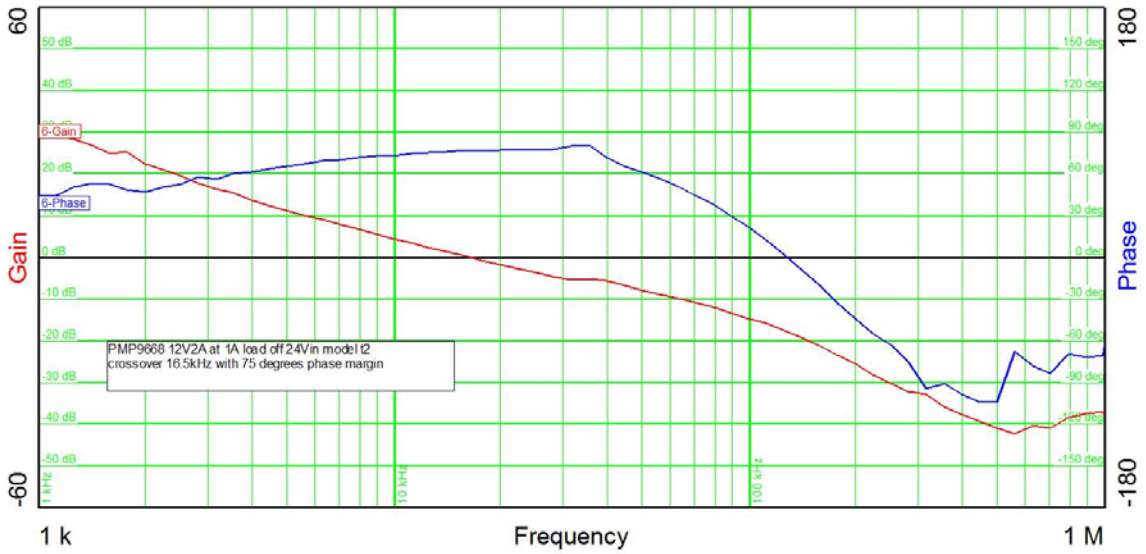


5V setting load 2 A

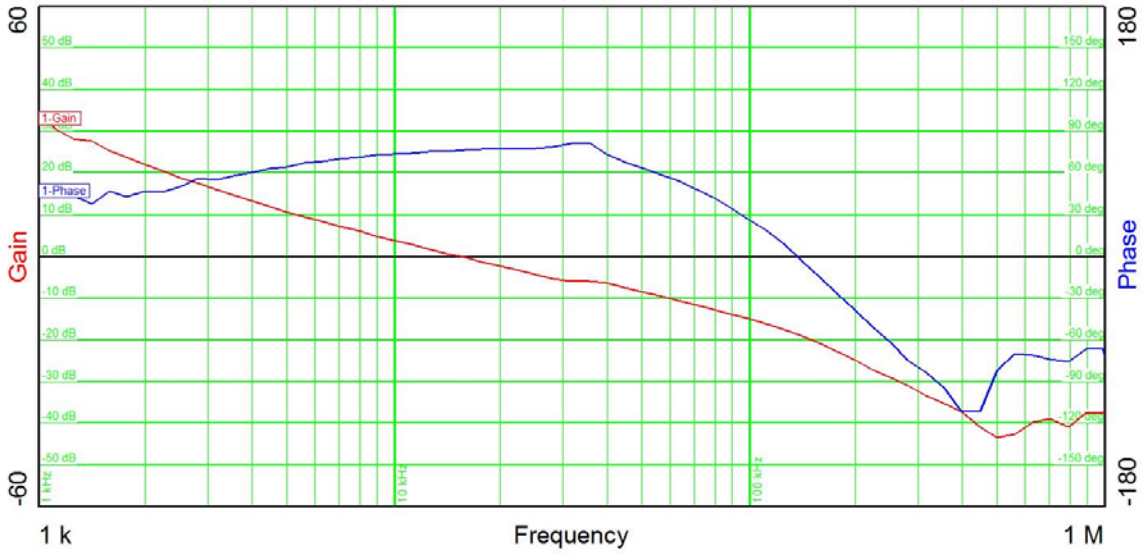


qq

Bode plots for 12V setting: TPS54335DDA
Load 1 A



Load 2 A



Qq

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