PMP15032 Test Results

Test Data

PMP15032

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Circuit Description

PMP15032 demonstrates the operation and performance of the LM5140-Q1 synchronous buck controller in high current Dual-Phase, single output application. The design operates over the input voltage range of 5.5V to 42 V. The output voltage is 5V and the maximum load current is 45A. The LM5140-Q1 switching frequency is set to 440 kHz to minimize the switching losses and obtain maximum efficiency

Power Specification

V_{IN} Min. (Default)	**5.5V**
V_{IN} Max.	**42V**
V_{OUT}	**5V (±1%)**
I_{OUT}	**45A**
Switching Frequency (Default)	**440 kHz**

PMP15032 Board Photo (with LM5140-Q1)

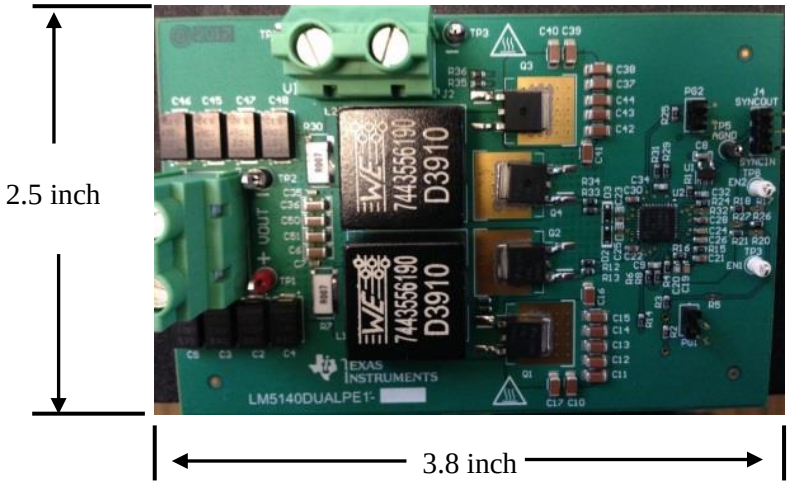

Figure 1. PMP15032 Top Side PCB

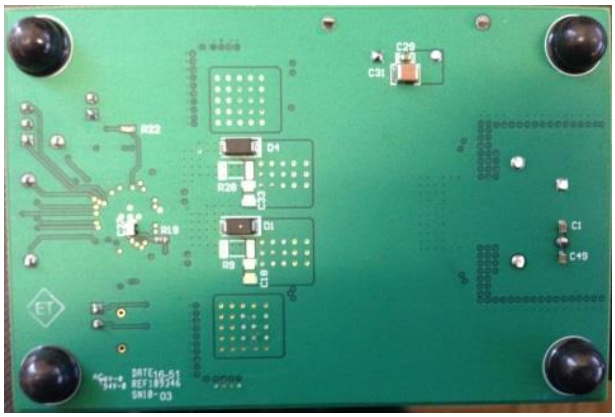

Figure 2. PMP15032 Bottom Side PCB

Thermal Images

Fan 558 LFM, V_{IN} 12V, I_{OUT}=45A, TA=25ºC

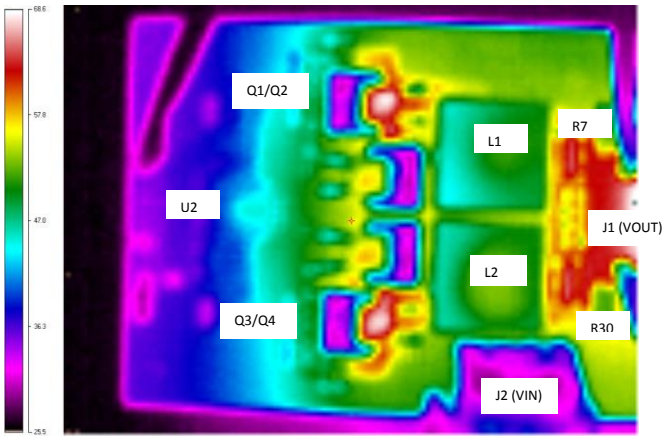

Figure 3. Top Side PCB

Figure 3 shows the top side the PCB, the case temperature of Q1/Q2 and Q3/Q4 is 68.6°C with V_{IN} 12V, and a 45A load

Thermal Image, Fan 558 LFM, V_{IN} 12V, I_{OUT}=22.5A, TA=25ºC

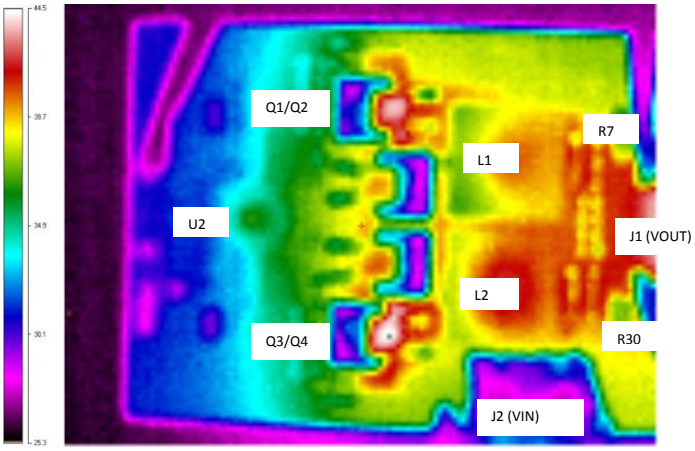

Figure 4. Top Side PCB

Figure 4 shows the top side the PCB, the case temperature of Q1/Q2 and Q3/Q4 is 44.5°C with V_{IN} 12V and a 22.5A load.

Thermal Image, No Fan, V_{IN} 12V, I_{OUT}=22.5A, TA=25ºC

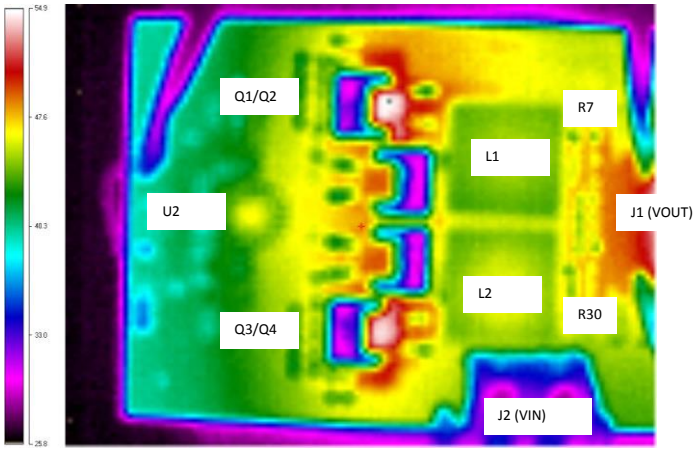

Figure 5. Top Side PCB

Figure 5 shows the top side the PCB, the case temperature of Q1/Q2 and Q3/Q4 is 54.3°C with V_{IN} 12V and a 22.5A load, no forced air cooling.

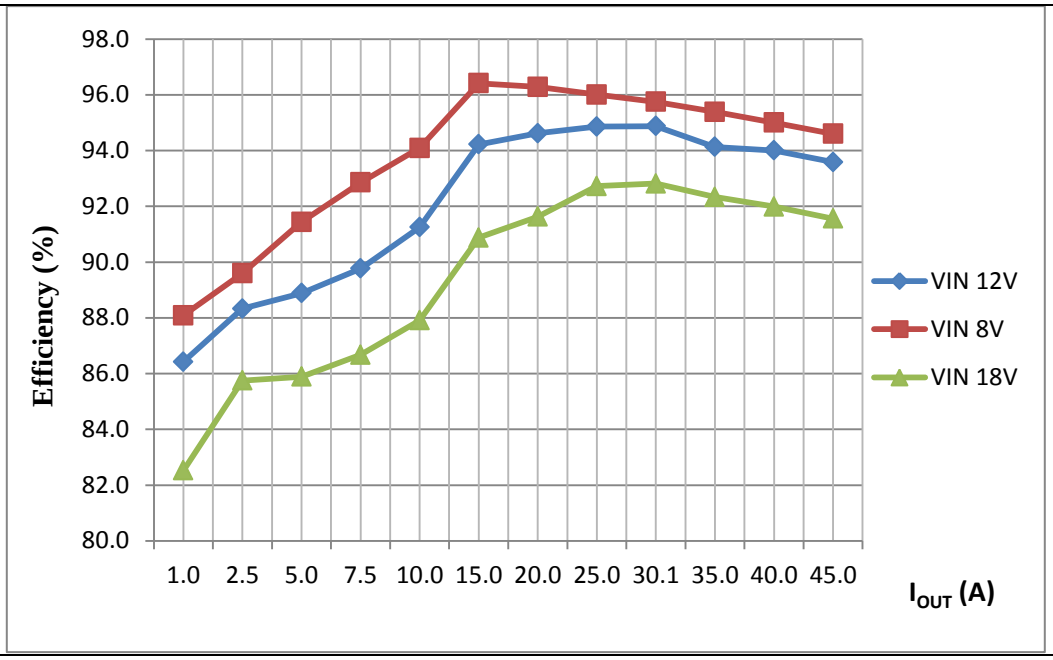

Figure 6. Efficiency

Efficiency Data

Vin	Iin	Pin	Vout	Iout	Pout	eff
8	0.7150	5.720	5.039	1.00	5.039	88.086
8	1.760	14.080	5.046	2.50	12.616	89.599
8	3.453	27.624	5.052	5.00	25.260	91.442
8	5.101	40.808	5.053	7.50	37.894	92.859
8	6.714	53.712	5.054	10.00	50.538	94.091
8	9.832	78.656	5.056	15.00	75.836	96.414
8	13.130	105.040	5.057	20.00	101.134	96.281
8	16.460	131.680	5.057	25.00	126.420	96.005
8	19.815	158.520	5.059	30.00	151.779	95.748
8	23.210	185.680	5.061	35.00	177.121	95.390
8	26.641	213.128	5.062	40.00	202.484	95.006
8	30.120	240.960	5.064	45.02	227.959	94.604

Vin	Iin	Pin	Vout	Iout	Pout	eff
12	0.4855	5.826	5.035	1.00	5.035	86.423
12	1.188	14.257	5.037	2.50	12.593	88.327
12	2.363	28.358	5.041	5.00	25.207	88.885
12	3.513	42.151	5.045	7.50	37.840	89.771
12	4.615	55.378	5.053	10.00	50.533	91.252
12	6.709	80.506	5.057	15.00	75.855	94.223
12	8.909	106.903	5.058	20.00	101.150	94.618
12	11.109	133.308	5.058	25.00	126.458	94.861
12	13.363	160.356	5.060	30.07	152.145	94.880
12	15.682	188.184	5.061	35.00	177.135	94.129
12	17.951	215.412	5.063	40.00	202.504	94.008
12	20.292	243.504	5.064	45.00	227.880	93.584

Vin	Iin	Pin	Vout1	Iout1	Pout	eff
18	0.3390	6.102	5.036	1.00	5.036	82.527
18	0.816	14.688	5.038	2.50	12.596	85.755
18	1.631	29.358	5.043	5.00	25.217	85.893
18	2.427	43.686	5.049	7.50	37.865	86.676
18	3.195	57.510	5.056	10.00	50.558	87.912
18	4.638	83.484	5.058	15.00	75.867	90.876
18	6.134	110.412	5.059	20.00	101.172	91.631
18	7.577	136.386	5.059	25.00	126.468	92.728
18	9.107	163.926	5.060	30.07	152.154	92.819
18	10.658	191.844	5.061	35.00	177.142	92.336
18	12.230	220.140	5.063	40.00	202.512	91.992
18	13.827	248.886	5.064	45.00	227.885	91.562

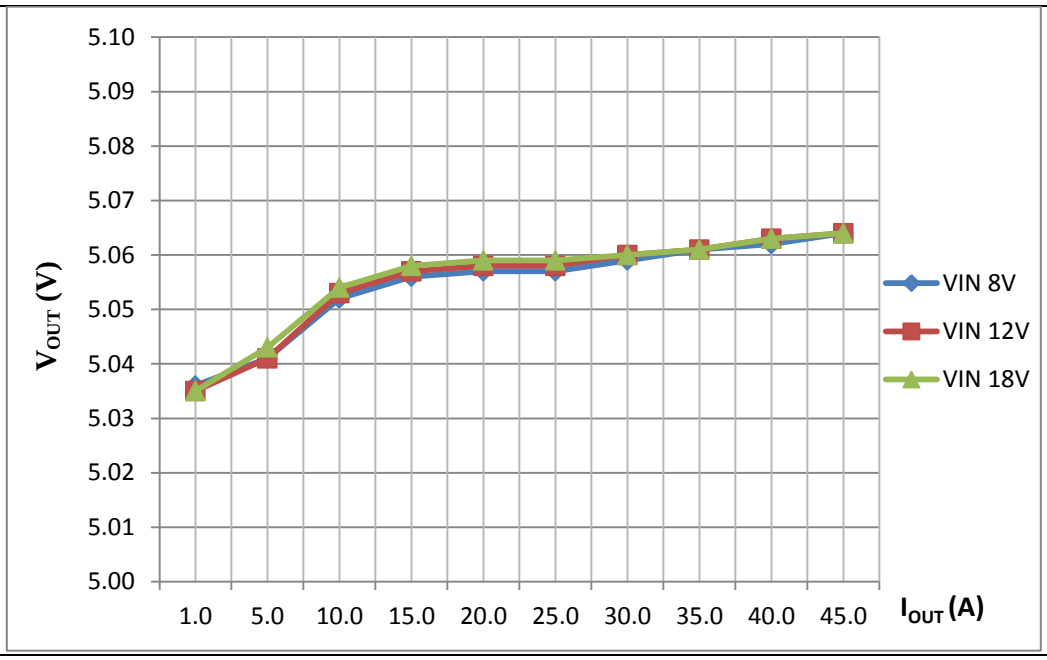

Figure 7. Voltage Regulation

Start-Up

Test condition: V_{IN} = 12V, No-load
C1 (Yellow) – V_{IN}
C2 (Red) – V_{OUT}

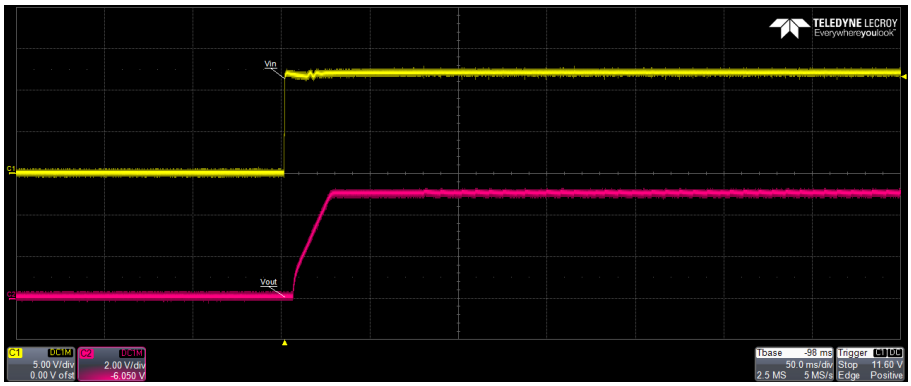

Figure 8. Startup at No-Load

Figure 8 shows the no-load start-up waveform, the start-up is monotonic with no output over shoot.

Test condition: VIN = 12V, Maximum Load (45A)

C1 (Yellow) – V_{IN}
C2 (Red) – V_{OUT}

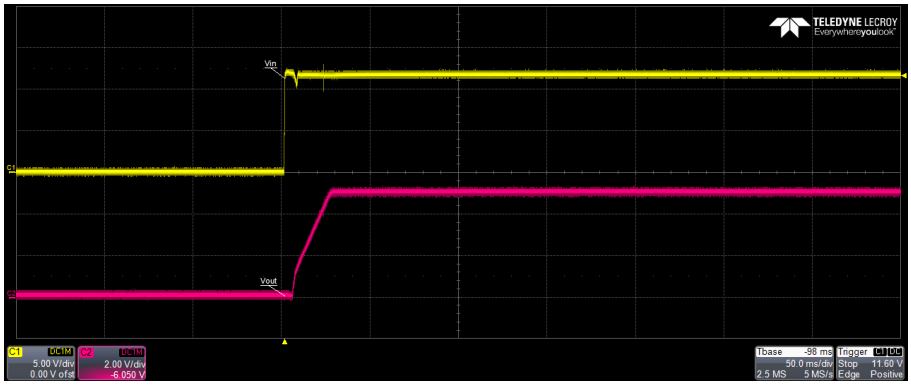

Figure 9. Startup at Full load

Figure 9 shows the full-load startup waveform, the start-up is monotonic with no output over shoot.

Load Transients

Load Step (4.5A-40.5A), 0.6A/µs
Test condition: V_{IN} = 12V
CH1 (Yellow)- V_{OUT} (AC coupled); ΔV_{OUT} = 200mV peak to peak
CH4 (Green) - I_{OUT}

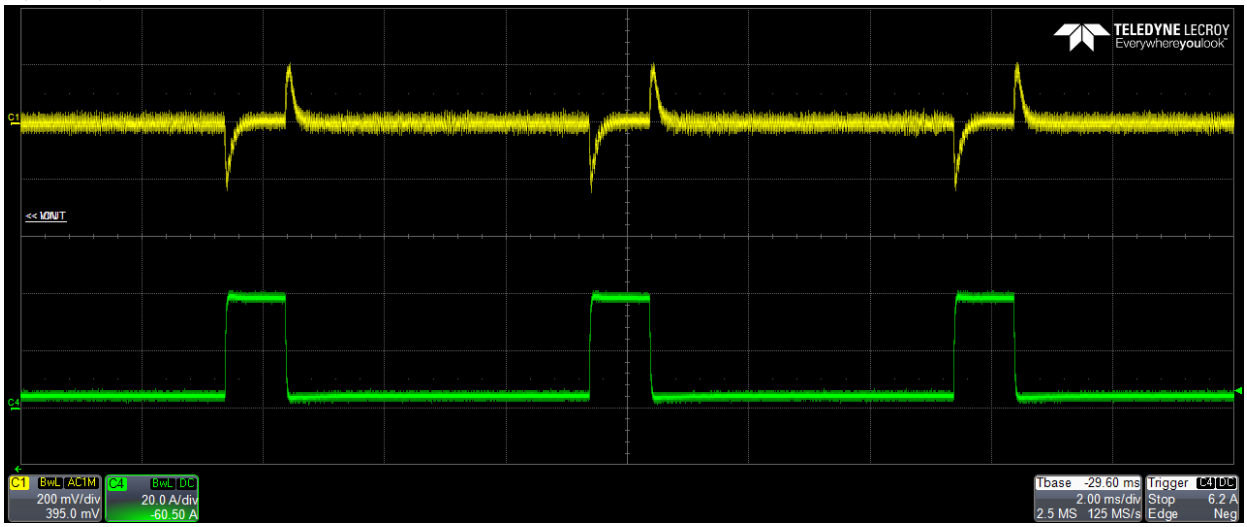

Figure 10. Load Step Response 4.5A-40.5A

Load Step (4.5A-22.5A), 0.6A/µs

Test condition: V_{IN} = 12V
CH1 (Yellow)- V_{OUT} (AC coupled); ΔV_{OUT} = 140mV peak to peak
CH4 (Green) - I_{OUT}

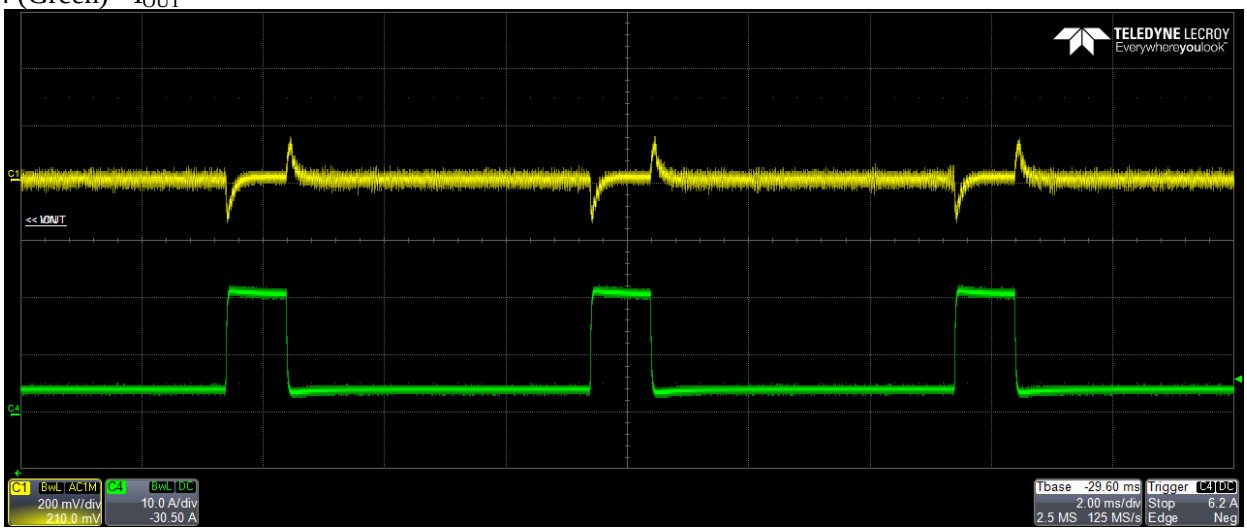

Figure 11. Load Step Response 4.5A-22.5A

Load Step (22.5A-45A), 0.6A/µs

Test condition: V_{IN} = 12V
CH1 (Yellow)- V_{OUT} (AC coupled); ΔV_{OUT} = 120mV peak to peak
CH4 (Green) - I_{OUT}

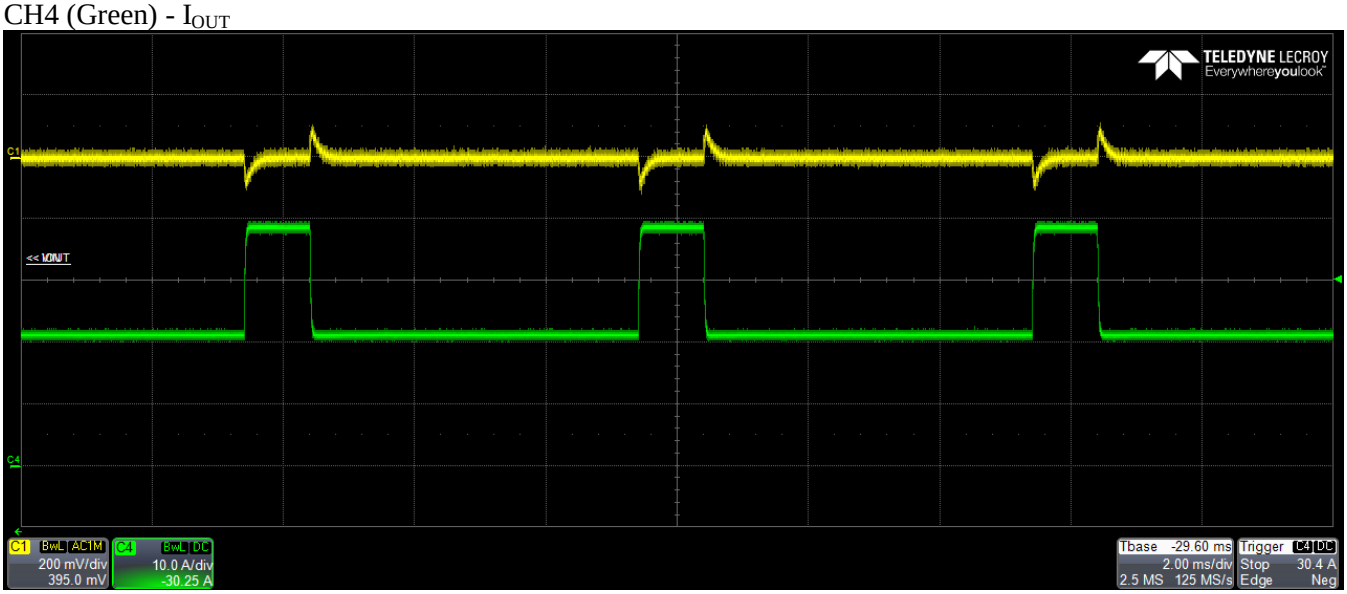

Figure 12. Transient Response 22.5A-45A

SW Node Voltage and Inductor Ripple Current Waveforms

Test condition: V_{IN} = 12V, I_{OUT} = 0.1A
C1 (Yellow) - Switch node voltage 1(SW1)
C2(Red)- Switch node voltage 2 (SW2)
C3(Blue)- Inductor current channel 1 (IL1)
C4 (Green) – Inductor current channel 2 (IL2)

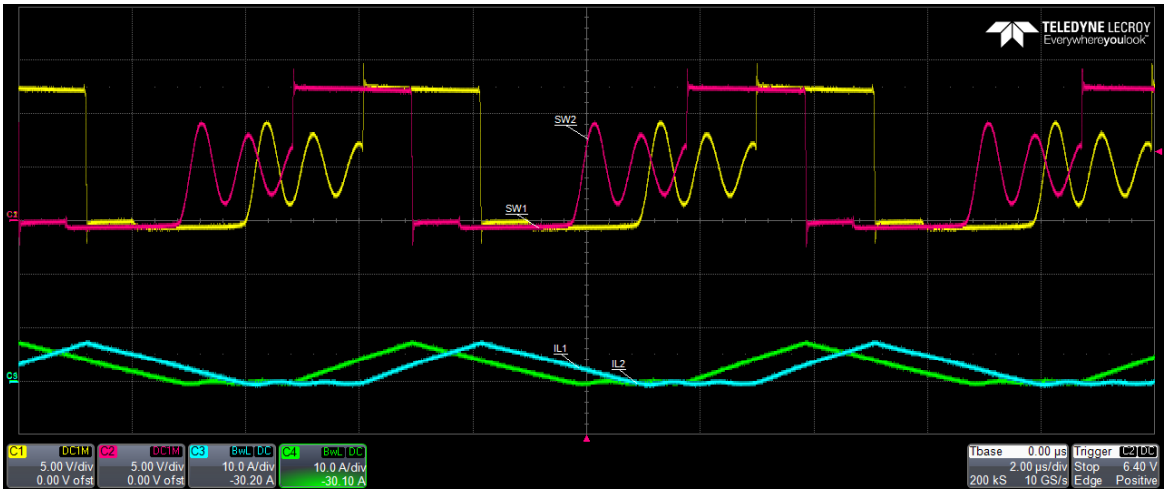

Figure 13. Steady State at 0.1A Load

Test condition: V_{IN} = 12V, I_{OUT} = 45A
C1 (Yellow) - Switch node voltage 1(SW1)
C2(Red)- Switch node voltage 2 (SW2)
C3(Blue)- Inductor current channel 1 (IL1)
C4 (Green) – Inductor current channel 2 (IL2)

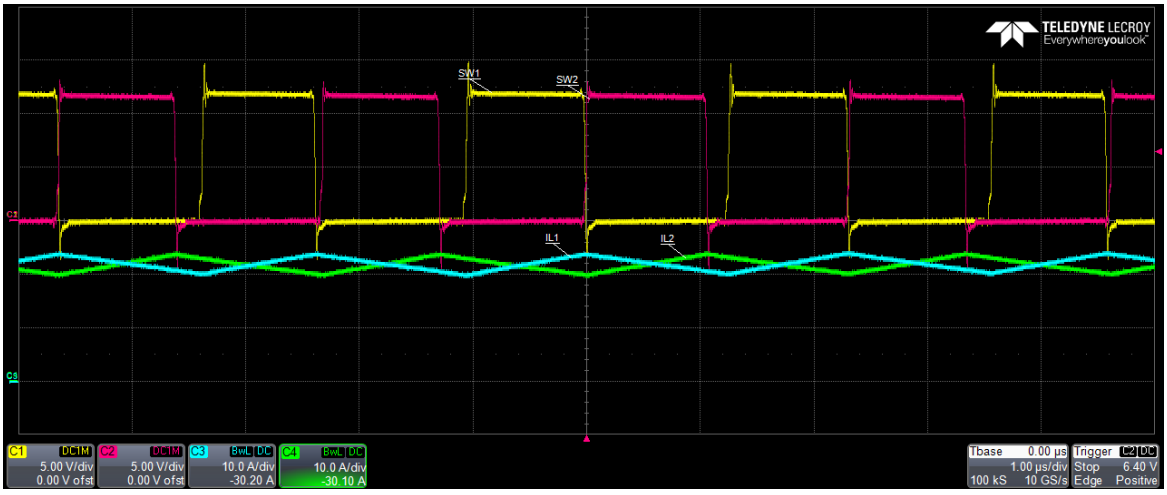

Figure 14. Steady State 45A Load

Overload

Test Conditions: V_{IN}=12V
C1 (Yellow) - V_{OUT}
C2 (Red)-IL2
C3-(Blue)-IL1
C4 (Green) – I_{OUT}

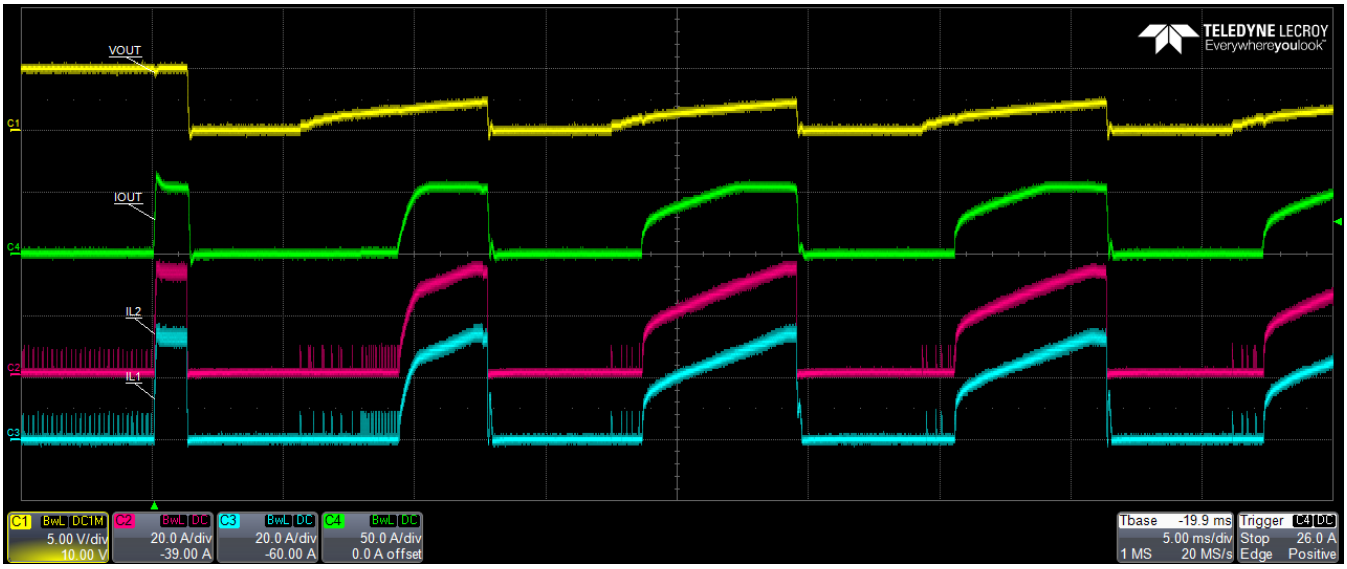

Figure 15. Overload

Bode Plot

Test conditions: V_{IN}=12V, V_{OUT} =5.0V, I_{OUT} =45A
The gain crossover frequency is 25 kHz with a phase margin of 67 degrees.

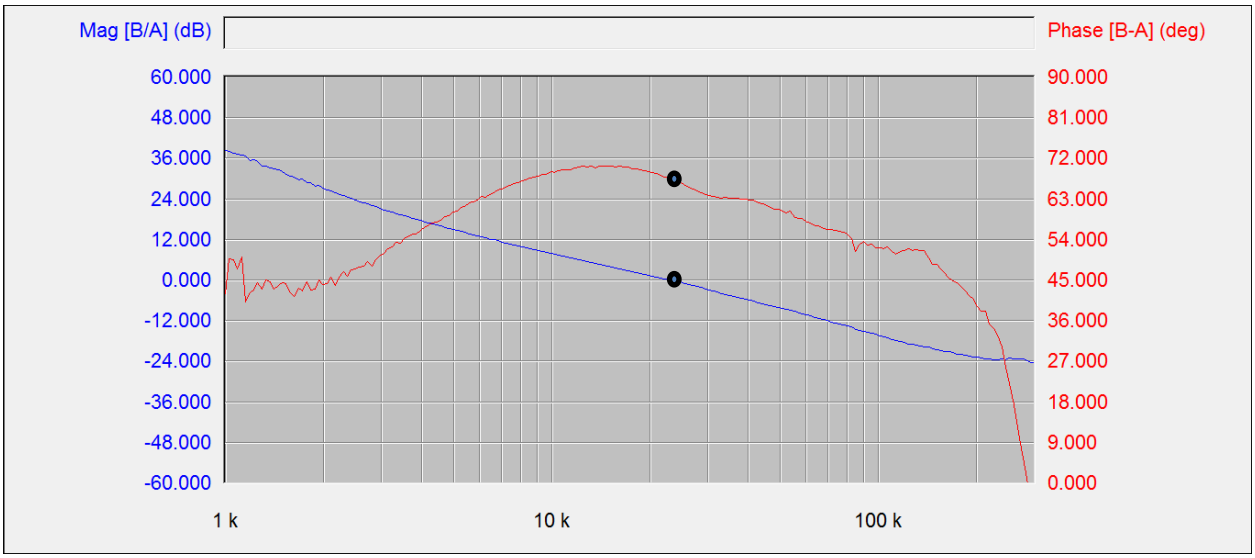

Figure 20. Bode Plot, Loop Gain and Phase

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265