Test Data
For PMP7969
3/9/2015

Test SPECIFICATIONS

Vin Min.	**9V DC**
Vin Max.	**16V DC**
Vout	**24V DC**
Iout	**25A Max.**
Target Switching Frequency	**1.6MHz (400KHz per phase)**

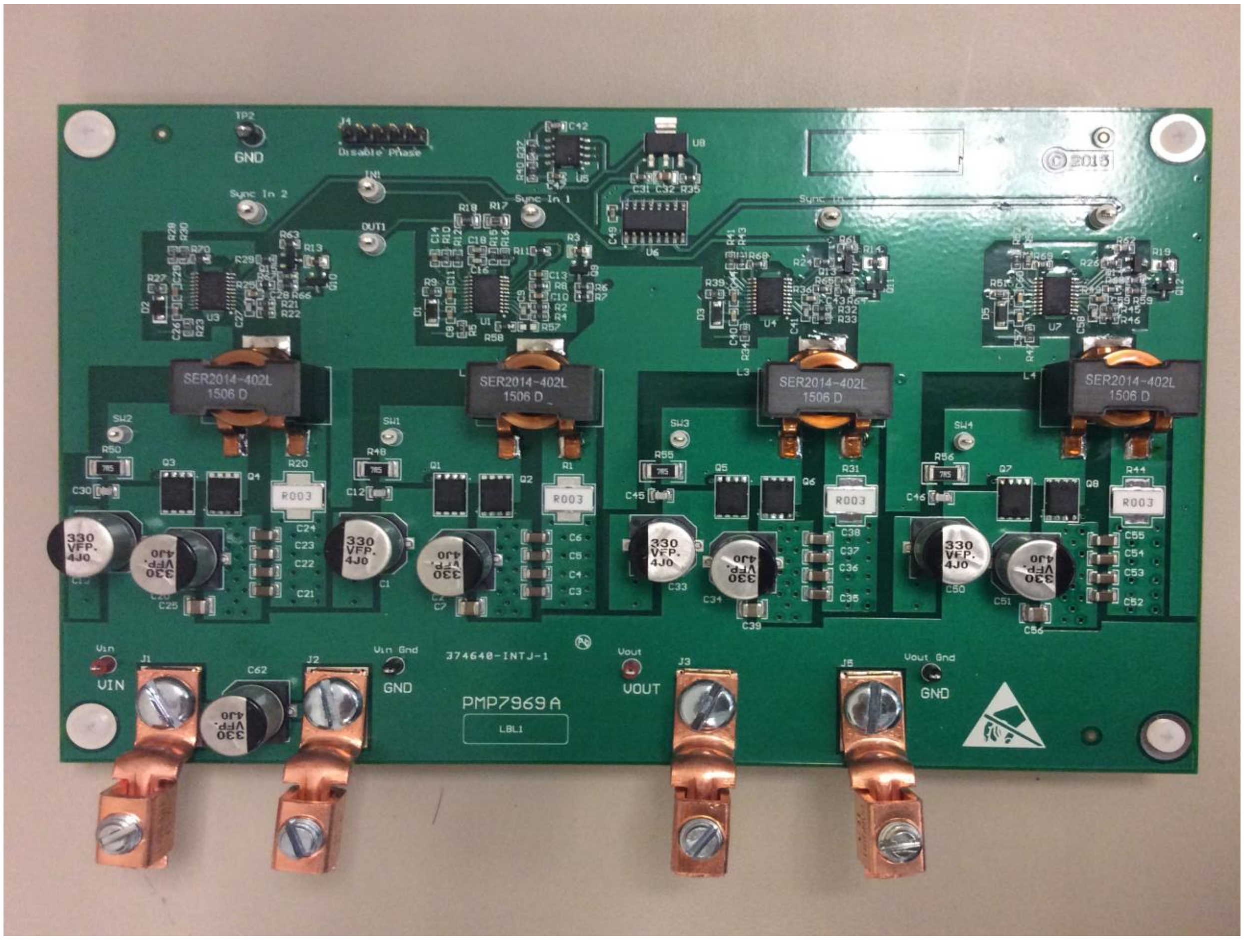
Circuit Description

PMP7969 is a 4-Phase Synchronous Boost Converter with the added capability of enabling and disabling each individual phase either manually, via 5 pin jumper, or using an MCU or other control circuitry. It is designed to accept an input range of 9VDC-to-16VDC. The output is set to 24VDC and can supply a maximum of 25A of current to the load.

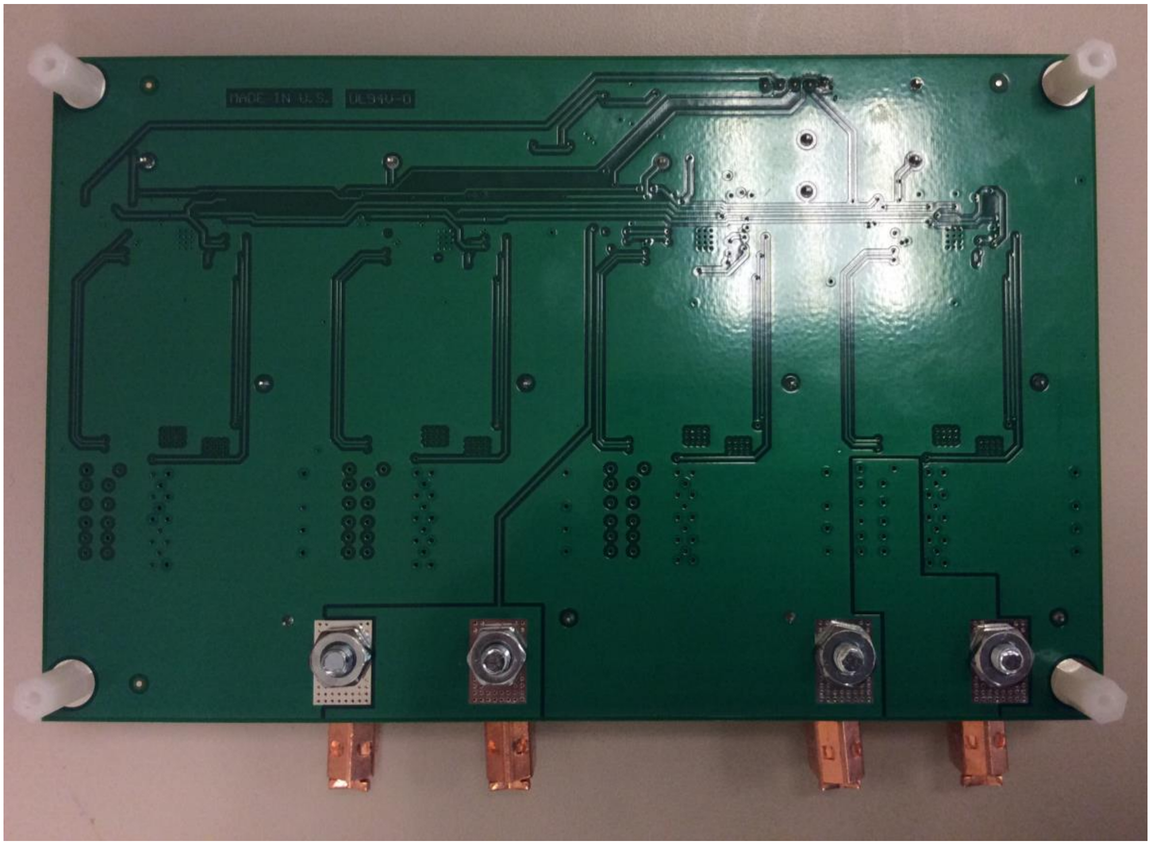
Note that hiccup mode will function only when all four phases are enabled. If three or less phases are enabled switching of all enabled phases will stop, all FETs will be OFF, and current will conduct through the body diode of all four synchronous FETs and the output voltage will be the input voltage minus the voltage drop of the four paralleled synchronous FET body diodes.

FABRICATION

Board Dimensions: 4.5” x 7”

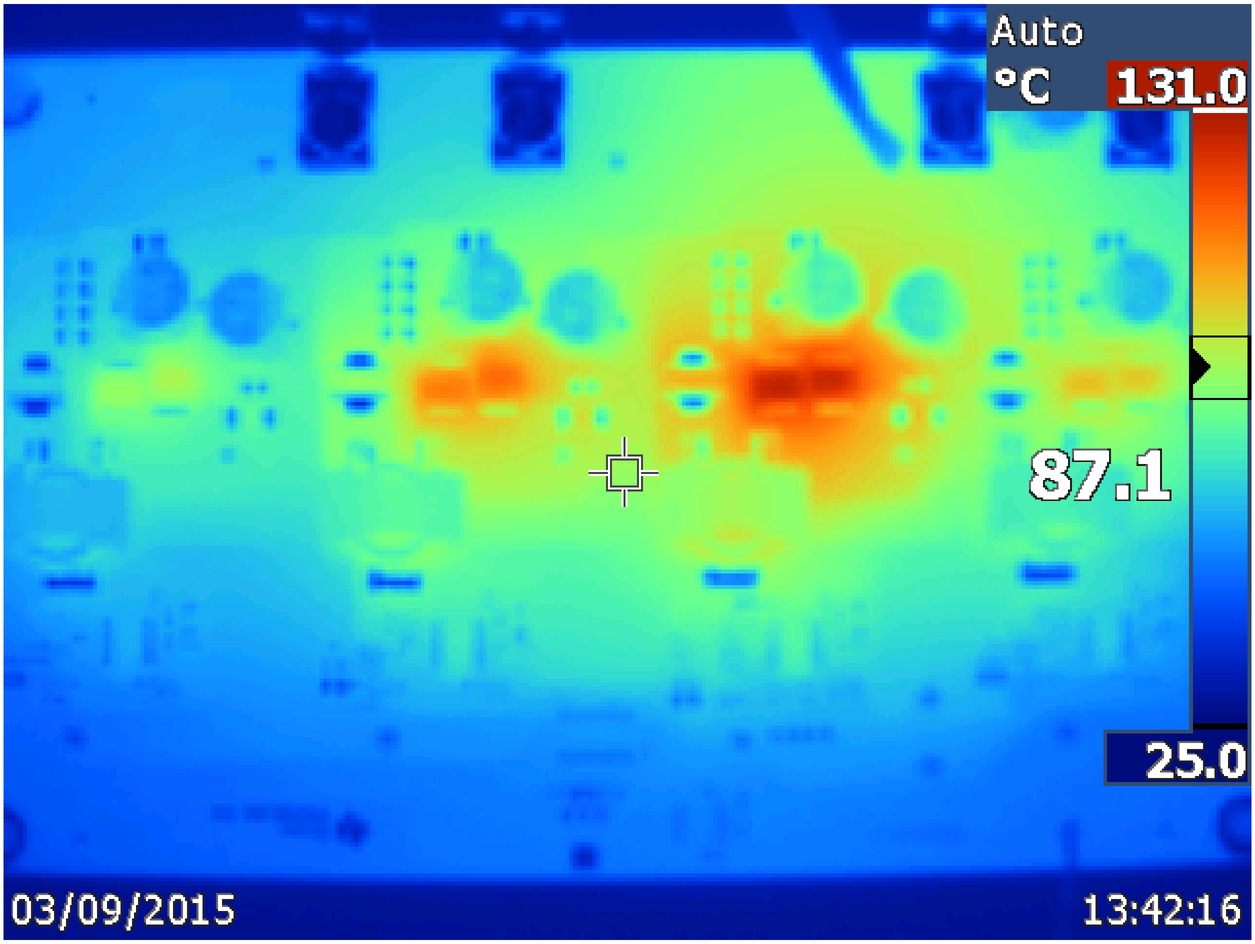


Board Photo (Top)

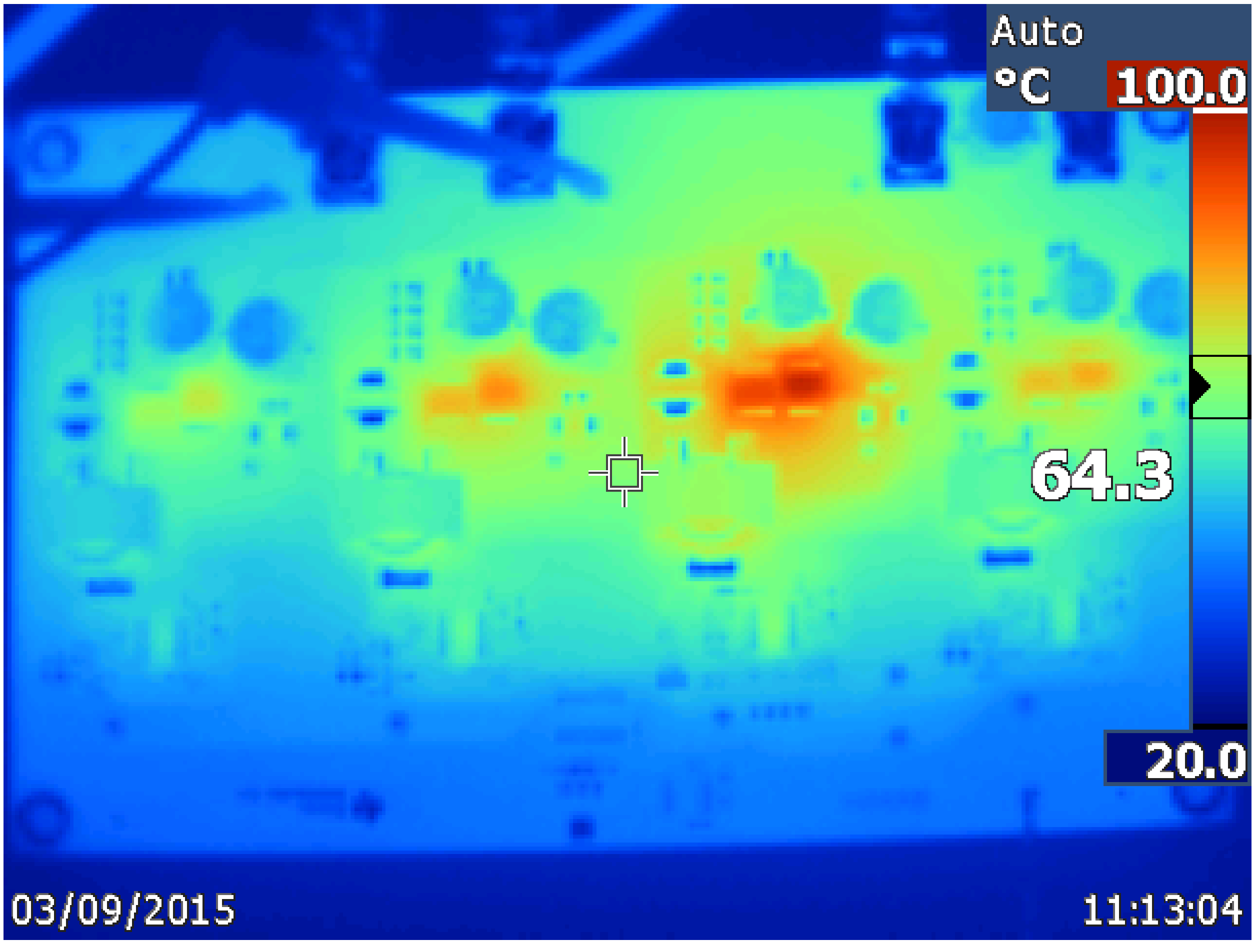


Board Photo (Bottom)

Thermal Data



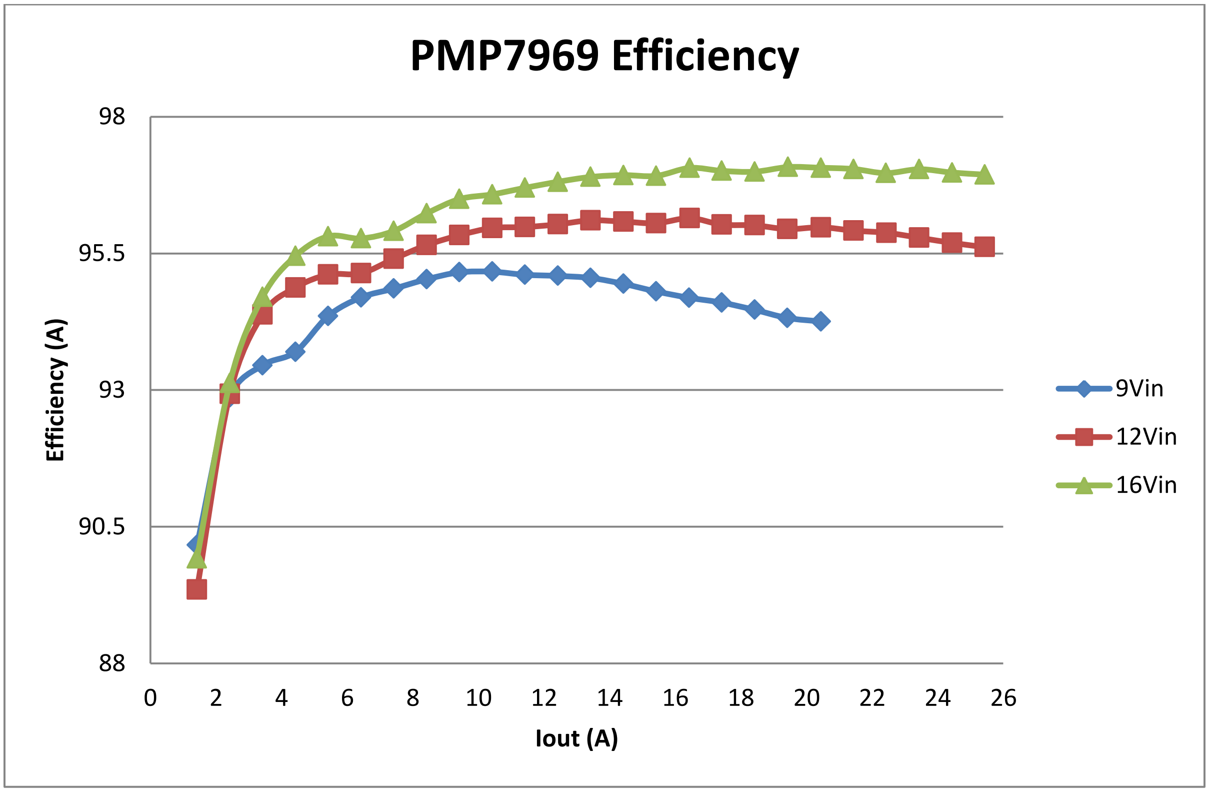
IR thermal image taken at steady state at 18A load and Vin = 9V with no airflow (thermal image taken is upside-down relative to photo of board displayed above; for improved thermal performance, it is recommended to use 2oz Copper or heavier, heatsinks for the FETs, and/or airflow)



IR thermal image taken at steady state at Full (25A) load and Vin = 16V with no airflow (thermal image taken is upside-down relative to photo of board displayed above; for improved thermal performance, it is recommended to use 2oz Copper or heavier, heatsinks for the FETs, and/or airflow)

TYPICAL PERFORMANCE

EFFICIENCY



Efficiency Data

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
9.008	0.31	24.026	0	0
9.008	4.2	24.023	1.42	90.165
9.007	6.95	24.022	2.42	92.867
9.007	9.76	24.021	3.42	93.452
9.007	12.58	24.02	4.42	93.699
9.006	15.32	24.019	5.42	94.355
9.006	18.08	24.017	6.42	94.694
9.006	20.86	24.016	7.42	94.855
9.005	23.63	24.015	8.42	95.027
9.005	26.4	24.014	9.42	95.154
9.004	29.2	24.012	10.42	95.165
9.004	32.02	24.011	11.42	95.109
9.004	34.83	24.01	12.42	95.088
9.003	37.65	24.008	13.42	95.051
9.003	40.5	24.007	14.42	94.943

9.003	43.37	24.006	15.42	94.804
9.002	46.24	24.004	16.42	94.689
9.002	49.1	24.003	17.42	94.6
9.002	51.99	24.002	18.42	94.467
9.001	54.9	24	19.42	94.319
9.001	57.82	23.999	20.44	94.255

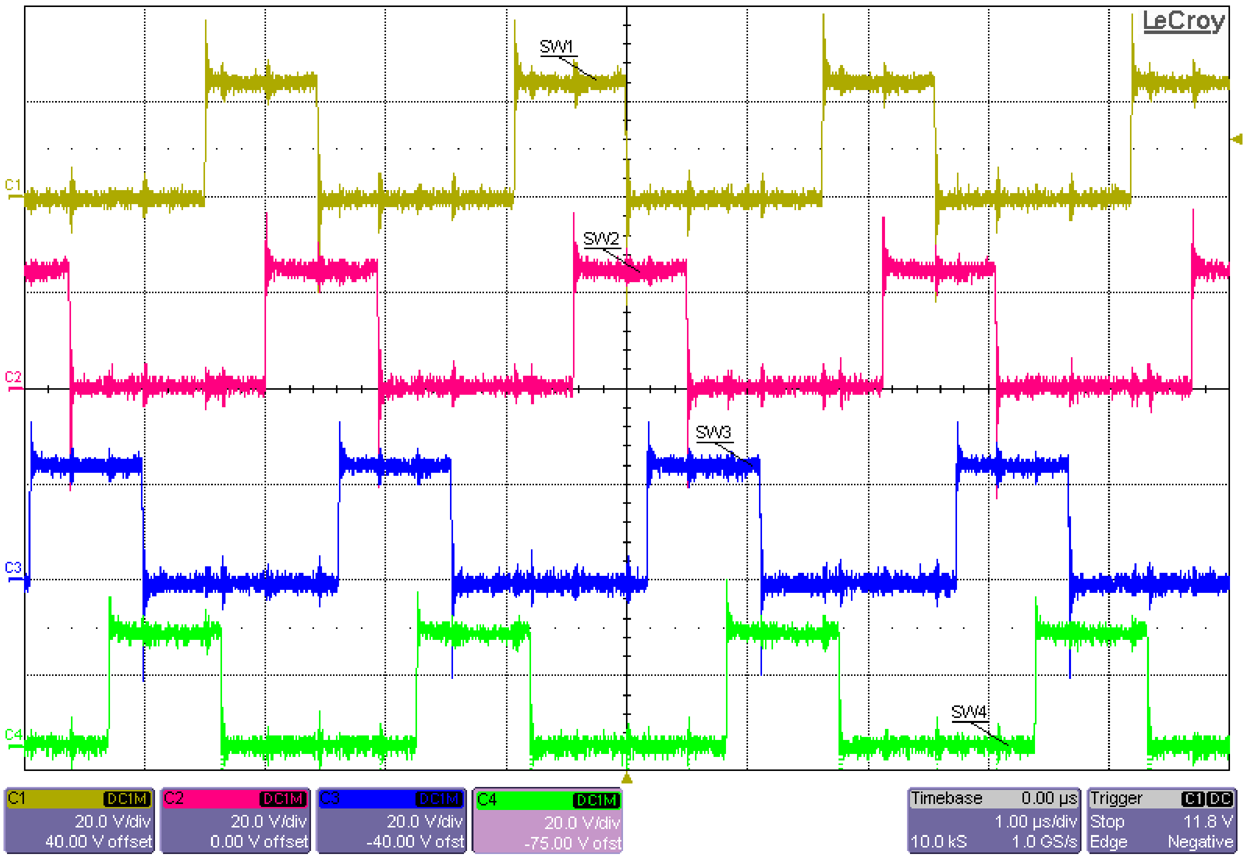
Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
12.01	0.28	24.029	0	0
12.008	3.18	24.027	1.42	89.349
12.009	5.21	24.026	2.42	92.929
12.008	7.25	24.025	3.42	94.38
12.009	9.32	24.024	4.42	94.873
12.009	11.4	24.024	5.42	95.111
12.008	13.5	24.022	6.42	95.135
12.007	15.56	24.021	7.42	95.401
12.007	17.61	24.02	8.42	95.651
12.009	19.66	24.019	9.42	95.833
12.007	21.72	24.018	10.42	95.964
12.006	23.8	24.016	11.42	95.982
12.006	25.87	24.015	12.42	96.031
12.006	27.93	24.014	13.42	96.105
12.005	30.02	24.013	14.42	96.081
12.005	32.11	24.012	15.42	96.053
12.005	34.2	24.011	16.44	96.144
12.005	36.28	24.009	17.42	96.027
12.004	38.37	24.008	18.42	96.013
12.004	40.48	24.007	19.42	95.945
12.004	42.59	24.006	20.44	95.977
12.004	44.7	24.005	21.44	95.916
12.004	46.8	24.003	22.44	95.877
12.004	48.93	24.002	23.44	95.786
12.003	51.07	24.001	24.44	95.692
12.003	53.2	24	25.44	95.615

Vin(V)	Iin(A)	Vout(V)	Iout(A)	Efficiency(%)
16.009	0.22	24.03	0	0
16.011	2.37	24.029	1.42	89.92
16.009	3.9	24.027	2.42	93.129

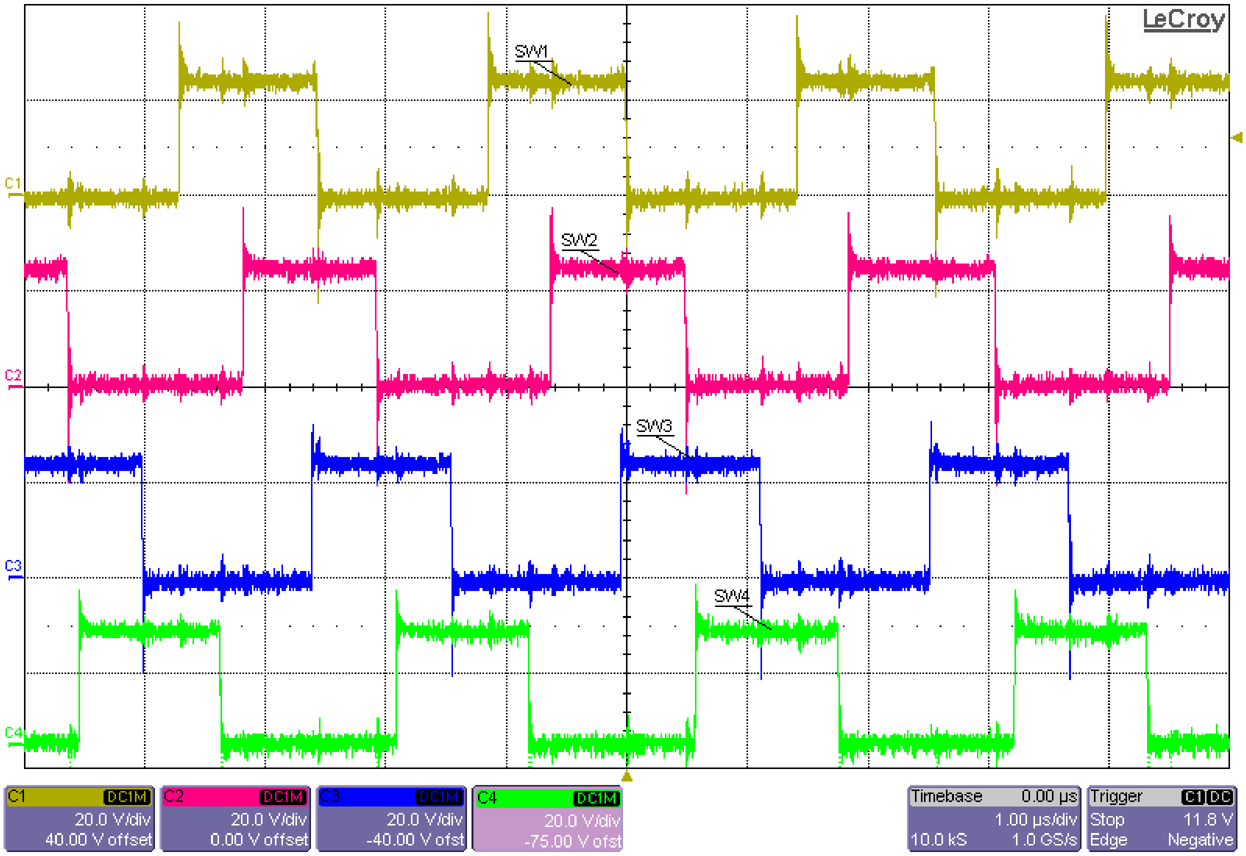
16.009	5.42	24.027	3.42	94.703
16.008	6.95	24.026	4.42	95.451
16.008	8.49	24.025	5.42	95.812
16.008	10.06	24.024	6.42	95.773
16.008	11.61	24.023	7.42	95.91
16.008	13.13	24.022	8.42	96.232
16.007	14.65	24.021	9.42	96.493
16.007	16.19	24.02	10.42	96.579
16.008	17.72	24.019	11.42	96.699
16.007	19.25	24.018	12.42	96.809
16.007	20.78	24.017	13.42	96.898
16.007	22.32	24.016	14.42	96.931
16.007	23.87	24.015	15.42	96.918
16.007	25.41	24.014	16.44	97.063
16.006	26.94	24.013	17.42	97.009
16.006	28.49	24.012	18.42	96.994
16.006	30.04	24.011	19.44	97.079
16.005	31.59	24.01	20.44	97.066
16.006	33.14	24.009	21.44	97.043
16.006	34.68	24.008	22.42	96.968
16.006	36.23	24.007	23.44	97.039
16.005	37.8	24.006	24.44	96.978
16.005	39.36	24.005	25.44	96.941

Waveforms

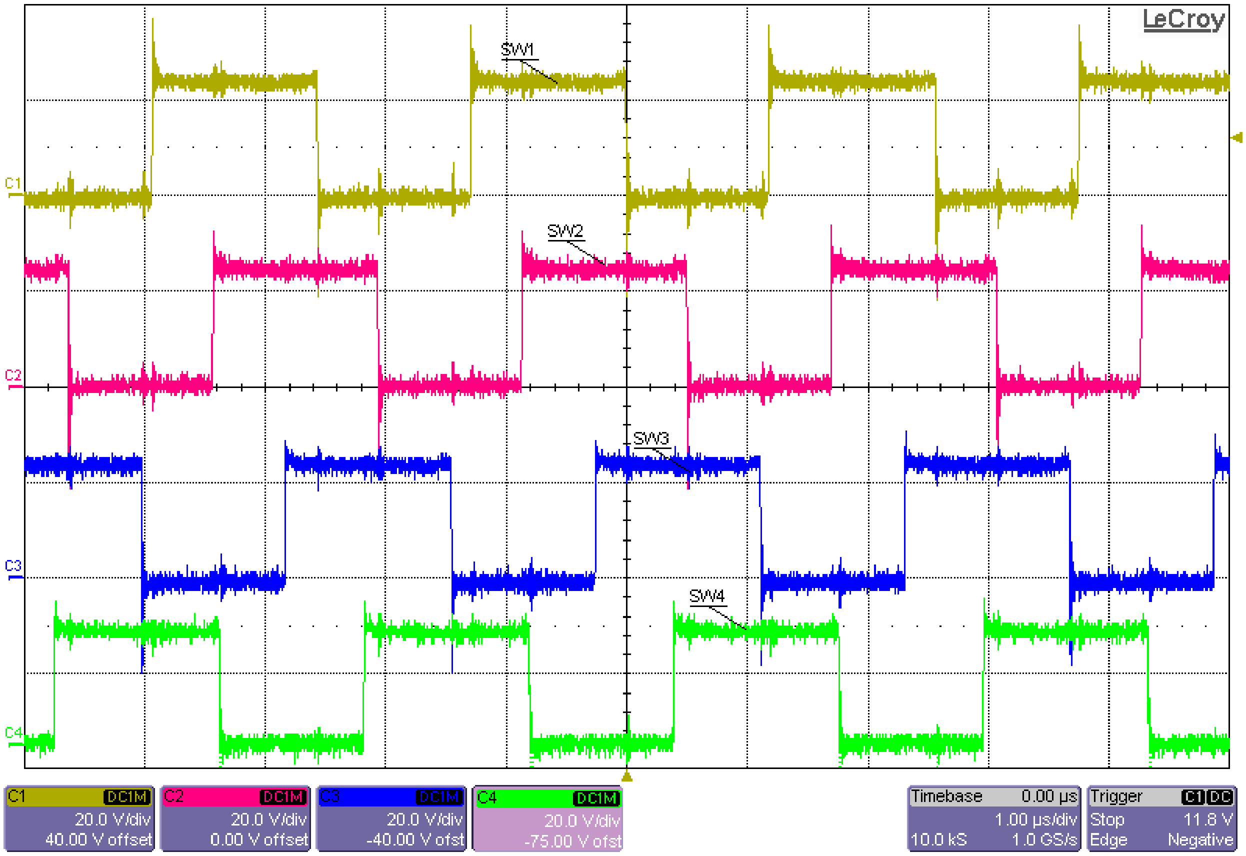
Switch Nodes



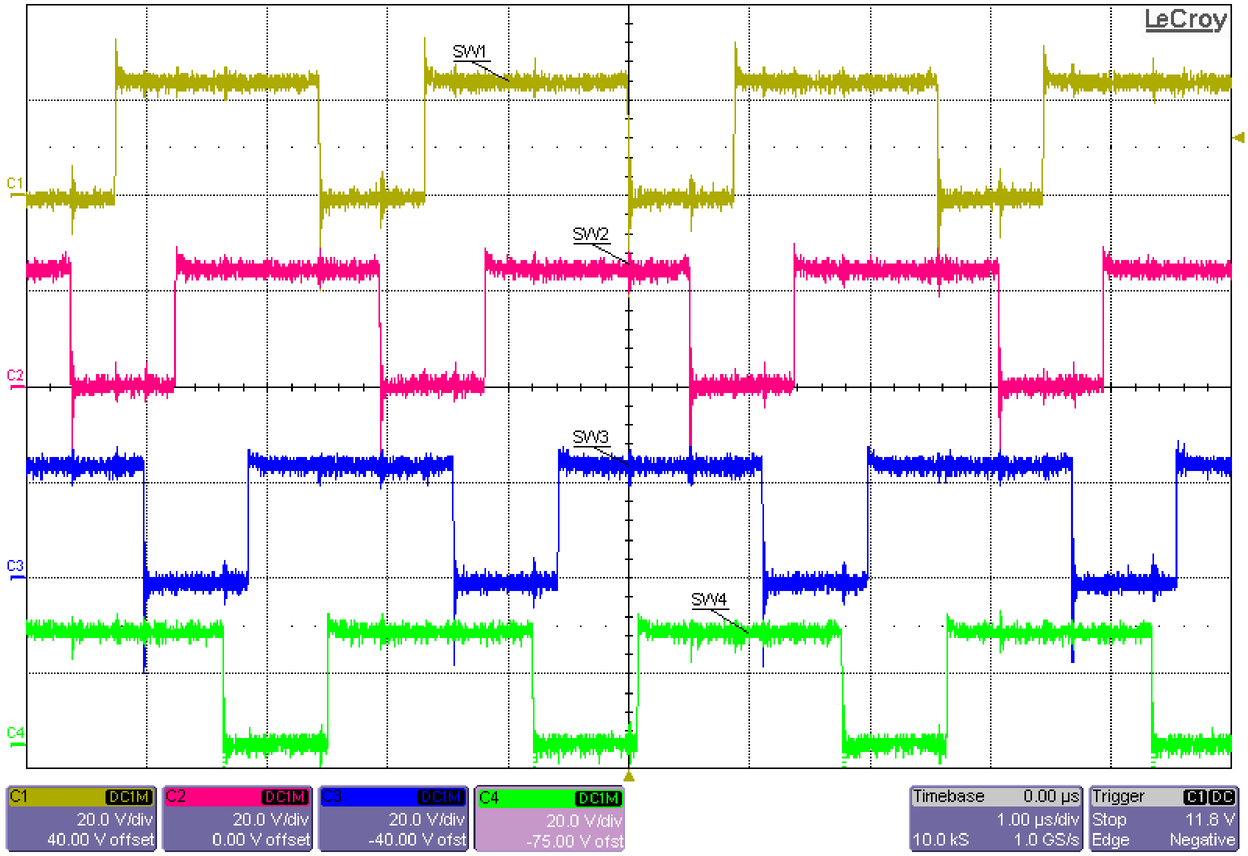
Switch Nodes of all 4 phases at Vin = 9V and 21A Load



Switch Nodes of all 4 phases at Vin = 11V and Full (25A) Load

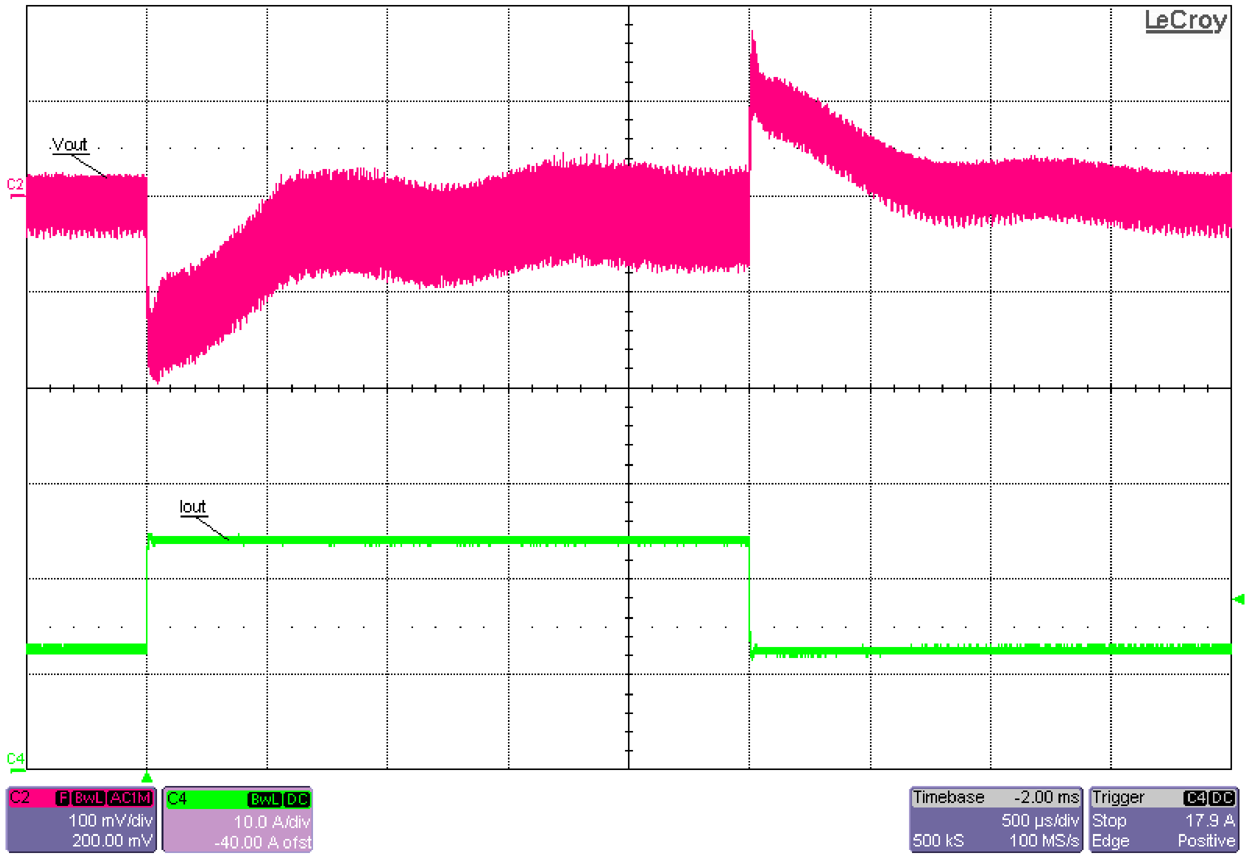


Switch Nodes of all 4 phases at Vin = 13V and Full (25A) Load

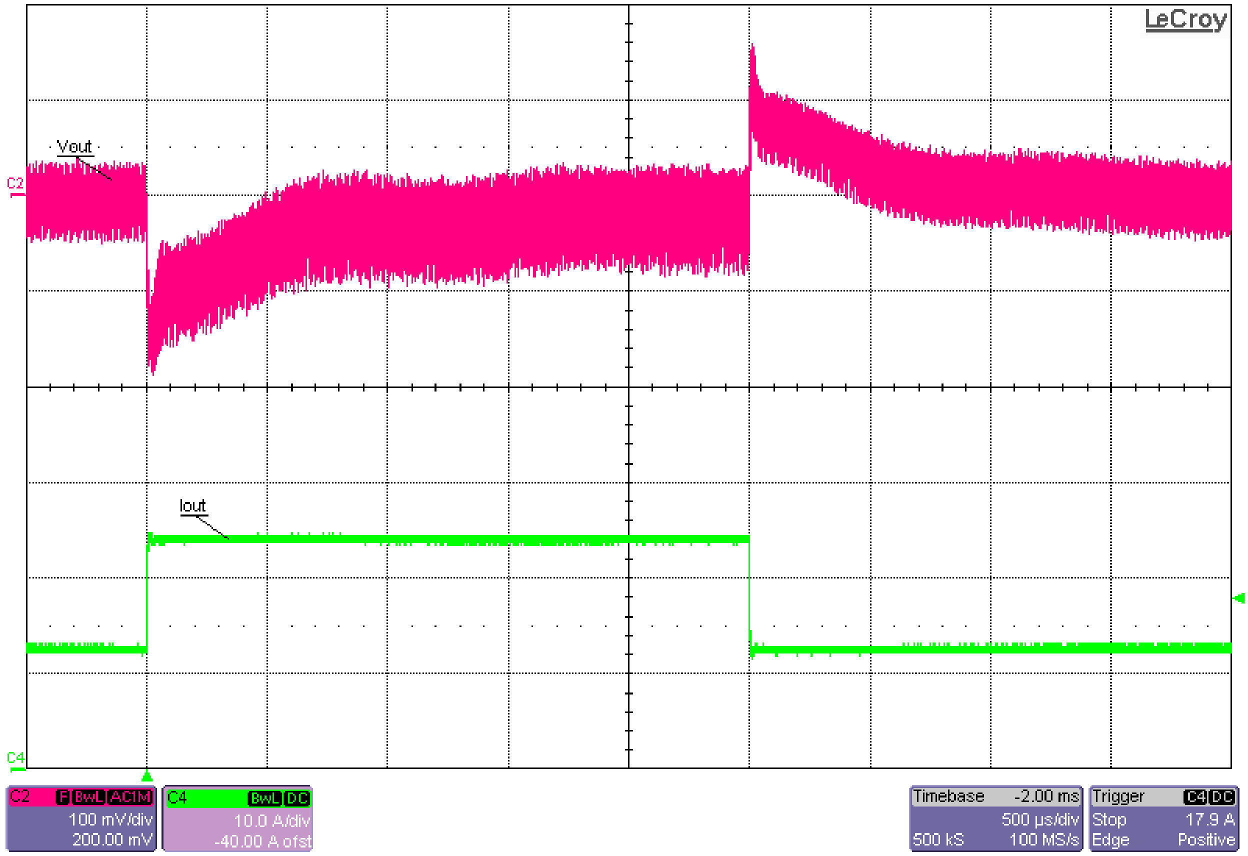


Switch Nodes of all 4 phases at Vin = 16V and Full (25A) Load

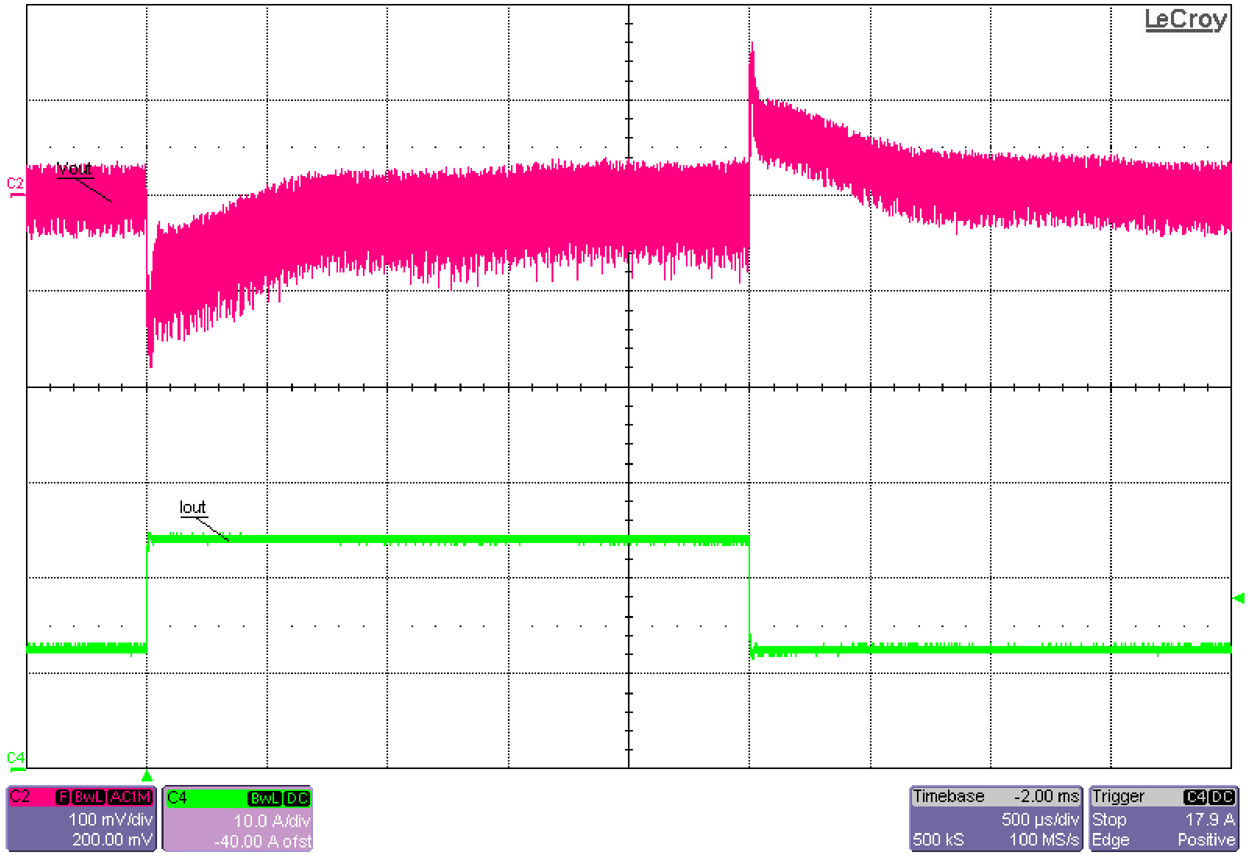
Load Transient Response



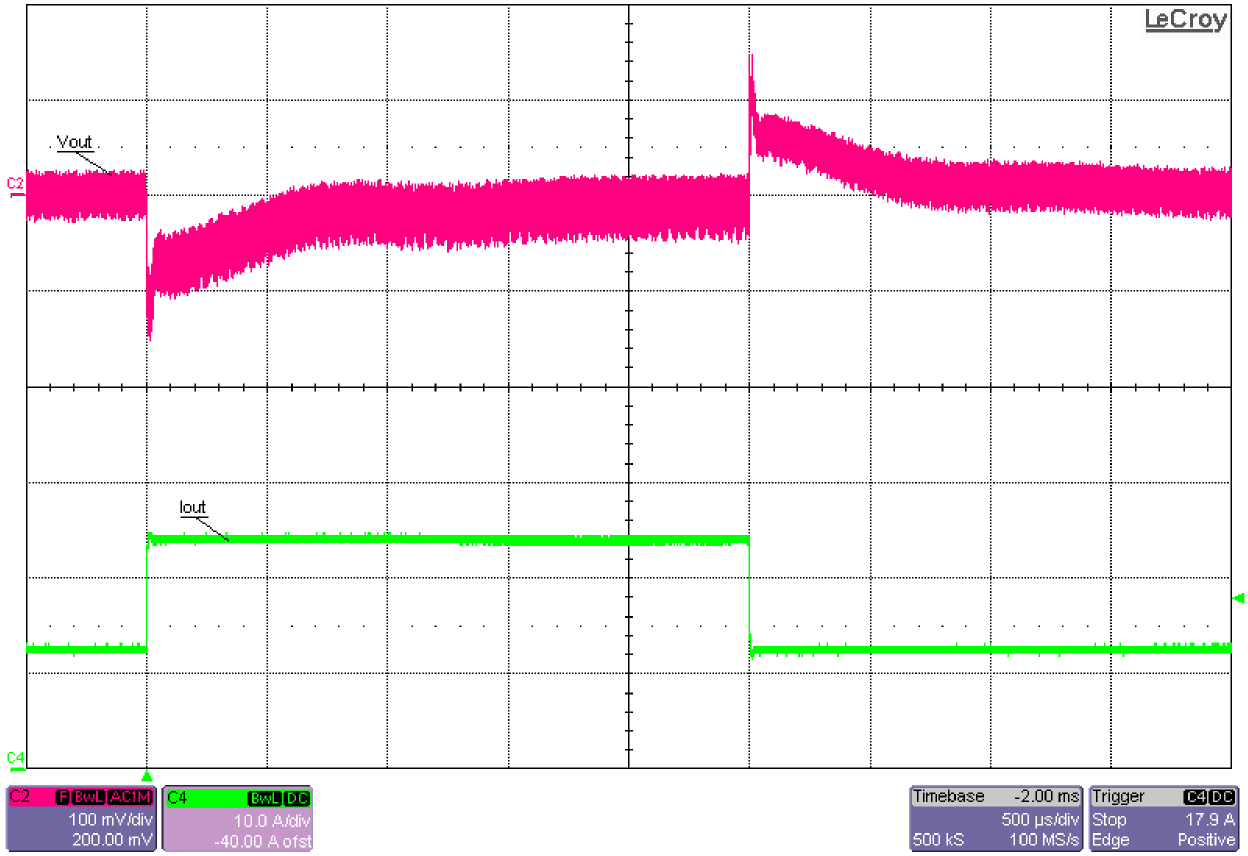
Load Transient Response at Vin = 9V with 50%-to-100% (12.5A-to-25A) Load Step



Load Transient Response at Vin = 11V with 50%-to-100% (12.5A-to-25A) Load Step

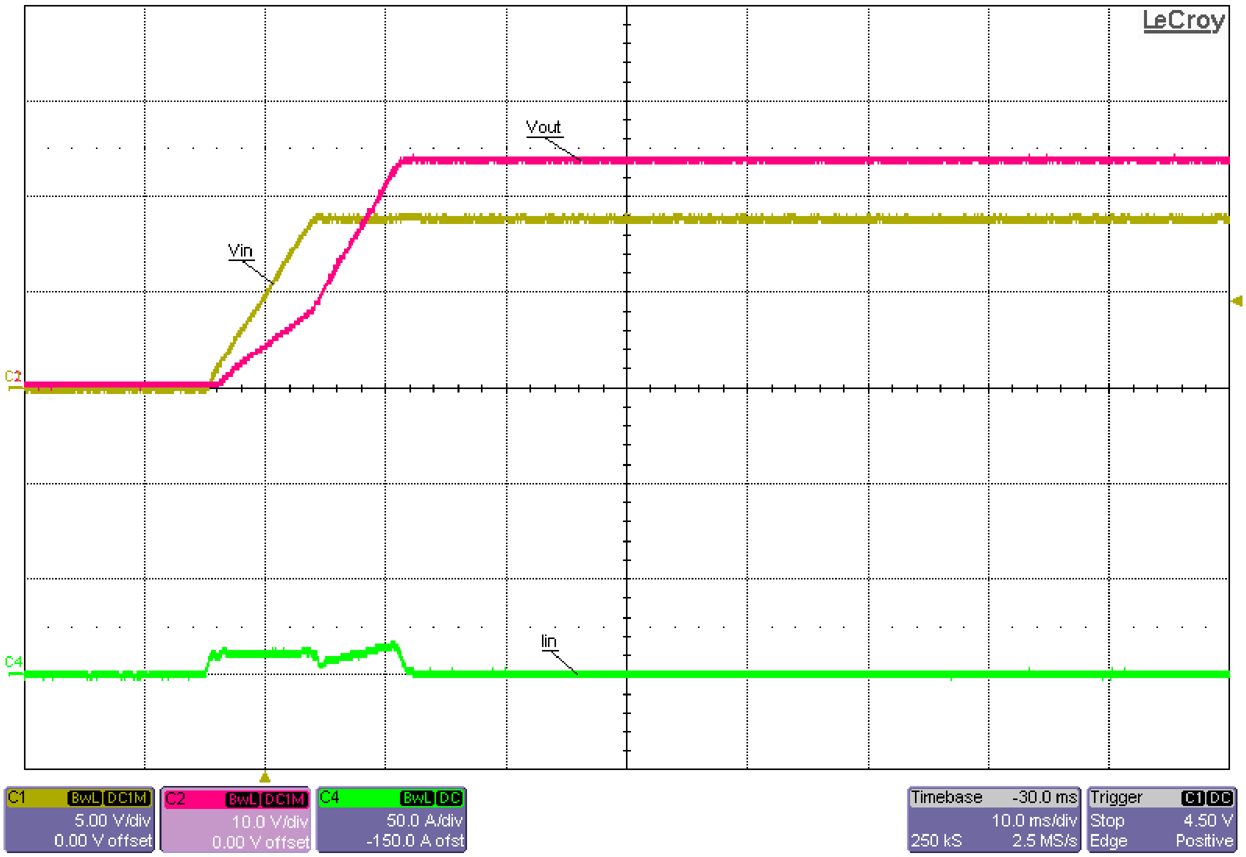


Load Transient Response at Vin = 13V with 50%-to-100% (12.5A-to-25A) Load Step

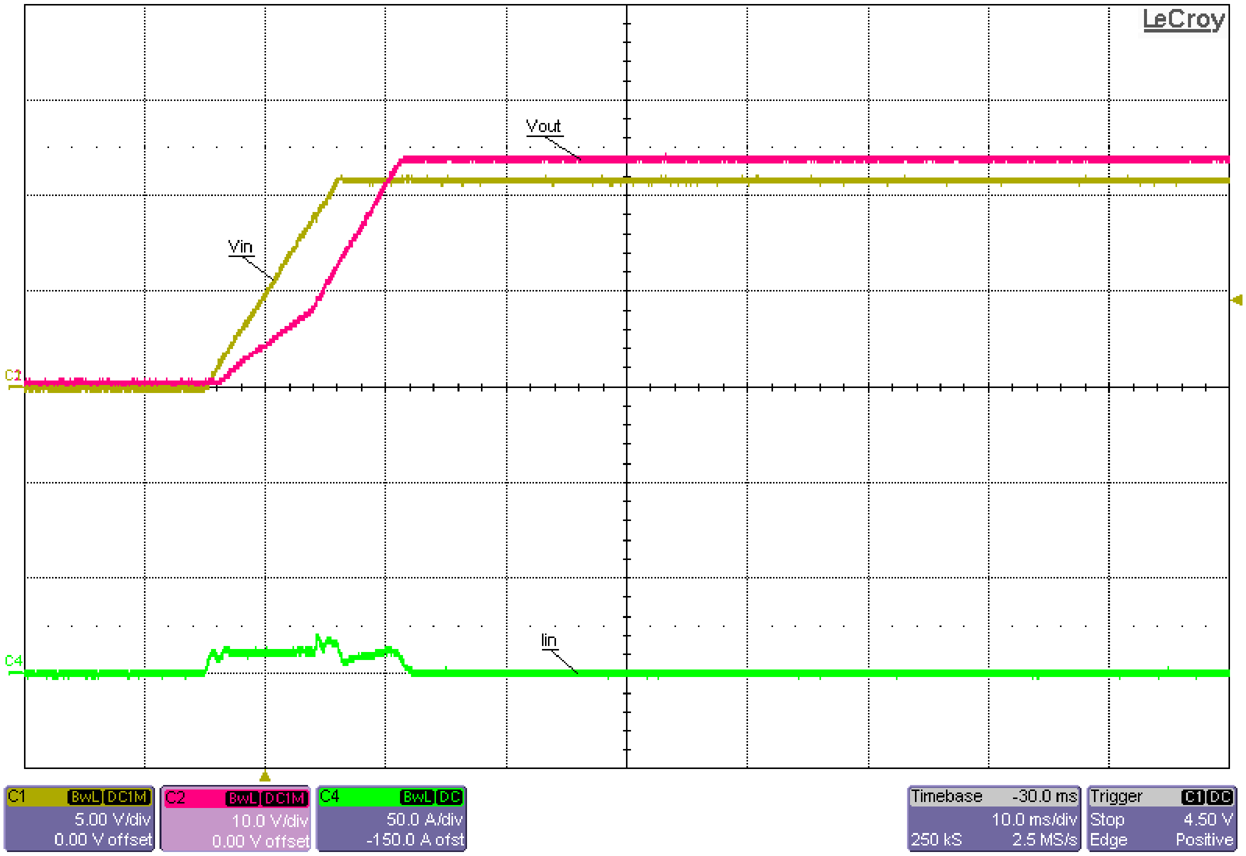


Load Transient Response at Vin = 16V with 50%-to-100% (12.5A-to-25A) Load Step

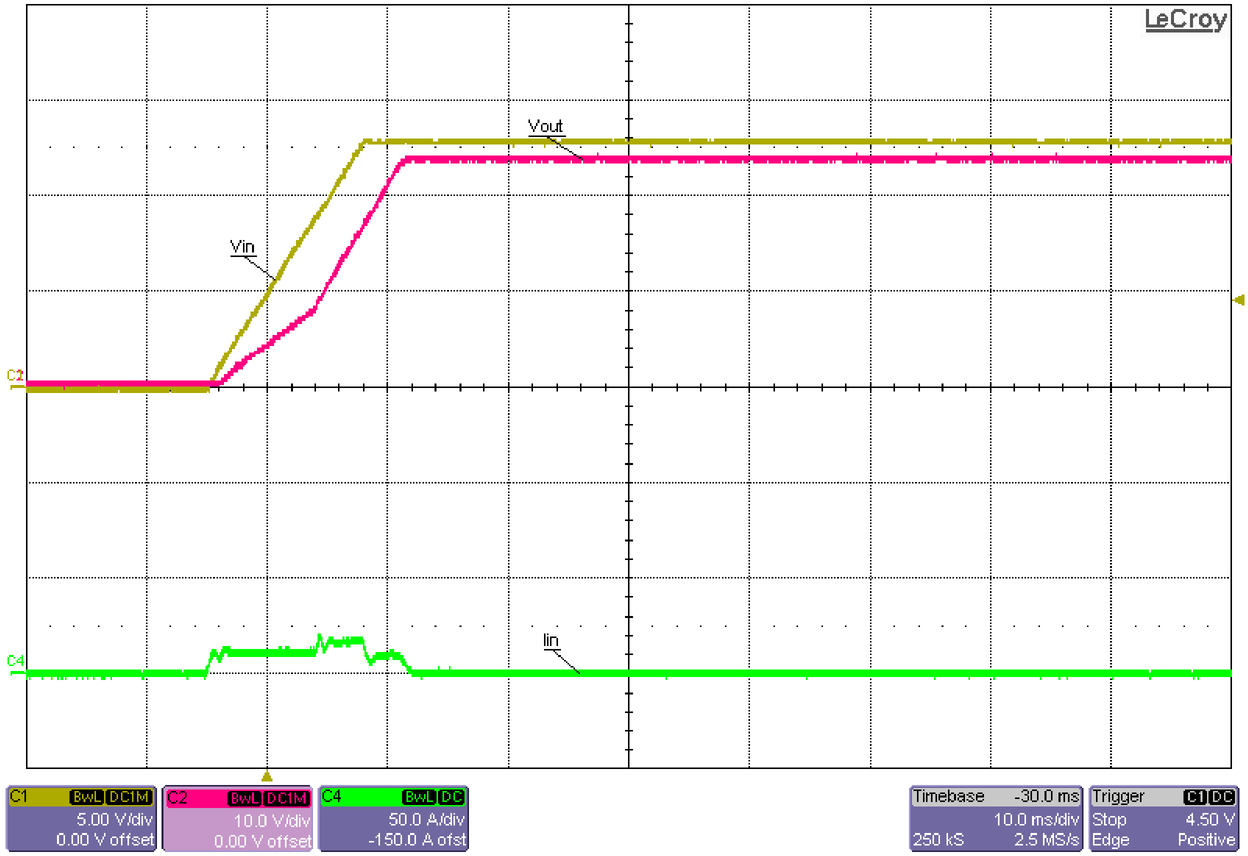
Startup



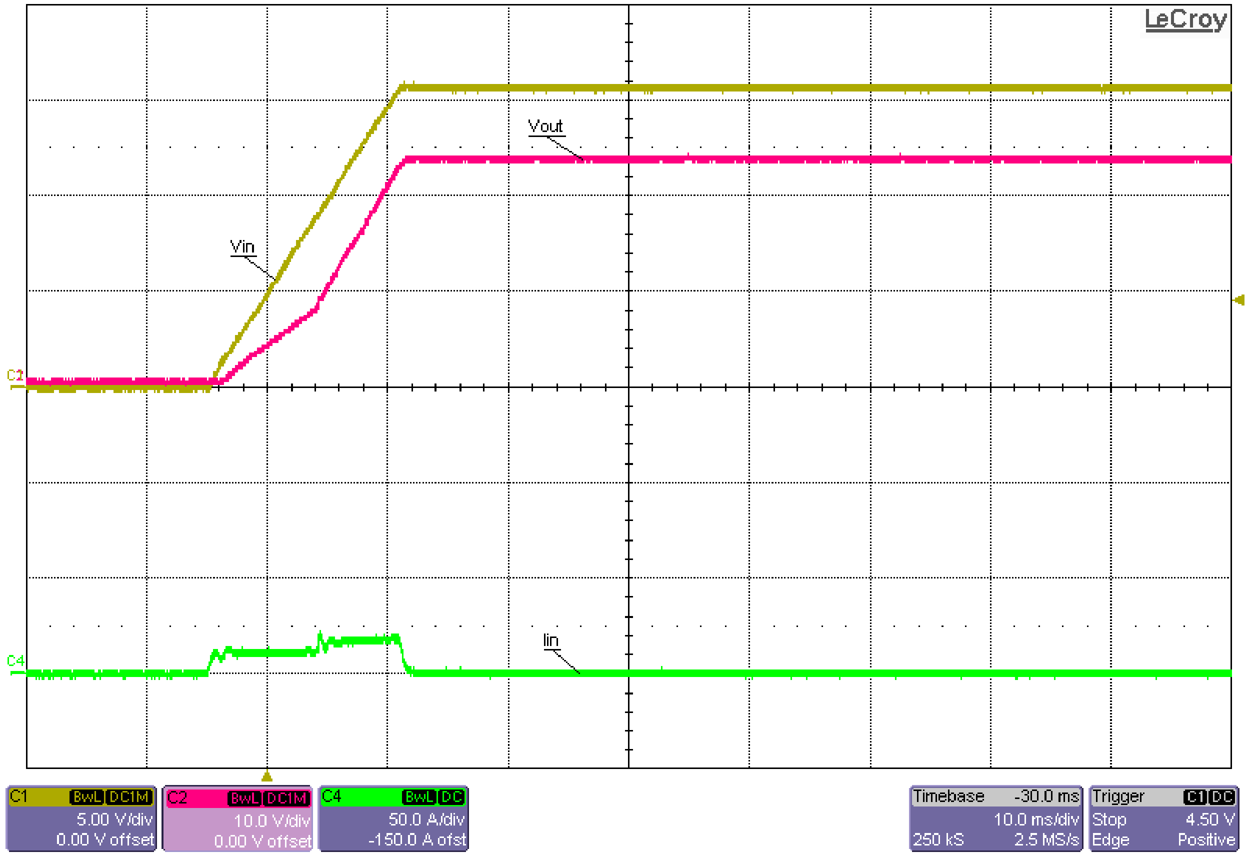
Startup into No Load (Vin = 9V)



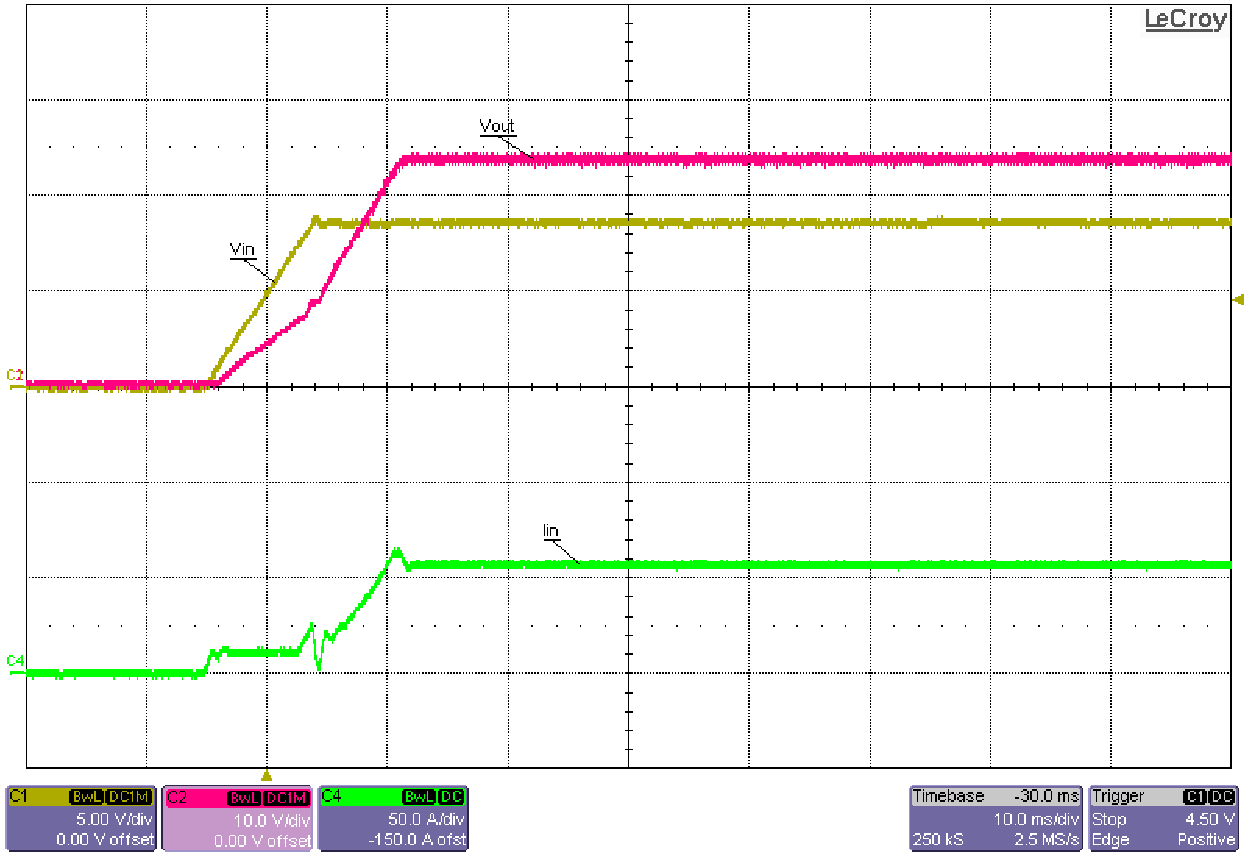
Startup into No Load (Vin = 11V)



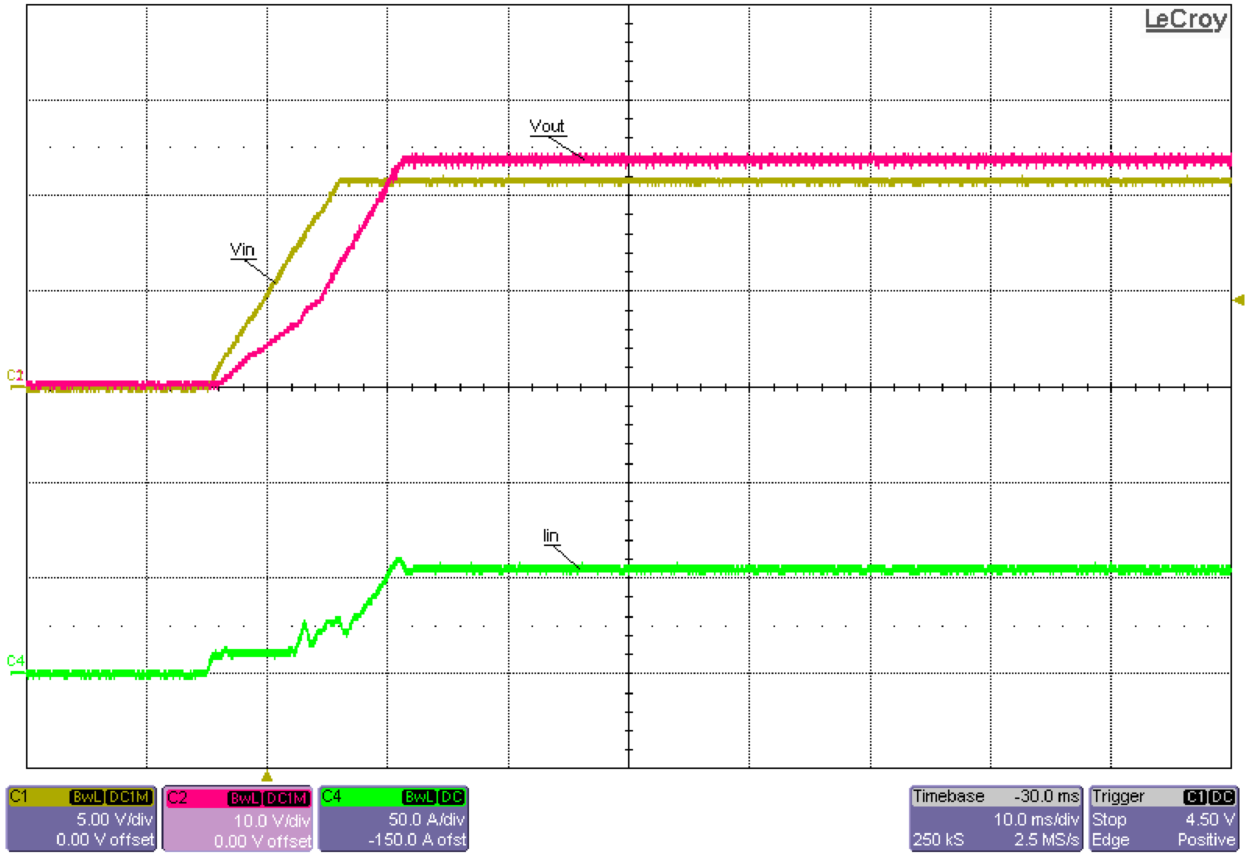
Startup into No Load (Vin = 13V)



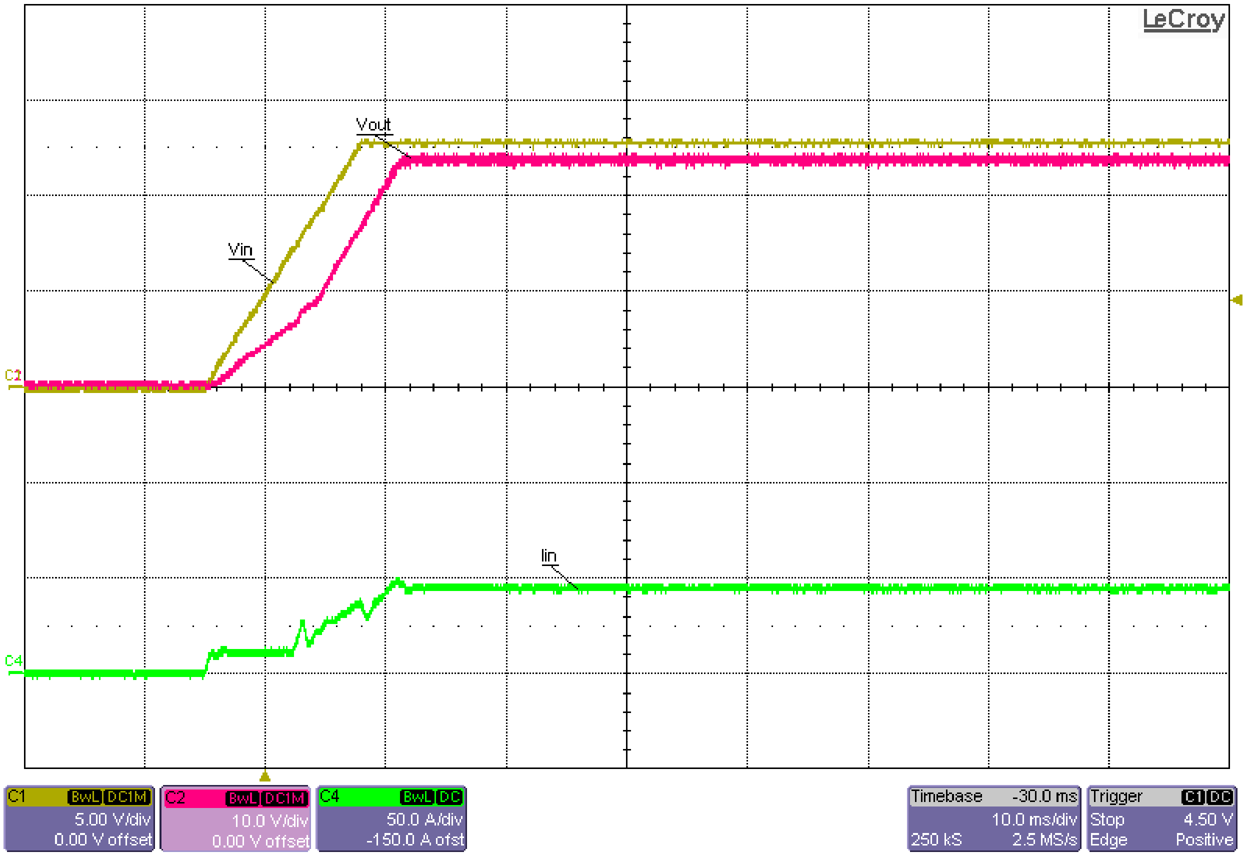
Startup into No Load (Vin = 16V)



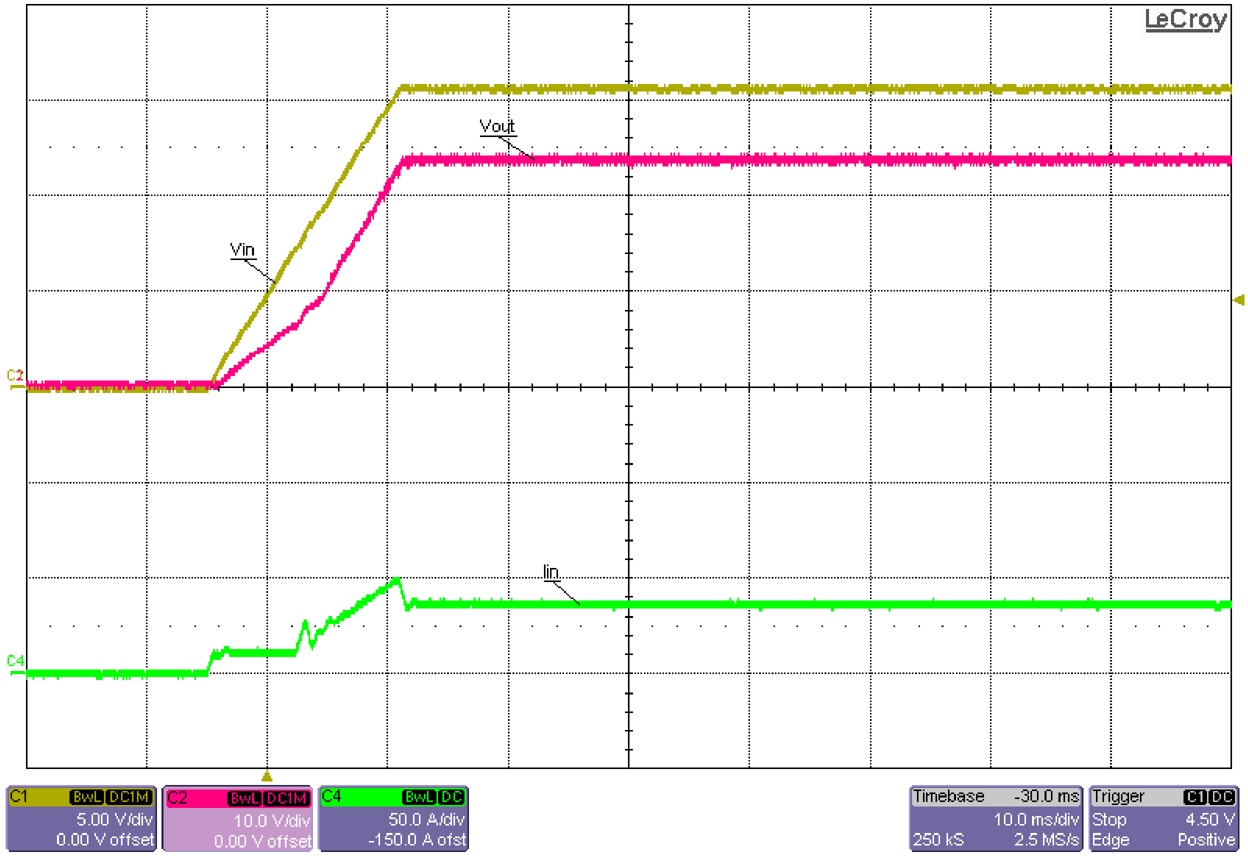
Startup into 21A Load (Vin = 9V) Note: Load current limited by available supply current limit.



Startup into Full (25A) Load (Vin = 11V)

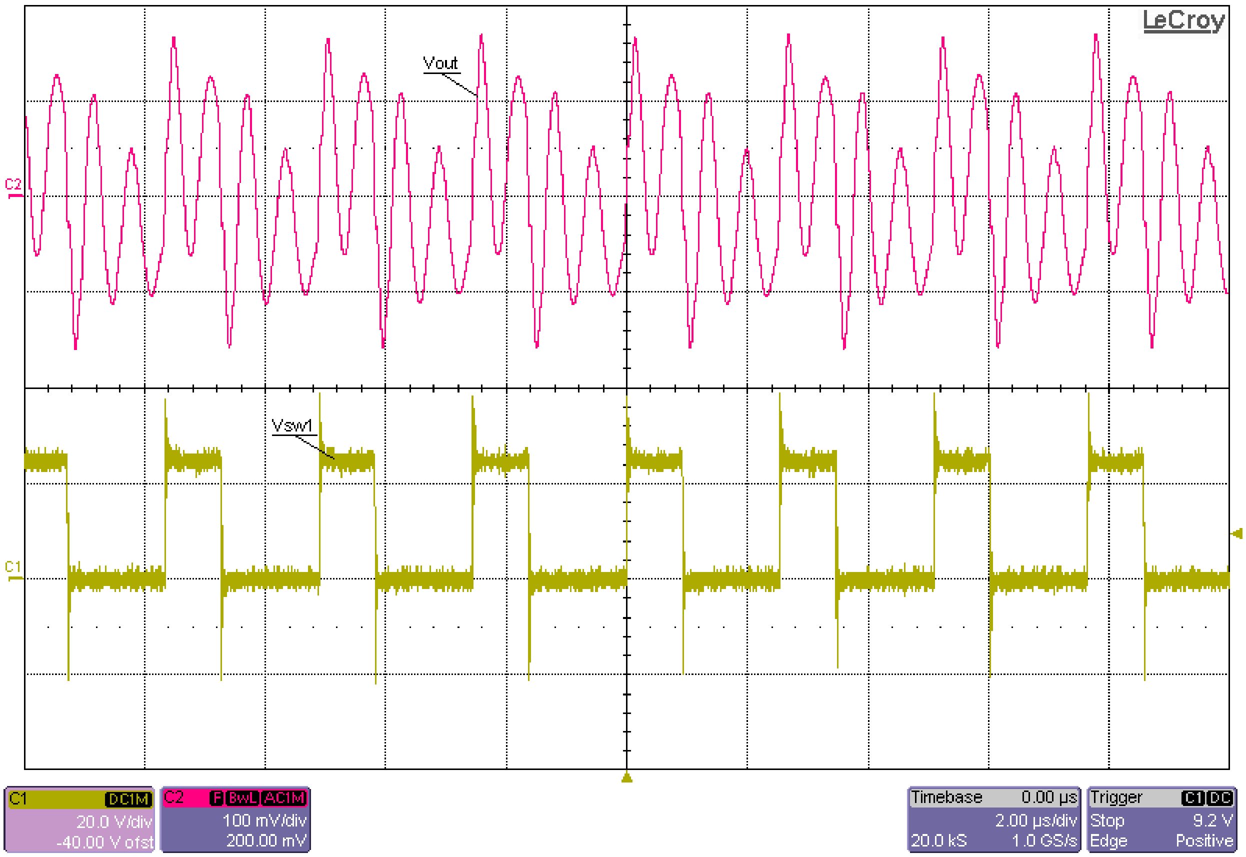


Startup into Full (25A) Load (Vin = 13V)

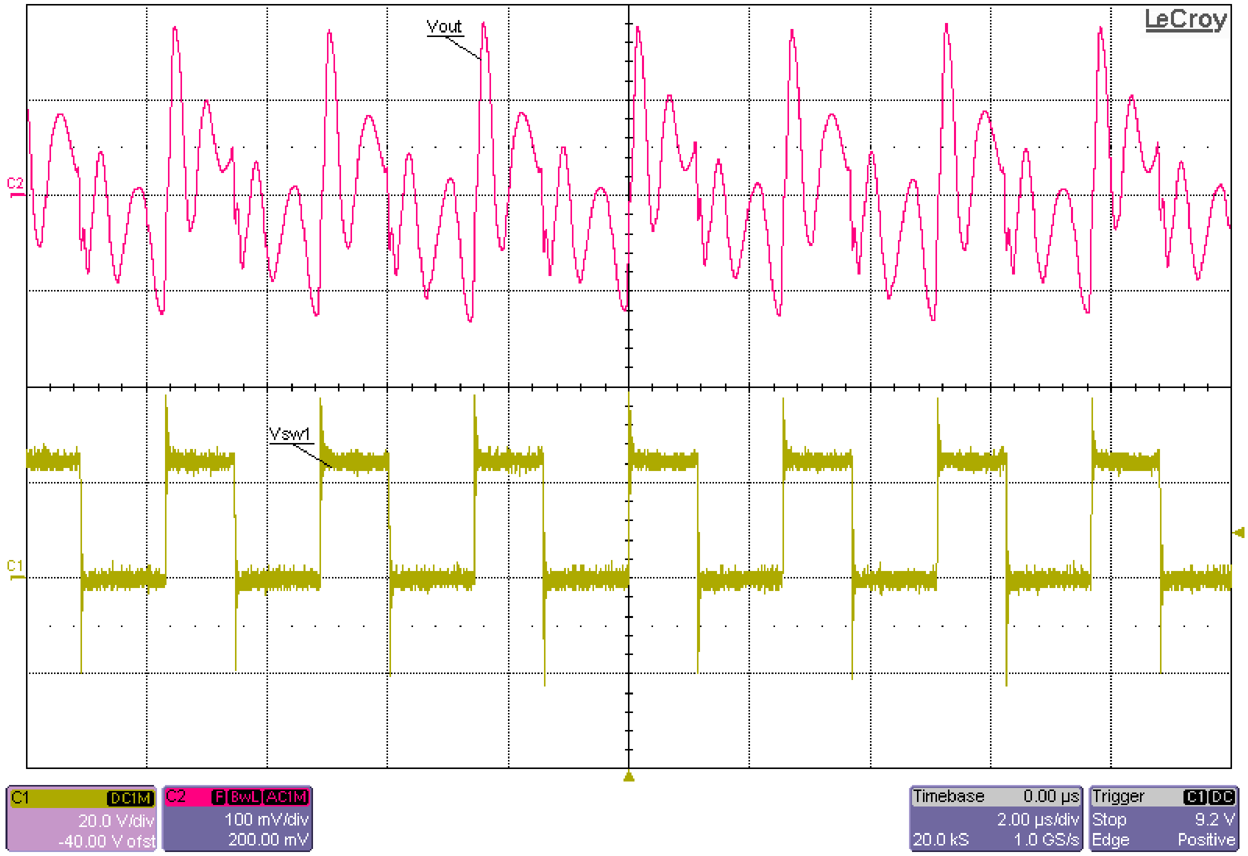


Startup into Full (25A) Load (Vin = 16V)

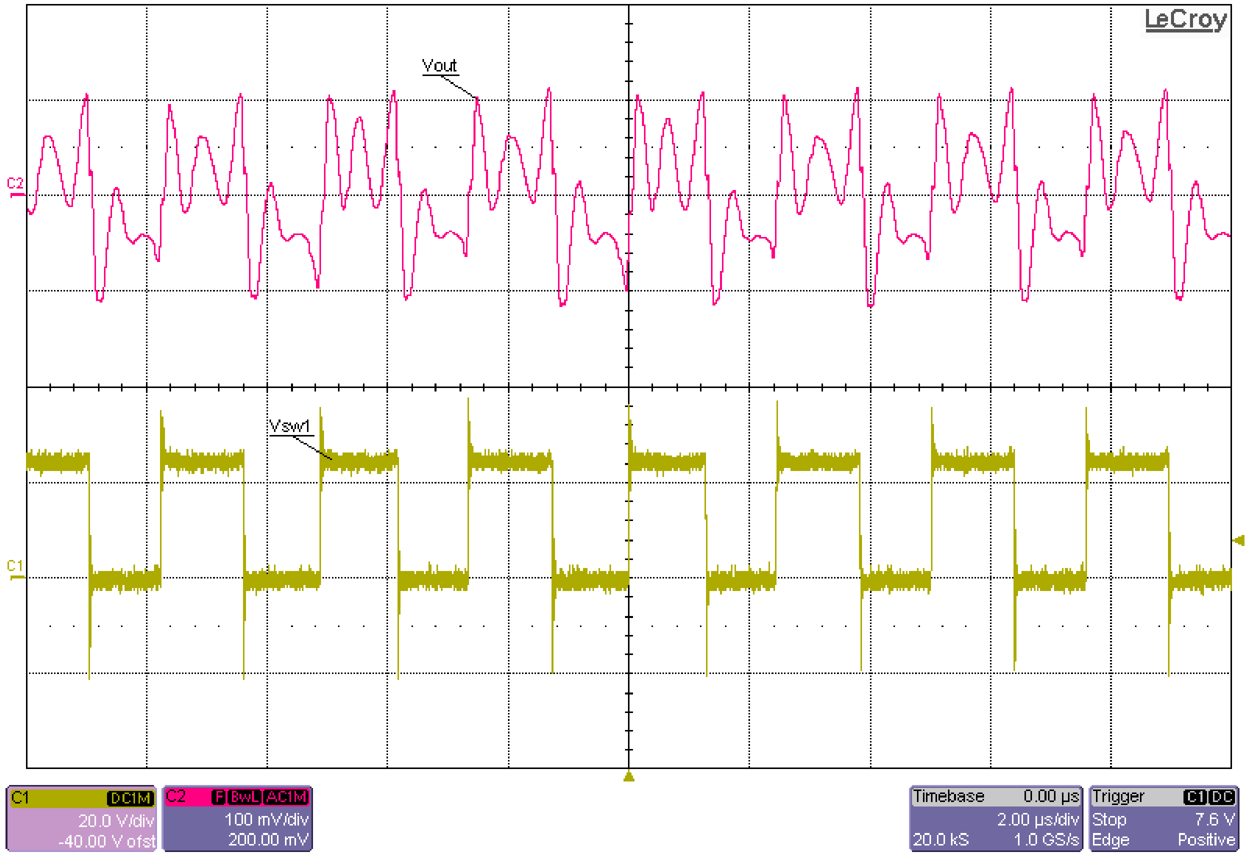
Output Voltage Ripple and Switch Node Voltage



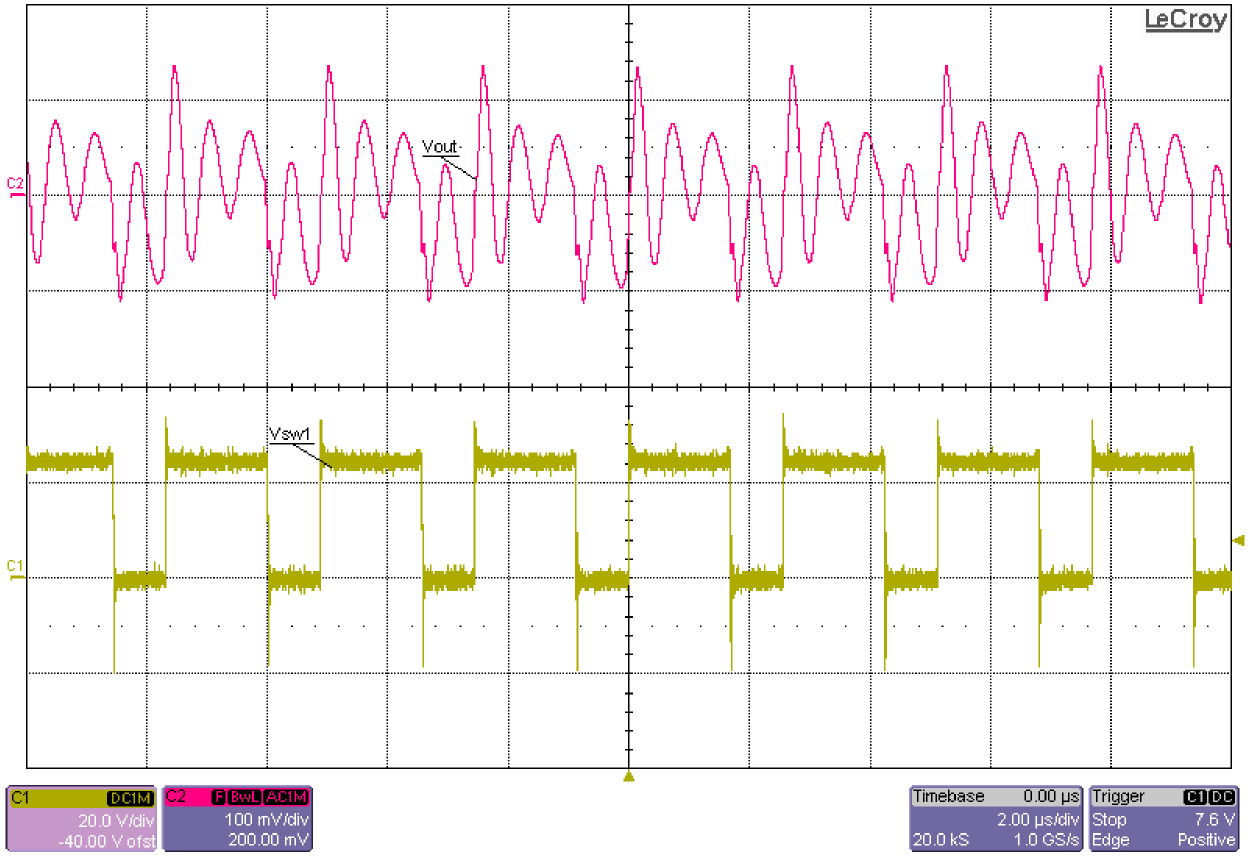
Output Voltage Ripple and Switch Node Voltage (Phase 1) at Vin = 9V and 21A Load (Vripple ≈ 330mVp-p)



Output Voltage Ripple and Switch Node Voltage (Phase 1) at Vin = 11V and 25A Load (Vripple ≈ 300mVp-p)

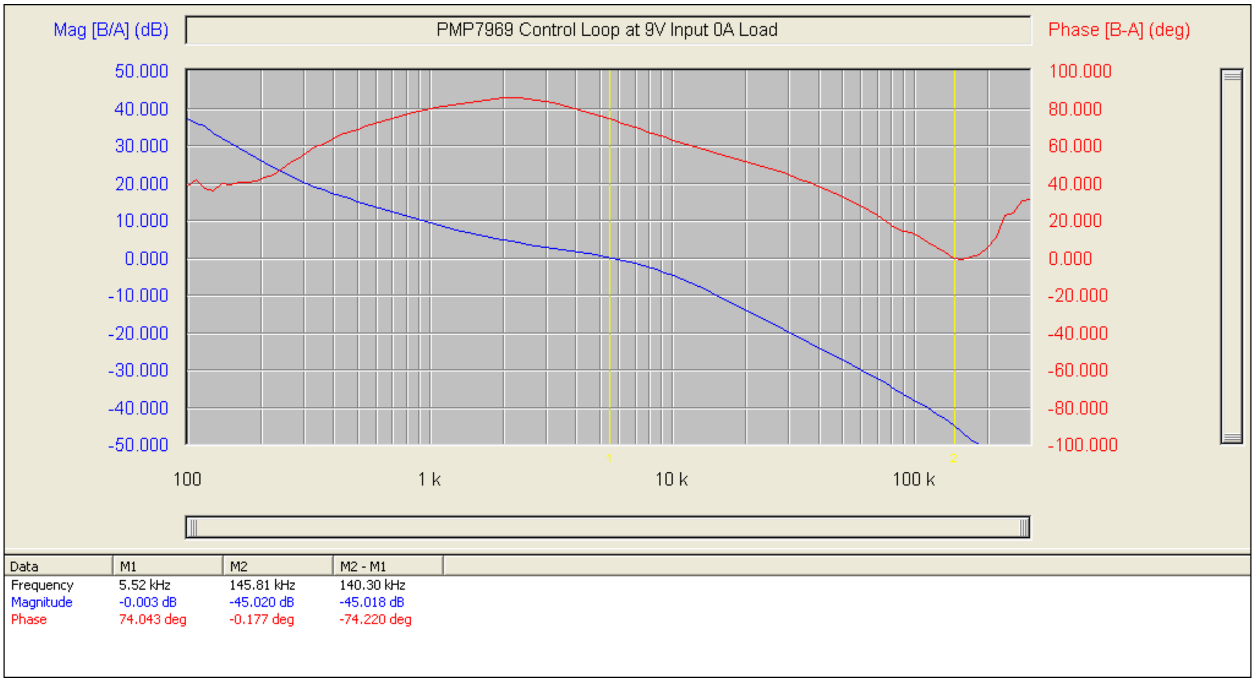


Output Voltage Ripple and Switch Node Voltage (Phase 1) at Vin = 13V and 25A Load (Vripple ≈ 230mVp-p)

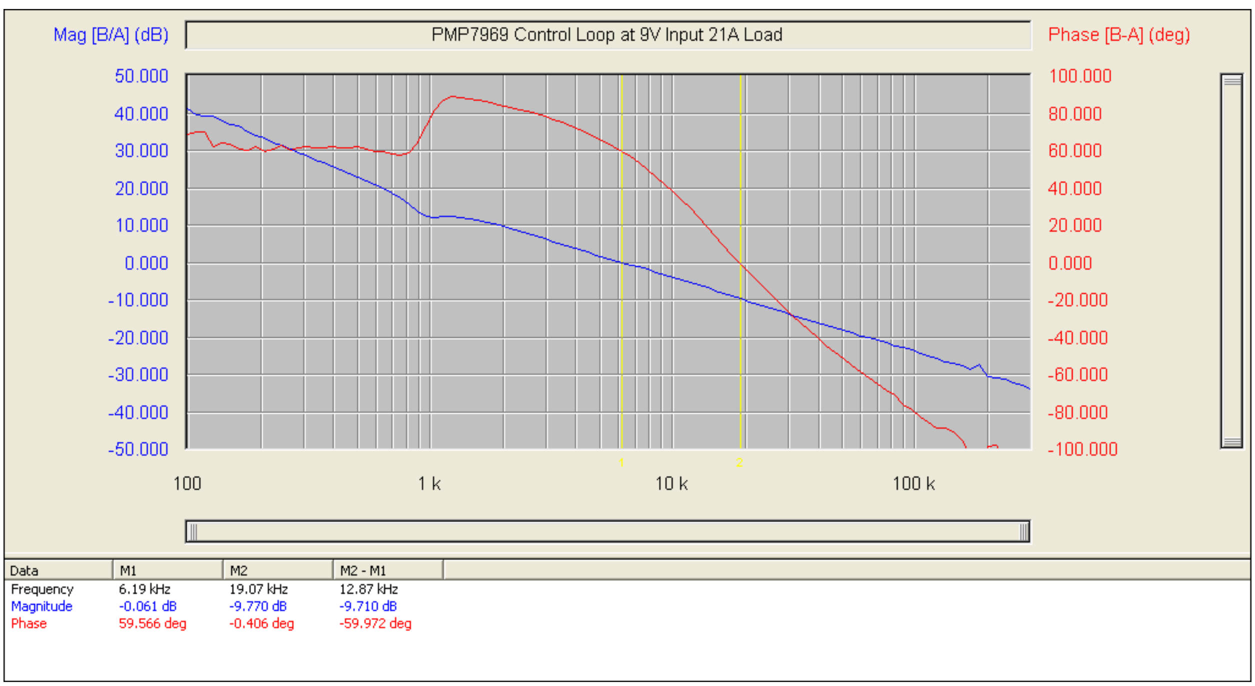


Output Voltage Ripple and Switch Node Voltage (Phase 1) at Vin = 16V and 25A Load (Vripple ≈ 245mVp-p)

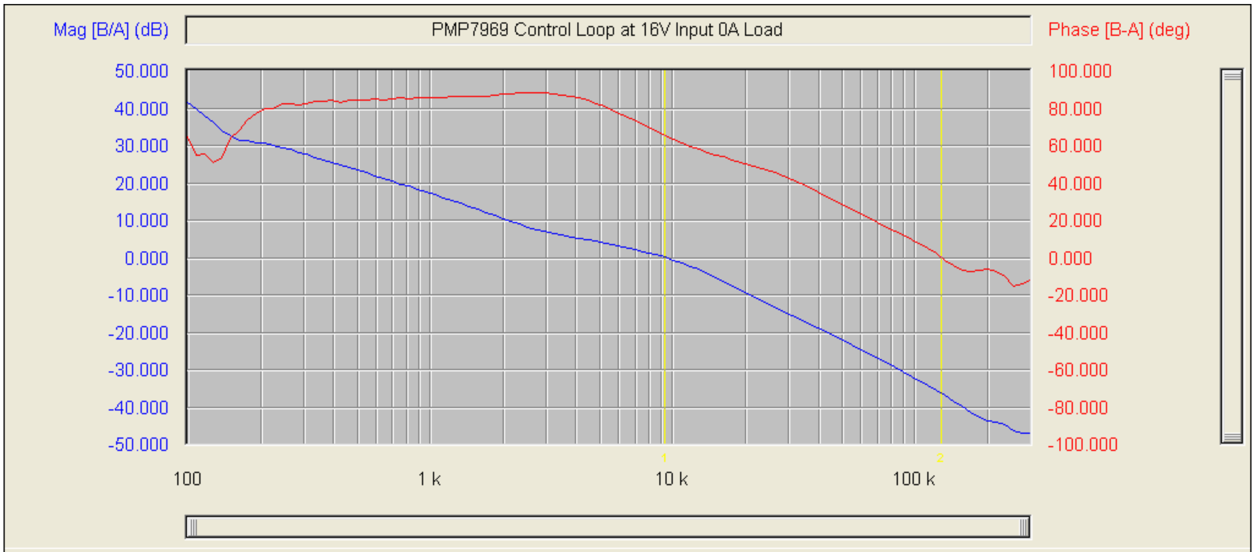
Control Loop Response



Control Loop Response at Vin = 9V and 0A Load; Phase Margin = 74 deg.; Gain Margin = -45 dB

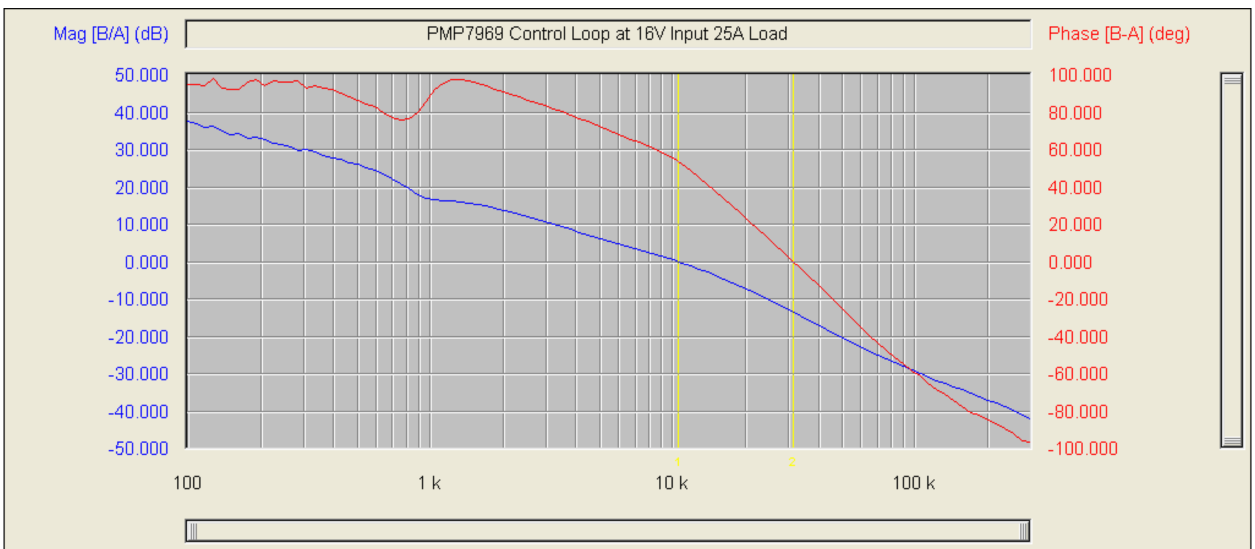


Control Loop Response at Vin = 9V and 21A Load; Phase Margin = 59.6 deg.; Gain Margin = -9.8 dB



Data	M1	M2	M2 - M1
Frequency	9.30 kHz	128.53 kHz	119.23 kHz
Magnitude	-0.001 dB	-36.312 dB	-36.310 dB
Phase	65.368 deg	-0.040 deg	-65.408 deg

Control Loop Response at Vin = 16V and 0A Load; Phase Margin = 65.4 deg.; Gain Margin = -36.3 dB



Data	M1	M2	M2 - M1
Frequency	10.54 kHz	31.58 kHz	21.04 kHz
Magnitude	-0.049 dB	-13.529 dB	-13.480 dB
Phase	53.332 deg	-0.176 deg	-53.507 deg

Control Loop Response at Vin = 16V and 25A Load; Phase Margin = 53.3 deg.; Gain Margin = -13.5 dB

Current Sharing

Test Condition = 16Vin and 25A Load	
Phase	**Current (A)**
Phase 1 (Master)	12.27
Phase 2	9.27
Phase 3	8.7
Phase 4	8.23

Current Cutoff Data

Input Voltage (V)	Enabled Phase	Cutoff Current (A)
16	Phase 1 Only (Master)	23.542
22	Phase 1 Only (Master)	24.87
16	Phase 1 (Master) and Phase 2	44.459
22	Phase 1 (Master) and Phase 2	46.062
16	Phase 1 (Master) and Phase 3	42.653
22	Phase 1 (Master) and Phase 3	45.128
16	Phase 1 (Master) and Phase 4	42.532
22	Phase 1 (Master) and Phase 4	45.617
N/A*	All four phases	N/A (Overcurrent hiccup should take place, but is not tested*)

***NOTE: The above cutoff current tests were performed at 16Vin and 22Vin and with only one or two phases enabled due to the current limitations of the input supply used/available. The term "cutoff current" implies that the controllers stopped switching at the noted input current values. During this time all FETs are OFF and the currents pass through the body diodes of all four synchronous FETs from the input to the output load. Hiccup mode should be enabled and working only with all four phases being enabled. This has not been tested, though, due to the current limitation of the input supply used.**