

**Test Data  
For PMP20904 Negative Buck  
6/30/2017**



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## 1. Design Specifications

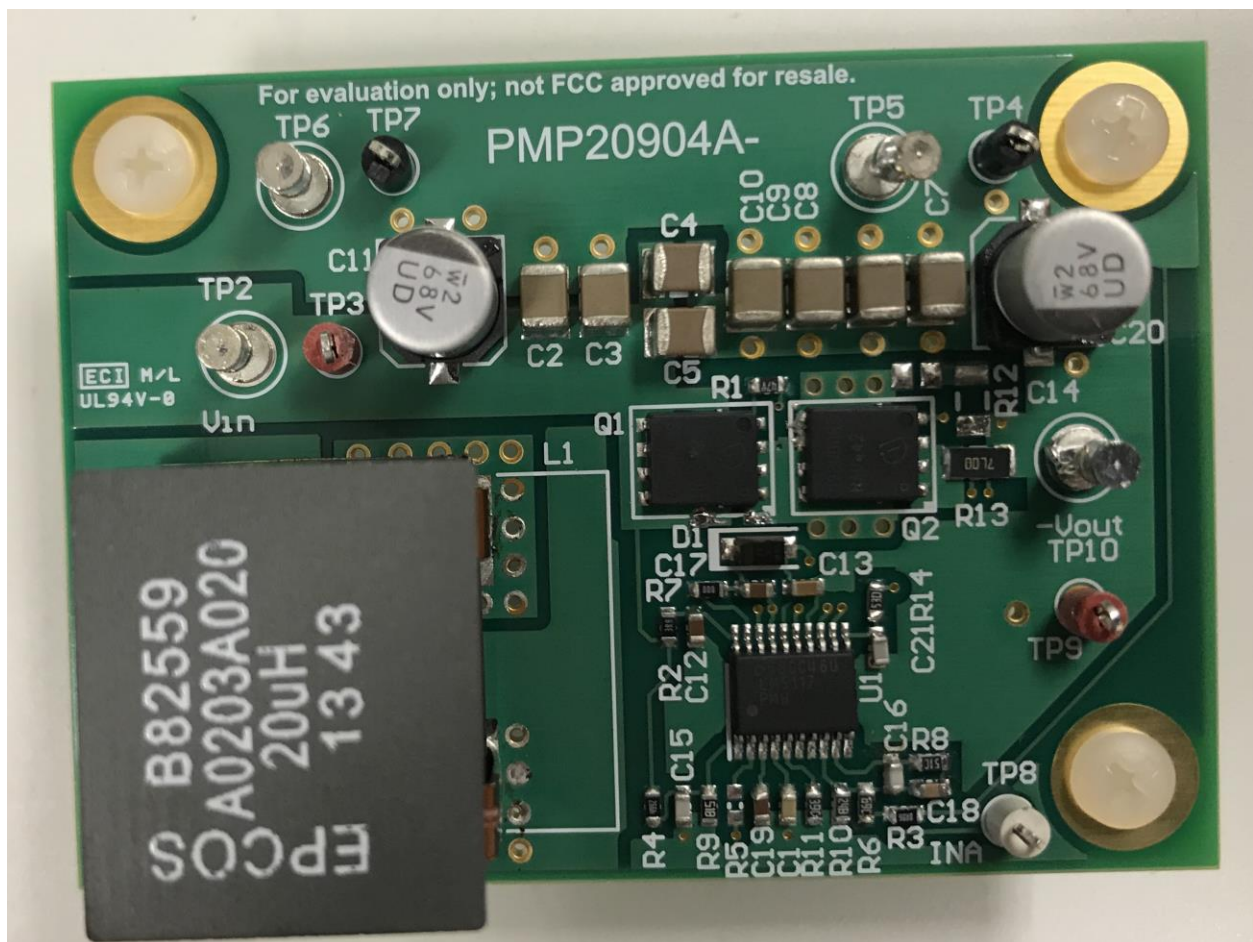
Vin Minimum	21.6VDC
Vin Maximum	26.4VDC
Vout	-24VDC @ 4A
Nominal Switching Frequency	≈ 200KHz

## 2. Circuit Description

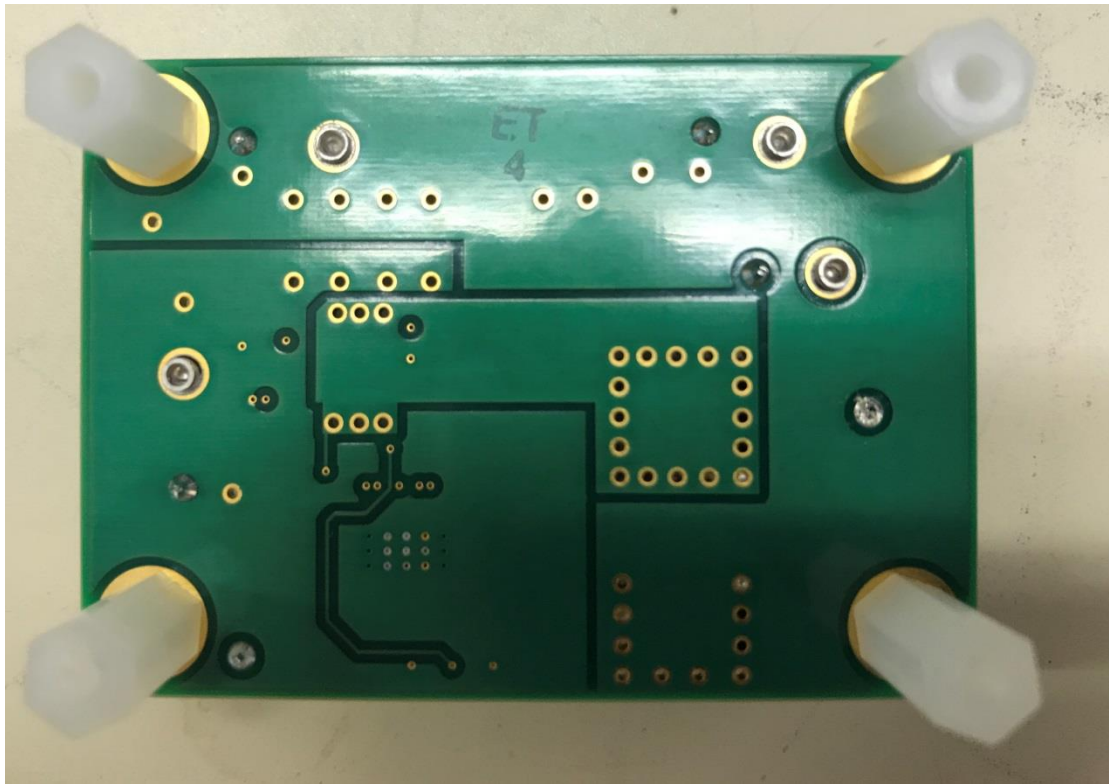
PMP20904 is a negative buck utilizing the LM5117 controller for industrial applications. This design can operate at 24Vin at +/-10%. The design has an output of -24V and capable of sourcing 2A continuous current and up to 4A transient. Switching frequency is set to 200kHz, and a 4 layer PCB is used.

## 3. Board Photo

Board Dimensions: 62.2mm x 44.5mm



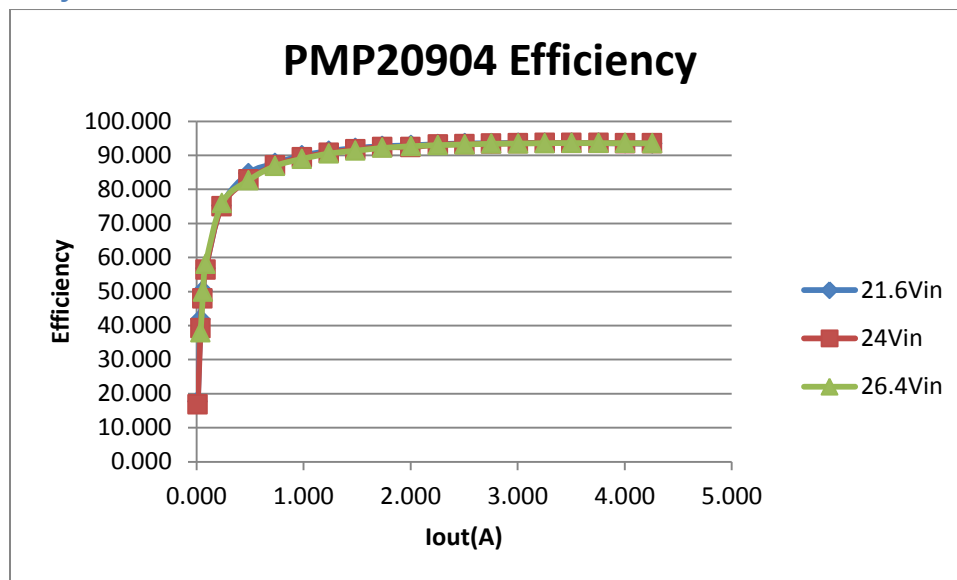
Board Photo (Top)



Board Photo (Bottom)

## 4 Efficiency

### 4.1 Efficiency Chart

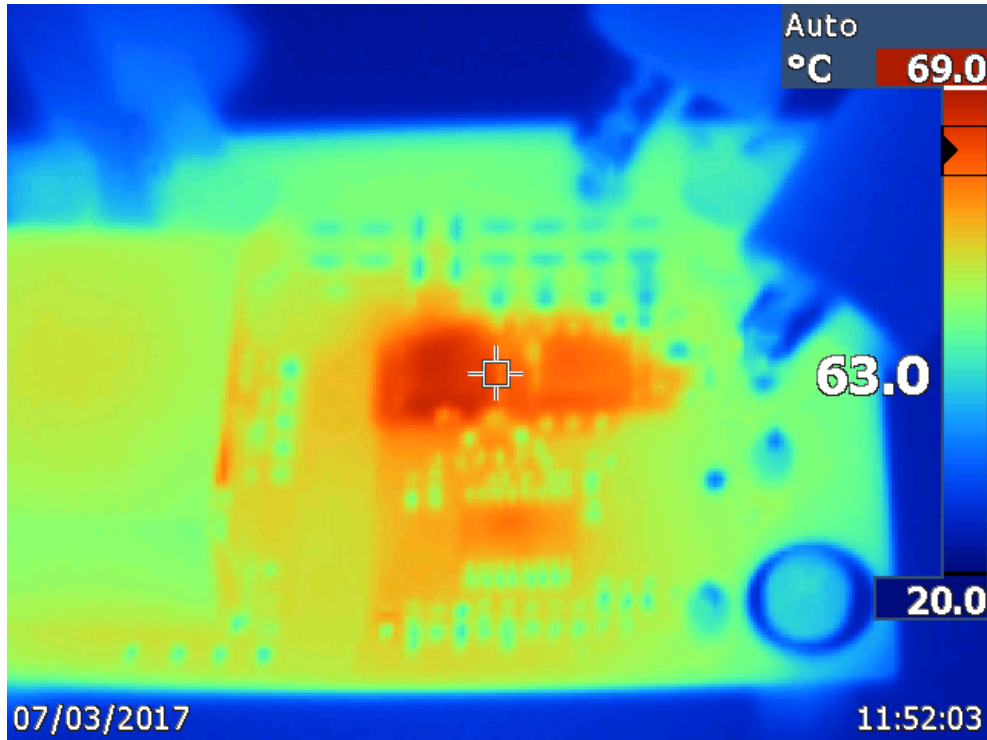


## 4.2 Efficiency Data

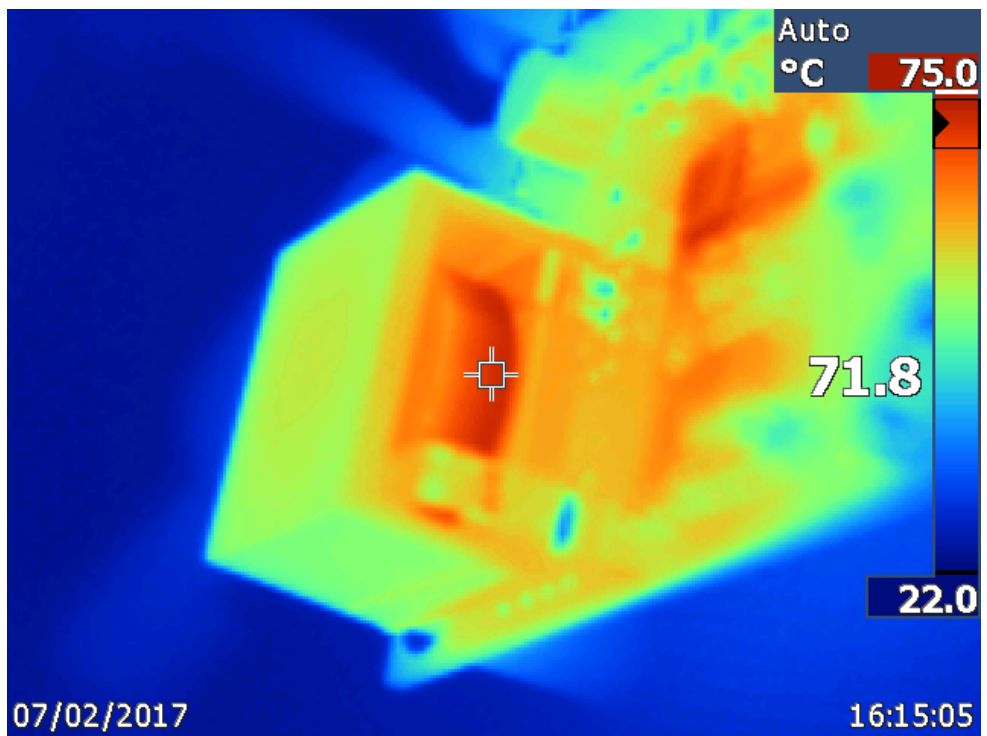
Vin(V)	Iin(A)	Vout(V)	Iout(A)	Pin(W)	Pout(W)	Ploss(W)	Efficiency
21.607	0.032	24.242	0.000	0.691	0.000	0.982	0.000
21.607	0.076	24.243	0.012	1.642	0.291	1.351	17.716
21.607	0.102	24.244	0.038	2.204	0.921	1.283	41.801
21.607	0.134	24.244	0.060	2.895	1.455	1.441	50.241
21.607	0.170	24.244	0.086	3.673	2.085	1.588	56.763
21.607	0.352	24.245	0.236	7.606	5.722	1.884	75.231
21.607	0.644	24.245	0.486	13.915	11.783	2.131	84.682
21.606	0.942	24.246	0.736	20.353	17.845	2.508	87.677
21.606	1.230	24.246	0.986	26.575	23.906	2.669	89.956
21.606	1.520	24.245	1.236	32.841	29.966	2.875	91.246
21.605	1.810	24.244	1.486	39.106	36.027	3.079	92.127
21.605	2.102	24.244	1.736	45.413	42.087	3.326	92.676
21.604	2.422	24.244	2.006	52.326	48.633	3.694	92.941
21.604	2.714	24.243	2.256	58.633	54.693	3.941	93.279
21.604	3.008	24.243	2.506	64.984	60.752	4.231	93.488
21.603	3.306	24.242	2.756	71.420	66.812	4.608	93.548
21.602	3.602	24.242	3.006	77.811	72.872	4.939	93.653
21.601	3.902	24.242	3.256	84.288	78.932	5.356	93.645
21.600	4.202	24.242	3.506	90.765	84.992	5.773	93.640
21.600	4.504	24.242	3.756	97.285	91.053	6.233	93.593
21.599	4.808	24.242	4.006	103.849	97.113	6.736	93.514
21.598	5.114	24.242	4.258	110.452	103.220	7.232	93.453
21.597	5.420	24.241	4.506	117.055	109.230	7.825	93.315
21.596	5.730	24.241	4.756	123.746	115.289	8.457	93.166
21.595	6.042	24.240	5.006	130.478	121.347	9.130	93.003
24.013	0.038	24.255	0.000	0.912	0.000	1.204	0.000
24.013	0.072	24.255	0.012	1.729	0.291	1.438	16.835
24.013	0.098	24.256	0.038	2.353	0.922	1.432	39.168
24.013	0.118	24.256	0.056	2.834	1.358	1.475	47.938
24.013	0.154	24.256	0.086	3.698	2.086	1.612	56.410
24.012	0.318	24.256	0.236	7.636	5.724	1.912	74.967
24.012	0.592	24.256	0.486	14.215	11.788	2.427	82.928
24.012	0.854	24.256	0.736	20.506	17.852	2.654	87.058
24.012	1.114	24.256	0.986	26.749	23.916	2.833	89.409
24.012	1.376	24.254	1.236	33.040	29.978	3.062	90.734
24.011	1.636	24.254	1.486	39.282	36.041	3.241	91.750
24.011	1.898	24.253	1.736	45.573	42.104	3.469	92.387

24.010	2.184	24.253	1.998	52.438	48.457	3.981	92.409
24.010	2.446	24.252	2.256	58.728	54.713	4.016	93.162
24.010	2.712	24.251	2.504	65.114	60.725	4.389	93.260
24.009	2.978	24.251	2.754	71.499	66.787	4.711	93.411
24.009	3.244	24.250	3.004	77.884	72.848	5.037	93.533
24.007	3.512	24.250	3.256	84.314	78.959	5.355	93.648
24.007	3.782	24.250	3.504	90.793	84.971	5.822	93.587
24.006	4.054	24.249	3.756	97.322	91.079	6.242	93.586
24.006	4.326	24.249	4.006	103.848	97.142	6.706	93.542
24.005	4.598	24.249	4.256	110.374	103.202	7.172	93.502
24.004	4.874	24.248	4.506	116.995	109.263	7.731	93.392
24.003	5.152	24.248	4.756	123.664	115.324	8.340	93.256
24.002	5.430	24.248	5.006	130.331	121.384	8.947	93.135
26.413	0.052	24.261	0.000	1.373	0.000	1.373	0.000
26.413	0.092	24.261	0.038	2.430	0.922	1.508	37.939
26.413	0.114	24.261	0.062	3.011	1.504	1.507	49.955
26.413	0.136	24.261	0.086	3.592	2.086	1.506	58.083
26.413	0.288	24.261	0.238	7.607	5.774	1.833	75.906
26.413	0.540	24.260	0.486	14.263	11.790	2.473	82.665
26.412	0.778	24.261	0.736	20.549	17.856	2.693	86.896
26.412	1.018	24.261	0.986	26.888	23.921	2.967	88.966
26.412	1.256	24.260	1.238	33.173	30.034	3.140	90.536
26.412	1.494	24.259	1.486	39.459	36.049	3.410	91.359
26.411	1.730	24.258	1.736	45.691	42.112	3.580	92.166
26.411	1.988	24.258	2.006	52.505	48.661	3.844	92.679
26.411	2.228	24.257	2.256	58.843	54.724	4.119	93.000
26.410	2.470	24.256	2.506	65.234	60.786	4.447	93.183
26.410	2.710	24.256	2.756	71.571	66.849	4.722	93.402
26.409	2.954	24.255	3.006	78.013	72.912	5.101	93.462
26.409	3.196	24.254	3.256	84.402	78.972	5.430	93.567
26.408	3.440	24.254	3.506	90.843	85.036	5.808	93.607
26.407	3.686	24.254	3.756	97.336	91.098	6.238	93.591
26.407	3.932	24.254	4.006	103.832	97.161	6.671	93.575
26.406	4.182	24.254	4.258	110.431	103.272	7.158	93.518
26.405	4.430	24.253	4.506	116.975	109.286	7.689	93.427
26.405	4.680	24.253	4.756	123.574	115.347	8.227	93.343
26.404	4.932	24.253	5.006	130.226	121.410	8.816	93.230

## 5 Thermal



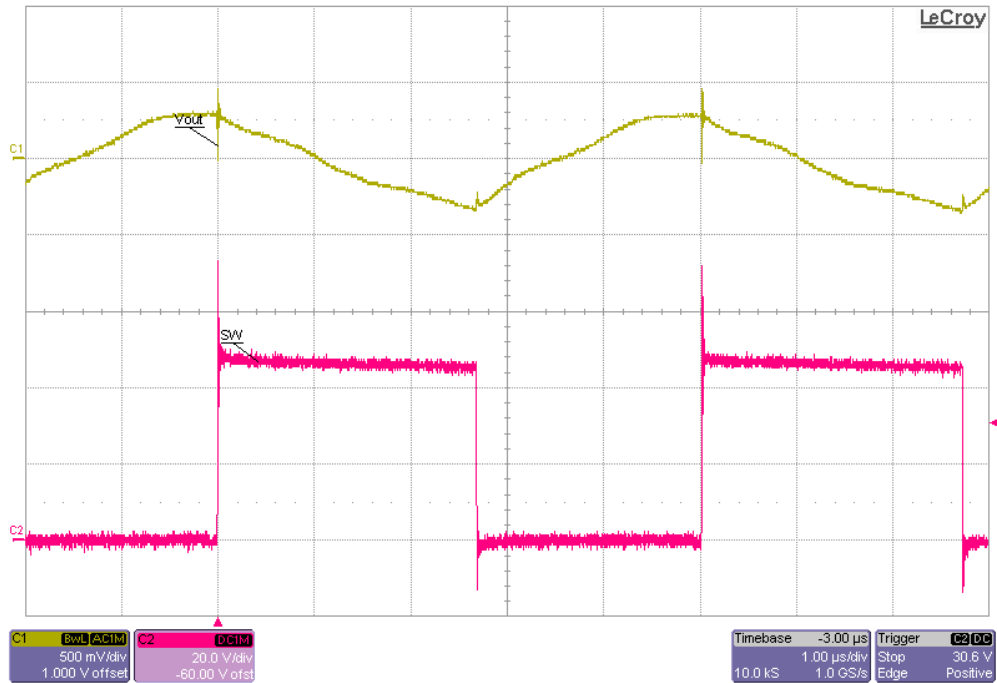
Thermal equilibrium was taken at 24Vin, 2A load on -24Vout. No air flow.



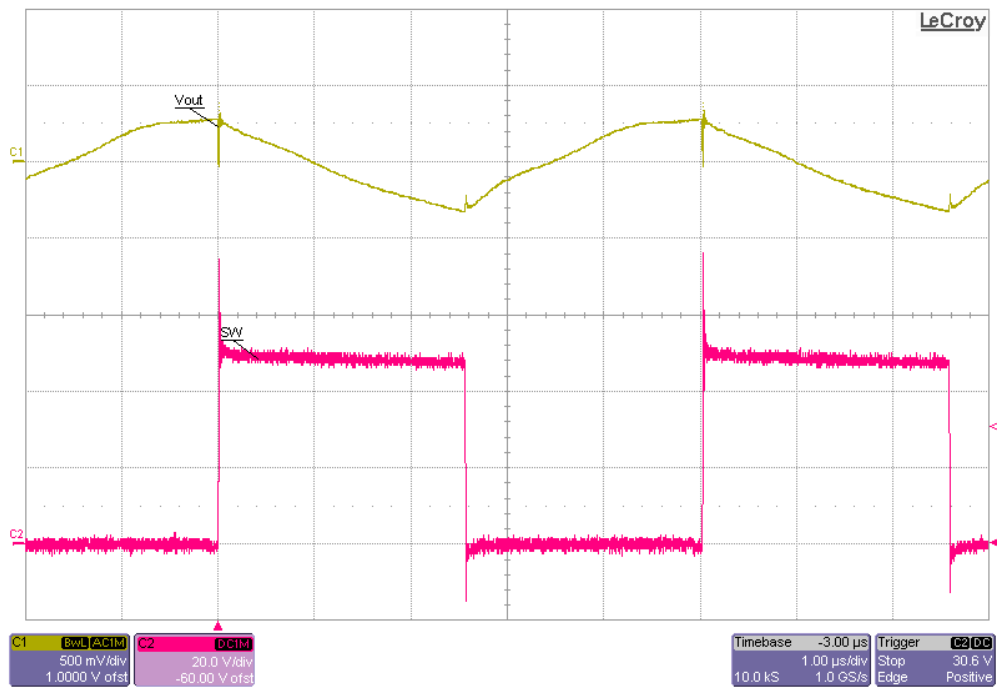
Thermal equilibrium was taken at 24Vin, 2A load on -24Vout. No air flow.

## 6 Waveforms

### 6.1 Switching Waveform and Output Ripple

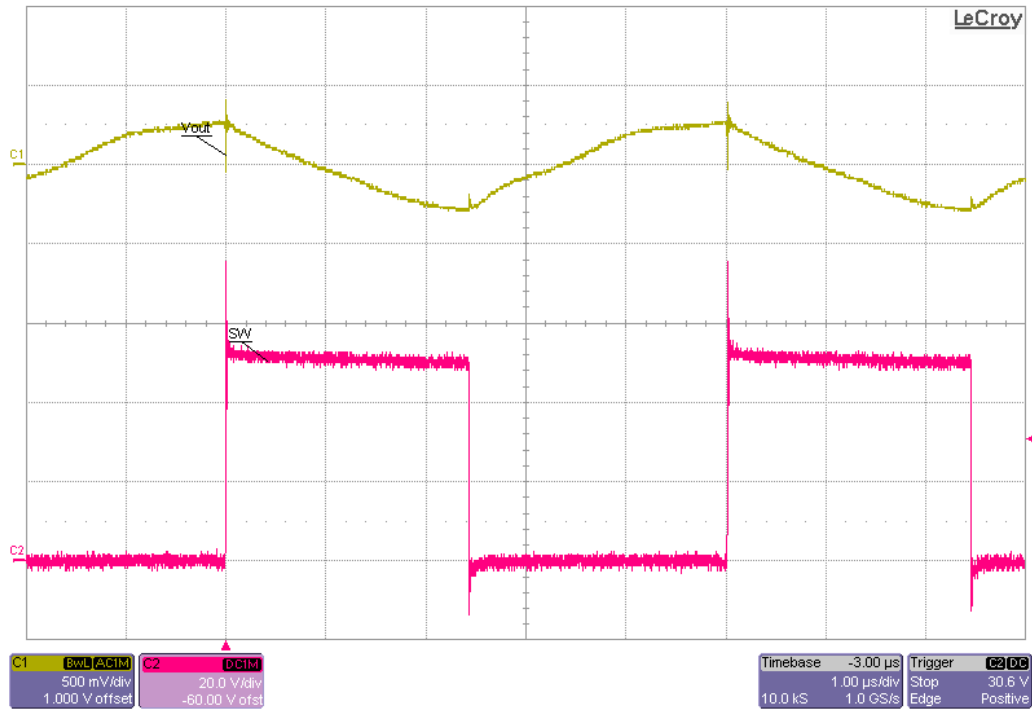


21.6Vin, full load. Ch1 measures Vout, Ch2 measures switch.



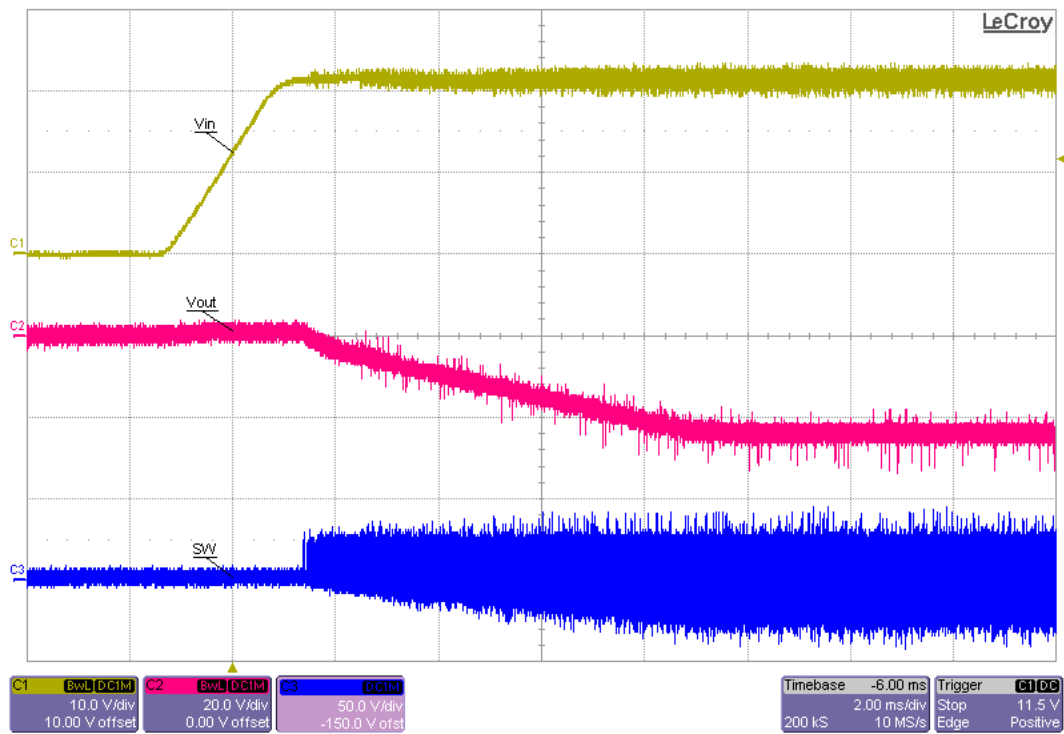
24Vin, full load. Ch1 measures Vout, Ch2 measures switch.



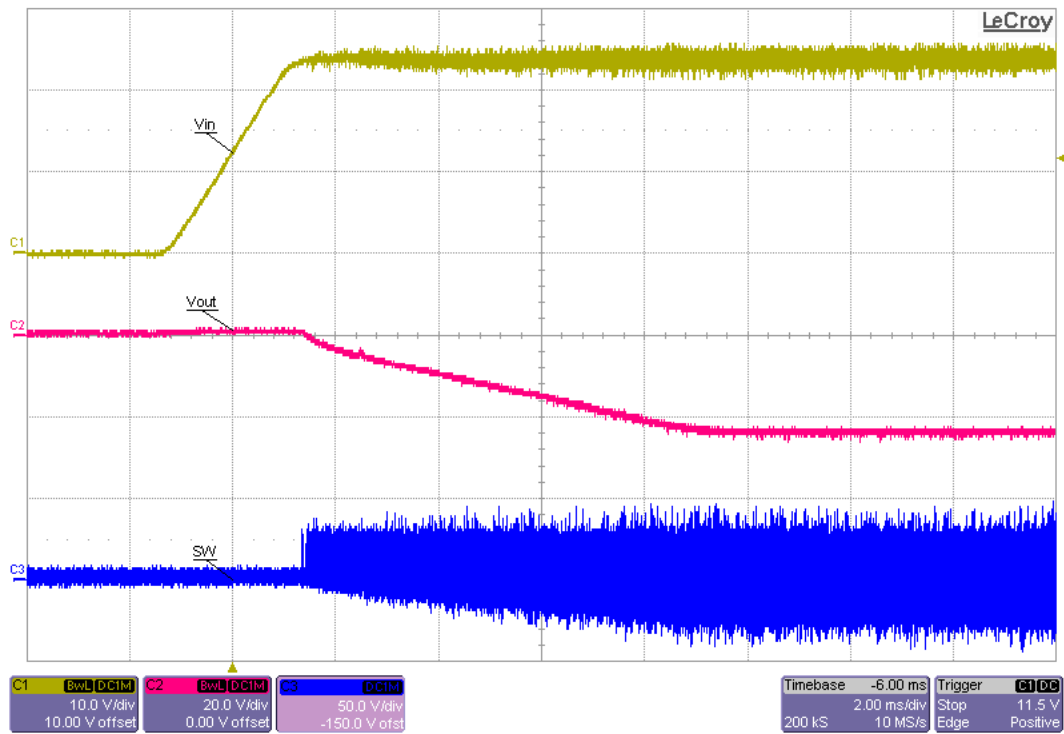


26.4Vin, full load. Ch1 measures Vout, Ch2 measures switch.

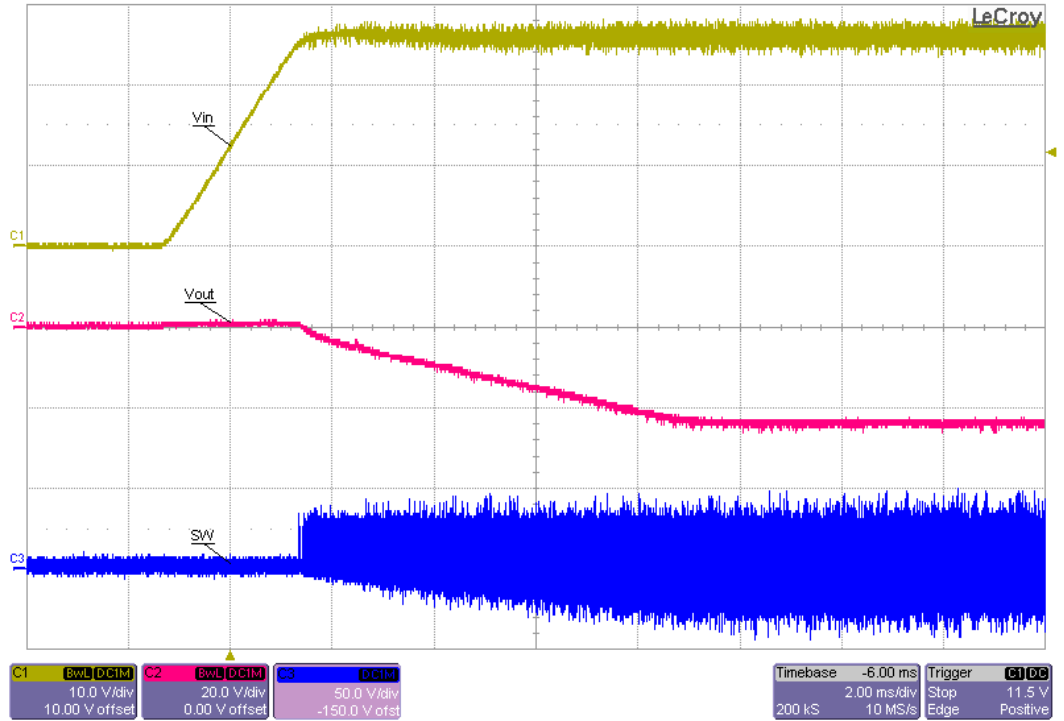
### 6.2 Start Up



21.6Vin, full load start up from Vin. Ch1 measures Vin, Ch2 measures Vout, and Ch3 measures switch.

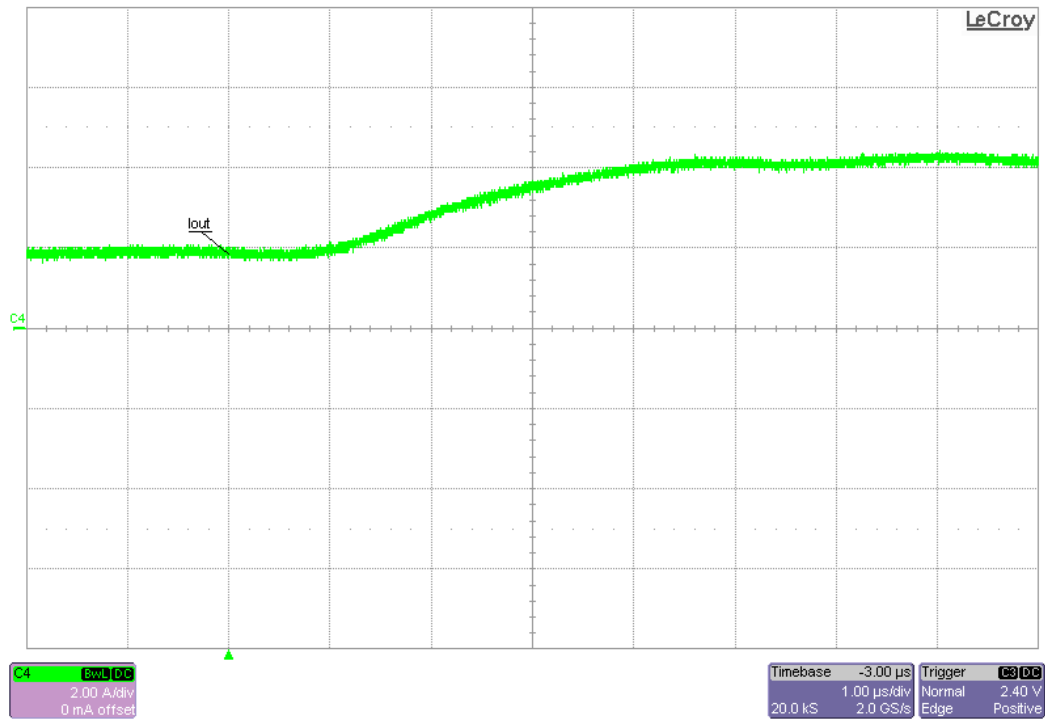


24Vin, full load start up from Vin. Ch1 measures Vin, Ch2 measures Vout, and Ch3 measures switch.

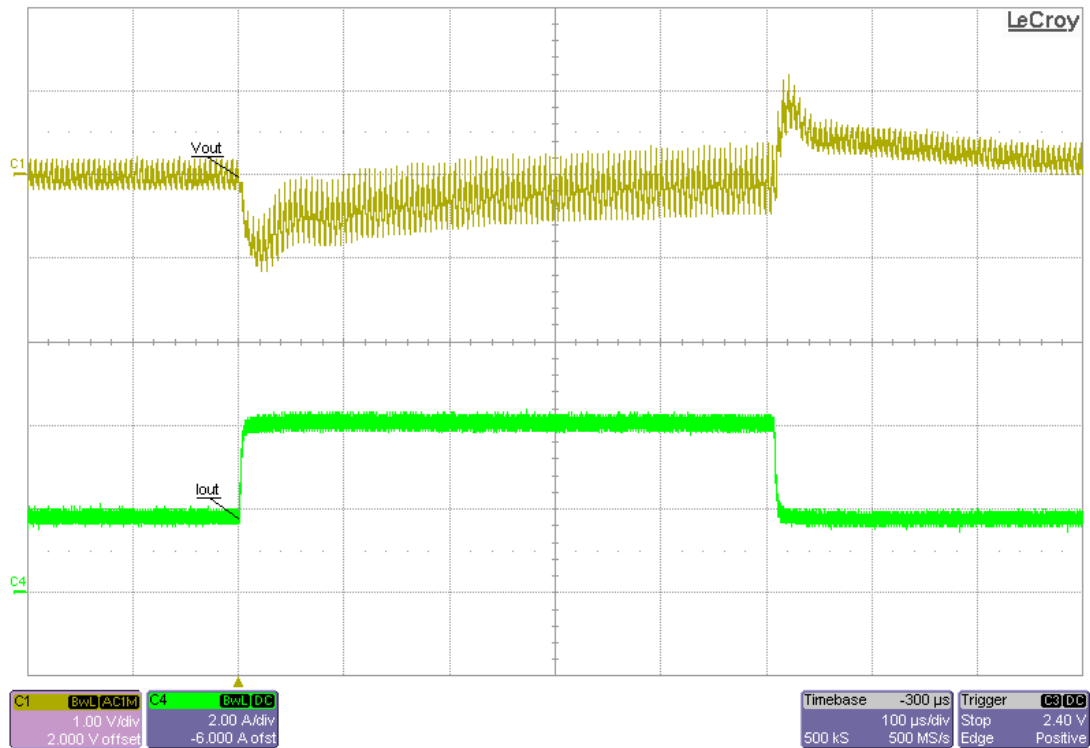


26.4Vin, full load start up from Vin. Ch1 measures Vin, Ch2 measures Vout, and Ch3 measures switch.

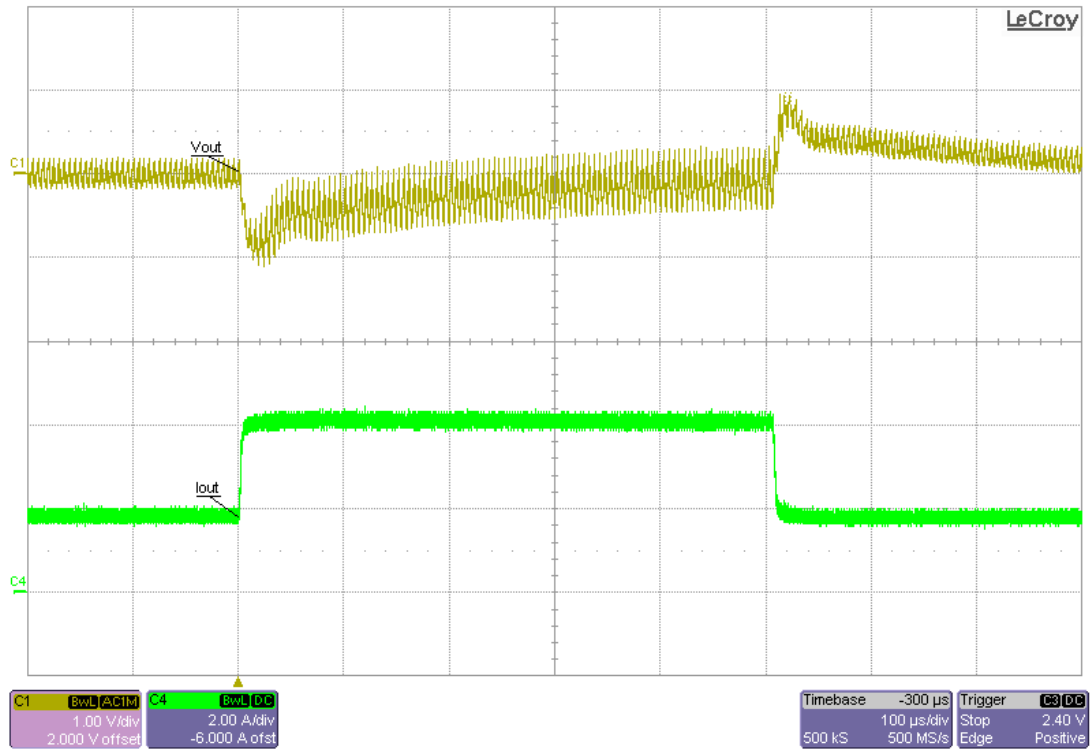
### 6.3 Transient Response



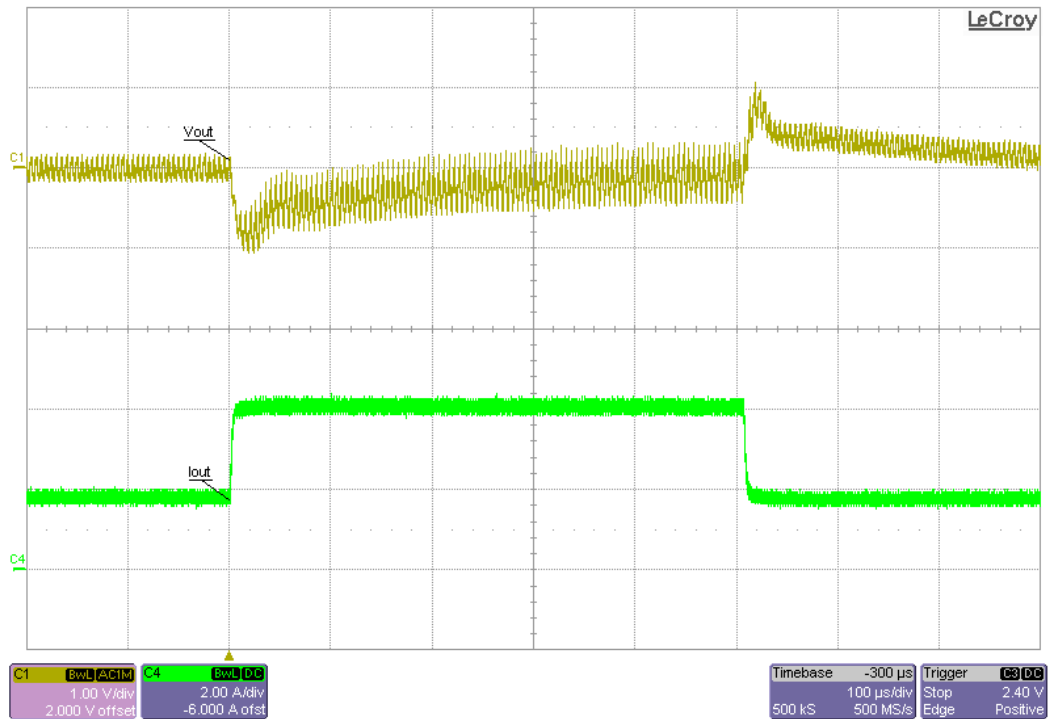
Ch4 measures load slew rate at 0.8A/ $\mu$ s.



21.6Vin, -24Vout 2A to 4A load transient. Ch4 measures Iout, and Ch1 measures Vout.

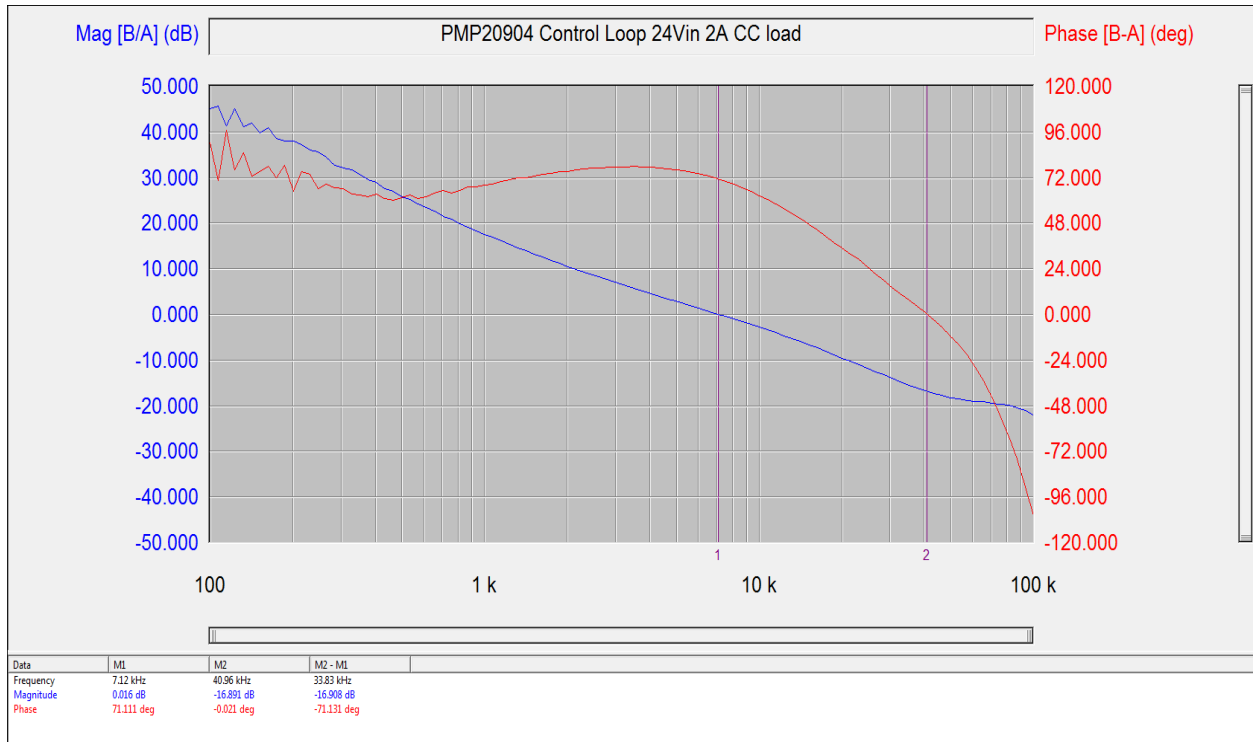


24Vin, -24Vout 2A to 4A load transient. Ch4 measures Iout, and Ch1 measures Vout.

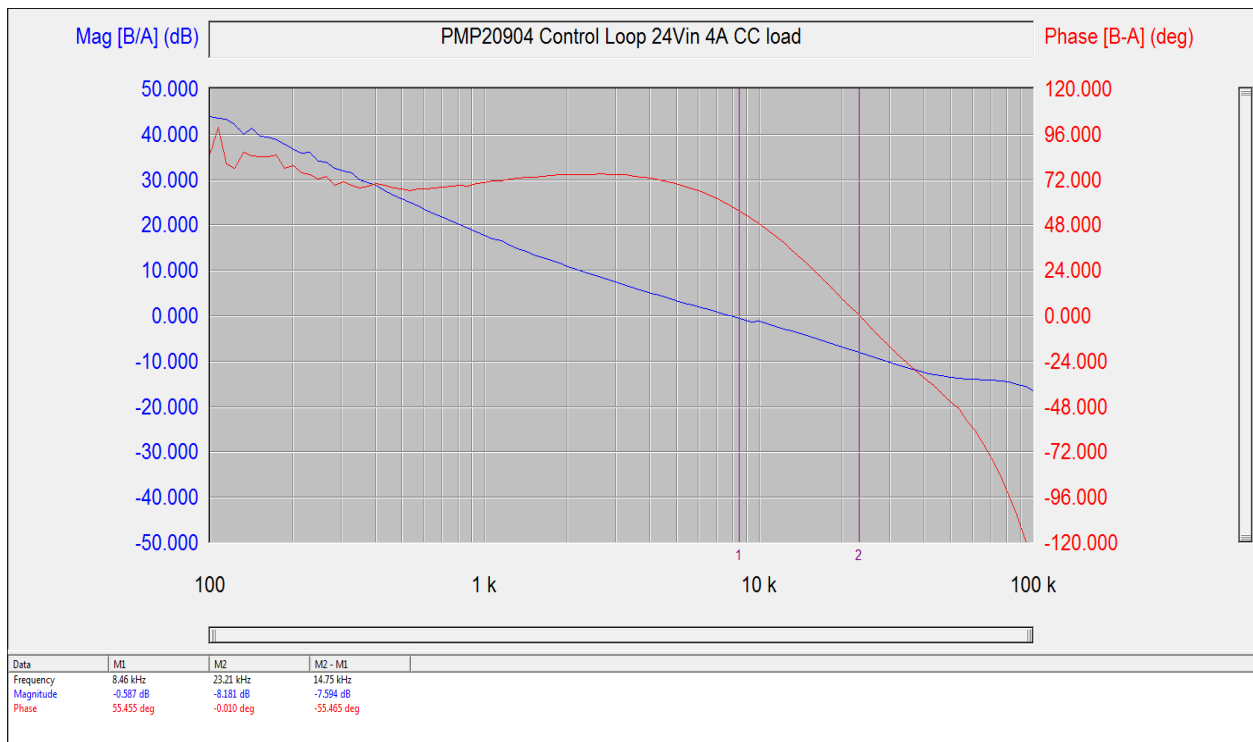


26.4Vin, -24Vout 2A to 4A load transient. Ch4 measures Iout, and Ch1 measures Vout.

## 6.4 Frequency Response



**24Vin, -24Vout 2A load. 71.11 degrees phase margin, -16.9dB gain margin.**



**24Vin, -24Vout 4A load. 55.46 degrees phase margin, -8.2B gain margin.**

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