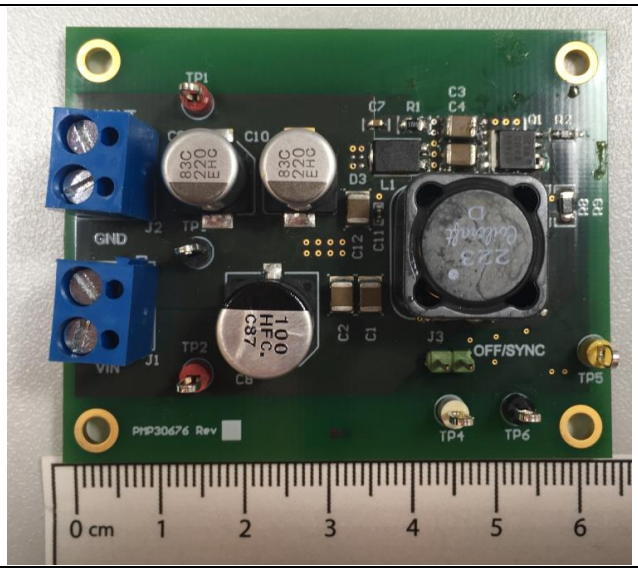
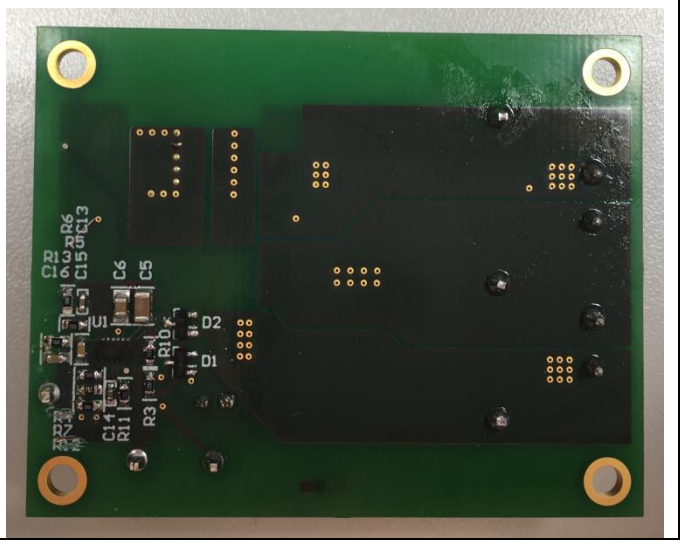
Test Report: PMP30676

24-W Nonsynchronous SEPIC Pre-Regulator Reference Design for Automotive Telematics Control Units

Description

This automotive pre-regulator reference design showcases a nonsynchronous SEPIC, which covers an input voltage range of 6.0 V to 36 V. The output voltage is 12.0 V with a maximum load current of 2.0 A. The design can operate down to an input voltage of 4.5 V to support automotive cranking.





1 Test Prerequisites

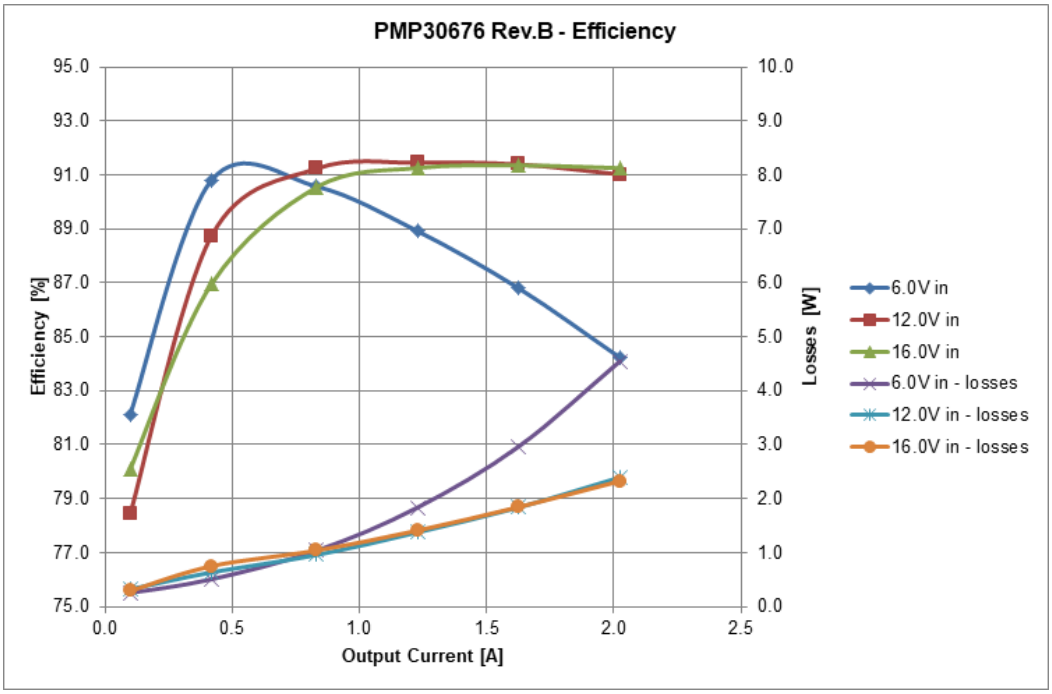
1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
V_{IN}	6.0 V – 16 V, 36 V peak, down to 4.5 V during cranking
V_{OUT}	12.0 V
I_{OUT}	2.0 A
Nominal switching frequency	300 kHz

2 Testing and Results

2.1 Efficiency Graphs



Efficiency at 6.0V, 12.0V and 16V in

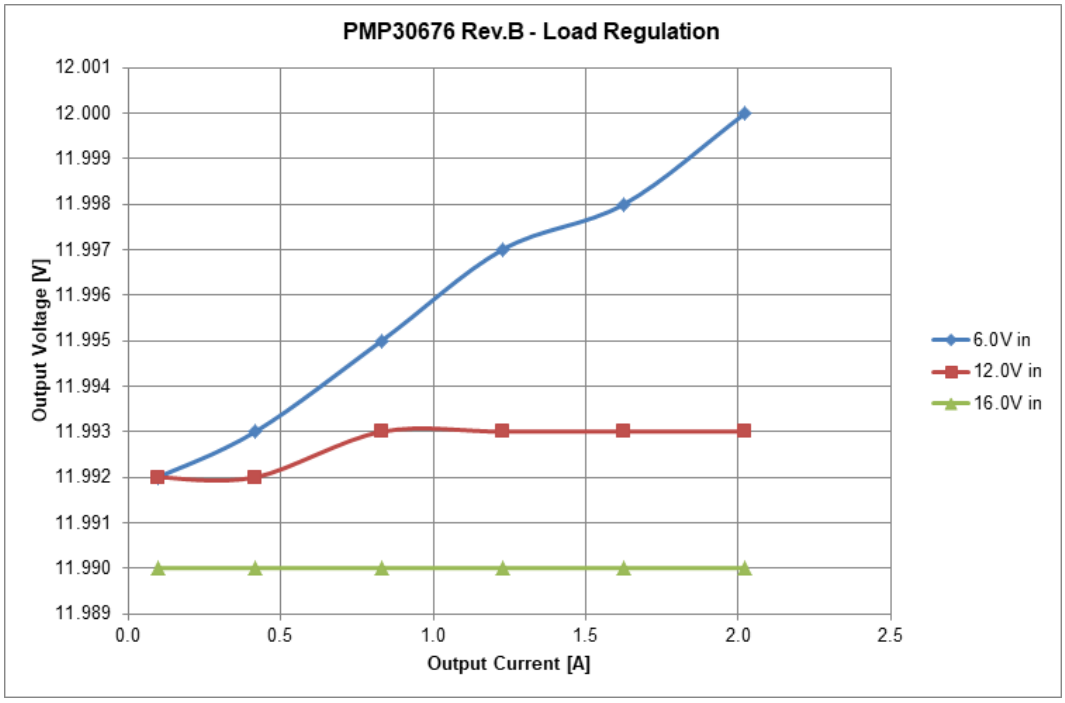
2.2 Efficiency Data

Voltage [V]	Current [A]	Power [W]	Voltage [V]	Current [A]	Power [W]	Losses [W]	Efficiency [%]
6.005	4.802	28.836	12.000	2.024	24.288	4.548	84.2
6.008	3.741	22.476	11.998	1.626	19.509	2.967	86.8
6.009	2.755	16.555	11.997	1.227	14.720	1.834	88.9
6.016	1.831	11.015	11.995	0.832	9.976	1.039	90.6
6.024	0.914	5.504	11.993	0.417	4.997	0.507	90.8
6.037	0.235	1.419	11.992	0.097	1.166	0.254	82.1

Voltage [V]	Current [A]	Power [W]	Voltage [V]	Current [A]	Power [W]	Losses [W]	Efficiency [%]
11.970	2.228	26.669	11.993	2.024	24.274	2.395	91.0
12.110	1.762	21.338	11.993	1.626	19.501	1.837	91.4
12.080	1.332	16.091	11.993	1.227	14.715	1.375	91.5
12.170	0.898	10.929	11.993	0.831	9.971	0.958	91.2
12.210	0.461	5.630	11.992	0.417	4.996	0.634	88.7
12.300	0.121	1.485	11.992	0.097	1.164	0.320	78.4

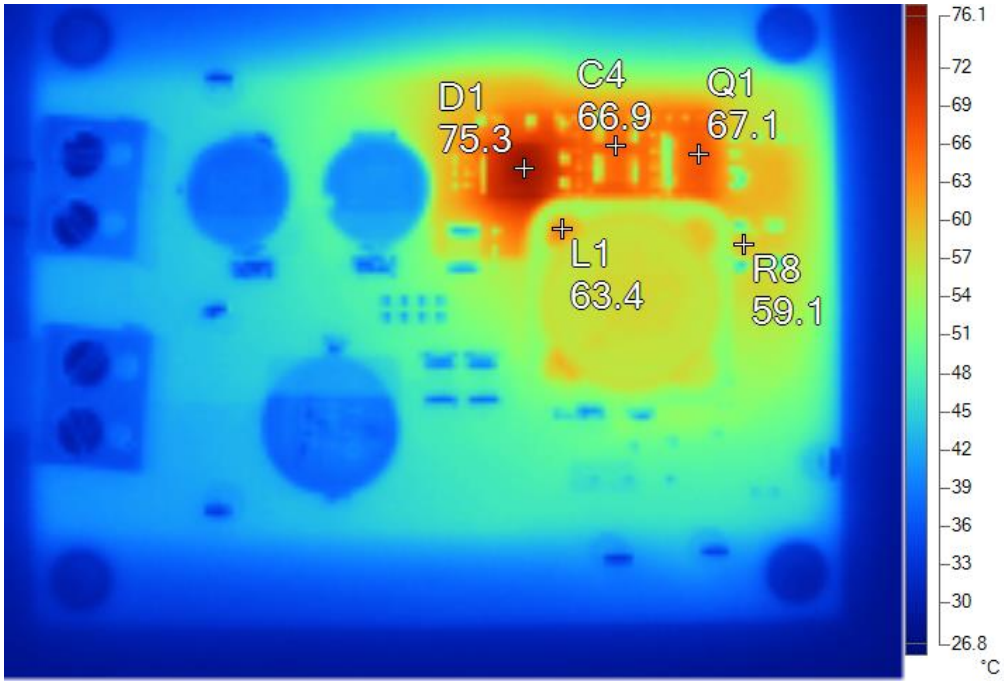
Voltage [V]	Current [A]	Power [W]	Voltage [V]	Current [A]	Power [W]	Losses [W]	Efficiency [%]
16.040	1.658	26.594	11.990	2.024	24.268	2.327	91.3
16.010	1.333	21.341	11.990	1.626	19.496	1.846	91.4
16.100	1.001	16.121	11.990	1.227	14.712	1.409	91.3
16.180	0.681	11.010	11.990	0.832	9.970	1.041	90.5
16.110	0.357	5.745	11.990	0.417	4.995	0.750	86.9
16.170	0.090	1.454	11.990	0.097	1.164	0.289	80.1

2.3 Load Regulation



Load regulation at 6.0V, 12.0V and 16V in

2.4 Thermal Images



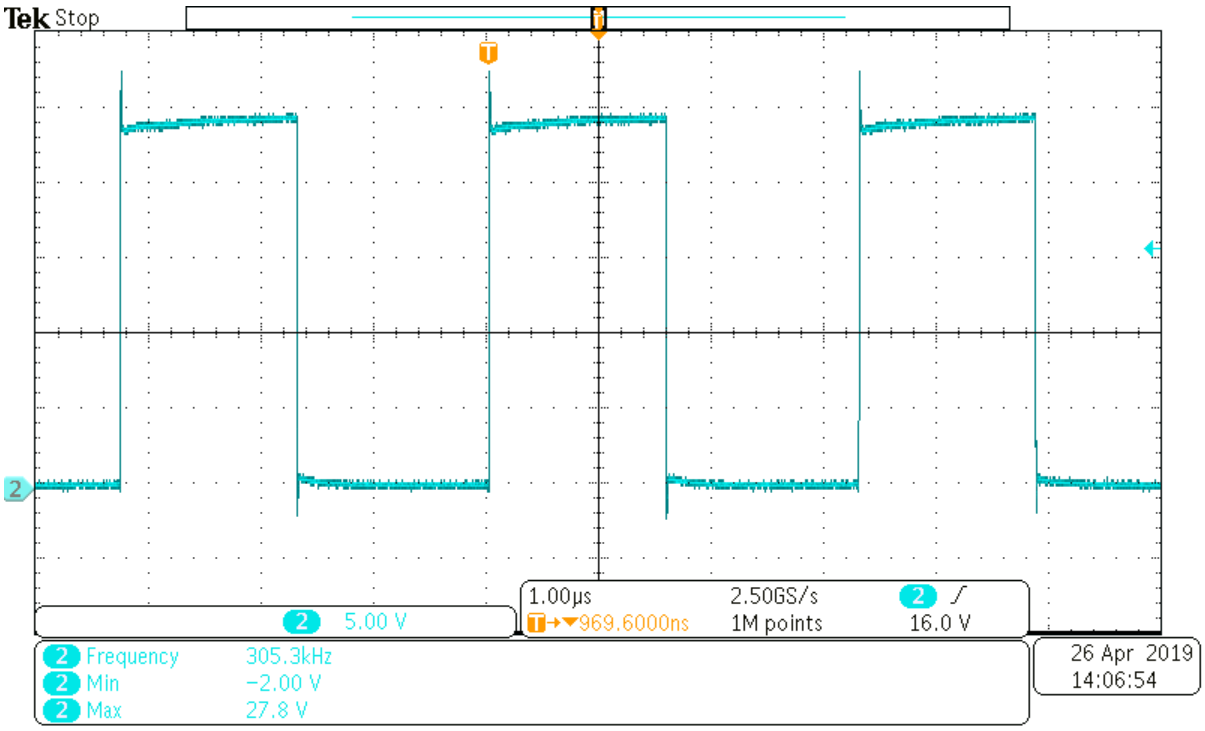
Thermal image of the PCB's top side at 12.0V in and 2.0A load current. Thermals can be improved by using a larger diode package and larger cooling areas.

2.5 Dimensions

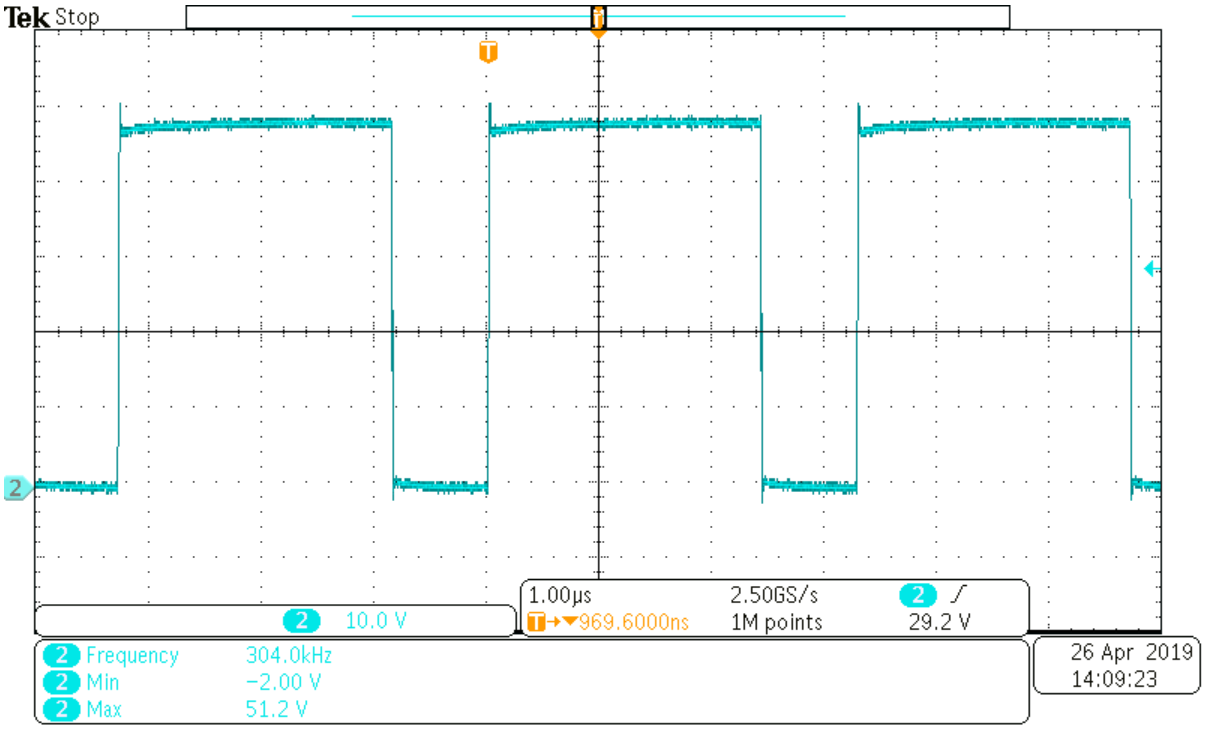
PCB: 63.5 mm x 50.2 mm

3 Waveforms

3.1 Switching

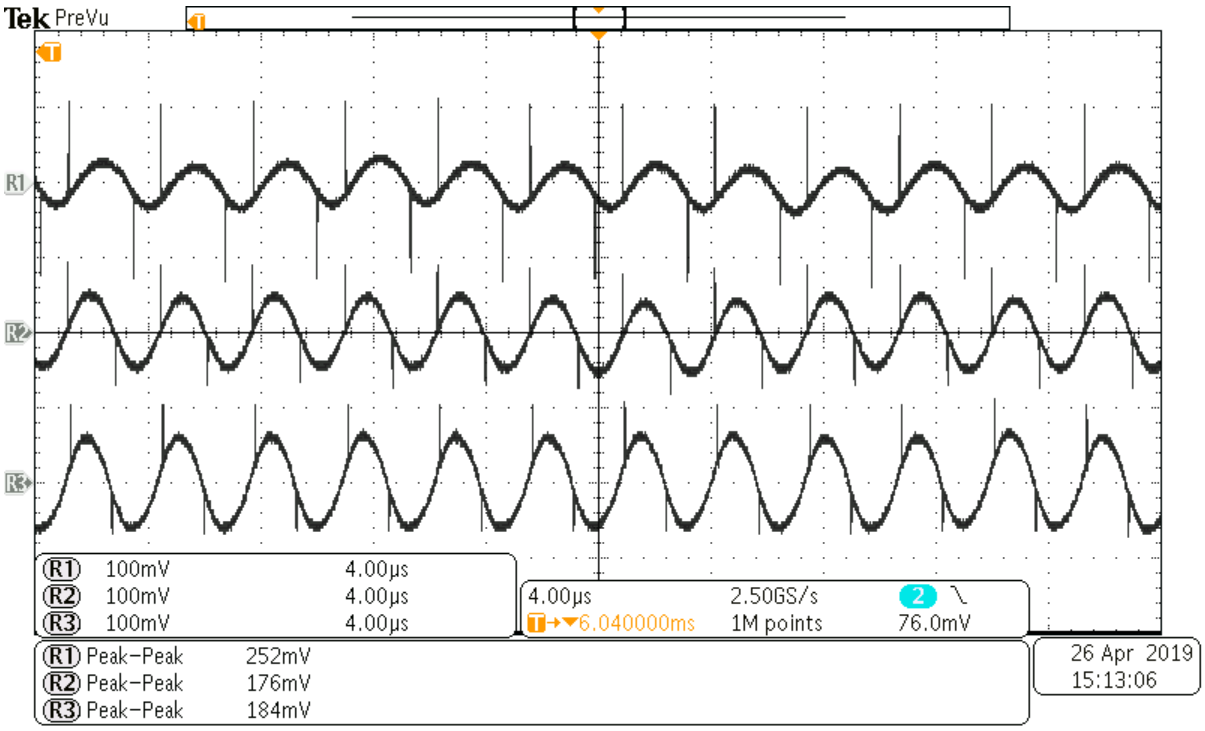


- Ch1: Switching node at 12.0V in and 2.0A load current [scale: 5.0V/div, 1.0us/div]



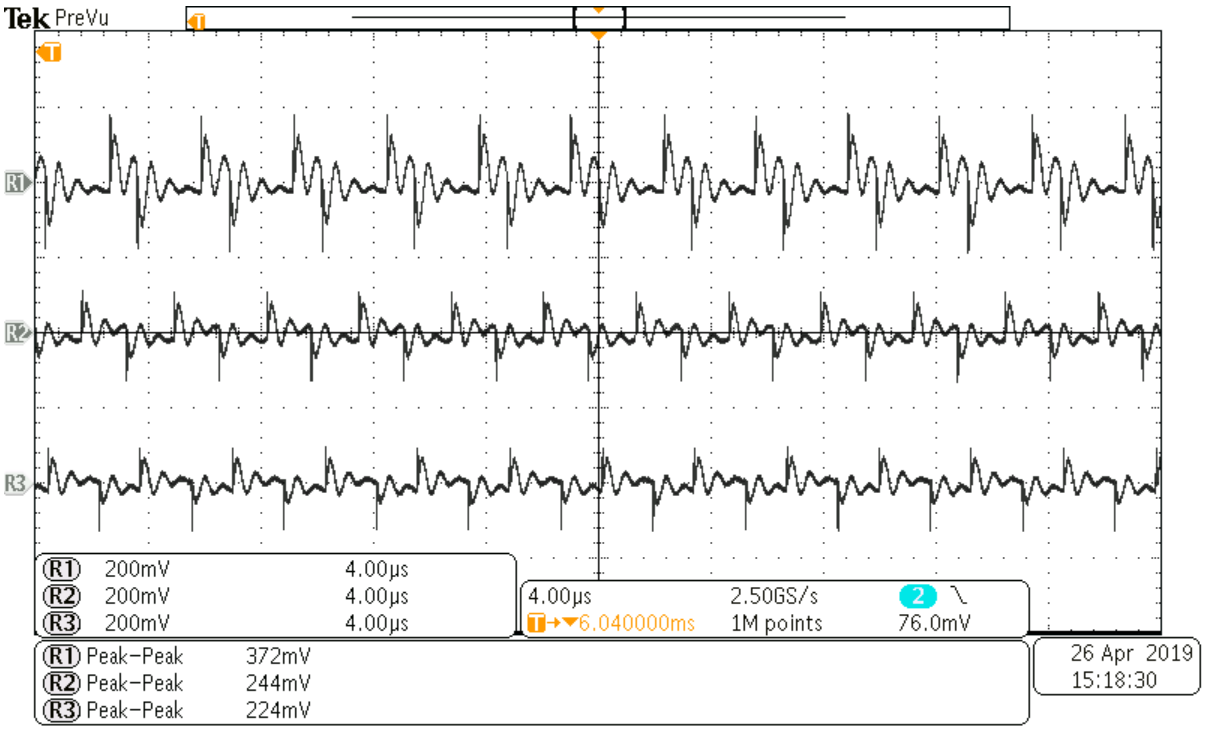
- Ch1: Switching node at 36.0V in and 2.0A load current [scale: 10.0V/div, 1.0us/div]

3.2 Input Voltage Ripple



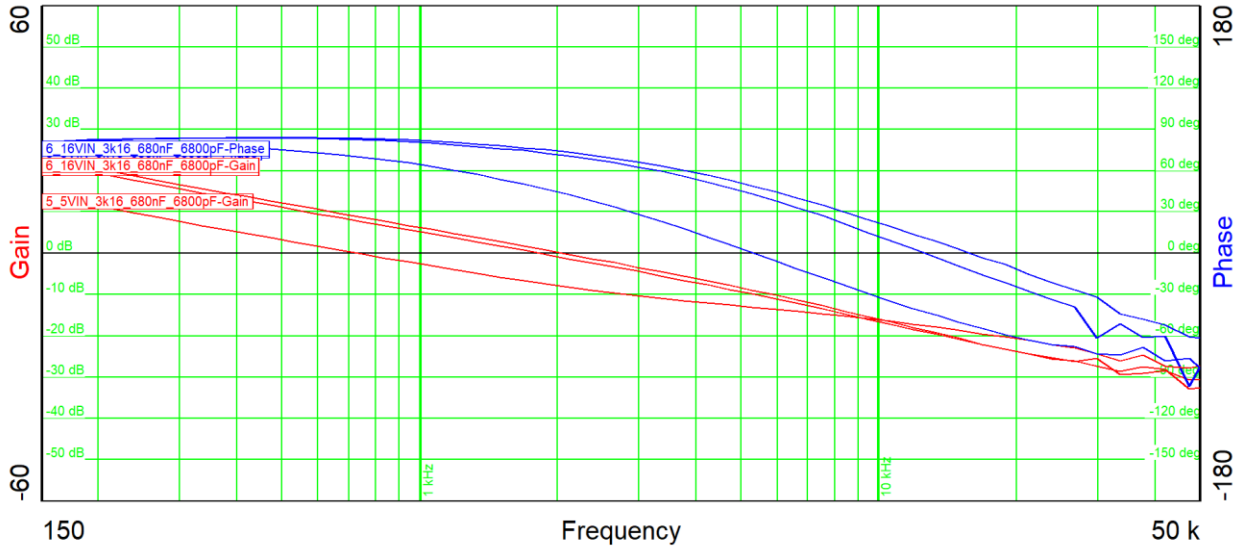
- R1: 6.0V in, 2.0A load, 252mV peak-peak-ripple, bw limited (20MHz) [scale: 100mV/div, 4.0us/div]
- R2: 12.0V in, 2.0A load, 176mV peak-peak-ripple, bw limited (20MHz) [scale: 100mV/div, 4.0us/div]
- R3: 16.0V in, 2.0A load, 184mV peak-peak-ripple, bw limited (20MHz) [scale: 100mV/div, 4.0us/div]

3.3 Output Voltage Ripple



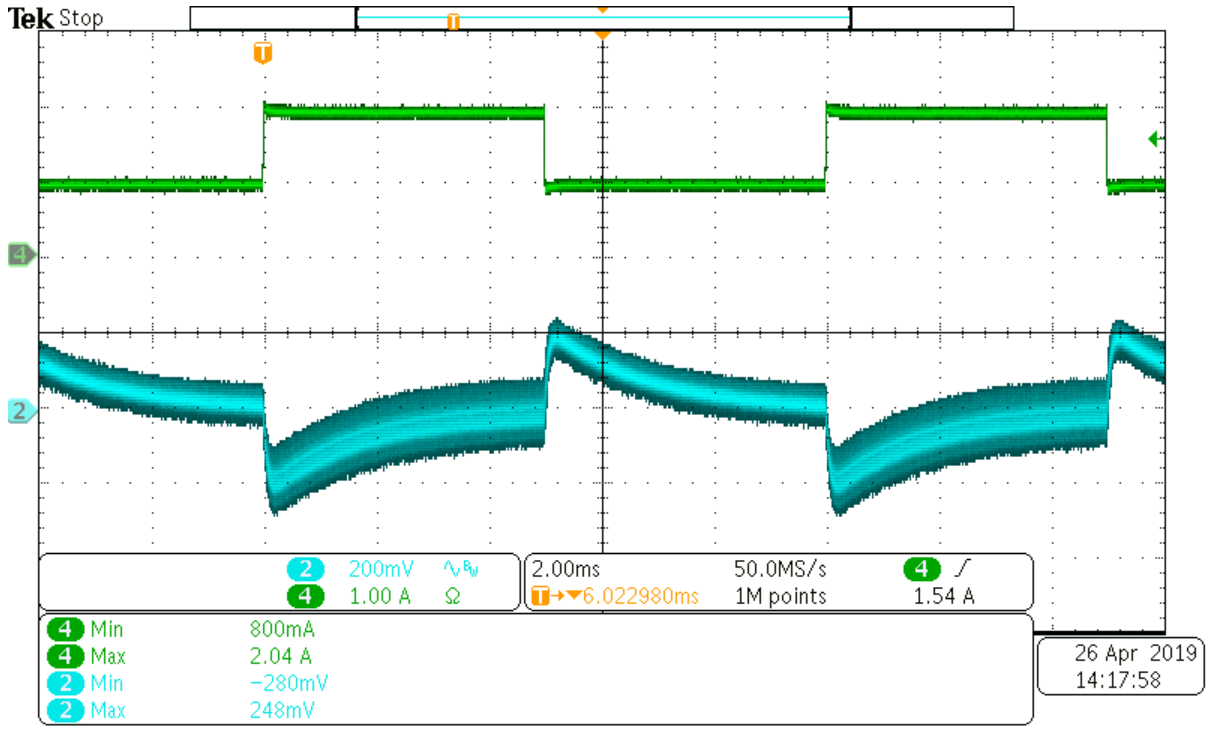
- R1: 6.0V in, 2.0A load, 372mV peak-peak-ripple, bw limited (20MHz) [scale: 200mV/div, 4.0us/div]
- R2: 12.0V in, 2.0A load, 244mV peak-peak-ripple, bw limited (20MHz) [scale: 200mV/div, 4.0us/div]
- R3: 16.0V in, 2.0A load, 224mV peak-peak-ripple, bw limited (20MHz) [scale: 200mV/div, 4.0us/div]

3.4 Bode Plot



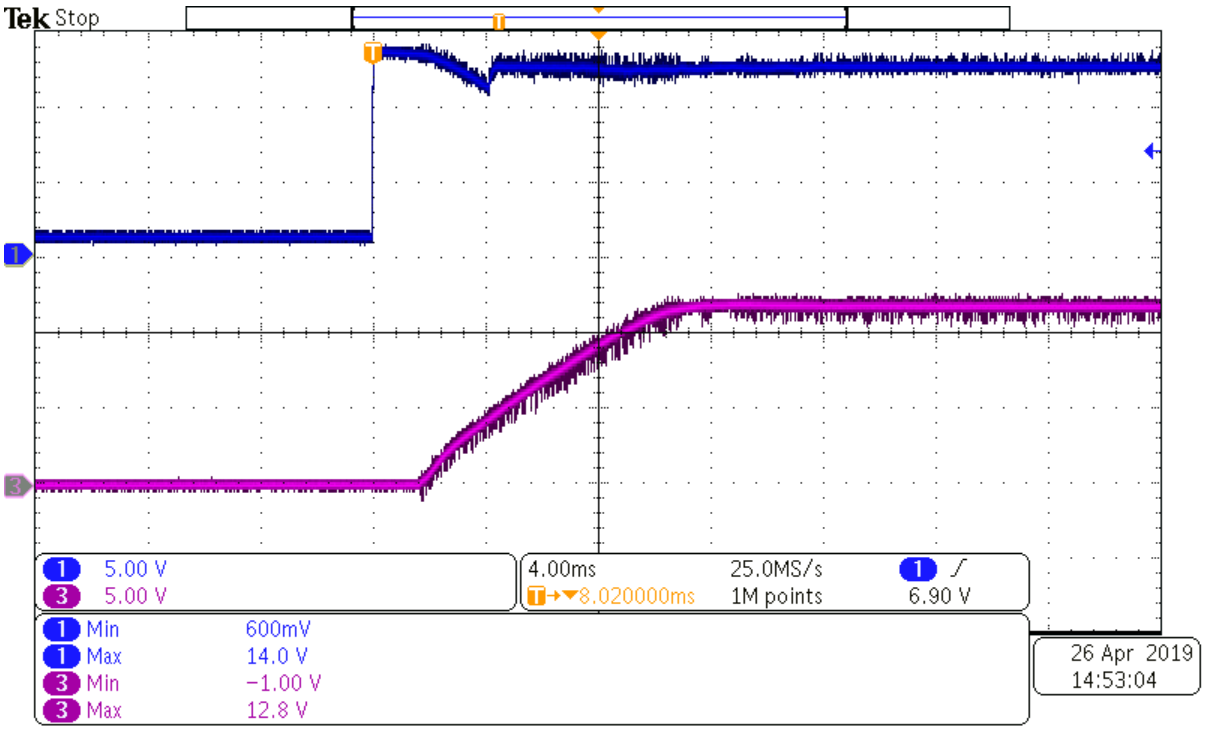
- 5.0V in, 2.0A load current: fco 0.7kHz, 70deg phase margin, -13dB gain margin
- 12.0V in, 2.0A load current: fco 1.8kHz, 73deg phase margin, -19dB gain margin
- 16.0V in, 2.0A load current: fco 2.0kHz, 74deg phase margin, -21dB gain margin

3.5 Load Transients



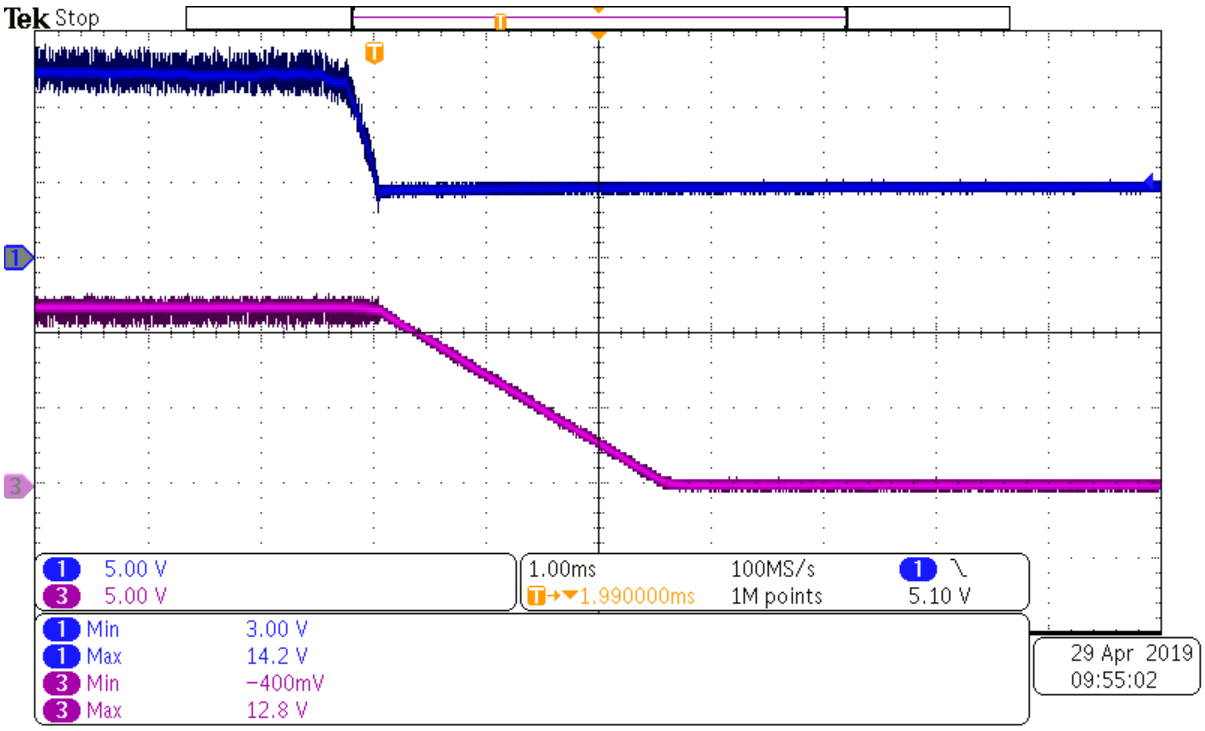
- Ch2: Load transient from 1.0A to 2.0A at 12.0V in [scale: 1.0A/div, 2.0ms/div]
- Ch4: AC-coupled output voltage, bw limited (20MHz) [scale: 200mV/div, 2.0ms/div]

3.6 Start-up Sequence



- Ch1: Input voltage [scale: 5.0V/div, 4.0ms/div]
- Ch3: Output voltage [scale: 5.0V/div, 4.0ms/div]

3.7 Undervoltage Protection



- Ch1: Input voltage [scale: 5.0V/div, 1.0ms/div]
- Ch3: Output voltage [scale: 5.0V/div, 1.0ms/div]

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