Test Report: PMP22343

+/-40-V Inverting Buck-Boost With Auxiliary Output Reference Design

Description

This reference design uses the TPS54560B in an inverting buck-boost topology to generate a -40-V output from a +5-V input. An auxiliary winding generates a +40-V output with reference to the same ground. For applications needing a positive and negative voltage, the buck topology provides a low-noise output with a minimal component count.

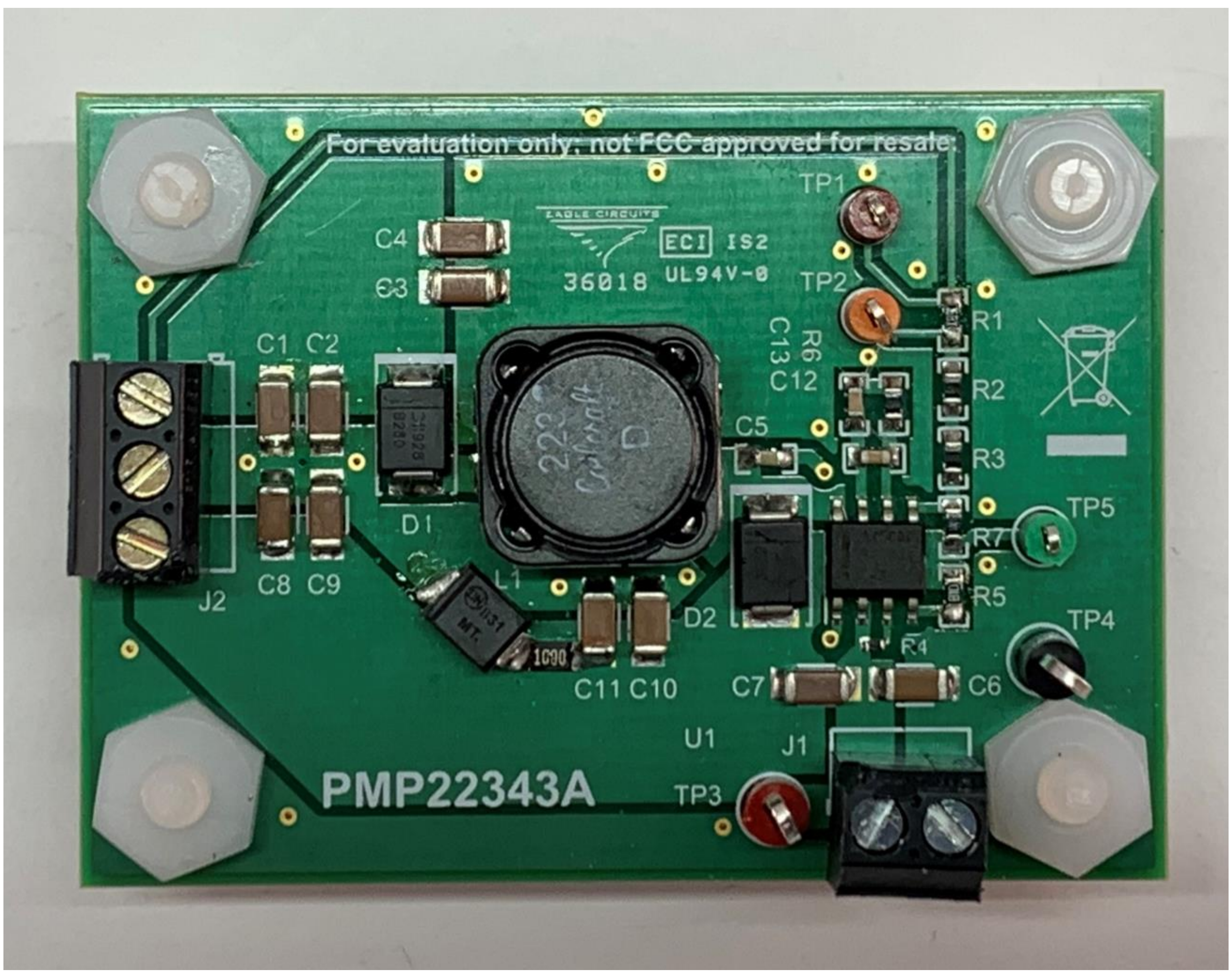

Figure 1. Board Top

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1 Test Prerequisites

1.1 Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage Range	+5 V +/- 5%
Output Voltage 1	+40 V +/- 1%
Output Current 1	0.125 A max, 0.03 A typical
Output Voltage 2	-40 V +/- 1%
Output Current 2	0.125 A max, 0.03 A typical

1.2 Considerations

For all tests a resistive load was used for Outputs 1 and 2. Also the input voltage was set to 5 V. Unless otherwise indicated, outputs 1 and 2 were loaded to 0.125 A for all tests.

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2 Testing and Results

2.1 Efficiency Chart

		+40Vdc Output		
		0 A	0.03 A	0.125 A
-40 Vdc output	0 A	25.686 %	76.275 %	83.823 %
	0.03 A	74.520 %	79.440 %	84.606 %
	0.125 A	83.642 %	84.392 %	80.730 %

Figure 2. Efficiency chart for various loading conditions

2.2 Efficiency and Cross Regulation Data

+40 V Output			-40 V Output		
Voltage (V)	Current (A)	Power (W)	Voltage (V)	Current (A)	Power (W)
40.381	0.001	0.040	-40.580	-0.001	0.041
39.608	0.030	1.188	-41.355	-0.001	0.041
37.399	0.125	4.675	-43.564	-0.001	0.044
40.604	0.001	0.041	-40.366	-0.030	1.211
40.338	0.030	1.210	-40.618	-0.030	1.219
40.103	0.125	5.013	-40.951	-0.030	1.229
40.835	0.001	0.041	-40.068	-0.125	5.009
40.452	0.030	1.214	-40.443	-0.125	5.055
40.020	0.125	5.003	-40.886	-0.125	5.111

Input			Calculations		
Voltage (V)	Current (A)	Power (W)	Output Power (W)	Efficiency (%)	Losses (W)
5.059	0.062	0.315	0.081	25.686	0.234
5.038	0.320	1.612	1.230	76.275	0.382
4.970	1.133	5.629	4.718	83.823	0.911
5.038	0.333	1.680	1.252	74.520	0.428
5.014	0.610	3.057	2.429	79.440	0.629
4.924	1.498	7.377	6.241	84.606	1.136
4.963	1.216	6.037	5.049	83.643	0.987
4.939	1.504	7.428	6.269	84.392	1.159
4.847	2.585	12.527	10.113	80.730	2.414

Figure 3. Raw data for cross loading conditions

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2.3 Waveforms

2.3.1 Switching

The switch node was measured across the rectifier diode (D2). The stresses on D2 were the same as D1 on the +40 V output.

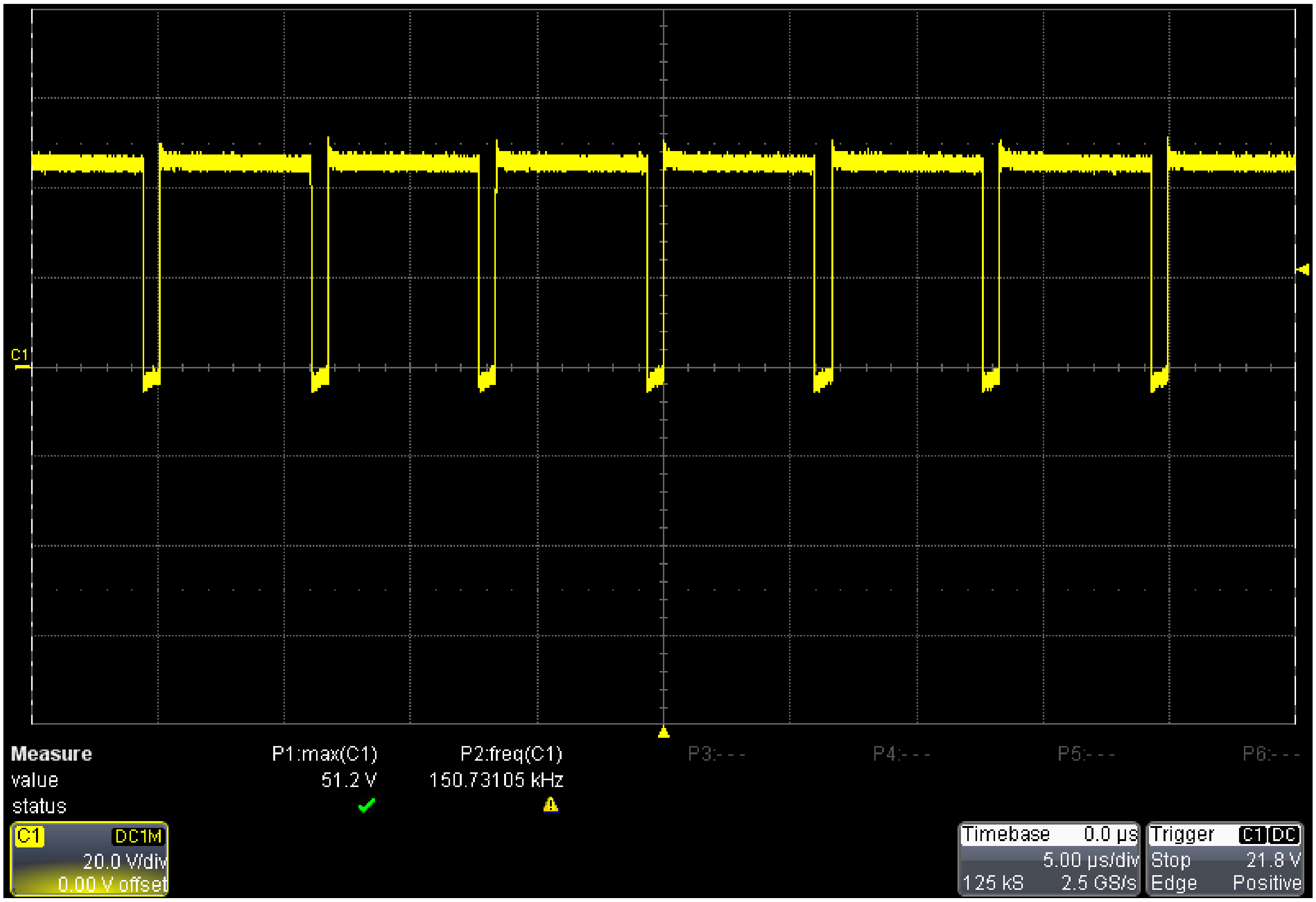

Figure 4. Primary Switching Node

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2.3.2 Output Voltage Ripple

Measurements were taken using the tip and barrel method across the output cap (C4 for the +40 V output, C11 for the -40 V output).

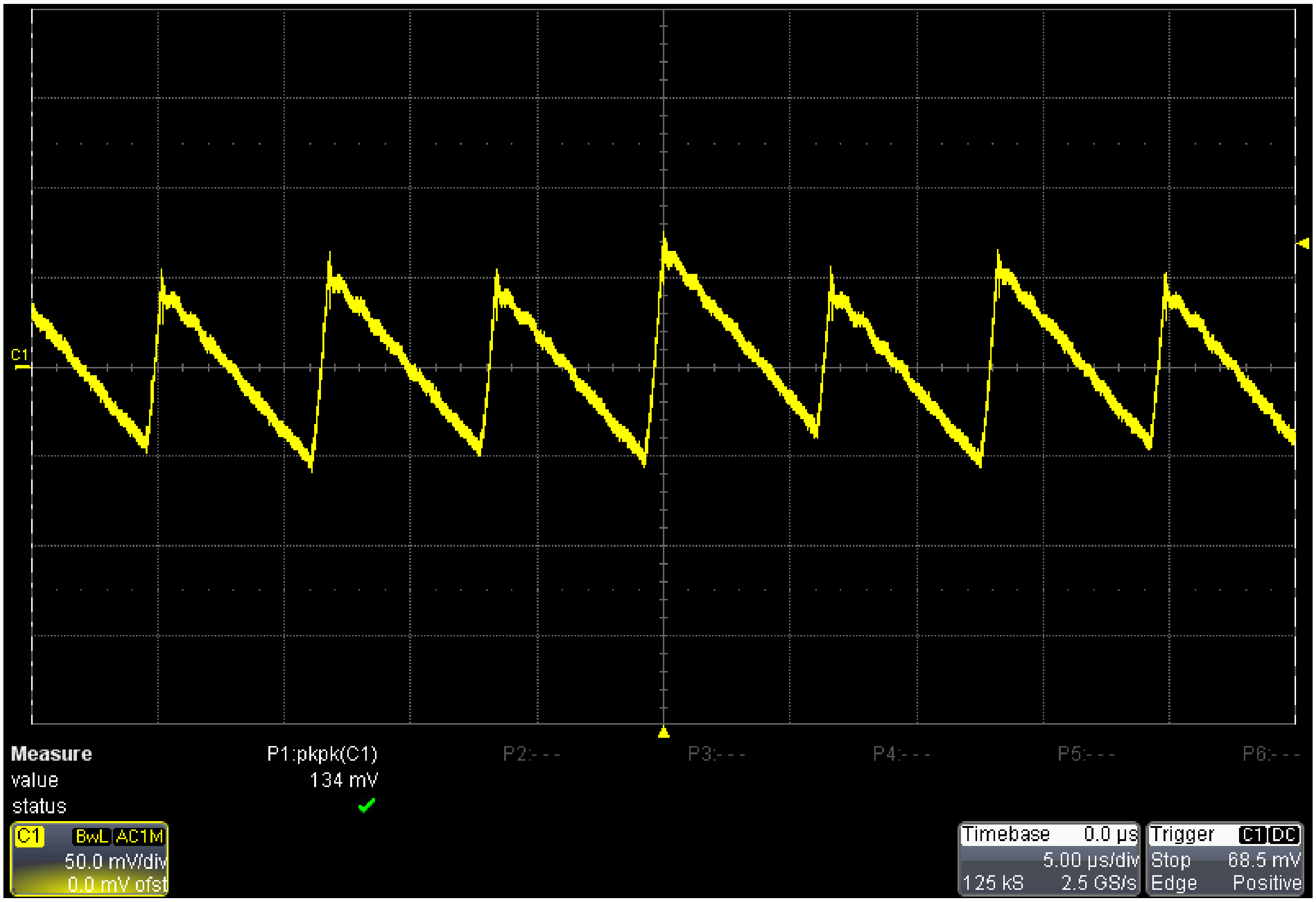

Figure 5. Output voltage ripple of the +40 V output

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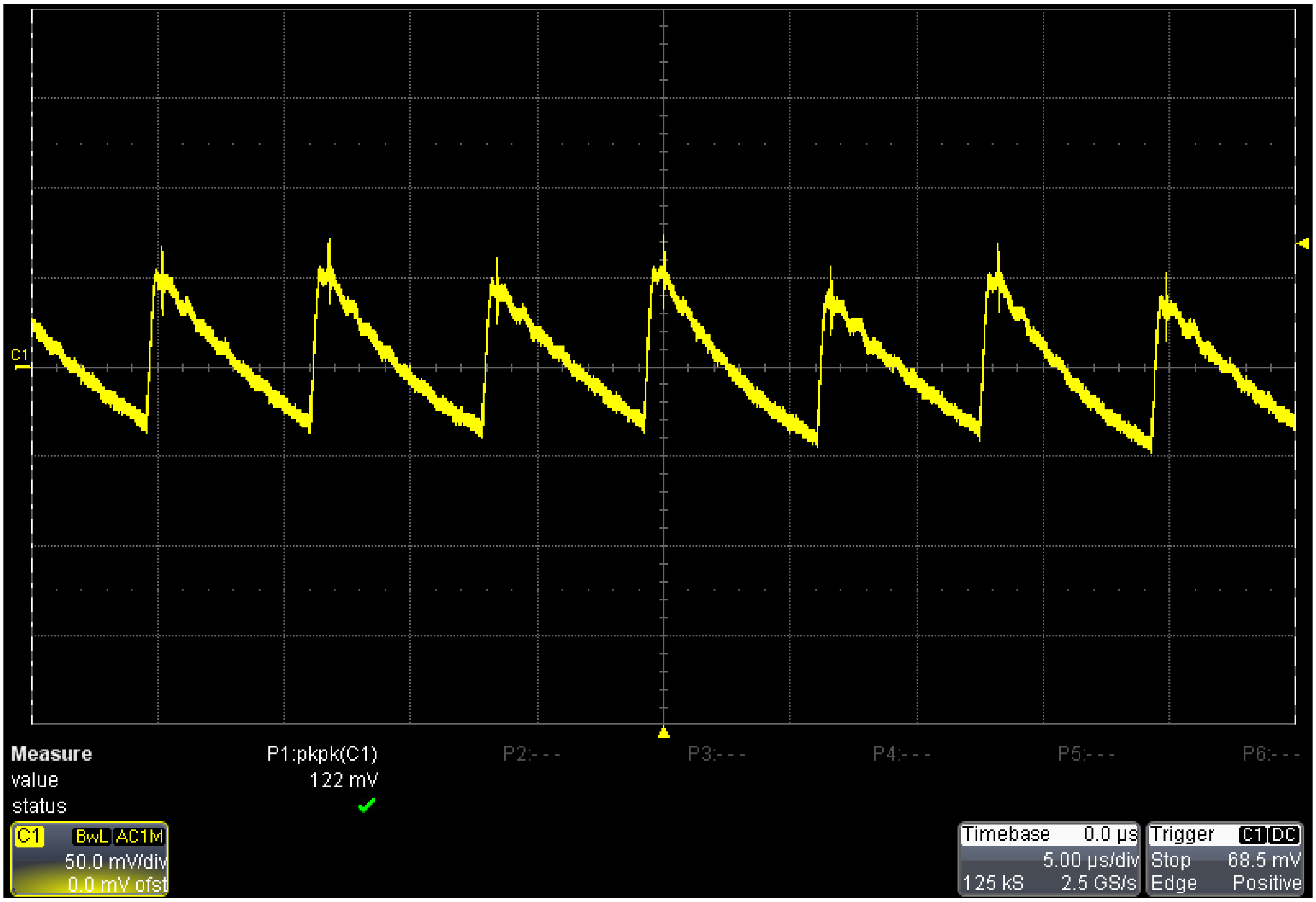

Figure 6. Output voltage ripple of the +40 V output

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2.3.3 Load Transients

The output voltage (AC coupled) was measured across the +40 V output capacitor (C4). The -40 V output was loaded to 30 mA (typical loading).

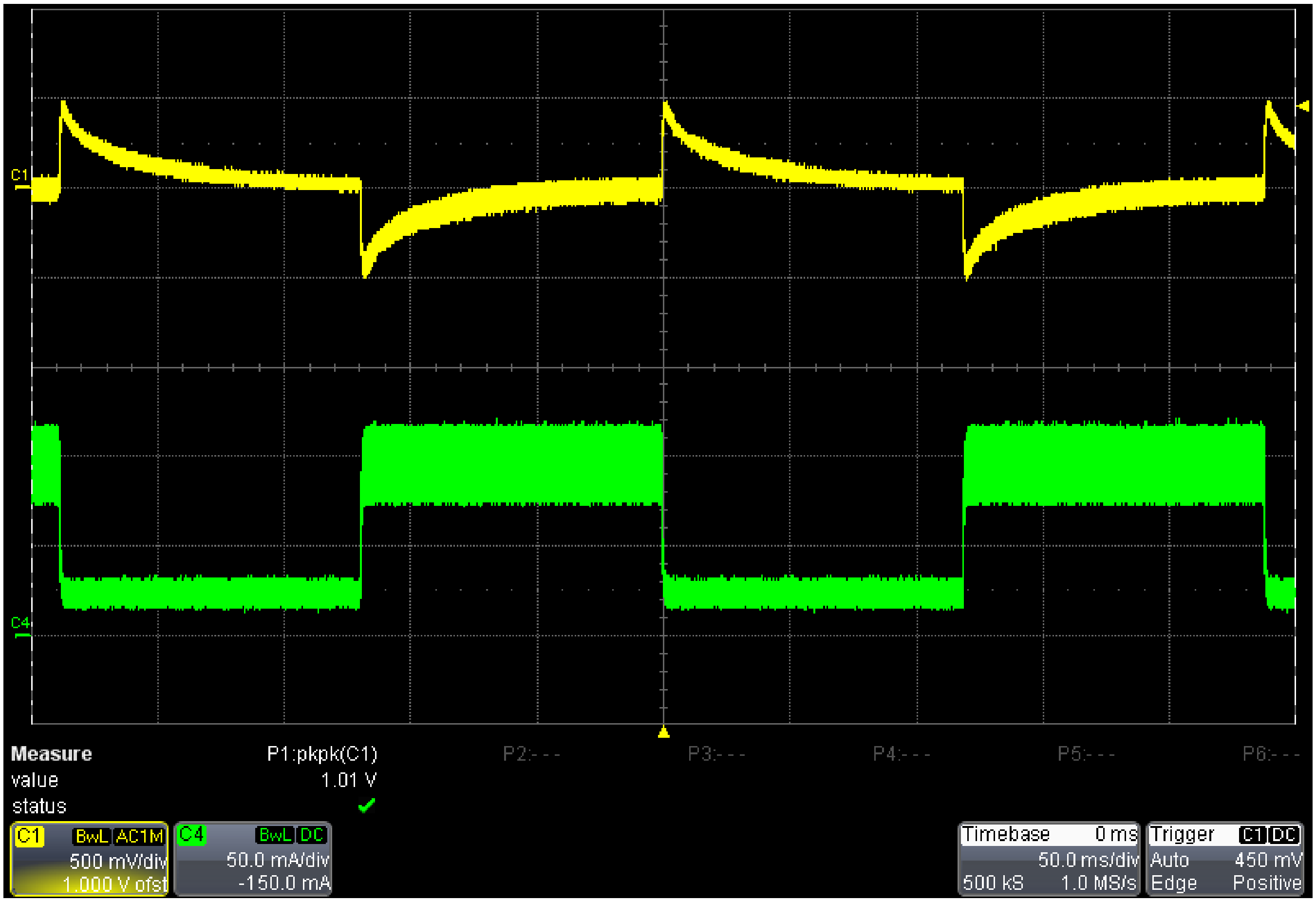

Figure 7. Load stepping Output 1 between 0.2 A and 1 A

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2.3.4 Control Loop/Stability

The table below shows the bandwidth and phase margin measurements.

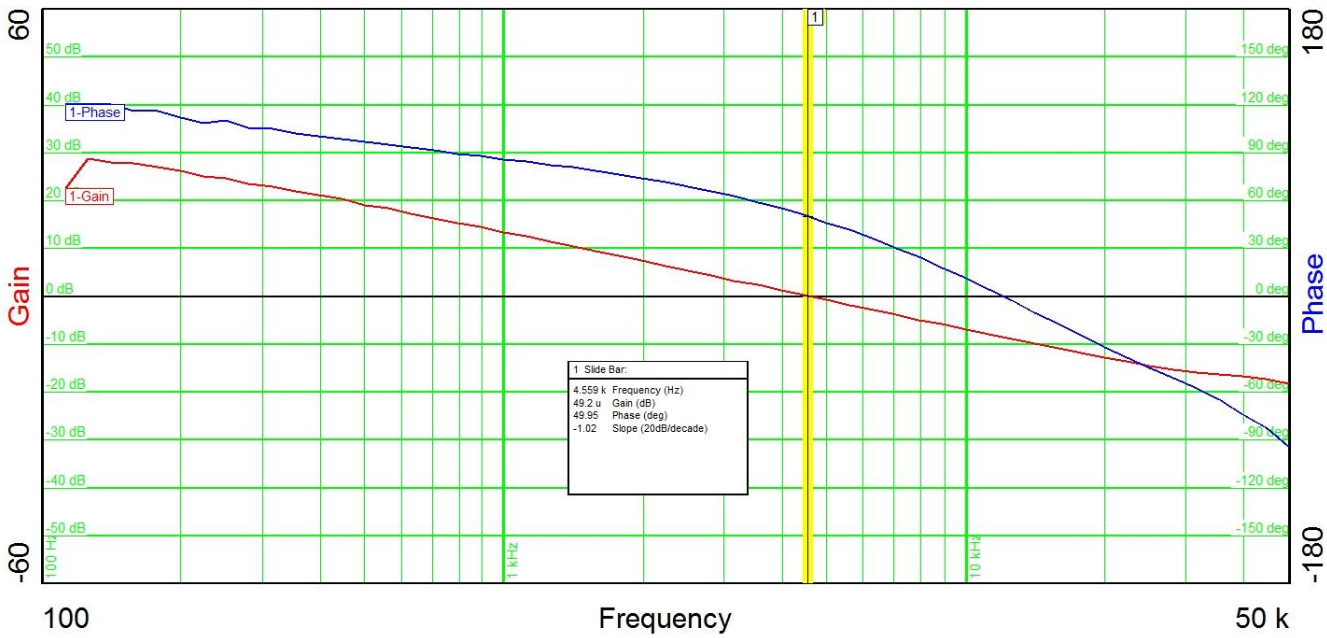

Figure 8.

Input Voltage (V)	Bandwidth (kHz)	Phase Margin (degrees)
5	4.559	49.95

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