Test Report: PMP23033

40-W, 5-V, Single-Switch Forward Converter With Magnetic Feedback Reference Design

Description

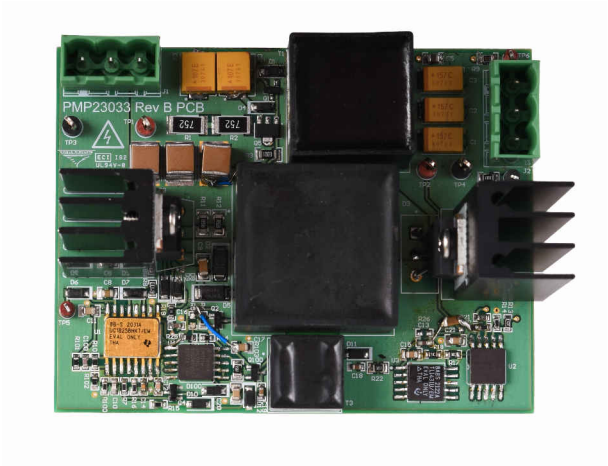
This reference design generates an isolated 5 V at 40 W from a 60-V to 120-V DC input voltage. The design uses a magnetic feedback circuit to replace the function of an optocoupler.

Features

- Use of 100-krad ICs and magnetics
- Magnetic feedback used to replace optocoupler
- Operation with external supply or self-bias
- Remote sensing

Applications

- Satellite buses and payloads
- Communications payload
- Optical imaging payload
- Radar imaging payload
- Space launch vehicles



1 Test Prerequisites

1.1 Voltage and Current Specifications

Table 1-1. Voltage and Current Specifications

Parameter	Specifications
V_{IN}	60–120 VDC
V_{OUT}	5 VDC
I_{OUT}	8 A

1.2 Dimensions

The board dimensions are 85 mm × 65 mm × 25.4 mm.

2 Testing and Results

2.1 Efficiency Graphs

Figure 2-1 shows the efficiency graph.

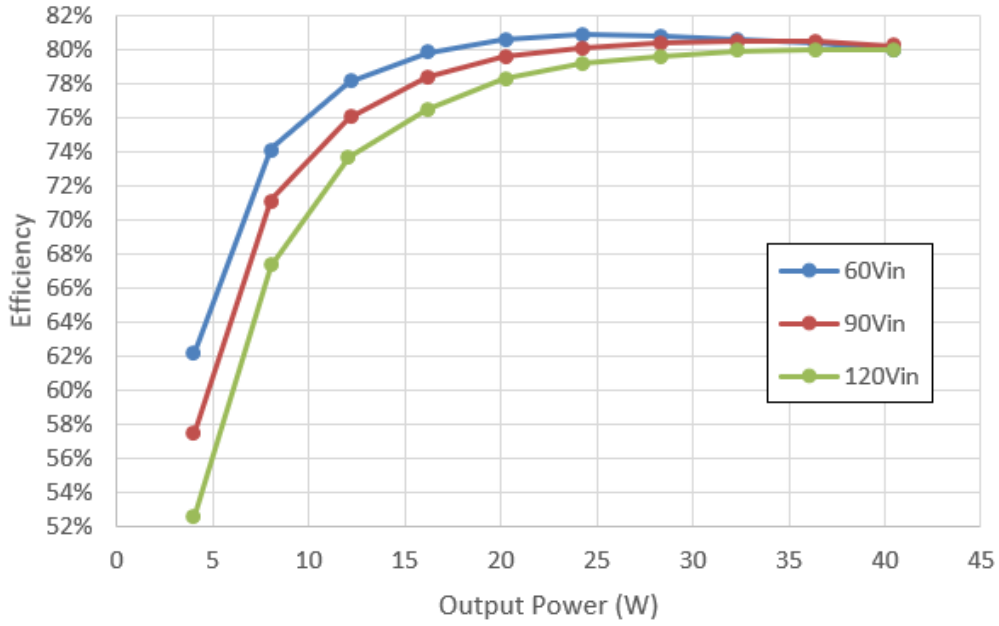


Figure 2-1. Efficiency

Figure 2-2 shows the power loss graph.

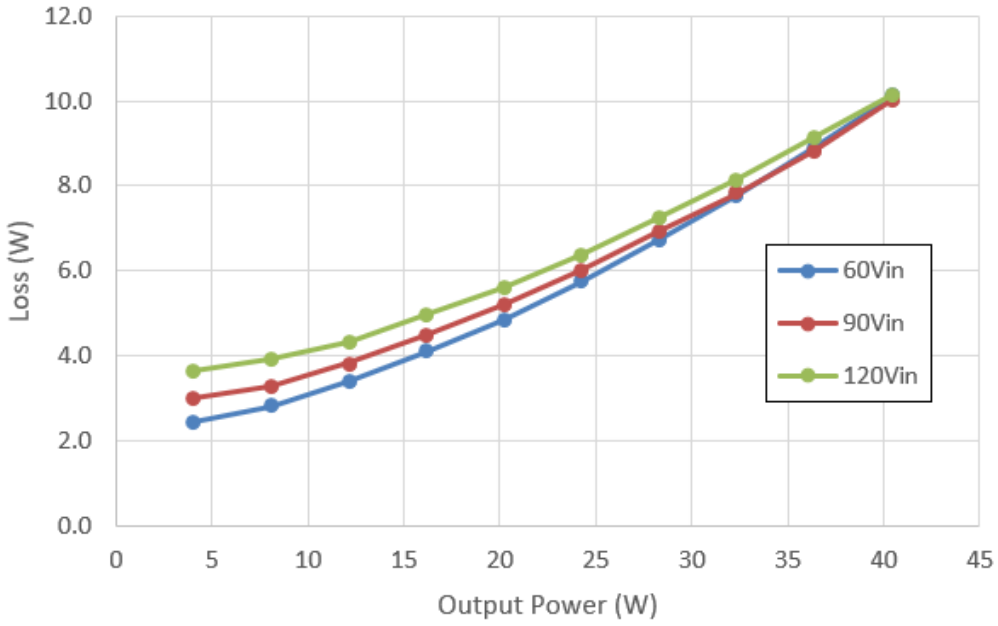


Figure 2-2. Power Loss

2.2 Efficiency Data - Minimum Load of 100 mA

Efficiency data is shown in the following tables.

I_{OUT} (A)	V_{OUT} (V)	V_{IN} (V)	I_{IN} (A)	P_{OUT} (W)	P_{IN} (W)	P_{loss} (W)	Efficiency (%)
0.100	5.05	60.2	0.027	0.51	1.63	1.12	31.0%
0.800	5.05	60.2	0.108	4.04	6.50	2.46	62.2%
1.60	5.05	60.2	0.181	8.08	10.90	2.82	74.2%
2.40	5.05	60.2	0.258	12.12	15.52	3.40	78.1%
3.20	5.05	60.2	0.337	16.17	20.27	4.10	79.8%
4.00	5.05	60.1	0.417	20.20	25.07	4.87	80.6%
4.80	5.05	60.1	0.499	24.24	29.99	5.75	80.8%
5.60	5.05	60.1	0.583	28.29	35.03	6.74	80.8%
6.40	5.05	60.1	0.668	32.33	40.11	7.79	80.6%
7.20	5.05	60.0	0.754	36.36	45.26	8.90	80.3%
8.00	5.05	60.0	0.842	40.40	50.52	10.12	80.0%

I_{OUT} (A)	V_{OUT} (A)	V_{IN} (V)	I_{IN} (A)	P_{OUT} (W)	P_{IN} (W)	P_{loss} (W)	Efficiency (%)
0.100	5.05	90.2	0.025	0.51	2.25	1.75	22.4%
0.800	5.05	90.2	0.078	4.04	7.03	2.99	57.5%
1.60	5.05	90.2	0.126	8.08	11.36	3.28	71.2%
2.40	5.05	90.1	0.177	12.12	15.95	3.83	76.0%
3.20	5.05	90.1	0.229	16.17	20.64	4.47	78.3%
4.00	5.05	90.1	0.282	20.20	25.41	5.20	79.5%
4.80	5.05	90.1	0.336	24.24	30.27	6.02	80.1%
5.60	5.05	90.1	0.391	28.29	35.22	6.93	80.3%
6.40	5.05	90.1	0.446	32.33	40.16	7.84	80.5%
7.20	5.05	90.0	0.502	36.37	45.20	8.83	80.5%
8.00	5.05	90.0	0.560	40.40	50.41	10.01	80.1%

I_{OUT} (A)	V_{OUT} (V)	V_{IN} (V)	I_{IN} (A)	P_{OUT} (W)	P_{IN} (W)	P_{loss} (W)	Efficiency (%)
0.100	5.05	120.2	0.021	0.51	2.52	2.02	20.0%
0.800	5.05	120.1	0.064	4.04	7.69	3.65	52.6%
1.60	5.05	120.1	0.100	8.08	12.01	3.93	67.3%
2.40	5.05	120.1	0.137	12.12	16.46	4.34	73.7%
3.20	5.05	120.1	0.176	16.17	21.14	4.97	76.5%
4.00	5.05	120.1	0.215	20.20	25.82	5.62	78.3%
4.80	5.05	120.1	0.255	24.24	30.62	6.38	79.2%
5.60	5.05	120.1	0.296	28.28	35.54	7.26	79.6%
6.40	5.05	120.1	0.337	32.32	40.46	8.14	79.9%
7.20	5.05	120.0	0.379	36.36	45.50	9.14	79.9%
8.00	5.05	120.0	0.421	40.40	50.53	10.13	80.0%

2.3 Thermal Images

All thermal images were captured with the DUT at 25ºC ambient, after a 30 minute warm up. The output was loaded with 40 W.

Figure 2-3. 60-VDC Input

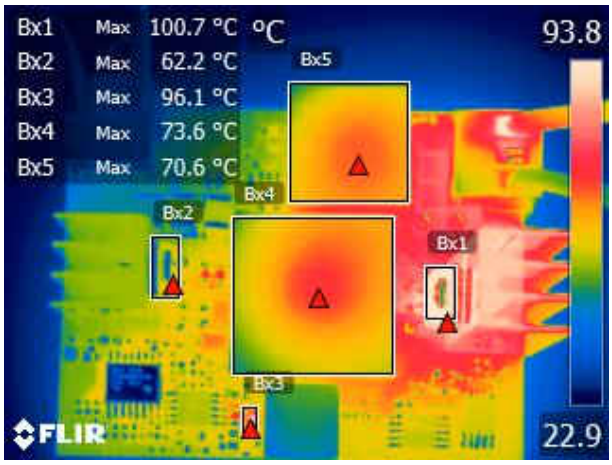


Figure 2-4. 90-VDC Input

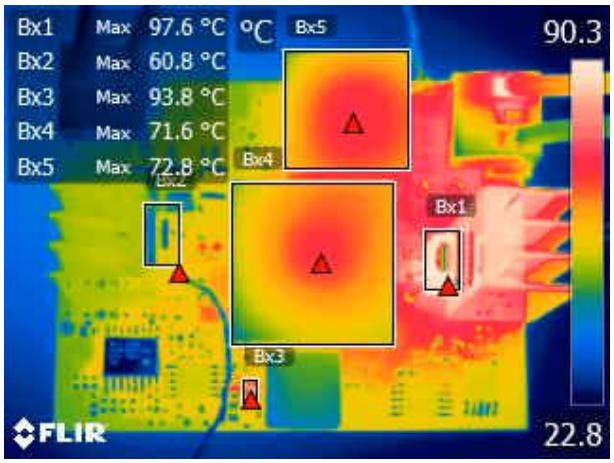


Figure 2-5. 120-VDC Input

2.4 Loop Response

Loop response at various input and load levels is shown in the following images.

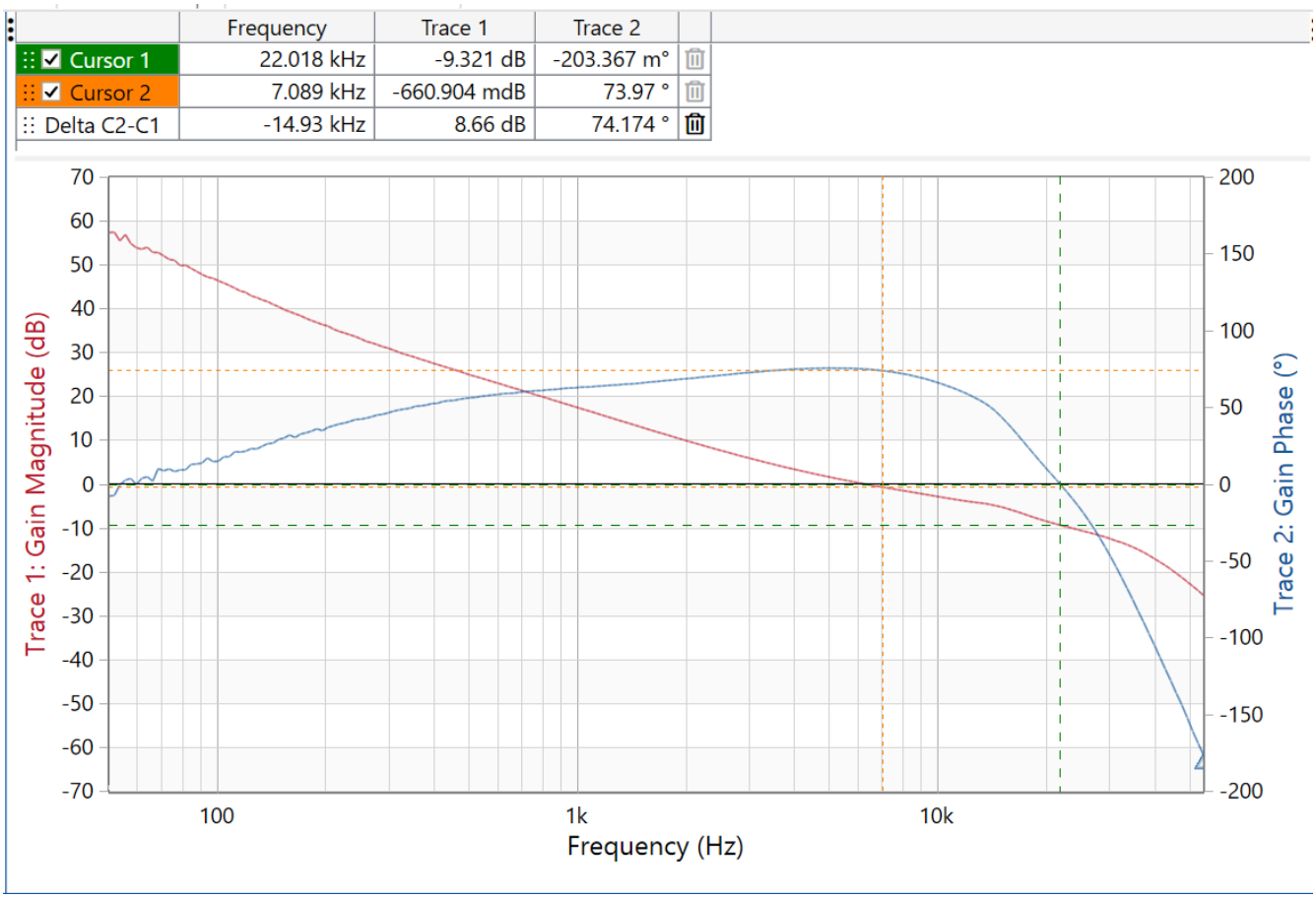


Figure 2-6. 60-VDC Input, 8-A Load

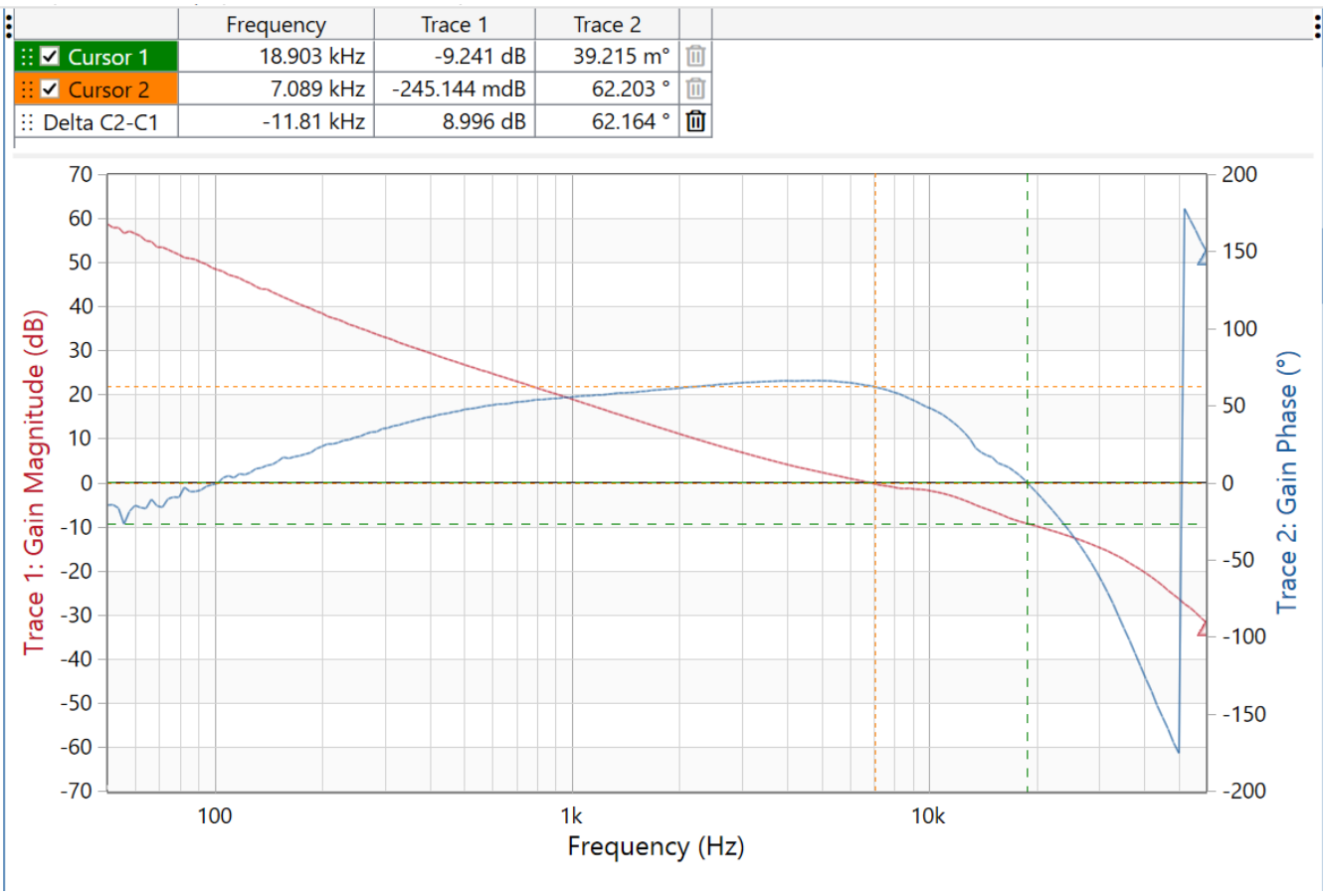


Figure 2-7. 60-VDC Input, 2-A Load

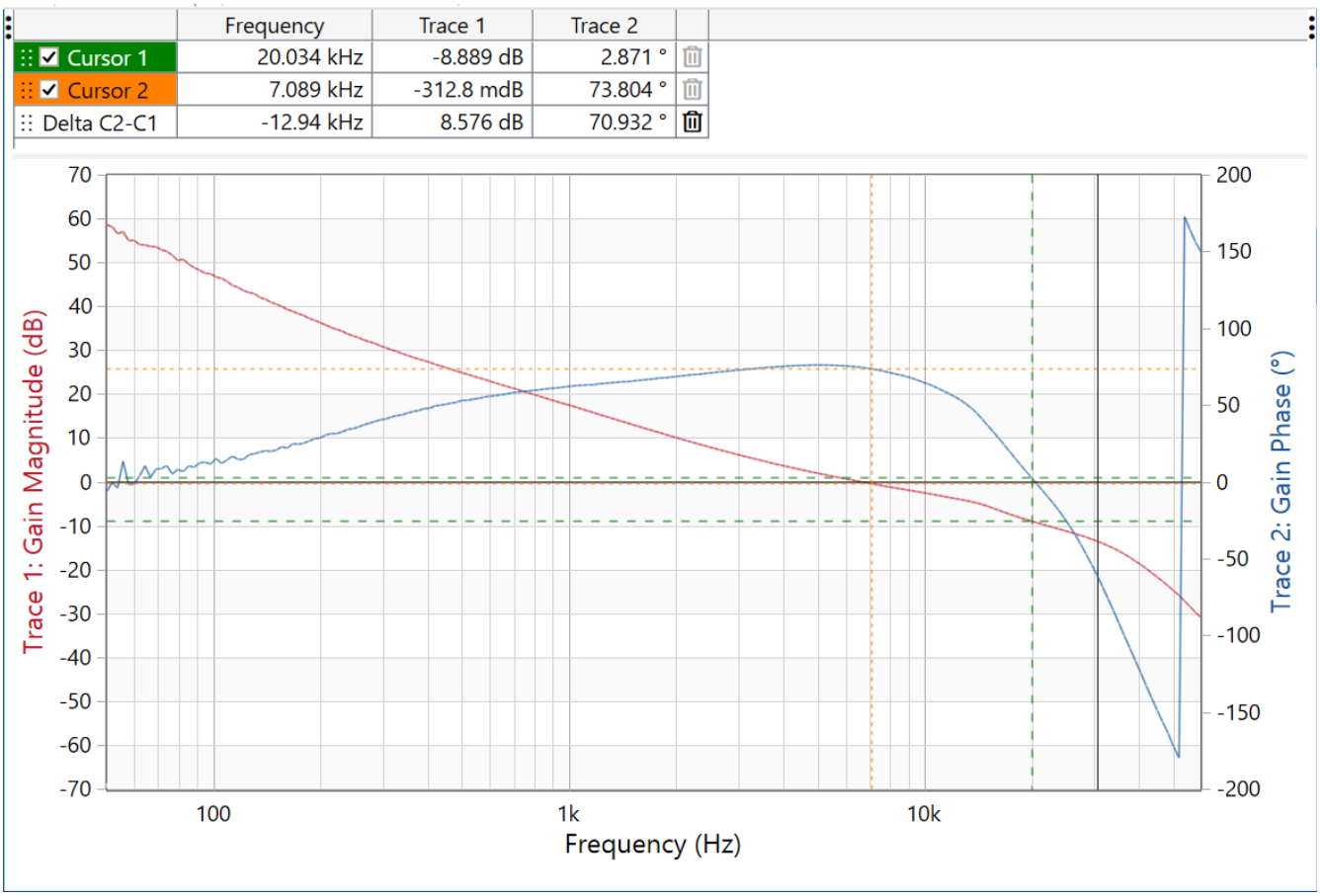


Figure 2-8. 120-VDC Input, 8-A Load

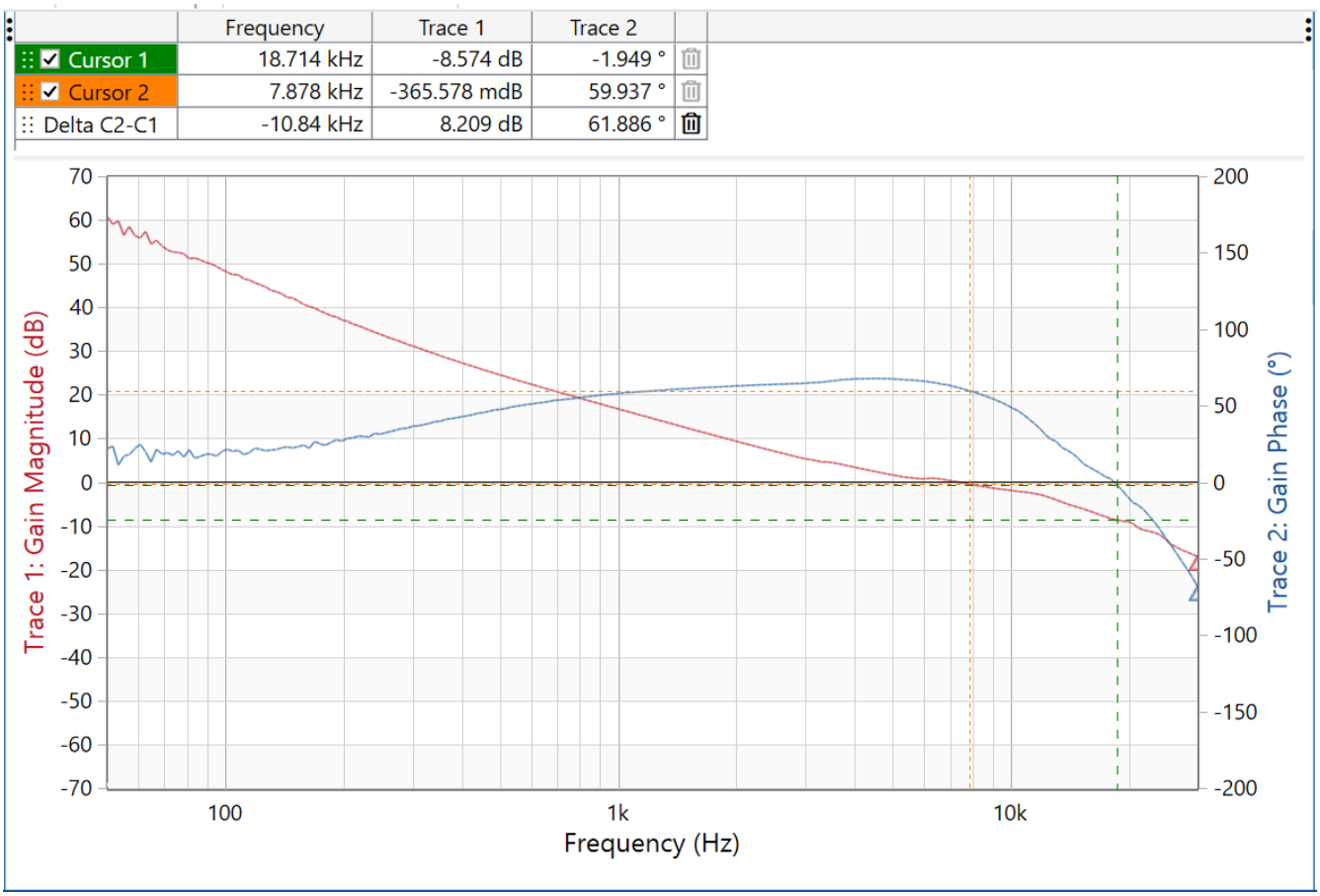


Figure 2-9. 120-VDC Input, 2-A Load

3 Waveforms

3.1 Switching

Switching behavior is shown in the following figures.

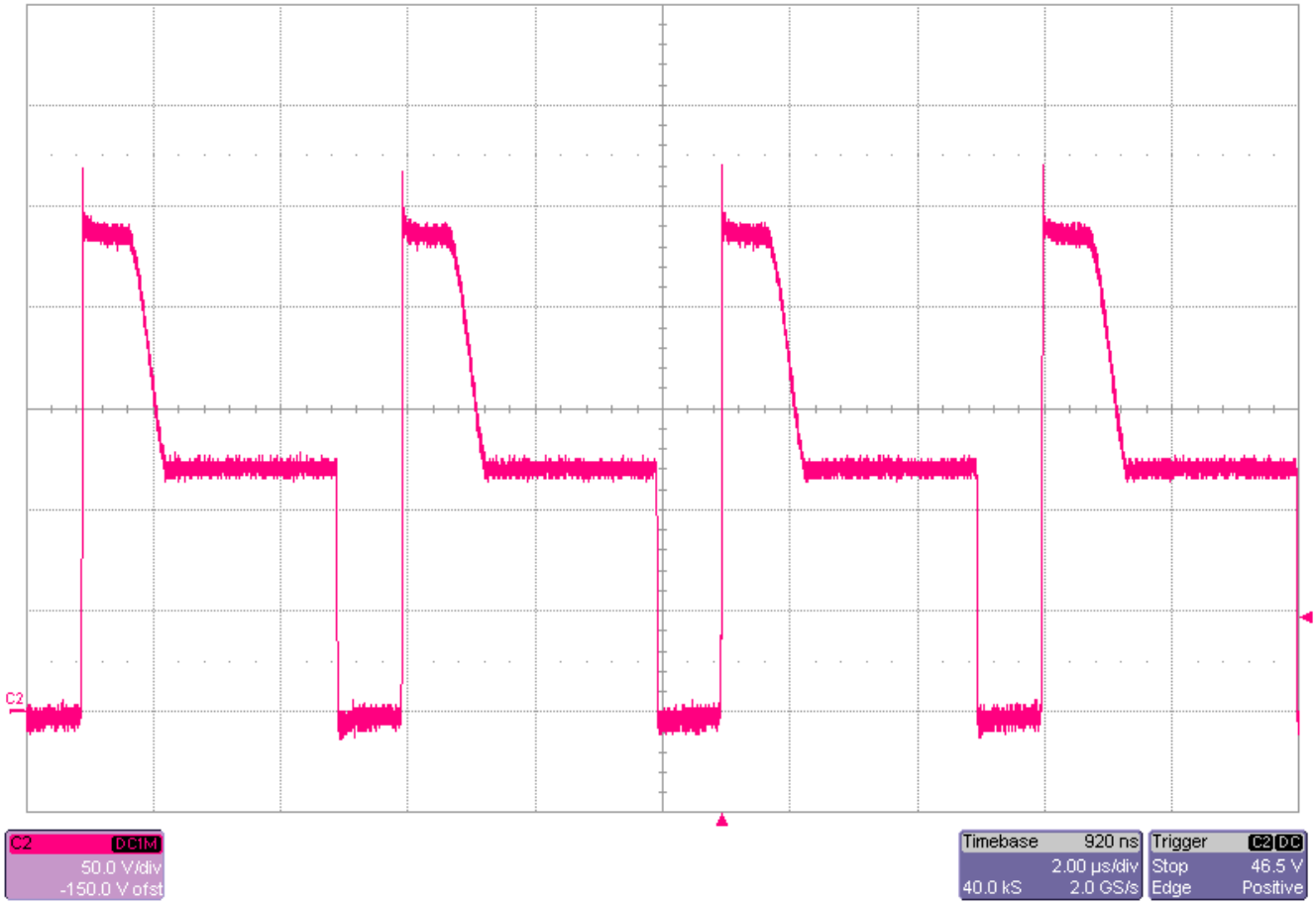


Figure 3-1. Vds of Primary FET (Q3), 120-VDC Input, 40-W Output

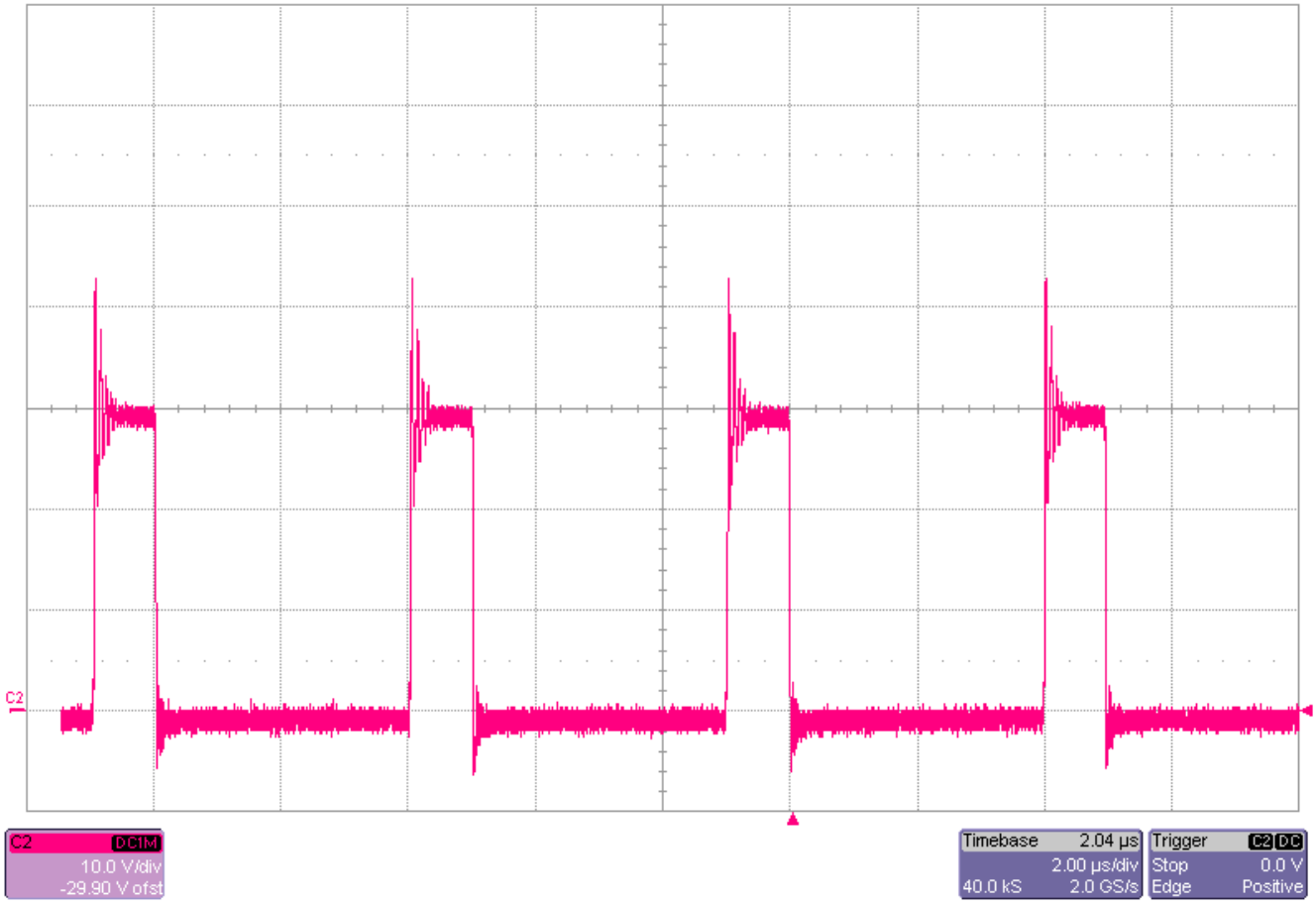


Figure 3-2. Voltage on Cathodes of Output Diodes (D3), 120-VDC Input, 40-W Output

3.2 Output Voltage Ripple

Output voltage ripple is shown in the following figures.

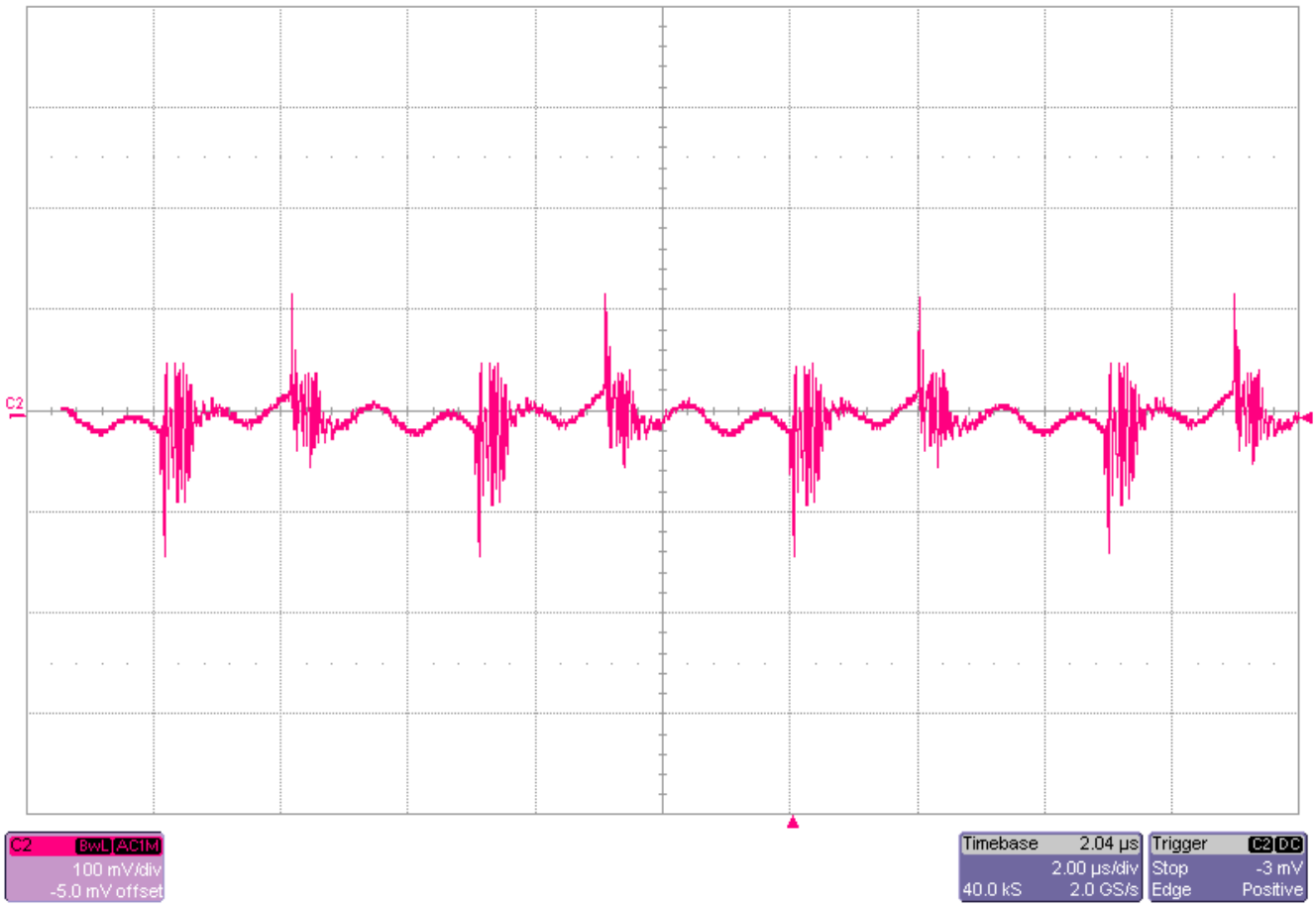


Figure 3-3. 60-VDC Input

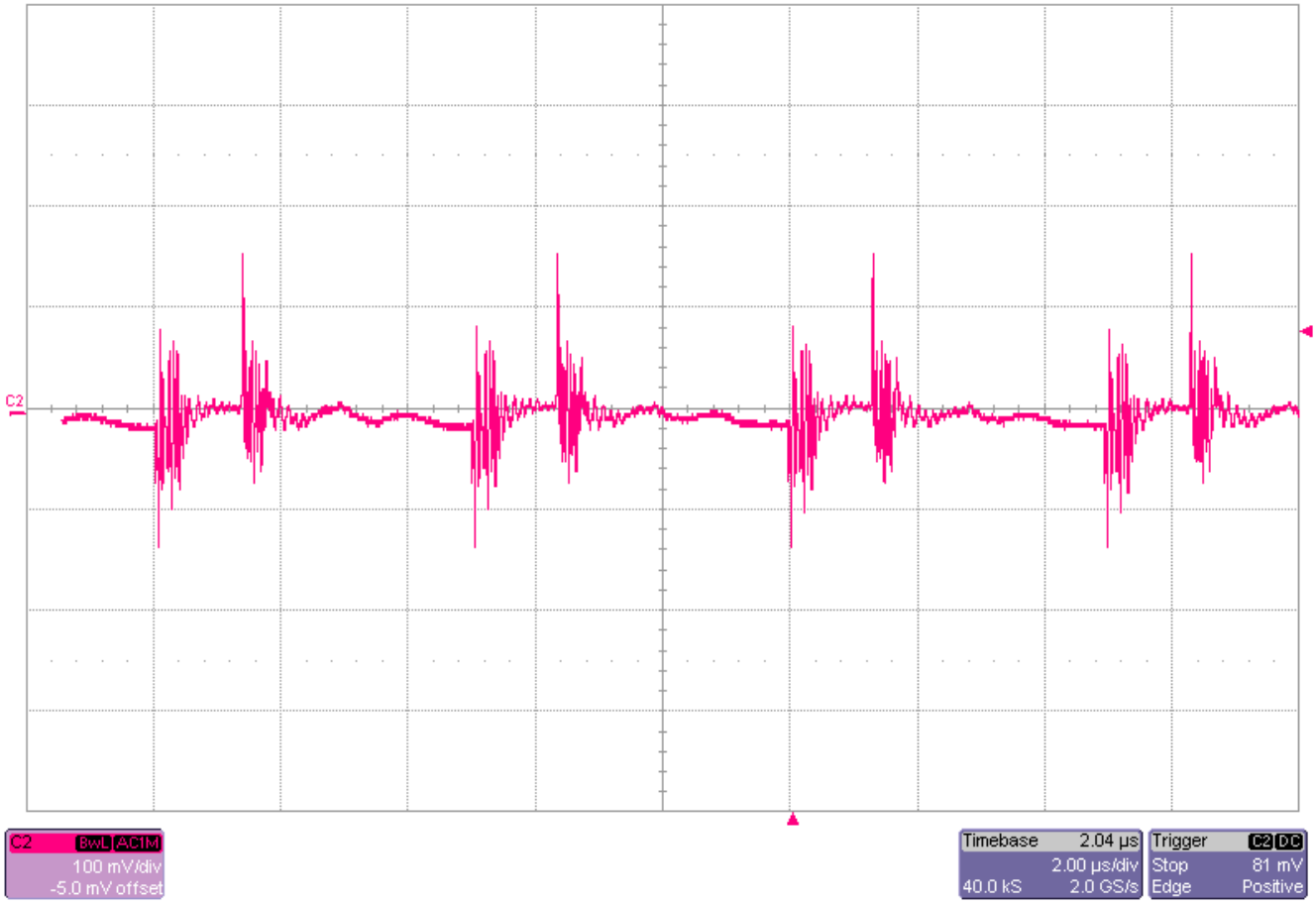


Figure 3-4. 90-VDC Input

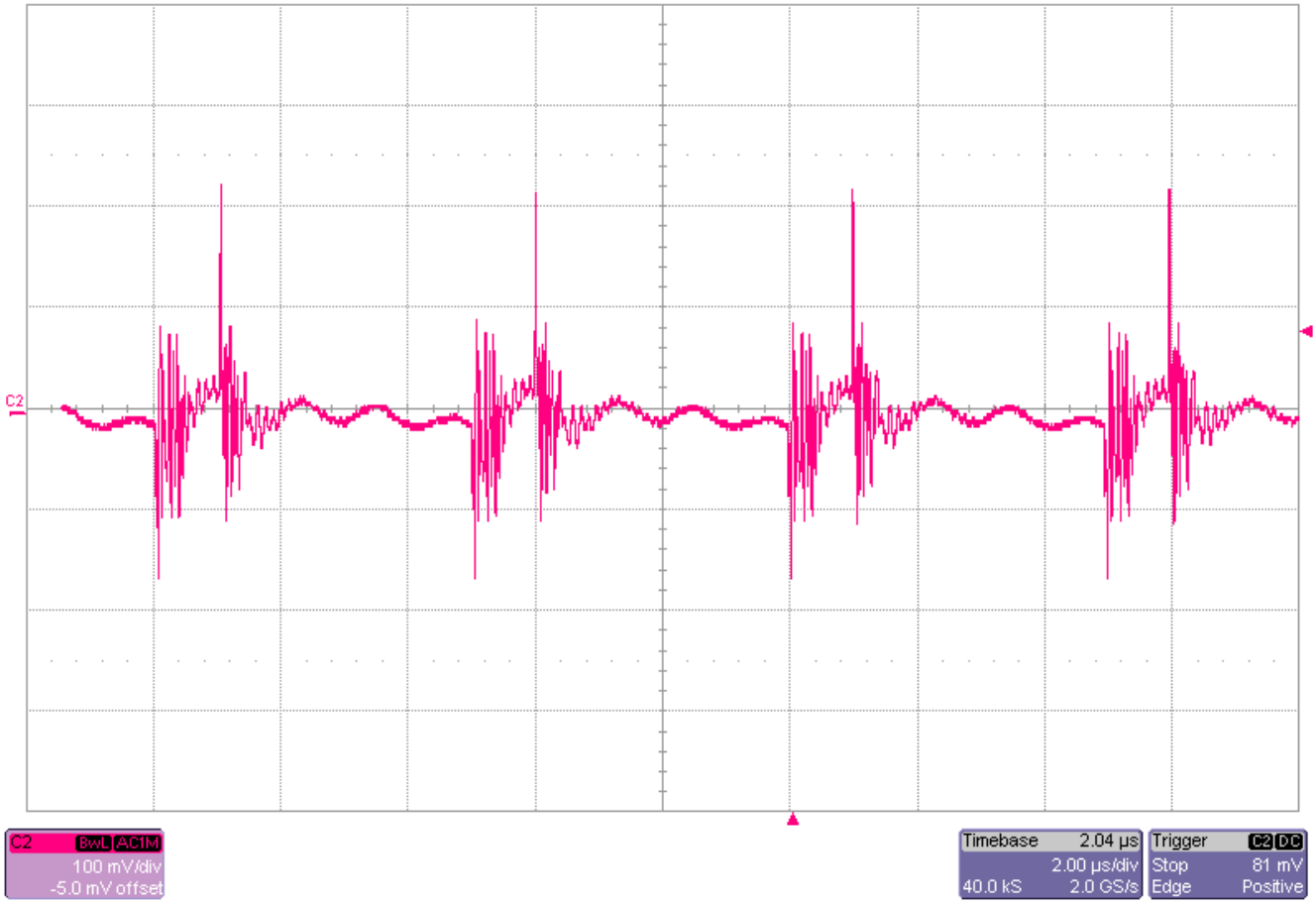


Figure 3-5. 120-VDC Input

3.3 Load Transients

Load transient response is shown in the following figures.

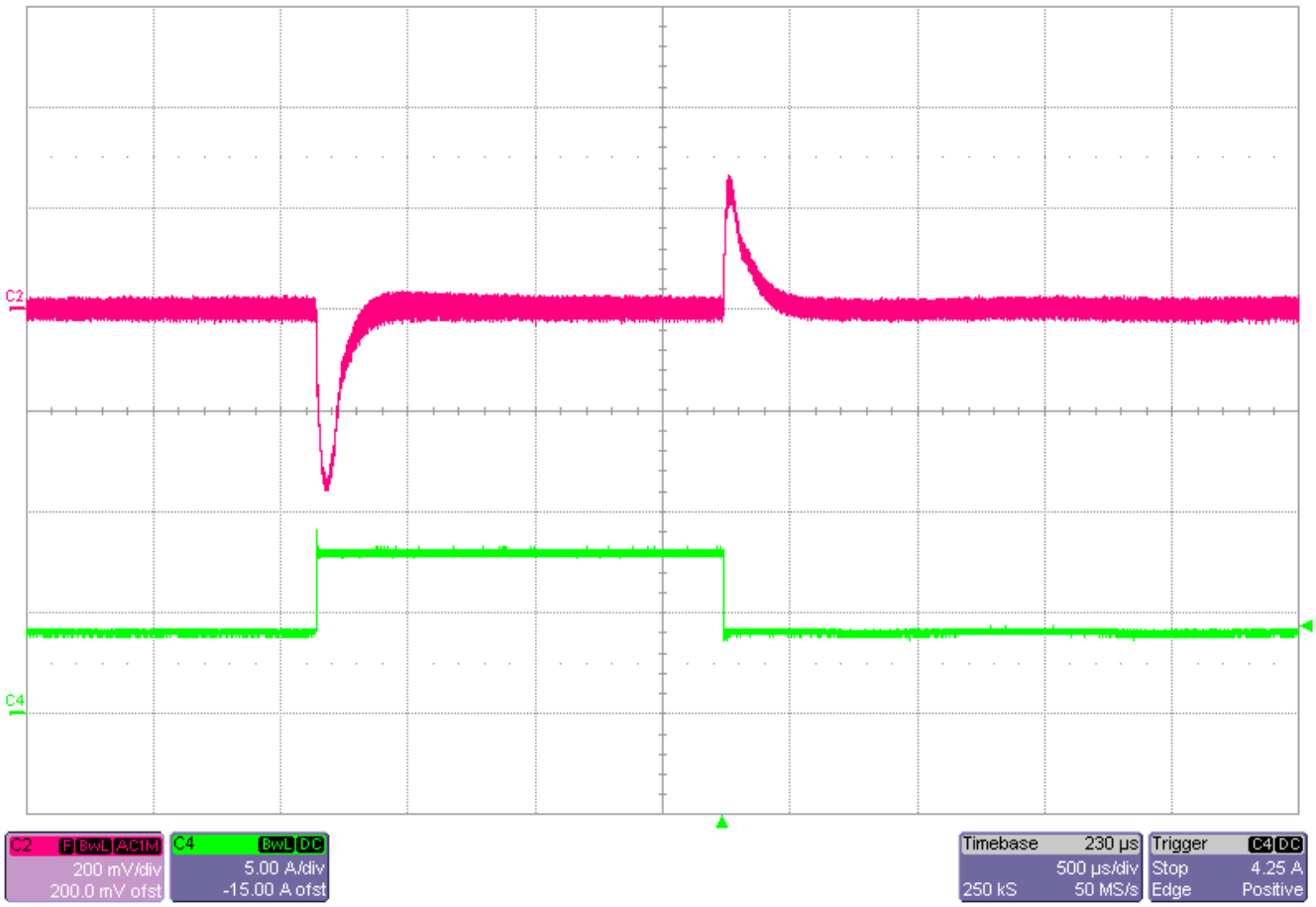


Figure 3-6. 4-A to 8-A Step, 60-VDC Input

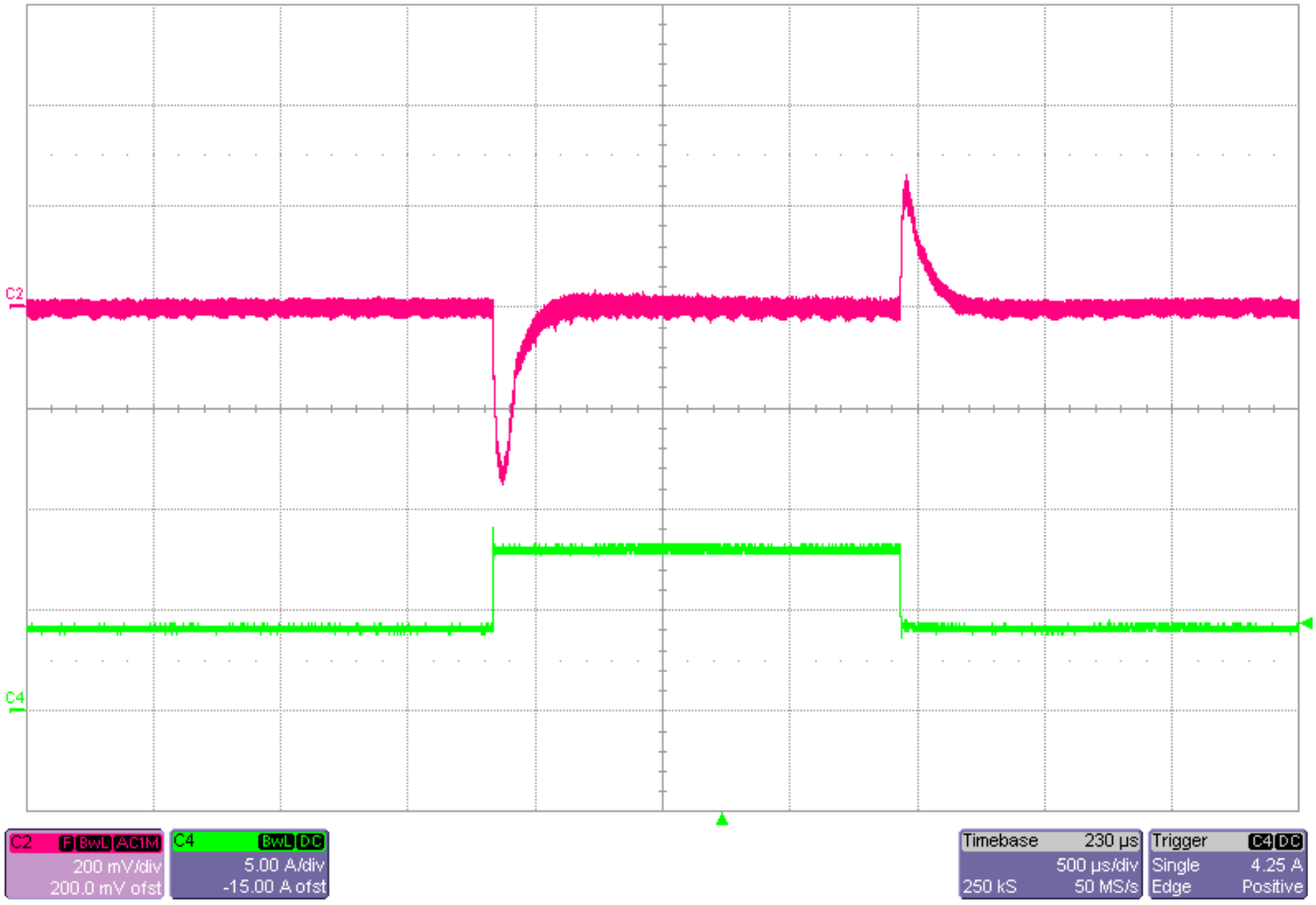


Figure 3-7. 4-A to 8-A Step, 90-VDC Input

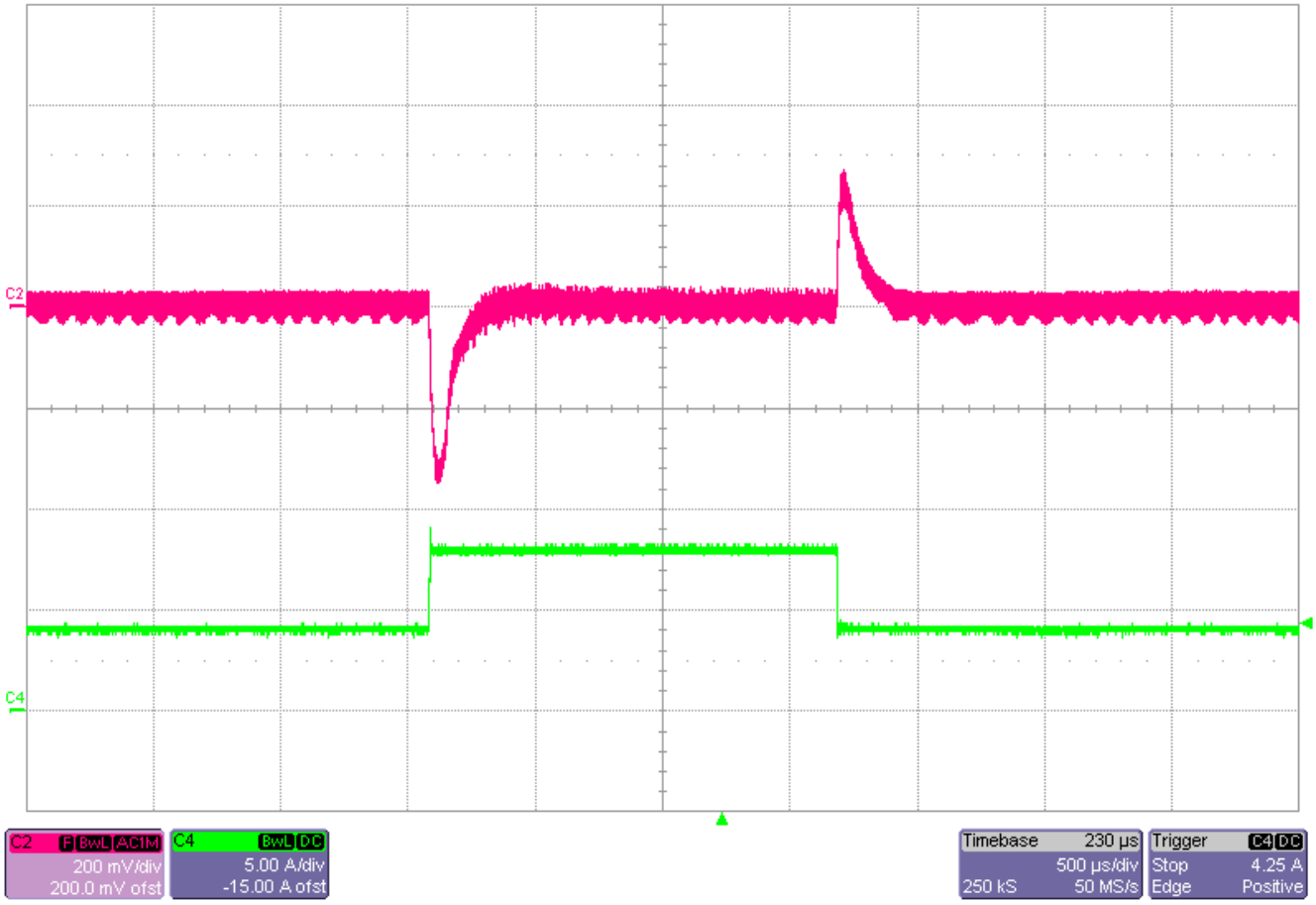


Figure 3-8. 4-A to 8-A Step, 120-VDC Input

3.4 Output Voltage at Start-up

Output voltage start-up behavior is shown in the following figure.

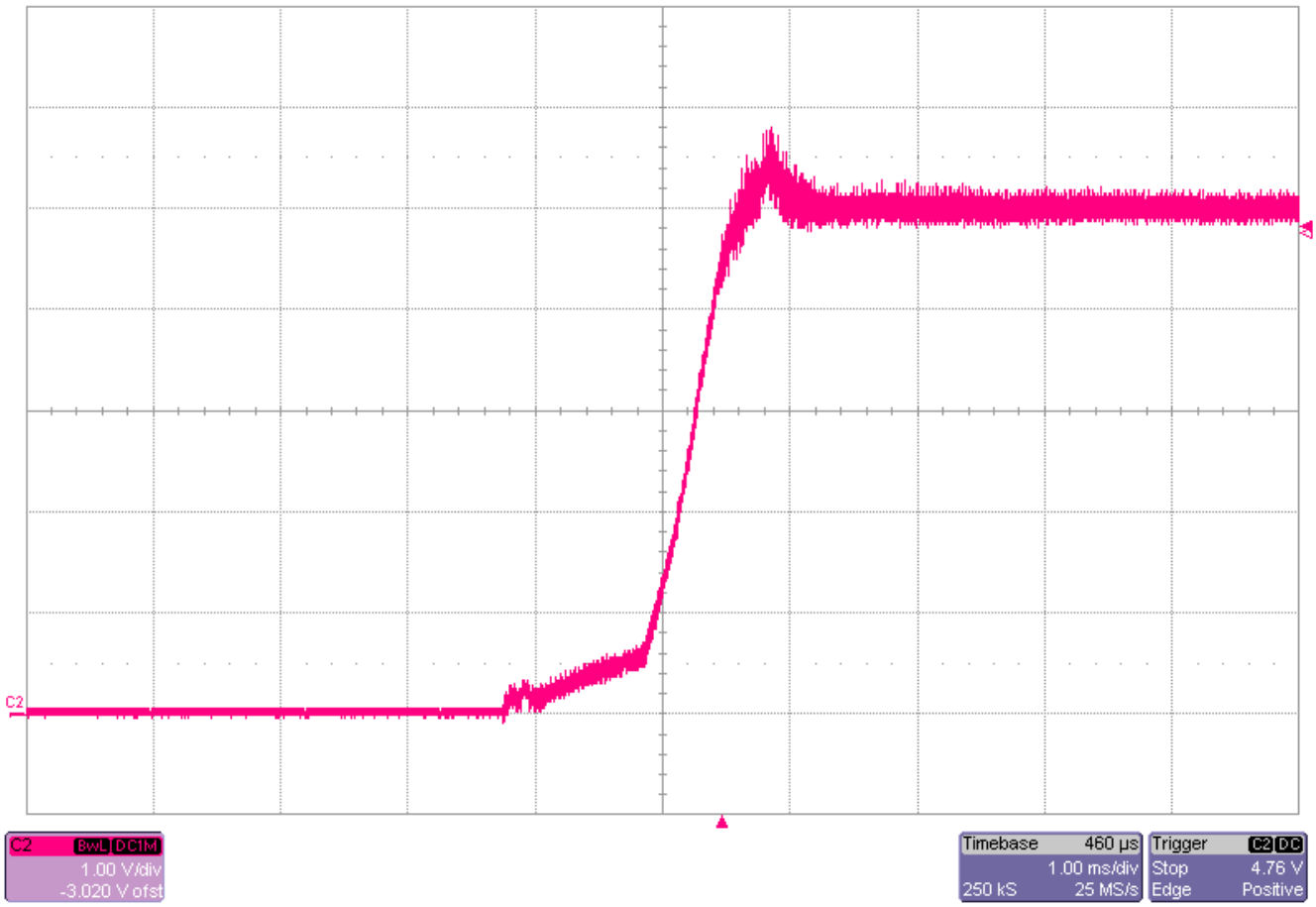


Figure 3-9. 120-V Input, 40-W Load

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