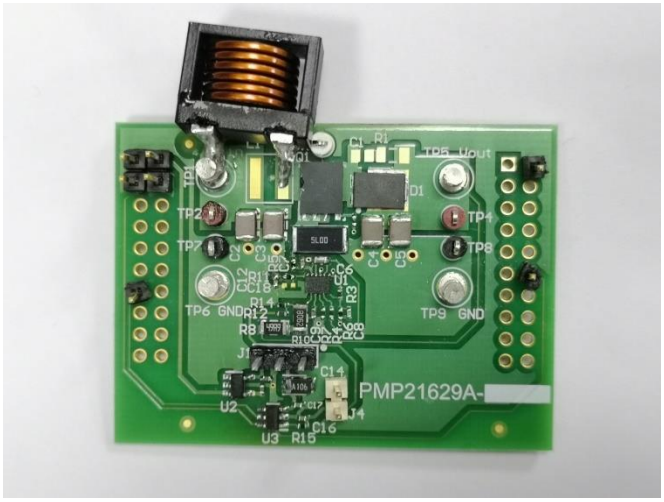
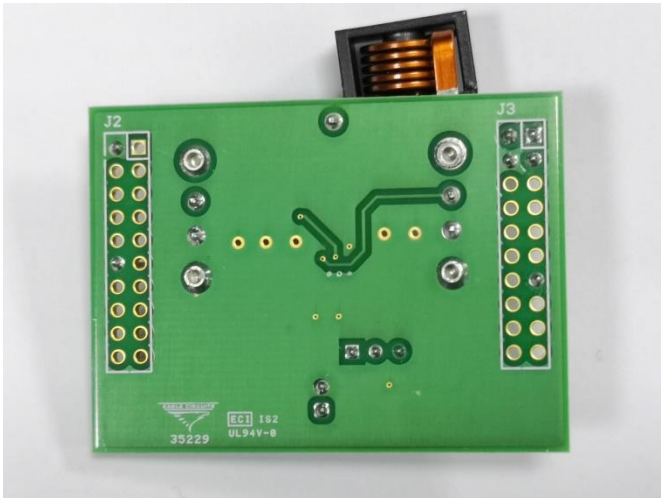
Test Report: PMP21629

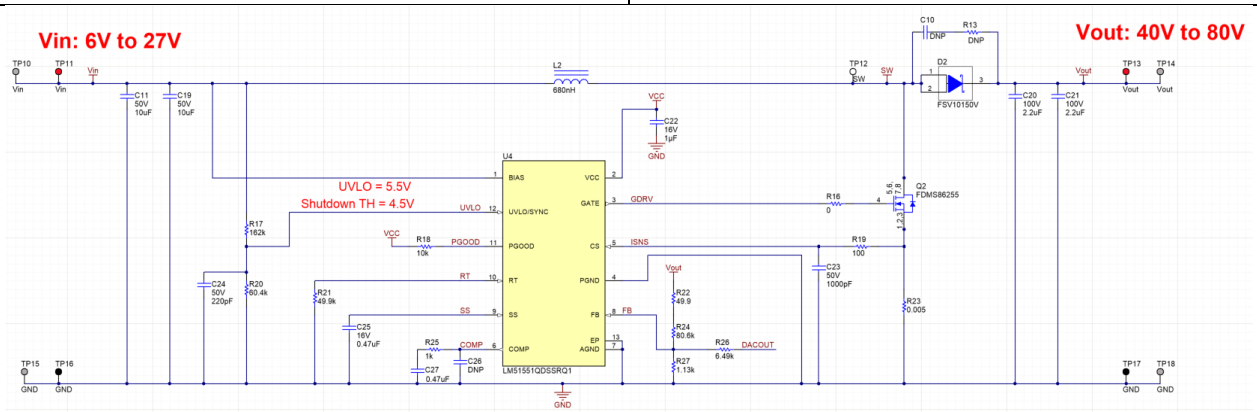
40-V to 80-V Adjustable Output Voltage Boost Reference Design for LiDAR Applications

Description

This reference design utilizes a non-synchronous boost controller to provide an adjustable output of between 40 V and 80 V capable of delivering a maximum of 100 mA of current to the load. This is an Automotive design intended to power various applications such as LiDAR systems, which require an adjustable voltage supply.







1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
V_{in}	6-27VDC
V_{out}	40VDC to 80VDC (adjustable)
I_{out}	0.1A Maximum
F_{sw}	400kHz Nominal

1.2 Required Equipment

- Power Supply
- Load Resistors
- DMMs
- Oscilloscope
- Auxiliary Power Supply (for providing DC signal that controls the output voltage)

1.3 Considerations

Using electronic loads may exhibit undesirable behavior due to the interaction of the regulation loop of the electronic load with the low output capacitance of the boost converter. It is recommended to use resistor loads instead.

2 Testing and Results

2.1 Efficiency Graphs

Figure 1 shows the converter efficiency for a 18-V input with 35-V, 100-V, and 150-V outputs.

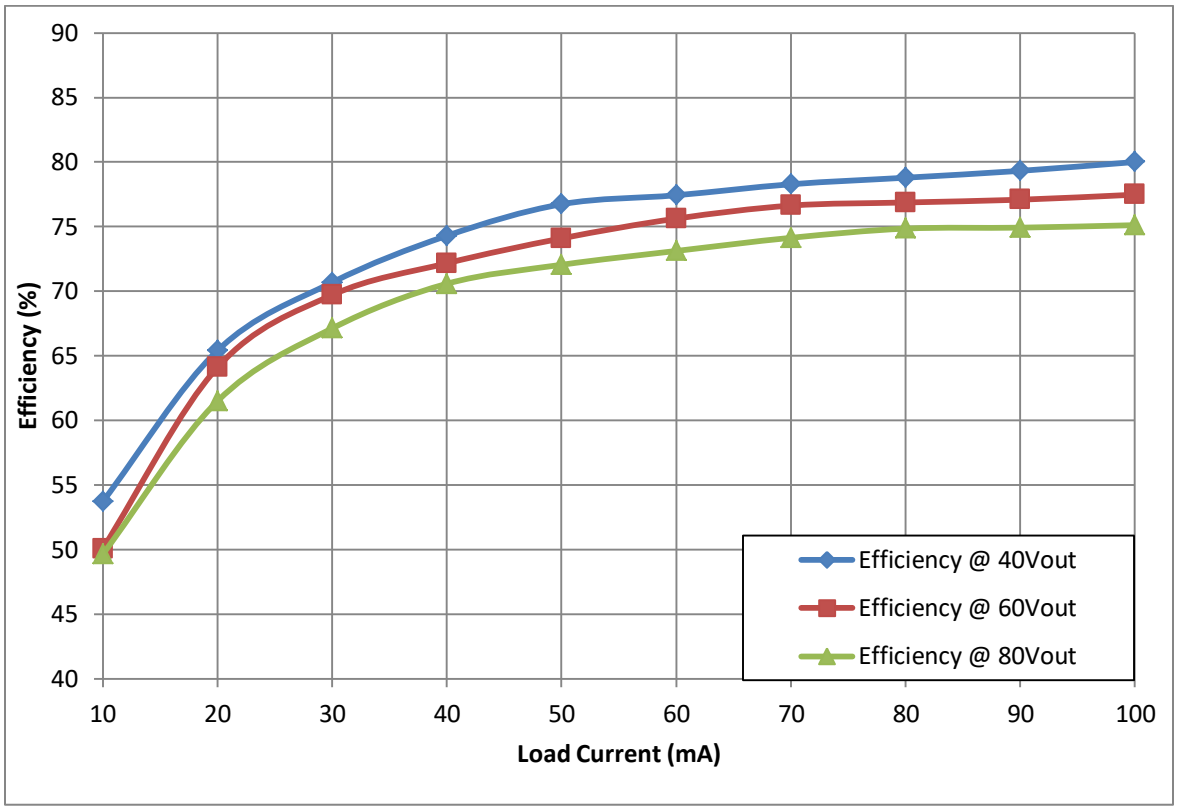


Figure 1. Converter Efficiency 6-V Input, 40-V, 60-V, and 80-V Outputs

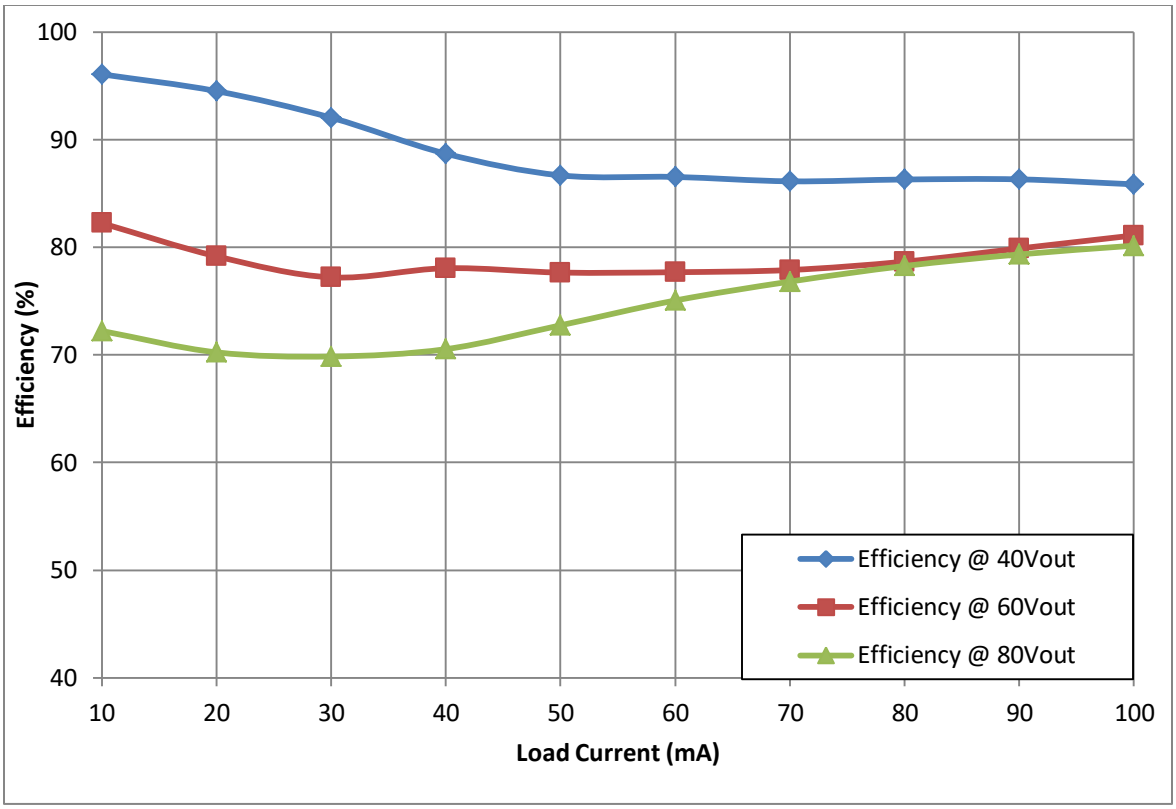


Figure 2. Converter Efficiency 24-V Input, 40-V, 60-V, and 80-V Outputs

2.2 Efficiency Data

Table 2, Table 3, and Table 4 show the efficiency data for 40-V, 60-V, and 80-V outputs with a 6-V input. Table 5, Table 6, and Table 7 show the efficiency data for 40-V, 60-V, and 80-V outputs with a 24-V input.

Table 2. Efficiency Data 6-V input, 40-V Output

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)
6	0.1228	40.025	0.01	0.7368	0.40025	54.32
6	0.20301	40.02	0.02	1.21806	0.8004	65.71
6	0.282	40.05	0.03	1.692	1.2015	71.01
6	0.3589	40.056	0.04	2.1534	1.60224	74.41
6	0.4348	40.052	0.05	2.6088	2.0026	76.76
6	0.5151	40.032	0.06	3.0906	2.40192	77.72
6	0.5968	40.045	0.07	3.5808	2.80315	78.28
6	0.677	40.073	0.08	4.062	3.20584	78.92
6	0.755	40.058	0.09	4.53	3.60522	79.59
6	0.8343	40.058	0.1	5.0058	4.0058	80.02

Table 3. Efficiency Data 6-V Input, 60-V Output

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)
6	0.19966	60.099	0.01	1.19796	0.60099	50.17
6	0.31185	60.104	0.02	1.8711	1.20208	64.24

6	0.4299	60.075	0.03	2.5794	1.80225	69.87
6	0.5538	60.127	0.04	3.3228	2.40508	72.38
6	0.6734	60.089	0.05	4.0404	3.00445	74.36
6	0.793	60.088	0.06	4.758	3.60528	75.77
6	0.912	60.124	0.07	5.472	4.20868	76.91
6	1.0389	60.074	0.08	6.2334	4.80592	77.10
6	1.16904	60.089	0.09	7.01424	5.40801	77.10
6	1.289	60.123	0.1	7.734	6.0123	77.74

Table 4. Efficiency Data 6-V Input, 80-V Output

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)
6	0.2655	80.08	0.01	1.593	0.8008	50.27
6	0.434	80.092	0.02	2.604	1.60184	61.51
6	0.59634	80.085	0.03	3.57804	2.40255	67.15
6	0.75374	80.072	0.04	4.52244	3.20288	70.82
6	0.9255	80.075	0.05	5.553	4.00375	72.10
6	1.0934	80.08	0.06	6.5604	4.8048	73.24
6	1.2596	80.112	0.07	7.5576	5.60784	74.20
6	1.424	80.098	0.08	8.544	6.40784	75.00
6	1.604	80.119	0.09	9.624	7.21071	74.92
6	1.771	80.114	0.1	10.626	8.0114	75.39

Table 5. Efficiency Data 24-V input, 40-V Output

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)
24	0.0174	40.167	0.01	0.4176	0.40167	96.19
24	0.0353	40.067	0.02	0.8472	0.80134	94.59
24	0.0544	40.075	0.03	1.3056	1.20225	92.08
24	0.07522	40.031	0.04	1.80528	1.60124	88.70
24	0.0957	40.032	0.05	2.2968	2.0016	87.15
24	0.1151	40.04	0.06	2.7624	2.4024	86.97
24	0.13518	40.1	0.07	3.24432	2.807	86.52
24	0.1545	40.166	0.08	3.708	3.21328	86.66
24	0.17359	40.105	0.09	4.16616	3.60945	86.64
24	0.1938	40.062	0.1	4.6512	4.0062	86.13

Table 6. Efficiency Data 24-V input, 60-V Output

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)
24.113	0.0303	60.087	0.01	0.730624	0.60087	82.24067
24.096	0.063	60.086	0.02	1.518048	1.20172	79.16219
24.08	0.097	60.109	0.03	2.33576	1.80327	77.20271
24.063	0.1279	60.056	0.04	3.077658	2.40224	78.05416
24.047	0.1608	60.051	0.05	3.866758	3.00255	77.65033
24.031	0.19301	60.052	0.06	4.638223	3.60312	77.68319

24.016	0.22476	60.06	0.07	5.397836	4.2042	77.88677
24.001	0.25449	60.06	0.08	6.108014	4.8048	78.66386
24.011	0.2818	60.06	0.09	6.7663	5.4054	79.88709
23.997	0.30911	60.157	0.1	7.417713	6.0157	81.09912

Table 7. Efficiency Data 24-V input, 80-V Output

Vin (V)	Iin (A)	Vout (V)	Iout (A)	Pin (W)	Pout (W)	Efficiency (%)
24.113	0.046	80.012	0.01	1.109198	0.80012	72.135
24.096	0.0947	80.014	0.02	2.281891	1.60028	70.12955
24.08	0.143	80.02	0.03	3.44344	2.4006	69.71517
24.063	0.189	80.02	0.04	4.547907	3.2008	70.37963
24.047	0.229	80	0.05	5.506763	4	72.63795
24.031	0.2665	80.011	0.06	6.404262	4.80066	74.9604
24.016	0.3034	80.01	0.07	7.286454	5.6007	76.86454
24.001	0.34056	80.005	0.08	8.173781	6.4004	78.30404
24.011	0.378	80.005	0.09	9.076158	7.20045	79.33368
23.997	0.416	80.02	0.1	9.982752	8.002	80.15826

2.3 Thermal Images

The thermal images in Figure 3, Figure 4, and Figure 5 show operation at 6-V input and 40-V, 60-V, and 80-V outputs at 100 mA load, with no airflow. The thermal images in Figure 6, Figure 7, and Figure 8 show operation at 24-V input and 40-V, 60-V, and 80-V outputs at 100 mA load, with no airflow. The thermals images show the component-side of the board and were captured/taken with the board having reached thermal equilibrium.

Figure 3. Thermal Image, 6V Input, 40-V Output at 100 mA Load

Figure 4. Thermal Image, 6-V Input, 60-V Output at 100 mA Load

Figure 5. Thermal Image, 6-V Input, 80-V Output at 100 mA Load

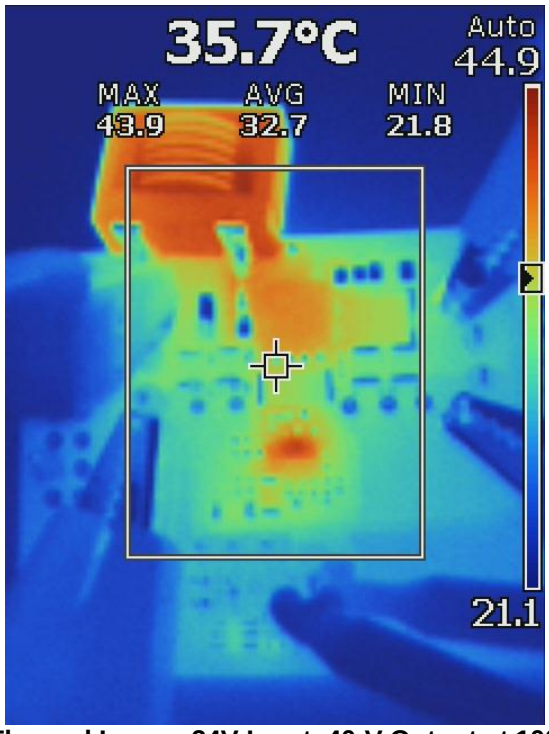


Figure 6. Thermal Image, 24V Input, 40-V Output at 100 mA Load

Figure 7. Thermal Image, 24V Input, 60-V Output at 100 mA Load

Figure 8. Thermal Image, 24V Input, 80-V Output at 100 mA Load

2.4 Dimensions

Figure 9 and Figure 10 present the top and bottom photos of the PMP21629 board. The board dimensions are 52.07mm x 38.1mm.

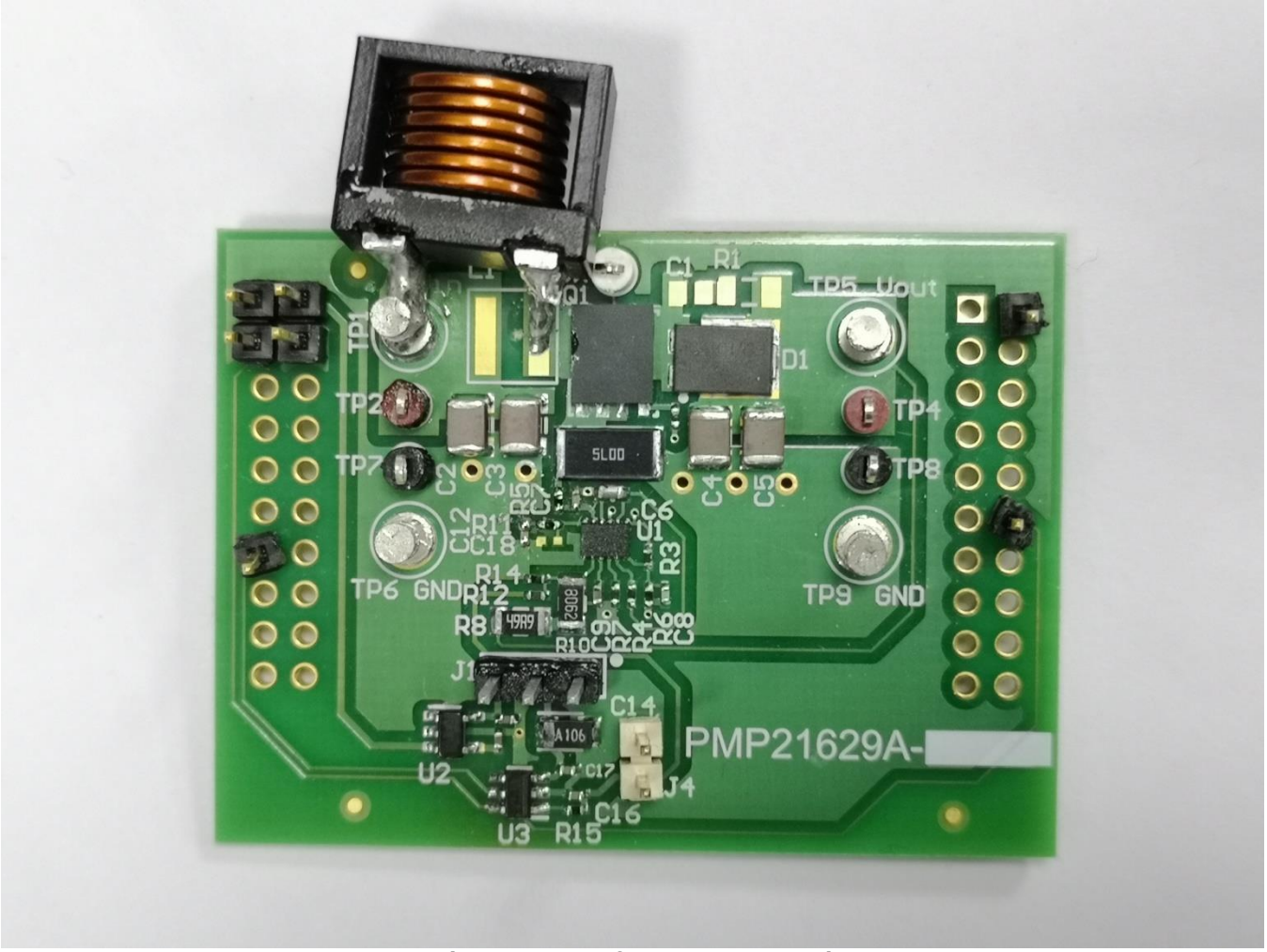


Figure 9. Top of PMP21629 Board

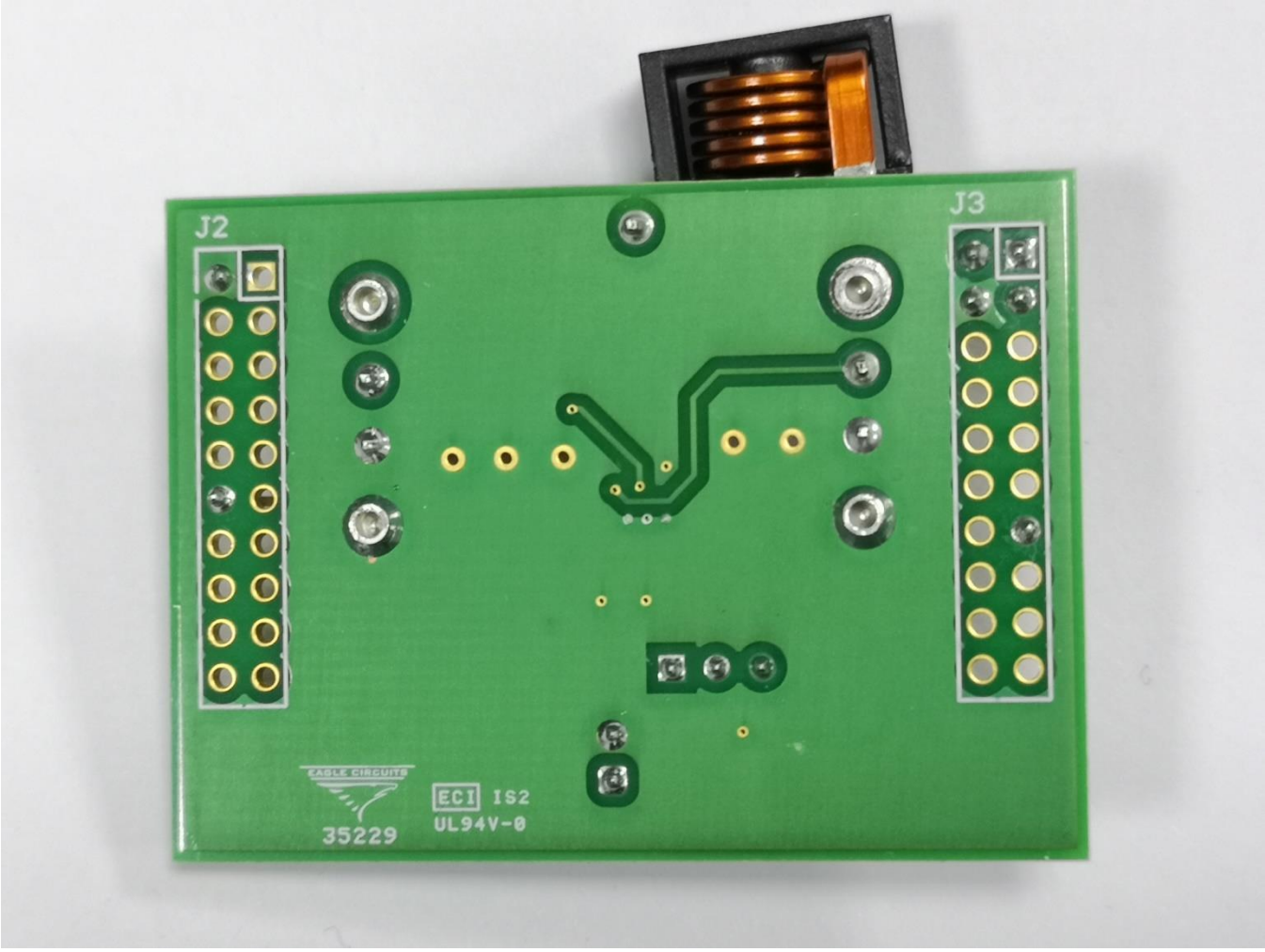


Figure 10. Bottom of PMP21629 Board

3 Waveforms

3.1 Switching

Figure 11 and Figure 12 show the switch node voltage of the converter at 6-V input and 40-V and 80-V output.

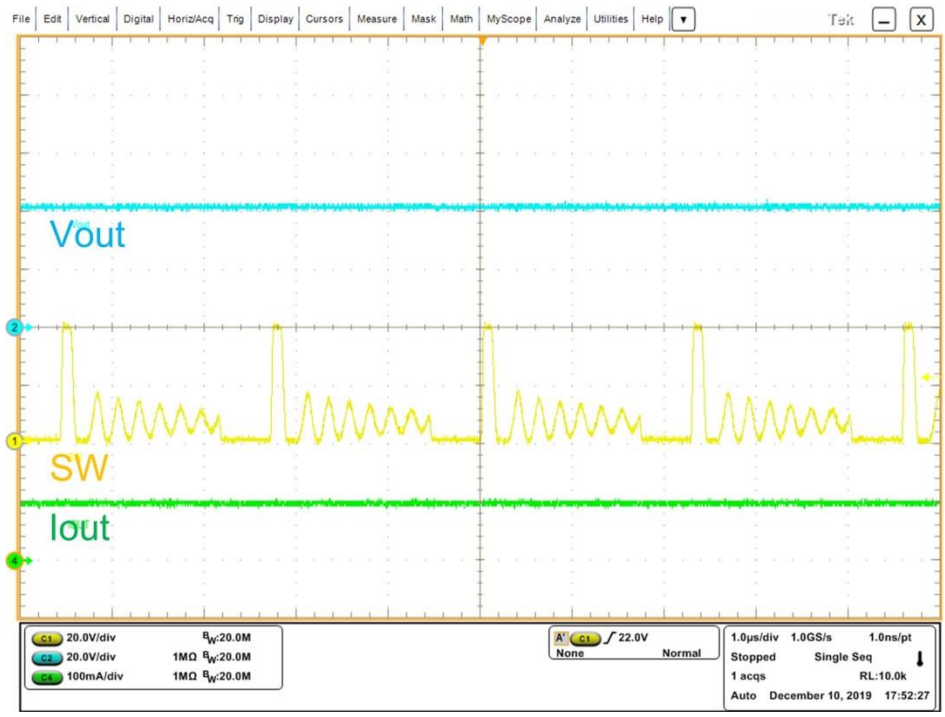


Figure 11. Switch Node Voltage, 6-V Input, 40-V Output, 100 mA Resistive Load

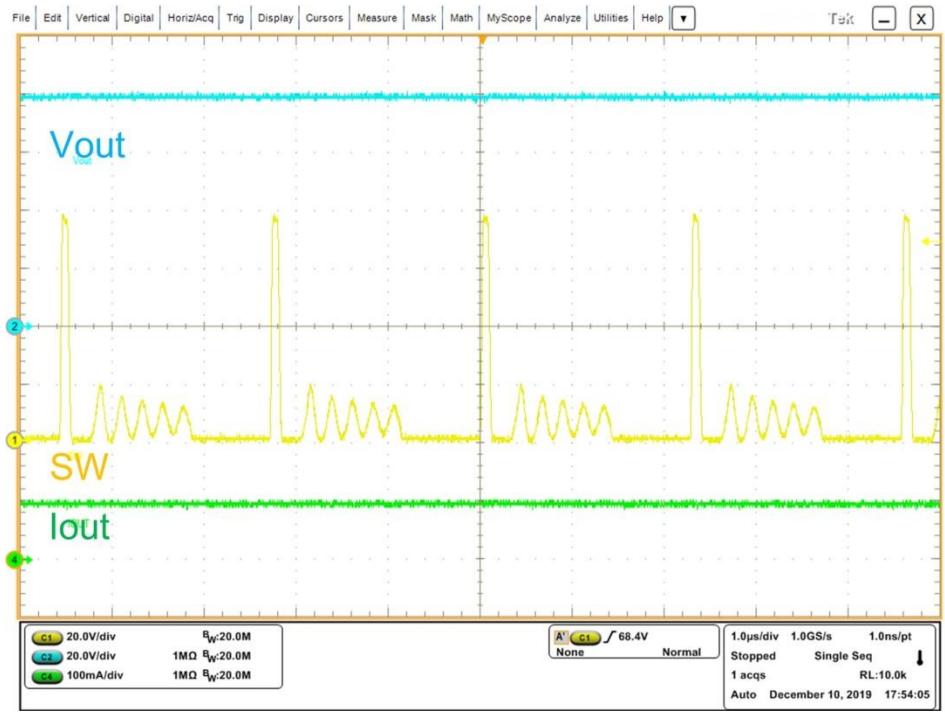


Figure 12. Switch Node Voltage, 6-V Input, 80-V Output, 100 mA Resistive Load

Figure 13 and Figure 14 show the switch node voltage of the converter at 24-V input and 40-V and 80-V output.

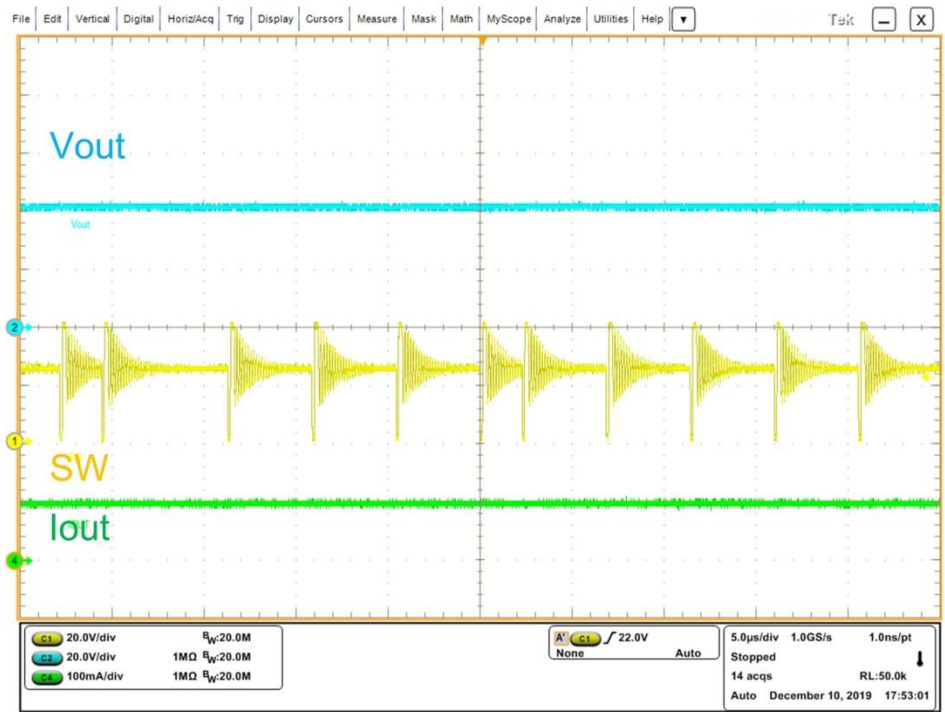


Figure 13. Switch Node Voltage, 24-V Input, 40-V Output, 100 mA Resistive Load

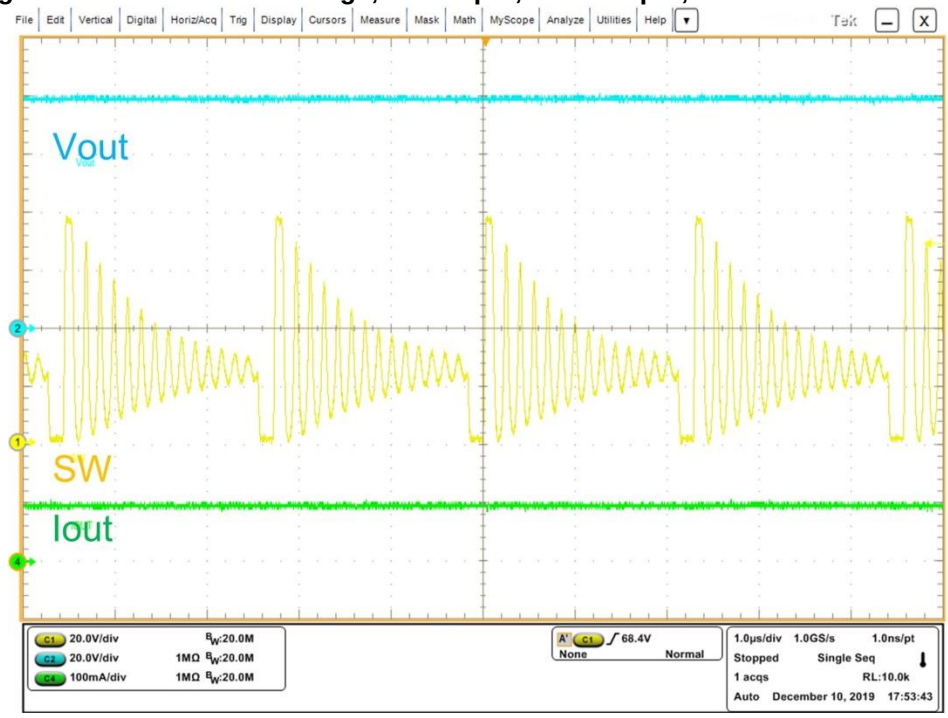


Figure 14. Switch Node Voltage, 24-V Input, 80-V Output, 100 mA Resistive Load

3.2 Output Voltage Ripple

Figure 15 and Figure 16 show the output voltage ripple. The images are taken at 6-V input, 40-V and 80-V outputs loaded at 100 mA.

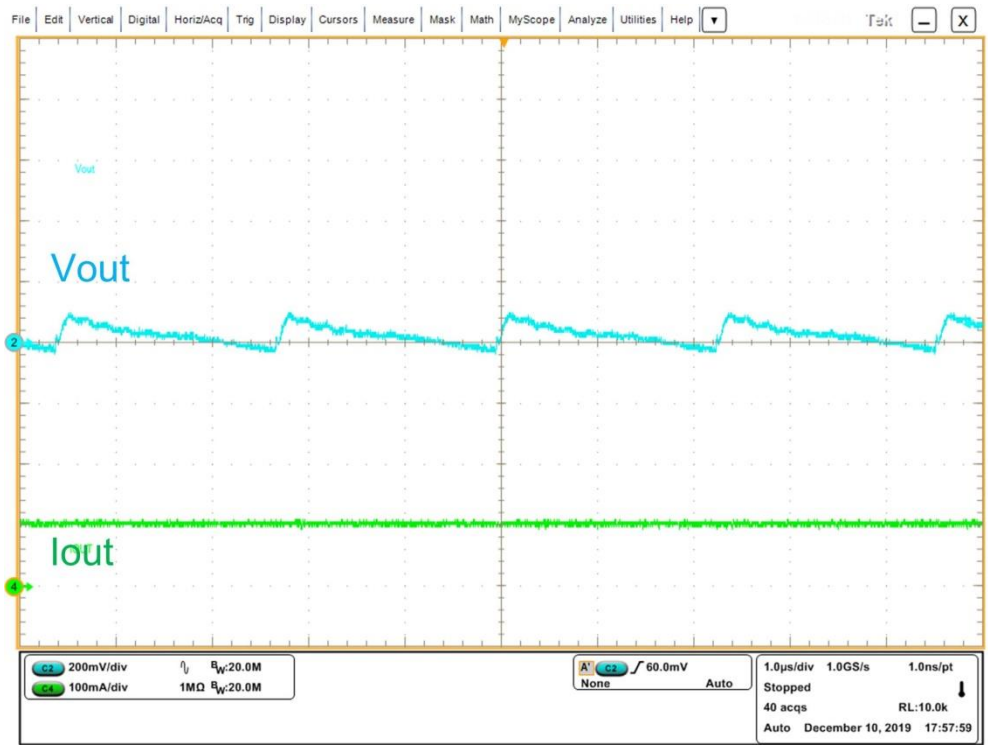


Figure 15. Output Voltage Ripple, 6-V Input, 40-V Output, 100mA Resistive Load

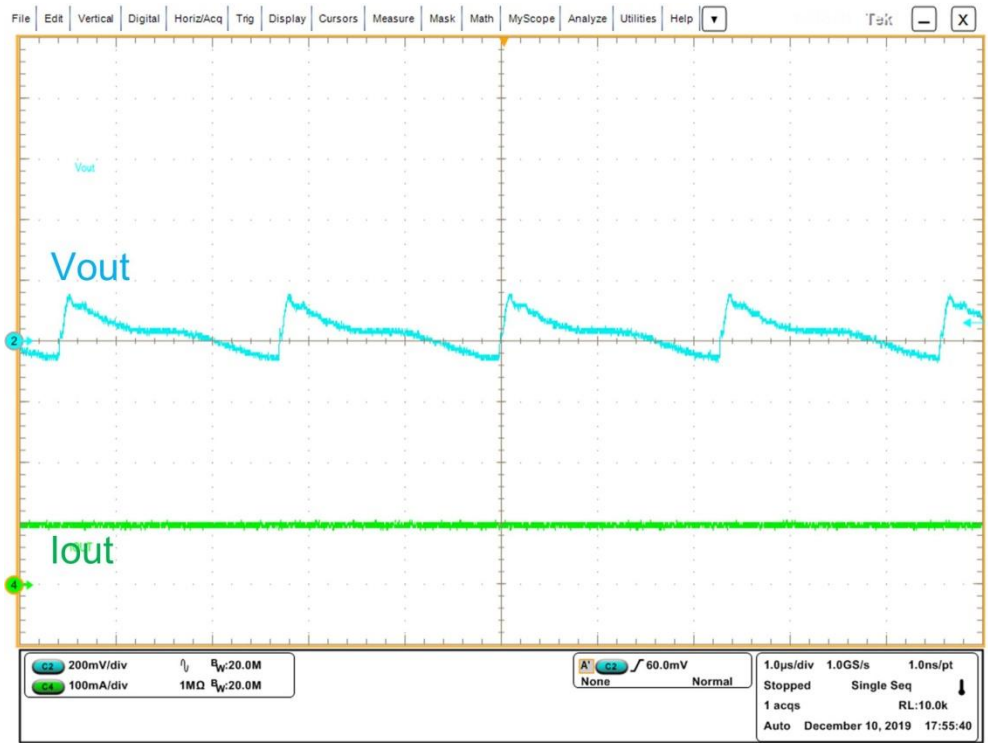


Figure 16. Output Voltage Ripple, 6-V Input, 80-V Output, 100mA Resistive Load

Figure 17 and Figure 18 show the output voltage ripple. The images are taken at 24-V input, 40-V and 80-V outputs loaded at 100 mA.

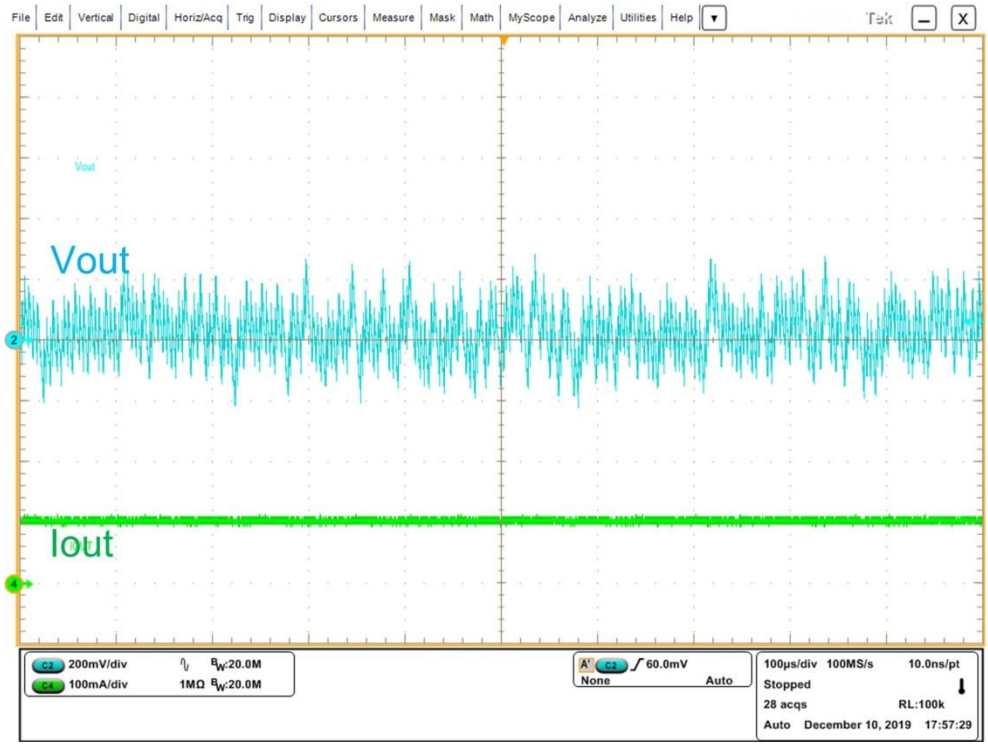


Figure 17. Output Voltage Ripple, 24-V Input, 40-V Output, 100mA Resistive Load

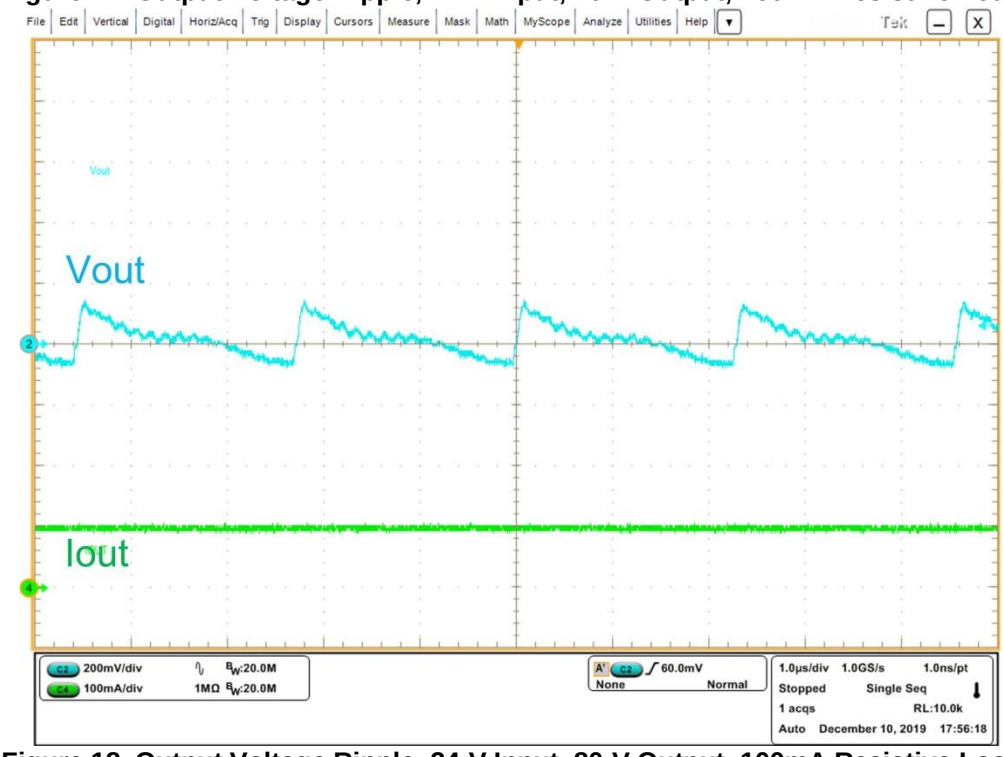


Figure 18. Output Voltage Ripple, 24-V Input, 80-V Output, 100mA Resistive Load

3.3 Load Transients

Figure 19 and Figure 20 show the load transient response of the converter at 6-V input and 40-V and 80-V outputs. The load is stepped from 50% to 100% of the load, corresponding to about 50 mA to 100 mA steps.

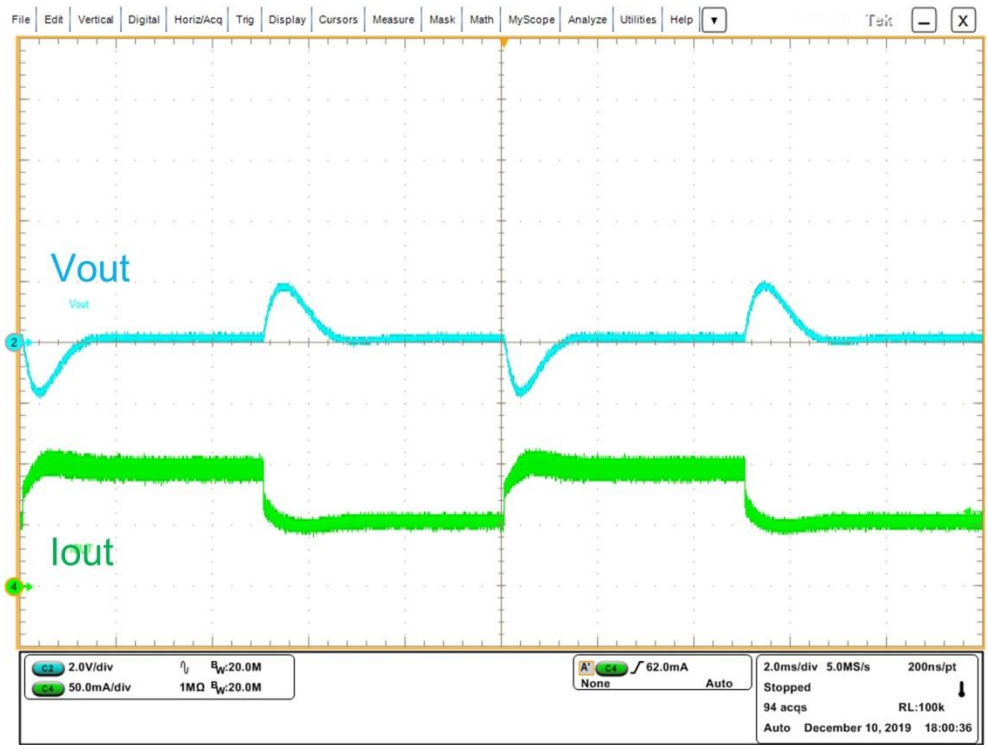


Figure 19. Load Transient Response, 6-V Input, 40-V Output, 50% to 100% Load Step

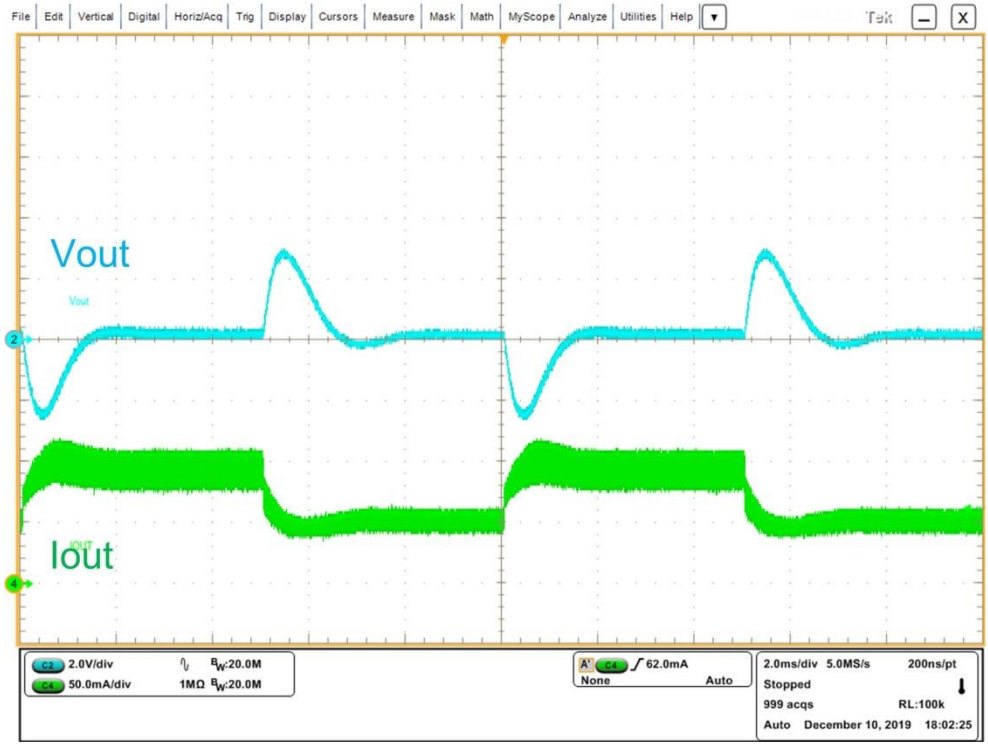


Figure 20. Load Transient Response, 6-V Input, 80-V Output, 50% to 100% Load Step

Figure 21 and Figure 22 show the load transient response of the converter at 24-V input and 40-V and 80-V outputs. The load is stepped from 50% to 100% of the load, corresponding to about 50 mA to 100 mA steps.

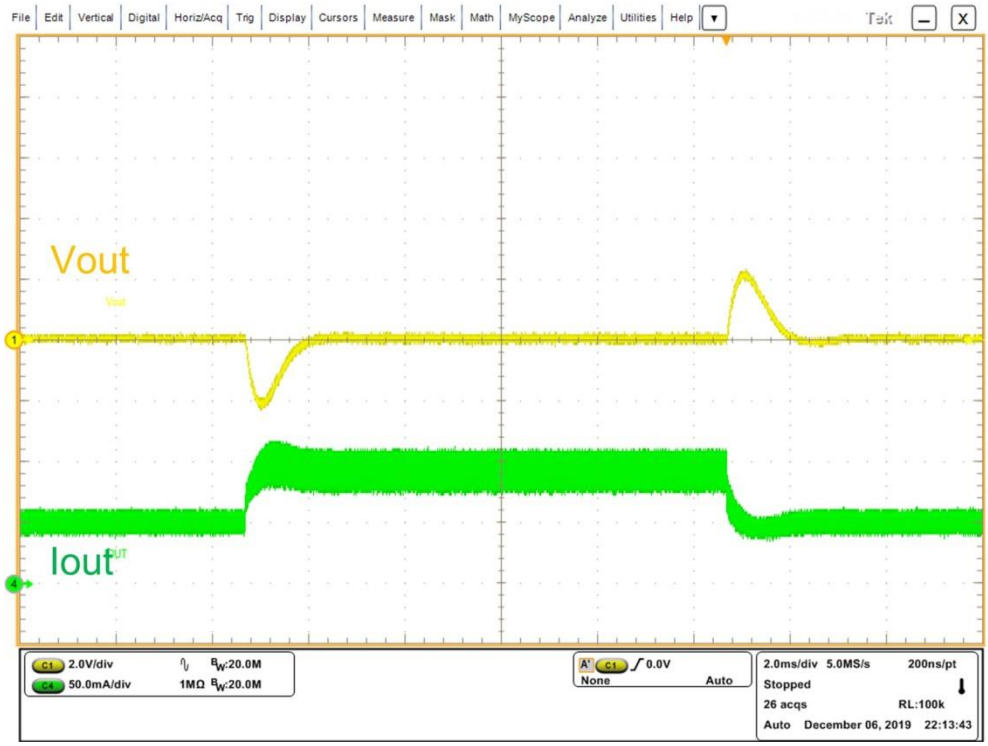


Figure 21. Load Transient Response, 24-V Input, 40-V Output, 50% to 100% Load Step

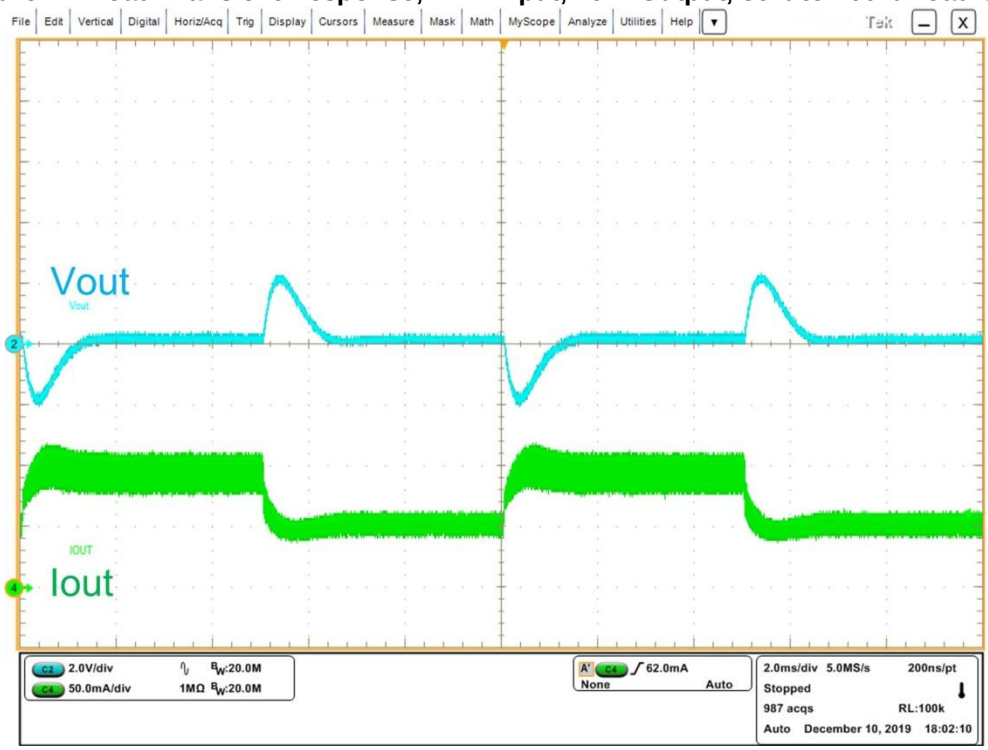


Figure 22. Load Transient Response, 24-V Input, 80-V Output, 50% to 100% Load Step

3.4 Start-up Sequence

Figure 23 and Figure 24 show the output voltage startup waveforms at 18-V input and 40-Vand 80-V output with the converter starting up into no load. Figure 25 and Figure 26 show the output voltage startup waveforms at 18-V input and 40-V and 80-V output with the converter starting up into a 100 mA resistive load.

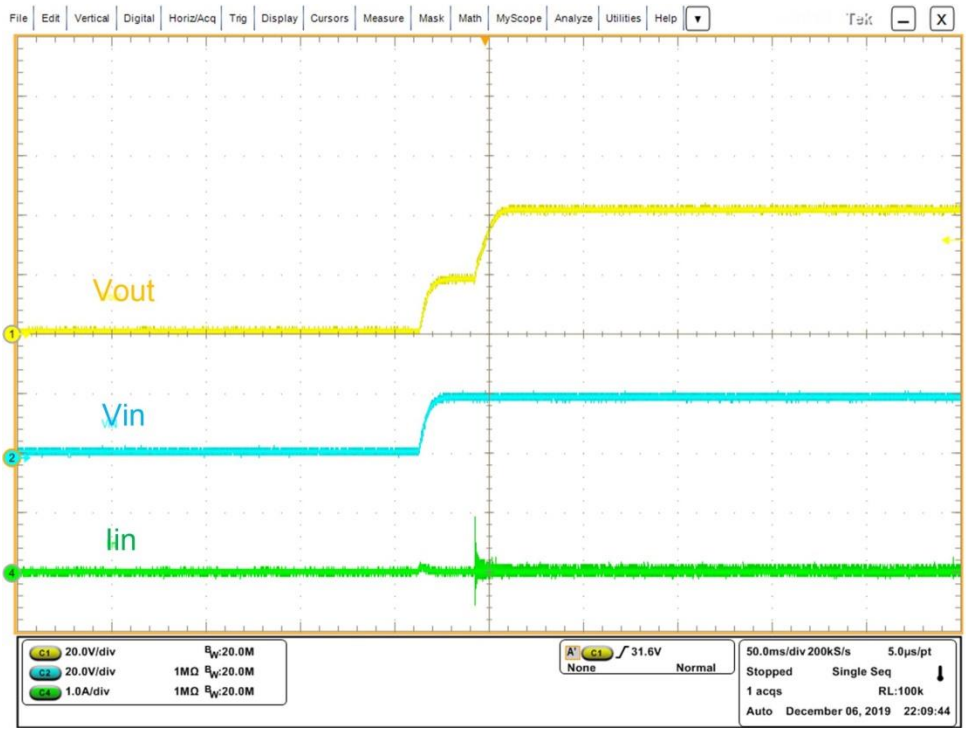


Figure 23. Startup Into No Load, 18-V Input, 40-V Output

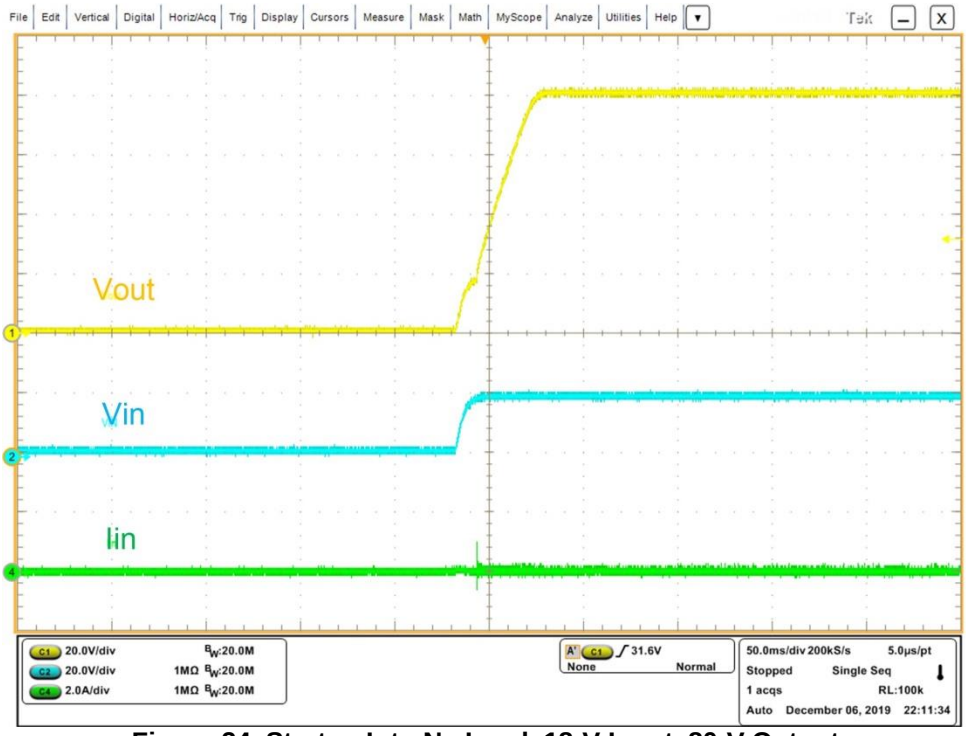


Figure 24. Startup Into No Load, 18-V Input, 80-V Output

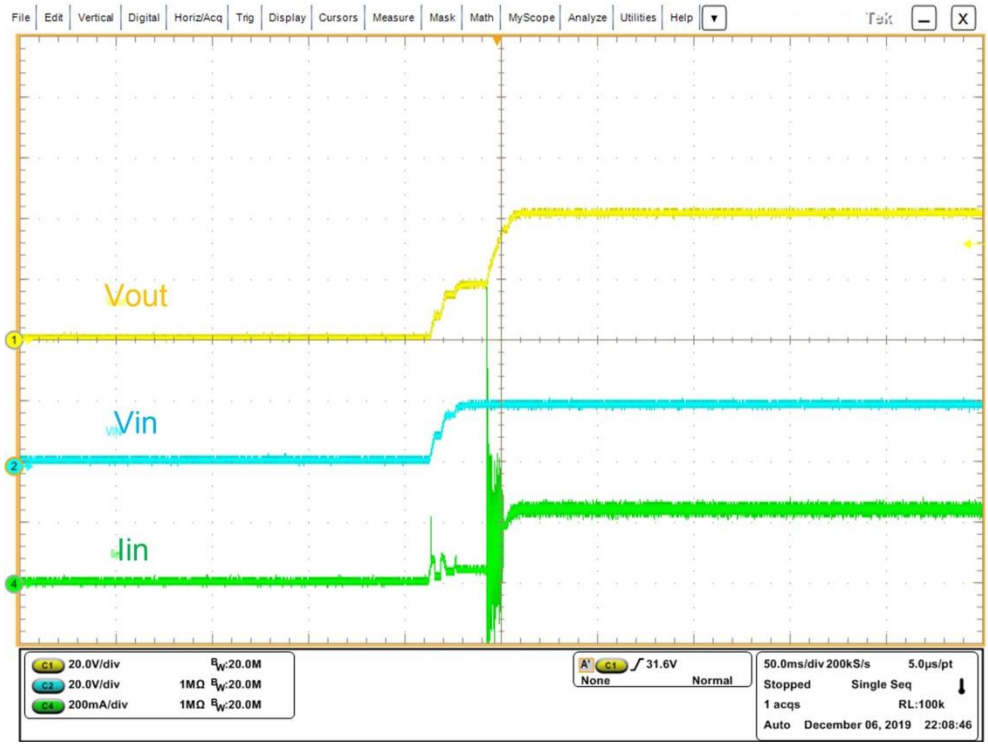


Figure 25. Startup Into 100 mA Resistive Load, 18-V Input, 40-V Output

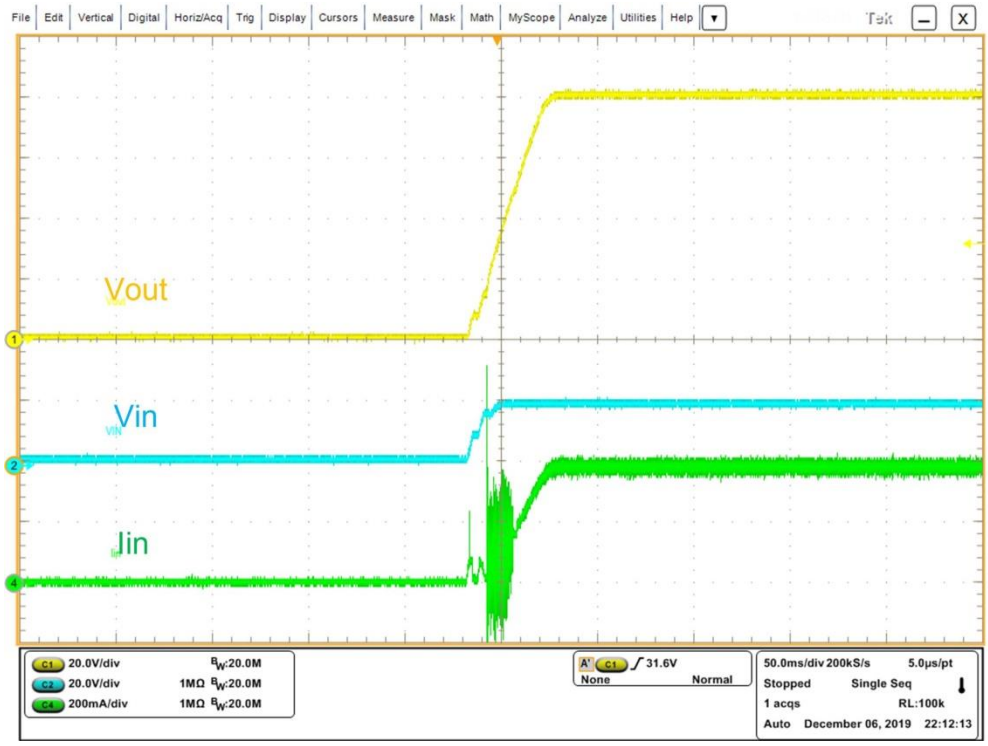


Figure 26. Startup Into 100 mA Resistive Load, 18-V Input, 80-V Output

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