

350-V to 1000-V DC Input, 56-W Flyback Isolated Power Supply Reference Design



Description

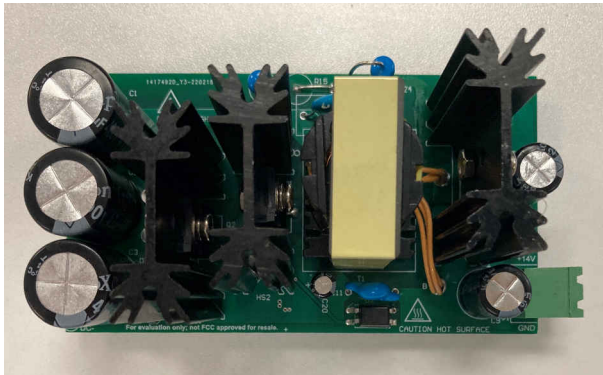
This reference design provides an isolated +14-V, 56-W output with a quasi-resonant flyback topology. The power supply can be powered from the 350-V to 1000-V DC input. This design uses the cascode MOSFETs and the flyback UCC28740-Q1 controller. The line and load regulation is regulated to within $\pm 1\%$ precision. The peak efficiency is 84.6% at 1000-V input and 56-W output.

Features

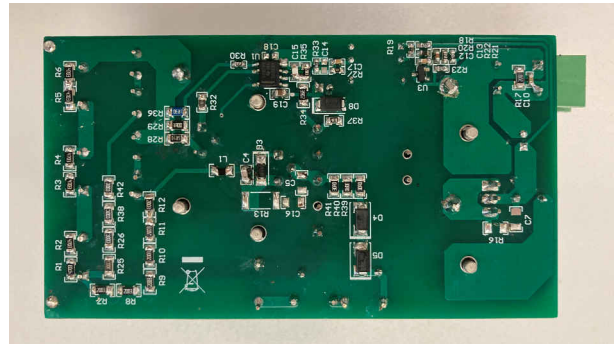
- Wide input range: 350-V to 1000-V DC
- High-precision output voltage
- Peak efficiency 84.6% at 1000-V input and 56-W output
- Quasi-resonant mode controller improves EMI performance

Applications

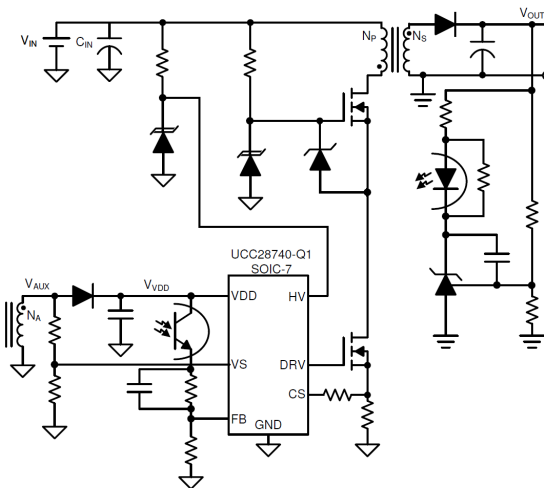
- [Auxiliary-power supplies](#)



Board Photo (Top)



Board Photo (Bottom)



Block Diagram

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

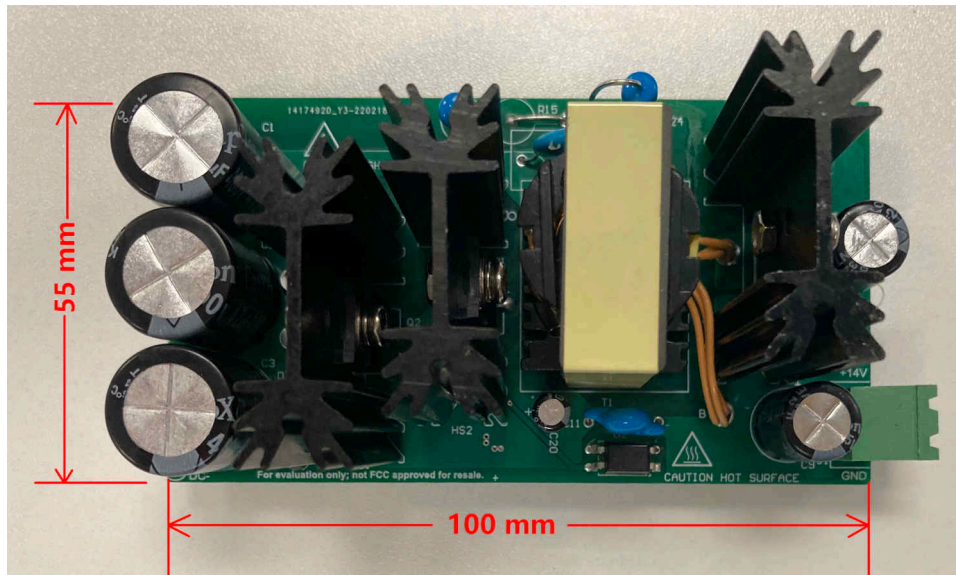
Parameter	Specifications
Input voltage range	350 V–1000 V DC
Output voltage	14 V
Maximum output current	4 A

1.2 Required Equipment

- Chroma DC Source 62024P-600-8
- Chroma DC E-load Model 6314A
- Tektronix DPO 3054
- Multimeter: Fluke 287C
- Electrical Thermography: Fluke TiS55

1.3 Dimensions

The board dimensions are 100 mm (length) × 55 mm (width) × 40 mm (height).



2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

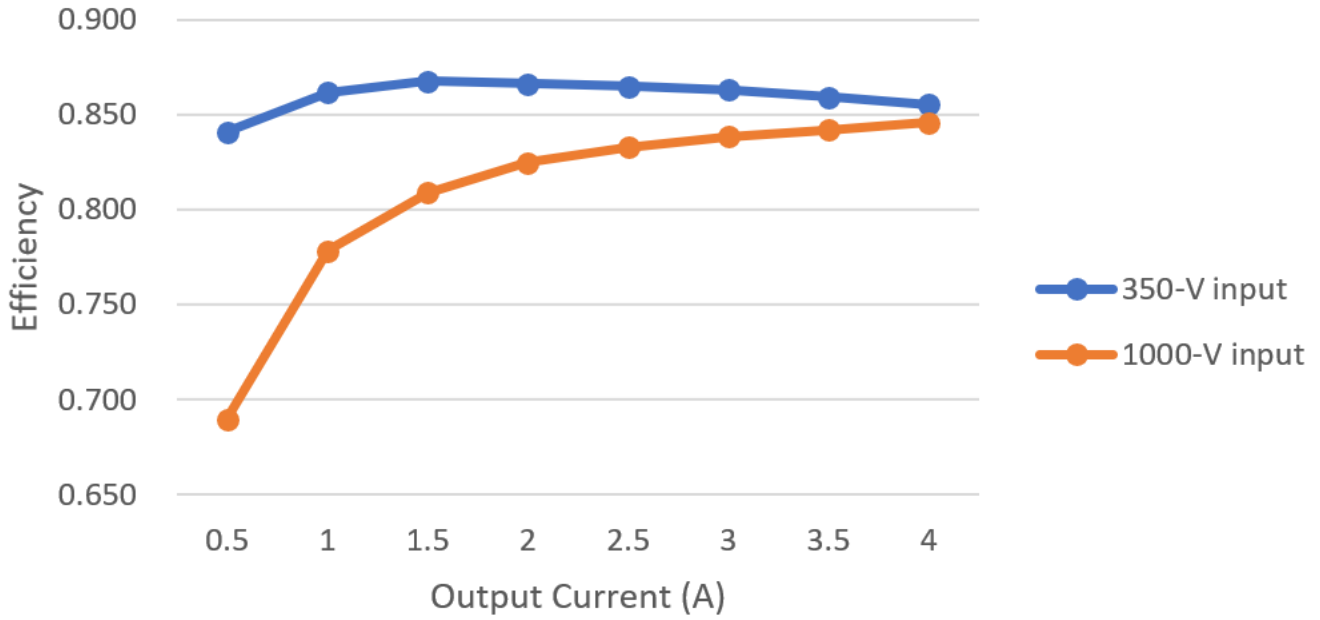


Figure 2-1. Efficiency Graph

2.2 Efficiency Data

Table 2-1 and Table 2-2 show the 350-V input and 1000-V input efficiency data, respectively.

Table 2-1. 350-V Input Efficiency

V_{IN} (V)	I_{IN} (mA)	P_{IN} (W)	V_o (V)	I_o (A)	Ploss (W)	Efficiency
350.03	0.757	0.3	13.983	0.000	0.3	
349.98	23.556	8.2	13.980	0.496	1.3	0.841
349.95	45.890	16.1	13.975	0.990	2.2	0.862
349.66	69.200	24.2	13.970	1.503	3.2	0.868
349.44	92.000	32.1	13.966	1.994	4.3	0.866
349.26	115.100	40.2	13.960	2.490	5.4	0.865
349.09	139.040	48.5	13.960	3.000	6.7	0.863
348.95	162.670	56.8	13.950	3.496	8.0	0.859
348.81	186.500	65.1	13.945	3.990	9.4	0.855

Table 2-2. 1000-V Input Efficiency

V_{IN} (V)	I_{IN} (mA)	P_{IN} (W)	V_o (V)	I_o (A)	Ploss (W)	Efficiency
1000	1.325	1.3	13.980	0.000	1.3	
1000	10.036	10.0	13.979	0.495	3.1	0.689
1000	17.807	17.8	13.970	0.990	4.0	0.777
999.9	25.908	25.9	13.970	1.500	5.0	0.809
999.9	33.811	33.8	13.968	1.996	5.9	0.825
999.9	41.744	41.7	13.960	2.490	7.0	0.833
999.9	49.935	49.9	13.956	3.000	8.1	0.839
999.8	57.920	57.9	13.950	3.495	9.2	0.842
999.8	65.810	65.8	13.946	3.990	10.2	0.846

2.3 Regulation Graph

The line and load regulation is shown in the following figure.

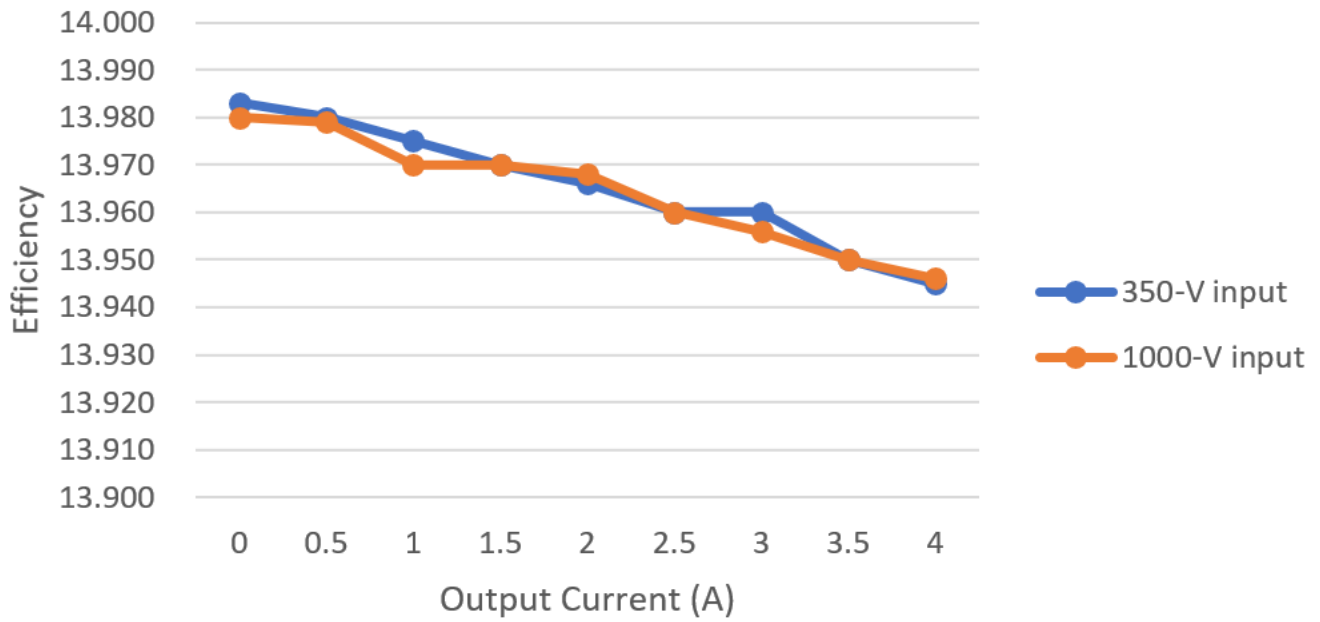


Figure 2-2. PMP41009 Regulation

2.4 Thermal Images

Figure 2-3 and Figure 2-4 show the PMP41009 thermal images.

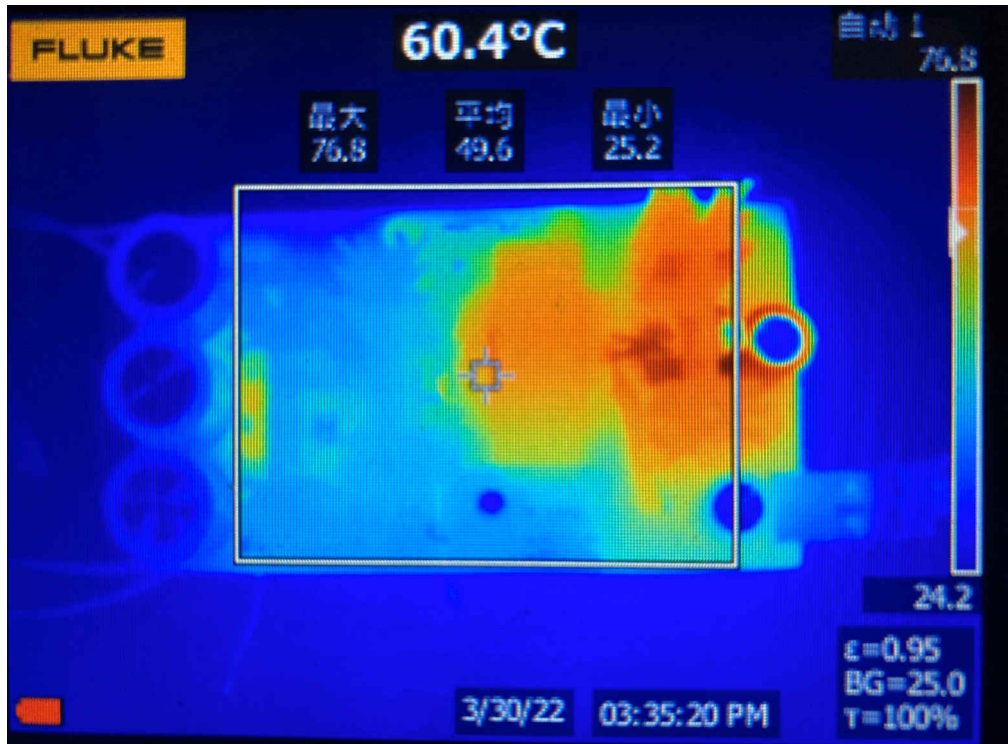


Figure 2-3. Top Thermal Image, $V_{IN} = 1000\text{ V}$, $I_o = 4\text{ A}$

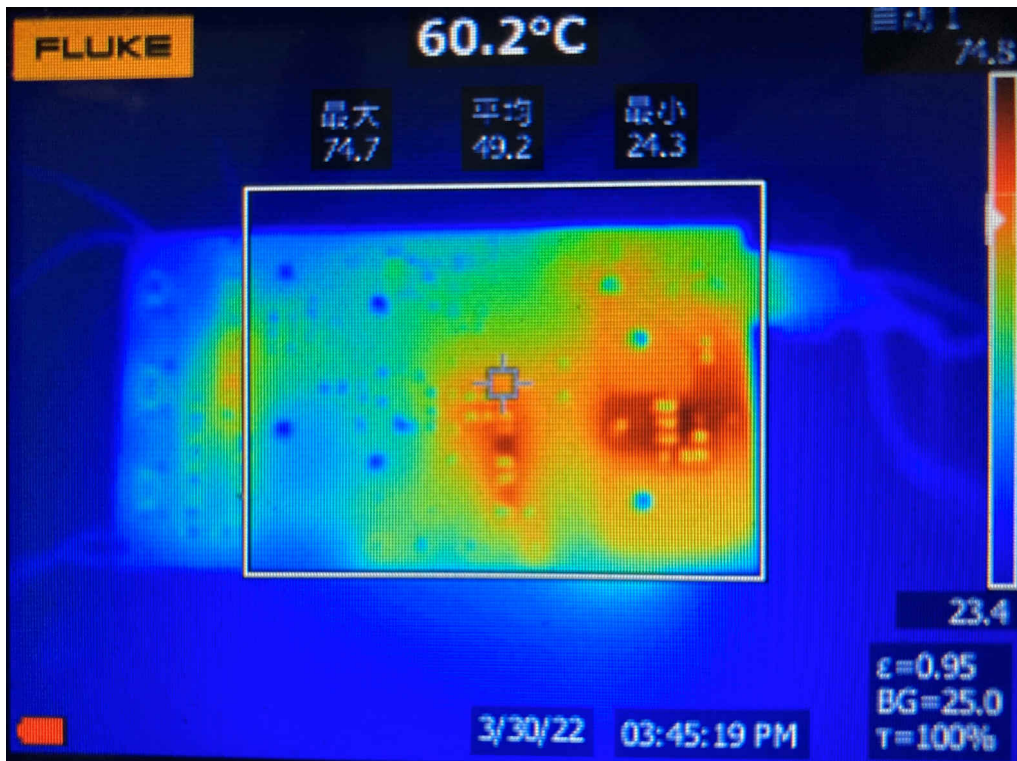
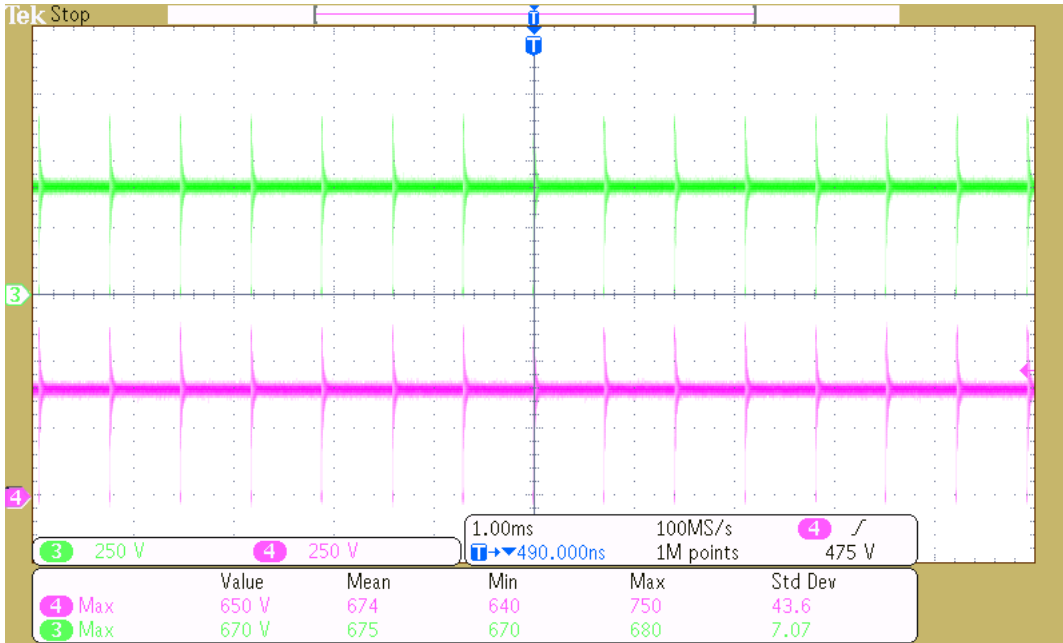


Figure 2-4. Bottom Thermal Image, $V_{IN} = 1000\text{ V}$, $I_o = 4\text{ A}$

3 Waveforms

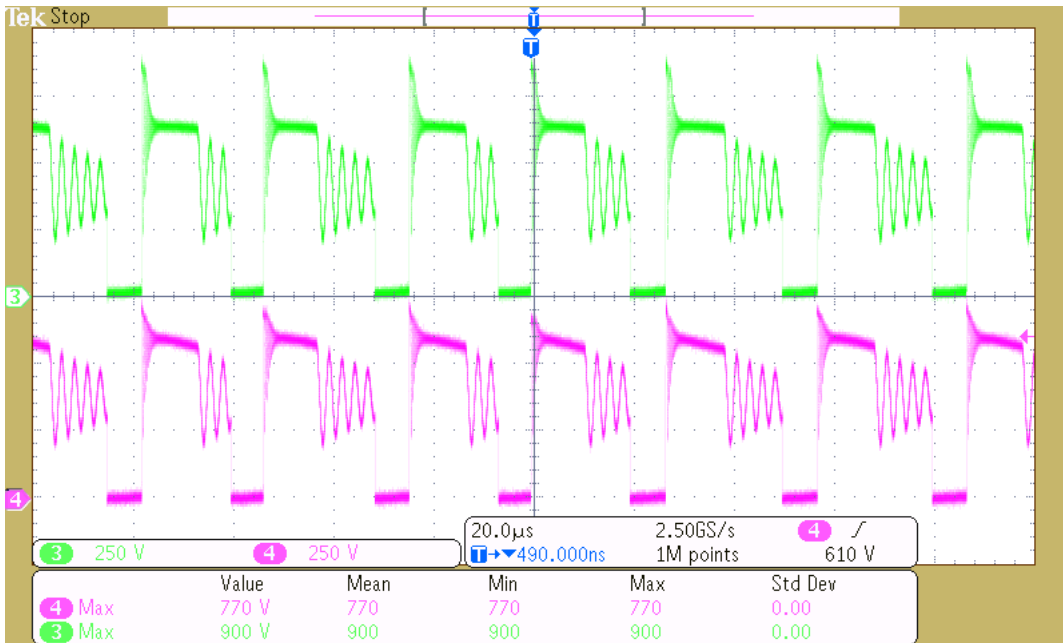
3.1 Switching

Switching behavior is shown in the following figures.



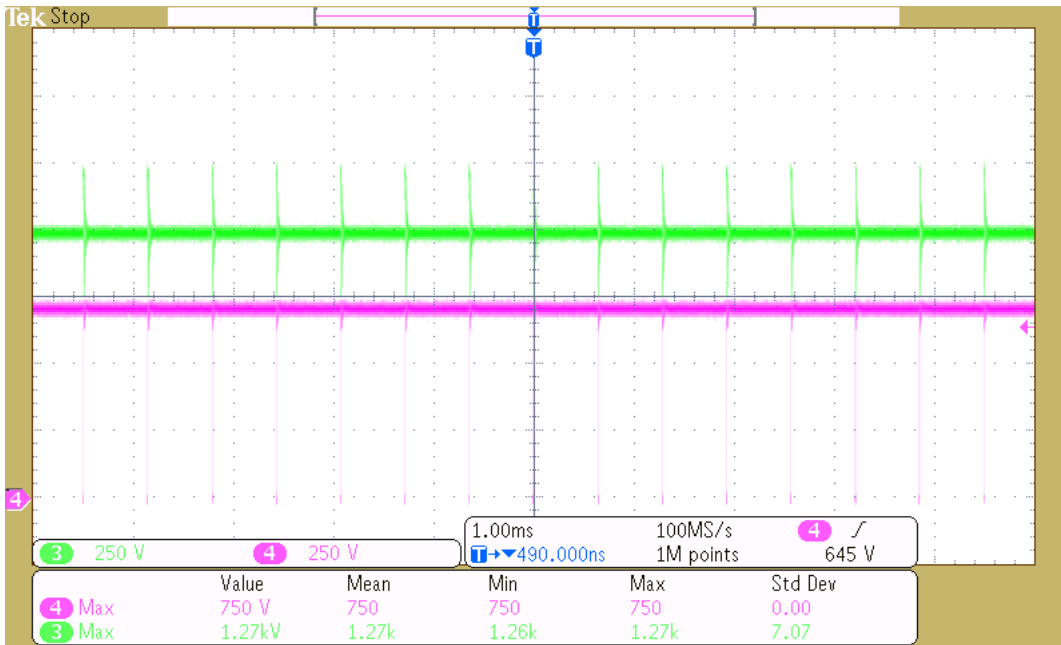
CH3: Upper FET Drain to GND voltage
CH4: Lower FET Vds

Figure 3-1. Switchnode Voltage, $V_{IN} = 400\text{ V}$, $I_o = 0\text{ A}$



CH3: Upper FET Drain to GND voltage
CH4: Lower FET Vds

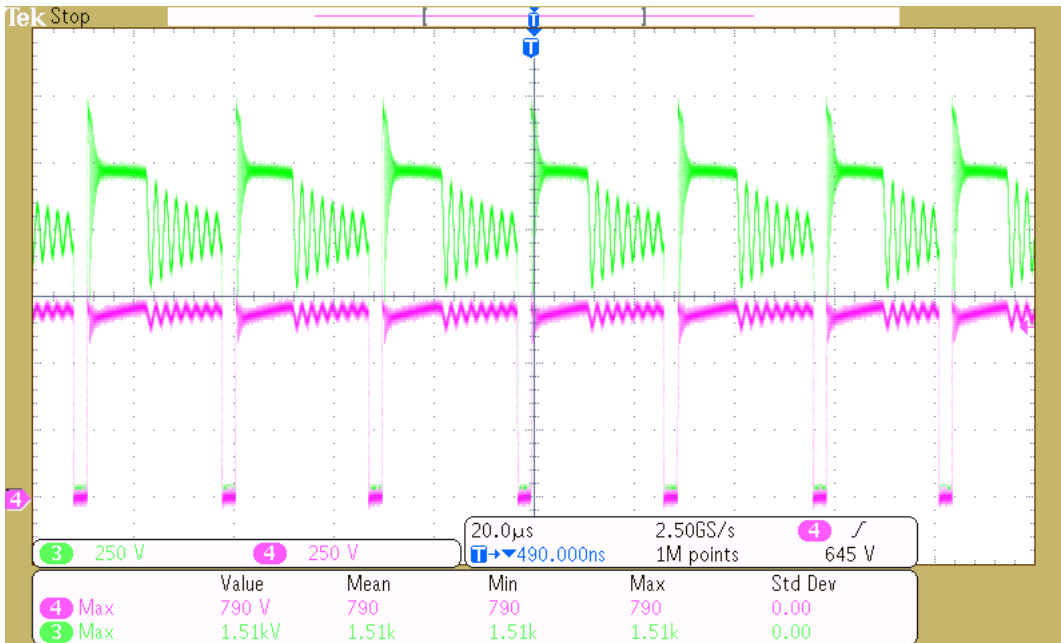
Figure 3-2. Switchnode Voltage, $V_{IN} = 400\text{ V}$, $I_o = 4\text{ A}$



CH3: Upper FET Drain to GND voltage

CH4: Lower FET Vds

Figure 3-3. Switchnode Voltage, $V_{IN} = 1000\text{ V}$, $I_o = 0\text{ A}$



CH3: Upper FET Drain to GND voltage

CH4: Lower FET Vds

Figure 3-4. Switchnode Voltage, $V_{IN} = 1000\text{ V}$, $I_o = 4\text{ A}$

3.2 Output Voltage Ripple

Output voltage ripple is shown in the following figures.

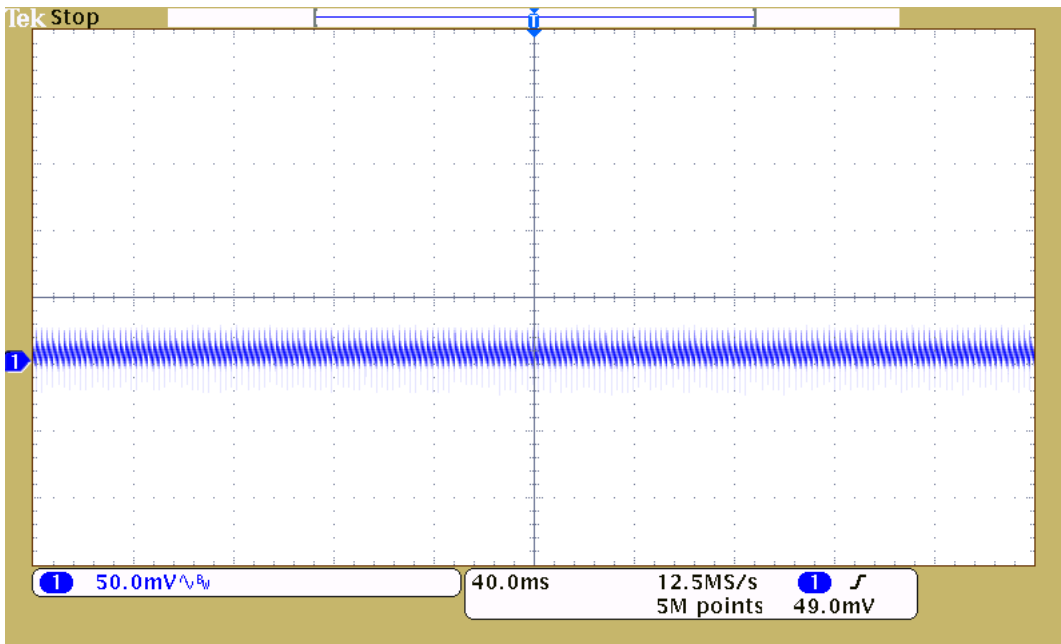


Figure 3-5. Output Voltage Ripple, $V_{IN} = 400\text{ V}$, $I_o = 0\text{ A}$

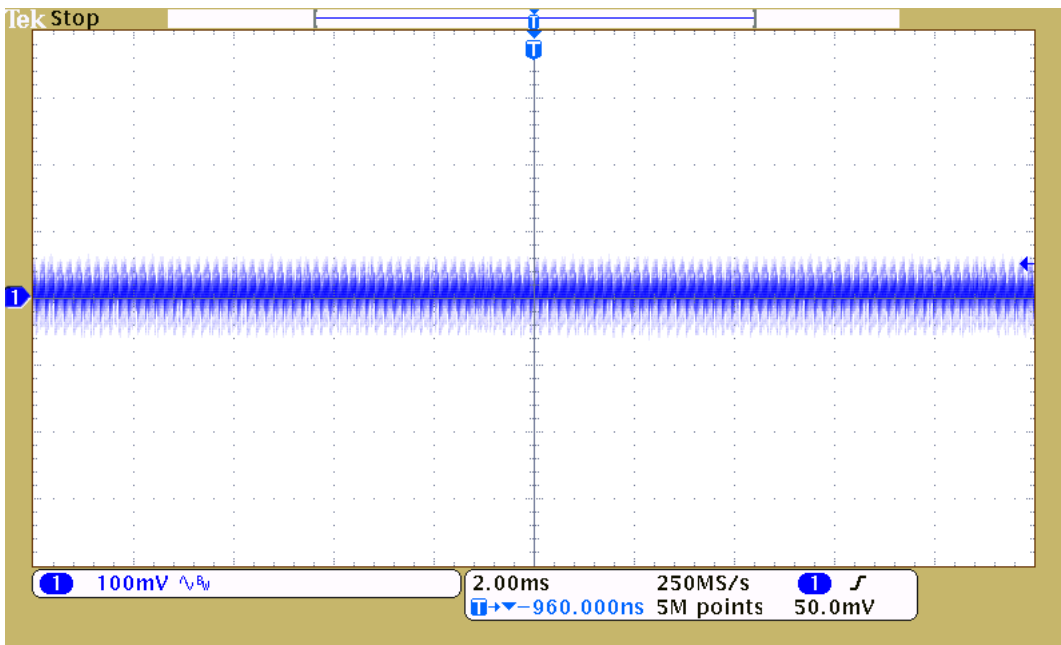


Figure 3-6. Output Voltage Ripple, $V_{IN} = 400\text{ V}$, $I_o = 4\text{ A}$

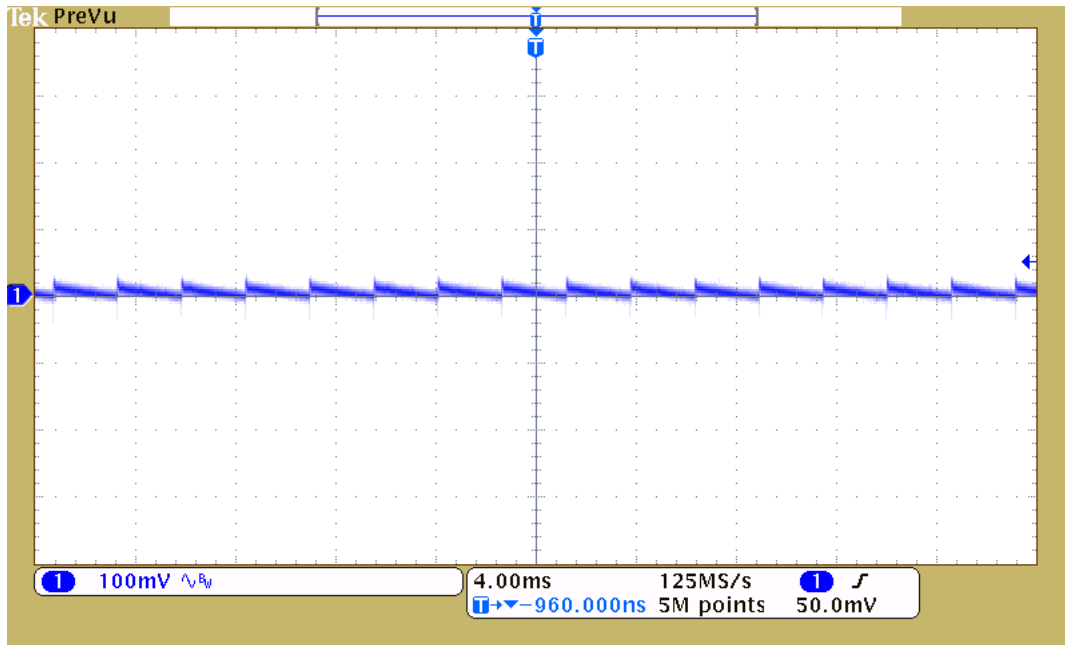


Figure 3-7. Output Voltage Ripple, $V_{IN} = 600\text{ V}$, $I_o = 0\text{ A}$

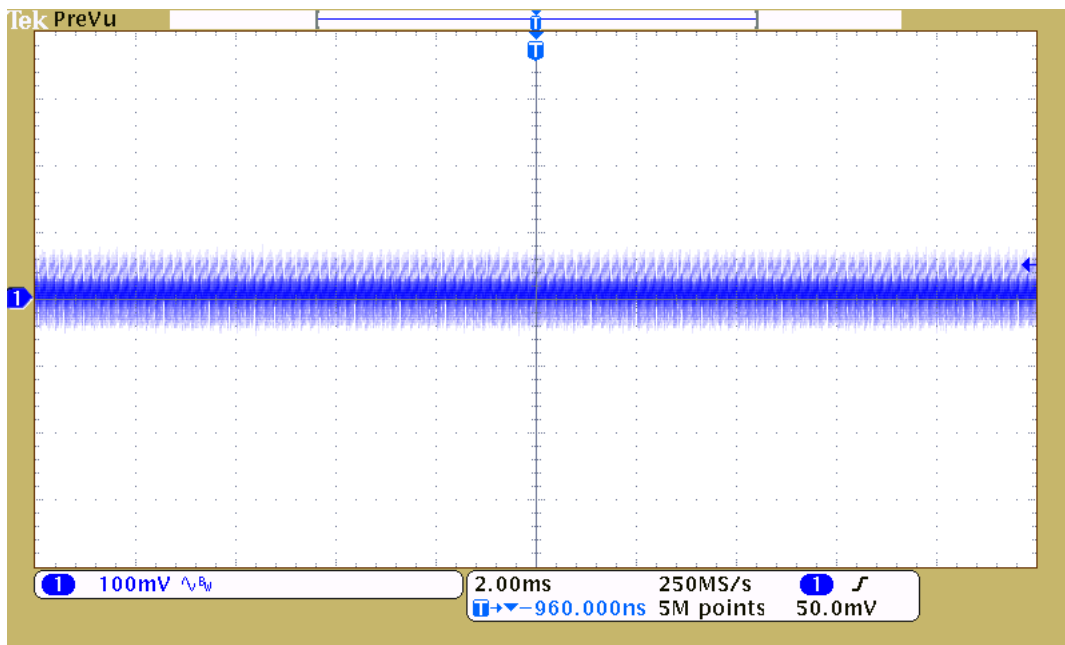


Figure 3-8. Output Voltage Ripple, $V_{IN} = 600\text{ V}$, $I_o = 4\text{ A}$

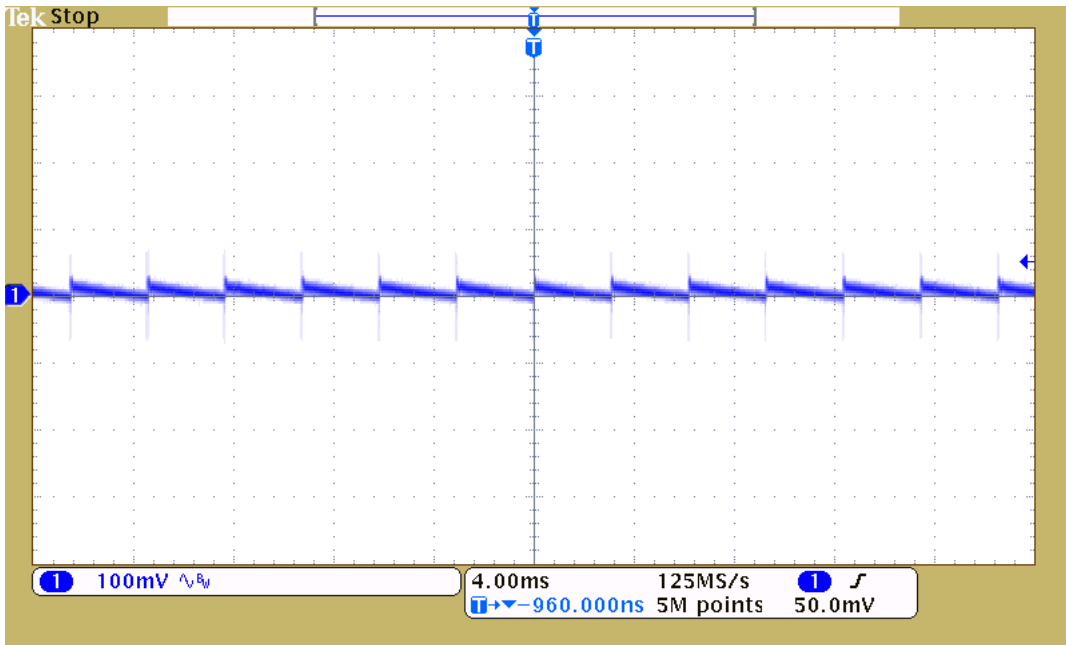


Figure 3-9. Output Voltage Ripple, $V_{IN} = 1000\text{ V}$, $I_o = 0\text{ A}$

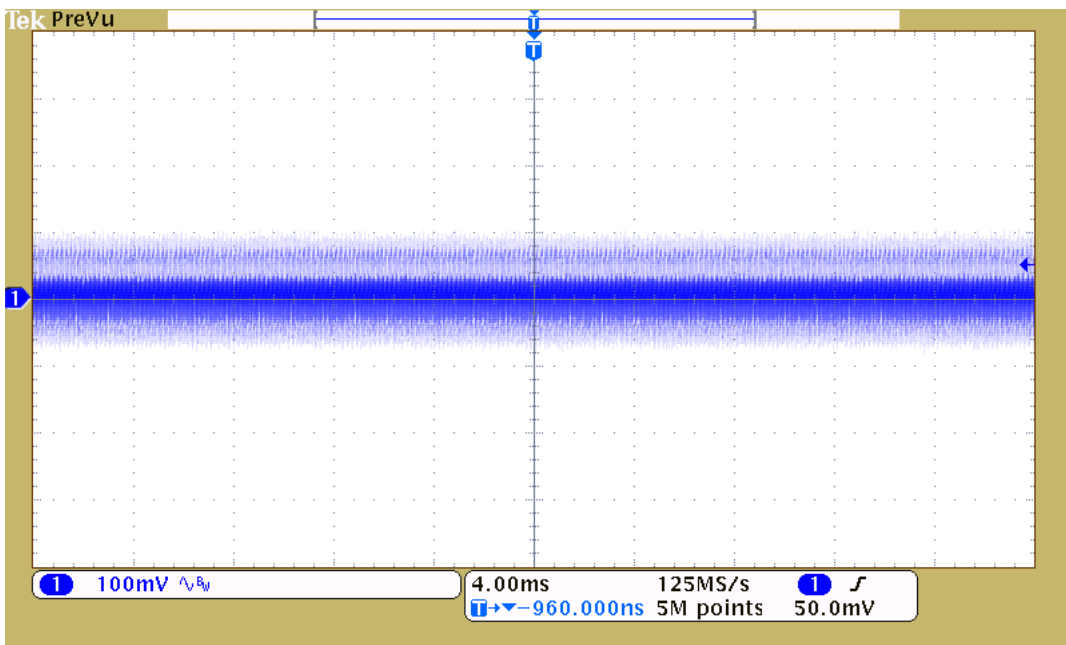


Figure 3-10. Output Voltage Ripple, $V_{IN} = 1000\text{ V}$, $I_o = 4\text{ A}$

3.3 Load Transients

Load transient response is shown in the following figures.

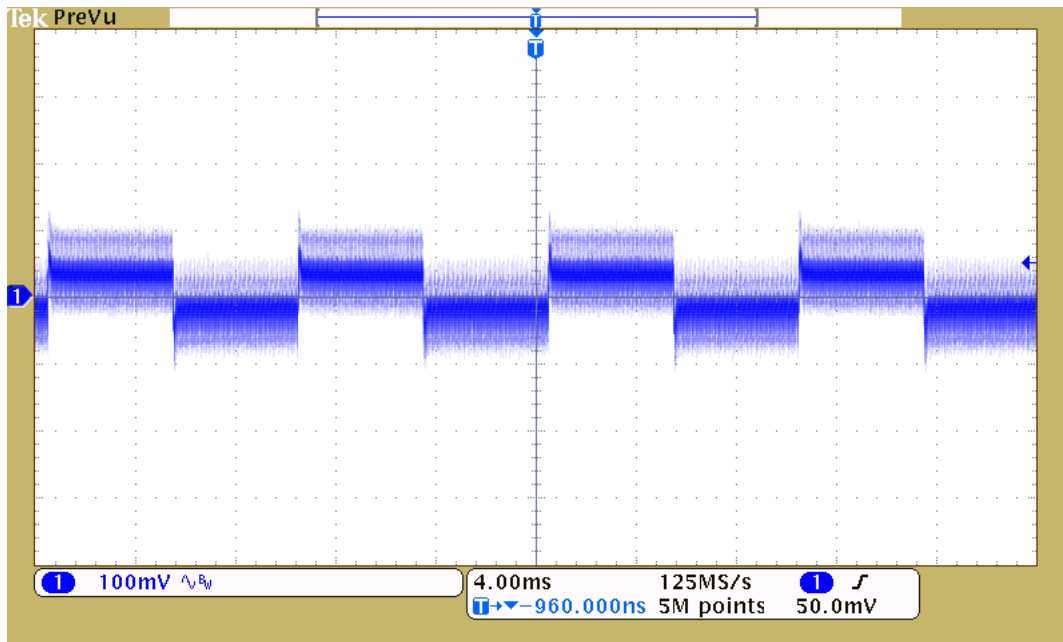


Figure 3-11. Load Transient, $V_{IN} = 800\text{ V}$, 2-A to 4-A Load Transient, 1 A/ μs

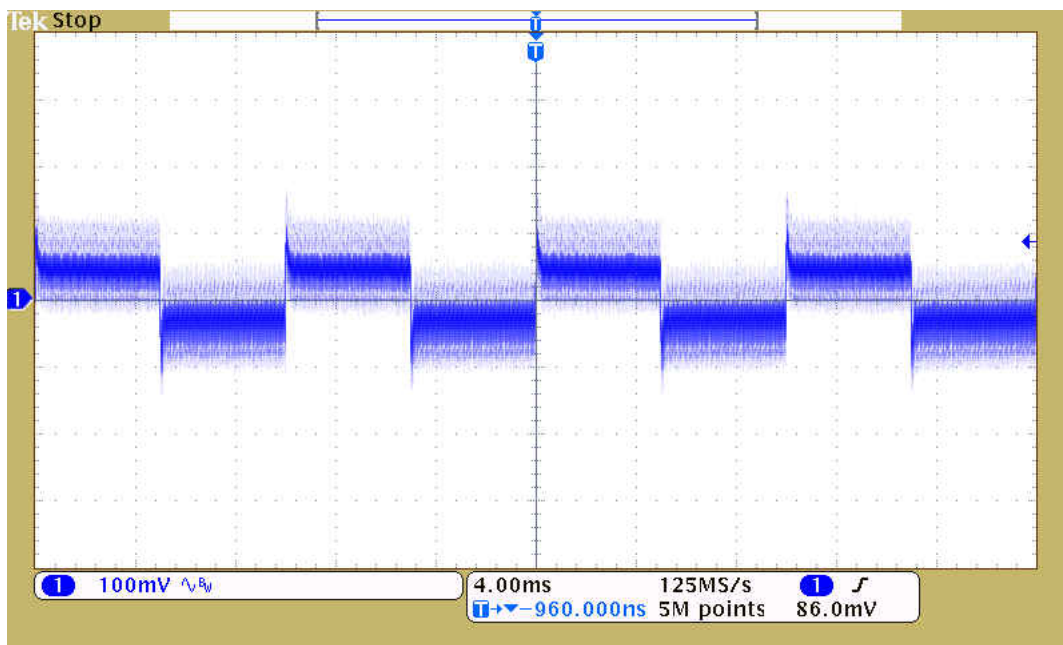


Figure 3-12. Load Transient, $V_{IN} = 800\text{ V}$, 1-A to 4-A Load Transient, 1 A/ μs

3.4 Output Voltage Start-Up Waveform

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

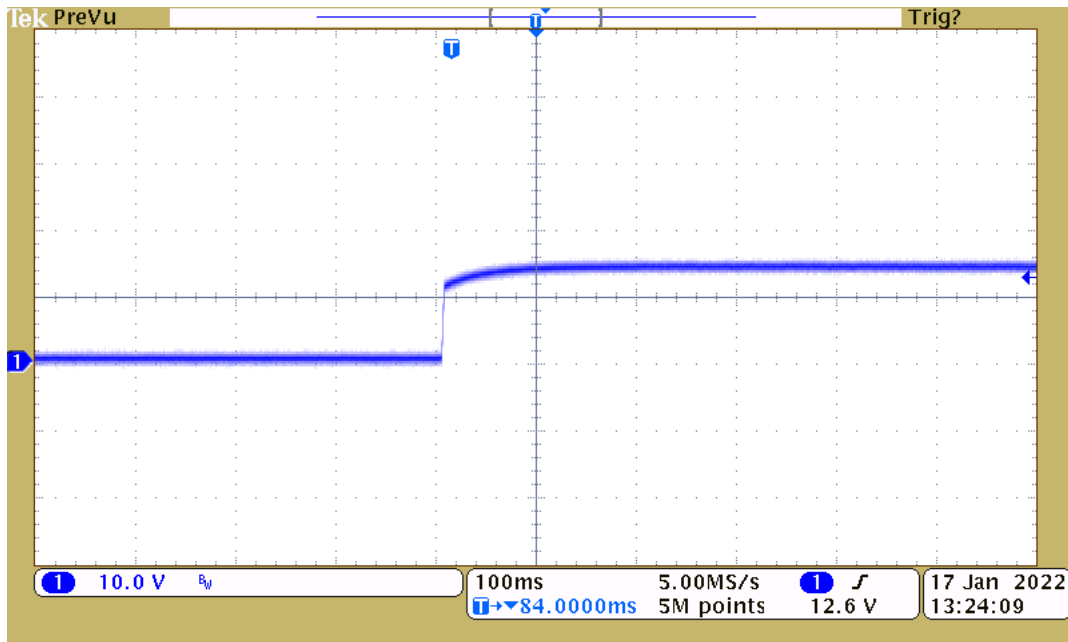


Figure 3-13. Output Voltage Start-Up, $V_{IN} = 350$ V, $I_o = 0$ A

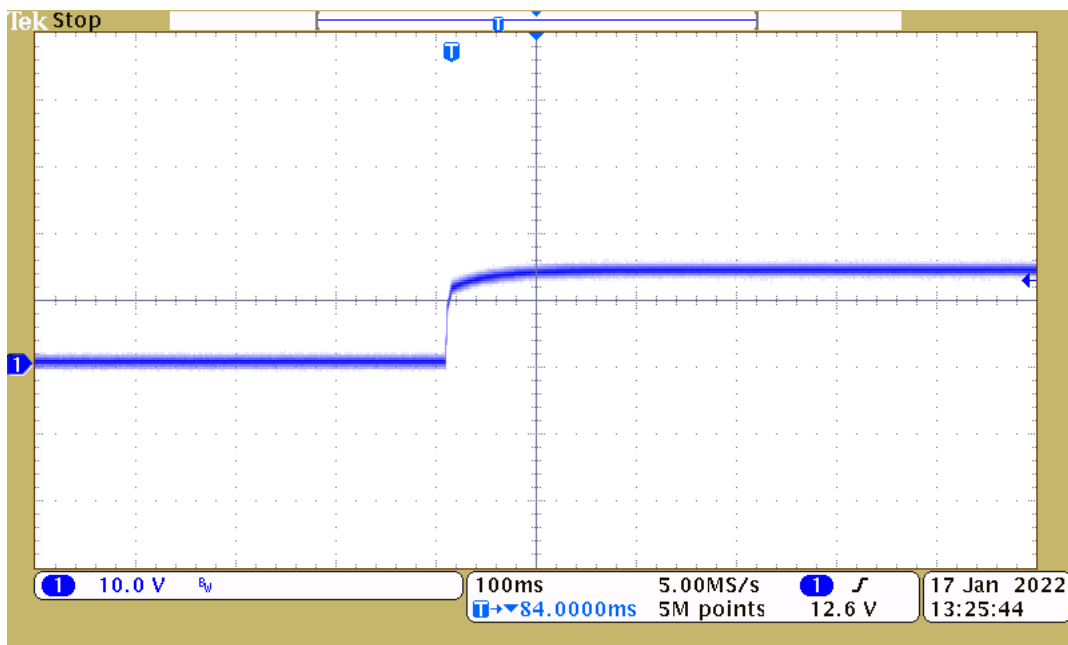


Figure 3-14. Output Voltage Start-Up, $V_{IN} = 350$ V, $I_o = 4$ A

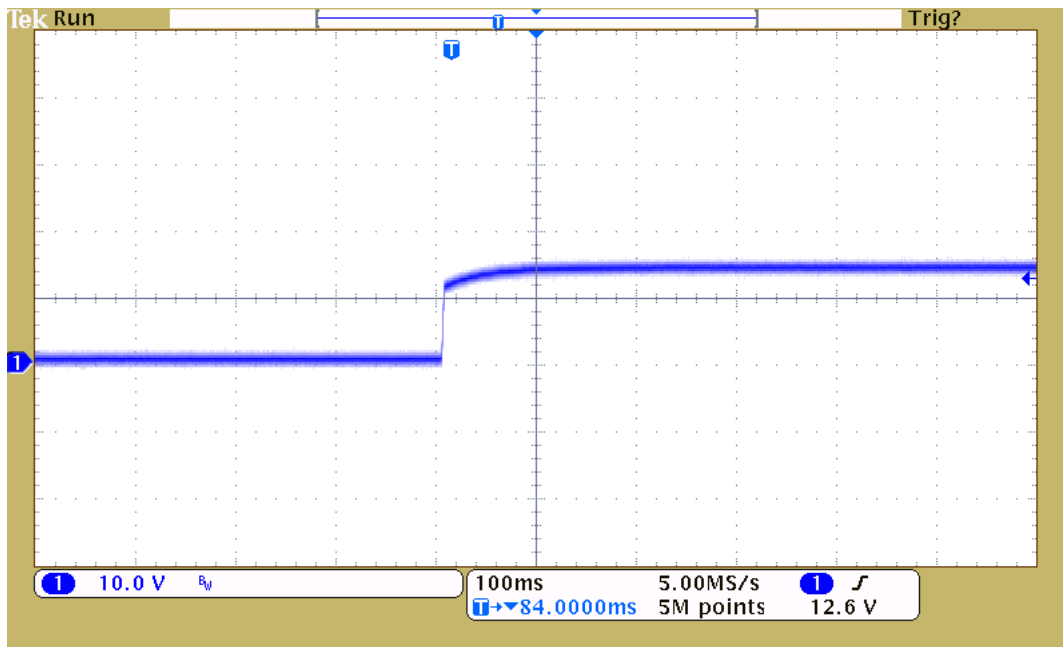


Figure 3-15. Output Voltage Start-Up, $V_{IN} = 600\text{ V}$, $I_o = 0\text{ A}$

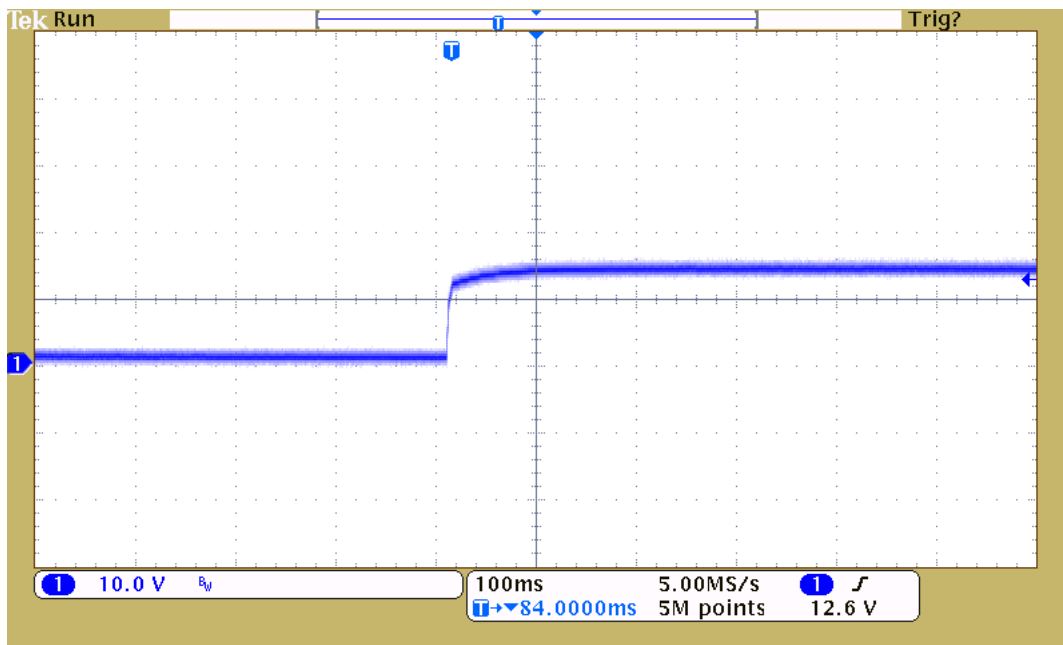


Figure 3-16. Output Voltage Start-Up, $V_{IN} = 600\text{ V}$, $I_o = 4\text{ A}$

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