

16-W SiC FET PSR Flyback Reference Design

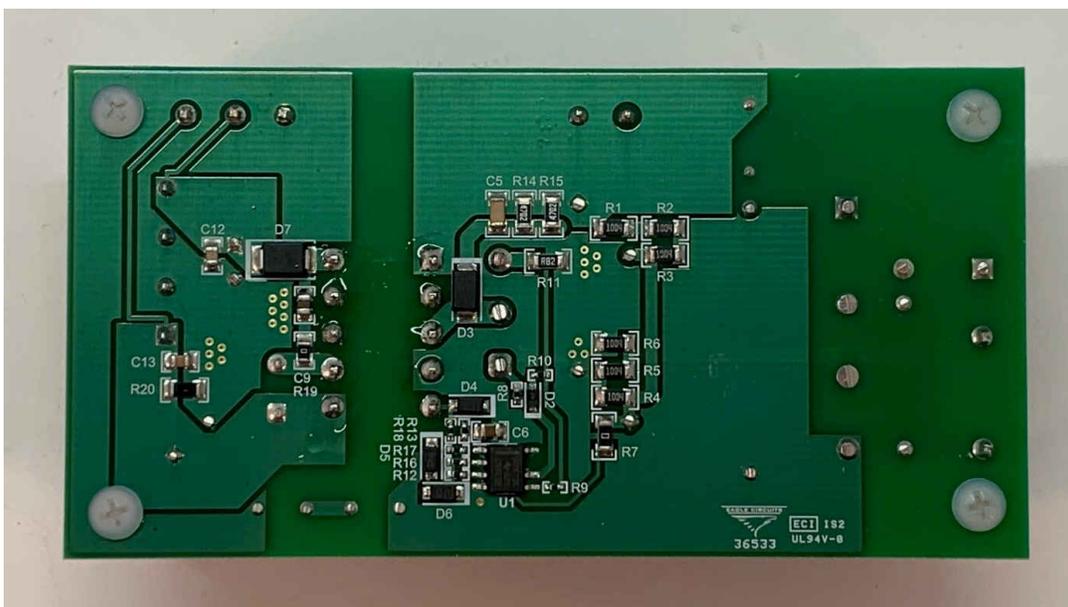


Description

This reference design converts a wide 85–480 V_{AC} input to a pair of reinforced, isolated 12-V and 24-V outputs. The 12-V output is capable of 14-W loading and the 24-V output is capable of 2.4-W loading. This reference design uses UCC28730 as a PSR valley-switching flyback design. A Silicon-Carbide low-side FET is used to achieve high efficiencies while operating across a wide input range. A balancing cap on the secondary keeps the two outputs in close regulation regardless of loading conditions.



Top Photo



Bottom Photo

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage Range	100–480 V _{AC}
Output Voltage 1	24 V _{AC} , ±5%
Output Current 1	0.1 A maximum
Output Voltage 2	12 V _{DC} , ±5%
Output Current 2	1.167 A maximum

1.2 Required Equipment

- AC Power Supply
- Electronic Load
- AC Power Meter
- Digital Multimeter
- Oscilloscope

1.3 Considerations

For all tests, a decade box for output 1 and an electronic load was used on output 2.

1.4 Dimensions

The PCB is a two-layer, 1-oz per layer design. The dimensions are 3.725 in × 1.8 in with a maximum component height is 1.1 in

2 Testing and Results

2.1 Efficiency Graphs

The following image shows the efficiency.

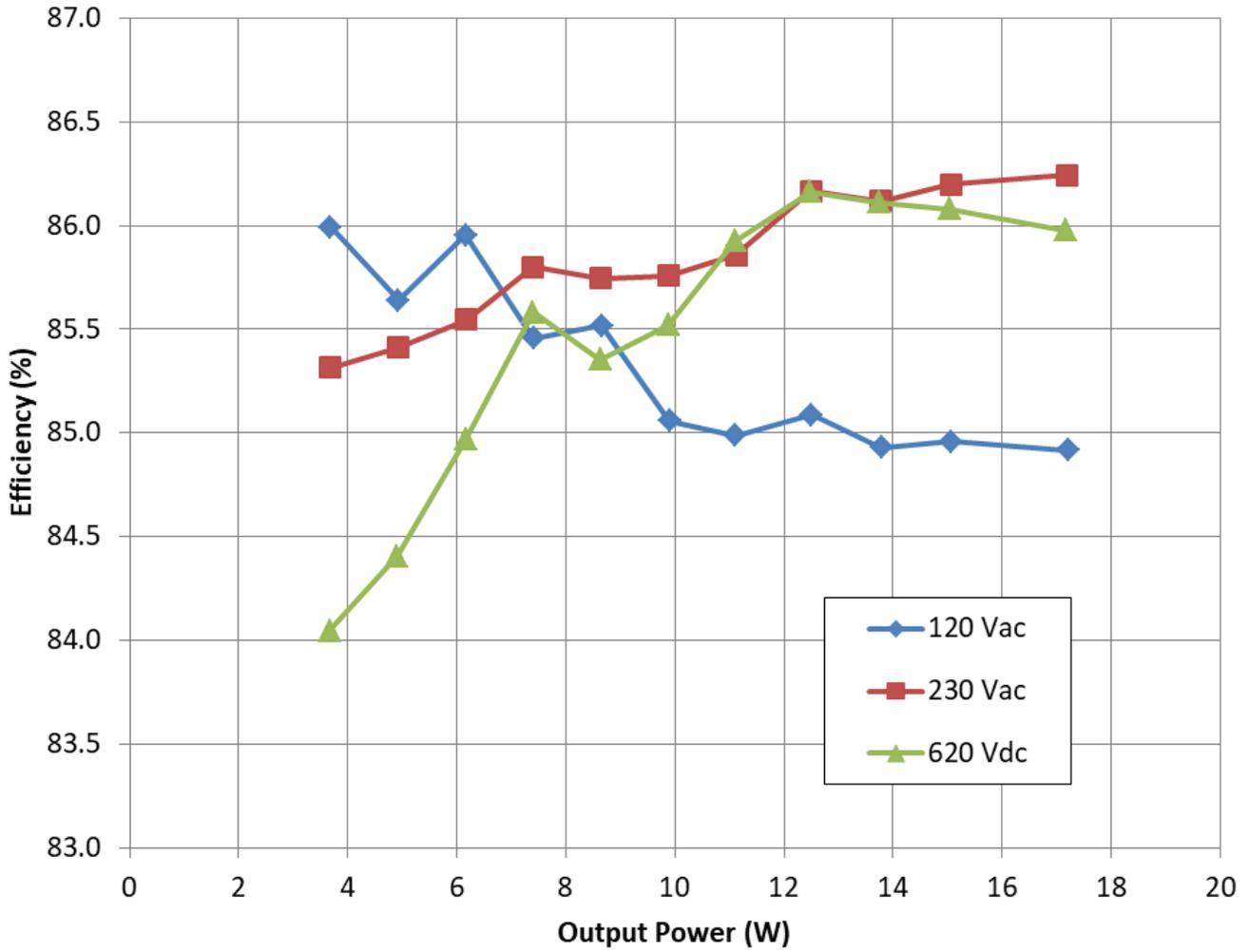


Figure 2-1. Efficiency Graph

2.2 Load Regulation Graphs

Efficiency Load Regulation

Figure 2-2 and Figure 2-3 illustrate total output power loading at 12- and 24-V, respectively.

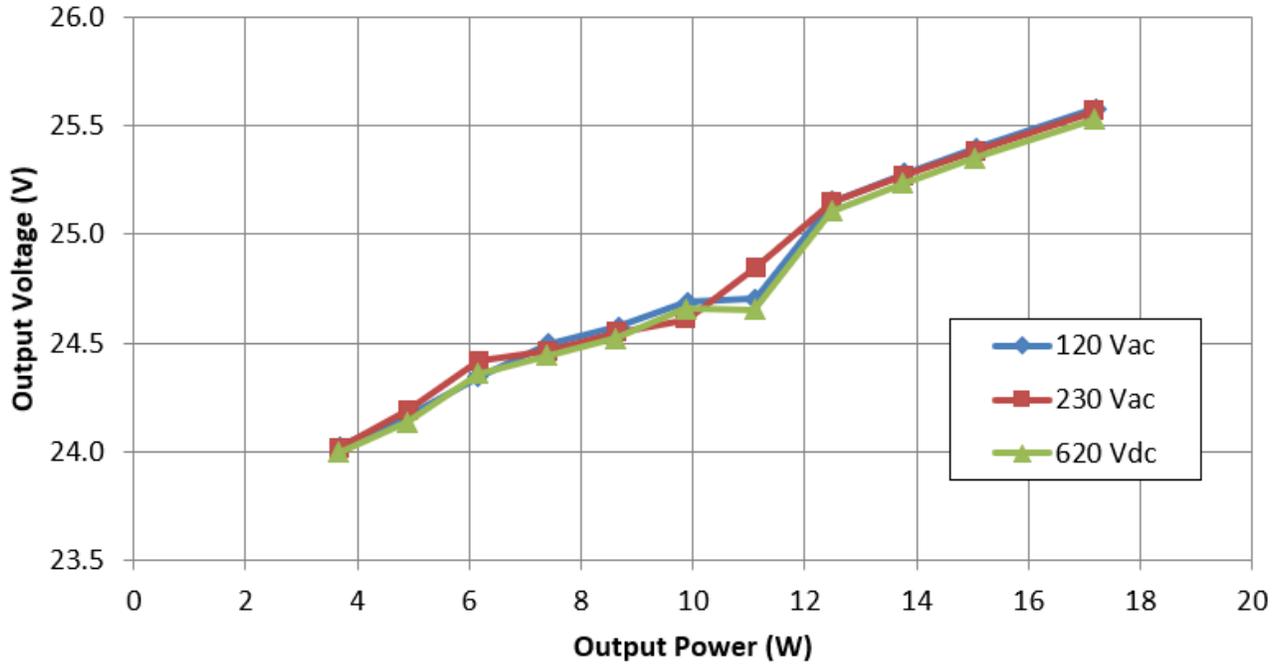


Figure 2-2. 12-V Output Across Total Output Power Loading

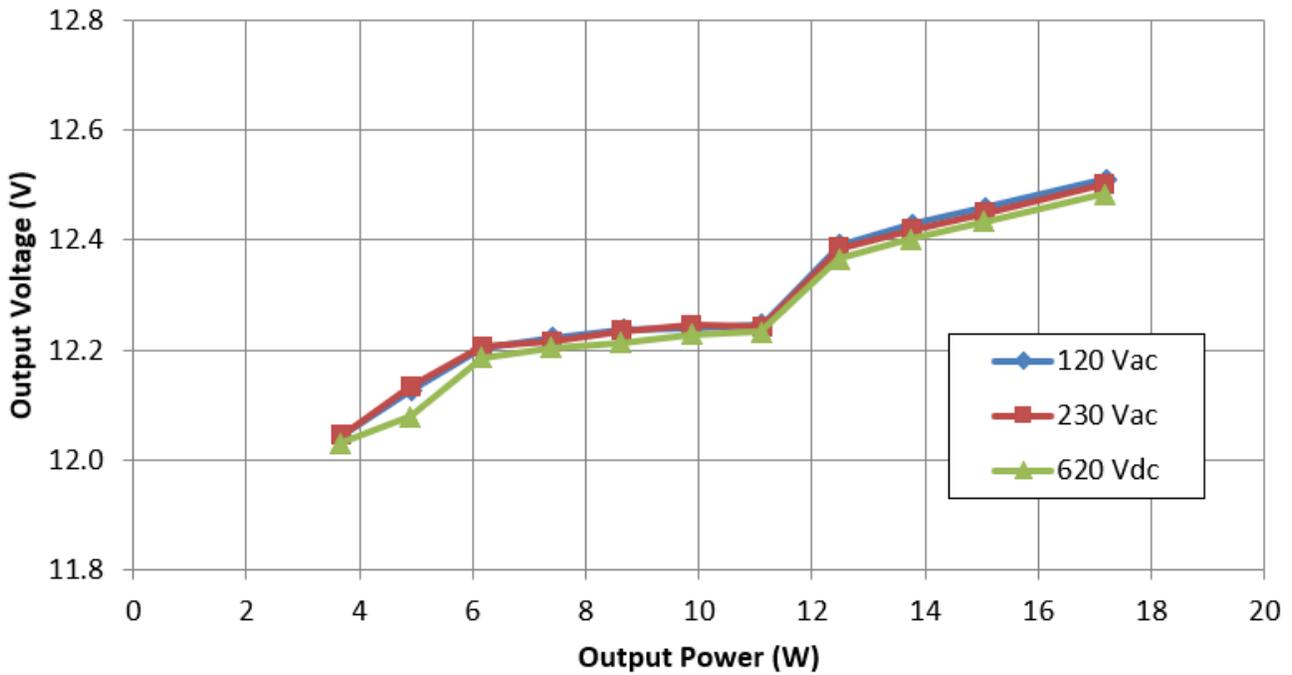


Figure 2-3. 24-V Output Across Total Output Power Loading

2.3 Efficiency Data

Table 2-1 lists the efficiency data.

Table 2-1. Efficiency Data

Input Voltage Setting	Output 1 Voltage (V)	Output 1 Current (A)	Output 2 Voltage (V)	Output 2 Current (A)	Total Output Power (W)	Input Power (W)	Efficiency (%)	Power Loss (W)
120 V _{AC}	24.026	0.1003	12.043	0.105	3.675	4.274	85.99	0.599
	24.345	0.1002	12.203	0.305	6.161	7.168	85.95	1.007
	24.576	0.1003	12.238	0.506	8.659	10.125	85.52	1.466
	24.705	0.1003	12.247	0.705	11.111	13.074	84.99	1.963
	25.281	0.1003	12.429	0.905	13.785	16.231	84.93	2.446
	25.577	0.1003	12.511	1.170	17.204	20.260	84.92	3.056
230 V _{AC}	24.017	0.1003	12.045	0.105	3.674	4.307	85.31	0.633
	24.417	0.1003	12.206	0.305	6.173	7.216	85.55	1.043
	24.549	0.1003	12.234	0.505	8.642	10.078	85.75	1.436
	24.847	0.1004	12.242	0.705	11.124	12.957	85.86	1.833
	25.270	0.1003	12.418	0.905	13.774	15.994	86.12	2.220
	25.567	0.1003	12.501	1.170	17.192	19.934	86.24	2.742
625 V _{DC}	23.997	0.1003	12.031	0.105	3.671	4.368	84.05	0.697
	24.359	0.1003	12.187	0.305	6.161	7.251	84.97	1.090
	24.523	0.1003	12.213	0.505	8.628	10.109	85.35	1.481
	24.654	0.1004	12.233	0.705	11.099	12.917	85.92	1.818
	25.236	0.1003	12.402	0.905	13.756	15.974	86.11	2.219
	25.531	0.1003	12.484	1.170	17.168	19.968	85.98	2.800

2.4 Thermal Images

Figure 2-4 and Figure 2-5 show the thermal images for the board. The images were taken after 15 minutes of running with both outputs at full load, 120-V_{AC} input and no airflow.

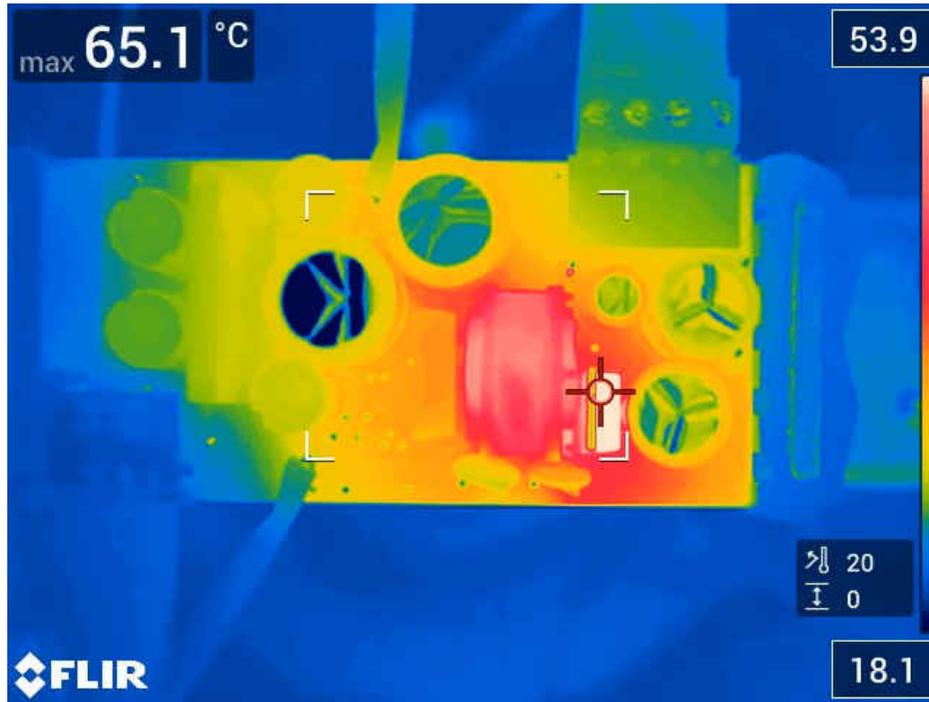


Figure 2-4. Thermal Image, Board Top

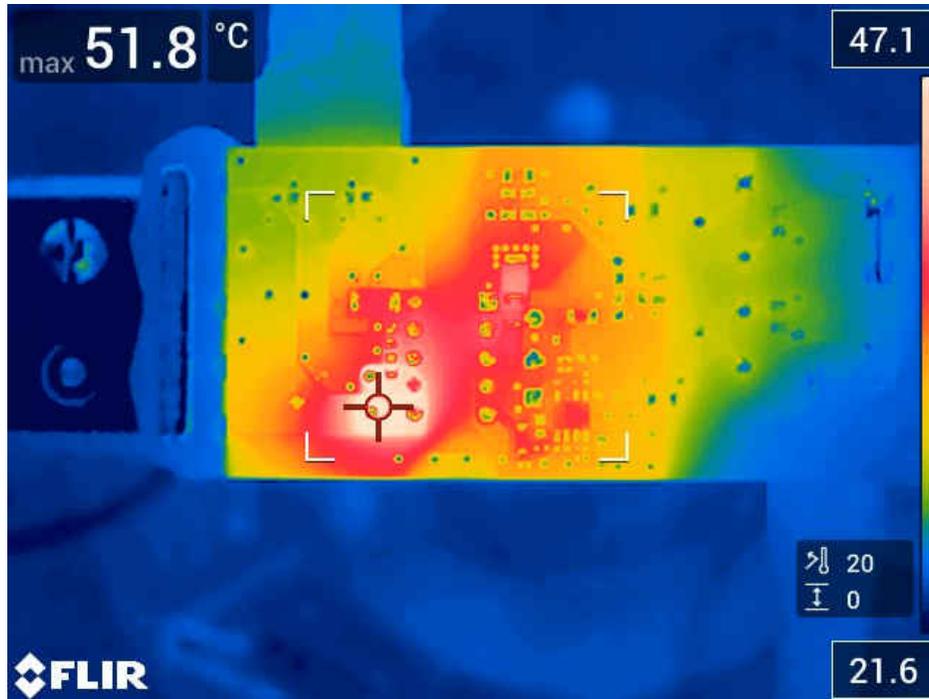
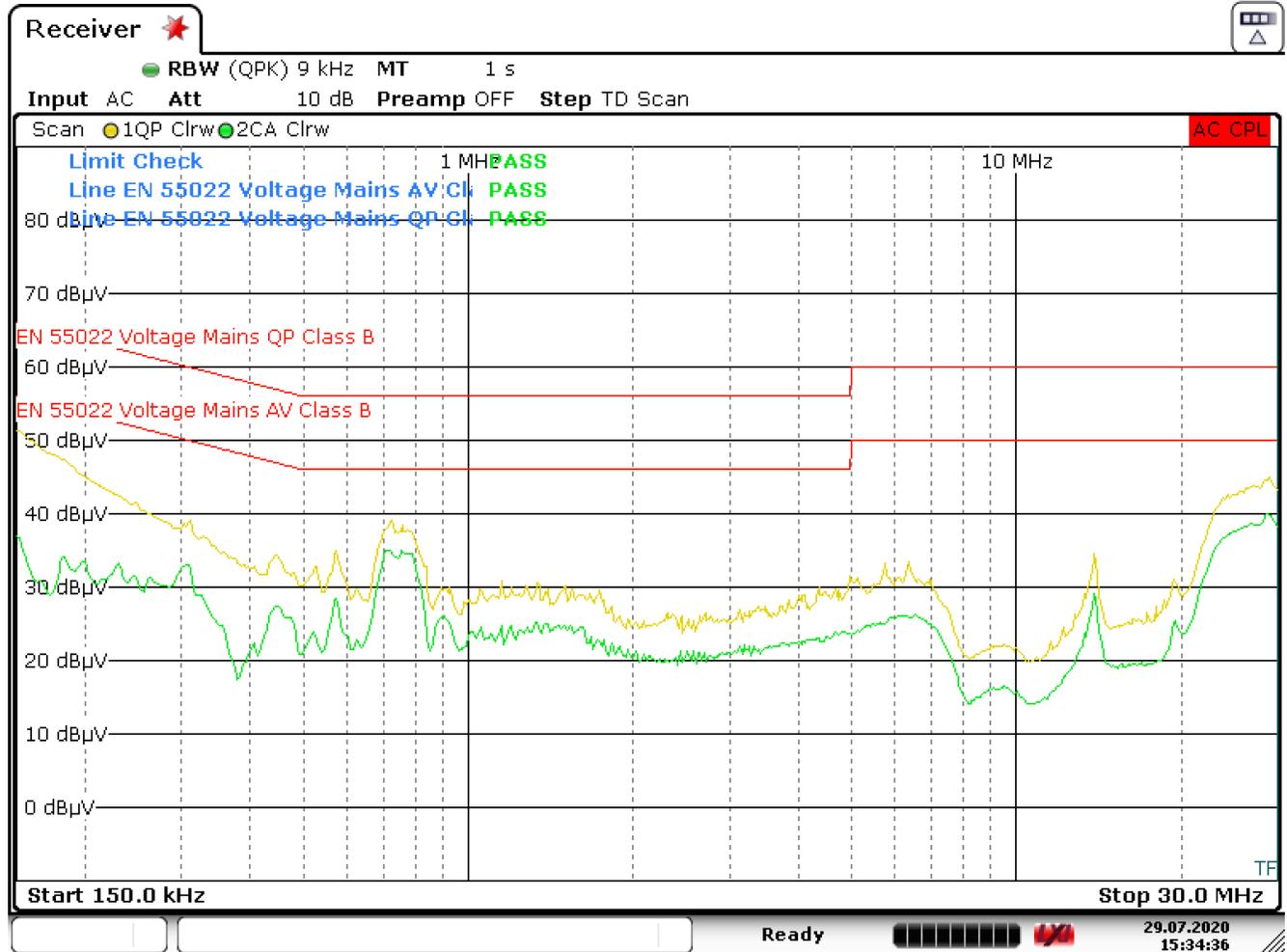


Figure 2-5. Thermal Image, Board Bottom

2.5 EMI

The following conducted emissions measurements were taken using both quasi-peak detector and average-peak detector methods (yellow and green traces, respectively). The measurements are compared to the CISPR-25 Class B regulations for quasi-peak and average tests. For these tests both the outputs were loaded to full output loading with resistive loads.



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Figure 2-6. Conducted Emissions With 120-V_{AC} Input Voltage

3 Waveforms

3.1 Switching

Figure 3-1 through Figure 3-3 illustrate the switching behavior. The switch node was measured with both outputs at full load.

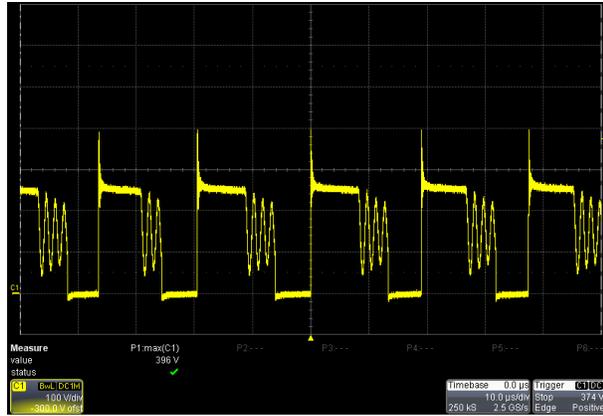


Figure 3-1. Primary Switching Node With 120-V_{AC} Input

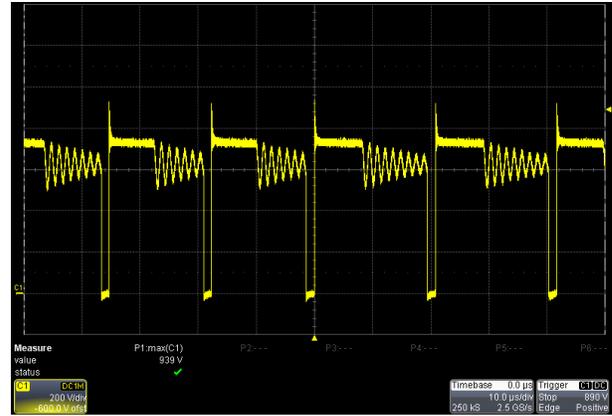


Figure 3-2. Primary Switching Node With 600-V_{DC} Input

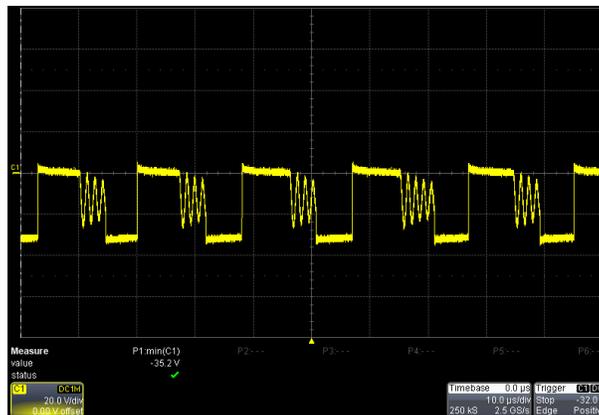


Figure 3-3. Secondary Switching Node With 120-V_{AC} Input

3.2 Output Voltage Ripple

Figure 3-4 and Figure 3-5 show the output voltage ripple. Measurements were taken using the tip and barrel method across a small ceramic capacitor by the output connector. The input was set to 120-V_{AC} for all tests.

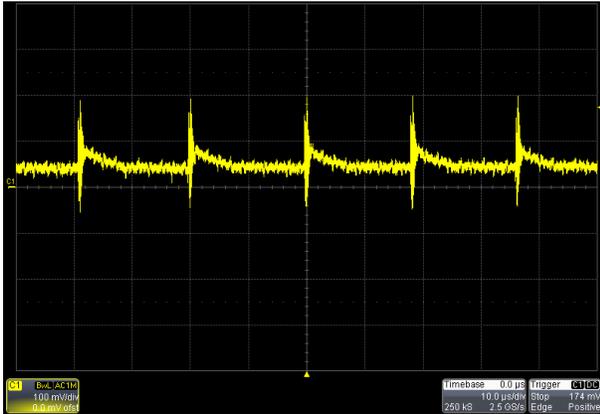


Figure 3-4. Output Voltage Ripple on 12-V Output

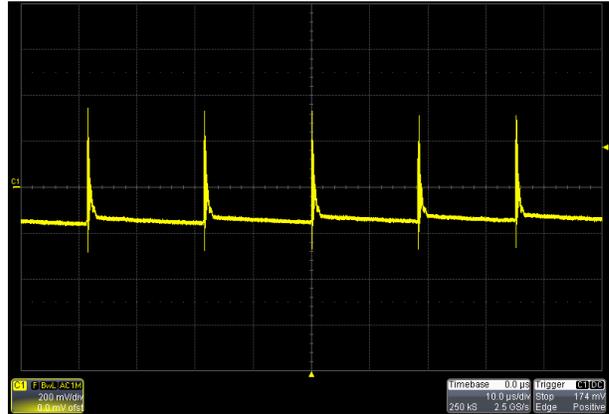


Figure 3-5. Output Voltage Ripple on 24-V Output

3.3 Load Transients

Figure 3-6 and Figure 3-7 show the load transient response.

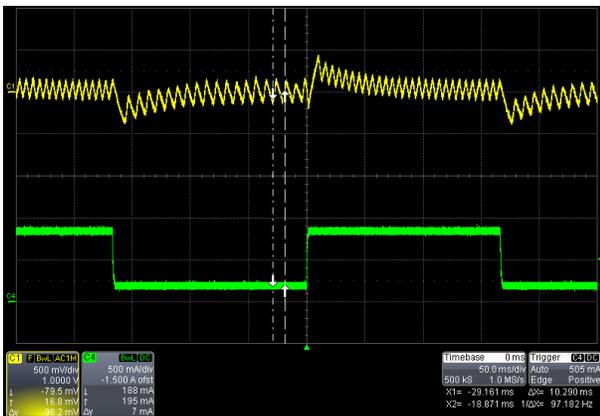


Figure 3-6. Load Transient 1

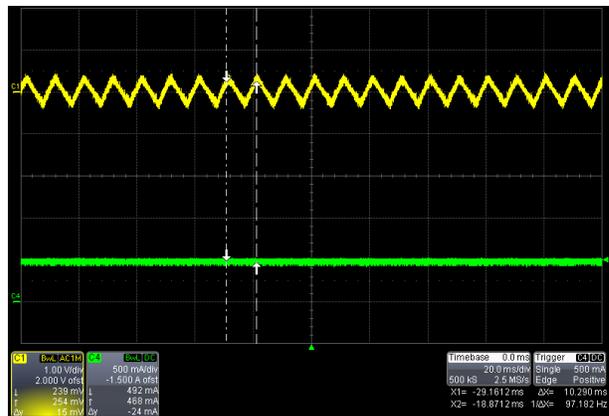


Figure 3-7. Load Transient 2

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