Test Report: PMP31087

31-W Offline Valley Switching Flyback With Multiple Outputs Reference Design

Description

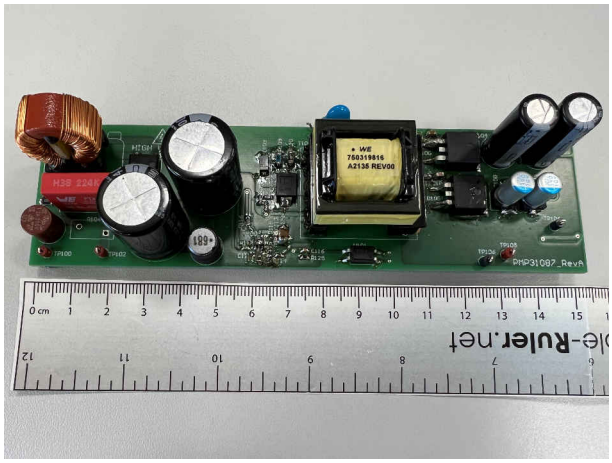
This reference design uses the UCC28742 flyback controller to generate two outputs (12 V at 2.2 A, 3.3 V at 1.5 A) from a universal input. The UCC28742 uses an optical coupler to regulate the output and to improve transient response. The valley-switching technique reduces switching losses and keeps the efficiency high.

Features

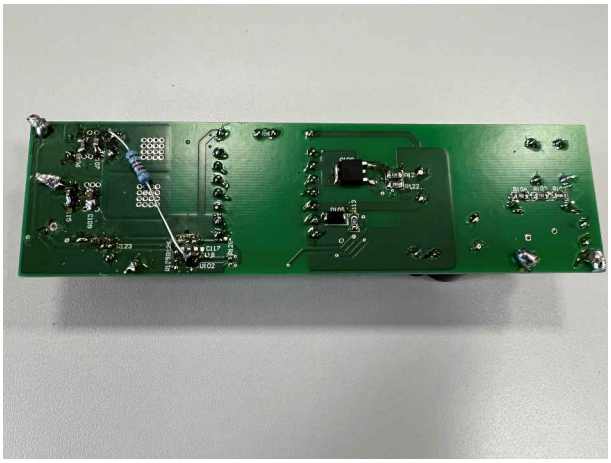
- Resonant-ring valley-switching operation
- Dual isolated outputs: 12 V, 2.2 A and 3.3 V, 1.5 A
- Universal AC input voltage range: 85 VAC to 265 VAC
- Output overvoltage and overcurrent protection

Applications

- Coffee machine



Board Top Photo



Board Bottom Photo

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage	85 VAC to 265 VAC
Output 1	12 V at 2.2 A
Output 2	3.3 V at 1.5 A

1.2 Required Equipment

- Oscilloscope
- Electronic load
- Power supply
- AC power source

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

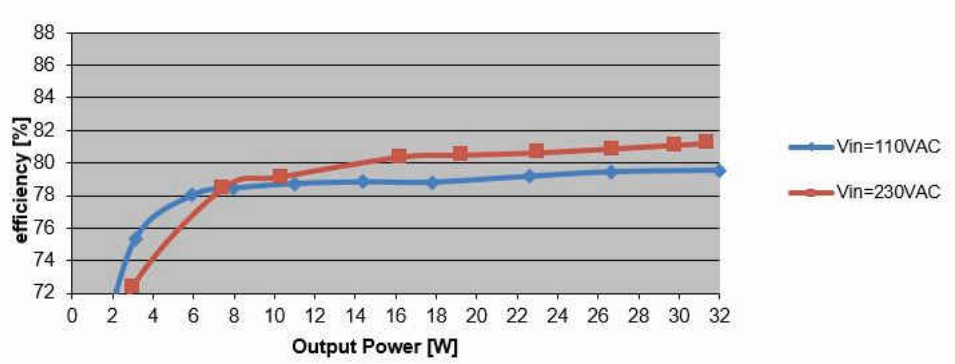


Figure 2-1. Efficiency Graph

2.2 Efficiency Data

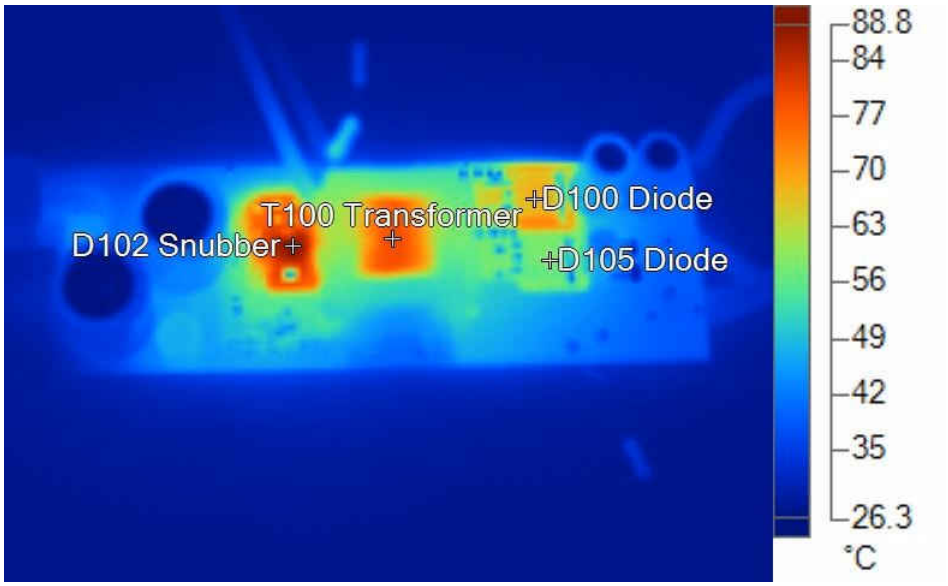
Efficiency data is shown in the following table.

Table 2-1. PMP31087 Efficiency Data

Input Voltage (VAC)	Input Power (W)	3.3-V Output Voltage (V)	3.3-V Output Current (A)	12-V Output Voltage (V)	12-V Output Current (A)	Output Power (W)	Efficiency (%)
110,000	1,860	3,286	0,034	10,683	0,108	1,261	67,79
110,000	4,152	3,285	0,129	11,581	0,234	3,129	75,36
110,000	7,592	3,284	0,339	12,070	0,399	5,922	78,01
110,000	10,195	3,283	0,531	12,270	0,510	7,997	78,44
110,000	13,980	3,283	0,742	12,370	0,693	11,007	78,73
110,000	18,222	3,283	0,934	12,390	0,912	14,365	78,84
110,000	22,540	3,282	1,127	12,350	1,139	17,766	78,82
110,000	28,570	3,282	1,228	12,200	1,524	22,623	79,18
110,000	33,550	3,282	1,326	12,110	1,842	26,659	79,46
110,000	40,170	3,281	1,518	12,060	2,237	31,959	79,56
230,000	1,847	3,287	0,034	10,192	0,103	1,162	62,92
230,000	2,720	3,285	0,129	11,659	0,118	1,798	66,10
230,000	4,199	3,285	0,227	11,855	0,194	3,041	72,42
230,000	9,525	3,284	0,435	11,930	0,507	7,472	78,44
230,000	13,050	3,283	0,742	12,250	0,644	10,330	79,15
230,000	20,200	3,282	0,934	12,100	1,088	16,234	80,37
230,000	23,930	3,282	1,030	12,030	1,320	19,261	80,49
230,000	28,510	3,281	1,228	12,030	1,576	22,988	80,63
230,000	32,980	3,280	1,420	12,010	1,833	26,672	80,87
230,000	36,780	3,280	1,517	11,960	2,078	29,829	81,10
230,000	38,680	3,279	1,517	11,900	2,222	31,416	81,22

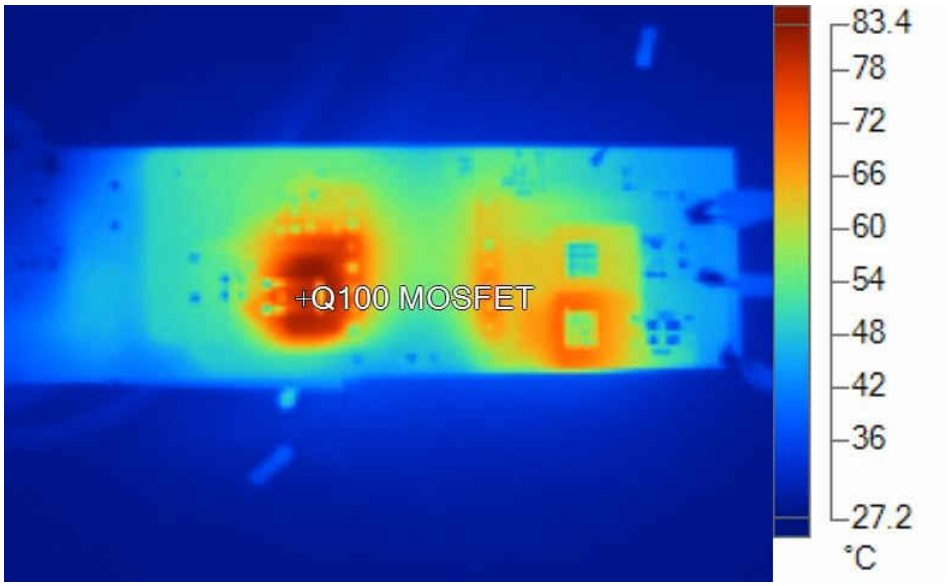
2.3 Thermal Images

The thermal images in this section were taken with full load at an ambient temperature of 25°C after 10 minutes.



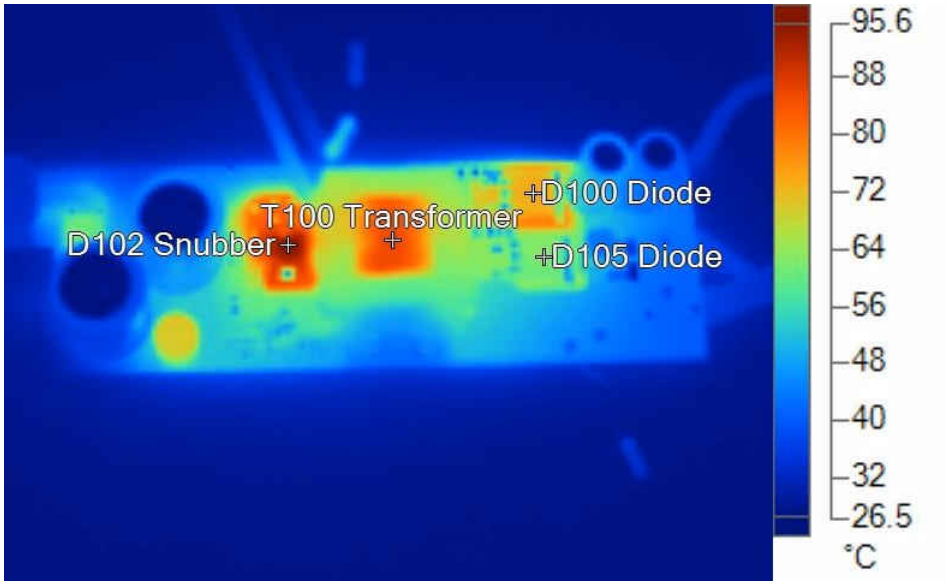
Name	Temperature
T100 Transformer	79.5°C
D102 Snubber	88.8°C
D100 Diode	68.6°C
D105 Diode	58.1°C

Figure 2-2. 230-VAC Input Top Thermal Image



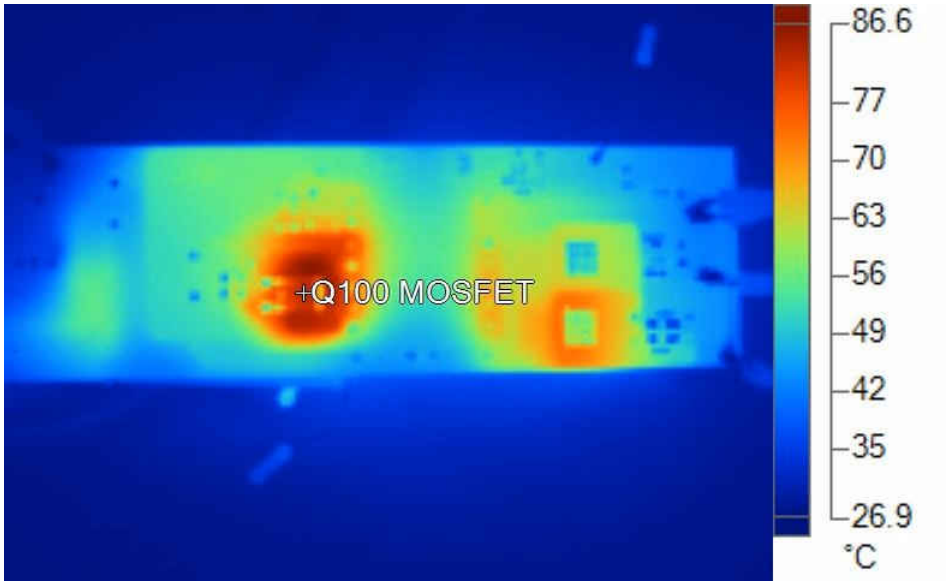
Name	Temperature
Q100 MOSFET	79.1°C

Figure 2-3. 230-VAC Input Bottom Thermal Image



Name	Temperature
T100 Transformer	86.1°C
D102 Snubber	95.6°C
D100 Diode	74.4°C
D105 Diode	62.4°C

Figure 2-4. 110-VAC Input Top Thermal Image



Name	Temperature
Q100 MOSFET	82.3°C

Figure 2-5. 110-VAC Input Bottom Thermal Image

2.4 Bode Plots

The following image shows the PMP31087 bode plot.

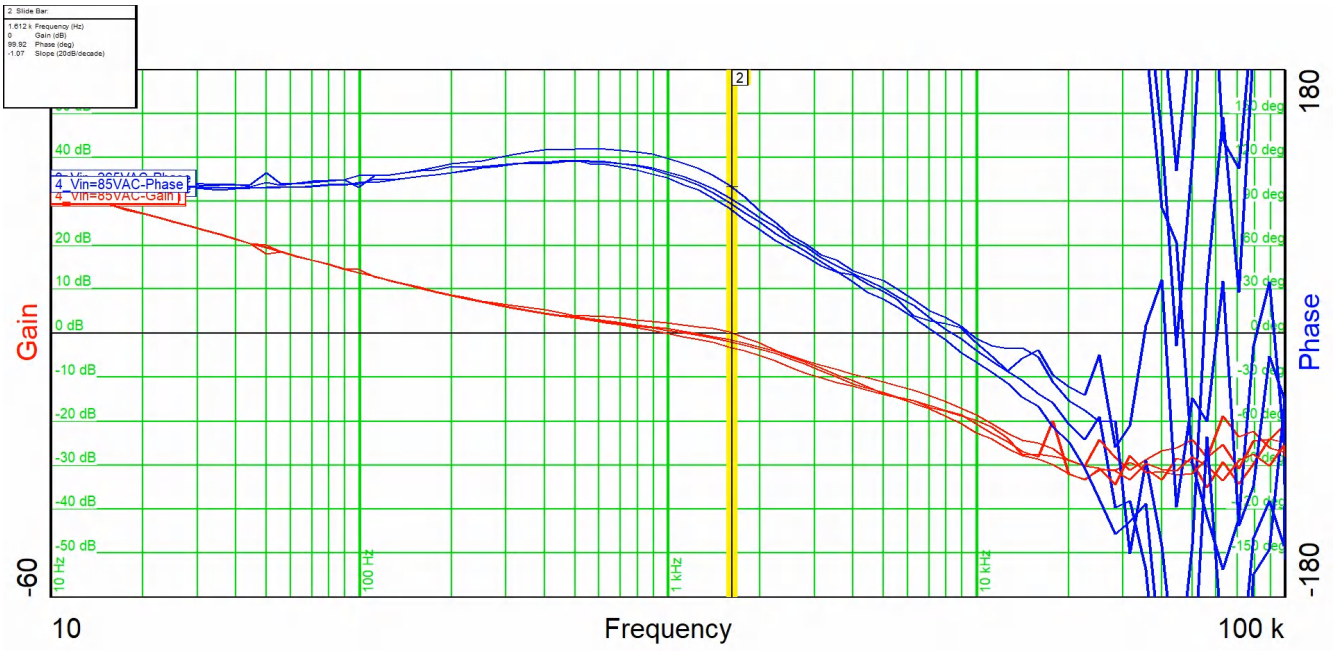


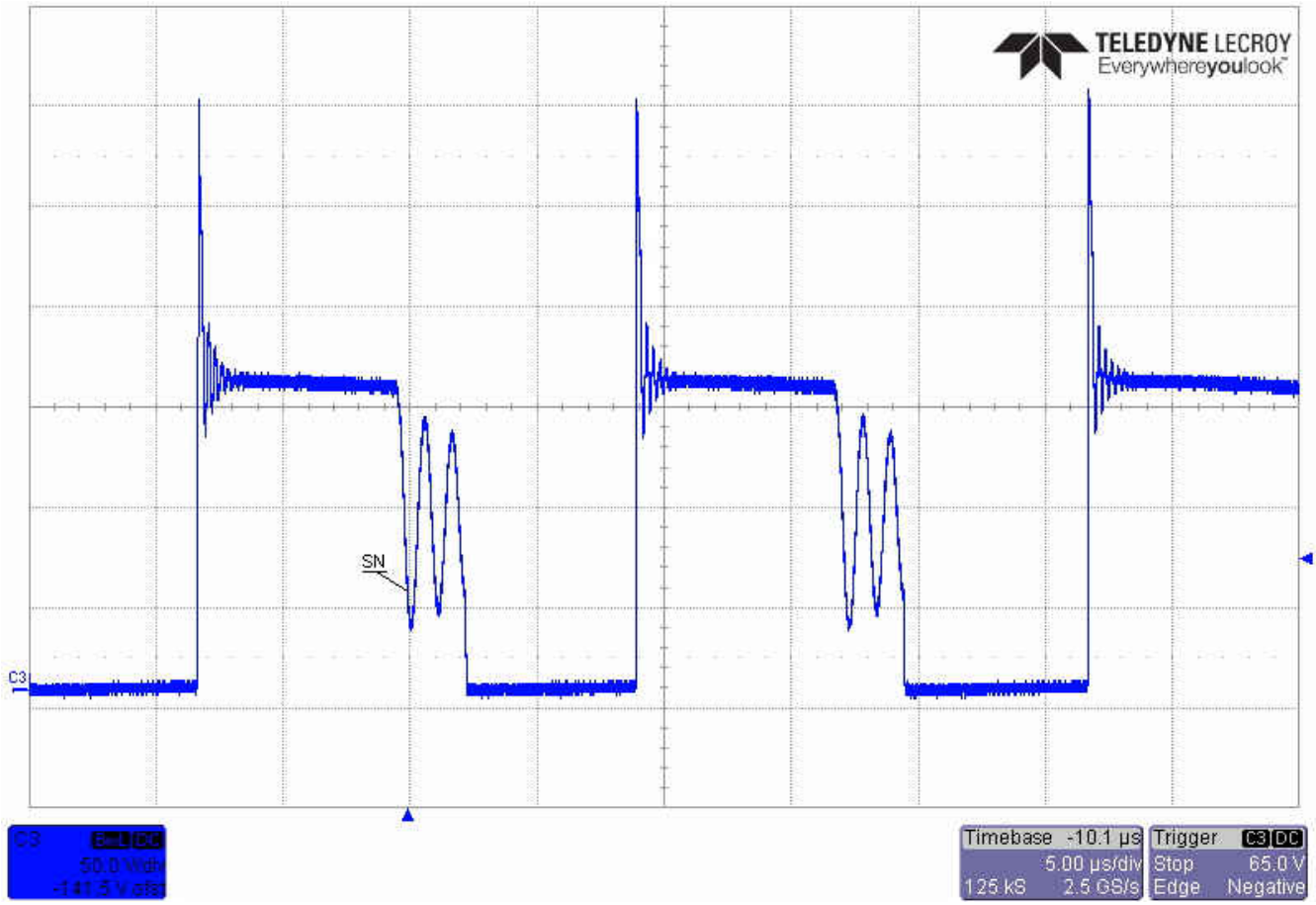
Figure 2-6. Bode Plot

Input Voltage	Output	Phase Margin	Gain Margin	Bandwidth
85 VAC	Full Load	102 deg	> 15 dB	1.2 kHz
110 VAC	Full Load	107 deg	> 15 dB	1.1 kHz
230 VAC	Full Load	106 deg	> 15 dB	0.99 kHz

3 Waveforms

3.1 Switching

Switching behavior is shown in the following figures.

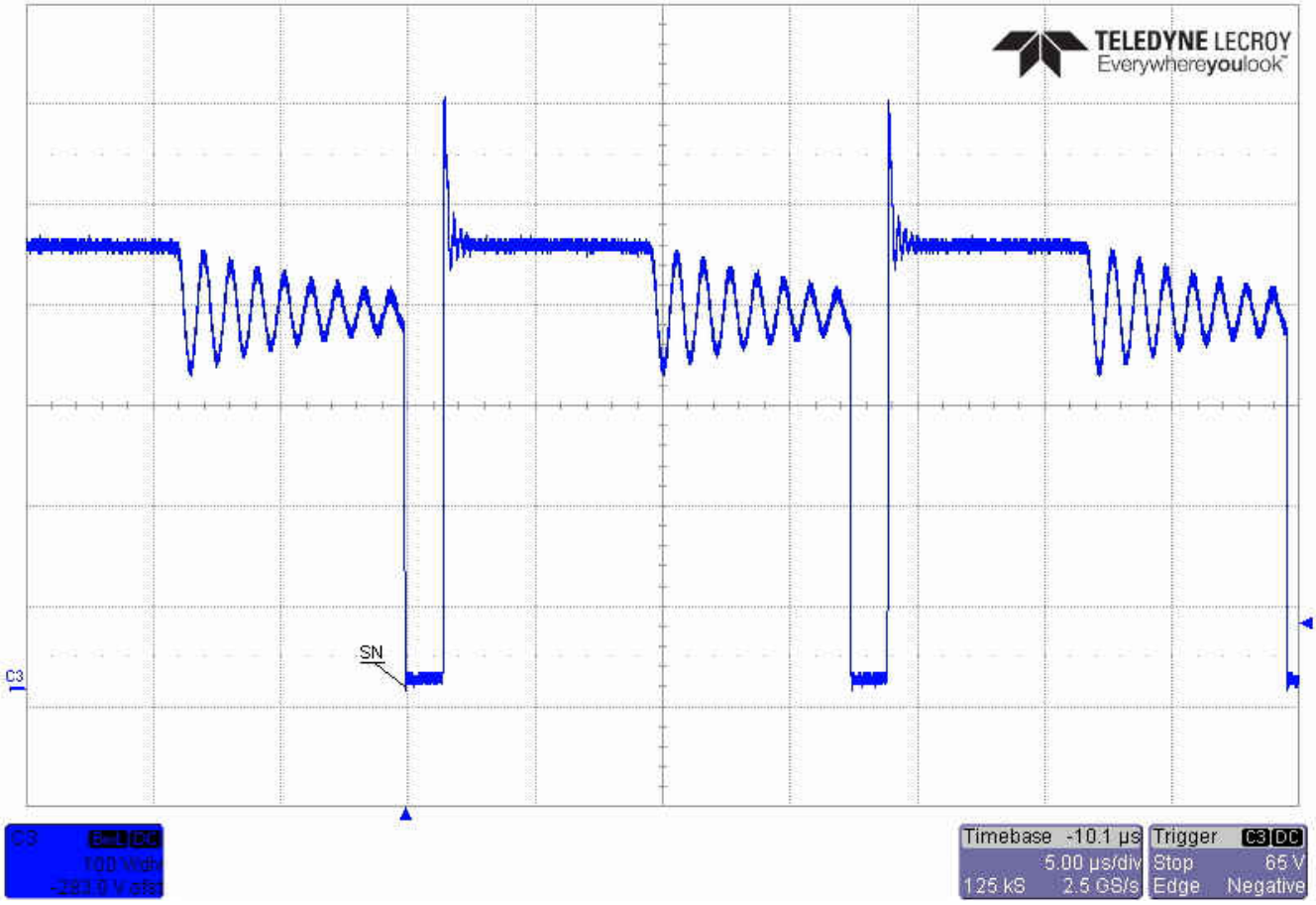


Input voltage = 85 VAC

Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-1. 85-VAC Switch Node, Full Load



Input voltage = 265 VAC

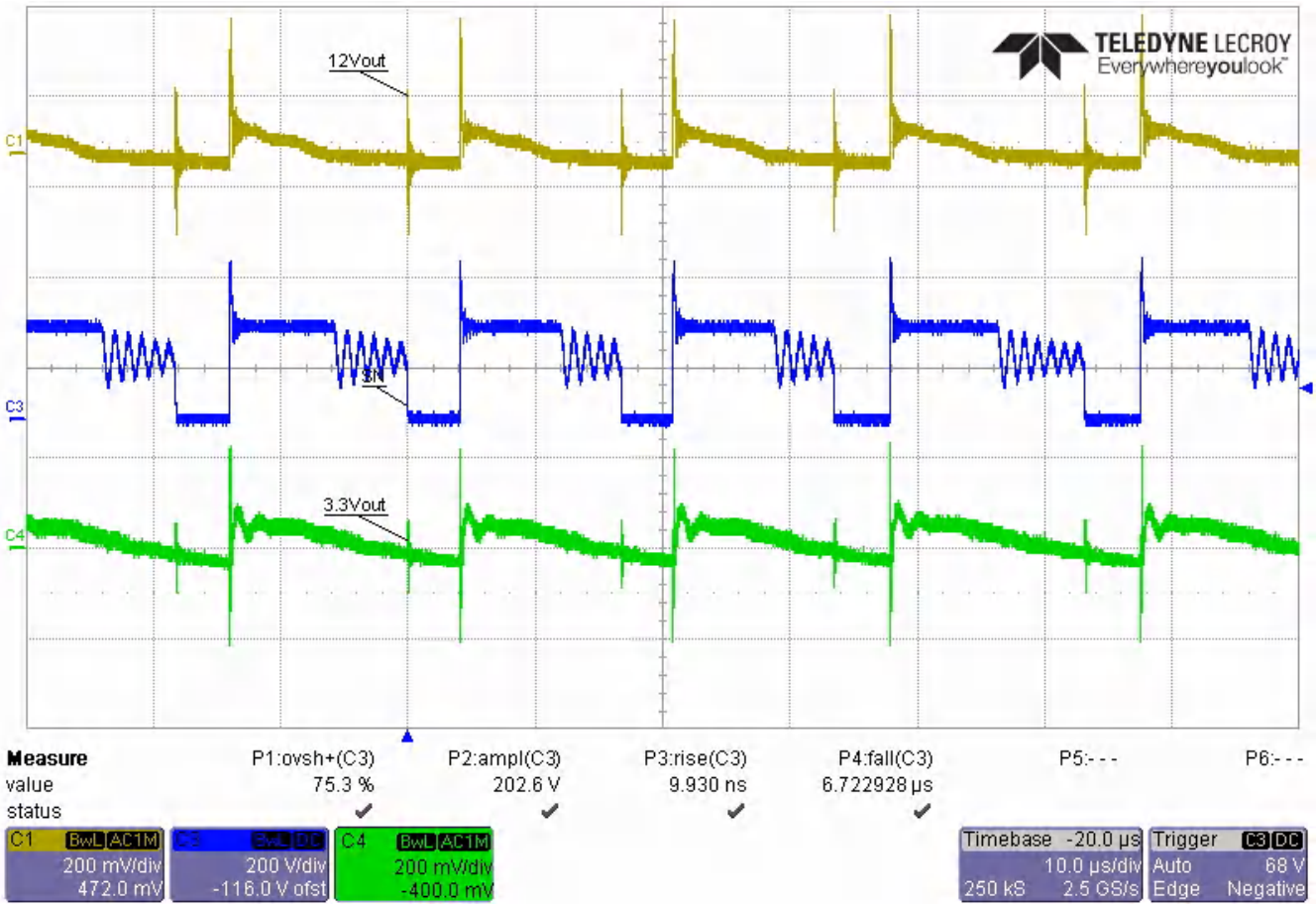
Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-2. 265-VAC Switch Node, Full Load

3.2 Output Voltage Ripple

Output voltage ripple is shown in the following figures.

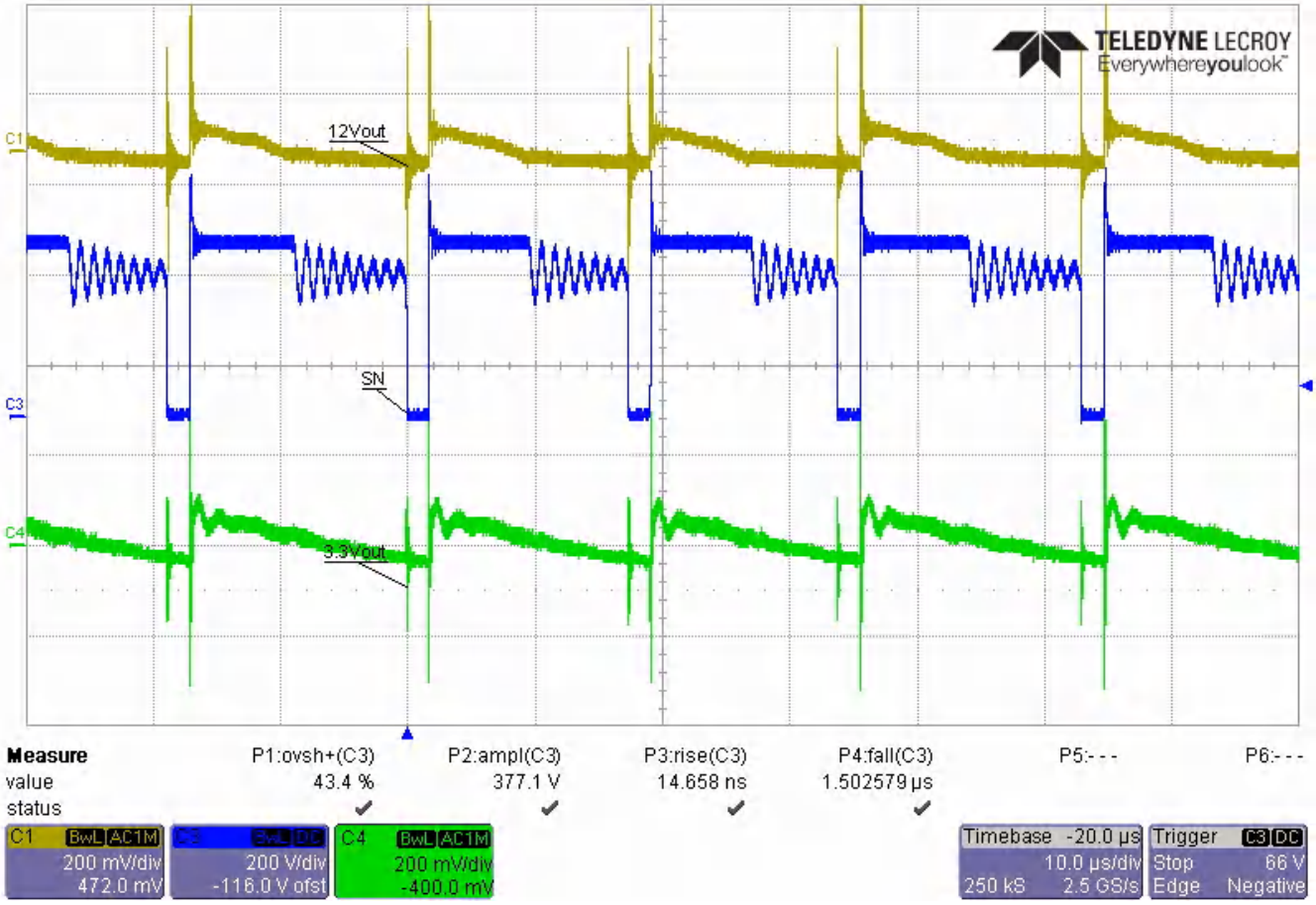


Input voltage = 110 VAC

Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-3. 100-VAC Output Voltage Ripple, Full Load



Input voltage = 230 VAC

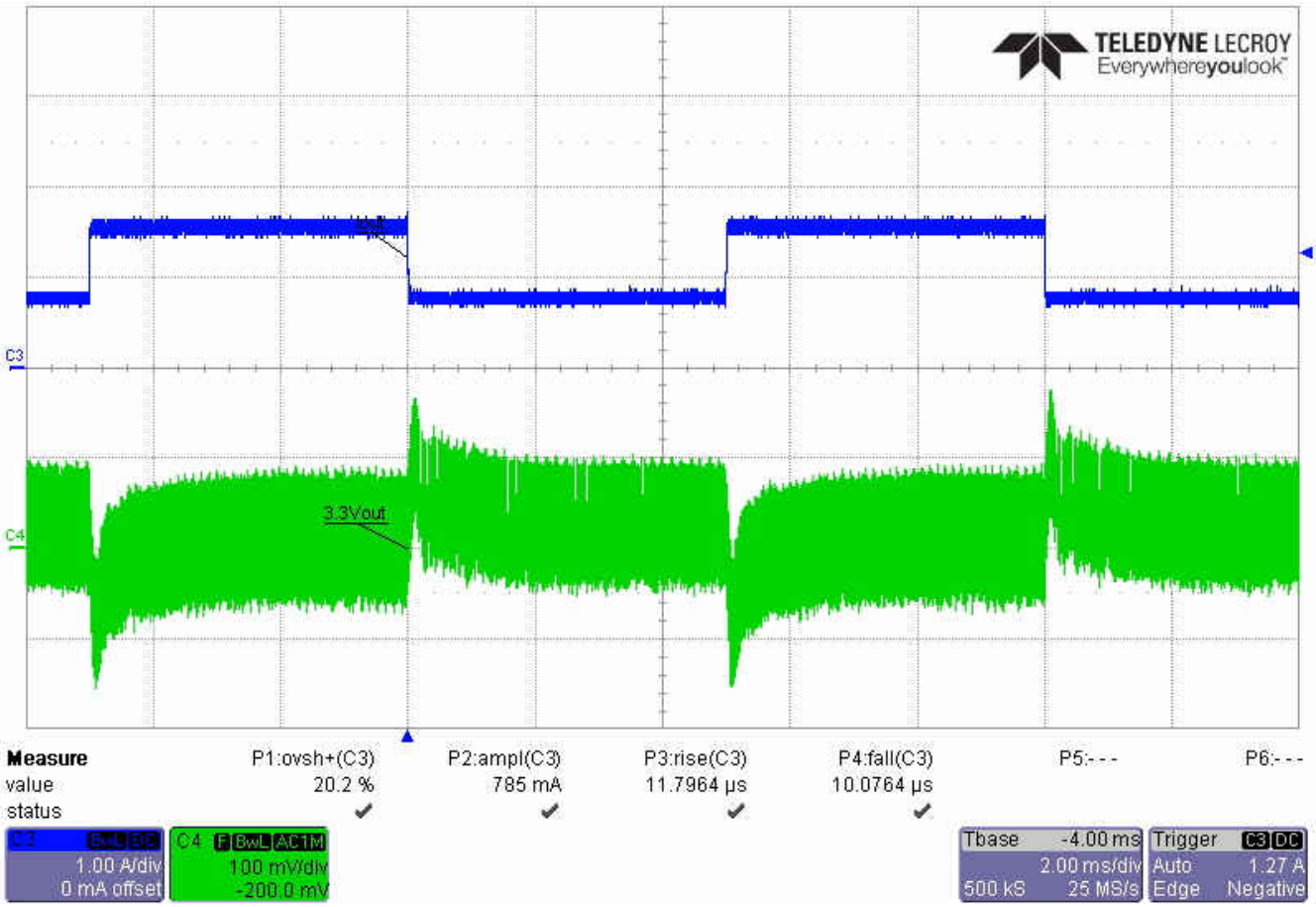
Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-4. 230 VAC Output Voltage Ripple, Full Load

3.3 Load Transients

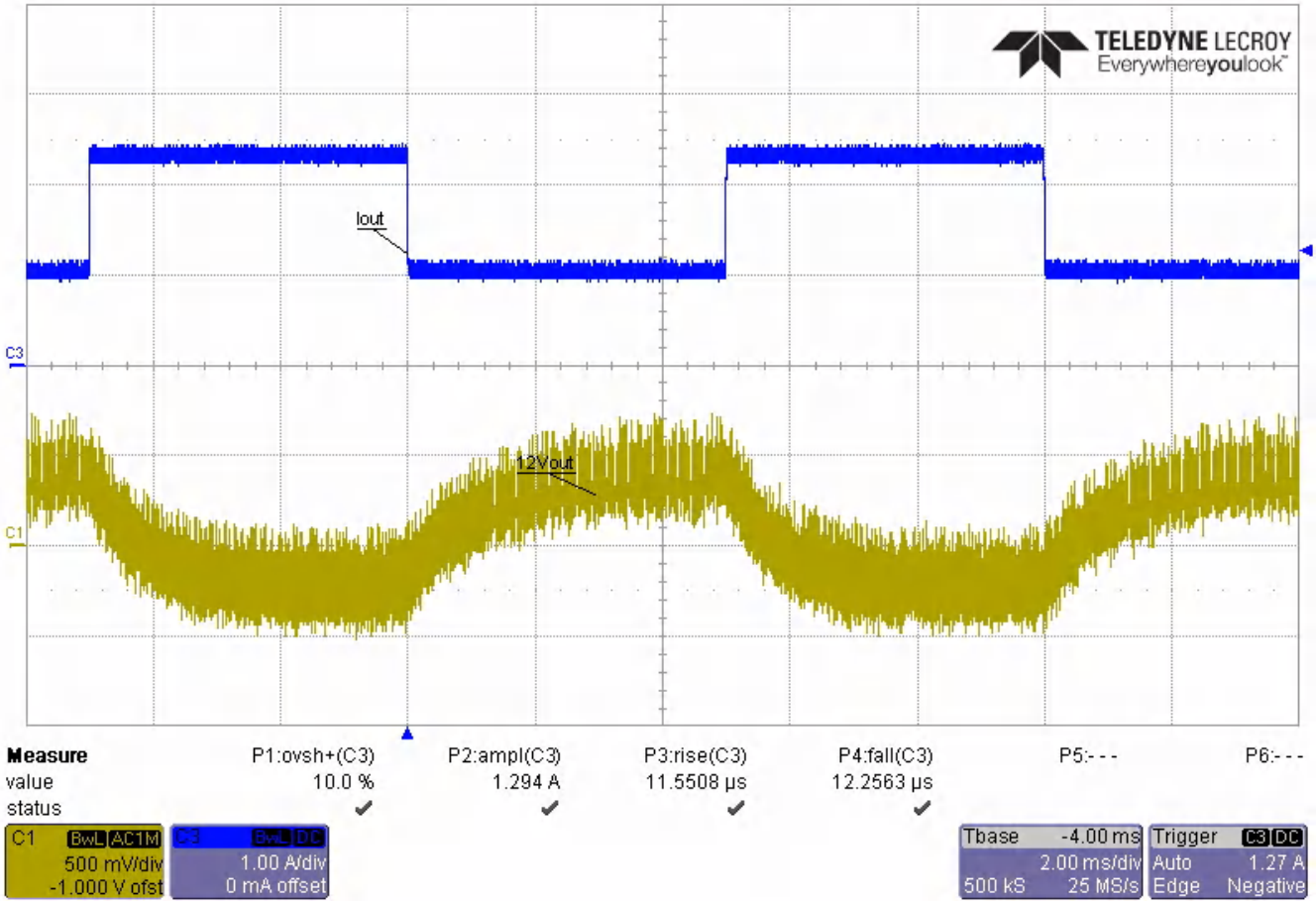
Load transient response is shown in the following figures.



Input voltage = 230 VAC

Load step output 2 = 3.3 V at 0.75 A–1.5 A

Figure 3-5. 230-VAC Input, 3.3-V Output Load Transient



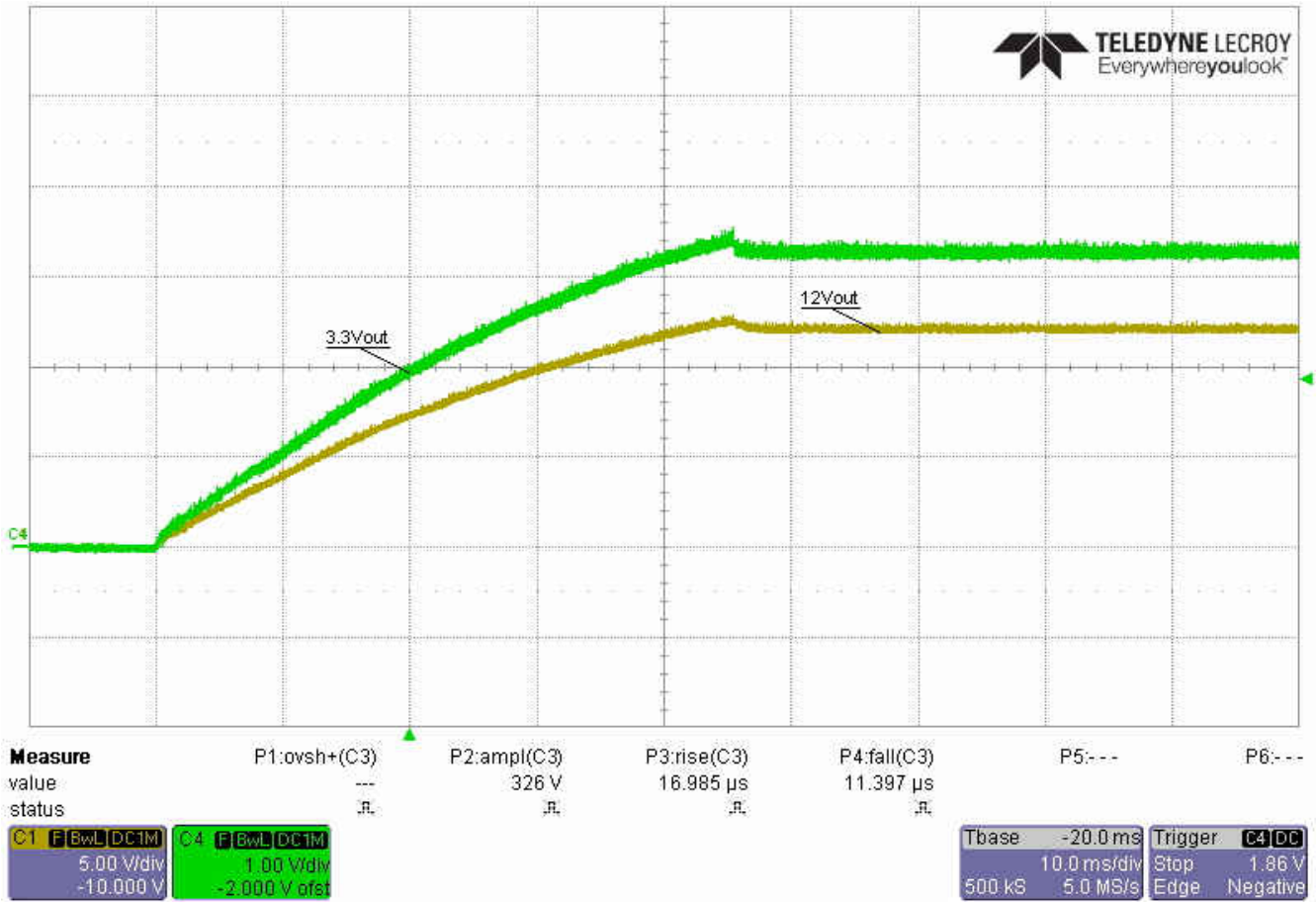
Input voltage = 230 VAC

Load step output 1 = 12 V at 1.5 A–2.2 A

Figure 3-6. 230-VAC Input, 12-V Output Load Transient

3.4 Start-Up Sequence

Start-up behavior is shown in the following figures.

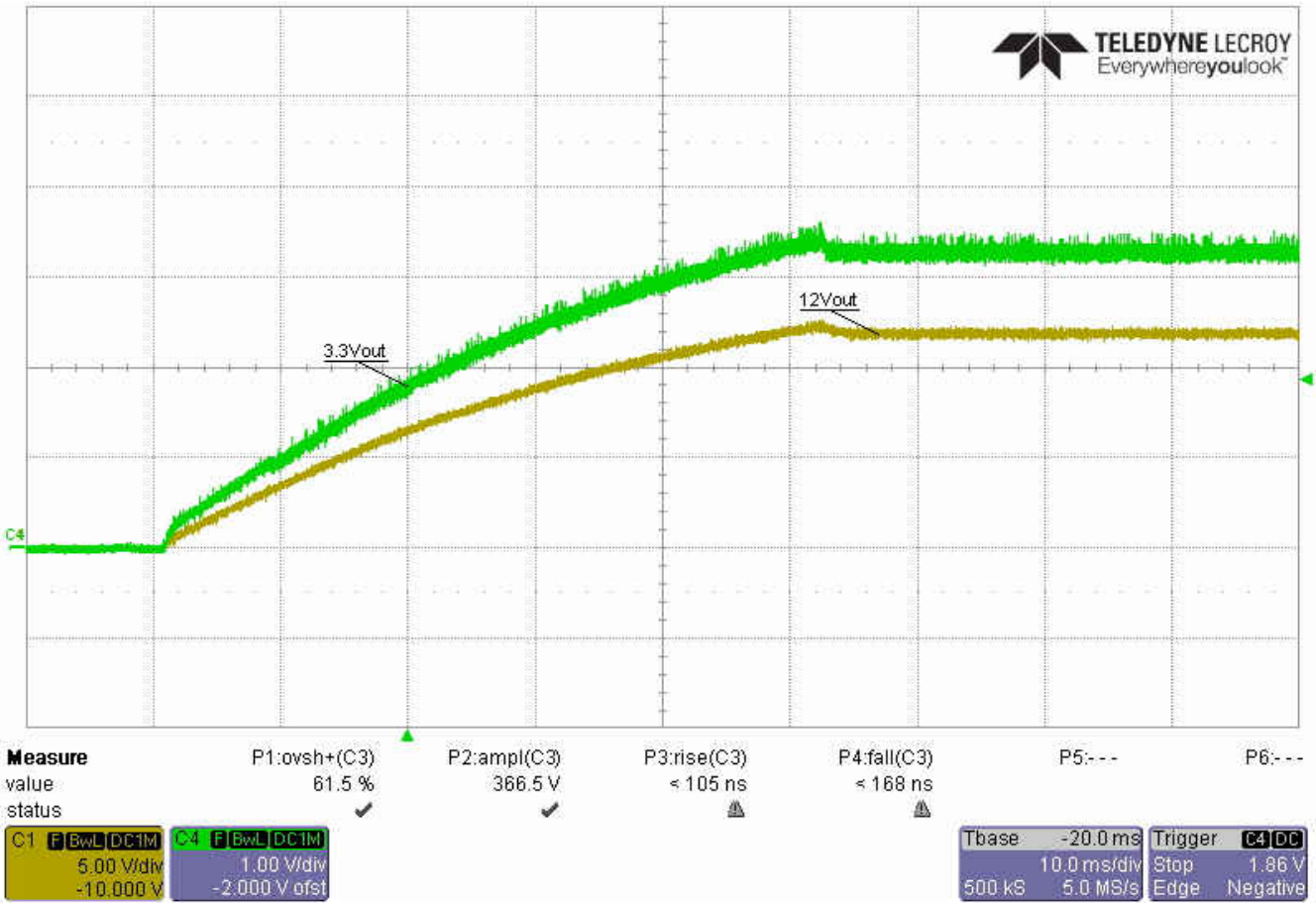


Input voltage = 85 VAC

Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-7. 85-VAC Input, Full Load Start-Up

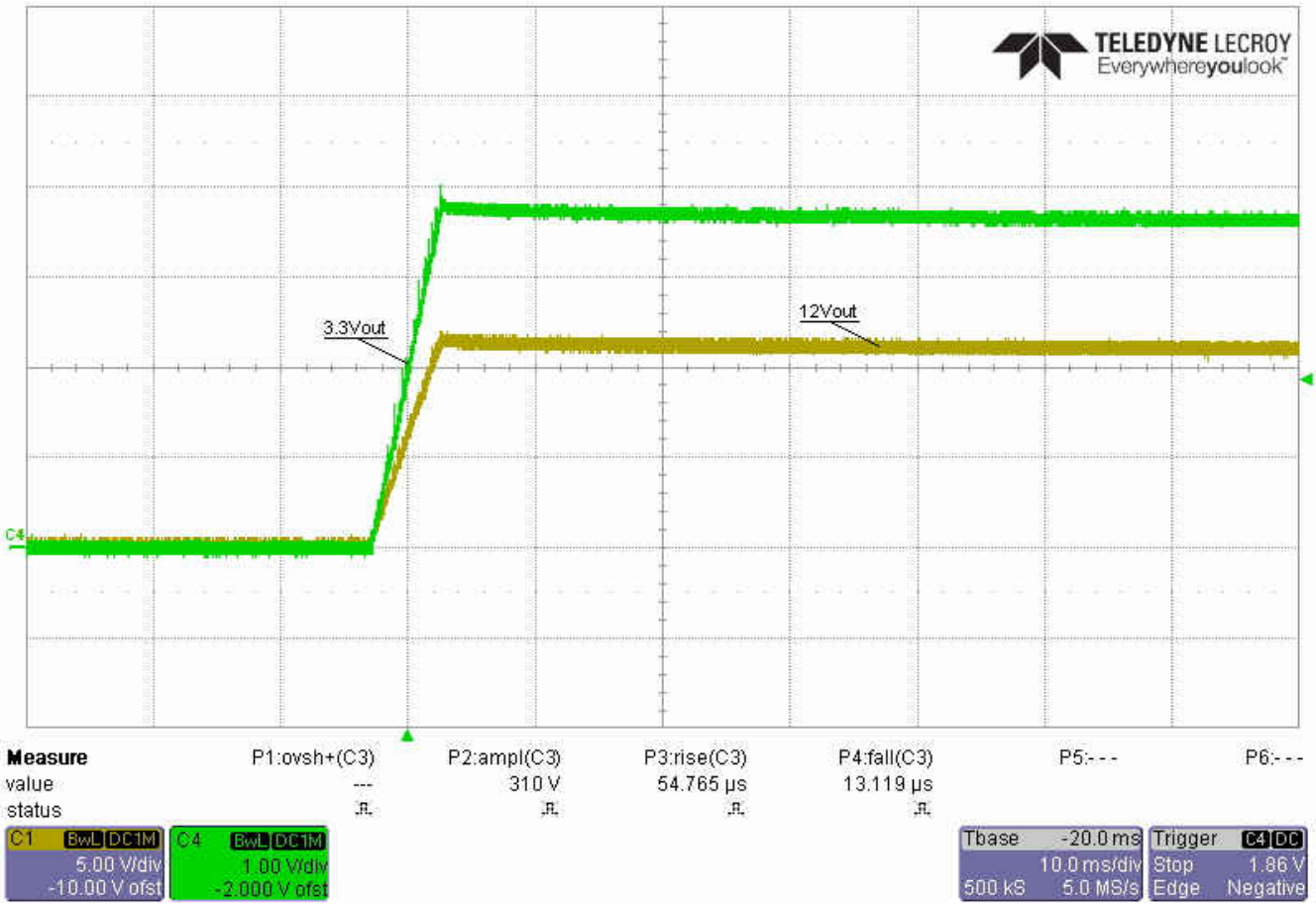


Input voltage = 265 VAC

Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-8. 265-VAC Input, Full Load Start-Up

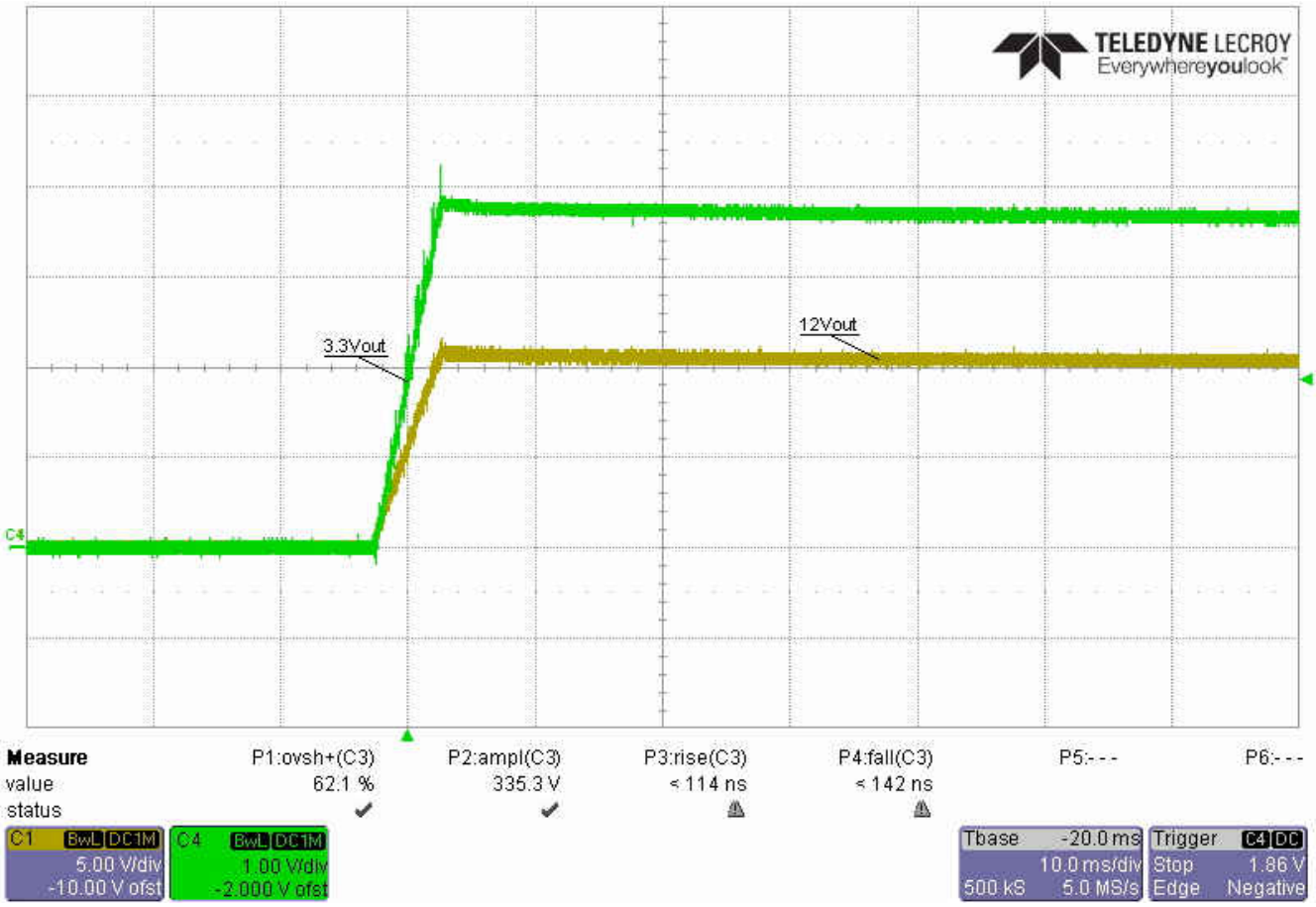


Input voltage = 85 VAC

Output 1 = 12 V at 0 A

Output 2 = 3.3 V at 0 A

Figure 3-9. 85-VAC Input, No Load Start-Up



Input voltage = 265 VAC

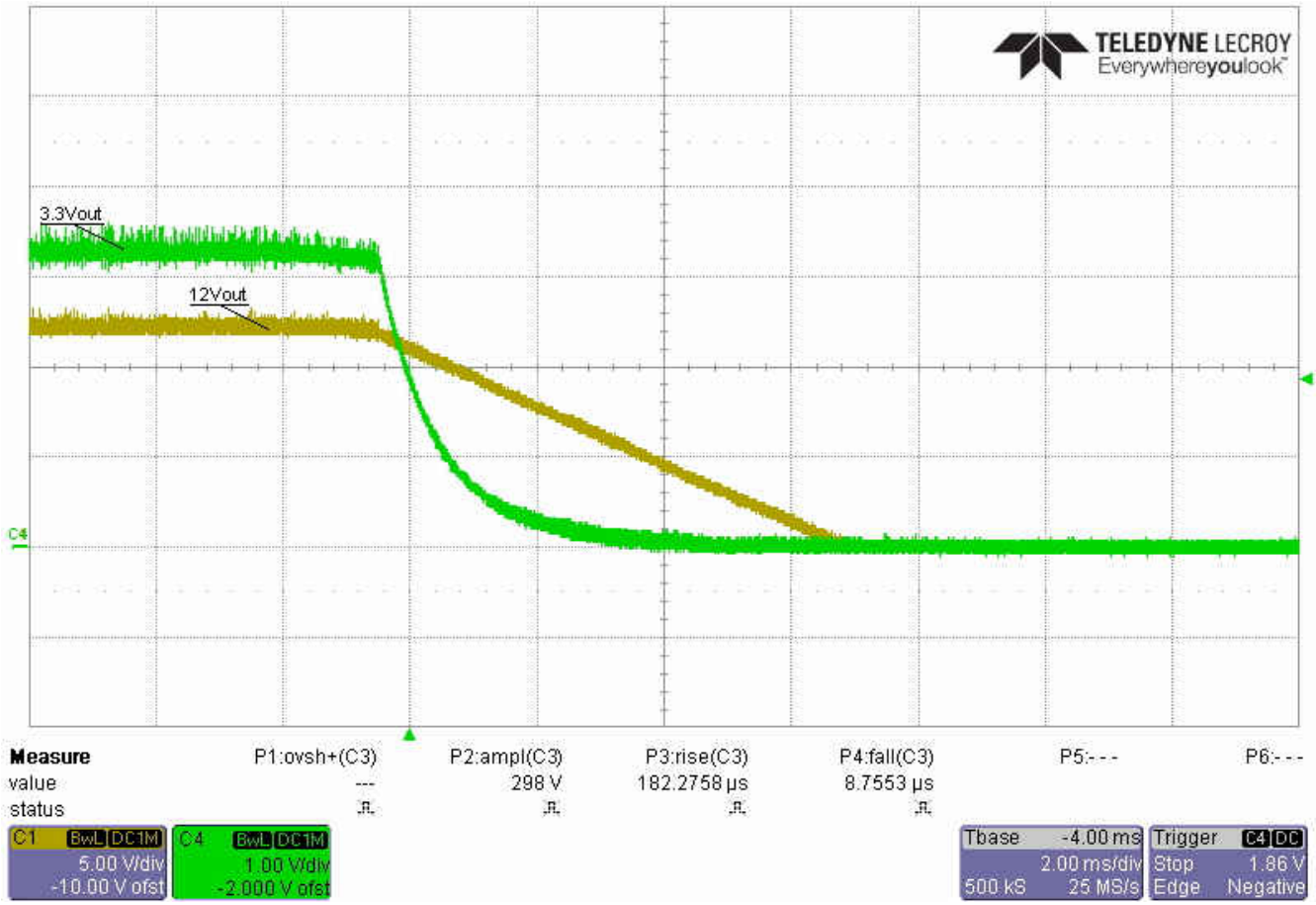
Output 1 = 12 V at 0 A

Output 2 = 3.3 V at 0 A

Figure 3-10. 265-VAC Input, No Load Start-Up

3.5 Shutdown Sequence

Shutdown behavior is shown in the following figures.

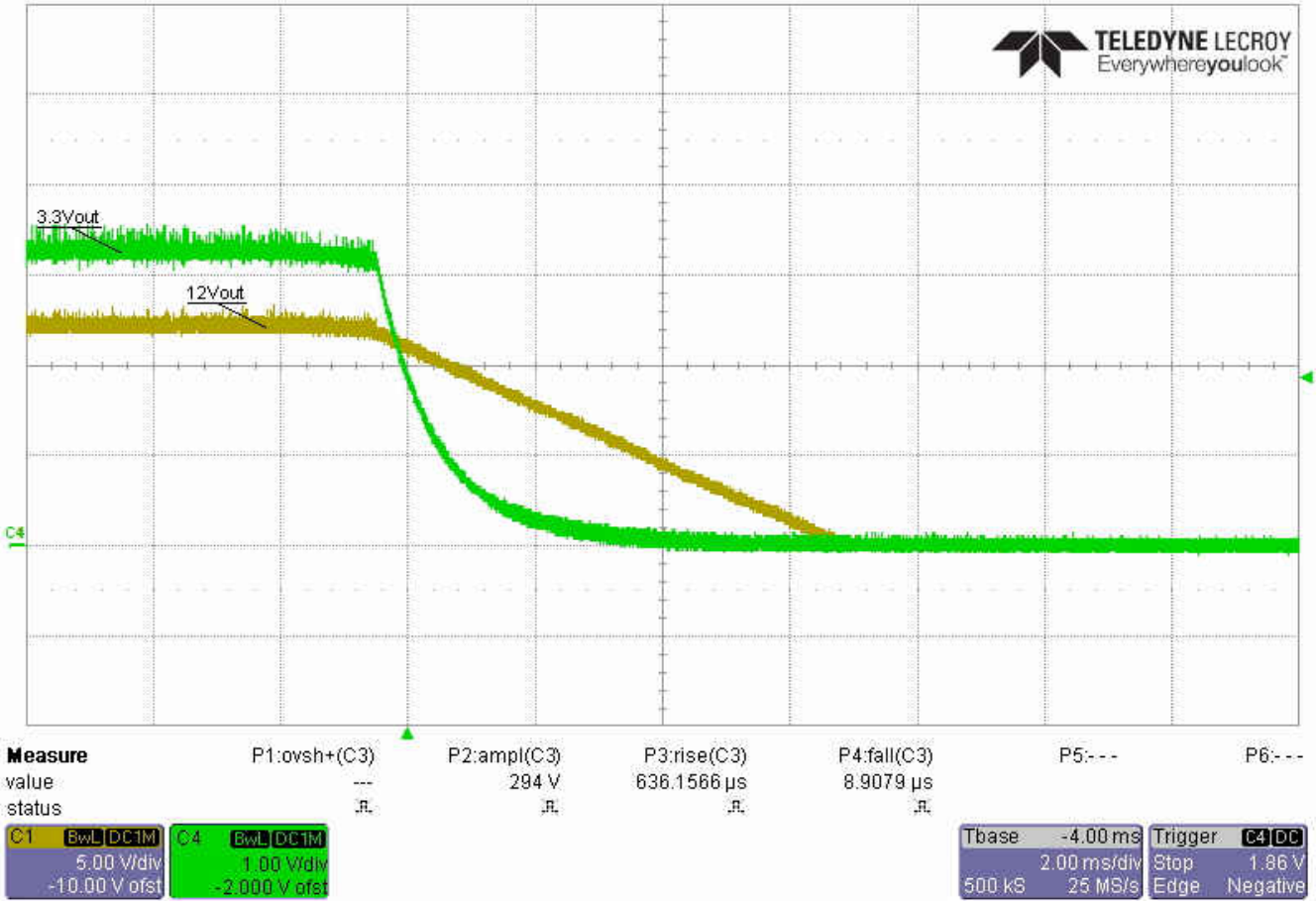


Input voltage = 85 VAC

Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-11. 85-VAC Input, Full-Load Shutdown



Input voltage = 265 VAC

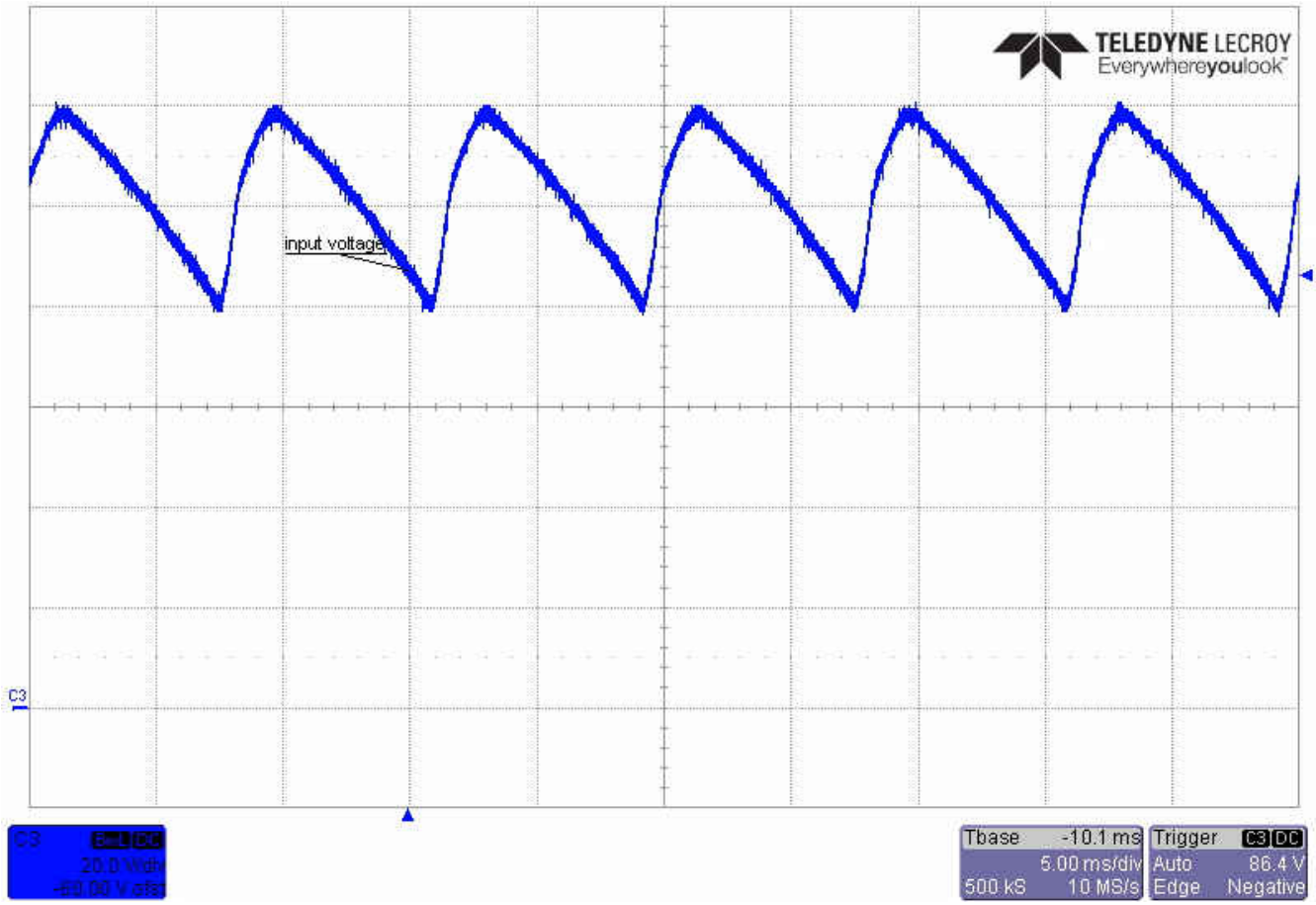
Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-12. 265-VAC Input, Full-Load Shutdown

3.6 Input Voltage Ripple

Input voltage ripple is shown in the following figures.



Input voltage = 85 VAC

Output 1 = 12 V at 2.2 A

Output 2 = 3.3 V at 1.5 A

Figure 3-13. 85-VAC Input, Full-Load Input Voltage Ripple

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265