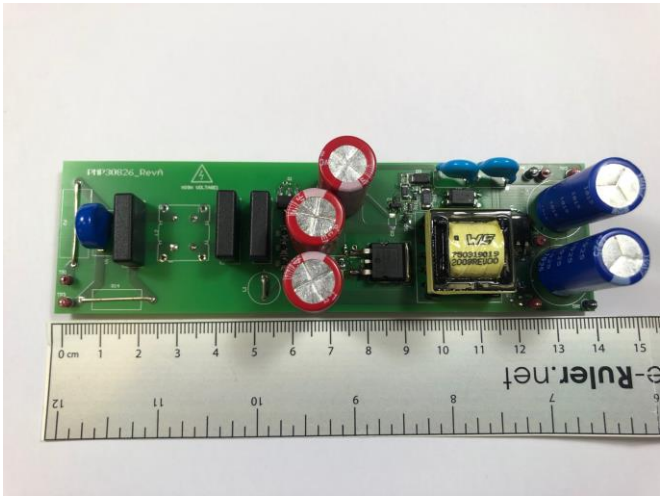
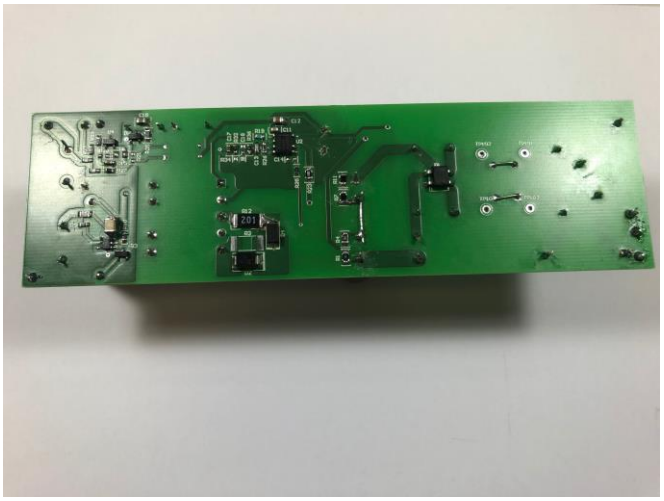
Test Report: PMP30826

Offline Supercapacitor Backup Power Supply With Active Cell Balancing Reference Design





Description

This reference design provides a backup voltage during a power interruption. It manages the charging of supercapacitors directly from the mains voltage (96 VAC - 272 VAC). The UCC28740 provides constant-voltage (CV) and constant-current (CC) output regulation. The supercapacitor capacitance and voltage define the energy that is available for the backup.

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

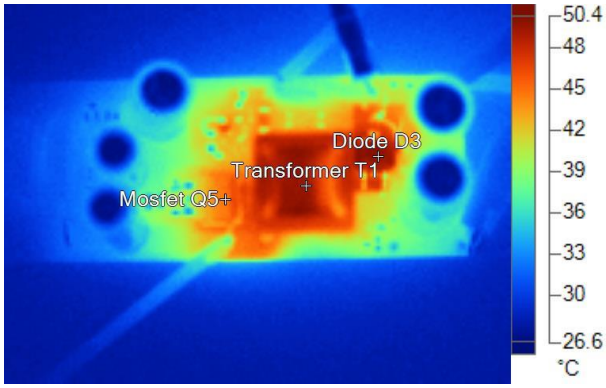
PARAMETER	SPECIFICATIONS
Input Voltage	96VAC – 552VAC
Output Voltage	4V
Output current	0.75A continuous; 3A peak

2 Testing and Results

2.1 Thermal Images

The images below show the infrared images taken from the FlexCam after 10min.

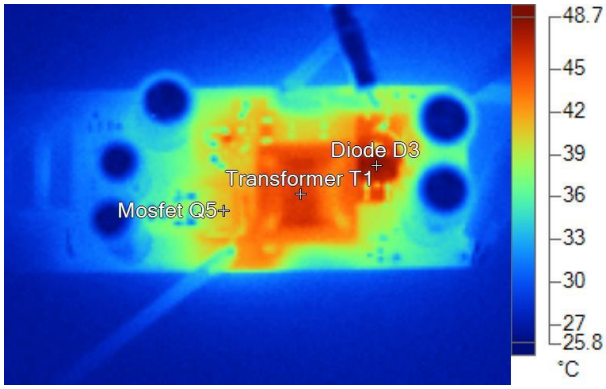
Input voltage = 230VAC
Load current = 0.75A
No airflow
Top Side



_1799 230VAC Iload=750mA Top.is2

Name	Temperature	
Mosfet Q5	45.0°C	
Transformer T1	49.6°C	
Diode D3	50.0°C	

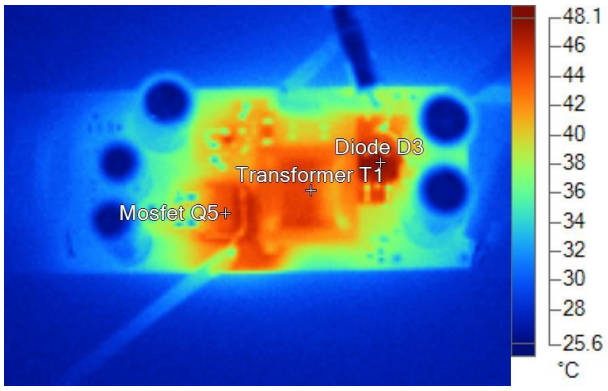
Input voltage = 96VAC
Load current = 0.75A
No airflow
Top Side



_1800 96VAC Iload=750mA Top.is2

Name	Temperature
Mosfet Q5	40.6°C
Transformer T1	45.6°C
Diode D3	48.4°C

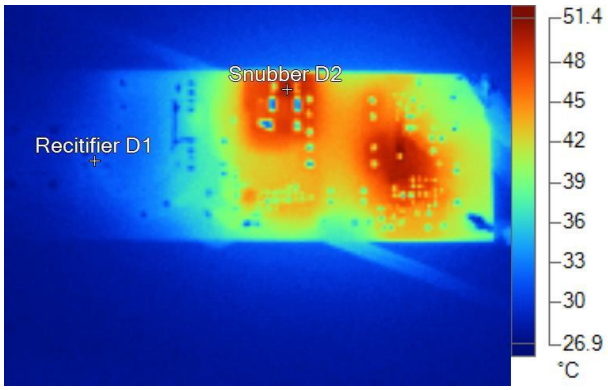
Input voltage = 273VAC
Load current = 0.75A
No airflow
Top Side



_1801 273VAC Iload=750mA Top.is2

Name	Temperature	
Mosfet Q5	44.4°C	
Transformer T1	44.2°C	
Diode D3	48.0°C	

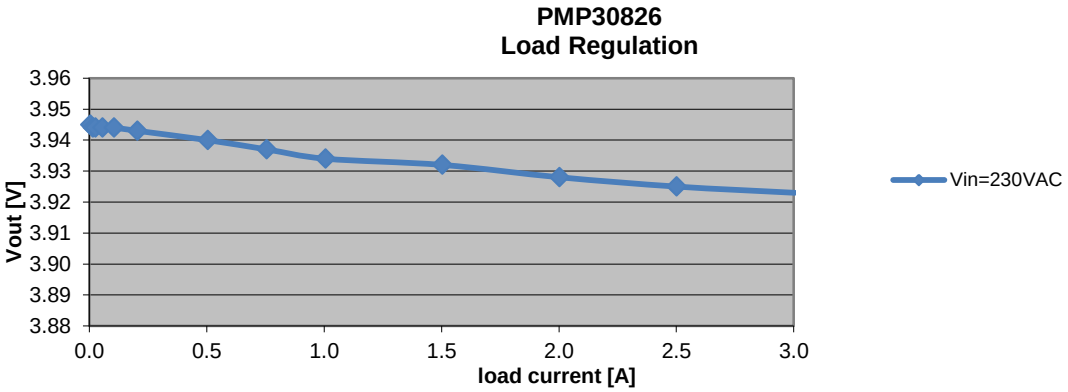
Input voltage = 273VAC
Load current = 0.75A
No airflow
Bottom Side

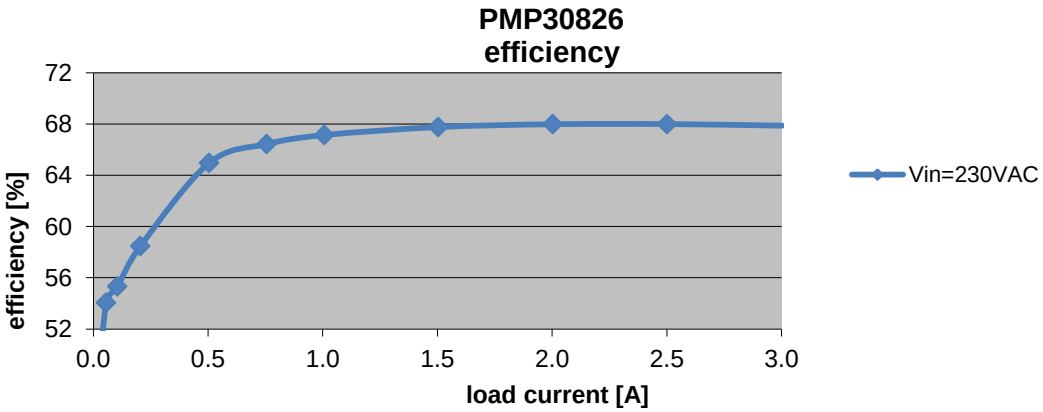


_1803 230VAC Iload=750mA Bottom.is2

Name	Temperature	
Snubber D2	49.8°C	
Recitifier D1	31.8°C	

2.2 Efficiency Data

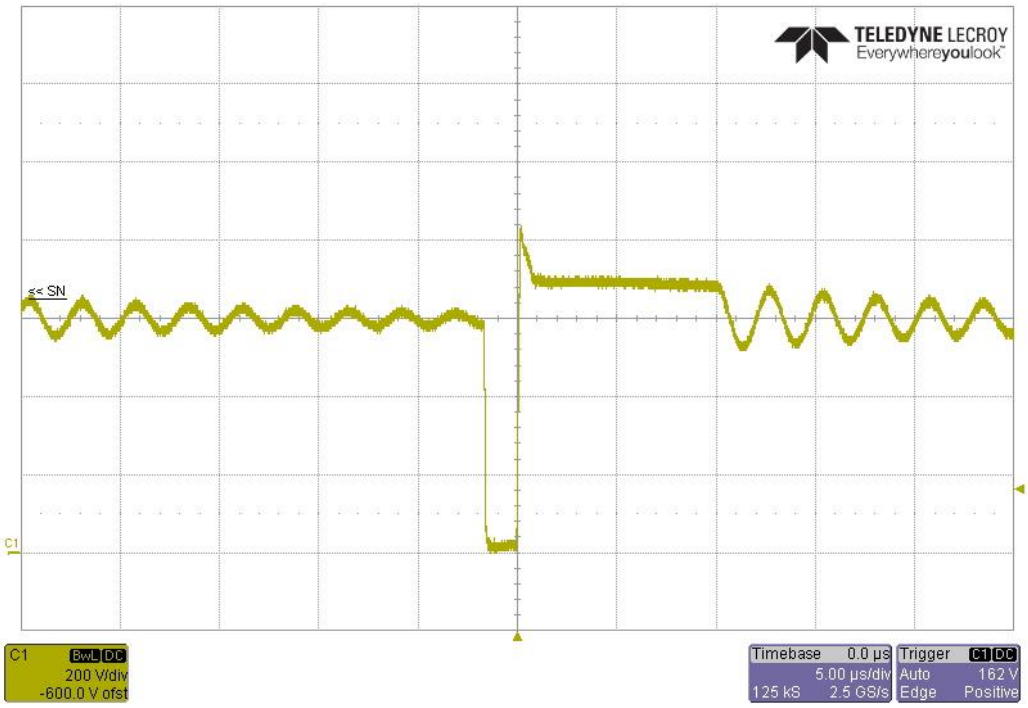




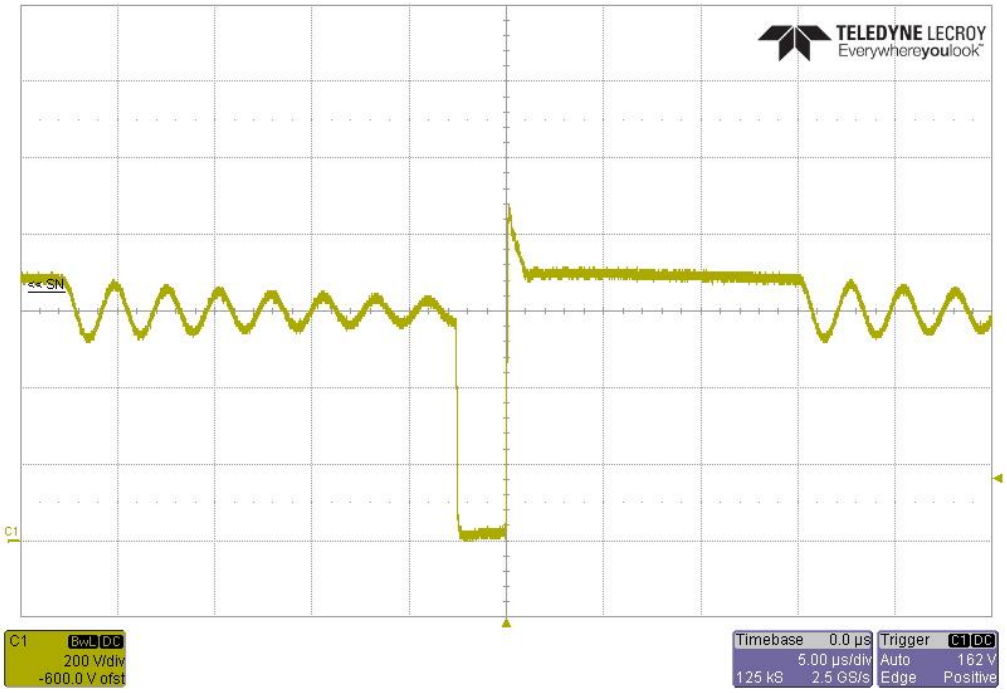
3 Waveforms

3.1 Switchnode Voltage

Input voltage = 600VDC
Load current = 0.75A

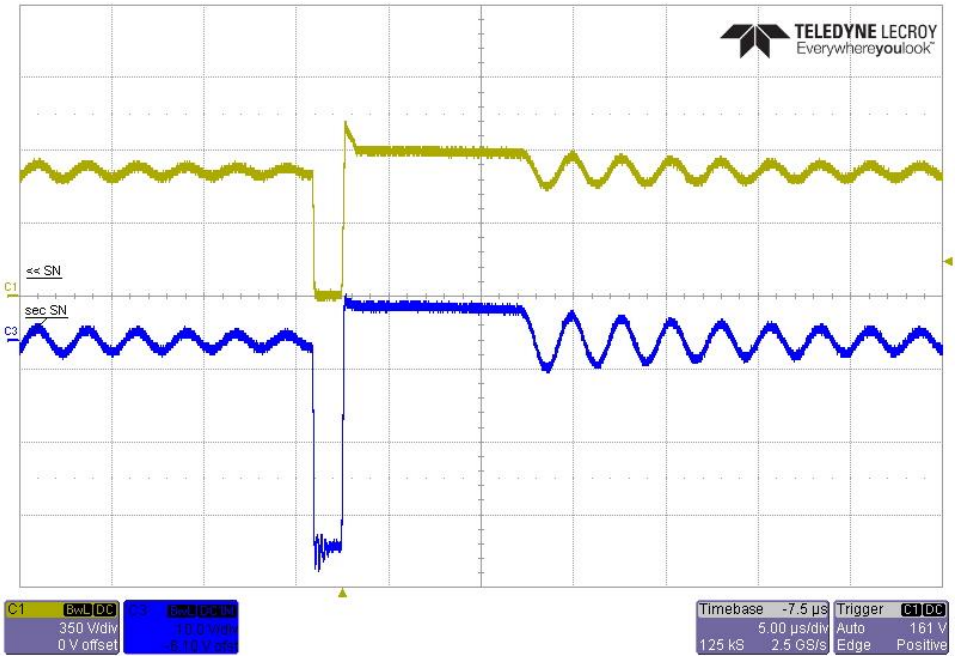


Input voltage = 600VDC
Load current = 3A

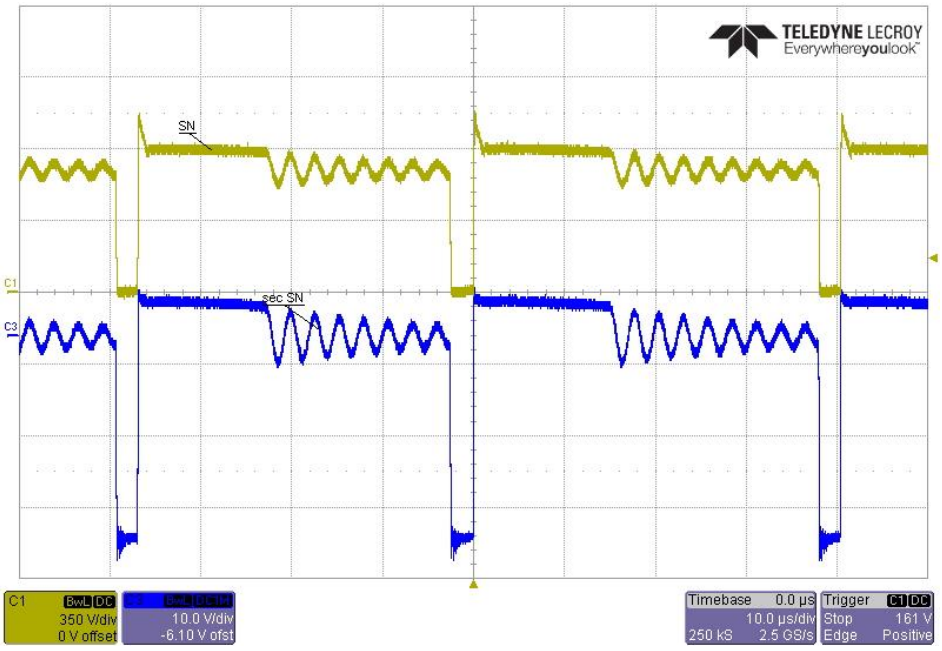


3.2 Secondary side Switchnode

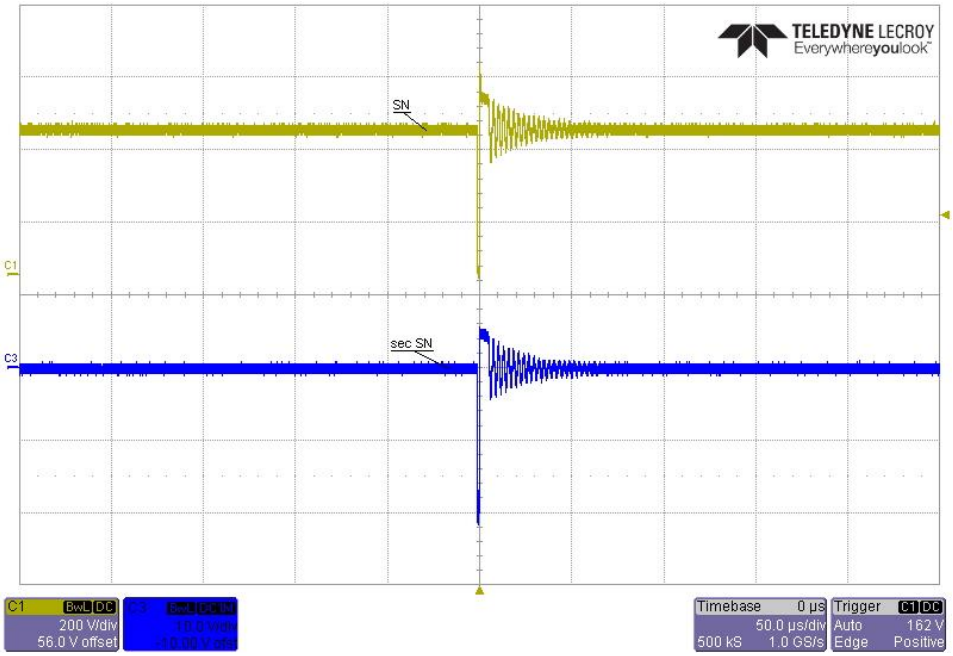
Input voltage = 600VDC
Load current = 0.75A



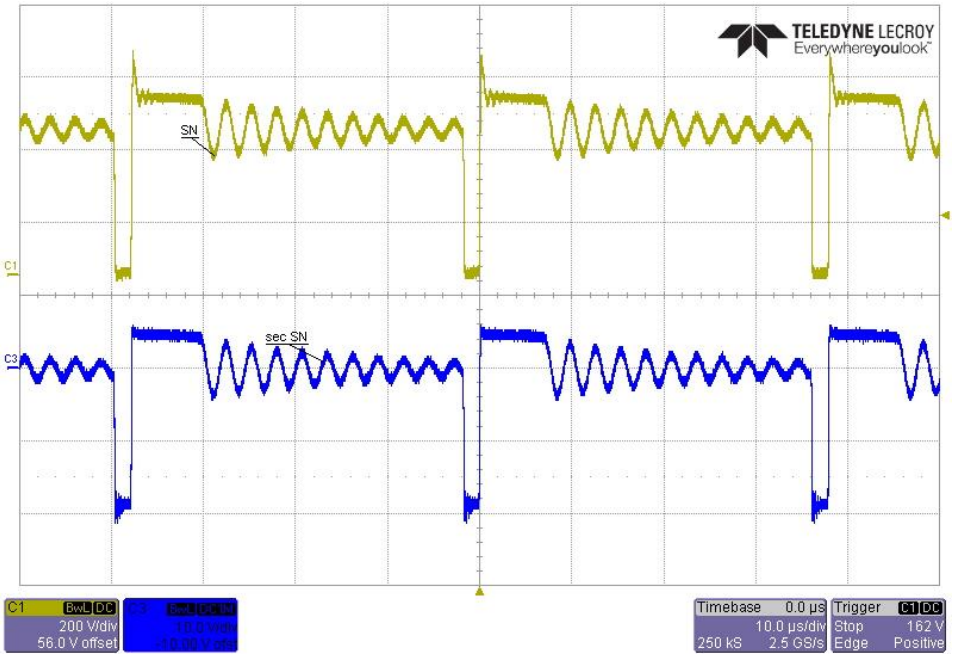
Input voltage = 600VDC
Load current = 3A



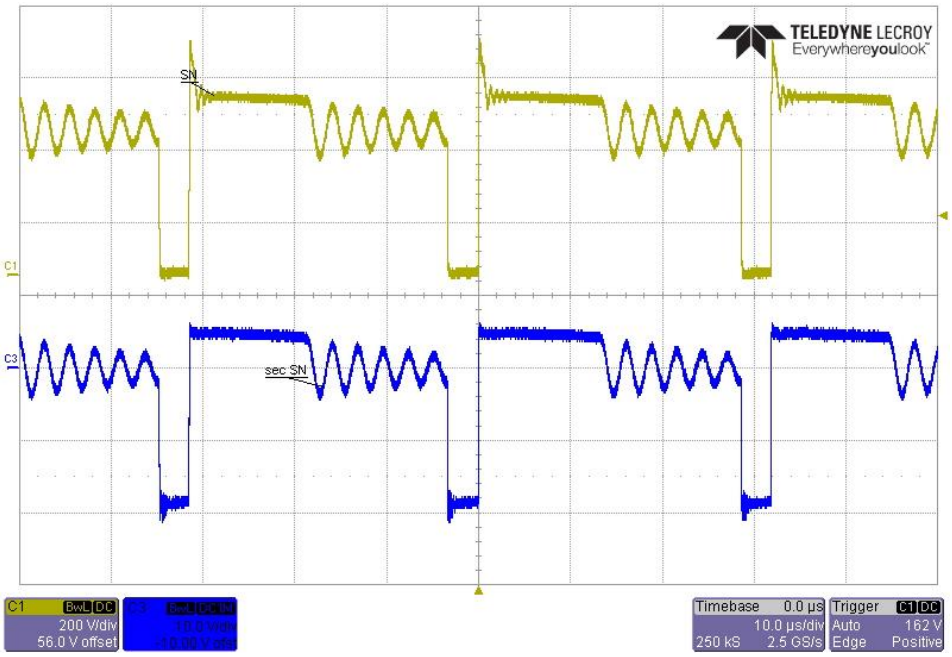
Input voltage = 400VDC
Load current = 0A



Input voltage = 400VDC
Load current = 0.75A



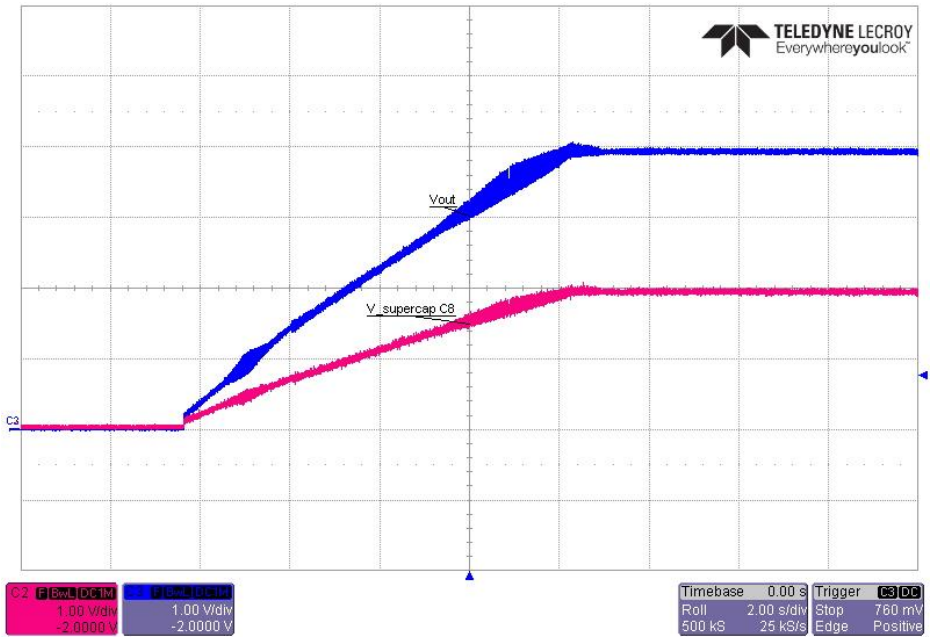
Input voltage = 400VDC
Load current = 3A



3.3 Other

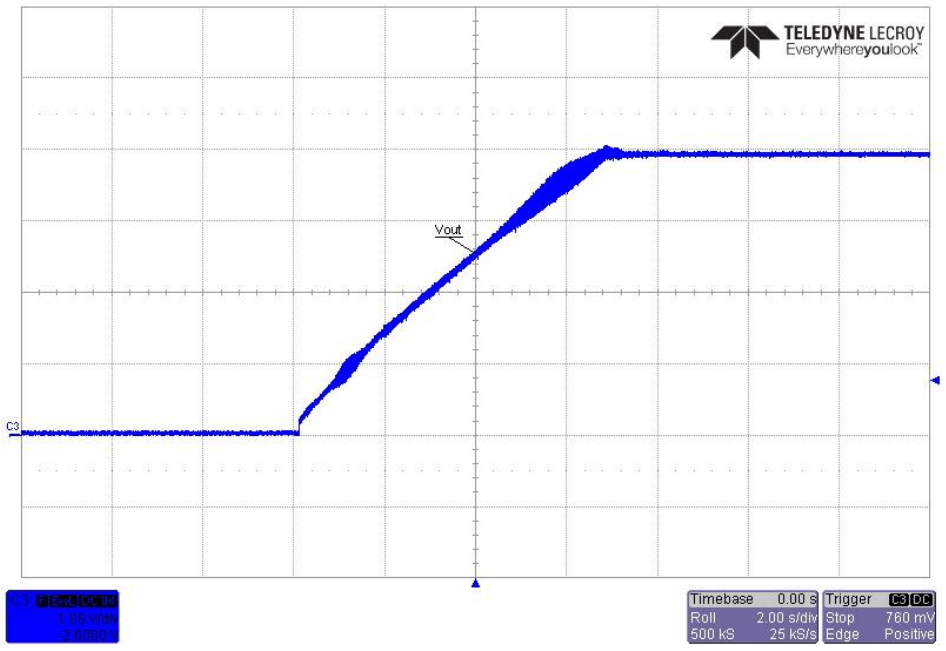
3.3.1 Supercap Voltage Balance

Input voltage = 230VAC
Load current = 0.75A

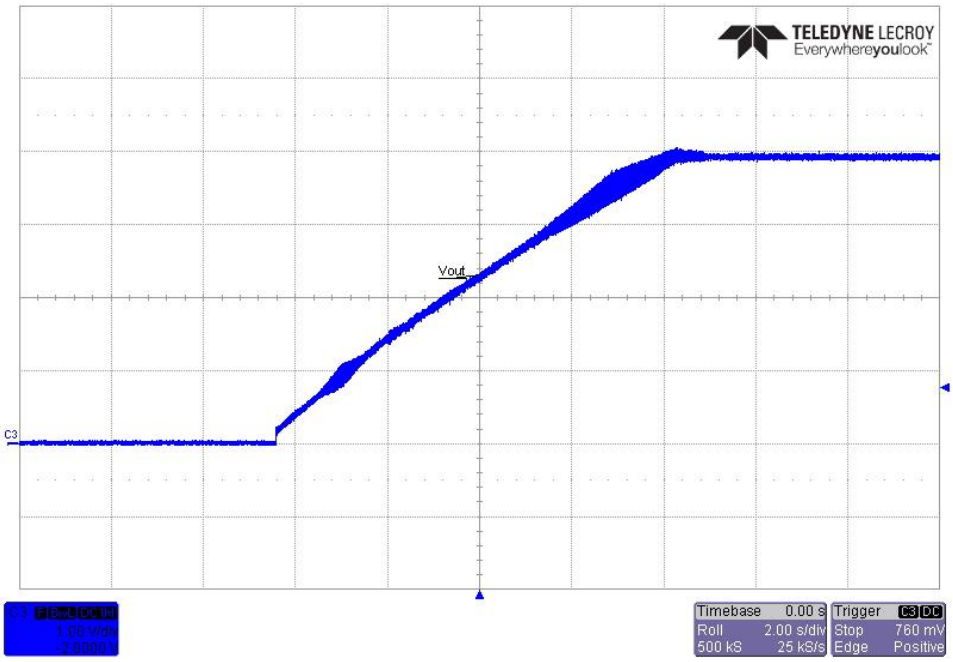


3.3.2 Supercap charging (Startup)

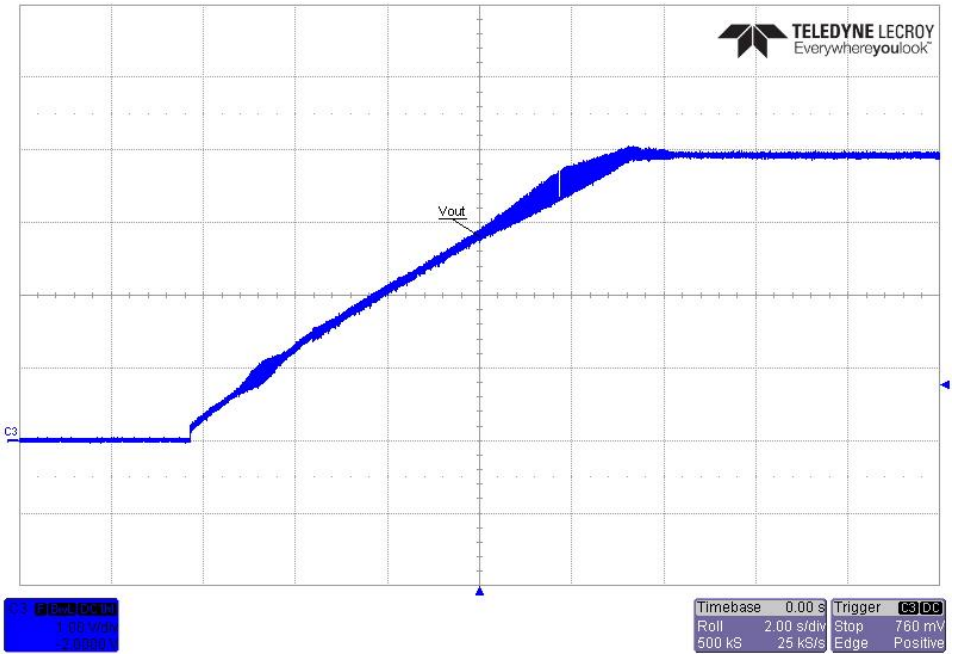
Input voltage = 230VAC
Load current = 0A



Input voltage = 230VAC
Load current = 0.75A

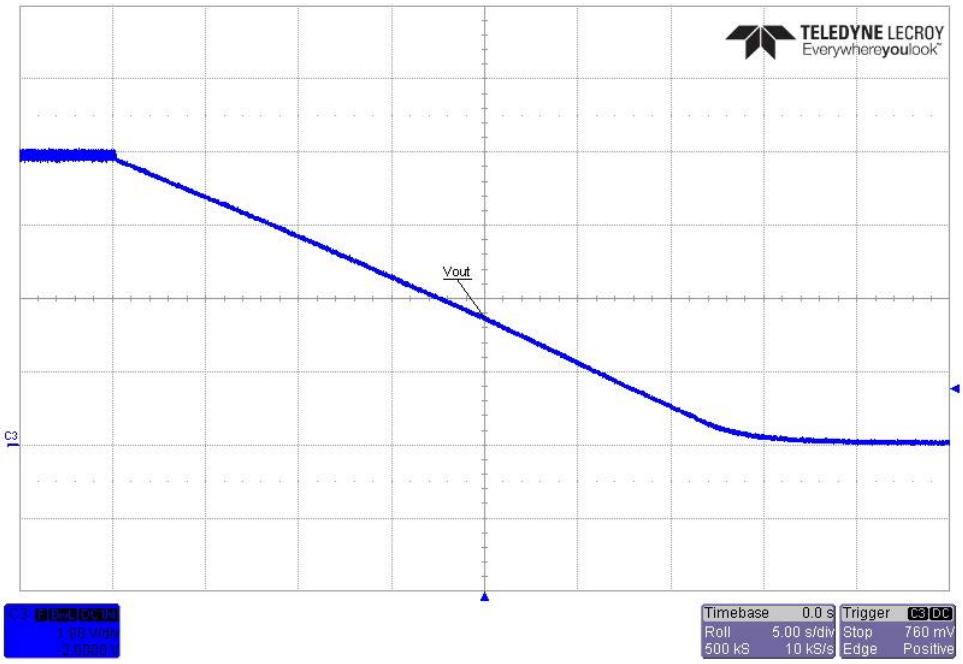


Input voltage = 230VAC
Load current = 1A

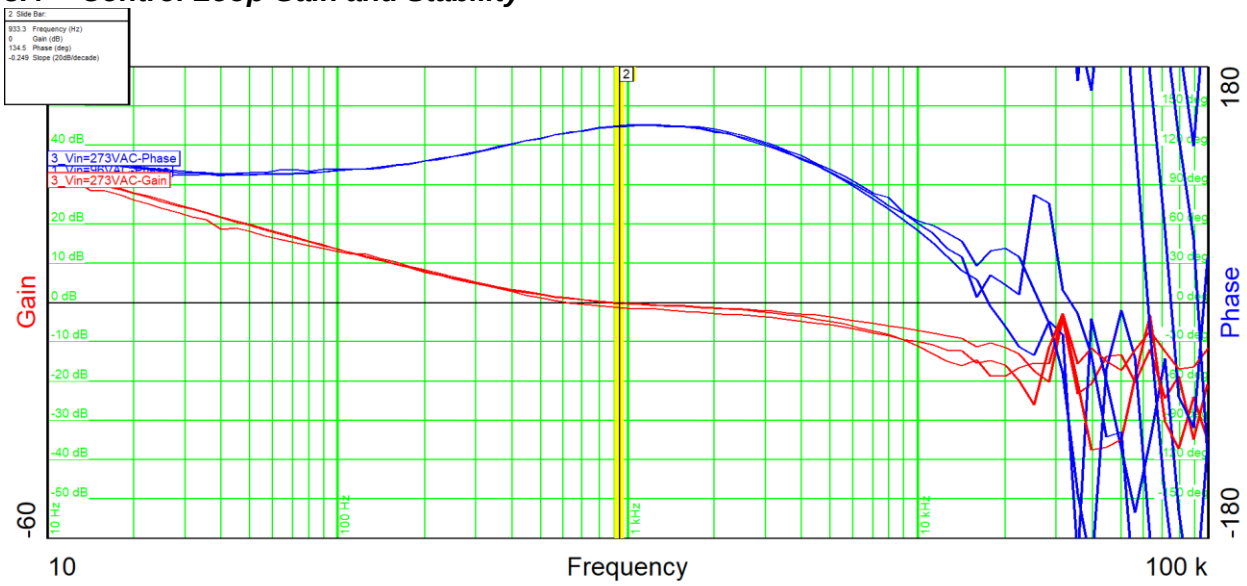


3.3.3 Supercap discharging (Shutdown)

Input voltage = 230VAC
Load current = 0.75A



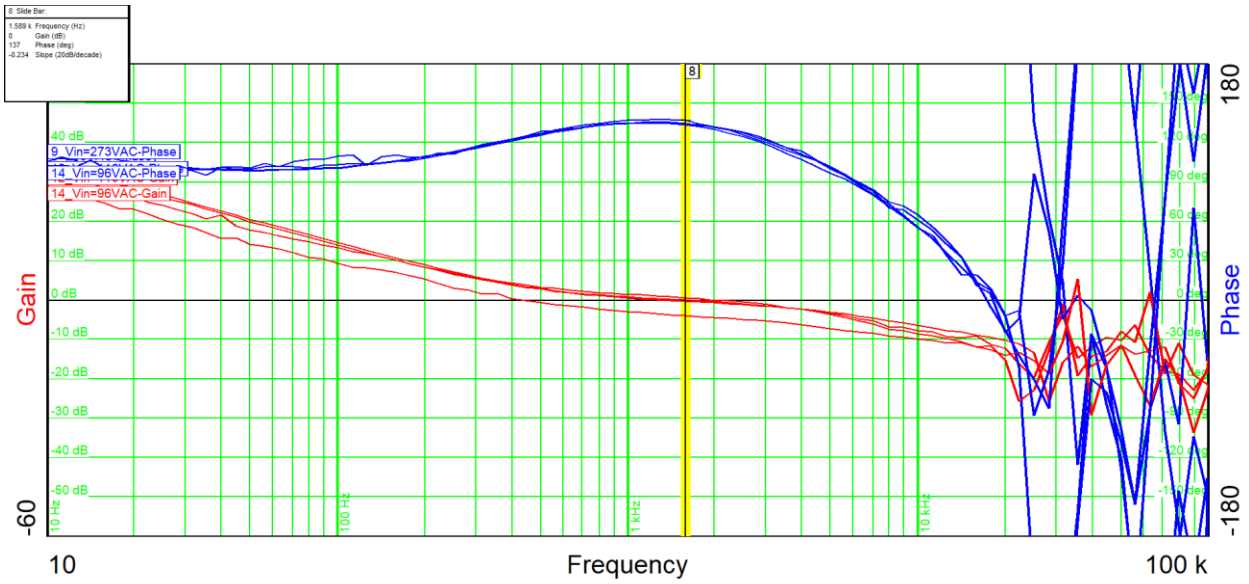
3.4 Control Loop Gain and Stability



Input Voltage = 96VAC
Load = 2.5A
Bandwidth = 0.88kHz
Phase Margin = 135°

Input Voltage = 230VAC
Load = 2.5A
Bandwidth = 0.93kHz
Phase Margin = 135°

Input Voltage = 273VAC
Load = 2.5A
Bandwidth = 0.63kHz
Phase Margin = 130°



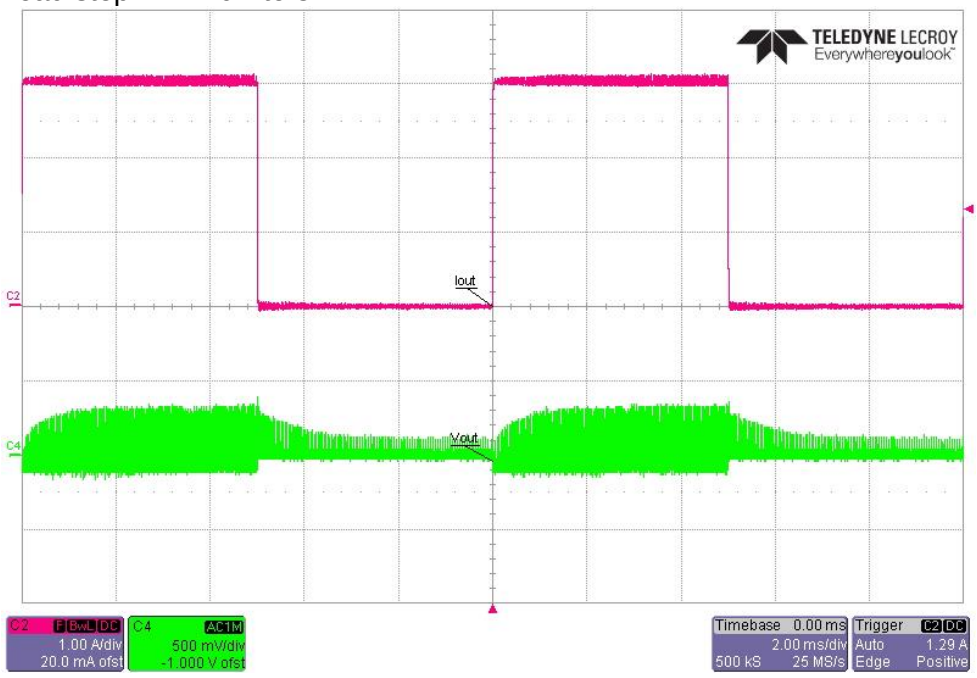
Input Voltage = 96VAC
Load = 3A
Bandwidth = 0.44kHz
Phase Margin = 124°

Input Voltage = 230VAC
Load = 3A
Bandwidth = 1.6kHz
Phase Margin = 137°

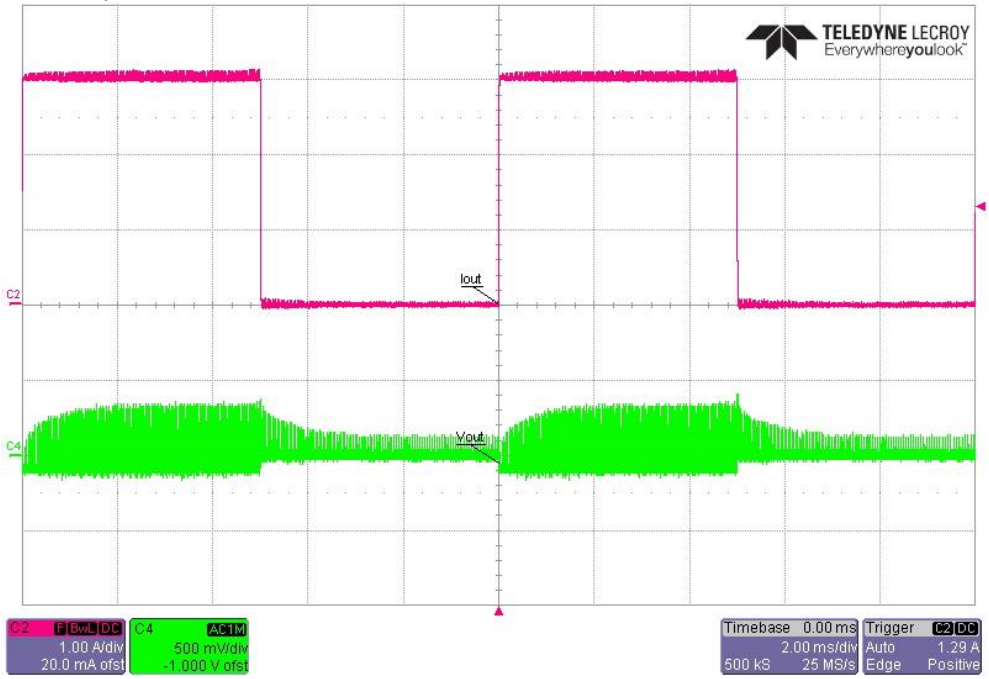
Input Voltage = 273VAC
Load = 3A
Bandwidth = 2.0kHz
Phase Margin = 132°

3.5 Load Transients

Input voltage = 96VAC
Load step = 0A to 3A

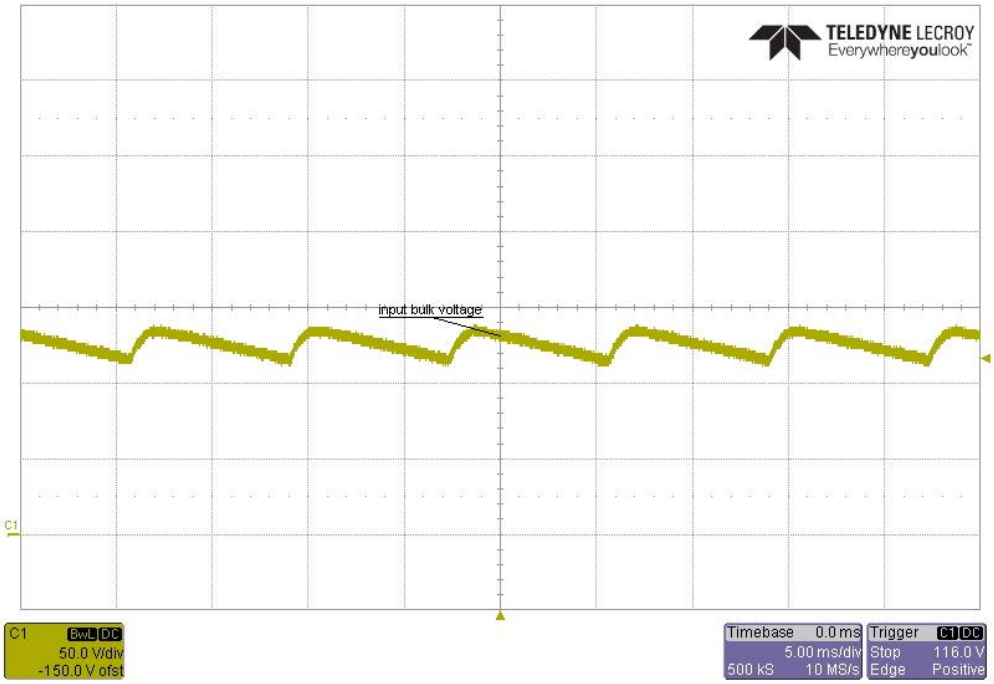


Input voltage = 273VAC
Load step = 0A to 3A

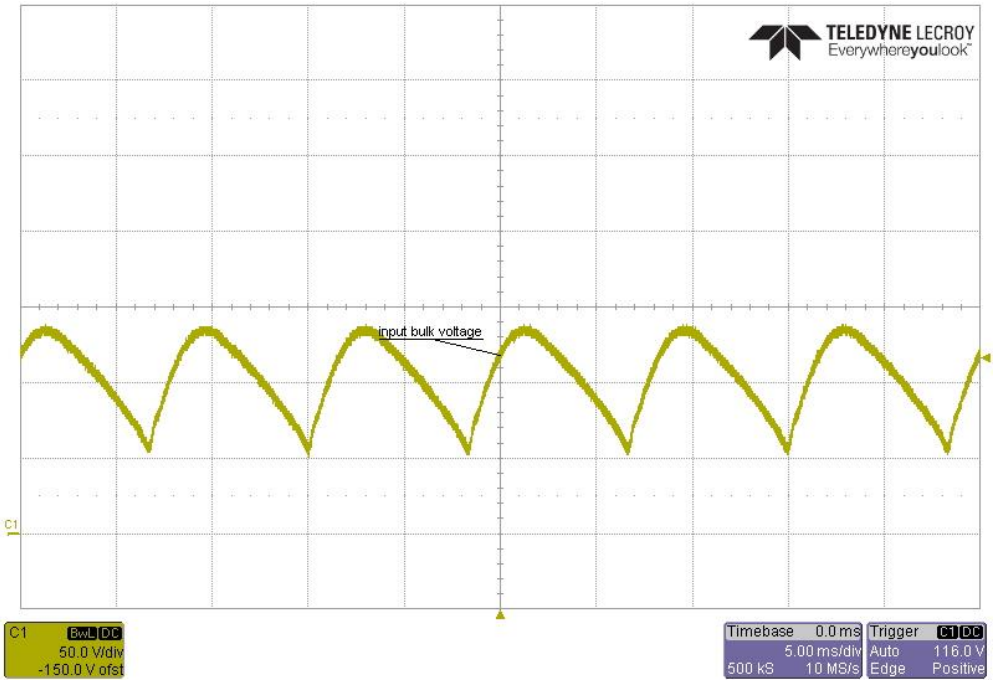


3.6 Input ripple Voltage

Input voltage = 96VAC
Load current = 0.75A

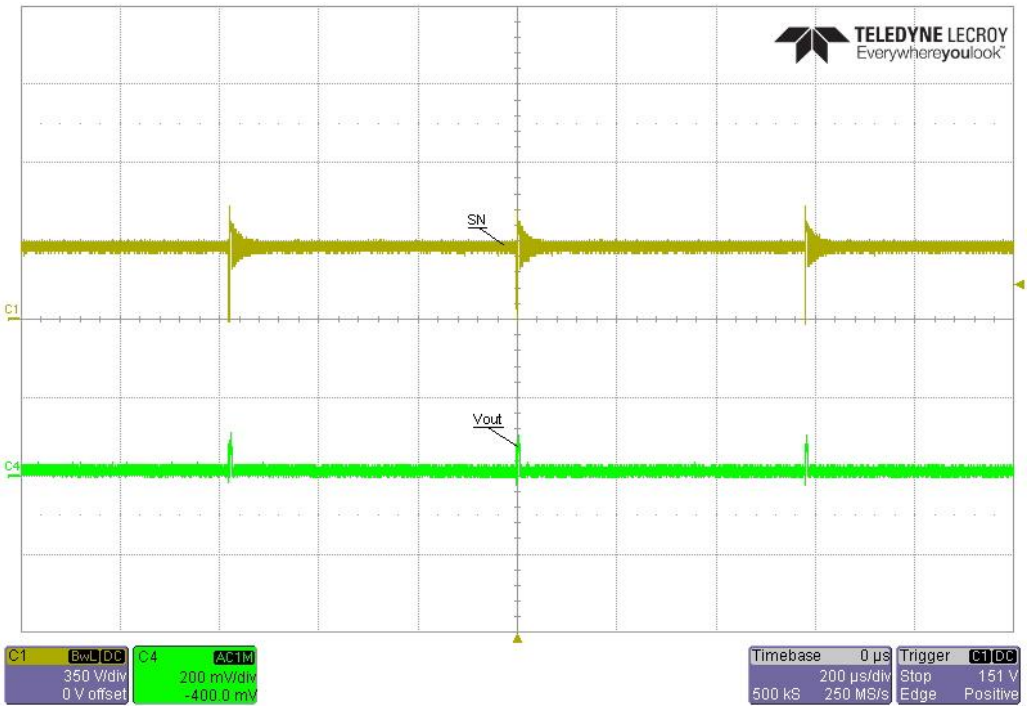


Input voltage = 96VAC
Load current = 3A

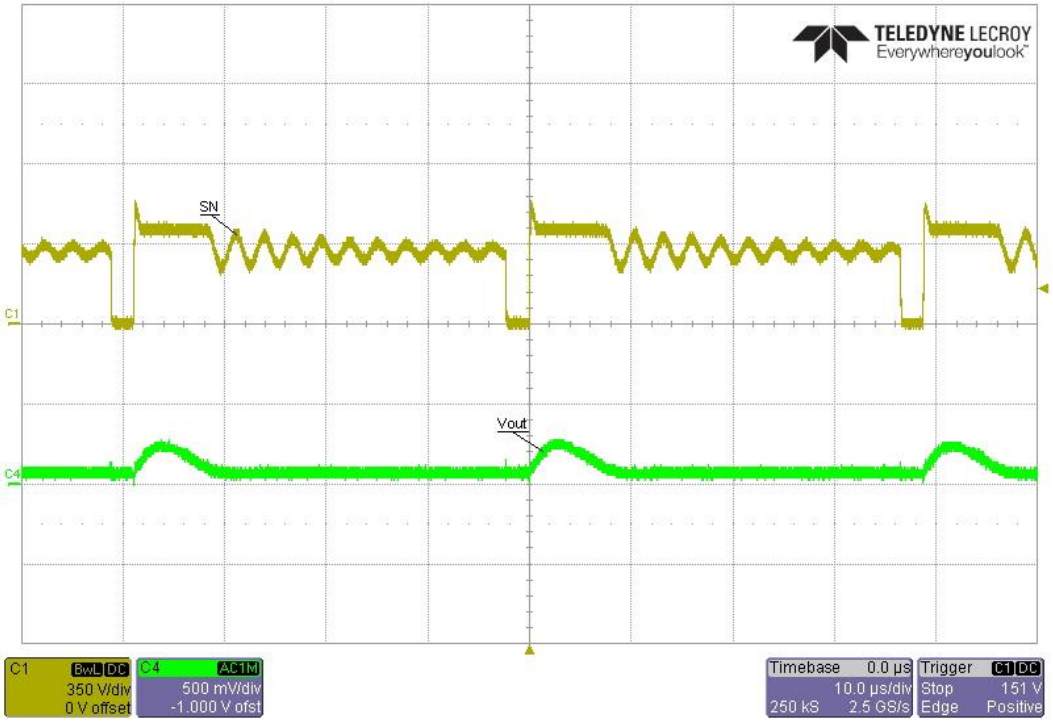


3.7 Output Ripple Voltage

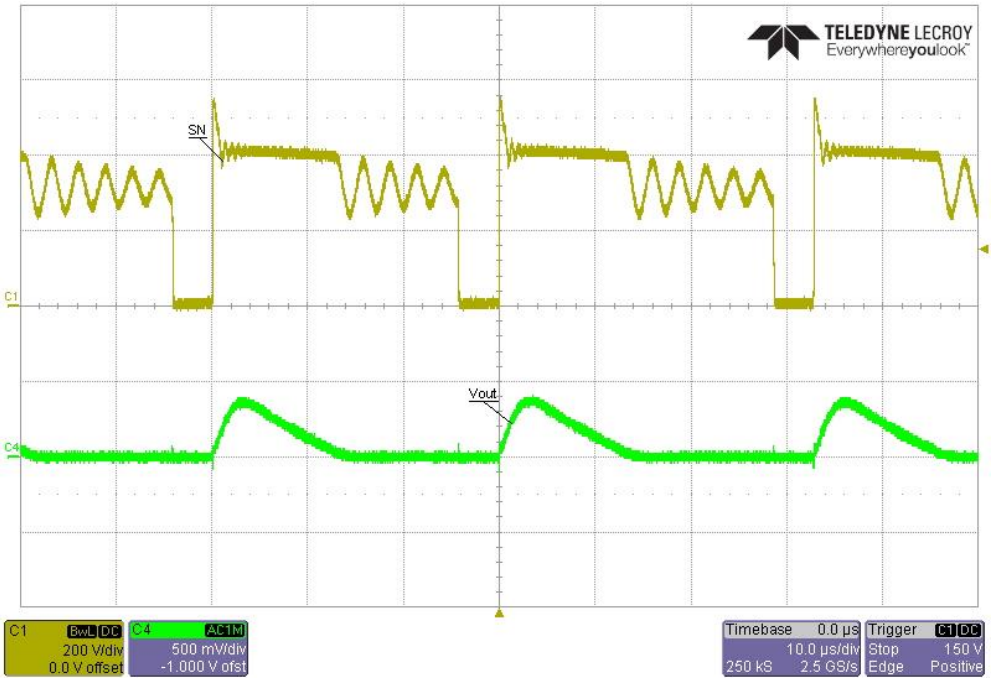
Input voltage = 230VAC
Load current = 0A



Input voltage = 230VAC
Load current = 0.75A



Input voltage = 230VAC
Load current = 3A



IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), 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, 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 (https:www.ti.com/legal/termsofsale.html) 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.

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