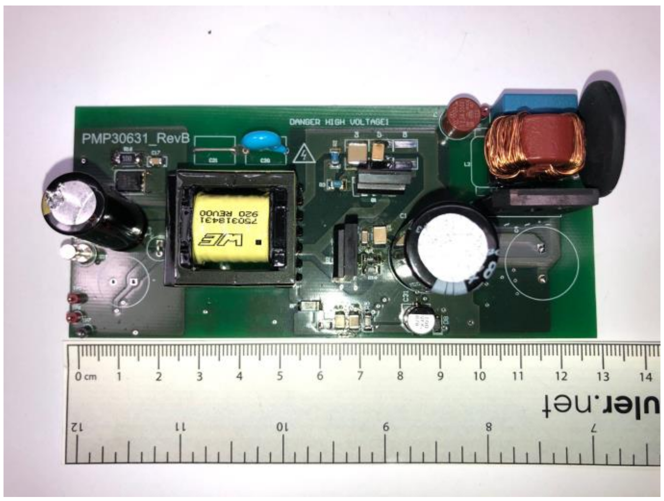
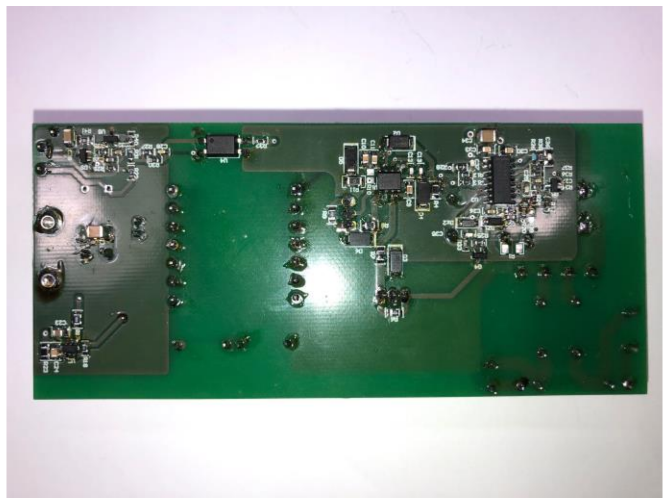
Test Report: PMP30631

High Efficiency, 70-W AC/DC Active Clamp Flyback Reference Design

Description

The PMP30631 uses the UCC28780 active clamp flyback controller to generate an isolated output of 20 V @ 3.5 A over an input voltage rage of 90 Vac to 264 Vac. The design also uses the UCC24612 synchronous rectifier controller on the secondary side. Zero voltage switching (ZVS) ensures high efficiency over a wide operating range.





1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input	90VAC – 265VAC
Output Voltage	20V
Output Power	70W

1.2 Dimensions

129 mm x 58 mm

1.3 *Considerations**

General Texas Instruments High Voltage Evaluation (TI HV EVM) User Safety Guidelines

WARNING:

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and those working around you. Contact TI's Product Information Center http://support/ti./com for further information.

Save all warnings and instructions for future reference.

Failure to follow warnings and instructions may result in personal injury, property damage or death due to electrical shock and burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise and knowledge of electrical safety risks in development and application of high voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments. If you are not suitable qualified, you should immediately stop from further use of the HV EVM.

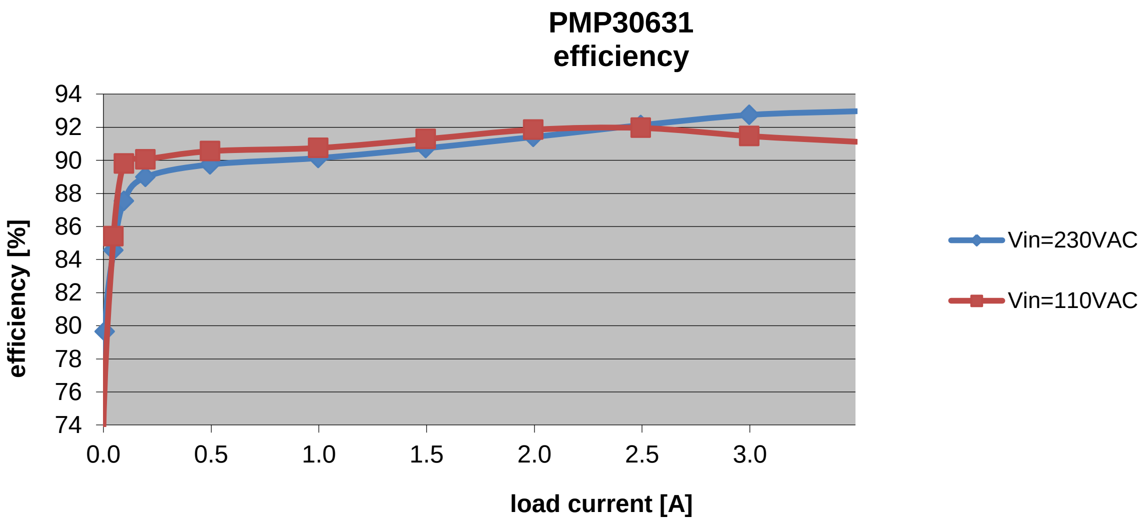
1. Work Area Safety:
a. Keep work area clean and orderly.
b. Qualified observer(s) must be present anytime circuits are energized.
c. Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access i
d. All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding
50Vrms/75VDC must be electrically located within a protected Emergency Power Off
EPO protected power strip.
e. Use stable and non conductive work surface.
f. Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.

2. Electrical safety:
As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.
a. De-energize the TI HV EVM and all its inputs, outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that TI HV EVM
power has been safely de-energized.
b. With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
c. Once EVM readiness is complete, energize the EVM as intended.

WARNING: WHILE THE EVM IS ENERGIZED, NEVER TOUCH THE EVM OR ITS ELECTRICAL CIRCUITS AS THEY COULD BE AT HIGH VOLTAGES CAPABLE OF CAUSING ELECTRICAL SHOCK HAZARD.

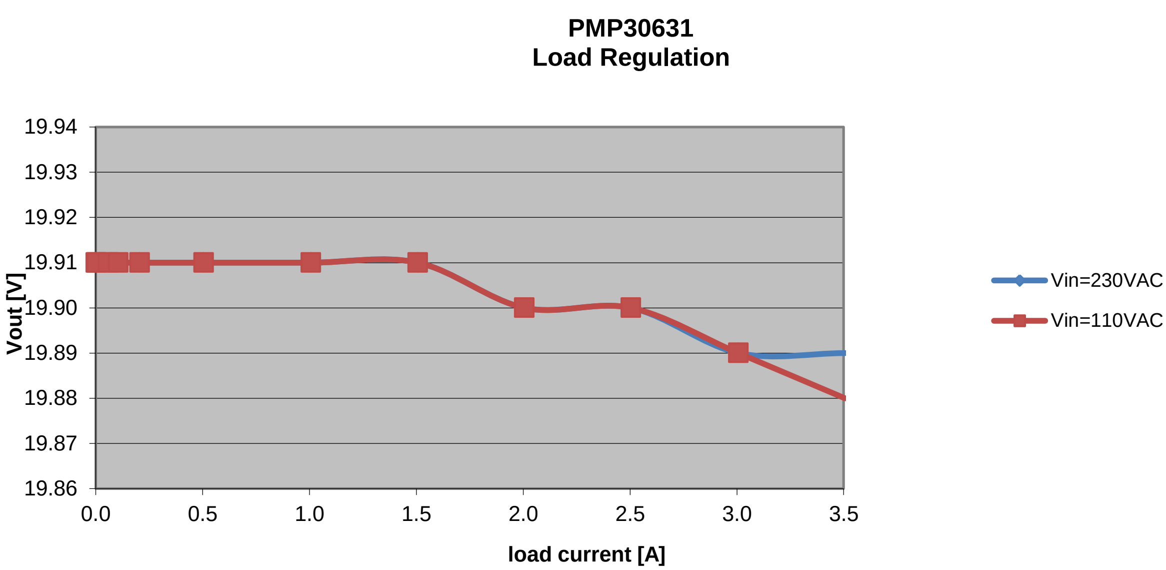
3. Personal Safety
a. Wear personal protective equipment e.g. latex gloves or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.
Limitation for safe use:
EVMs are not to be used as all or part of a production unit.

1.4 Efficiency Graphs



The NTC “RT1” was shorted for the efficiency measurements.

1.5 Load Regulation



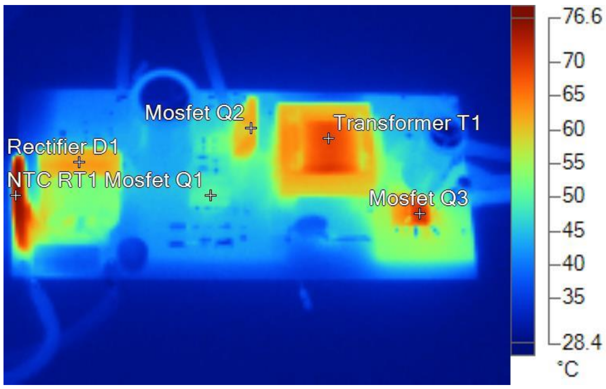
1.6 Short Circuit Recovery

Vin = 110VAC -> Output Overcurrent Protection = 3.9A
Vin = 230VAC -> Output Overcurrent Protection = 4.1A

1.7 Thermal Images

The images below show the infrared images taken from the FlexCam after 15min at full load output power (20V@3.5A).

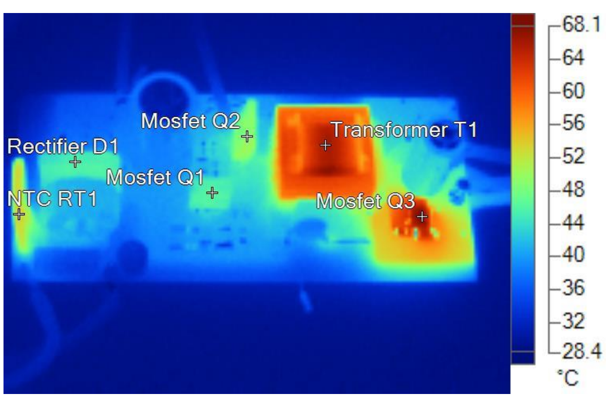
Input voltage = 110VAC
Load current = 3.5A
No airflow



Vin=110VAC 20V@3.5A.is2

Name	Temperature	
NTC RT1	76.6°C	
Rectifier D1	62.7°C	
Mosfet Q1	49.8°C	
Mosfet Q2	60.8°C	
Transformer T1	69.1°C	
Mosfet Q3	71.8°C	

Input voltage = 230VAC
Load current = 3.5A
No airflow



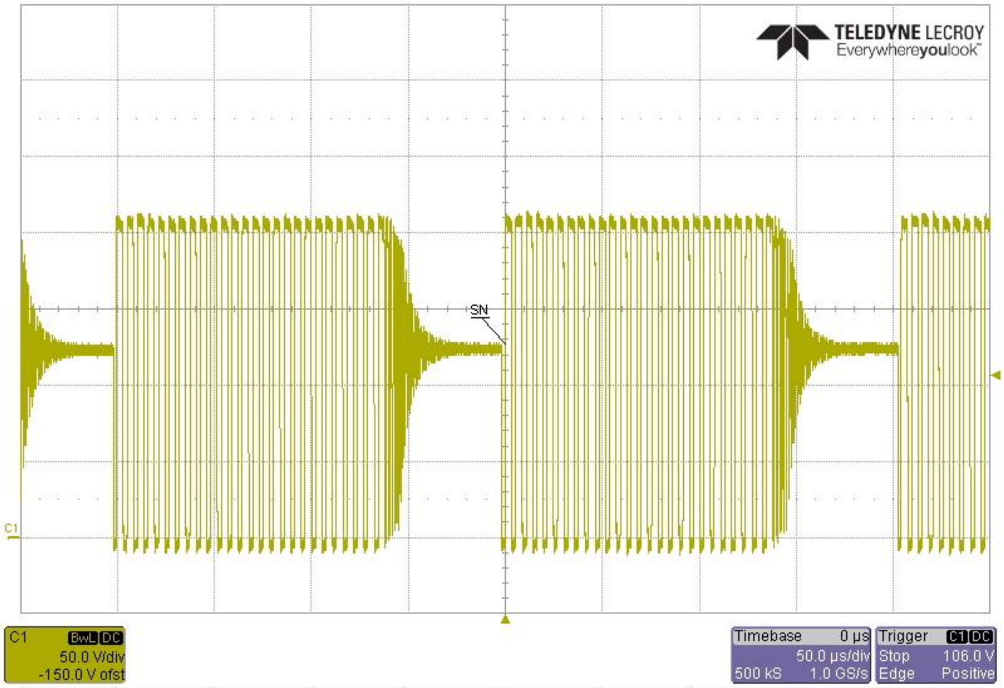
Vin=230VAC 20V@3.5A.is2

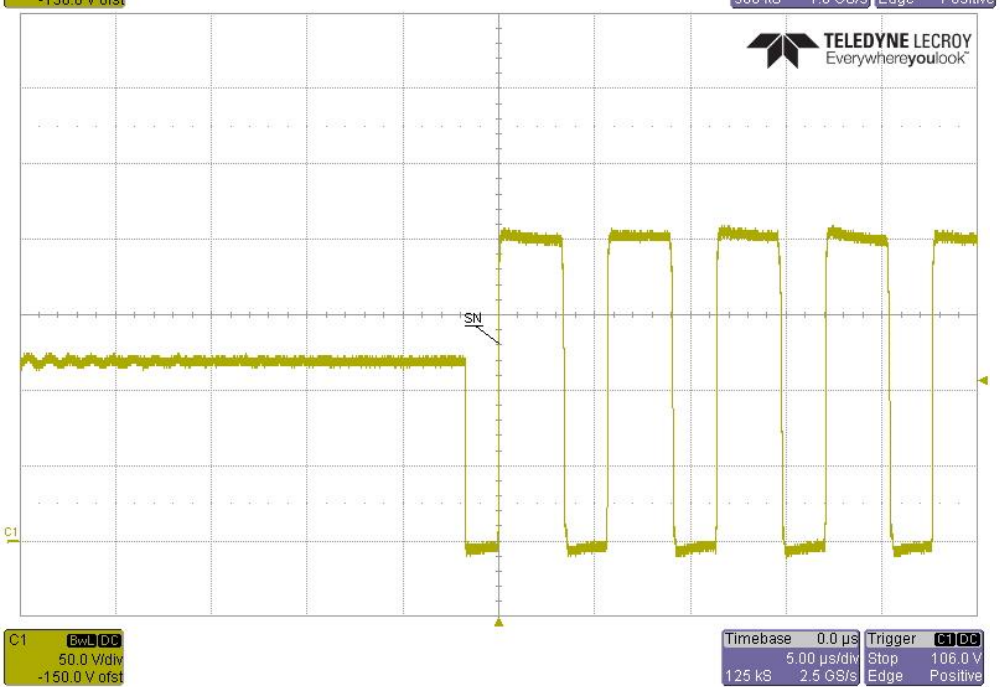
Name	Temperature	
Transformer T1	66.1°C	
Mosfet Q3	68.1°C	
Rectifier D1	45.5°C	
NTC RT1	53.4°C	
Mosfet Q1	46.4°C	
Mosfet Q2	49.6°C	

2 Waveforms

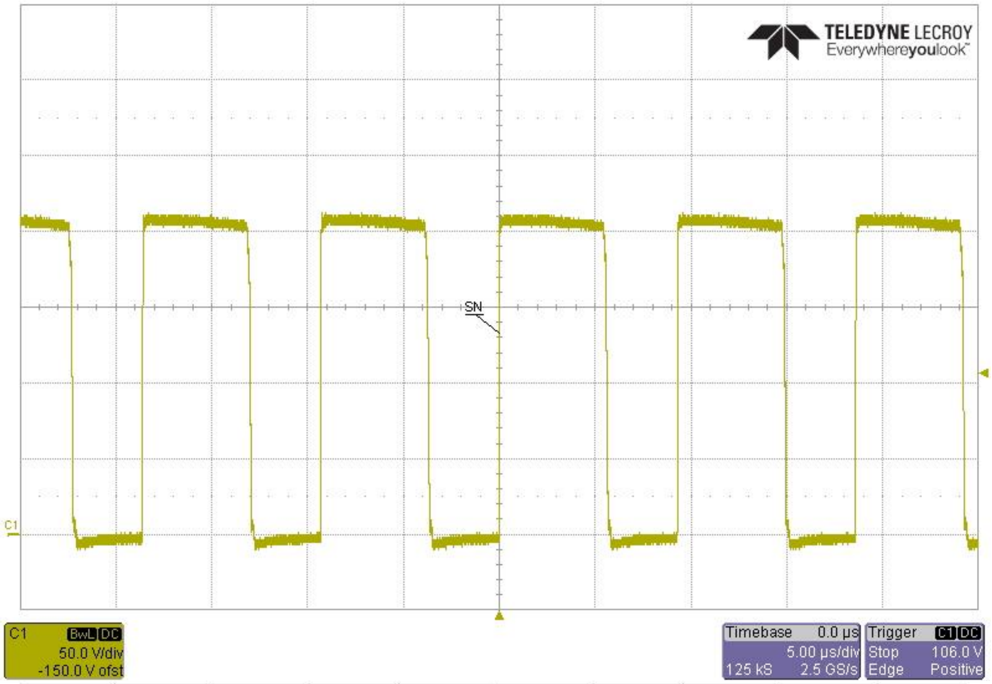
2.1 Switch Node low line

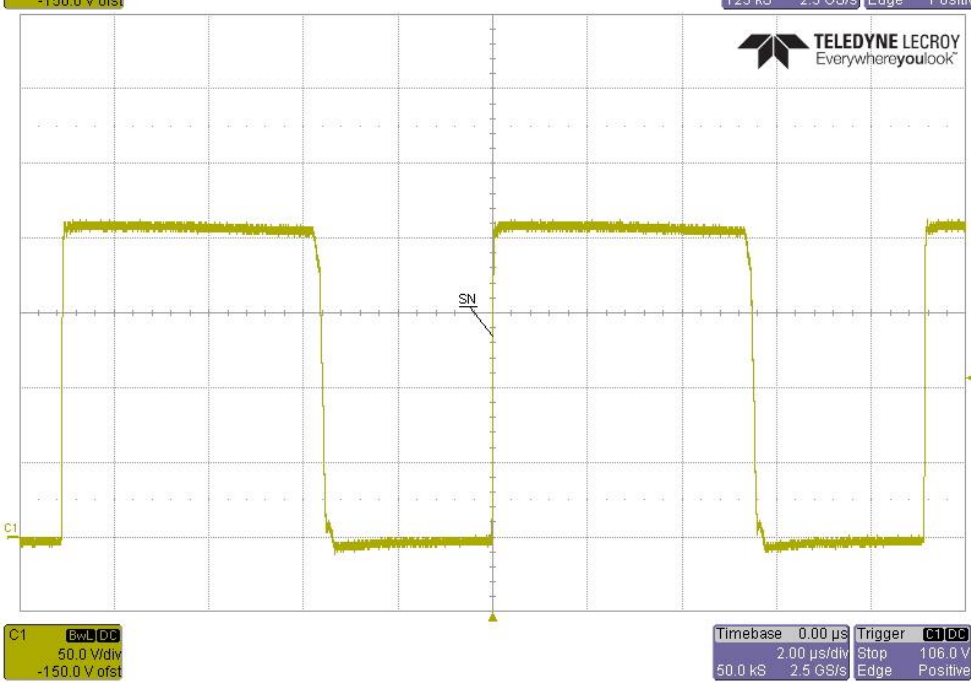
Input Voltage = 90VAC
Load current = 1A





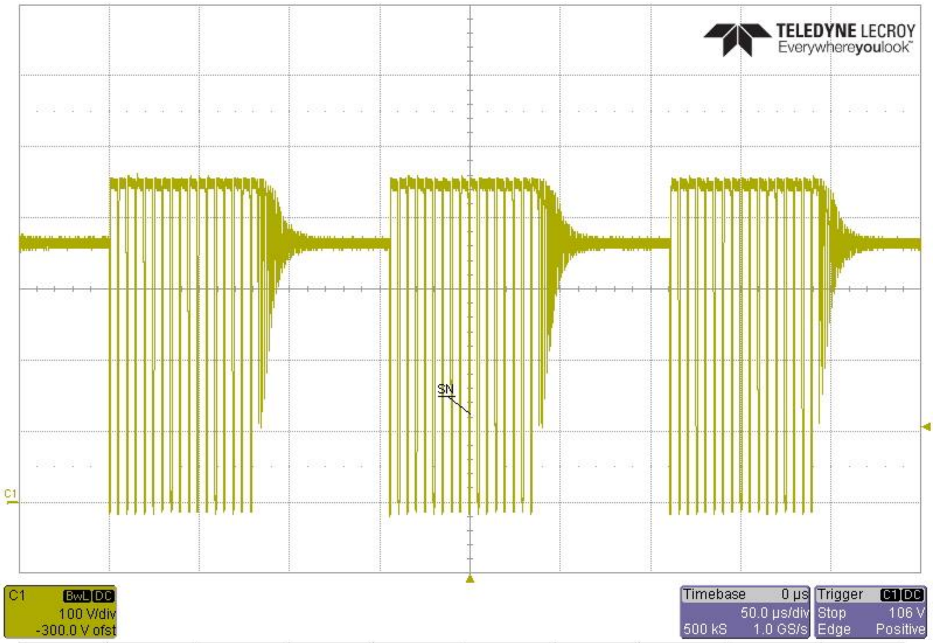
Input Voltage = 90VAC
Load current = 3.5A

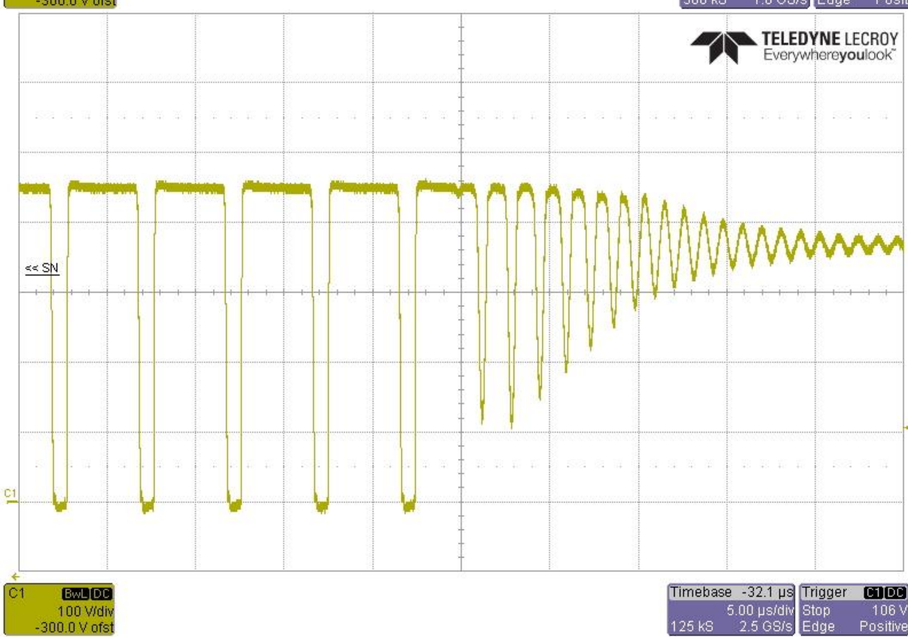




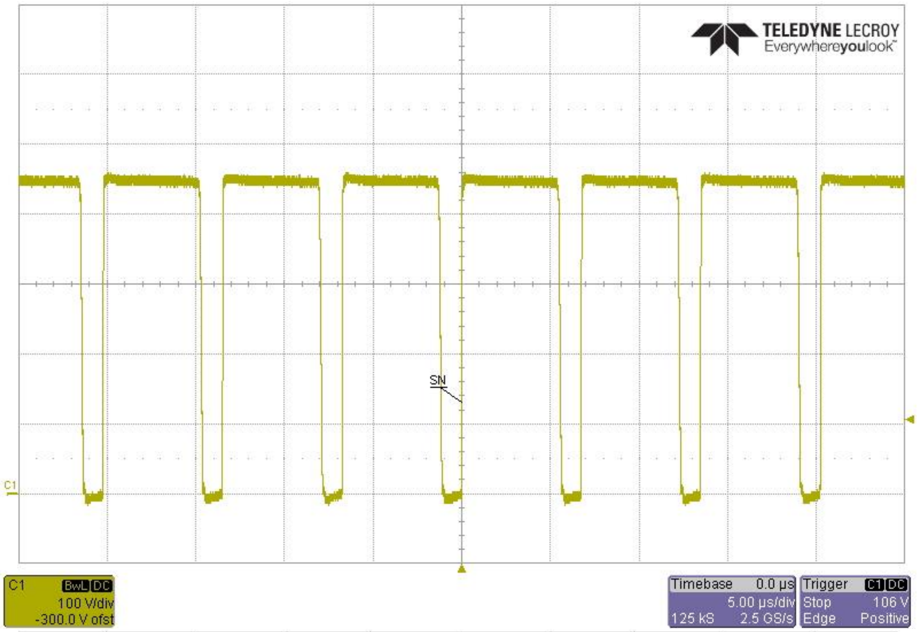
2.2 Switch Node High Line

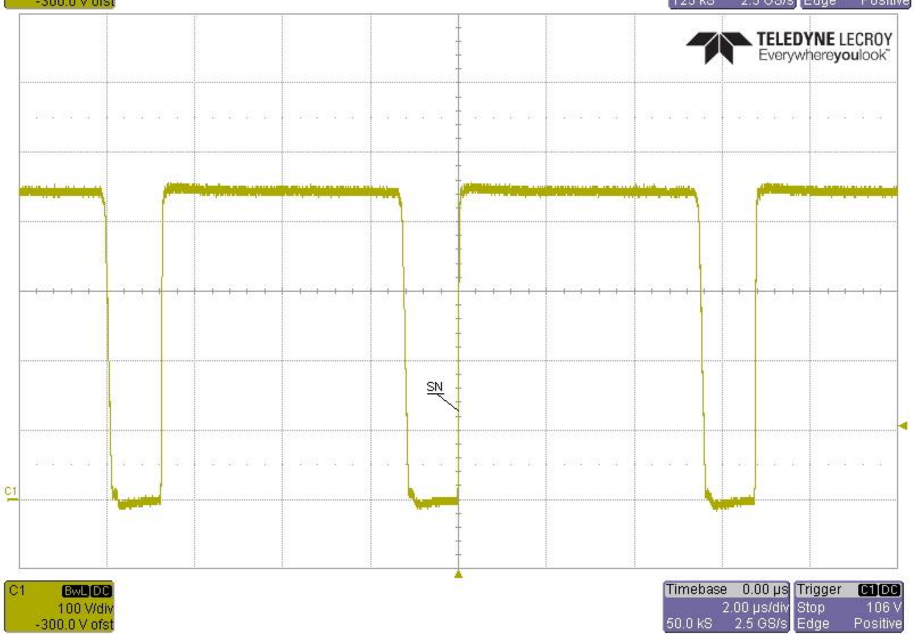
Input Voltage = 265VAC
Load current = 1A





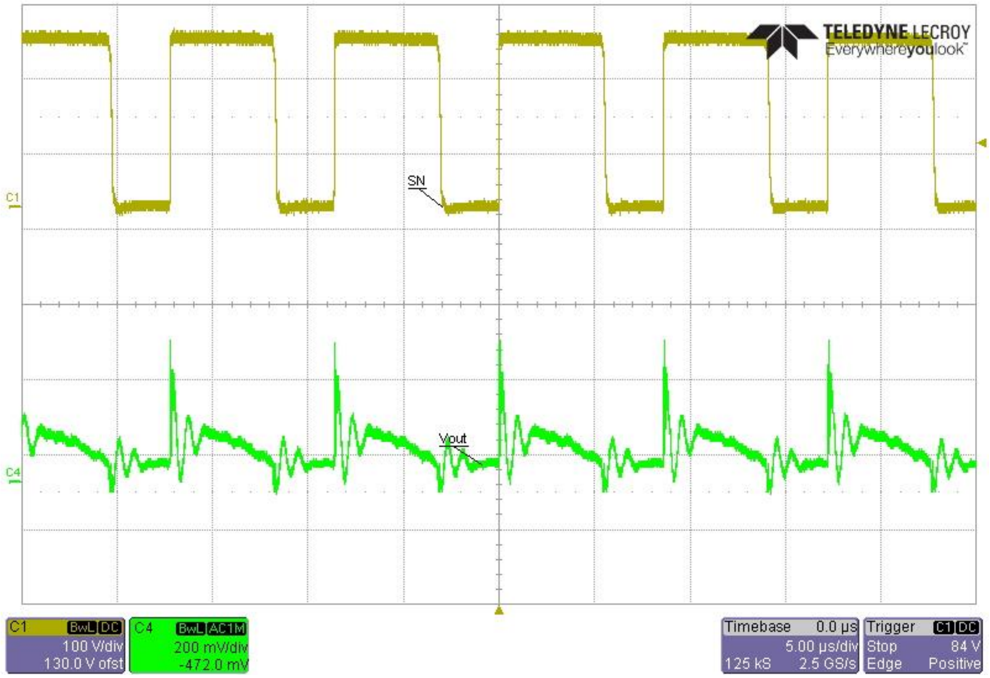
Input Voltage = 265VAC
Load current = 3.5A



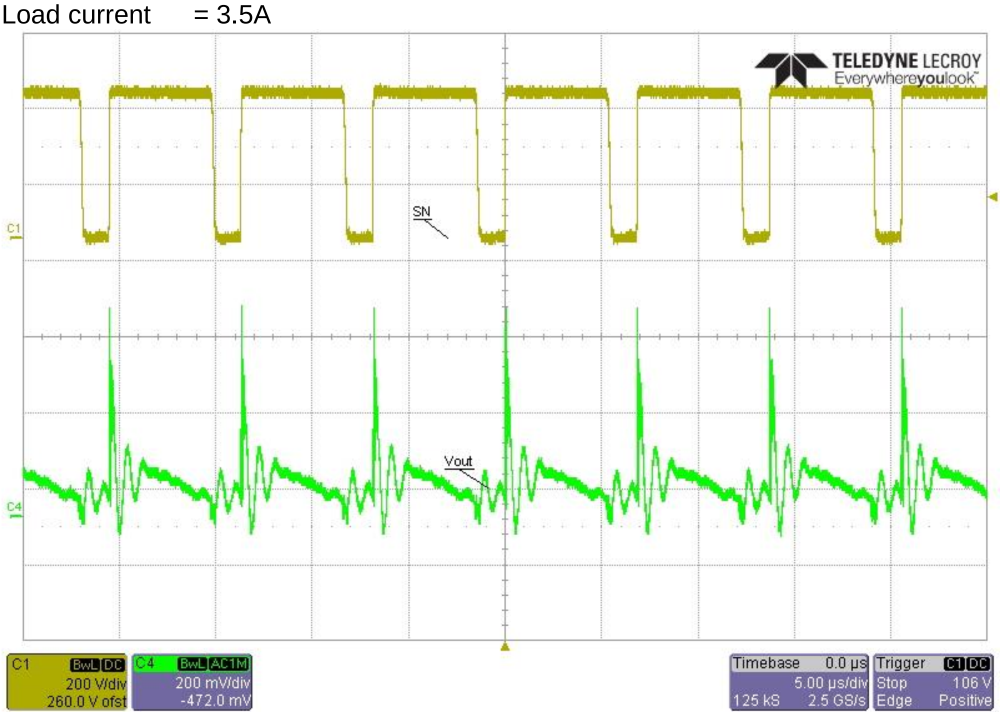


2.3 Output Voltage Ripple

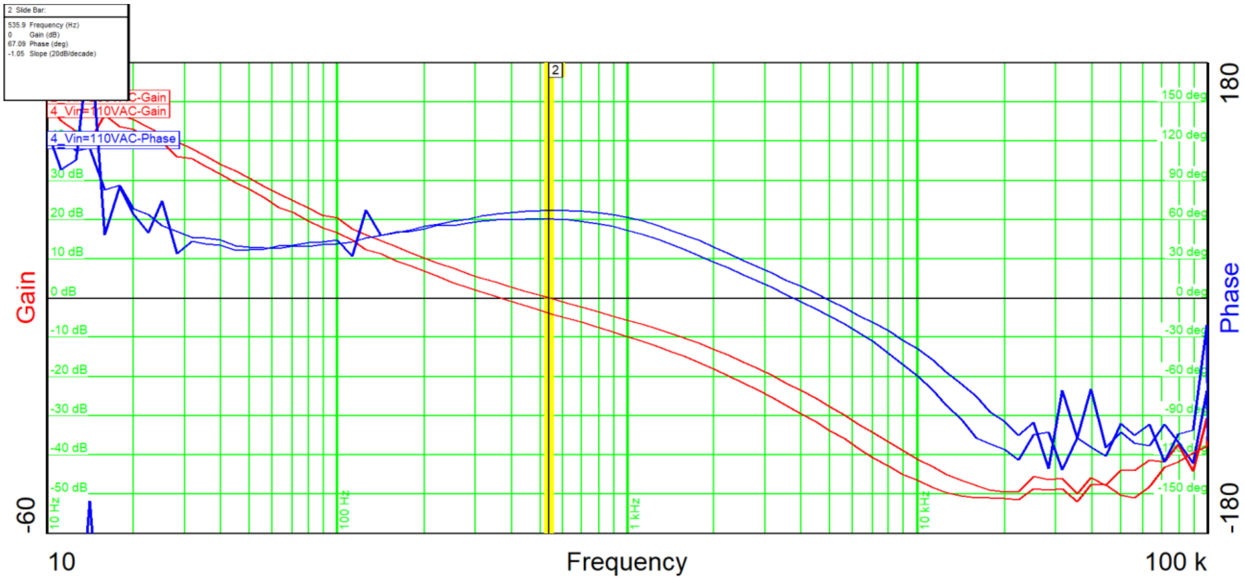
Input Voltage = 110VAC
Load current = 3.5A



Input Voltage = 230VAC
Load current = 3.5A



2.4 Bode Plot

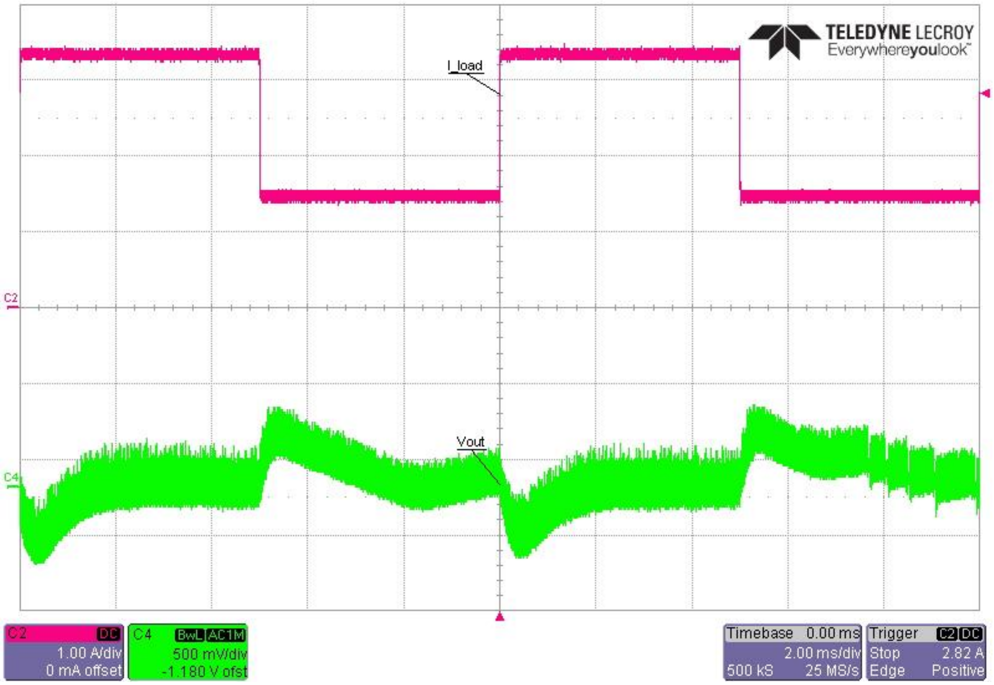


Input Voltage = 110VAC
Load = 3.5A
Bandwidth = 0.4kHz
Phase Margin = 60°

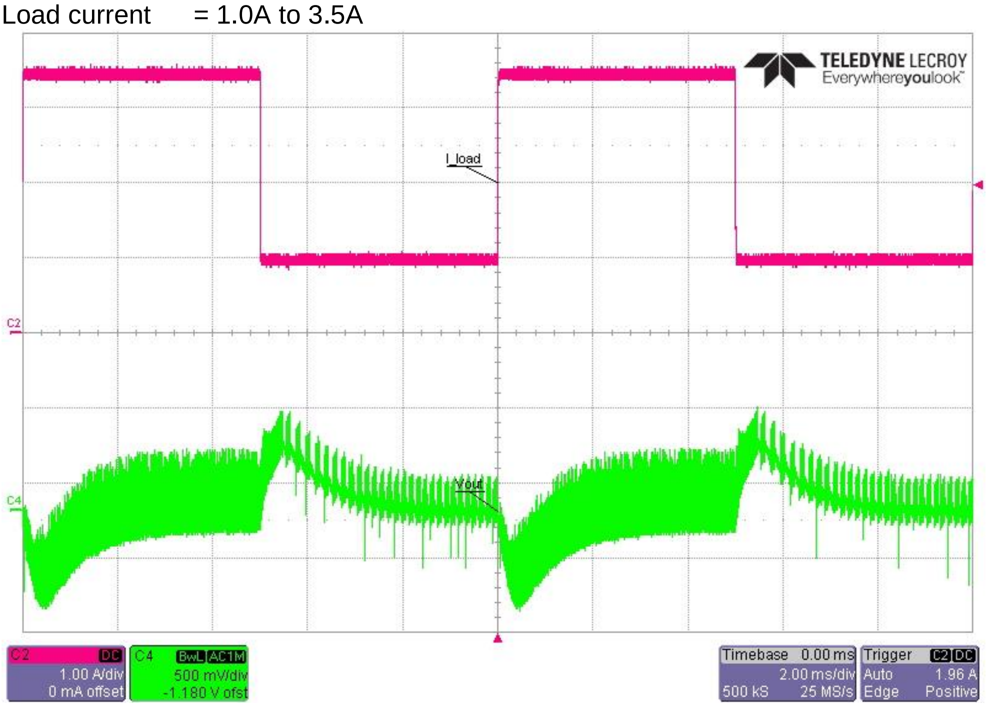
Input Voltage = 230VAC
Load = 3.5A
Bandwidth = 0.5kHz
Phase Margin = 67°

2.5 Load Transients

Input Voltage = 110VAC
Load current = 1.5A to 3.5A



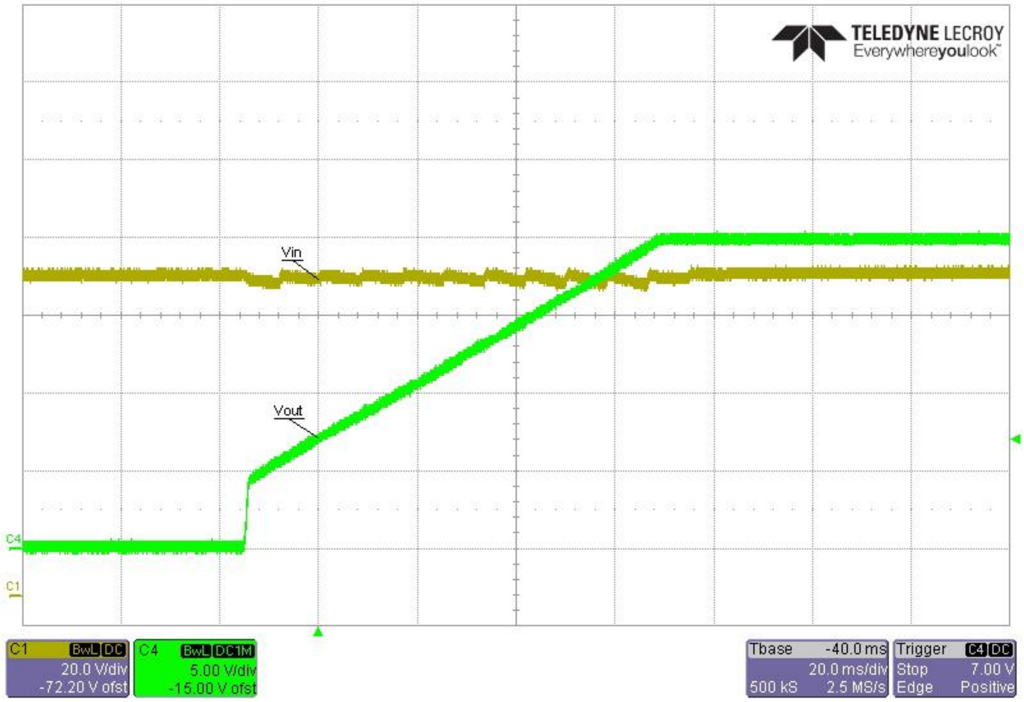
Input Voltage = 230VAC
Load current = 1.0A to 3.5A



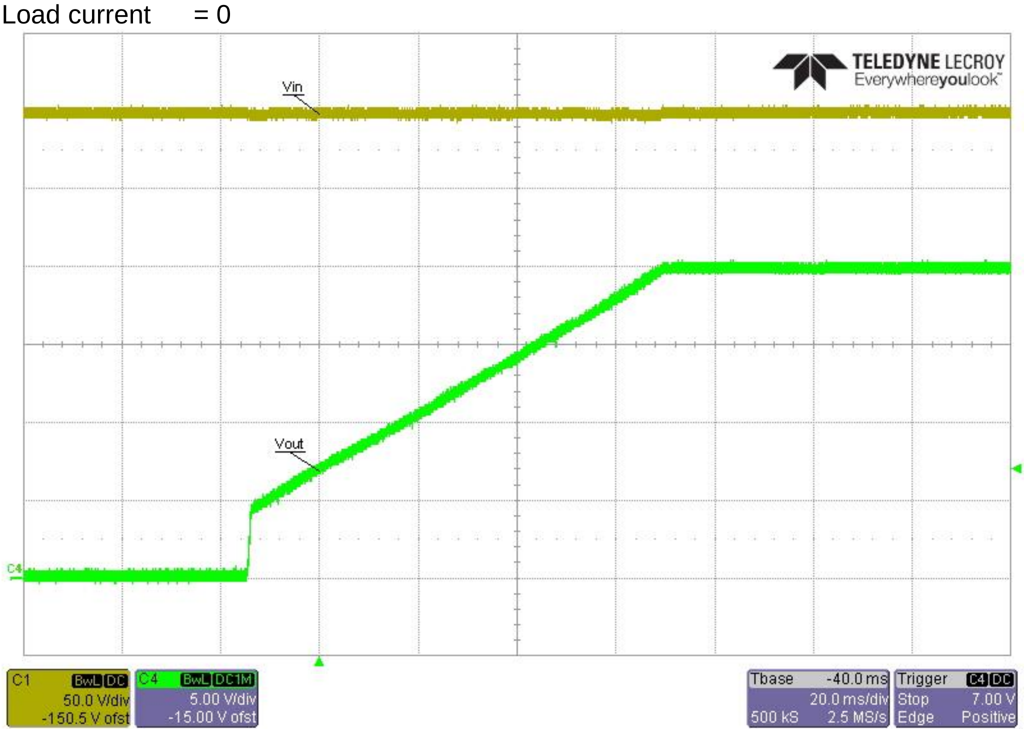
2.6 Start-up

2.6.1 no load

Input Voltage = 90VAC
Load current = 0

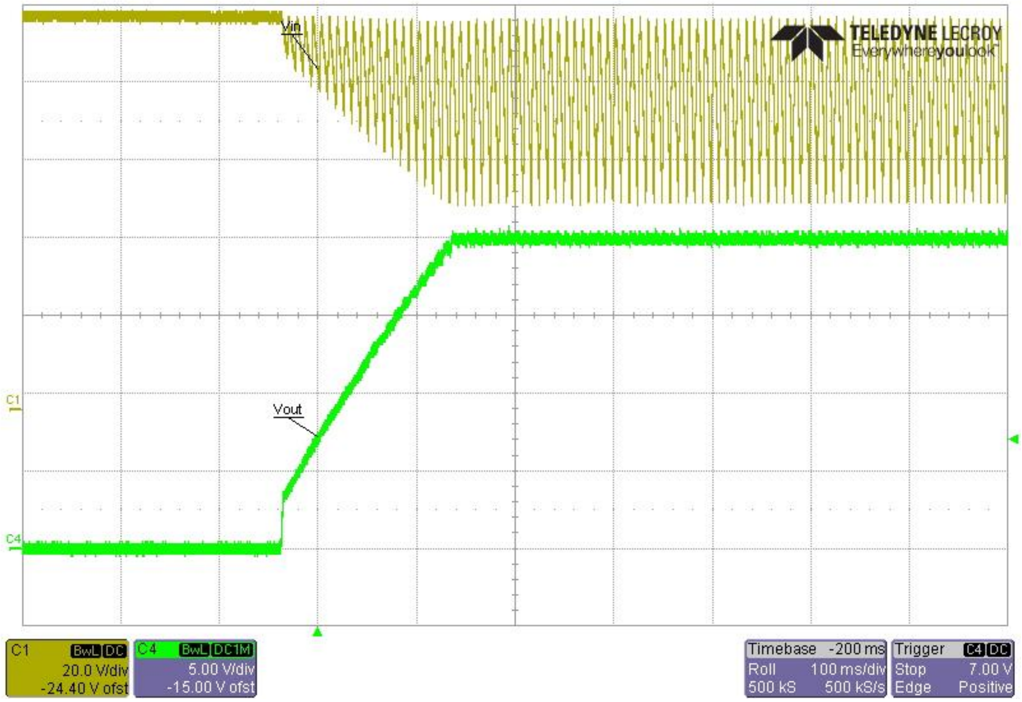


Input Voltage = 265VAC
Load current = 0

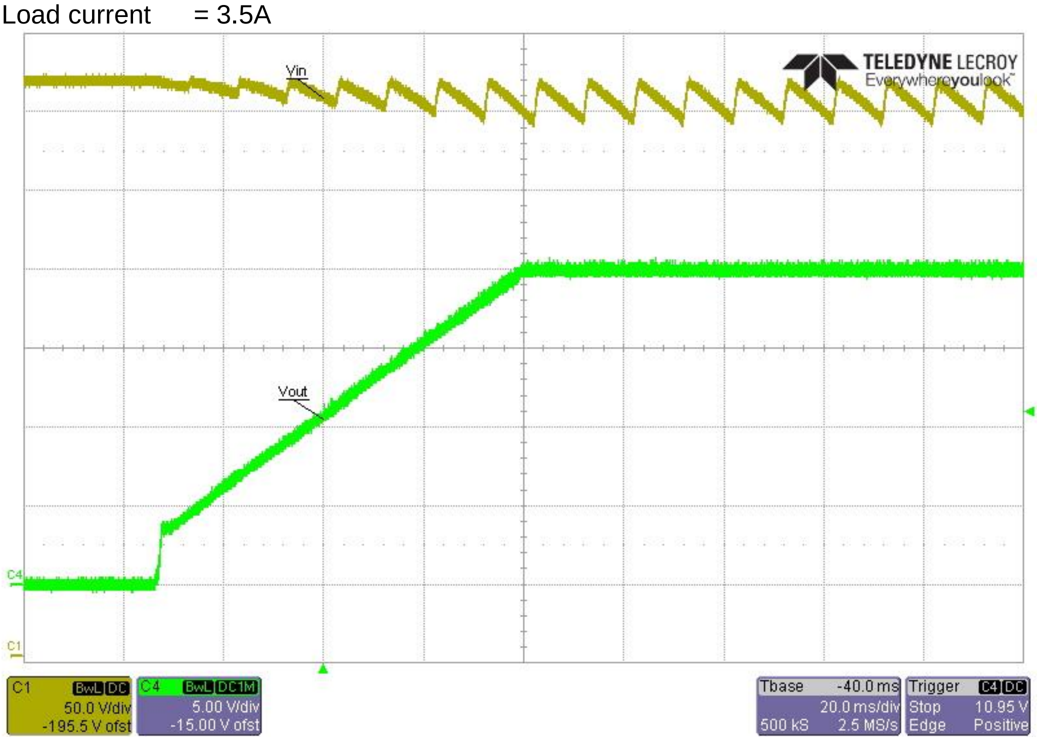


2.6.2 full load

Input Voltage = 90VAC
Load current = 3.5A

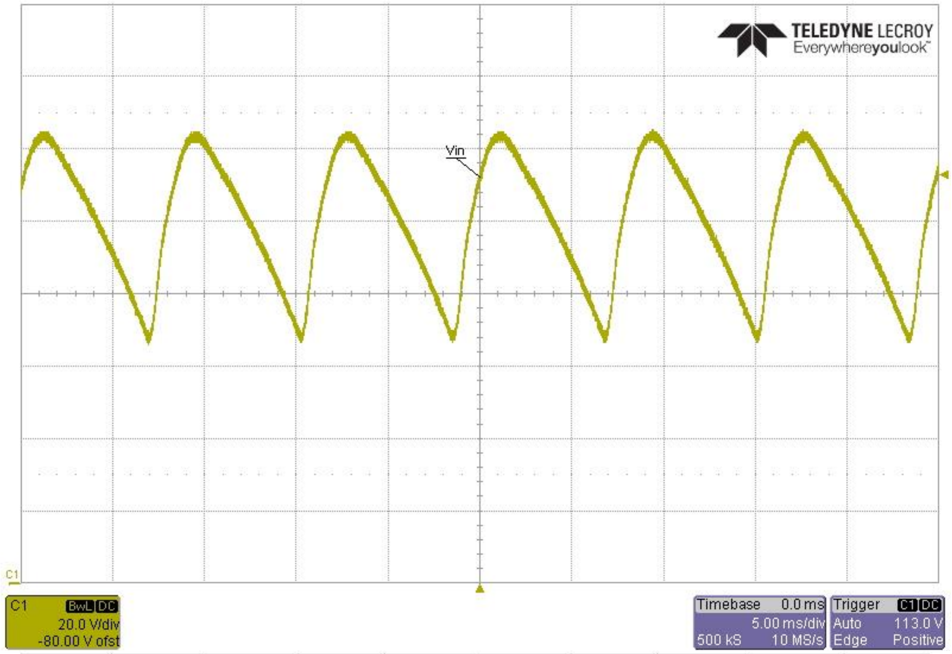


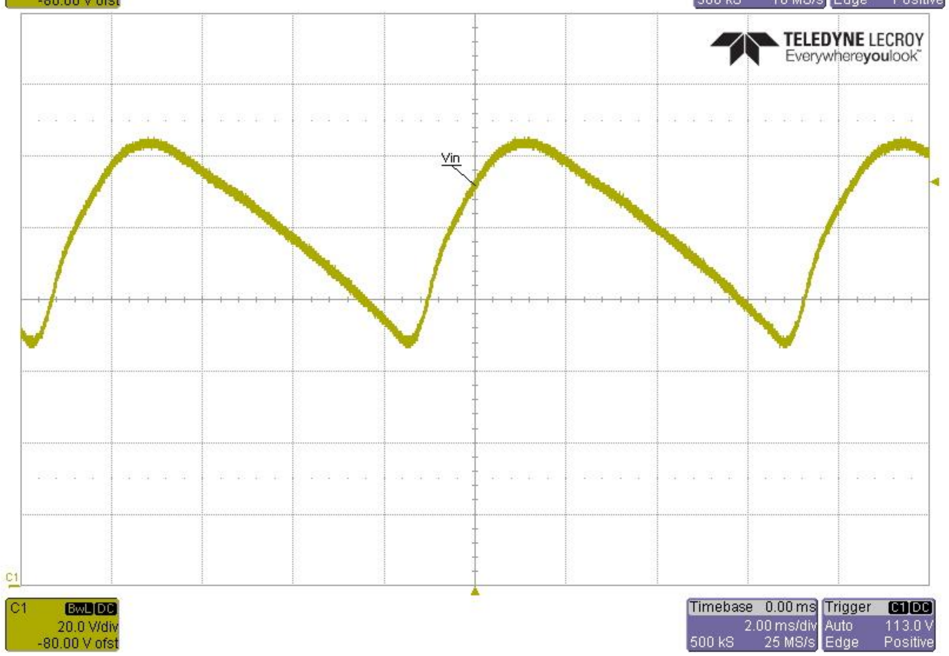
Input Voltage = 265VAC
Load current = 3.5A



2.7 Input Voltage Ripple

Input Voltage = 90VAC
Load current = 3.5A

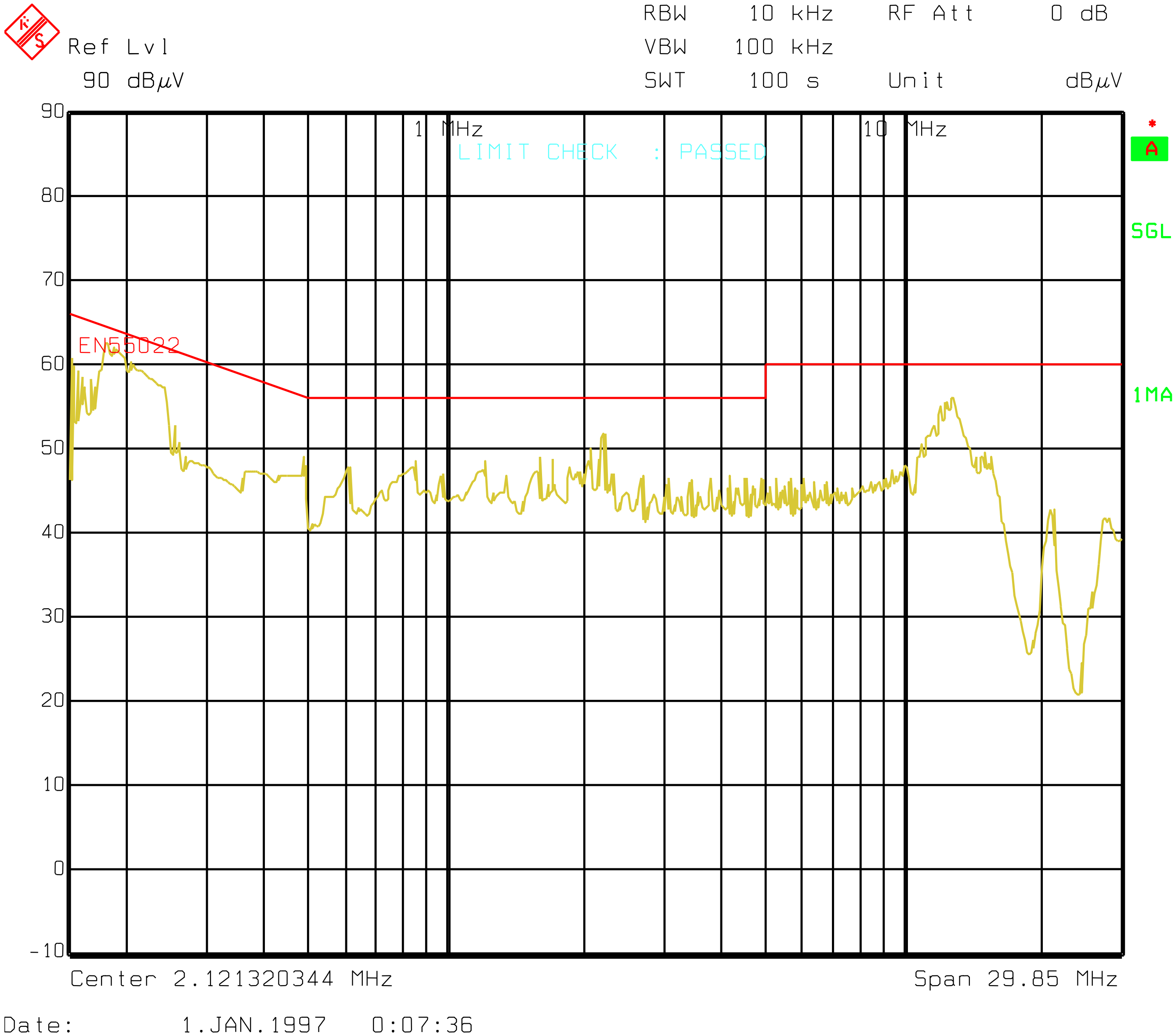




2.8 EMI Measurment

The graph below shows the conducted emission EMI noise and the EN55022 Class-B Quasi- Peak limits (measurement from the worst case line). The measurement is not certified. The board was connected to a LISN and an isolation transformer; the load was a power resistor. The receiver was set to Quasi-peak detector, 10 KHz bandwidth. The negative terminal of the converter has been connected to the ground of the LISN.

Input Voltage = 110VAC
Load current = 3.5A



Input Voltage = 230VAC
Load current = 3.5A