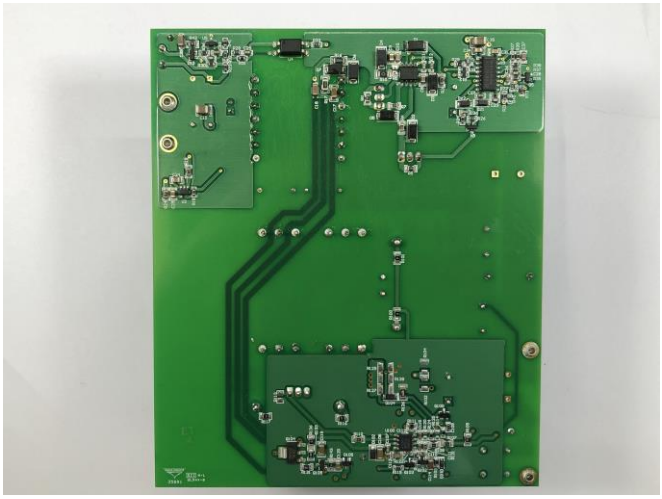
Test Report: PMP30720
High Efficiency, Ultra-Wide Input (20 VDC to 375 VDC) Isolated Power Supply Reference Design

Description

The PMP30720 uses the UCC28C42 boost controller and the UCC28780 active clamp flyback controller to generate an isolated output of 24 V @ 3.5 A over an ultra-wide input voltage rage of 20 V to 375 V. 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	20VDC – 375VDC
Output Voltage	24V
Output Power	84W

1.2 Dimensions

137 mm x 116 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.

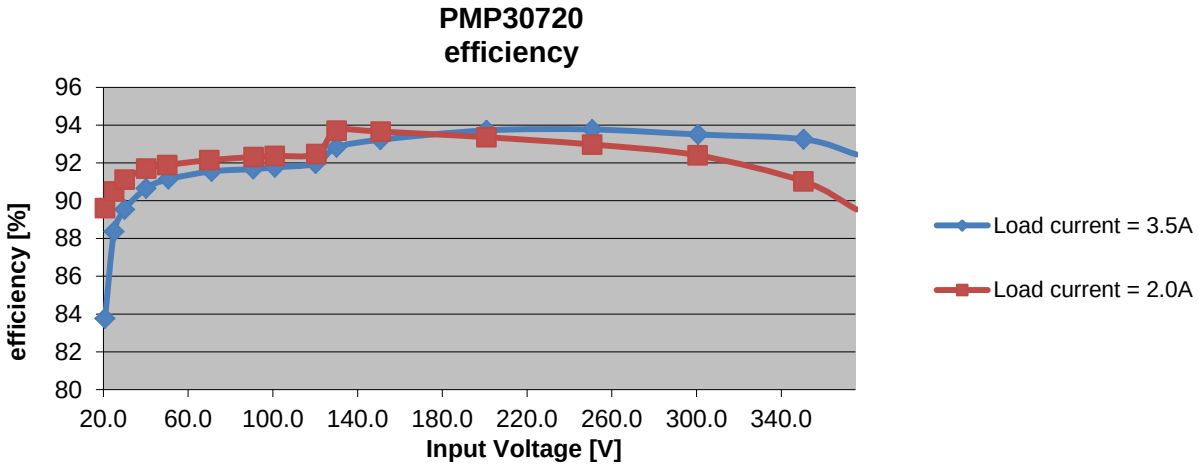
2. Electrical safety:
As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.
a. De-energize the TI HV EVM and all its inputs, outputs and electrical loads before performing any electrical or other diagnostic 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.

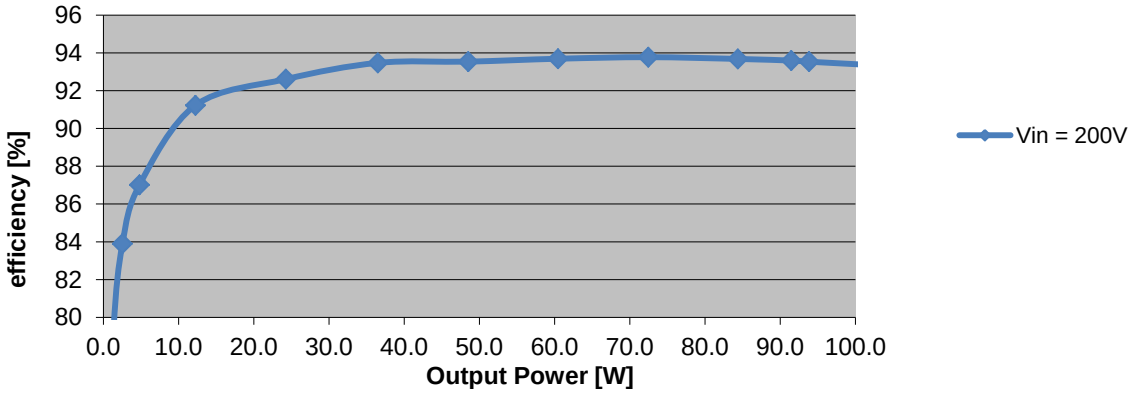
WARNING: WHILE THE EVM IS ENERGIZED, NEVER TOUCH THE EVM OR ITS ELECTRICAL CIRCUITS AS THEY COULD BE AT HIGH VOLTAGES CAPABLE OF CAUSING ELECTRICAL SHOCK HAZARD.

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 RT100 was shorted for the efficiency measurements.

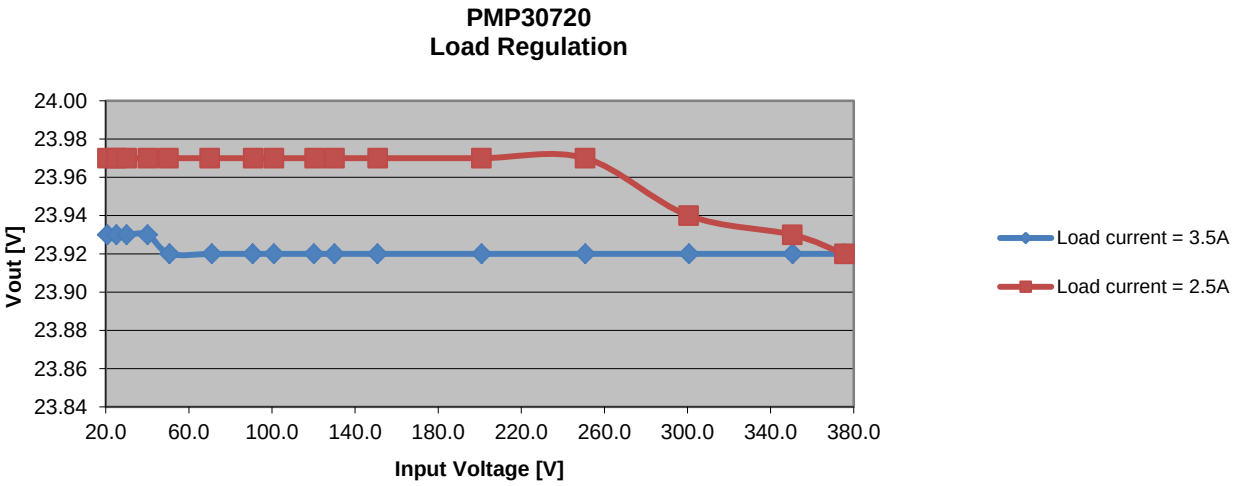




1.5 Short Circuit Recovery

Input voltage = 20VDC	->	Iload_shutdown = 3.87A
Input voltage = 375VDC	->	Iload_shutdown = 3.93A

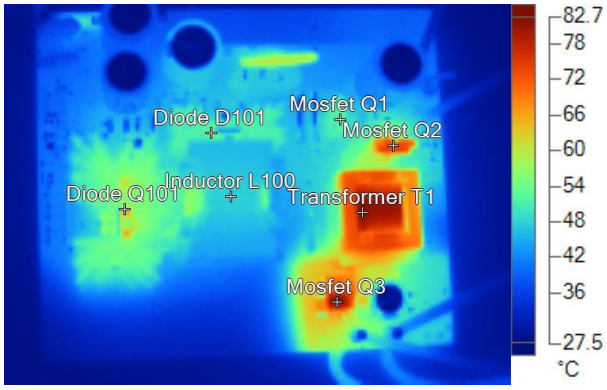
1.6 Load Regulation



1.7 Thermal Images

The images below show the infrared images taken from the FlexCam after 15min at full load output power (24V@3.5A).

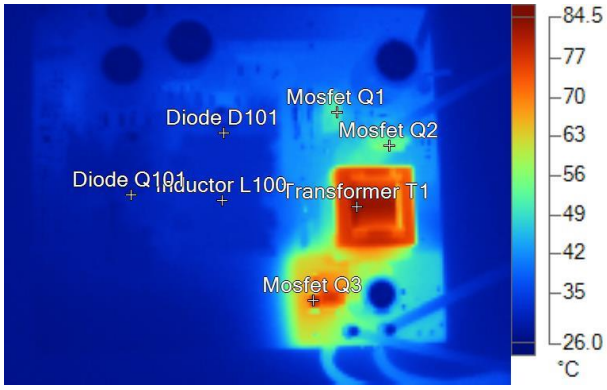
Input voltage = 20VDC
Load current = 3.5A
No airflow



1718_Vin=20V Iload=3.5A.is2

Name	Temperature	
Diode Q101	66.0°C	
Inductor L100	47.9°C	
Diode D101	52.8°C	
Transformer T1	82.6°C	
Mosfet Q3	82.5°C	
Mosfet Q2	74.4°C	
Mosfet Q1	52.5°C	

Input voltage = 375VDC
Load current = 3.5A
No airflow



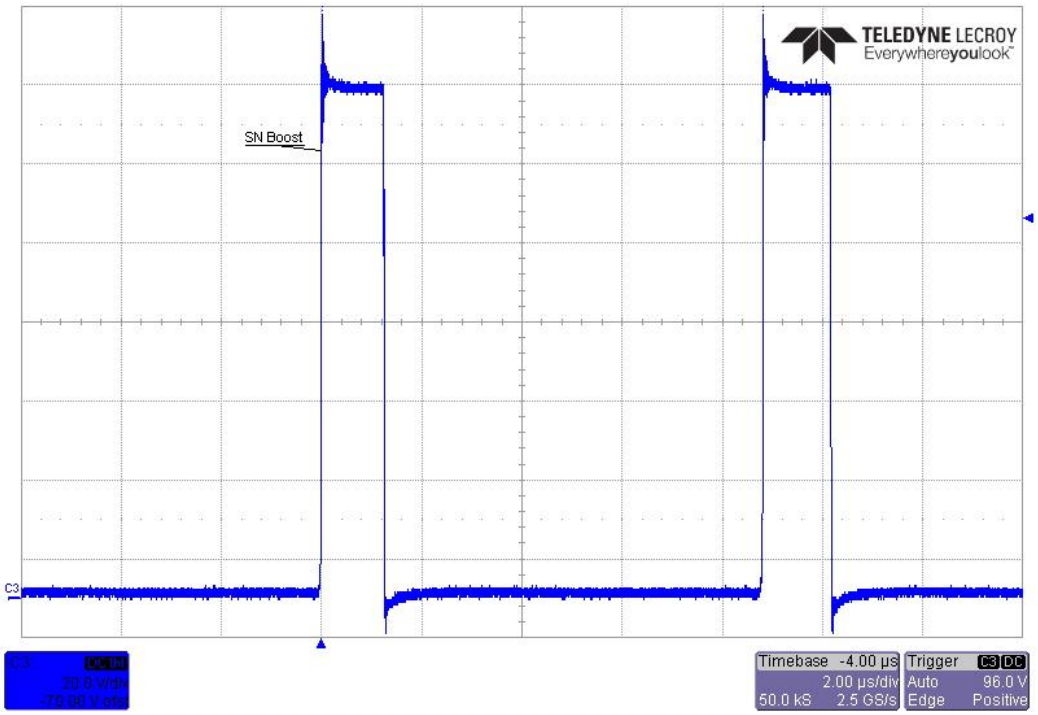
1717_Vin=375VDC Iload=3.5A.is2

Name	Temperature	
Mosfet Q1	51.7°C	
Mosfet Q2	55.3°C	
Transformer T1	84.4°C	
Mosfet Q3	79.9°C	

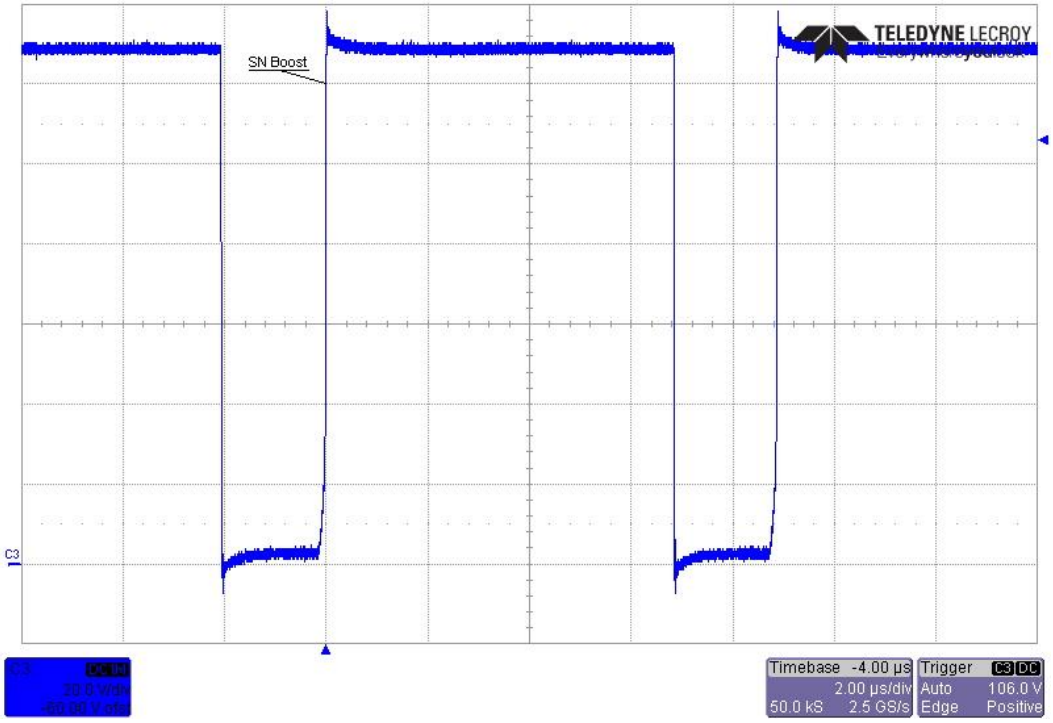
2 Waveforms

2.1 Switch Node Boost (U100)

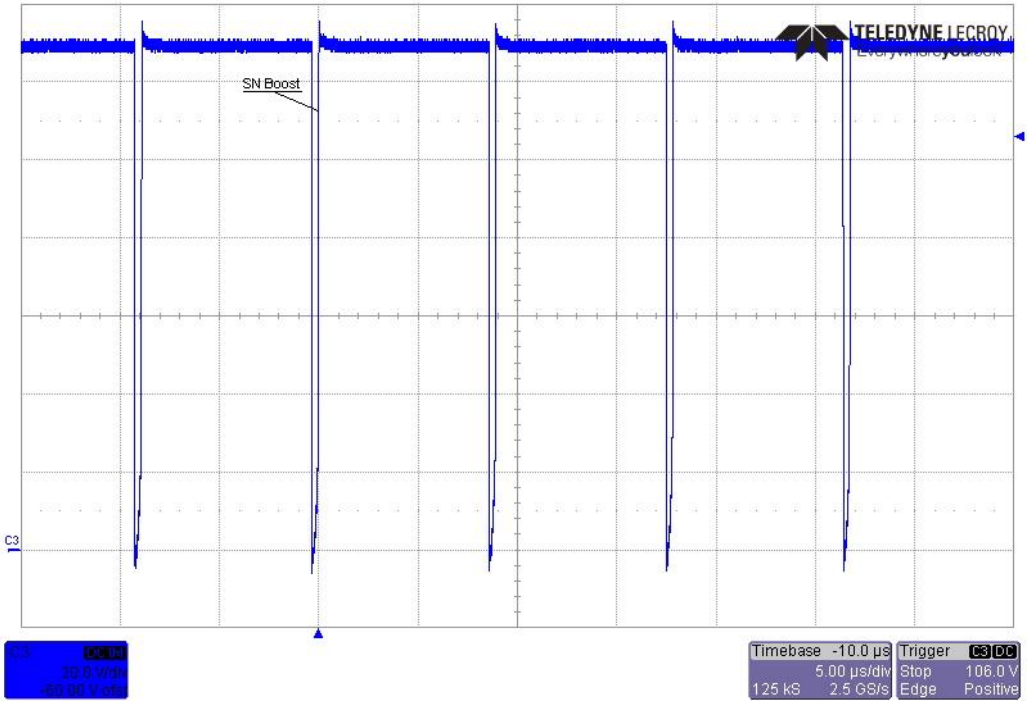
Input Voltage = 20VDC
Load current = 3.5A



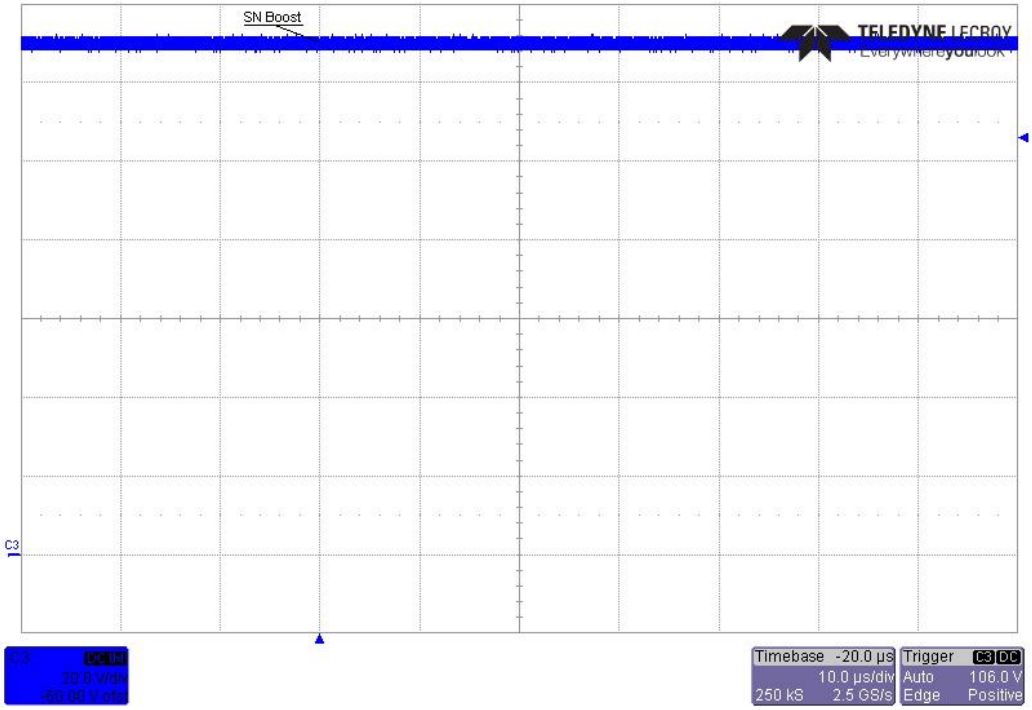
Input Voltage = 100VDC
Load current = 3.5A



Input Voltage = 125VDC
Load current = 3.5A

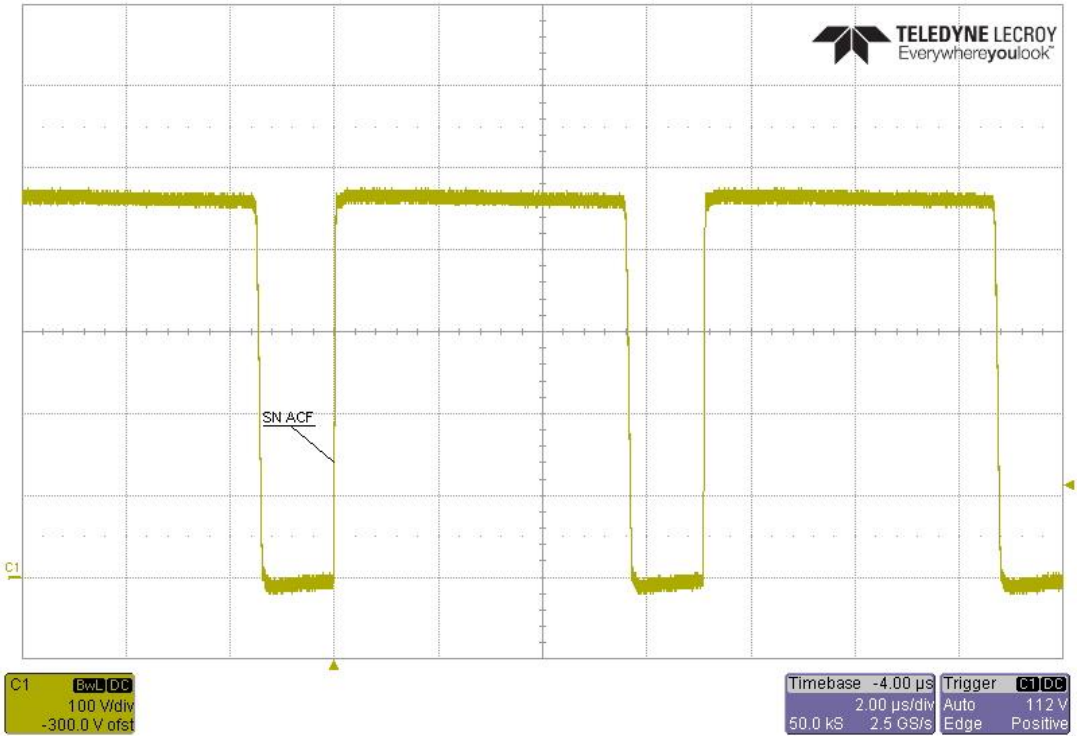


Input Voltage = 130VDC
Load current = 3.5A

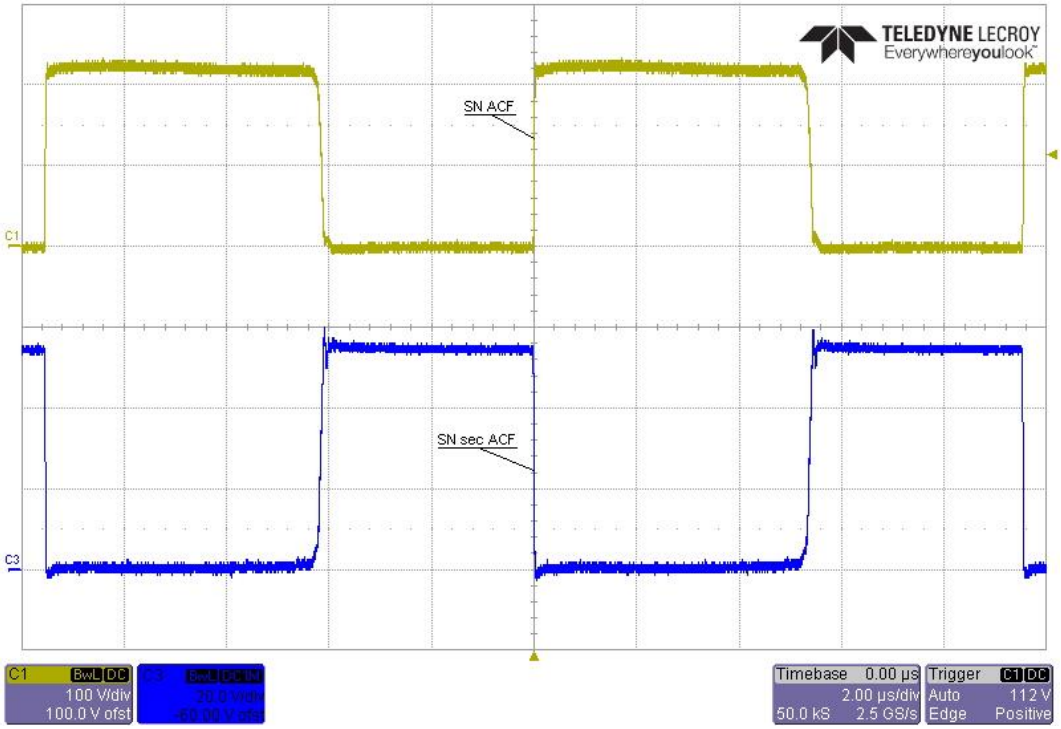


2.2 Switch Node ACF (U3)

Input Voltage = 375VDC
Load current = 3.5A

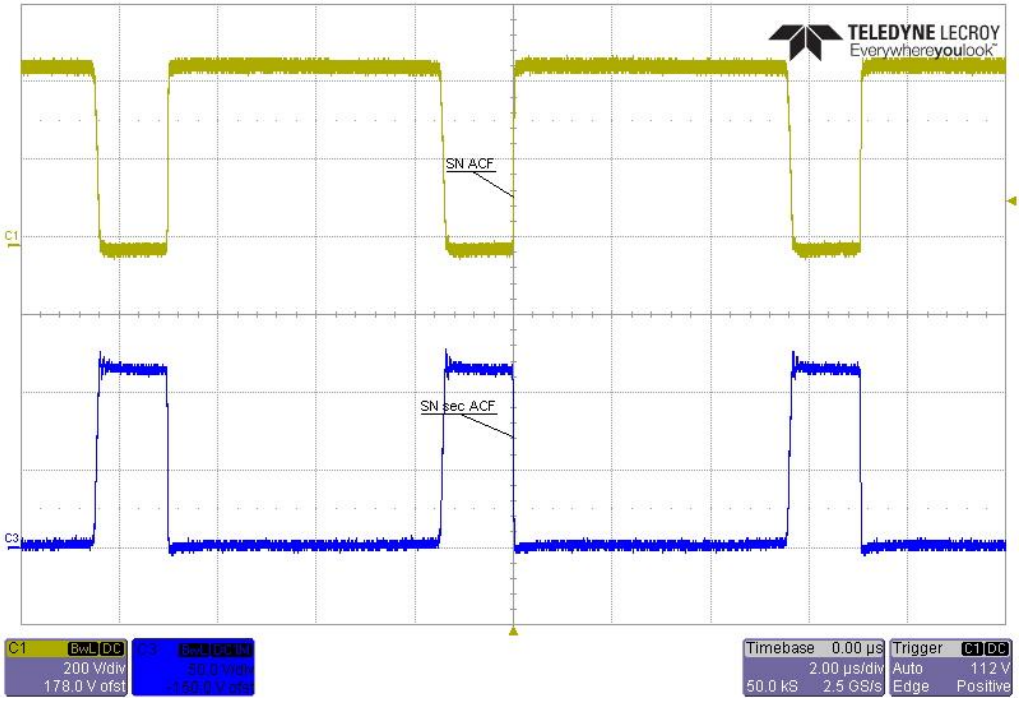


Input Voltage = 130VDC
Load current = 3.5A



2.3 Secondary Side Switch Node (Q3)

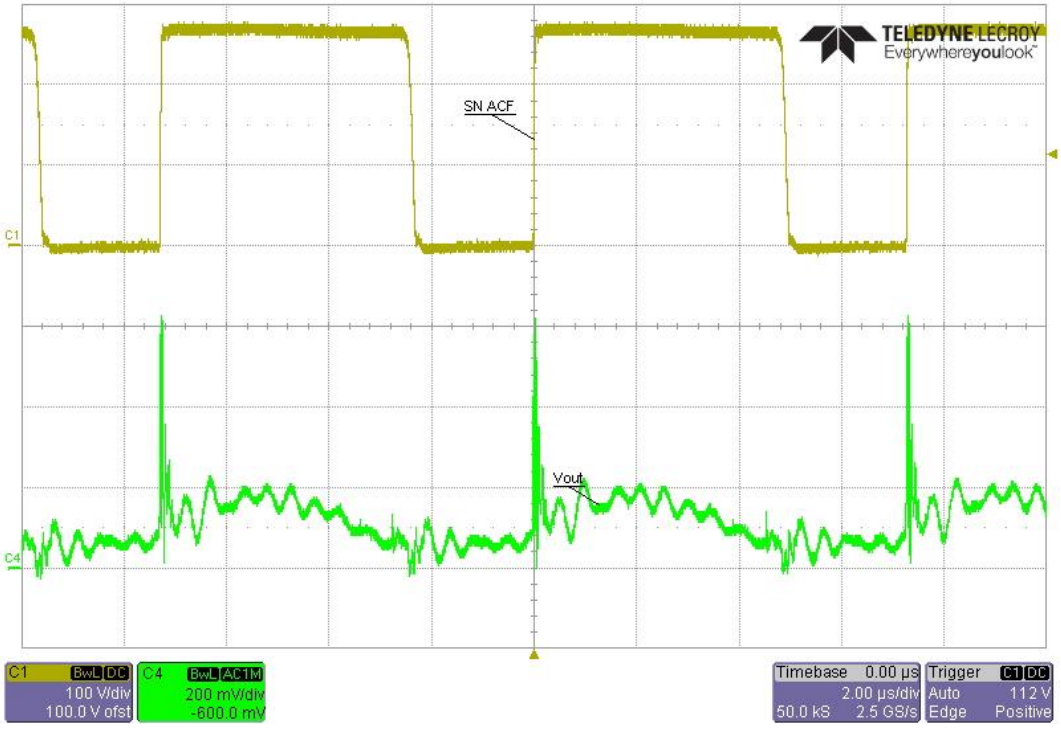
Input Voltage = 375VDC
Load current = 3.5A



Channel 1: Switch Node active clamp flyback (Q2)
Channel 2: Secondary Side Switch Node (Q3)

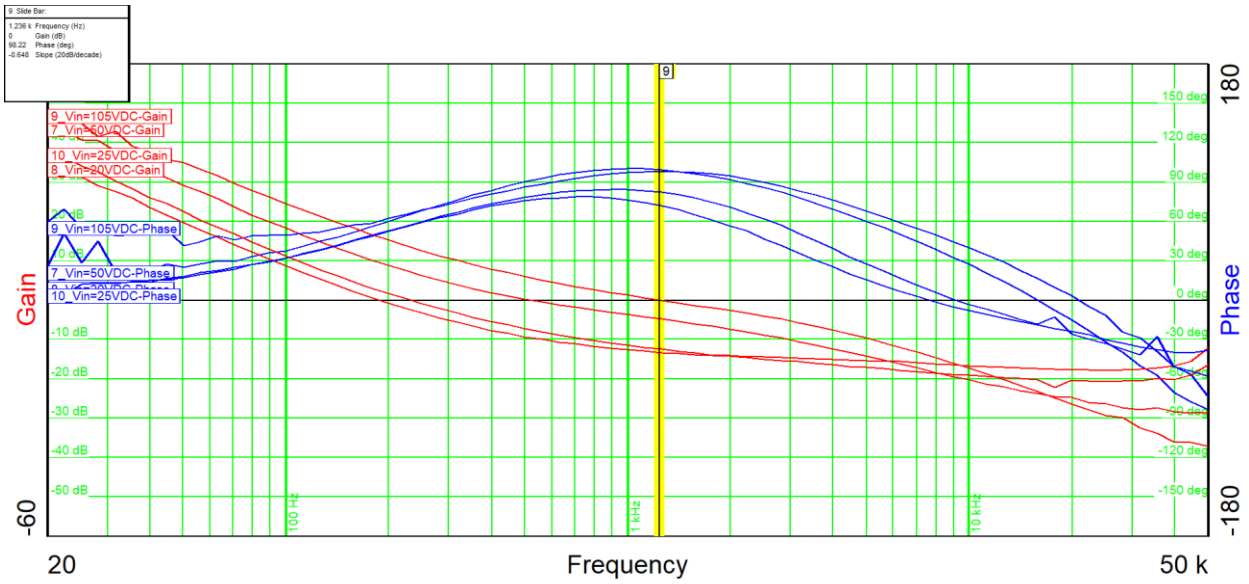
2.4 Output Voltage Ripple

Input Voltage = 200VDC
Load current = 3.5A



2.5 Bode Plot

2.5.1 Boost (U100)



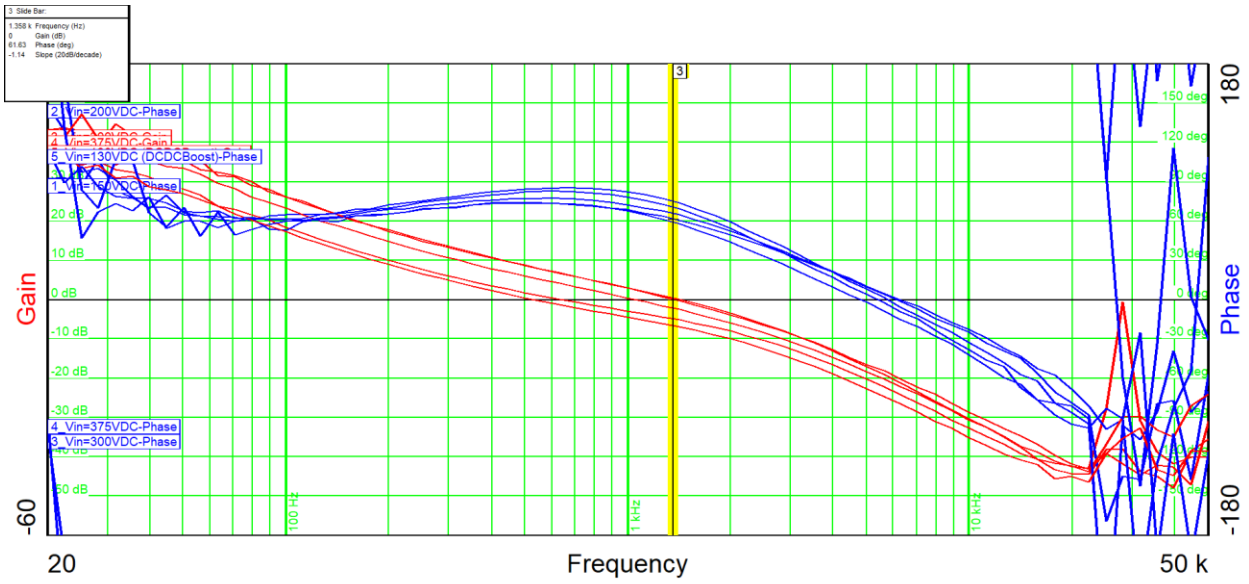
Input Voltage = 20VDC
Load = 3.5A
Bandwidth = 0.2kHz
Phase Margin = 52°

Input Voltage = 25VDC
Load = 3.5A
Bandwidth = 0.2kHz
Phase Margin = 58°

Input Voltage = 50VDC
Load = 3.5A
Bandwidth = 0.5kHz
Phase Margin = 91°

Input Voltage = 105VDC
Load = 3.5A
Bandwidth = 1.2kHz
Phase Margin = 98°

2.5.2 ACF (U3)



Input Voltage = 130VDC
Load = 3.5A
Bandwidth = 0.5kHz
Phase Margin = 83°

Input Voltage = 150VDC
Load = 3.5A
Bandwidth = 0.6kHz
Phase Margin = 85°

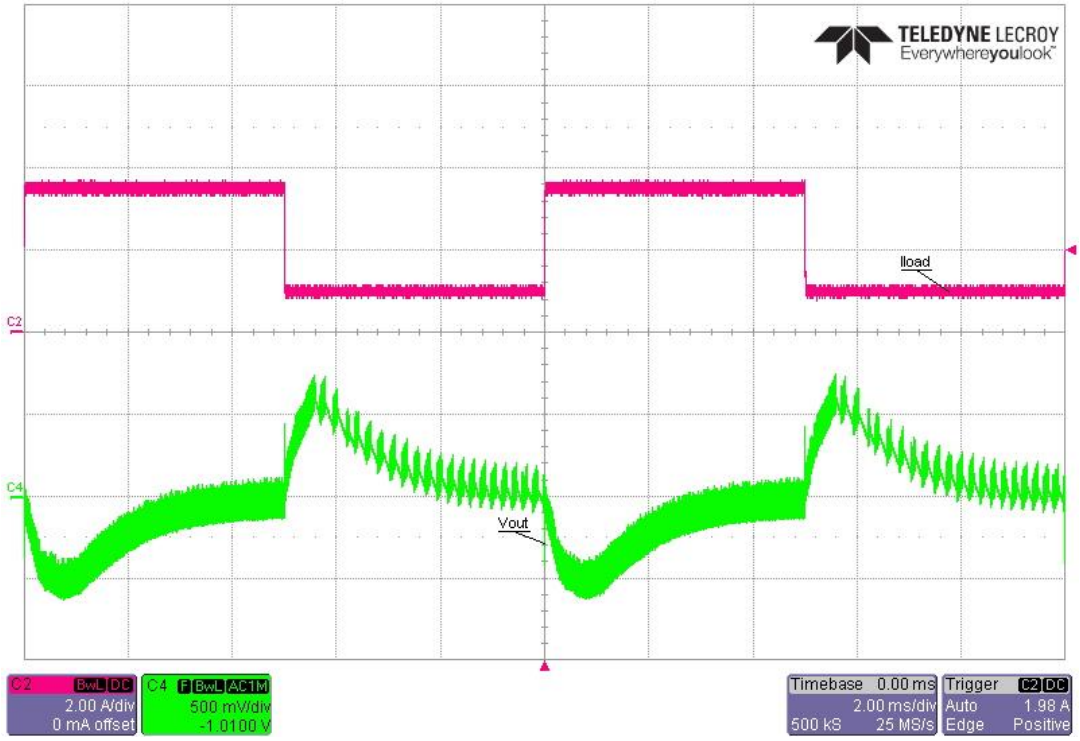
Input Voltage = 200VDC
Load = 3.5A
Bandwidth = 1.0kHz
Phase Margin = 72°

Input Voltage = 300VDC
Load = 3.5A
Bandwidth = 1.4kHz
Phase Margin = 62°

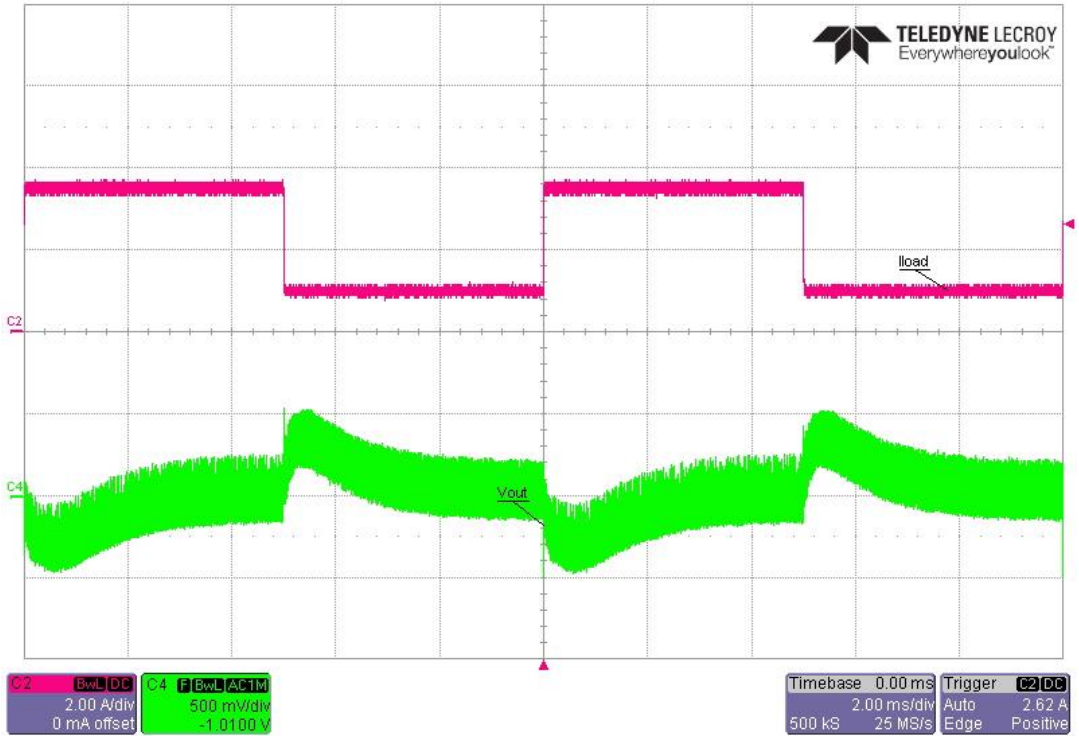
Input Voltage = 375VDC
Load = 3.5A
Bandwidth = 1.4kHz
Phase Margin = 57°

2.6 Load Transients

Input Voltage = 130VDC
Load current = 1.0A to 3.5A



Input Voltage = 375VDC
Load current = 1.0A to 3.5A

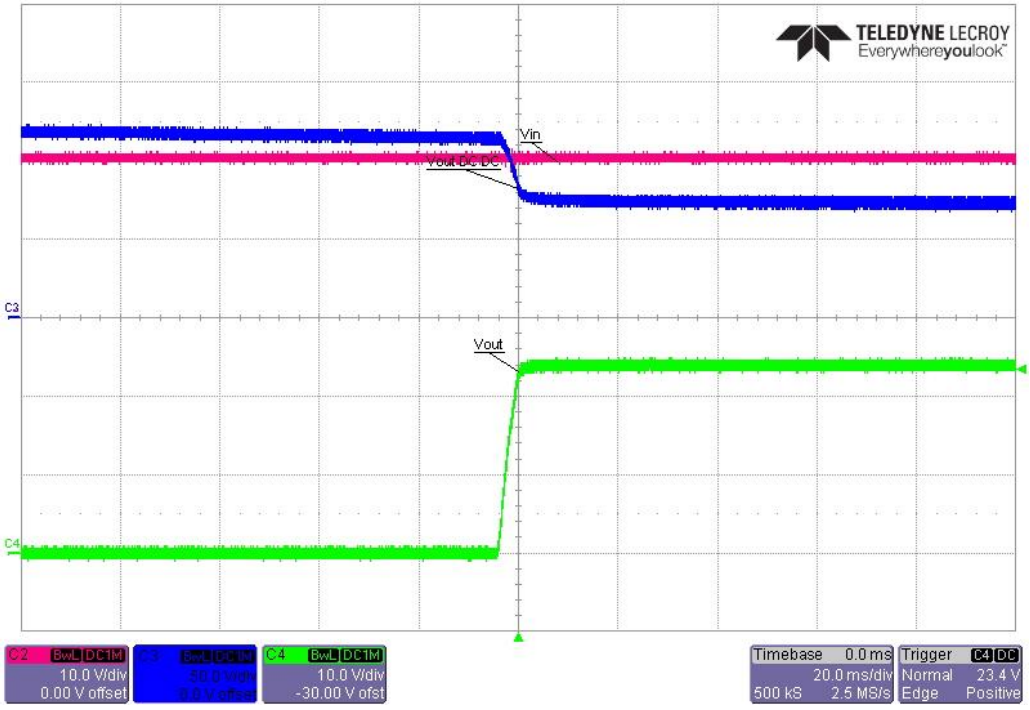


2.7 Start-up

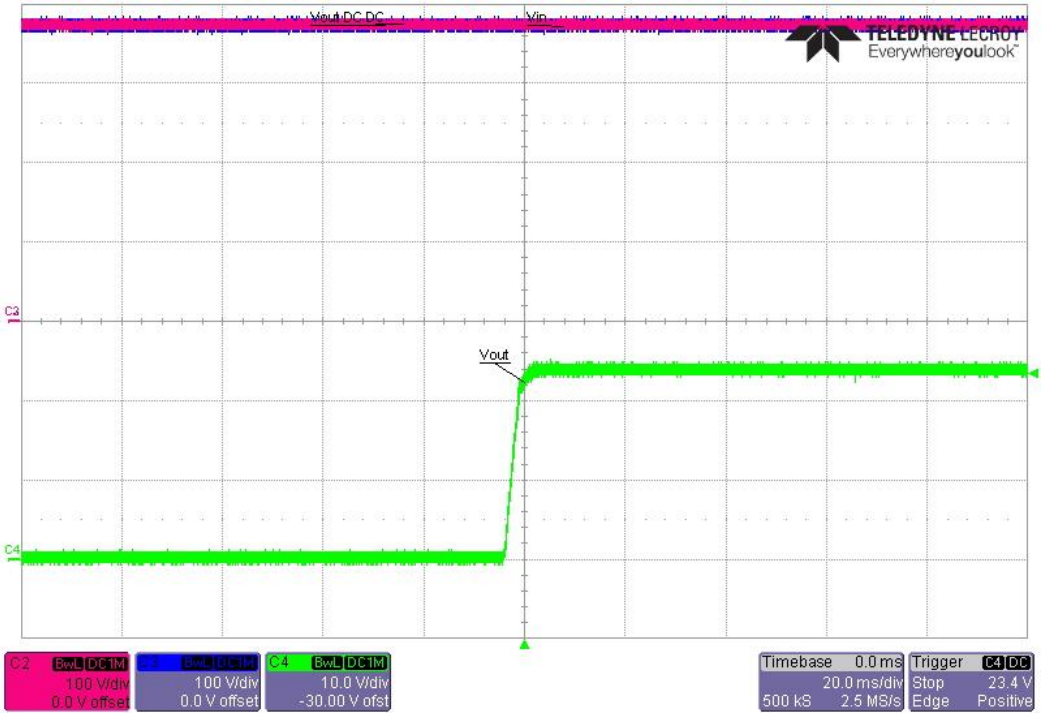
Channel 2: Input Voltage
Channel 3: Boost Voltage (C13)
Channel 4: Output Voltage

2.7.1 no load

Input Voltage = 20VDC
Load current = 0A

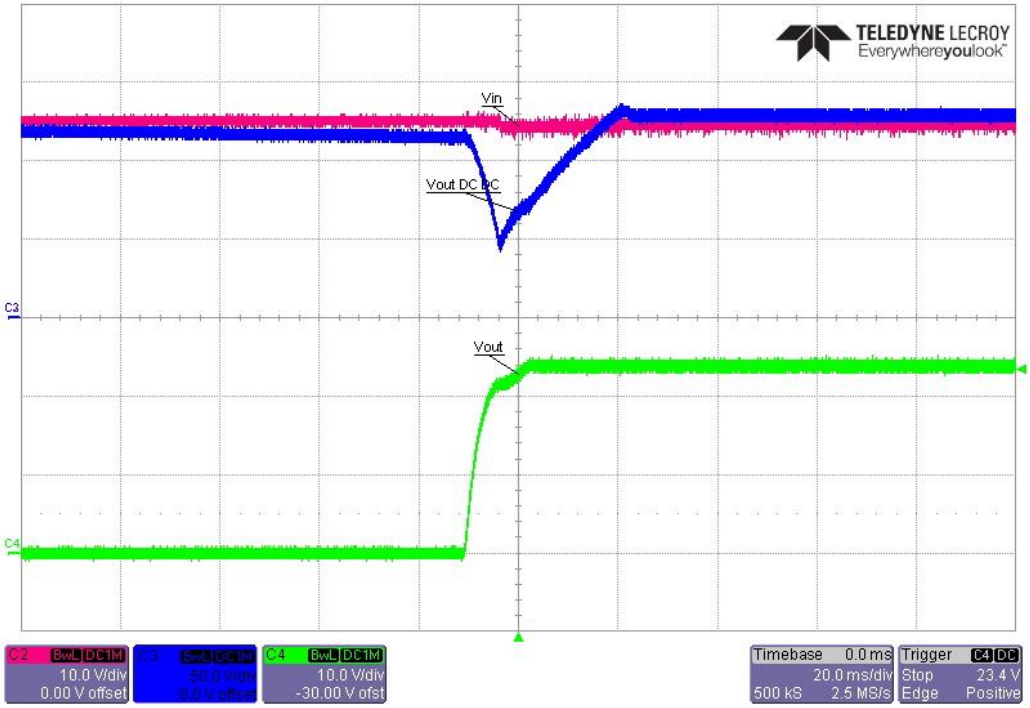


Input Voltage = 20VDC
Load current = 0A

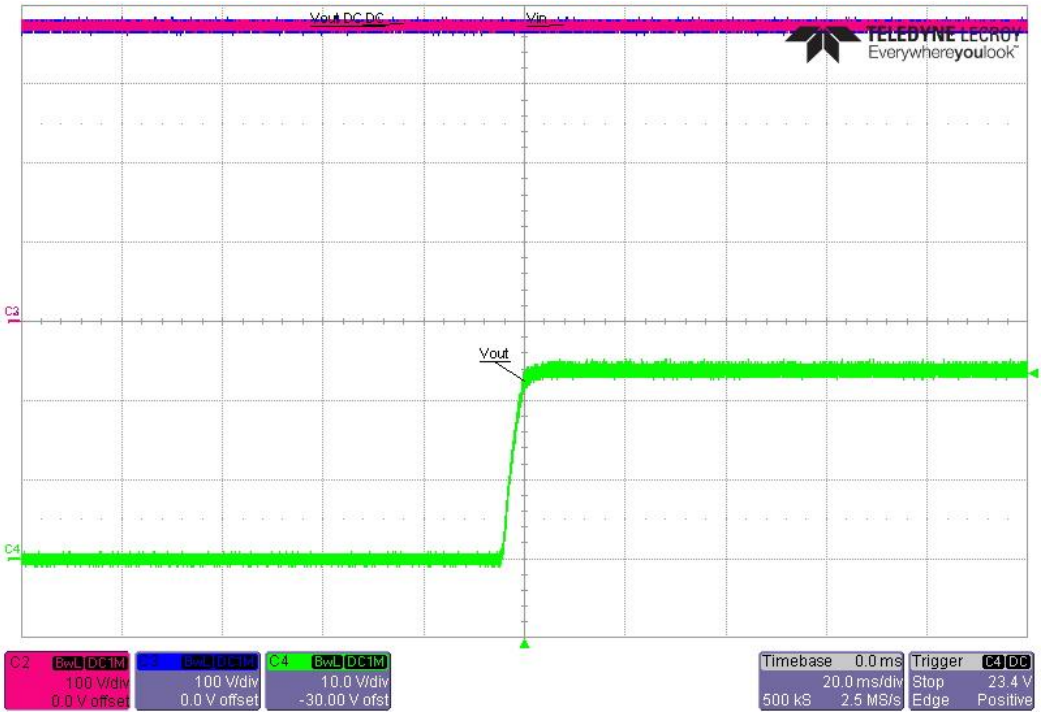


2.7.2 full load

Input Voltage = 25VDC
Load current = 3.5A



Input Voltage = 375VDC
Load current = 3.5A



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