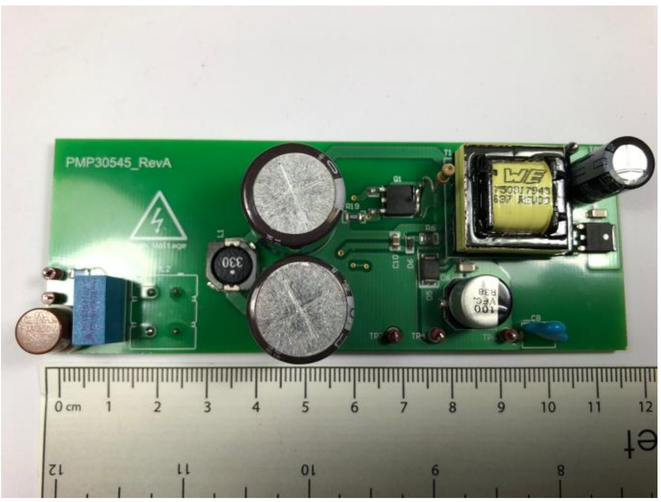
Test Report: [PMP30545_RevB]

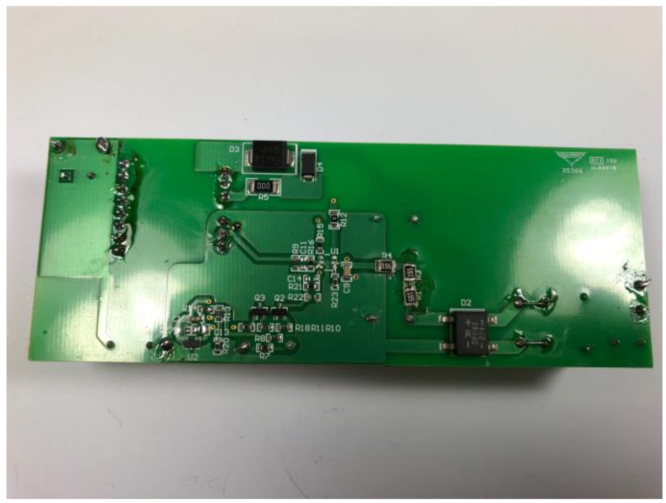
90-VAC - 265-VAC input, non-isolated flyback reference design with multiple output

TEXAS INSTRUMENTS

Description

This offline flyback reference design uses the UCC28742 controller to generate a non-isolated output (15 V at 130 mA) and an isolated output (24 V at 830 mA) from an AC input (90 VAC - 265 VAC). The UCC28742 provides a cost effective and precise constant-voltage and constant-current regulation. The valley-switching technique reduces switching losses and keeps the efficiency high.





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1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage	90VAC – 265VAC
Output Voltage1	15V@0.13A
Output Voltage2	24V@0.83A

1.2 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.

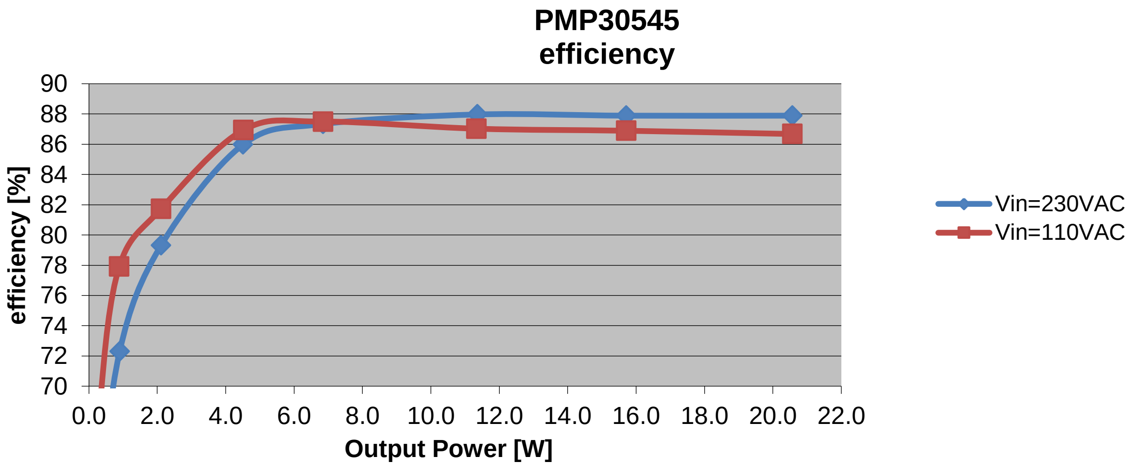
1. Work Area Safety:
a. Keep work area clean and orderly.
b. Qualified observer(s) must be present anytime circuits are energized.
c. Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages 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.

1.3 Efficiency Graphs



1.4 Efficiency / Load Regulation Data

input			output2		output1		Pout	efficiency
voltage [V]	Power [W]		voltage [V]	current [A]	voltage [V]	current [A]	Power [W]	[%]
230VAC	0.106		26.85	0.000	15.03	0.000	0.000	0.0
230VAC	0.249		23.77	0.005	15.03	0.000	0.119	47.8
230VAC	0.551		24.83	0.005	15.03	0.014	0.339	61.5
230VAC	1.245		26.33	0.005	15.02	0.051	0.900	72.3
230VAC	2.659		28.86	0.005	15.02	0.131	2.109	79.3
230VAC	5.248		24.32	0.105	15.02	0.131	4.513	86.0
230VAC	7.845		23.89	0.205	15.02	0.131	6.852	87.3
230VAC	12.917		23.26	0.405	14.92	0.131	11.363	88.0
230VAC	17.877		22.80	0.604	14.84	0.131	15.712	87.9
230VAC	23.410		22.32	0.836	14.73	0.130	20.576	87.9
110VAC	0.078		26.70	0.000	15.03	0.000	0.000	0.0
110VAC	0.212		23.75	0.005	15.03	0.000	0.121	57.2
110VAC	0.493		24.80	0.005	15.02	0.014	0.341	69.2
110VAC	1.143		26.21	0.005	15.02	0.050	0.891	77.9
110VAC	2.581		28.97	0.005	15.02	0.131	2.109	81.7
110VAC	5.192		24.33	0.105	15.02	0.131	4.514	86.9
110VAC	7.832		23.89	0.205	15.01	0.131	6.853	87.5
110VAC	13.025		23.24	0.405	14.92	0.130	11.336	87.0
110VAC	18.085		22.78	0.604	14.82	0.132	15.715	86.9
110VAC	23.730		22.30	0.836	14.71	0.131	20.569	86.7

24Vout Overload / Shortcircuit

230VAC			22.420	0.92	14.66	0.1671	23.076	
230VAC			22.370	0.94	14.65	0.1670	23.474	
230VAC	shutdown		0.00	0.98	0.00	0.1670	0.000	

15Vout Overload / Shortcircuit

230VAC			23.060	0.82	14.67	0.33	23.78	
230VAC			23.160	0.82	14.63	0.41	24.99	
230VAC	shutdown		0.00	0.82	0.00	0.42	0.00	

1.5 *Thermal Images*

The images below show the infrared images taken from the FlexCam after 10min at full load output power.

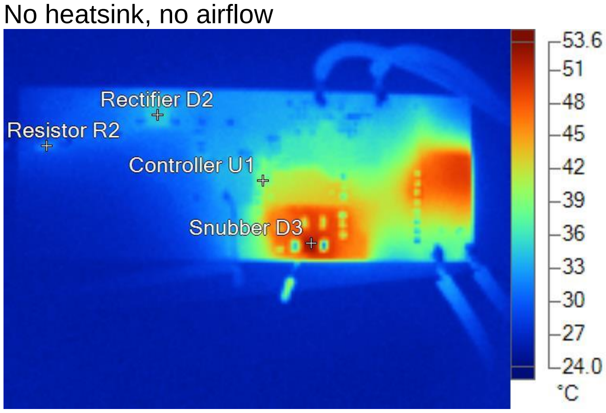
1.5.1 Bottom Side

Input voltage = 90VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A
Ambient temperature = 25°C
No heatsink, no airflow

Vin=90VAC full load bottom.is2

Name	Temperature	
Snubber D3	58.6°C	
Controller U1	41.9°C	
Rectifier D2	48.5°C	
Resistor R2	49.0°C	

Input voltage = 265VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A
Ambient temperature = 25°C
No heatsink, no airflow

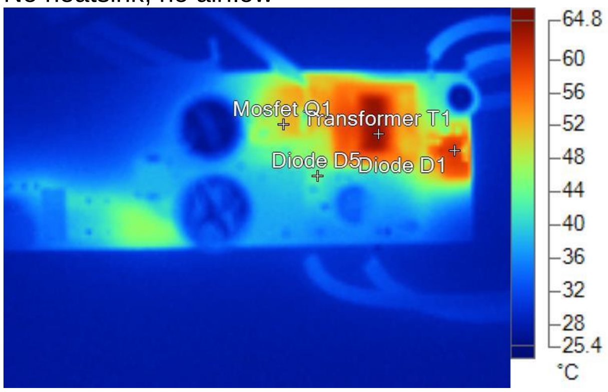


Vin=265VAC full load bottom.is2

Name	Temperature	
Snubber D3	52.7°C	
Controller U1	39.0°C	
Resistor R2	32.2°C	
Rectifier D2	34.8°C	

1.5.2 Top Side

Input voltage = 90VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A
Ambient temperature = 25°C
No heatsink, no airflow



Vin=90VAC full load top.is2

Name	Temperature	
Transformer T1	64.1°C	
Diode D1	60.1°C	
Mosfet Q1	51.0°C	
Diode D5	43.6°C	

Input voltage = 265VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A
Ambient temperature = 25°C
No heatsink, no airflow

Vin=265VAC full load top.is2

Name	Temperature	
Transformer T1	67.0°C	
Diode D5	44.5°C	
Mosfet Q1	53.9°C	
Diode D1	60.3°C	

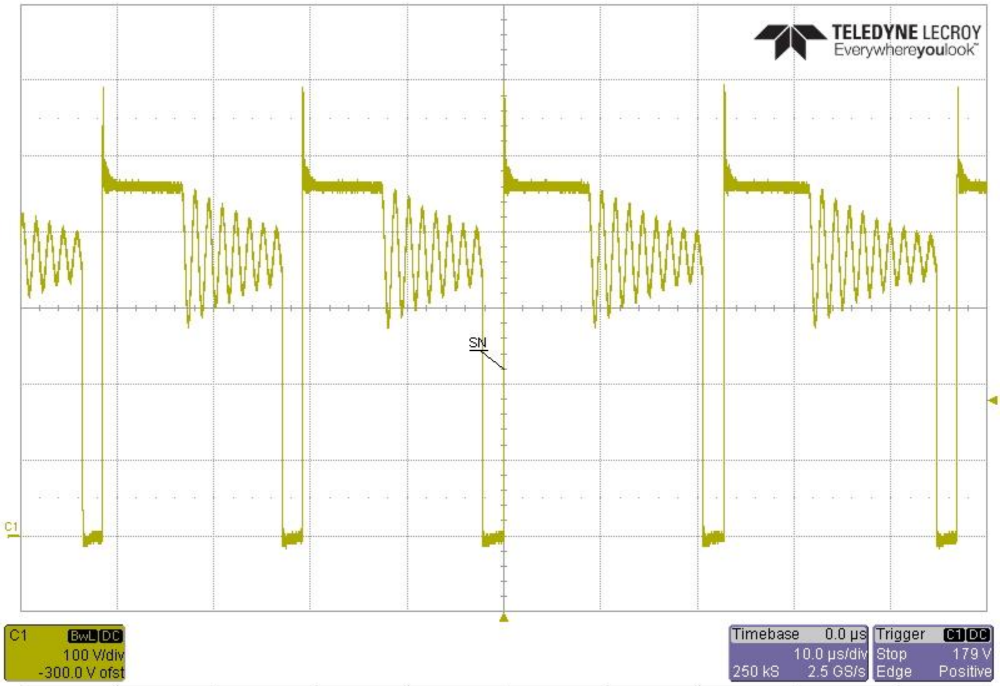
1.6 Dimensions

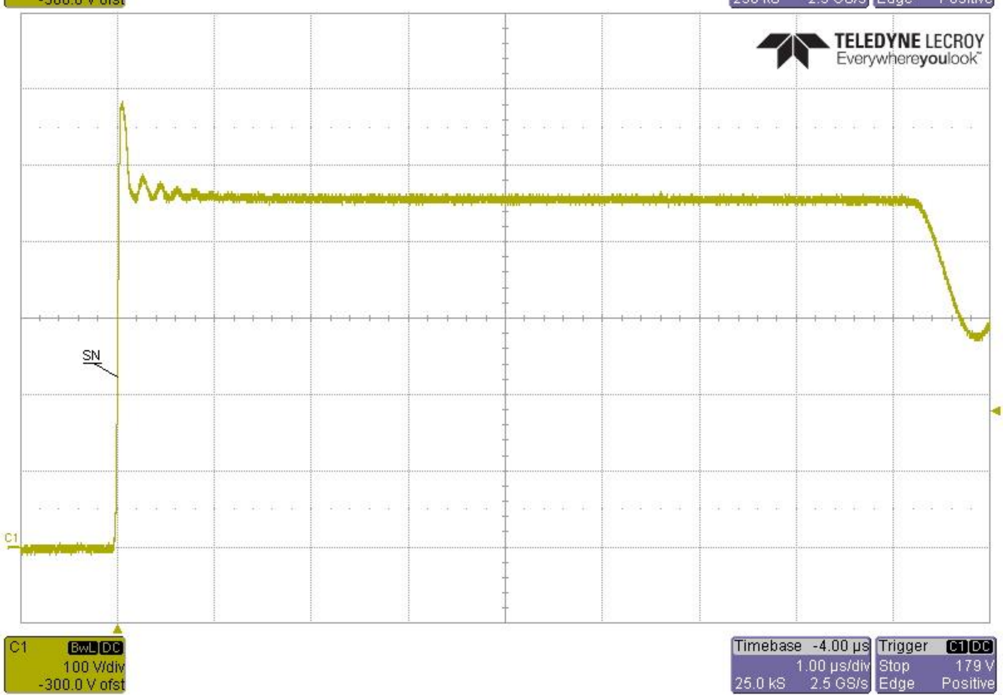
119mm x 44mm

2 Waveforms

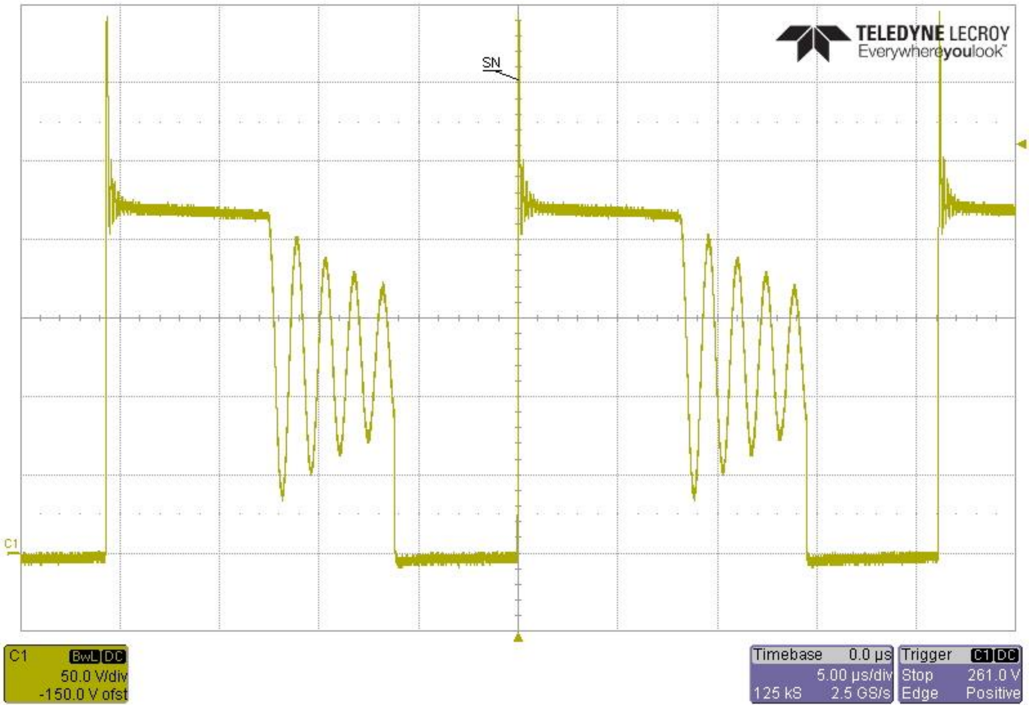
2.1 Switch Node

Input voltage = 265VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A





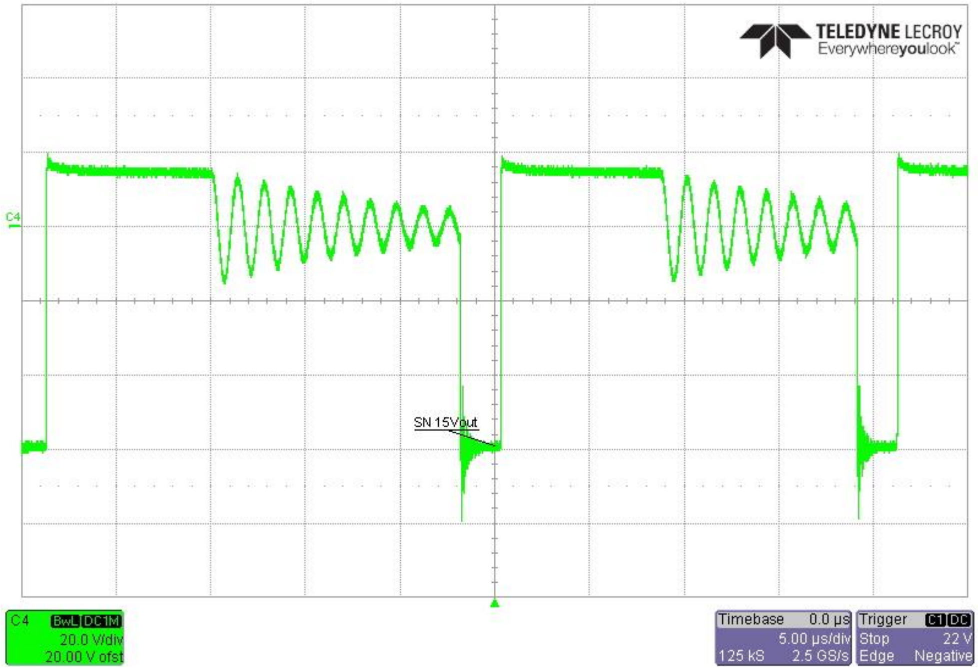
Input voltage = 90VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A



2.2 *Secondary Side Switchnode*

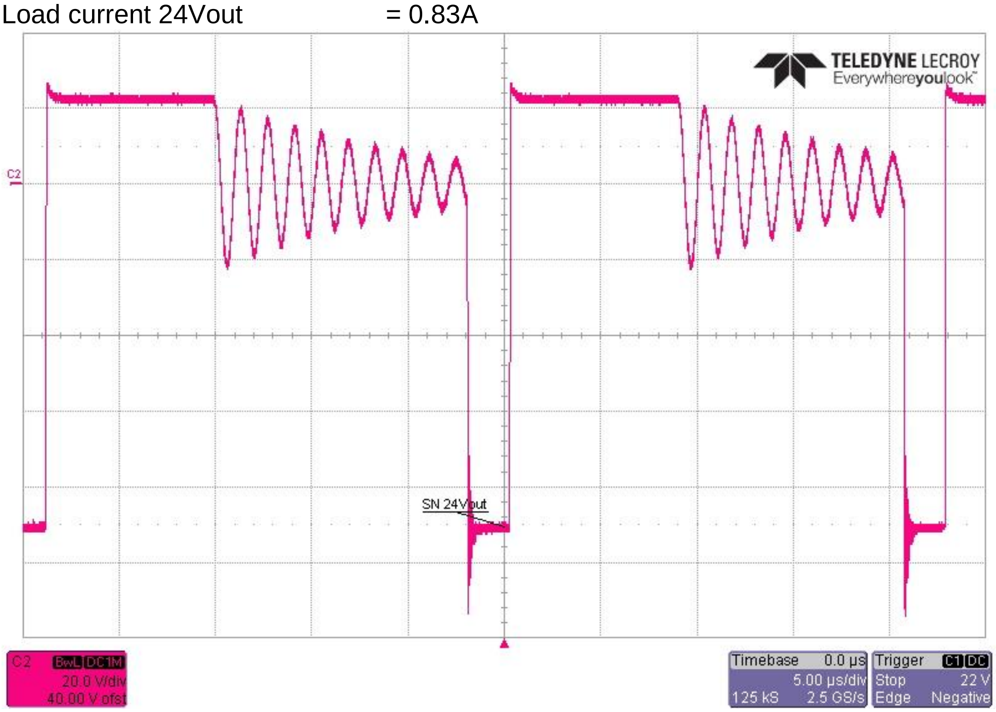
2.2.1 15Vout

Input voltage = 375VDC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A



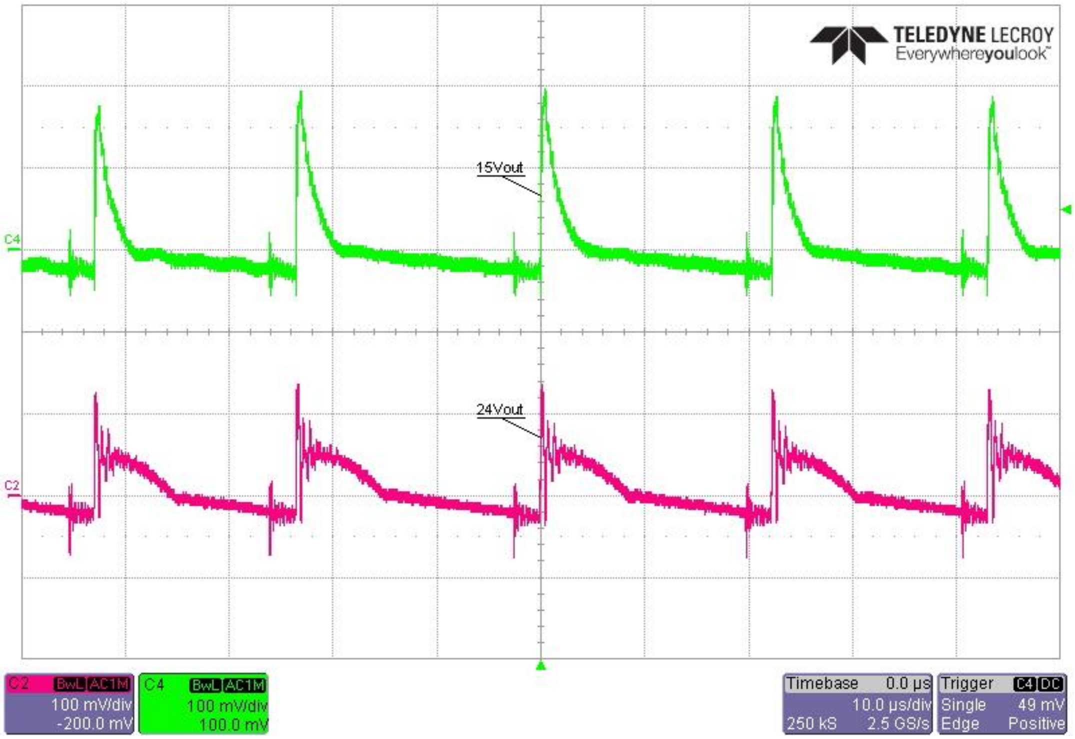
2.2.2 24Vout

Input voltage = 375VDC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A

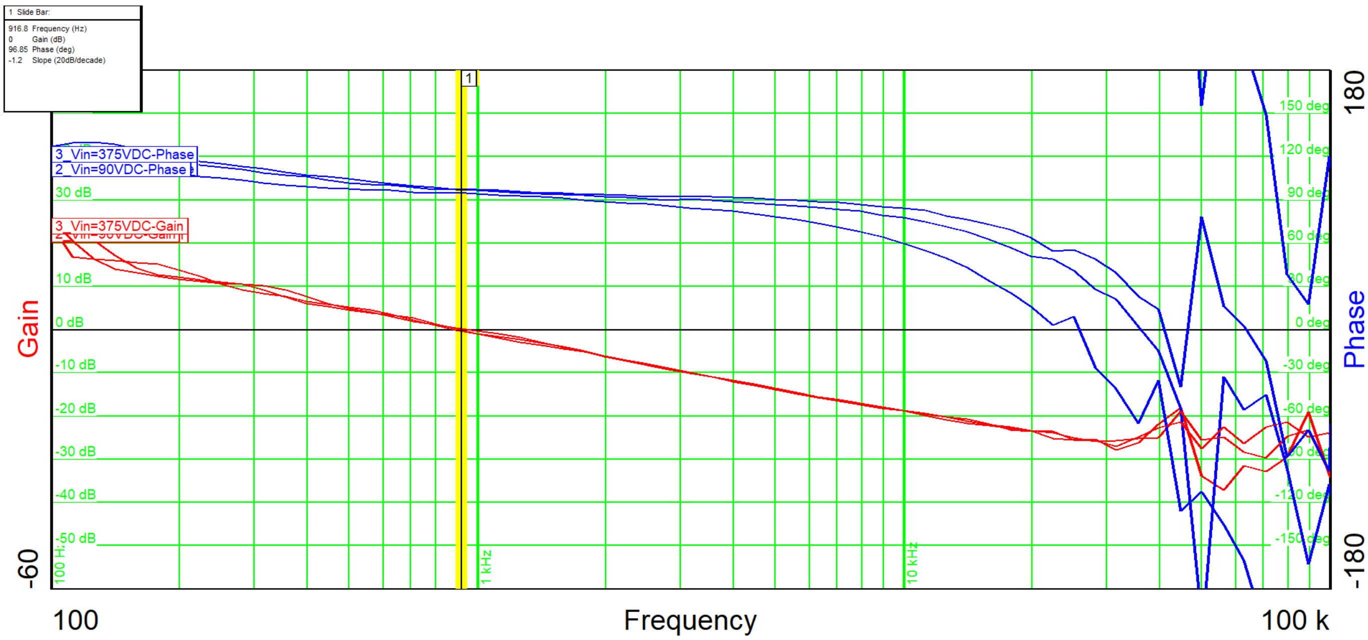


2.3 Output Voltage Ripple

Input voltage = 325VDC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A



2.4 Bode Plot



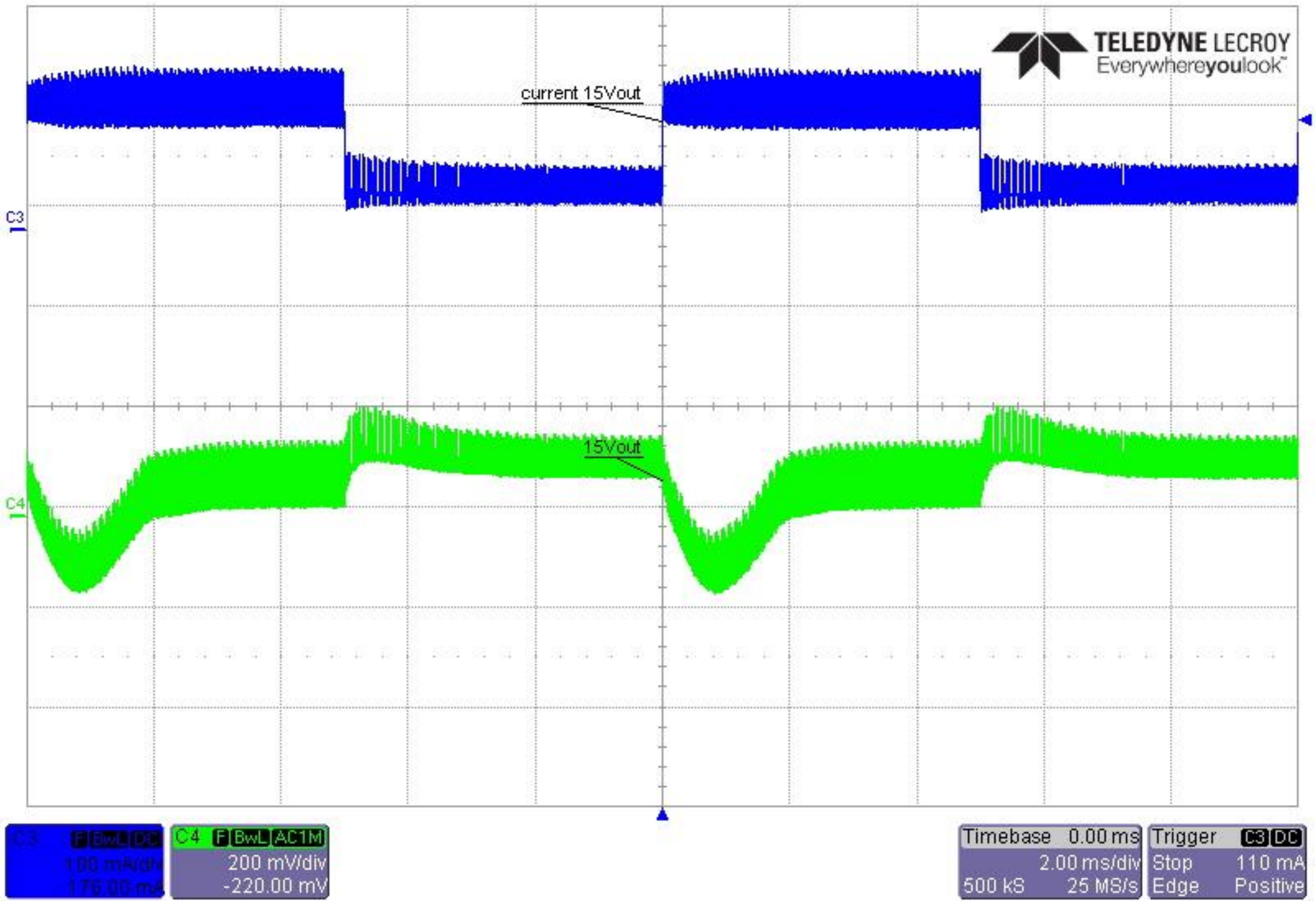
Input voltage	= 90VDC
Load current 15Vout	= 0.13A
Load current 24Vout	= 0.83A
Phase margin	= 95°
Bandwidth	= 0.9kHz

Input voltage	= 200VDC
Load current 15Vout	= 0.13A
Load current 24Vout	= 0.83A
Phase margin	= 97°
Bandwidth	= 0.9kHz

Input voltage	= 375VDC
Load current 15Vout	= 0.13A
Load current 24Vout	= 0.83A
Phase margin	= 97°
Bandwidth	= 0.9kHz

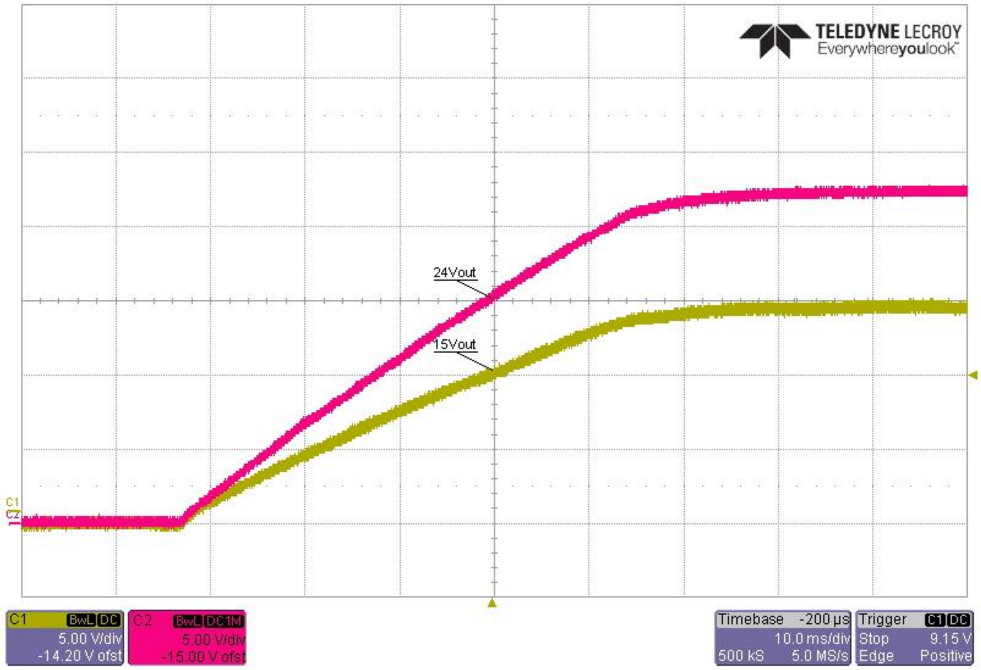
2.5 Load Transient 15Vout

Input voltage	= 325VDC
Load current 15Vout	= 50mA-130mA
Load current 24Vout	= 0.83A

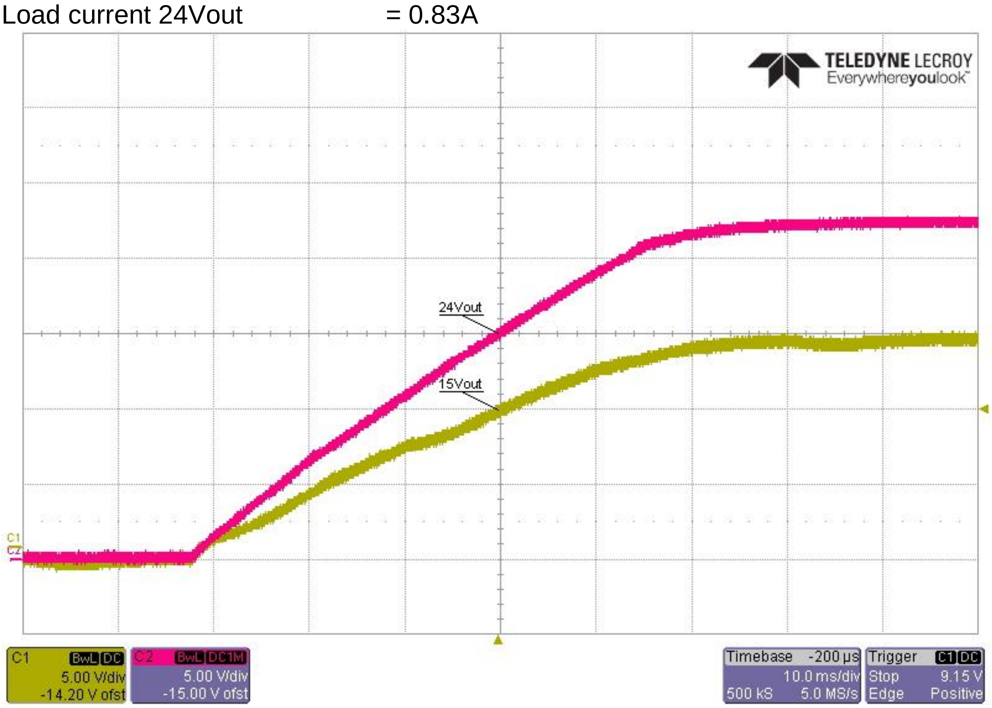


2.6 Start-up Sequence

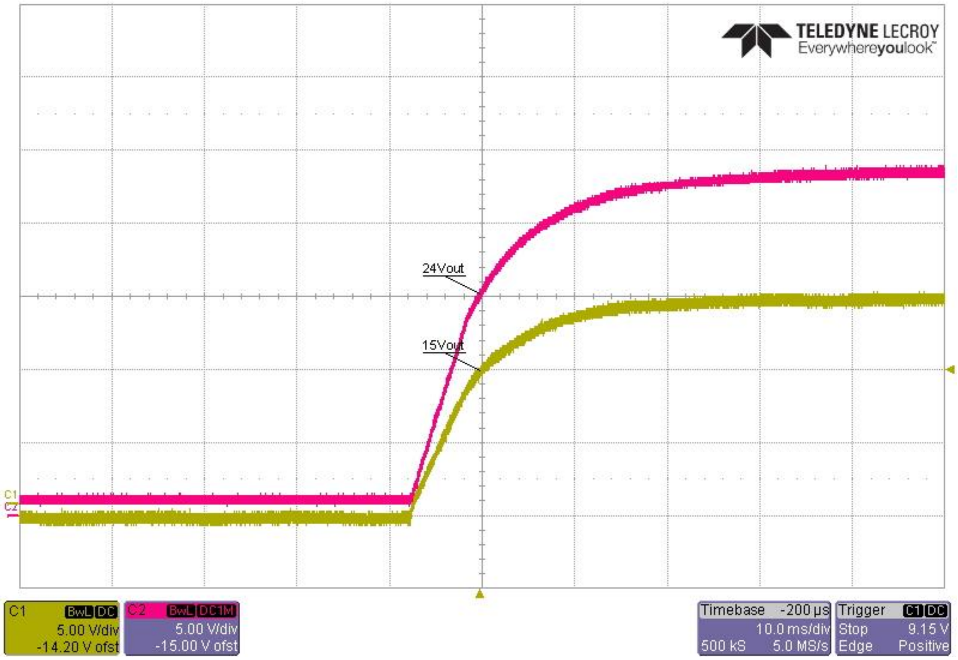
Input voltage = 90VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A



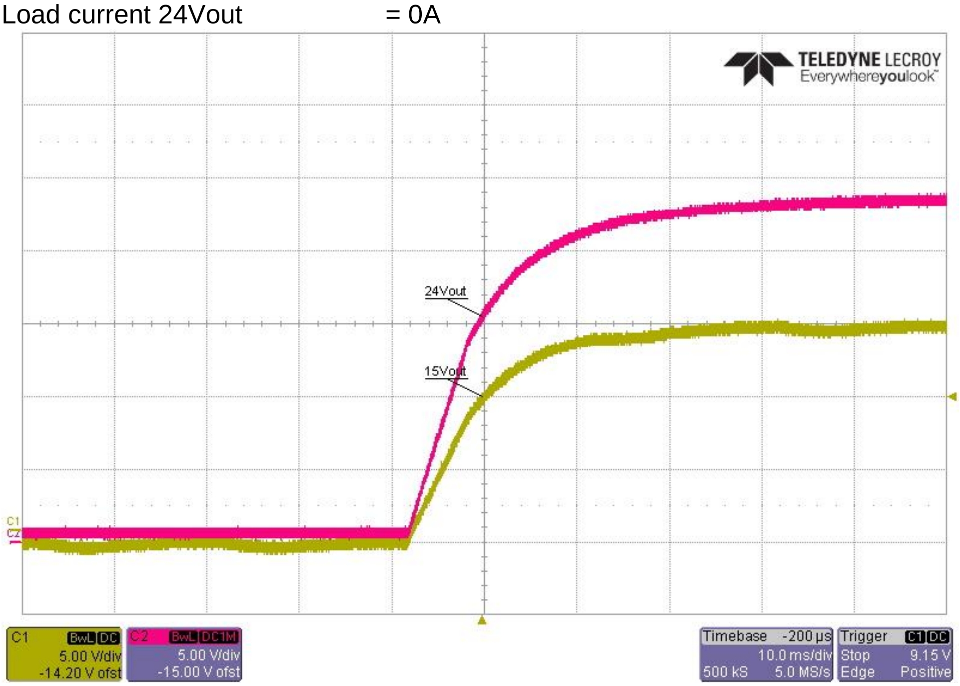
Input voltage = 265VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A



Input voltage = 90VAC
Load current 15Vout = 0A
Load current 24Vout = 0A

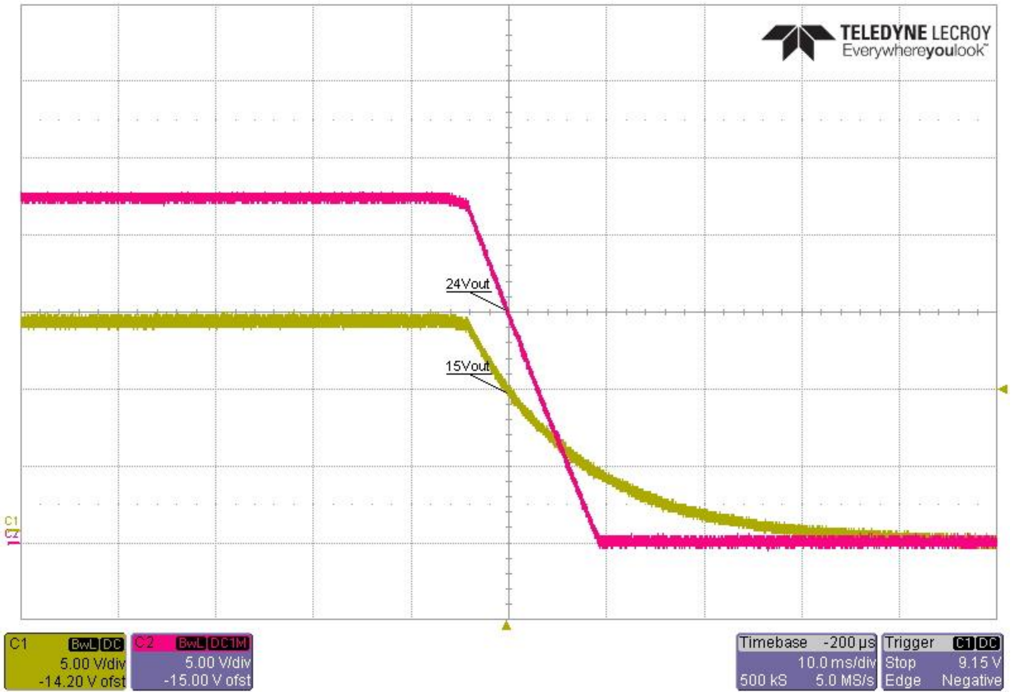


Input voltage = 265VAC
Load current 15Vout = 0A
Load current 24Vout = 0A



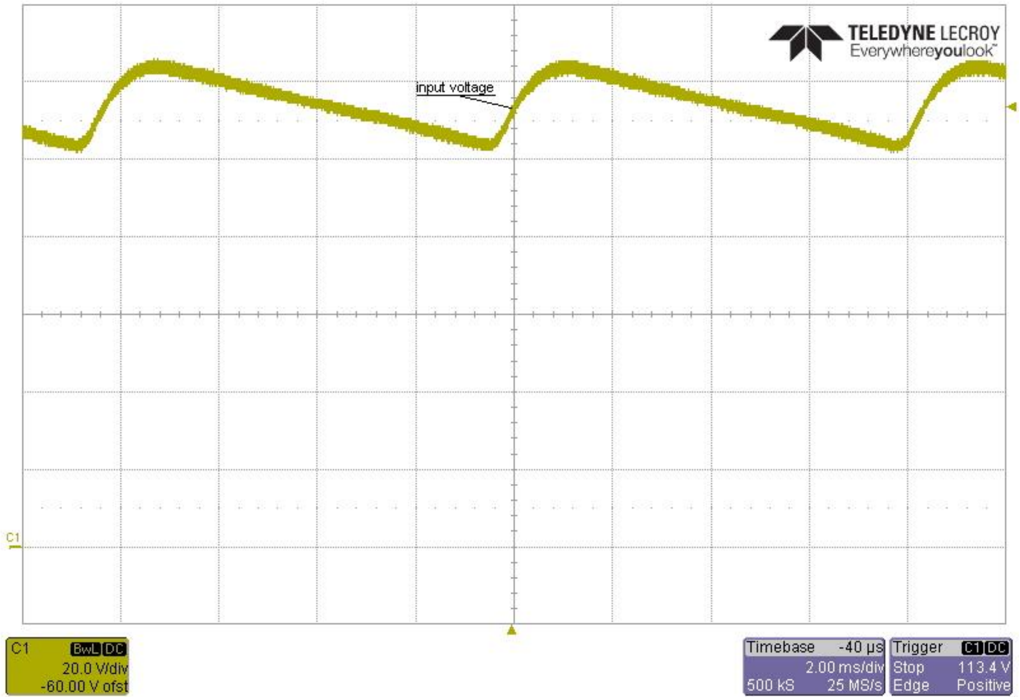
2.7 Shutdown Sequence

Input voltage = 230VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A



2.8 Input Voltage Ripple

Input voltage = 90VAC
Load current 15Vout = 0.13A
Load current 24Vout = 0.83A



2.9 EMI Measurement

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 isolated output has **not** been connected to the ground of the LISN.

Input voltage	= 230VAC
Load current 15Vout	= 0.13A
Load current 24Vout	= 0.83A