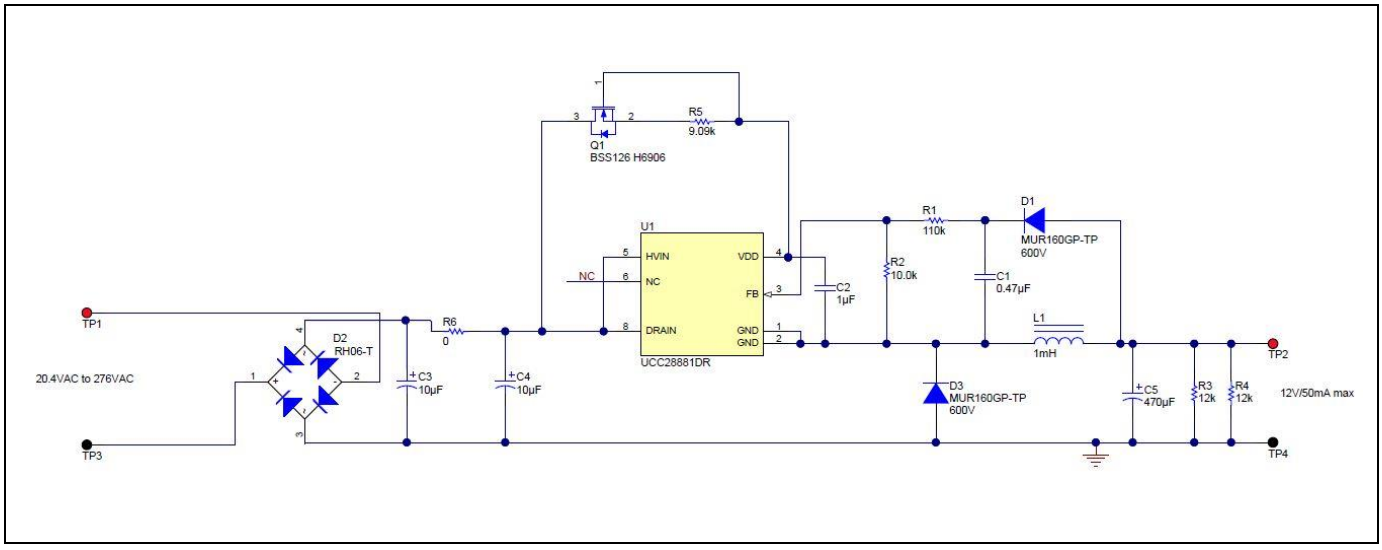
Test Report: PMP21007

HV AC-DC buck converter reference design with ultra wide input voltage range

Description

The PMP21007 reference design is an AC-DC Buck converter reference design with ultra-wide input range (20.4-Vac to 276-Vac). Using UCC28881 controller, we only need minimum number of discrete components as the controller has integrated the main switch and high voltage startup with low quiescent current needed. To allow sufficient supply current to the UCC28881 controller, a depletion MOSFET circuit is added as a low power dissipation current source. This design is able to provide 12-V/50-mA output.



1 System Specification

1.1 Board Dimension:

1” x 3.4” x 0.85”

1.2 Input/output Characteristics

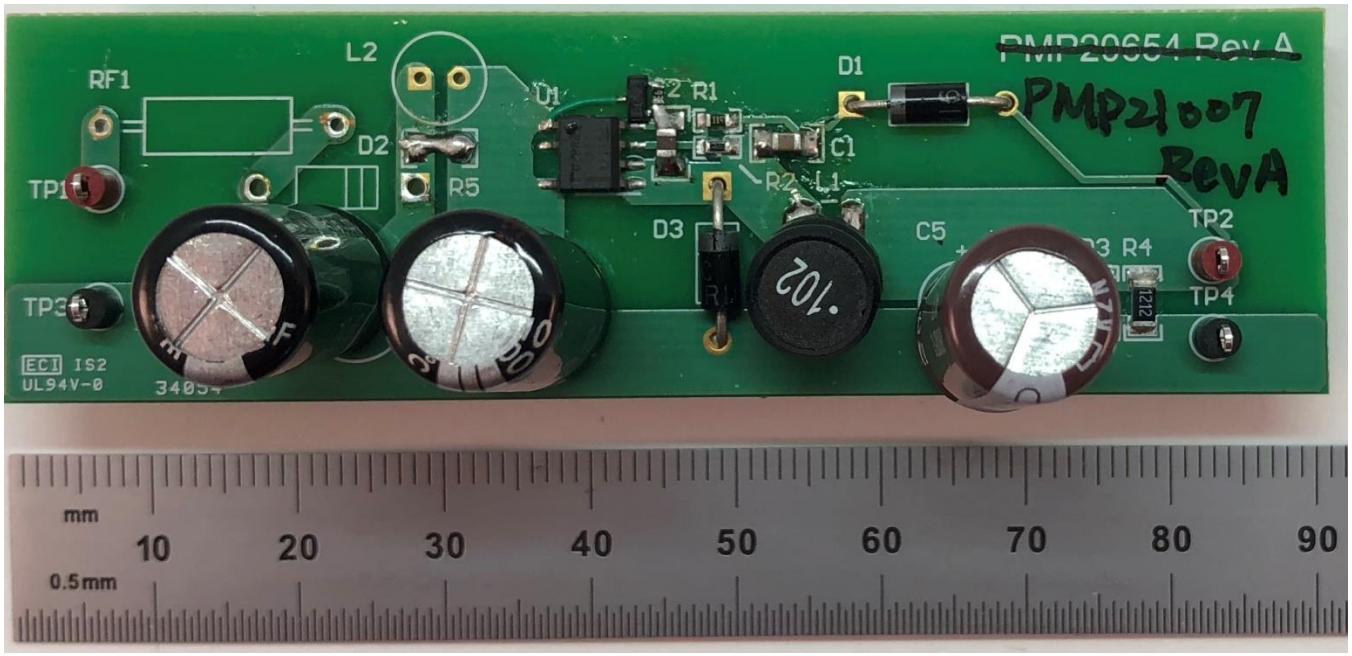
The power supply unit should be able to supply 12V/50mA output with 20.4VAC to 276VAC input.

2 Testing and Results

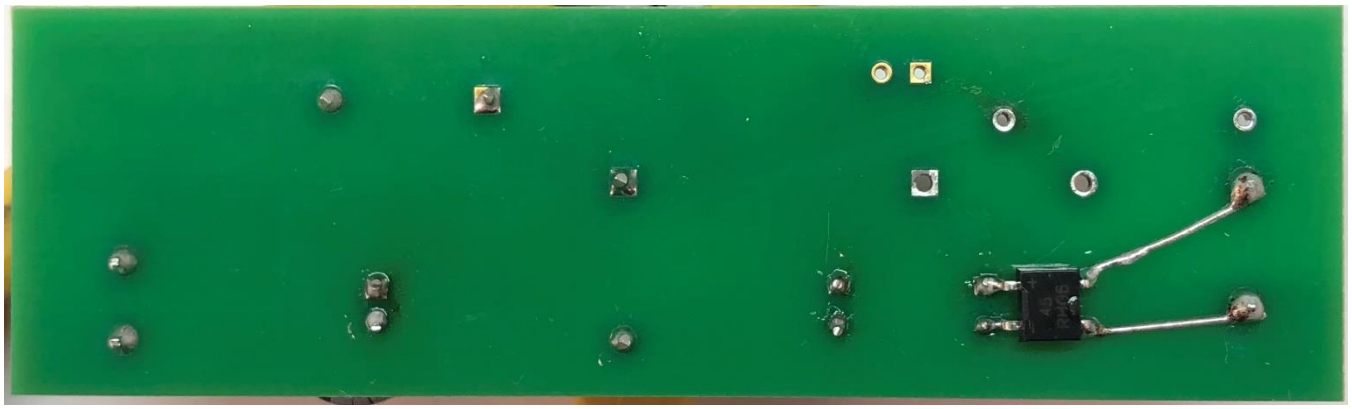
2.1 Board Photos

The photographs below show the top and bottom view of the PMP21007Rev A board. This circuit was built on a PMP20654 Rev A.

2.1.1 Top Side



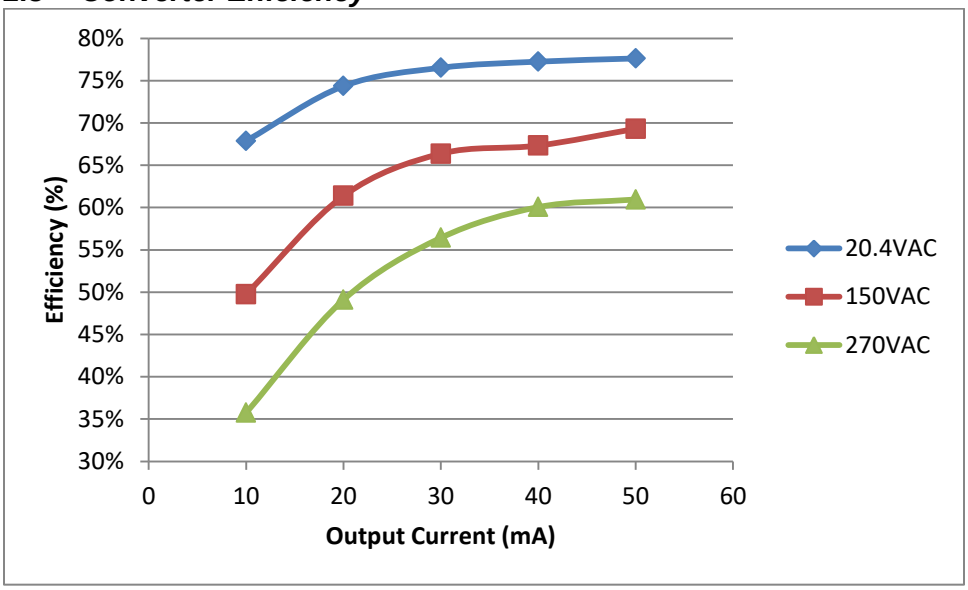
2.1.2 Bottom Side



2.2 No-Load Regulation

Vin (V_{AC})	Iout (mA)	Vout (V)
20.4	0	12.34
150	0	13.03
270	0	13.08

2.3 Converter Efficiency

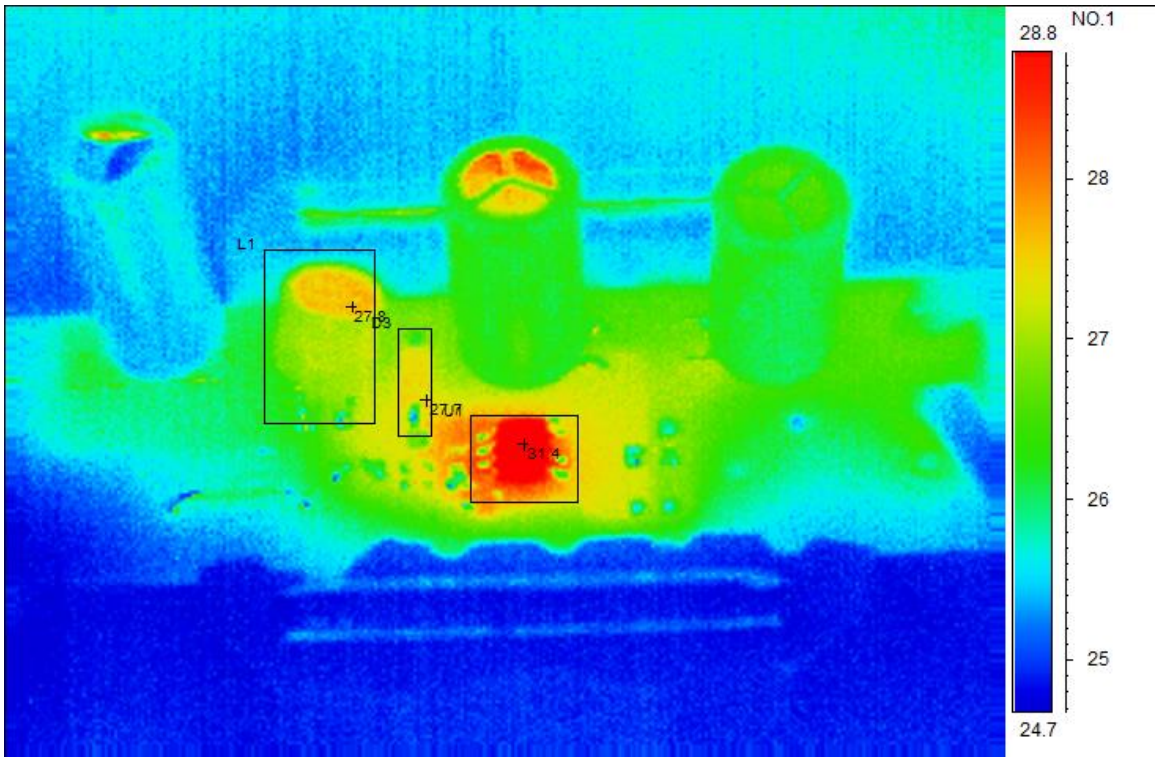


Vin(V_{AC})	Iin(mA)	Pin(W)	Vout(V)	Iout(mA)	Pout(W)	Efficiency (%)
20.4	57.15	0.764	11.86	50	0.593	77.62%
20.4	51.47	0.624	12.05	40	0.482	77.24%
20.4	41.85	0.474	12.09	30	0.3627	76.52%
20.4	30.53	0.326	12.12	20	0.2424	74.36%
20.4	18.5	0.179	12.15	10	0.1215	67.88%
150	19.6	0.86	11.92	50	0.596	69.30%
150	16.47	0.71	11.95	40	0.478	67.32%
150	12.89	0.542	11.99	30	0.3597	66.37%
150	9.6	0.392	12.03	20	0.2406	61.38%
150	6.11	0.244	12.14	10	0.1214	49.75%
270	15.5	0.977	11.91	50	0.5955	60.95%
270	13.17	0.796	11.95	40	0.478	60.05%
270	10.8	0.637	11.98	30	0.3594	56.42%
270	8.27	0.49	12.03	20	0.2406	49.10%
270	5.43	0.34	12.15	10	0.1215	35.74%

2.4 Thermal Images

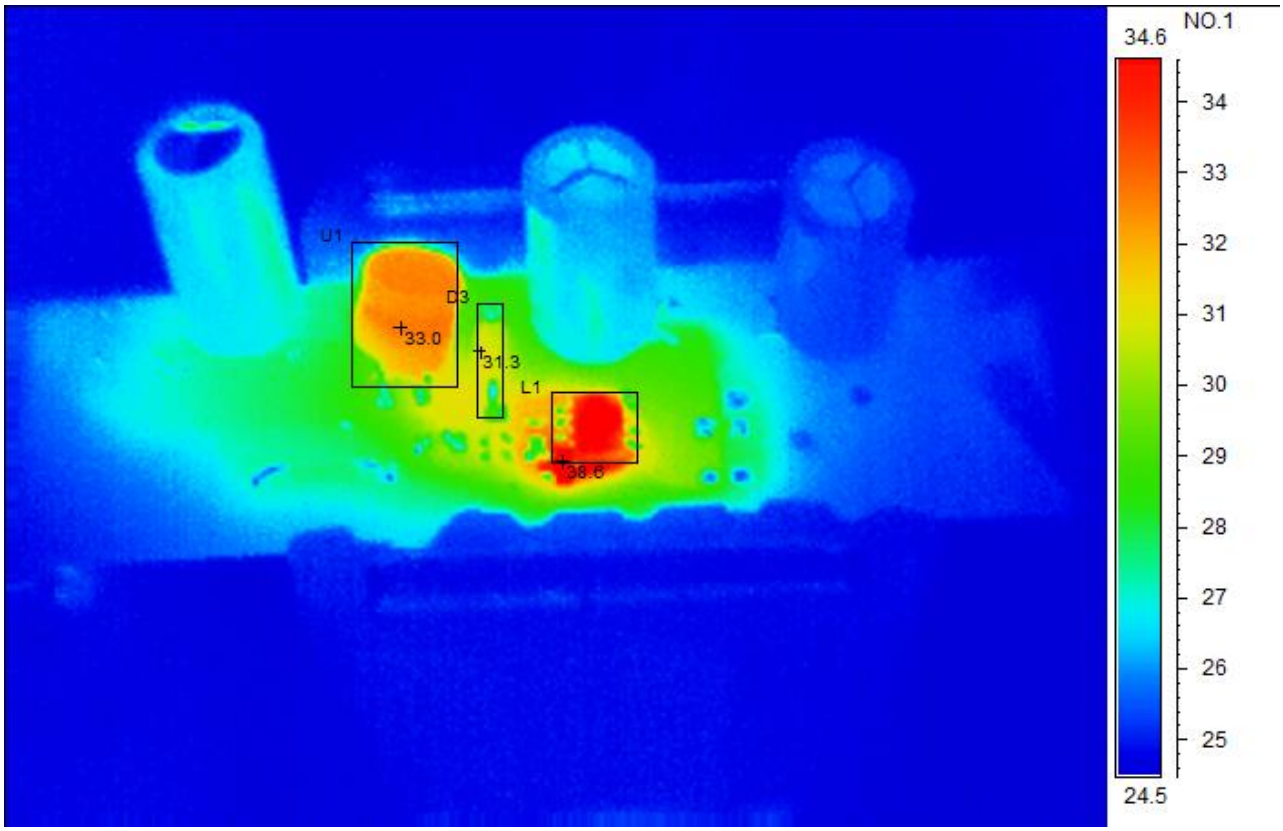
The thermal images below show a top view of the board. The ambient temperature was 20ºC with no forced air flow. The output was at full load: 12V/50mA.

2.4.1 V_{in}=20.4V_{AC}/60Hz



Parameters	Value
Ambient	22.0°C
Area analysis	**Value**
U1Max	31.4°C
D3Max	27.7°C
L1 Max	27.8°C

2.4.2 V_{in}=270V_{AC}/60Hz

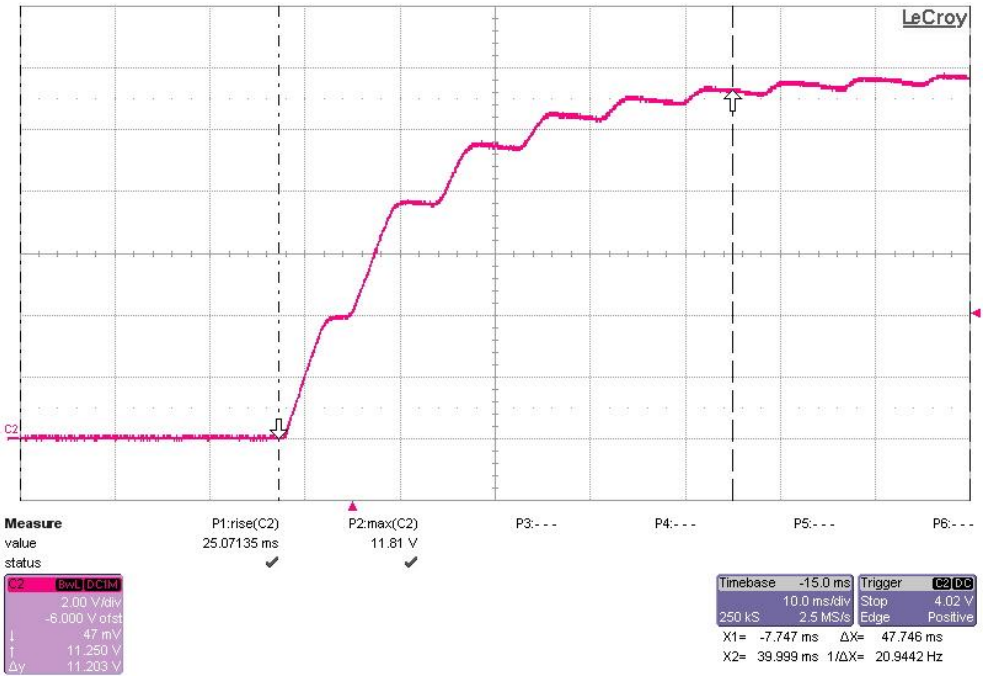


Parameters	Value
Ambient	25.0°C
Area analysis	**Value**
U1Max	33.0°C
L1 Max	38.6°C
D3 Max	31.3°C

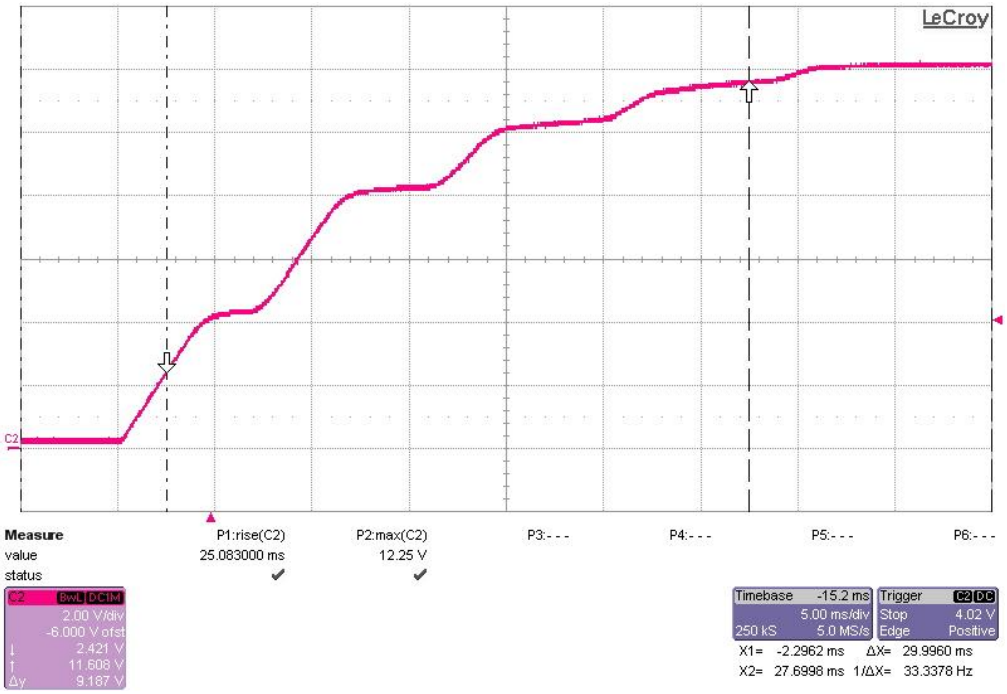
2.5 Startup

The output voltages at startup are shown in the images below.

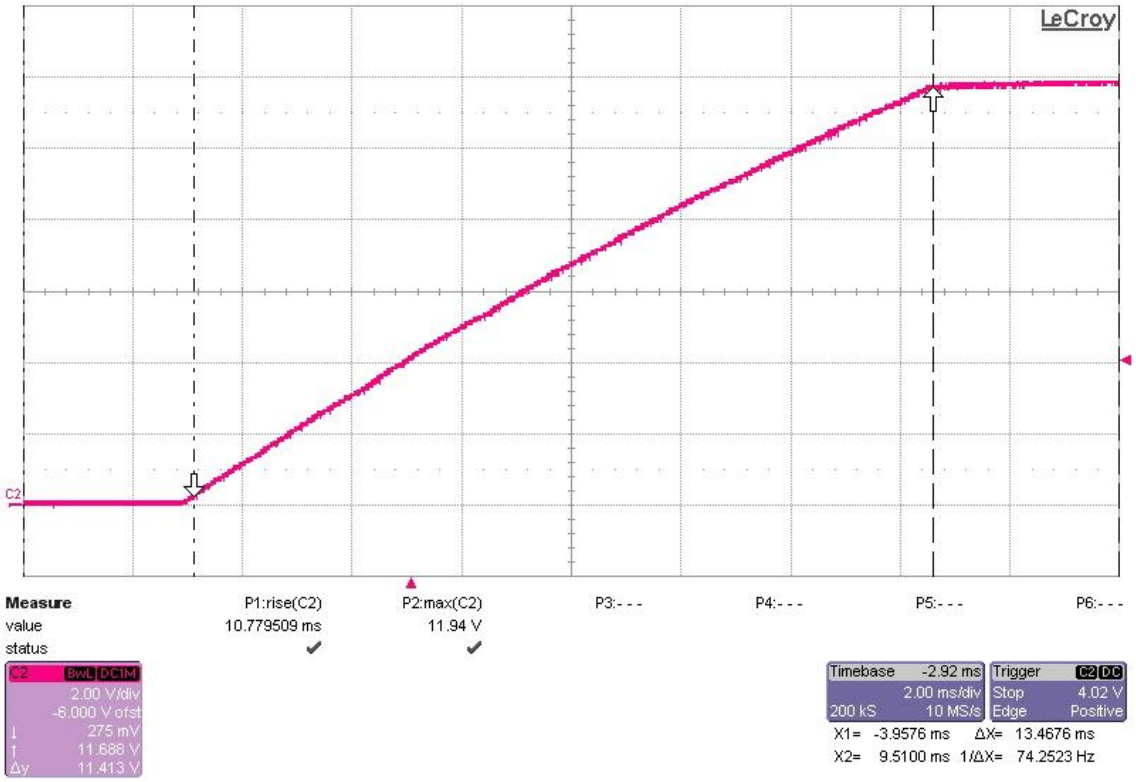
2.5.1 Start Up @ 20.4V_{AC}: 12V/50mA.



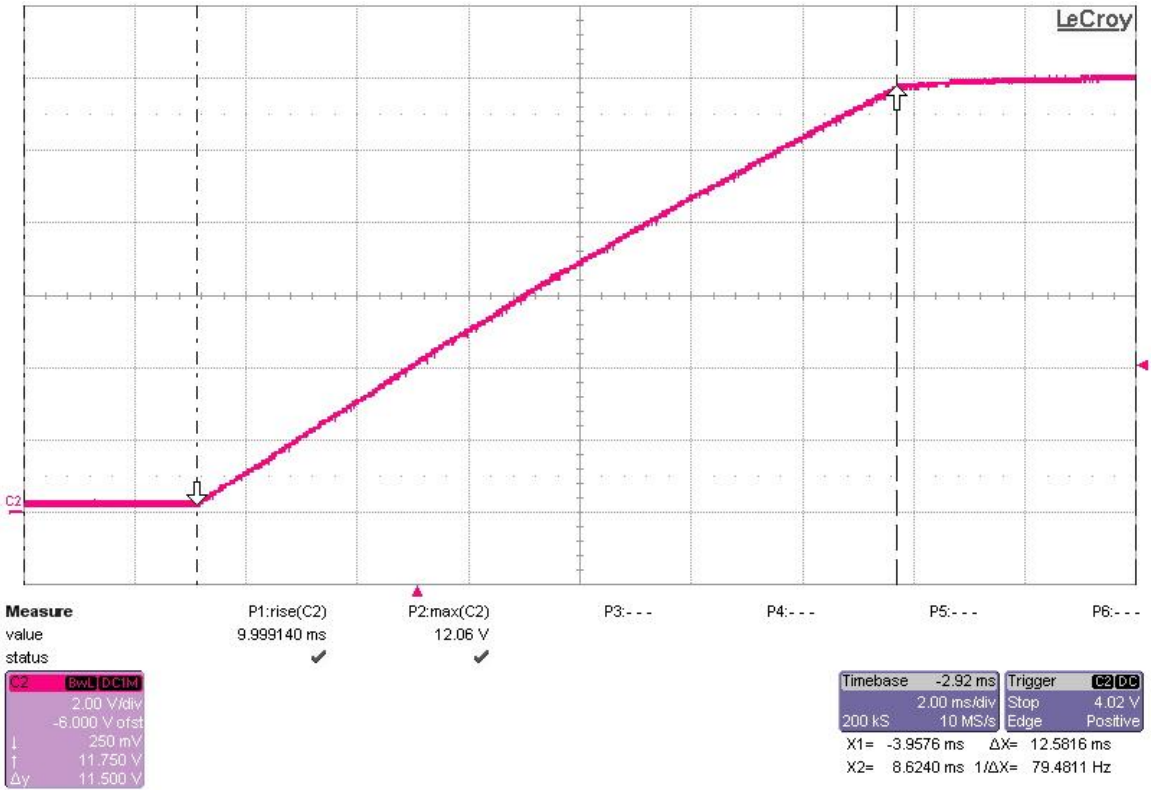
2.5.2 Start Up @ 20.4V_{AC}: no load.



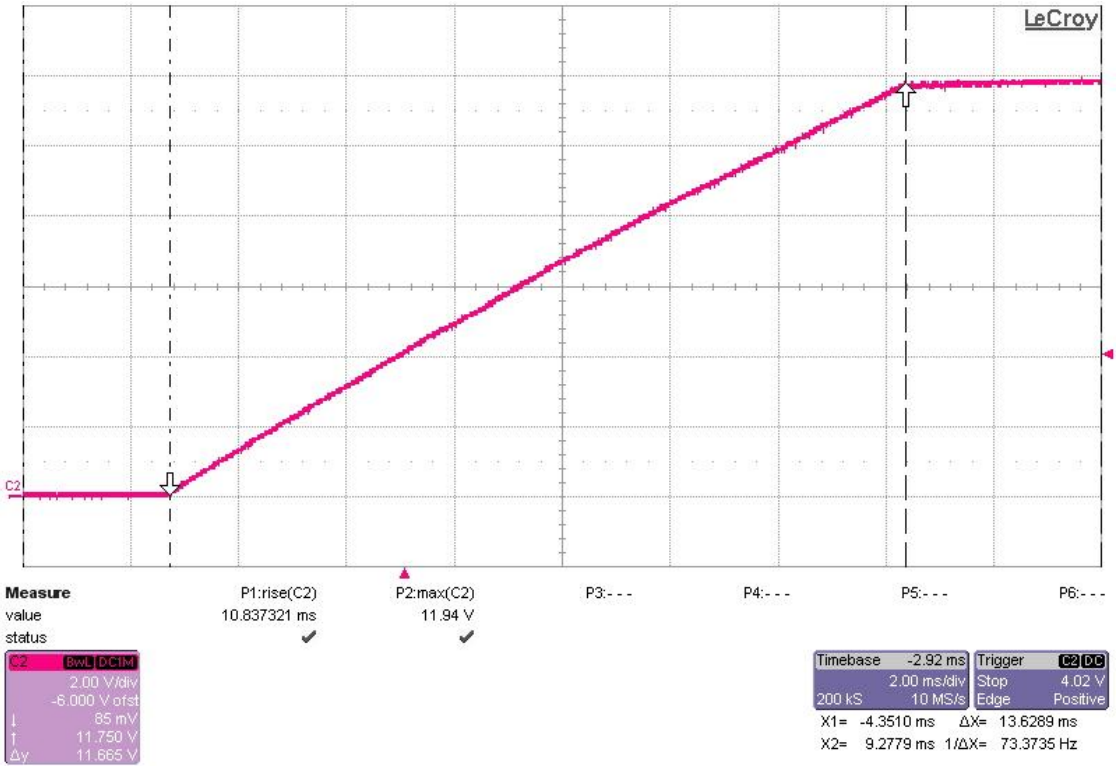
2.5.3 Start Up @ 150VAC: 12V/50mA.



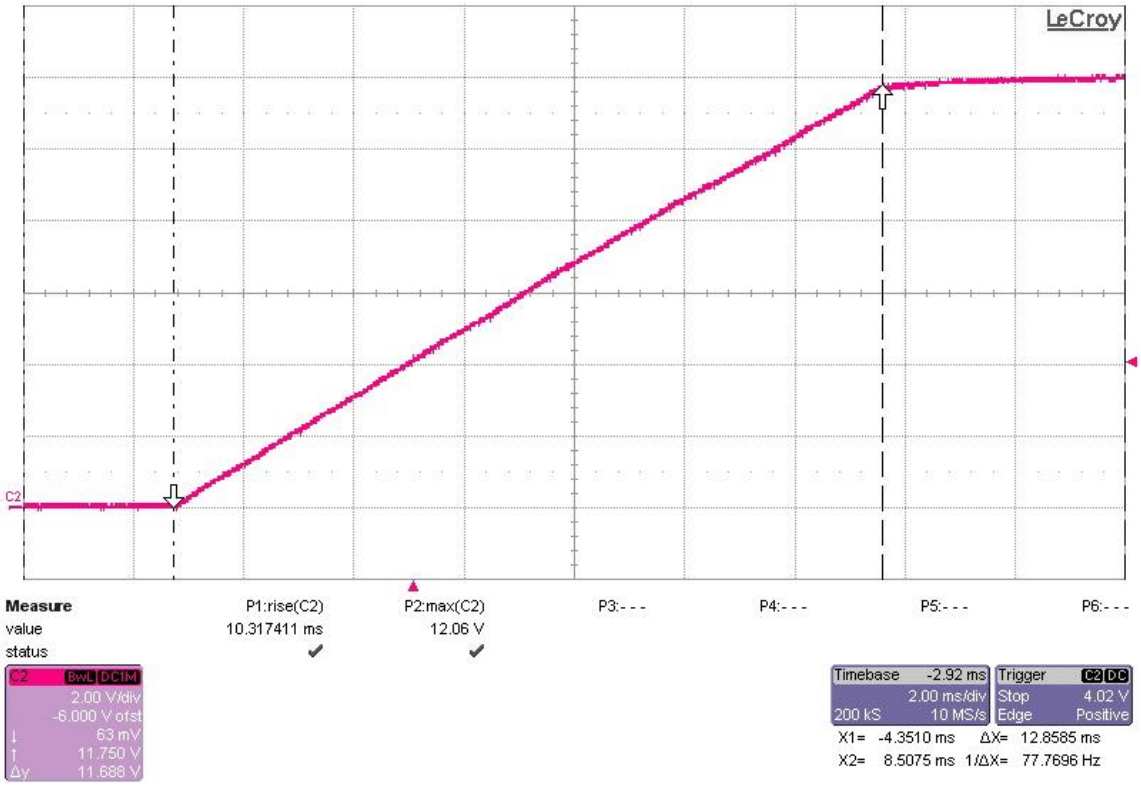
2.5.4 Start Up @ 150VAC: 12V/50mA.



2.5.5 Start Up @ 270VAC: 12V/50mA.



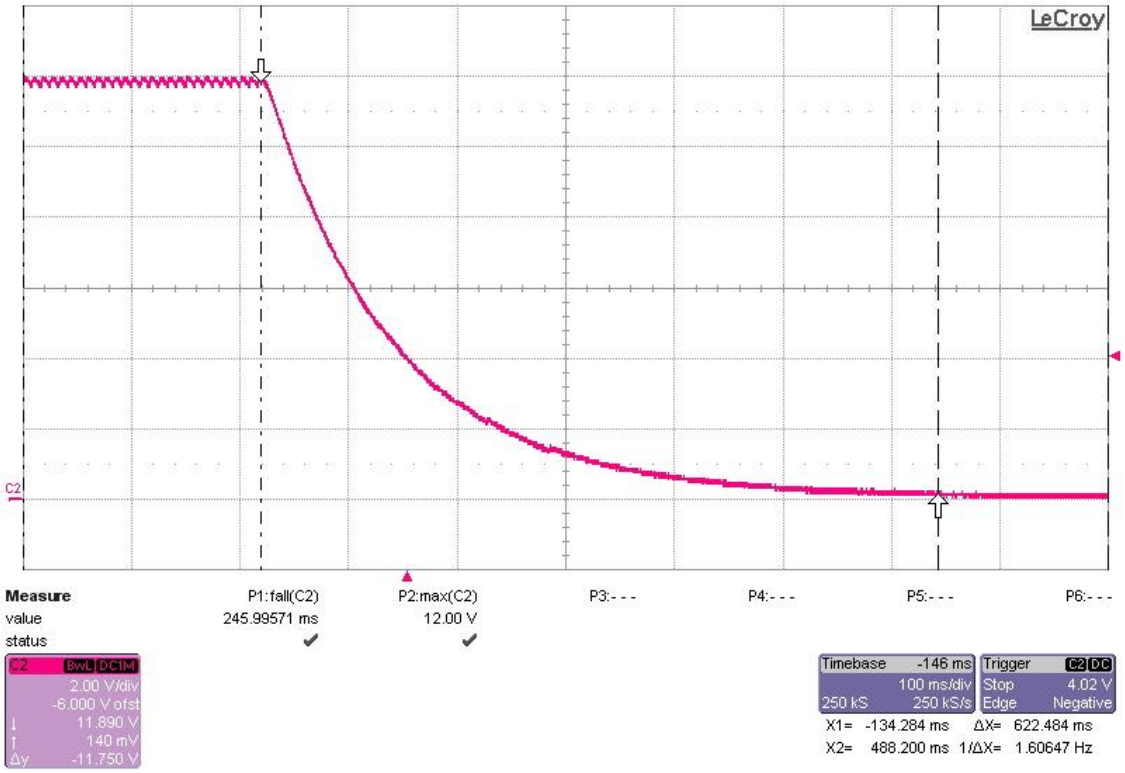
2.5.6 Start Up @ 270VAC: no load.



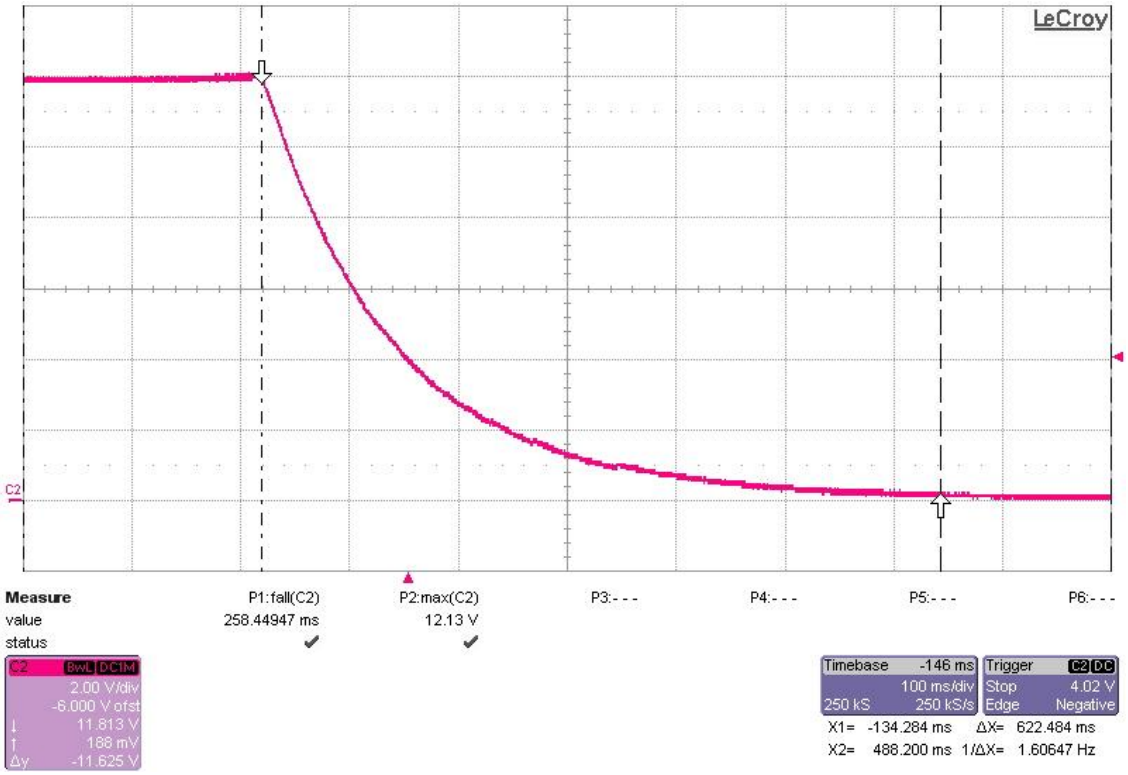
2.6 Turn Off

The output voltage at turn off transient is shown in the image below at full load (12V/50mA).

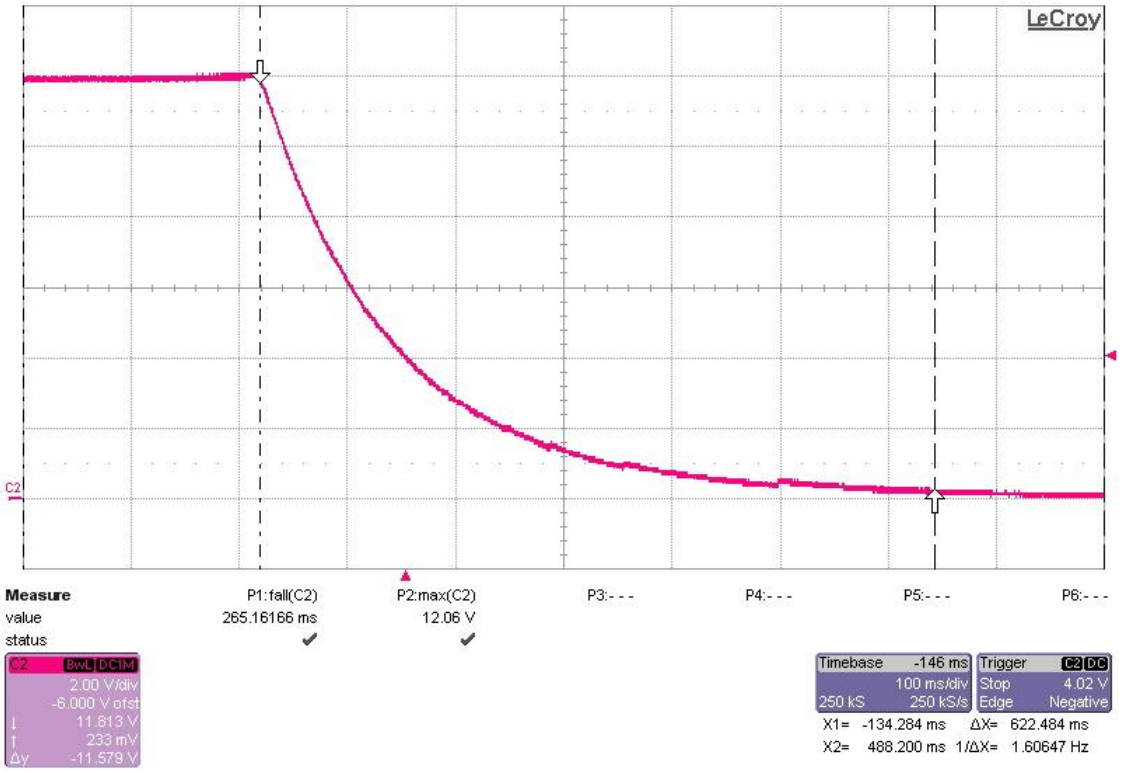
2.6.1 Turn off @ 20.4V_{AC}: 12V/50mA.



2.6.2 Turn off @ 150V_{AC}: 12V/50mA.



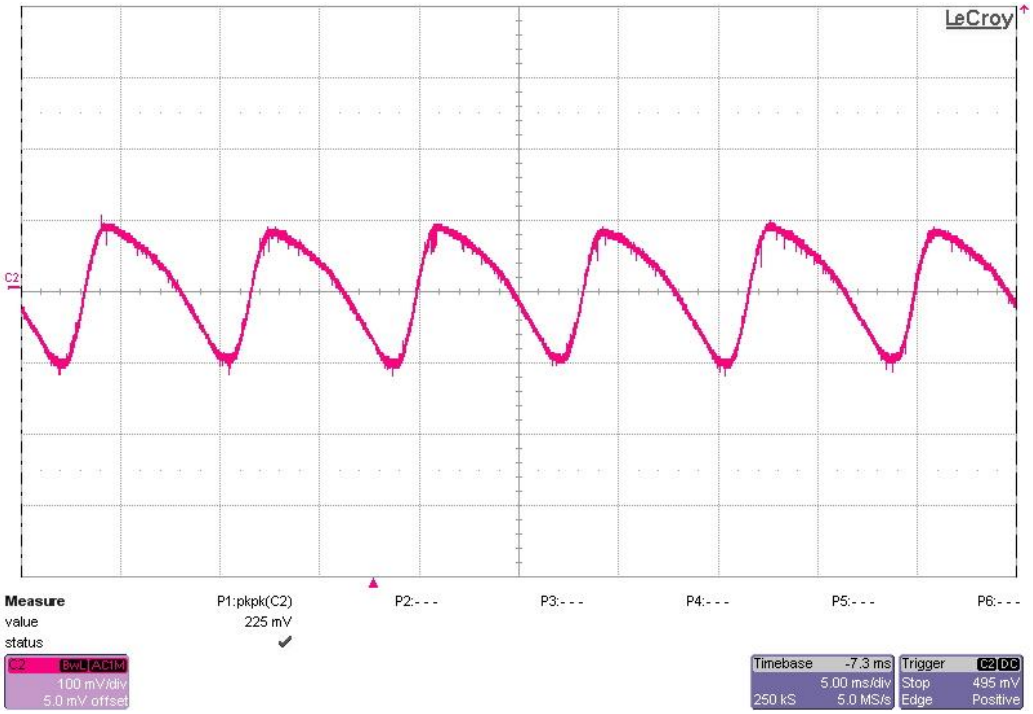
2.6.3 Turn off @ 270V_{AC}: 12V/50mA.



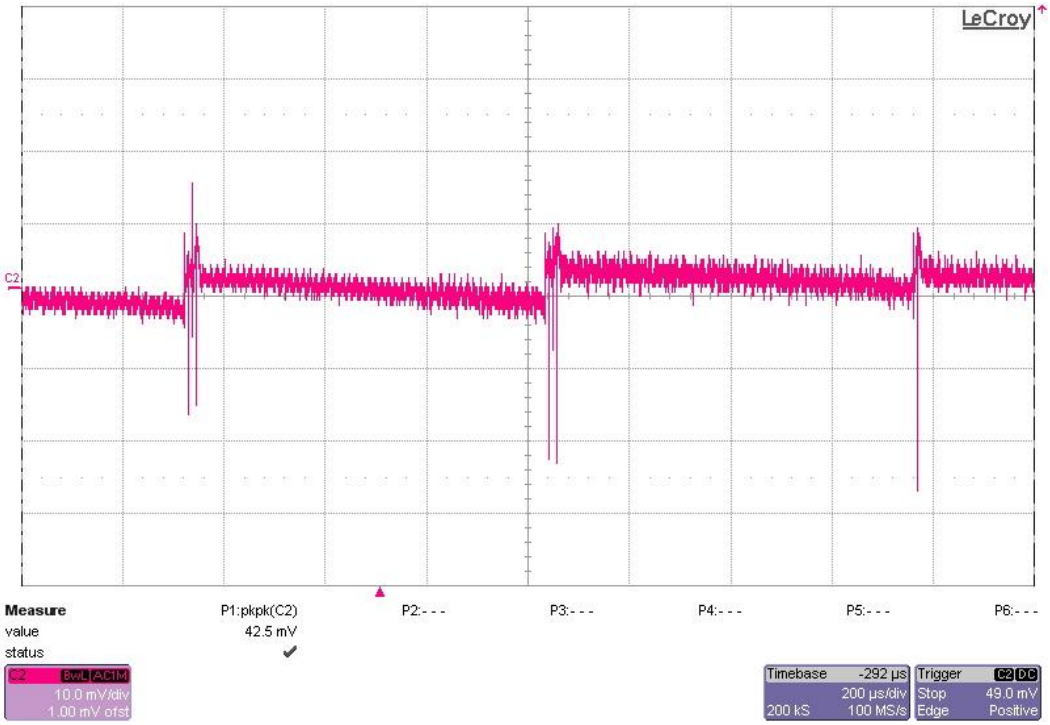
2.7 Output Ripple Voltages

The output ripple voltages are shown in the plots below.

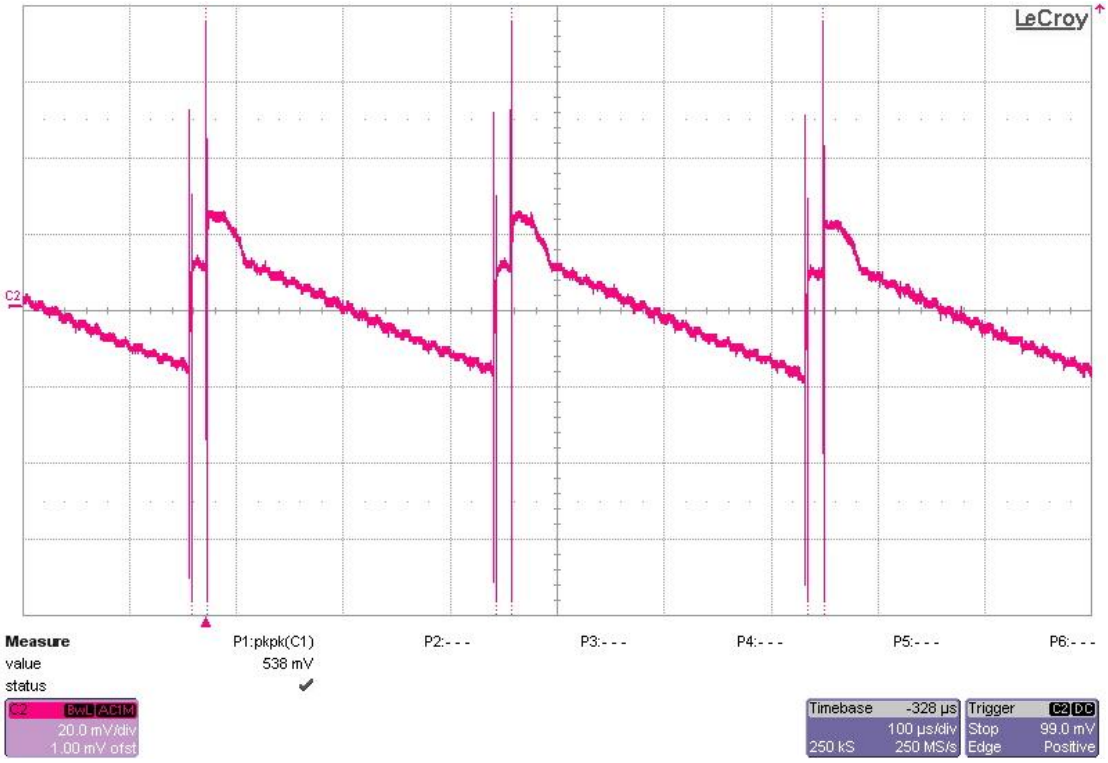
2.7.1 20.4V_{AC}: 12V/50mA:



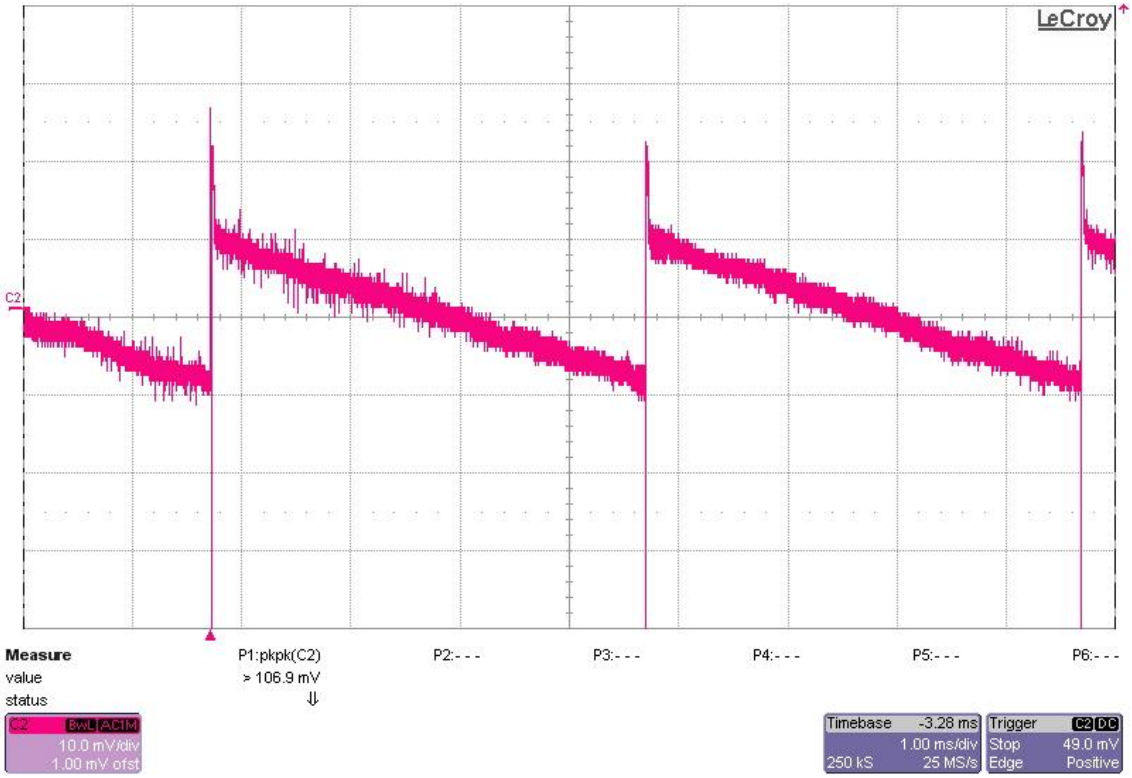
2.7.2 20.4V_{AC}: no load:



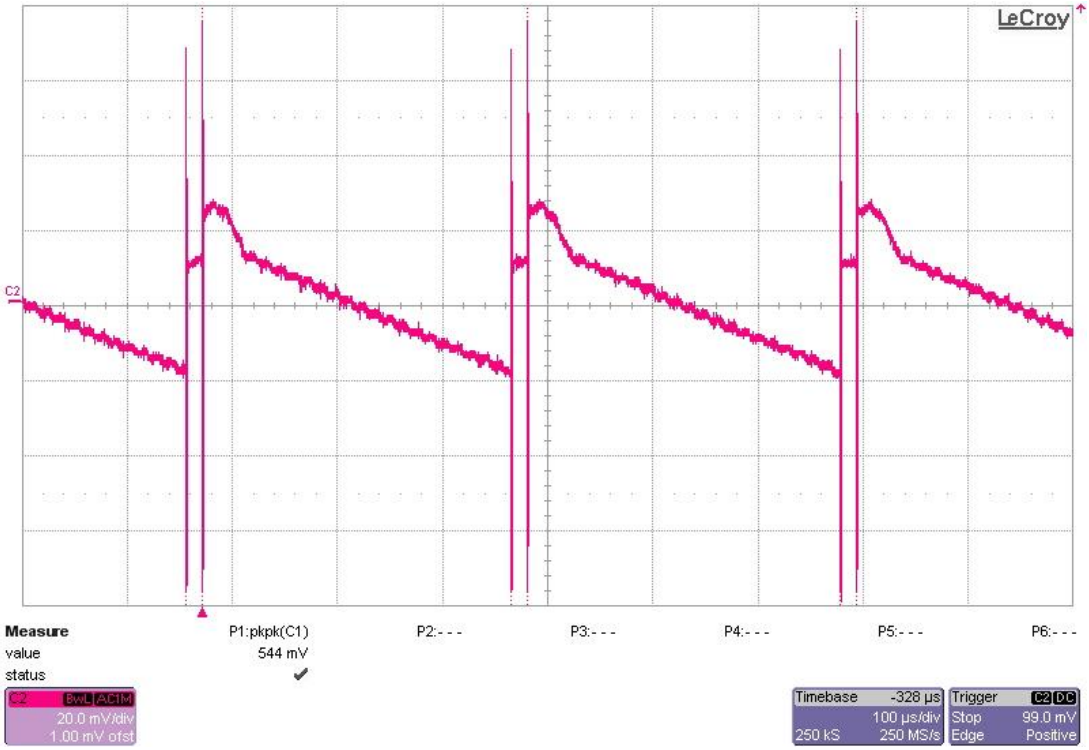
2.7.3 150V_{AC}: 12V/50mA:



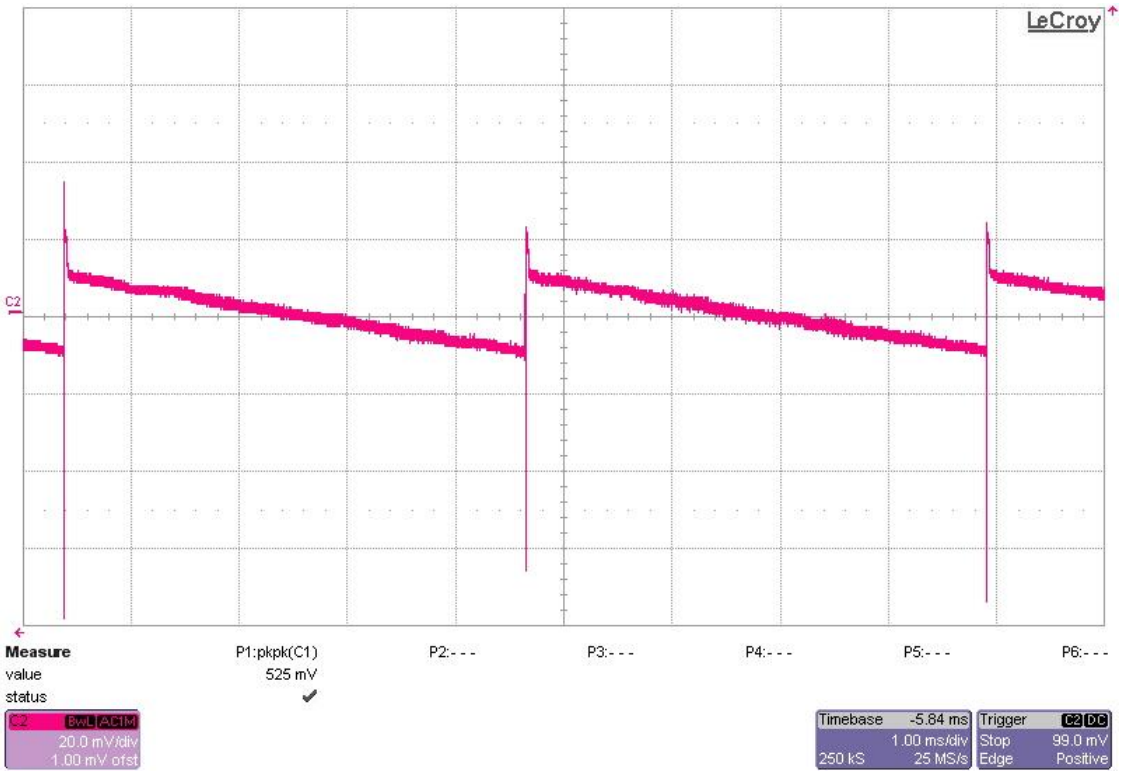
2.7.4 150V_{AC}: no load:



2.7.5 270V_{AC}: 12V/50mA:

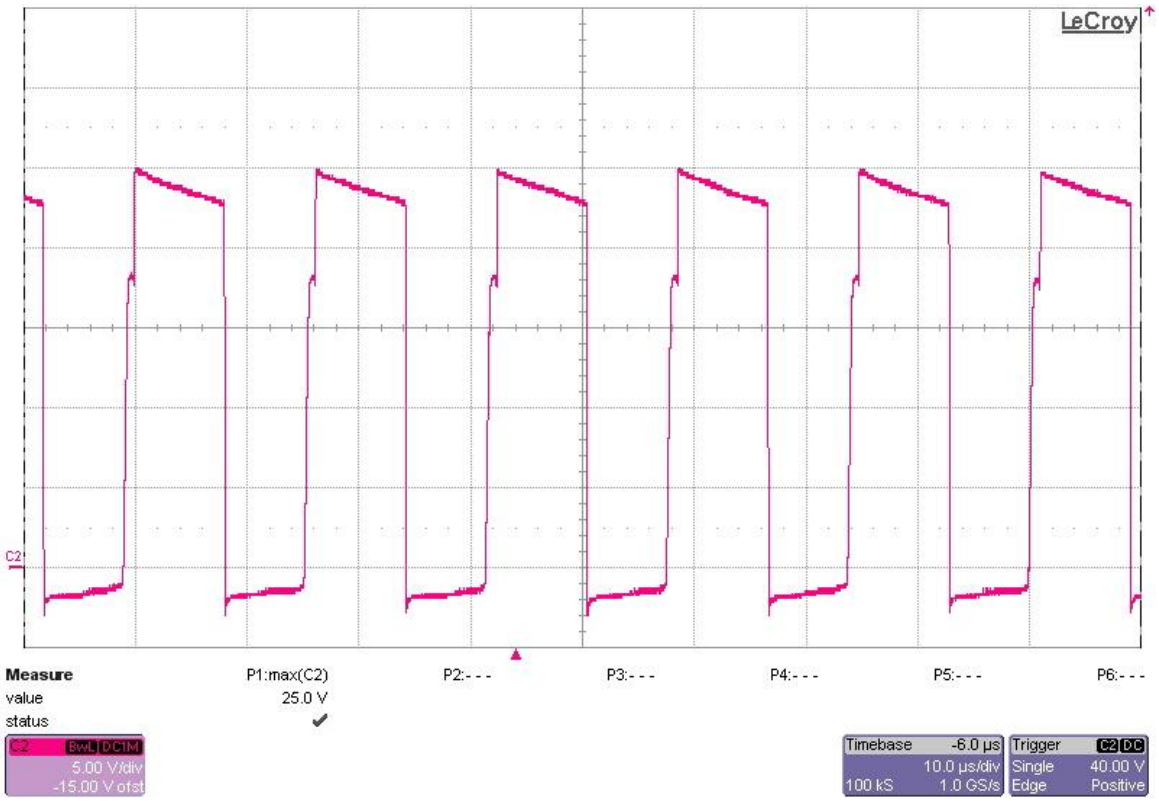


2.7.6 270V_{AC}: no load:

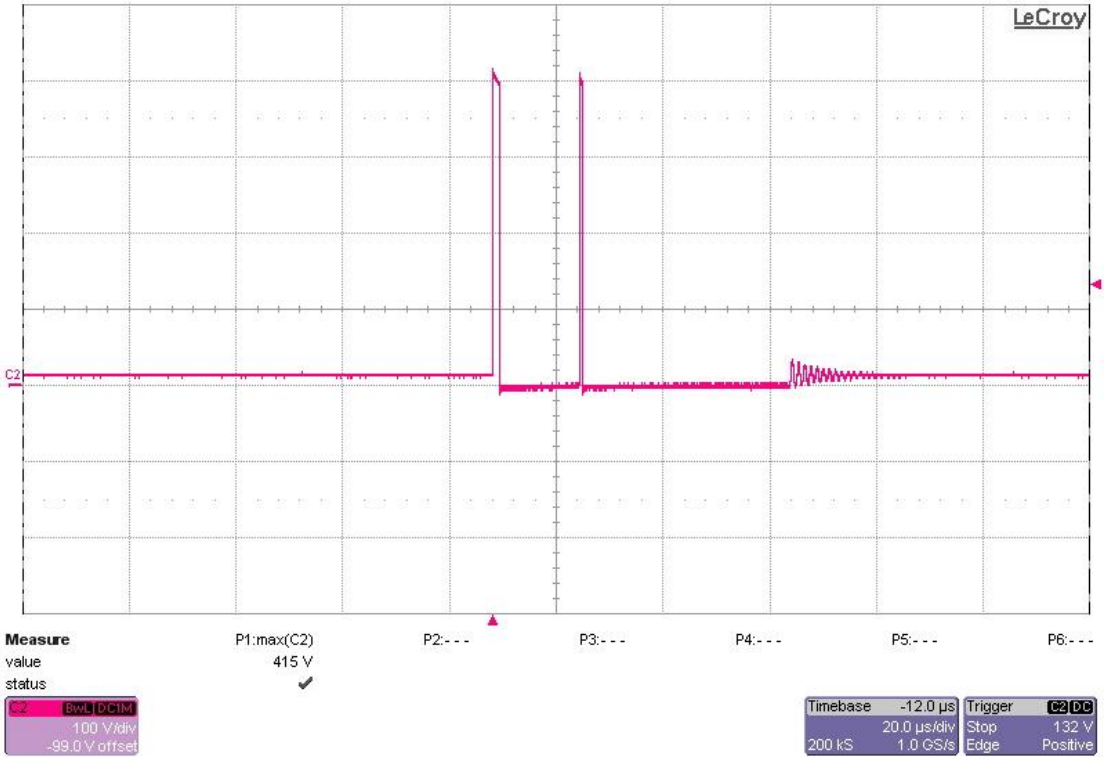


2.8 Switching Waveforms

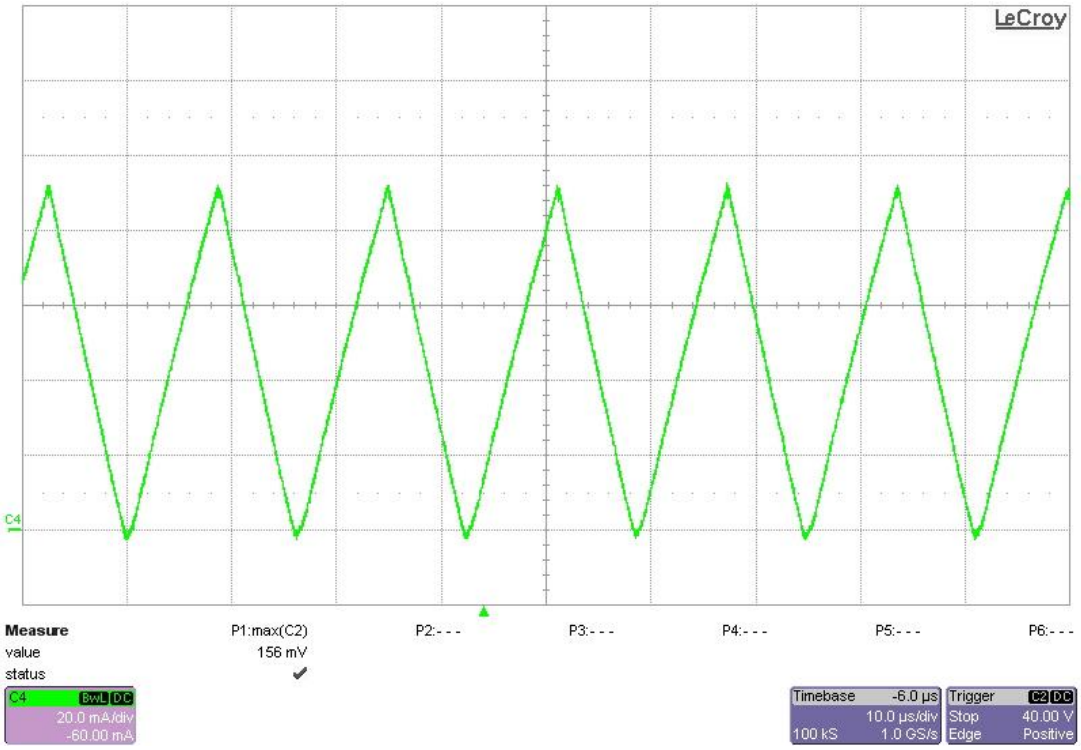
2.8.1 Diode D3 @ 20.4V_{AC}/60Hz



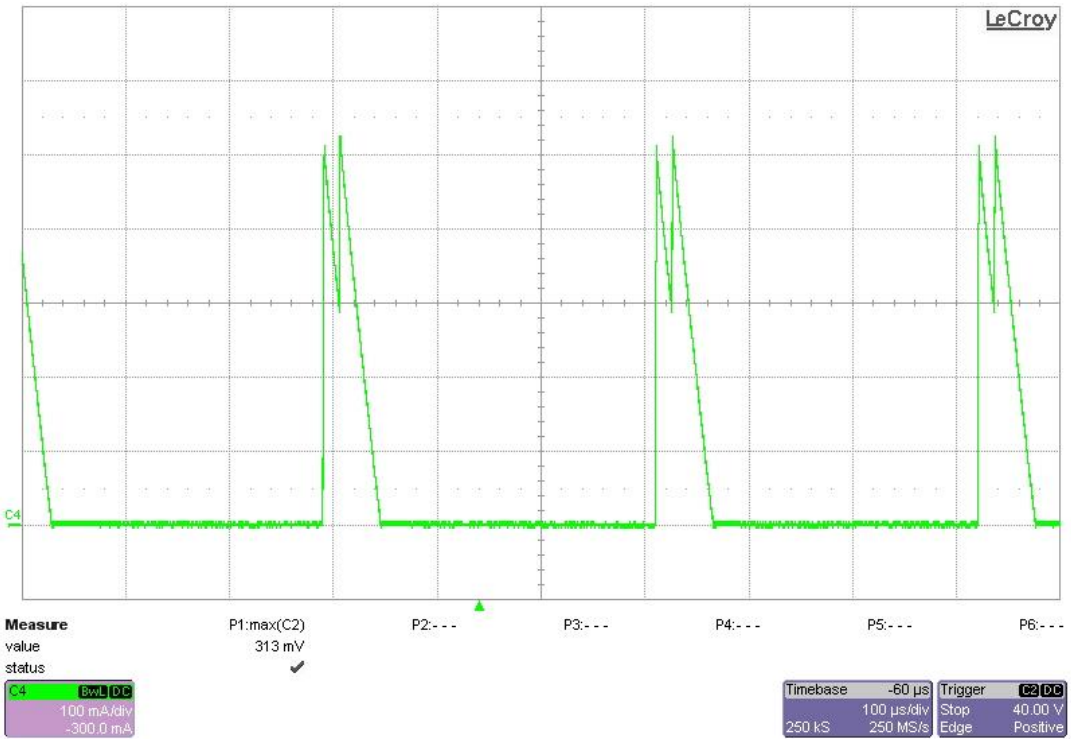
2.8.2 Diode D3 @ 270V_{AC}/60Hz



2.8.3 L1 current @ 20.4AC (12V/50mA)



2.8.4 L1 current @270VAC (12V/50mA)



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