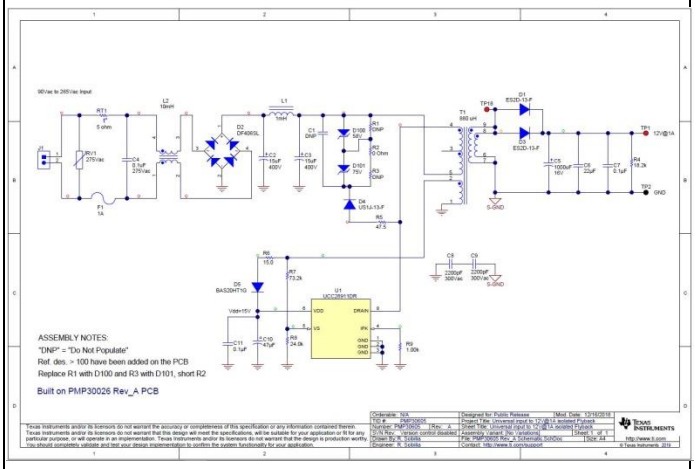
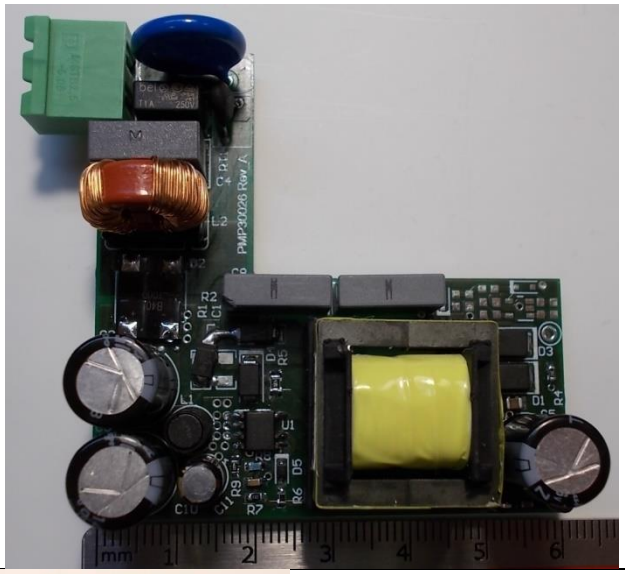
Test Report: PMP30605
Universal input to 12 V at 1-A isolated flyback reference design

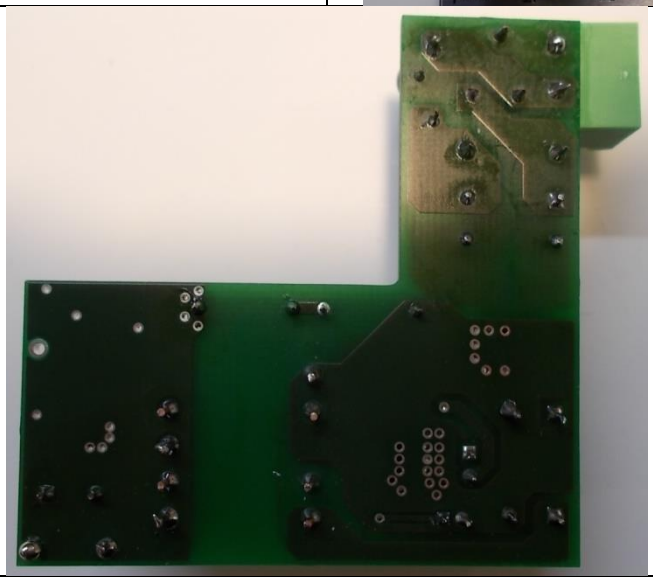
Description

Constant voltage/constant current power supplies generate 12 V at 1-A output at 80% average efficiency with greater than 75% efficiency at 10% load and less than 30 mW (at 230 VAC) no load power. The design features primary side regulation (PSR) and integrated 700-V FET. With a low component count, this reference design can be used as general purpose power supply.

The reference design PMP30605 Rev_A has been built on PMP30026 Rev_A PCB.







1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage	90VAC – 265VAC
Output Voltage	12VDC
Output Current	1A

1.2 Required Equipment

- 90…265VAC, (minimum current limit 3Arms), AC constant voltage source (VS1)
- Electronic load, (constant current range 0…2A)
- Oscilloscope (min. 100 MHz bandwidth)
- Current probe (min. 100 KHz bandwidth)
- Optional: infrared camera

1.3 Considerations

a) Connect the source VS1 to J1-1 and J1-2.
b) Connect the load to TP1 (plus) and TP2 (ground).
c) After turn off, wait ~ 5 minutes until C2 and C3 input capacitors are completely discharged (warning: HIGH VOLTAGE)

2 Testing and Results

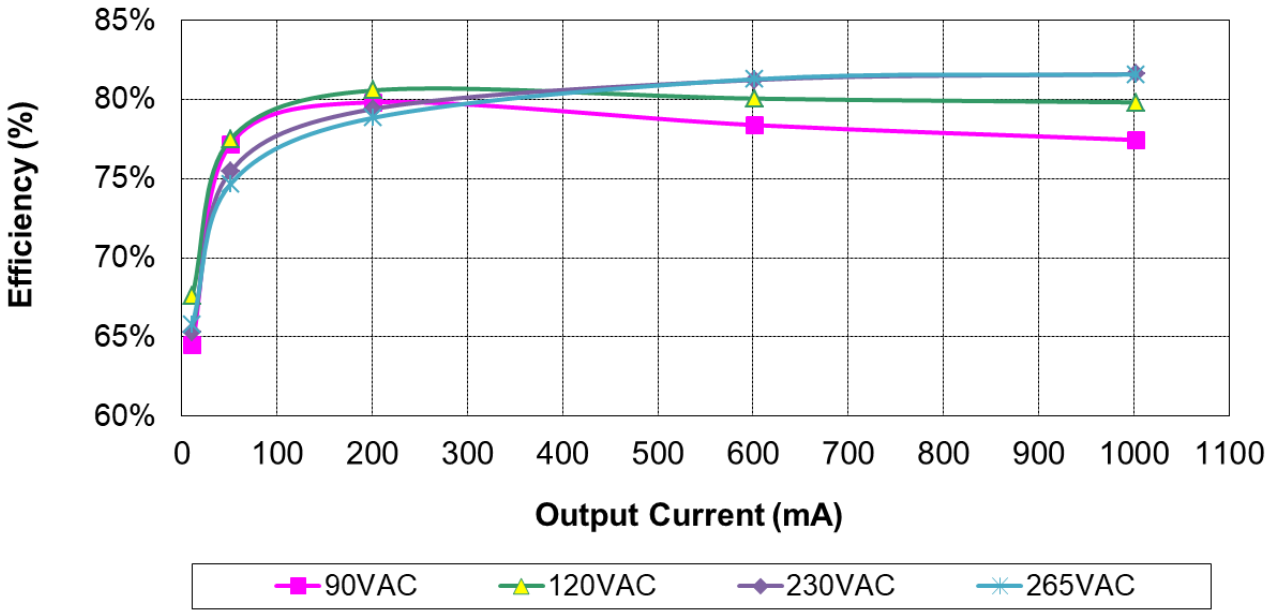
2.1 Dimensions

The board dimensions are 60 mm x 60 mm, with 18 mm height.

2.2 Efficiency Graph and Data

2.2.1 Efficiency Graph:

The efficiency data, versus input AC voltage and load, are shown in the tables and graph below. The input voltage has been set respectively to 90VAC, 120VAC, 230VAC and 265VAC.



2.2.2 Efficiency Data:

The efficiency graph reports the data from the tables shown below:

VAC	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
90	0.02991	11.96	0	0	0.0%
90	0.2004	11.85	10.9	0.129	64.5%
90	0.782	11.81	51.1	0.603	77.2%
90	2.973	11.83	200.6	2.37	79.8%
90	9.095	11.84	602.1	7.13	78.4%
90	15.349	11.85	1003	11.89	77.4%

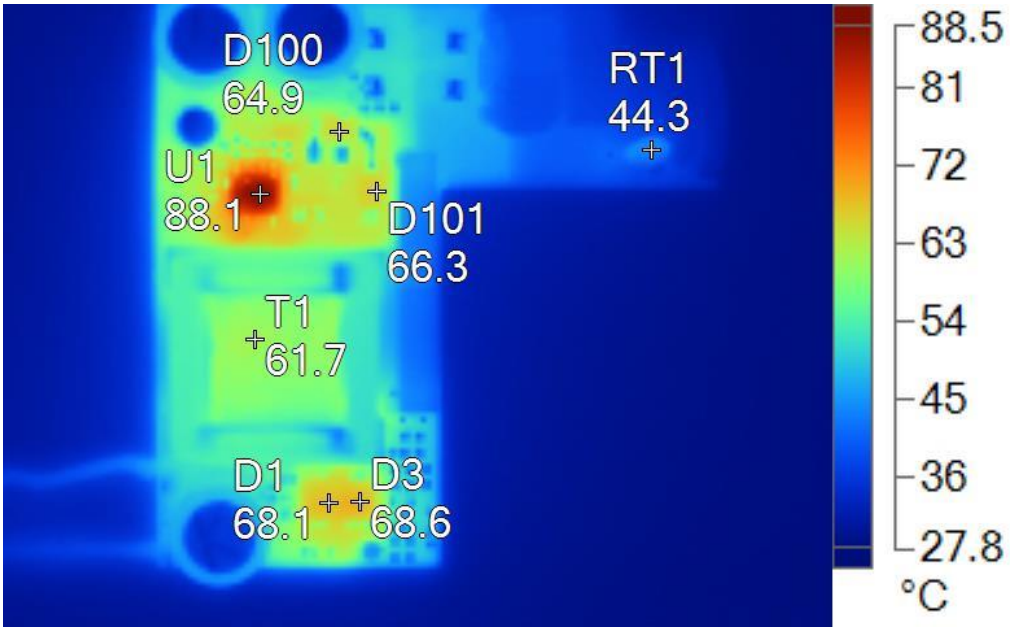
VAC	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
120	0.03252	11.96	0	0	0.0%
120	0.1929	11.86	11.0	0.130	67.6%
120	0.779	11.82	51.1	0.604	77.5%
120	2.941	11.81	200.7	2.37	80.6%
120	8.891	11.82	602.1	7.12	80.1%
120	14.887	11.85	1003	11.88	79.8%

VAC	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
230	0.02958	11.94	0	0	0.0%
230	0.1993	11.83	11.0	0.130	65.3%
230	0.800	11.81	51.1	0.604	75.5%
230	2.984	11.80	200.7	2.37	79.4%
230	8.767	11.83	602.1	7.12	81.2%
230	14.584	11.86	1003	11.90	81.6%

VAC	Pin (W)	Vout (V)	Iout(mA)	Pout (W)	Efficiency (%)
265	0.03274	11.94	0	0	0.0%
265	0.1978	11.83	11.0	0.130	65.8%
265	0.809	11.81	51.1	0.604	74.7%
265	3.005	11.80	200.7	2.37	78.8%
265	8.762	11.83	602.1	7.12	81.3%
265	14.587	11.86	1003	11.90	81.6%

2.3 Thermal Image

The graph below shows the thermal picture of the converter supplied at 120VAC, 60Hz. The image has been taken after the board was running for 30 minutes, placed horizontal on the bench, at full load, with ambient temperature of 25.5°C and in still air condition.

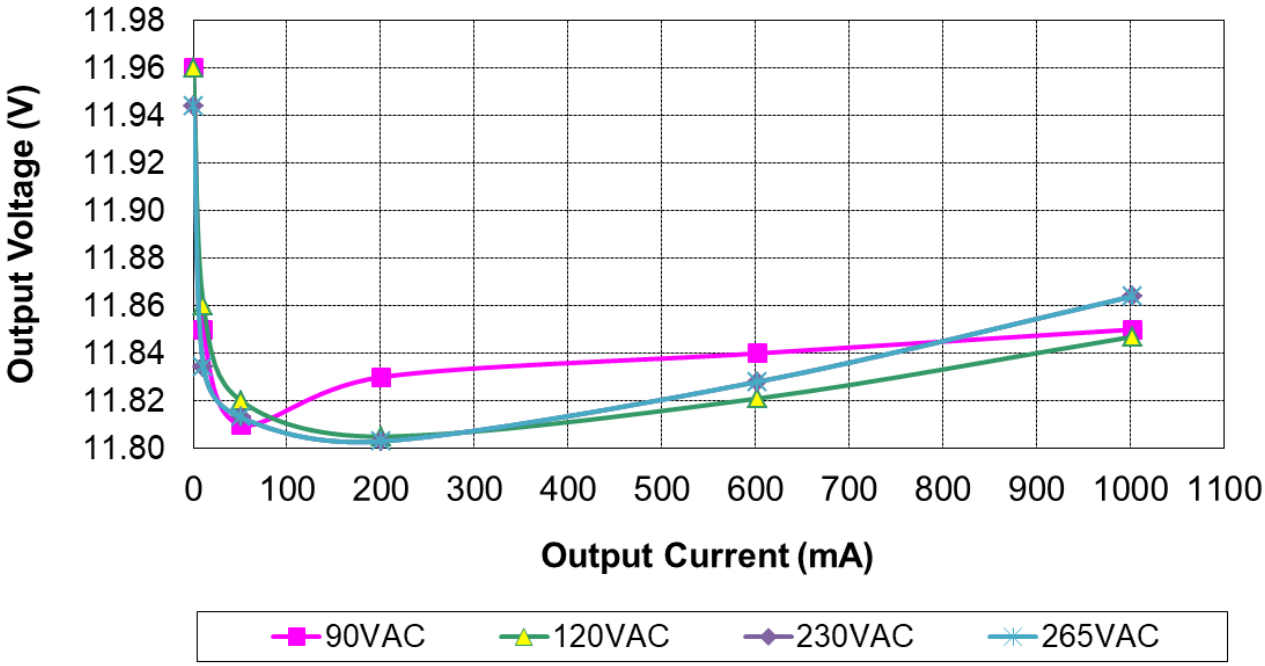


Main Image Markers

Name	Temperature	Emissivity	Background
U1	88.1°C	0.96	25.5°C
T1	61.7°C	0.96	25.5°C
D1	68.1°C	0.96	25.5°C
D3	68.6°C	0.96	25.5°C
D101	66.3°C	0.96	25.5°C
D100	64.9°C	0.96	25.5°C
RT1	44.3°C	0.96	25.5°C

2.4 Static Output Voltage Variation versus Load

The output voltage regulation versus load current is shown in the graph below.



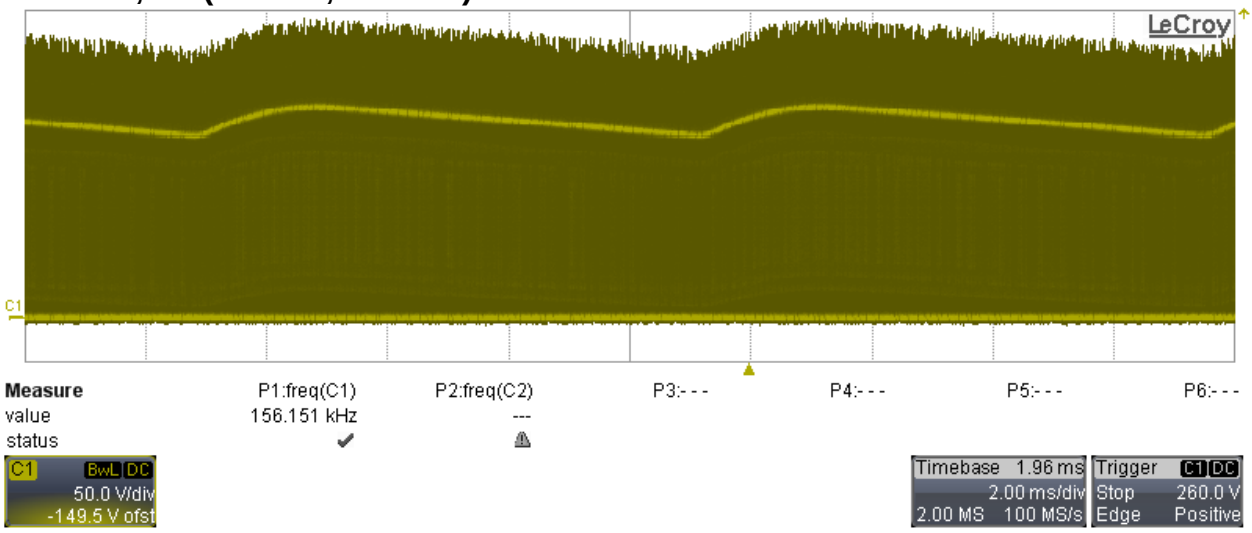
3 Waveforms

3.1.1 Switching Waveforms on Drain of main FETs

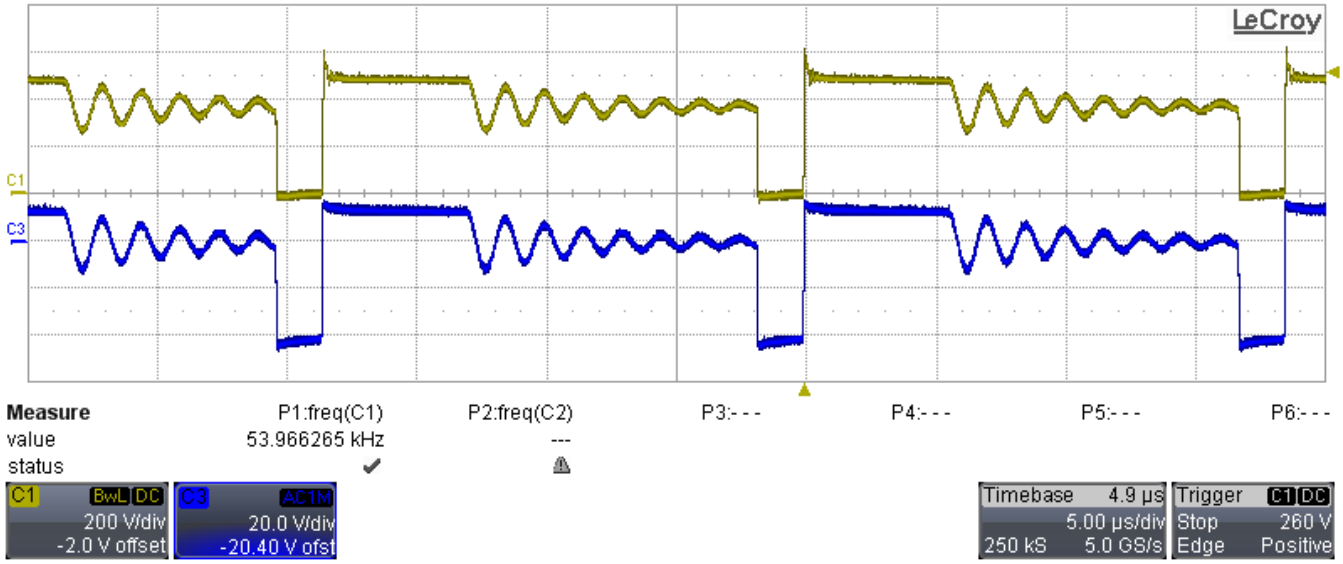
The switching waveforms have been measured by supplying the converter at 90VAC (useful to show 120Hz ripple) and 265VAC input voltage while the output was fully loaded. The second screenshot shows also TP18 voltage (anode of D1, D3); for all waveforms both probes have been set to DC coupling and 200MHz bandwidth limit.

Full load, Vin = 90VAC, 60Hz:

C1: Pin 8, U1 (50V/div, 2ms/div)



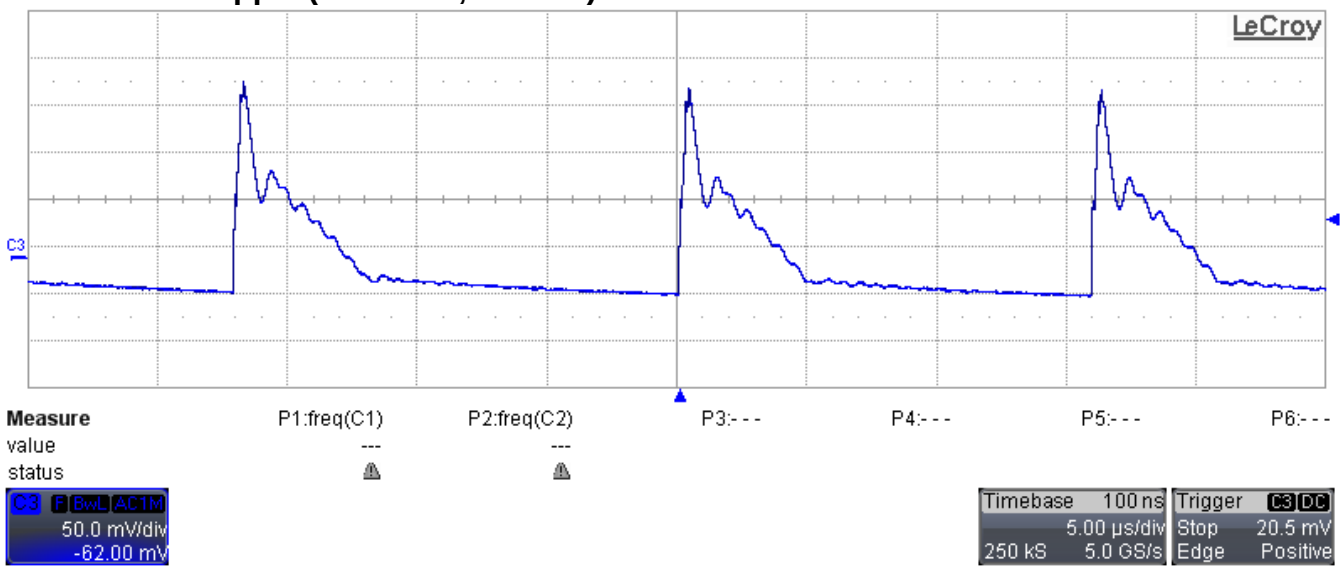
Full load, Vin = 265VAC, 50Hz:
C1: Pin 8, U1 (200V/div, 5us/div), C3: Voltage on TP18 (20V/div)



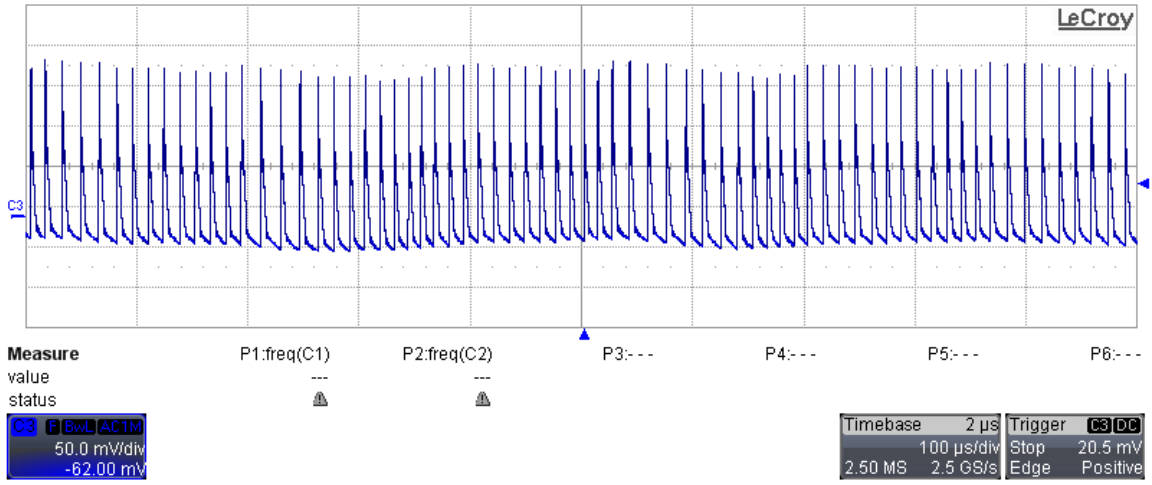
3.2 Output Voltage Ripple

The output voltage ripple has been measured by supplying the converter at 90VAC, 230VAC and 265VAC in light and full load condition. All screenshots have been taken with 20MHz bandwidth, with AC coupling.

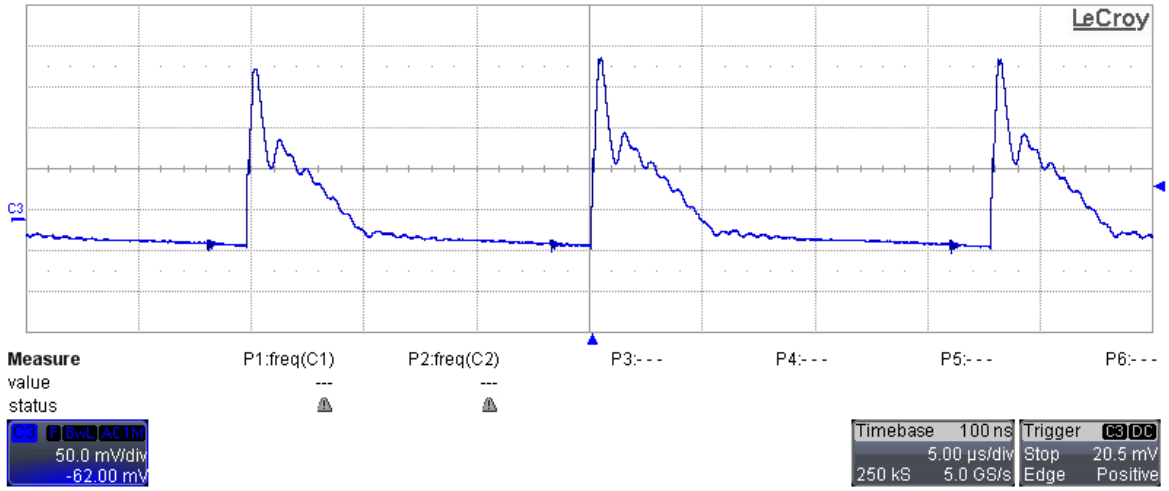
Full load, Vin = 90VAC, 60Hz:
C3: Vout ripple (50mV/div, 5us/div)



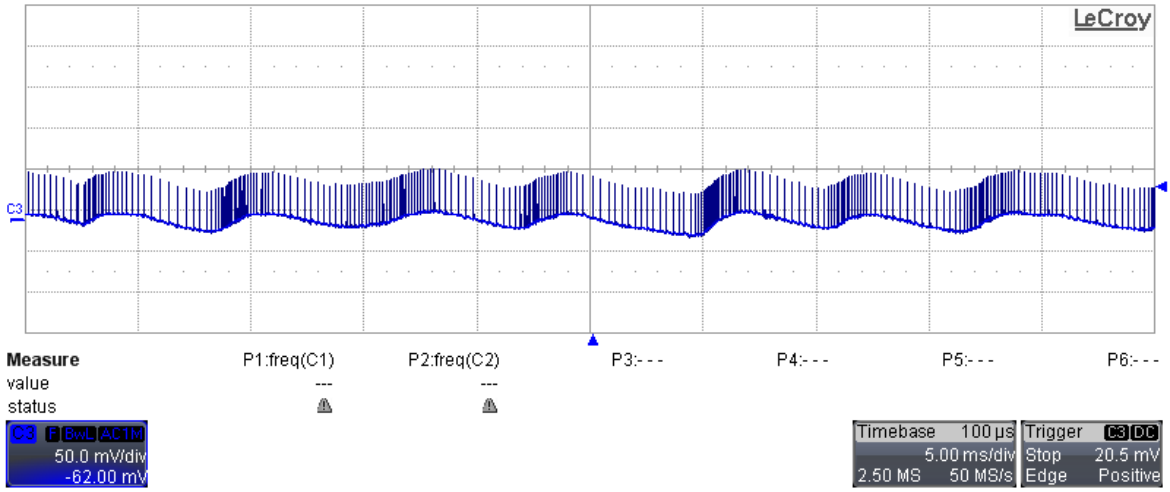
Full load, Vin = 90VAC, 60Hz:
C3: Vout ripple (50mV/div, 100us/div)



Full load, Vin = 265VAC, 50Hz:
C3: Vout ripple (50mV/div, 5us/div)



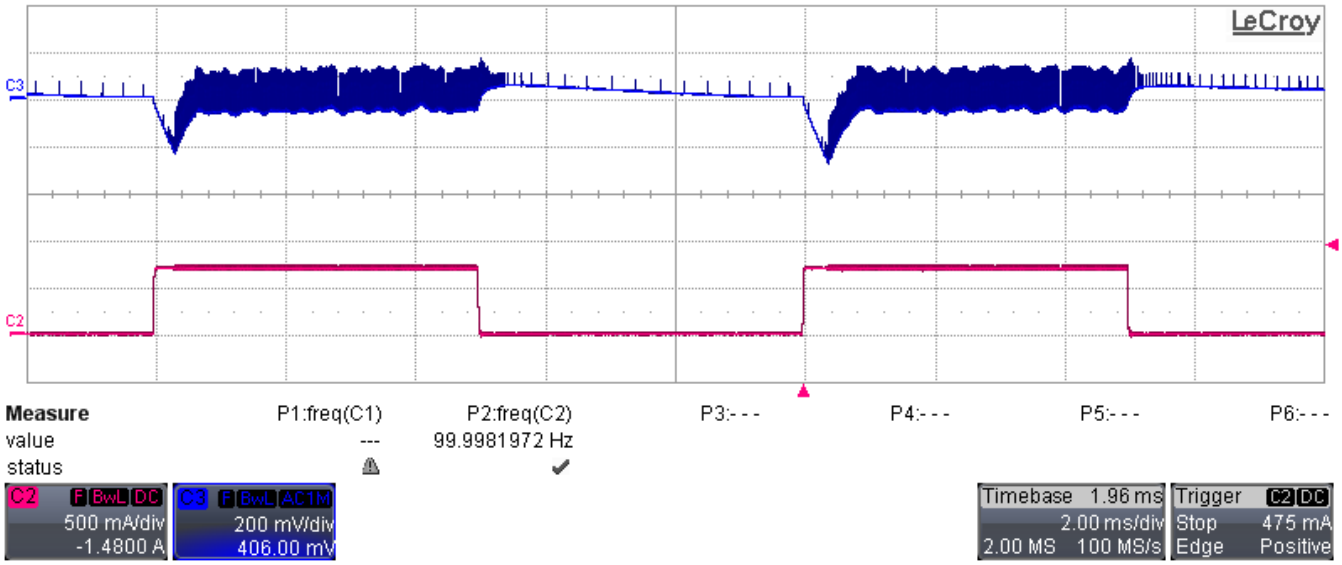
Load = 13mA, Vin = 230VAC, 50Hz:
C3: Vout ripple (50mV/div, 5ms/div)



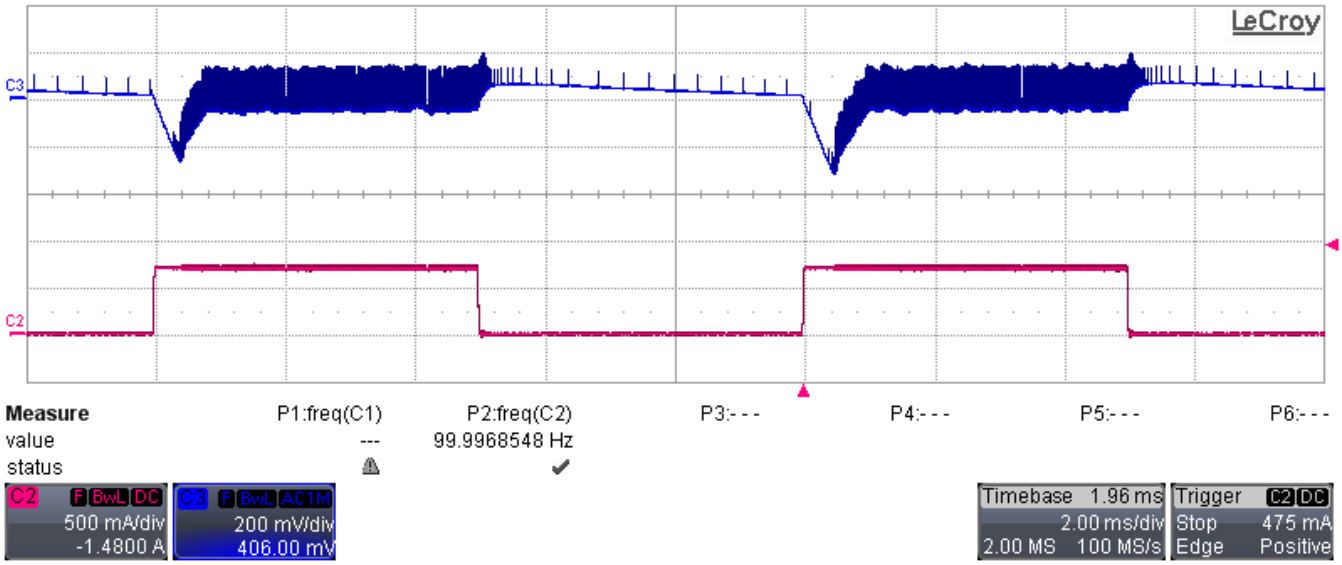
3.3 Load Transients

The output voltage variation, during load transients, has been measured by supplying the converter at 90VAC and 230VAC. For all waveforms the bandwidth of the scope has been set to 20 MHz.

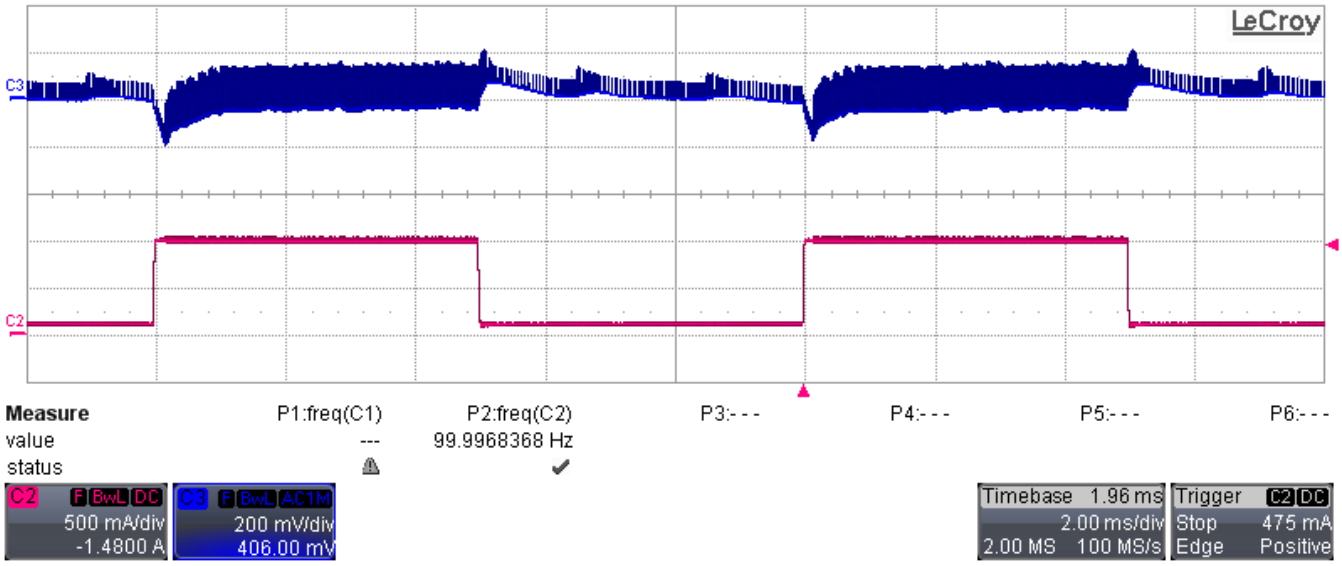
Vin = 90VAC, 60Hz; Iout = 10mA → 700mA
C2: Output current (500mA/div, 2ms/div, DC coupling)
C3: Output voltage (200mV/div, AC coupling)



Vin = 230VAC, 50Hz; Iout = 10mA → 700mA
C2: Output current (500mA/div, 2ms/div, DC coupling)
C3: Output voltage (200mV/div, AC coupling)



Vin = 230VAC, 50Hz; Iout = 100mA → 1A
C2: Output current (500mA/div, 2ms/div, DC coupling)
C3: Output voltage (200mV/div, AC coupling)

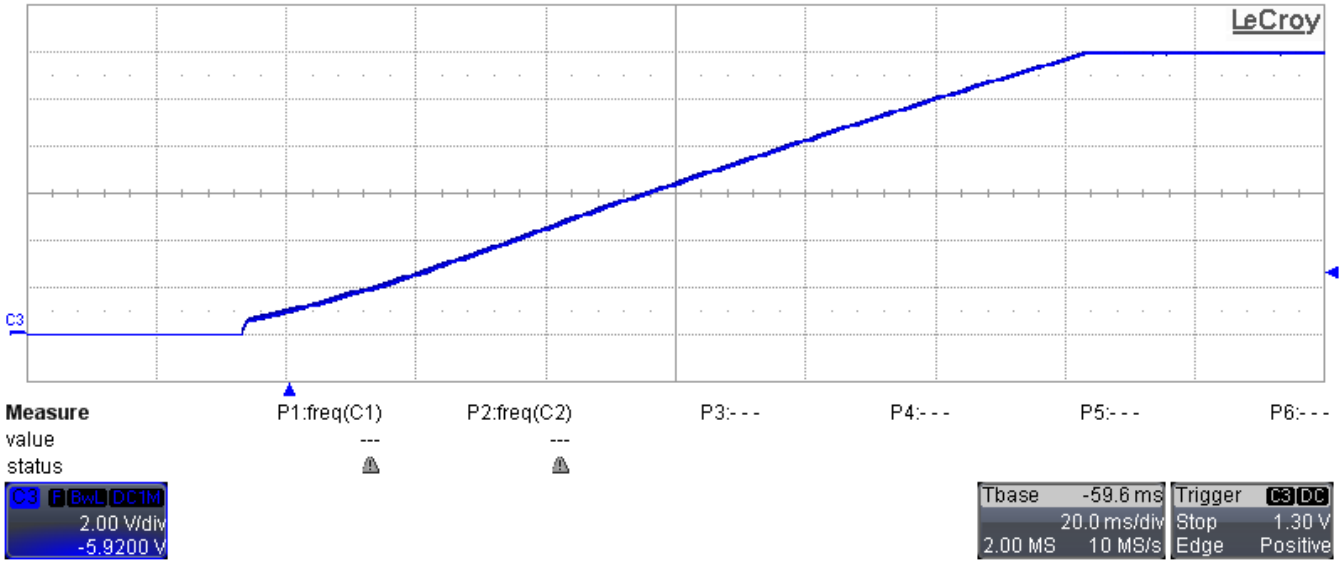


3.4 Start-up and shut-down Sequences

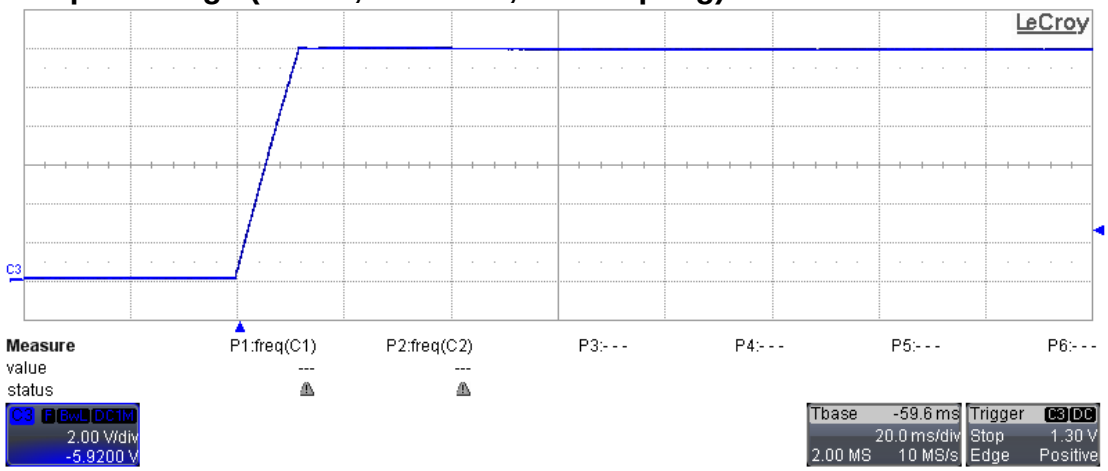
3.4.1 Start-up

The output voltage behavior at start-up versus load and input AC voltage is shown in the images below. The input voltage was set to minimum and maximum value, respectively 90VAC and 265VAC. All waveforms were taken with DC coupling and at 20 MHz bandwidth.

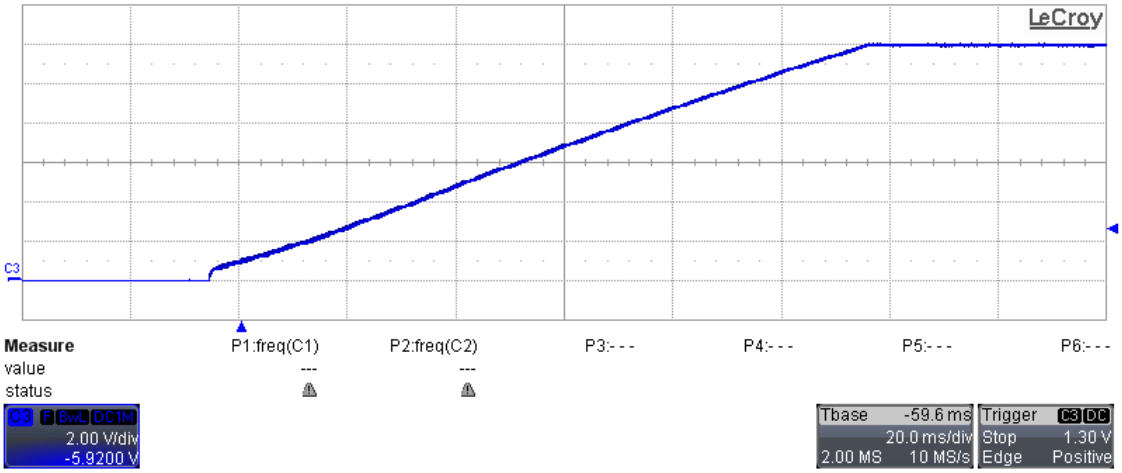
Full load, Vin = 90VAC, 60Hz;
C3: Output voltage (2V/div, 20ms/div, DC coupling)



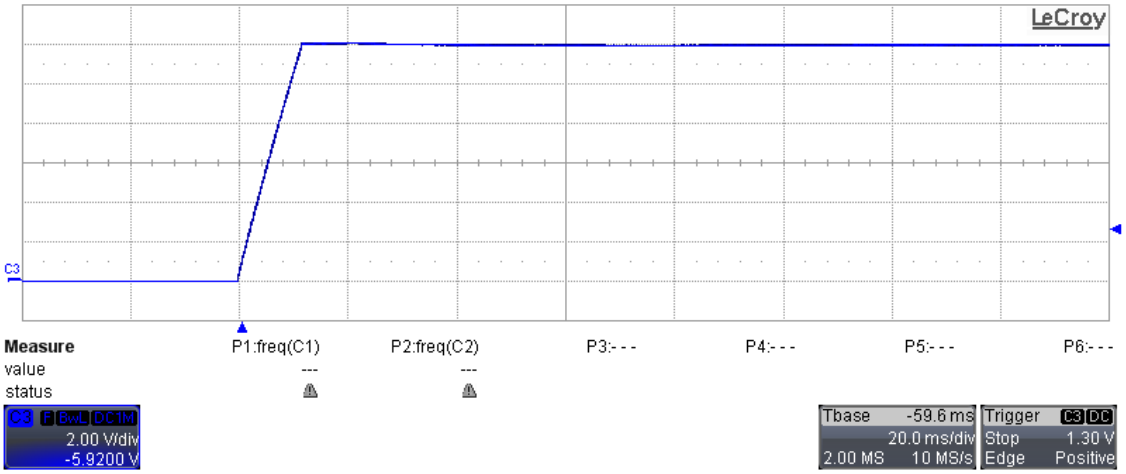
No load, Vin = 90VAC, 60Hz;
C3: Output voltage (2V/div, 20ms/div, DC coupling)



Full load, Vin = 265VAC, 50Hz;
C3: Output voltage (2V/div, 20ms/div, DC coupling)



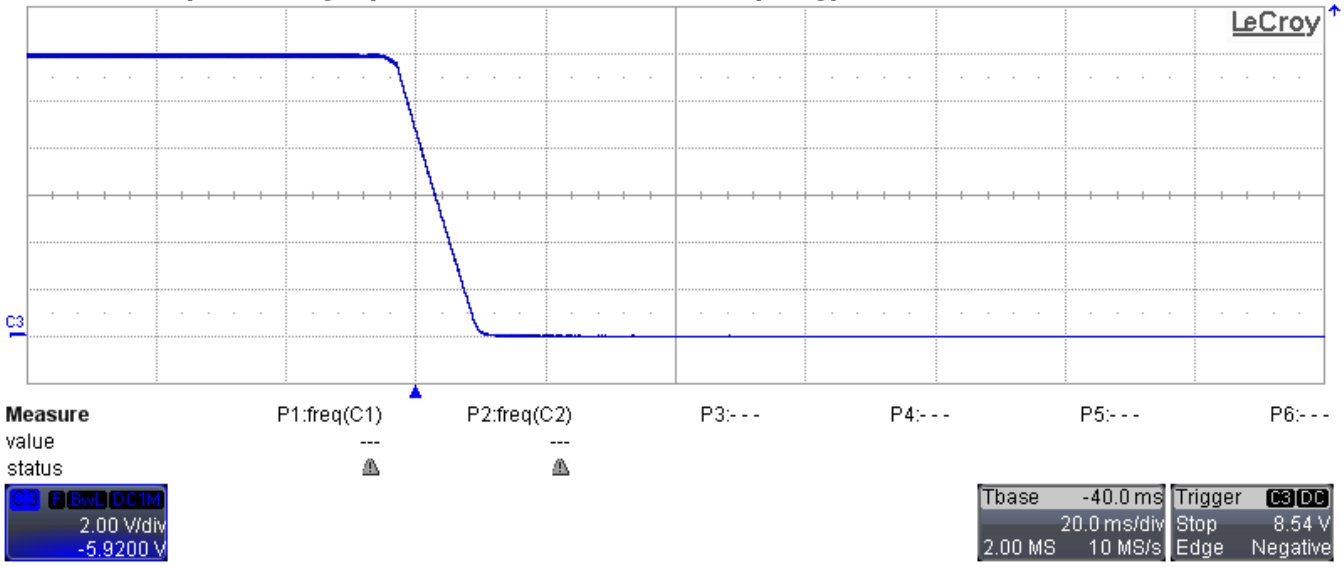
No load, Vin = 265VAC, 50Hz;
C3: Output voltage (2V/div, 20ms/div, DC coupling)



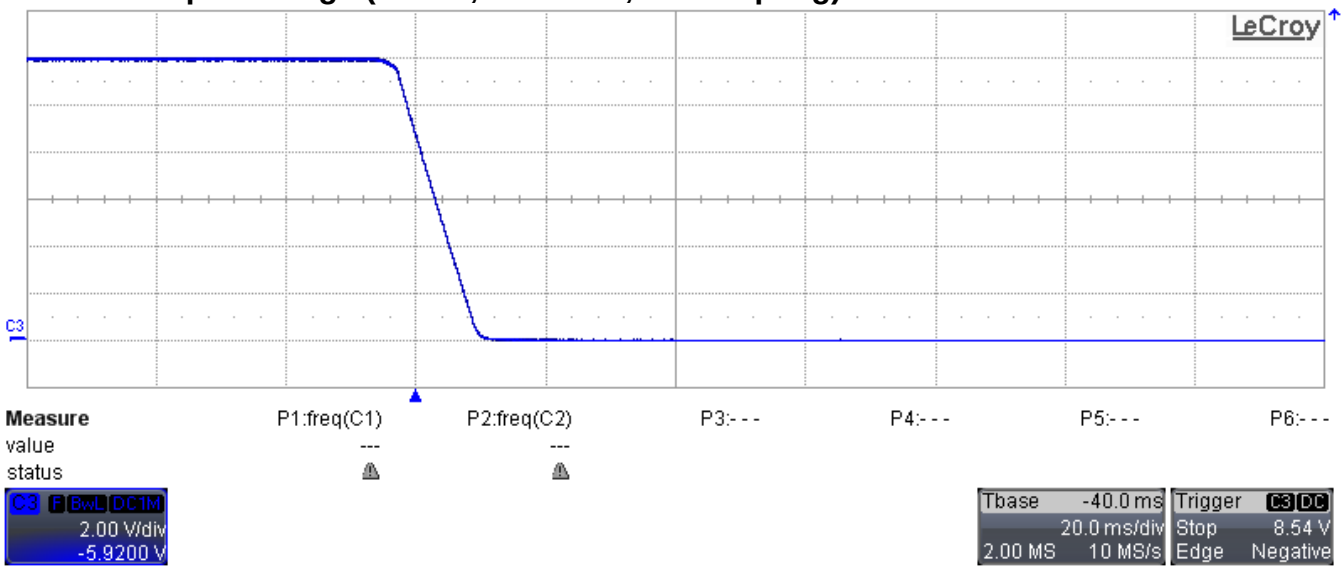
3.4.2 Shutdown

During full load condition, the input AC source has been disconnected. The output voltage ramp down behavior is shown below.

Full load, Vin = 90VAC, 60Hz;
C3: Output voltage (2V/div, 20ms/div, DC coupling)



Full load, Vin = 265VAC, 50Hz;
C3: Output voltage (2V/div, 20ms/div, DC coupling)



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