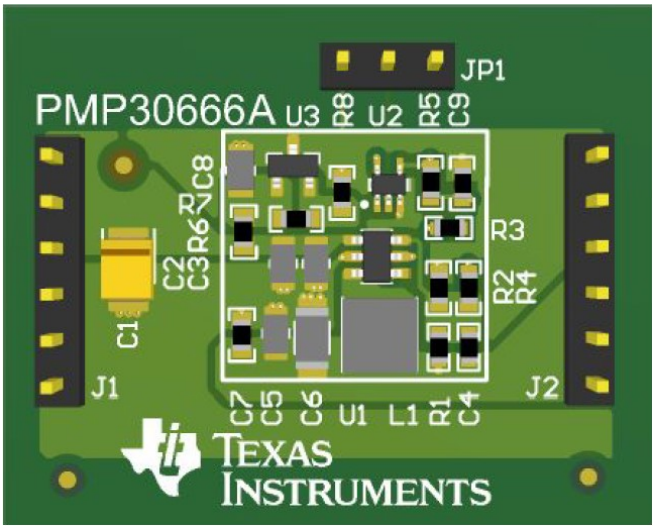
Test Report: PMP30666

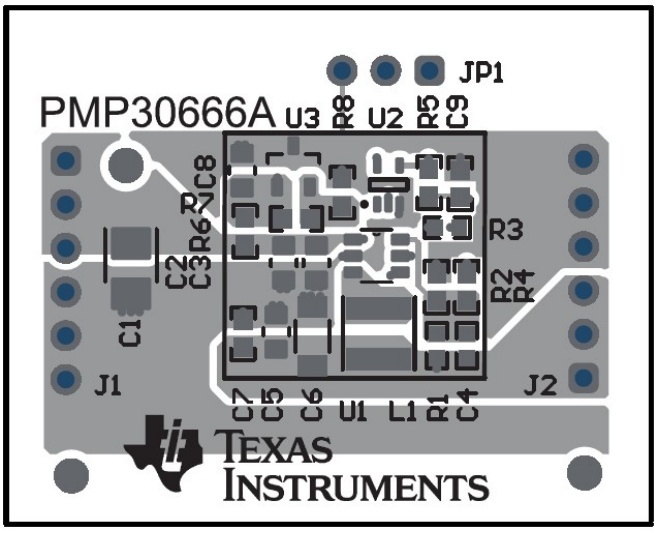
PWM Output Voltage Scaling Reference Design for Enterprise Systems

Description

This reference design shows a buck converter with adjustable output voltage using the TLV62569. The voltage can be adjusted with a PWM signal scaling an output voltage from 2.5 V through 4.3 V at maximum load currents of 1.5 A. The output voltage adjustment achieved with a PWM signal in this reference design is at given following conditions:

- PWM Frequency of 20 kHz
- Output Voltage Step of 100 mV at 5.5 % duty cycle





1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
Input Voltage	VI = 5 V
Output Voltage Range	2.5 V to 4.3 V
Output Current	1.5 A
Output Voltage Step Size	100 mV
Switching Frequency	1.5 MHz
PWM Frequency	20 kHz

1.2 Required Equipment*

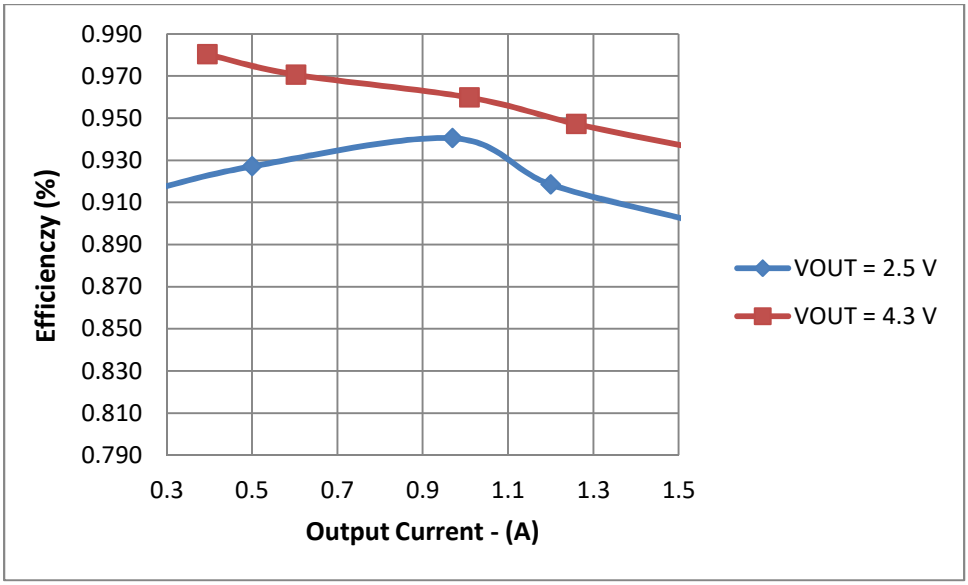
- Power Supply EA-PS 3032-10B
- Oscilloscope LeCroy Wavesurfer 24Xs
- Resistive Loads
- Multimeter

1.3 Considerations*

To prevent PWM ripple on output consider using a buffer stage in the injection path.

2 Testing and Results

2.1 Efficiency Graphs



2.2 Efficiency Data

Input Voltage	Input Current	Output Voltage	Output Current	Efficiency
5.2	0.79	2.42	1.53	0.901
5.2	0.608	2.42	1.2	0.919
5.2	0.48	2.42	0.97	0.940
5.2	0.251	2.42	0.5	0.927
5.2	0.116	2.45	0.225	0.914
5.2	0.334	4.31	0.395	0.980
5.2	0.503	4.21	0.603	0.971
5.2	0.852	4.21	1.01	0.960
5.2	1.077	4.21	1.26	0.947
5.2	1.302	4.21	1.507	0.937

2.3 Thermal Images

The following figure shows the thermal image of the board measured at room temperature.

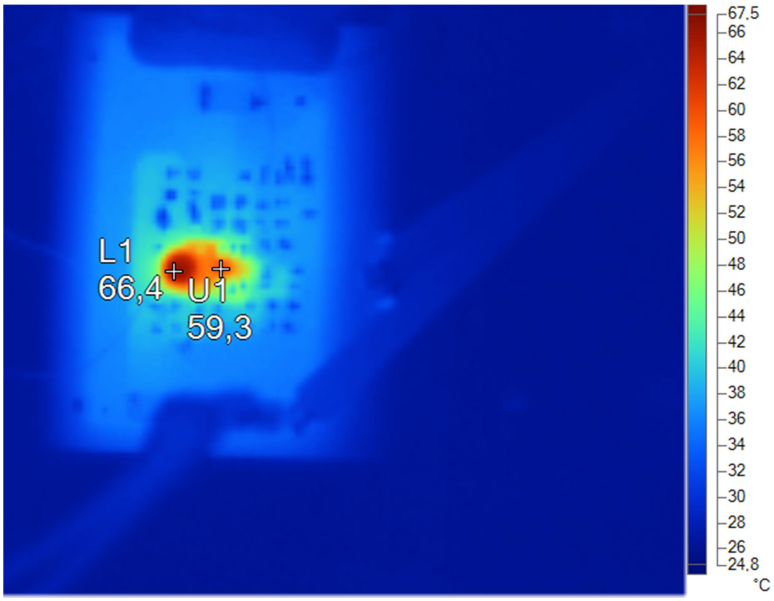


Figure 1: Thermal Image at normal operation

2.4 Dimensions

PCB:	37 mm x 29 mm
Component Placement:	15 mm x 14 mm

3 Waveforms

If not otherwise specified, following graphs show the performance of the board at nominal operating conditions at room temperature.

3.1 Switching

CH1: Switching Node (1 V/div)
Time Scale: 500 ns/div

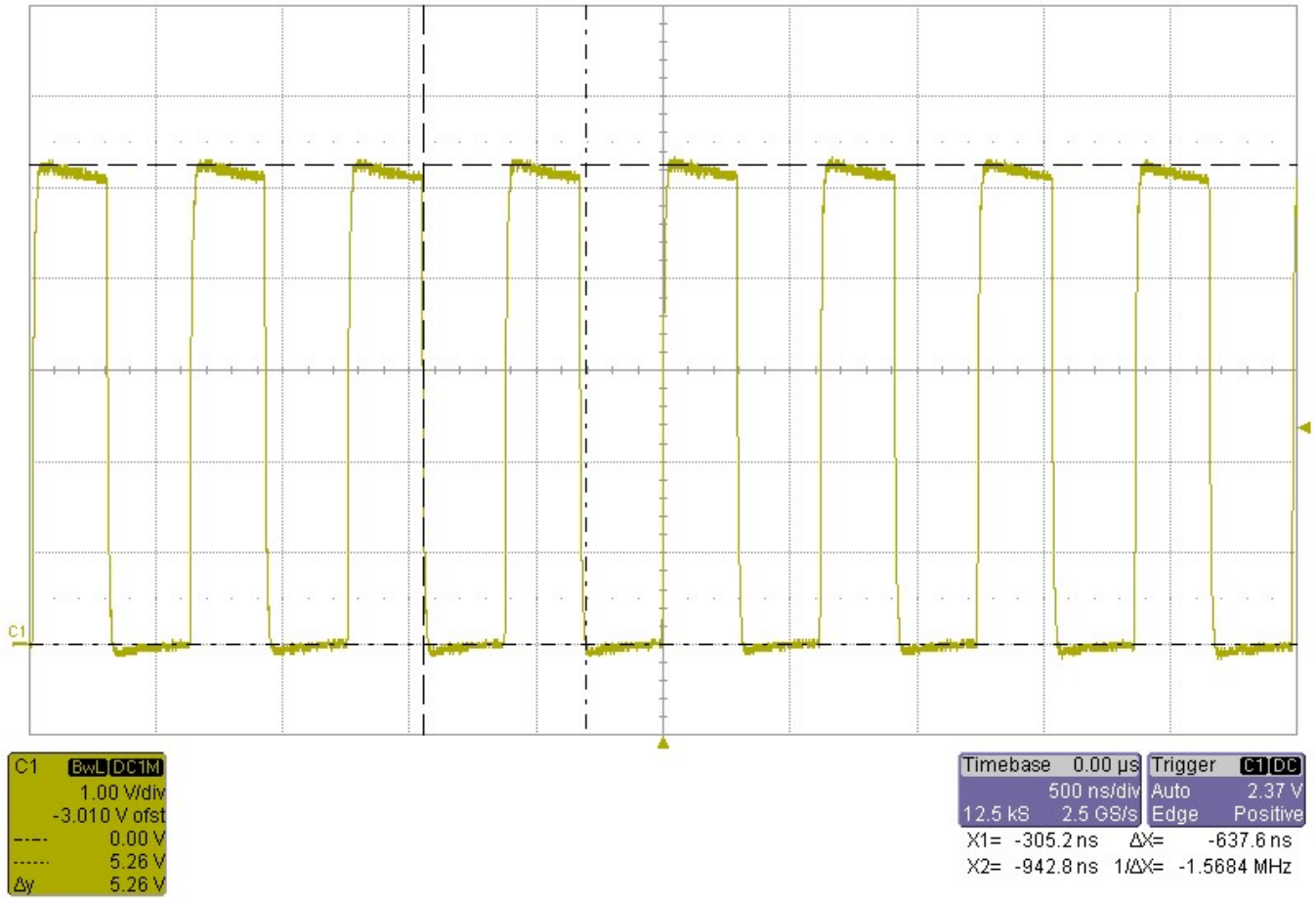


Figure 2: Switching for V_{OUT} = 2.5 V, I_{OUT} = 1.5 A

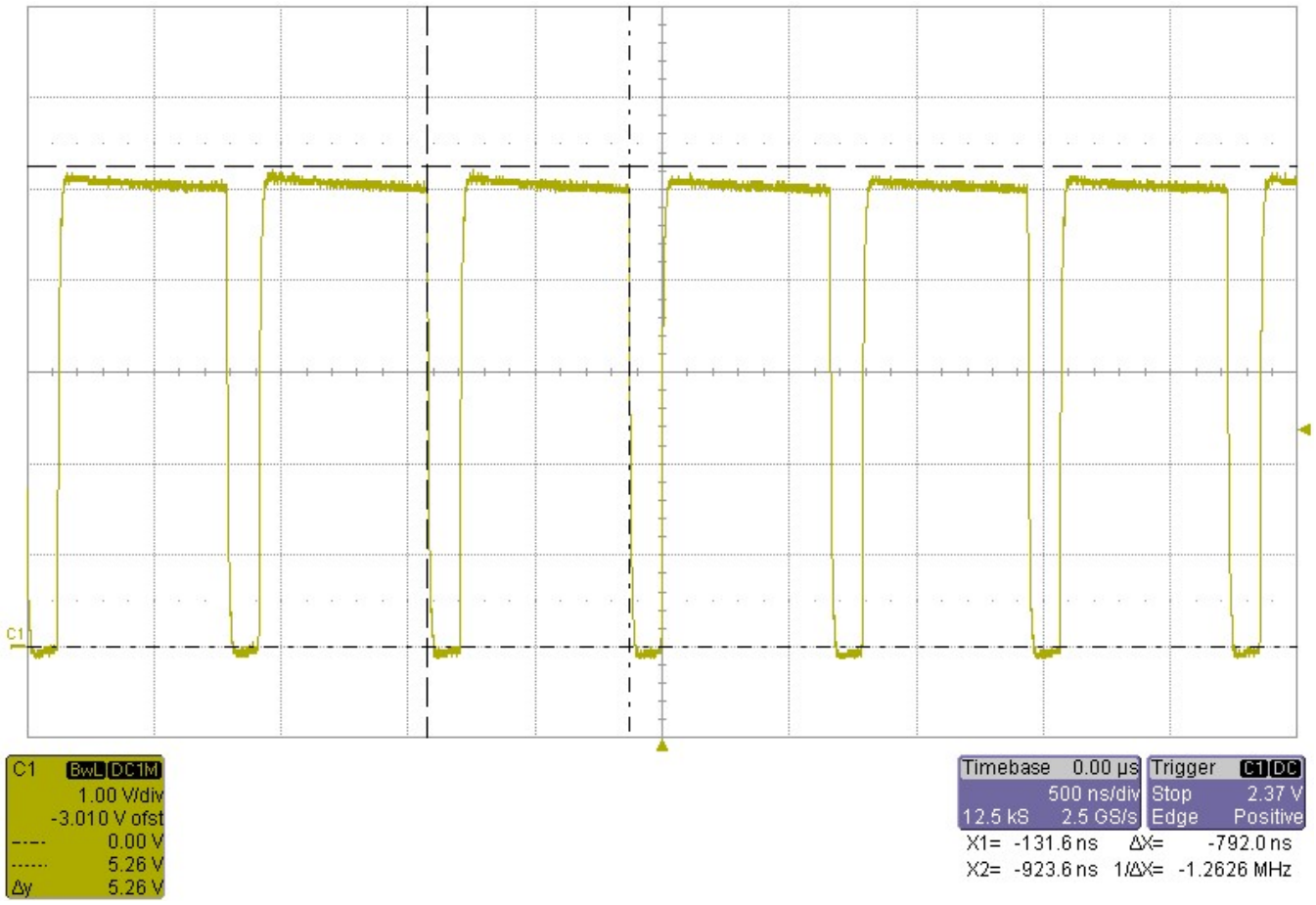


Figure 3: Switching for V_{OUT} = 4.3 V, I_{OUT} = 1.5 A

3.2 Output Voltage Ripple

CH1: Output Voltage AC coupled (2 mV/div)
Time Scale: 500 ns/div

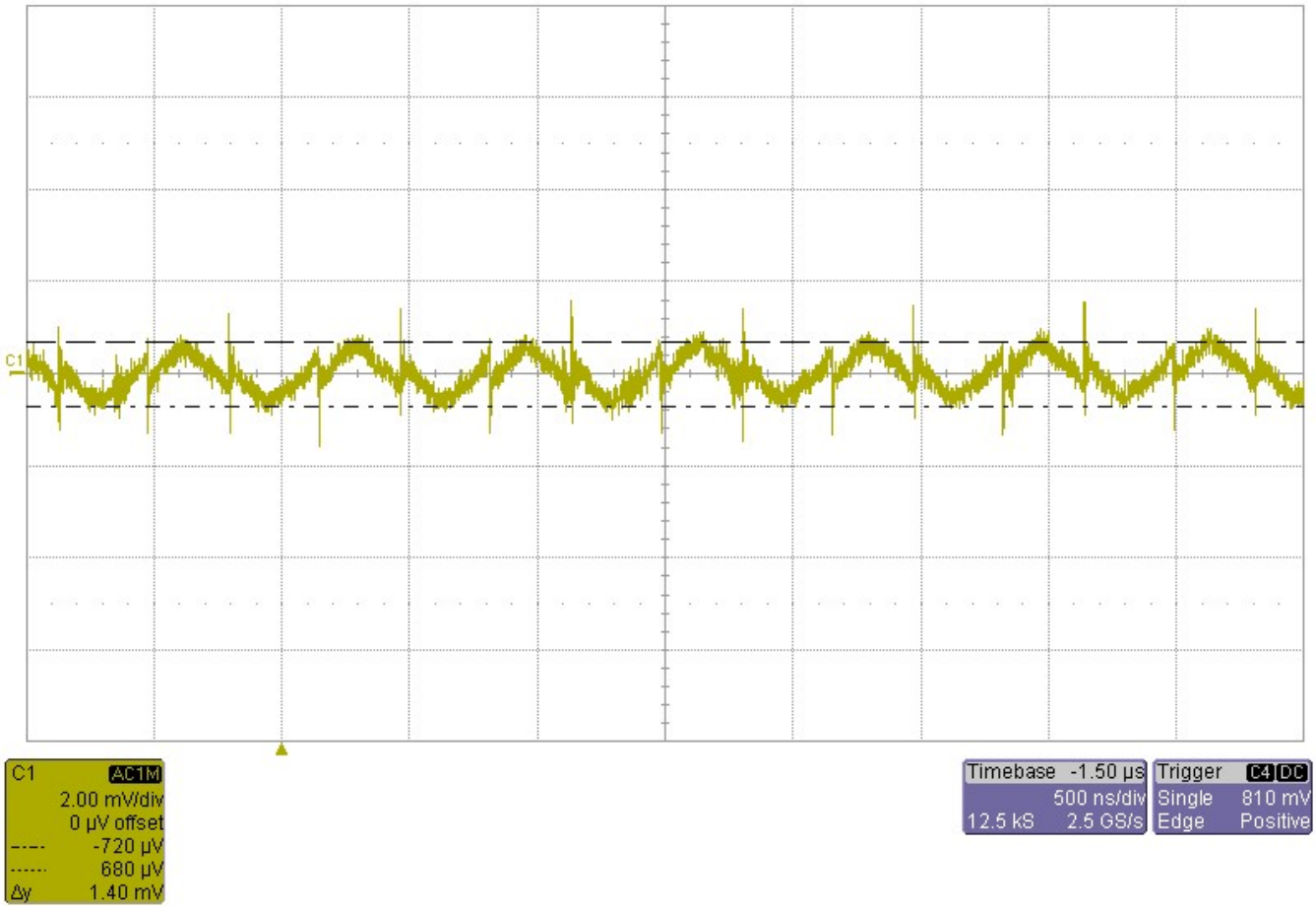


Figure 4: Output voltage ripple for V_{OUT} = 2.5 V, I_{OUT} = 1.5 A

CH1: Output Voltage AC coupled (2 mV/div)
Time Scale: 500 ns/div

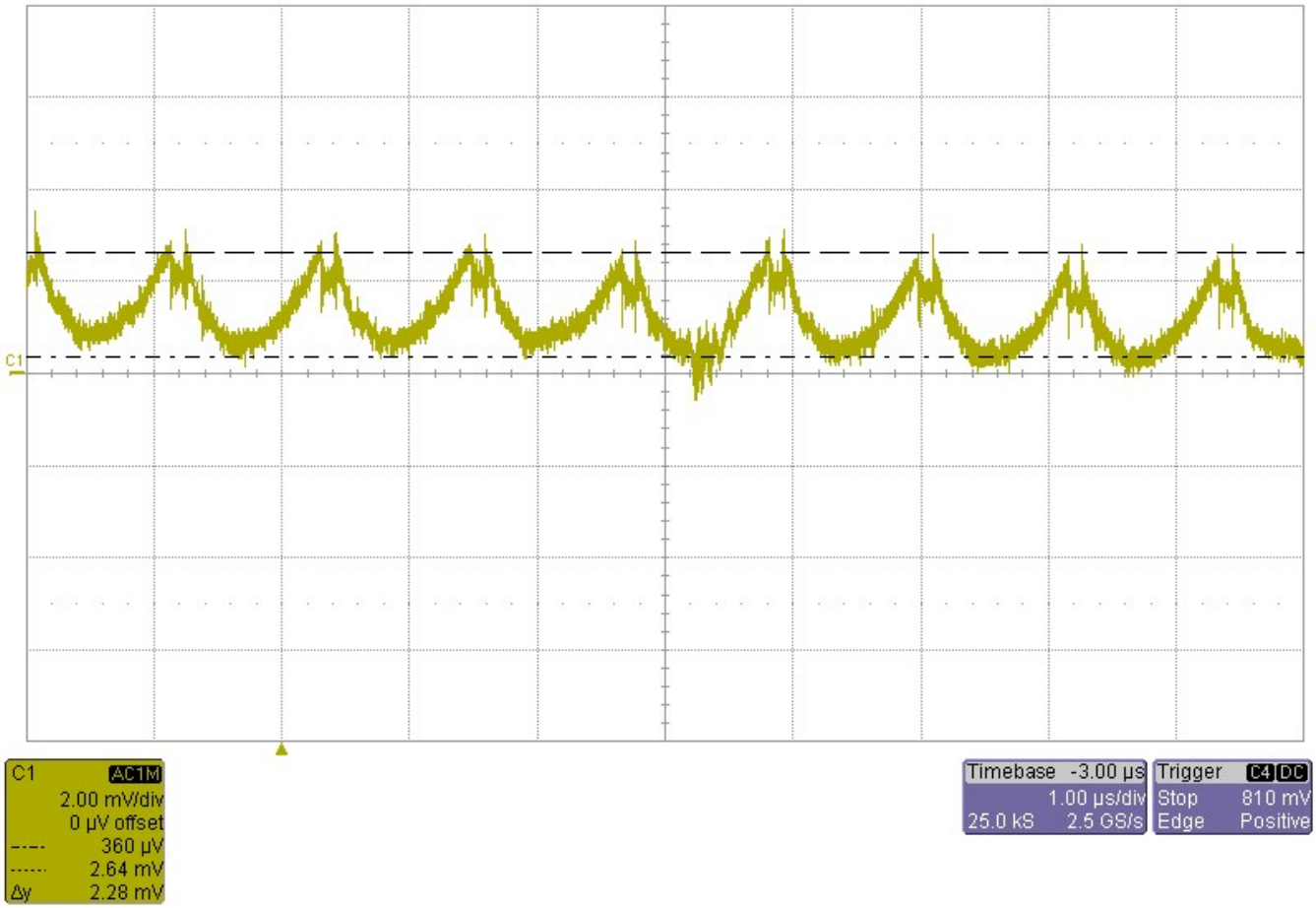


Figure 5: Output voltage ripple for V_{OUT} = 4.3 V, I_{OUT} = 1.5 A

*3.3 Load Transients**

Following graphs show the load step response of the TLV62569 at minimum output voltage and maximum output voltage and a load step of 500 mA to 1.5 A and 1.5 A to 500 mA.

3.3.1 Load Transient at V_{OUT} = 2.5 V

Following scope plot shows the load step response of the converter at an input voltage of 5 V. The maximum deviation is at 23.6 mV which corresponds to 0.94 %.

CH1: Output Voltage (AC coupled, 20 mV/div)
CH4: Output Current (0.5 A/div)
Time scale: 20 us/div

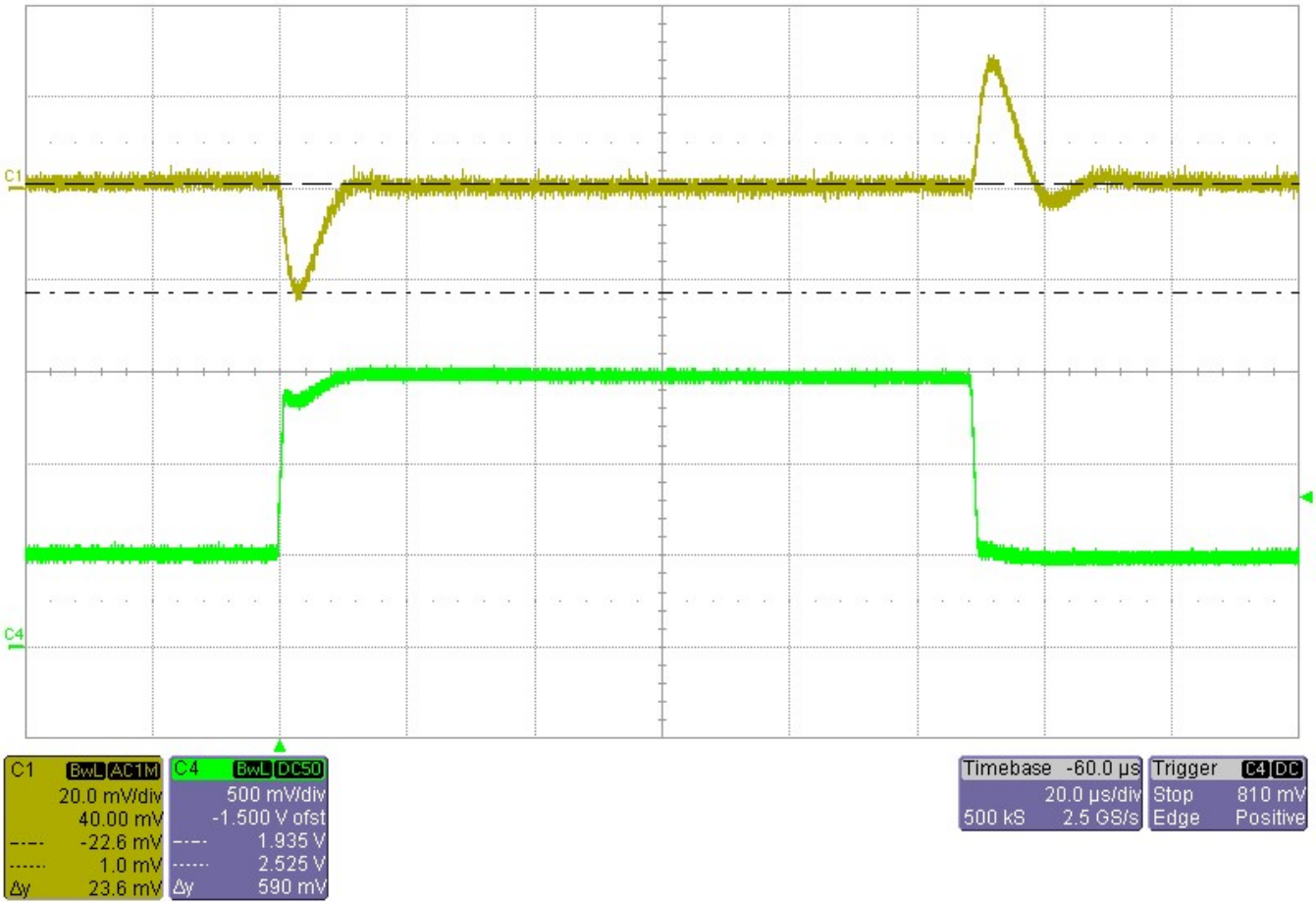


Figure 6: Load Transient Response at VOUT = 2.5 V

3.3.2 Load Transient at V_{OUT} = 4.3 V

Following scope plot shows the load step response of the converter at an input voltage of 5 V. The maximum deviation is at 23.5 mV which corresponds to 0.55%.

CH3: Output Voltage (AC coupled, 50 mV/div)
CH4: Output Current (0.5 A/div)
Time scale: 50 us/div

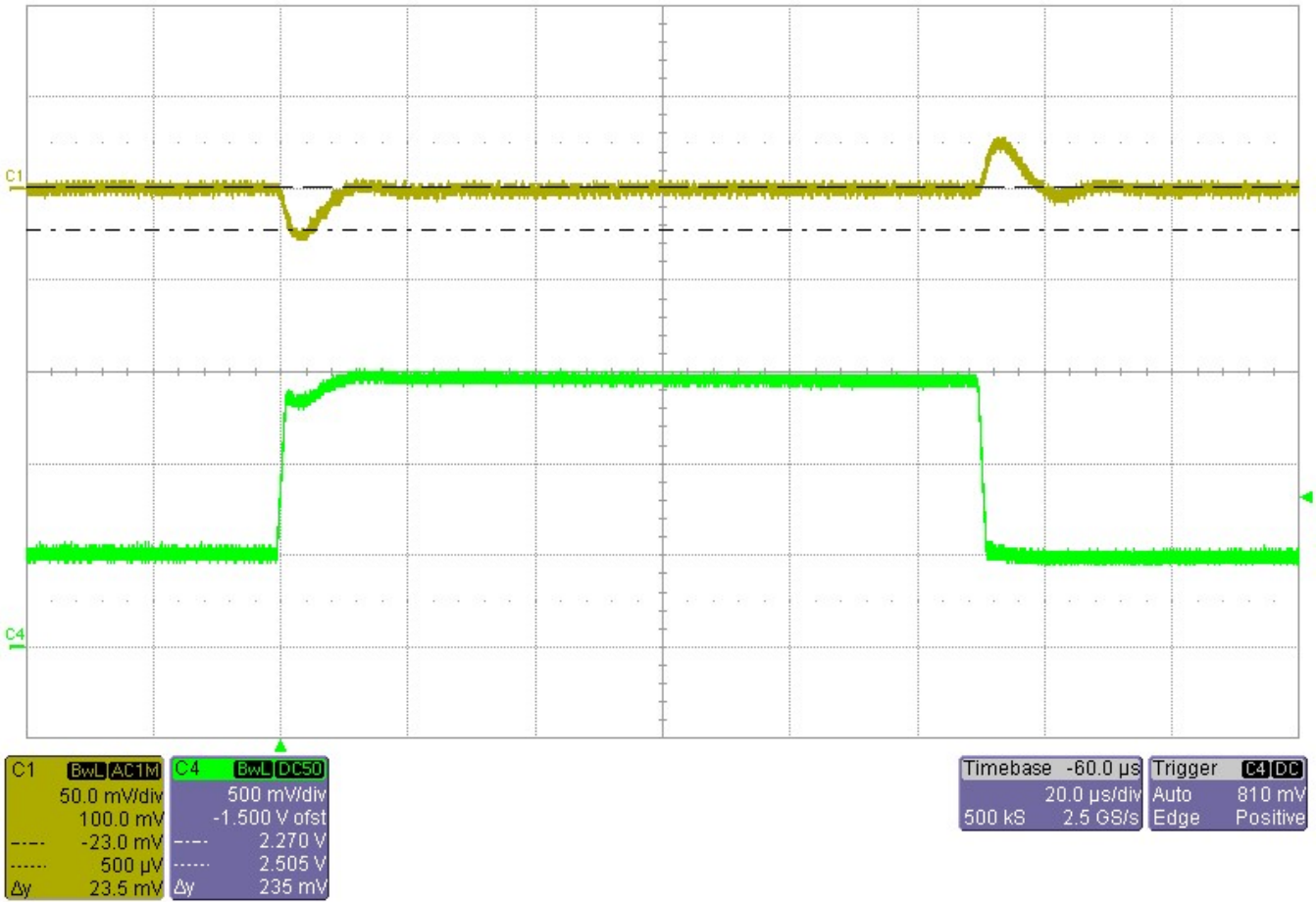


Figure 7: Load Transient Response at VOUT = 4.5 V

3.4 Bode Plot

Following figures depicts the small signal response of the design at 500 mA output load and 1.5 A output load.

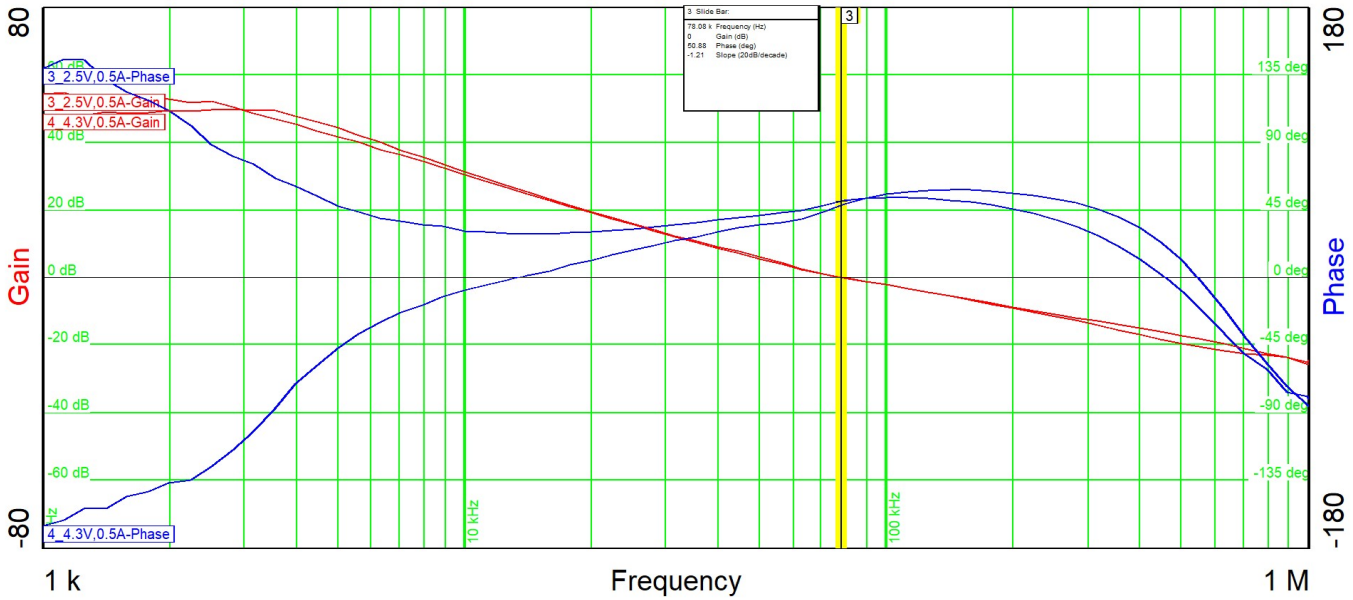


Figure 8: Bode plot at I_O = 500 mA

Test Conditions	Crossover Frequency	Phase Margin	Slope (20dB/decade)	Crossover Frequency	Gain Margin	Slope (20dB/decade)
Vo = 2.5 V Io = 0.5 A	78.1 kHz	50.9 deg	-1.2	454.3 kHz	-18.6 dB	-1.2
Vo = 4.3 V Io = 0.5 A	77.3 kHz	47.9 deg	-1.3	543.1 kHz	-18.1 dB	-1.1

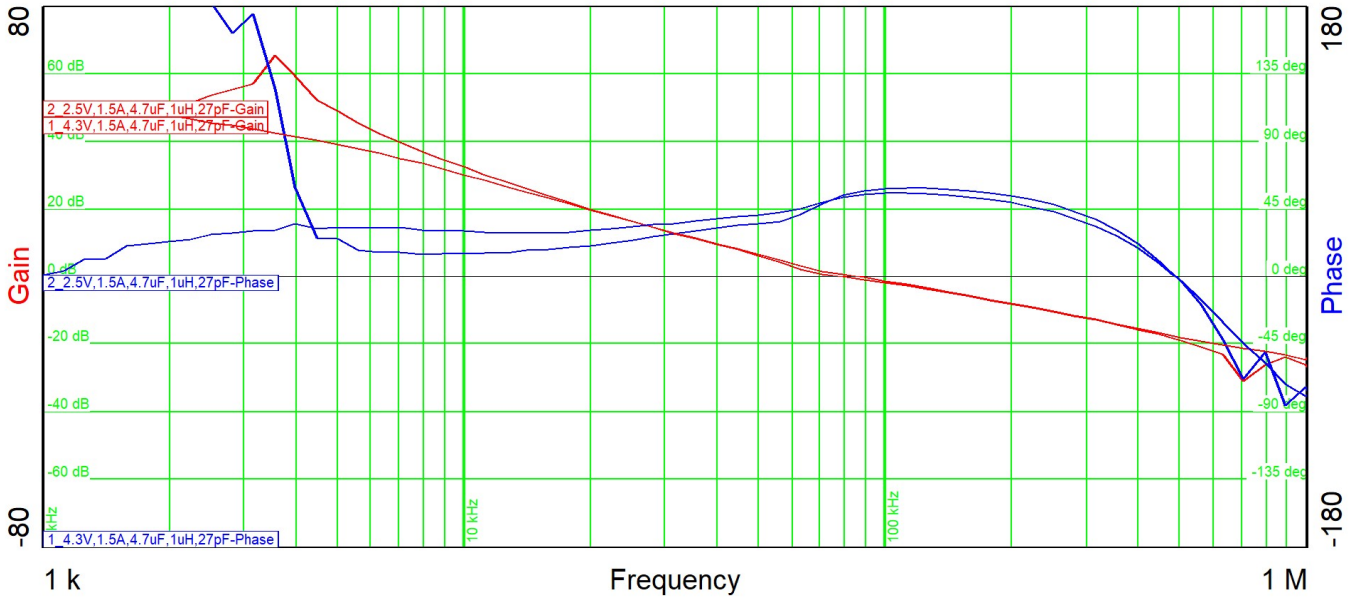


Figure 9: Bode Plot at I_O = 1.5 A

Test Conditions	Crossover Frequency	Phase Margin	Slope (20dB/decade)	Crossover Frequency	Gain Margin	Slope (20dB/decade)
Vo = 2.5 V Io = 1.5 A	85.28 kHz	54.28 deg	-1	485.8 kHz	-17.8 dB	-1.4
Vo = 4.3 V Io = 1.5 A	77.7 kHz	53.3 deg	-0.96	489.4 kHz	-18.6 dB	-1.7

3.5 Start-up Sequence

CH3: Input Voltage (1 V/div)
CH1: Output Voltage (2 V/div)
Time scale: 10 ms/div

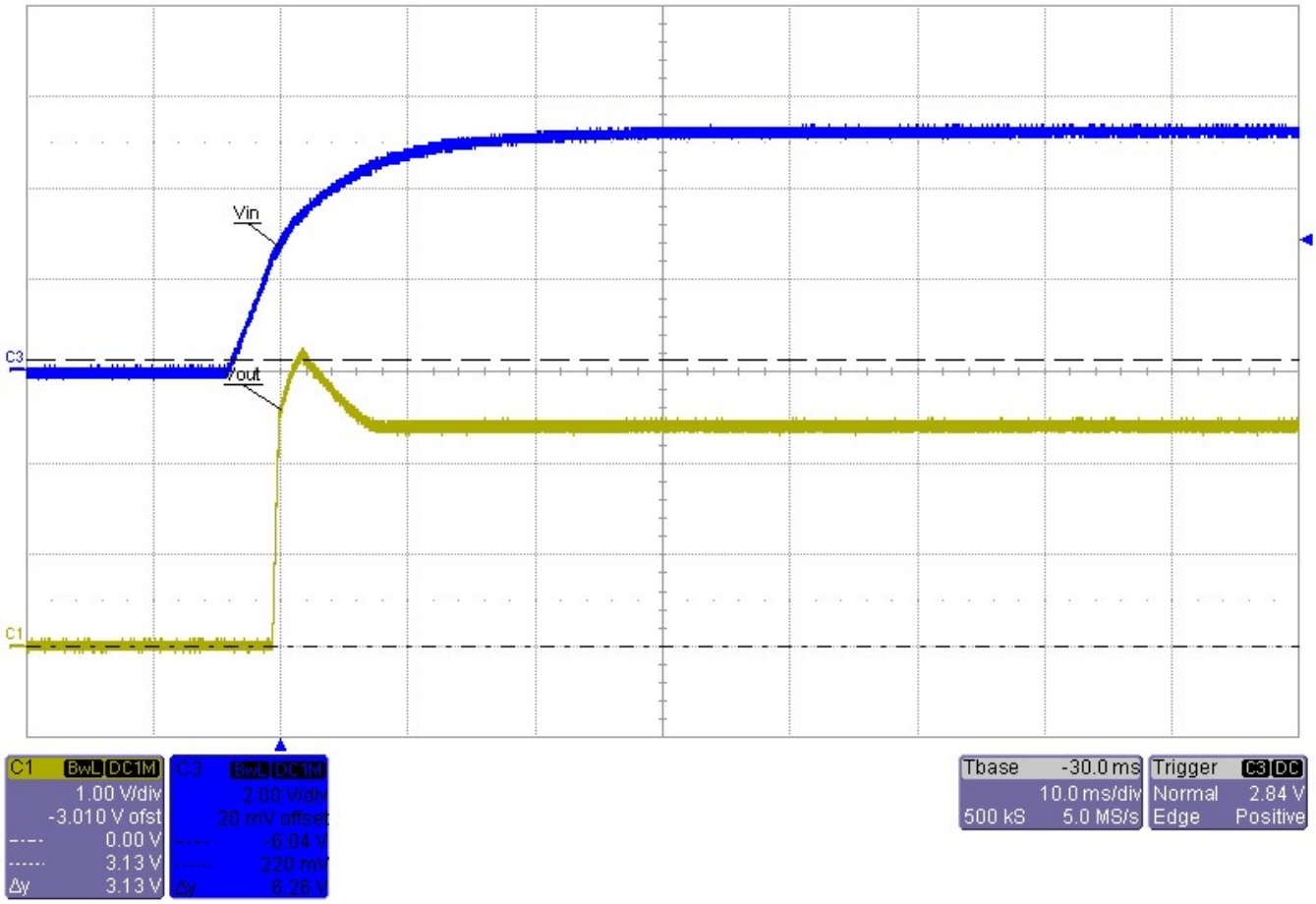


Figure 10: Start-Up Sequence, No PWM

3.6 Shut-down Sequence

CH3: Input Voltage (1 V/div)
CH1: Output Voltage (2 V/div)
Time scale: 10 ms/div

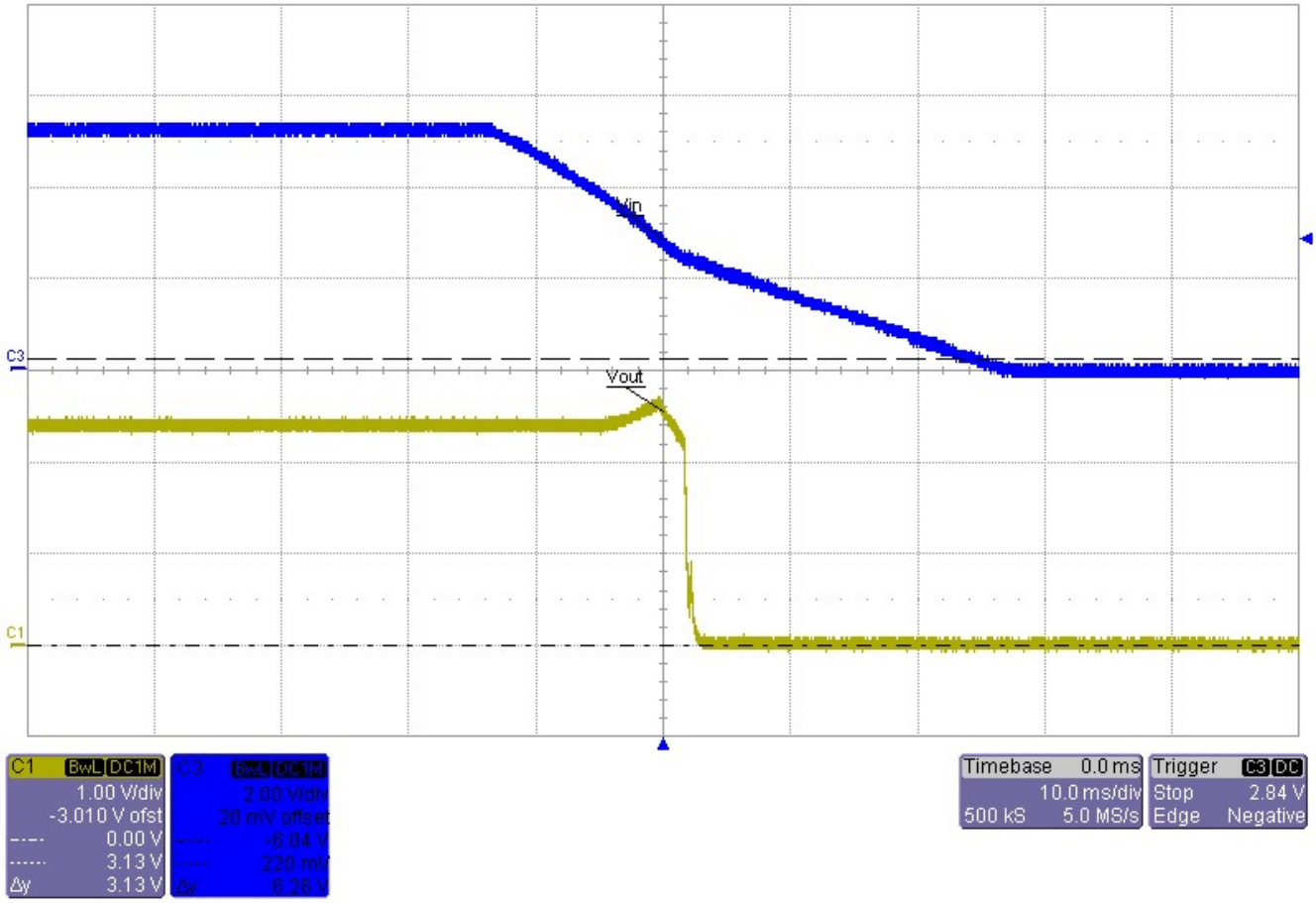


Figure 11: Shut-down Sequence, No PWM

3.7 Other

3.7.1 PWM Output Voltage Scaling

Following graphs show the output voltage settling time at maximum output scaling.

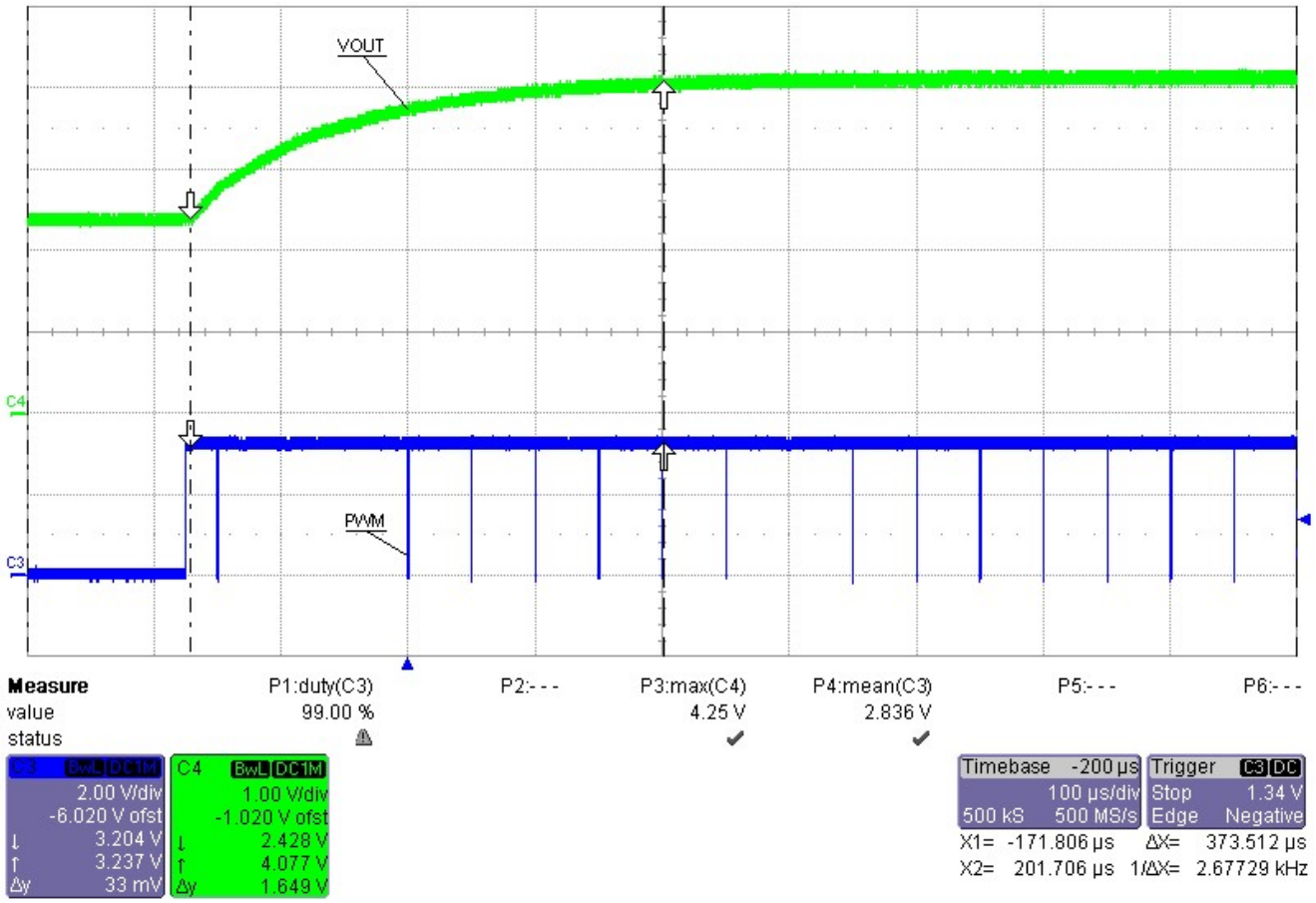


Figure 12: Output scaling from 0% to 99%

At a PWM step from duty cycle 0% to 99% the output voltage settles from 2.5 V to 4.3 V at approximately 370 us.

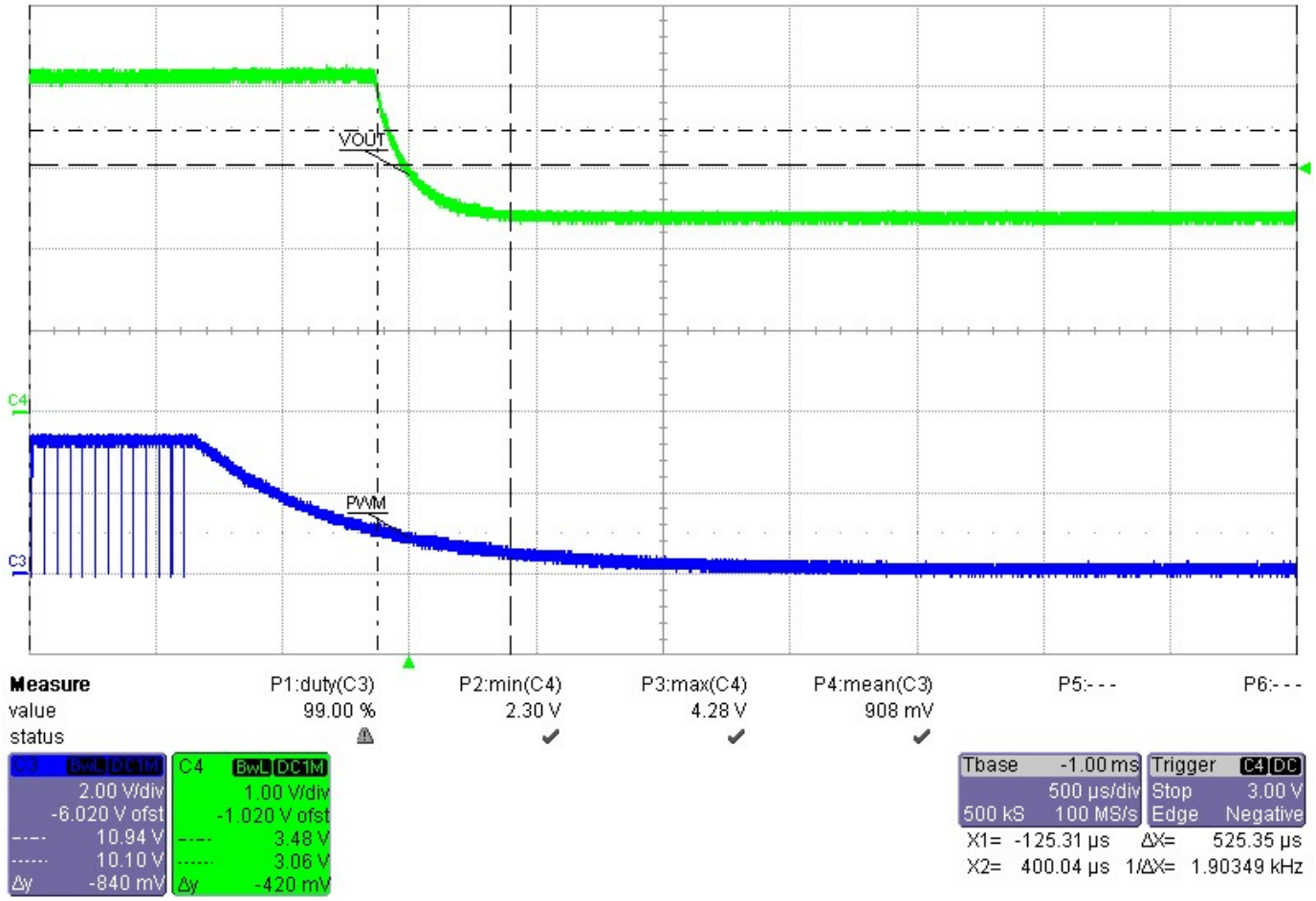


Figure 13: Output scaling from 99% to 0%

At a PWM step from duty cycle 99% to 0% the output voltage settles from 4.3 V to 2.5 V at approximately 525 us.

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