

5-W Inverting Buck-Boost Reference Design



Description

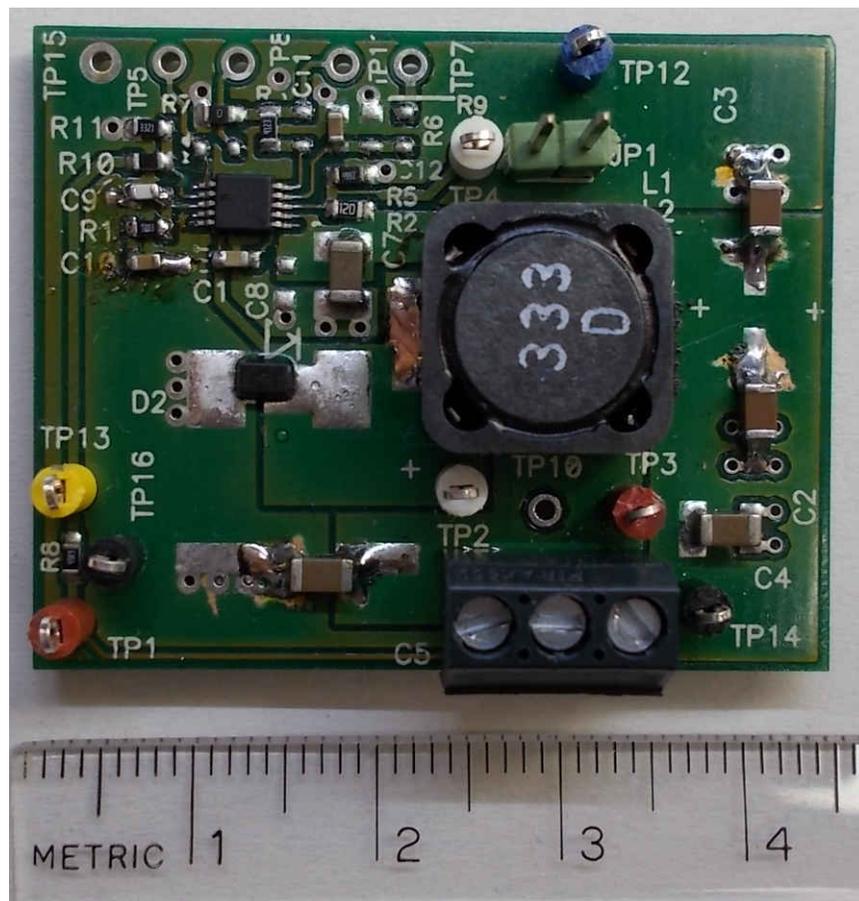
This tiny inverting buck boost provides negative voltage up to -45 V out of input voltage 5.2 V for light detection and ranging (LIDAR) applications. Maximum load current is limited here to 120 mA – for bigger loads, use the TPS54260 or TPS54360 devices. Those buck devices are well suited to cover the needed high duty cycle range and easily start up well below 5-V input.

Features

- SIMPLE SWITCHER® power converter using integrated FET in inverting buck-boost configuration
- Cost-effective inverter using just a single inductor and a standard buck device
- Sinusoidal input and output ripple reduces conducted emissions
- Clean waveforms (no ringing, no overshoot) prevents FM band noise

Applications

- [Mechanically scanning LIDAR](#)
- [Robot sensing module](#)
- [Mobile robot sensing module](#)
- [Drone vision](#)



Board Photo (Top)

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
IC	TPS57160-Q1
Topology	Inverting Buck Boost
Input Voltage Range	4.7 V to 5.7 V
Output Voltage	-45 V
Maximum Output Current	120 mA
Switching Frequency	300 kHz

1.2 Considerations

Remember the following considerations while working with this design:

- The measured switching frequency is around 280 kHz
- The circuit starts up at an input voltage of 4.4 V
- Unless otherwise mentioned, the test was done with a input voltage of 5.2 V and output current was adjusted to 0.12 A with a resistor
- For availability reasons, this design was tested using the Coilcraft MSS1260-333 (33 μ H)
- The Coilcraft XGL6060-333 is recommended for the smallest board space

1.3 Dimensions

The PMP30942 board dimensions are 41.9 mm \times 33.7 mm.

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

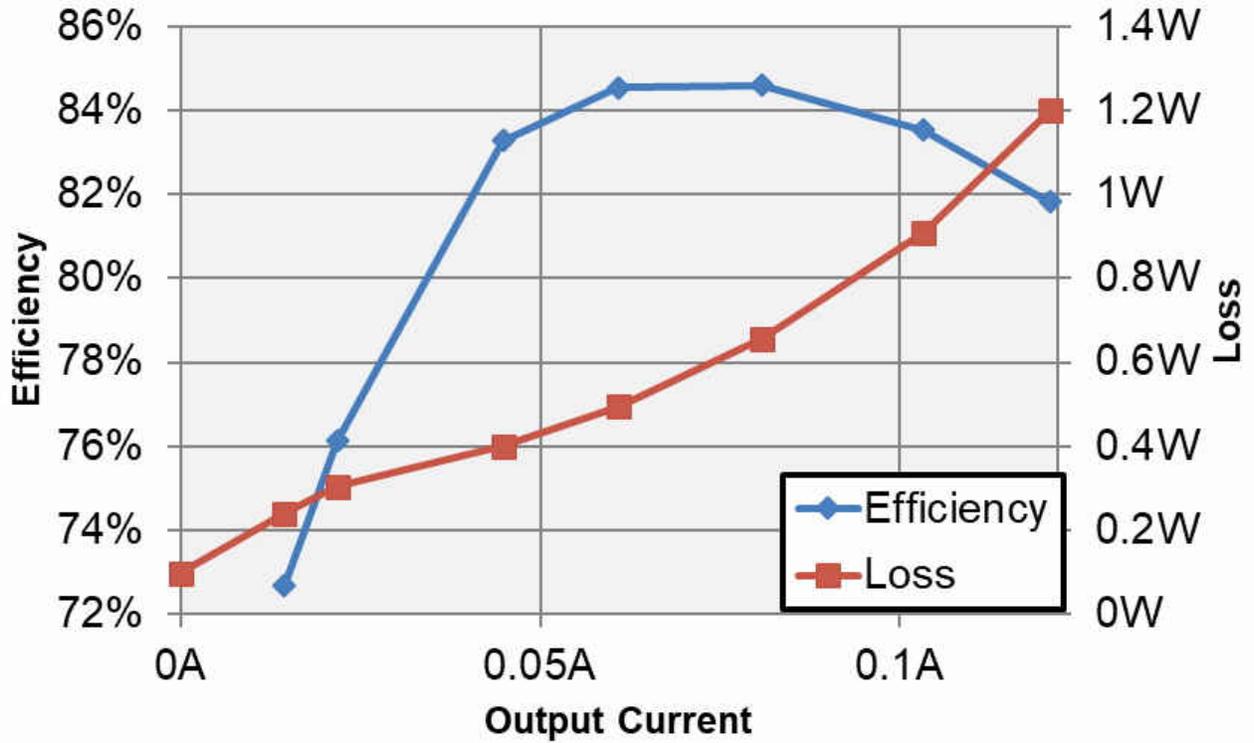


Figure 2-1. Efficiency and Loss vs Output Current

2.2 Load Regulation

The load regulation is shown in the following curve.

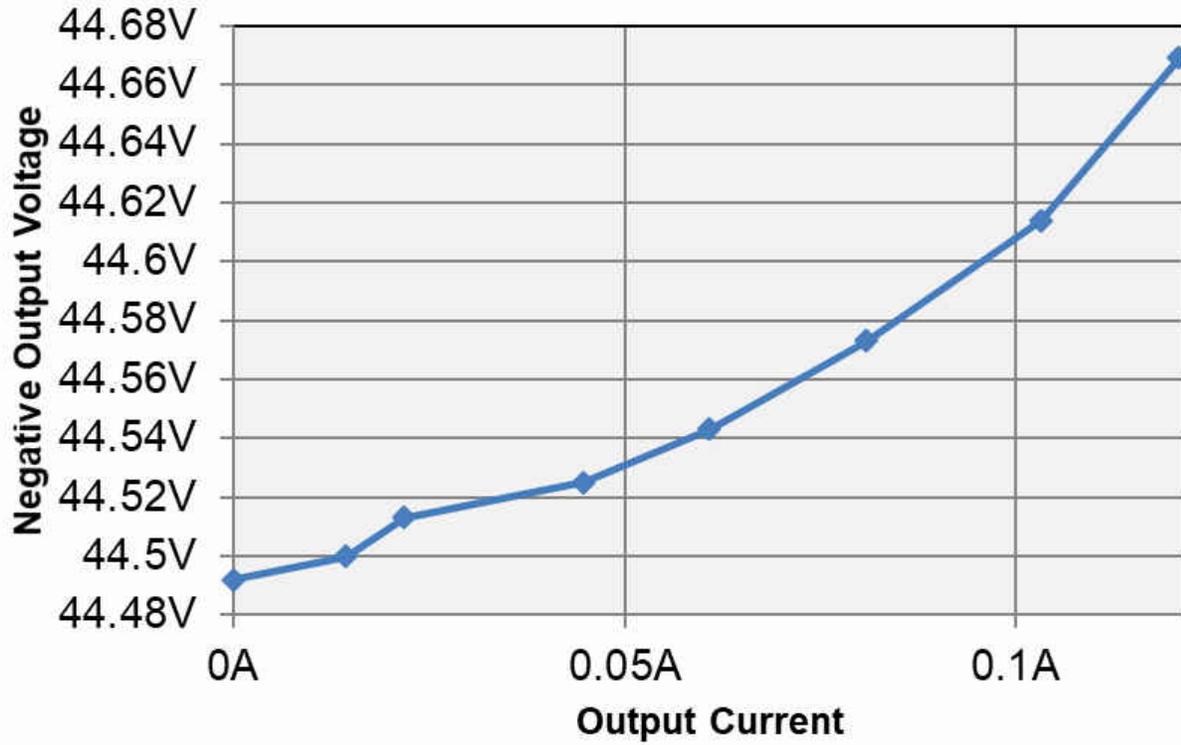


Figure 2-2. Output Voltage vs Output Current

2.3 Thermal Images

The thermal image is shown in the following figure.

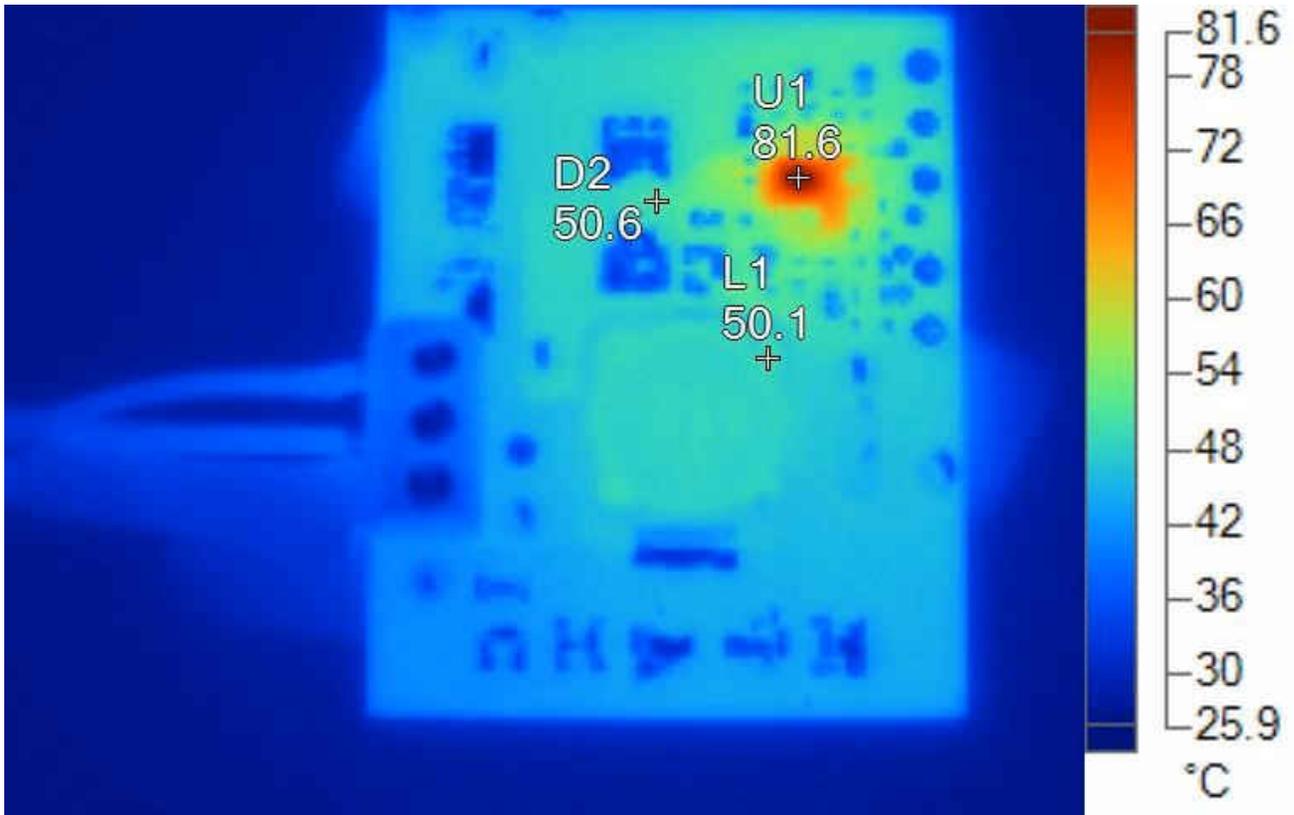


Figure 2-3. Thermal Image

Name	Temperature
D2	50.6°C
L1	50.1°C
U1	81.6°C

2.4 Bode Plots

The bode plot is shown in the following figure.

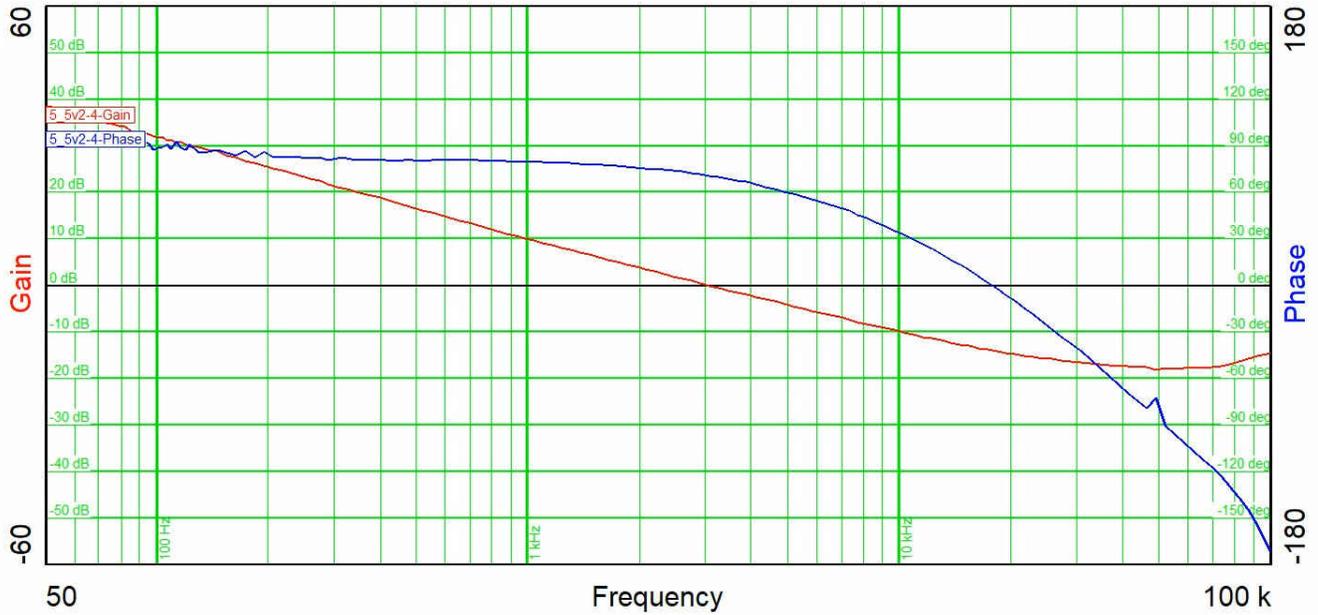


Figure 2-4. Control Loop Frequency Response

V_{IN}	5.2 V
Bandwidth (kHz)	3
Phase Margin	70.7°
Slope (20 dB / decade)	-0.95
Gain Margin (dB)	-14
Slope (20 dB / decade)	-0.73
Freq (kHz)	17.8

3 Waveforms

3.1 Switching

3.1.1 Switchnode to GND

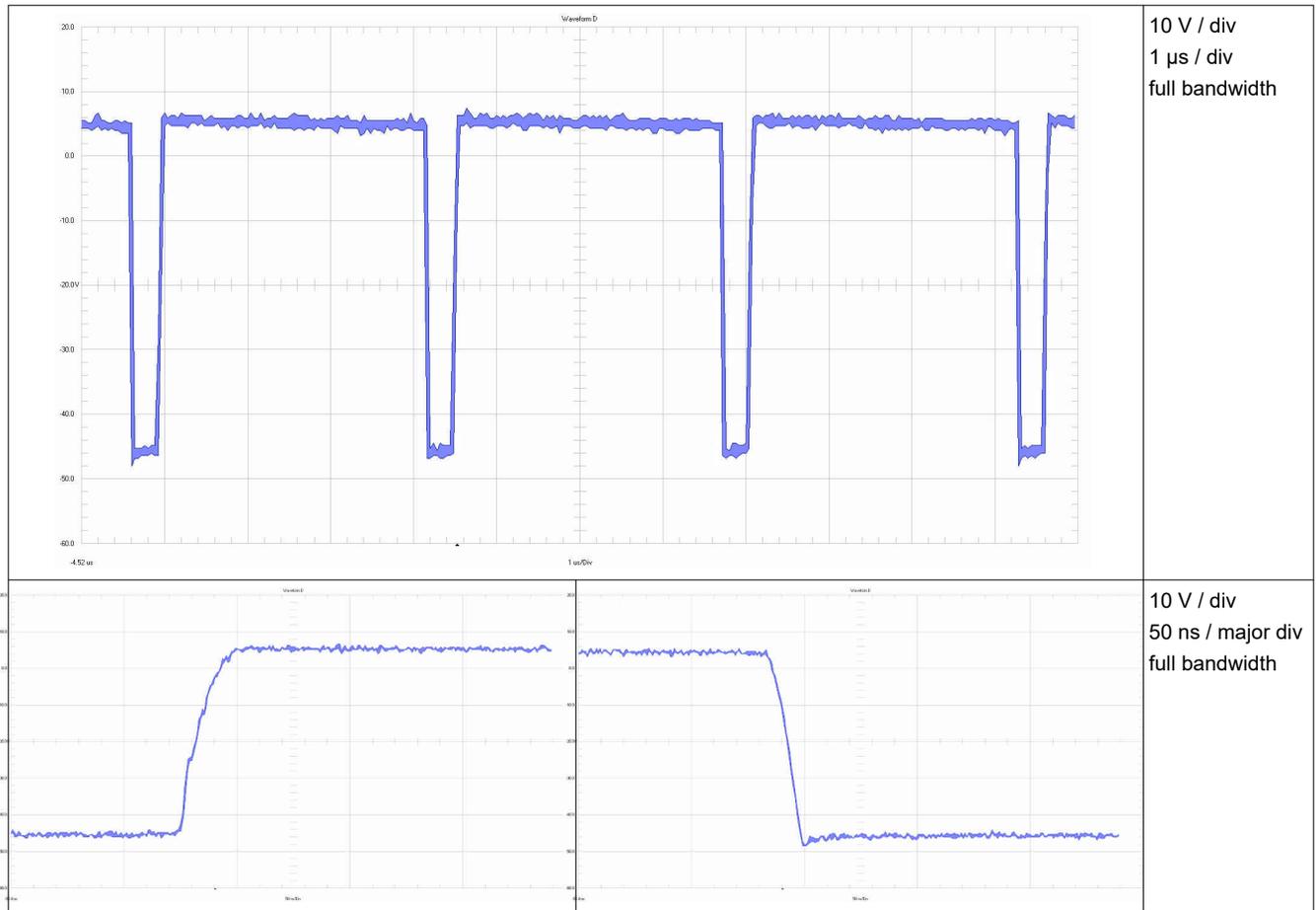
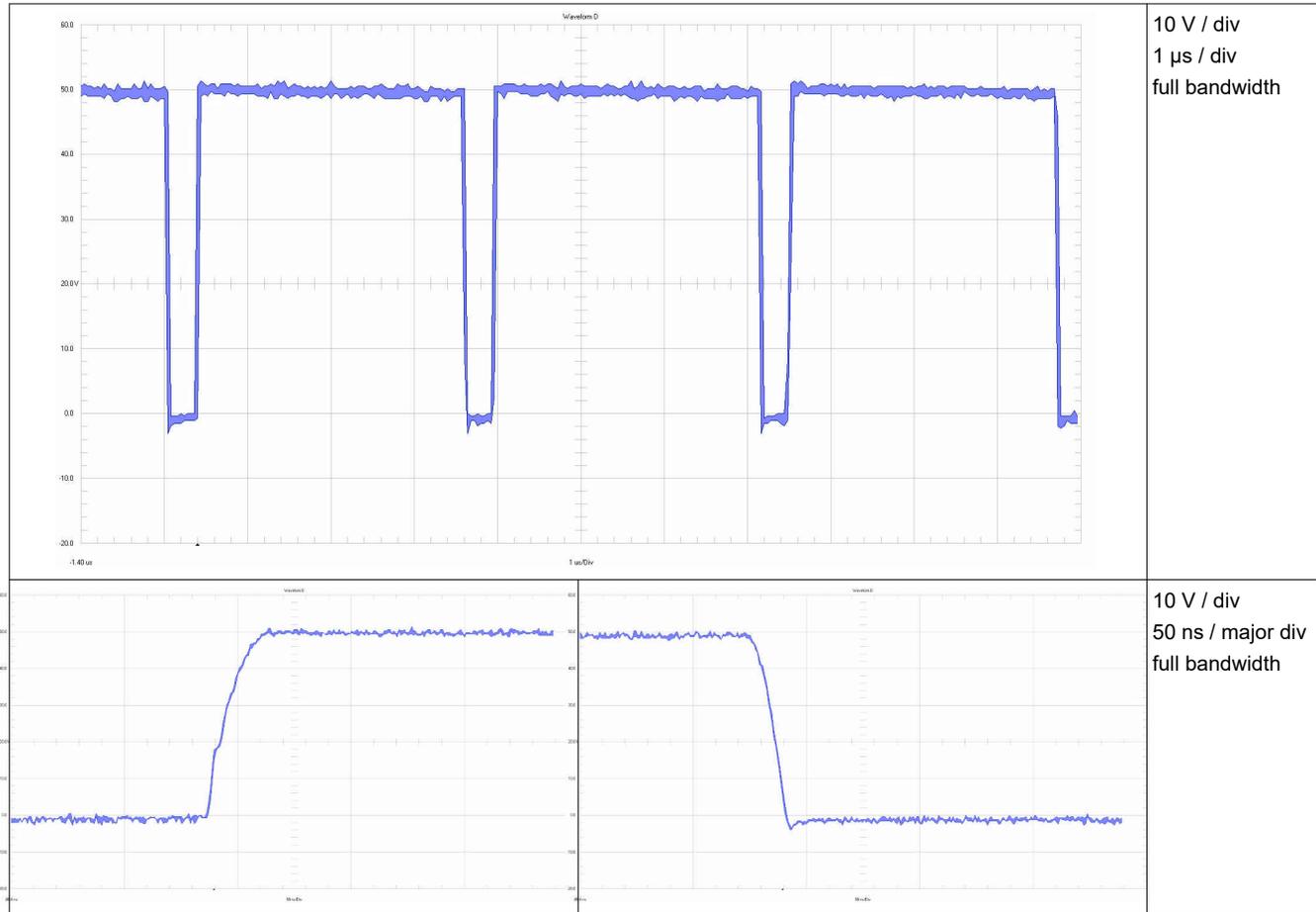


Figure 3-1. Switchnode to GND

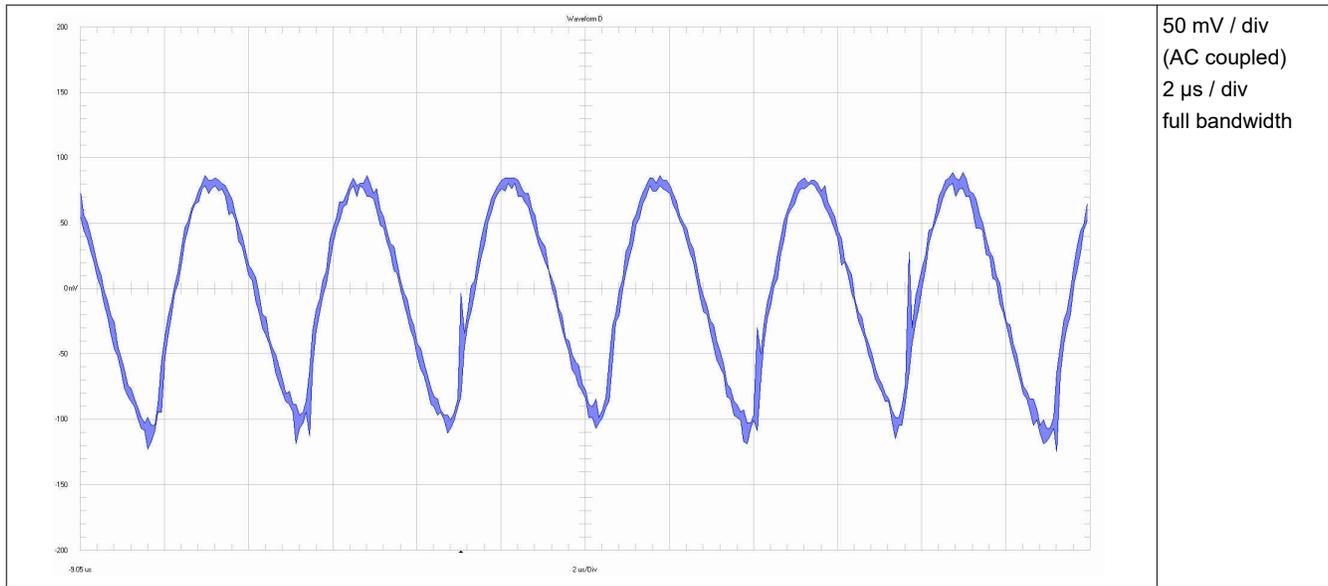
3.1.2 Switchnode to $-V_{OUT}$



The waveforms do not show any ringing and no overshoot.

Figure 3-2. Switchnode to $-V_{OUT}$

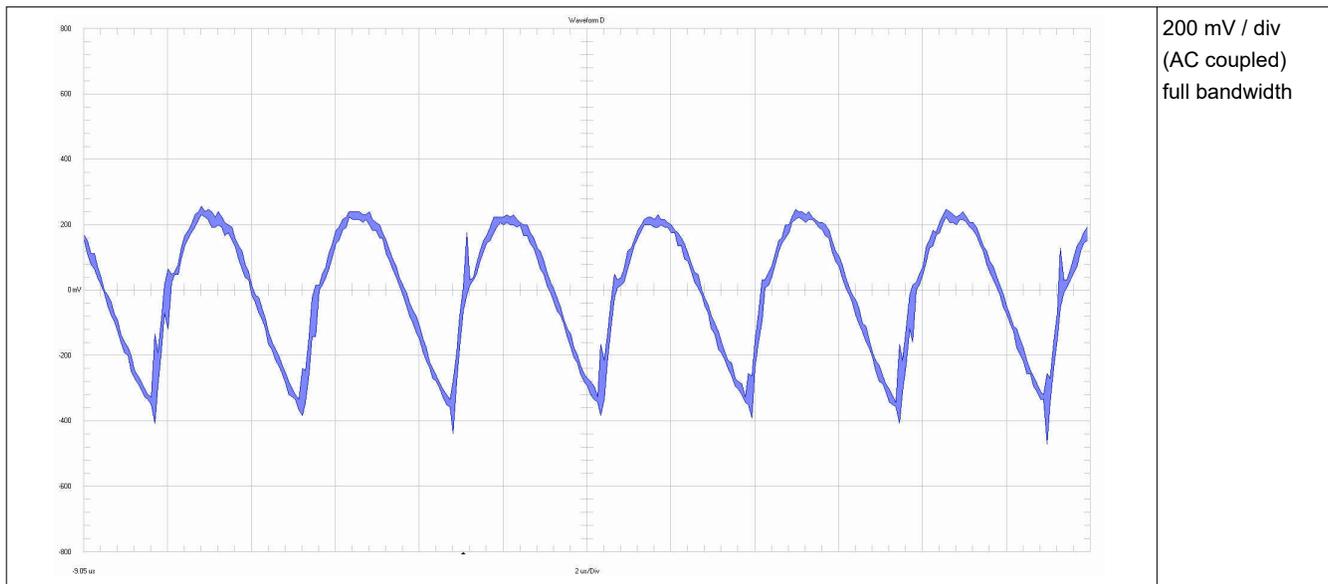
3.2 Input Voltage Ripple



The amplitude of the waveform is around 200 mV_{pp} sinusoidal.

Figure 3-3. Input Voltage Ripple

3.3 Output Voltage Ripple



The amplitude of the waveform is around 600 mV_{pp}.

Figure 3-4. Output Voltage Ripple

3.4 Load Transients

The electronic load switches between 0.6 A to 0.12 A with a frequency of 100 Hz – deviation 3% of V_{OUT} .

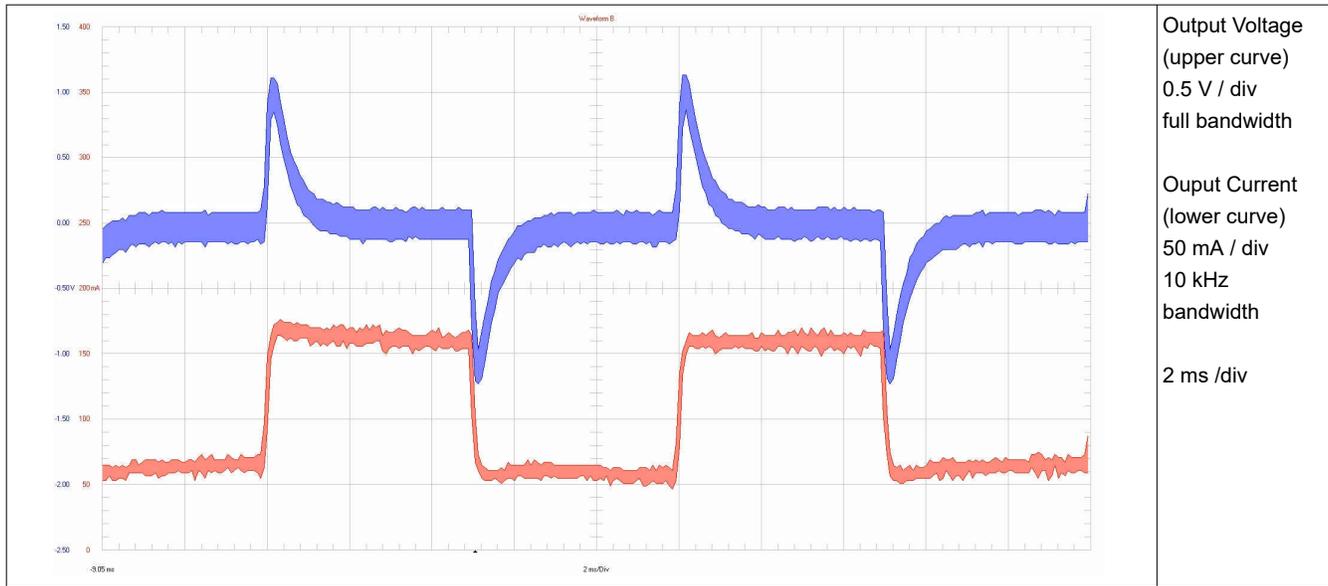


Figure 3-5. Load Transient 0.6 A - 0.12 A

3.5 Start-Up Sequence

The bandwidth was set to 20 MHz for both channels and soft start was set around 40 ms to 50 ms.

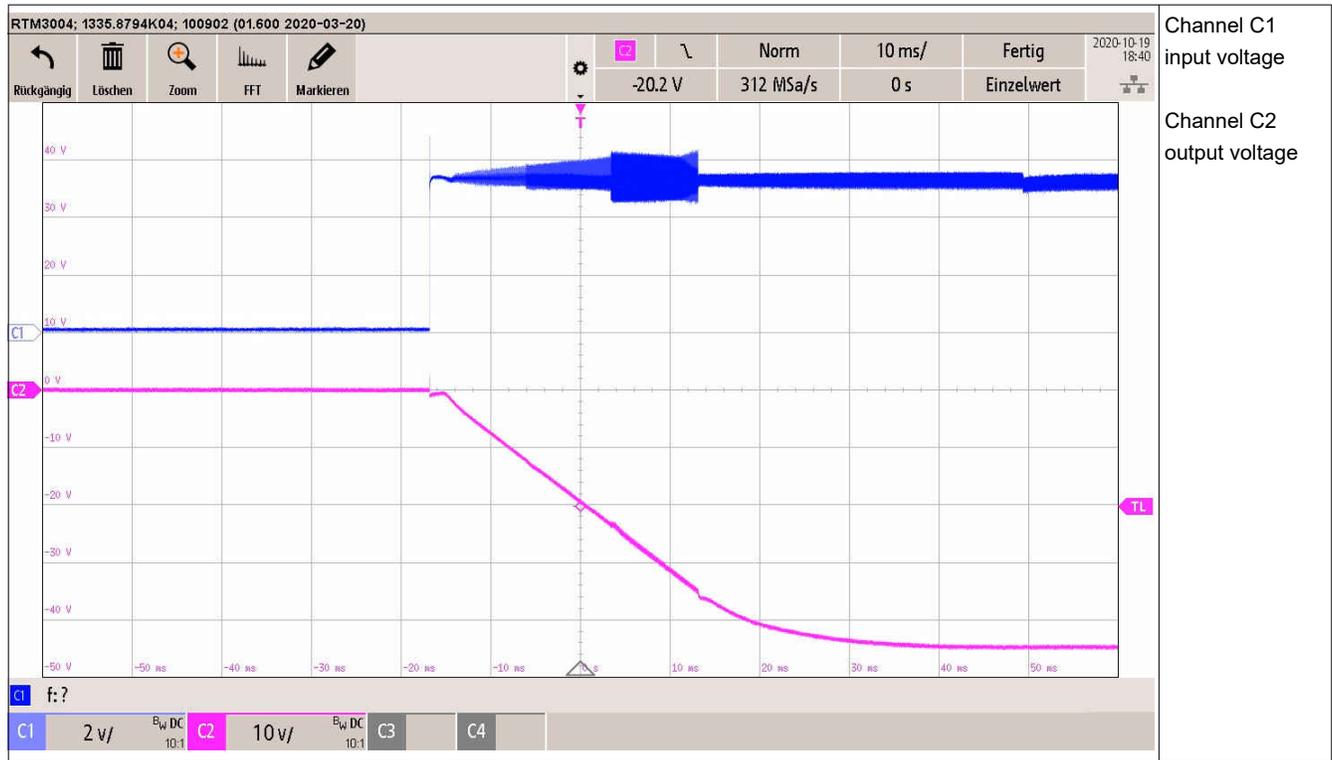


Figure 3-6. Start-up Sequence

3.6 Shutdown Sequence

The bandwidth was set to 20 MHz for both channels.

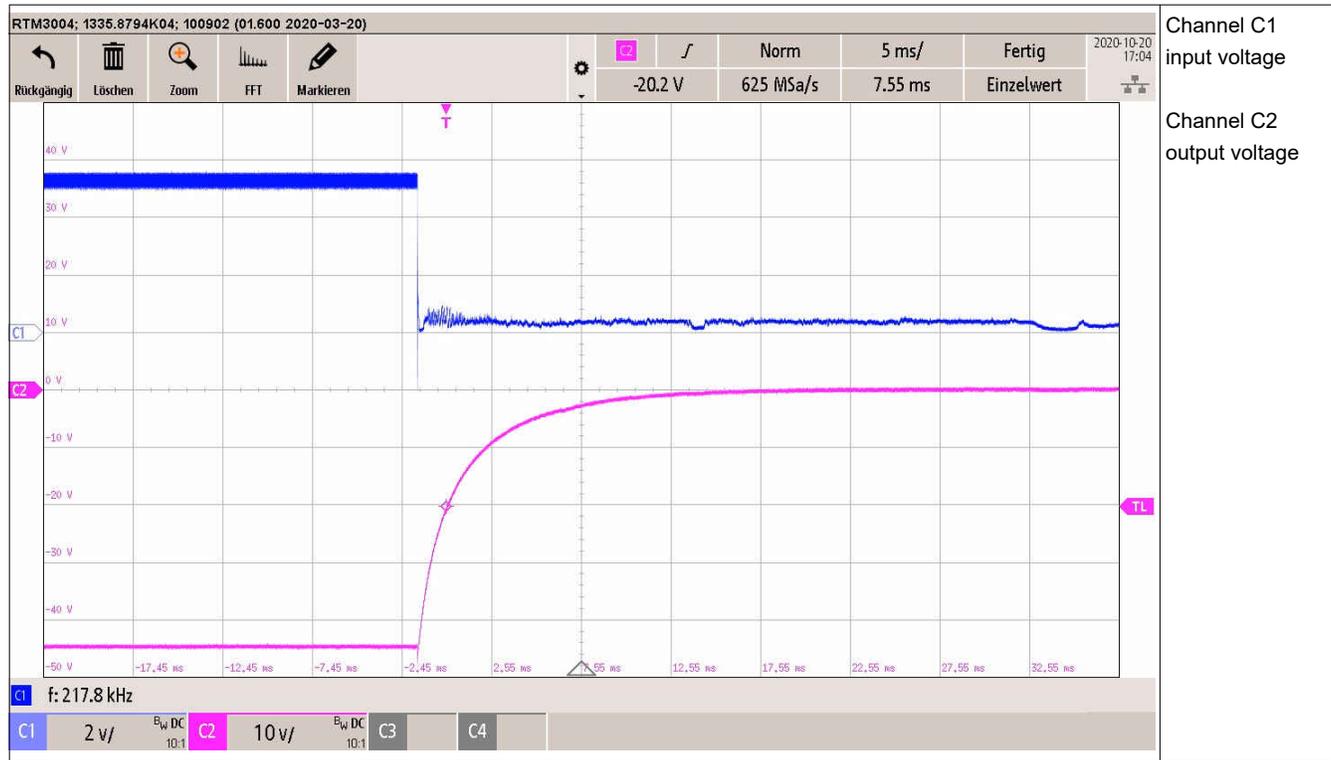


Figure 3-7. Shutdown Sequence

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