

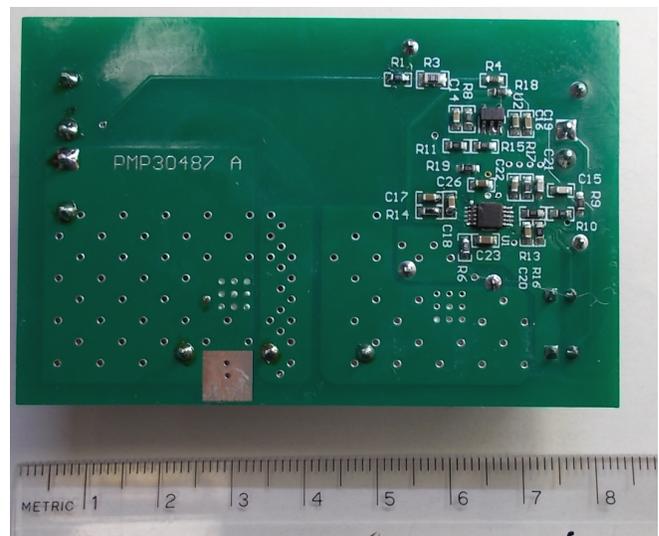
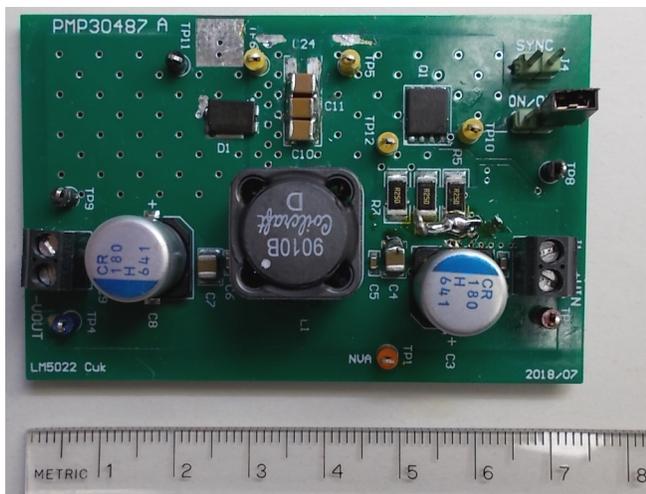
# Test Report: PMP30487

## Inverting SEPIC Reference Design for Noise Sensitive Loads



### Description

This reference design is an inverting SEPIC (Cuk) Converter powering 50-W continuous and up to 70-W peak. The used Cuk topology provides continuous currents at input and output, which allows the lowest conducted emissions in both directions. Compared to an inverting flyback radiated emissions are low as well due to no RF ringing at the switch node.



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## 1 Test Prerequisites

### 1.1 Voltage and Current Requirements

**Table 1. Voltage and Current Requirements**

PARAMETER	SPECIFICATIONS
$V_{IN}$	36 V
$V_{OUT}$	-36 V
Nominal switching frequency	200 kHz
Output Current	2 A

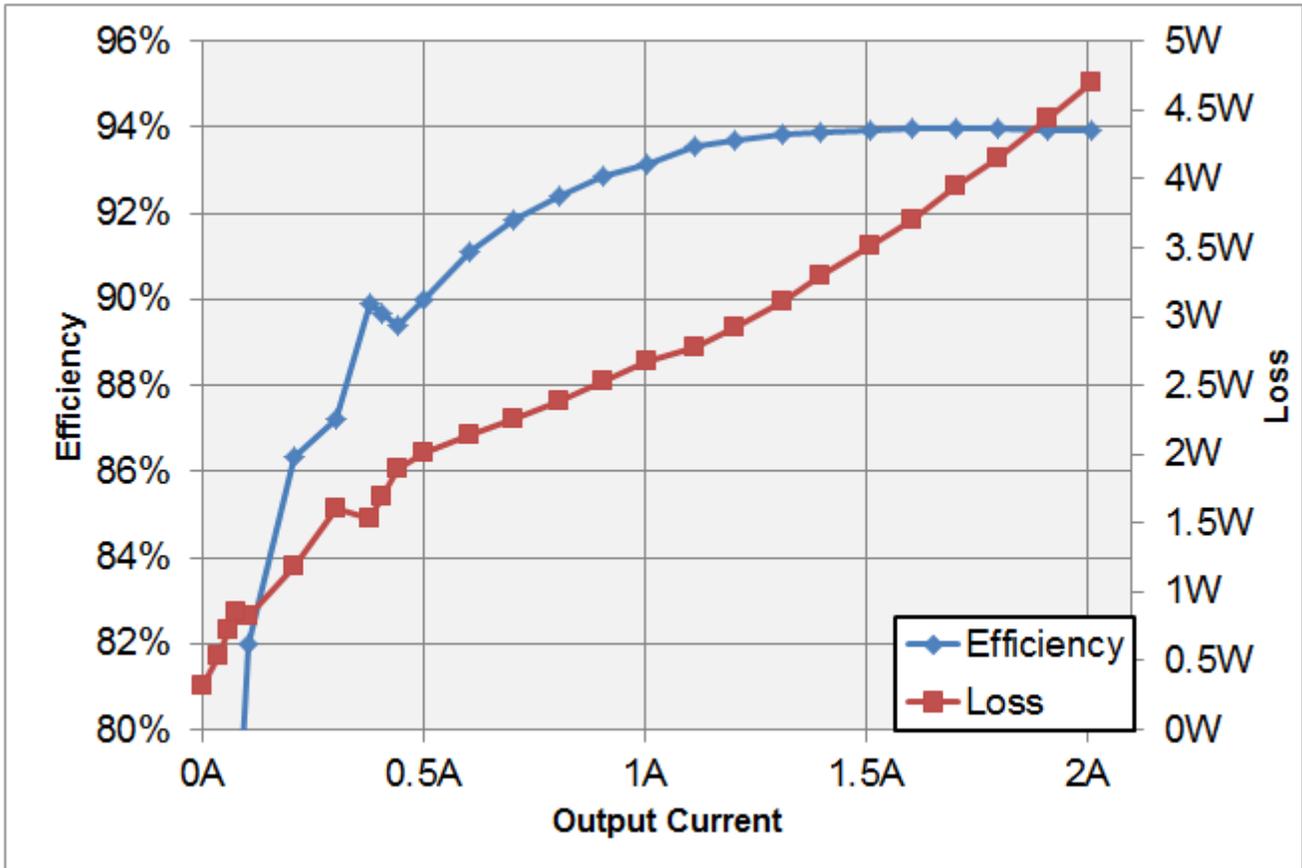
### 1.2 Considerations

The inductor for that design is a modified (footprint, coupling) of the shelf inductor. Except for load transient measurements, resistive load were used. Unless otherwise indicated the input voltage was set to 36 V. The circuit switches on at about 32.7 V and switches off at a voltage about 27.5V

## 2 Testing and Results

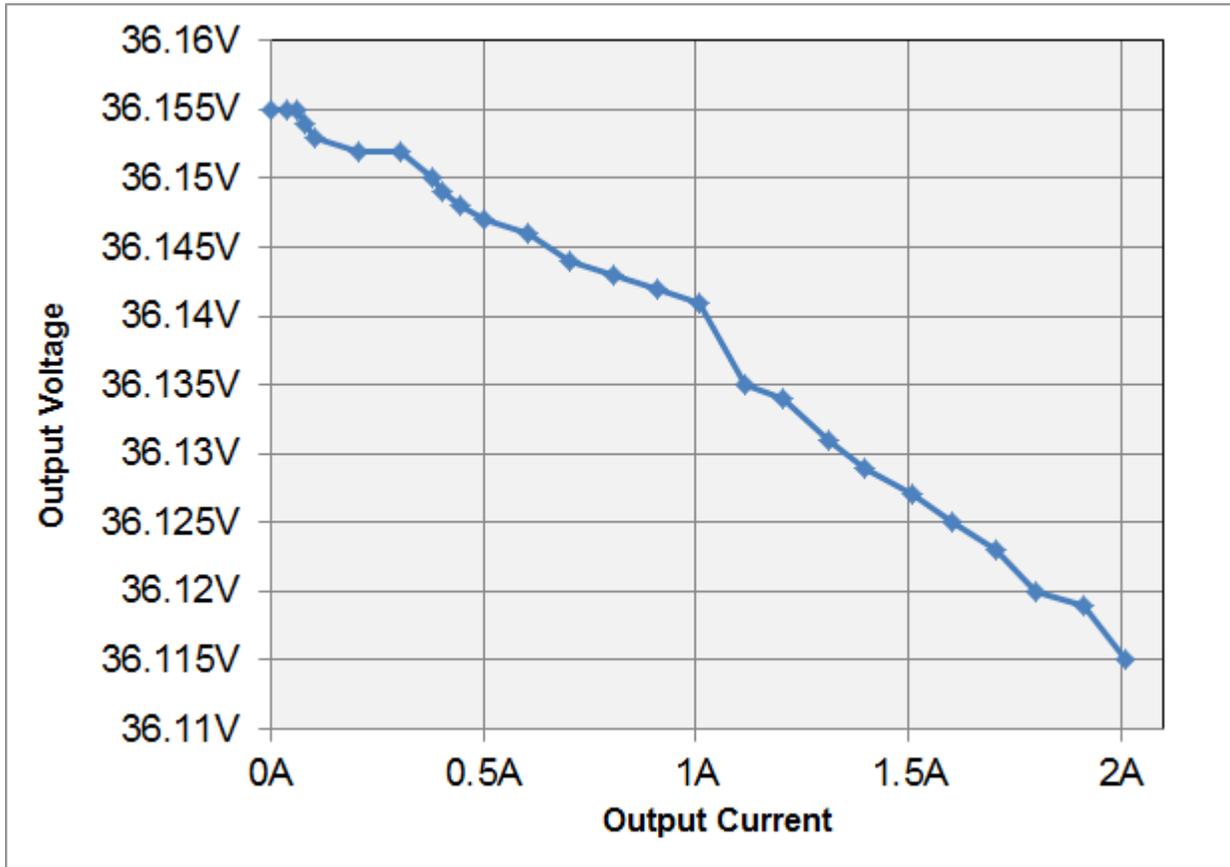
### 2.1 Efficiency Graphs

Figure 1. Efficiency and Loss vs Output Current ( $V_{IN} = 36V$ )



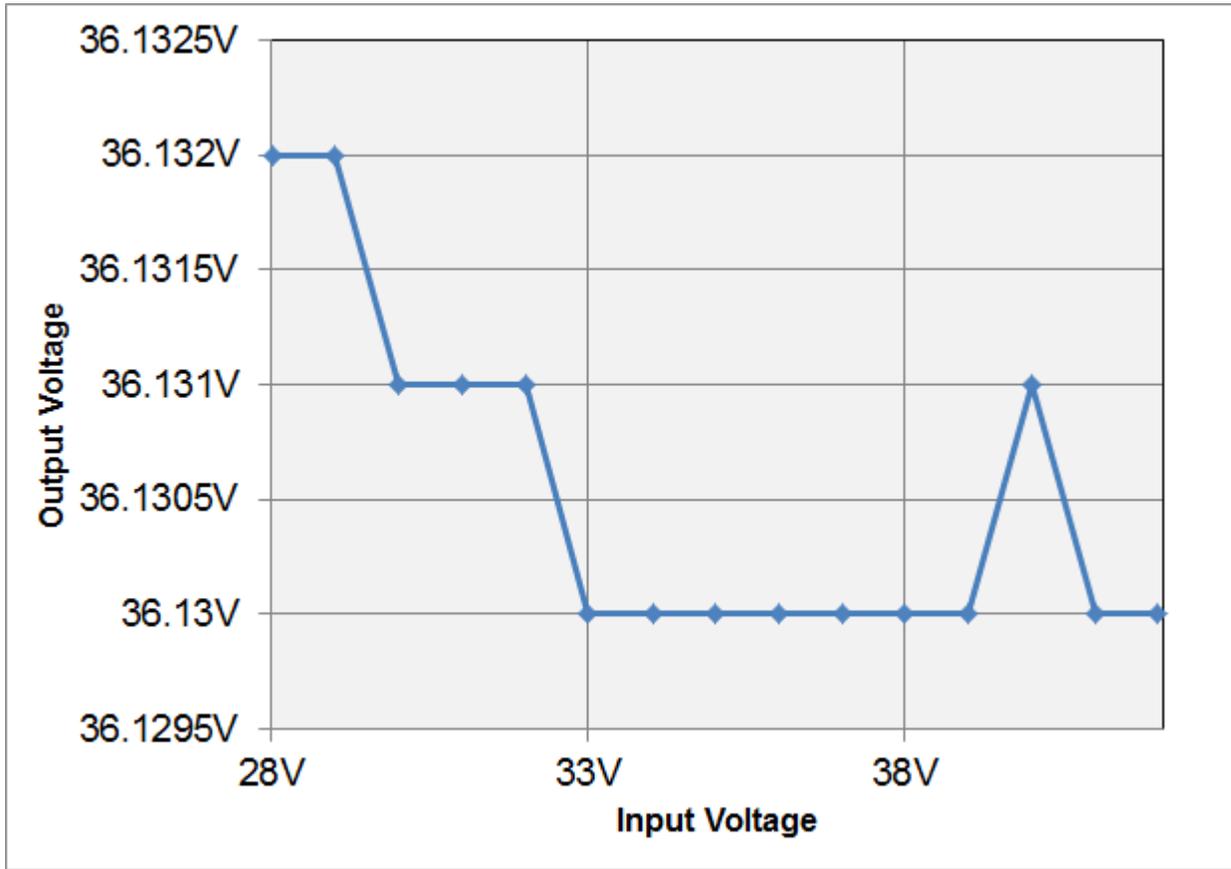
**2.2 Load Regulation**

**Figure 2. Output Voltage vs Output Current ( $V_{IN} = 36\text{ V}$ )**



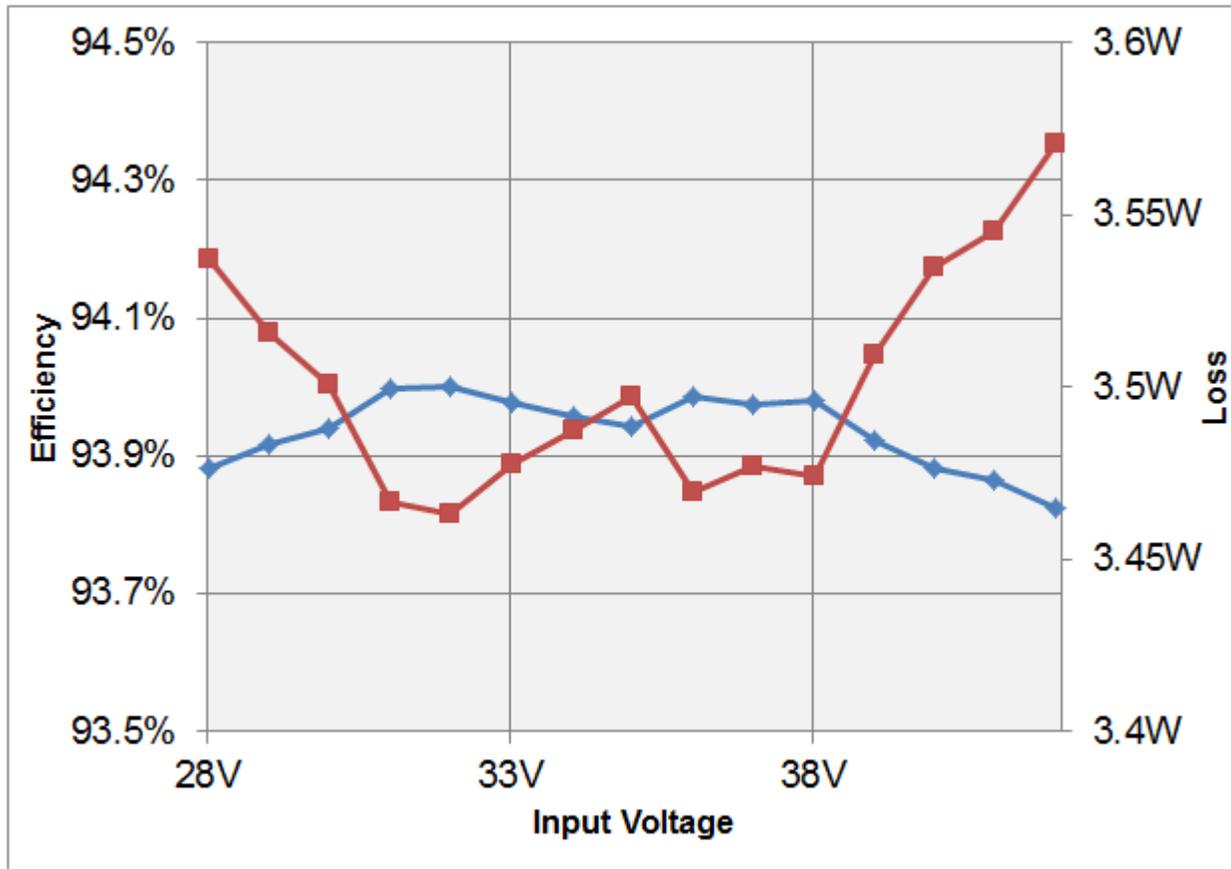
2.3 Line Regulation

Figure 3. Output Voltage vs Input Voltage ( $I_{OUT}=1.5A$ )



During the measurements for line regulation the efficiency and loss were calculated.

**Figure 4. Efficiency and Loss vs Input Voltage ( $I_{OUT}=1.5A$ )**



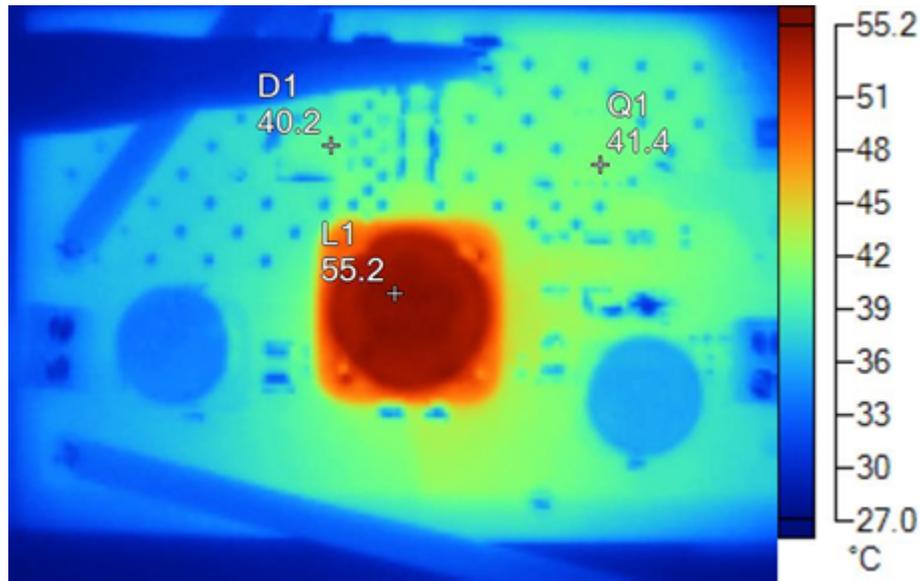
## 2.4 Thermal Images

The table summarizes the results of the thermal images below

$I_{out}$	0.4 A	1 A	1.5 A	2 A
D1	40.2°C	55.2°C	65.4°C	77.1°C
L1	55.2°C	69.4°C	80.0°C	94.1°C
Q1	41.4°C	60.0°C	70.5°C	83.9°C

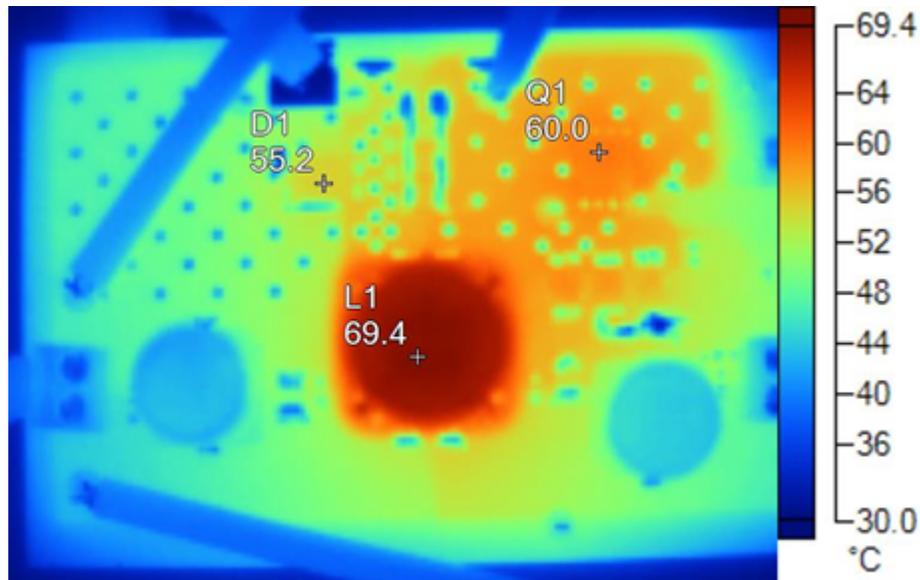
**2.4.1 0.4A Output Current**

**Figure 5. Thermal Image for 0.4 A Output Current**



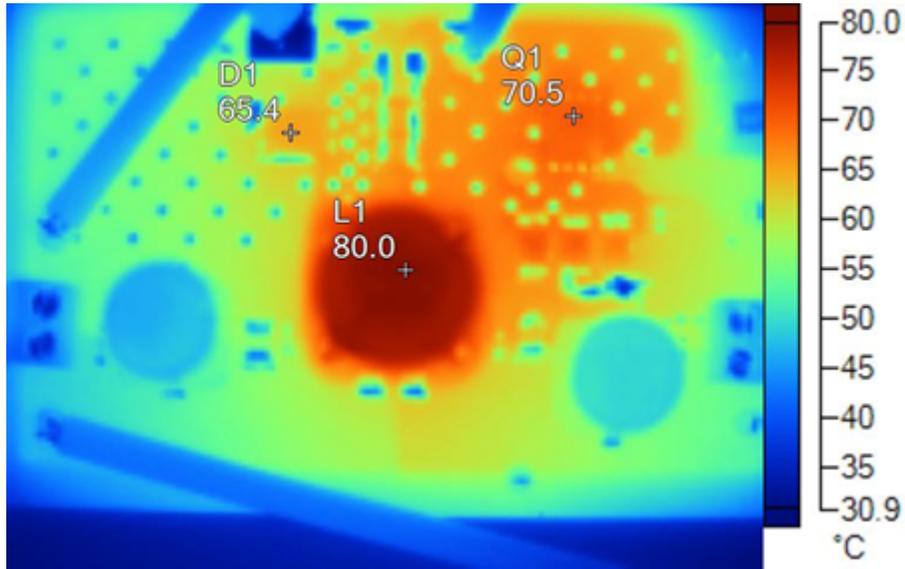
**2.4.2 1A Output Current**

**Figure 6. Thermal Image for 1 A Output Current**



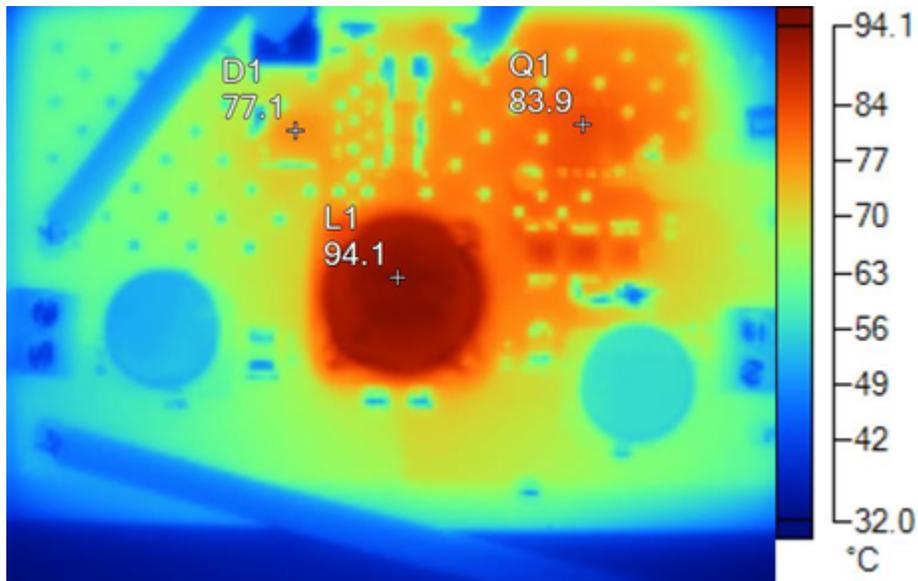
2.4.3 1.5 A Output Current

Figure 7. Thermal Image for 1.5 A Output Current



2.4.4 2 A Output Current

Figure 8. Thermal Image for 2 A Output Current



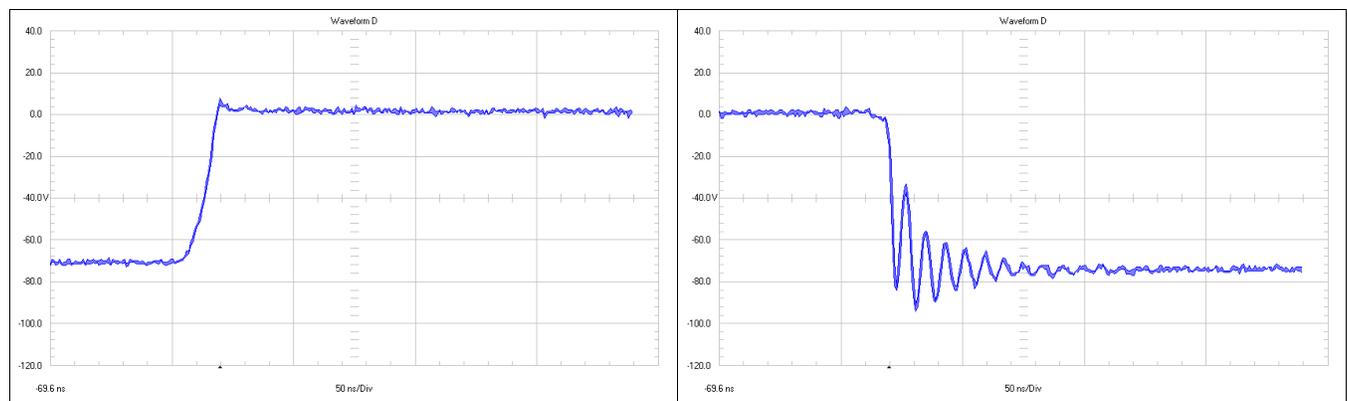
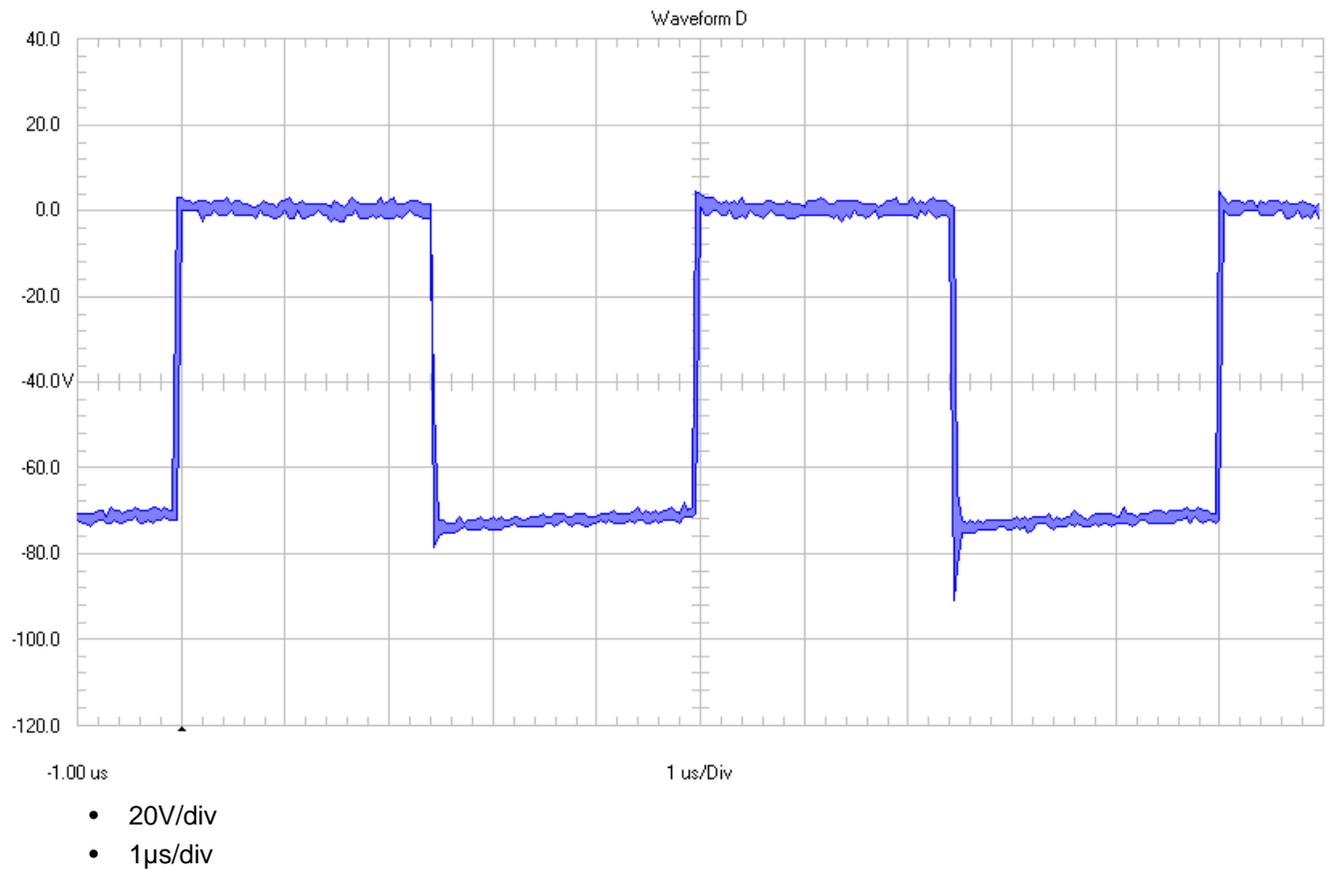
### 3 Waveforms

#### 3.1 Switching

All waveforms in this section are measured with full bandwidth. The output current was set to 2 A.

##### 3.1.1 Diode D1

**Figure 9. Switch Node Voltage Diode D1**

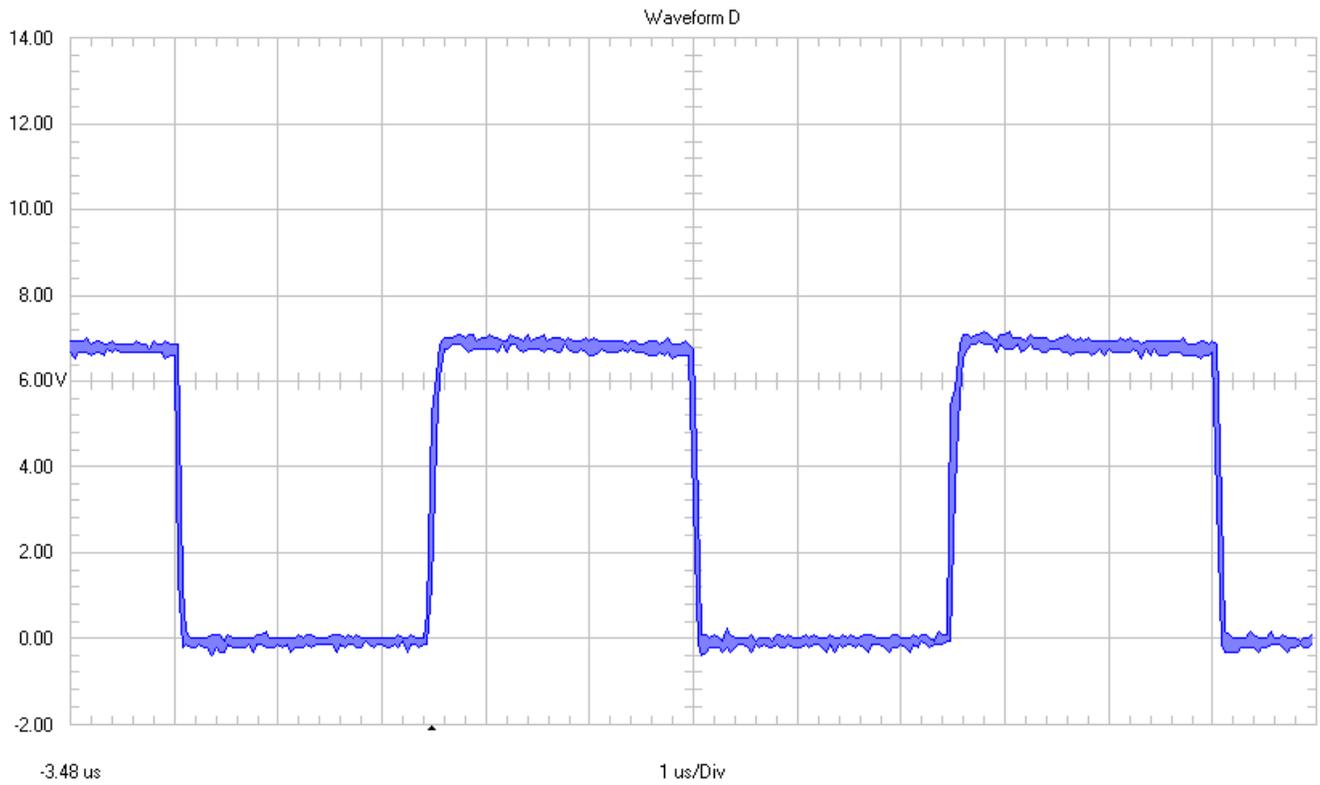


- 50ns/major div

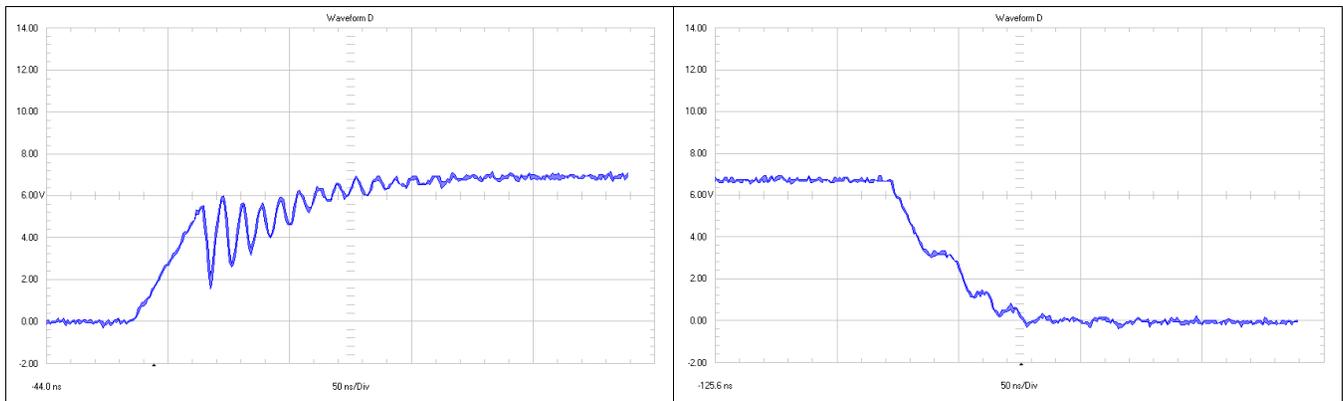


3.1.2.2 Gate to Source

Figure 11. Gate to Source



- 2V/div
- 1 $\mu$ s/div



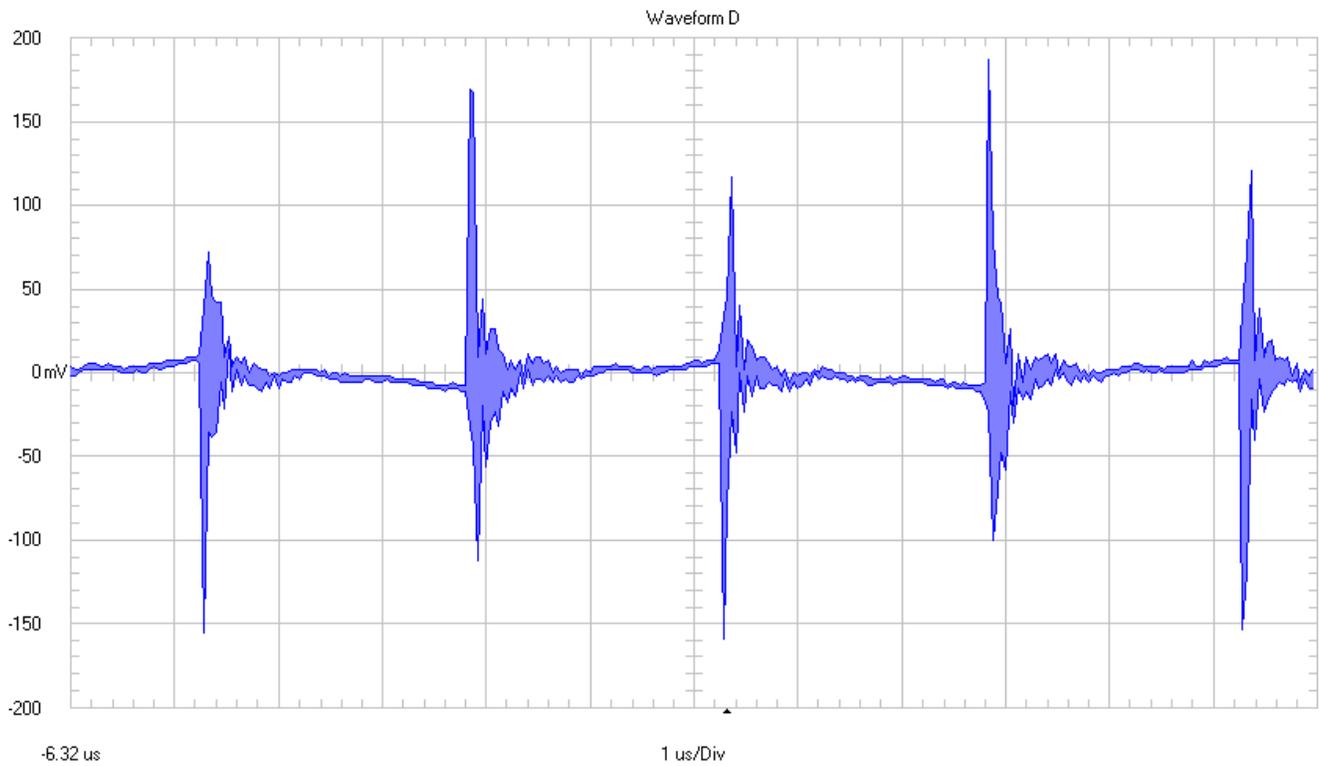
- 50ns/ major div



### 3.3 Input Ripple Voltage

The input ripple waveform was measured direct on the terminal block.

**Figure 13. Input Ripple @ 2 A I<sub>OUT</sub>**

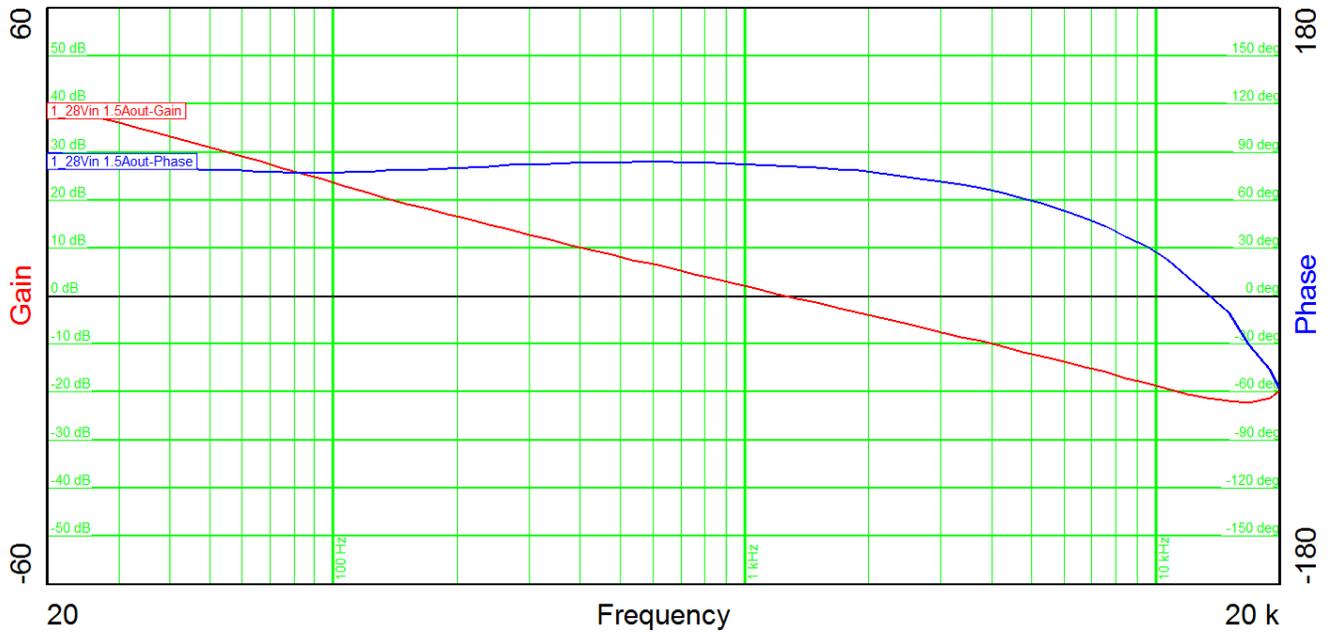


- 50mV/div (20MHz bandwidth filter)
- 1μs/div

### 3.4 Bode Plot

The bode box for 10Hz to 1kHz were used for these measurements.

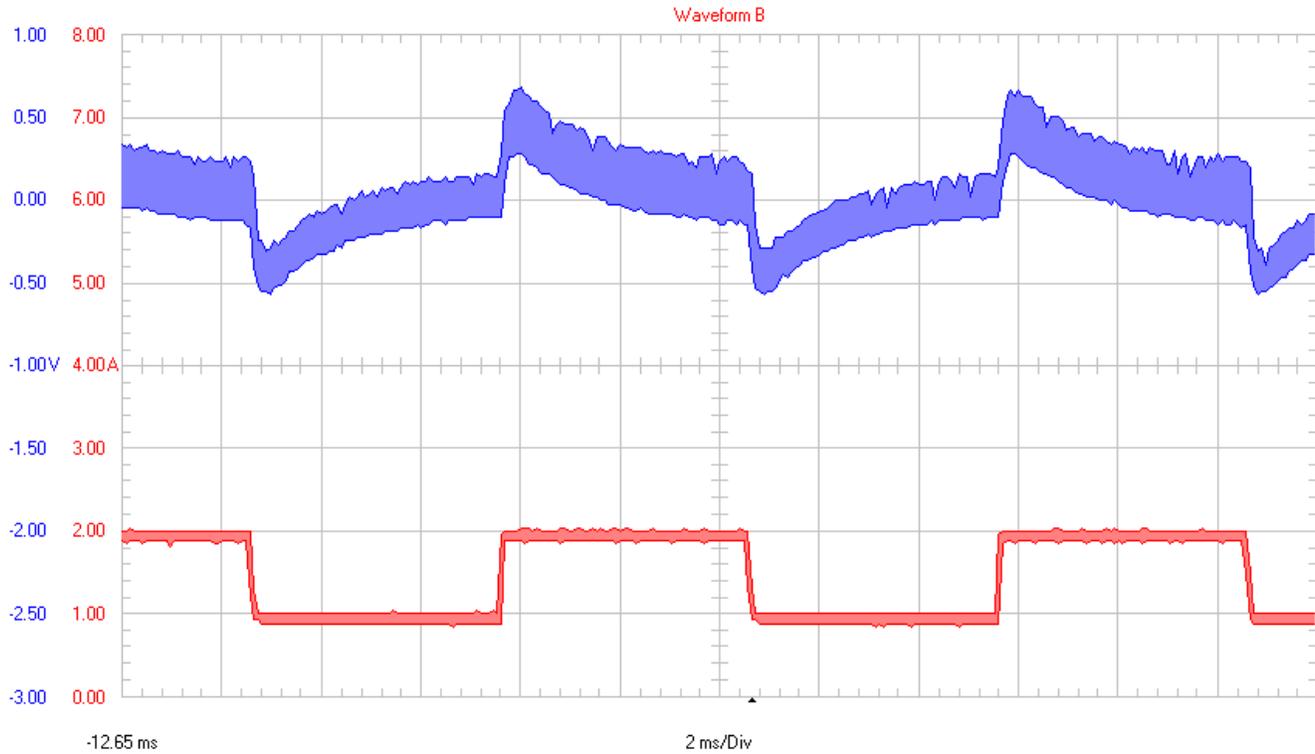
Figure 14. Bode Plot for 36 V Input Voltage and 1.5 A Output Current



Bandwidth (kHz)	1.28
Phase margin	81°
slope (20dB/decade)	-1
gain margin (dB)	-21.4
slope (20dB/decade)	-0.63
freq (kHz)	13.7

### 3.5 Load Transients

Figure 15. Transient Response for Loadstep from 1 A to 2 A

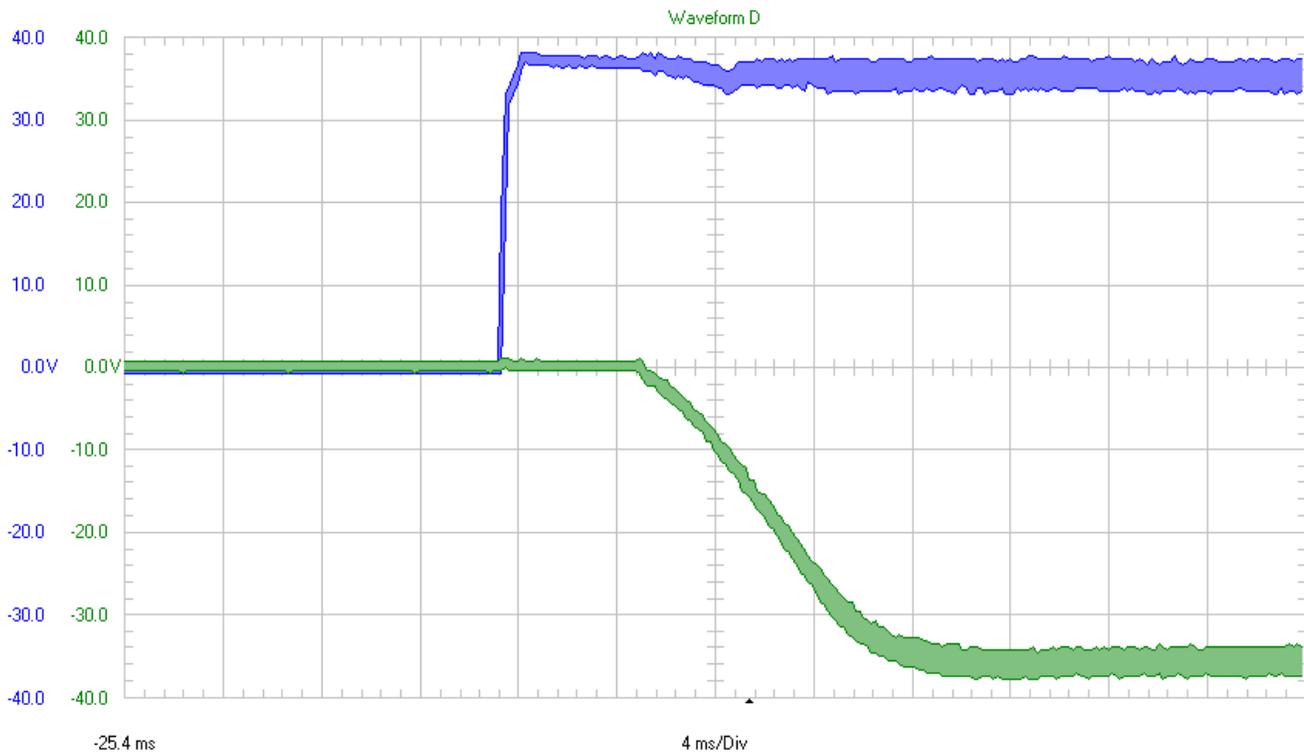


- channel 1 (blue): Output Voltage => 50mV/div AC (20MHz bandwidth filter)
- channel 2 (red): Output Current => 1A/div (20MHz bandwidth filter)
- 2ms/div

### 3.6 Start-up Sequence

The power supply was plugged in.

**Figure 16. Start-up with 2 A Output Current**

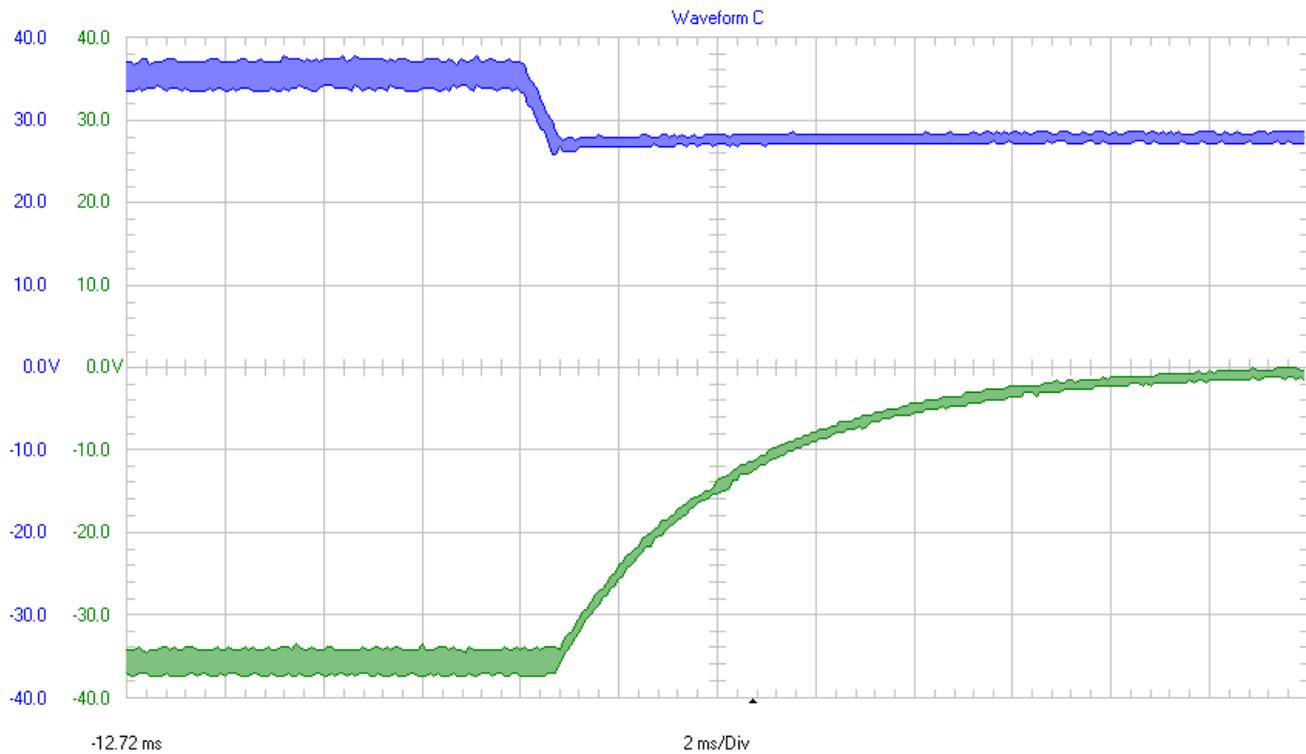


- channel 1 (blue): Input Voltage => 10V/div (20MHz bandwidth filter)
- channel 2 (green): Output Voltage => 10V/div (20MHz bandwidth filter)
- 4ms/div

### 3.7 Shutdown Sequence

The power supply was disconnected.

Figure 17. Shutdown with 2 A Output Current



- channel 1 (blue): Input Voltage => 10V/div (20MHz bandwidth filter)
- channel 2 (green): Output Voltage => 10V/div (20MHz bandwidth filter)
- 2ms/div

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