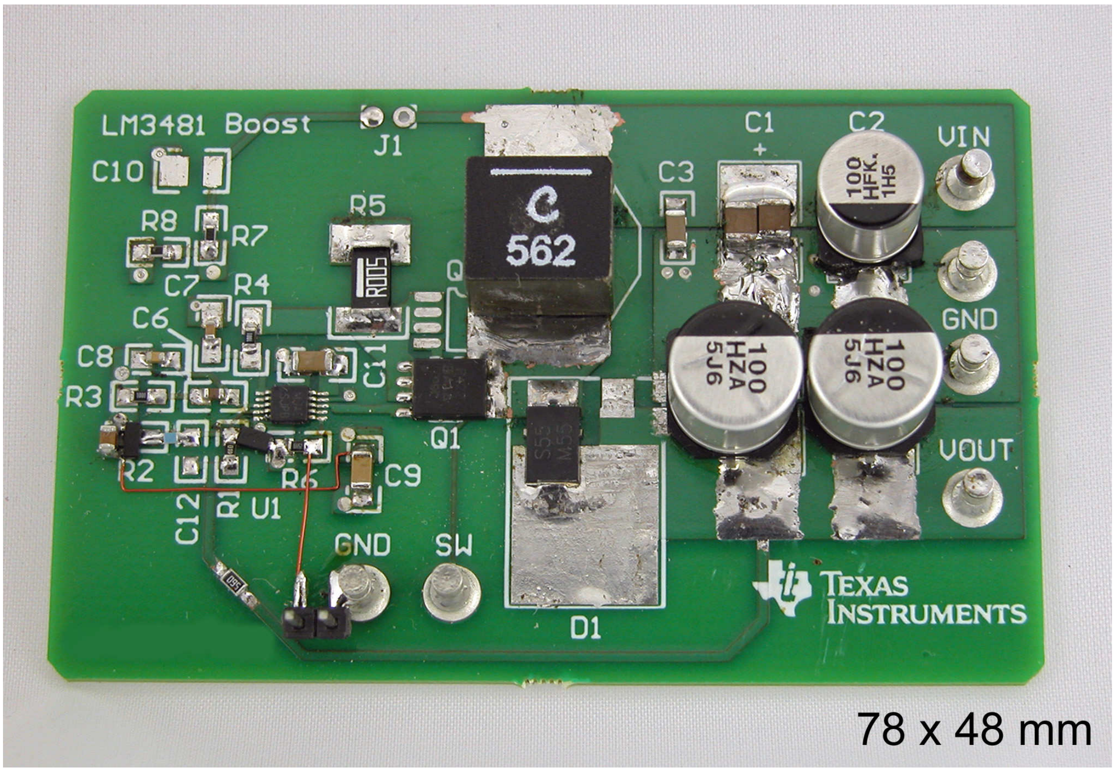
Automotive Boost for E-Call

- Input 2.0 .. 9.0V, 40V peak, 3.5 .. 4.0V nominal
- Output 9.5V @ 1.3A / 2.8A peak (100ms)
- Free-Running Switching Frequency of 300 kHz
- Modified LM3481EVAL Board



1 Startup

The startup waveform is shown in Figure 1. The input voltage is set at 3.5V, with no load on the 9.5V output.

Channel C1: **3.5V Input voltage**
2V/div, 10ms/div

Channel C2: **9.5V Output voltage**
2V/div, 10ms/div

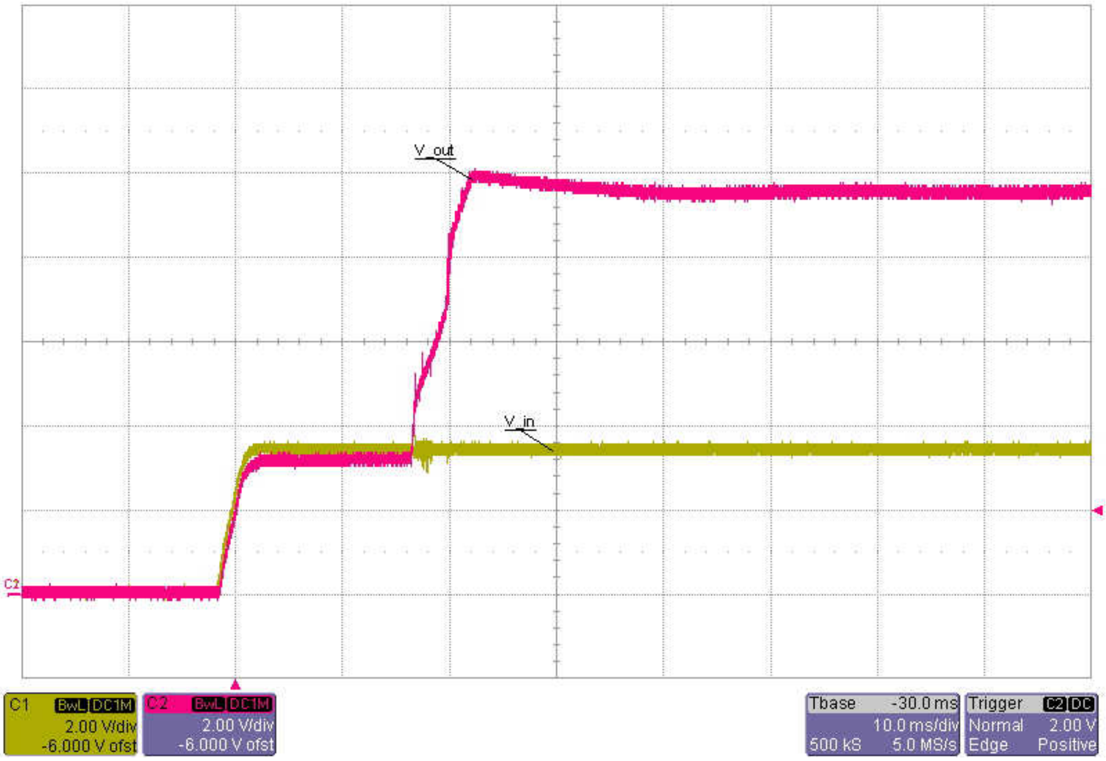


Figure 1

2 Shutdown

The shutdown waveform is shown in Figure 2. The input voltage is set at 3.5V with a 1.3A load on the 9.5V output.

Channel C1: **3.5V Input voltage**
2V/div, 2ms/div

Channel C2: **9.5V Output voltage**
2V/div, 2ms/div

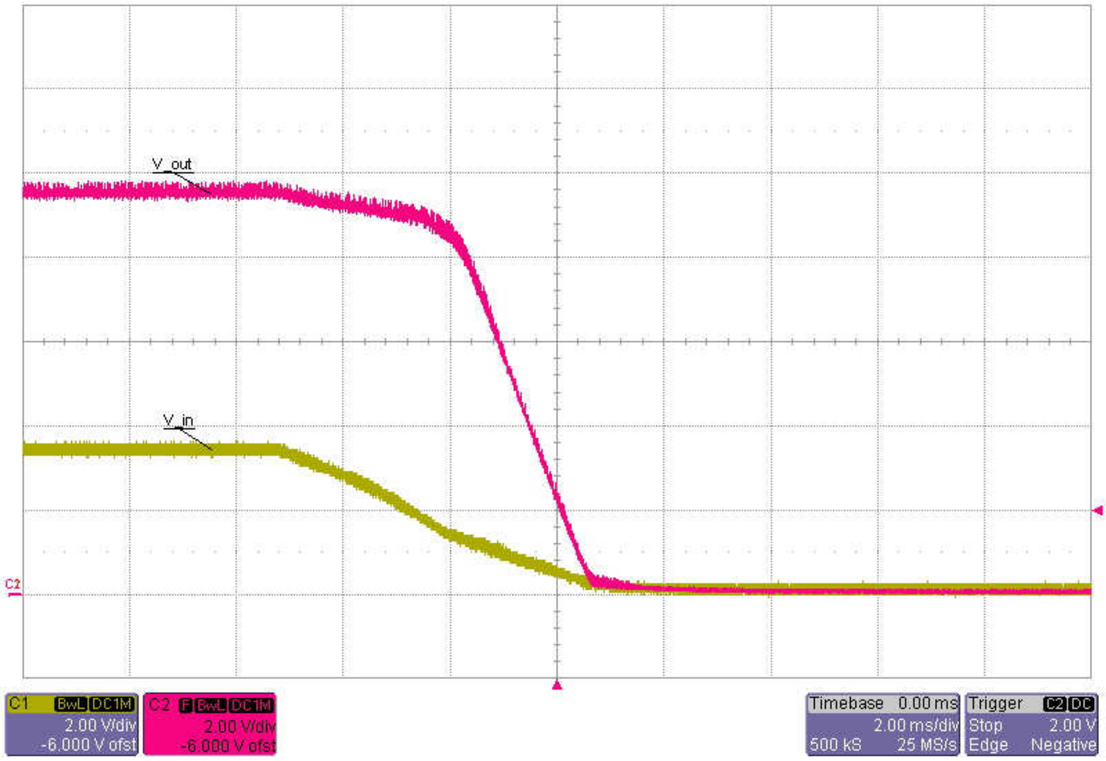


Figure 2

3 Efficiency

The efficiency and load regulation are shown in Figure 3 and Figure 4.

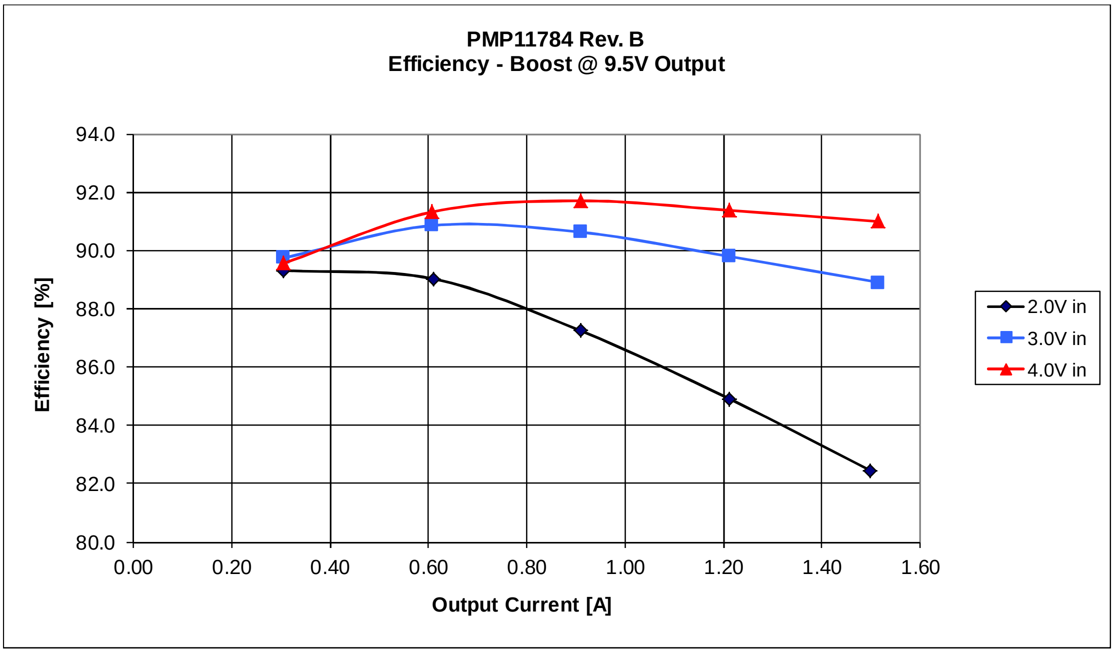


Figure 3

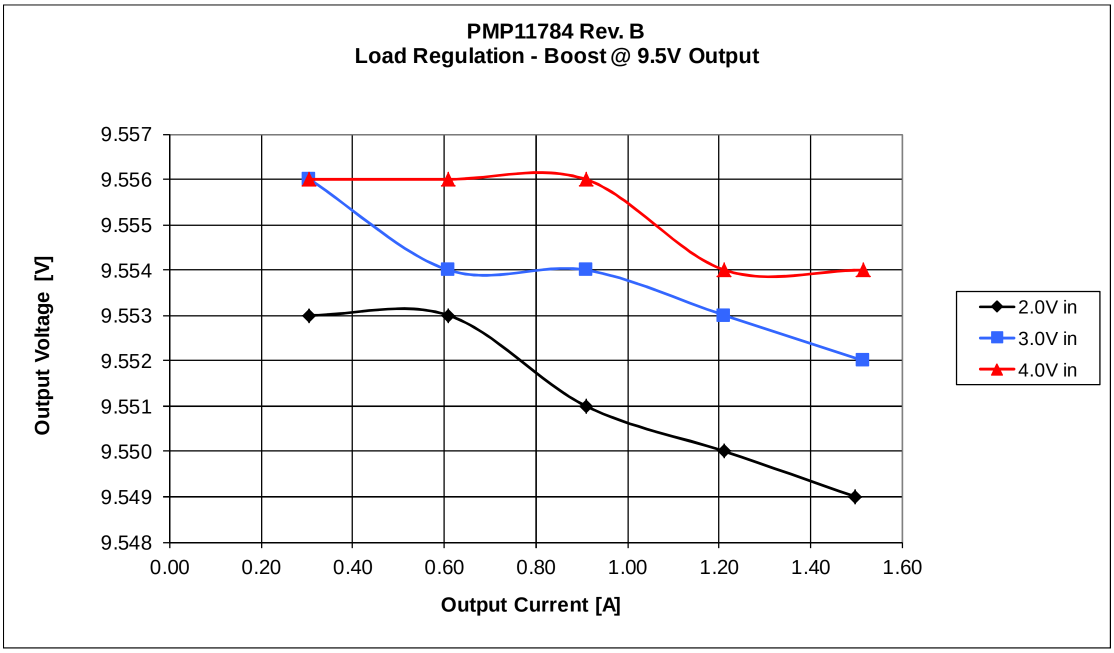


Figure 4

4 Transient Response

The response to a load step and a load dump for the 9.5V output at an input voltage of 3.5V is shown in Figure 5 and Figure 6.

Channel C2: **Output voltage**, -690mV undershoot (7.3%), 526mV overshoot (5.5%)
500mV/div, 2ms/div, AC coupled

Channel C1: **Load current**, load step 1.0A to 2.0A and vice versa
1A/div, 2ms/div

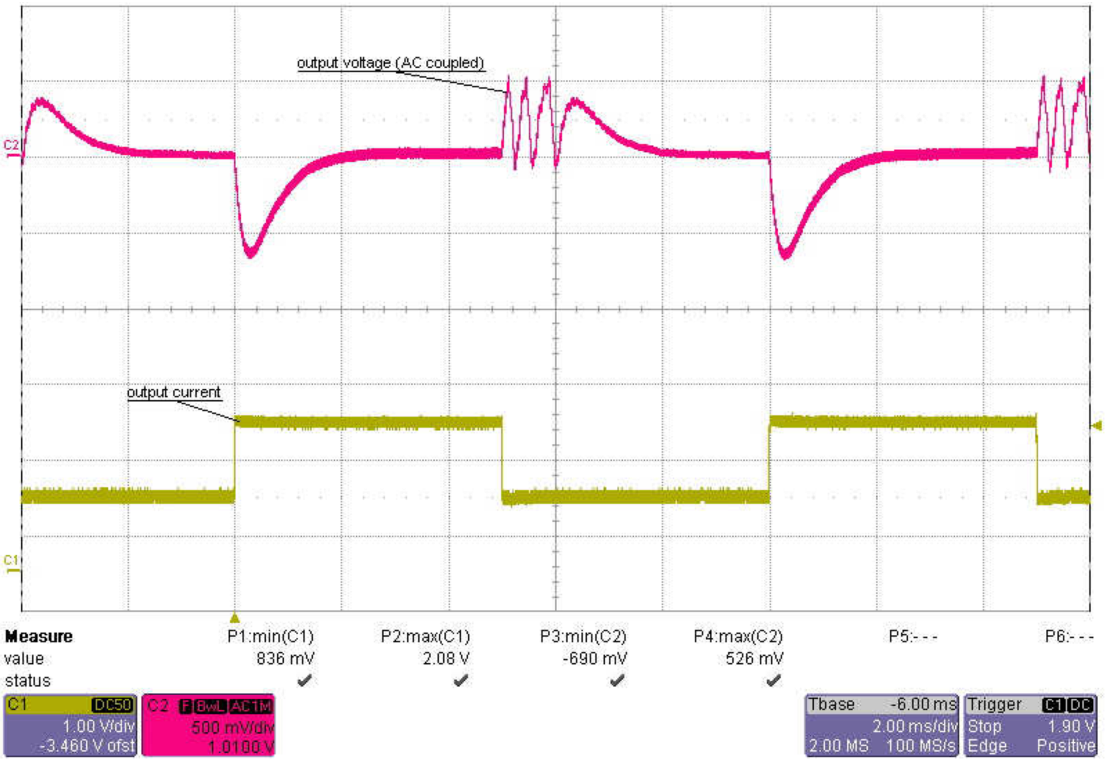


Figure 5

Channel C2: **Output voltage**, -1.17V undershoot (12.3%), 642mV overshoot (6.8%)
500mV/div, 2ms/div, AC coupled

Channel C1: **Load current**, load step 0.9A to 2.8A and vice versa
1A/div, 2ms/div

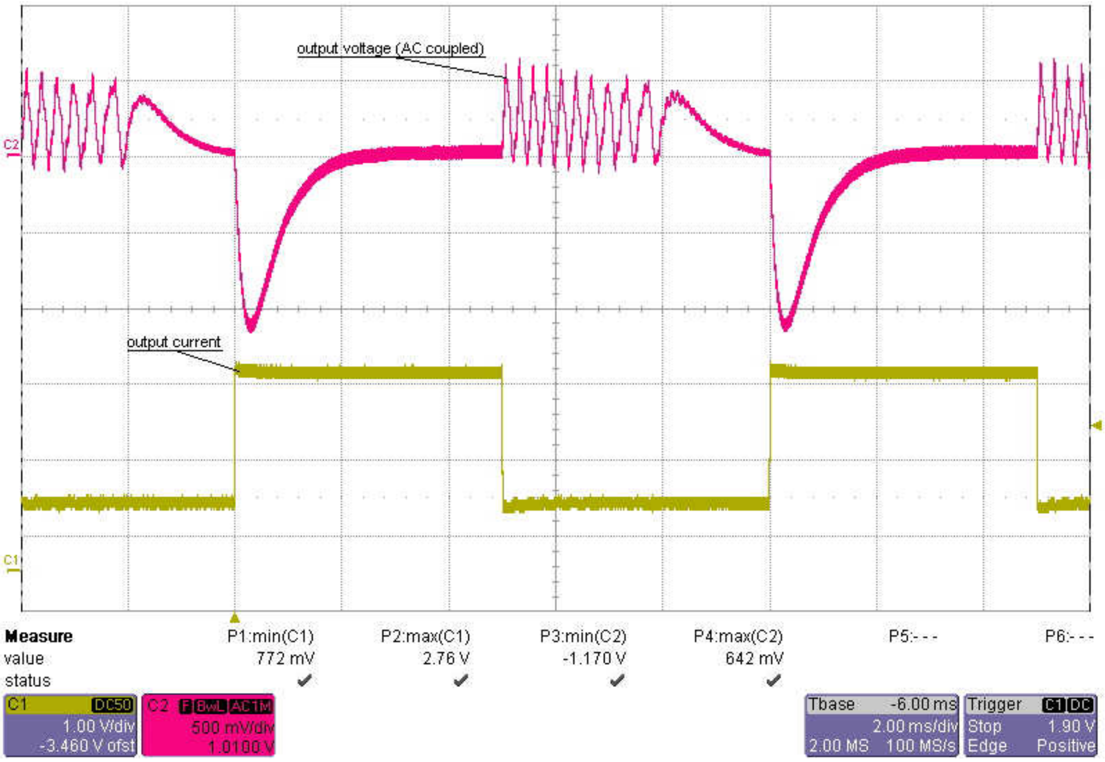


Figure 6

During a load step the output voltage drops and recovers immediately as it is expected from a power supply. After removing a large load, the output voltage rises and before it is regulated to the nominal output voltage, some kind of ringing is seen.
This is caused by the overvoltage protection of the LM3481 controller. If the voltage on the feedback pin is 85mV (typ.) higher than the feedback voltage (1.275V typ.), the controller stops switching the FET, until the voltage falls below 1.29V (70mV typ. hysteresis). When the voltage has fallen below 1.29V it starts switching again.

The inductor current is very high, which means, a lot of energy is stored in the inductor. When the load is removed, the energy from the inductor is stored in the output capacitor which causes the output voltage to rise. If the converter stops switching, practically the switching frequency is reduced, but there is still energy stored in the inductor. Therefore it takes some cycles until the inductor current is reduced to the new lower value.

This behavior is technically and functionally alright and the output voltage meets tolerance requirement of 15%.
In case this behavior is not wanted, the output capacitance needs to be increased that the energy stored in the inductor can be transferred into the output capacitor without increasing the output voltage above the overvoltage threshold.

5 Frequency Response

Figure 7 and Figure 8 shows the loop response at 2.0V, 3.0V and 4.0V input voltage.

2.0V input

- 1.3A load 63 deg phase margin, 430 Hz bandwidth, -22 dB gain margin

3.0V input

- 1.3A load 76 deg phase margin, 615 Hz bandwidth, -28 dB gain margin

4.0V input

- 1.3A load 88 deg phase margin, 829 Hz bandwidth, -34 dB gain margin

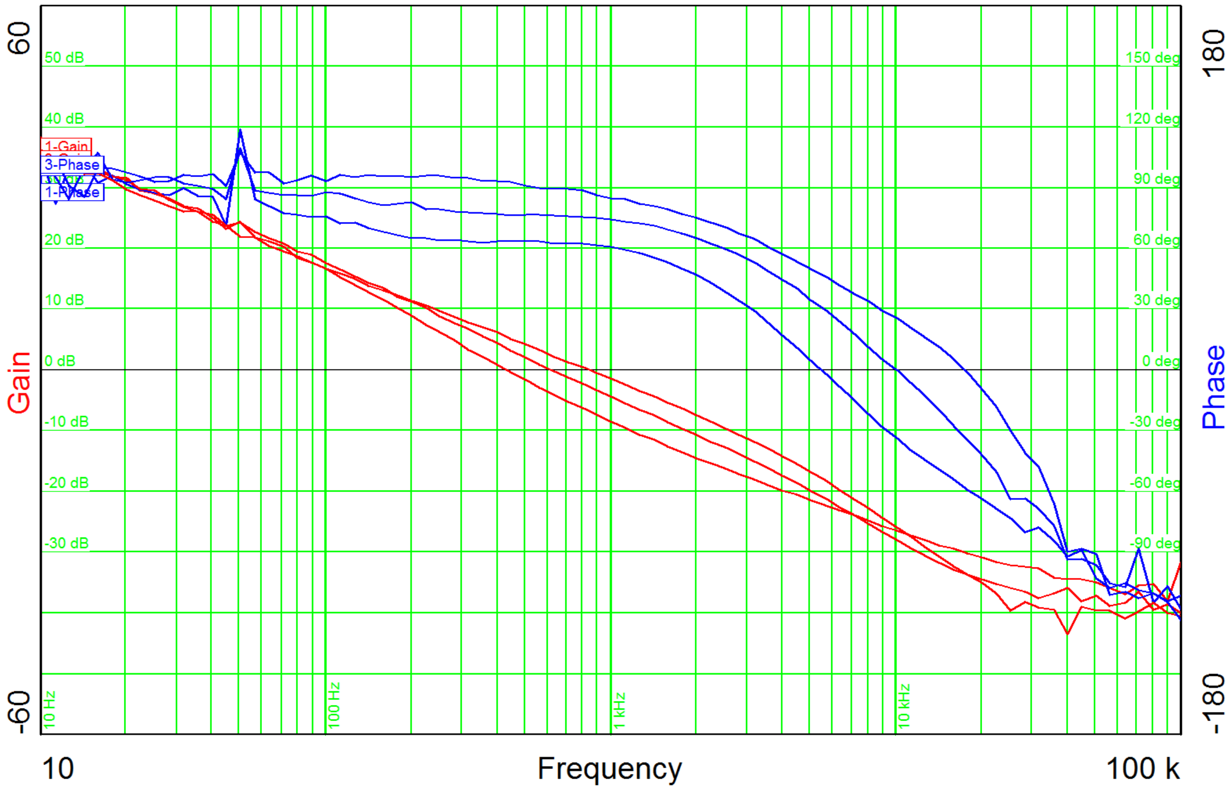


Figure 7

2.0V input

- 2.8A load 47 deg phase margin, 217 Hz bandwidth, -12 dB gain margin

3.0V input

- 2.8A load 82 deg phase margin, 489 Hz bandwidth, -19 dB gain margin

4.0V input

- 2.8A load 91 deg phase margin, 704 Hz bandwidth, -24 dB gain margin

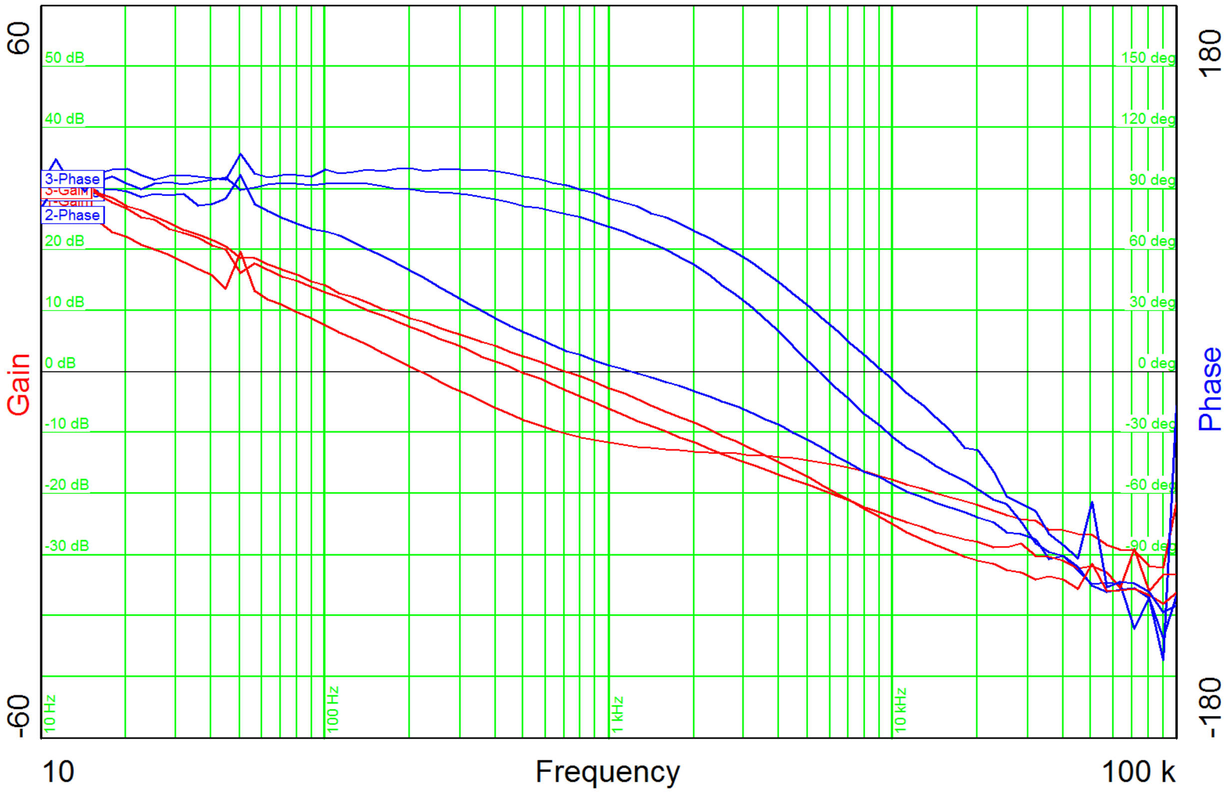


Figure 8

6 Output Ripple Voltage

The output ripple voltage at 1.3A load and 2.0V, 3.0V and 4.0V input voltage is shown in Figure 9.

Channel M1: **Output voltage @ 2.0V input**, 132mV peak-peak
50mV/div, 2us/div, AC coupled

Channel M2: **Output voltage @ 3.0V input**, 115mV peak-peak
50mV/div, 2us/div, AC coupled

Channel M3: **Output voltage @ 4.0V input**, 101mV peak-peak
50mV/div, 2us/div, AC coupled

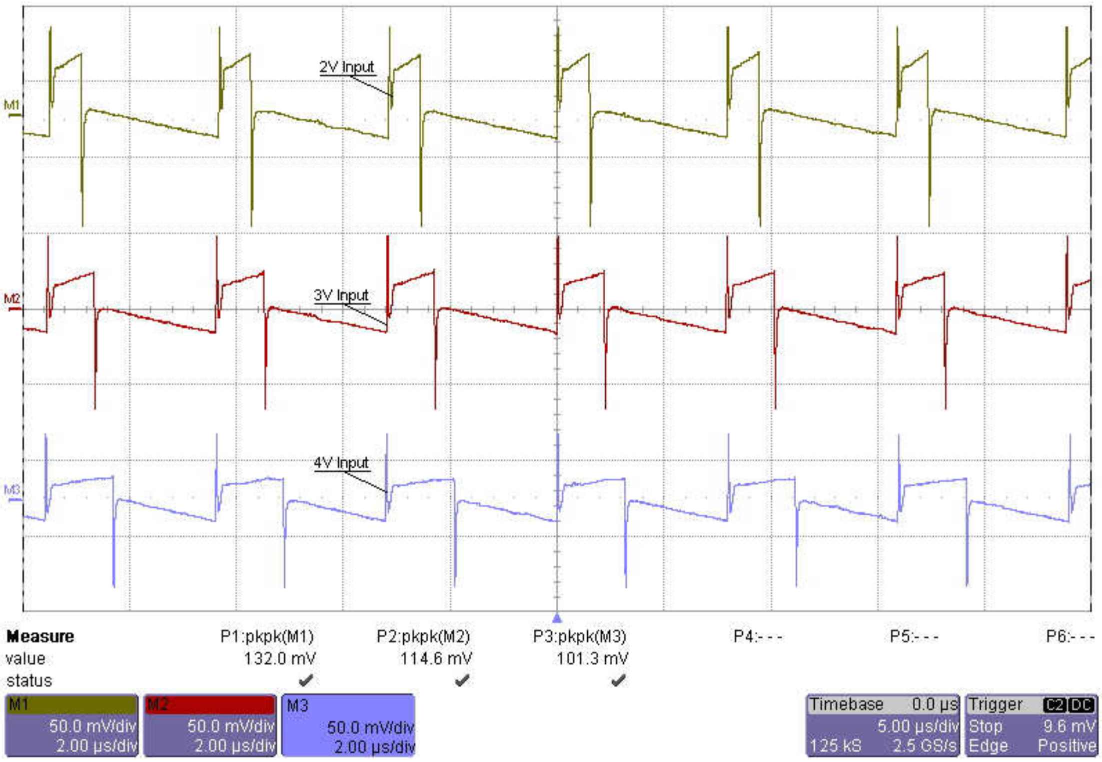


Figure 9

7 Thermal Measurement

The thermal image (Figure 10) shows the circuit at an ambient temperature of 21 °C with an input voltage of 3.5V and a load of 1.3A.

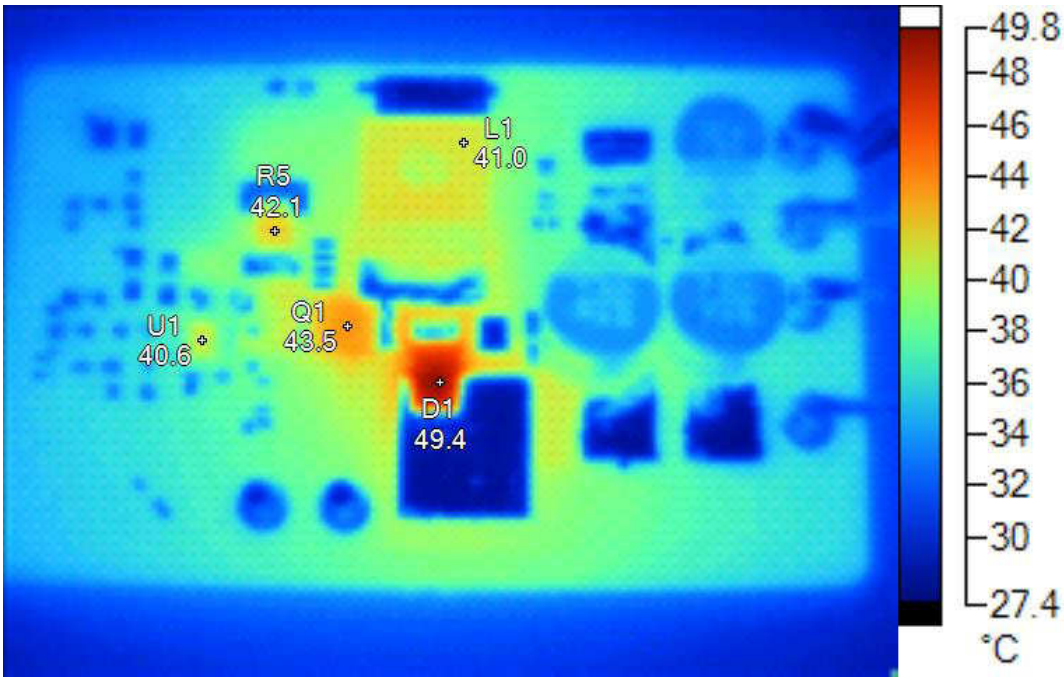


Figure 10

Markers

Label	Temperature	Emissivity	Background
L1	41.0°C	0.95	21.0°C
D1	49.4°C	0.95	21.0°C
Q1	43.5°C	0.95	21.0°C
U1	40.6°C	0.95	21.0°C
R5	42.1°C	0.95	21.0°C