Test Report: PMP40871

48-V Output Low-Noise Phantom Power Reference Design

1 Description

This reference design delivers a 48-V output, low-noise power supply for the phantom power application using the TPS61391 and TPS7A4101 devices. The TPS61391 is a 700-kHz PWM step-up converter that converts 3.3 V or 5 V to 48.5 V. The TPS7A4101 is a 50-V tolerant input and 0.29-V drop LDO that steps 48.5 V down to 48 V and minimizes the output ripple. The design supports 48-V, 20-mA output power at 5-V input. The output ripple is only around 8.4 mV, which is pretty low for phantom power applications.

Figure 1-1. Top Photo

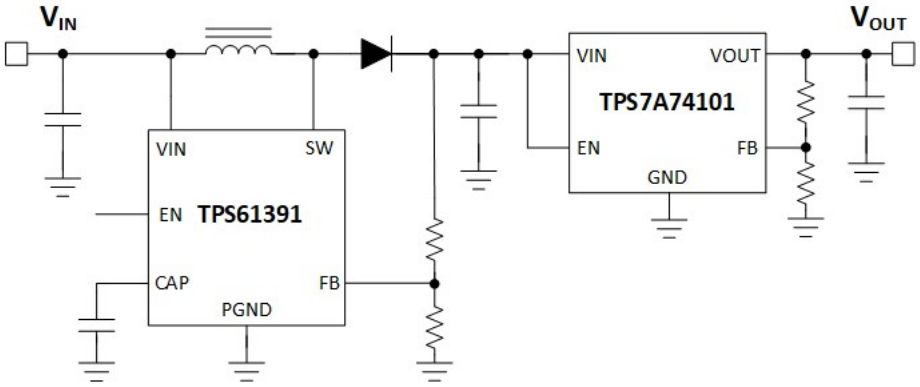


Figure 1-2. Block Diagram

2 Test Prerequisites

2.1 Voltage and Current Requirements

Table 2-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage	3.3-5 VDC
Output Voltage	48 VDC
Output Current	10-mA at 3.3-VDC input 20-mA at 5-VDC input

2.2 Required Equipment

- Multimeter (current): Fluke 287C
- Multimeter (voltage): Fluke 287C
- DC Source: Chroma MODEL 62012P-100-50
- E-Load: Chroma 63110A
- Oscilloscope: Tektronix DPO3054
- Electrical Thermography: Fluke TiS65

2.3 Dimensions

The board dimensions are 58.4 mm (length) × 30.5 mm (width) × 8.4 mm (height).

3 Testing and Results

3.1 Efficiency Graphs

Efficiency is shown in the following figure.

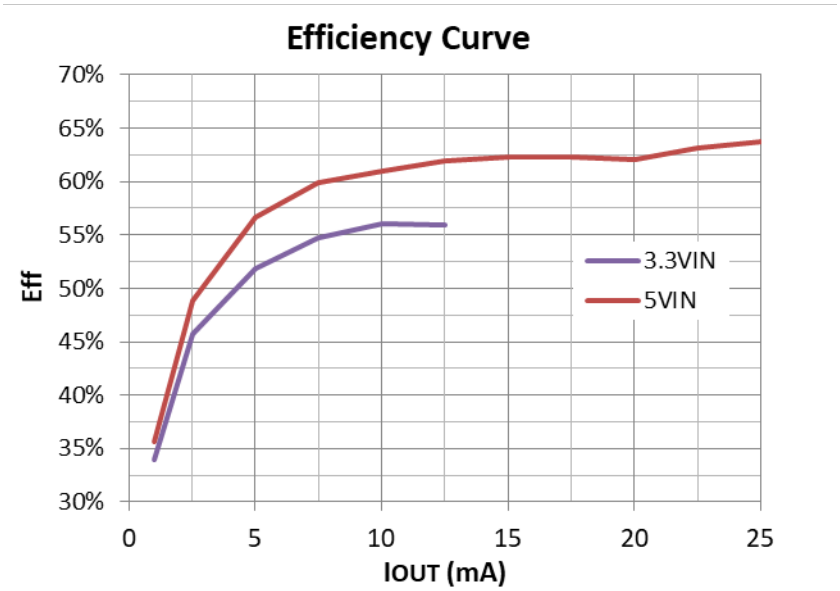


Figure 3-1. Efficiency Graph

3.2 Efficiency Data

Efficiency data is shown in the following table.

V_{IN} (V)	I_{IN} (mA)	P_{IN} (W)	Boost $_{OUT1}$ (V)	LDO V_{OUT} (V)	I_{OUT} (mA)	P_{OUT} (W)	P_{LOSS} (W)	Eff.
3.3045	16.54	0.0547	48.239	47.636	0	0.0000	0.0547	
3.3013	43.5	0.1436	48.239	47.614	1.026	0.0489	0.0948	34.02%
3.2914	79.5	0.2617	48.239	47.604	2.516	0.1198	0.1419	45.77%
3.2923	140.3	0.4619	48.239	47.593	5.032	0.2395	0.2224	51.85%
3.2856	198.4	0.6519	48.24	47.586	7.504	0.3571	0.2948	54.78%
3.2968	257.7	0.8496	48.242	47.576	10.018	0.4766	0.3730	56.10%
3.2972	322.9	1.0647	48.242	47.571	12.530	0.5961	0.4686	55.99%
4.9943	10.64	0.0531	48.242	47.638	0	0.0000	0.0531	
4.997	27.34	0.1366	48.241	47.613	1.023	0.0487	0.0879	35.65%
4.9913	49.1	0.2451	48.241	47.603	2.515	0.1197	0.1254	48.85%
4.9936	84.6	0.4225	48.242	47.593	5.032	0.2395	0.1830	56.69%
4.9963	119.2	0.5956	48.242	47.584	7.503	0.3570	0.2385	59.95%
4.9926	156.7	0.7823	48.242	47.578	10.018	0.4766	0.3057	60.92%
4.9938	192.8	0.9628	48.242	47.57	12.531	0.5961	0.3667	61.91%
4.9924	230.1	1.1488	48.242	47.563	15.047	0.7157	0.4331	62.30%
4.9894	268.2	1.3382	48.242	47.555	17.519	0.8331	0.5050	62.26%
4.9937	307.5	1.5356	48.242	47.546	20.033	0.9525	0.5831	62.03%
4.9876	340	1.6958	48.239	47.537	22.505	1.0698	0.6260	63.09%
4.9855	371.5	1.8521	47.501	47.142	25.021	1.1795	0.6726	63.69%

3.3 Thermal Images

Thermal images are shown in the following figures.

Note

Testing was done after 20 minutes of operation, T_a = 19.0°C.

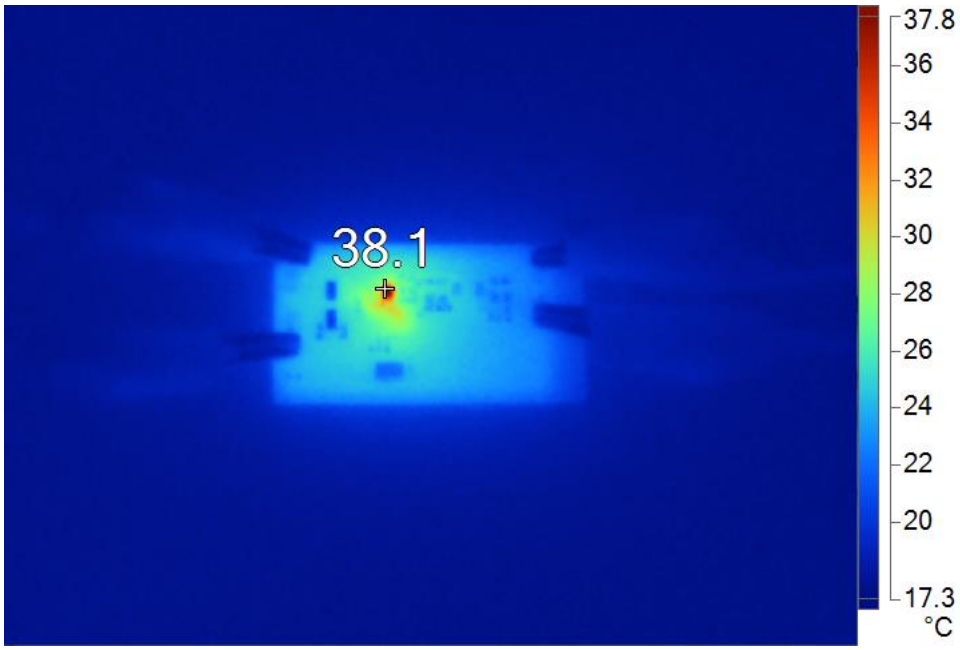


Figure 3-2. 3.3-V Input, 48-V, 10-mA Output, top Side

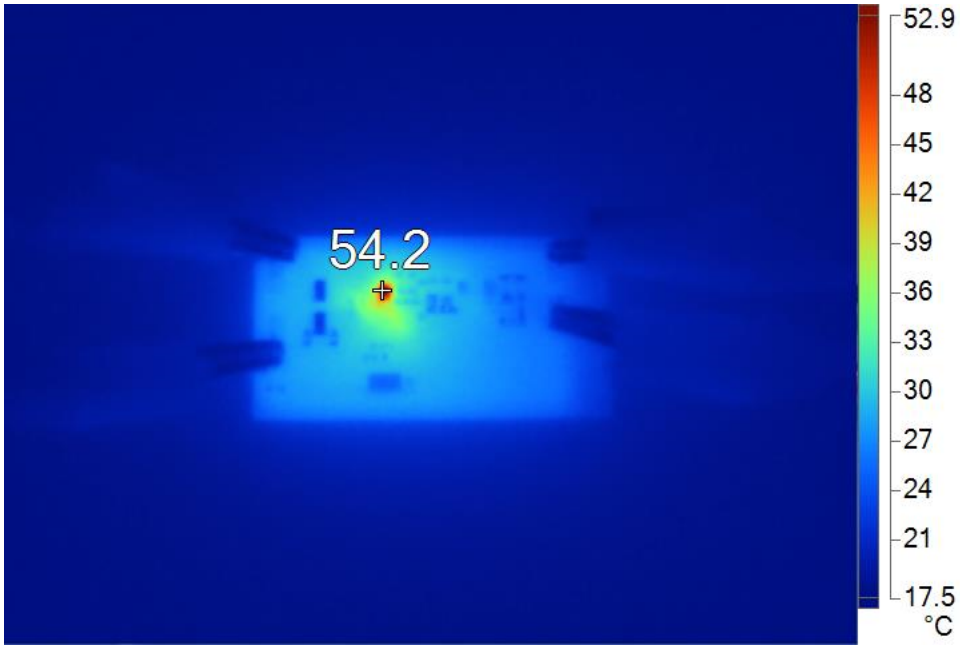


Figure 3-3. 5-V Input, 48-V, 20-mA Output, top Side

3.4 Load Regulation

Load regulation is shown in the following figure.

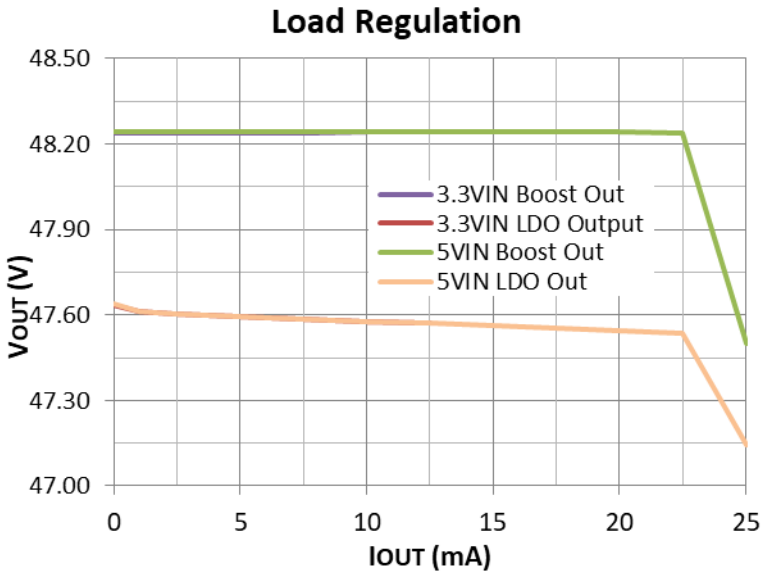
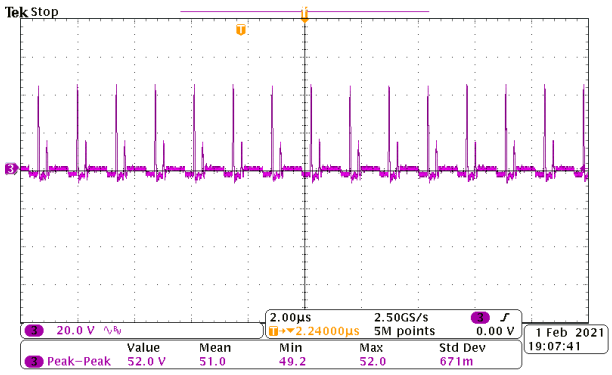


Figure 3-4. Load Regulation

4 Waveforms

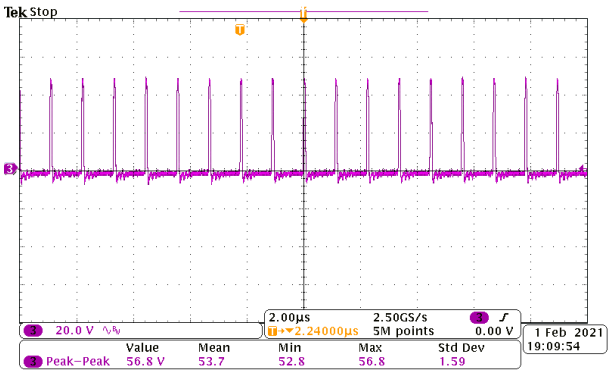
4.1 Switching

Switching behavior of the TPS61391 is shown in the following figures.



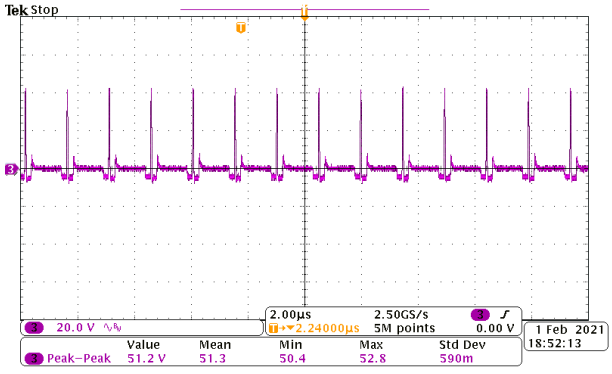
CH3: V_{SW}

Figure 4-1. 3.3-V input, 48-V no load



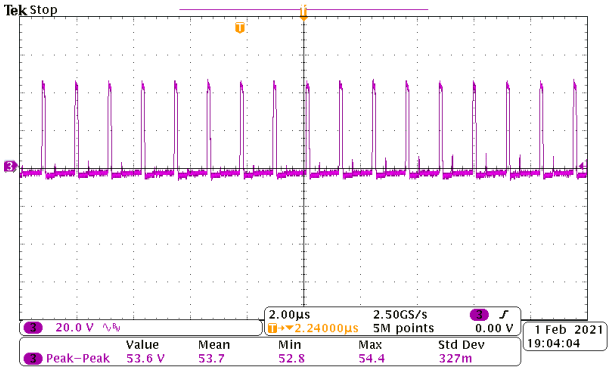
CH3: V_{SW}

Figure 4-2. 3.3-V Input, 48-V, 10-mA Load



CH3: V_{SW}

Figure 4-3. 5-V Input, 48-V no Load

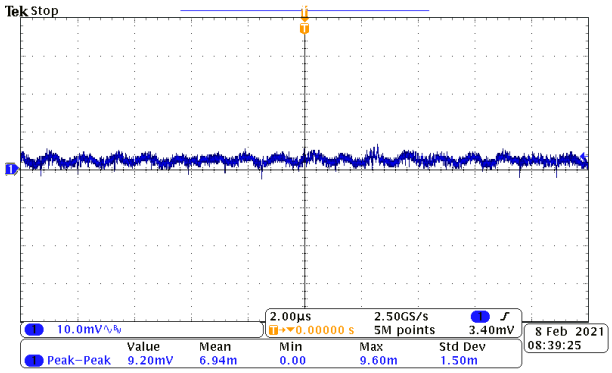


CH3: V_{SW}

Figure 4-4. 5-V Input, 48-V, 20-mA Load

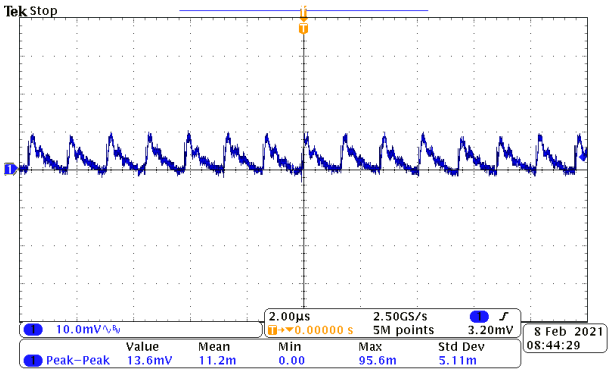
4.2 Output Voltage Ripple

The output voltage ripple of the TPS61391 is shown in the following figures. It is also the input voltage ripple of the TPS7A4101.



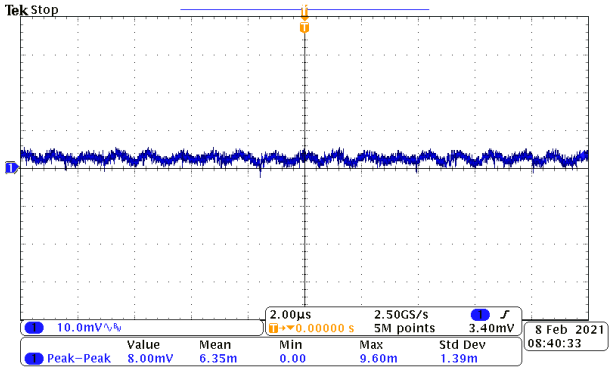
CH1: $V_{OUT(Boost)}$

Figure 4-5. 3.3-V Input, 48-V no Load



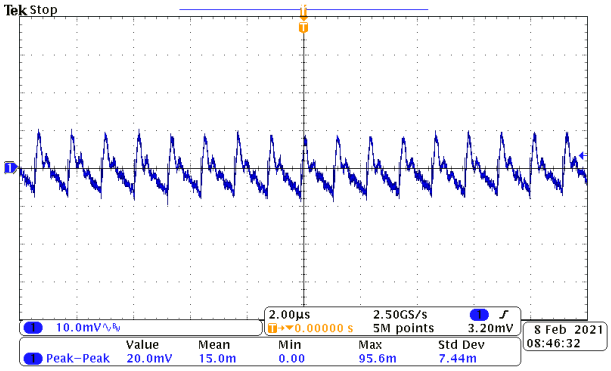
CH1: $V_{OUT(Boost)}$

Figure 4-6. 3.3-V Input, 48-V, 10-mA Load



CH1: $V_{OUT(Boost)}$

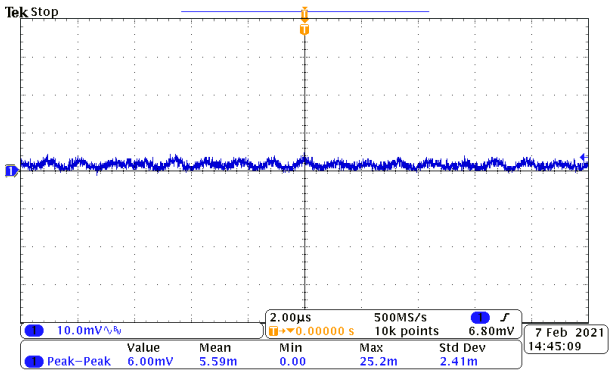
Figure 4-7. 5-V Input, 48-V no Load



CH1: $V_{OUT(Boost)}$

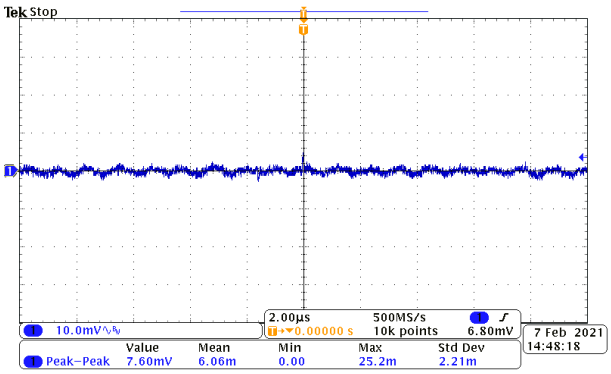
Figure 4-8. 5-V Input, 48-V, 20-mA Load

The output voltage ripple of the LDO is shown in the following figures.



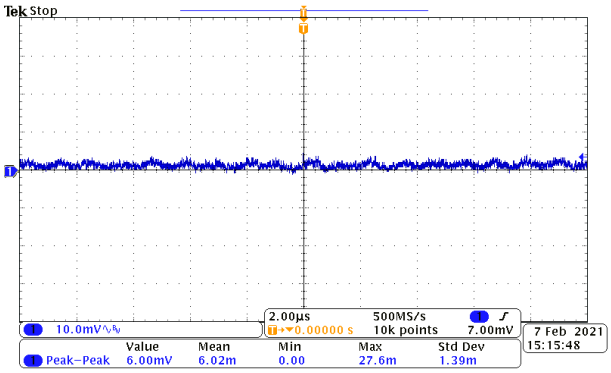
CH1: V_{OUT}

Figure 4-9. 3.3-V Input, 48-V no Load



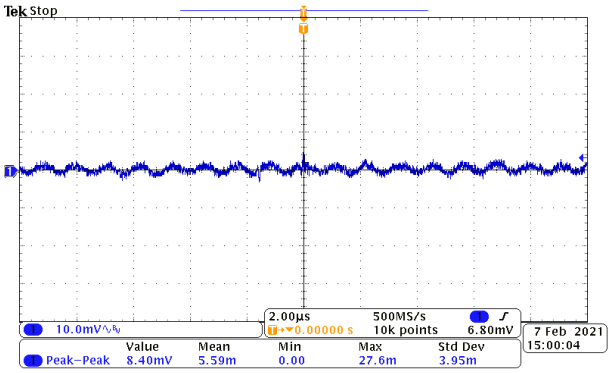
CH1: V_{OUT}

Figure 4-10. 3.3-V Input, 48-V, 10-mA Load



CH1: $V_{OUT(Boost)}$

Figure 4-11. 5-V Input, 48-V no Load

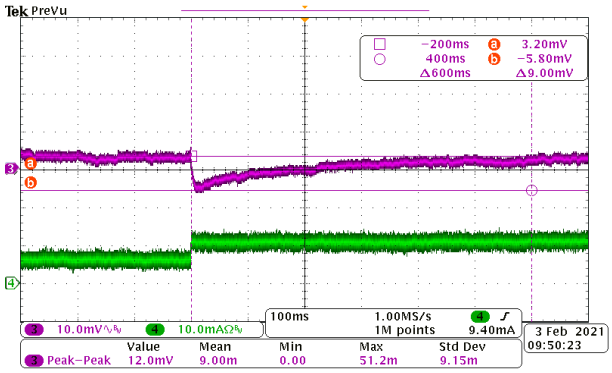


CH1: $V_{OUT(Boost)}$

Figure 4-12. 5-V Input, 48-V, 20-mA Load

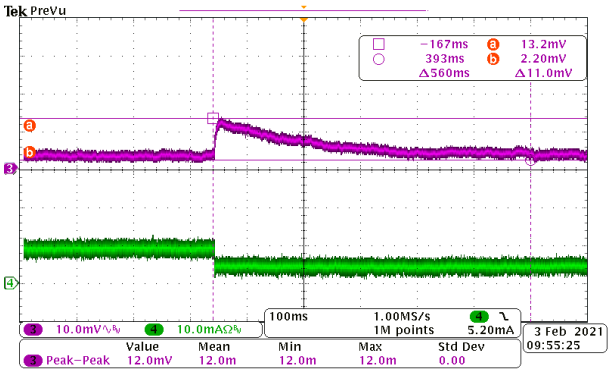
4.3 Load Transients

The waveforms of output AC ripples at load transient (with 10-nF CBYP) are shown in following images.



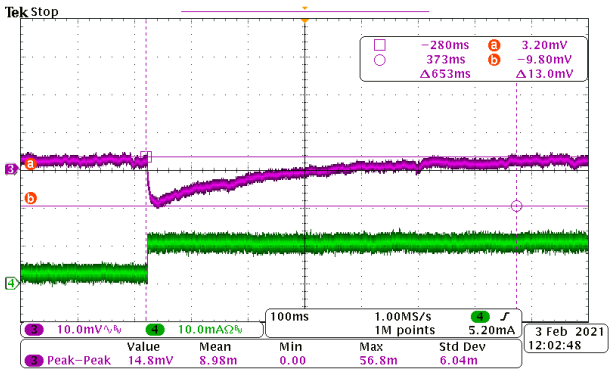
CH3: V_{OUT}, CH4: I_{OUT}

Figure 4-13. 3.3-V Input, 48 V, 5 mA to 10 mA



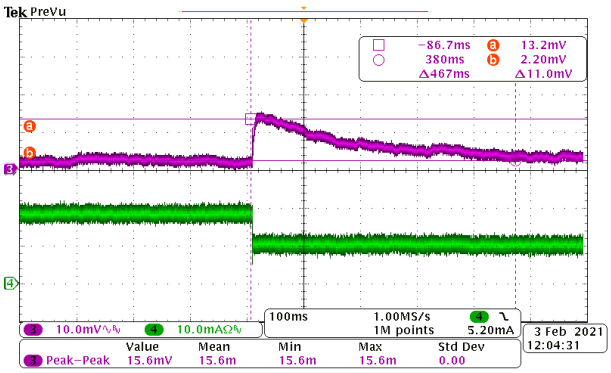
CH3: V_{OUT}, CH4: I_{OUT}

Figure 4-14. 3.3-V Input, 48 V, 10 mA to 5 mA



CH3: V_{OUT}, CH4: I_{OUT}

Figure 4-15. 5-V Input, 48 V, 10 mA to 20 mA

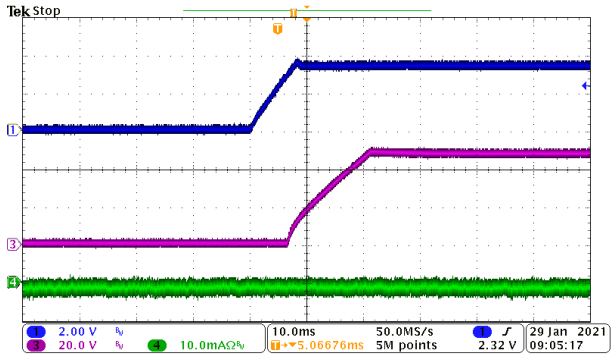


CH3: V_{OUT}, CH4: I_{OUT}

Figure 4-16. 5-V Input, 48 V, 20 mA to 10 mA

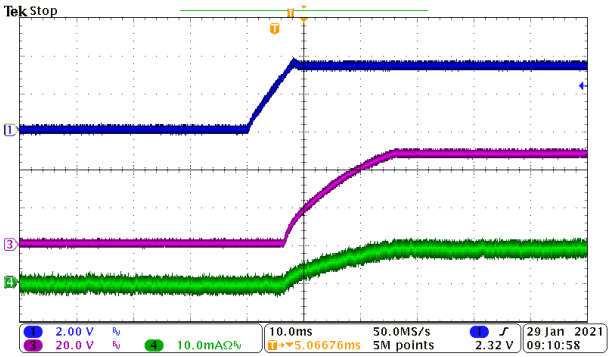
4.4 Start-up Sequence

Start-up behavior is shown in the following figures.



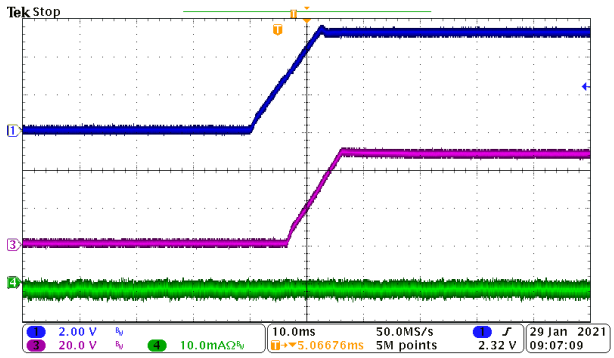
CH1: V_{IN}, CH3: V_{OUT}, CH4: I_{OUT}

Figure 4-17. 3.3-V Input,48-V no Load



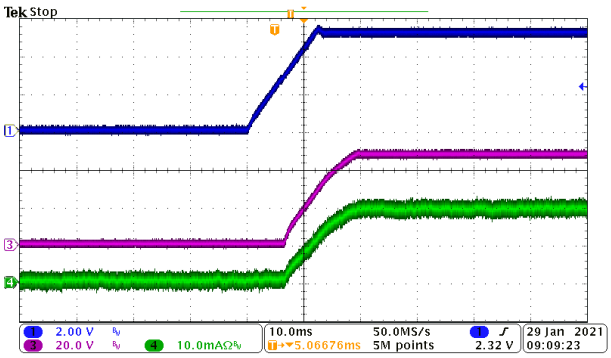
CH1: V_{IN}, CH3: V_{OUT}, CH4: I_{OUT}

Figure 4-18. 3.3-V Input, 48-V, 10-mA Load



CH1: V_{IN}, CH3: V_{OUT}, CH4: I_{OUT}

Figure 4-19. 5-V Input, 48-V no Load



CH1: V_{IN}, CH3: V_{OUT}, CH4: I_{OUT}

Figure 4-20. 5-V Input, 48-V, 20-mA Load

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