Test Report: PMP22764

Isolated Flyback Converter (56 V, 1.25 A) Reference Design

1 Description

This reference design utilizes a diode rectified flyback converter for a 24-V input to isolated 56-V, 1.25-A output. A LM51551 PWM controller provides the control for the flyback converter, including hiccup mode short-circuit protection. This reference design is ideally suited when any well-regulated 56-V output is required, such as the power source for Power over Ethernet (PSE).

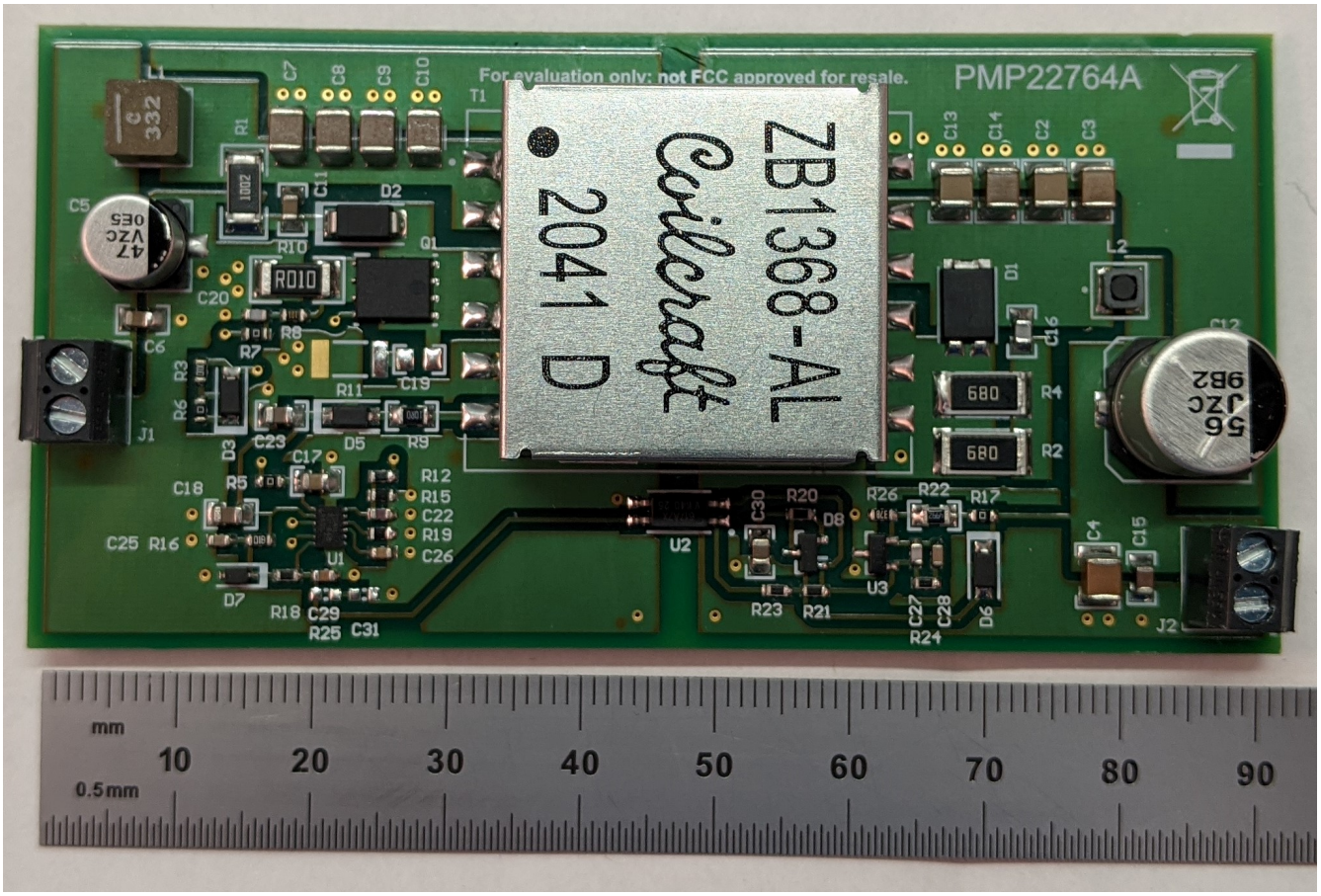


Figure 1-1. Top of Board

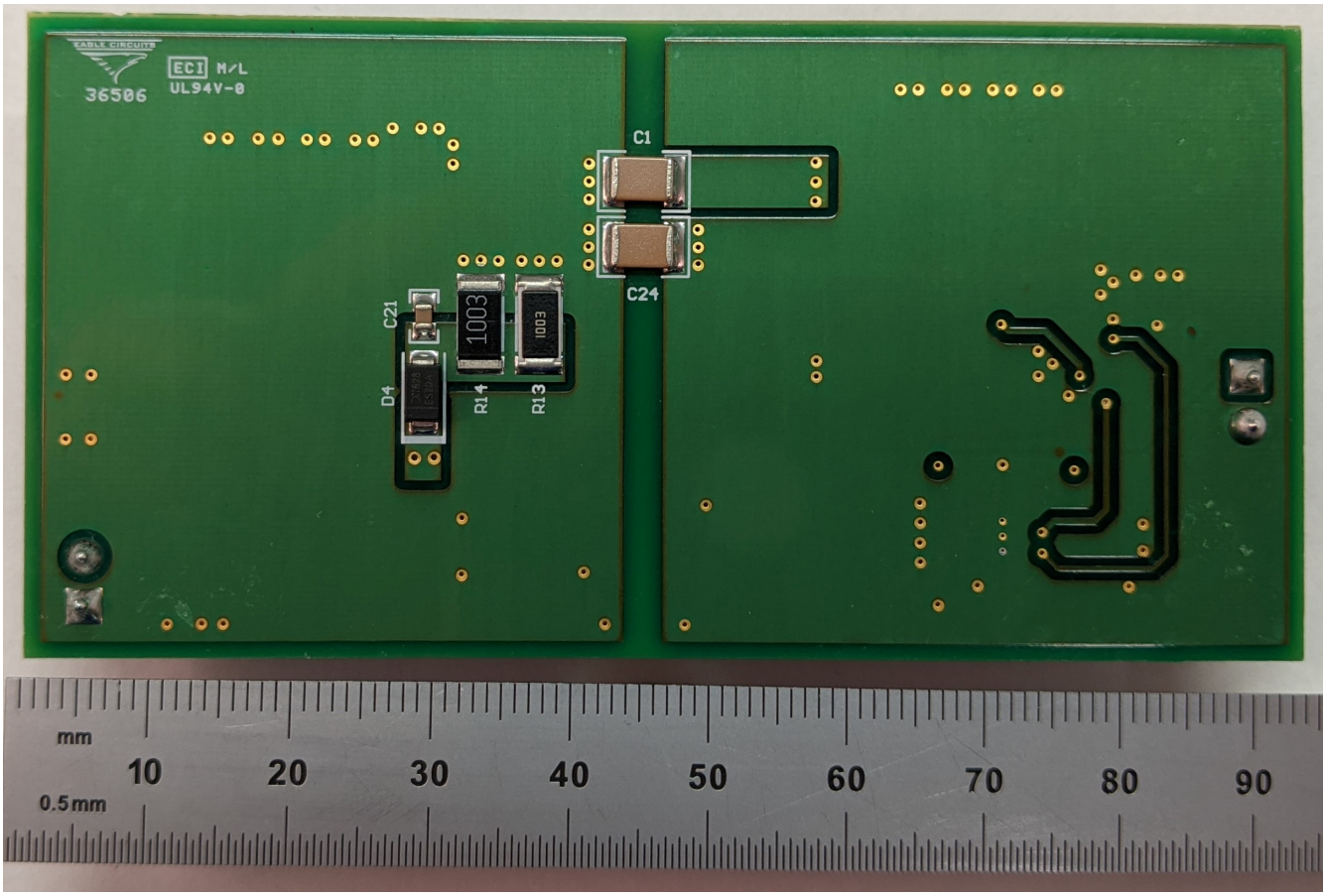


Figure 1-2. Bottom of Board

2 Test Prerequisites

2.1 Voltage and Current Requirements

Table 2-1. Voltage and Current Requirements

Parameter	Specifications
Input voltage	19.2–28.8 V
Output Voltage	56 V ±3%
Output Current	1.25 A
Nominal Switching Frequency	250 kHz

2.2 Required Equipment

- Isolated DC power source, 16–30 V, 5.0 A minimum
- 100 V, 5-A electronic load

2.3 Considerations

All measurements are taken at approximately 25°C ambient.

All measurements are taken with 24-V input and 1.25-A load, unless noted.

2.4 Dimensions

Board length × width = 93 mm × 46 mm

3 Testing and Results

3.1 Efficiency Graphs

Efficiency is shown in the following figure.

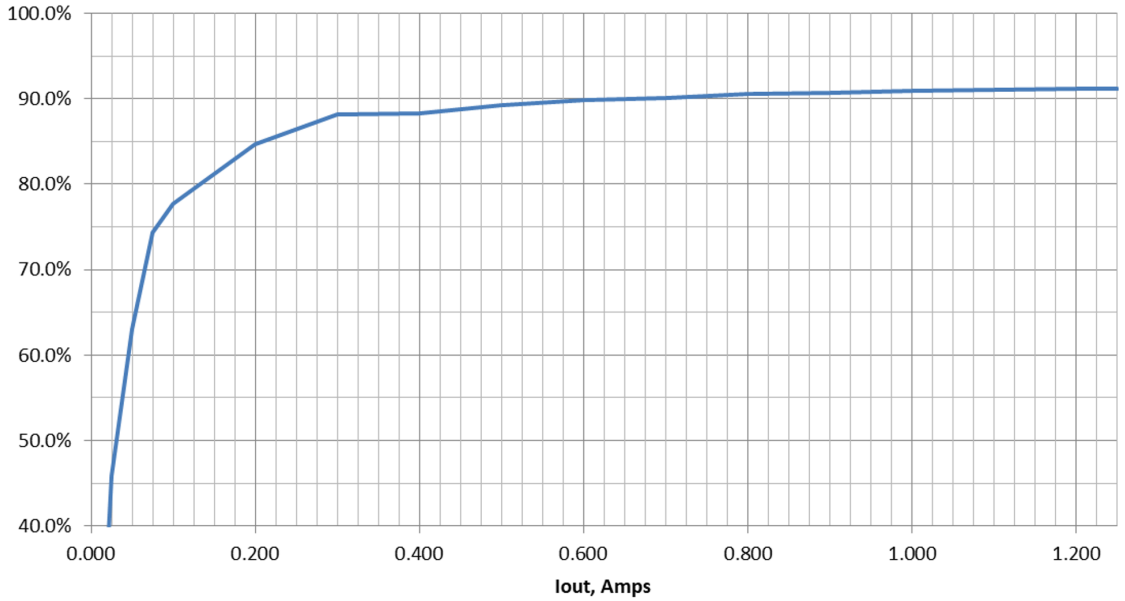


Figure 3-1. PMP22764 Rev B Efficiency Graph

3.2 Efficiency Data

Efficiency data is shown in the following table.

I_{OUT} (A) (J2)	V_{OUT} (V) (J2)	P_{OUT} (W)	I_{IN} (A) (J1)	V_{IN} (V) (J1)	P_{IN} (W)	Efficiency (%)
0.000	55.99	0.000	0.051	24.04	1.226	0.0
0.025	55.99	1.400	0.127	24.02	3.051	45.9
0.050	55.99	2.800	0.185	24.01	4.442	63.0
0.075	55.99	4.199	0.235	24.03	5.647	74.4
0.100	55.98	5.598	0.300	24.02	7.206	77.7
0.200	55.98	11.196	0.551	24.00	13.224	84.7
0.300	55.97	16.791	0.793	24.02	19.048	88.2
0.400	55.96	22.384	1.056	24.02	25.365	88.2
0.500	55.95	27.975	1.305	24.01	31.333	89.3
0.600	55.95	33.570	1.557	24.01	37.384	89.8
0.700	55.94	39.158	1.810	24.02	43.476	90.1
0.800	55.94	44.752	2.056	24.04	49.426	90.5
0.900	55.94	50.346	2.311	24.01	55.487	90.7
1.000	55.94	55.940	2.561	24.01	61.490	91.0
1.100	55.94	61.534	2.814	24.03	67.620	91.0
1.200	55.95	67.140	3.070	24.00	73.680	91.1
1.250	55.96	69.950	3.195	24.01	76.712	91.2

3.3 Thermal Images

The following figure shows the top and bottom thermal images.

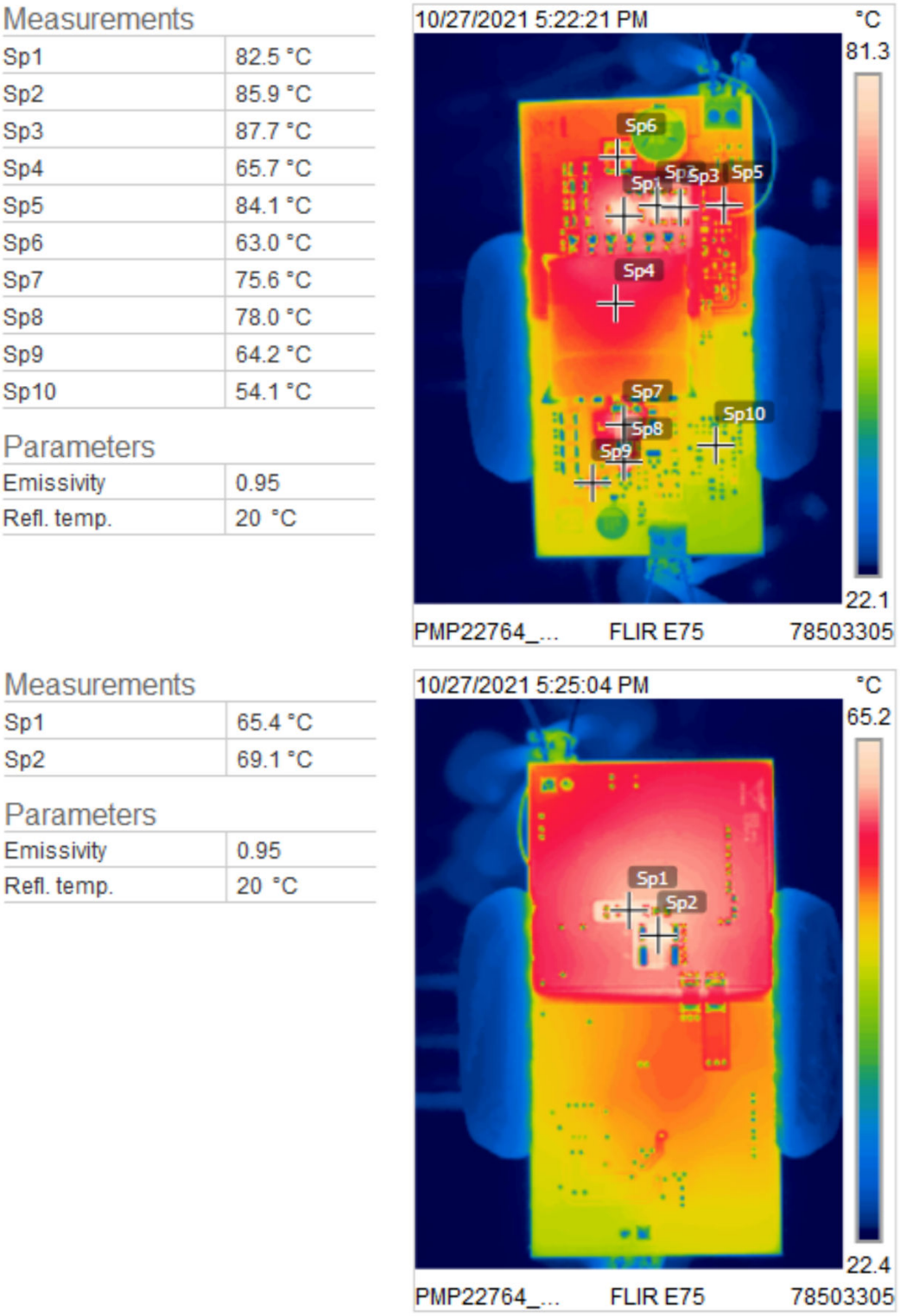
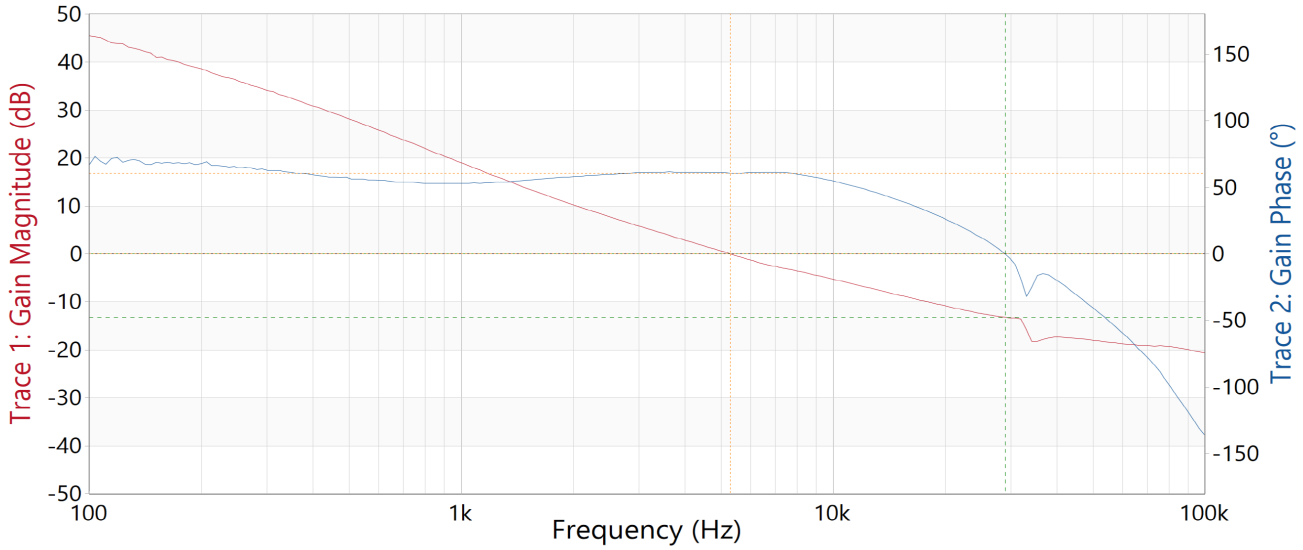


Figure 3-2. Top and Bottom Thermal Measurements

3.4 Bode Plots

The following figure shows the bode plot.

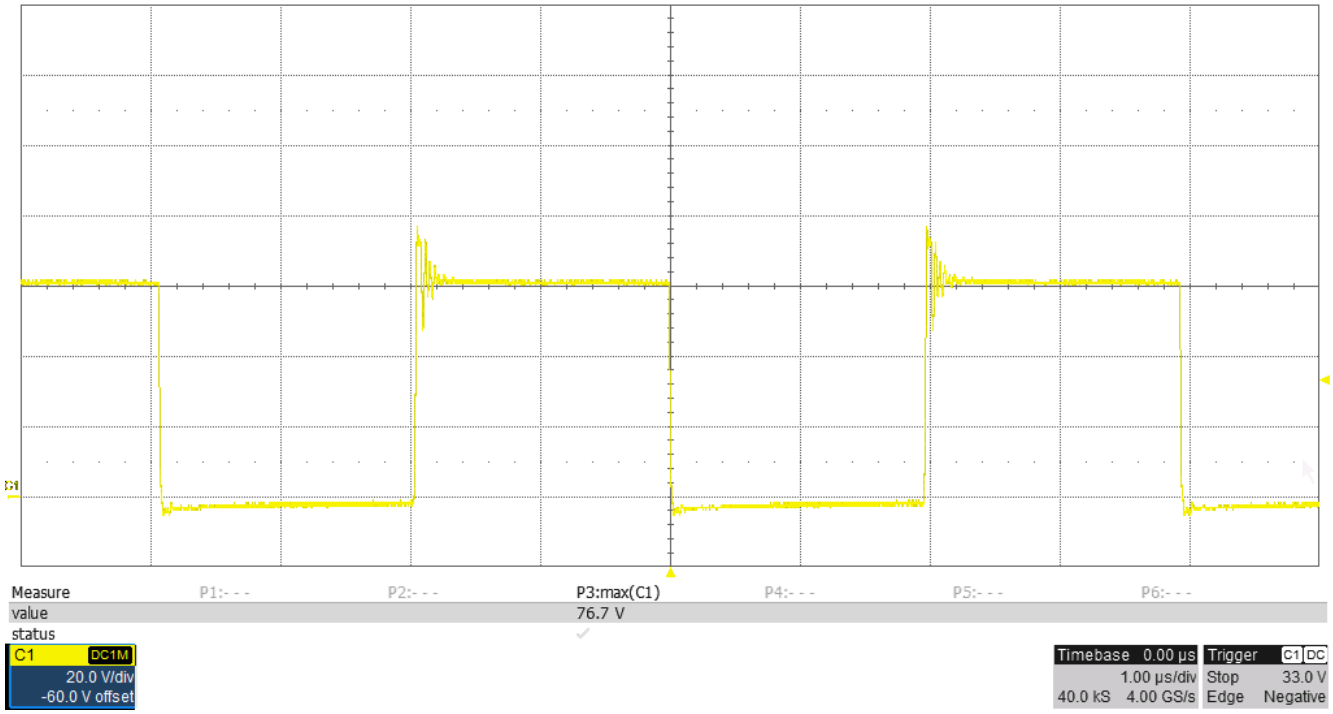


Bandwidth = 5.3 kHz , Phase Margin = 60 degrees , Gain Margin = 13.2 dB

Figure 3-3. Bode Plot

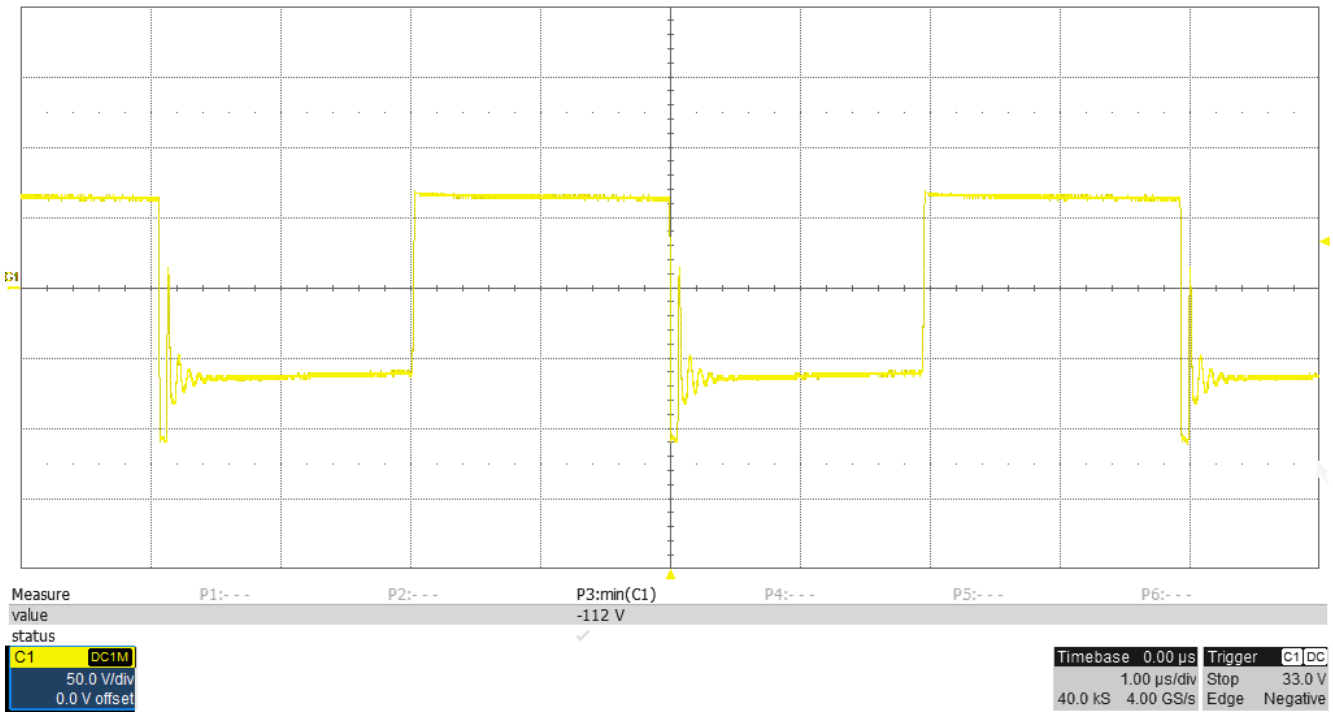
4 Waveforms

4.1 Switching



Voltage drain to PGND, Q1, 28.8-V input, 1.25-A load, 20 V/div, 1 µs/div, measured 76.7 Vpeak

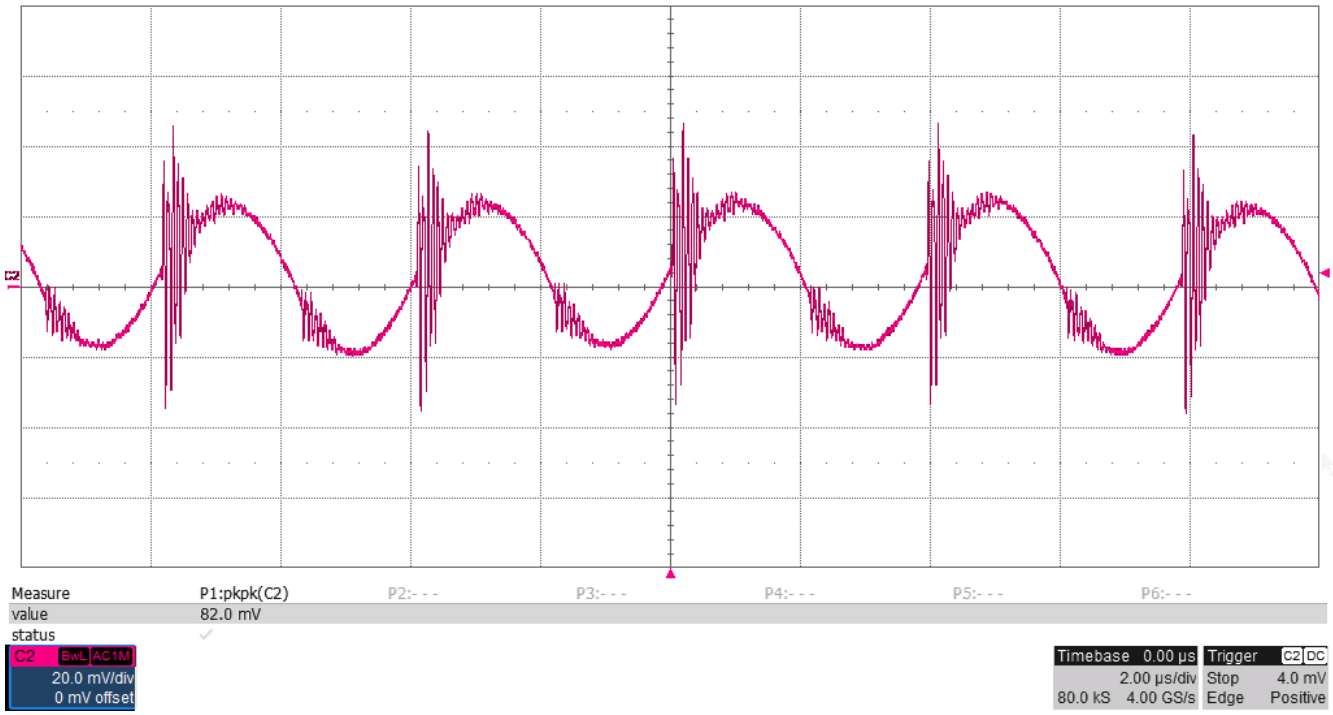
Figure 4-1. Voltage Drain to PGND



Voltage anode to GND, D1, 28.8-V input, 1.25-A load, 50 V/div, 1 µs/div
Measured 168 Vpeak (112 V + 56 V_{OUT})

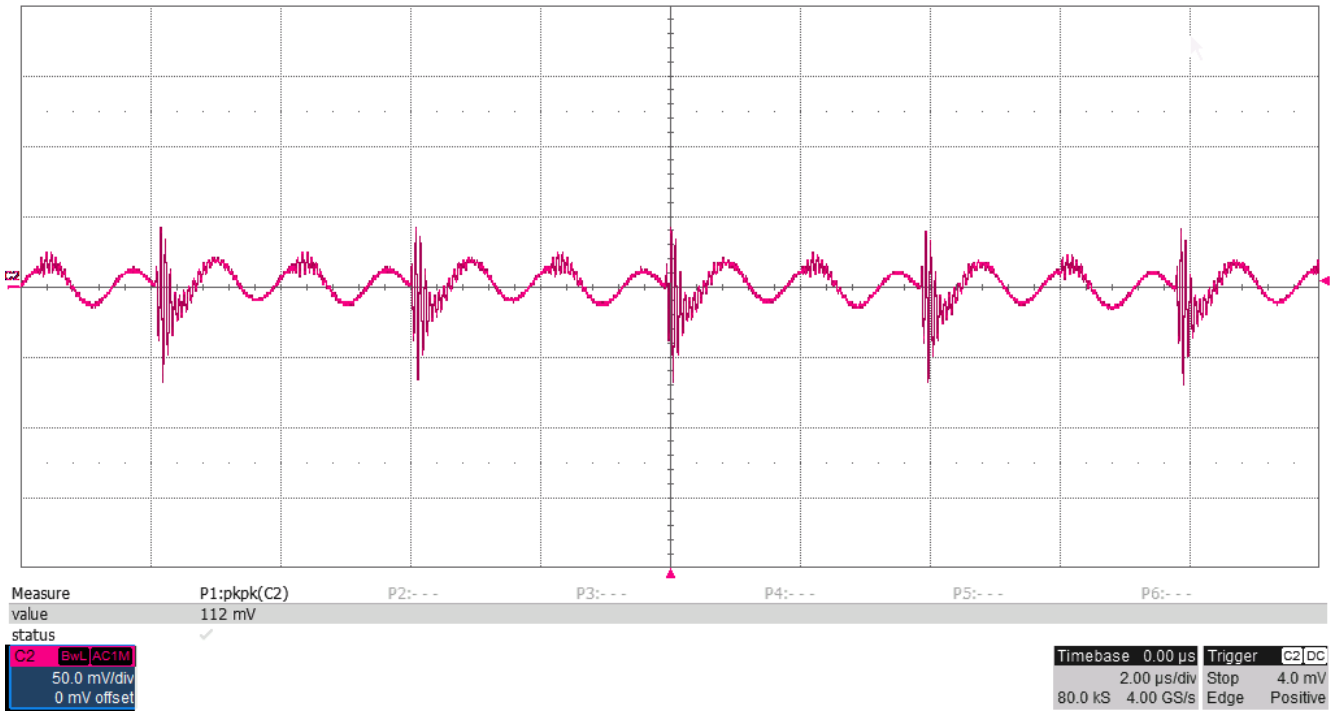
Figure 4-2. Voltage Anode to GND

4.2 Voltage Ripple



Output ripple (J1), 20 mV/div, 2 µs/div, measured 82.0 mVpp

Figure 4-3. Output Voltage Ripple



Input ripple (J2), 50 mV/div, 2 µs/div, measured 112 mVpp

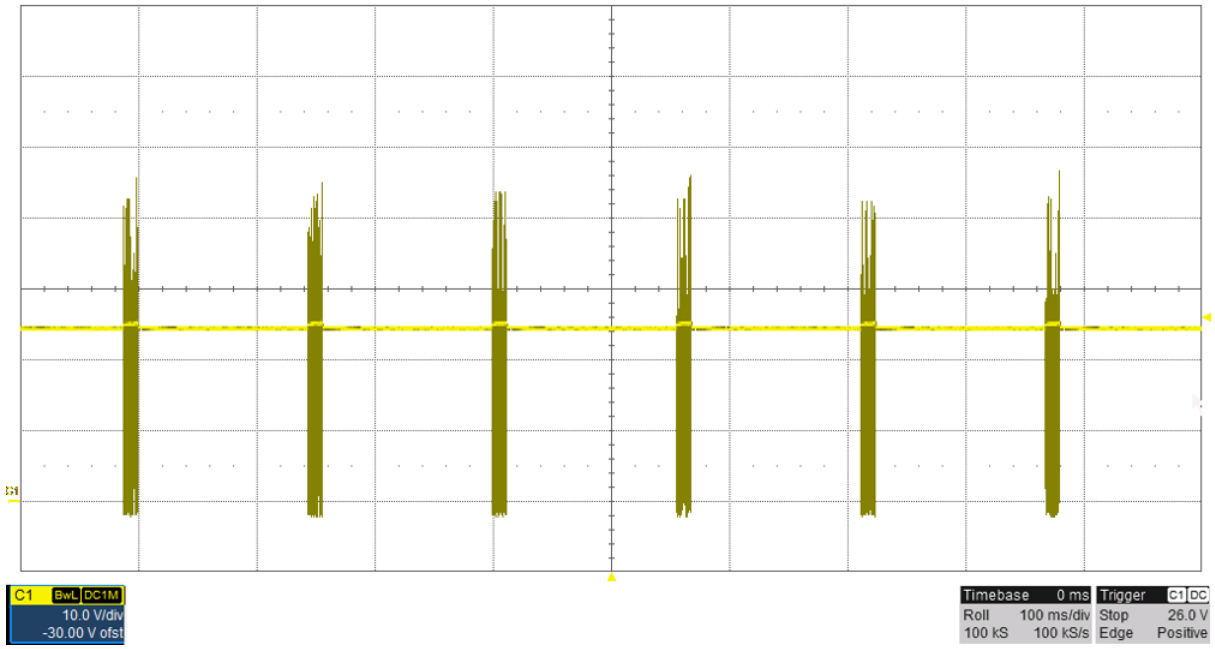
Figure 4-4. Input Voltage Ripple

4.3 Short-Circuit Hiccup Protection

This section shows the short circuit and short-circuit hiccup protection waveforms.

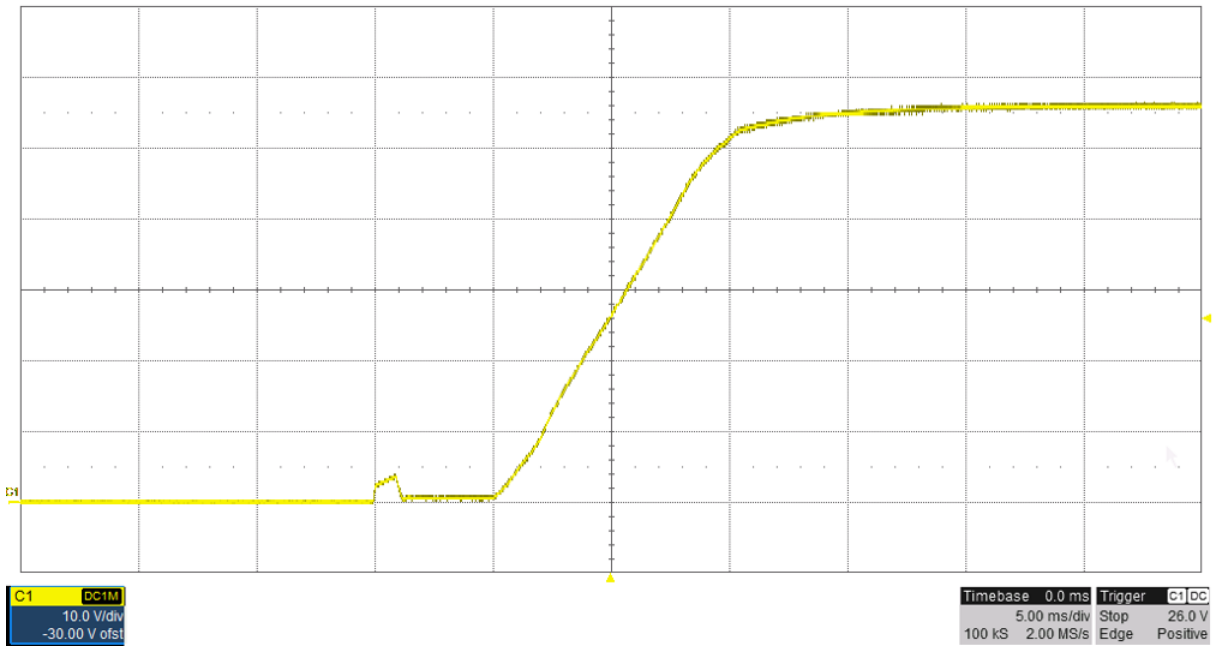
Note

The on time is 256 µs (64 cycles × 4 µs). The oscilloscope was aliasing, so the on time below is wider than actual. The off time is 131 ms (32,768 cycles × 4 µs)



Short at output connector J2. Voltage, drain to PGND, Q1, 10 V/div, 100 ms/div

Figure 4-5. Short Circuit

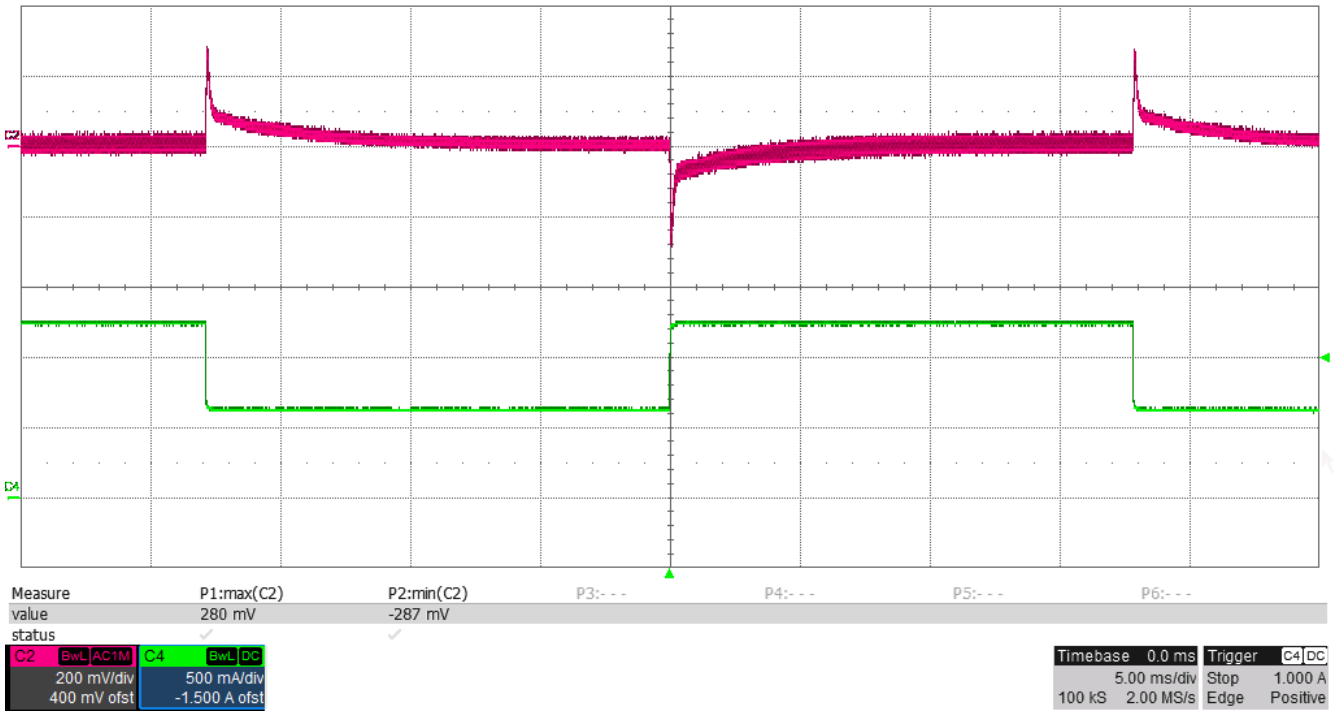


Recovery from short-circuit hiccup mode. output voltage, 10 V/div, 5 ms/div

Figure 4-6. Short-Circuit Hiccup Recovery

4.4 Load Transients

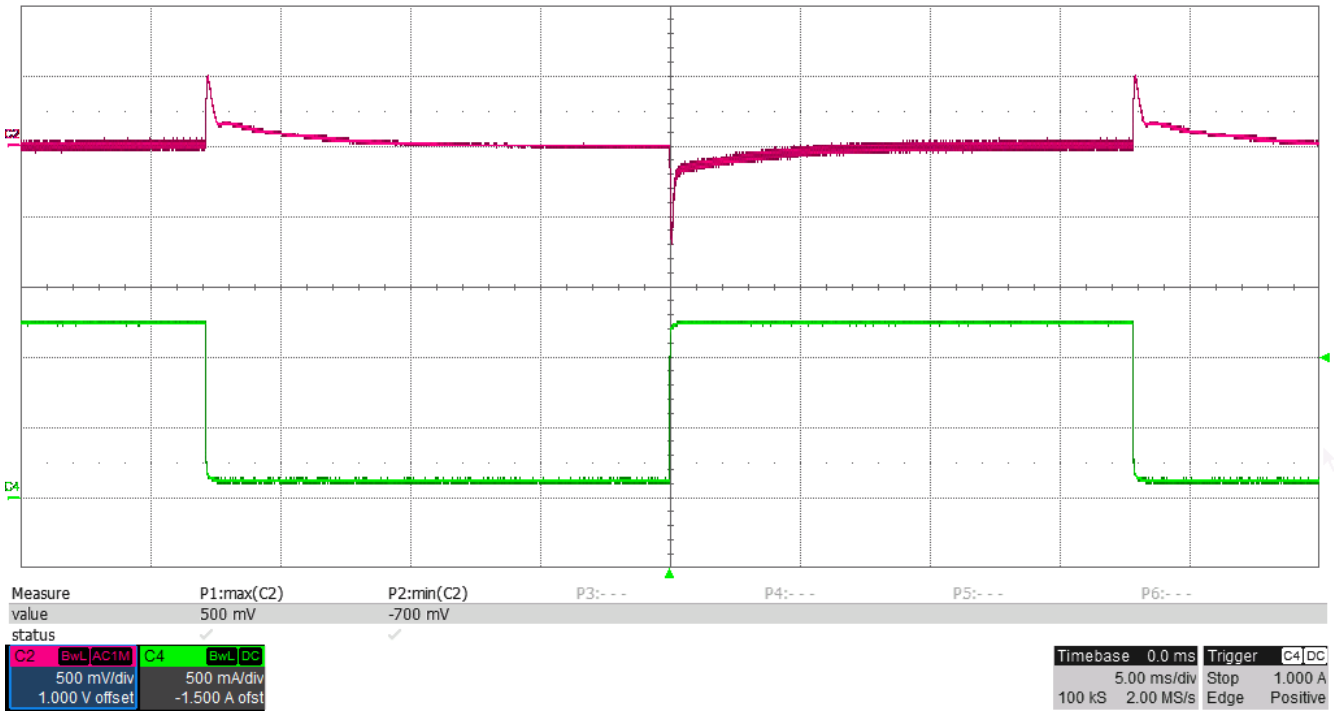
Load transient response is shown in the following figures.



Output load step response, 0.625 A to 1.25 A load step

200 mV/div, 500 mA/div, 5 ms/div, slew rate = 250 mA/µs, measured at 280 mV and –287 mV

Figure 4-7. Load Transient 1



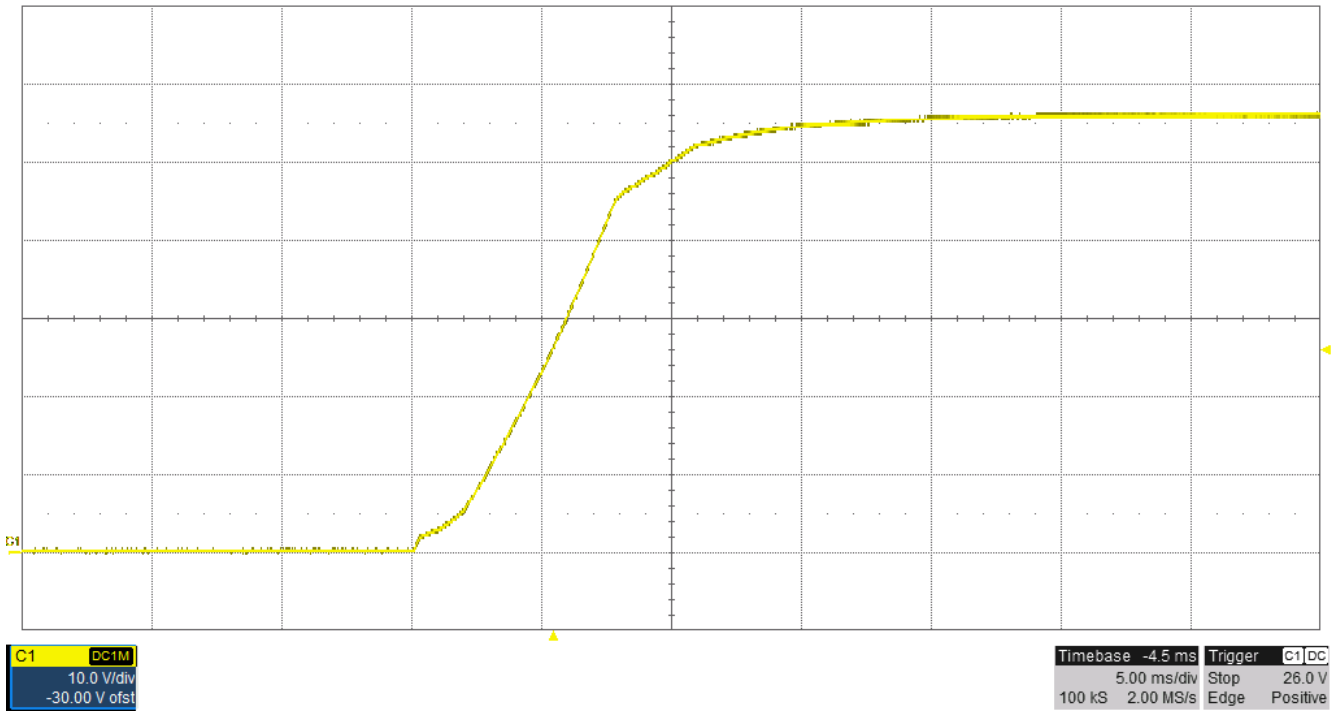
Output load step response, 125 mA to 1.25 A load step

500 mV/div, 500 mA/div, 5 ms/div, slew rate = 250 mA/µs, measured at +500 mV and –700 mV

Figure 4-8. Load Transient 2

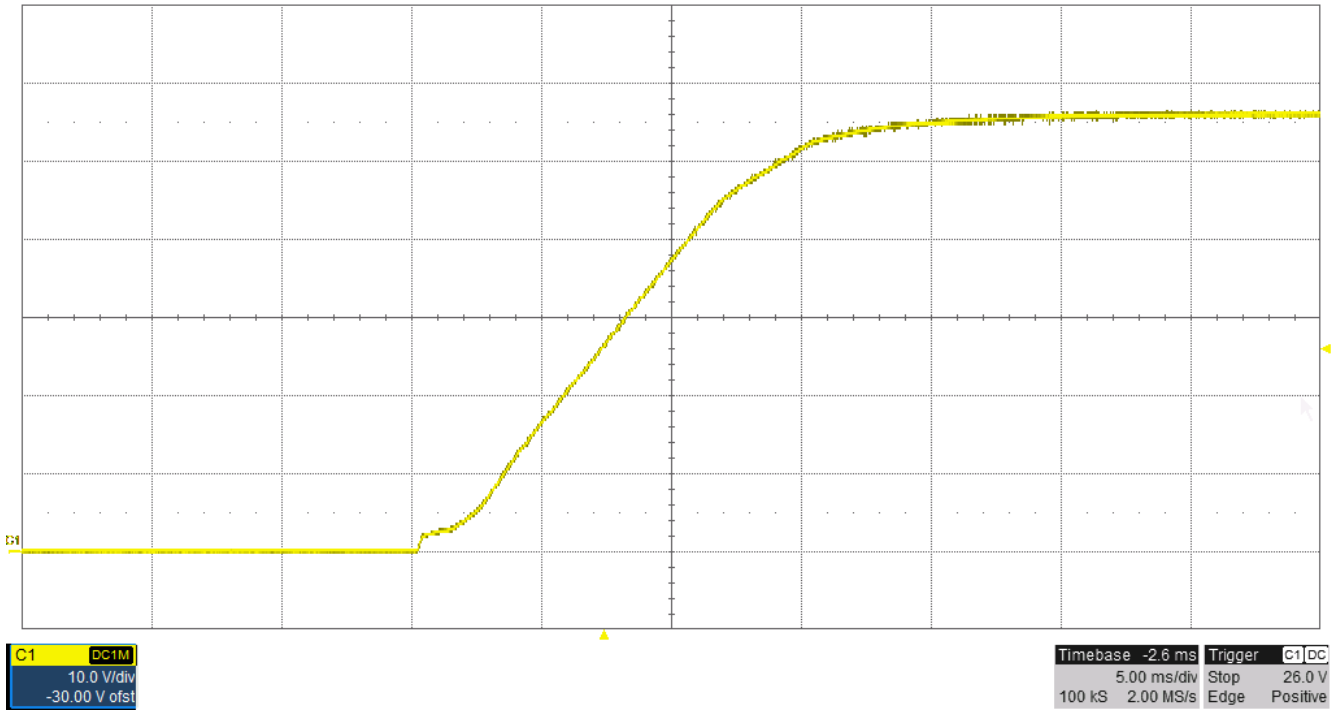
4.5 Start-up Sequence

Start-up behavior is shown in the following figures.



0-A load, 5 ms/div, 10 V/div

Figure 4-9. Start-up 1



1.25-A load, 5 ms/div, 10 V/div

Figure 4-10. Start-up 2

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265