Test Report: PMP21318

Class 8 PoE PD Active Clamp Forward Converter (12 V, 6 A) Reference Design

Description

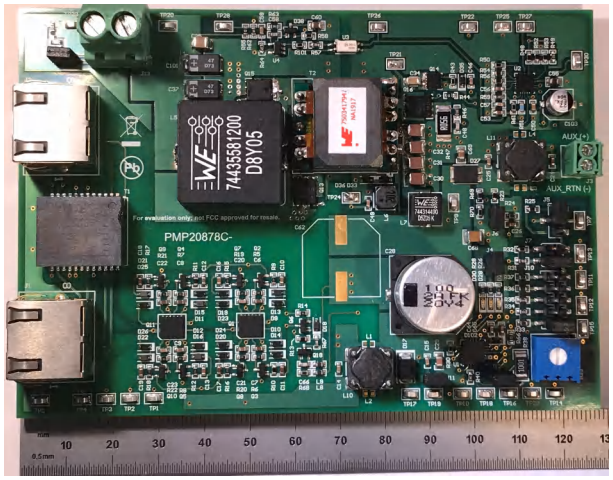
This TI reference design features a Type-4, Class 8, 71-W Active Clamp Forward converter for powered devices (PD) through Power over Ethernet (PoE). The TPS2373-4 PD controller provides detection and classification while also powering up the UCC2897ARGPR pulse-width modulation (PWM) controller through its advanced start-up feature.

Feature

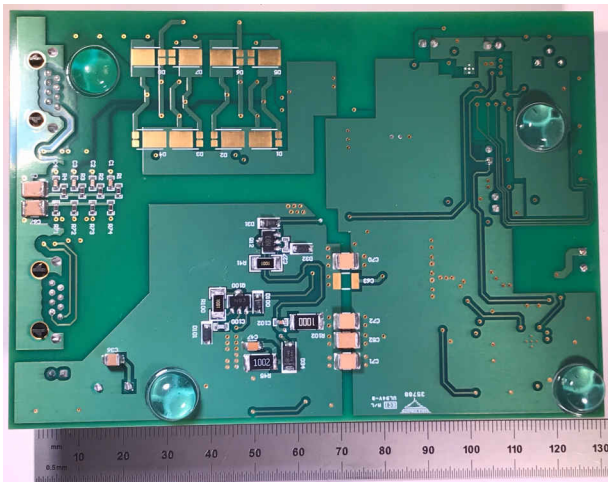
- Supports power levels for IEEE802.3bt Type 4
- Automatic Maintain Power Signature (MPS)
- Advanced start up
- Synchronous rectifiers for high efficiency

Applications

- IP network camera
- WLAN, Wi-Fi® access point



Top Photo



Bottom Photo

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage	37 V–57 V (48 V nominal)
Output Voltage	12 V
Output Current	6 A
Nominal Switching Frequency	200 kHz

1.2 Required Equipment

- Type 4 PoE Power Source Equipment (PSE)
- Isolated DC power source, 0 V–57 V, 2-A minimum
- 12-V, 6-A electronic load

1.3 Considerations

- All measurements were taken at approximately 25°C ambient
- All measurements taken with 48-V input and 6-A load, unless noted

2 Testing and Results

2.1 Efficiency Graphs

Figure 2-1 shows the PMP21318 Rev. C efficiency curve.

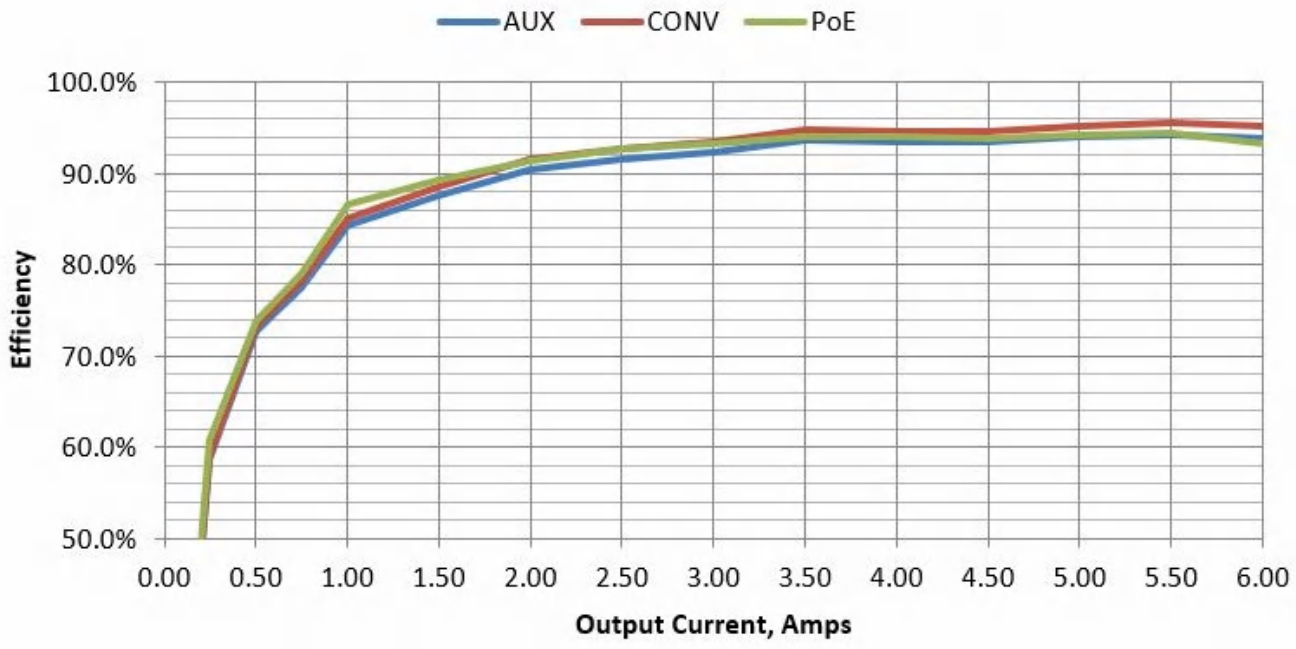


Figure 2-1. PMP23278 Rev. C Efficiency Graph, PoE Diode Bridge

2.2 Efficiency Data

Efficiency data is shown in the following table.

I_{OUT} (J13)	V_{OUT} (J13)	I_{IN} (J3)	V_{IN} (J3)	Efficiency (J3)	V_{IN} (VDD,PGND)	Efficiency (CONV)	I_{IN} (J1)	V_{IN} (J1)	Efficiency (J1)
0.00	12.147	0.063	48.00	0.0%	47.60	0.0%	0.058	48.00	0.0%
0.25	12.147	0.108	48.00	58.6%	47.58	59.1%	0.104	48.00	60.8%
0.50	12.146	0.174	48.00	72.7%	47.56	73.4%	0.171	48.01	74.0%
0.75	12.146	0.245	48.00	77.5%	47.55	78.2%	0.240	48.00	79.1%
1.00	12.145	0.300	48.01	84.3%	47.54	85.2%	0.292	48.01	86.6%
1.50	12.144	0.433	48.00	87.6%	47.51	88.5%	0.425	48.00	89.3%
2.00	12.143	0.559	48.00	90.5%	47.48	91.5%	0.553	48.00	91.5%
2.50	12.142	0.690	48.00	91.7%	47.46	92.7%	0.682	48.00	92.7%
3.00	12.141	0.822	48.00	92.3%	47.44	93.4%	0.814	48.00	93.2%
3.50	12.140	0.945	48.00	93.7%	47.42	94.8%	0.941	48.00	94.1%
4.00	12.139	1.082	48.00	93.5%	47.39	94.7%	1.075	48.00	94.1%
4.50	12.138	1.218	48.00	93.4%	47.37	94.7%	1.212	48.00	93.9%
5.00	12.137	1.345	48.00	94.0%	47.35	95.3%	1.342	48.00	94.2%
5.50	12.135	1.474	48.00	94.3%	47.33	95.7%	1.473	48.00	94.4%
6.00	12.134	1.615	48.00	93.9%	47.31	95.3%	1.626	48.00	93.3%

2.3 Thermal Images

Figure 2-2 and Figure 2-3 show the thermal images at full load and nominal line (48 V).

Measurements	
Sp1	43.3 °C
Sp2	51.4 °C
Sp3	46.3 °C
Sp4	46.8 °C
Sp5	48.5 °C
Sp6	91.8 °C
Sp7	38.7 °C

Parameters	
Emissivity	0.94
Refl. temp.	20 °C

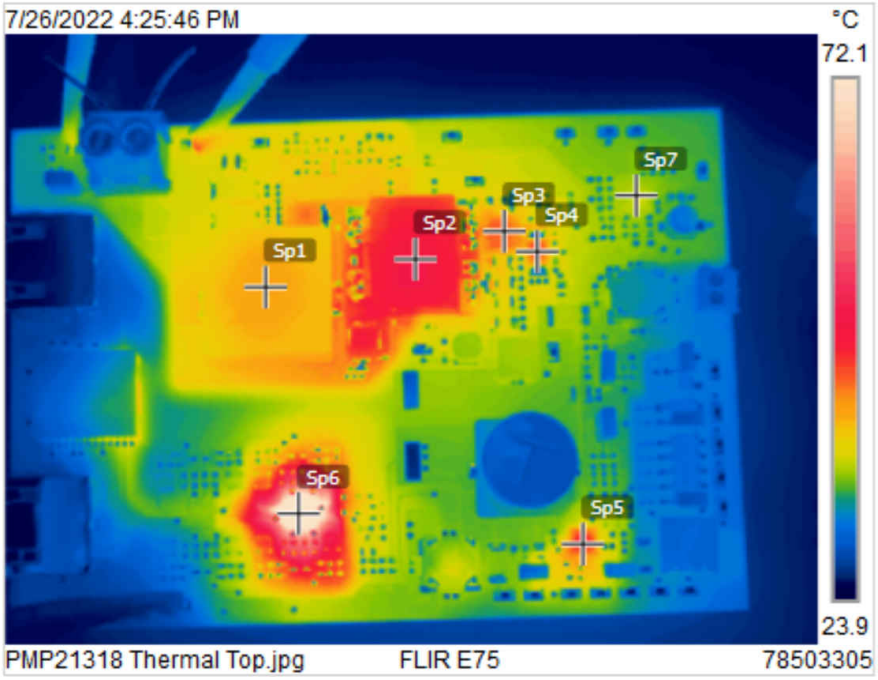


Figure 2-2. Top Thermal Image

Measurements	
Sp1	57.5 °C
Sp2	47.7 °C
Sp3	46.3 °C
Sp4	58.0 °C
Sp5	44.2 °C
Sp6	41.9 °C

Parameters	
Emissivity	0.94
Refl. temp.	20 °C

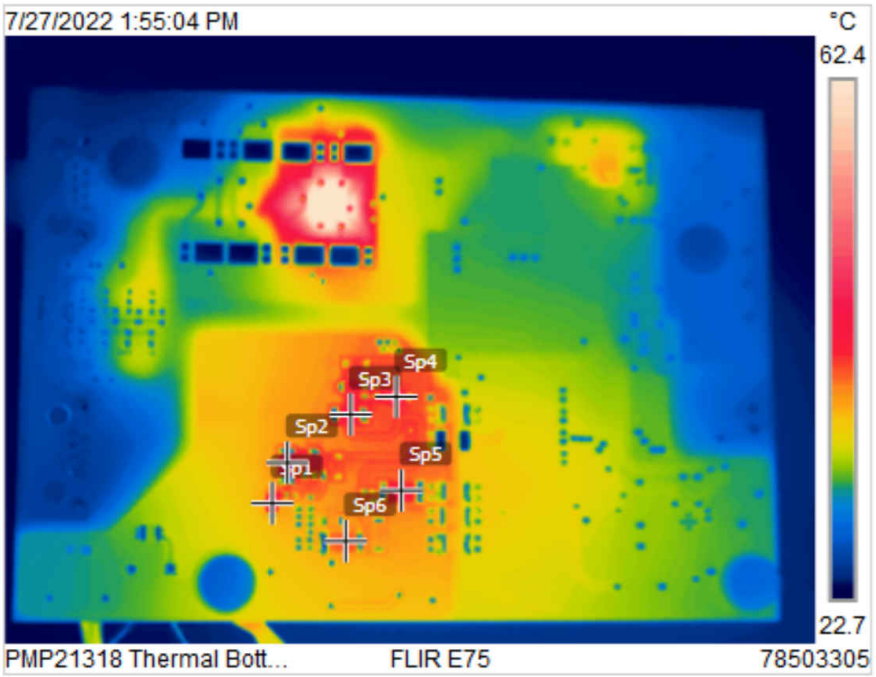


Figure 2-3. Bottom Thermal Image

2.4 Bode Plots

Figure 2-4 shows the bode plot waveform.

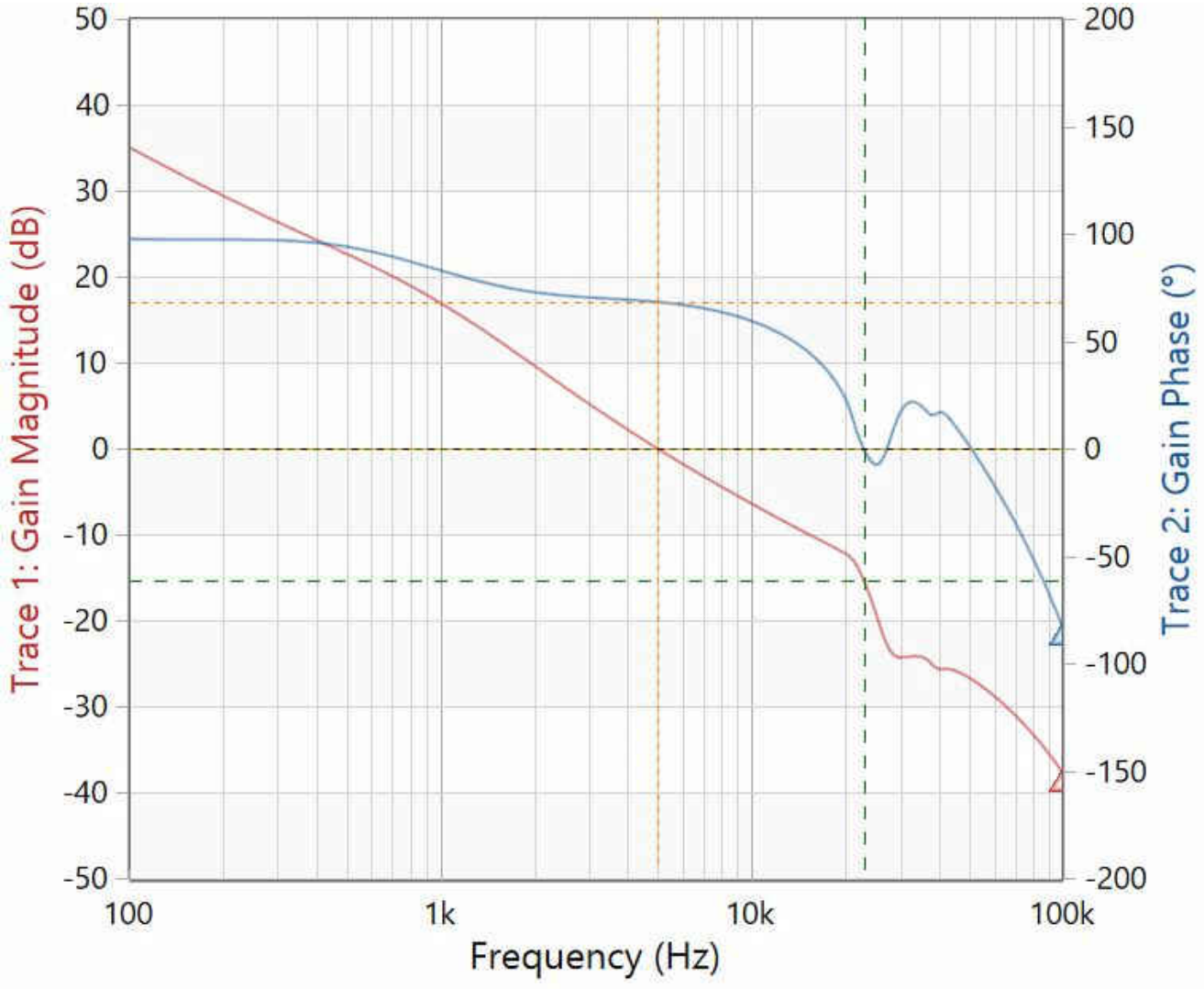


Figure 2-4. Bandwidth = 5.0 kHz, Phase Margin = 68.2 Degrees, Gain Margin = 15.3 dB

3 Waveforms

3.1 Switching

Switching behavior is shown in the following figures.

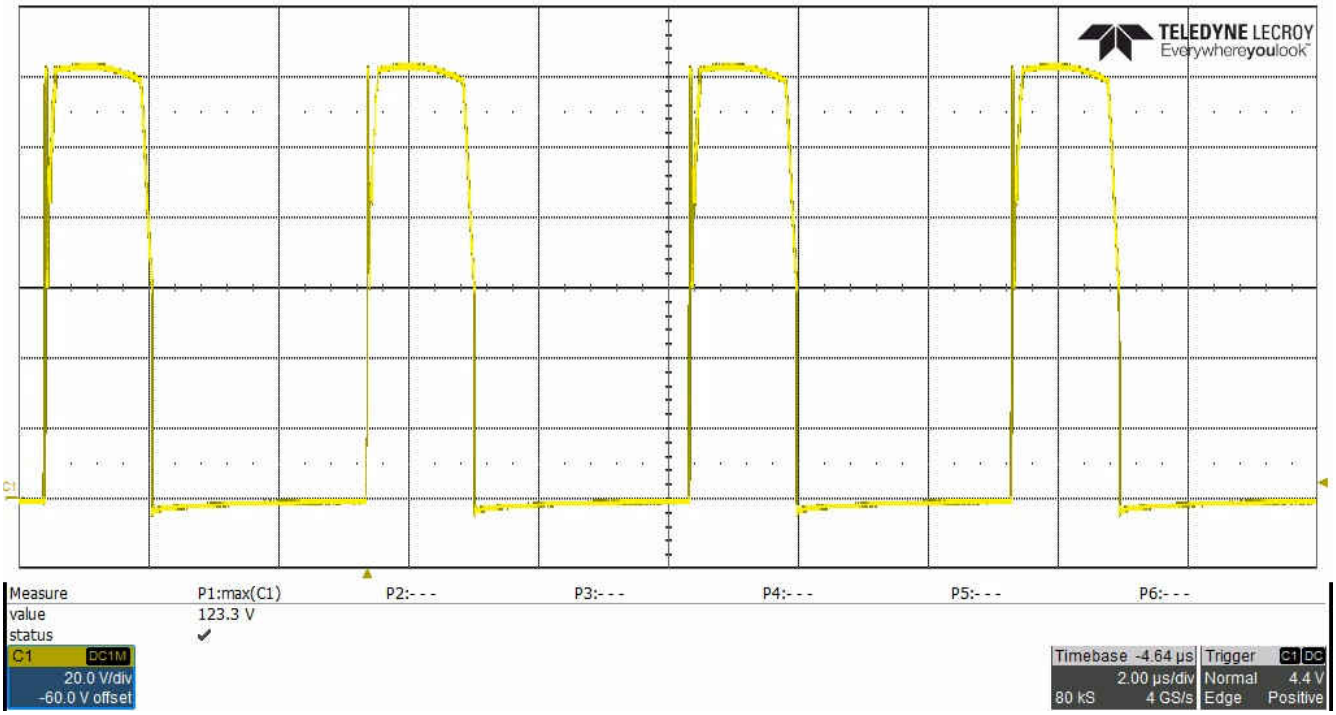


Figure 3-1. Voltage Drain-to-Source, Q16, 39-V Input, 6-A Load, 20 V/div, 2 µs/div, Measured 123.3 Vpeak

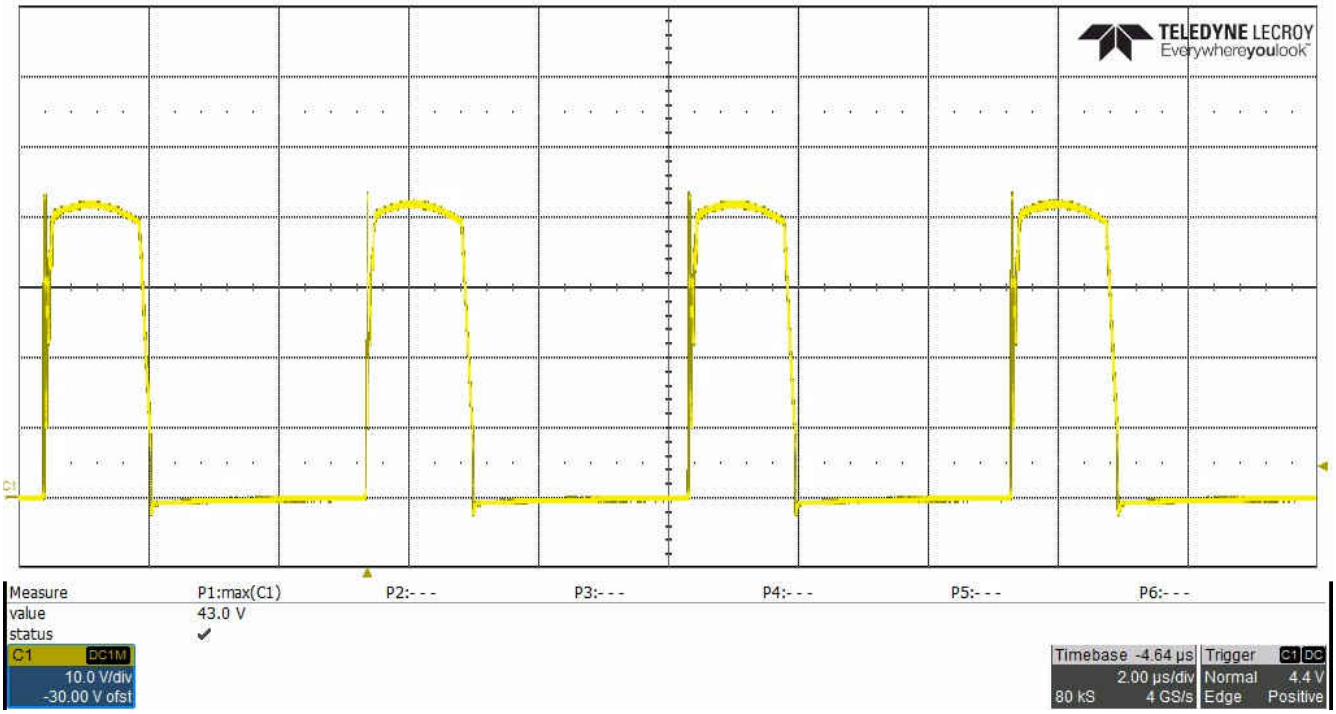


Figure 3-2. Voltage Drain-to-Source, Q13, 39-V Input, 6-A Load, 10 V/div, 2 µs/div, Measured 43.0 Vpeak

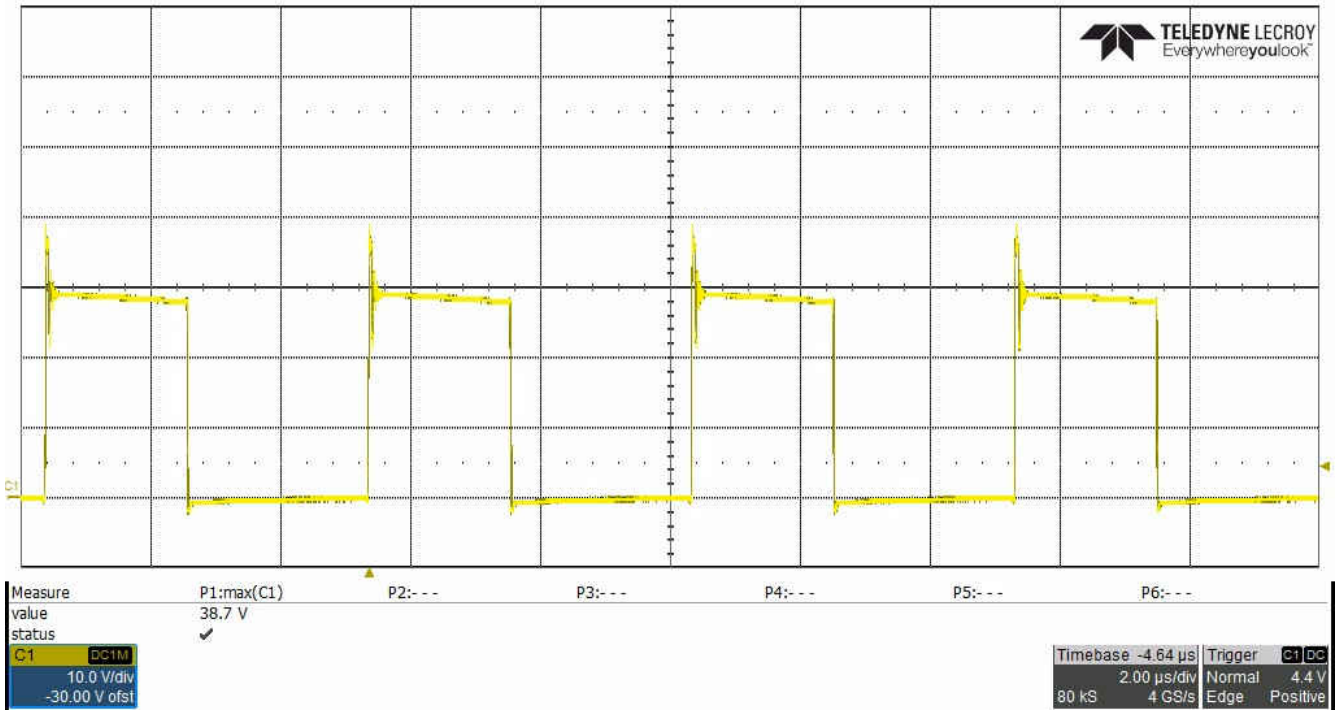


Figure 3-3. Voltage Drain-to-Source, Q15, 57-V Input, 6-A Load, 10 V/div, 2 µs/div, Measured 38.7 Vpeak

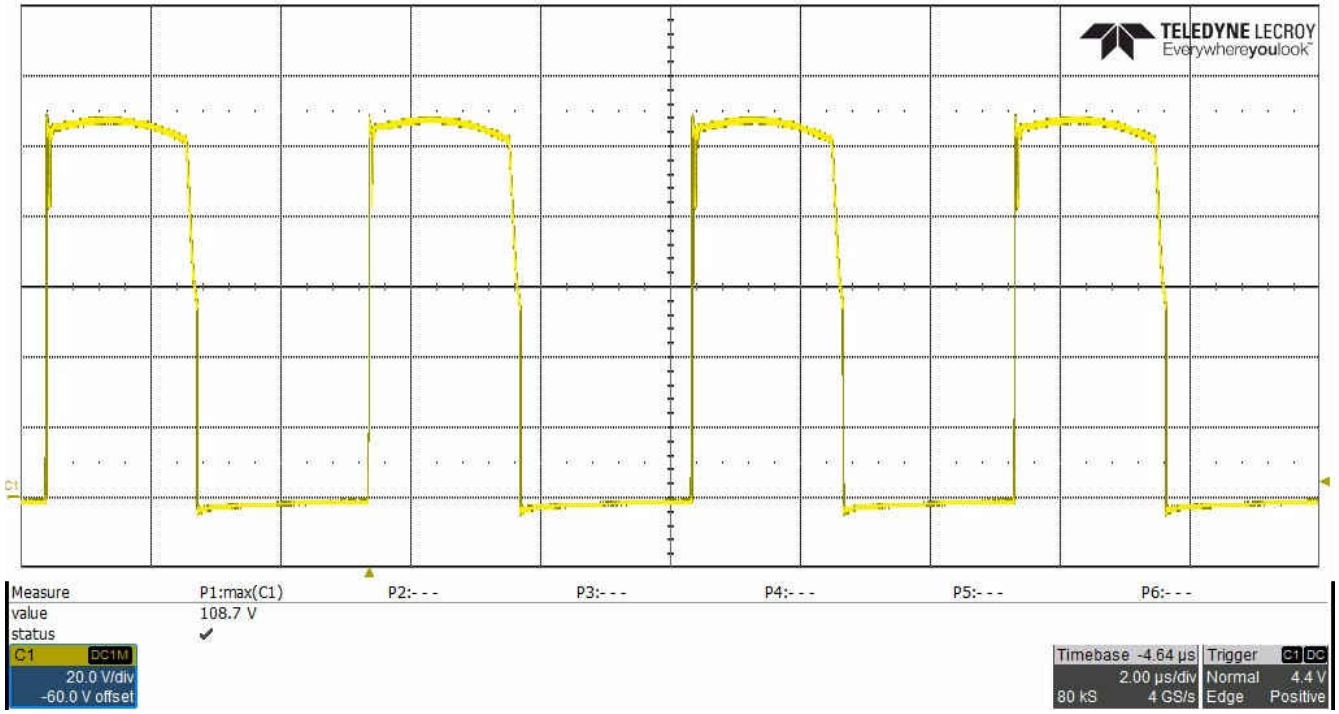


Figure 3-4. Voltage Drain-to-Source, Q16, 48-V Input, 6-A Load, 20 V/div, 2 µs/div, Measured 108.7 Vpeak

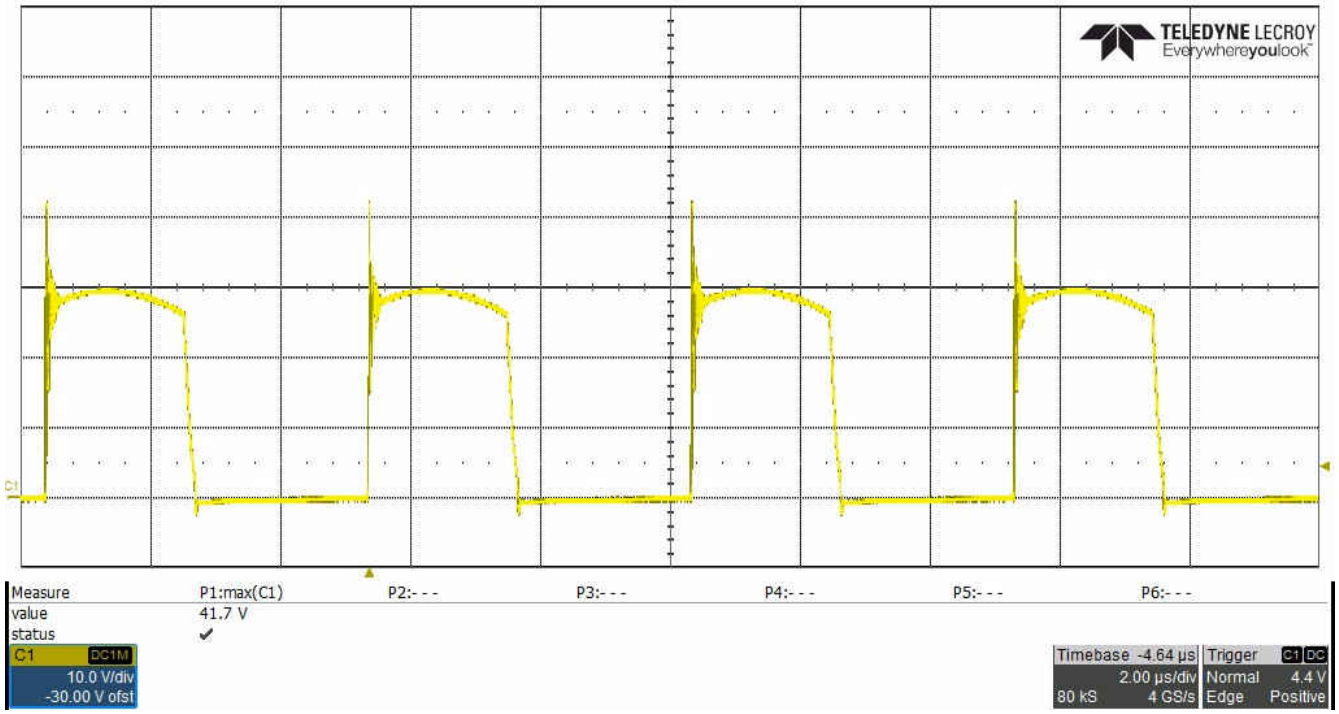


Figure 3-5. Voltage Drain-to-Source, Q13, 48-V Input, 6-A Load, 10 V/div, 2 µs/div, Measured 41.7 Vpeak

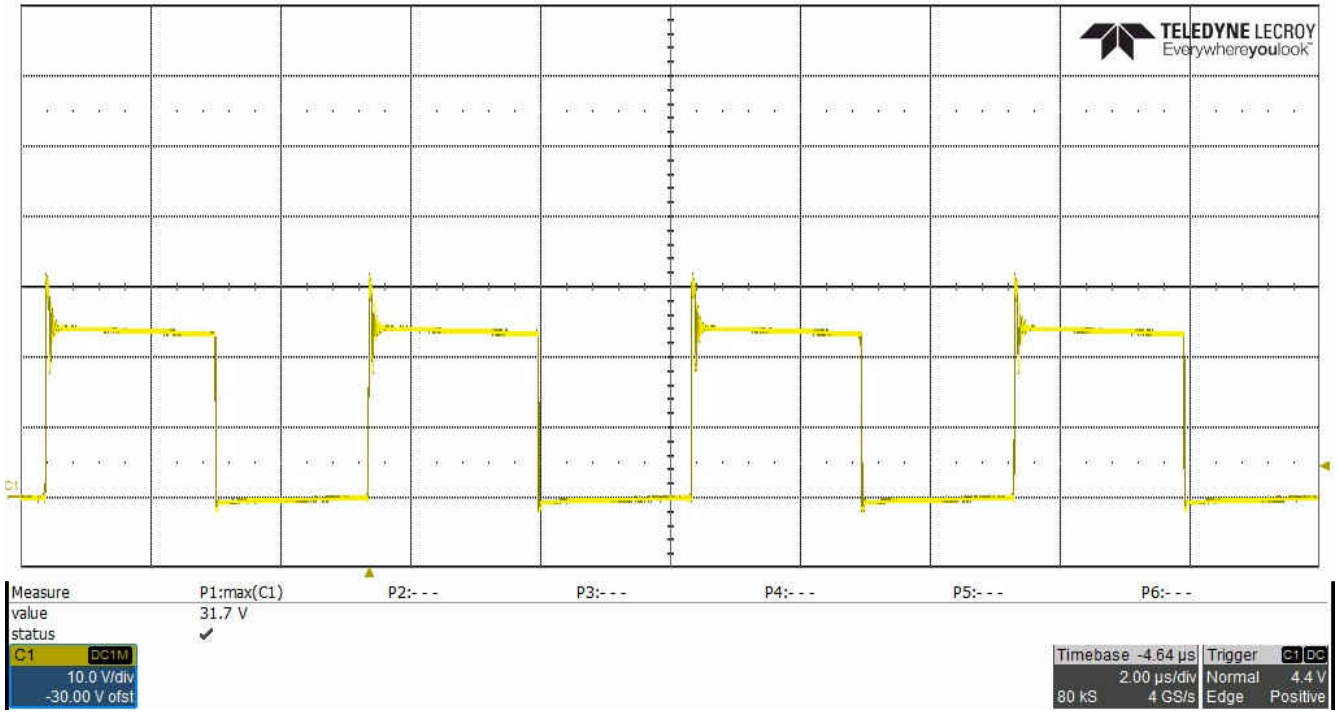


Figure 3-6. Voltage Drain-to-Source, Q15, 48-V Input, 6-A Load, 10 V/div, 2 µs/div, Measured 31.7 Vpeak

3.2 Voltage Ripple

Ripple measurements were taken with a 48-V input, 6-A load, and 20-MHz Bandwidth Limit (BWL).

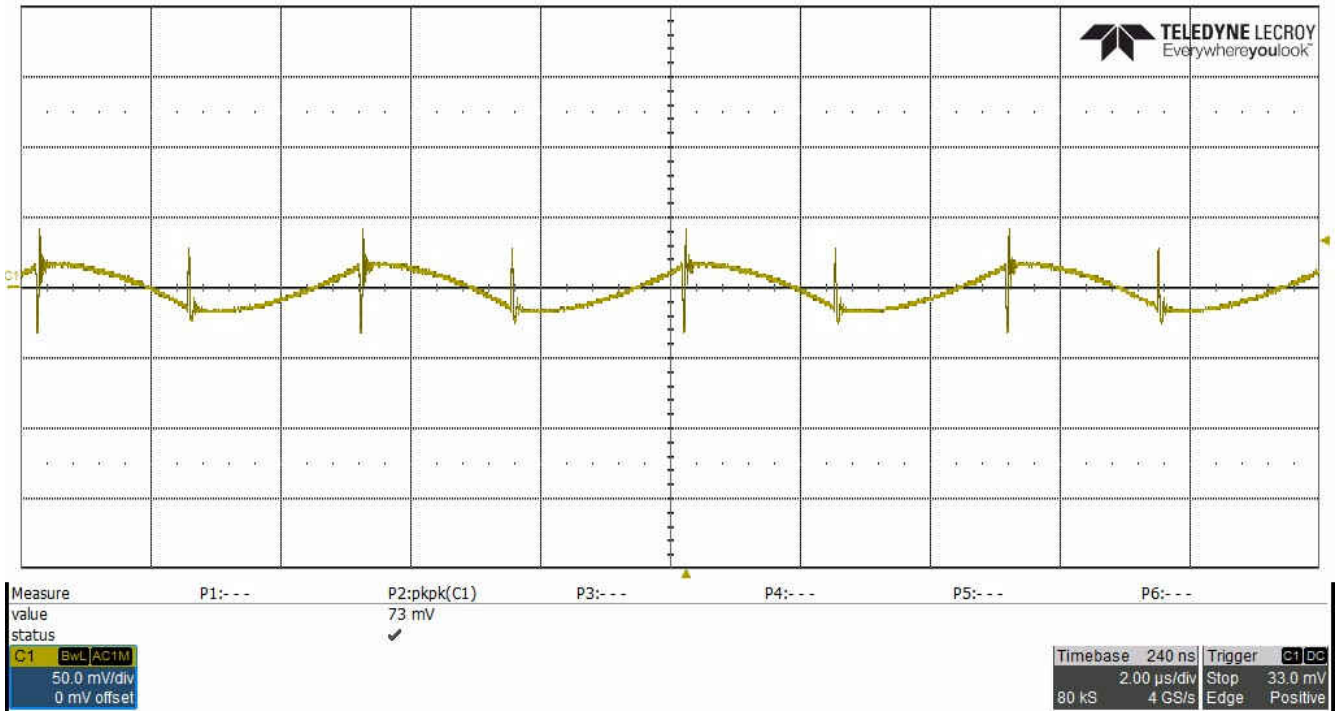


Figure 3-7. Output Voltage Ripple (J13), 50 mV/div, 2 µs/div, Measured 73 mVpp

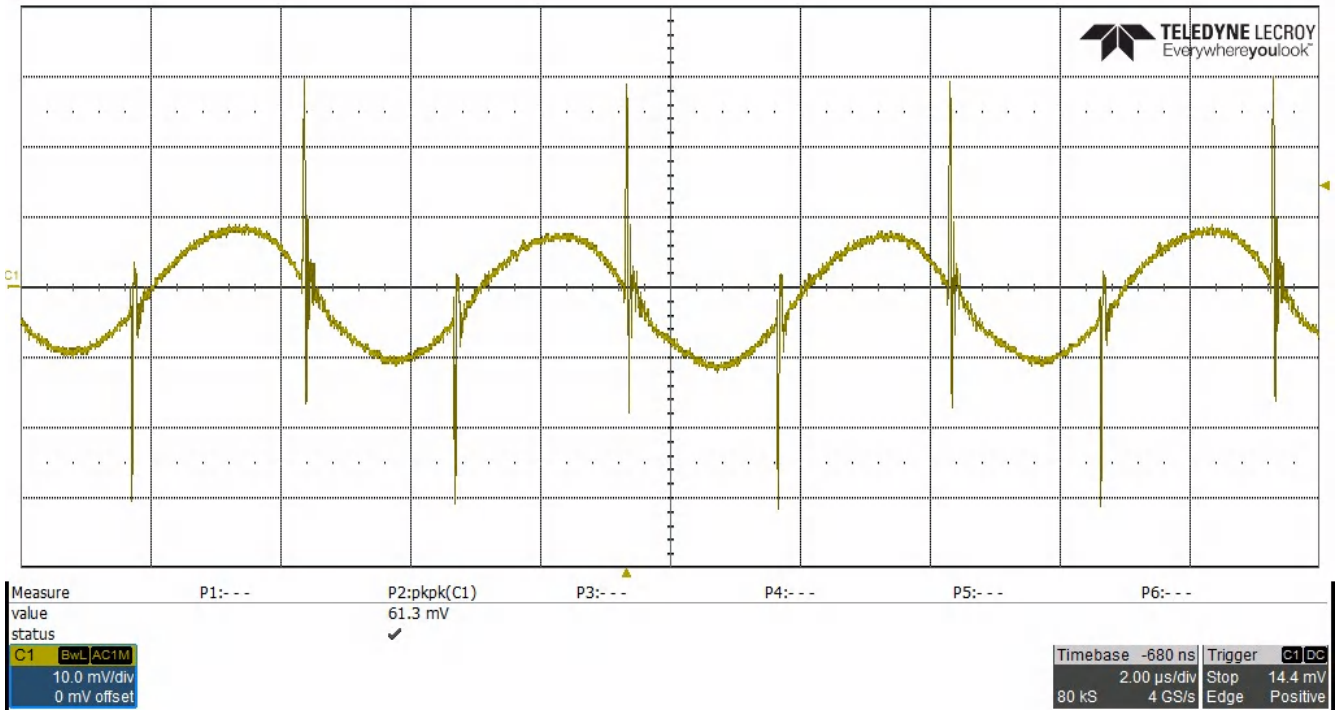


Figure 3-8. Input Voltage Ripple (C68), 10 mV/div, 2 µs/div, Measured 61.3 mVpp

3.3 Load Transients

Load transient response is shown in the following figures.

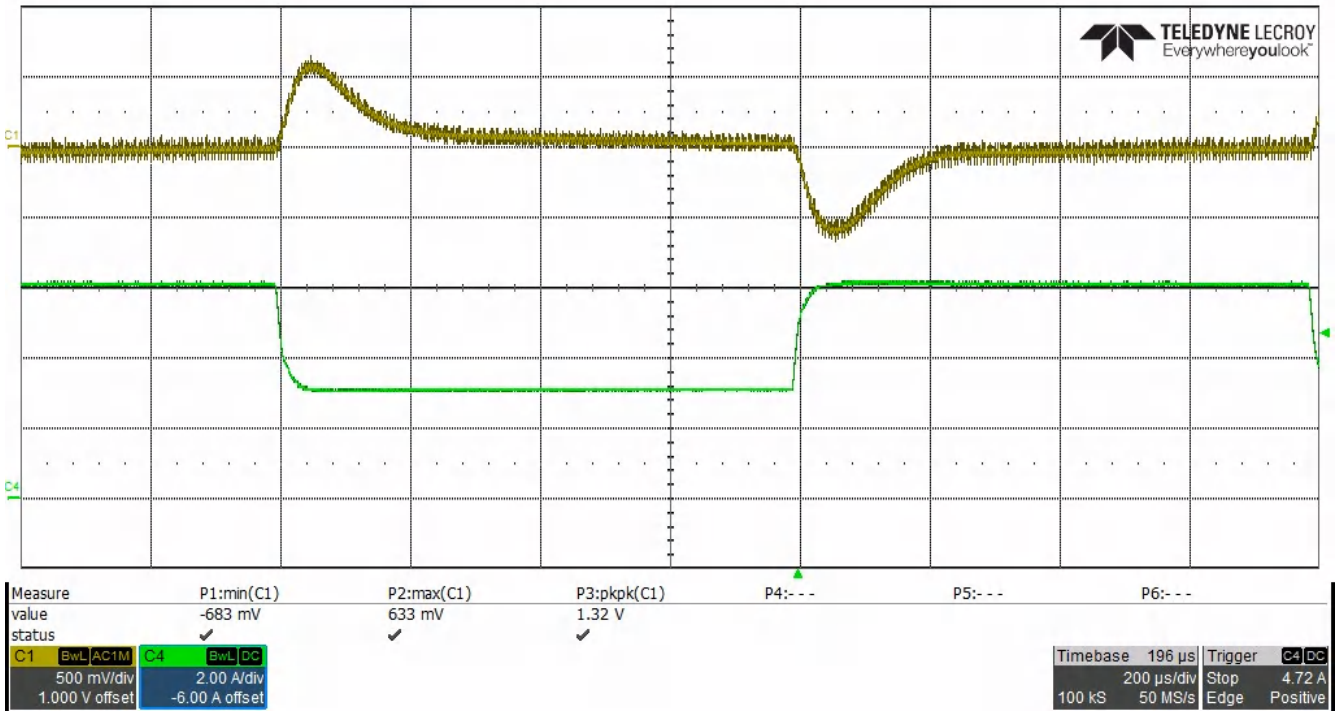


Figure 3-9. Output Load Step Response, 3.0-A to 6.0-A, 500 mV/div, 2 A/div, 200 µs/div, Slew Rate = 300 mA/µs, Measured –683 mV to +633 mV

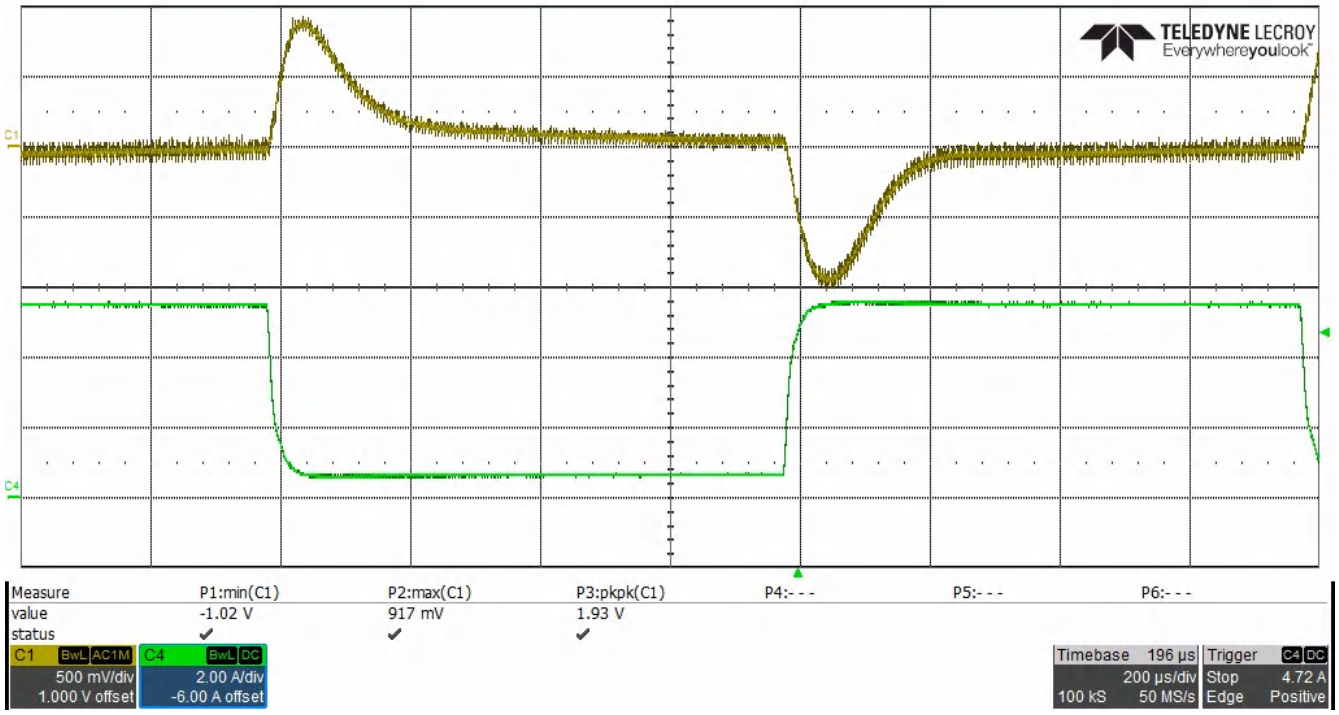


Figure 3-10. Output Load Step Response, 600-mA to 5.4-A, 500 mV/div, 2 A/div, 200 µs/div, Slew Rate = 300 mA/µs, Measured –1.02 V to +917 mV

3.4 Start-Up Sequence

Start-up behavior is shown in the following figures.

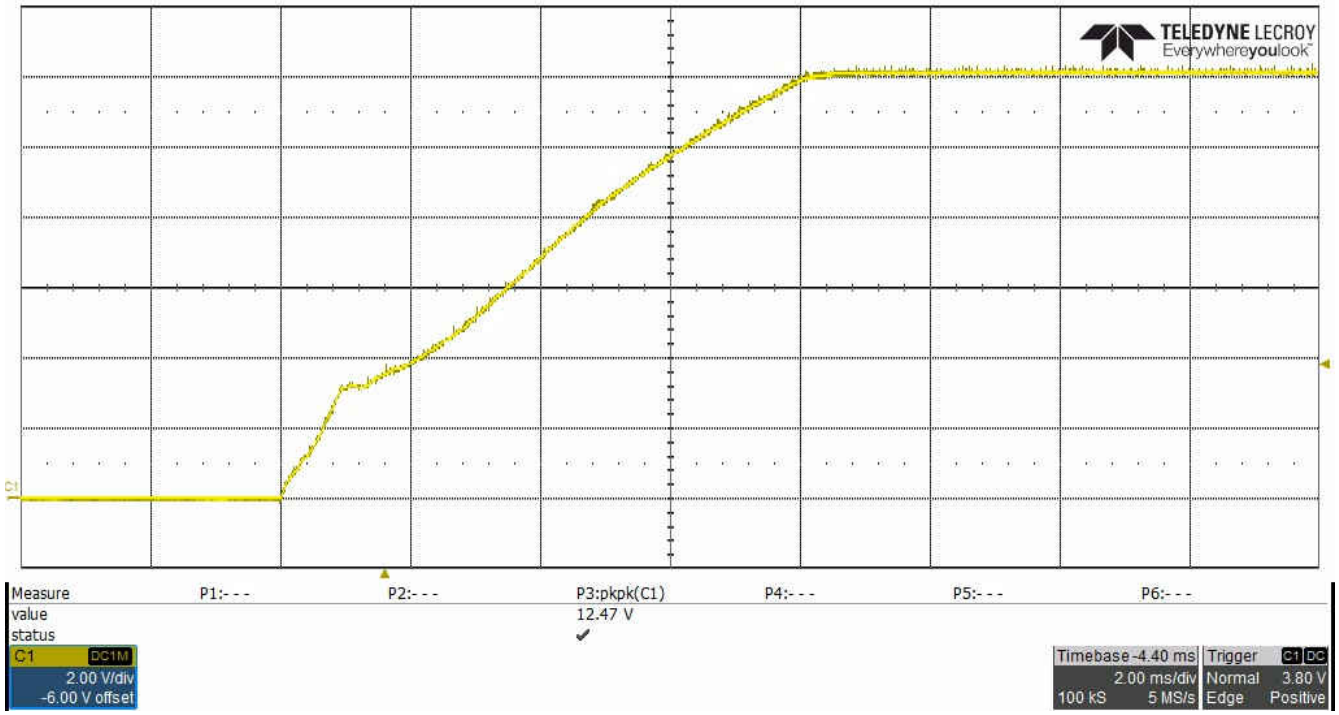


Figure 3-11. 6.0-A Load, 2 V/div, 2 ms/div

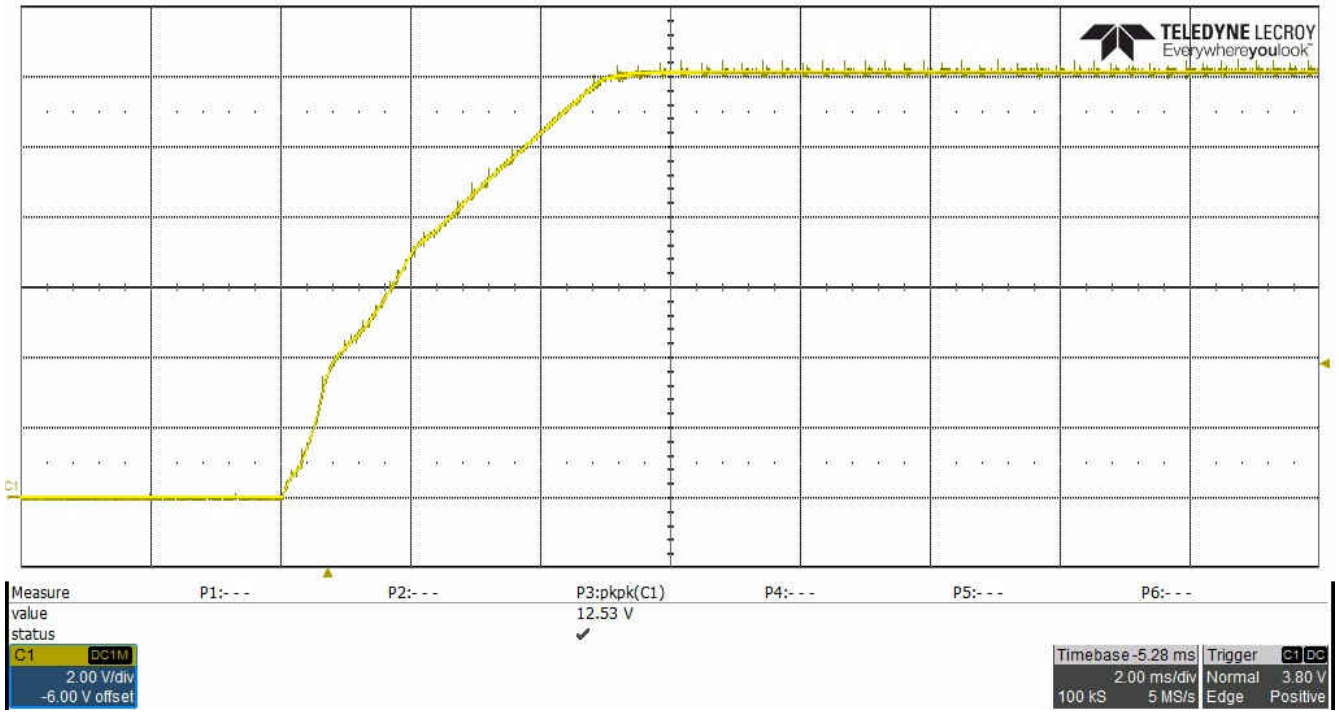


Figure 3-12. 0-A Load, 2 V/div, 2 ms/div

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