Test Report: PMP23253

Class 6, PoE PD Active Clamp Forward Converter (15 V, 3.3 A) Reference Design

Description

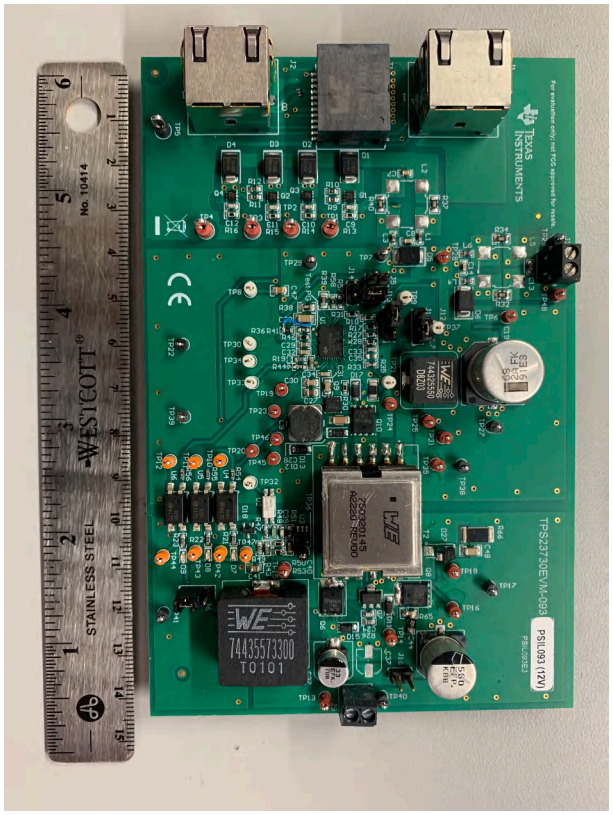
This reference design implements a Power-over-Ethernet (PoE) power device (PD) active clamp forward converter with 15-V and 3.3-A output. A TPS23730 PD with integrated pulse-width modulator (PWM) controller provides all the necessary functions to implement the PoE PD control and the PWM control for the active-clamp forward converter. This design uses secondary-side regulation (SSR) with an optocoupler feedback.

Features

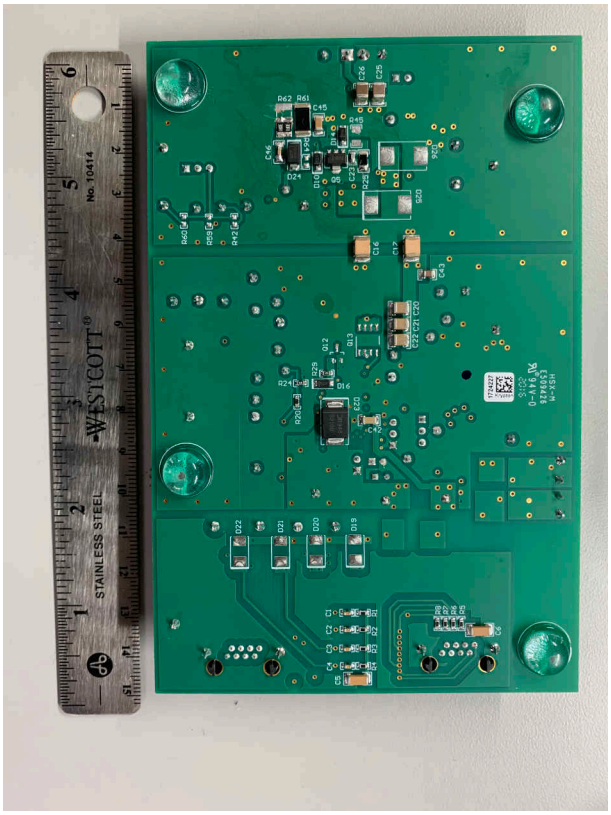
- IEEE802.3bt Type 3 compliant PoE PD
- Integrated PWM controller for flyback or active clamp forward configuration
- Frequency dithering for EMI reduction
- Soft-start control with advanced start-up and hiccup mode overload protection
- Soft-stop shutdown
- Optional adapter input

Applications

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



Top Photo



Bottom Photo

Copyright © 2022 Texas Instruments Incorporated

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	15 V
Output current	3.3 A
Nominal switching frequency	250 kHz

1.2 Required Equipment

- Type 3 or 4 PoE Power Source Equipment (PSE)
- Isolated DC power source, 0 V to 57 V, 2-A minimum
- 15-V, 3.3-A electronic load

1.3 Considerations

All measurements were taken under the following conditions:

- Approximately 25°C ambient
- 48-V input and 3.3-A load unless noted
- Using CAT5E 1-ft Ethernet cable

Copyright © 2022 Texas Instruments Incorporated

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

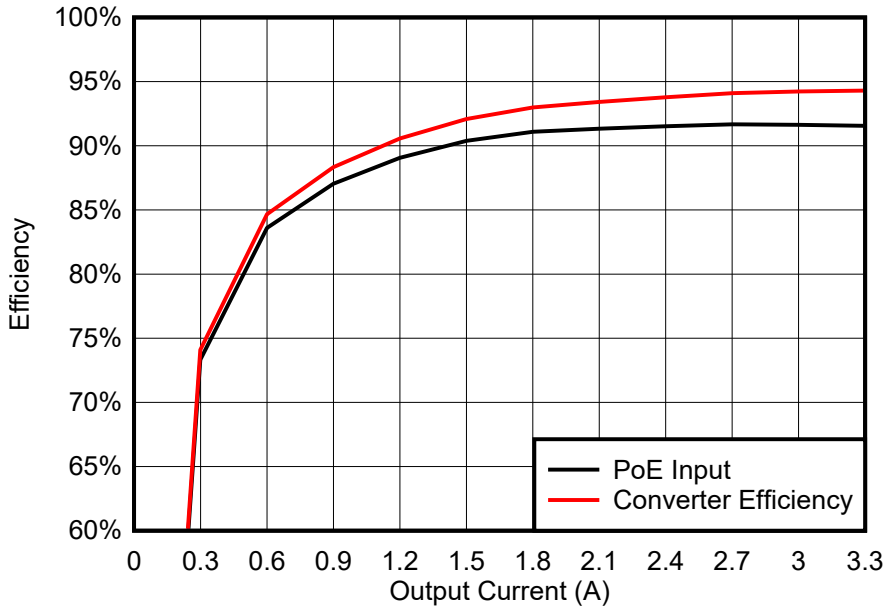


Figure 2-1. PMP23253 Rev. A Efficiency Graph, PoE Ideal Diode Bridge

Copyright © 2022 Texas Instruments Incorporated

2.2 Load Voltage Regulation

Load voltage regulation is shown in the following figure.

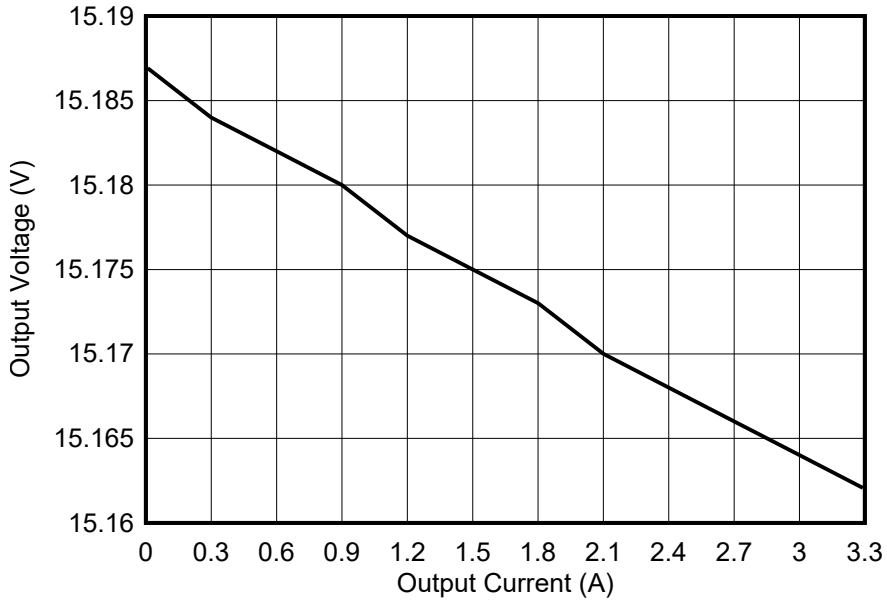


Figure 2-2. PMP23253 Rev. A, Load Voltage Regulation Curve

2.3 Efficiency Data

Efficiency data is shown in the following table.

Table 2-1. PMP23253 Efficiency Data

PoE Input Voltage (V)	PoE Input Current (A)	DC/DC Input Voltage (V)	Output Voltage (V)	Output Current (A)	PoE Efficiency	DC/DC Efficiency
48	0.034	47.619	15.187	0	0.0%	0.0%
48	0.129	47.499	15.184	0.299	73.3%	74.1%
48	0.227	47.397	15.182	0.6	83.6%	84.7%
48	0.327	47.299	15.18	0.9	87.0%	88.3%
48	0.426	47.205	15.177	1.2	89.1%	90.6%
48	0.525	47.112	15.175	1.501	90.4%	92.1%
48	0.625	47.02	15.173	1.801	91.1%	93.0%
48	0.727	46.931	15.17	2.101	91.3%	93.4%
48	0.829	46.844	15.168	2.401	91.5%	93.8%
48	0.931	46.762	15.166	2.701	91.7%	94.1%
48	1.035	46.675	15.164	3.002	91.6%	94.2%
48	1.139	46.594	15.162	3.301	91.5%	94.3%

Copyright © 2022 Texas Instruments Incorporated

2.4 Thermal Images

The thermal images are shown in the following figures.

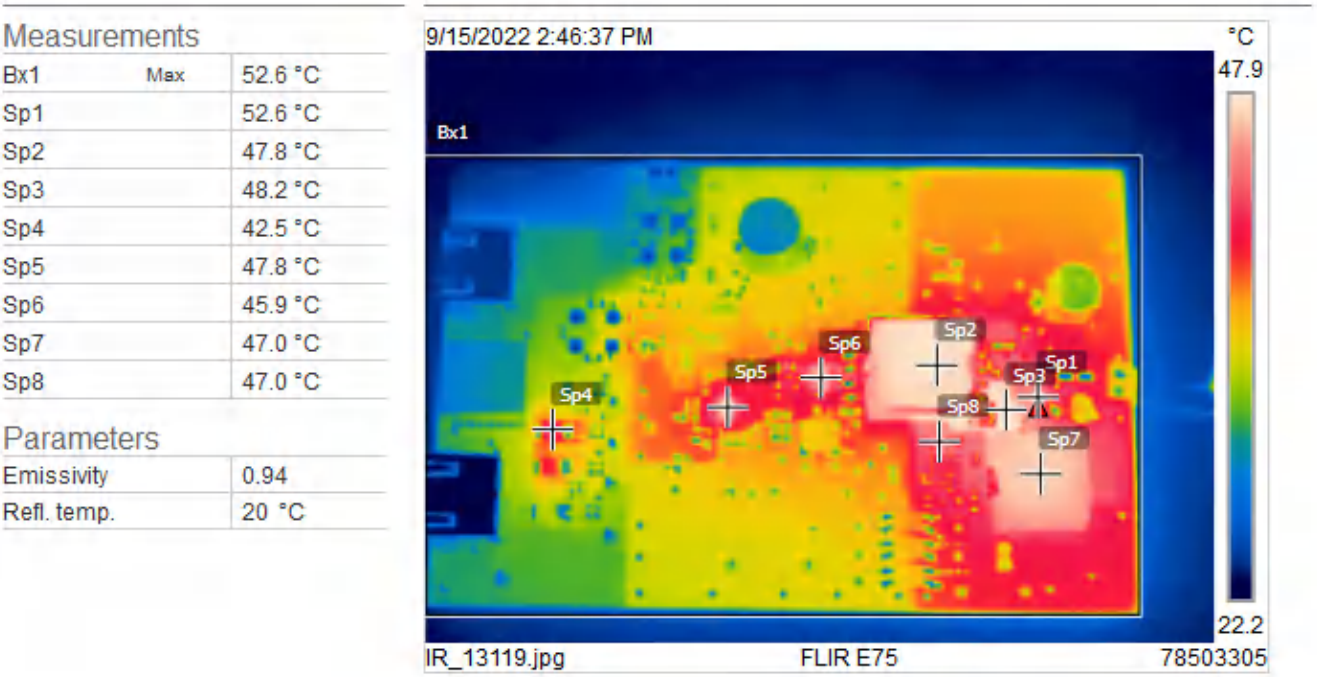


Figure 2-3. Top Thermal Image, 48-V Input, 3.3-A Load

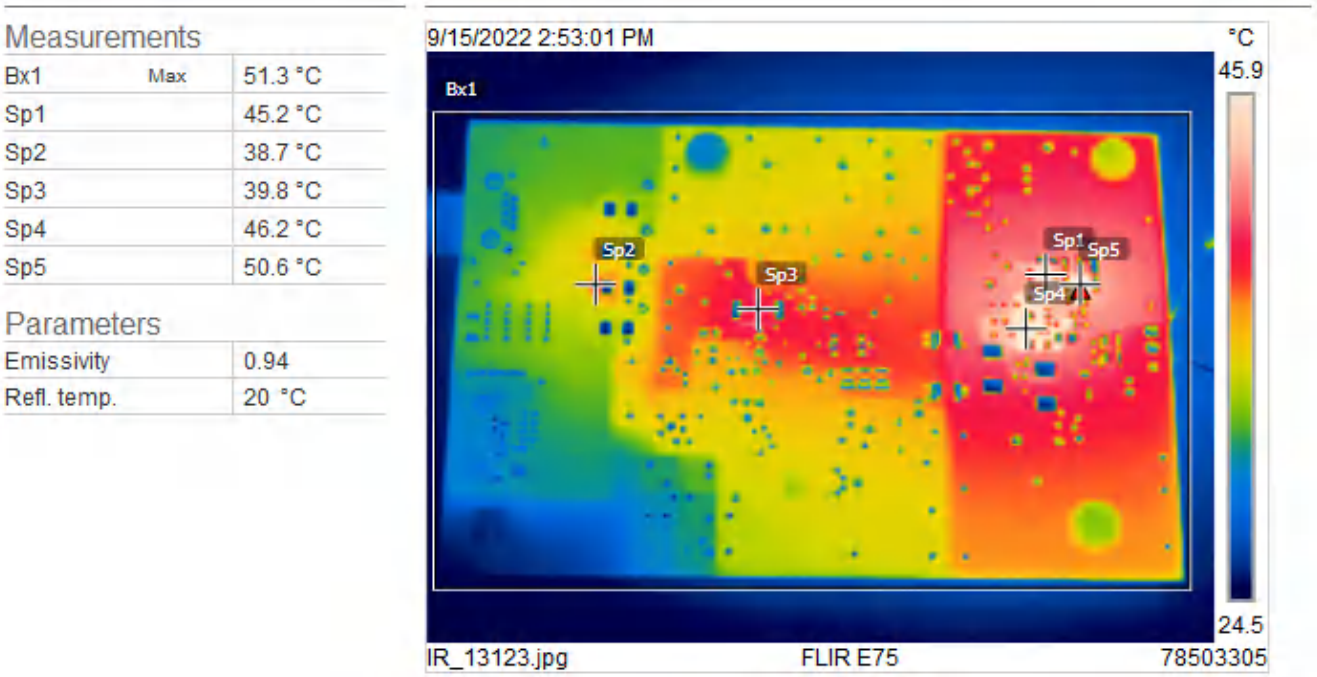


Figure 2-4. Bottom Thermal Image, 48-V Input, 3.3-A Load

Copyright © 2022 Texas Instruments Incorporated

2.5 Bode Plots

The PMP23253 bode plots are shown in the following figures.

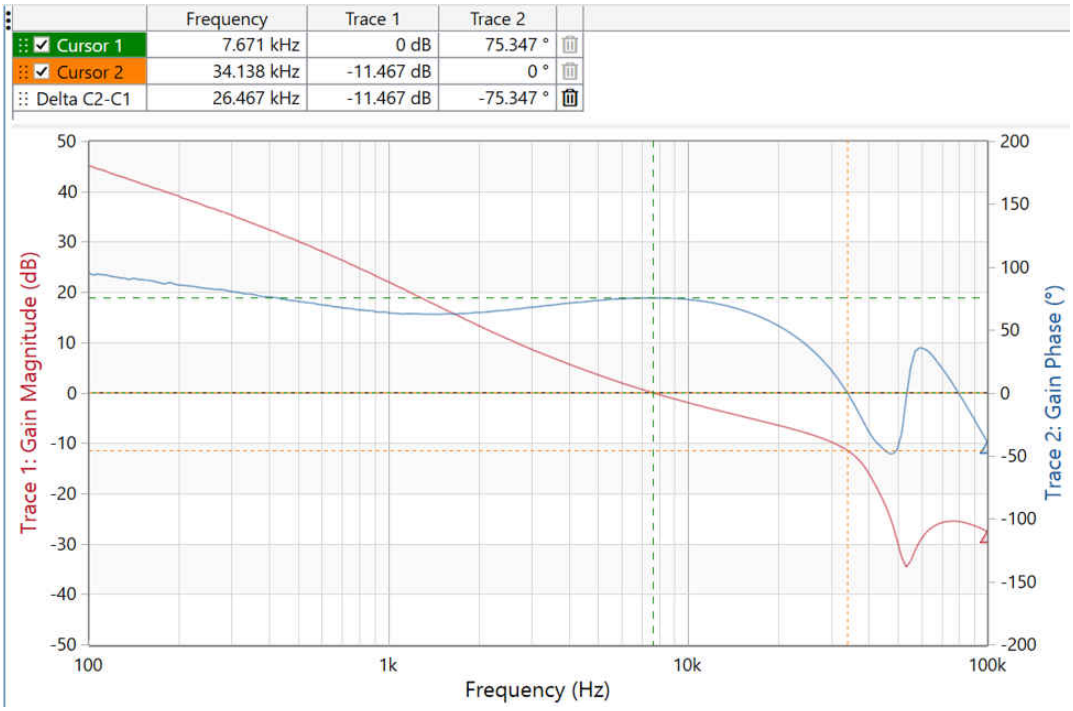


Figure 2-5. At 0-A Load Bandwidth = 7.7 kHz, Phase Margin = 75.3 Degrees, Gain Margin = 11.5 dB

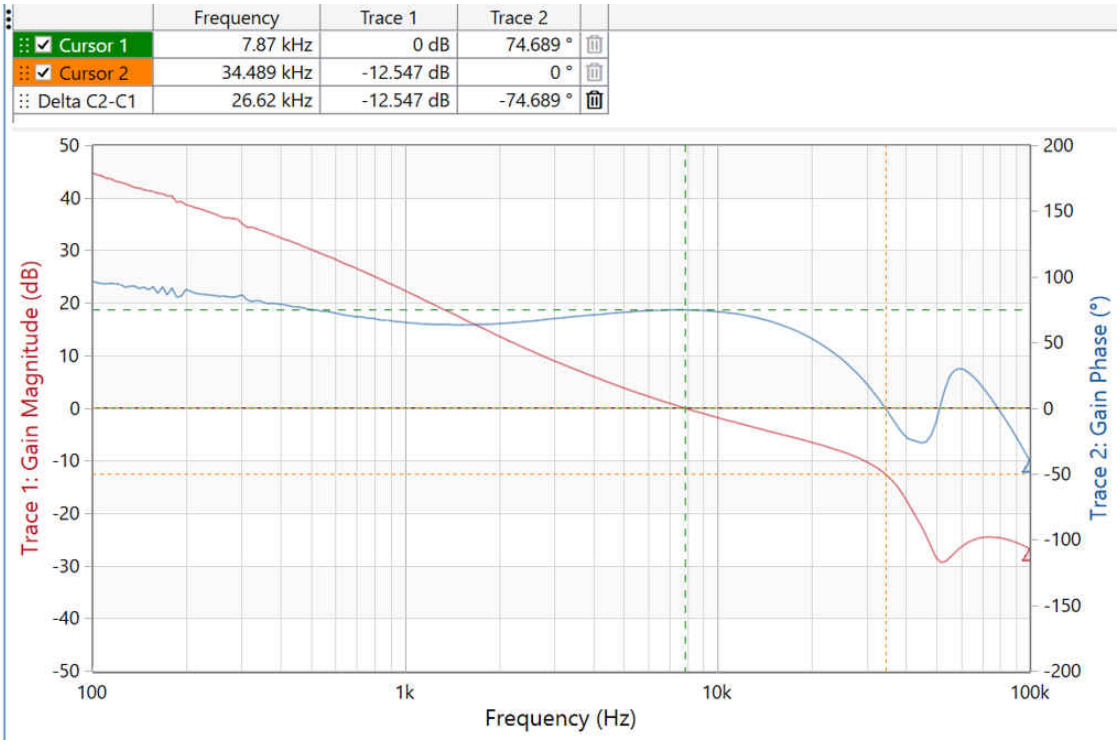


Figure 2-6. At 3.3-A Load Bandwidth = 7.9 kHz, Phase Margin = 74.7 Degrees, Gain Margin = 12.5 dB

Copyright © 2022 Texas Instruments Incorporated

3 Waveforms

3.1 Switching

Switching behavior is shown in the following figures.

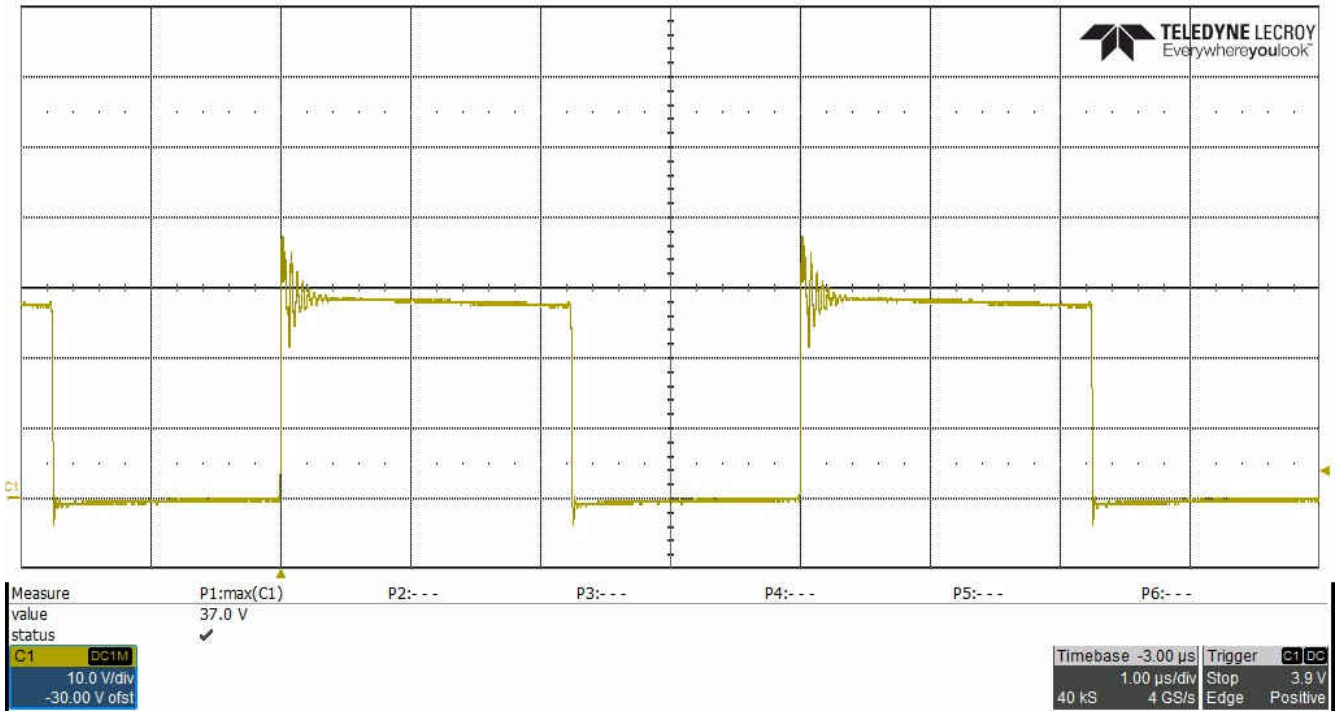


Figure 3-1. Voltage Drain-to-Source, Q6, 37-V Input, 3.3-A Load, Measured 37.0-V V_{peak}

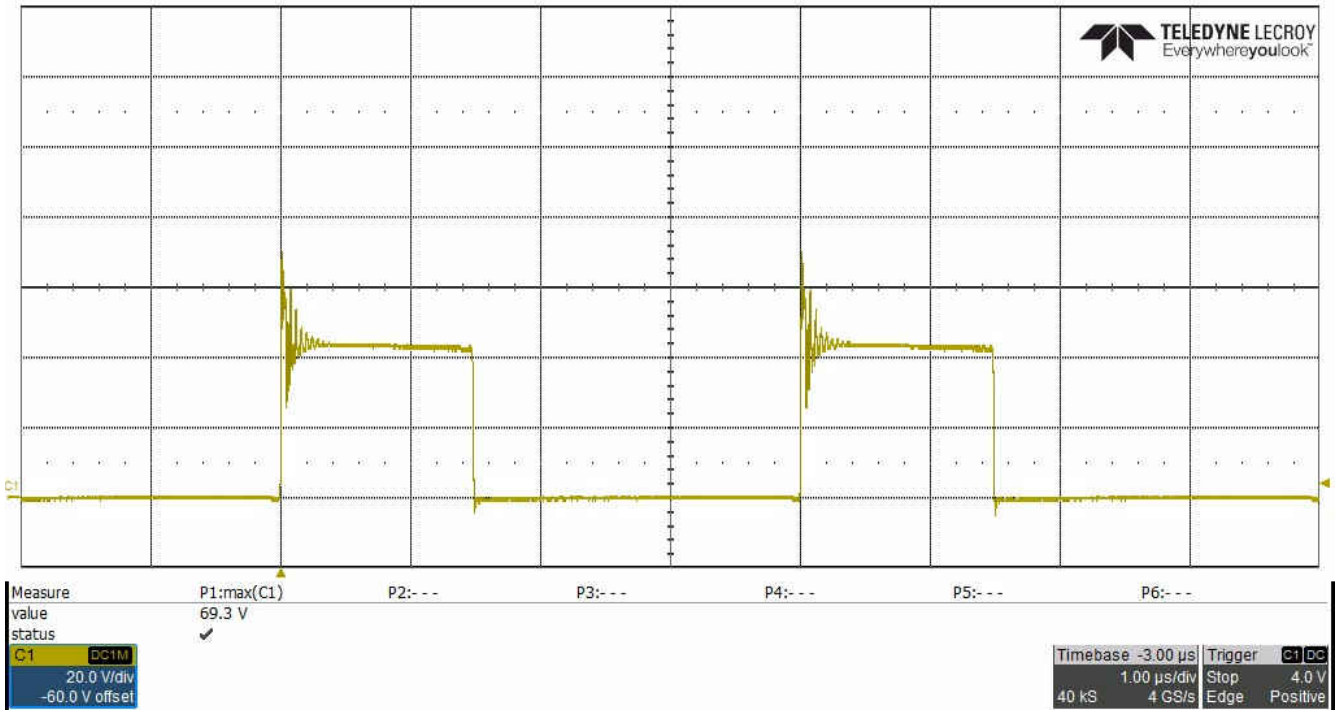


Figure 3-2. Voltage Drain-to-Source, Q6, 57-V Input, 3.3-A Load, Measured 69.3-V V_{peak}

Copyright © 2022 Texas Instruments Incorporated

Figure 3-3. Voltage Drain-to-Source, Q8, 37-V Input, 3.3-A Load, Measured 42.7-V V_{peak}

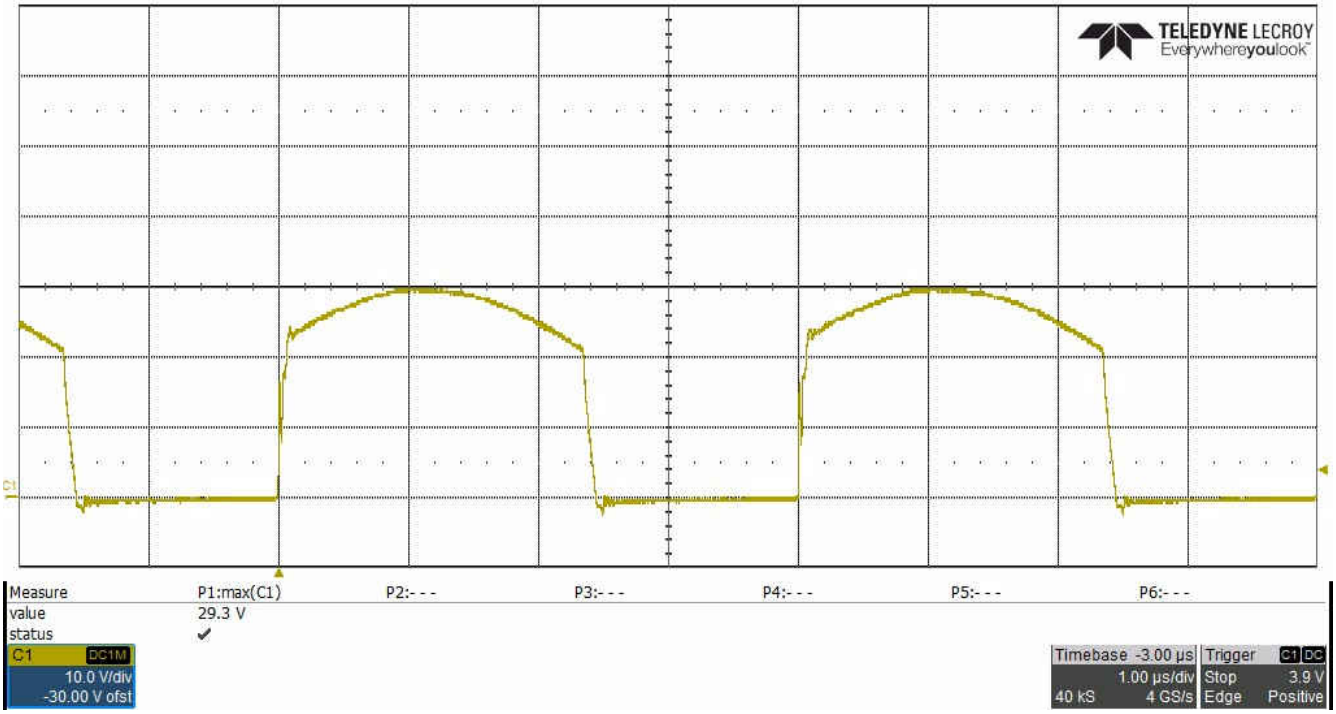


Figure 3-4. Voltage Drain-to-Source, Q8, 57-V Input, 3.3-A Load, Measured 29.3-V V_{peak}

Copyright © 2022 Texas Instruments Incorporated

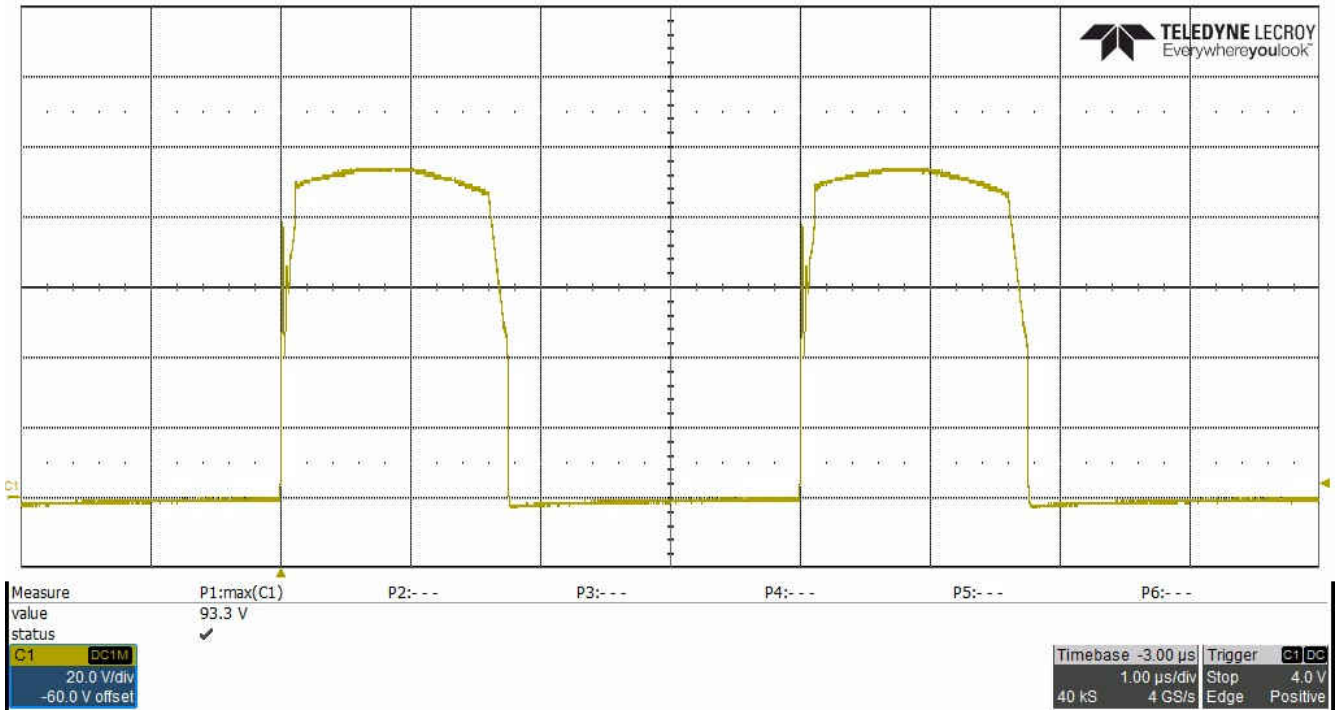


Figure 3-5. Voltage Drain-to-Source, Q10, 37-V Input, 3.3-A Load, Measured 93.3-V V_{peak}

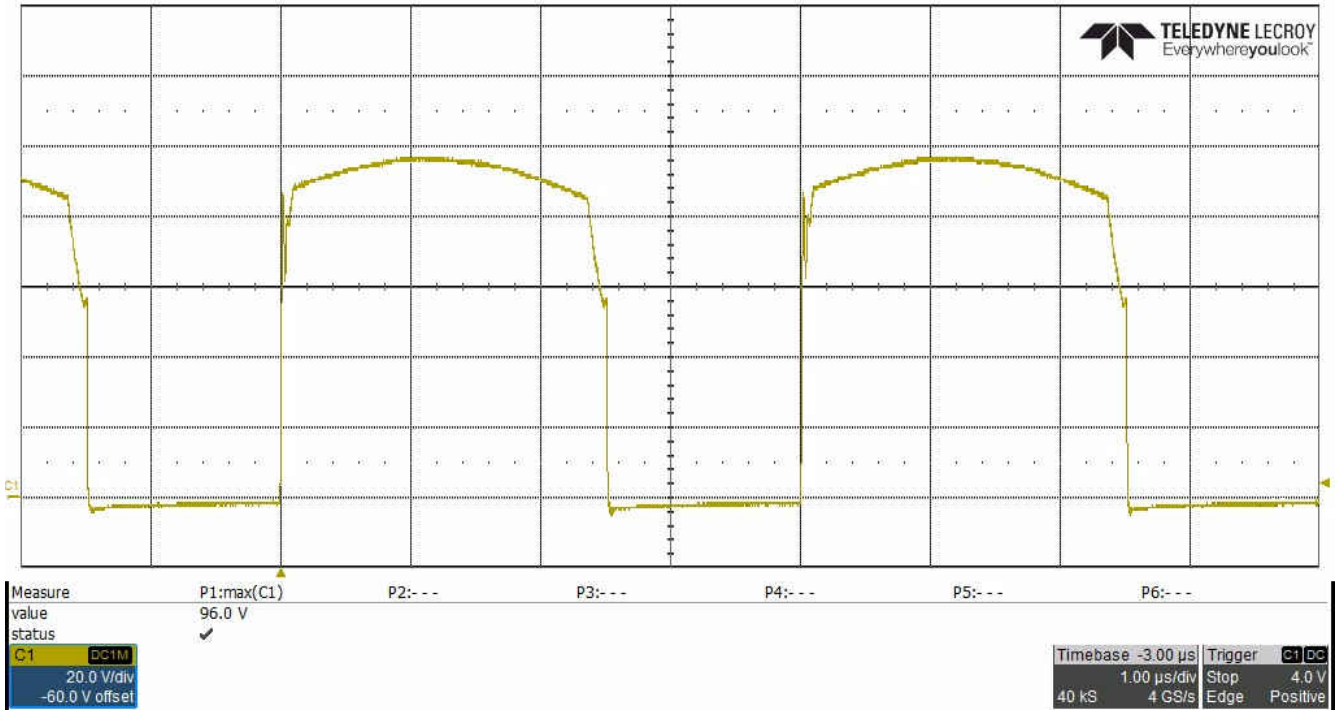


Figure 3-6. Voltage Drain-to-Source, Q10, 57-V Input, 3.3-A Load, Measured 96.0-V V_{peak}

Copyright © 2022 Texas Instruments Incorporated

3.2 Output Voltage Ripple

Voltage ripple waveforms are shown in the following figures.

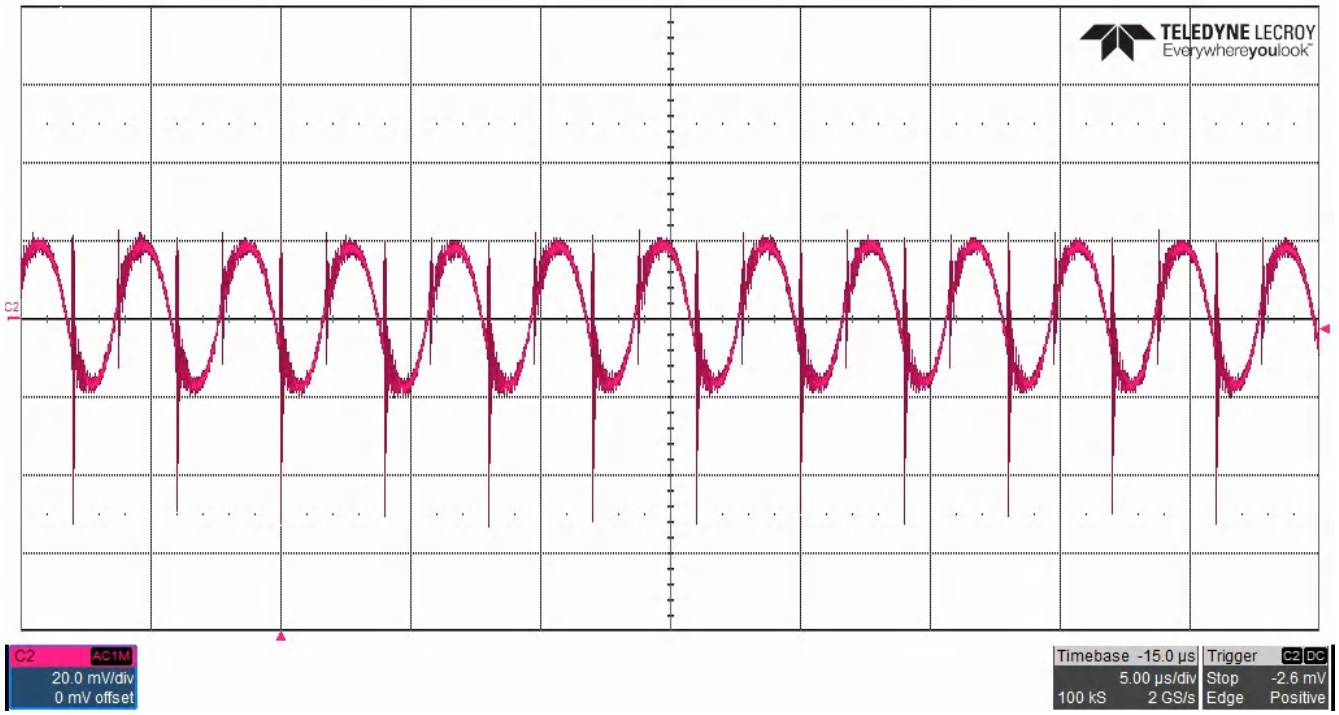


Figure 3-7. Output Voltage Ripple

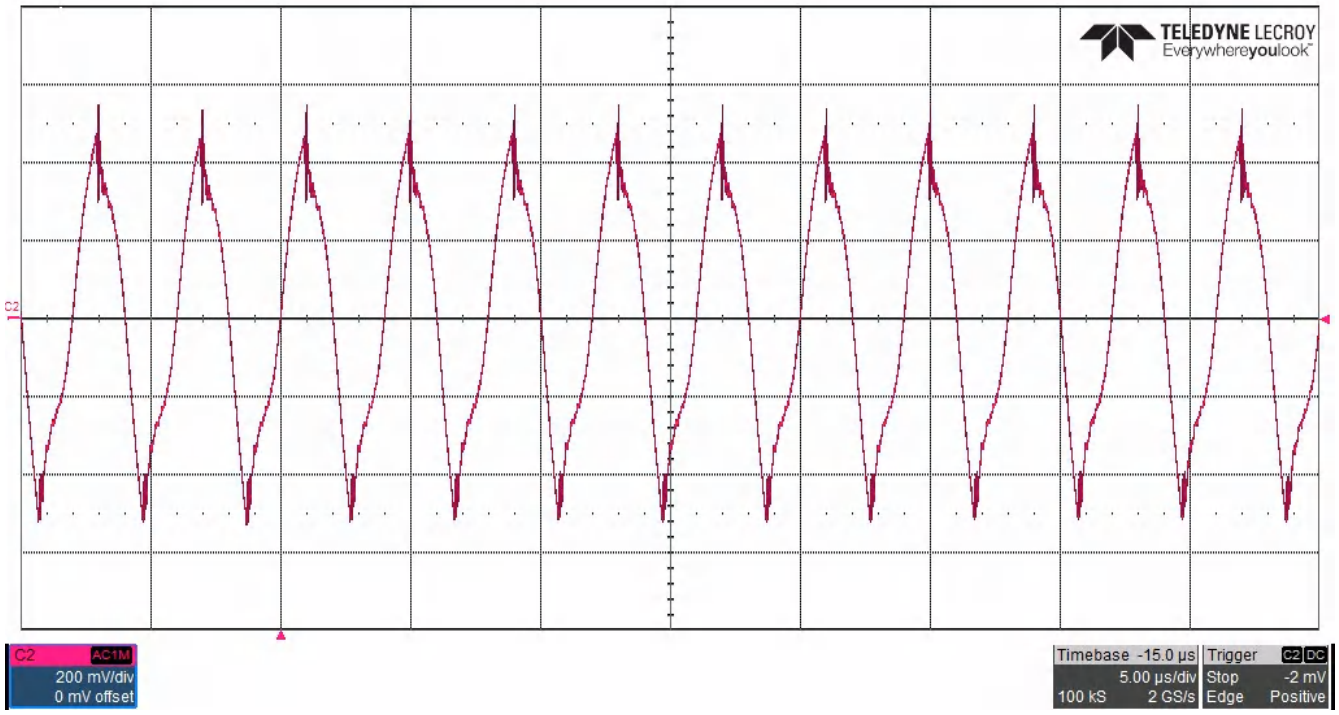


Figure 3-8. DC/DC Converter Input Voltage Ripple

Copyright © 2022 Texas Instruments Incorporated

3.3 Load Transients

Load transient response waveforms are shown in the following figures.

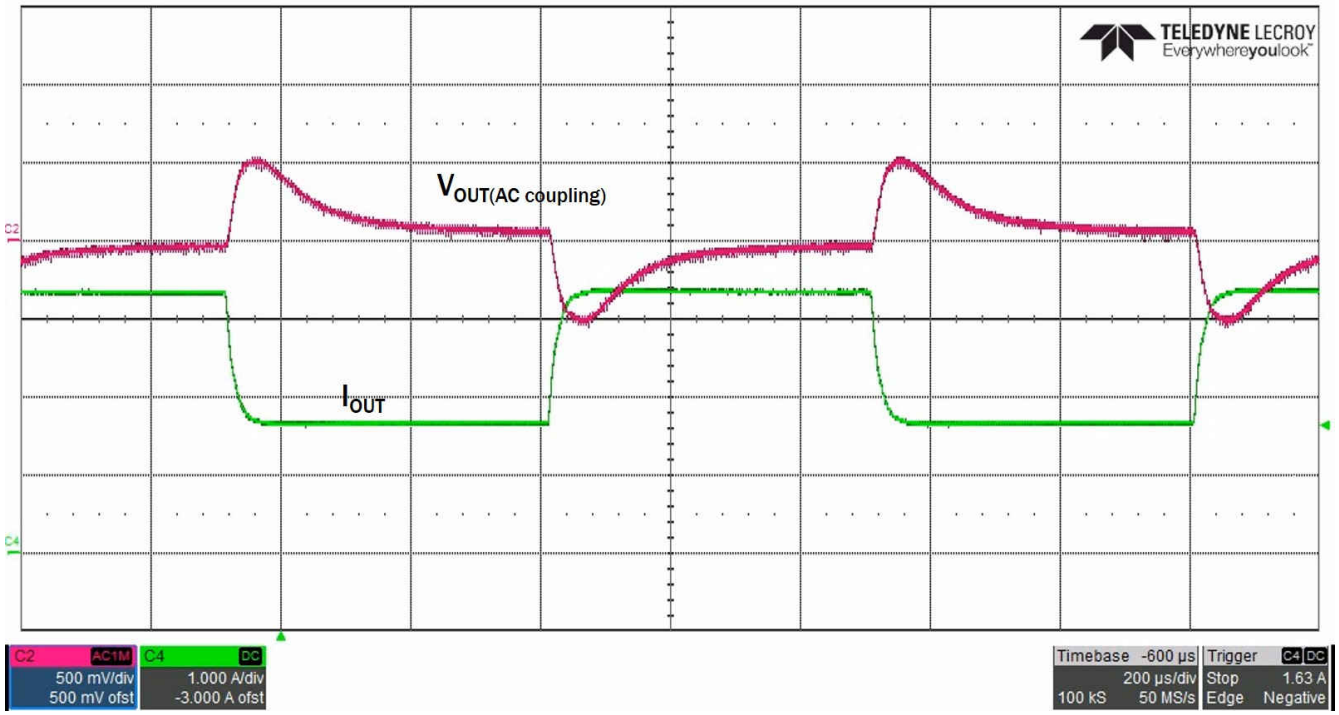


Figure 3-9. Output Load Step Response, 1.65-A to 3.30-A Load Step

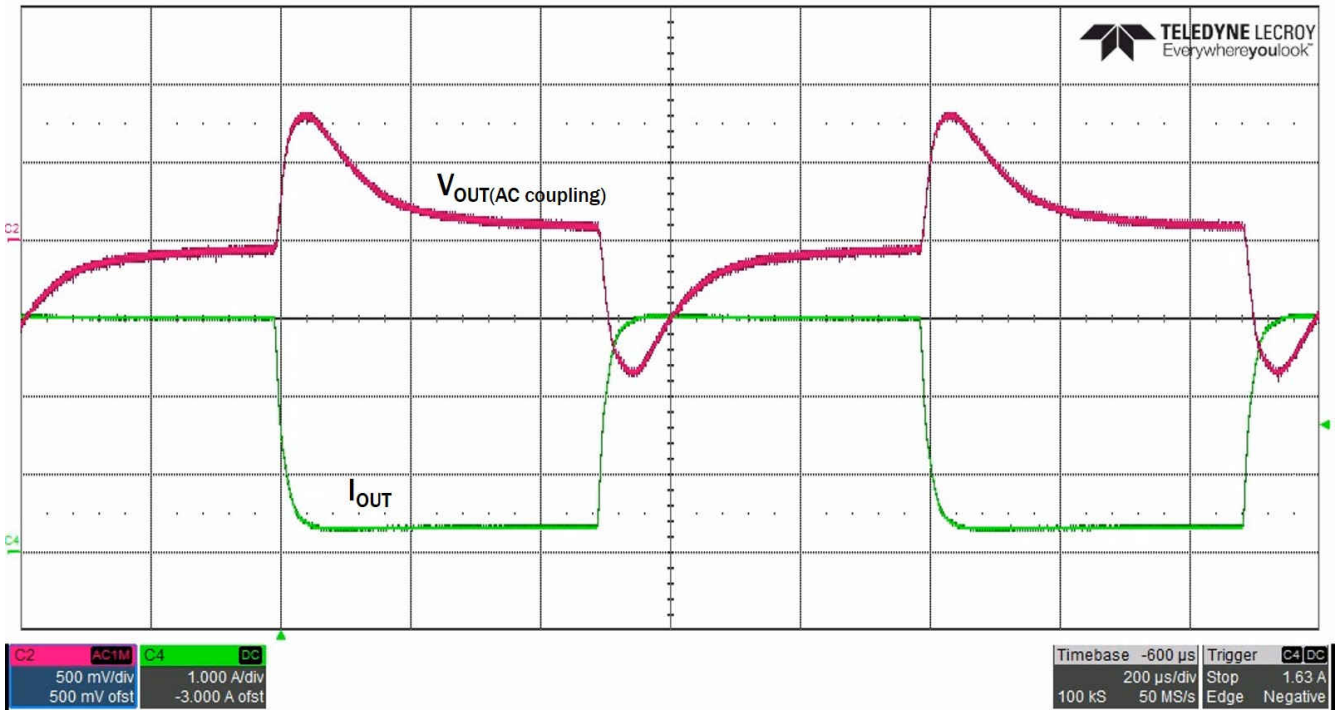


Figure 3-10. Output Load Step Response, 0.33-A to 2.97-A Load Step

Copyright © 2022 Texas Instruments Incorporated

3.4 Start-Up Sequence

Start-up behavior is shown in the following figures.

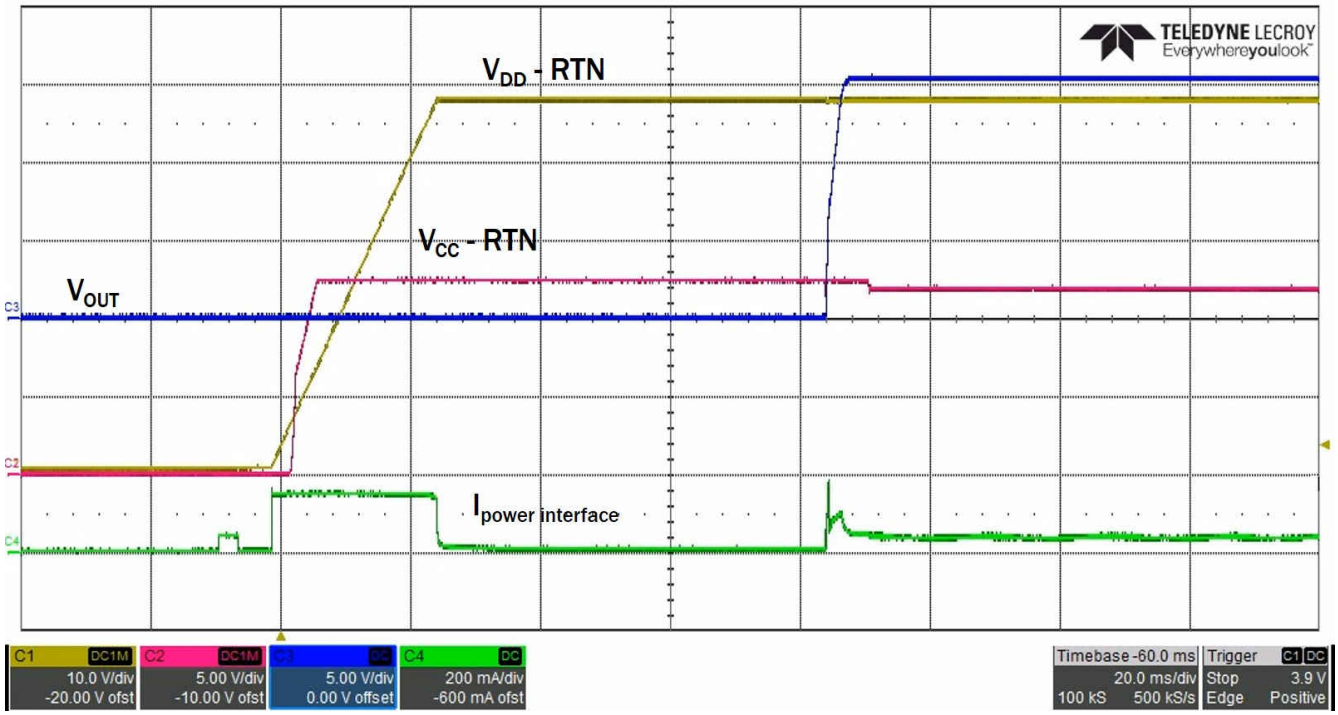


Figure 3-11. 0-A Load

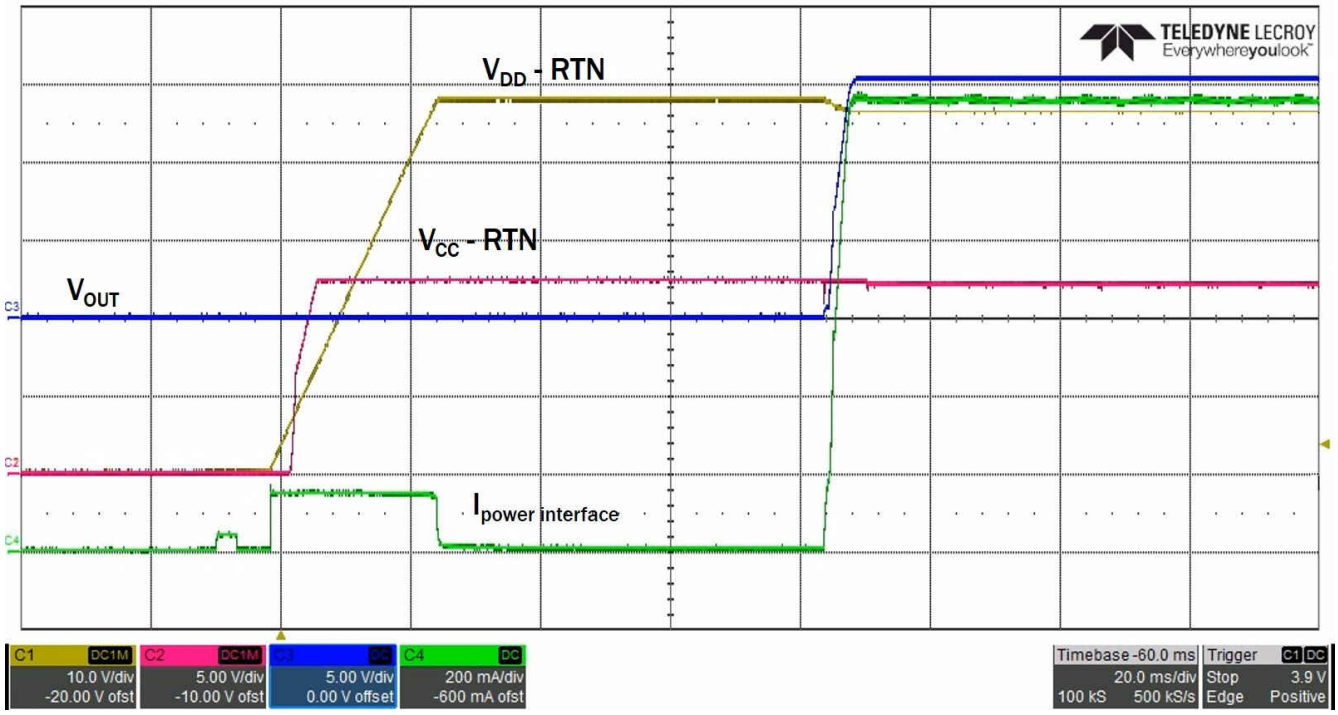


Figure 3-12. 3.3-A Load

Copyright © 2022 Texas Instruments Incorporated

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
Copyright © 2022, Texas Instruments Incorporated