Test Report: PMP23287

Class 6, PoE PD Active Clamp Forward Converter (24 V, 2.5 A) Reference Design

Description

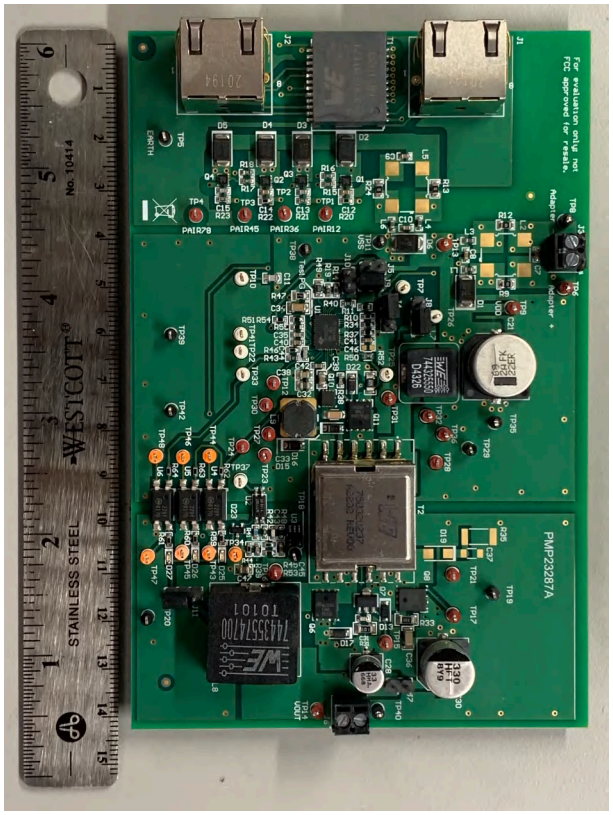
This reference design implements a Power over Ethernet (PoE) power device (PD) active clamp forward converter with 24-V and 2.5-A output. A TPS23730 PD with integrated pulse width modulator (PWM) controller provides all the necessary functions to implement the PoE PD control and the PWM control for the active clamp forward converter. This design uses secondary-side regulation (SSR) with an optocoupler feedback.

Features

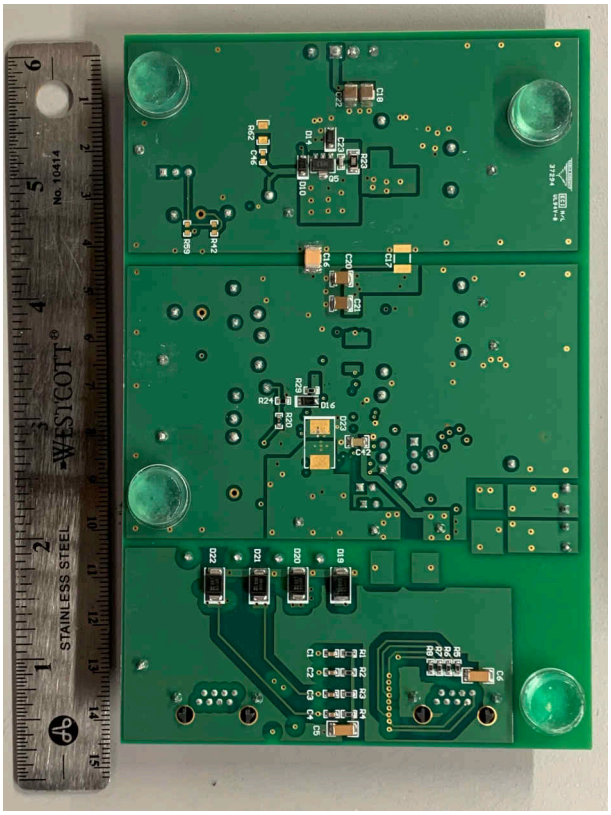
- IEEE802.3bt Type 3 compliant PoE PD
- Integrated PWM controller for flyback or active clamp forward configuration
- Frequency dithering for EMI reduction
- Soft-start control with advanced start-up and hiccup mode overload protection
- Soft-stop shutdown
- Optional adapter input

Applications

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



Top Photo



Bottom Photo

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1 lists the voltage and current requirements.

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input voltage	37 V–57 V (48-V nominal)
Output voltage	24 V
Output current	2.5 A (2.1 A with PoE, > 2.1 A with adapter)
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
- 24-V, 2.5-A electronic load

1.3 Considerations

- All measurements were taken at approximately 25°C ambient
- All measurements taken with 48-V input and 2.5-A load unless noted
- All measurements taken with CAT5E 1-ft Ethernet cable

2 Testing and Results

2.1 Efficiency Graphs

Efficiency is shown in the following figure.

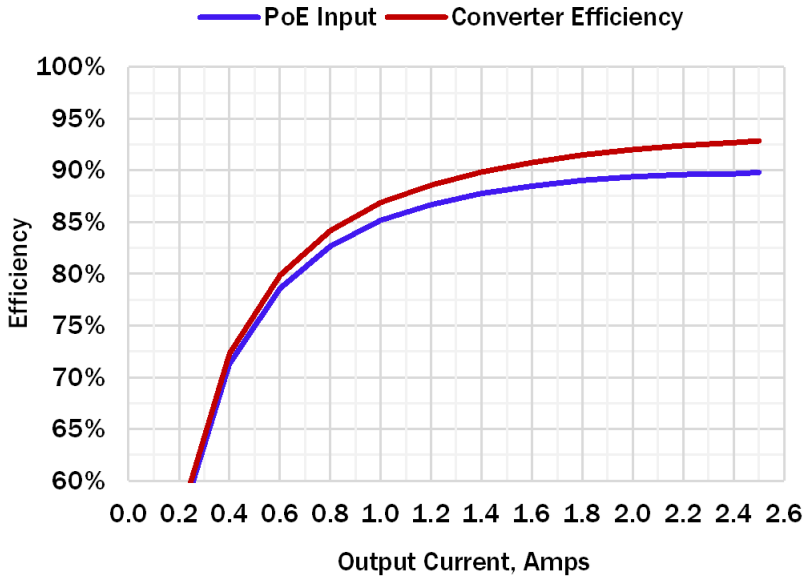


Figure 2-1. PMP23287 Rev. A Efficiency Graph, PoE Diode Bridge

2.2 Load Voltage Regulation

Load voltage regulation is shown in the following figure.

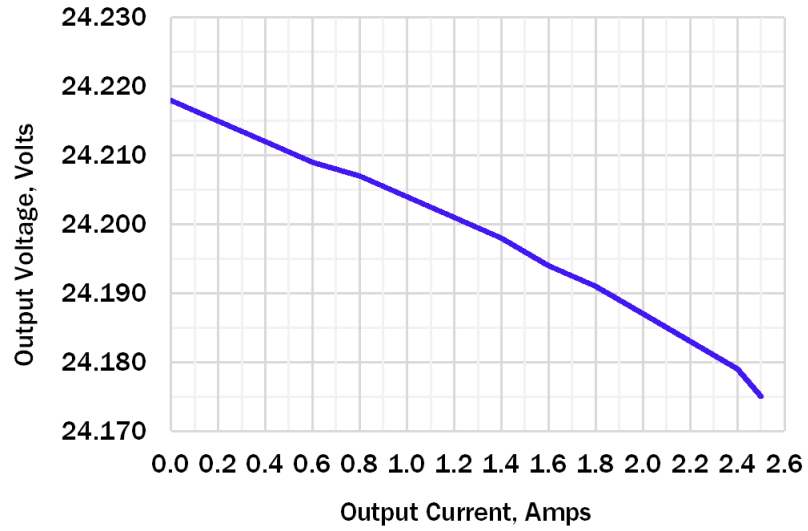


Figure 2-2. PMP23287 Rev. A Load Voltage Regulation Curve

2.3 Efficiency Data

Efficiency data is shown in the following table.

Table 2-1. Efficiency Test 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	0.082	47.555	24.218	0.000	0.0%	0.0%
48	0.181	47.452	24.215	0.199	55.5%	56.1%
48	0.283	47.349	24.212	0.400	71.3%	72.3%
48	0.385	47.250	24.209	0.600	78.6%	79.8%
48	0.488	47.153	24.207	0.800	82.7%	84.2%
48	0.592	47.057	24.204	1.000	85.2%	86.9%
48	0.698	46.971	24.201	1.200	86.7%	88.6%
48	0.804	46.891	24.198	1.400	87.8%	89.9%
48	0.911	46.796	24.194	1.599	88.5%	90.7%
48	1.019	46.712	24.191	1.800	89.0%	91.5%
48	1.128	46.624	24.187	2.001	89.4%	92.0%
48	1.237	46.539	24.183	2.200	89.6%	92.4%
48	1.348	46.454	24.179	2.400	89.7%	92.7%
48	1.402	46.422	24.175	2.500	89.8%	92.9%

2.4 Thermal Images

Thermal images are shown in the following figures.

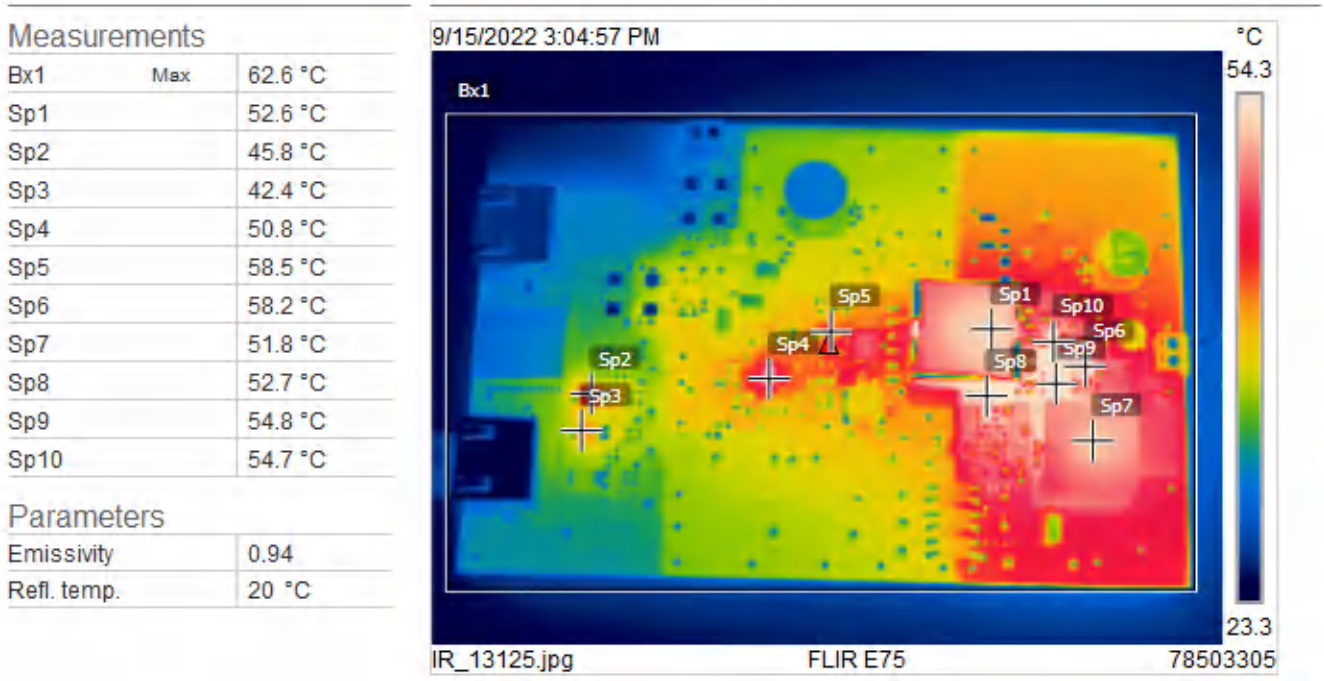


Figure 2-3. Top Thermal Image, 48-V Input, 2-A Load

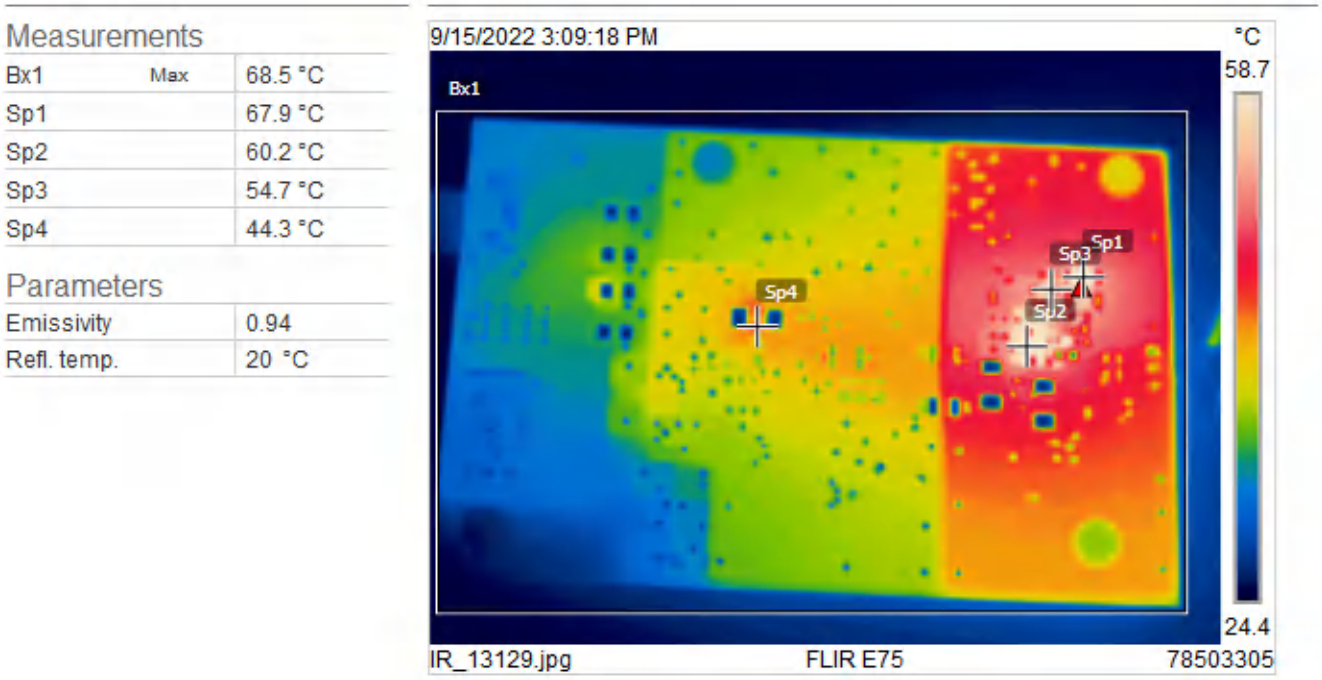


Figure 2-4. Bottom Thermal Image, 48-V Input, 2-A Load

2.5 Bode Plots

Bode plots are shown in the following figures.

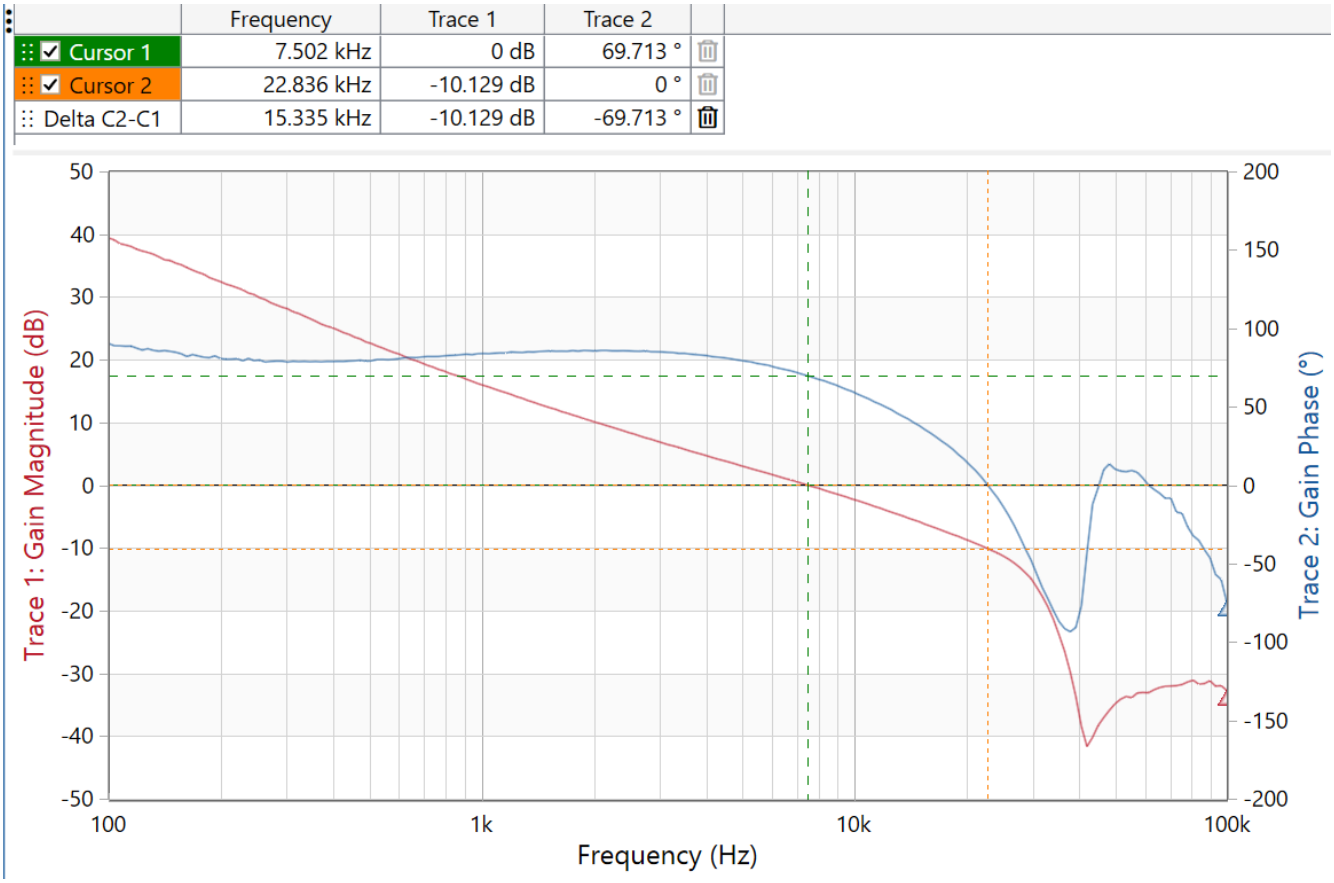


Figure 2-5. At 0-A Load Bandwidth = 7.5 kHz, Phase Margin = 69.7 Degrees, Gain Margin = 10.1 dB

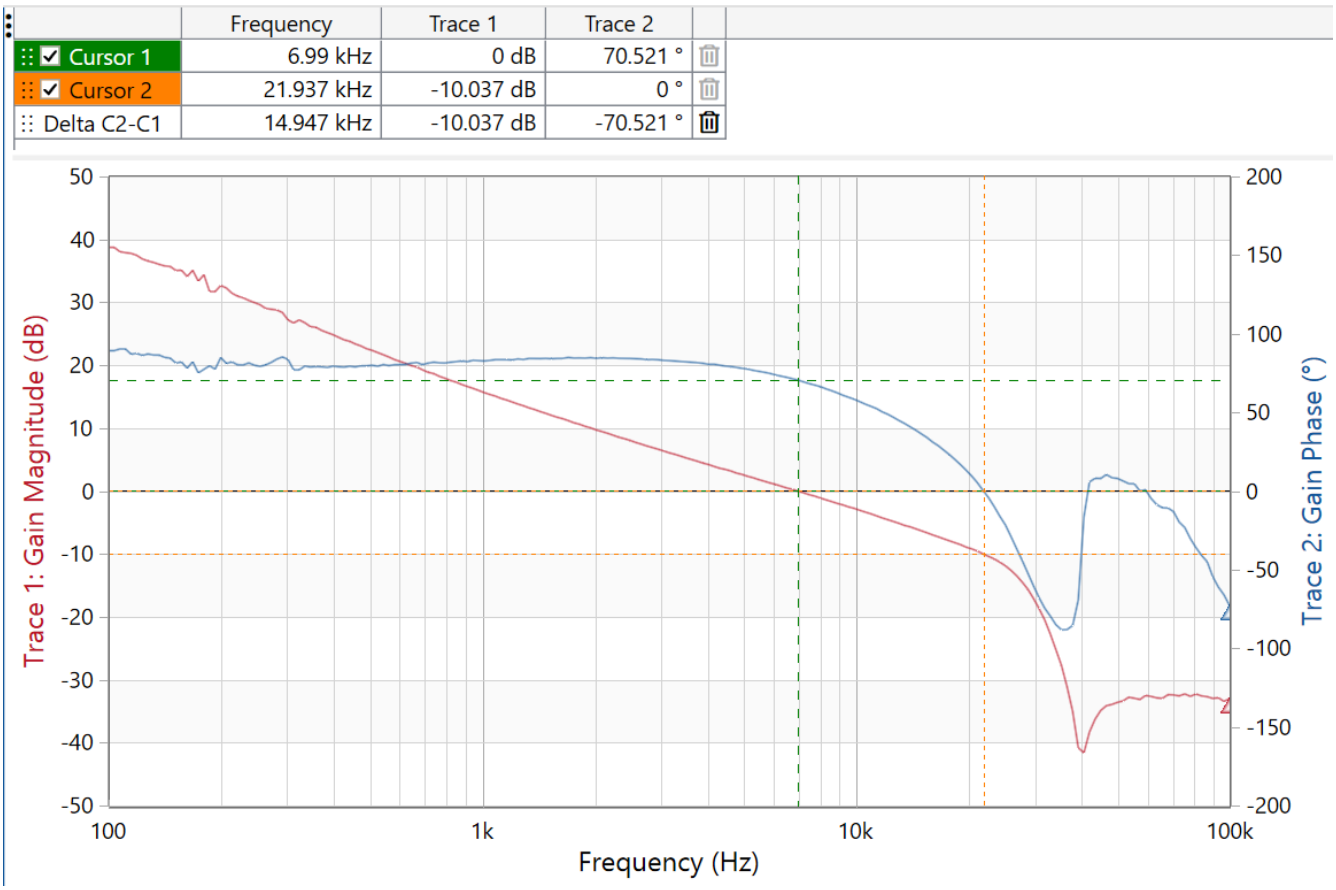


Figure 2-6. At 2.5-A Load Bandwidth = 7.0 kHz, Phase Margin = 70.5 Degrees, Gain Margin = 10.0 dB

3 Waveforms

3.1 Switching

Switching behavior is shown in the following figures.

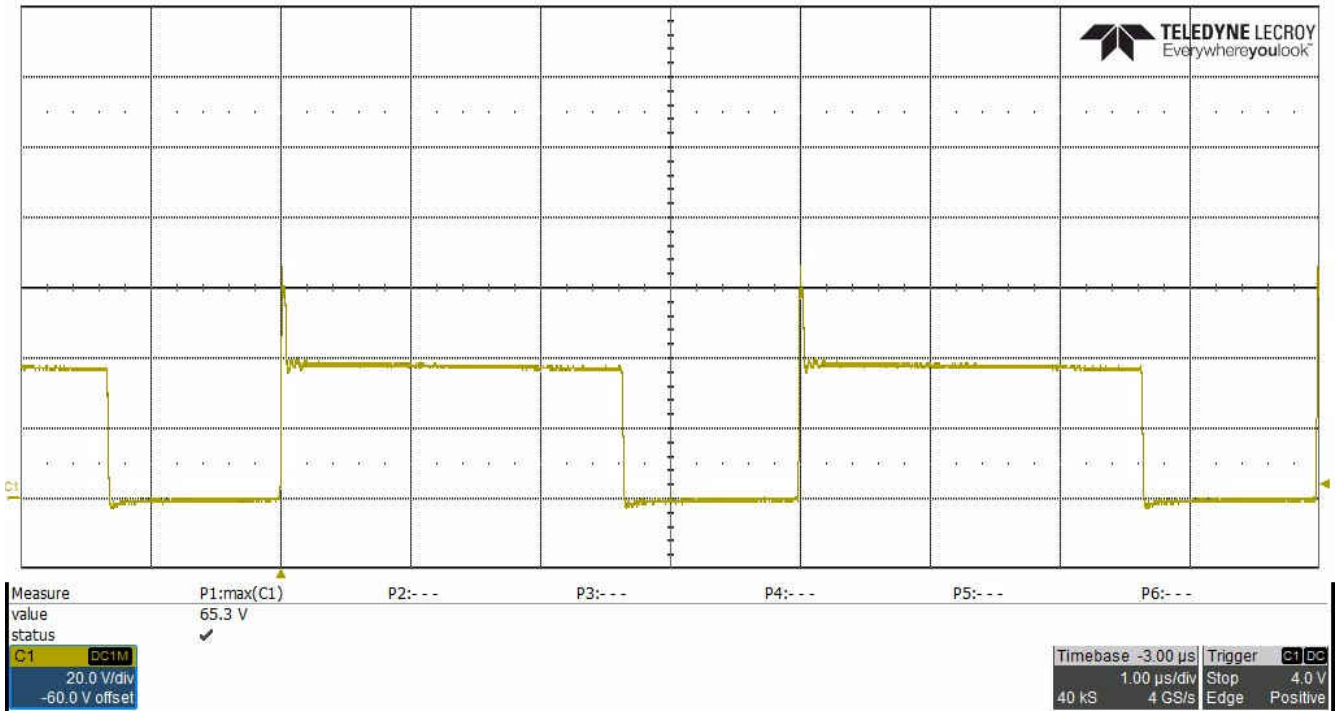


Figure 3-1. Voltage Drain-to-Source, Q6, 37-V Input, 2.5-A Load, Measured 65.3-V V_{peak}

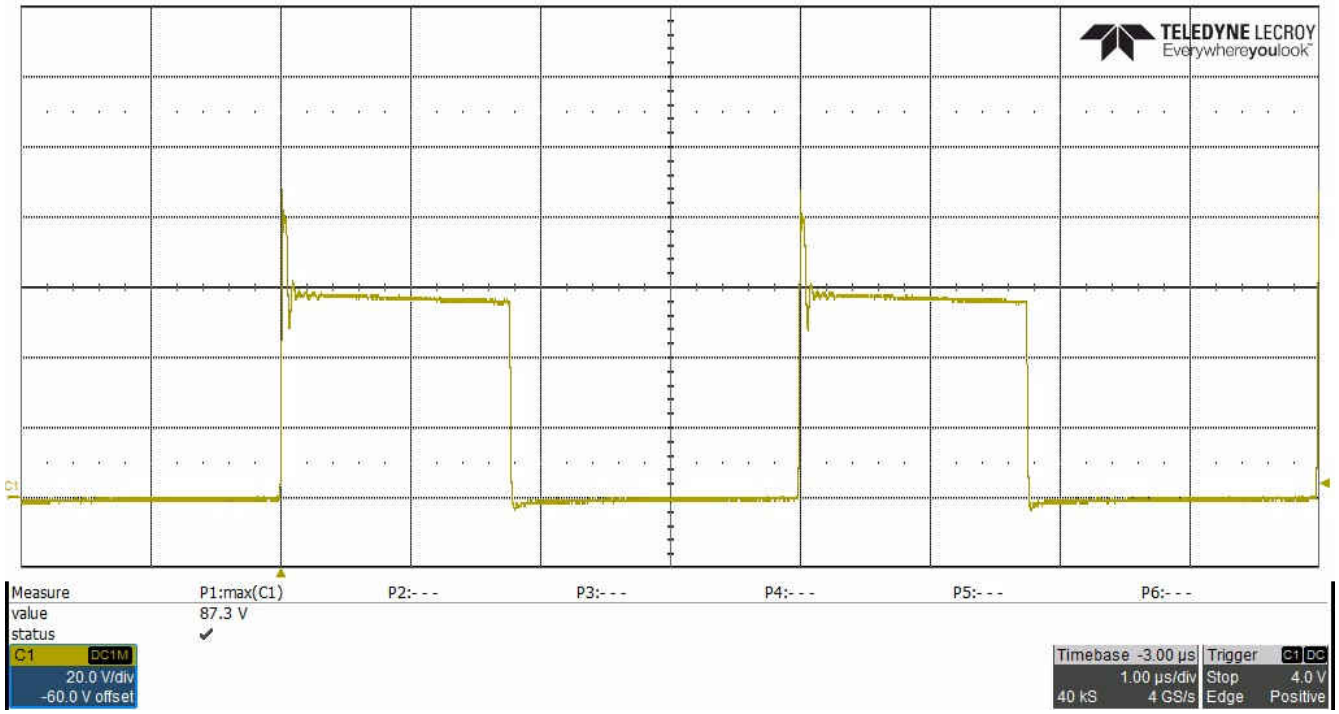


Figure 3-2. Voltage Drain-to-Source, Q6, 57-V Input, 2.5-A Load, Measured 87.3-V V_{peak}

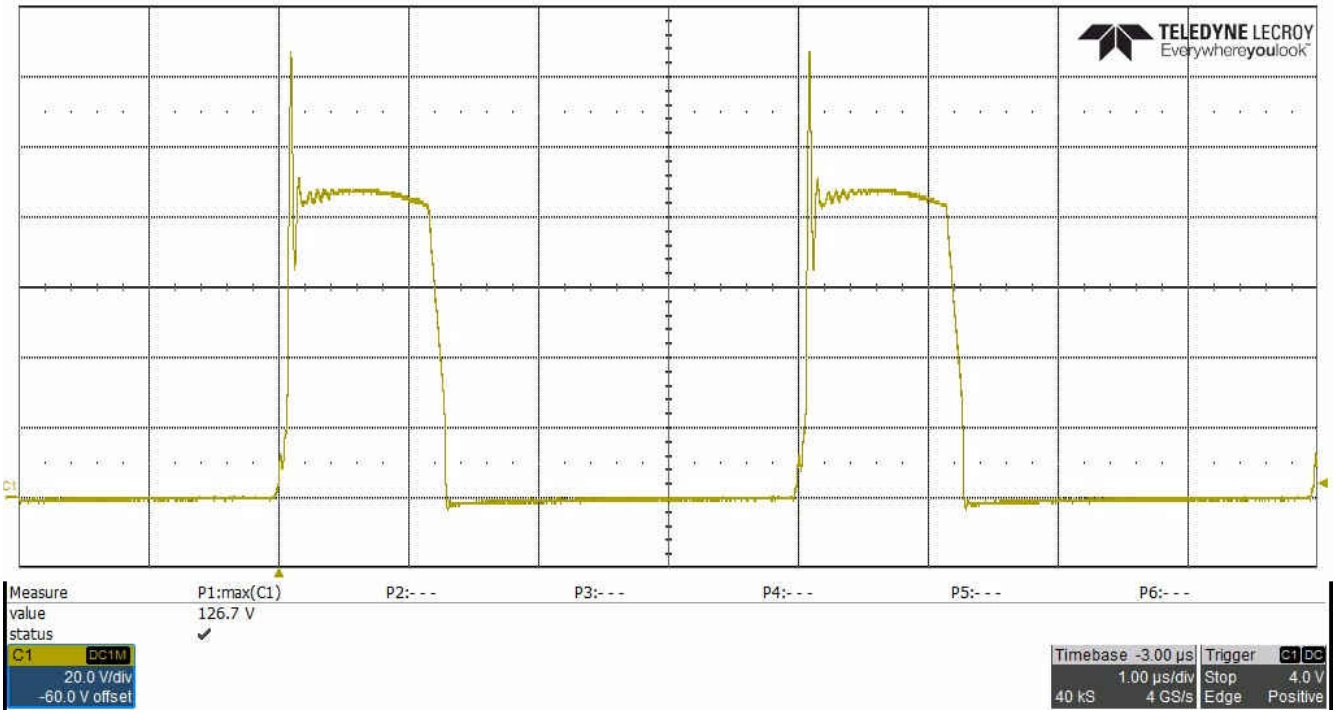


Figure 3-3. Voltage Drain-to-Source, Q8, 37-V Input, 2.5-A Load, Measured 126.7-V V_{peak}

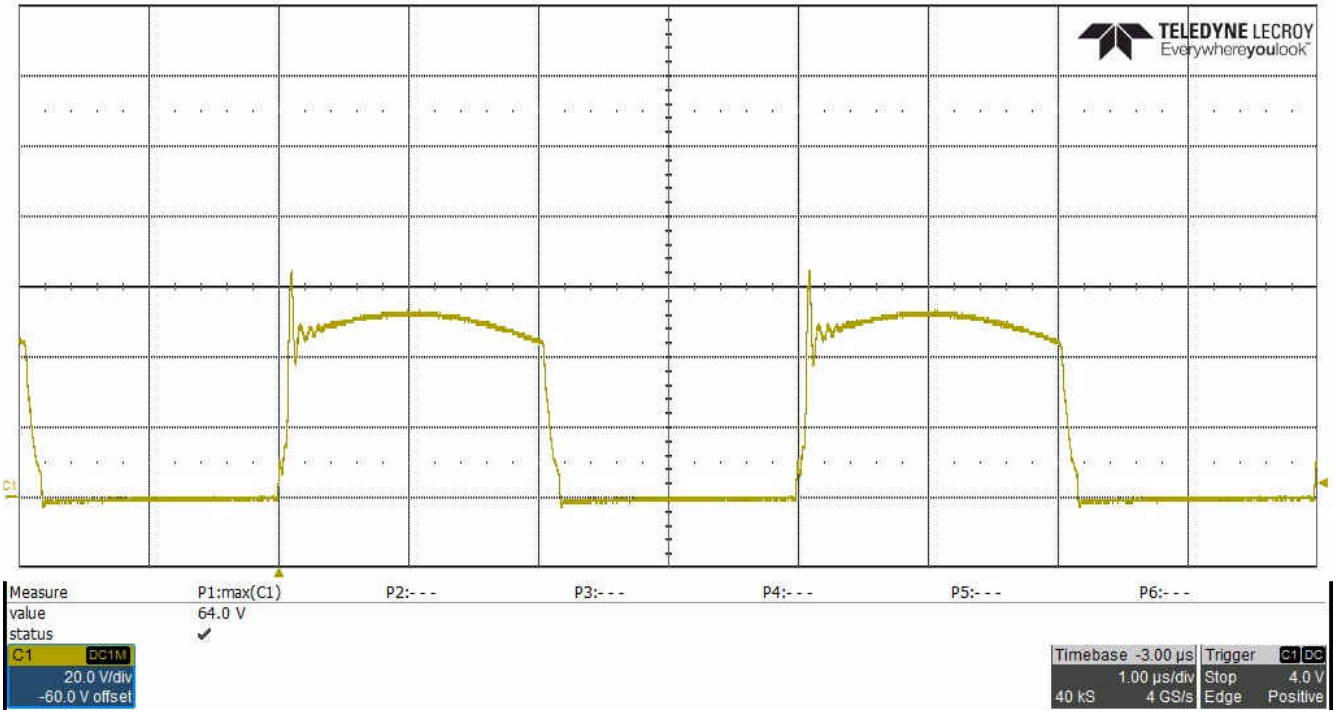


Figure 3-4. Voltage Drain-to-Source, Q8, 57-V Input, 2.5-A Load, Measured 64.0-V V_{peak}

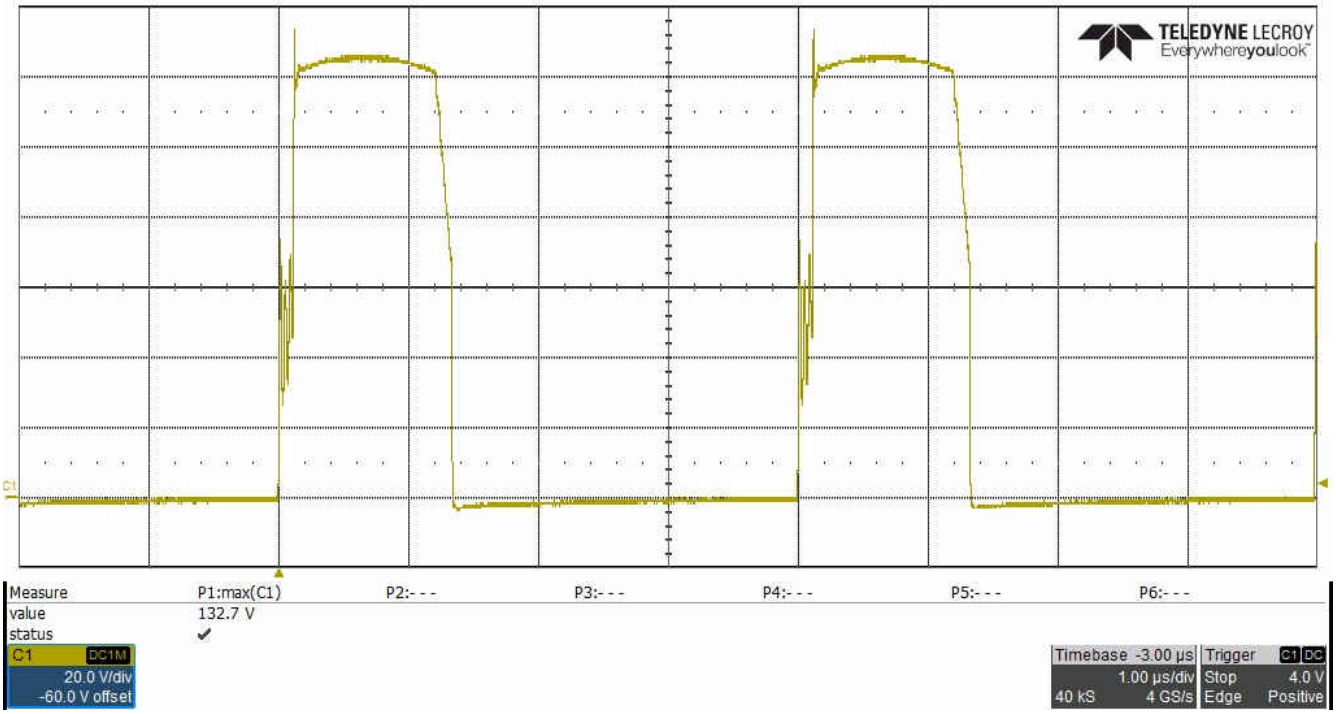


Figure 3-5. Voltage Drain-to-Source, Q10, 37-V Input, 2.5-A Load, Measured 132.7-V V_{peak}

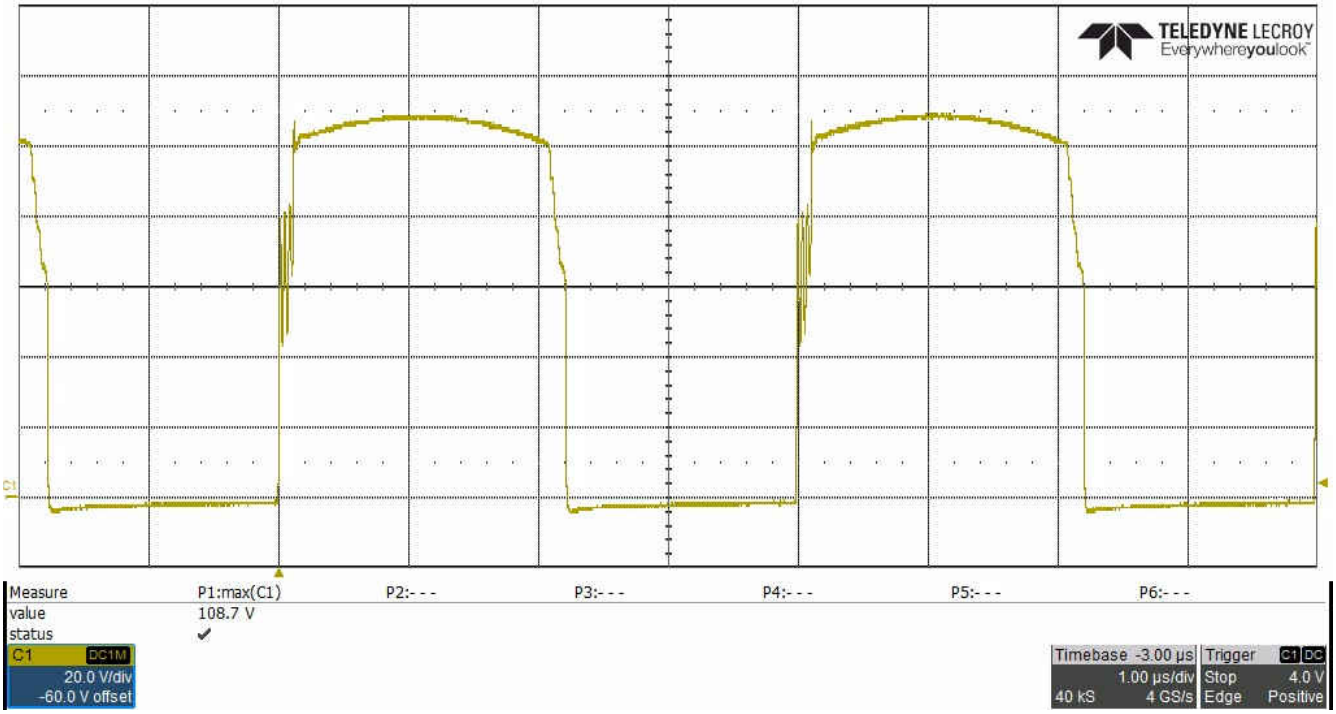


Figure 3-6. Voltage Drain-to-Source, Q10, 57-V Input, 2.5-A Load, Measured 108.7-V V_{peak}

3.2 Voltage Ripple

Voltage ripple is shown in the following figures.

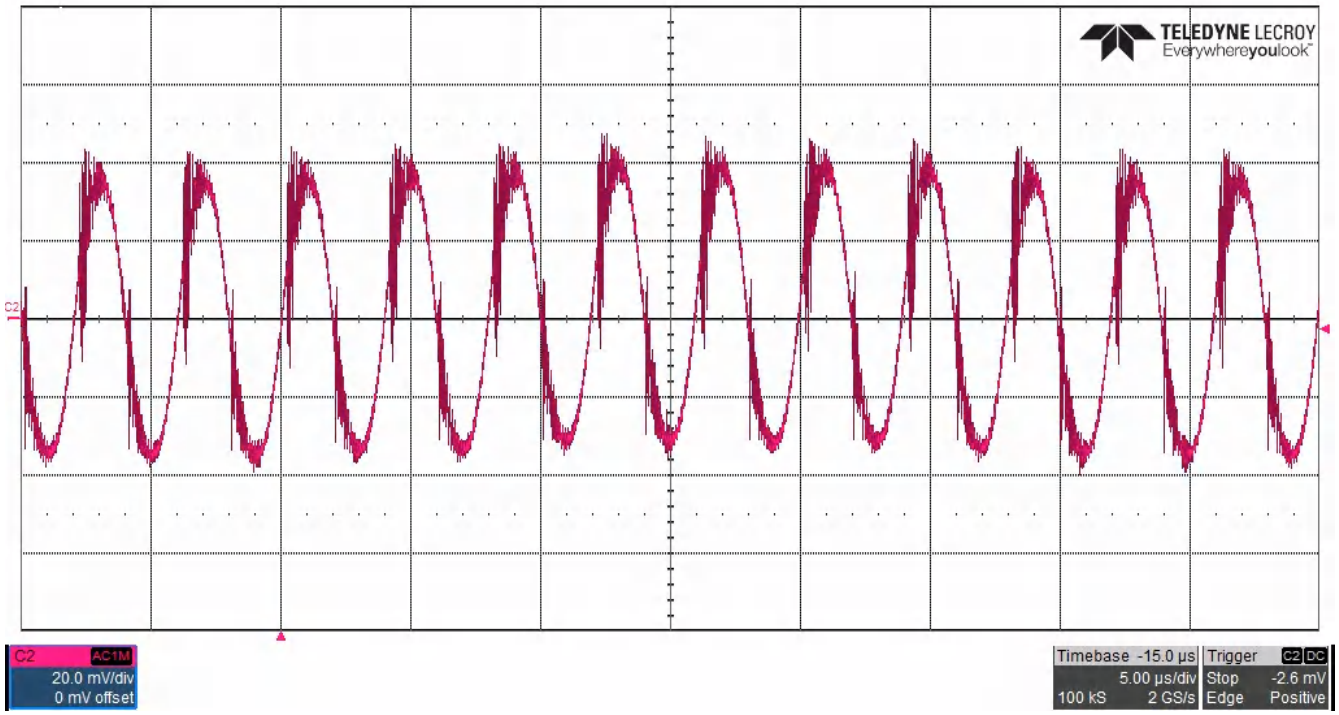


Figure 3-7. Output Voltage Ripple

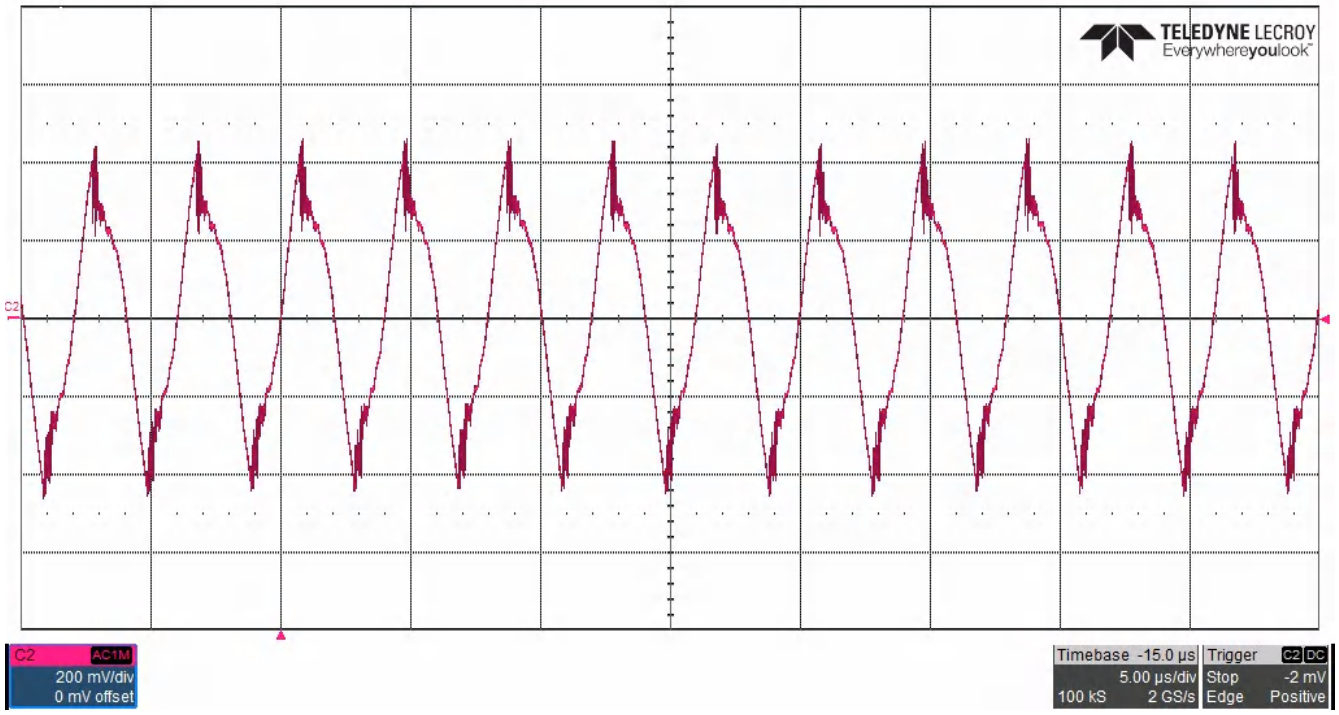


Figure 3-8. DC/DC Converter Input Voltage Ripple

3.3 Load Transients

Load transient response is shown in the following figures.

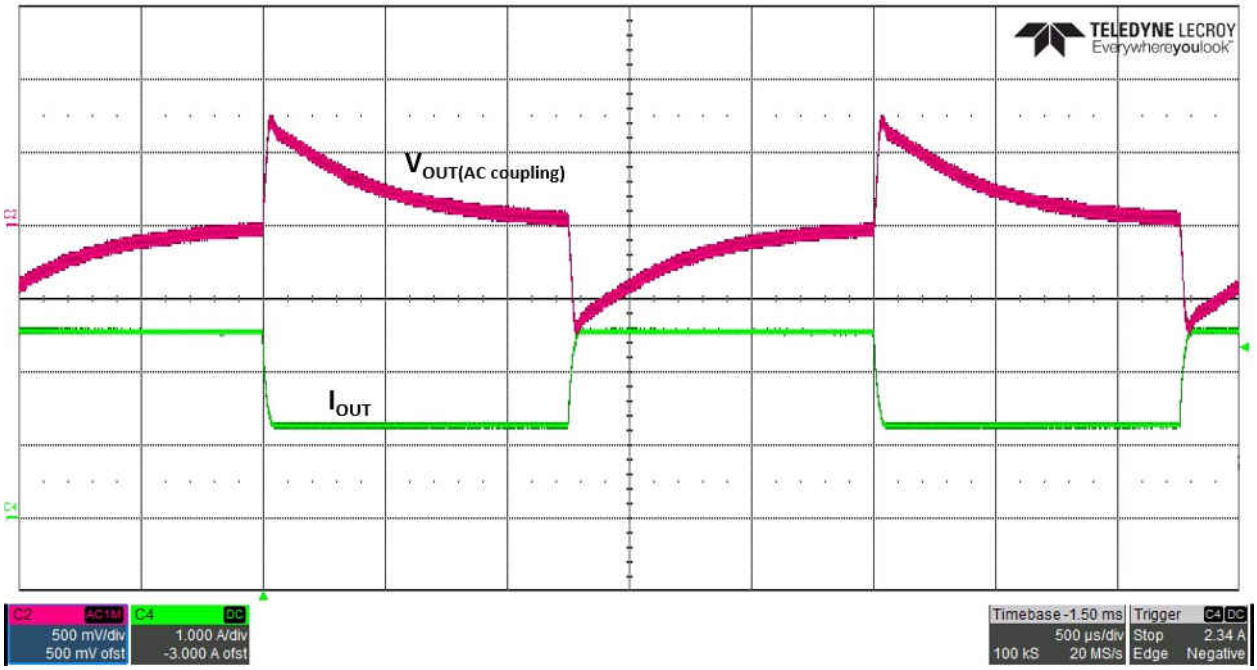


Figure 3-9. Output Load Step Response, 1.25-A to 2.50-A Load Step

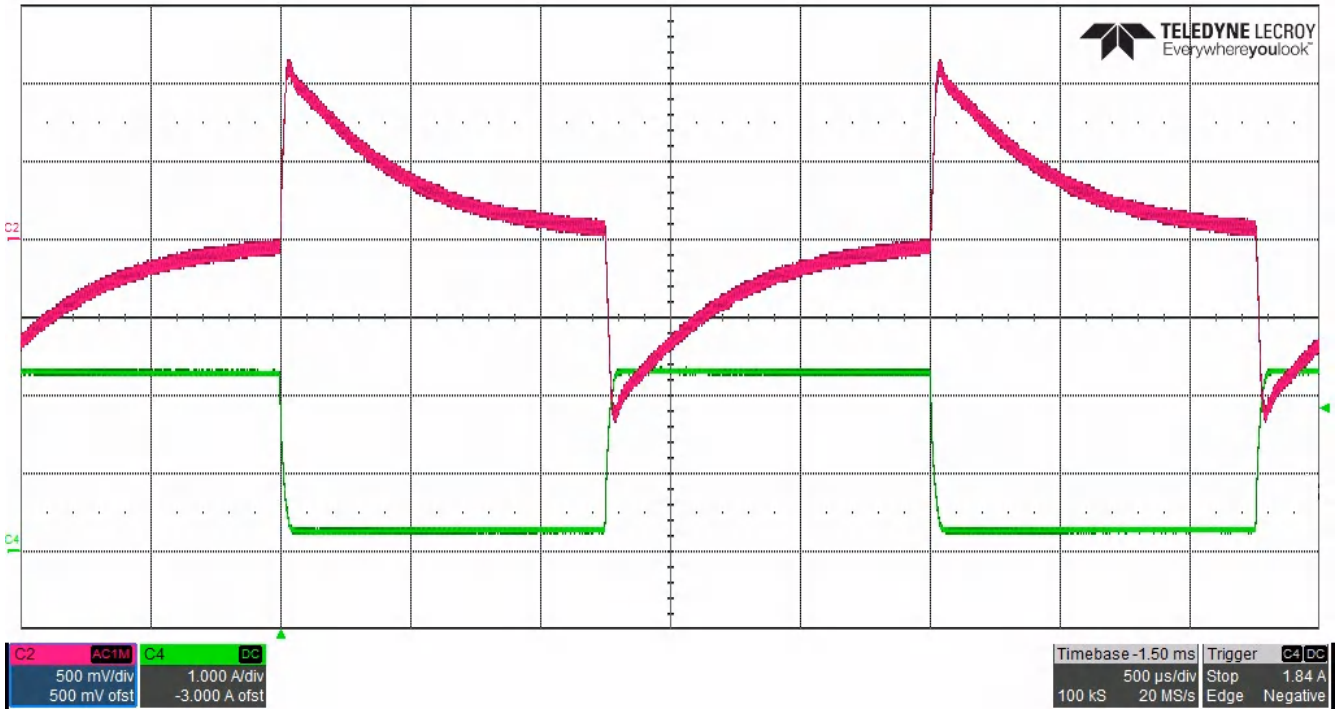


Figure 3-10. Output Load Step Response, 0.25-A to 2.25-A Load Step

3.4 Start-Up Sequence

Start-up behavior is shown in the following figures.

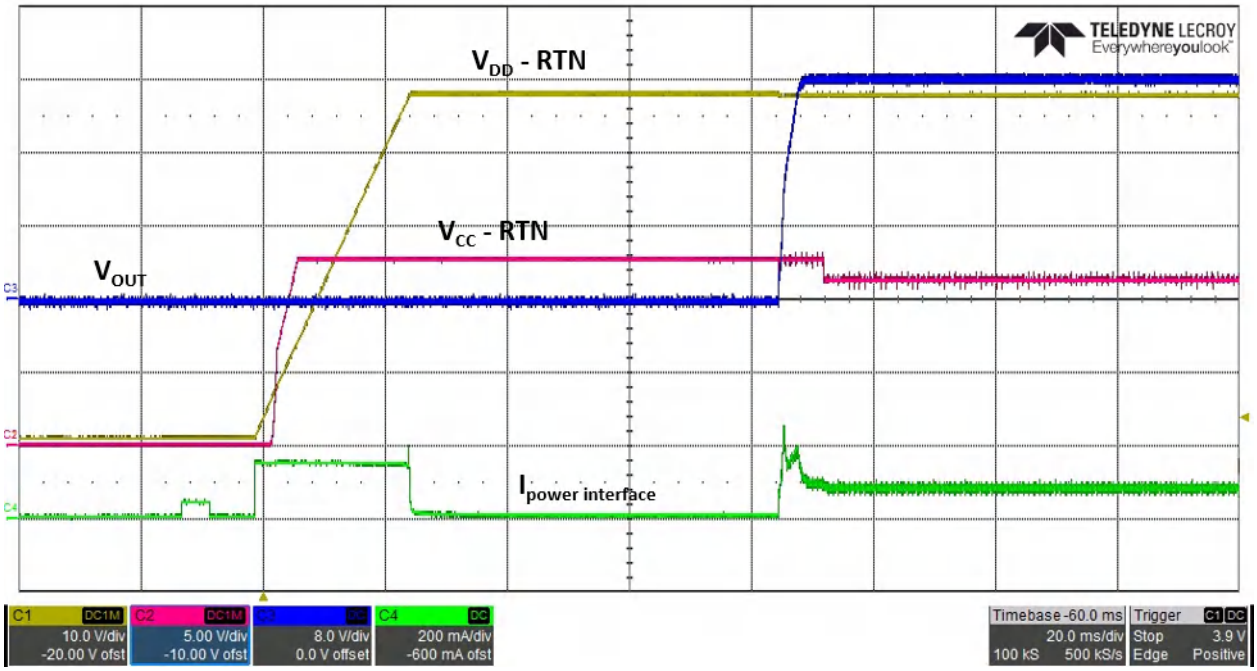


Figure 3-11. 0-A Load

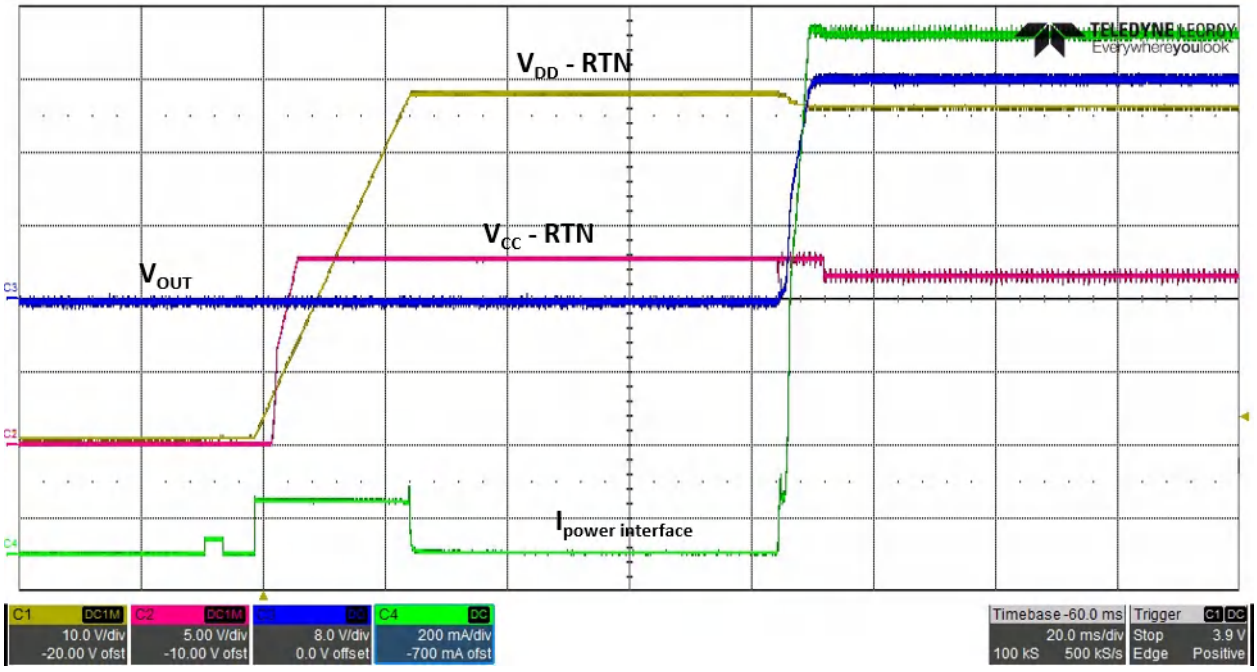


Figure 3-12. 2.5-A Load

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