

Test Report: PMP22301

Class 4 PoE PD (24-V/0.9-A) Power Supply Reference Design



Description

This reference design utilizes a flyback converter for a standard Class 4 Power over Ethernet (PoE) Powered Device (PD) with a 24-V/0.9-A output. The input can be standard PoE or a 24/48-Vdc adapter. A TPS23754 combination PD/PWM controller provides all PoE PD functions such as Detection, Class and In-rush limiting and the flyback PWM controller in one package. This reference design is ideally suited for PoE applications such as audio, signage and IP cameras.

Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements

PARAMETER	SPECIFICATIONS
PoE Input voltage	42.5-57 Vdc
Adapter input voltage	18-57 Vdc
Output voltage	24 Vdc
Output current	0.9 A (PoE), 1.0 A (Adapter)
Switching Frequency	250 kHz

1.2 Required Equipment

- IEEE802.3.bt Type 2 PSE
- Isolated DC power source, 18-57 V, 2.0 A minimum
- CAT5e ethernet cables (<100m)
- 24 V/1.5 A electronic load

1.3 Considerations

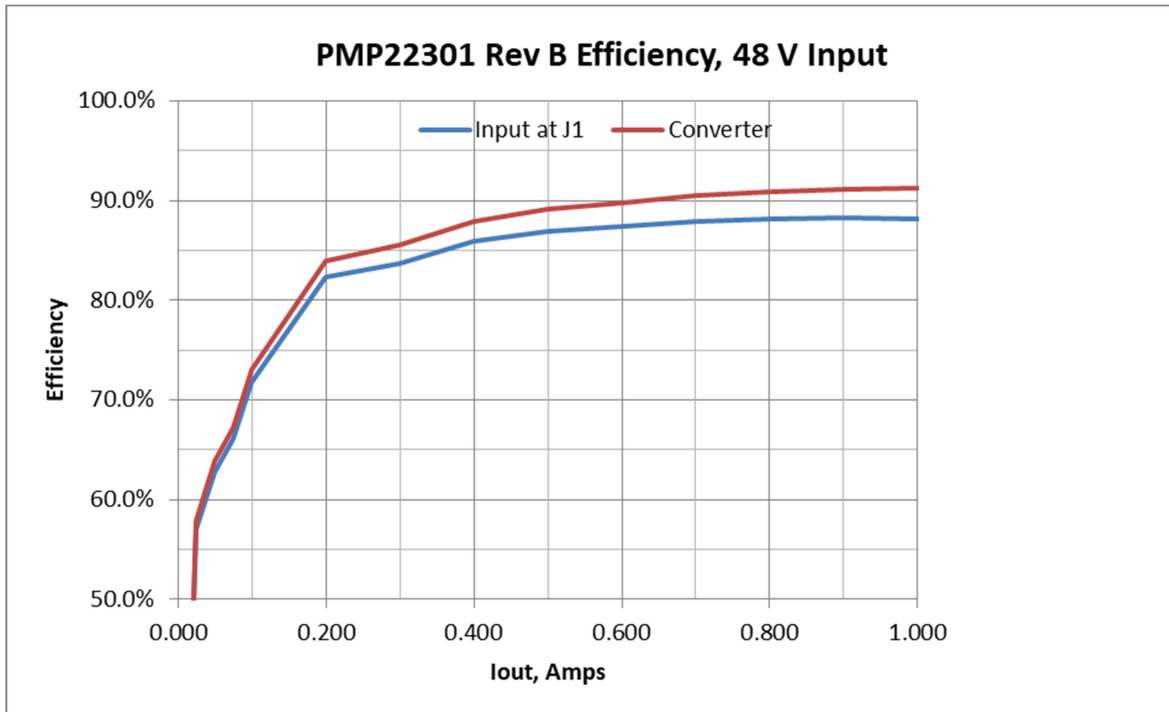
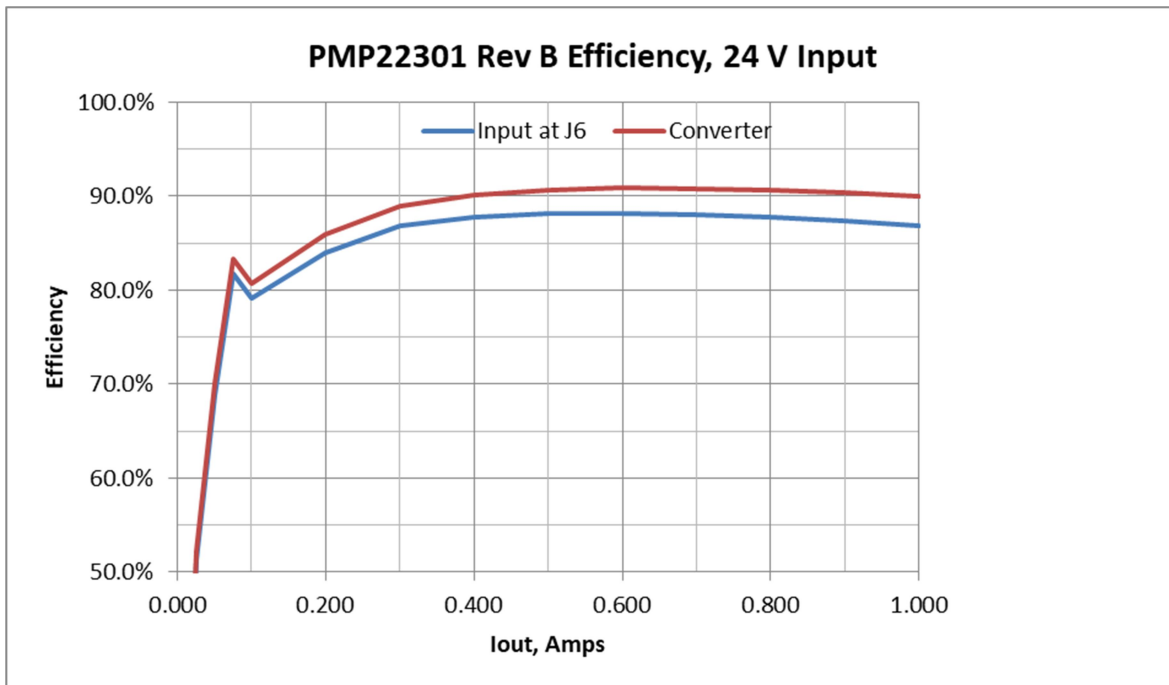
All measurements taken at approximately 25C ambient.



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2 Testing and Results

2.1 Efficiency Graphs



2.2 Efficiency Data

J4	J4	J6	J6	J6	VDD/PGND	CONV
<u>I_{out}</u>	<u>V_{out}</u>	<u>I_{in}</u>	<u>V_{in}</u>	<u>Eff</u>	<u>V_{in}</u>	<u>Eff</u>
0.000	24.12	0.015	24.01	0.0%	23.64	0.0%
0.025	24.12	0.049	24.00	51.3%	23.59	52.2%
0.050	24.12	0.073	24.00	68.8%	23.57	70.1%
0.075	24.11	0.092	24.03	81.8%	23.58	83.4%
0.100	24.11	0.127	24.00	79.1%	23.53	80.7%
0.200	24.11	0.239	24.01	84.0%	23.48	85.9%
0.300	24.11	0.347	24.00	86.9%	23.42	89.0%
0.400	24.11	0.458	24.00	87.7%	23.38	90.1%
0.500	24.11	0.570	24.00	88.1%	23.34	90.6%
0.600	24.11	0.683	24.01	88.2%	23.31	90.9%
0.700	24.11	0.799	24.00	88.0%	23.27	90.8%
0.800	24.11	0.915	24.02	87.8%	23.25	90.7%
0.900	24.11	1.034	24.01	87.4%	23.21	90.4%
1.000	24.11	1.156	24.00	86.9%	23.18	90.0%

J4	J4	J1	J1	J1	VDD/PGND	CONV
<u>I_{out}</u>	<u>V_{out}</u>	<u>I_{in}</u>	<u>V_{in}</u>	<u>Eff</u>	<u>V_{in}</u>	<u>Eff</u>
0.000	24.12	0.015	48.01	0.0%	47.32	0.0%
0.025	24.12	0.022	48.01	57.1%	47.29	58.0%
0.050	24.12	0.040	48.00	62.8%	47.23	63.8%
0.075	24.12	0.057	48.02	66.1%	47.21	67.2%
0.100	24.12	0.070	48.02	71.8%	47.18	73.0%
0.200	24.12	0.122	48.00	82.4%	47.07	84.0%
0.300	24.12	0.180	48.03	83.7%	46.99	85.6%
0.400	24.12	0.234	48.01	85.9%	46.89	87.9%
0.500	24.12	0.289	48.02	86.9%	46.81	89.1%
0.600	24.12	0.345	48.00	87.4%	46.70	89.8%
0.700	24.12	0.400	48.02	87.9%	46.64	90.5%
0.800	24.11	0.456	48.00	88.1%	46.54	90.9%
0.900	24.11	0.512	48.02	88.3%	46.48	91.2%
1.000	24.11	0.570	48.00	88.1%	46.37	91.2%

2.3 Thermal Images

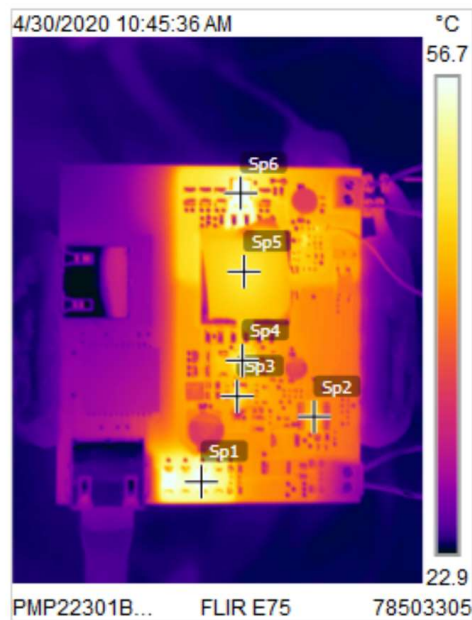
48 V Input, 1 A Load, Top:

Measurements

Sp1	57.1 °C
Sp2	45.1 °C
Sp3	47.6 °C
Sp4	50.4 °C
Sp5	49.0 °C
Sp6	57.5 °C

Parameters

Emissivity	0.94
Refl. temp.	20 °C



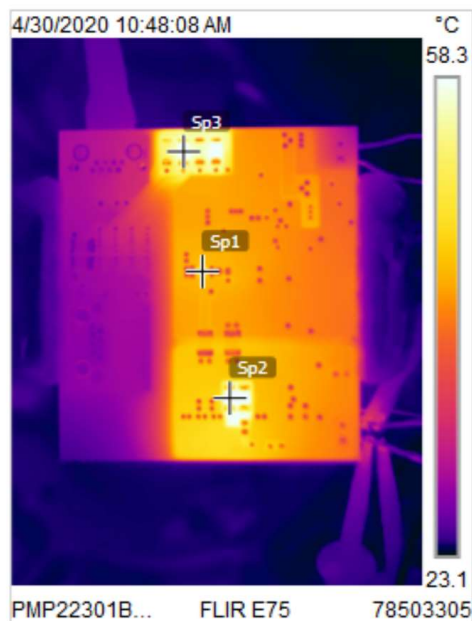
48 V Input, 1 A Load, Bottom:

Measurements

Sp1	47.4 °C
Sp2	64.5 °C
Sp3	58.7 °C

Parameters

Emissivity	0.94
Refl. temp.	20 °C



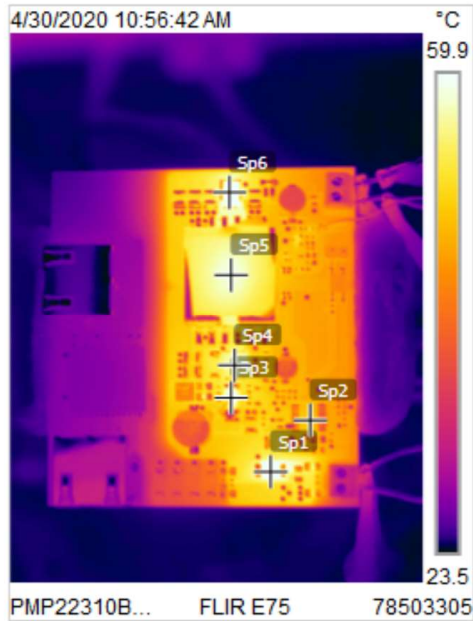
24 V Input, 1 A Load, Top:

Measurements

Sp1	69.4 °C
Sp2	50.2 °C
Sp3	54.6 °C
Sp4	57.6 °C
Sp5	58.7 °C
Sp6	60.8 °C

Parameters

Emissivity	0.94
Refl. temp.	20 °C



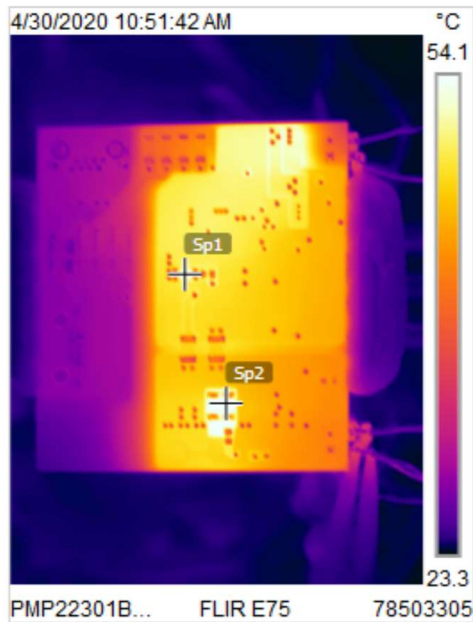
24 V Input, 1 A Load, Bottom:

Measurements

Sp1	52.2 °C
Sp2	57.2 °C

Parameters

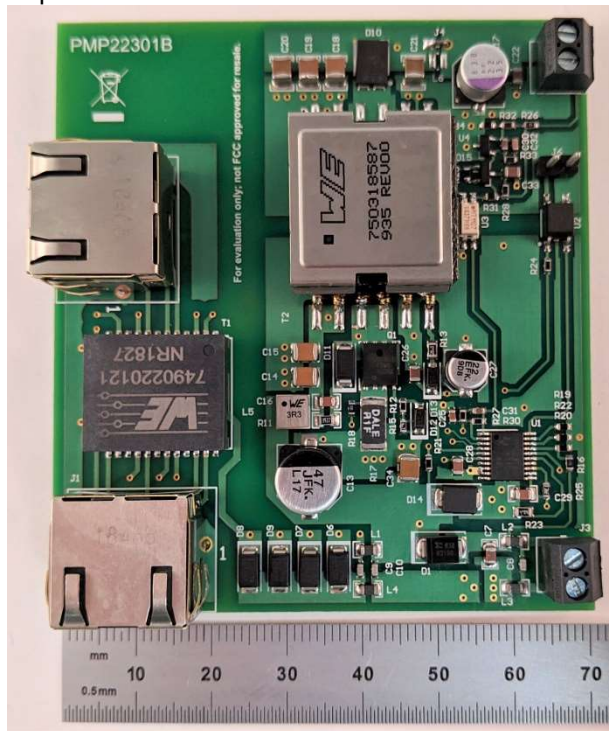
Emissivity	0.94
Refl. temp.	20 °C



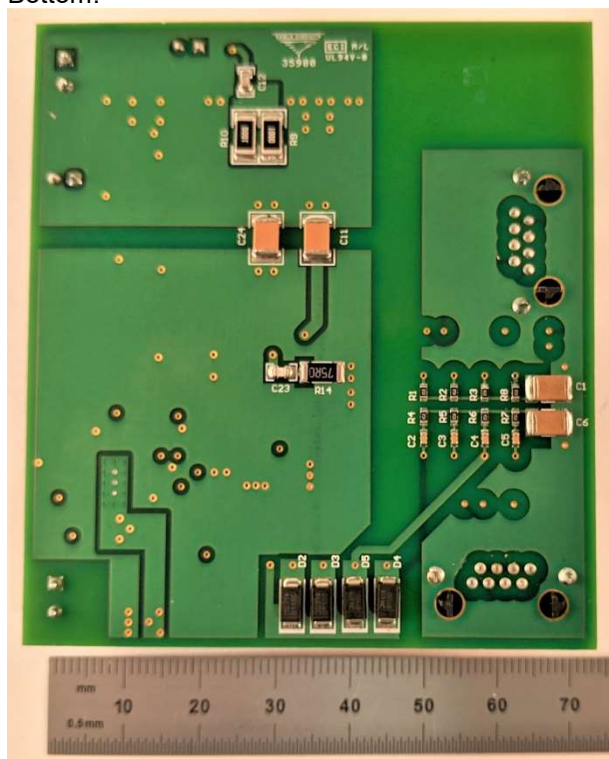
2.4 Photo

The board measures 71 mm x 78 mm.

Top:



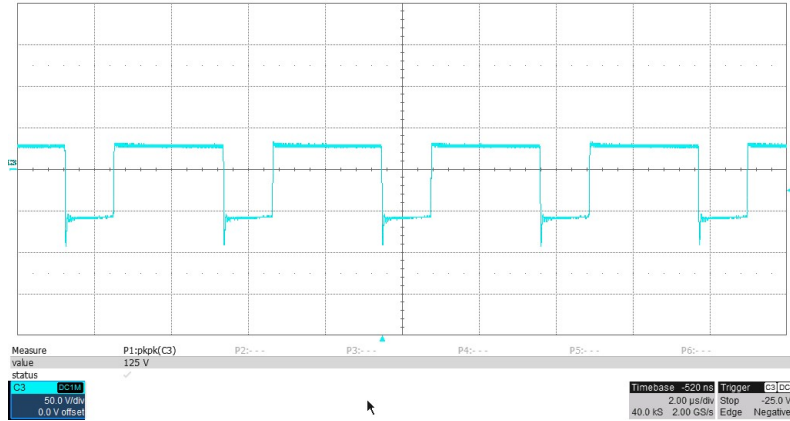
Bottom:



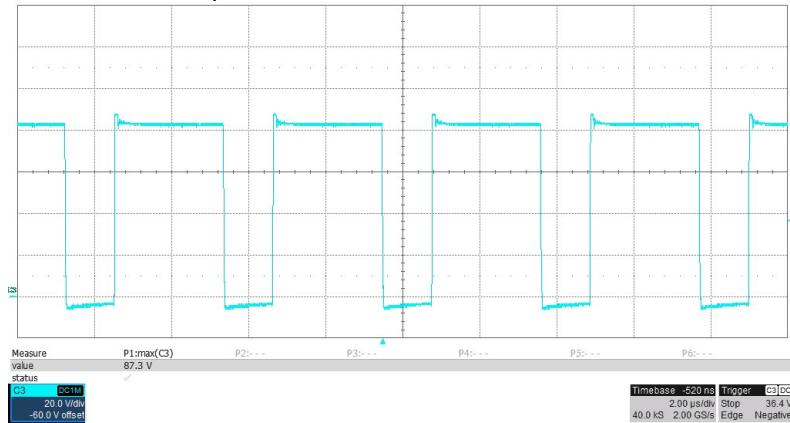
3 Waveforms

3.1 Switching

VAK, D10, 57 V input, 1 A load, 50 V/div, 2 usec/div, measured 125.0 Vpeak:

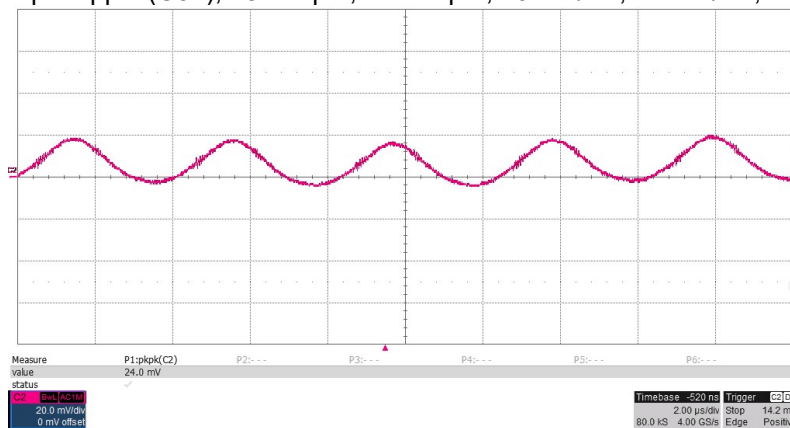


VDS, Q2, 57 V input, 1 A load, 20 V/div, 2 usec/div, measured 87.3 Vpeak:

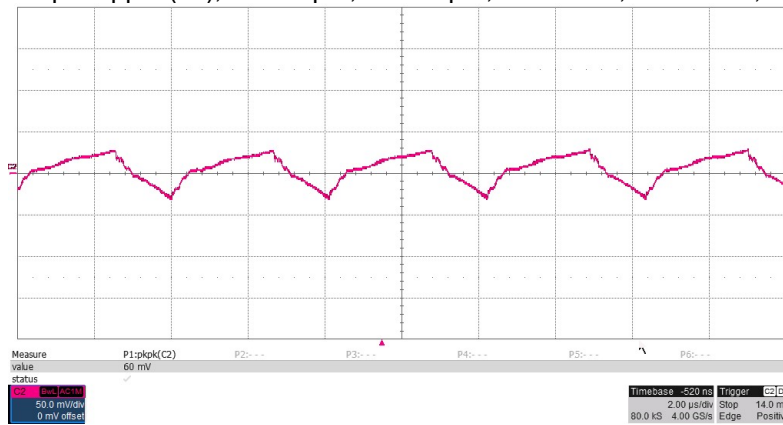


3.2 Ripple and Noise

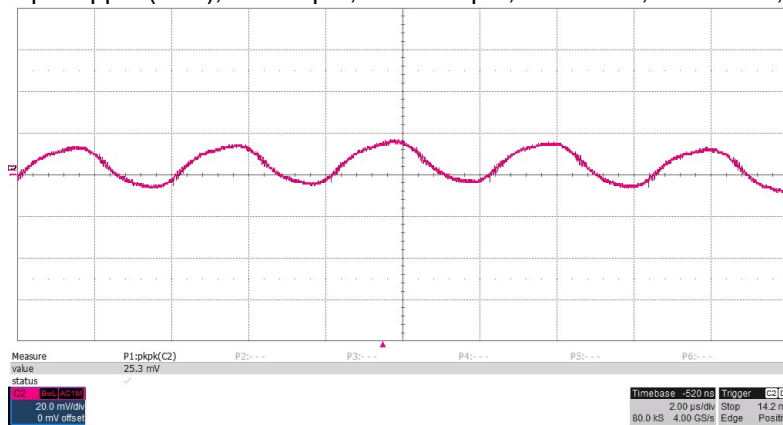
Input ripple (C34), 48 V input, 1 A output, 20 mV/div, 2 usec/div, measured 24.0 mVpp:



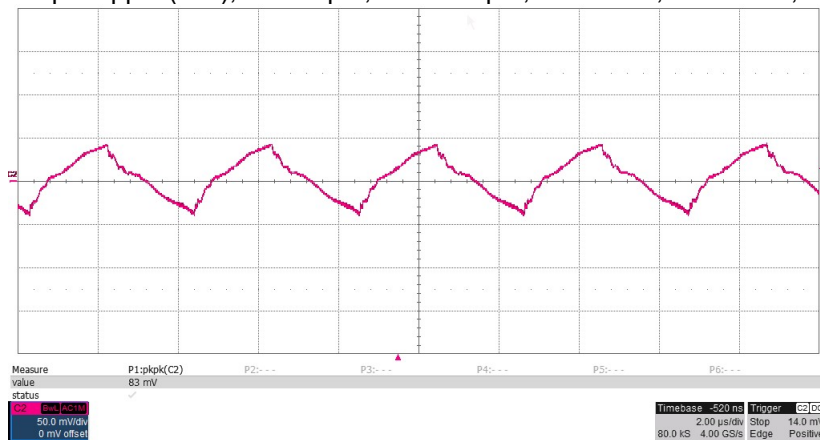
Output ripple (J5), 48 V input, 1 A output, 50 mV/div, 2 usec/div, measured 60.0 mVpp:



Input ripple (C34), 24 V input, 1.0 A output, 20 mV/div, 2 usec/div, measured 25.3 mVpp:

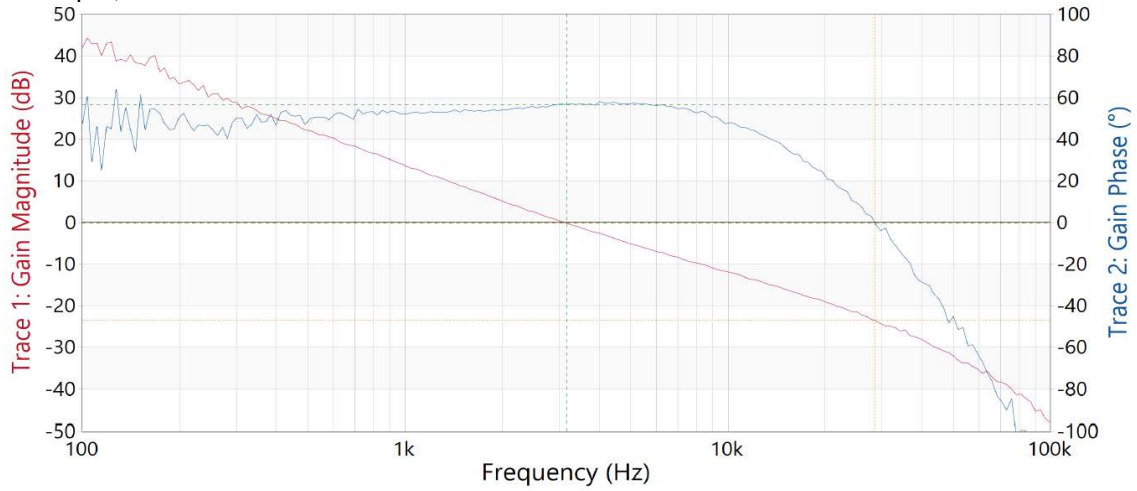


Output ripple (J52), 24 V input, 1.0 A output, 50 mV/div, 2 usec/div, measured 83.0 mVpp:



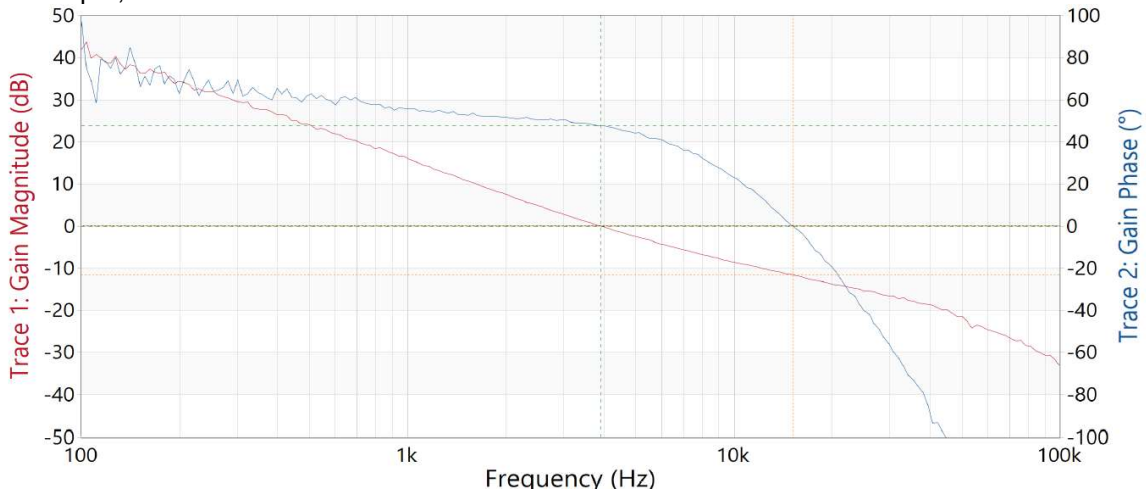
3.3 Bode Plot

24 V Input, 0.1 A Load:



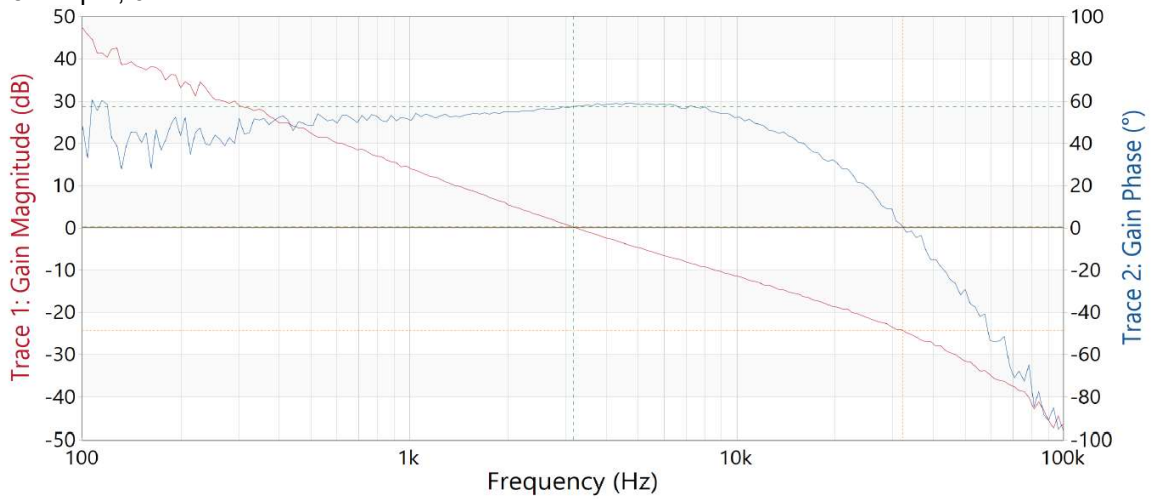
Bandwidth = 3.1 kHz Phase Margin = 56.7 degrees Gain Margin = 23.4 dB

24 V Input, 1 A Load:



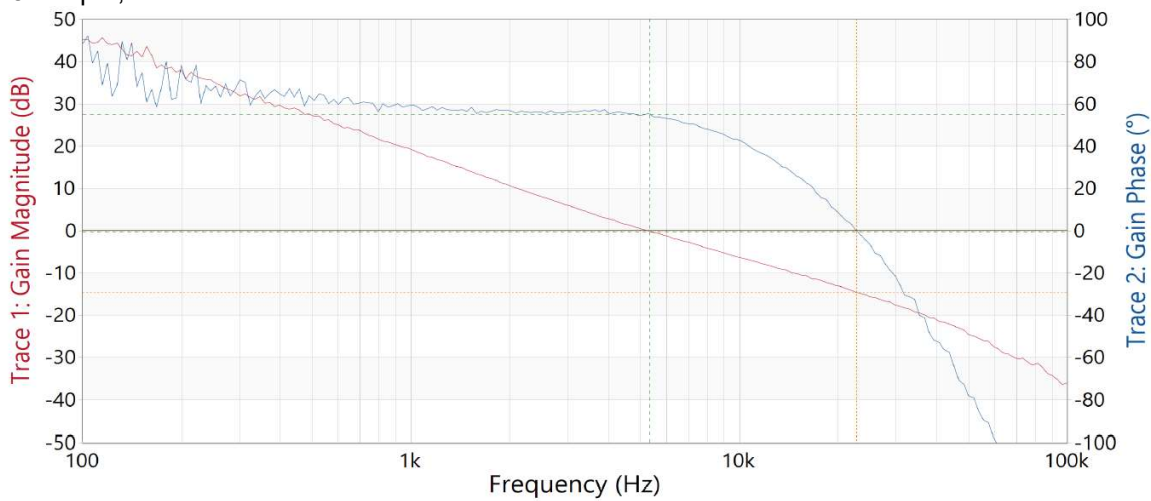
Bandwidth = 3.9 kHz Phase Margin = 47.6 degrees Gain Margin = 11.5 dB

48 V Input, 0.1 A Load:



Bandwidth = 3.1 kHz Phase Margin = 57.4 degrees Gain Margin = 24.3 dB

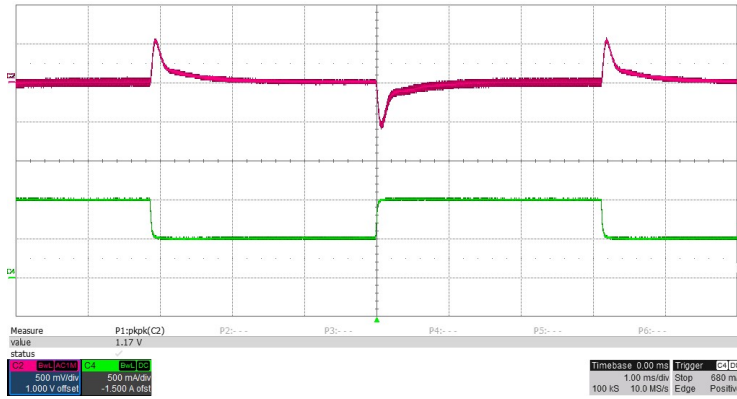
48 V Input, 1 A Load:



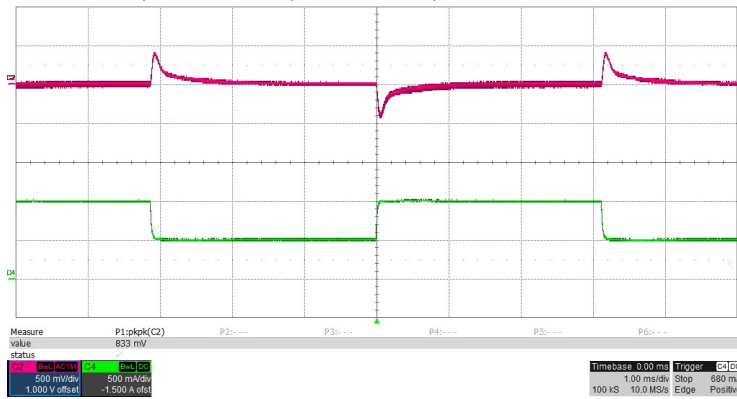
Bandwidth = 5.3 kHz Phase Margin = 55.0 degrees Gain Margin = 14.5 dB

3.4 Load Transients

Output load step response, 24 V input, 0.5 A to 1.0 A load step
 500 mV/div, 500 mA/div, 1 msec/div, slew rate = 250 mA/usec, measured 1.17 Vpp:

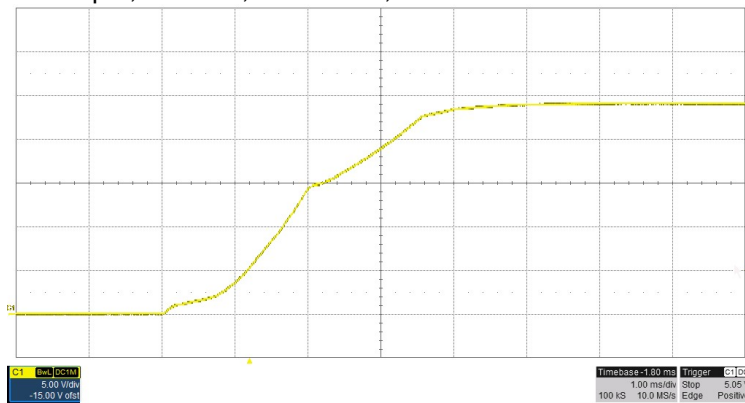


Output load step response, 48 V input, 0.5 A to 1.0 A load step
 500 mV/div, 500 mA/div, 1 msec/div, slew rate = 250 mA/usec, measured 833 mVpp:

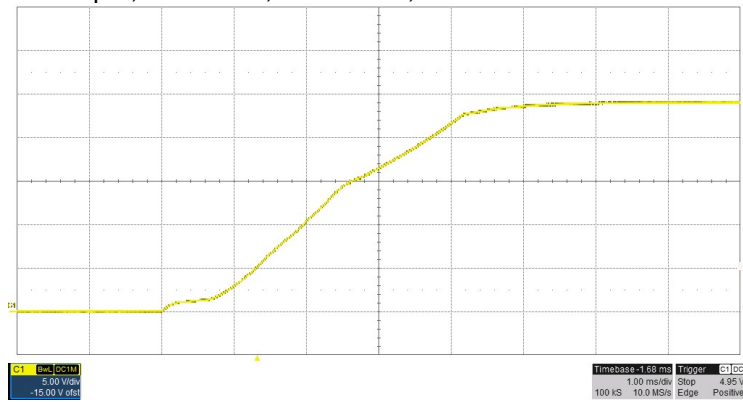


3.5 Start-up

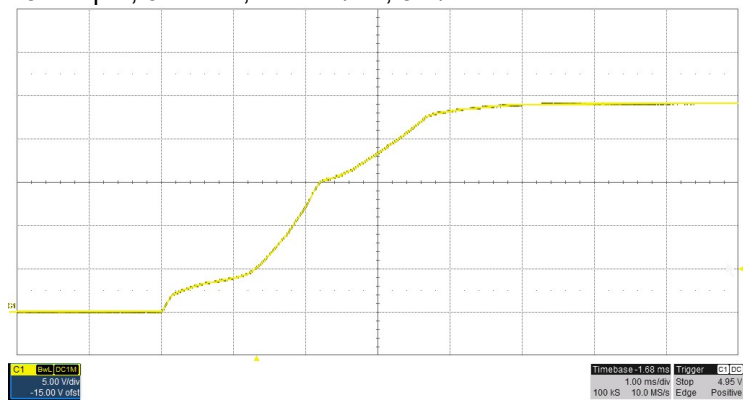
24 V Input, 0 A load, 1 msec/div, 5 V/div:



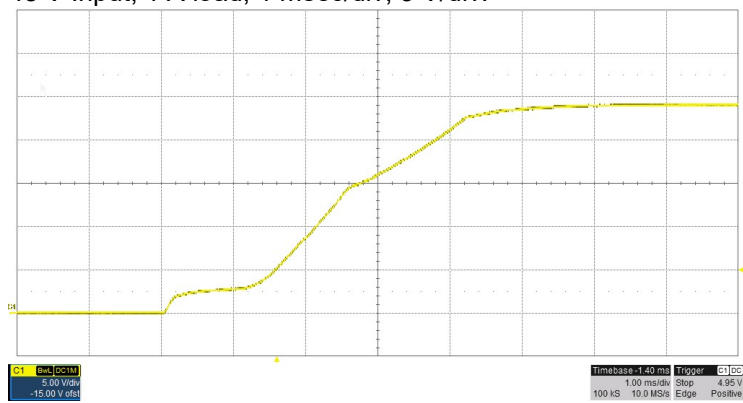
24 V Input, 1.0 A load, 1 msec/div, 5 V/div:



48 V Input, 0 A load, 1 msec/div, 5 V/div:



48 V Input, 1 A load, 1 msec/div, 5 V/div:



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