Test Report: PMP31263

Dual-Phase Boost Converter Reference Design for Class-H Audio Applications

Description

This reference design features a dual-phase automotive boost converter for Class-H audio applications offering analog or digital output voltage tracking. The peak output power of over 800W can be achieved at 11V input voltage.

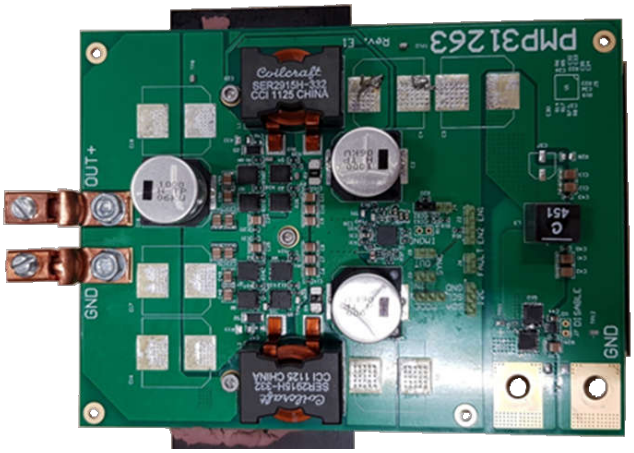
This test report is based on the LM5125-Q1, which is configured using external resistors. The pin-compatible LM51251-Q1 variant offering I²C for diagnostic and control can also be used on this design.

Features

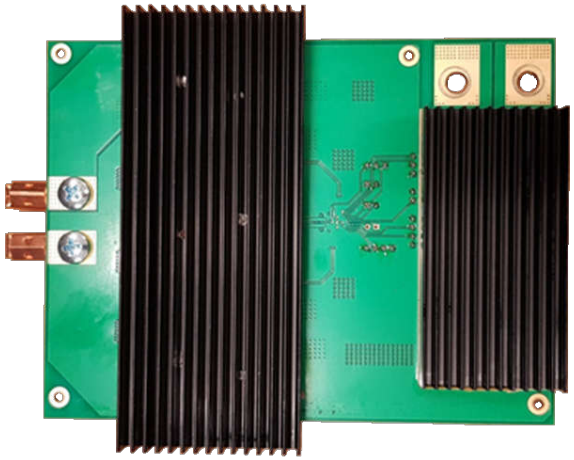
- Digital and analog voltage tracking
- With I²C control (IC-variant dependent)
- High efficiency and high peak output power

Applications

- Premium audio



Top of Board



Bottom of Board

1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1-1. Voltage and Current Requirements

Parameter	Specifications
Input Voltage	9V to 18V, 36V peak, full output power at ≥ 11V
V_{OUT} LM5125-Q1	40.8V at 25A peak
Switching Frequency	300kHz

1.2 Considerations

- Unless otherwise noted, the input voltage was set to 10V at the input of the boost converter (after the input filter)
- The voltage drop from the input terminal to the voltage sense point was about 405mV at 109A input current (1kW output power)
- Electrolytic input capacitance 2mF, electrolytic output capacitance 1mF
- Heat sinks are mounted to the bottom side and artificial airflow was provided during testing. No other components are mounted on the bottom side.
- Peak output power (1kW) was tested at 10V input voltage measured directly at the input of the converter. Converter efficiency at 25A was about 92.5%

1.3 Dimensions

The four-layer board is fabricated with 2oz copper on all layers. The size is 148.5mm × 111mm.

2 Testing and Results

2.1 Efficiency Graph

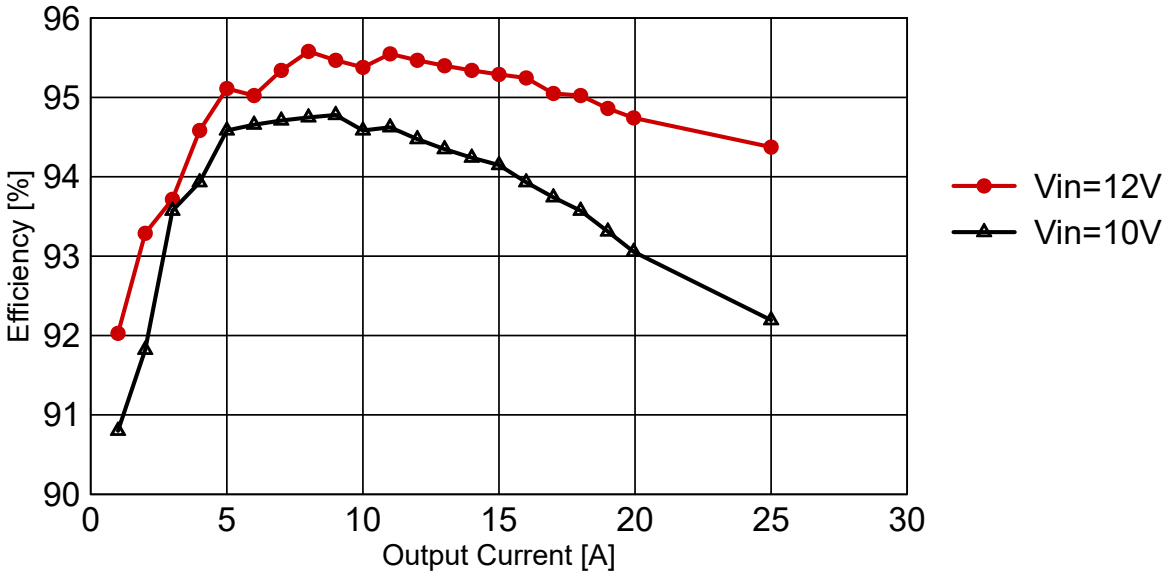


Figure 2-1. Efficiency Graph

2.2 Efficiency Data

2.2.1 10V Input Voltage

Table 2-1 shows the efficiency data at 10V.

Table 2-1. 10V Input Voltage

V_{IN}	I_{IN}	P_{IN}	V_{OUT}	I_{OUT}	P_{OUT}	Efficiency
12	3.7	44.4	40.86	1	40.86	92.0%
12	7.3	87.6	40.86	2	81.72	93.3%
12	10.9	130.8	40.86	3	122.58	93.7%
12	14.4	172.8	40.86	4	163.44	94.6%
12	17.9	214.8	40.86	5	204.3	95.1%
12	21.5	258	40.86	6	245.16	95.0%
12	25	300	40.86	7	286.02	95.3%
12	28.5	342	40.86	8	326.88	95.6%
12	32.1	385.2	40.86	9	367.74	95.5%
12	35.7	428.4	40.86	10	408.6	95.4%
12	39.2	470.4	40.86	11	449.46	95.5%
12	42.8	513.6	40.86	12	490.32	95.5%
12	46.4	556.8	40.86	13	531.18	95.4%
12	50	600	40.86	14	572.04	95.3%
12	53.6	643.2	40.86	15	612.9	95.3%
12	57.2	686.4	40.86	16	653.76	95.2%
12	60.9	730.8	40.86	17	694.62	95.0%
12	64.5	774	40.86	18	735.48	95.0%
12	68.2	818.4	40.86	19	776.34	94.9%
12	71.7	860.4	40.86	19.95	815.157	94.7%
12	90.2	1082.4	40.86	25	1021.5	94.4%

2.2.2 12V Input Voltage

Table 2-2 shows the efficiency data at 12V.

Table 2-2. 12V Input Voltage

V_{IN}	I_{IN}	P_{IN}	V_{OUT}	I_{OUT}	P_{OUT}	Efficiency
10	4.5	45	40.86	1	40.86	90.8%
10	8.9	89	40.86	2	81.72	91.8%
10	13.1	131	40.86	3	122.58	93.6%
10	17.4	174	40.86	4	163.44	93.9%
10	21.6	216	40.86	5	204.3	94.6%
10	25.9	259	40.86	6	245.16	94.7%
10	30.2	302	40.86	7	286.02	94.7%
10	34.5	345	40.86	8	326.88	94.7%
10	38.8	388	40.86	9	367.74	94.8%
10	43.2	432	40.86	10	408.6	94.6%
10	47.5	475	40.86	11	449.46	94.6%
10	51.9	519	40.86	12	490.32	94.5%
10	56.3	563	40.86	13	531.18	94.3%
10	60.7	607	40.86	14	572.04	94.2%
10	65.1	651	40.86	15	612.9	94.1%
10	69.6	696	40.86	16	653.76	93.9%
10	74.1	741	40.86	17	694.62	93.7%
10	78.6	786	40.86	18	735.48	93.6%
10	83.2	832	40.86	19	776.34	93.3%
10	87.6	876	40.86	19.95	815.157	93.1%
10	110.8	1108	40.86	25	1021.5	92.2%

2.3 Thermal Images

The thermal picture in Figure 2-2 was taken at 12V V_{IN}, 10A output current, after 10 minutes without artificial air flow, and with the board lying flat on the table. The ambient temperature is 25 degrees Celsius. The board photos show the mounted heat sinks.

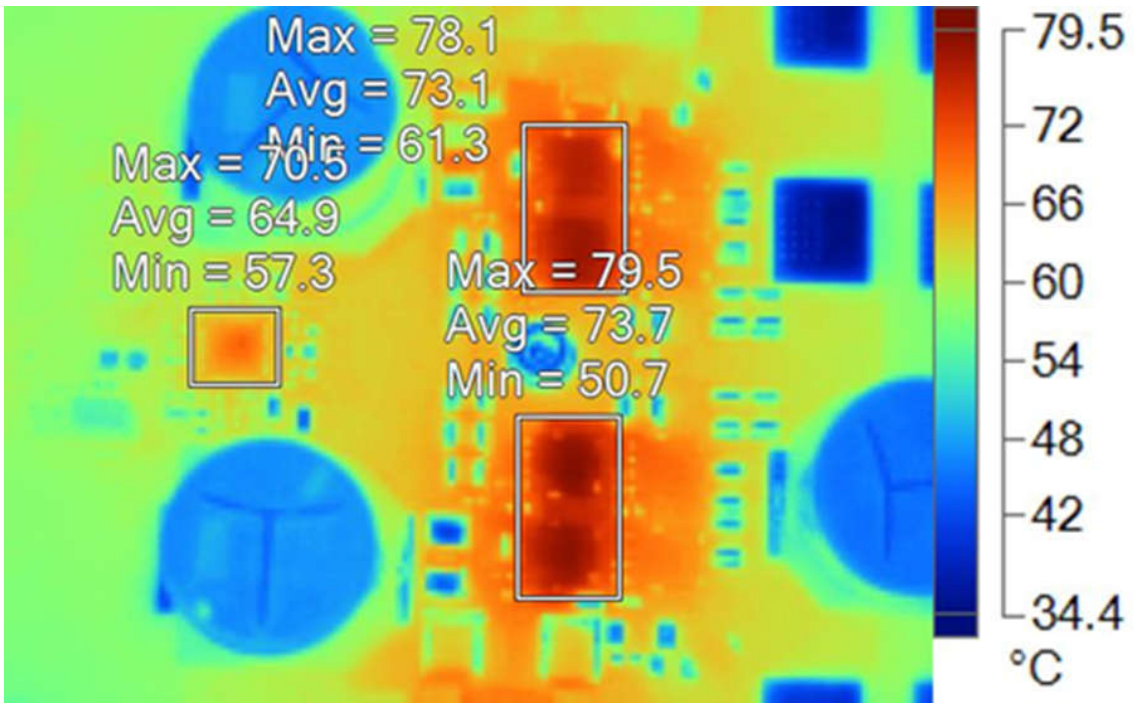
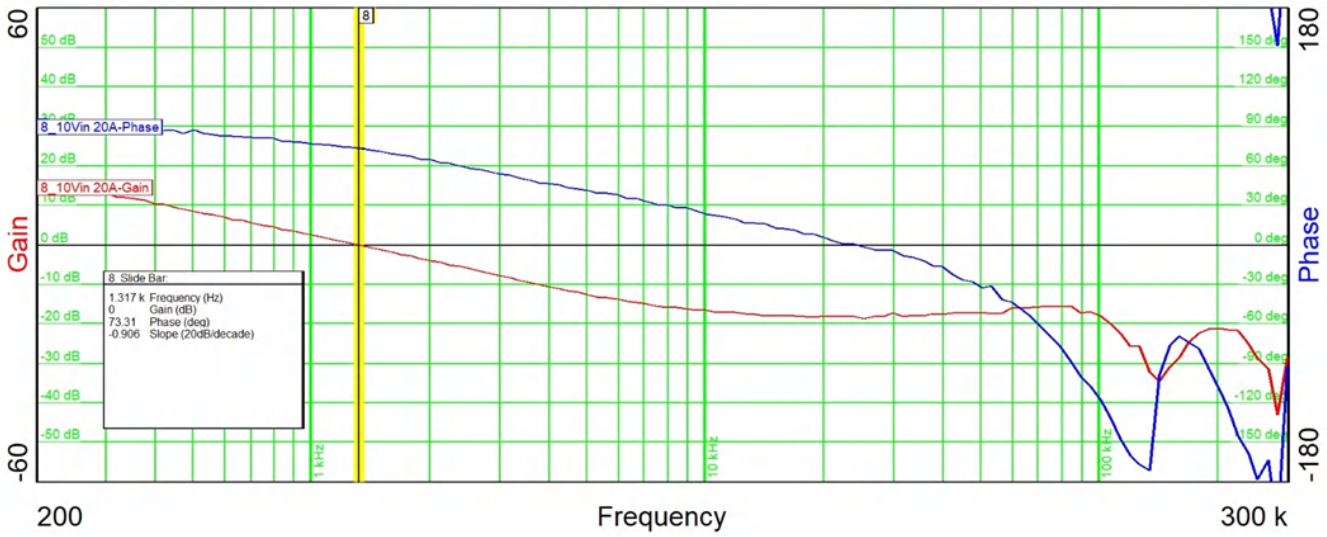


Figure 2-2. Thermal Image

2.4 Bode Plots



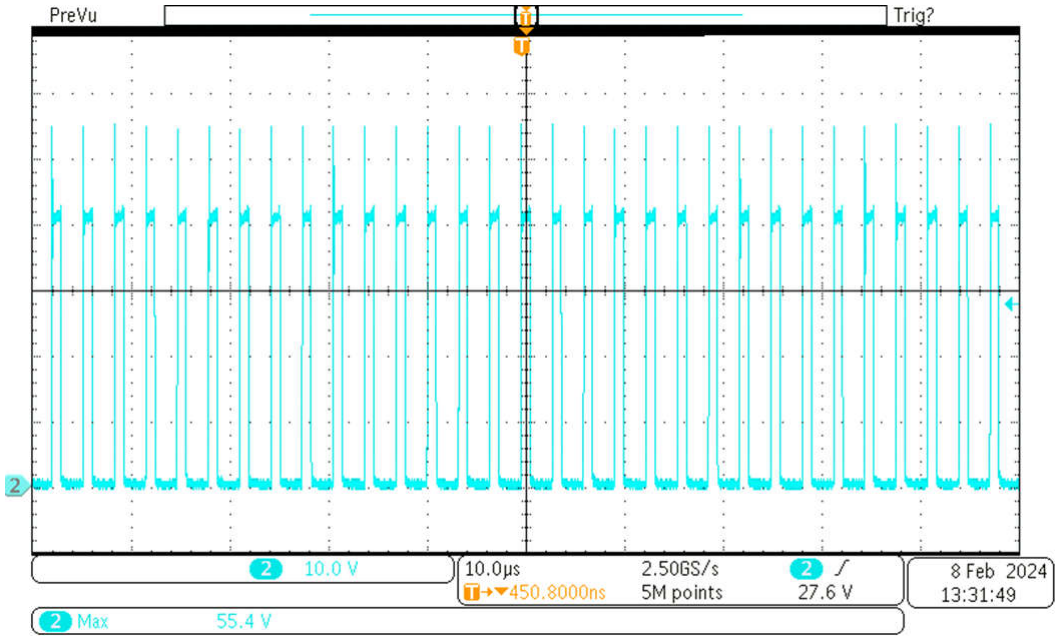
- Crossover frequency 1.3kHz
- Phase margin 73°
- Gain margin 18dB

Figure 2-3. Bode Plot : 10V_{IN}, 20A_{OUT}

3 Waveforms

Unless otherwise noted, the following tests were done with 10V input voltage at 20A output current.

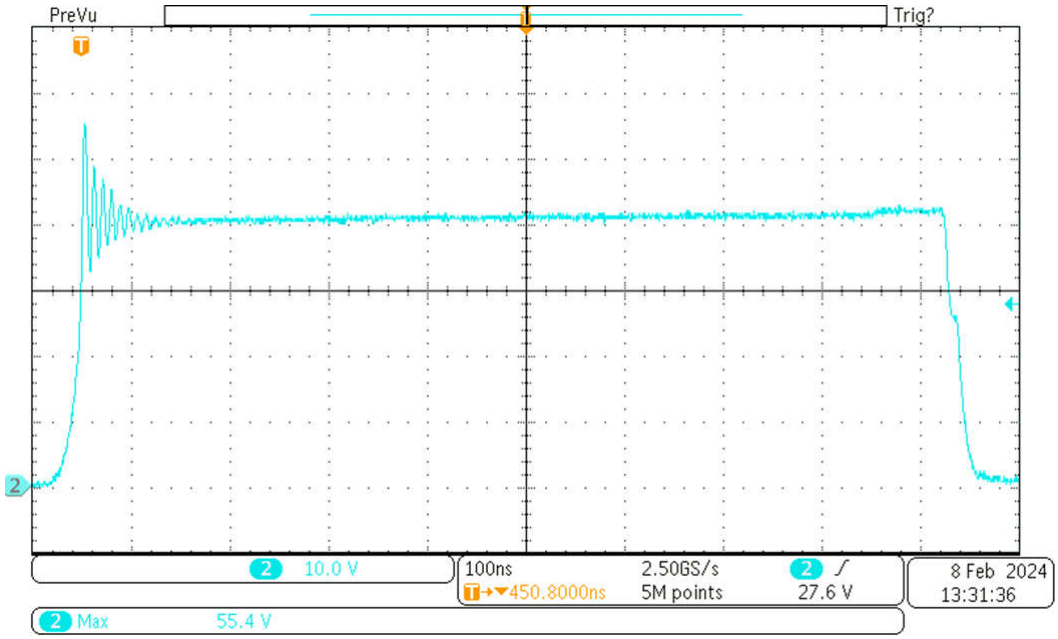
3.1 Switching



- CH2: DC-coupled switch node voltage [scale: 10V/div, 10µs/div, 500MHz bandwidth]
- Output current: 20A

Figure 3-1. Switching Waveform (10µs/div)

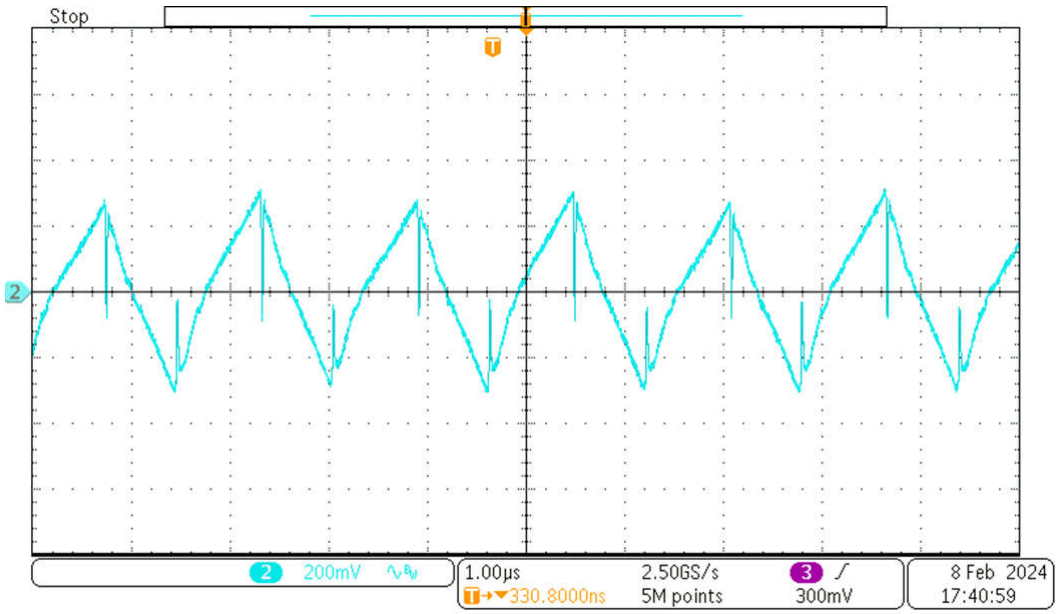
The waveform in Figure 3-2 is captured with the same settings as in Figure 3-1 only the time base is different.



- CH2: DC-coupled switch node voltage [scale: 10V/div, 100ns/div, 500MHz bandwidth]
- Output current: 20A

Figure 3-2. Switching Waveform (100ns/div)

3.2 Output Voltage Ripple

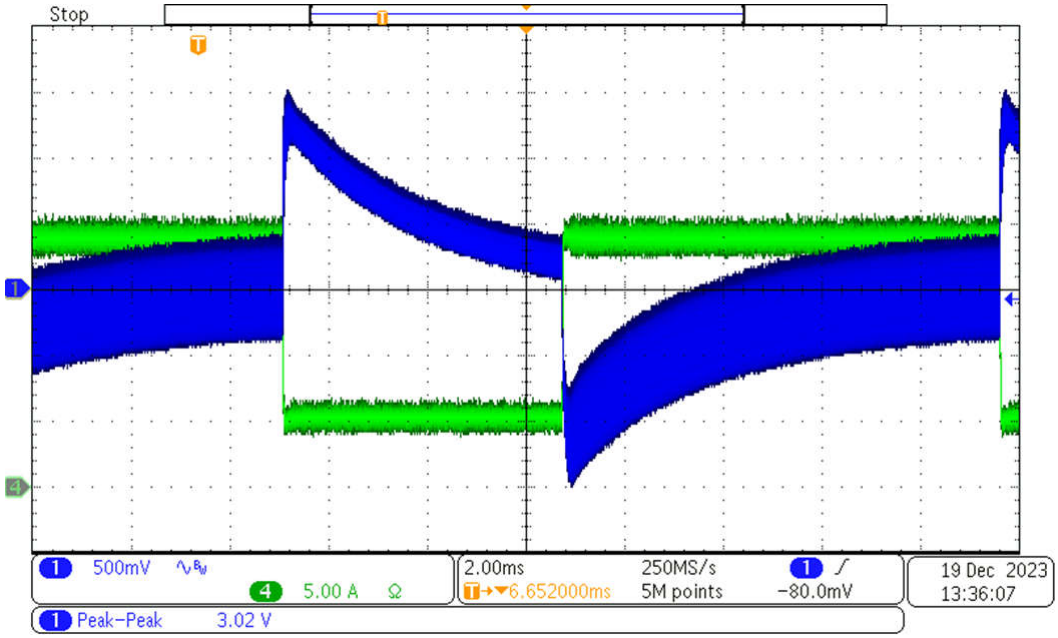


- CH2: AC-coupled output voltage [scale: 200mV/div, 1µs/div, 20MHz bandwidth]

Figure 3-3. Output Voltage Ripple

3.3 Load Transients

Load step response from 5A to 20A to 5A results in a V_{OUT} deviation of $3.02V_{PP}$.



- CH1: AC-coupled output voltage [scale: 500mV/div, 2ms/div, 20MHz bandwidth]
- CH4: Output current [scale: 5A/div, 2ms/div]

Figure 3-4. Load Step Response

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