Starts at 11AM PDT 8PM CEST Europe 2AM China CST 3AM Japan JST

No Compromise Needed: Cost-Effective, 2-Layer PCBs Deliver Impressive EMI and Thermal Performance

March 2021

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All attendees are muted. Live QA available via chat.

Agenda

- Motivation
- 4-Layer PCB vs. 2-Layer PCB
- MPQ4323 – Compact, Low I_Q, 36V/3A, Sync Buck
- MPQ4323 – Recommended Schematic
- MPQ4323 – Recommended Layout
- MPQ4323 – Recommended Placement
- MPQ4323 – Recommended DC/DC Layout
- MPQ4323 – Recommended Bottom Layer Layout
- MPQ4323 – Recommended Filter Layout
- MPQ4323 – Thermal Effect of Different Layouts
- MPS's MPQ4323 vs. Competitors
- EMC Results from Recommended Layout
- Conclusions

Motivation

Increasing cost pressure has led to the reintroduction of 2-layer PCB designs, which are a cost-effective alternative to 4-layer PCB ECUs.

Strict EMC limits are difficult to meet in a 4-layer PCB, and are even more difficult to meet in a 2-layer PCB.

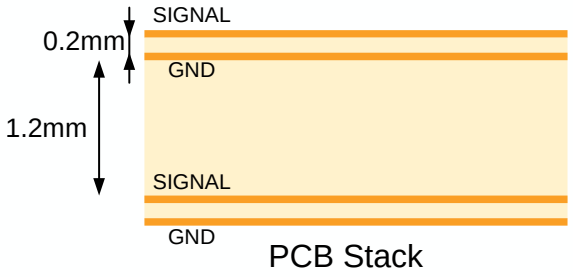
Operating $T_{AMBIENT}$ requirements have reached >100°C.

MPS conducted an experiment to determine the best 2-layer PCB layout for buck converters featuring the MPQ4323.

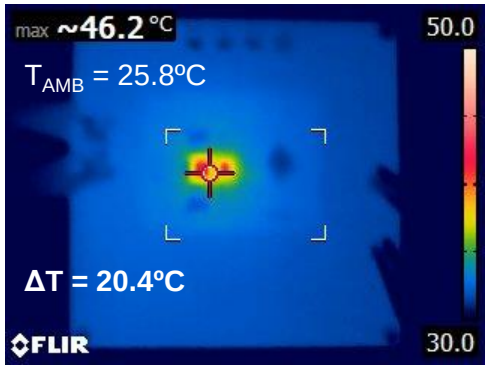
PCB Panel with 9 Different Layouts

4-Layer PCB vs. 2-Layer PCB

4-Layer

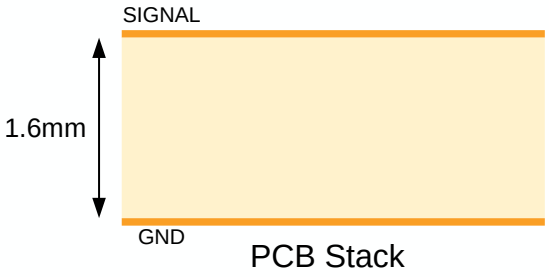


PCB Stack

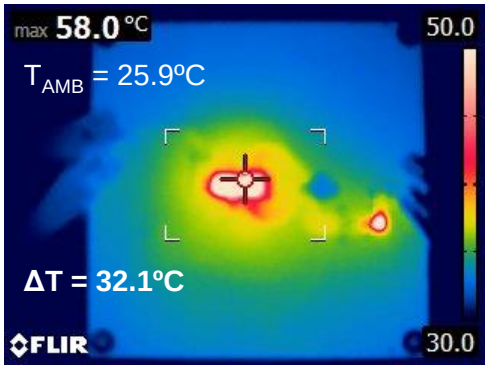


PCB Thermal Image*

2-Layer



PCB Stack



PCB Thermal Image*

The return path is 8 times longer in a 2-layer PCB.

The IC case temperature is 12°C higher with 2-layer PCBs.

*Conditions: V_{IN} = 13.5V, V_{OUT} = 5V, I_{OUT} = 3A, f_{SW} = 430kHz, 2-hour runtime.

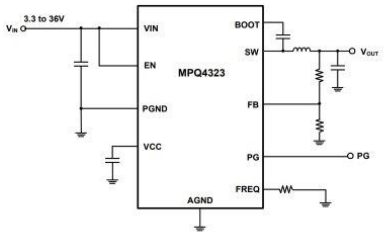
MPQ4323 – Compact, Low I_Q, 36V/3A, Sync Buck

Features:

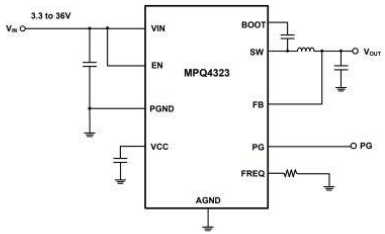
- Wide 3.3V to 36V Operating Voltage Range
- Supports 42V Load Dump, Cold Crank as Low as 3V
- **MPQ432x: Family of Pin-to-Pin Parts Covers 0.5A to 4A Applications**
- **20µA Input Current under No-Load Conditions**
- **Up to 96% Peak Efficiency**
- 350kHz to 2.5MHz Configurable Switching Frequency
- Adjustable Output Voltage
- Fixed-Output Versions: 1V, 1.1V, 1.8V, 2.5V, 3.0V, 3.3V, 3.8V, or 5V
- **Frequency Spread Spectrum for Low EMI**
- **Symmetric V_{IN} for Low EMI**
- Accurate Power Good/RESET Monitors for Over-Voltage and Under-Voltage Conditions
- AAM or Forced CCM Versions
- **250mV Low-Dropout at 2A**
- Available in a Compact QFN (2mmx3mm) Package with Wettable Flanks

Applications:

- Automotive Infotainment, Clusters
- Advanced Driver Assistance Systems (ADAS)
- Industrial Power Systems



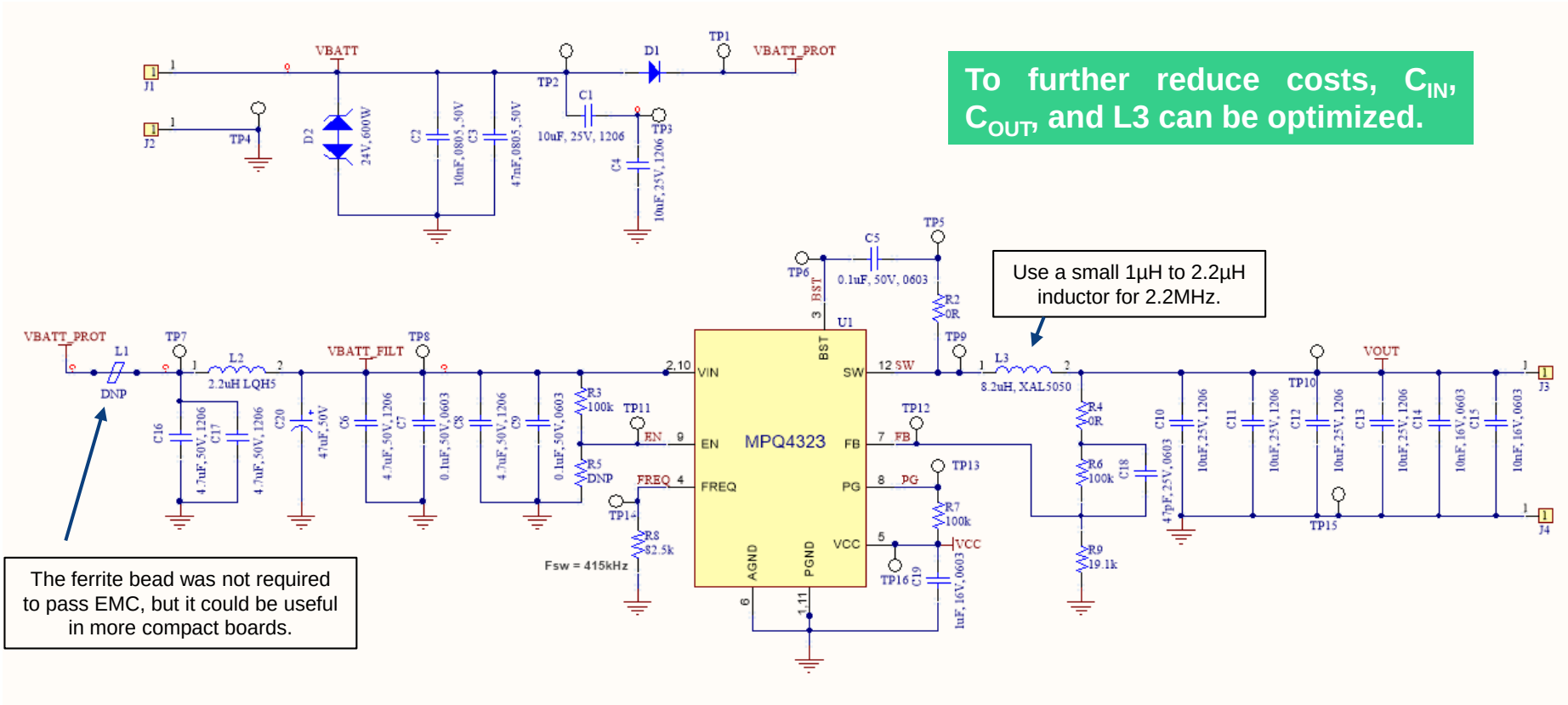
Output Adjustable Version



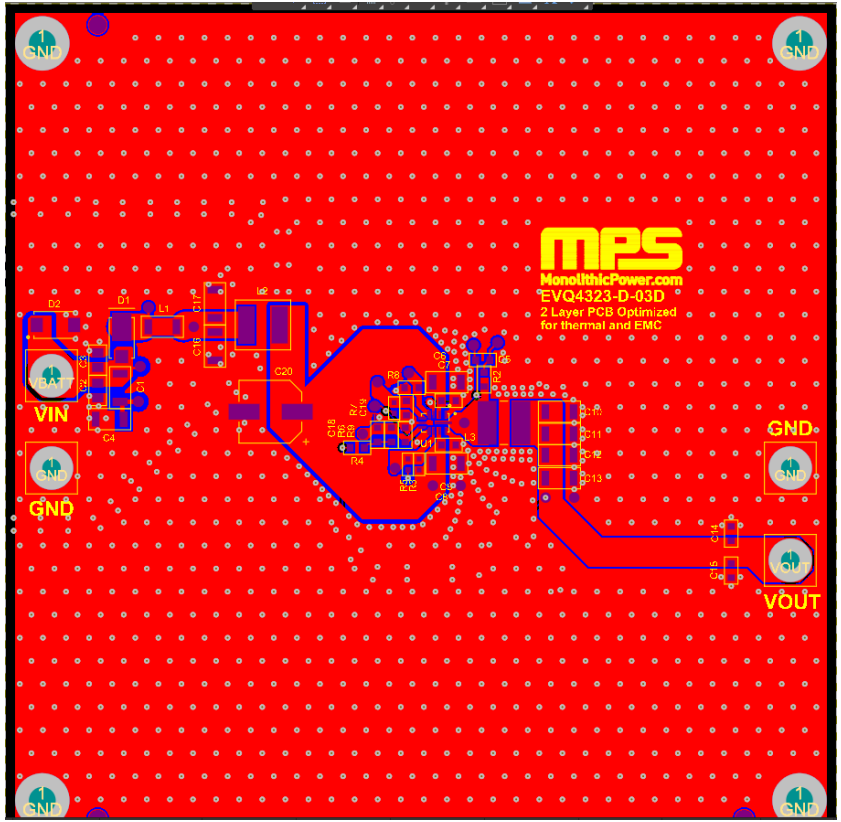
Output Fixed Version

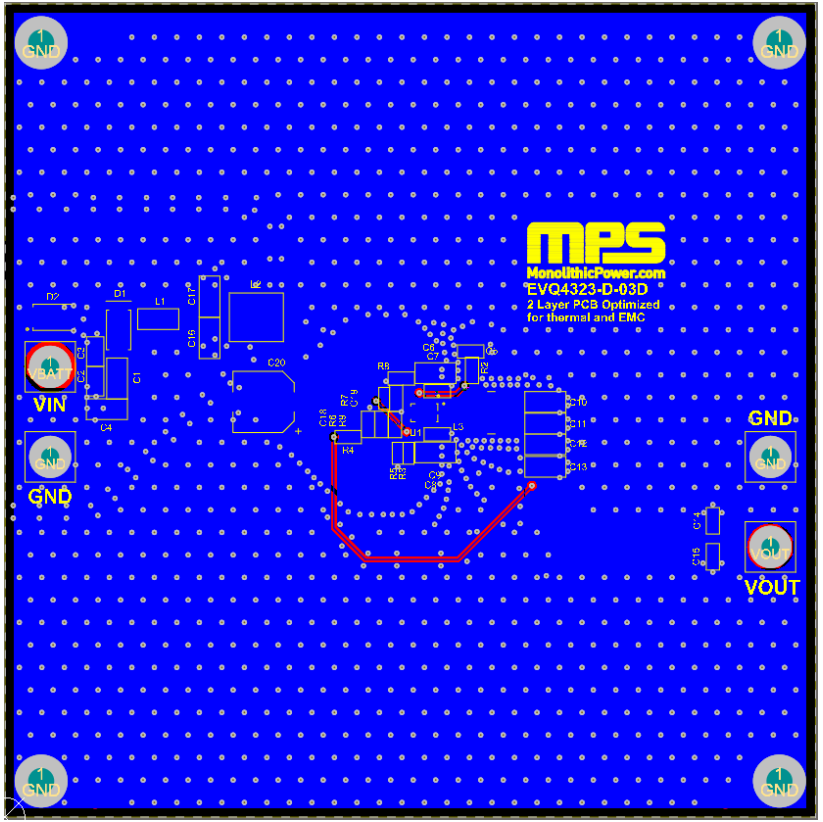
Key Specifications	
Input Voltage	3.3V to 42V load dump
Output Voltage	Adjustable: 5V, 3.8V, 3.3V, or 2.5V
Switching Frequency	350kHz to 2.5MHz
HS-/LS-FET $R_{DS(ON)}$	65mΩ/45mΩ
Package	FCQFN-12 (2mmx3mm)

MPQ4323 – Recommended Schematic

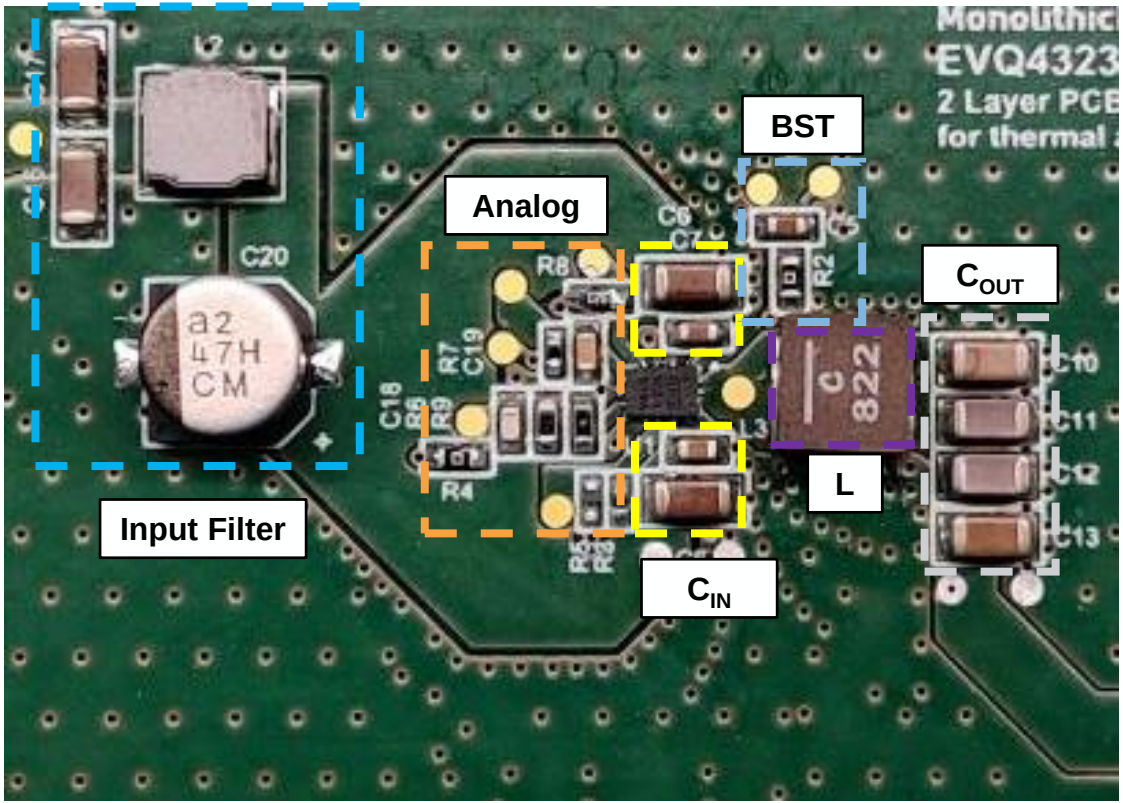


MPQ4323 – Recommended Layout

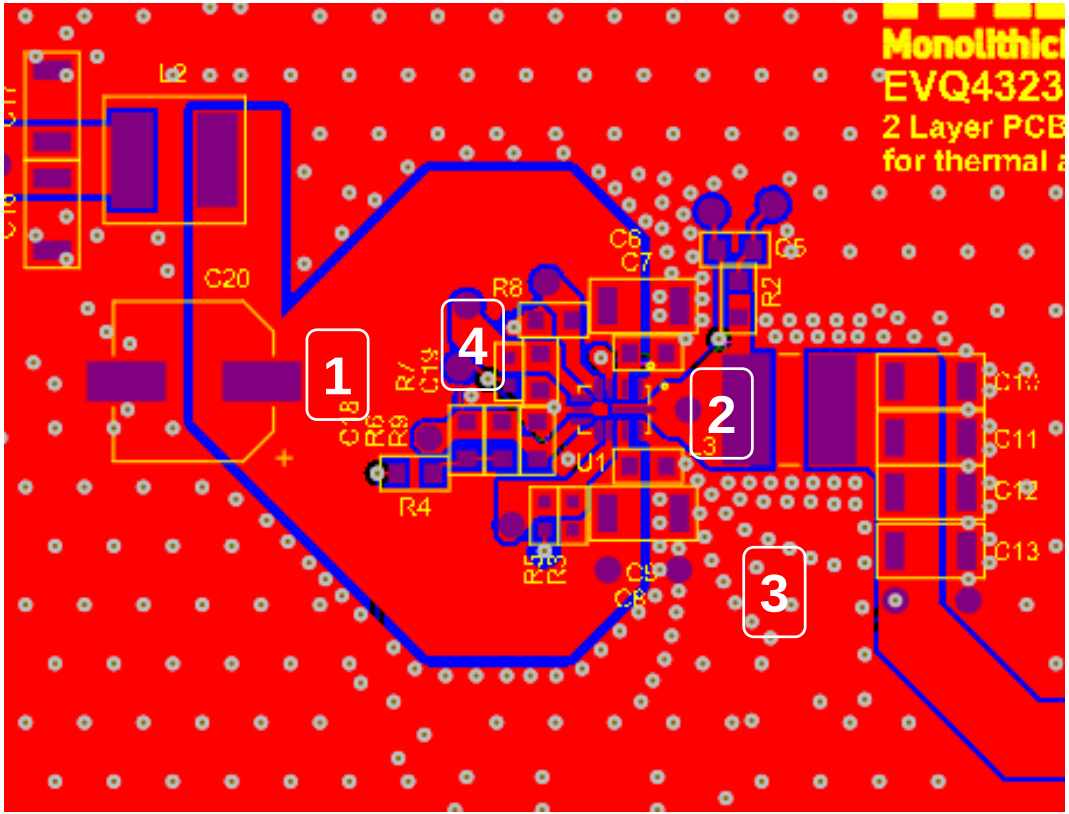




MPQ4323 – Recommended Placement

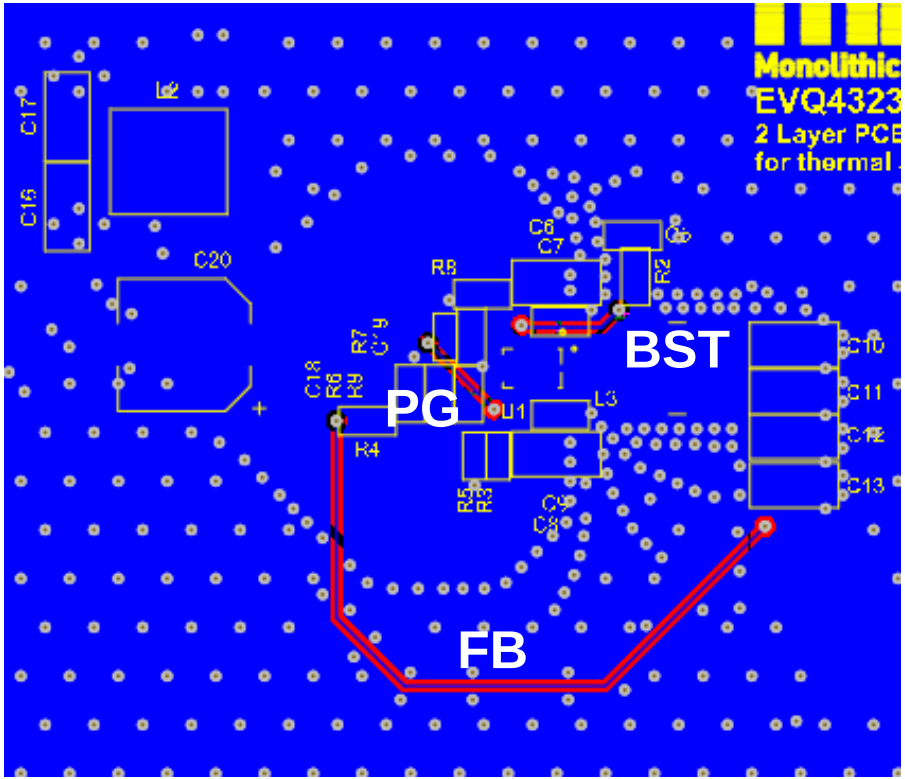


MPQ4323 – Recommended DC/DC Layout



1. Connect VIN to a wide copper polygon to improve heat dissipation. Use a symmetrical VIN input, and wrap it around the analog signals.
2. Keep the SW node small, with just enough area to connect it to the inductor while adding a test point.
3. Connect PGND to a large plane. Avoid making any cuts around it. Place several vias on the bottom-side plane, especially near the inductor.
4. Connect the signal pins using wide traces to improve heat dissipation, as every mm^2 counts.

MPQ4323 – Recommended Bottom Layer Layout

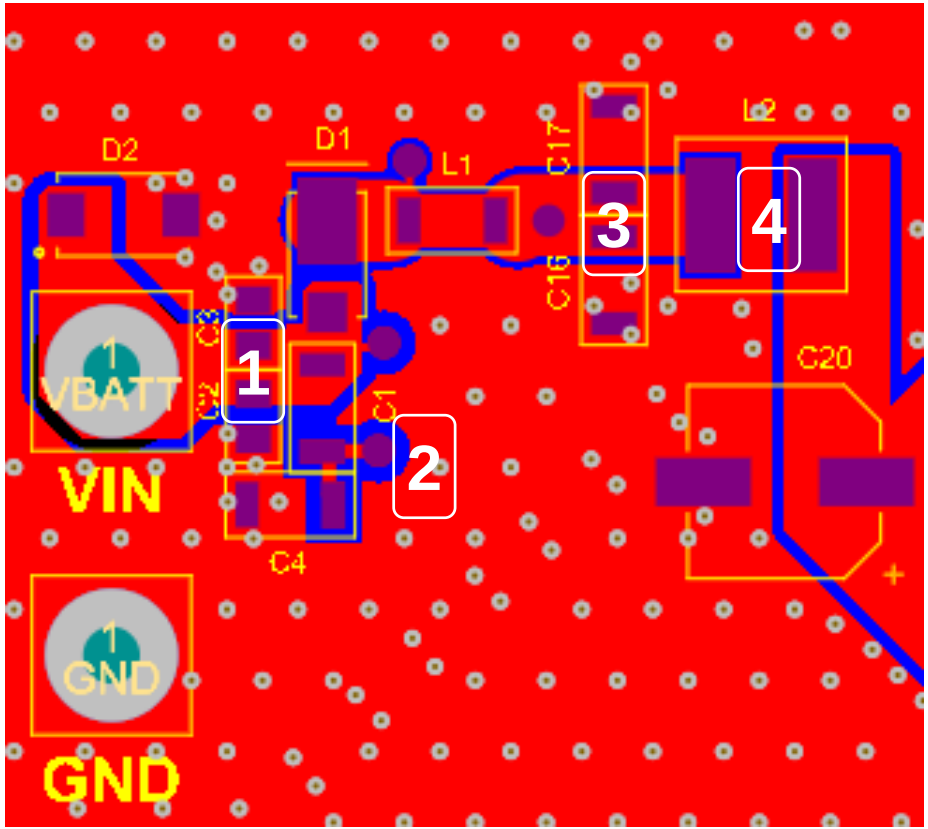


When possible, avoid routing signals in the bottom layer.

Route the FB trace on the bottom layer to avoid interrupting the VIN path. If the trace gets too long, it may be a good idea to alternate between bottom and top layers in a stitching pattern.

The FB resistors must be close to the IC, so that high frequency noise sees a low impedance in the long trace to C_{OUT}.

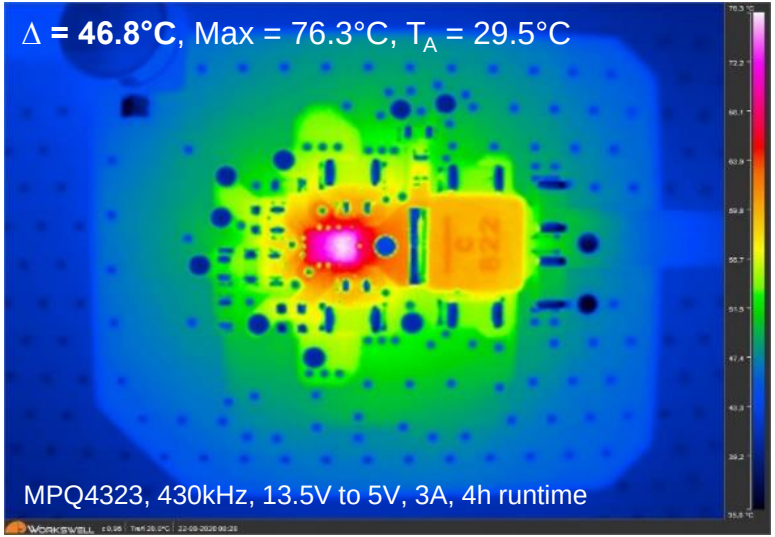
MPQ4323 – Recommended Filter Layout



1. Place the small-value capacitors very close to the connector. This helps filter higher frequencies, and is key to passing EMC.
2. Use 2 capacitors in series (connected in a 90° orientation to one other) to avoid fire if one of the MLCCs cracks.
3. Place the higher-value capacitors close to the inductor in a symmetrical layout.
4. When looking from the DC/DC converter, the inductor should be the first component of the input filter. This prevents high-frequency noise from getting too close to the connector.

MPQ4323 – Thermal Effect of Different Layouts

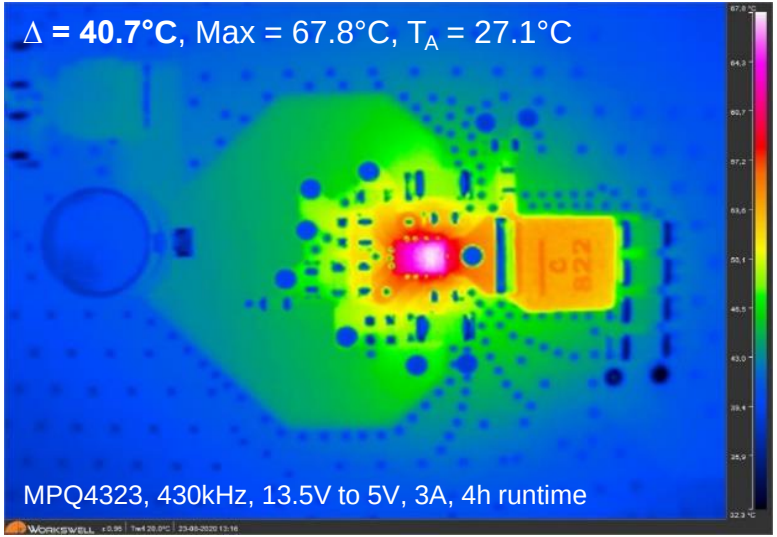
Traditional



A traditional layout has a cut in GND around the DC/DC converter, and VIN is connected on the bottom layer with a Y shape.

- 6°C

Recommended

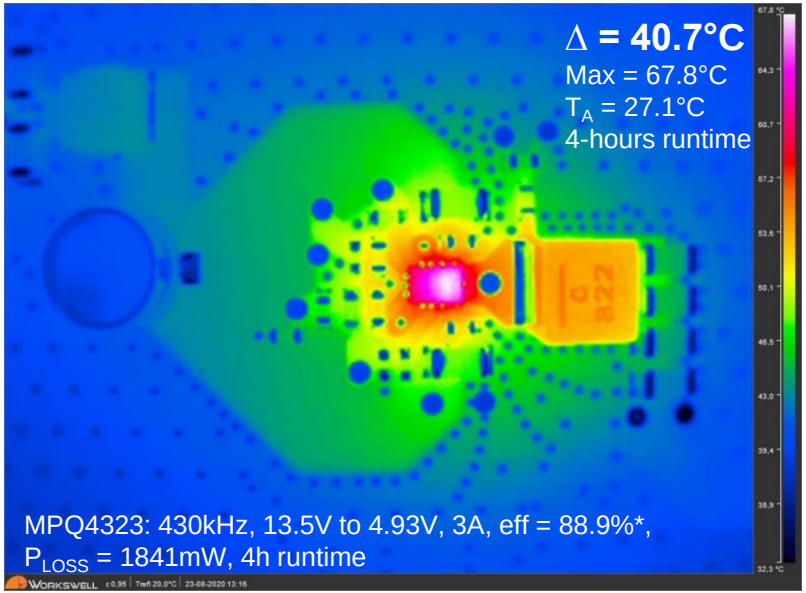


The new, recommended layout has a large VIN polygon to extract heat, as well as a solid GND plane. It also has many more vias connecting the top and bottom.

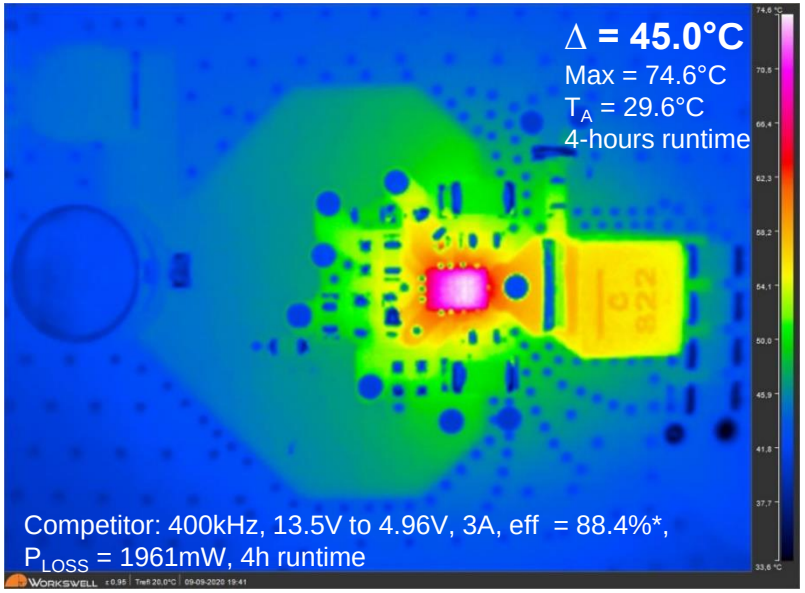
MPS's MPQ4323 vs. Competitors

The MPQ4323 is >4°C cooler. The observed difference was consistent when tested using a variety of PCBs.

MPQ4323



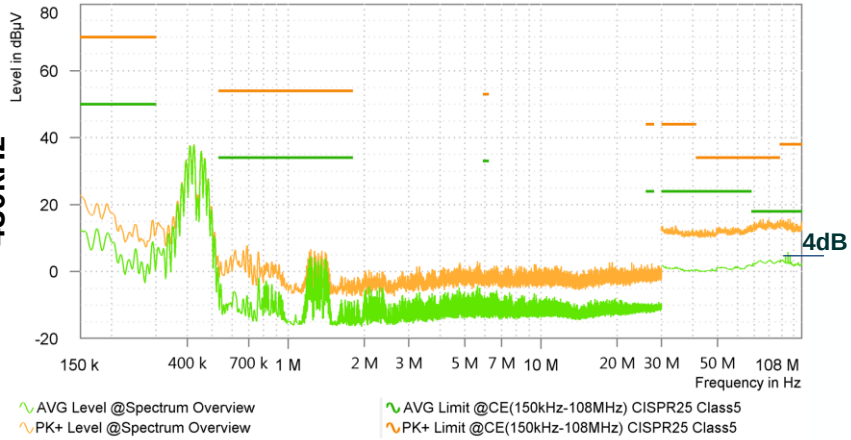
Competitor's Part



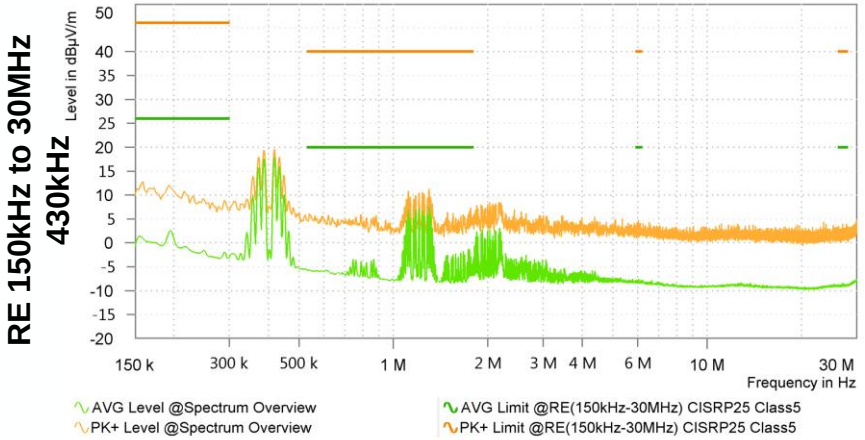
*The efficiency measurement includes the input filter, protection diode, and power inductor losses.

EMC Results from Recommended Layout

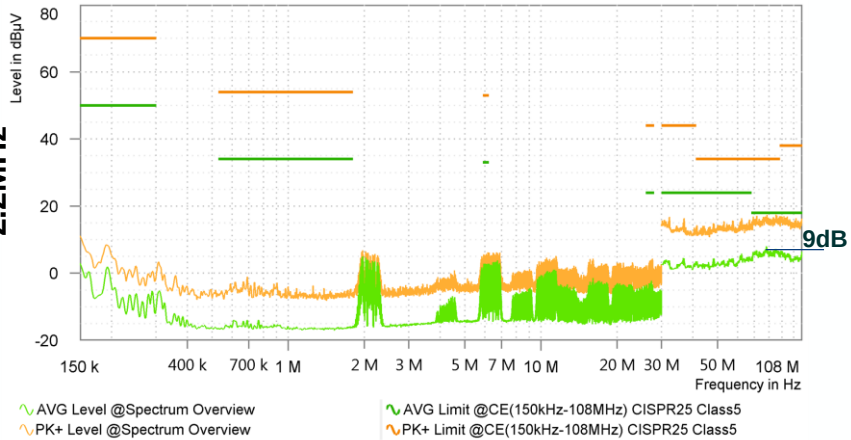
CE 150kHz to 108MHz 430kHz



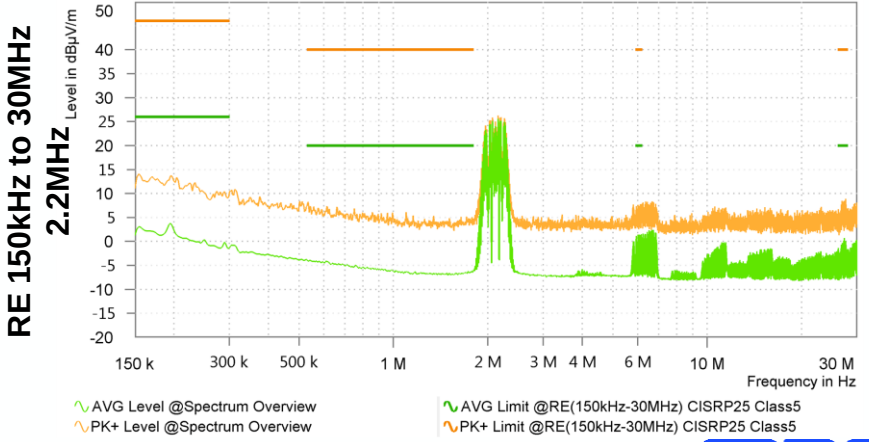
RE 150kHz to 30MHz 430kHz



CE 150kHz to 108MHz 2.2MHz

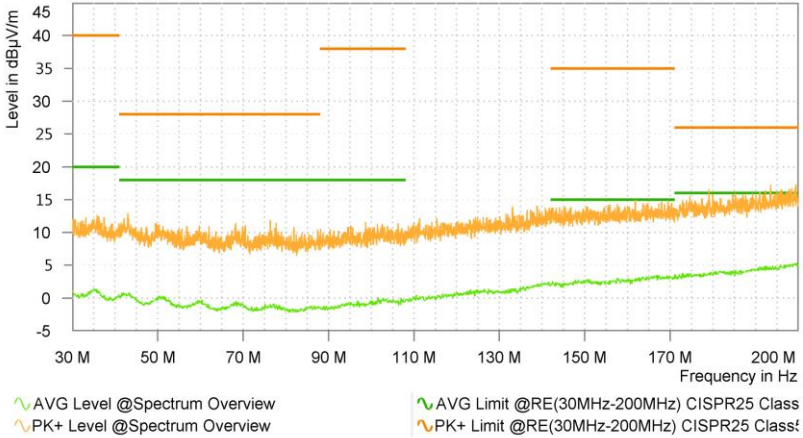


RE 150kHz to 30MHz 2.2MHz

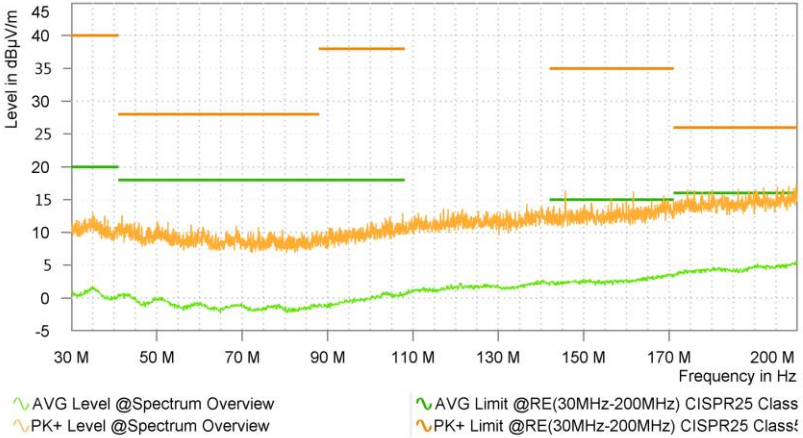


EMC Results from Recommended Layout

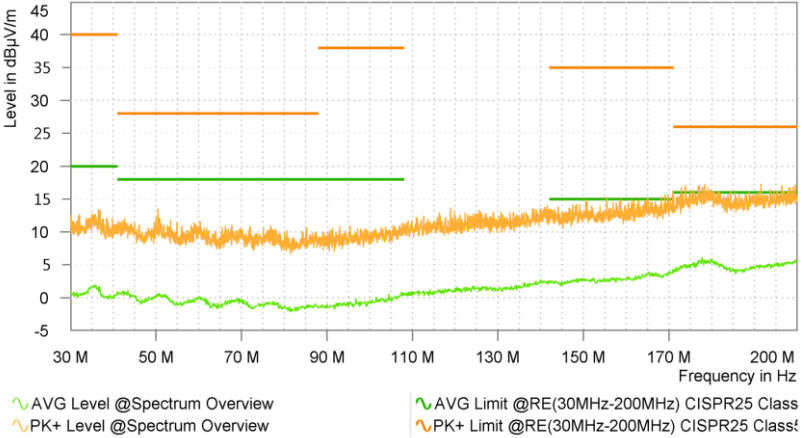
RE H 30MHz to 200MHz 430kHz



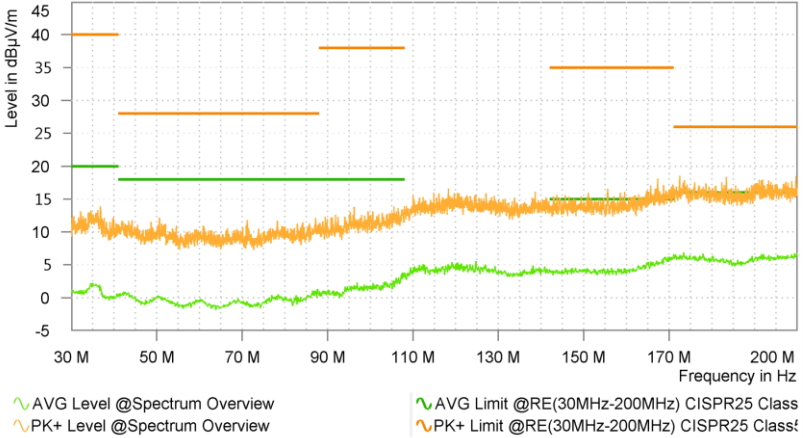
RE V 30MHz to 200MHz 430kHz



RE H 30MHz to 200MHz 2.2MHz

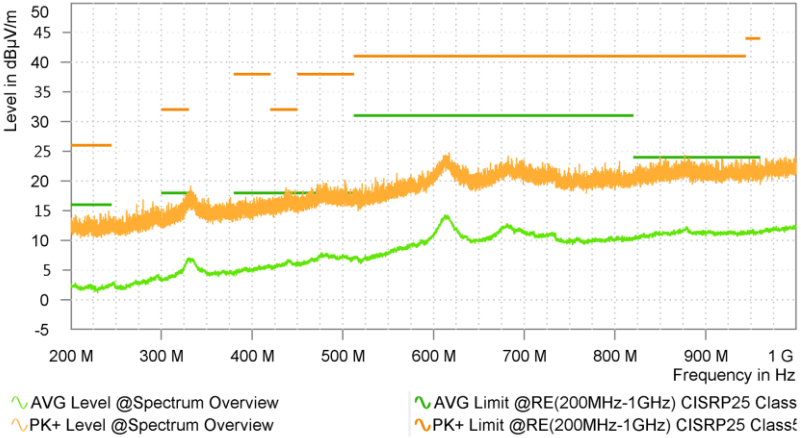


RE V 30MHz to 200MHz 2.2MHz

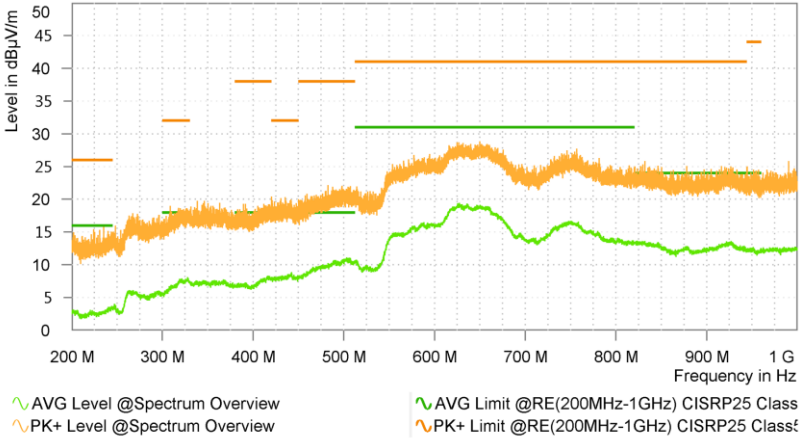


EMC Results from Recommended Layout

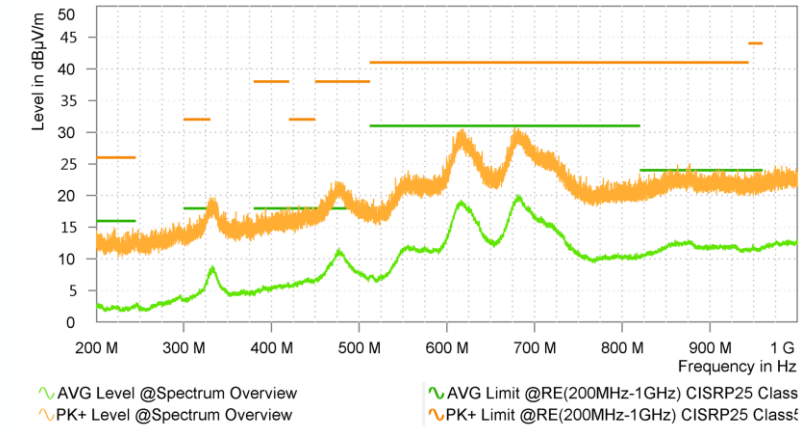
RE H 200MHz to 1GHz 430kHz



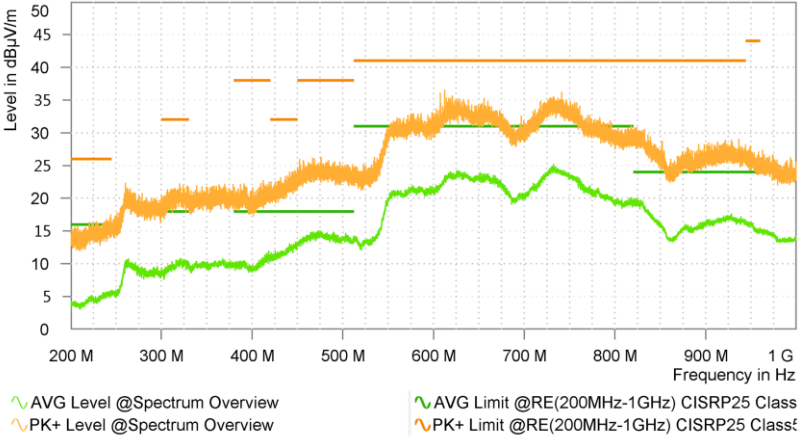
RE V 200MHz to 1GHz 430kHz



RE H 200MHz to 1GHz 2.2MHz



RE V 200MHz to 1GHz 2.2MHz



Conclusion

- The MPQ4323 allows cost-effective, 2-layer PCB designs to perform well in harsh environments.
- The IC can achieve close to full output operation in ambient temperatures that are approximately 100°C when operating at 400kHz, and approximately 80°C when operating at 2.2MHz*.
- The MPQ4323 is thermally superior to our direct competitor’s part due to a larger bump connection to the lead frame and higher efficiency.
- A low-cost design can pass the EMI test with CISPR25 and OEM limits with sufficient margin. Customers’ boards may have design constraints, but we are confident that these tests can be passed with the space-saving MPQ4323.

* When given a sufficient copper area for dissipation.

Q&A

Let us know your questions

For Customer Use Only

Thank You – Q&A

For more information, contact:
automotive@monolithicpower.com

Check out our AEC-Q100 Power Management Solutions at **MonolithicPower.com**