DESIGN SOLUTIONS

POWER

Pack More Power Than Ever in Your Small Sensor

Introduction

The current trend of creating smart factories using automation and data exchange in manufacturing technologies (also dubbed Industry 4.0) goes hand-in-hand with the advances in sensor technologies. As Internet of Things (IoT) devices and sensors become smaller and more complex, so do their on-board voltage regulators. They must deliver more power in a smaller space, with minimum heat generation, and must have ease of design for fast cycle time. How is this achieved?

The electronics industry continues to find ways to pack more data in the same space, first with Moore's Law for silicon, and then beyond ("More than Moore") with sophisticated IC packaging techniques. These packaging techniques help push the power density envelope by packing more Watts in the same square millimeters. This article presents a disruptive approach to advancing the power density envelope for industrial sensors with a novel, miniaturized, easy-to-design, high-performance solution.

The Industrial Sensor Environment

In industrial applications, the sensor may be located anywhere on the factory floor. The controller (typically a programmable logic controller or PLC) receives information from the sensor through digital/analog I/O modules and sends the appropriate instruction to the actuator via a field bus. While digital sensors include a transceiver or binary interface, analog sensors work on a 4–20mA loop. To improve factory throughput and enable adaptive manufacturing, modern sensors add microcontrollers to make simple decisions at the sensor level, eliminating the need to wait on the PLC. This has put an extraordinary burden on thermal budgets and device size, requiring a technical revolution in power supply.

The digital sensor "housing" includes a transceiver such as an IO-Link® interface, which handles data and routes the 24V power to a step-down voltage regulator. The regulator delivers either 5V or 3.3V to the microcontroller and to the sensing element. The 24V to 5V/3.3V down-conversion is a step that can be costly in terms of power loss, space occupancy, and length of design. Although we are discussing sensors as an example, this is true with motor encoders as well.

Traditional LDO Solution

If the current is low enough, then an LDO solution is often considered for its benefits of small size and ease of design. However, this solution is very dissipative at only 21% efficiency (5V/24V). If the current is high, as with modern sensors, then the solution requires a bulky heat-sink, and the LDO's size advantage disappears.

Traditional Switcher Solution

A PCB layout for a typical state-of-the-art synchronous $24V_{IN}$, 150mA switching regulator is shown in Figure 1. While still an effective solution in terms of power supply, the constraints of the layout and passives stress utilization of the PCB area (net component area of 32.5mm²) and consequently, the power density of the device.

This approach requires knowledge of switching regulator design and significantly increases time for design and testing. Plus, your manufacturing guidelines on clearance between components will add additional area.

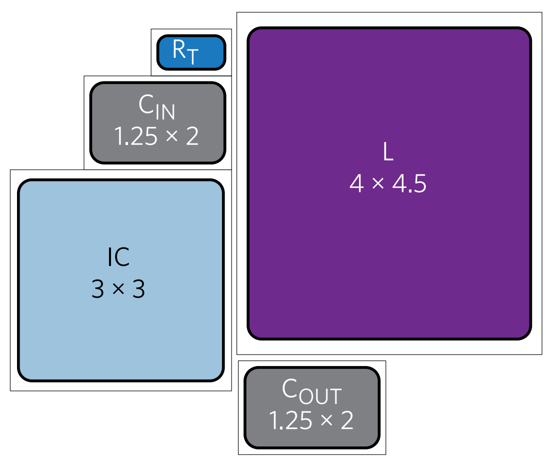

Figure 1. Traditional Buck Converter Layout (Net Component Area 32.5mm²)

Traditional Module Solution

To specifically address ease of use, many vendors have developed switching regulator modules. A typical switching regulator module that houses the buck converter IC and the inductor in a single case is shown in Figure 2. This solution attempts to address the ease-of-design and efficiency requirements, but clearly falls short in the PCB area utilization. In this example, at a net component area of 47.2mm², the module solution takes up 45% more area than even the discrete DC-DC regulator with external inductor implementation of Figure 1.

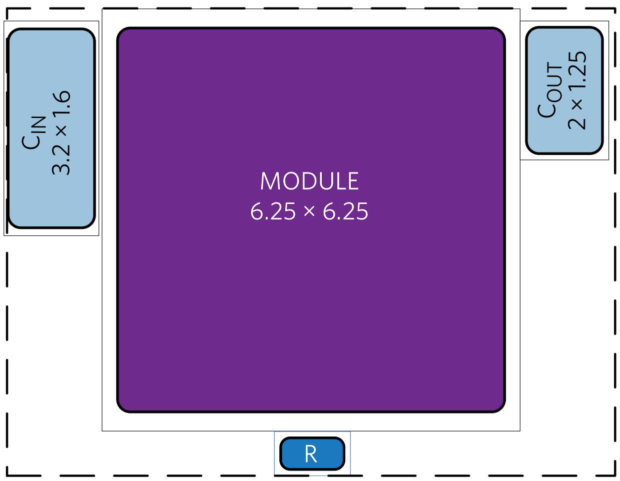

Figure 2. Traditional Buck Converter Module Layout (Net Component Area 47.2mm²)

uSLIC Packaging Technology

Can more power be delivered in a smaller module? A revolutionary technology, known as uSLIC™ architecture, has been created which co-packages a state-of-the-art Himalaya buck converter with passive components to develop a system-level IC. The Himalaya uSLIC power module delivers more power in a smaller space than ever before, with high efficiency and faster time to market.

uSLIC Power Module

The micro system-level IC or uSLIC power module vertically integrates the inductor and the buck converter IC, dramatically reducing the PCB space occupied by the standard buck converter solution. This still meets expectations of high-voltage tolerance and high-temperature operation. The **MAXM17532** module is available in a low-profile, compact 10-pin, 2.6mm x 3mm x 1.5mm (W x L x H) uSLIC package. The device operates over a wide temperature range from -40°C to +125°C. Figure 3 shows the dramatic size reduction achieved with the MAXM17532, 100mA, 42V buck converter uSLIC module. For higher loads, the 300mA **MAXM15462** is available in the same form factor.

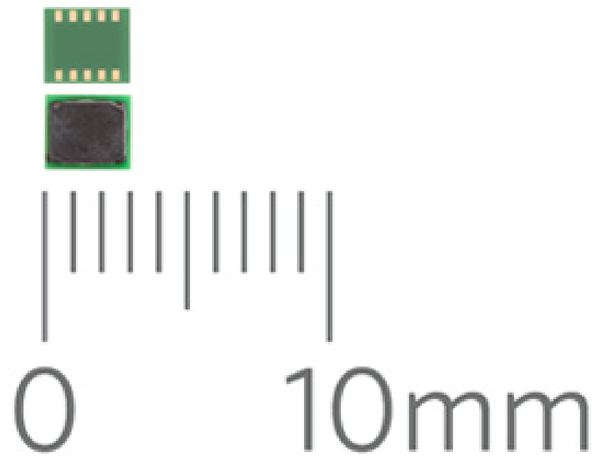

Figure 3. MAXM15462 uSLIC Buck Converter

Miniaturized Size

Figure 4 shows the MAXM17532 switching regulator module's PCB area. Thanks to the vertical integration of the inductor, the net component area is a mere 14.3mm².

Compared to the IC solution of Figure 1, the uSLIC module net component area is 2.25X smaller. Compared to the traditional module of Figure 2, the uSLIC module solution is 3.3X smaller!!

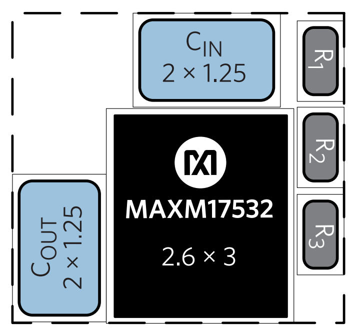

Figure 4. MAXM17532 uSLIC 5V_{OUT}, 100mA Buck Solution (Net Component Area 14.3mm²)

High Efficiency

Figure 5 shows the excellent efficiency of MAXM17532 with 5V output and different input voltages. Despite the small size, the buck converter delivers high efficiency with peaks up to 90%!

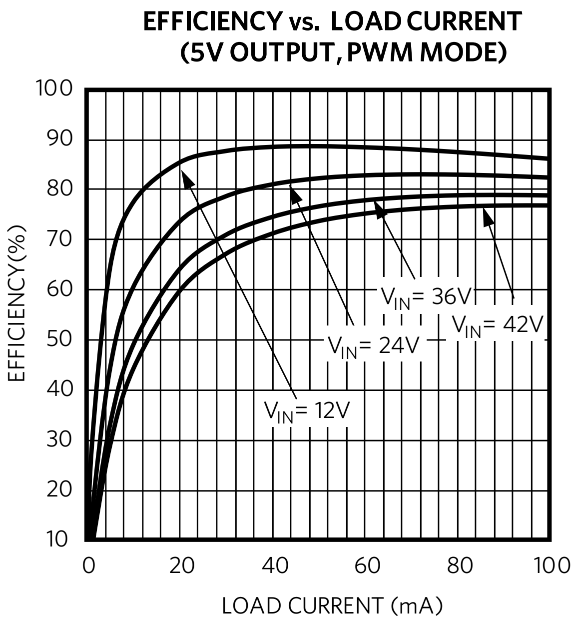

Figure 5. MAXM15462 uSLIC Efficiency

Rugged: Low EMI

The module PCB layout is designed to minimize trace lengths and eliminate ground loops for minimum radiated emissions. The use of high-frequency ceramic capacitors minimizes conducted emissions.

Figure 6 shows the MAXM17532 radiated emission, comfortably meeting the CISPR22 CLASS B specification.

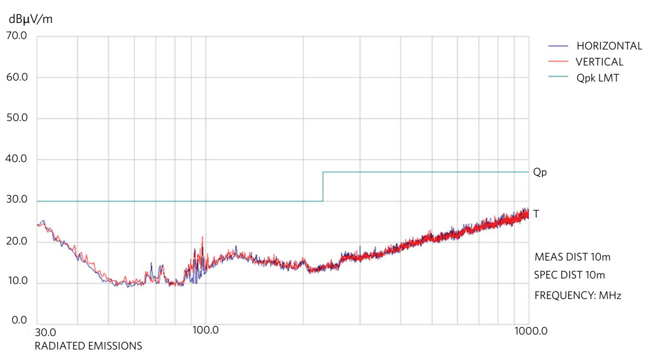

Figure 6. MAXM17532 Radiated Emission

Figure 7 shows the MAXM17532 conducted emission comfortably meeting the CISPR22 CLASS B specification.

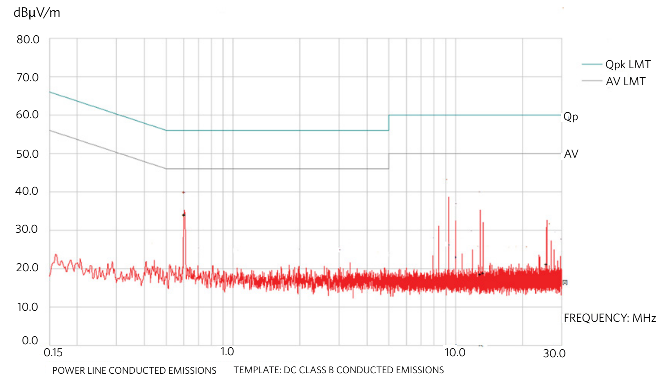

Figure 7. MAXM17532 Conducted Emission

Rugged: Drop, Shock, and Vibration Tolerance

Beyond thermal, electrical, and electromagnetic performance, it is important that power supplies are tolerant to mechanical stresses. Himalaya uSLIC modules meet JESD22-B103/B104/B111 standards for drop, shock, and vibration guaranteeing fool-proof operation in sensors deployed in harsh industrial, medical, defense, and consumer applications.

For Higher Current

For higher loads (300mA), the MAXM15462 Himalaya uSLIC module is also available in a 2.6mm x 3mm footprint. Its 1.5mm height provides benefits in size, efficiency, CISPR 22 compliance along with shock, drop, and vibration tolerance.

Conclusion

We discussed the challenges of delivering higher power more efficiently with minimum heat generation and without adding delays to the design cycle for small industrial sensor applications. We saw how a typical LDO solution falls short on efficiency. The IC switching solution falls short on size and design cycle time, especially for modern sensors, while the traditional module implementation falls short on the utilization of the PCB area. Finally, we introduced a disruptive approach that stretches the power density envelope with a novel, miniaturized, easy-to-design, high-performance buck converter module based on uSLIC technology. The MAXM17532 and MAXM15462 uSLIC power modules provide high-efficiency, small-size, low-EMI buck converters that are easy to design in and are ideal for powering tiny sensors in multiple end applications.

Learn more:

MAXM15462 4.5V to 42V, 300mA, Compact Step-Down Power Module

MAXM17532, 4V to 42V, 100mA, Compact Step-Down Power Module

Design Solutions 10: Pack More Punch in Your Small Sensor While Keeping It Cool

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