DESIGN SOLUTION 7092

POWER YOUR PLC WITH A SMALL POL MODULE

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Abstract:
This design solution outlines smart factory automation trends that are fueled by distributed processing modules powered by point-of-load (POL) voltage regulators. After reviewing a typical POL, we introduce a novel solution that yields a POL module that has higher efficiency across an extended range of loads, is smaller, and requires a minimum number of external components.

Introduction

The vision of the smart factory is a reality in many industries, thanks to advancements in automation and data exchange in manufacturing technologies. Factory floors are filled with controllers, sensors, I/Os, and actuators. A controller can be a programmable logic controller (PLC, **Figure 1**), motor/motion controller, or a distributed control system (DCS) using advanced processors and microcontrollers. Sensors can be either digital or analog and used for proximity, vision, weight, or temperature. Actuators can be robots, valves, motors, computerized numerical control (CNC), contactors, and other moving mechanisms. Inputs and outputs (I/Os) can be digital or analog or even universal I/Os that connect sensors and actuators to controllers.

Figure 1. Programmable logic controller module.

Figure 2 shows a PLC or an industrial computer that monitors and controls a single manufacturing process. It includes a processor, I/O modules, memory/programming, and a power supply. The 24V field bus is bucked down to 5V with the flyback converter, a transformer-based architecture that isolates the PLC module from the harsh industrial electrical environment. The flyback output is converted down to the necessary PLC voltage rail by the POL voltage regulator. PLCs and other control systems are orchestrated by software packages like SCADA (supervisory control and data acquisition), monitoring and controlling multiple interfaces and peripherals.

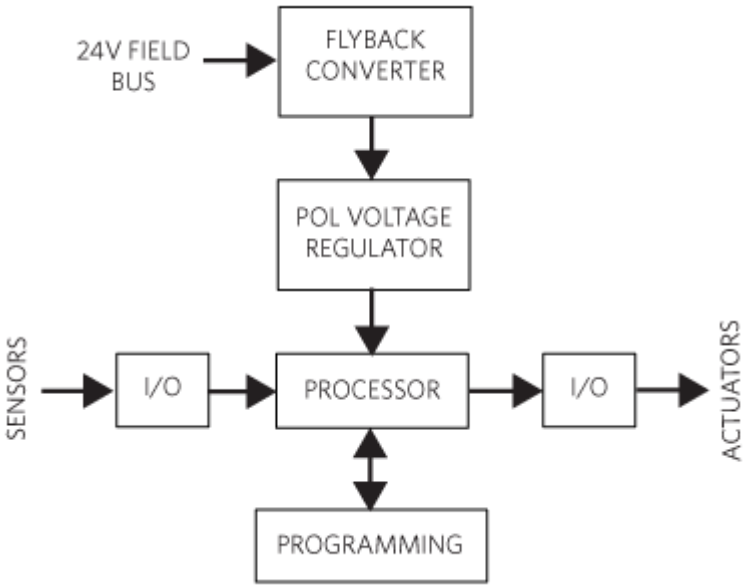

Figure 2. Programmable logic controller module.

The PLC receives inputs from sensors on the factory floor, processes them locally, and drives the proper actuators. Today's sensors, I/Os, and actuators are equipped with internal processors that make simple decisions locally without the need to escalate to the controller, thereby improving throughput. Unless multiple devices need to be considered, the PLC is not even involved. By networking the data generated by all the equipment to the cloud, analytics can be run in real time using advances in AI to determine the action to be taken.

The Challenge

The proliferation of processors and connectivity interfaces into every controller, sensor, I/O, and actuator on the factory floor, places new requirements on system hardware: reduced component size to fit additional electronics in the same chassis, improved energy efficiency to perform within the same or lower thermal budget and increased electrical/mechanical safety and reliability to reduce downtime.

A module approach to a voltage regulator powering the PLC, where the inductor is mounted vertically on top of the IC, reduces the solution BOM, footprint and improves reliability and time-to-market. The voltage regulator module's POL must also be efficient to reduce heat generation, further improving system reliability.

In this design solution, we review a typical module approach to powering the PLC and present a new solution that is cost effective and superior in efficiency and size.

Typical POL Module

A PCB layout for a typical synchronous $5V_{IN}$, 1A switching regulator module is shown in **Figure 3**. The confinement of the inductor results in a reduced footprint of 16.6mm^2.

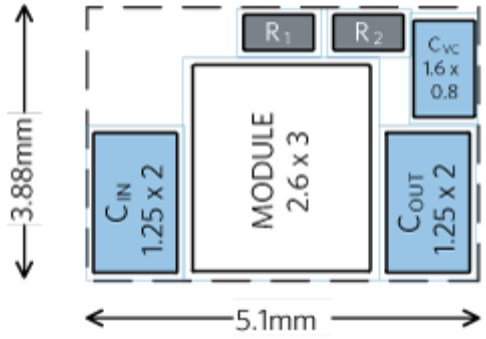

Figure 3. Typical solution net area of 16.6mm^2 for a switching regulator module.

uSLIC POL Module

The uSLIC™ module in **Figure 4** supports up to 1A load current and allows use of small, low-cost input and output capacitors. A reduced module size (2.6mm x 2.1mm^2 vs. 2.6 x 3mm^2).and a reduced BOM (5 components vs. 4 and in a smaller size) results in a cost-effective solution and footprint net area of 11.8mm^2 or 29% smaller than the typical solution.

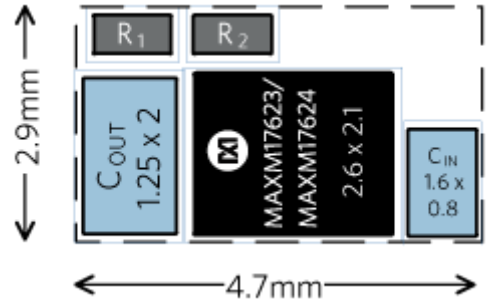

Figure 4. Improved solution net area 11.8mm^2 using a uSLIC POL module.

The output voltage can be adjusted from 0.8V to 3.3V. The module significantly reduces design complexity, manufacturing risks, and offers a true plug-and-play power supply solution, reducing overall time-to-market.

Efficiency Advantage

Figure 5 compares the efficiency of the two solutions. The generic solution (red curve) is ill equipped at light load, where the efficiency drops dramatically, and at full load it falls short of 3% points.

The uSLIC module has high efficiency across the entire range of operation (green curve), making it ideal for line-powered as well as power-stingy battery-powered applications.

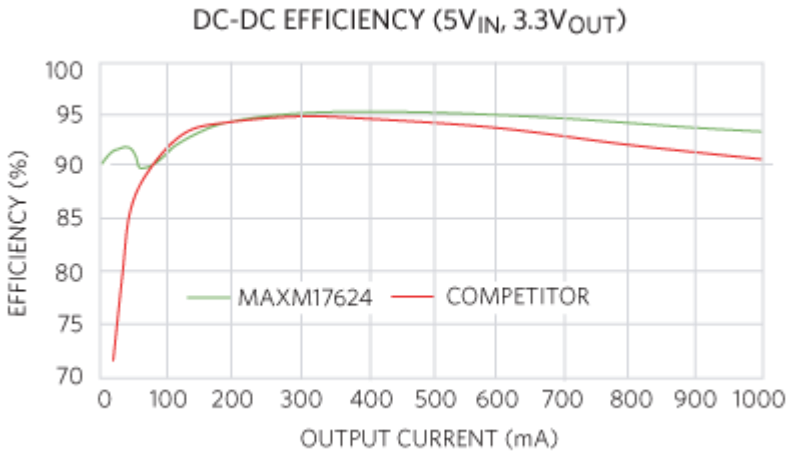

Figure 5. Efficiency comparison between the uSLIC module and competition.

Conclusion

The smart factory relies on a plethora of sensors and actuators placed across the factory floor. The information is processed by PLC modules powered by voltage regulator POLs. A modular approach to the POL reduces system BOM, improves reliability and time-to-market. In this design solution, we reviewed a typical POL and compared it to a novel approach that yields a module that is smaller, has higher efficiency, and is more cost effective.

Related Parts

MAXM17623	2.9V to 5.5V, 1A Himalaya uSLIC Step-Down Power Modules
MAXM17624	2.9V to 5.5V, 1A Himalaya uSLIC Step-Down Power Modules

A similar version of this design solution originally appeared on Power Systems Design on December 04, 2019.