Simplifying Power Supply Design with a 15A, 42V Power Module

Introduction

The DC/DC buck converter is one of the most popular and widely used power supply topologies, finding applications in industrial, servers, telecom, and automotive sectors. The non-isolated buck converter also sees increasing use as a point-of-load (POL) solution to deliver power from a DC bus to individual POLs. It steps down the DC bus voltage to lower regulated output voltages. An ideal POL solution should be capable of supporting a wide range of input voltages while providing a stable operation at small duty cycles. For applications constrained by board space, a compact, higher power density design is required, and to minimize power losses and provide cost savings, high conversion efficiency is needed.

Discrete POL solutions involve careful selection of components, including inductor, MOSFETs and capacitors, and that requires an experienced power supply designer. In addition, the placement of the components on the PCB is crucial since they have a direct correlation with efficiency, noise and thermal performance. Compensation elements must be carefully selected to keep the converter stable across all operating conditions. This is a cumbersome task, especially if the system has multiple POL power rails. All of these factors can lead to longer design cycles and increased cost of ownership.

This white paper explores the simplicity of using a power module for POL designs, and describes how it can reduce the burden on power supply designers, leading to shorter design cycles and faster time to market. A look inside a new 15A, 42V power module shows that it offers a highly integrated, characterized solution that provides superior efficiency, power density and reliability.

Power Module: A Simple Approach

Power modules provide an alternative to the lengthy and arduous process of discrete power supply design by integrating all of the key components inside the package. Figure 1 shows that a power module is a complete power supply in a condensed package that requires only a few external components to function.

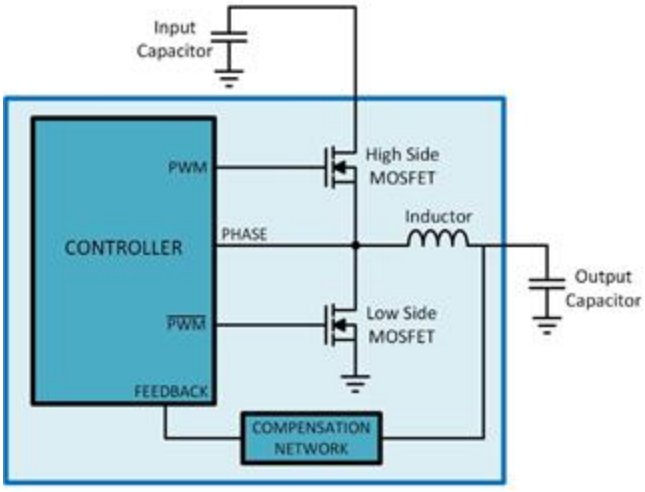

Figure 1. Inside the ISL8215M power module

A power module includes the high-side and low-side MOSFETs, inductor, controller, and the compensation network. The designer typically only needs to select the input and output capacitors, along with a few resistors to complete the power supply design. Power modules offer several advantages:

- Higher integration offers increased power density to occupy less board space
- Shorter development times lead to reduced cost of ownership
- Higher reliability due to detailed manufacturer characterization
- Efficient thermal management due to better packaging technology
- Simplified PCB layout and reduced design complexity due to fewer external components
- Easier manufacturing and assembly process with direct placement on application boards

Power Module Challenges

The 12V DC bus is a popular power rail found in data centers, automotive and battery backup systems. Most POL solutions can easily achieve a step-down ratio from 12V to 0.9V/1V while delivering good transient performance and efficiency. However, as the trend moves towards higher input voltages, the performance and efficiency tend to suffer.

Industrial applications typically use a 24V~36V DC bus, which is stepped down to a lower voltage level to feed key downstream components such as microprocessors, FPGAs, DSPs, memory, and more. This big conversion ratio leads to narrow pulses that can be a challenge to control. Moreover, if the input DC voltage is not properly regulated, there might be voltage spikes present on the bus; this may necessitate the need for an even wider input voltage range for the power module.

Because of their inherent compact and dense nature, thermal dissipation can pose a serious challenge. Thermal performance becomes even more important when considering operations over a wide range of temperature. High efficiencies can lead to lower power dissipation, which can aid thermal performance greatly. Use of heat sinks and system airflow may also be required to realize better performance efficiency.

Increasing power density in a module usually leads to a tradeoff between package size and the output current supported. Higher output voltages supported by the power module also increases the power processed through the converter, which poses a thermal challenge. Again, good efficiency is the key in pushing the module to higher power densities while keeping the size of the package small.

Achieving High Power Density

The ISL8215M is a first of its class single-phase power module supporting a wide input/output voltage range, while delivering up to 180W output power from a small 13mm x 19mm thermally enhanced High Density Array (HDA) package. This makes it one of the highest power density POL solutions. The input voltage can vary from 7V to 42V and the output voltage is adjustable from 0.6V to 12V, while allowing a programmable switching frequency from 300kHz to 2MHz.

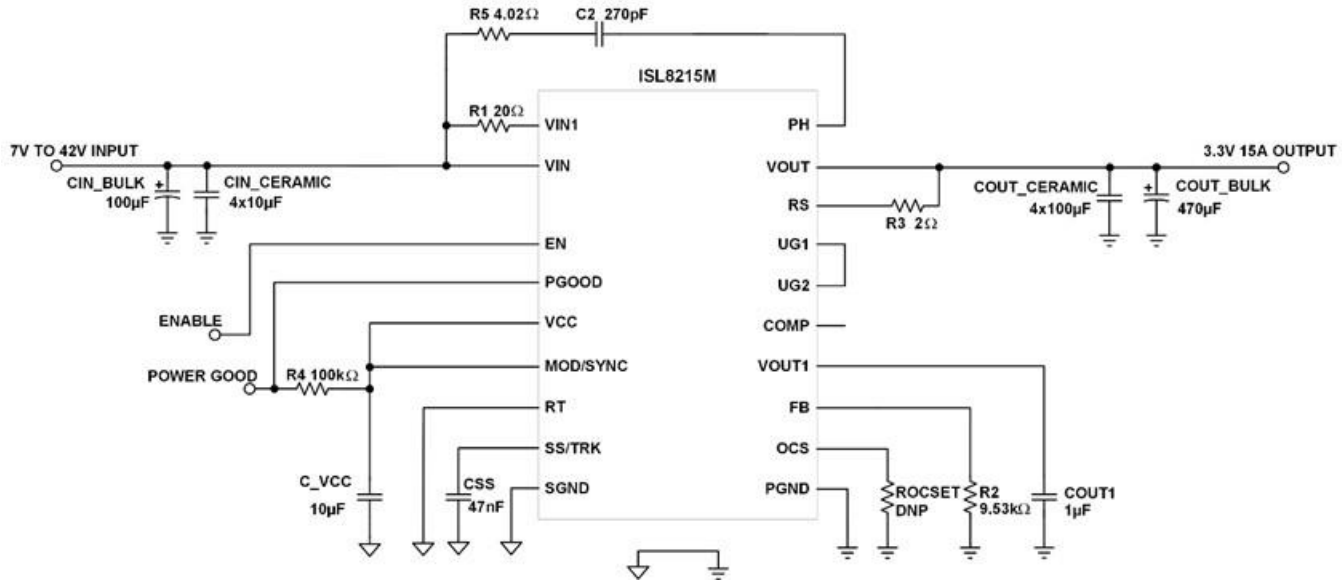

Figure 2. ISL8215M typical application circuit

As seen in Figure 2, the ISL8215M requires only a few external resistors and capacitors to form a complete power supply solution. Internal compensation networks are implemented to stabilize the converter and achieve an optimal transient response across the full range of input and output operating conditions.

The ISL8215M is able to operate from a 42V input rail, providing the designer with extra input voltage safety margin. This makes it ideal for industrial applications. It is able to achieve a high conversion ratio (42V input to 1.2V/3.3V output) by employing valley current mode control with an input voltage feedforward ramp. This eliminates the need for blanking time (as is the case with peak current mode), making it possible to control very narrow on-time pulses and provide excellent transient performance.

A high conversion ratio also eliminates the need for multistage conversion since 42V can be directly stepped down to 1.2V, without the need of an intermediate 12V/5V bus. It should also be noted that this intermediate 12V/5V bus voltage can also be generated by the ISL8215M, making it a versatile solution.

The ISL8215M's small footprint is possible due to advanced packaging technology that utilizes a copper lead frame on which the MOSFETs and inductor are directly mounted. This allows for a direct heat transfer to the PCB, making thermal management more efficient and allowing the power module to run cooler and more efficiently without the need for heatsinks or system airflow. As shown in Figure 3, we can see that the ISL8215M mounted on its standard evaluation board can safely deliver up to 10A of continuous current at 85°C ambient temperature--with no airflow on a 24V to 3.3V conversion.

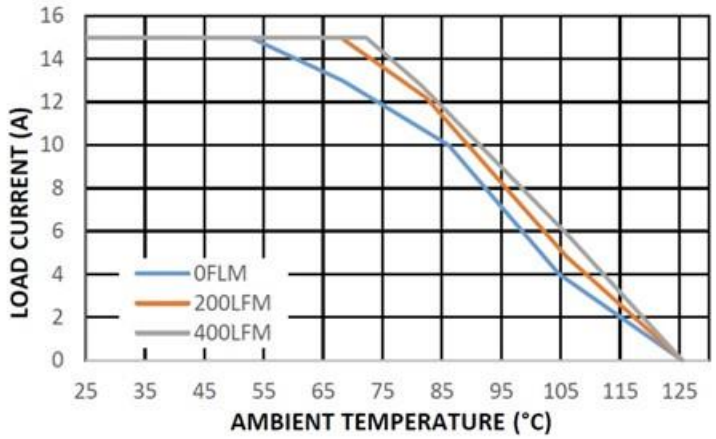

Figure 3. Derating curve, PWM/CCM mode, Vin = 24V, Vout = 3.3V, fsw = 300kHz

The ISL8215M can support current up to 15A, while the output voltage can be set as high as 12V. This high power density is possible due to the high efficiency of the module, which reduces power loss and makes thermal management easier. With a peak efficiency greater than 96% and over 80% efficiency for most of its output current range and conversions, it is possible for the power module to achieve a compact form factor.

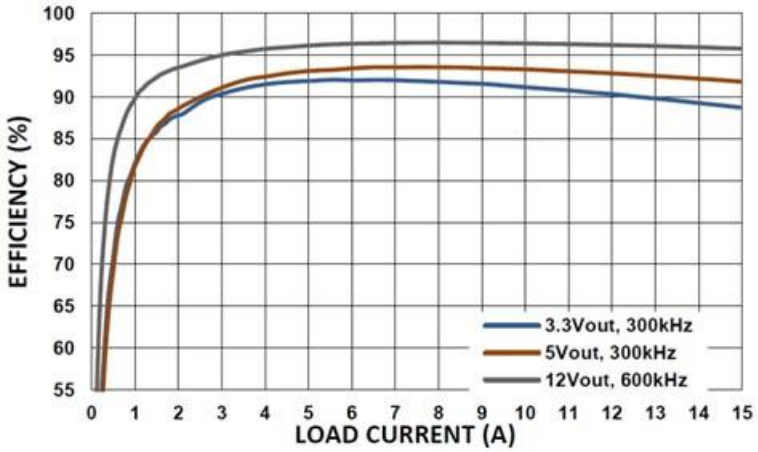

Figure 4. PWM/CCM mode, Vin = 24V

The ISL8215M also provides a host of protection features which guarantees the safe operation of the module under abnormal or adverse operating conditions. Some of these features include programmable soft-start (for reducing inrush current), pre-bias power up, short-circuit protection, under voltage lockout, and output over voltage protection.

Conclusion

Power modules are a simple and effective solution, which eliminate all the intricacies associated with designing a discrete power supply solution. This can translate to shorter design cycles and faster time to market, which helps reduce the overall development cost. Their integrated and compact design can help save a lot of valuable PCB real estate. A simplified PCB layout can help solve noise issues and enable a more effective thermal design.

As we have shown, the ISL8215M is a highly characterized, reliable power module, which requires a minimal number of external components for developing a complete power supply solution. Its advanced packaging technology provides an excellent thermal performance over a wide range of operating temperatures. And, its high power density in a small footprint is made possible due to the high efficiency of the module, which reduces power dissipation and increases the current rating of the device. A wide output voltage range from 0.6V to 12V enables the module to be an efficient POL solution, while also allowing for an intermediate 12V/5V bus voltage generation.

Next Steps

- Learn more about the ISL8215M 15A, 42V analog power module
- Download the datasheet
- Watch a video demonstration

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