Application Note

Detailed Comparison Between TPSM843620 Family and TPS543620 Family

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ABSTRACT

The TPSM843620 family is the next generation module to the TPS543620 family of converters. To assist deciding and selecting a part that better fits an application, this application note compares aspects of both TPS543620 family and TPSM843620 family.

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1 Introduction

The TPSM843620 family is the next generation of 4-V to 18-V input, advanced current mode, synchronous SWIFT™ step-down power modules. This application note provides a detailed comparison of both the converter and module families. In particular, the application note highlights the main benefits that the module family can provide over the converter.

2 Features Comparison

2.1 Design Size

2.1.1 MicroSiP™ Packaging

The MicroSiP™ package is Texas Instrument's latest response to the market's ever-increasing demand for smaller and smaller components, and MicroSiP comes with a massive increase in power density when compared to previous designs. The MicroSiP package manages this by integrating inductor and other external components into one compact package. To achieve this, while keeping the size of the package small, the passive components are integrated vertically rather than horizontally. The integrated circuit of the chip is embedded inside a PCB substrate. Then passive components, for example, capacitors and inductors, are stacked and soldered on the top of the PCB. The MicroSiP packaging uses ball grid array pins with the total vertical thickness of the package being the combined thickness of the ball grid array, the PCB substrate, and the passive components. This is how the TPSM843620 family achieves a compact package size of 12.25 mm^2 with a height of only 1.6 mm.

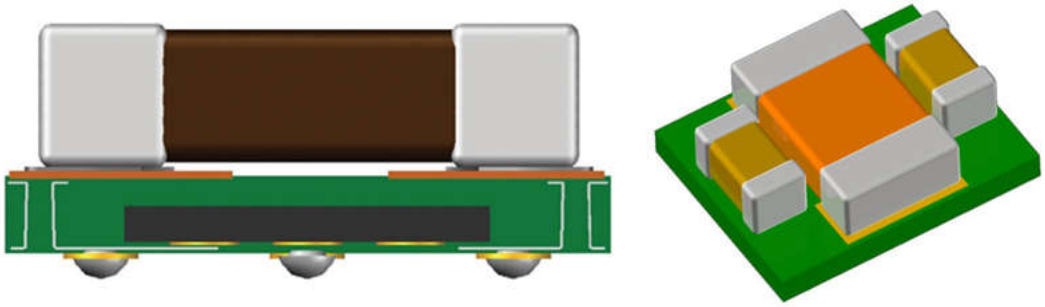

Figure 2-1. MicroSiP Package Example

The TPSM843620 family has higher power density when compared to the TPS543620 family because of the small MicroSiP package. The compact design can greatly reduce the overall design size. This design can be used to cut down on board space and cost. Alternatively, the additional space saved due to the smaller form factor can be used to add more features to the product that cannot be possible in a design with space constraints if the TPS543620 family was used.

2.1.2 PCB Design Size Comparison

The external components for both the TPS543620 and TPSM843620 PCB design size were selected based on data sheet recommendations for identical applications. The selected design parameters are shown in Table 2-1.

Table 2-1. Design Parameters

Parameter	Value
Input voltage range (V_{IN})	4 to 18 V, 12 V nominal
Output voltage (V_{OUT})	1.0 V
Output current rating (I_{OUT})	6 A
Switching Frequency (f_{SW})	1000 kHz
Input Capacitance (C_{IN})	20.2 µF
Output Capacitance (C_{OUT})	94 µF
Output Inductance (L_{OUT})	470 nH

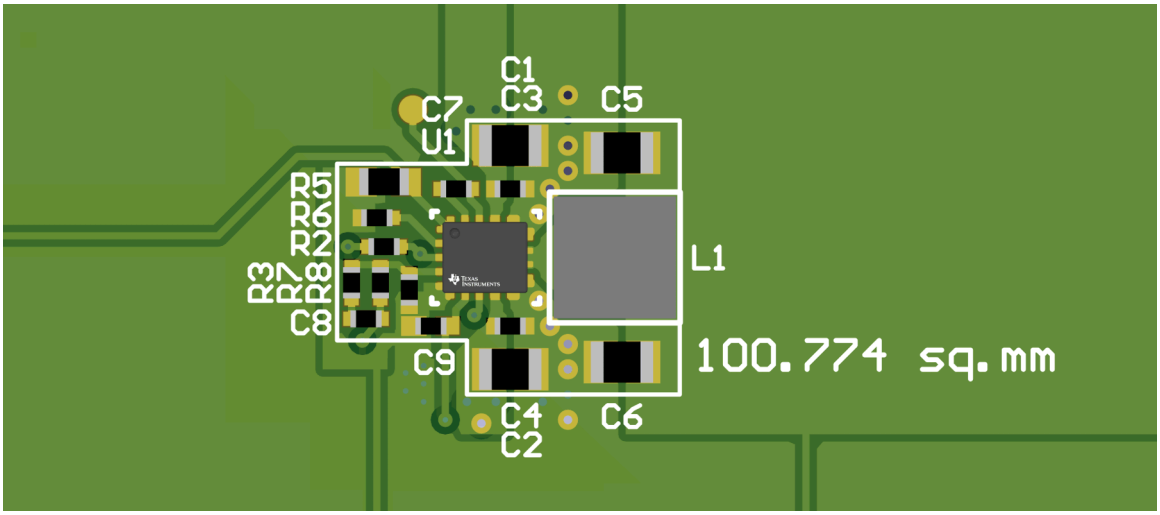

Figure 2-2. TPS543620 PCB Design Size

The total design size of the TPS543620 converter circuit design was measured to be approximately 100.774 mm^2.

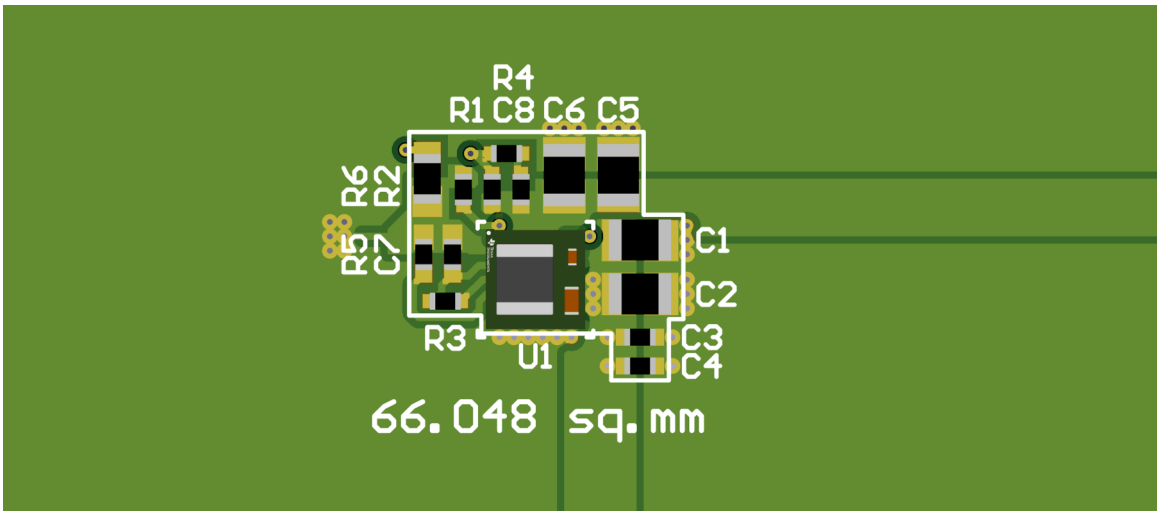

Figure 2-3. TPSM843620 PCB Design Size

The total design size of the TPSM843620 module circuit design was measured to be approximately 66.048 mm^2.

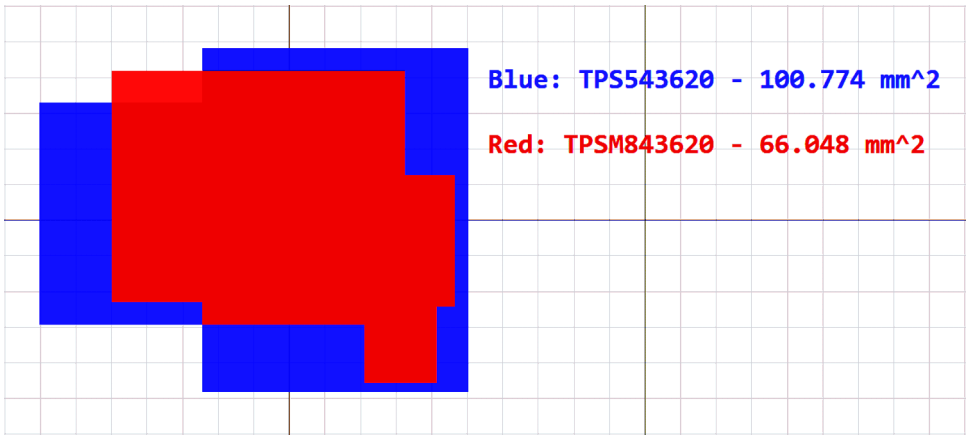

Figure 2-4. PCB Design Size Overlay Comparison

When comparing the PCB design size of both the TPS543620 converter and the TPSM843620 module, it is clear that the module has a smaller design size than the converter by about 34.5%. This noticeable difference is because the module uses a small MicroSiP package and reduces the number of external components to significantly decrease the final design size.

2.1.3 Minimizing External Components

As mentioned, external components are integrated into TPSM843620 to reduce design size, Figure 2-5 and Figure 2-6 show that the TPSM843620 requires less components to be configured to the application when compared to the TPS543620. The overall reduction of external components allows the TPSM843620 to have a further reduced PCB design size when compared to the TPS543620.

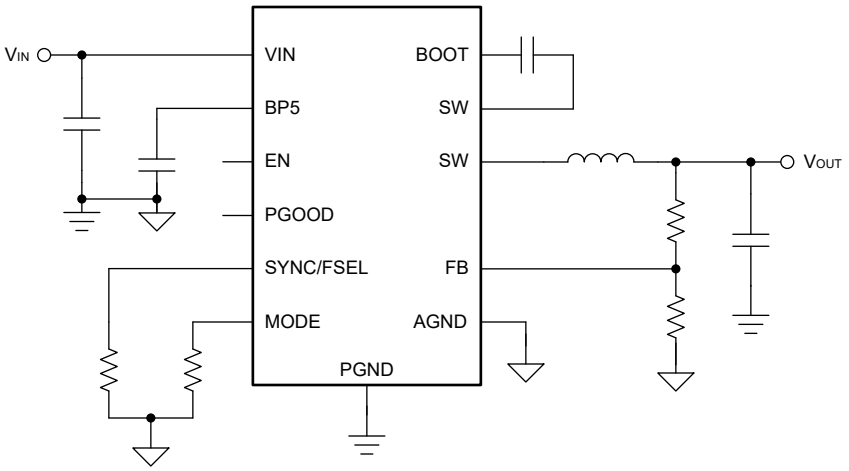

Figure 2-5. TPS543620 Simplified Schematic

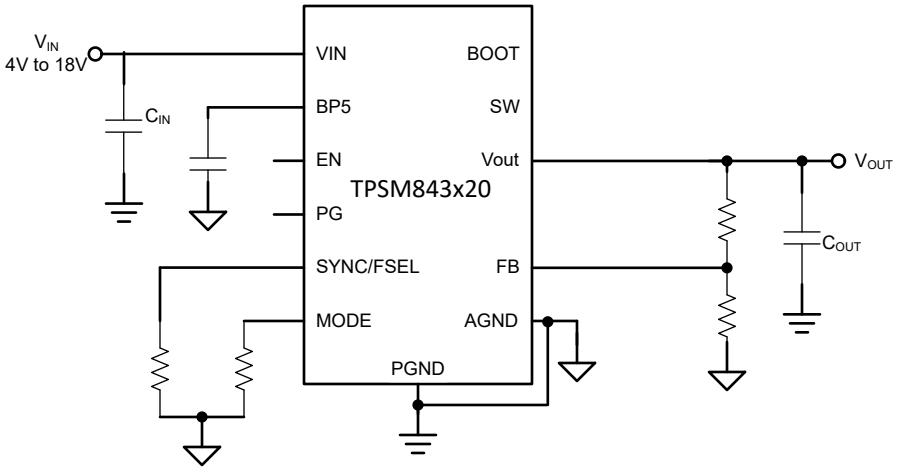

Figure 2-6. TPSM843620 Simplified Schematic

3 Performance

3.1 Flexibility and Application Optimization

The efficiency of both devices is an important factor to consider when comparing the TPS543620 family and the TPSM843620 family. With the TPS543620 family having more flexibility in regards to inductor selection, the TPS543620 family allows the user to further optimize the performance of the converter for their application. However, TPSM843620 family still offers great performance across a wide range of applications under 6 A. TPSM843620 family allows for high efficiency at high switching frequencies as well making it a strong power dense device. Figure 3-1 shows the efficiency of the TPSM843620 at different input voltages and output currents.

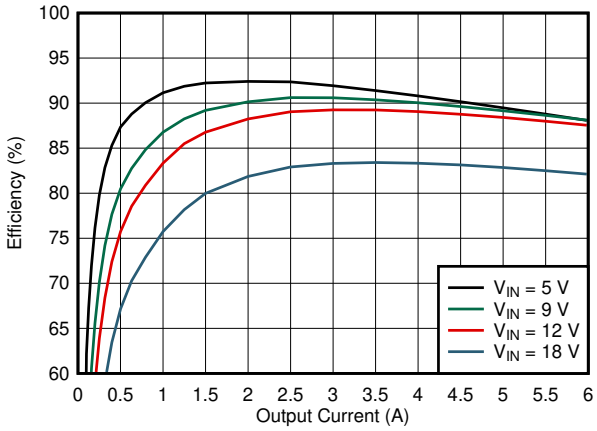

Figure 3-1. TPSM843620 Efficiency Graph

4 Design Complexity

The TPS543620 series is a discrete converter option that provides additional design flexibility, with the inductor being changeable to directly meet one's individual needs. However, to effectively use this versatility, power design knowledge is required. A module component, on the other hand, such as the TPSM843620 family, can enable an easier time to design/validate a workable design. Using power modules vs using converters can also take less time to design and create than a converter, reducing total time to market and development costs.

There are a few advantages of the TPSM843620 family that allow for a simpler design. The module package is subjected to extensive testing and characterization to make sure that the component is compatible with many designs. This allows design engineers to easily figure out and account for the characteristics such as thermals without any extensive testing. The TPSM843620 family is subjected to thermal characterization and the data is also recorded in the data sheet for design reference. Data such as the module's thermal at different power conditions and potential derated performance can be useful for simplifying the thermal design process.

While the TPS543620 family provides greater flexibility at the expense of a more complex design than the module equivalents, there are additional hazards associated with the addition of more parts to the BOM that must be considered. As the number of components increases, so does the ordering complexity for procurement. A more complex sourcing process carries more risks, such as reduced reliability in shipping and delivery periods. This is an important component to consider while creating a design.

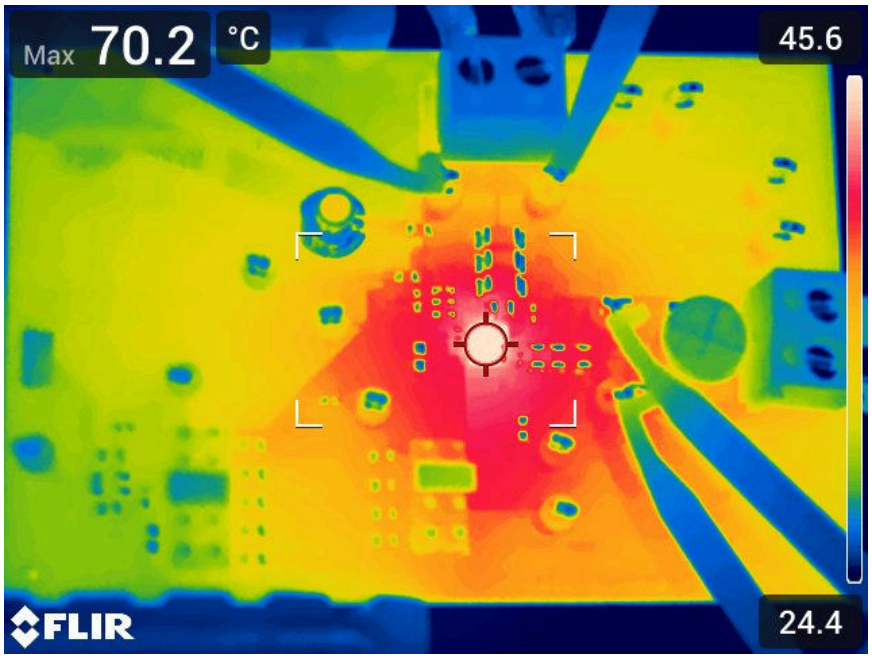

Figure 4-1. TPSM843620 Thermal Image

5 Total Design Cost

When developing a project, the cost of a component is a critical variable to consider. When comparing the prices of the TPS543620 family and the TPSM843620 family, it is clear that the TPS543620 family has a cheaper upfront cost than the TPSM843620 family. This is due to the fact that the TPSM843620 series is a modular design with integrated inductor and capacitor components, giving TPSM843620 series a more comprehensive package than the discrete converter counterpart. The TPS543620 family, is also a discrete design family that requires extra external components to be implemented. While the TPS543620 family has a similar BOM cost to the TPSM843620 family, design complexity and other considerations complicate cost comparison.

The TPS543620 family is a more discrete design where more external components can be required when compared to the TPSM843620 family. While the overall cost of the discrete design and external components might be similar than the initial BOM cost of the TPSM843620 family, there are several additional cost factors to be taken into consideration when using external components. One consideration is the additional cost of qualifying these external components. Before a product is taken into market,the product needs to endure several rounds of extensive qualifications to guarantee that the product can function as intended. Extensive resources are invested in the qualification of a new product after the design process. The addition of external components results in additional resources being dedicated on further testing to see if these components are qualified to be implemented into the design. These additional components and the cost with verifying the components can be cut out of the equation when going with a module component like the TPSM843620 due to many of these external components being integrated into the package. The TPSM843620 undergoes several rounds of internal qualifications before release to make sure a high standard of performance and reliability in any design, which ends up being more cost-effective over time. In the event that failure occurs, it is significantly easier to replace a module component when compared to replacing a discrete component with extra external components.

The monetary cost of testing is a very important factor to consider, but cost of time can be just as important. When going with discrete designs, more time needs to be dedicated to researching and selecting an external component from the list of potential designs. Running these components through a lot of individual stress tests can also be a very time-consuming process. In addition, due to the uncertainty of external components, a failure in the testing process can require a reselection of the components or even a complete redesign of the circuit. This can greatly increase the time complexity of the development process.

6 Summary

The performance of both components must be considered when contrasting the TPS543620 family with the TPSM843620 family. The TPSM843620 family has a set inductor, hence the module's potential for performance flexibility is lower than the TPS543620. However, the TPSM843620 family continues to deliver excellent performance and is comparable to the TPS543620 in many applications. With the addition of the MicroSiP package, the TPSM843620 family allows for higher power density when compared to the TPS543620 family. This size reduction not only helps with space constraints and allows for additional features to be added to the product. While the upfront cost of the TPSM843620 family is more than that of the TPS543620 family, additional costs associated with designing and additional testing can make the TPSM843620 family win out in terms of overall cost. for these reasons, the TPSM843620 is a very attractive option for customers who are willing to pay a higher up-front cost for higher power density and a simpler and quicker design process.

7 References

- Texas Instruments, *TPSM843620 4-V to 18-V Input, 6-A Synchronous SWIFT™ Step-Down Converter MicroSiP™ Power Module With Integrated Inductor and Internally Compensated Advanced Current Mode Control*, data sheet.
- Texas Instruments, *TPS543620 4-V to 18-V Input, 6-A Synchronous SWIFT™ Step-Down Converter with Internally Compensated Advanced Current Mode Control*, data sheet.

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