Choosing the Right DC/DC Solution for Automotive Front Camera Systems

We may still have to wait some time for widely available autonomous vehicles, but advanced driver assistance systems (ADAS) are becoming more robust every year. One of the most important enablers of these systems is the front camera. Front camera systems take video data of the road and environment in front of the vehicle and interpret information such as traffic lights, other vehicles, and pedestrians. At the heart of these intelligent systems are powerful application processors. While they enable powerful features, these processors have challenging power requirements that make choosing a power solution with good thermal performance especially critical.

What's Driving Higher Power Requirements?

The Society of Automotive Engineers (SAE) classifies 'how autonomous' a vehicle is into five levels. A major trend in ADAS today is the move from Level 2 vehicle automation systems, where the car can assist with functions like steering and acceleration, to Level 3 vehicle automation systems, where under certain conditions (like freeway driving) the car can operate independently of a driver. To enable Level 3 automation, front camera systems must process significantly more data, and their power requirements increase accordingly.

Since the environment these systems operate in remains small and enclosed, it's important to design a power solution with good efficiency and thermal performance. In this note, we'll focus on the parameters that can help you select an effective buck converter solution for the high current point-of-load rails that are common in front camera systems.

Thermal Considerations

While it's not the only contributor to a converter's thermal performance, efficiency is a good starting point for determining if a device will fit your application. Using a device with low $R_{DS(ON)}$ MOSFETs will enable a power solution that is efficient across the full load range. Figure 1 compares measured efficiency data between TI's TPS54618-Q1 and similar devices from other suppliers under a common operating condition for ADAS systems.

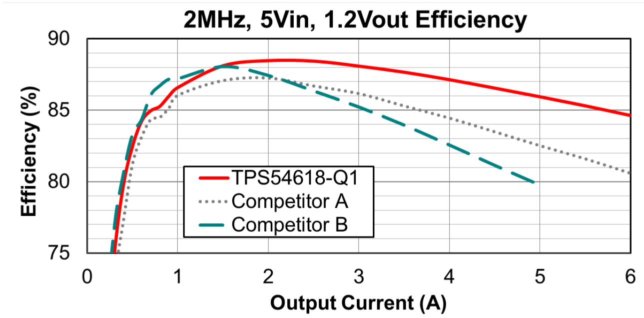

Figure 1. Efficiency of TPS54618-Q1 vs competitors' devices

At 5 A output, the TPS54618-Q1 has 3.5 to 6 percentage points higher efficiency than other solutions. This represents a 30 to 55% reduction in power loss (shown in Figure 2), which ultimately means there is less heat to be dissipated in the front camera system.

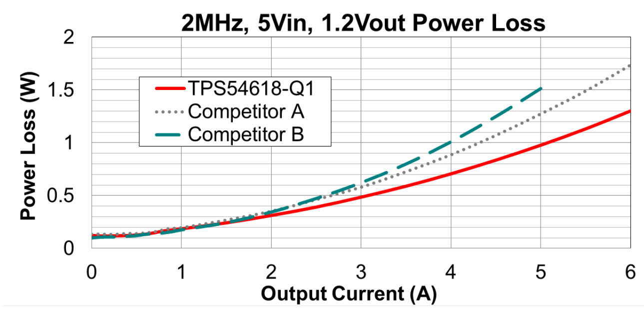

Figure 2. Power loss of the same devices as above

In addition to efficiency, package thermal resistance ($R_{\theta JA}$) is also useful for estimating how much heat the converter can dissipate. Temperature rise, the product of thermal resistance and power loss, is important because it governs both the maximum ambient temperature in which a buck converter can operate and how much current it can output before hitting thermal limits. In automotive systems, where ambient temperatures can be upwards of 80 °C, a converter with poor temp rise can quickly hit its maximum operating junction temperature. Below are the calculated temp rise values for each device at 5 A load.

DEVICE	$R_{\theta JA}$ (°C/W)	POWER LOSS (W)	EXPECTED TEMP RISE (°C)
TPS54618-Q1	44.3	0.98	43.49
Competitor A	38	1.27	48.32
Competitor B	43	1.52	65.48

To illustrate how these parameters affect real device operation, Figures 3, 4, and 5 show the evaluation boards for each device in thermal steady state with a 5 A load at room temperature. The measured device temperatures are not as high as predicted based on the $R_{\theta JA}$ values listed in the datasheets because the effective $R_{\theta JA}$ of each device on its evaluation board is lower in practice. Nonetheless, the thermal performance does follow the anticipated trend based on power loss and thermal resistance.

As expected, Competitor B's device is the hottest due to its high power loss. Even though Competitor A's device has significantly more power loss than the TPS54618-Q1, it only gets a few degrees hotter. This is primarily the result of its lower effective thermal resistance due to a larger package size and a much larger board design with more copper filling. This board design may not be representative of what would be expected in a true space-constrained automotive front camera system. Overall, the TPS54618-Q1 has the best thermal performance even with a small PCB area.

Conclusion

As front camera systems evolve to support higher levels of automation, their power requirements become more aggressive. This necessitates choosing a power solution with good thermal performance. While efficiency is an important piece of the puzzle, it's critical that designers don't overlook the other factors that contribute to thermal dissipation, especially in automotive applications where board space is limited and ambient temperatures are high.

For further reading on TI's automotive point-of-load buck converters, see Let's break it down: how buck converters make your power supply more flexible. For an intro to thermal metrics, see Semiconductor and IC Package Thermal Metrics. See TIDA-00805 and TIDA-01524 for examples of complete high efficiency power designs for ADAS applications. When you're ready to get started on your front camera system design, visit TI's Front Camera portal for more technical documents, device recommendations, and reference designs.

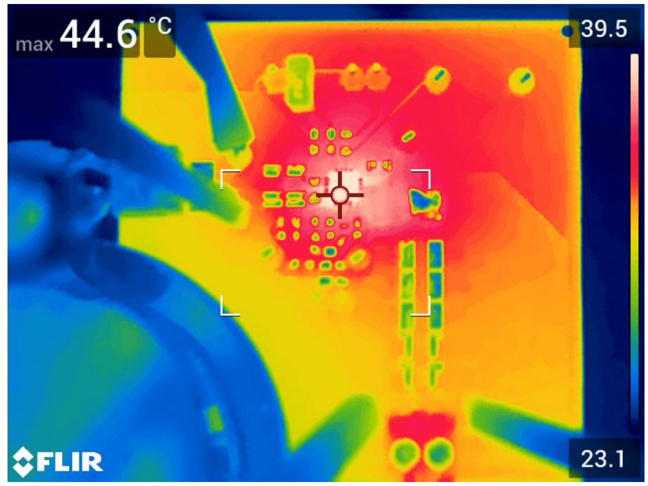

Figure 3. TPS54618EVM-606 Thermals

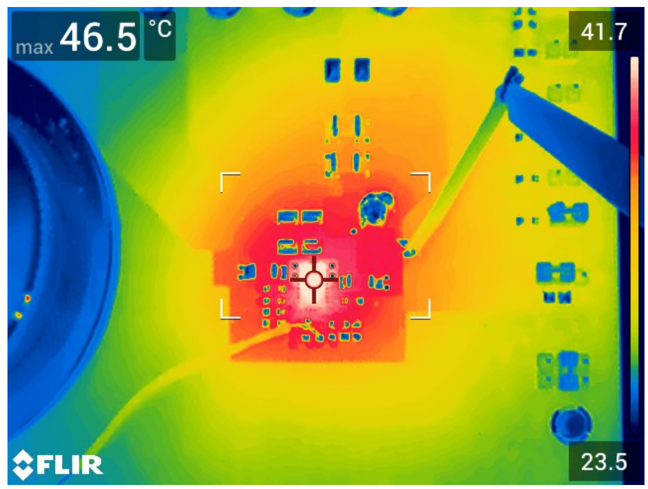

Figure 4. Competitor A's Evaluation Board Thermals

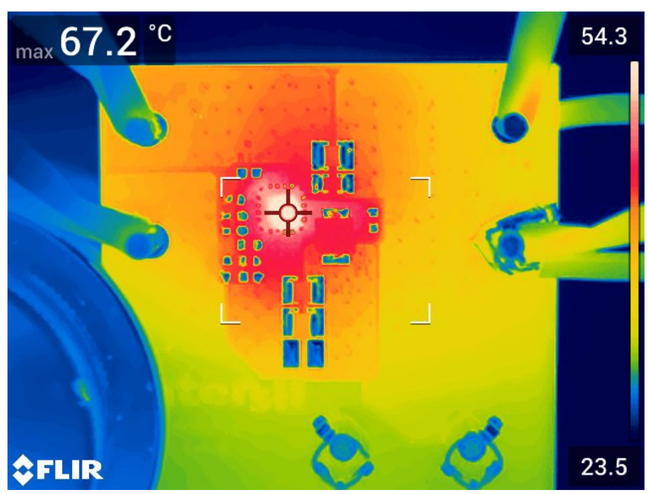

Figure 5. Competitor B's Evaluation Board Thermals

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