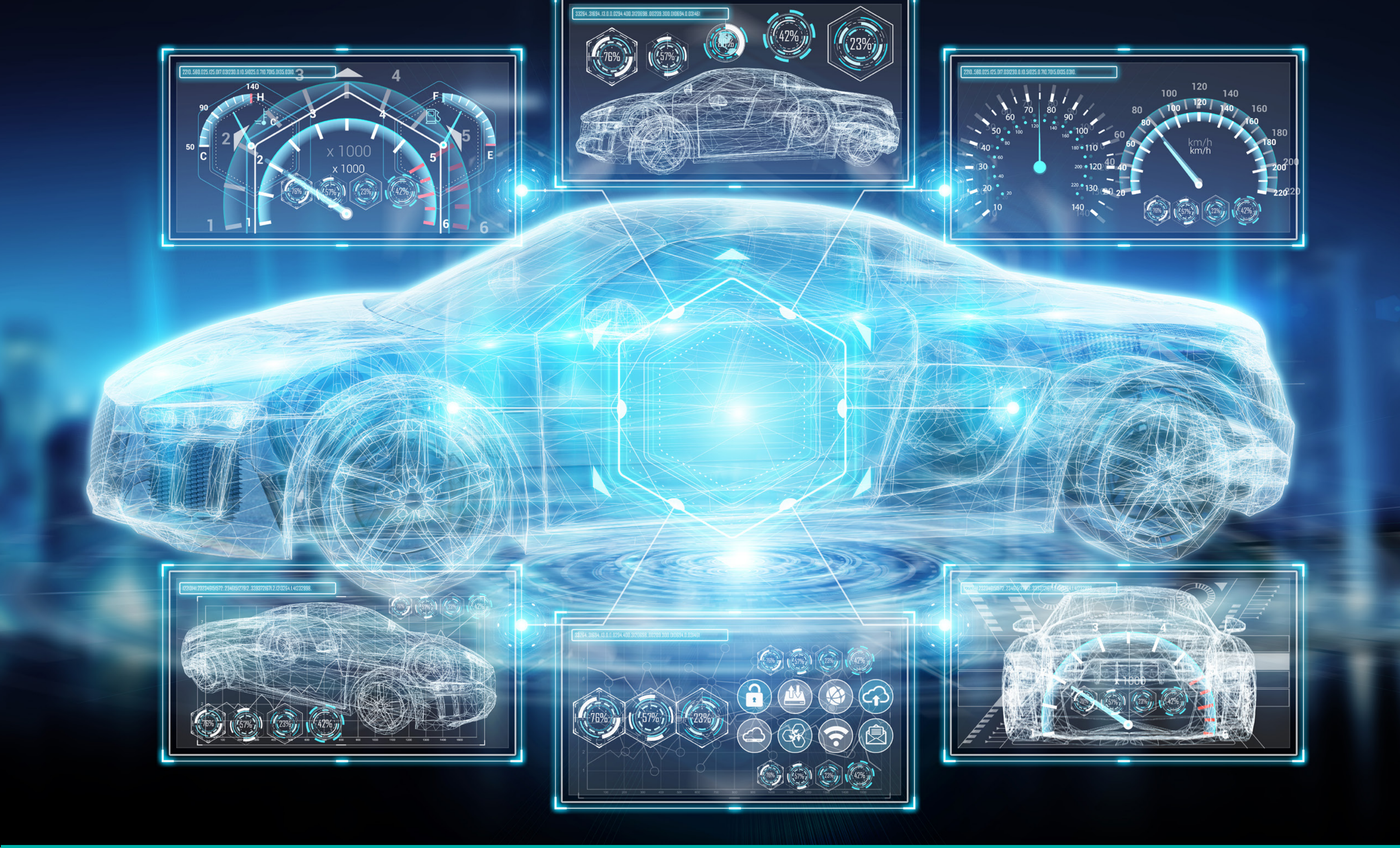

Balancing Power Supply Requirements in ADAS Applications

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Abstract

Thanks to advanced driver assistance systems (ADAS), cars are becoming safer to drive. The cameras in these systems, in combination with sensors, sophisticated algorithms, and microprocessors, are alerting drivers to obstructions in the roadway, braking for them when necessary, pointing out blind spots, and more. To operate properly, ADAS applications require power supplies that meet certain voltage accuracy and load transient requirements. This paper examines the criteria needed to ensure that car battery voltages are properly regulated to sufficiently power ADAS cameras, sensors, and processors in the harsh operating environment of the vehicle.

Introduction

Ensuring a Safer Drive

Today's automotive power management ICs must be precise, flexible, and small

Applications like ADAS are driving an increase in in-vehicle processing power to run the advanced algorithms that are guiding drivers on a safer path. With more processing power, of course, comes the need to manage the power supply in order to align with system performance targets. However, given the noisy operating environment of vehicles, with their multiple electronic subsystems, balancing power demands with power constraints is quite a challenge.

In fast-growing segments like ADAS modules, infotainment head units, and smart instrument clusters, many automotive engineers are powering each component via multiple power rails, often with specific voltage regulation precision requirements (Figure 1). To meet these stringent system requirements, automotive power management solutions that deliver precision, flexibility, and small solution size are essential. Thermal constraints, electromagnetic interference (EMI), and heat dissipation are other key considerations that need to be addressed.

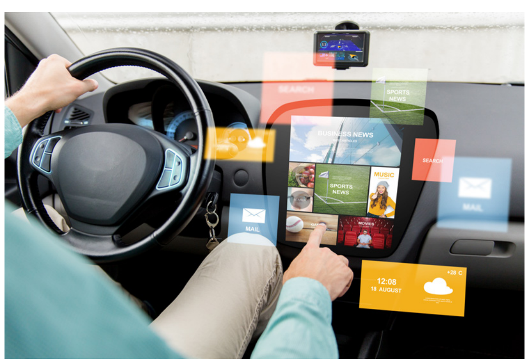

Figure 1. Vehicle infotainment systems are among the automotive applications that would benefit from precise, flexible, and small power management solutions.

Meeting Electrical and Power Needs in Vehicle Subsystems

Managing the electrical and power considerations of vehicle subsystems requires a delicate balance. Processors, memories, displays, and other components need well-regulated voltages at various current levels. The regulators, in turn, must be efficient in order to deliver the power needed to run these critical circuits without too much heat dissipation. When there are multiple power rails in play, that's when things get really complicated because there are so many more voltage and current spikes to manage. Certain voltage rails in a car have specific voltage accuracy requirements. For example, to guarantee performance levels, system-on-chip (SoC) cores generally have a specified voltage tolerance. Processor performance is no longer guaranteed when the voltage is out of spec. Given the critical nature of ADAS applications for safety, this is clearly an unacceptable direction.

Then, there's the car's electrical and thermal environment to factor into the equation. DC rails in cars are noisy. There are large and sudden drops when the car is started in various temperature situations, such as cold cranking, warm cranking, or

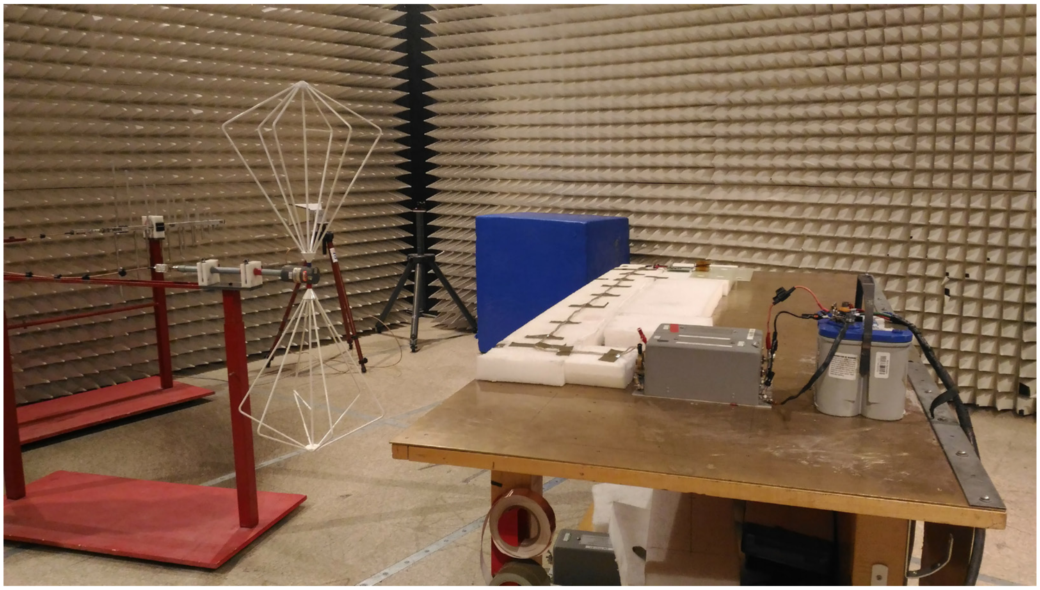

Figure 2. Maxim's automotive PMICs undergo conducted and radiated emissions testing to pass the stringent CISPR 25 Class 5 specification.

load dump scenarios. Load transients like these basically occur when the processor suddenly faces an increased demand and draws more current. For instance, the processor could be in standby mode at one moment, consuming about one-third of its peak power. Then, when the processor is called to action, it could draw the full amount of its current. In this scenario, the switch-mode power supply's output voltage would temporarily dip and then bounce around before settling in at its target voltage. The key here in dealing with these load transients is to have a well-designed power converter manage the output voltage swing to prevent the swing from going out of spec and, thus, impacting the performance of the processor.

EMI is another challenge that engineers need to mitigate. Cars have a lot of RF electrical noise from both internal and external sources, causing EMI that can hamper performance in various vehicle subsystems. Inside today's vehicles are a host of electrical subsystems, from automotive networking systems to the safety systems, all in close proximity in a very confined space. Outside, everything from mobile phones to transmission towers emit noise that can affect the car's performance (Figure 2). Automotive OEMs must ensure that electronic systems do not emit excessive EMI and that they are immune to noise from other subsystems (CISPR 25 from the International Special Committee on Radio Interference provides a standard for conducted and radiated emissions in vehicles.)

Many existing systems utilize discrete

power solutions for each voltage rail because of the limited availability of options to address system power requirements. For example, some Tier 1 companies use one set of linear and switching DC-DC regulators for each DC power rail in their design. However, this approach calls for expertise in carefully selecting the right component to address each rail's requirements. Without the right combination, there's potential for EMI and interference issues due to the frequency mixing. Some opt to integrate components with more capacitance into their designs to dampen voltage ripples with load transients; however, automotive-qualified components with greater capacitance are costly. As for EMI, metal enclosures to shield the ADAS subsystem from radiation can be effective, but the tradeoff is added cost and weight. Spread-spectrum frequency modulation, on the other hand, has proven to be effective for EMI mitigation.

EMI has become a bigger problem in vehicles, but not all mitigation methods are suitable for cars

Automotive-Grade PMICs that Meet EMI Standards

Meeting ADAS performance and power requirements while passing EMI standards calls for automotive-grade power management integrated circuits (PMICs). The high level of integration available in these devices reduces overall solution size. The inclusion of a spread-spectrum oscillator mitigates the effects of EMI. High output voltage accuracy across temperature and voltage operating range ensure that the devices will meet tight SoC core voltage requirements. Automotive Safety Integrity Level (ASIL) compliance provides the assurance of functional safety.

Maxim's broad portfolio of automotive-qualified PMICs, which work with any microprocessor or microcontroller, address power requirements while also meeting needs for high efficiency and small footprint. The newest members of the low-voltage PMIC family (many of which have pin-compatible ASIL-C variants) include:

- MAX20014 high-efficiency, three-output DC-DC converter, which features a synchronous 3.8V to $8.5V_{OUT}$ 750mA boost converter, dual synchronous 1A to 3A buck converters, 2.2MHz switching frequency, and spread-spectrum oscillator in a 24-pin, 4mm x 4mm TQFN-EP package. It is used in conjunction with the MAX20003 36V, 3A high-voltage buck converter
- MAX20075/76 36V, 600mA/1.2A mini buck converter with 3.5µA quiescent current and integrated high-side and low-side switches, available in a 3mm x 3mm 12-pin TDFN package

For cameras in ADAS applications, Maxim also offers these new camera-protection PMICs:

- MAX20087 ASIL-B-/D-grade quad/dual camera power protector IC, which features high-side current limit to protect individual camera modules
- MAX20019 dual synchronous buck converter, providing the industry's smallest 3.2MHz dual step-down power supply in a 2mm x 3mm package

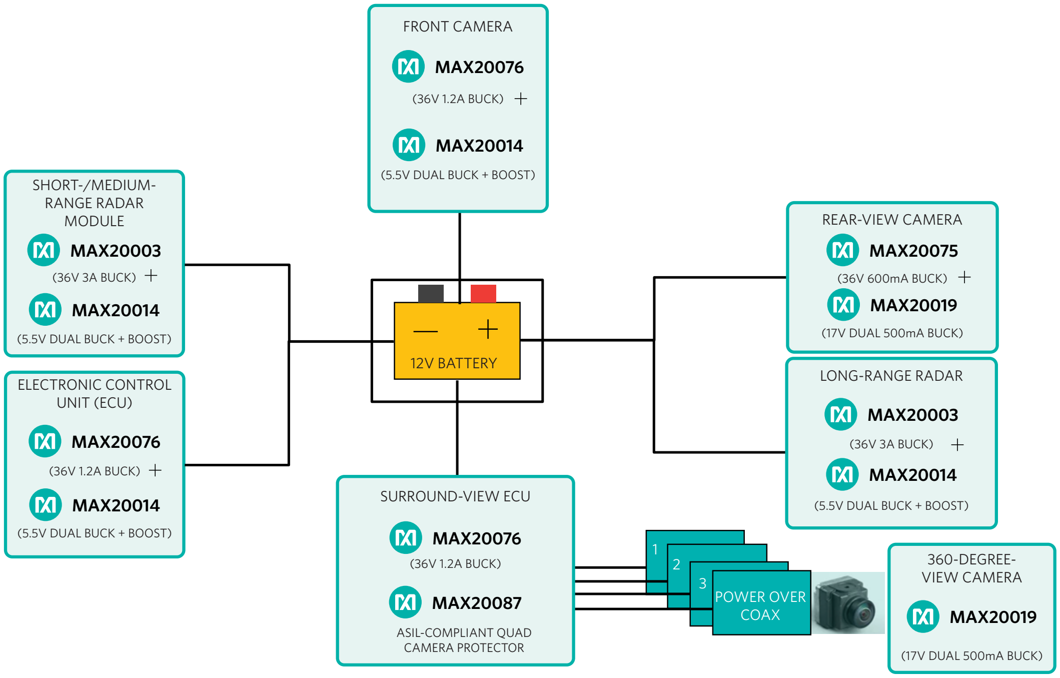

Figure 3. Maxim power management solutions can be integrated into various automotive subsystems.

Summary

As cameras, sensors, microprocessors, and other underlying components for ADAS applications continue to become more prevalent in next-generation vehicles, the need to precisely manage the power supplies for them becomes more critical. Automotive-grade PMICs that balance power demands with power constraints, while addressing EMI and small solution size requirements, play an important role in ensuring that safety functions do their job well.

Learn More

Find out more about Maxim's Power Management Technologies for ADAS.

Find out more about Maxim's ADAS Technologies.

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