Choosing the Right Automotive ICs for Next-Generation Vehicles

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July 2018

Abstract

From lane departure warnings to pedestrian detection capabilities, safety features in cars are continuing to increase in sophistication. Much of this progress is due to advancements in the electronic components behind advanced driver assistance systems (ADAS) and infotainment applications. In this paper, we'll take a look at the technical capabilities needed to support applications such as vehicle networking, power management, lighting, and signal-chain control.

This white paper originally appeared on Avnet's website.

Introduction

Inside Safer, Smarter Cars

Safety, infotainment, and other capabilities rely on a host of automotive-grade ICs

Thanks to engineering ingenuity and the electronic components that have become pervasive inside vehicles of all types, cars are smarter and, in many ways, safer to drive. As the automotive industry advances toward Level 5 fully autonomous vehicles, automotive engineers will have to continue driving more functionality out of vehicle subsystems that deliver safety, infotainment, and other features.

Today, many of us are already benefiting from semi-autonomous capabilities like adaptive cruise control, lane departure warning, pedestrian detection, automatic braking, and blind-spot monitors. The underlying technologies that are making these functions possible will continue to be critical to enable self-driving cars.

What enables these types of applications are high-bandwidth data links which transport incredible amounts of data from a variety of sensors—cameras, radars, and, in some cases, LiDARs to the processors. In addition, advanced power solutions supply tens or even hundreds of watts to these processors, and do so with the highest possible efficiency and accuracy to ensure these processors always operate in the most optimal state.

In addition, vehicle interiors are quickly going digital with large, high-resolution displays as consumers demand no lesser infotainment experience than what they get on their latest TV sets or personal devices. This further drives the need for high bandwidth, low-latency data links, and advanced power solutions.

Let's take a closer look at what is needed to enable safer, smarter cars.

Vehicle Networking Calls for Lightning-Fast Serial Links

Today's ADAS and infotainment systems require massive amounts of bandwidth to transport voluminous amounts of audio and video data. If tomorrow's cars are to support simultaneous activities such as video conference calls, gaming, HD video streaming, and the like, then even faster serial links will be in demand. Ethernet is a common element inside cars, given its ability to transport data over a link 100x faster than a CAN bus (which is more suitable for low-bandwidth communications). Demands for transporting megapixel resolution images with low latency inside cars are outstripping the capabilities of Ethernet. What's more, video feed running through Ethernet pipelines must be compressed at the source and then decompressed at the destination. Compression is problematic for the machine vision technology that is becoming critical for safety functions like object and pedestrian detection, as compression results in artifacts and lost information.

Maxim's Gigabit Multimedia Serial Link (GMSL) serializer/deserializer (SerDes) technology offers an answer. GMSL SerDes links simultaneously transport HD video, audio, control information, aggregated sensor data, and Gigabit Ethernet over 15m of a single coaxial or shielded-twisted pair cabling. It meets the stringent specifications for automotive electromagnetic compatibility (EMC), and can transport multi-megapixel images without compression. A built-in spread-spectrum feature reduces EMI of the link. To address concerns over vehicle weight, the power-over-coaxial architecture of GMSL SerDes ICs eliminates the need for additional power or ground wires. Also, due to the bidirectional architecture of GMSL, a single microcontroller can program the serializer, deserializer, and all of the connected peripherals, eliminating the need for a remote-side microcontroller and its support components. Figure 1 shows how support for video multi-streaming enables multiple vehicle displays, while Figure 2 depicts a video aggregation example.

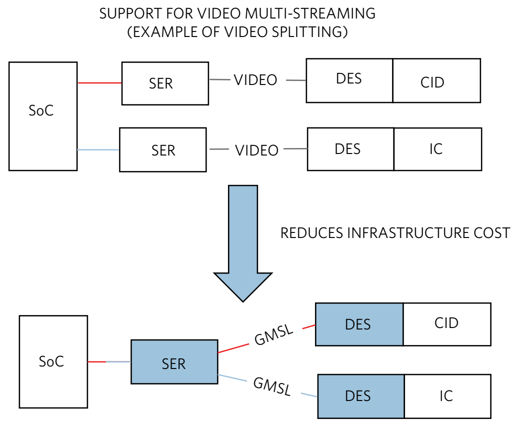

Figure 1. The ability to split video streams from an SoC allows a single data stream to be split into multiple streams to drive multiple displays in an automotive information cluster (IC) and the central information display (CID).

Maxim developed a quad deserializer (MAX9286) that's designed to work with surround-view camera clusters. The backchannel is used to synchronize the cameras so that frames are delivered in a synchronous fashion to the host.

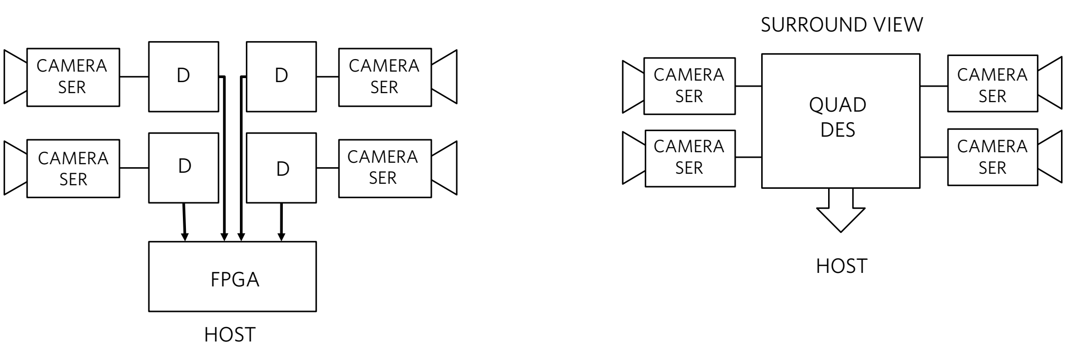

Figure 2. Video aggregation example.

Why Diverse Power Management is Important

The increase in powered control modules, sensors, actuators, and motors distributed throughout today's vehicles is creating a greater need for more diverse power management and voltage regulation circuits. These ICs are needed to manage the power at the point of load in each of these devices.

As an example application, let us take a look at the head unit, which supports a variety of electronic functions from its place in the console and instrument cluster. Here is where you'll find various displays, signal routing functions, the user interface, and internal electronics. The head unit can contain as many as 10 major subsystems, making it a critical location for providing multiple DC-power rails and addressing heat dissipation. Well-regulated voltages at various current levels are needed for the processors, memories, displays, and other components. It's essential for the DC-DC regulators to be efficient in order to minimize the associated temperature rise from the power subsystem. Regulator efficiency is also important even when the regulators are providing just a few milliamps of current to keep critical circuits functioning (examples here include keyless entry, the clock, and alarms). After all, a driver would certainly be disappointed if the car battery depletes to a level where the car can't start if the vehicle has just been sitting in the garage for a few days or weeks. Then there's the inherently harsh electrical and thermal environment to consider. Regulation circuitry has to

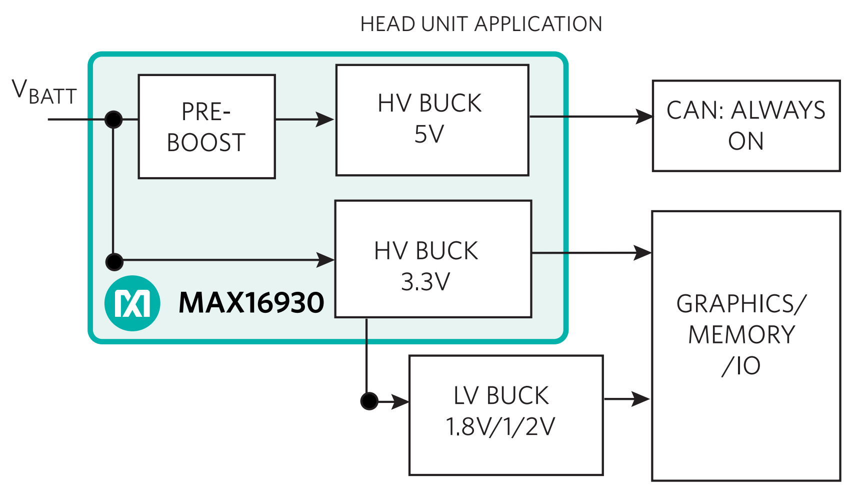

Figure 3. The MAX16930 provides an example of a dual buck with preboost and 20µA quiescent current. The preboost enables robust CAN bus operation during cold crank and start up. Low quiescent current minimizes the amount of discharge in the car battery during standby. The device operates 180 degrees out-of-phase at frequencies up to 2.2MHz to allow small external components, reduced output ripple, and to guarantee no AM band interference. To minimize EMI, the device provides a spread-spectrum option. The MAX16930 can be used for navigation and radio head units, as well as automotive power applications.

resist the effects of transients that occur due to the noisy basic DC rail of the car, not to mention the transients and load dumps stemming from start-stop mode. Electromagnetic interference (EMI) must also be mitigated to prevent impact on performance of various automotive subsystems.

One approach to addressing these challenges is to use one set of linear and switching DC-DC regulators for each DC power rail required in the design. But this approach requires considerable skill in choosing the right component to meet the requirements for each rail. Based on the frequencies used in the switching regulators, EMI and interference consequences of frequency mixing could arise, impacting performance. Highly integrated, automotive-grade power management ICs (PMICs) that provide multiple DC rails are a more effective option. Maxim offers a vast variety of PMICs as well as DC-DC converters, voltage regulators, and USB charging devices for automotive power management and lighting applications. The MAX16930, as shown in the head unit block diagram in Figure 3, is an example.

LED Drivers Help Light the Way for Safer Rides

Thanks to LED lighting technology, we have brighter, smarter, and more energy-efficient automotive lighting. To ensure optimal performance, automotive LED lighting design challenges must be addressed. Consider high-brightness (HB) LEDs. In this type of lighting, inherently high switching frequency can cause EMI.

A vehicle's harsh thermal and electrical environment is a factor affecting IC selection

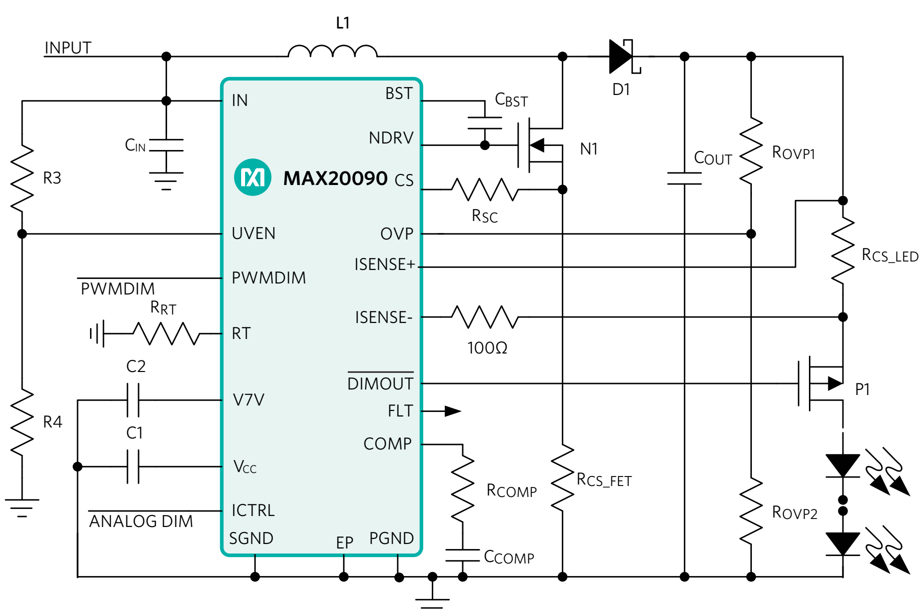

Figure 4. Typical operating circuit of the MAX20090, which is ideal for automotive front-light applications such as high beam, low beam, and daytime running lights.

EMI can also be tough to tackle in matrix lighting, where there are many LED lights in a densely concentrated space. Some of the methods to minimize EMI, unfortunately, can induce flickering.

Maxim offers LED driver ICs with capabilities such as wide dimming ranges, fault tolerance, and EMI reduction. The MAX20090 single-channel HB LED controller, for example, drives a string of LEDs with a maximum output voltage of 65V, providing flexibility for boost, high-side buck, SEPIC mode, and buck-boost mode configurations. It features built-in spread-spectrum modulation for improved electromagnetic compatibility performance.

In addition to MAX20090 (shown in Figure 4), Maxim offers a family of AEC-Q100 qualified linear and switching regulators (SEPIC, boost, buck/boost) for interior and exterior automotive lighting applications.

Low-Noise RF and Wireless ICs for Infotainment Applications

Vehicle infotainment systems have evolved to encompass much more than radios and navigation features. Active noise reduction, in-vehicle connectivity, security systems, and visual sensors like back-up cameras are all grouped into the infotainment category. Traditional infotainment architectures have had separate analog and digital RF blocks serving as signal sources and connected to a multimedia processor that feeds audio and visual displays and speakers. This architecture works well but is expensive to design and manufacture and can be a burden in terms of space and power consumption.

What today's and tomorrow's vehicles need is an architecture that minimizes power and footprint. Maxim's highly integrated radio, navigation, and television tuners and receivers deliver low power and low noise in small packages for vehicle infotainment systems. Low-noise amplifiers support applications including remote keyless entry, navigation, telematics, and active antennas. The MAX2181 (Figure 5) provides an example of an amplifier for automotive antenna applications. The company's GPS, GLONASS, Compass, and Galileo front-end ICs simplify the design of navigation systems.

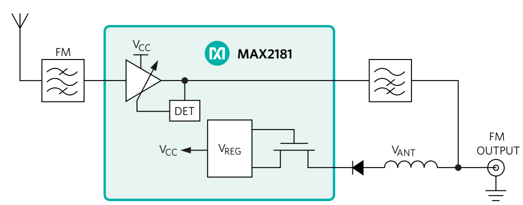

Figure 5. Simplified block diagram of MAX2181, an example of a highly integrated FM variable-gain low-noise amplifier for automotive FM and FM-diversity active antenna applications.

High-Performance Analog ICs for the Signal Chain

Closed-loop signal-chain control is enabling automated capabilities that are enriching the functions in vehicles. Features such as antilock brakes, cruise control, automatic transmissions, and traction controls all utilize the signal chain. Another example of an automotive signal chain is the electronic control unit (ECU), which controls the engine as well as the features just noted. The ECU provides a good example of a signal chain because it senses one or more physical parameters, applies logic or intelligence, and produces an action to benefit the user[1].

Integrated analog ICs can help optimize signal chain designs. Amplifiers, interface ICs, data converters, and voltage references are among the wide selection of high-performance, low-power analog ICs that Maxim provides for automotive signal chain applications.

Summary

The road to safer, smarter cars is paved with highly integrated, innovative and reliable ICs. From PMICs to LED drivers, high-speed serial links, RF and wireless ICs, and high-performance analog ICs, an array of circuitry is enabling a variety of vehicle subsystems. With these technologies, automotive designers are enhancing today's and tomorrow's vehicles with sophisticated ADAS, infotainment, and other autonomous functions.

Learn More

Get more insights into Maxim's automotive technologies, including solutions for infotainment, ADAS, body electronics, power and lighting, and EV powertrain.

Notes:

1. https://www.maximintegrated.com/en/app-notes/index.mvp/id/4490

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www.maximintegrated.com