APPLICATION NOTE 5810

AUTO INFOTAINMENT - DRIVING THE COURSE FOR CONNECTIVITY

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Abstract: System solutions from Maxim Integrated make it possible to cultivate a forward-looking automotive infotainment landscape.

A similar version of this article appeared February 20, 2014 in *EE Times Europe*.

Maxim Integrated offers market-leading semiconductor solutions that are used in modern in-vehicle infotainment systems as well as in the networking infrastructure for the electrical systems employed in modern automobiles. An overview of the latest developments.

Evolution of Auto Infotainment

Over the past few decades, in-car infotainment capabilities have evolved continuously. It all began with simple audio systems adapted to meet the needs of the motor-vehicle environment. Later other services were added, such as Germany's "*Autofahrer-Rundfunk-Informationssystem*" (Car Driver's Radio Information System) for receiving traffic announcements from radio stations in the mid-1970s. That was followed in 1998 by the Radio Data System (RDS), later renamed Traffic Message Channel (TMC), which made it possible to transmit traffic data right into the car.

These services were implemented through analog radio broadcasting, so all of the functions were contained in the car radio. In the 1990s, however, the emergence of navigation systems (GPS) augmented the functionality offered by a conventional car radio. This marked the start of a new era for automotive infotainment. Now GPS required additional IT-based data processing, more technical capabilities for evaluating the GPS signals, and input from other sensors to calculate the vehicle's exact position. To operate the GPS system and deliver information, the user interface had to be expanded. More system enhancements were needed, including sophisticated display units offering higher information densities, and high-resolution color displays and input units with advanced controls, such as rotary-push knobs. Later systems operated with the aid of touch screens, voice control, and gesture control.

New Designs Bring New Challenges

These sophisticated user interfaces made it possible to integrate other functions that were formerly not available as independent units, such as on-board computers, telephony, vehicle-specific configurations and, of course, a multitude of multimedia applications.

We begin by examining radio reception in the vehicle. The traditional AM/FM radio has turned into an infotainment system. The various transmission standards developed over the years frequently employ a very heterogeneous structure. Individual functions are often realized as separate hardware blocks that use specific software. Examples of this include analog AM/FM radio, digital audio broadcasting (DAB) radio, analog/digital TV, navigation, and digital satellite reception (**Figure 1**).
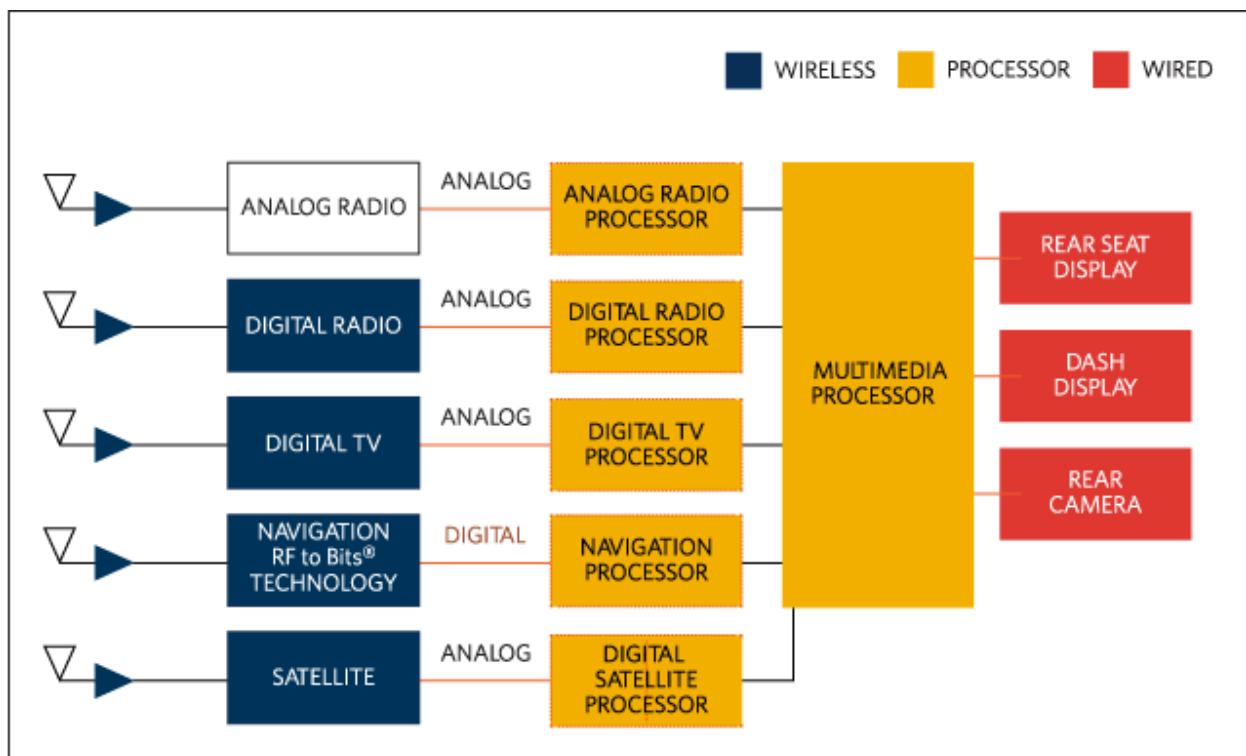

Figure 1. The current infotainment approach uses dedicated hardware connected with a dedicated interface technology.

Separate hardware and software components are employed for each reception system, which increases the costs and space requirements and lengthens the development periods. It also restricts new design flexibility.

Different regional standards increase the complexity, and with that usually comes greater cost. New designs must remove redundancies; they must coordinate and integrate whatever different versions are required for different countries. Meanwhile, the possibilities for providing software updates to keep pace with changing requirements are very limited. There are high power-consumption requirements to meet. The heat that arises from increased package density creates additional problems. Beyond that, the efforts required to integrate systems and ensure the simple reusability of functional blocks are also a challenge.

New Generation of Receiver Modules

There is a new design approach that resolves these requirements. A new generation of receiver modules is based on Maxim's RF to Bits® architecture and the first DAB/FM tuner (the MAX2173) is already available.

Today, modern standard processors with sufficiently inexpensive compute power are replacing the older ASIC coprocessors that were dedicated to a specific reception system. Now the actual radio front-end makes the receive signal available to these processors in digital form. Since the system-specific tasks are realized in the software, engineers gain considerable freedom when it comes to designing the RF portion of the system.

Employing standardized interfaces (such as I^2S or LVDS) to the greatest possible extent makes it possible to configure and scale systems very flexibly. Now the front-ends do not exclusively support a single reception system (such as FM), but rather flexibly cover diverse standards. This eliminates the redundancy that was required because a receiver had to be available for each system. All that is needed now is a universal tuner. The powerful processor employs software to accomplish the system-relevant tasks, such as demodulation and decoding.

Thus, this new centralized structure (**Figure 2**) solves a series of problems.
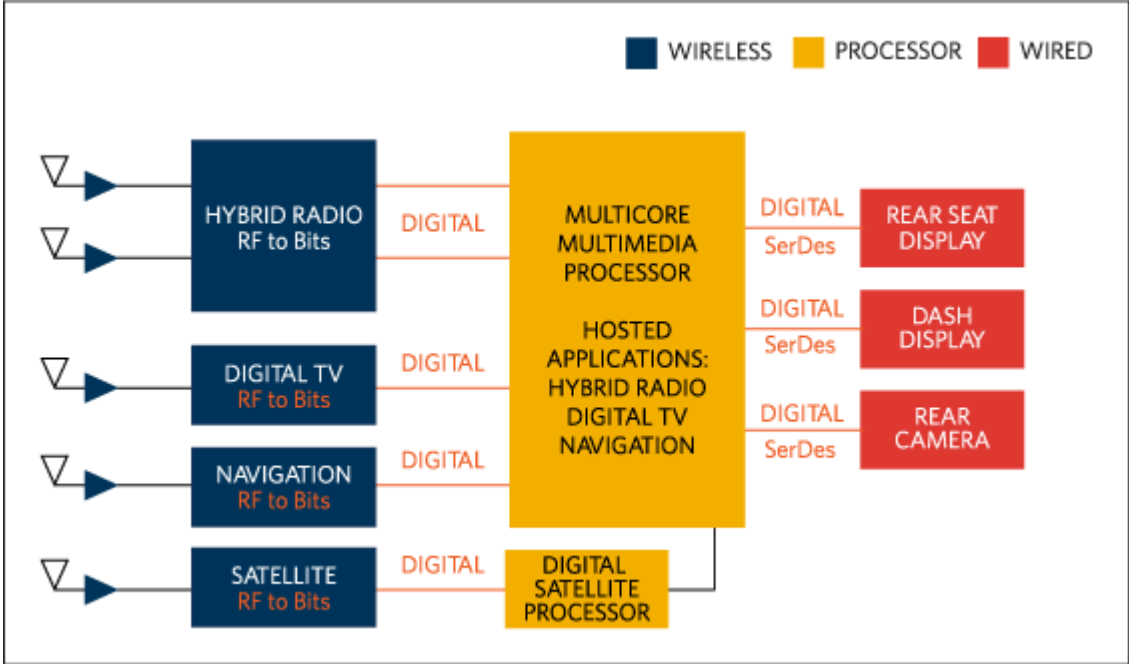

Figure 2. The RF to Bits architecture uses one piece of hardware to support different standards.

One Hardware Unit for Different Standards

The use of front-ends for different standards helps to avoid redundant structures, which, in turn, significantly reduces the number of components and leads to lower overall system costs. A baseband processor with standardized interfaces for all applications and systems can be configured for different regional requirements. The application-specific software is only activated when it is required. Therefore, compute power only needs to be available for applications that are currently active.

The system-specific functions, such as demodulation and decoding, are realized exclusively in firmware, which makes the system flexible. Software updates—software over the air—enable adaptations to new requirements and new standards, even after the design has begun or is in the field.

As a result, this structure also provides upgrade capabilities. Now it is possible to react more quickly to changes in customer requirements and to new standards without having to make significant hardware changes. That flexibility, in turn, increases customer satisfaction over the product's lifespan. The compact hardware structures of this approach require less volume in the head unit, again because redundancies are eliminated. In sum, one front-end now covers different standards and systems.

There is another benefit that should not be underestimated. The reduction in power consumption from the lower number of ICs helps to mitigate higher temperature problems.

Finally, offering better-organized structures and well-defined interfaces between front-ends and the baseband accelerates the design time to market. Analog and digital blocks can be developed independently. The use of standardized interfaces means that no fixed assignment is required between the RF front-end and the baseband, and this also improves scalability.

Suitable Architecture for Communications

Today the entire auto infotainment system has emancipated itself from being a simple, self-contained radio navigation system to become a complex, distributed system. It now accesses the functionality offered by the many control units integrated into the vehicle and then processes the information from these different sources in parallel. A system interlinked in this way requires a suitable architecture for communications, because there are too many individual signals to realize with point-to-point connections. To accomplish all this simultaneous activity, scalability is required.

Besides the proprietary solutions employed in the not-too-distant past, bus systems or communication protocols such as LIN, CAN, FlexRay[®], and MOST (and recently Ethernet-based systems) have become established. Multiple bus systems of both the same and different types are used in vehicles. For example, a LIN bus controls the interior lighting and maintains communications with control units in the doors and the roof liner. Multiple additional CAN buses perform communications for engine and suspension control as well as comfort and convenience functions. Finally, the MOST protocol links the components that comprise the multimedia infotainment system with different audio amplifiers, tuners, and CD/DVD changers.

There is also a need for encrypted or unencrypted transmission of uncompressed video data with bandwidths of 2Gbps, or more. These transmissions require additional point-to-point connections, usually employing serializers and deserializers (SerDes) (**Figure 3**). Here, too, the technology has transitioned from simple, high-speed video transmission to combined methods that support the video and audio signals together with control channels, which in some cases support IP protocols.
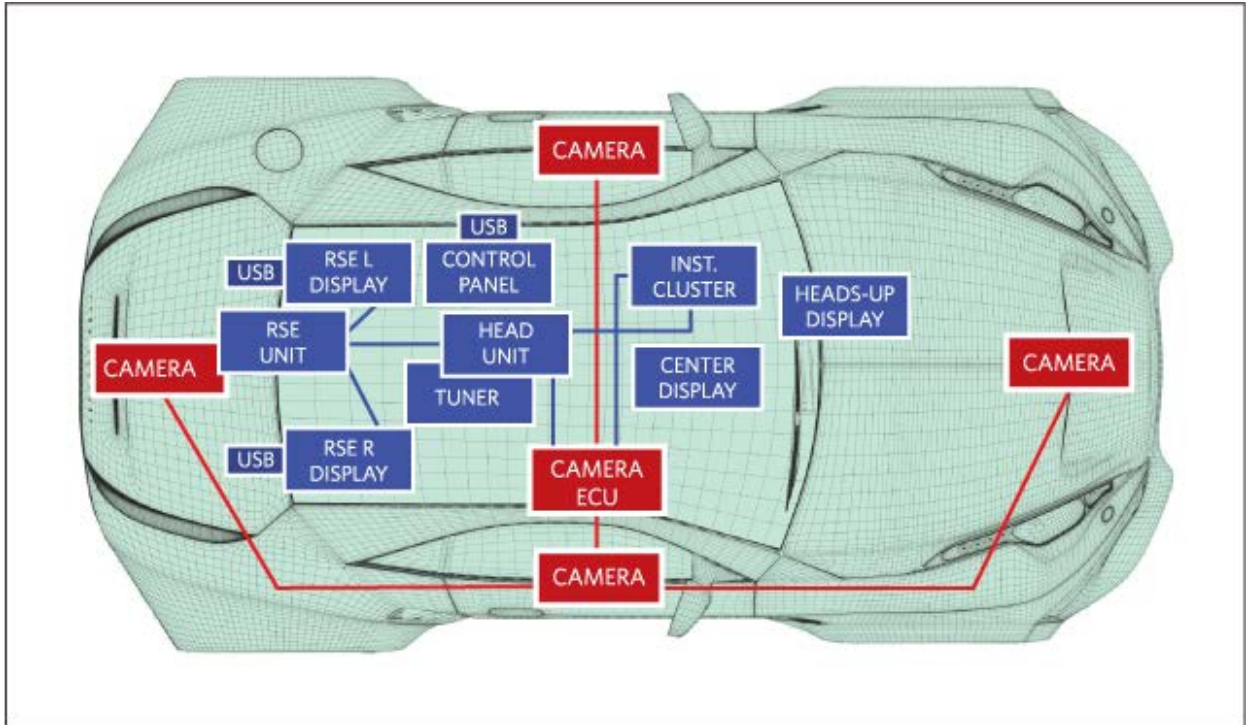

Figure 3. A modern in-vehicle infotainment system requires multiple point-to-point connections that usually use SerDes chipsets.

It is also not surprising that technologies from the consumer-electronics sector are making their way into automotive electronics. This is where gigabit multimedia serial link (GMSL) technology is so valuable. GMSL devices support audio, video, and control communications and provide a wide range of bandwidths (**Figure 4**). A GMSL SerDes chipset like the MAX9263/MAX9264 and a MAX9266 serialized with LVDS interface are optimized for display applications; the MAX9271 and MAX9272 SerDes are optimized for camera applications. GMSL also supports differential or coaxial transmission media that accommodate the special requirements for EMC, ESD, power consumption, and the cost framework.
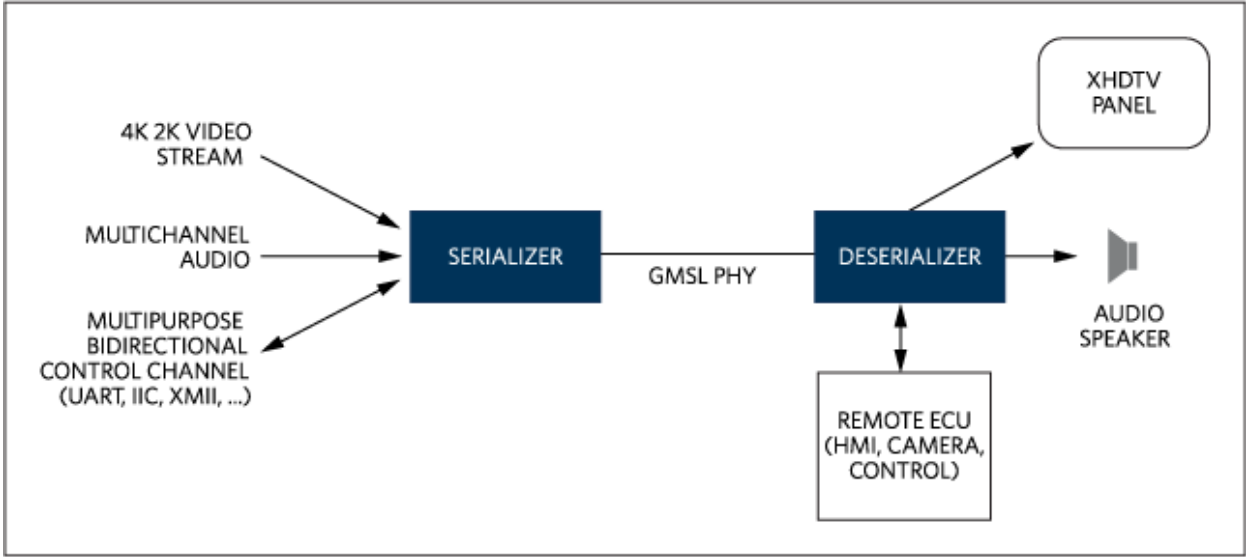

Figure 4. GMSL link with audio, video, and control communications.

High Bandwidth at a Reasonable Price

Recent rapid advancements in computer technology and multimedia applications provide excellent computing power, large memory capacities, high-value display units, and the required data rates at acceptable cost. Not surprisingly, automobile customers also expect their cars to have the same functions and applications that are already in home entertainment, mobile communications, and information technology. Common examples include individual configurations (i.e., personalization), the integration of cell phones and smartphones, new added capabilities with software apps, and an appealing, state-of-the-art HMI offering high levels of convenience.

As a consequence, automotive-grade versions of the processor and memory products used in consumer electronics are being integrated into cars. The new automotive circuits must support typical interfaces such as USB, HDMI®, and MHL, plus wireless technologies such as Bluetooth®and Wi-Fi®, and wireless energy transmission for charging purposes. While the technologies that have traditionally been employed in automotive and consumer electronics differed greatly in the past, significant technical convergence is evident now.

Integration and Protection of USB Connections in Vehicles

The Universal Serial Bus (USB) originally emerged in the 1990s as an interface for connecting disparate end-user devices to a computer. Since then, USB has become a standard interface for mobile communication devices. Now consumers want USB connections for their mobile devices in their vehicles.

The expectation is that all smartphone capabilities will remain functional and, of course, the device's battery should be charged by the vehicle's electrical system.

There are significant challenges to making the USB interface usable in automobiles. Both the USB's data lines and its 5V V_{BUS} power supply must be protected against short circuiting to the vehicle ground or to the battery voltage. Moreover, the same levels of ESD protection that are normally provided in a vehicle must be maintained. In accordance with ISO 10605, devices like our MAX16984 achieve ±25kV ESD protection (Air-Gap Discharge) for the USB connection.

Integrating the USB interface into a vehicle means that the cable connections from the host processor to the user's USB terminal device become longer. Permanently installed cables with lengths of up to three meters are now common in vehicles. The passenger's cable to the smartphone adds to that length. Today's mobile devices require charging currents of up to 2A. Because of the ohmic losses in the cables, it is necessary to compensate for the voltage drop caused by the cables used when such high charging currents are employed. This compensation can be accomplished with a load-dependent increase in the V_{BUS} voltage.

It is now possible to ensure that the USB port in a new car satisfies all automotive-specific requirements and still serves the consumer's portable device faithfully. The MAX16984 automotive DC-DC converter is optimized for this role and is equipped with a USB host charger adapter emulator. Using the MAX16984, the USB V_{BUS} voltage is generated directly from the vehicle battery with an integrated feedback adjustment circuit. To compensate for cable losses, it automatically adapts to the load current. Furthermore, the MAX16984 ensures that the requirements for short-circuit and ESD protection are satisfied for the data lines and the V_{BUS} voltage (**Figure 5**).
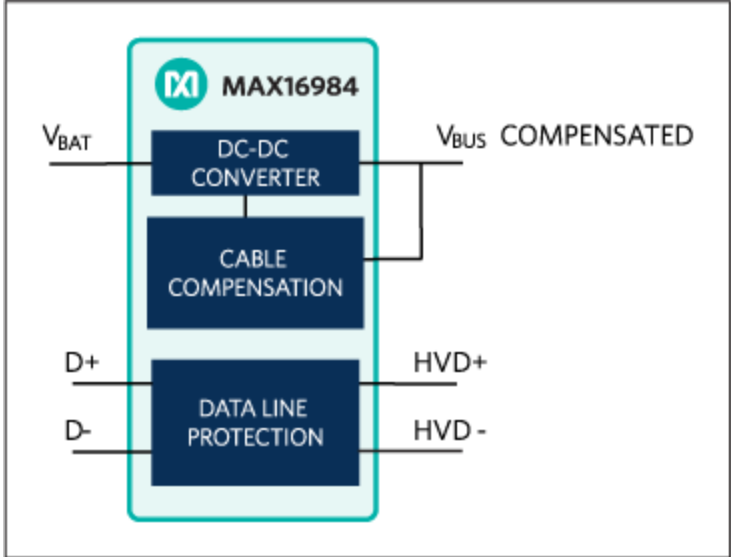

Figure 5. Diagram for the MAX16984 automotive DC-DC converter with USB protection circuit.

In the Future: Transmissions at Rates Up to 10Gbps

In the near future, the convergence of consumer and automotive electronics will present further technical challenges. Communications bandwidth and data rates will continue to grow. The data rate available for video interfaces today will triple, making support of transmissions of up to 10Gbps necessary. Special

attention must be given to using suitable cables and connectors. One promising approach for this is the use of coaxial physical layers. Tests with coaxial physical layers and ICs available today show that this approach will serve the need for point-to-point connections in the car for the next few years.

Efforts have begun to increase the transmission bandwidth for automotive applications into the 1Gbps range, which is necessary for IP-based communications. Designers are investigating cables and connectors that are as simple as possible, unshielded, and inexpensive.

Connectivity is a theme that has underscored much of this discussion. There is connectivity within a vehicle, between vehicles, and between a vehicle and its immediate environment. As the demands for connectivity become increasingly more complex, so do the measures needed to ensure data security and to prevent data manipulation. There is a special focus on safety-relevant systems that must comply with corresponding ASIL ratings and meet all requisite legal expectations as well. All this will require considerable design effort.

Summary

Semiconductor products have already been developed for in-vehicle infotainment applications. IC solutions like the RF to Bits tuners are opening the door to completely new system approaches that will cut costs and provide greater system flexibility. Today's infotainment approaches include high-speed video transmission to control high-resolution displays in the vehicle, reliable and safe USB connections for portable consumer devices, more bandwidth and computing power. All these advances will also address tomorrow's increasingly stringent requirements for transmissions at higher data rates in a car. This is the near-term future of auto infotainment.

General References
Background on ICs for automotive and transportation: Maxim Automotive Solutions
The MAX9271/MAX9272 Coax Evaluation (EV) Kit

At a glance

A Homogenous In-Vehicle Infotainment Landscape
To ensure that cars can be equipped with a comprehensive, homogenous, space-saving, and energy-saving solution that provides all infotainment functions in a way that is safe and ready for the future, the semiconductor industry is facing the challenge of driving the required innovations forward. Maxim Integrated offers modern solutions in all directions—from the industry's first DAB/FM tuner with an RF to Bits ®architecture to automotive DC-DC converters with an integrated USB host charger adapter emulator or display controllers all the way to wired high-speed serial interface links that support the transmission of video, audio, and control signals.

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Wi-Fi is a registered certification mark of Wi-Fi Alliance Corporation.

Related Parts		
MAX16984	Automotive High-Current Step-Down Converter with USB Protection/Host Charger Adapter Emulator	Free Samples
MAX2173	RF to Bits Tuner for Digital Audio Broadcast	Free Samples
MAX9263	HDCP Gigabit Multimedia Serial Link Serializer/Deserializer	Free Samples
MAX9264	HDCP Gigabit Multimedia Serial Link Serializer/Deserializer	Free Samples
MAX9266	HDCP Gigabit Multimedia Serial Link Deserializer with LVDS System Interface	Free Samples

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