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Car Camera Bus (C²B)—Cost-Efficient Camera Connectivity

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Abstract

Technology is transforming the automotive industry to create a safer, more comfortable driving experience. Automotive camera connectivity is a key enabling technology with an average of four cameras expected per vehicle by 2024.[1] A significant challenge for the industry is how to include extra cameras without adding further cost to the vehicle. This article investigates different automotive camera interfaces in terms of cost and performance. It proposes an optimized solution that delivers excellent video performance while enabling a low cost cable harness.

Introduction

Automotive camera connectivity is a significant cost addition for camera applications, but it enables new safety and comfort features. The latest market research estimates each vehicle will have an average of four cameras[1] by 2024 as the market responds to consumer and regulatory demands. New applications such as surround view monitoring (SVM), driver status monitoring (DSM), and drive recording are at the forefront of this explosion in camera technology. SVM and rear-view cameras enable safer parking. DSM cameras are used to monitor the driver's position and eye movements to detect and prevent driver distraction. Drive recording cameras are used to record accidents. DSM and drive recording cameras are mandated in UN regulations on automated lane keeping systems[2] (ALKS), which came into force in January 2021. More than 60 countries have adopted ALKS, which utilizes Level 3 vehicle automation (autonomous features that require the driver to be able to resume driving when requested) to keep the vehicle within its driving lane. DSM is also a fundamental requirement of the Euro NCAP 2020 assisted driving rating system.[3] The automotive manufacturing industry is already one of the most heavily indebted[4] and lowest margin industries globally. The challenge for the industry is how to provide the required camera performance without adding significant cost.

SVM camera systems provide a 360° view around the outside of a car when parking. These systems help decrease the risk of low speed accidents, particularly with pedestrians and blind pedestrians. Up to 70% of vehicles will have SVM installed in Asian countries where congested streets and small parking spaces make parking especially difficult. SVM is a great example of a camera application that saves lives and creates a first-rate driving experience. SVM also makes an interesting case study for the performance-cost analysis of automotive camera systems. Each SVM system uses four cameras to create the panoramic view. HD cameras often use coax cables, which are expensive, heavy, and difficult to route through small spaces. SVMs using coax cable harnesses require expensive coax connectors, resulting in several million dollars of additional system costs to automotive OEMs. The industry is faced with a significant question: what video interface from the camera provides the optimized cost point?

Staying with an SD Solution Is Not an Option

Standard definition (SD) cameras have been used in the majority of automotive camera designs for many years. They use a low cost cable and connector infrastructure to minimize the system cost of the SVM module. SD camera systems, however, are often only compliant to 100 mA bulk current injection (BCI), and most OEMs today require 200 mA BCI performance. As in-cabin display sizes increase, the visual performance of SD becomes objectionable. SD video (720 × 480) is very small size and needs to be scaled to fit modern automotive displays (for example, 1920 × 720). Scaling involves interpolating or creating new pixels to fill the space. This interpolation process causes many visual artifacts including, for example, jaggies on diagonal lines. Consumers are accustomed to HD camera performance in their smartphones, and SD performance is no longer acceptable. Although SD video provides a very low cost solution, many OEMs are planning to obsolete SD cameras from all models by 2025 because of the limited EMC/I (BCI) and video performance.

LVDS Is a Costly Option

Low voltage digital signaling (LVDS) camera links provide a high performance albeit expensive solution for automotive HD cameras. LVDS is a digital serial transmission scheme and accurately transports video from the camera to the electronic control unit (ECU). LVDS camera solutions are ideal for high end, front-facing cameras at 4 to 8 megapixels. Front-facing cameras require the highest video resolution in automotive cameras to support adaptive cruise control, object detection, traffic sign recognition, and collision avoidance. LVDS uses high bandwidth and requires shielded cables to pass automotive EMC and EMI testing. LVDS links typically use coax and mini-coax cables. The bend ratio of these cables and the robustness to many bend cycles make the manufacturability of these cables a problem for automotive OEMs—for example, when routing cables through door hinges to mount cameras on mirrors, or in the ceiling of the vehicle for occupant sensing, or even on the back of the front seats for video conferencing. The cost of the coax connectors makes HD camera connectivity prohibitively expensive for entry to mid-end vehicles.

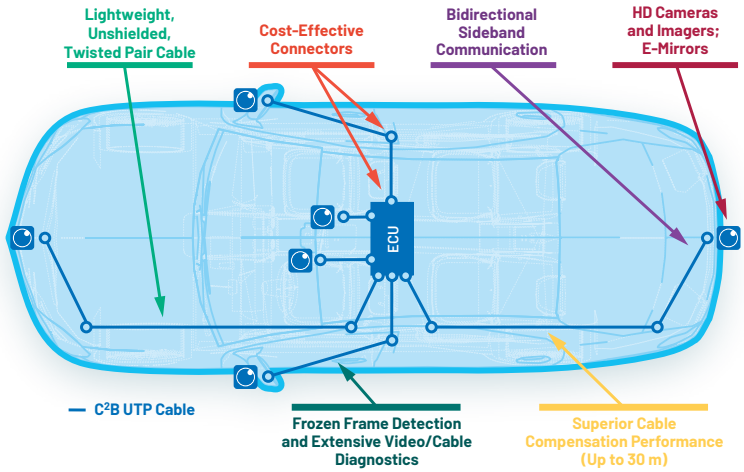

Figure 1. Camera and connectors for C²B in a car.

C²B Enables a Leading Technology Solution

An alternative option is to use a technology specifically designed to address these automotive challenges. Car Camera Bus™ (C²B™) is an automotive HD camera link technology with indistinguishable performance to LVDS interfaces. C²B enables HD performance over a low cost UTP cable harness, eliminating the need for expensive coax connectors. C²B can utilize block connectors in the wiring harness to enable a very low harness cost. Additionally, automotive OEMs are using the C²B video interface over their existing UTP cable harnesses to reduce costs when transitioning from SD cameras to HD cameras. Optimized video encoding, differential signaling, and internal filtering ensure C²B delivers the most robust EMC performance on UTP infrastructure, including conformance to 200 mA BCI testing. A high speed backchannel over the same twisted pair enables remote control of the C²B camera from the ECU. The backchannel allows manufacturers to optimize camera performance based on lighting conditions—a clear improvement over NTSC cameras. C²B's lower system cost allows automotive OEMs to realize HD camera resolution in entry and mid-level vehicles.

Table 1. Technology Comparison

Feature/Technology	NTSC	C²B	LVDS
High Speed Backchannel	✘	✓	✓
HD Resolution	✘	✓	✓
Low Cost Harness	✓	✓	✘

Conclusion

C²B is an elegant solution for the automotive industry, providing the best HD camera performance at a system cost that's sustainable for the mass market. C²B offers the opportunity to implement camera systems to all cars and allows for the implementation of safety critical systems to the benefit of all traffic participants. For more information on C²B technology, visit analog.com/C2B, analog.com/ADV7992, analog.com/ADV7382, or analog.com/ADV7383.

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About the Author

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