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Broadening The Automotive Infotainment Experience With Video-Bridges

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Introduction

With the move towards autonomous driving in the future, vehicles will need to provide significant improvements in their infotainment offering to differentiate against competitors and entertain occupants who are no longer required to drive. Even todays assisted driving systems rely upon camera inputs and output displays to support advanced parking features and blind-spot detection. According to IHS, shipments of automotive displays will rise by 11% in 2018, a rise of 2% compared to 2017.

Instrument clusters, centre-stacks and rear-seat entertainment displays are the primary systems that require automotive displays. But, in their bid to differentiate, automakers are integrating ever more displays, moving away from segmented LCDs (liquid crystal displays) to more full-colour, high-definition solutions. In the future, the instrument cluster could consist solely of a display, customised to meet the desires and mood of the driver, a feature already available in high-end vehicles.

One of the challenges of the automotive market is the slow speed with which new electronic hardware can be introduced to the market. An electronic control unit (ECU), once completed and certified, may need to support a range of vehicle models for 5 to 8 years. In that time, a range of facelifts and upgrades may require that varying video inputs and a range of displays require interfacing without making large changes to the hardware.

Here we look at a range of flexible video-bridges that can help to accommodate a wide range of video inputs and outputs, helping automotive engineers to adapt to a range of displays and input sources.

Supporting the platform approach

The automotive industry is in a state of flux. Consumers, along with governments and regulators, are pressing for greener transport solutions, along with features that increase comfort and simplify daily challenges, such as cameras to support parking in a tight space. The smartphone revolution has also provided consumers with the expectation that their high-value products can be customised via apps and software upgrades. Some vehicle manufacturers have started along this path, simplifying the integration of the smartphone into the car, and even pushing software updates to vehicles. However, with high-definition handsets already in their hands, climbing into anything but a top-of-the-range vehicle can leave drivers feeling a little underwhelmed when it comes to the integrated video technology.

With the functionality of a vehicle’s electronic systems being defined months to years before it is launched, and a need to utilise automotive qualified electronic parts, ECUs may be required to interface with a wide range of video input formats and types and support a collection of display dimensions with different interface types over the lifetime of the vehicle model. Supply shortages or the end-of-life of electronic components, especially displays, requires that there is flexibility in configuration and interfacing to accommodate market fluctuations and disruptions in the supply chain.

On the video input side, most automotive system-on-chip solutions (SoC) can accommodate either a parallel video input or the MIPI Alliance Camera Serial Interface 2 (CSI-2). The parallel input is well suited to CMOS cameras that provide a YUV or RGB output along with synchronisation signals. However, since back-up, rear view and blind spot cameras need to be mounted on the body of the vehicle, solutions necessarily need to leverage a SerDes (serializerdeserializer) solution to link the camera to the ECU that processes the video data. This allows the parallel data and any control information, such as an I2C configuration interface, to be transported over a wired interface, such as a twisted-pair cable.

Of course, parallel interfaces also require many pins, so SoCs cannot be expected to support significant numbers of parallel video camera interfaces. As the number of cameras implemented in the vehicle increase to support a range of assisted driving and comfort features, alternative video interfaces need to be considered. The MIPI Alliance CSI-2 interface is a widely adopted standard that is available on automotive qualified SoCs, offering high performance, low power and, perhaps most importantly for the automotive industry, low EMI (electromagnetic interference). With support for resolutions of up to 8k or more for video, as well as high-resolution photography, the interface technology looks suitable for upcoming in-vehicle video demands. However, the automotive industry is currently working with MIPI within an Automotive Working Group to review how the future video needs of the industry can be accommodated. Currently, an automotive approved standard along with engineering samples for silicon implementations are not expected until 2020, with use in production vehicles following in around 2024.

With changes of supplier and qualification of automotive components taking long periods of time, it is more likely that existing qualified parallel output cameras along with qualified SerDes solutions will continue to interface with CSI-2 interfaces on SoCs. In such cases, devices such as the TC9591XBG are an ideal bridge device to convert the parallel interface to the required CSI-2 signals as demanded by the SoC (Figure 1). Supporting a 1080P resolution at 60fps, the power consumption lies under 80mW. The video bridge can be configured using the I2C interface, most likely already in use as part of the video configuration interface for the camera, or SPI. The parallel input supports 24-bit un-packed formats such as RGB888/666/565, RAW8/1/12/14 as well as YUV422 8-bit and 10-bit data formats, and a PCLK frequency of up to 166MHz. Even if the camera solution were to change over the lifetime of the vehicle, the video bridge can be reconfigured to accommodate.

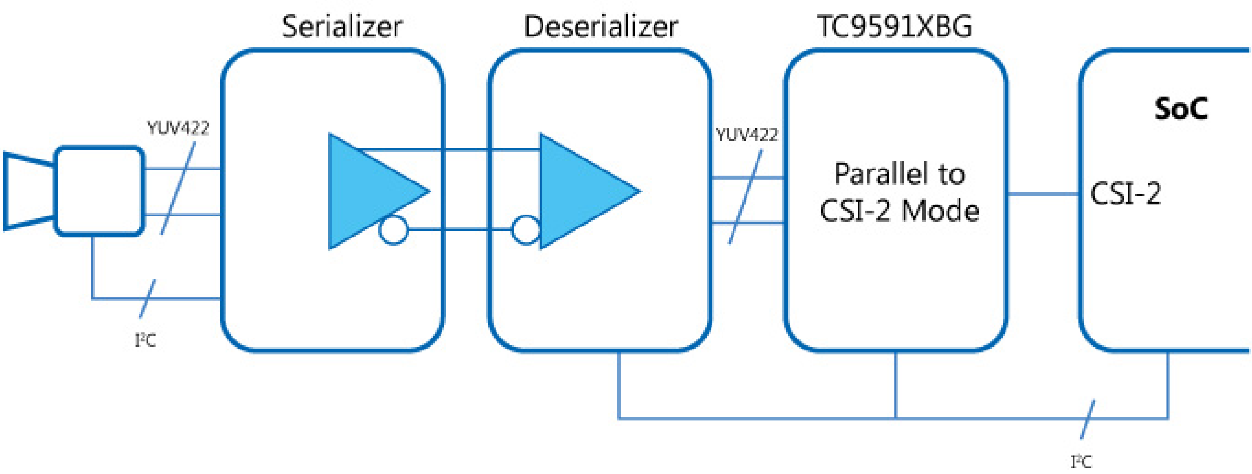
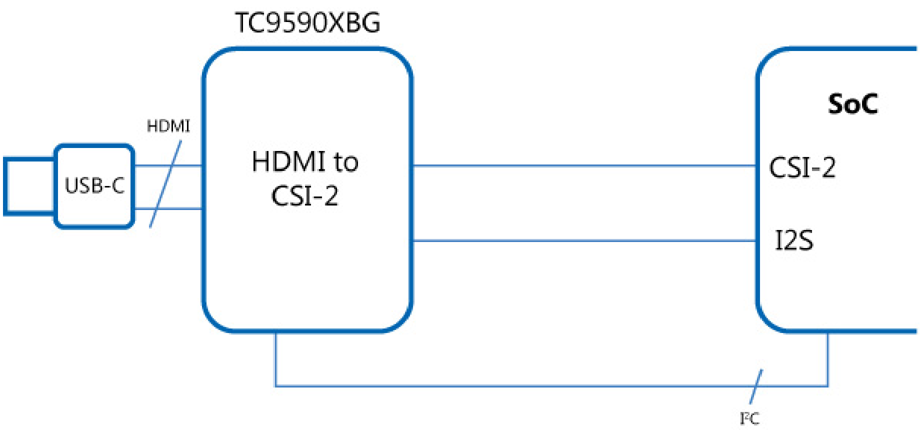


Figure 1 – An example of how the TC9591XBG can be used in a video bridge to connect a parallel interface video camera to an SoC with a CSI-2 input

Sharing occupant video within the vehicle.

The USB interface is now commonly available in the car, primarily being used for charging of smartphones when on the move. When supported by vehicle and handset, in-vehicle entertainment systems can be enhanced with Android Auto or Apple CarPlay over the USB interface, offering navigation, voice control, and access to music services and apps. But with potentially more time on our hands in future when the vehicle is in autonomous mode, sharing video with the other occupants via HDMI could be on the list of vehicle features.

With the introduction of the USB Type-C connector, the HDMI Alt Mode can make use of the connector to provide full HDMI support. In future, smartphones with HDMI support could simply be used as a video source to the in-vehicle entertainment system. This video input will need to be converted to CSI-2 if HDMI is not natively supported by the SoC, requiring a video bridge such as the TC9590XBG. Supporting video resolutions of up to 1080P at 60fps, the bridge also handles High-bandwidth Digital Content Protection (HDCP), Display Data Channel (DDC) and Extended Display Identification Data (EDID) functionality. When handling full resolution video, power consumption lies at just under 550mW, dropping to just 109µW in sleep mode. Audio is output using either the I2S or TDM interface. Of course, if the SoC only has a parallel video input available, both the TC9590XBG and TC9591XBG can be combined to convert the incoming HDMI to CSI-2, before final conversion to a suitable parallel video input format (Figure 2) is done.



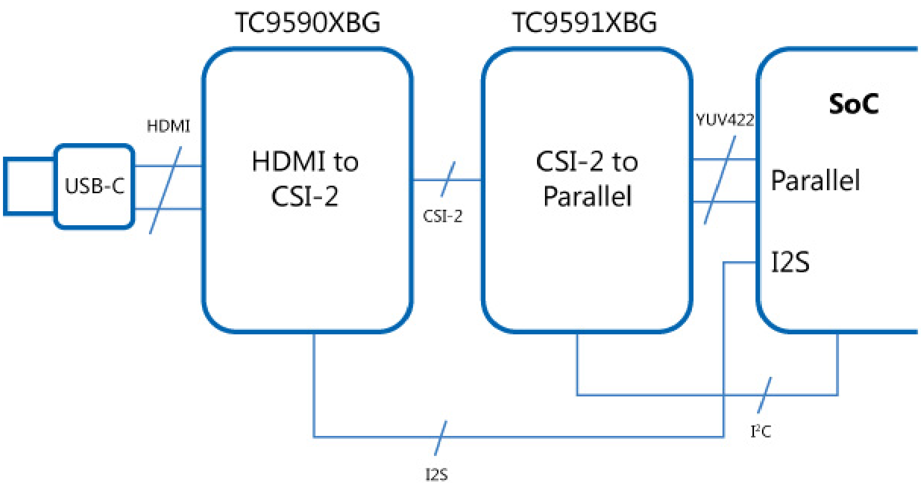


Figure 2 – The block diagram on the left provides a solution for HDMI inputs via a USB-C connector to SoCs with a CSI-2 input. The block diagram on the right is an alternative solution for SoCs with a parallel video input interface.

Getting video out to in-vehicle displays

Having got the video into the SoC, some of it may need to be output to various displays. This may include multiple displays for rear-view entertainment systems or the multiple screens of the navigation system when providing the reversing camera video feed. The MIPI Display Serial Interface (DSI) is one of the possible choices of output. The display will more than likely offer either an LVDS interface, or support the Embedded DisplayPort standard (eDP). Again, a video bridging solution is required to get the SoC interfacing with the displays.

Conversion from DSI to LVDS displays can be accommodate by solutions such as the TC9592XBG and TC9593XBG (Figure 3). Both video bridges support resolutions of up to 1600 x 1200 (UXGA) at 24-bits per pixel in the TC9592XBG on a single-link LVDS, while the dual-link LVDS capable TC9593XBG supports up to WUXGA (1920 x 1200 at 24-bit per pixel). The devices also feature an I2C master that can be controlled via the DSI link, enabling other devices to be controlled across this standard interfacing technology. Power consumption at maximum resolution lies below 100mW. The bridges also support the Toshiba Magic Square algorithm, enabling displays with a colour-depth below 24-bits to improve on colour graduation, bringing the output quality close to that of a true 24-bit display.

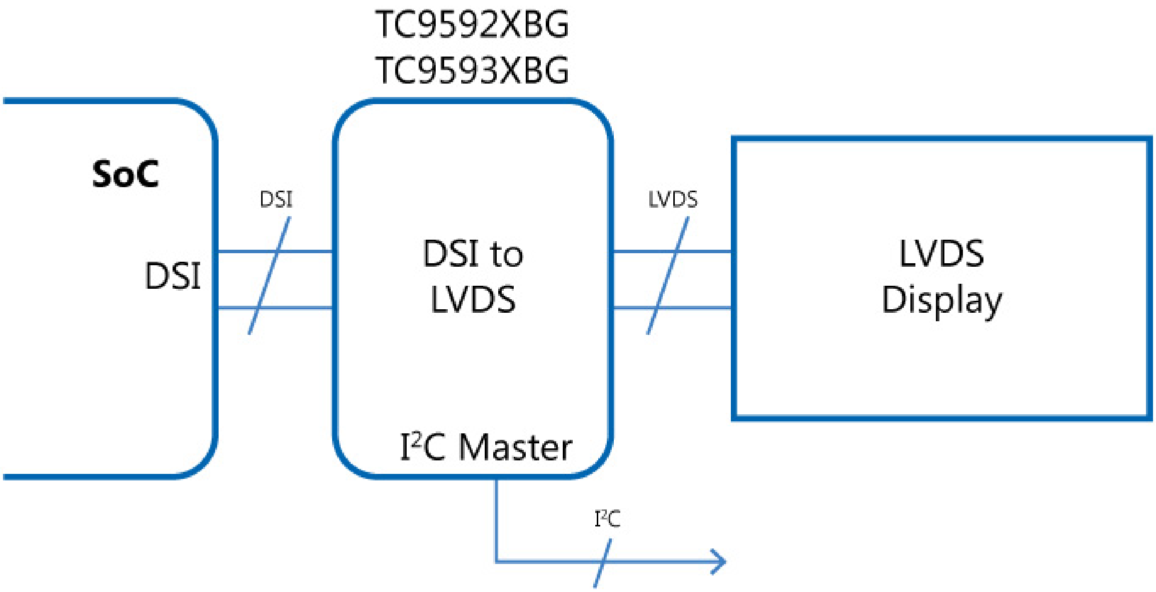


Figure 3 – A DSI output of an SoC can be converted to LVDS using video bridges such as the TC9592XBG and TC9593XBG.

Getting started with video bridges

With such a broad and rich set of features, evaluation of the video bridges is a must prior to selection. A range of evaluation kits and reference models are available along with other tools that ease testing. The TC9591XBG and TC9593XBG evaluation boards can be connected to a PC via a suitable USB-to-I2C adapter. This allows the developer to configure the video bridge into the desired modes for evaluation of the video output on an LVDS screen. With such a large number of registers available, configuration is simplified through the provision of an Excel spreadsheet curated to export register settings to suitable tools.

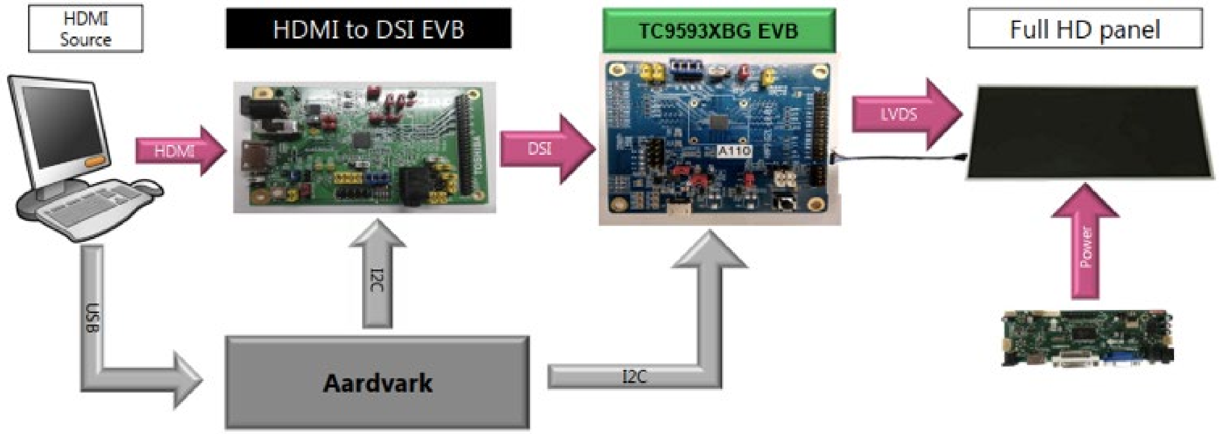


Figure 4: The video bridge products offer a range of evaluation tools, enabling developers to review their functionality prior to selection for a target application.

Summary

Video, whether from cameras, as part of the navigation system, or in-vehicle entertainment is an integral part of the vehicle ownership experience. Handheld consumer products, such as smartphones and tablets, have raised the expectations in consumers for video, image quality and functionality. Unfortunately, the design cycles for automotive electronics limits how quickly new technology can be introduced into the market. Flexible video bridges enable developers to accommodate improved cameras or larger, higher resolution displays, into vehicle model facelifts without the need to make changes to the ECU hardware. A simple modification of the configuration is all that is required. With appropriate planning and careful selection of video solutions, such in-vehicle electronics can remain capable of meeting new functionality needs over the lifetime of an automotive electronics platform.

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