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APPLICATION NOTE 4019

LVDS Offers Robust Video Interface for Automotive Applications

Abstract: In automotive video applications, one way to minimize video interference is to use digital instead of analog signals. The most effective interface for digital video transmission has proved to be low-voltage differential signaling (LVDS), as its low signal amplitude (0.35V) and differential structure minimizes electromagnetic radiation.

The fastest-growing signal format for modern vehicles is video. Until a few years ago, the only video display to be found in vehicles was a small screen for the navigation system near the navigation electronics. Luxury vehicles supplemented that arrangement with a TV signal shown on the same display. The video signal, however, had to be transmitted a considerable distance from the TV receiver to the display. The format for image information was an analog video signal called composite video baseband signal (CVBS).

Several developments in recent years have spurred a great increase in the availability of video sources, displays, and the associated video-transmission lines. The following discussion covers some of these developments.

The navigation display was once separated from its electronics so it could be mounted in a location more easily visible to the driver. This separation of subsystems required an additional video-transmission line. Today, more and more displays are being fitted into vehicles, including the electronic panel that displays speed, revolutions per minute, vehicle status, etc., and multimedia displays for the rear passengers, who can then watch TV or DVDs. Each display requires a video transmission line.

Future vehicles may include various cameras to assist the driver, such as cameras for the rear-view mirror and wing mirror, night-vision cameras, and cameras that recognize road markings. Again, each camera requires its own video-transmission line routed to the display.

The growing number of transmission lines in a vehicle, and particularly the greater length of individual lines, is presenting more and more problems in the transmission of analog CVBS signals. That signal format is not especially resistant to the electromagnetic interference to be expected in vehicles, and the advent of larger displays and higher resolution makes the video-signal interference even more apparent. (One such manifestation of interference is the multipath effect.)

One way to minimize video interference is to use digital instead of analog signals. Bear in mind, however, that a video line by itself is not the cause of interference. Low-voltage differential signaling (LVDS) has proven to be the most suitable interface for digital video transmission. Its low signal amplitude (0.35V) and differential structure gives LVDS lines the best qualities for minimizing electromagnetic radiation.

First-generation devices such as the MAX9213/MAX9214 chipset, currently being integrated in automotive video systems, provide one clock output and three data outputs for connecting the navigation display with LVDS transmission/reception components (**Figure 1**). Three parallel outputs are required to achieve the data rates necessary for image transmission, and the clock output is used to synchronize the transmission.

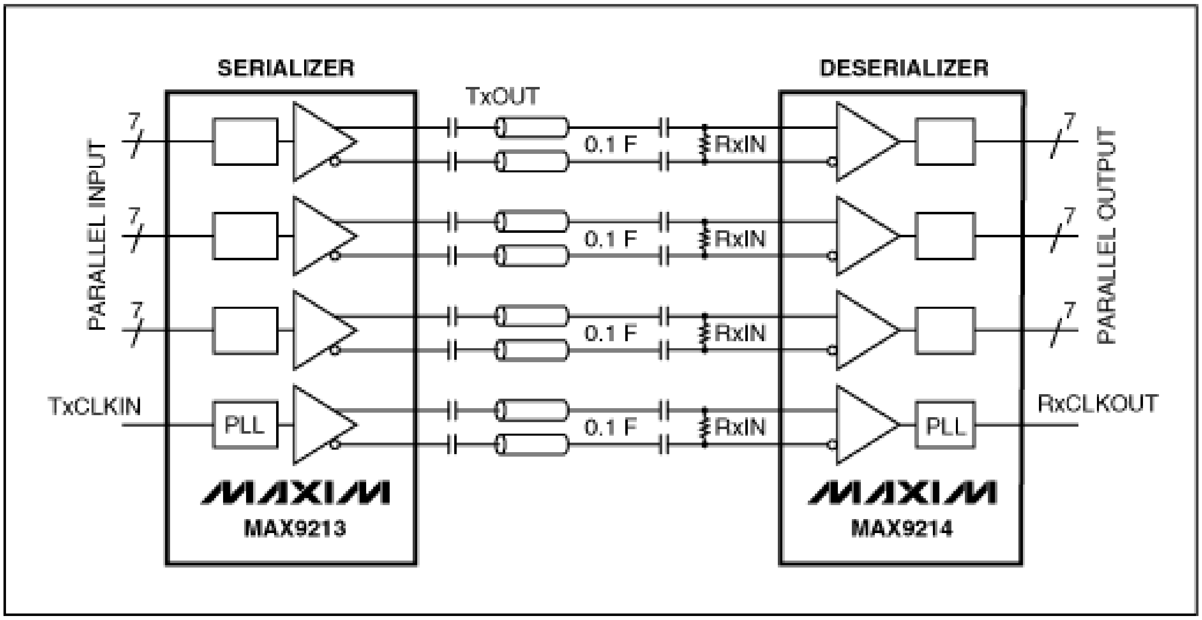

Figure 1. This first-generation LVDS transmitter/receiver has eight outputs.

One disadvantage of first-generation LVDS devices is that four twisted pairs of wires (eight outputs) are required to achieve transmission at the necessary data rate. Eight outputs are harder to install due to mechanical inflexibility, and they are obviously more costly than a single pair of wires. In response, the second generation of LVDS devices offers an improvement: ICs such as the MAX9247/MAX9248 chipset (**Figure 2**) employ only a single pair of wires for transmitting the image data and clock.

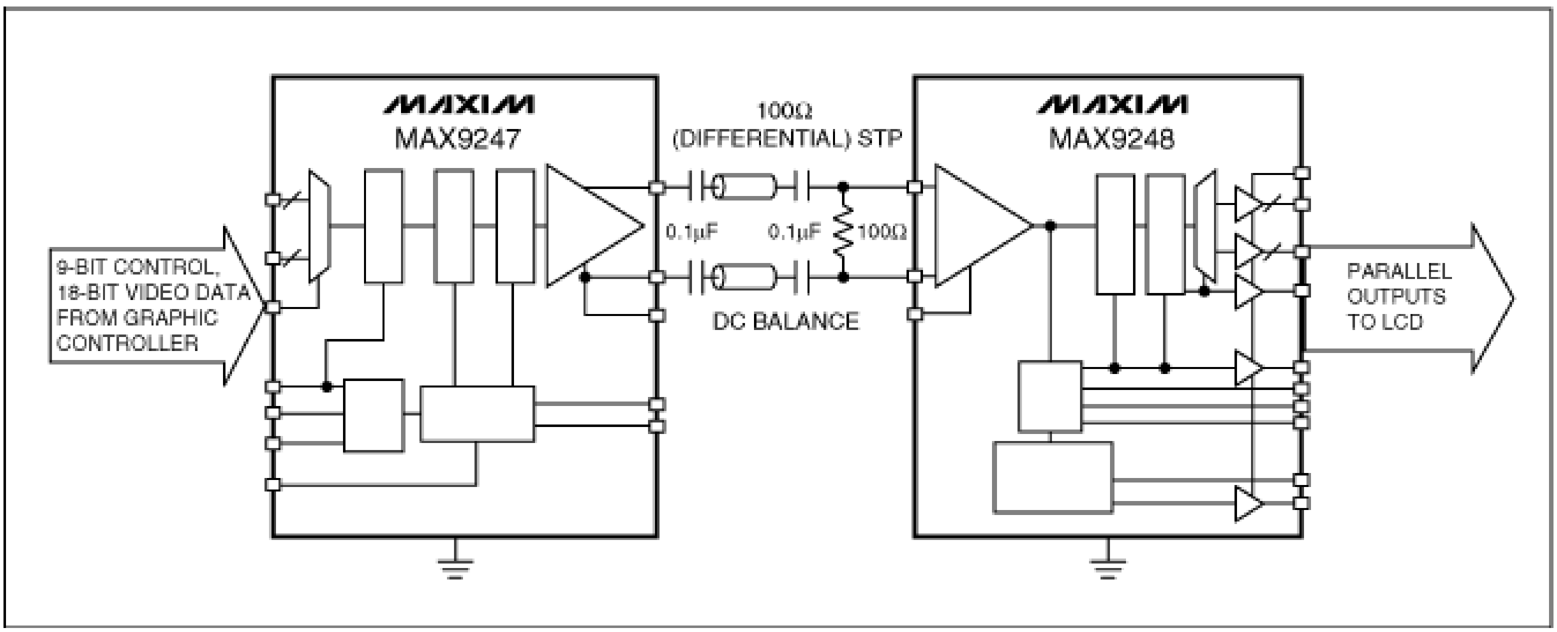

Figure 2. Second-generation LVDS transmitter/receivers have two outputs.

An important feature of this second-generation chipset (not usually available with LVDS) is the option of capacitively decoupling the outputs. Such decoupling avoids the problem of ground offset between transmitter and receiver, which can measure several volts. For a DC-coupled interface, such potential differences can prevent data transmission entirely or even produce enough current to destroy an electronic module.

When implementing capacitive decoupling, take care to ensure that the transmitted data does not charge the capacitors for too long in one direction. That occurs, for example, in transmitting a long sequence of "ones." A second-generation device such as the MAX9247 or MAX9248 uses the "DC-balancing" method to avoid that problem. It monitors transmitted data for excessively long chains of ones or zeroes, and inverts parts of such chains before sending them. When that data reaches the receiver, it is inverted once again to restore the original form. Thus, to avoid overcharging the capacitors, the transmitter informs the receiver whether each batch of data is normal or inverted.

The second-generation devices are able to operate at up to 42MHz, thus achieving data rates as high as 1.15Gb. This increase in clock frequency also produces more electromagnetic radiation. Therefore, technologies such as spread-spectrum transmission are employed to minimize EMI. Spread-spectrum technology spreads the energy of EMI peaks across the frequency band by dithering the clock at a low dither frequency. Because the overall energy remains the same, the maximum EMI amplitude is reduced (**Figure 3**).

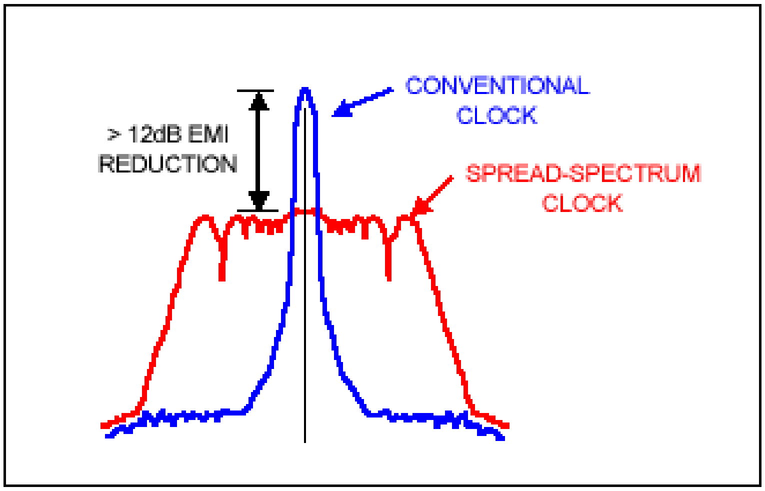

Figure 3. Spread-spectrum techniques reduce EMI.

Second-generation devices are designed mainly for connecting large displays. The connection of various cameras in the vehicle does not require the high data rate needed for displays, so the third generation of Maxim's LVDS devices will include devices that function at lower clock frequencies down to 5MHz and feature a reduced-width parallel bus.

A further requirement of third-generation devices (which are used mainly for connecting to cameras, but also to displays) is the transmission of control data. Such data is used to set brightness or contrast for displays, or sensitivity for cameras. Current systems employ another separate interface (CAN, LIN, or UART), which obviously means more components, cables, space, and cost. Third-generation LVDS devices will offer the possibility of transmitting control data directly through the LVDS interface, and thereby eliminating the need for an extra interface.

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