Active USB cable for automotive applications

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Examine the issues when using remote USB ports in automotive applications and learn how to overcome them.

Connecting mobile phones and devices to automotive infotainment systems provides a number of information and entertainment functions. These functions include updated navigation, messaging, media storage and streaming music applications provided by Apple's CarPlay and Google's Android Auto. The ability to connect a mobile device to the automobile changes the way consumers interact with their devices. It can even influence a consumer's decision-making process when buying a new vehicle.

Many of today's automobiles have a USB port located directly on or very close to the infotainment system. Remote USB ports are usually located in the center console and/or at the rear seats of the vehicle. While USB ports located close to or directly on the infotainment system can support both charging and USB data connection to mobile devices, remote ports (rear seat for example) can be used only for charging. This hampers a passenger's ability to connect a mobile device to enjoy many of the available applications.

Active USB cable solution

Most remote USB ports are 2-5 meters (m) from the infotainment system (**Figure 1**) and use a passive cable to the USB connector.

Figure 1. Automotive infotainment concept.

Using a passive USB cable with longer cable lengths can cause signal-integrity issues. The result is bit errors that can be observed as lost data, corrupted audio, or even a lost connection. **Figure 2** shows an eye diagram taken from a typical system using a passive 3-m cable from the infotainment system to the USB connector.
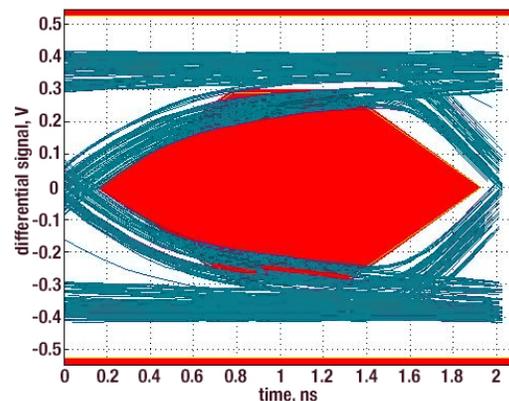

Figure 2. High-speed near-end eye diagram using a 3-m passive cable

Although convenient for charging devices, the location of remote ports often prohibits the automobile's infotainment system from operating properly due to poor signal integrity. The USB specification limits the length of a cable to 5 m between USB 2.0 devices (full speed or high speed). Many applications are limited to maximum cable lengths of 1–2 m in order to pass both near- and

far-end eye-diagram masks and ensure proper functionality. This cable-length requirement is needed because some applications require the host (infotainment system) and device (mobile phone) to change roles in order to enable full functionality. This dual-role support is known as USB On-The-Go (OTG).

In order to implement a fully functional remote USB port, an active USB cable is needed. An active USB cable enables the use of an additional USB device (usually a USB hub) located at the end of the cable, close to the USB connector. This additional device receives the degraded USB signal and generates a new signal with adequate voltage swing at the USB port. The result is an open eye diagram (*Figure 3*) that greatly reduces the chances of receiving bit errors and ensures a stable, error-free USB connection.
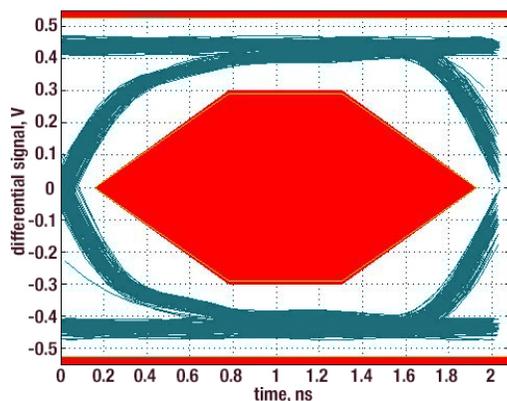

Figure 3. High-speed near-end eye diagram using a 3-m active cable

While passive and active cables can successfully extend the length of a USB cable, both have drawbacks. USB OTG is inherently supported with a passive USB cable, but the cable length is limited. Passive cables are inexpensive because they require no additional components, but again are limited in length.

Active USB cables using a USB hub can require additional components such as electrically-erasable programmable read-only memory (EEPROM), an external regulator, oscillator and external-port power controller, which significantly increases the total bill of materials (BOM) cost. Typical active cables using a USB hub do not support OTG, as most hub devices cannot support OTG. USB hubs that do support OTG may require additional software or hardware control, and possibly additional components.

The Texas Instruments TUSB211 USB 2.0 signal conditioner provides the benefits of an active cable without the additional cost incurred when using a USB hub. This signal conditioner offers improved performance over a passive USB extender cable and supports USB OTG.

Summary

Fully harnessing the capabilities of modern automobile infotainment systems requires a stable USB connection to mobile devices. This connection is currently available only to passengers in the front seat, while those in other rows can only charge their USB-compatible devices. An active USB cable enables a connection to the infotainment system from the remote USB ports, now enabling a connection between a passenger's device and the infotainment system.

Additional Resources

Learn more about the TUSB211 USB 2.0 signal conditioner:

www.ti.com/product/tusb211

www.ti.com/usb

Here's more information about TI's automotive end-equipment solutions:

http://www.ti.com/lsds/ti/apps/automotive/applications.page

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