FPD-Link III – doing more with less

By Mark Sauerwald
Applications Engineer, Automotive Connectivity and Ethernet

Flat panel display link III, better known as FPD-Link III, is an interface used in many automotive applications to transport video from point to point. This interface enables the transport of high-definition digital video, as well as a bidirectional control channel, over a low-cost cable, either twisted pair or coax. There are FPD-Link III serializers and deserializers (SerDes) that have been optimized either for the link between a processor and a display, or between the processor and a camera (Figure 1). This article provides an overview of these links, the advances that can be expected in the near future, and how to get even more out of the technology.

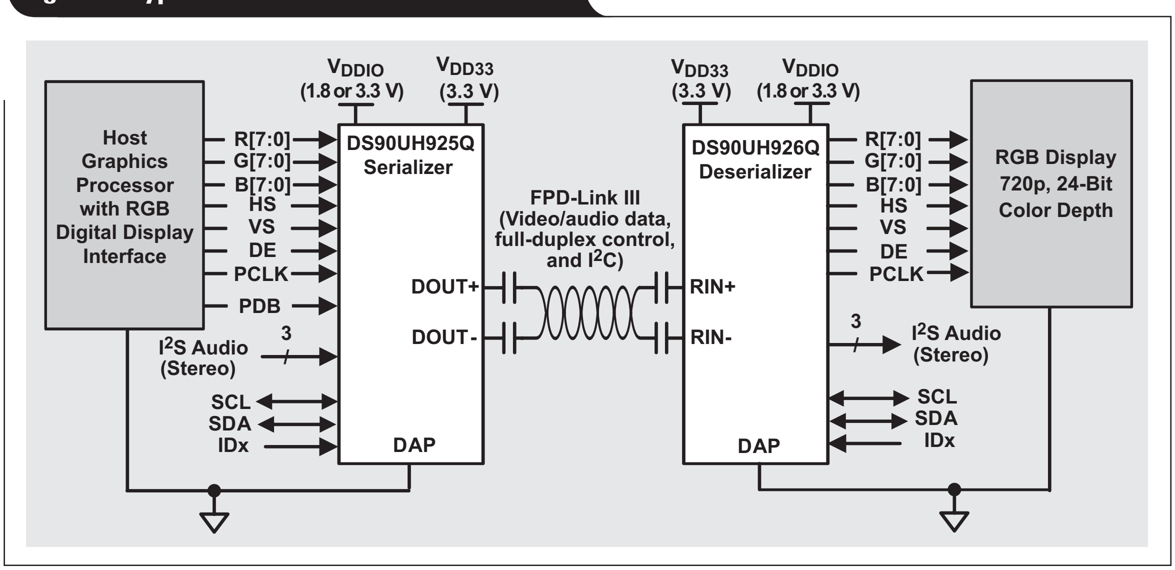
Not long ago, cameras were a novel feature in an automobile, mostly used in larger vehicles to aid in seeing behind the vehicle while backing up. Today, backup cameras are included even in low-cost, sub-compact cars. As automobiles develop, there will be more and more applications for cameras in the vehicle, and the cameras will become more and more sophisticated.

The backup camera allows the driver to see directly behind the vehicle, something that is difficult if not impossible to do with mirrors alone. The next step beyond this is surround-view systems. In a typical surround-view system, there are four cameras mounted on the car – usually one in each of the front and rear bumpers, and one in each side view "wing mirror." Each camera is fitted with a fisheye lens, so that between the four images, a complete image of what is happening around the car can be generated. In a surround-view system, the four fisheye images are presented to a video image processor such as the TI DRA74x "Jacinto 6." This processor removes the fisheye distortion, changes the apparent point of view, and merges the four images together to generate a virtual bird's-eye view of the automobile, allowing the driver to clearly see any obstacles in front, behind, or to either side of the vehicle.

When these images are processed, certain portions of the image are magnified, while others are compressed. In order to retain high image quality, the density of pixels needs to be higher than what a standard human viewer would require. The current automotive imagers support 1-megapixel (MP) images, but 2-MP imagers are on the horizon. To support this next generation of image sensors, automotive designers can expect to see new SerDes designs optimized for 2-MP imagers. Along with the higher data rates that these imagers require, there will be next-generation interfaces to be supported.

Another aspect of the evolution of automotive vision systems is that the industry is moving from the single camera system, such as a backup camera, to where multiple cameras are being used. With multiple cameras, imager synchronization becomes an important feature. In an application such as the surround view application, having all of the imagers synchronized makes the processing easier. However, if two cameras are to be used in tandem to create a stereo image of a 3D scene in front of the vehicle, synchronization is required to determine the accurate position of a moving object – or even a stationary object as

Figure 1. Typical interface with FPD-Link III



seen from a moving vehicle. Next-generation systems will have to accommodate the potential for supporting multiple cameras that are all synchronized.

In many areas, adding more capabilities to an existing technology has made the interconnects more complicated and more expensive. For example, adding copy protection to the link from your home DVD player to your video monitor requires changing from an analog coax cable to an HDMI cable. The new connection method gives better quality video, along with the copy protection. But this is at the cost of a much more expensive cable/connector ecosystem, and there's also the difficulty of supporting longer cable runs.

When confronted with a similar issue within the automobile, FPD-Link III was extended to allow the same twisted-pair cable to carry copy-protected content from a Blu-ray™ player or server to a back-seat entertainment screen. The specification is to do so with no penalty for the cost of the media, or the range of the older, non-copy-protected media. The chipset shown in Figure 1 embodies this technology. In these devices, the same information that was carried over separate conductors is now encoded and carried along the FPD-Link III – sharing the same conductors that carry the video content.

Getting video out of a camera and to the processor, or from a Blu-ray player to a screen, is not enough. In both cases, control signals going in the opposite direction are also required. In the case of the camera, the processor needs to configure the imager. In the case of the back-seat entertainment panel, the user interface is often a touch screen, and touch commands must be sent back from the screen to the processor.

FPD-Link III handles this with an integrated back channel, which allows the same piece of coax or twisted pair to carry video in one direction, and to have an independent, bidirectional control channel sharing the same conductor. This allows the cable to remain thin, flexible and inexpensive. But what about power – cameras and displays still need to be powered. Can the same cable be used to power the device as well as provide a communications link?

Power over coax

The key to using the same cable for power and communications is to think of what is going on in the frequency domain. The video forward channel and the bidirectional control channel on FPD-Link III are able to share the same cable because they occupy different spaces in the frequency domain. Using the DS90UB913A-Q1 and DS90UB914A-Q1 as an example, the control channel occupies the space from about 1 MHz to about 5 MHz. The video channel occupies a space from about 70 MHz to about 700 MHz. The addition of power to the same cable must be accomplished without interfering with either of these two bands.

For power over coax (POC), a circuit is required that will split the input signal into two branches (Figure 2). One branch carries DC power for the POC circuit, and the second branch carries the signals without DC power. To do this, an element is placed in the signal-path branch that passes both the back channel and the forward channel, but blocks the DC. A simple capacitor works for this. The 0.1-µF capacitor has very low impedance from the start of the 1-MHz back-channel band through the 700-MHz upper limit. It is readily available and inexpensive. Parasitic inductance for a 0.1-µF, 0603 capacitor is on the order of 1 nH, so it does not really come into play within the band of interest. The capacitors are a good choice to separate the AC signals from the DC power.

The other branch, one that passes the DC but doesn't interfere with the AC signal, is a bit harder. Since the data channels are being passed over a controlled impedance transmission line, the impedance of the low-pass circuit must be large over the band of the forward channel.

Figure 2. Block diagram showing the power-over-coax topology

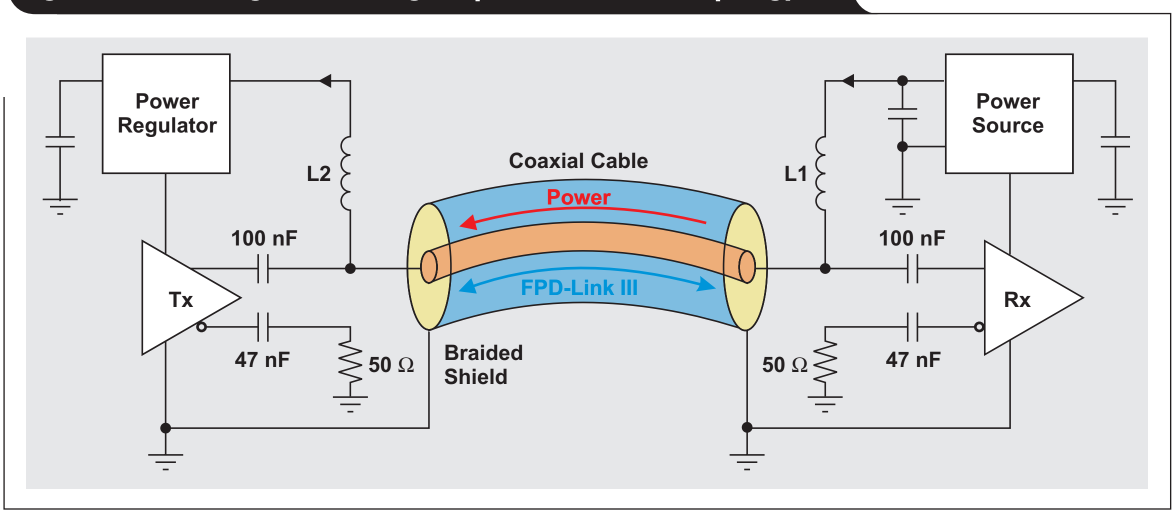
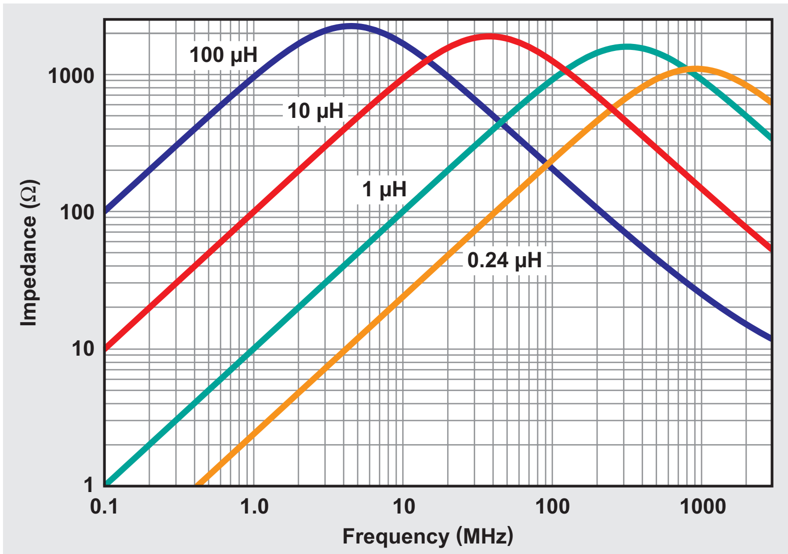


Figure 3. Impedance plots of various inductors



For the power circuit to not interfere with the data path, the impedance of this circuit must be greater than about 20 times the characteristic cable impedance. So for a 50-Ω coax line, the impedance should be greater than 1 kΩ from 1 MHz up to 700 MHz. An ideal inductor would work for this application.

Unfortunately, ideal inductors are much harder to find than ideal capacitors. To have over 1-kΩ impedance at the 1-MHz lower band of the back channel, a 100-µH inductor is required. But a typical 100-µH inductor has a parasitic capacitance, which drops its impedance below 1 kΩ at frequencies above 70 MHz. Thus, it would interfere with the forward channel.

Figure 3 shows plots of the impedance of some different inductors versus frequency. Notice how impedance rises up to a certain point where the parasitic capacitance becomes dominant, and then the impedance drops. This figure shows that a 100-µH inductor will do a good job of blocking the control channel since its impedance is about 1 kΩ from 1 MHz up through 5 MHz. However, when the forward channel is at 150 MHz, the impedance drops to about 200 Ω. The solution is to use a circuit with two series inductors, a 100-µH inductor to block the control channel, and a second, smaller inductor that blocks the video channel. It turns out that about 5 µH is right for the second inductor.

The physics of the requirements dictate the values of the inductors (100 µH and 4.7 µH), but the physical size is dominated by the ability of the core to sustain the magnetic field. Physically, smaller inductors have lower saturation currents. One way to use a smaller inductor is to reduce the current requirement of the circuit. This can be done by increasing the voltage that is being carried by the coax cable. If the camera requires 1.5 W, and power over the coax is a voltage of 5 V, then the current required is 300 mA. The 100-µH inductor that was chosen is probably about the smallest physical size that could be tolerated (it is 7 mm x 7 mm x 4 mm in size). However, if a 12-V supply is used, then only 125 mA is required. An inductor that supports this lower current occupies about one-fourth of the physical space of one that will support the 300 mA.

Conclusion

Video is becoming a bigger part of the modern automobile. FPD-Link III is an ideal technology to support today's and tomorrow's needs, minimizing the system cost through using inexpensive cable to do more. It is also a technology that is ready to keep pace with future advances.

Related Web sites

For more information about FPD-Link III solutions, visit:

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