MANAGING DIGITAL DISPLAY DESIGN, DVI VS HDCP

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Abstract: Because the trends of nowadays are to replaced the analogical transmission with digital transmission, this paper should give an overview of encoding and decoding aspects used in TV digital transmission. Also, an introduction on HDCP aspects is done as well. DVI offers better image quality than the conventional analog RGB interface. In electronics consumer a wide-spread DVI adoption is expected. HDCP satisfies MPA requirements for content protections. A CMOS solution for DVI-HDCP has been demonstrated.

Key words: DVI, HDCP, Panel link, TDMS.

1. INTRODUCTION

Due to the inadequacies of the traditional analog RGB interface, a digital conversion is necessary. The analog to digital trend has already occurred in many markets. LP records have been replaced by CDs, and new digital phones have dated their analog counterparts. In the video world, DVDs are rapidly replacing VHS tapes. This trend is also occurring in the display market, where digital displays are replacing analog displays.

The most common example is the replacement of CRT monitors by slim, flat-panel displays. A Digital Visual Interface (DVI) is needed to enable this transition to digital. Data is inherently transferred in digital form. DVI eliminates the need for a digital to analog conversion before transmission, as well as the subsequent conversion from analog back to digital after the data is received by the display. DVI enables better image quality than the conventional analog interface because it eliminates the degradation in image quality associated with the analog to digital conversion. In addition, DVI enables transmissions over longer distances and is capable of providing many services other than just sending images

2. DIGITAL VIDEO INTERFACE

Digital video transmission technology has traditionally been very expensive due to the high bandwidth requirement for medium resolution (more than 1 Gbps), which is quite foreboding. Recently, however, the transition-minimized differential signaling (TMDS) method has been developed for CMOS implementation, making it a low-cost interface affordable enough for mass-market adoption. Developed by Silicon Image, this TMDS technology has become the basis for the industry's DVI standard introduced by the Digital Display Working Group in April 1999. Panel Link(r), Silicon Image's proprietary implementation of the TMDS technology, is the leading implementation of the DVI interface. Since the transmission of a digital signal is flawless with no degradation in quality, consumers are beginning to demand high definition (HD) video. However, if this content were to be made available with no restrictions, unauthorized copying would likely occur. The lawsuit many record companies have brought against Napster, the company that allows consumers to download and swap music tracks off the web, is a similar example. Specifically, HDTV content providers do not want to repeat the same mistake that the music industry made when they converted their contents from LP to CD by not providing adequate content protection in CDs. To prevent this unauthorized copying and piracy of HD video content, it must adequately protected from unauthorized tapping into the digital video cable. Such protection is absolutely necessary for content providers since it impacts their business.

Content providers have been requested to incorporate Digital Transmission Content Protection (DTCP) to the IEEE 1394 serial I/O bus standard before they release and transmit any copyrighted and otherwise proprietary content through a 1394 cable. A similar incidence occurred with the Motion Picture Association when they wanted to release their HDTV content. The industry is at a stalemate, with consumers wanting HD content, but content providers unwilling to provide this content until it is protected from unauthorized duplication. DVI offers a viable solution with the addition of High-bandwidth Digital Content Protection (HDCP). Physically, the DVI architecture is composed of a transmitter chip, two connectors, a cable and a receiver chip. The transmitter is located in the graphics controller or video source, and the receiver is located in the display. A 24-bit, true-color video input and a dot clock are sent to the transmitter. They are then converted to four channels of TMDS signals with a transition minimized, DC-balanced coding algorithm. There are three RGB twisted pair lines, and a pair of clock lines is used in the cable. Within the cable, differential signaling on the twisted pair is used for reducing electromagnetic interference. The link can be extended to more than five meters, while the traditional analog interface is limited to 1.8 meters in length. A video signal is recovered in the receiver by the reverse process, called decoding. Each color channel can provide up to 1.65 Gbps to support HDTV resolution. For even higher resolution displays, additional channels can be used in parallel.

For example, for QXGA resolution with 2048 by 1536 pixels, six TMDS channels are required for the 60Hz refresh rate in LCD displays, while only three channels are used in most of the display resolutions. DVI can also be applied in CRTs as well. However, in such cases, more bandwidth is required, so there is a higher chance that parallel channels may be required for higher resolution displays since their scan overhead is larger.

The architecture of DVI is, like any other communication protocol, multi-layered. Its physical layer emphasizes low cost per bandwidth. So, it is preferably implemented in the state of- the-art technologies such as over sampling. DVI's coding layer offers both transition minimization and DC-balancing, while other conventional coding schemes such as IBM 8B/10B give higher transitions. In doing so, TMDS offers better EMI characteristics and enables direct connection to fiber optics for longer cables. Even with such desirable characteristics, widespread adoption and customer acceptance is impossible without standardization.

This standardization was the purpose of forming the Digital Display Working group (DDWG) in June 1997. Industry technology leaders Intel, IBM, Compaq, Fujitsu, HP and NEC united with Silicon Image to standardize the DVI specification based on Silicon Image's TMDS protocol. The final industry specification was released in April 1999, and significant penetration to PC hosts and LCD displays, such as FPDs and digital projectors, is now occurring. The application of DVI to LCD displays is occurring first because a significant cost advantage is expected by removing DACs in the graphics controllers and very expensive ADCs in the displays since everything in between is digital. The PC adoption rate of DVI is currently approximately 5 percent, with up to 35 percent of all PCs expected to be equipped with a DVI output by the end of 2001. According to market research firm Dataquest, 15 million units will be shipped in digital FPDs and projectors in 2003 and 2004. Also, digital CRTs from a number of consumer electronics manufacturers were demonstrated in 1999 at Comdex. Digital CRTs are already available for purchase from Acer and View Sonic and are eventually expected to replace existing CRT monitors with analog interfaces. One reason is that HDCP only works with DVI, and not an analog interface. See fig 1.

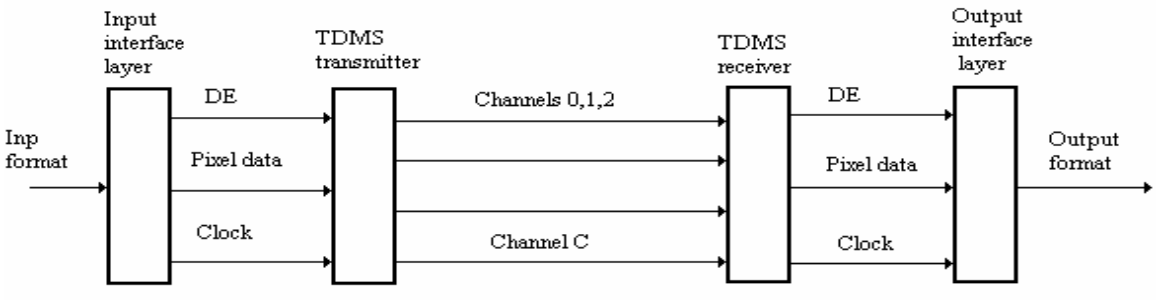

Fig. 2 Digital video interface

For HDTV content to be widely distributed content protection mechanisms must be incorporated all the way to the display since the contents are transferred to the display through a digital link. One primary concern for Hollywood is the video piracy that costs

motion picture companies 2.5 billion dollars a year. The Motion Picture Association of America (MPA), which represents Hollywood, is currently reluctant to release any video content, although it has a massive library of movies and television productions that are better viewed in HDTV formats. They are waiting for the adoption of an effective means to limit unauthorized copying. HDCP for the DVI link was developed by Intel with contributions from Silicon Image. Its specification was released at the Intel Developer Forum in February 2000. There, the first silicon to incorporate HDCP was also demonstrated by Silicon Image. HDCP is supported by MPA members, including Warner Brothers, Disney, Fox and Universal Studios. HDCP for DVI offers the highest bandwidth available in industry and is capable of supporting up to 1080p formats.

3. HIGH - BANDWHIDTH Digital Content Protection System

HDCP is composed of three elements—Authentication and Key Exchange (AKE), Content Encryption and System renew ability. The goal of authentication is to affirm that the receiver is authorized to receive protected information from the transmitter. Each authorized device is provided with a unique set of secret device keys from the Digital Content Protection LLC. Exchange of keys between authorized parties generates a shared secret key that cannot be determined by eavesdroppers. The secret key can then be used to encrypt video content intended for the authorized receiver only. The values exchanged between the video transmitter and receiver is sent over the I2C serial interface bus of the DVI interface. After a secret key is obtained through AKE, data encryption is applied in the transmitter by a bit-wise exclusive, or (XOR) of the video data with a key-dependent pseudo-random number stream. The reverse operation is done in the receiver with the same key. System renew ability is a mechanism capable of revocation of compromised devices that might have been exposed to unauthorized parties. A video transmitter manages system renew ability messages that carry the KSV revocation list. On finding the receiver with the KSV on the revocation list, the transmitter refuses service while authorized receivers are unaffected. See fig 2.

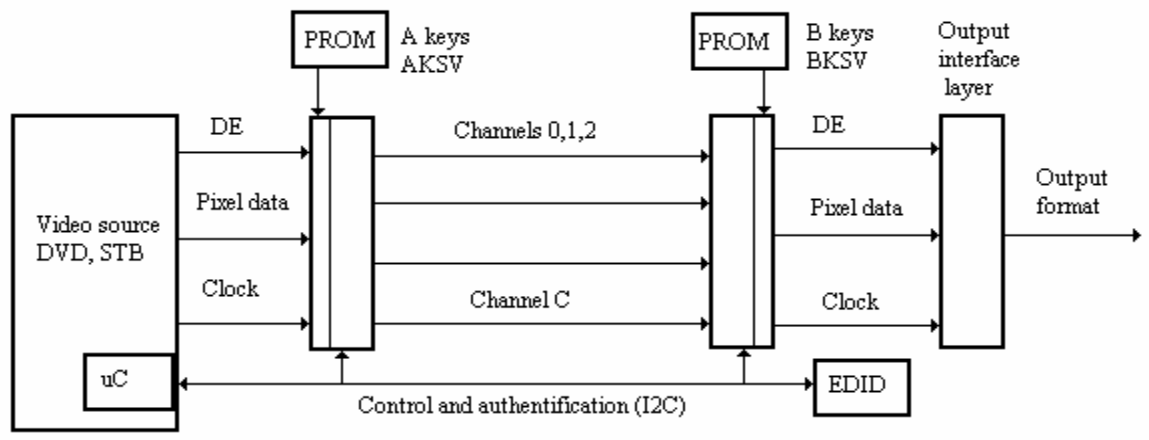

Fig. 2 HDCP Implementation

4. CONCLUSION

DVI offers better image quality than the conventional analog interface. Furthermore, it can reduce system cost especially in flat panel displays by removing expensive ADCs. The standardization of DVI accelerated the adoption of DVI in PC and consumer electronics. Moreover, explosive growth is expected in 2004. For widespread adoption in consumer electronics devices, MPA-approved HDCP has been incorporated in DVI, and its prototype has been demonstrated.

Summary:

- DVI offers better image quality than the conventional analog RGB interface;
- Wide-spread DVI adoption is expected in PC and consumer electronics;
- HDCP satisfies MPA requirement for content protection;
- HDCP can be implemented on top of DVI;
- CMOS solution for DVI-HDCP has been demonstrated.

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