AN-6015 FSHDMI04 Applications Guide

Applications

HDMI switches simplify designs and lower total system cost by allowing the addition of secondary HDMI inputs or outputs while reusing existing single input circuitry. The first applications to benefit from these products are high-definition video displays of all formats; CRT, LCD, DLP, plasma, etc. The FSHDMI04 enables a quick upgrade of existing designs using a single HDMI input by adding a second port without requiring qualification of newer, more–expensive, dual-input receivers. HDMI switches, such as the FSHDMI04, are inserted between the chosen HDMI receiver and the two HDMI connectors. Such a configuration allows users to have both a digital set-top box (STB) and a game station or future HDMI-enabled, high-definition DVD player connected to the display. Using standard single-input displays, users must unplug the STB to play movies or video games using the HDMI cable. Because the FSHDMI04 is bi-directional, it can be used in sink applications (eg. displays) as well as source applications (eg. STB, computing) in which a single HDMI source is routed to different output locations. Figure 1 is an application showing how to add a second HDMI input to an existing design. Note that this solution includes the FSAV330 or FSAL200 used to route higher voltage lower frequency control signals. This second switch must be a 5V-capable quad SPDT switch with at least 165MHz. For this reason, either the FSAV330 or FSAL200 could be used. These control signals are used in the initial handshake between sink and source, which the source uses to determine the video resolution the sink is capable of handling. The FSHMDI04, and a second switch for routing control data, are all that is required to fully implement a second HDMI input on a single-input design.
The following is a brief comparison of HDMI and DVI.

HDMI

HDMI is the newer of the two formats and builds on the older DVI specification. While DVI only handles video data, HDMI includes audio as well as video data, along with increased piracy protection in the form of a digital encryption protocol called high-definition content protection (HDCP). Because the HDMI connection contains both video and audio data, it allows for a single connection between source and sink. Both standards use the Transition Minimized Differential Signaling (TMDS) electrical format and, for this reason, passive video switches like the FSHDMI04 do not distinguish between HDMI and DVI signals. These standards both use four differential pairs consisting of three data pairs and a clock pair for each link. HDMI transmits data in one of two basic digital configurations, either single link or dual link. The maximum bandwidth of any given link is 4.95Gbps (3 TMDS pairs each transmitting 1.65Gbps in parallel), corresponding to a maximum clock rate of 165 MHz. The difference in data and clock frequencies is due to the data sent in 10-bit packets called pixels. For video displays with resolutions requiring less than 165 Mpix/sec, a single-link connection is

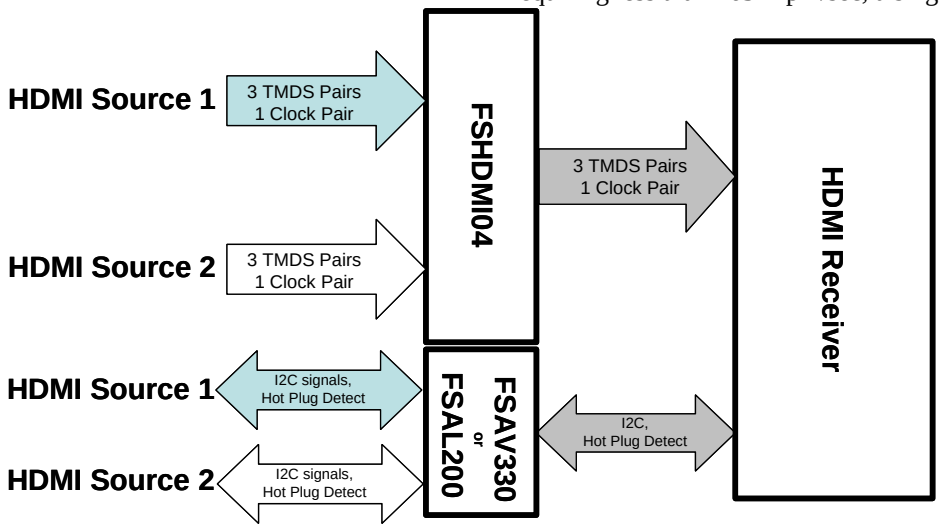

Figure 1

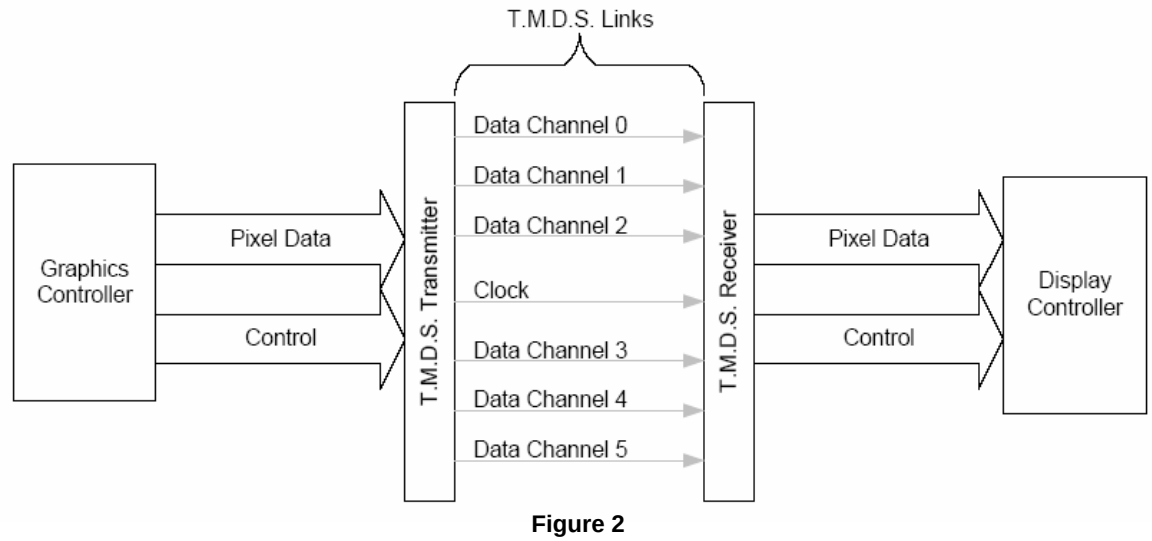

Figure 2

sufficient. Resolutions requiring between 165 Mpix/sec and 350 Mpix/sec, a second link is used to send the data in parallel. Because both links share a common clock pair, the maximum clock frequency is always 165 MHz. Figure 2 shows the basic dual-link architecture. This allows either a single-link or dual-link connection.

DVI

DVI was the first purely digital video connection standardized throughout the market. Like HDMI, the need for a single- or dual-link configuration is dependent on the display resolution selected, along with the type of display and corresponding refresh rates. DVI connections are still popular in computing applications and many systems have DVI outputs, allowing for a direct digital connection to a digital LCD monitor. For example, an LCD with a 60Hz (1920x1080) would use a single link DVI connection with a clock frequency of approximately 130MHz. This can be observed in Figure 3 as referenced from the DVI specification.

HDMI/DVI Application Challenges and Key Specifications

Because the fundamental electrical characteristics for DVI and HDMI are based on the same standard, switches like the FSHDMI04 are suitable for either single-link digital video format. HDMI and DVI data rates are extremely high for transmission of uncompressed digital video. In a single link HDMI connection, each TMDS pair transmits data at rates up to 1.65Gbps, more than three times as fast as Hi-Speed USB. Designing with high-speed data transfer protocols brings new application challenges. In such environments,

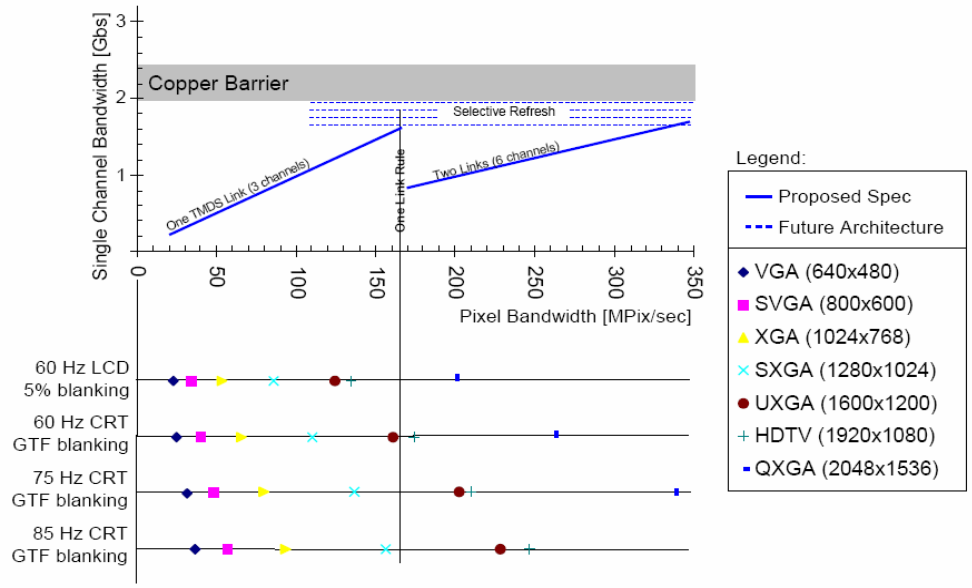

Figure 3

refresh rate capable of high-definition resolution previously insignificant stray capacitance, line loading, and

signal mismatch can result in increased bit error rates and failure to successfully transmit or receive data. Both the HDMI and DVI specifications allow very little tolerance in the electrical specifications to accommodate the addition of a non-ideal switch. As a result, makers of high-performance switches for HDMI and DVI must carefully tailor the products to the specific application needs to ensure they function correctly in the system. Following are some of the key performance characteristics that indicate whether or not a switch will function in this high-speed environment.

On Capacitance vs. On Resistance

On capacitance of the switch most significantly determines the impact of the switch on the TMDS data stream. Excess switch capacitance results in rounded off edges, causing slower rise and fall times. Consequently, the system has increased jitter and corresponding elevated bit error rates. Mismatches in channel on capacitance are of great importance relative to the HDMI and DVI specifications, making it increasingly difficult to meet a very tight skew specification. For example, when transmitting at the highest data rate, intra-pair skew cannot exceed 0.15Tbit, which is equivalent to no more than 90ps. One of the design tradeoffs that HDMI/DVI switch designers must confront is between on capacitance and on resistance. Low on capacitance and high-bandwidth performance comes at the expense of increased on resistance. Because this tradeoff is unavoidable, this is one of the fundamental reasons HDMI/DVI switches must be designed for the application. Many designers are familiar with voltage-driven applications and assume that on resistance is the most important specification in choosing a switch. This focus results from legitimate concerns about insertion loss and the signal attenuation that on resistance causes when in a voltage source application. Fortunately, HDMI and DVI signals do not have this problem because they use a current source with termination resistor to establish signaling levels. Figure 4 shows is a schematic illustrating TMDS signal generation.

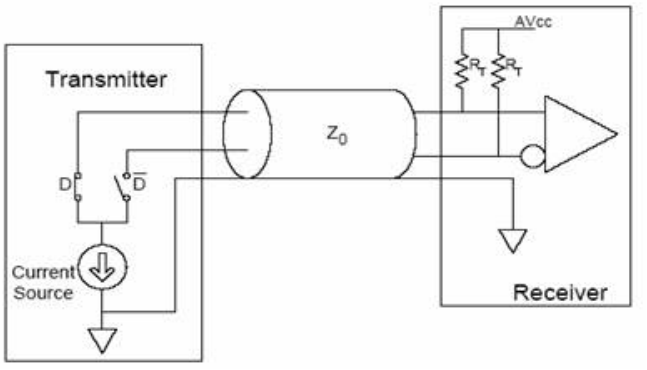

Figure 4

Knowing that the typical signaling range for TMDS signals is from AV_{CC} to AV_{CC}-0.5V, the current source is set to pull 10mA of current through the 50 Ohm bias resistor (R_T), establishing the receiver input voltage. With a constant 10mA source, the correct voltage level is present at the receiver input regardless of the voltage drop across the HDMI switch. (No current source is ideal, so remember the switch on resistance should not be excessive.)
For these reasons, the FSHDMI04 switch has very little on capacitance with slightly higher on resistance. When confronted with the on capacitance / on resistance trade-off, opt for lower on capacitance because on capacitance effects are more significant relative to system performance. On capacitance should be no more than 5-6pF. It is acceptable for on resistance to be in the mid teens (eg. FSHDMI04).

Bandwidth

A second crucial switch characteristic is bandwidth. To transmit data at the highest data rates, an HDMI/DVI switch must have at least 825MHz bandwidth. This number is derived by knowing that data is transmitted at 1.65Gbps and that data is triggered on both the rising and falling edges. The switch must have no more than 3dB of signal loss over the frequency range 0 to 825MHz. A switch without such performance severely attenuates the data stream when transmitting the highest video resolutions. This could result in a failure to recover data by the HDMI or DVI receiver. Limited bandwidth decreases acceptable cable lengths, making the end design less attractive to consumers. For these reasons, the HDMI/DVI switch should have at least 825MHz bandwidth.

Impedance Matching and Reflections

Finally, think about impedance matching and the impact of adding a switch in a high-speed data line on signal reflections. While it is impossible for the HDMI/DVI switch to perfectly match the line impedance of the transmission line, these switches can be designed so signal reflections are minimized. Selecting an HDMI switch with low on capacitance and relatively low on resistance minimizes the total system reflections. The on resistance and capacitance would ideally be zero, but this is impossible in a real-world implementation. In terms of signal reflections, opt for lower on capacitance at the expense of slightly higher on resistance. This results in a voltage standing wave ratio (VSWR) having a greater amplitude at the input to the switch than a switch with lower on resistance and higher on capacitance. A higher VSWR amplitude at the input to the switch helps compensate for any loss incurred by slightly higher on resistance and provides added eye mask margin.