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APPLICATION NOTE 4056

Using the MAX4929E for HDMI/DVI Low-Frequency Switching

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Abstract: The MAX4929E is a low-frequency HDMI/DVI switch, designed for use in a monitor or HDTV receiver. The device handles all the low-frequency signals that must be switched, and is a companion part to the new MAX4886 TMDS switch or any TMDS receiver with two inputs.

Basic HDMI/DVI Operation

The world of video transmission has undergone a nearly complete transition from analog to digital links in recent years. VGA and component video—analog video links—are being replaced by HDMI™ and DVI™. These two digital video standards have nearly identical requirements, and must handle a set of high-frequency and low-frequency signals simultaneously. The DVI specification was finalized in 1999, and the HDMI specification is in version 1.3 at the time of this writing. Both specifications use TMDS®

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(Transition Minimized Differential Signaling) for the high-frequency (video) portion of the data. The TMDS signal carries R,G,B and clock through four differential pairs, which occupy 8 pins of a 19-pin connector. Both HDMI and DVI are designed to be "plug and play" where the monitor (sink) and the source link up and find a way to function together at optimal performance. Many new TMDS HDTV chips include two complete sets of TMDS (high-frequency) inputs, but cannot address the LoF (low-frequency) signals.

To accomplish the "plug and play" function in HDMI and DVI systems, the source (usually a computer, DVD player, or game) and the sink (usually a monitor or receiver) must link up. HDMI and DVI both borrowed from the VESA (Video Electronics Standard Association) open standard, which uses the DDC (Digital Display Channel), one new signal called HPD (Hot-Plug Detect), and a standard 5V signal capable of supplying 50mA from a source to a sink. In the normal VESA approach, the source addresses an EDID (Extended Display Identification Data) EPROM. This EPROM device contains data for the brand of the sink, its model number, and the resolution modes that it supports. The source and sink must have at least one common display mode for them to function. **Figure 1** illustrates the use of an EDID EPROM connected from source to sink through the HDMI/DVI connector.
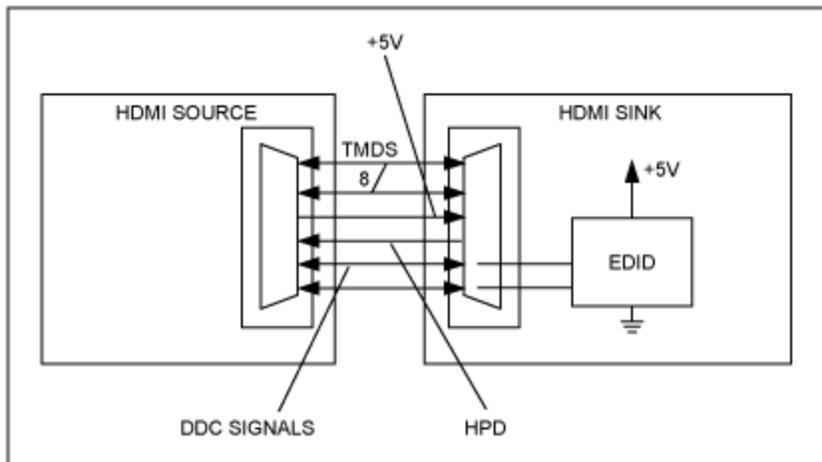
Figure 1. Schematic shows a HDMI/DVI connector joining an EDID EPROM from source to sink.

In Figure 1 the TMDS signals are connected as four differential pairs: the +5V, HPD, and DDC signals. The DDC signals are connected to the EDID. The power for the EDID is provided internally by the sink. This illustrates a general mode of connection between source and sink. The source and sink communicate over the DDC lines, which are I²C compatible. The I²C specification formulated in the 1980s is a +5V specification. A typical EDID EPROM such as the 24LC22 contains 2kb of EPROM to store the required information, and functions from 2.5V to 5.5V. When operating from +3.3V, the typical low-cost EDID EPROMs are not +5V-tolerant. The EDID EPROM device must be operated from +5V, or it must be protected against +5V externally.

To switch between two HDMI/DVI sources, the designer must handle two disparate signals: the TMDS high-frequency signals and all the LoF signals previously mentioned. Several modern HDMI processors now include two sets of TMDS inputs that handle the high-frequency TMDS signals, but cannot handle the relatively high voltages encountered with the LoF signals. Maxim has designed the MAX4929E to permit maximum flexibility and choices in the LoF signals.

Switching Between LoF Video Sources

With the MAX4929E all signals that can go to an outside connector are protected to ±15kV HBM (Human Body Model). This very high level of ESD protection generally eliminates the need for further protection on these pins. The MAX4929E permits two sets of DDC signals to be present, and the device selects either input. This source switching accomplishes several functions: it protects the signals from ESD; it selects only one source at a time; and it provides logic-level clamping to protect the EDID EPROM from voltages that can be higher than its source. The MAX4929E draws very little current and can have its +5V requirement supplied by a source device.

The MAX4929E has no voltage-sequencing requirements, a benefit that frees the designer from worrying about what can happen if a particular source device is on while the other is off. Switching between sources is highly desirable for several reasons. Switching puts the sink in control of which device can be connected. It also prevents a second cable from loading the I²C bus. This latter benefit solves two problems from having both sources attached to the same load simultaneously:
  1. Possible master conflicts
  2. Excess capacitive loading (each cable can exhibit 200pf/m)

If a second 2m cable is added to a primary cable, the maximum capacitance specification of 700pf is violated. By using a switch, the I²C driver only "sees" one load at a time. In this approach, even two 3m

cables do not violate the 700pf specification.

In most systems, an MCU controls the events. The MCU must determine if an input is active, and after the EDID handshake occurs, return a TTL-compatible HPD signal. There are three problems that the MAX4929E solves with this function (**Figure 2**):
1. ESD protection on the HPD output
2. Allows the MCU to determine if the selected HDMI input is, in fact, connected
3. Provides logic-level translation from a low-voltage MCU to a 5V TTL-compatible signal
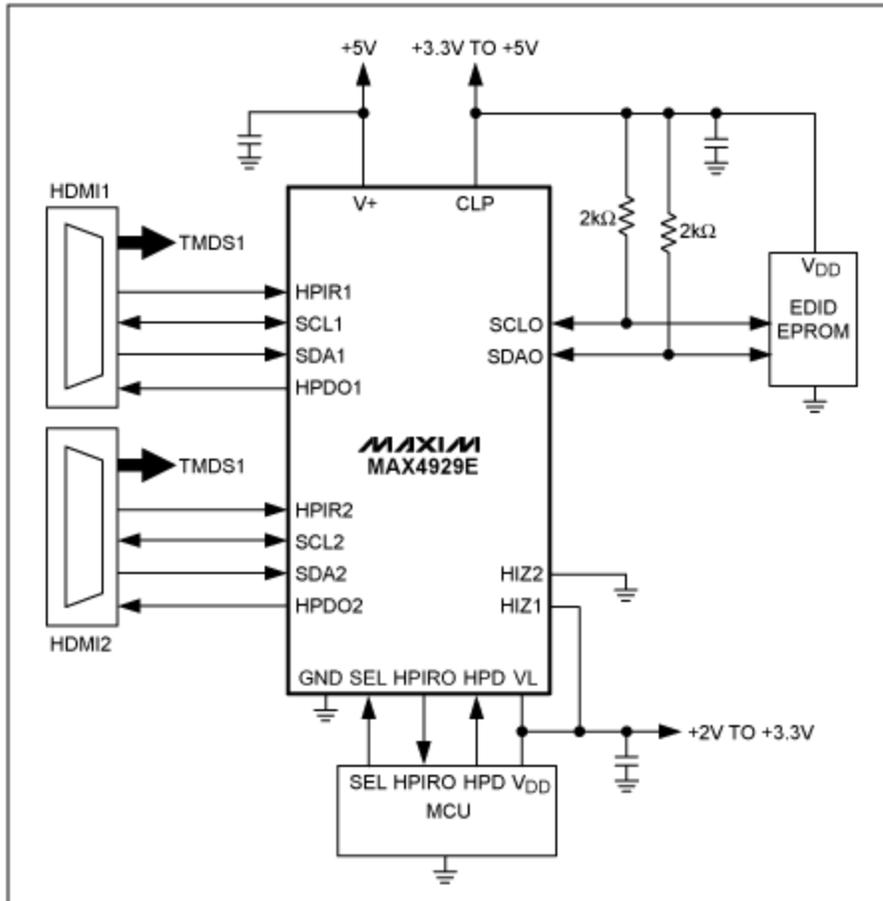

Figure 2. Schematic shows the typical circuit hookup of the MAX4929E. This device provides all the switching, logic-level matching, and ESD protection required to complete a 2:1 HDMI or DVI switch.

ESD protection has already been discussed. If the HPR signal is logic-high (+5V nominal), then a logic-high is presented to a pin routed to the MCU. This latter pin is assured to be logic-level compatible with the MCU because a reference pin on the MAX4929E is tied to the MCU's power supply. If there is a +5V signal present on the selected input, then the MCU sees a logic-level-compatible signal. After receiving this signal, the MCU can then present the HPD signal. The MAX4929E "steers" the HPD signal to the appropriate HDMI device, and presents that device with a fully TTL-compatible signal. The MAX4929E takes the low-voltage MCU logic 1 or logic 0 and produces a noninverted 0 or 1 that is TTL compatible for the HPD. As with its input, this signal is assured to be logic-level compatible, since its reference is tied to the same supply as the MCU.

In addition to being able to function with TMDS devices that contain two high-frequency inputs, the

MAX4929E can form a chipset with the MAX4886 HDMI/DVI video switch, which takes two sets of TMDS inputs and channels them to a single set. The MAX4886/MAX4929E chipset seamlessly adds a second set of inputs to a single input device.

Conclusion

The MAX4929E manages the switching of all LoF signals needed for a 2:1 HDMI/DVI switch. It adds high-level ESD protection to all outside lines. The MAX4929E mates with an EDID EPROM, accepting +5V signal levels at the input and clamping the output to +3.3V to match the EDID. In addition, the MAX4929E removes the capacitance of one of the lines, so the DDC output only has one set of DDC connections at a time. The MAX4929E has a third input voltage, which can be tied to the same supply as the system MCU. This feature assures that the SEL, HPR, and HPD signals are logic-level compatible with the MCU. The MAX4929E handles all the switching, logic-level matching, and ESD protection required to complete a 2:1 HDMI or DVI switch. The MAX4929E also adds to the MAX4886's capabilities to complete the switching function for a single-input device.

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