

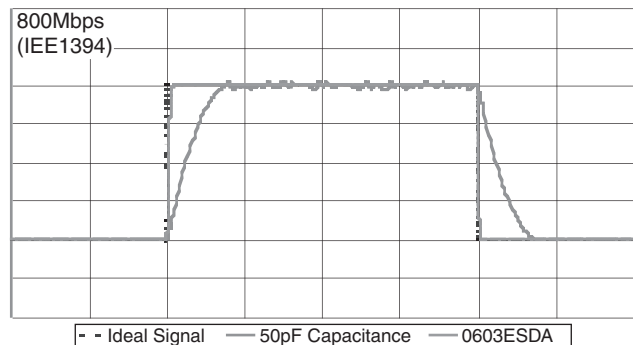
# ESD Protection for high speed digital video solutions (DVI & HDMI)

## Overview

High speed, uncompressed, digital video solutions such as Digital Visual Interface (DVI) and High Definition Multimedia Interface (HDMI) utilize small geometry CMOS processes in order to provide maximum performance in a small package. However these geometries are more susceptible to electrostatic discharge (ESD) and the high-speed digital signals present a real challenge when selecting an appropriate protection device.

## DVI/HDMI High speed data rates

DVI equipment can, currently, transmit at up to 1.6 Gbps for a 1600 x 1200 resolution signal. The receiver end can support up to 1.08 Gbps for 1280 x 1024 resolution but will soon increase to 1.65 Gbps. HDMI is an advancement of DVI that handles both audio and video signals with enough bandwidth for data rates of up to 5 Gbps. These high-speed data rates require any ESD protection device to have low capacitance in order to minimize signal distortion. At high frequency any capacitance will be seen as a low impedance path to ground, thus loading the data signal. Figure 1 shows the minimal effect of a Voltage Variable Material (VVM) ESD Suppressor on an 800 Mbps data signal compared to a 50 pF capacitor.



**Figure 1.** IEE1394 Signal distortion due to 50 pF and 0603ESDA VVM ESD suppressor

Traditional low capacitance steering diode solutions have a number of problems when used in high-speed data applications such as HDMI & DVI. Diodes are typically connected rail to rail as shown in Figure 2. During a negative voltage transient the bottom diode conducts clamping the voltage to a diode drop below ground. During a positive voltage transient the top diode will conduct the surge current (I1) into the power rail. Dumping the surge current into an unprotected supply rail can cause latch up of the protection circuit, so an additional transient voltage suppression (TVS) device between the supply rail and ground is required.

## DVI/HDMI High speed data rates

Typically discrete steering diodes are not rated for the high transient currents associated with ESD. This misuse results in a short cycle life and eventual diode failure, which is commonly in short circuit mode. This short circuit failure mode usually results in the equipment no longer functioning, even though the ESD event has passed. The preferred failure mode is open, since the equipment will certainly not operate with a shorted device, but has a potential to operate longer if the device were to fail open.

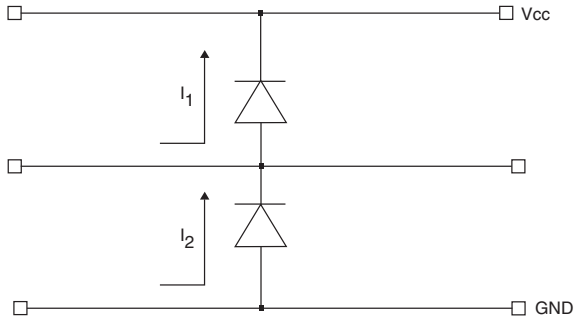


Figure 2. Rail to rail diode connection

In order to make a low capacitance diode a small junction area is used which presents a high resistance during ESD transients. Also, diode response time is slow compared to the ESD voltage rise time and the complete solution has significant parasitic inductance associated with the device leads and tracking. All this results in a large amount of voltage overshoot and a much higher clamping voltage. With the HDMI/DVI chip still exposed to several hundred or even one thousand volts following an ESD event, using this protection technique, there is potentially enough stress to damage the device.

Other solutions such as zener diodes, multilayer varistors (MLV's) and TVS all exhibit levels of capacitance that are too large for them to be practical solutions in DVI and HDMI applications. With capacitance values from 25 pF to 500 pF coupled with leakage currents of 0.5-50  $\mu$ A the level of loading on the signal lines becomes unacceptable.

## Voltage Variable Material ESD suppressor product family

The Eaton VVM ESD suppressor provides the solution to the problem of providing ESD protection for these new high-speed circuits. This product is a bi-directional device that has leakage current of less than 1 nA and capacitance less than 0.15 pF. This ultra-low capacitance makes the VVM ESD suppressor a viable solution for high data rate protocols like HDMI and DVI. With an insertion loss of less than -0.2 dB at frequencies up to 6 GHz the VVM ESD suppressor is invisible to the circuit, introducing no additional loading or signal distortion.

The VVM ESD suppressor product families are comprised of the 0402ESDA-MLP1, 0603ESDA-MLP, PS04LTVA1 and 0603ESDA2-TR2 ESD suppression devices. All are discrete devices exhibiting ultra-low capacitance to maintain signal integrity while protecting all but the most sensitive IC's from the harmful effects of ESD strikes up to 15 kV (air discharge).

### Summary

Commercial products require ESD surge protection of all the interface hardware schemes. New higher end consumer electronics are increasingly using high data rate protocols such as DVI and HDMI. The traditional protection devices have all been used with varying success, however the increase in data rates now indicates a need for ultra low capacitance devices, such as Eaton's VVM ESD Suppressors.

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