

# Benefits of "Air Gap" ESD Suppression Devices for High Speed ESD Protection

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Modern electronic devices that utilize some type of cable for data communication are exchanging information at higher speeds than ever. HDMI, DVI, USB, and high-speed Ethernet port connections all have data transfer rates above 1 Gbit per second. High data rates pose a challenge for protecting the data lines and connection points because many ESD protection devices do not respond fast enough or will distort the high-speed signal. This document will discuss several ESD suppression technologies and their strengths and weaknesses and how air gap ESD suppression devices excel at high speed data line and port protection.

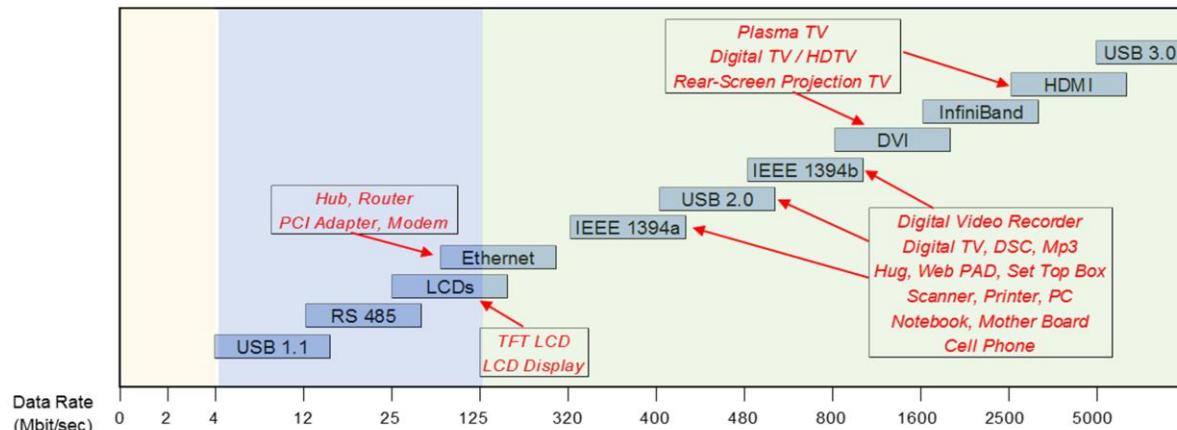


Fig. 1 Data Communication Transfer Rates

### High Voltage Suppressor Technologies

There are four main high voltage suppressor technologies commonly found in current electronics design. Polymer gap ESD devices are manufactured on the PCB and function by means of the breakdown of the polymeric material between the electrical contacts. This provides very low leakage and low breakdown voltage; however, it requires a high trigger and high clamping voltage which may not be suitable for high speed low voltage devices. Multilayer varistors are a common choice as they function by utilizing the threshold voltage of the zinc-oxide crystal barrier. Multilayer varistors provide protection with a low breakdown voltage, but inherently higher leakage current, and limited capacitance which may slow response and distort high speed signals. Low capacitance MLV options will typically only handle lower level ESD events. Semiconductor-based TVSD which function through the breakdown of the semiconductor junction offer excellent ESD protection with low trigger voltage and clamping voltage. Unfortunately, semiconductor-based ESD suppressors typically have higher leakage current and limited device capacitance which may slow response time and distort high speed data signals. Finally, air gap-based ESD suppressors which function through the breakdown of the air between electrical contacts offer the best high speed data line protection. Air gap ESD suppressors are capable of very low capacitance, have low leakage current and low clamping voltage, and can withstand high level ESD pulses reliably and repeatedly.



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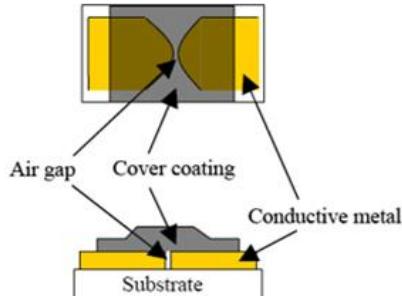


Fig. 2 Air Gap-Based ESD Suppressor Cross Section

### Air Gap ESD Suppressors

Air gap ESD suppressors, unlike polymer gap devices, provide a protective response that does not degrade. After a thousand 8 KV discharges, air gap ESD suppressors show little to no change in clamping voltage, leakage current, trigger voltage, or capacitance. Another important measure of the effectiveness of an ESD suppression device is insertion loss. If insertion loss is too high, the signal strength will diminish especially at high frequencies. Air gap ESD suppressors have a typical insertion loss of ~ 0.92 dB at 5.1 GHz.

Finally, the 3.4 GHz HDMI eye diagram calibration pattern shows exceptional signal integrity and very low distortion as shown in the figures below.

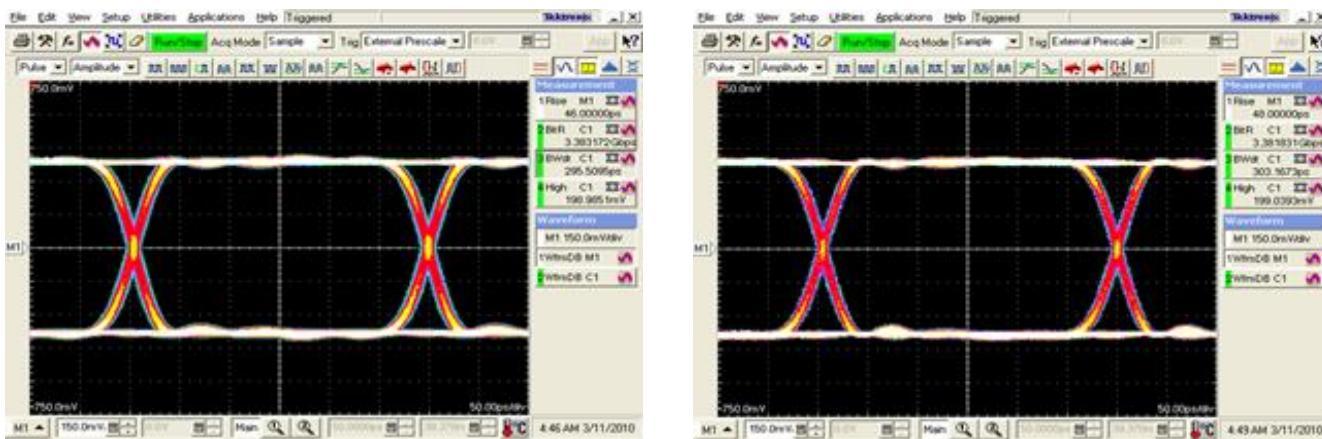


Fig. 3 HDMI 3.4 GHz Calibration Pattern (left) and Pattern with Air Gap ESD Suppression Device Inserted (right)

### Summary

High speed data transmission, such as through USB or HDMI, requires ESD protection that is fast to respond and does not distort or attenuate the data signal. Polymer gap, multilayer varistors, and semiconductor-based TVS devices all have their specific strengths but have important drawbacks that limit their capability to protect high speed data lines and ports from ESD events. Air gap type ESD suppressors offer the ability to withstand thousands of high voltage pulses with no performance degradation. Air gap ESD devices offer low leakage, low clamping voltage, and are capable of extremely low capacitance which allows them to respond extremely fast, with low attenuation, and virtually no signal distortion.

