

## Applications & Cases



CeraDiodes for HDMI interfaces

October 2007

### No chance for ESD

EPCOS presents a CeraDiode as a protective ESD component for the HDMI interfaces of appliances such as flat-screen TVs, DVD recorders and set-top boxes.

Because of their complex microelectronics, flat-screen TVs are extremely sensitive to transient overvoltages such as ESD. A dreaded ESD pulse is most likely to penetrate the appliance when cables from peripheral terminals are touched or connectors are unplugged. The pulse then travels from the terminal via the data and voltage-supply leads to the circuit board, potentially destroying the board or the components on it. ESD protection of the HDMI interface presents a particular challenge to manufacturers of consumer electronics equipment. As the first of a whole family of ESD protection elements for HDMI interfaces, EPCOS has launched a CeraDiode of the 0402 series with a typical capacitance of 0.6 pF (maximum capacitance 0.9 pF).



#### PRODUCT PROFILE: CERADIODE FOR HDMI TERMINALS



<b>Series</b>	0402
<b>EPCOS type</b>	CDS2C05HDMI1
<b>Package</b>	SOD-723
<b>Rated voltage</b>	5.6 V
<b>Breakdown voltage</b>	150 V
<b>Typical capacitance</b>	0.6 pF
<b>Pin assignment</b>	P1 GND P2 I/O Line

#### Constant protection properties

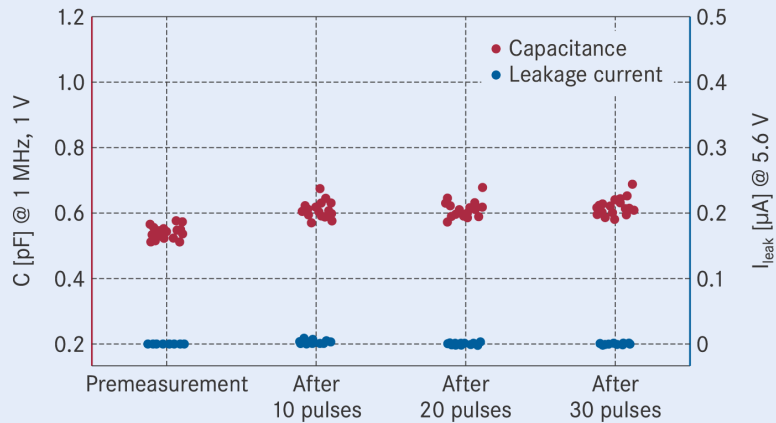
Conventional semiconductor diodes are not well suited for ESD protection in flat-screen TVs because their protective properties start to become impaired at 25 °C (derating). In contrast, the CeraDiode developed by EPCOS is immune to the high temperatures often occurring in LCD and plasma TVs. Its protective properties remain unchanged up to an operating temperature of 85 °C. EPCOS already supplies several types of this ceramic component designed for the ESD protection of data, audio and video lines, as well as ICs or inputs/outputs (interfaces).

CeraDiodes are not only the cost-effective alternative to corresponding ESD protection components based on semiconductors such as zener or TVS diodes, but also offer technical advantages: in many cases they can replace a semiconductor diode on the solder pad one-to-one with no changes. In addition, because CeraDiodes are bidirectional components, there is no danger of inserting them in the wrong direction during placement.

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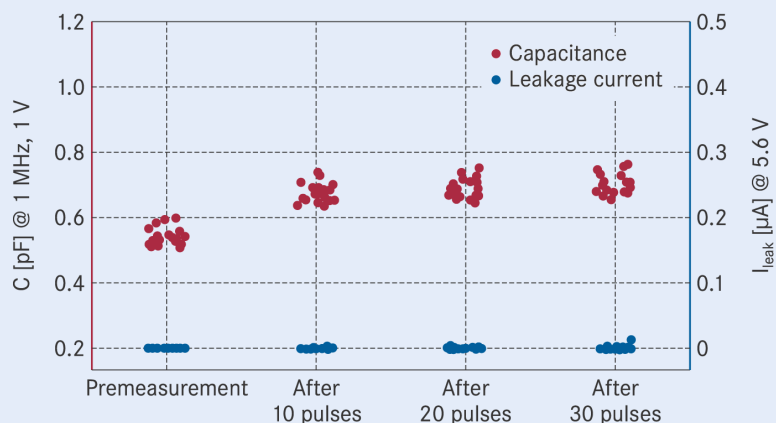
**FIGURE 1: ESD STABILITY WITH 8 KV CONTACT DISCHARGE**



Change in capacitance (red) and leakage current (blue) of the CeraDiode CDS2C05HDMI1.



**FIGURE 2: ESD STABILITY WITH 15 KV AIR DISCHARGE**



Change in capacitance (red) and leakage current (blue) of the CeraDiode CDS2C05HDMI1.

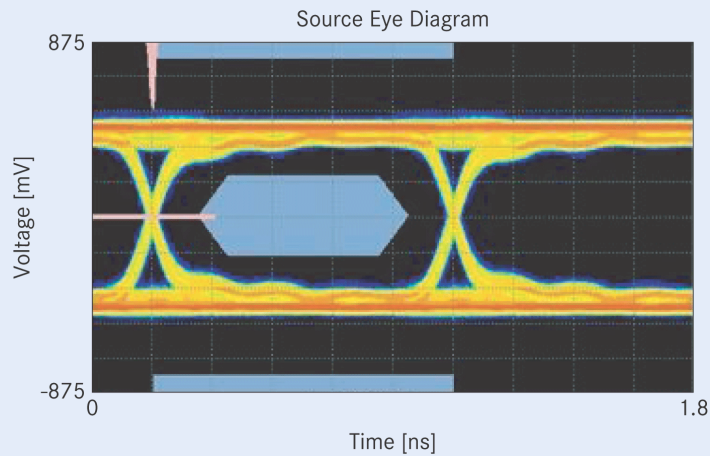
### Maximum requirements

Because very fast data rates of up to 10 Gbit/s run via the HDMI interface, the capacitance of the ESD protective element must be minimized in order to avoid transmission losses; in the case of HDMI less than 1 pF. In addition, the protective components must satisfy the requirements of the international ESD standard IEC 61000-4-2, ideally to Level 4. In the case of the CeraDiode, neither the maximum capacitance of 0.9 pF nor the maximum leakage current of 1  $\mu$ A may be exceeded even after ten positive and ten negative pulses with a contact discharge of 8 kV or an air discharge of 15 kV (Figs. 1 and 2). The new CeraDiode with the designation CDS2C05HDMI1 not only satisfies but greatly exceeds these requirements. Even after 30 positive and negative pulses, these parameters remain within their limits. The new CeraDiodes are tested within the human body model (330  $\Omega$  / 150 pF). In the case of ESD, they have a reaction time of less than 0.5 ns.

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**FIGURE 3: SOURCE EYE DIAGRAM TEST**



The suitability of the EPCOS CeraDiodes for HDMI terminals was confirmed in an HDMI compliance test to Standard 1.3a. Data jitter of  $0.05 T_{\text{BIT}}$  was measured in these tests.

### HDMI compliance test

The suitability of the CeraDiodes from EPCOS for HDMI terminals was confirmed in a HDMI compliance test to Standard 1.3a.

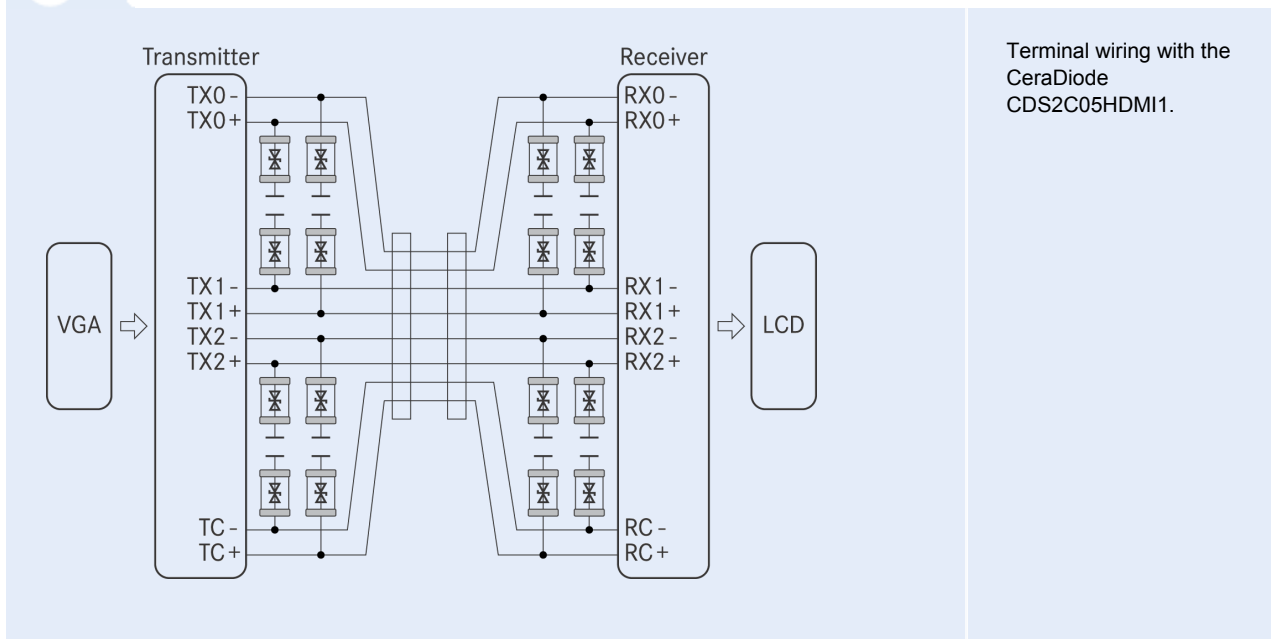
The following tests were performed and successfully passed:

- Source eye diagram test (Fig. 3)
- Clock jitter test
- Clock duty cycle test
- Rise and fall time test
- Clock-data inter-pair skew test
- Data-data inter-pair skew test
- Overshoot and undershoot test
- Differential impedance test

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**FIGURE 4: EXAMPLE OF AN HDMI TERMINAL WIRING**



Although the new CeraDiode CDS2C05HDMI1 was developed for the ESD protection of DVI or HDMI interfaces (Fig. 4), it is also very well suited for protecting gigabit Ethernet and IEEE 1394b terminals. It may also be used in applications with lower data rates such as USB and IEEE 1394a. Other HDMI CeraDiodes are currently in development, including a 0603 type as a discrete component as well as space-saving arrays.



### BACKGROUND: HDMI INTERFACES IN CONSUMER ELECTRONICS

The widespread use of flat screens (LCD and plasma) led to the establishment of high-definition television with up to 1920 x 1080 pixels (HDTV). Both DVI (digital video interface) and HDMI (high definition multimedia interface) have come into general use for digital image and sound transmission. Whereas DVI is widely used in computers to connect the monitor and PC, consumer electronics equipment like TVs and their peripherals such as HD DVD players, Blu-ray disc players, HDTV set-top boxes and hard disk/DVD recorders are linked digitally via HDMI. Thanks to transmission rates of up to 10 Gbit/s (HDMI 1.3 standard), which are very high compared with analog connections, both these digital interfaces together with relevant players offer ideal conditions for maximum sound and picture quality. Whereas few high-end TV and DVD devices had HDMI two years ago, today even entry-level appliances have at least one HDMI interface and mid-range appliances usually offer at least two.