

## Applications & Cases

ESD protection

January 2004

# ESD protection in entertainment electronics

Entertainment electronics products are becoming more and more complex and thus more susceptible to ESD. CeraDiodes can solve this problem simply and economically.



PROFILE CERADIODES

CeraDioden von EPCOS sind eine Alternative zu TVS-Dioden. Sie benötigen nur noch ein Drittel des Platzes und arbeiten bidirektional. Durch die parasitären Kapazitäten erfolgt neben dem ESD-Schutz gleichzeitig eine Filterfunktion. Die Bauelementzahl wird reduziert und die Unempfindlichkeit gegen Über-temperatur verbessert.

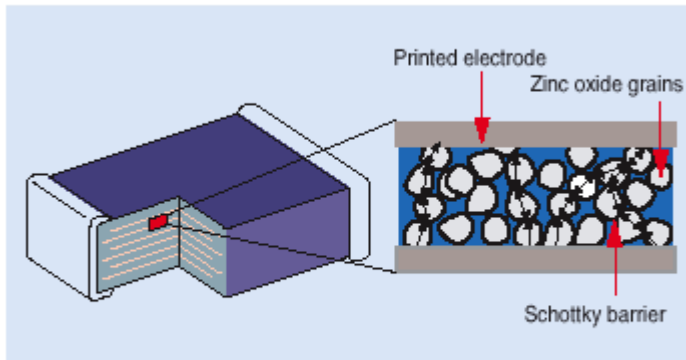


On average, a state-of-the-art entertainment electronics product contains more than 80 lines conducting analog and digital signals. These may be internal connections such as data buses, or may link I/O ports and control elements such as switches and push-buttons. All these lines terminate in highly integrated circuits, which are extremely sensitive to static discharges.

A new series of ceramic semiconductors from EPCOS known as CeraDiodes offers almost ideal ESD protection for such equipment. Manufactured from ceramic oxides in multilayer technology, these components effectively suppress voltage transients. The various layers are built up from numerous zinc oxide grains. A micro-CeraDiode is formed at the boundary layers of the various grains, comparable to a zener diode. Thanks to the large number of individual micro-CeraDiodes, the overall ESD strength of a CeraDiode is significantly greater than that of a TVS diode, which has only a single pn-junction → 1.

## Applications & Cases

### 1 Internal structure of a CeraDiode



1 Micro-CeraDiodes are located inside the CeraDiode. The number of layers determines the response voltage.

The CeraDiode series consists of various SMDs in size 0603. In addition to the single-element series, a quad array in size 1206 is currently under development. Prototypes are already available. The range of applications covers DC operating voltages from 5.6 V to 22 V and capacitances from 2 to 470 pF. Selection of an optimum CeraDiode depends on the ambient variables and the specific application → 2.

Type	Part Number	DC Voltage	Capacitance	Recommended for	Applications	Features
0603	CDS3C05GTA	5.6 V	470 pF	Set-top boxes, LCD monitors, TVs, DVD players, etc.	Audio lines, filters for high-frequency noise	Low leakage currents
0603	CDS3C09GTA	9 V	220 pF			
0603	CDS3C15GTA	16 V	160 pF			
0603	CDS3C20GTA	22 V	56 pF		Data, video and audio lines	Low capacitance to prevent signal distortion, low leakage current
0603	CDS3C30GTH	20 V	10 pF		High-speed data and video lines	
0603	CDS3C16GTH	16 V	3 pF		Ultra high-speed data and video lines (e.g. USB 2.0)	
1206 Quad array	CDA5C09GPA	8.5 V	220 pF	Digital equipment portable equipment	Audio lines	Low leakage current
1206 Quad array	CDA5C20GPA	22 V	56 pF		Data, video and audio lines	

### Applications in entertainment electronics

CeraDiodes are already used to protect circuits in many entertainment electronics products: set-top boxes, digital TVs, LCD monitors, LCD TVs, DVD players and digital cameras. They must be connected in parallel with the component protected. If the voltage exceeds a certain limit, they provide a low-impedance path running parallel to the sensitive component.

### Major applications

#### Scart/RCA jack connectors

Most of the 21 pins of a Scart/RCA connector → 3 and → 4 need ESD protection to prevent destruction of the downstream electronics. The following protection measures are recommended in this case:

#### 1. Video I/O line

Low-capacitance CeraDiodes are ideal in this application to prevent signal distortion. Type CDS3C20GTA is suitable for lower frequencies, type CDS3C30GTH for high frequencies up to 200 MHz. Type CDS3C16GTH is the best choice for frequencies above 240 MHz, and type CDA5C20GPA, a CeraDiode quad array in size 1206 package, is the preferred option where board space is at a premium.

#### 2. Audio lines

To obtain high-quality audio signals, high-frequency noise must be filtered out. CeraDiodes handle both RFI

## Applications & Cases

suppression and ESD protection. Suitable types with corresponding capacitances are the CDS3C15GTA with 160 pF, CDS3C09GTA with 220 pF and CDS3C05GTA with 470 pF.

The audio leads in a Dolby system cannot be protected by a unidirectional diode, as this would drive the negative component of the audio signal to saturation. Here CeraDiodes are even more attractive thanks to their bidirectional operation. In contrast, the alternative bidirectional TVS diodes are large and expensive.

### I<sup>2</sup>C Bus

Type CDS3C20GTA is a very good choice for protecting an SCL/SDA (serial clock/serial data) line connected to the microprocessor.

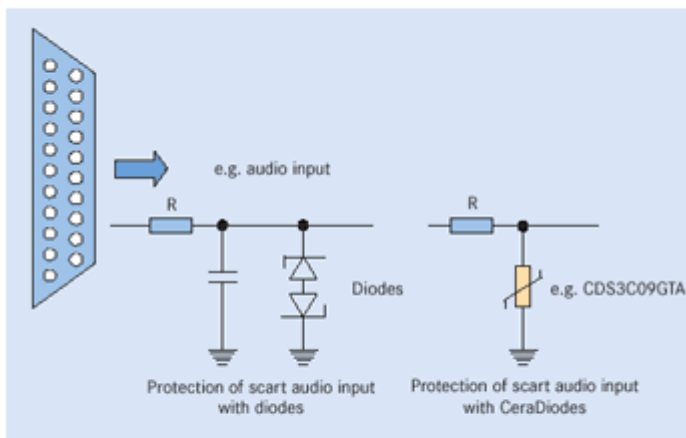
### Push-buttons

CeraDiodes protect push-button lines for channel selection, sound volume control, etc. connected to an IC → 5.

### Infrared line of preamplifier

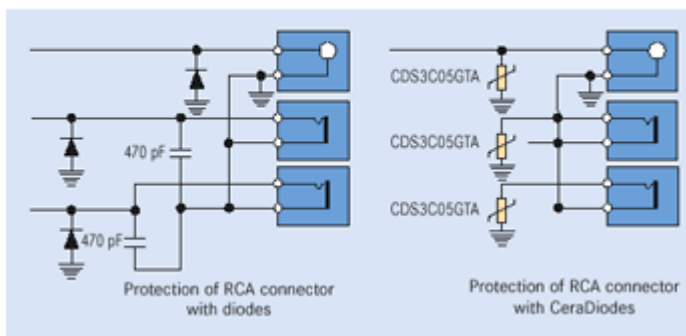
CeraDiodes protect the infrared line of a preamplifier connected to a microprocessor.

### 3 | Scart connector with 21 pins



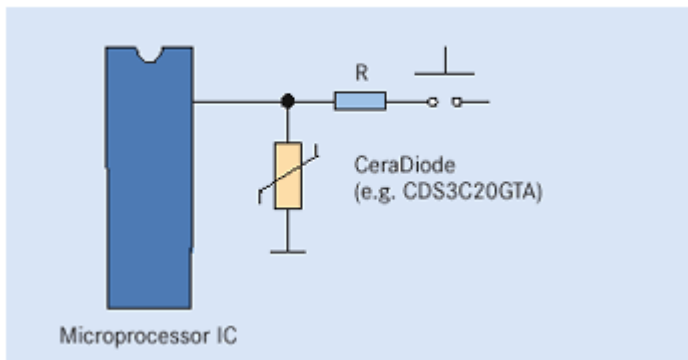
3 Most leads require ESD protection. They include R,G,B,video-in,video-out,audio-in, audio-out,slow switch,fast switch.

### 4 | RCA connector:conventional protection (left), with CeraDiodes (right)



## Applications & Cases

### 5 | Protection of an IC with switches or pushbuttons



#### CeraDiode benefits at a glance

CeraDiodes are SMDs in size 0603. Most TVS packages are up to three times larger. This advantage is decisive in compact equipment such as portable DVD players and PDAs.

TVS zener package	Size comparison (times larger than CeraDiode)
SOD-323	1.28
SOD-123	2.51
SOD-23	2.94

Unlike TVS diodes, CeraDiodes are bidirectional devices. To implement this function with TVS diodes, either two components or a significantly more expensive and larger dual element in a single chip must be used.

#### Use of parasitic capacitances for RFI suppression

CeraDiodes have a very stable capacitance which is largely unaffected by temperature fluctuations and DC bias voltages. This means that the parasitic capacitance itself can be used as a filter for high-frequency noise components → 7. The CeraDiode can consequently replace several external components which would otherwise be required for ESD protection and the simultaneous filter function → 6.

#### Faster response

Thanks to their smaller dimensions and internal structure, CeraDiodes have very low parasitic inductances and therefore response times of less than 0.5 ns. This is quite sufficient to ensure reliable ESD protection for a circuit. In contrast, TVS diodes have response times of 0.8 ns or more because of their larger dimensions and higher parasitic inductances.

#### Lower leakage currents

The leakage currents of CeraDiodes are invariably lower than those of TVS diodes. EPCOS also offers specific types with extremely low leakage currents. They are particularly suitable for protection of portable equipment in order to prolong battery life.

#### Benefits in temperature response

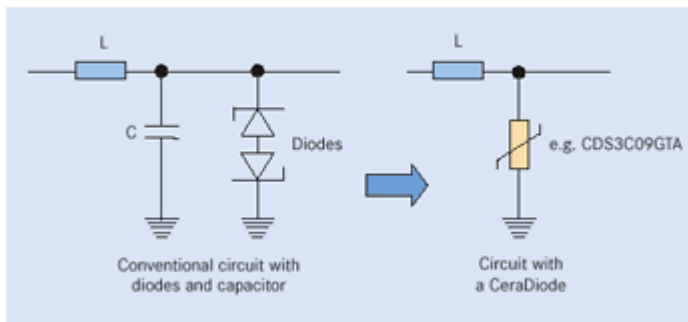
Up to temperatures of 85 °C, the electrical characteristics of CeraDiodes remain practically unchanged. In contrast, the TVS diodes start derating at 25 °C.

#### Optimized placement and quality costs

Unlike TVS diodes, CeraDiodes are bidirectional, symmetrical components. Pick-and-place machines must position TVS diodes with the correct polarity. This results in greater complexity, higher error probability and thus higher costs.

## Applications & Cases

### 6 | CeraDiodes for filtering RF inputs



### 7 | Capacitance as a function of bias voltage

