

# CeraDiode

## General Presentation

# Definition

1. The CeraDiode is a ceramic component for the ESD protection of data-, audio- and video lines, ICs and I/O ports in electronic devices.
2. The CeraDiode is a (cost effective) alternative to semiconductor protection devices such as Zener and TVS diodes.
3. In many cases, the CeraDiode is a 1:1 replacement for these diodes (F.F.F. fit form function).
4. The CeraDiode offers several technical advantages.

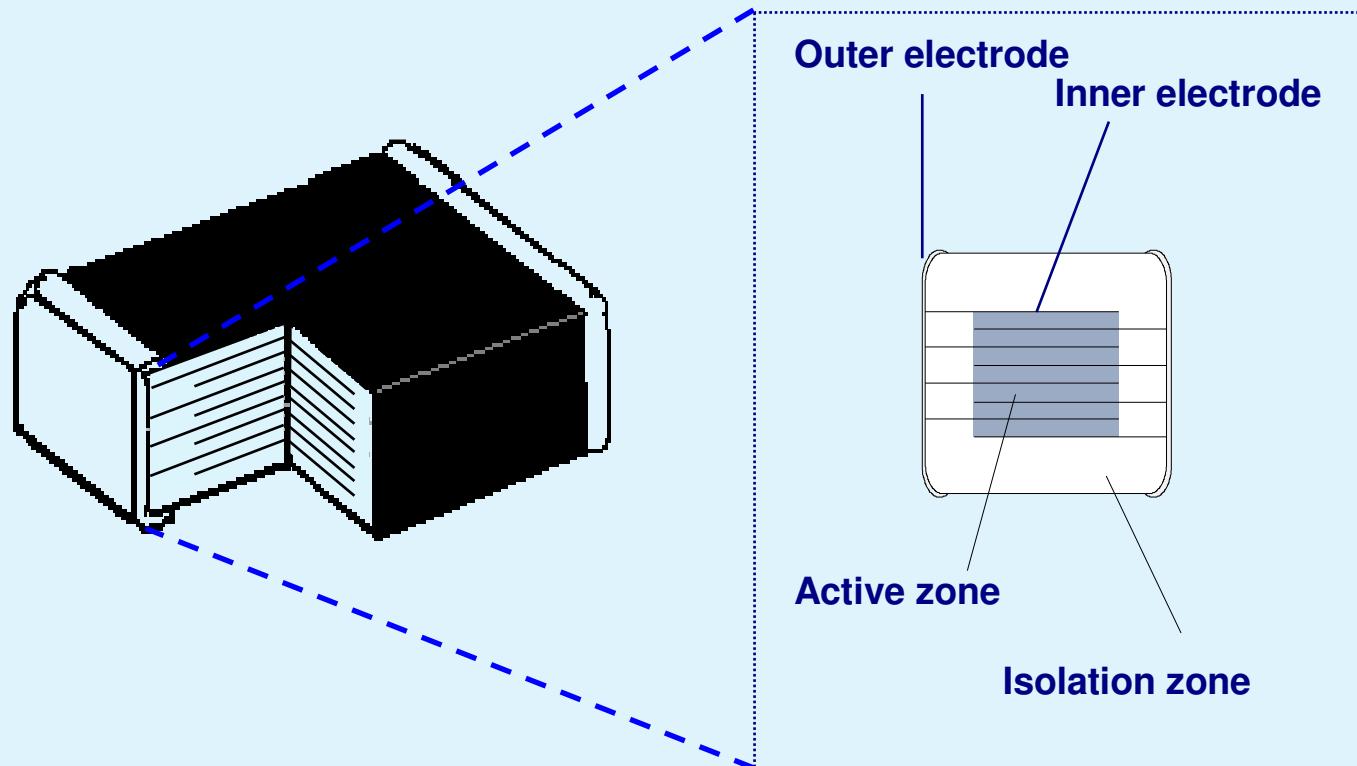
# Benefits for customer applications

## CeraDiode offers several features and advantages:

- 1) Bi-directional protection in a single component
- 2) High ESD stability to IEC 61000-4-2
- 3) No change in ESD protection performance at temperatures > 25 °C
- 4) Use of parasitic capacitance for RFI suppression and HF filtering (replacement of additional MLCC)
- 5) Low leakage current
- 6) Fast response time < 0.5 ns
- 7) Ruggedness against surge currents



# Construction of a CeraDiode



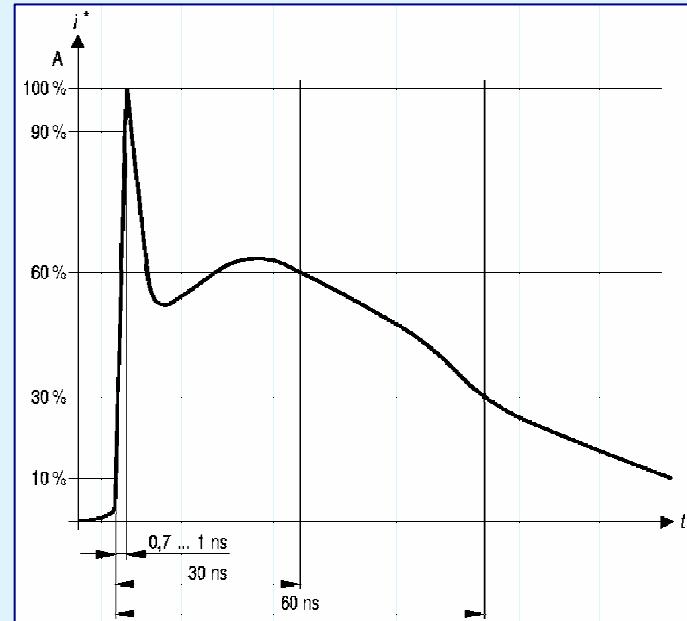
## MATERIALS

Ceramic layers:  
Inner electrodes:  
Outer electrodes:

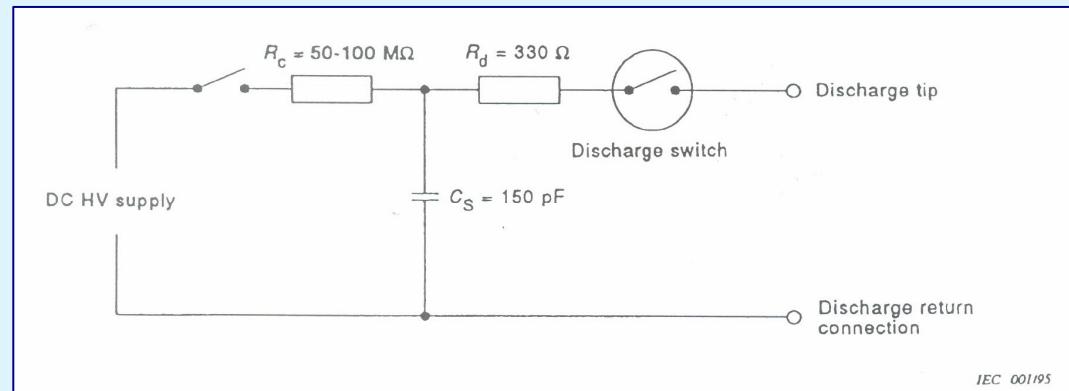
Metal-oxide ceramic  
Silver-palladium  
Nickel barrier (Ag / Ni / Sn)

# IEC 61000-4-2 International ESD Standard

## ESD discharge current



## ESD discharge generator (Human Body Model)



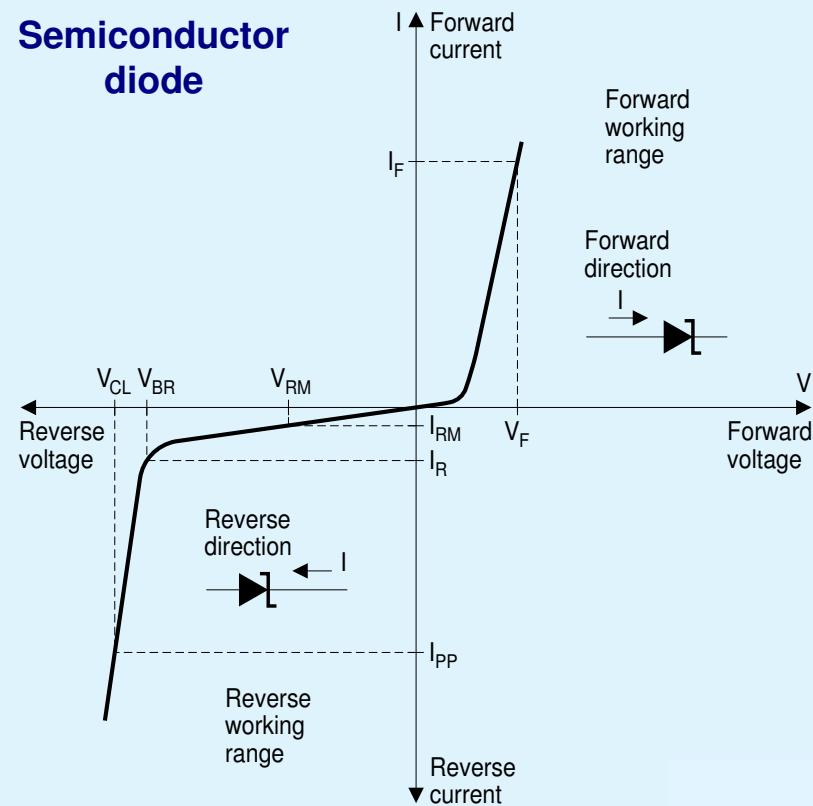
## ESD discharge levels

IEC 61000-4-2 test level	Test voltage (contact discharge)	Test voltage (air discharge)
1	2 kV	2 kV
2	4 kV	4 kV
3	6 kV	8 kV
4	8 kV	15 kV

# Comparison Semiconductor diode – CeraDiode

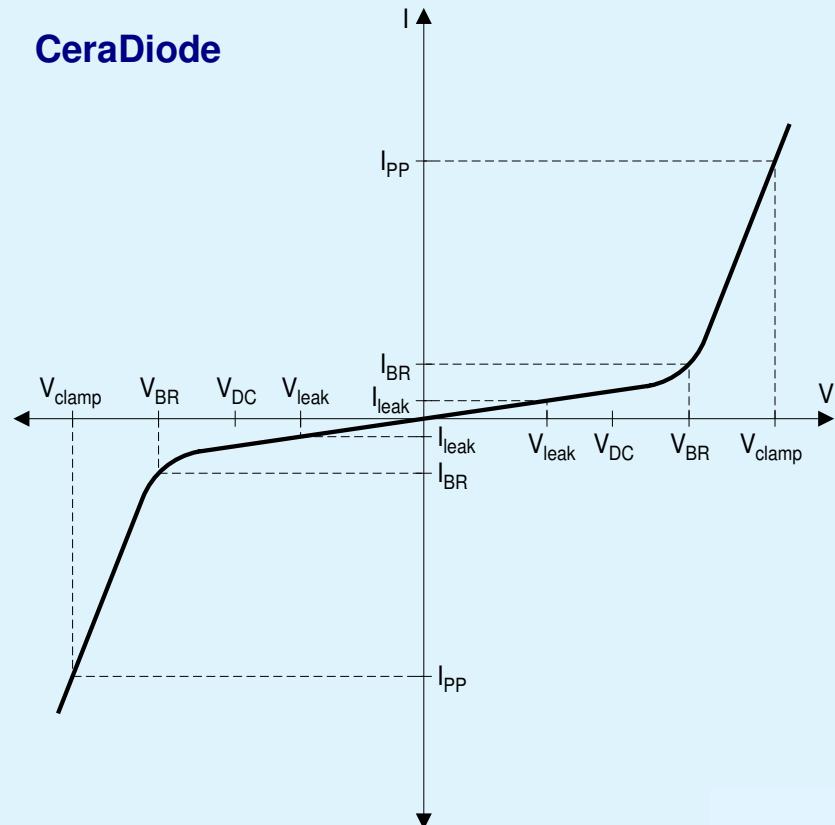
## Characteristic curves

**Semiconductor  
diode**



**uni-directional**

**CeraDiode**



**bi-directional**



**EPCOS** CeraDiode

# Comparison Semiconductor diode – CeraDiode

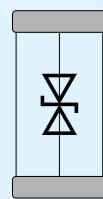
## Characteristic curves: Glossary

	Semiconductor diode	CeraDiode
(Reverse) stand-off voltage, working voltage, operating voltage	$V_{RM}$ , $V_{RWM}$ , $V_{WM}$ , $V_{DC}$	$V_{DC}$
(Reverse) current @ maximum reverse stand-off voltage, working voltage, operating voltage	$I_{RM}$ , $I_{RM,max}$ , $I_{RM,max} @ V_{RM}$	-
(Reverse) leakage current	$I_{RM}$	$I_{leak}$
(Reverse) voltage @ leakage current	$V_{RM}$ , $V_{RWM}$ , $V_{WM}$ , $V_{DC}$	$V_{leak}$
(Reverse) breakdown voltage	$V_{BR}$	$V_{BR}$
(Reverse) current @ breakdown voltage	$I_R$ , $I_T$	$I_{BR}$
Clamping voltage	$V_{cl}$ , $V_C$	$V_{clamp}$
Current @ clamping voltage	$I_{PP}$	$I_{PP}$
Peak pulse power	$P_{PP}$	$P_{PP}$
Peak pulse current	$I_P$ , $I_{PP}$	$I_{PP}$
Forward voltage	$V_F$	-
Current @ forward voltage	$I_F$	-

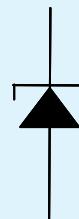


# Comparison Semiconductor diode - CeraDiode

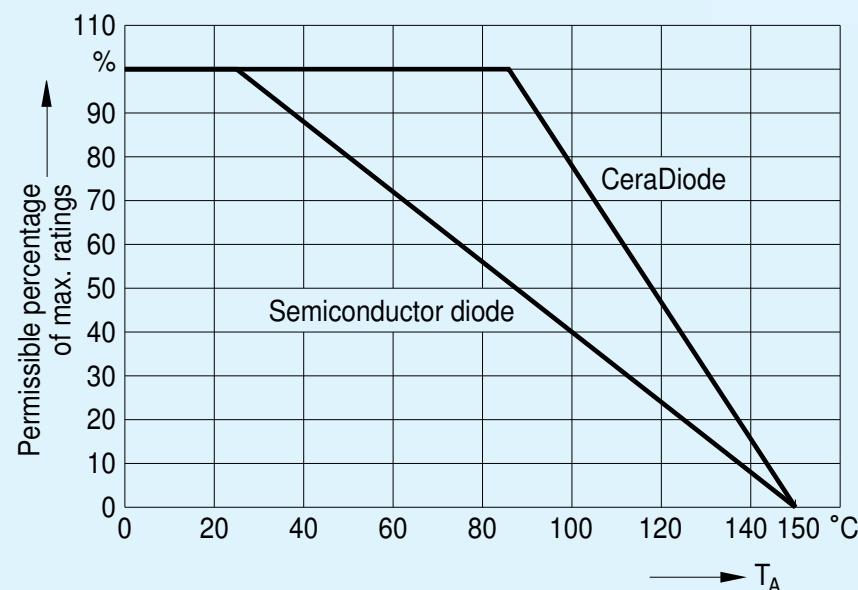
CeraDiodes show no change in ESD protection performance at temperature > 25 °C



**Millions** of pn junctions:  
Energy absorption over the entire volume of the component.  
**No change** in ESD protection performance at temperatures > 25 °C.



**One** pn junction:  
Energy absorption only in this small area.  
**ESD protection performance starts to decline** at 25 °C.

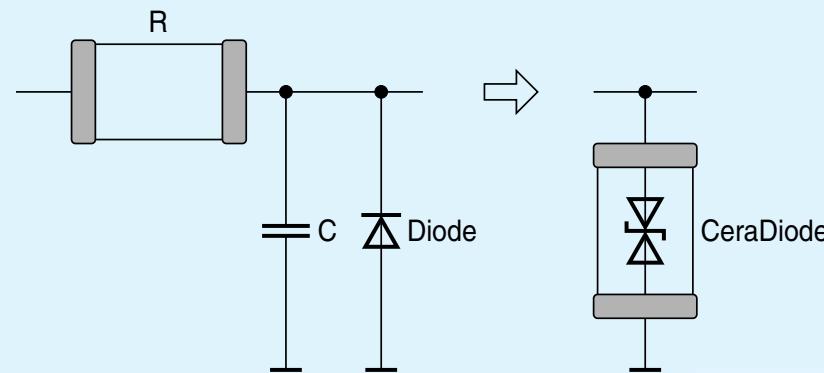


ESD protection with CeraDiodes can dispense with a series resistance for limiting the current!



# Advantages of CeraDiode

**Use of parasitic capacitance for RFI suppression and HF filtering  
(replacement of additional capacitor, MLCC)**



resistor

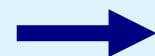
+

capacitor

+

semiconductor diodes

CeraDiode



Space and cost saving effects

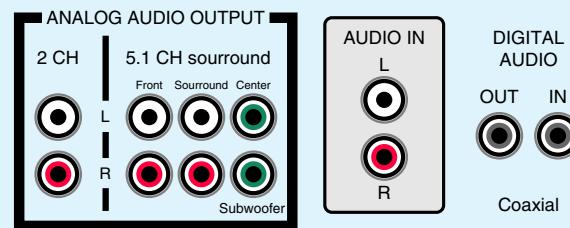


EPCOS CeraDiode

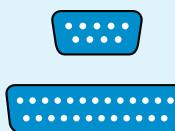
KB VS PM, 2007  
9

# Interfaces ESD protected by CeraDiode

Audio



Serial/Parallel



ISDN/  
xDSL modem



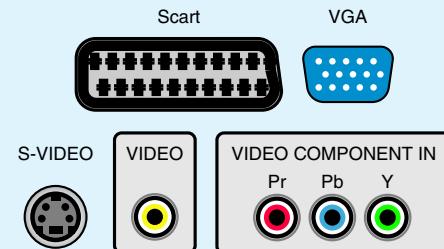
PS/2



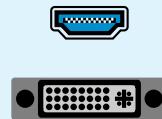
Push button



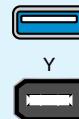
Video



HDMI/DVI



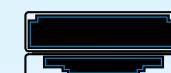
USB/  
IEEE 1394



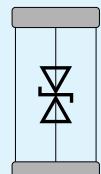
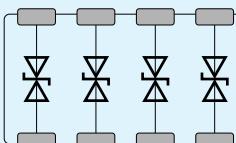
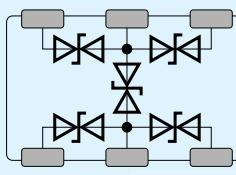
Ethernet  
LAN



Memory card



# Product range

CeraDiode case size	Device	Package semi-diode	Lines to protect	CeraDiode photo	CeraDiode schematic	Semi-diode photo	$V_{DC}$ [V]	$C_{typ}$ [pF]
0402 0603 1003	single	SOD723 SOD532 SOD323	1				5.6 to 30	0.6 to 470
0508 0612	array	-	4				16 to 22	3 to 56
1012	array	SOT23-6L	up to 4 data + 1 supply				5.6	7

# Application matrix

				Video analog (Scart, Composite, Component, S-Video, VGA)	Audio analog	Audio digital	DVI	HDMI	LCD	USB	IEEE 1394 (Firewire, DV, i.Link)	Ethernet	SATA	Serial port	Parallel port	Memory card	SIM card	Analog modem / ISDN	xDSL modem	Keyboard, Pushbuttons, PS2	
Devices	Case size	EPCOS type code	Semi-diode package																		
Single standard	0402	CDS2C05GTA	SOD-723		x	x <sup>1)</sup>								x			x	x <sup>1)</sup>	x		
	0402	CDS2C15GTA	SOD-723		x	x <sup>1)</sup>				x <sup>2)</sup>				x			x	x <sup>1)</sup>	x		
	0603	CDS3C05GTA	SOD-523		x	x <sup>1)</sup>								x			x	x <sup>1)</sup>	x		
	0603	CDS3C09GTA	SOD-523		x	x <sup>1)</sup>								x			x	x <sup>1)</sup>	x		
	0603	CDS3C15GTA	SOD-523		x	x <sup>1)</sup>			x <sup>2)</sup>	x <sup>2)</sup>				x			x	x <sup>1)</sup>	x		
	0603	CDS3C20GTA	SOD-523	x <sup>1)</sup>	x	x <sup>1)</sup>								x			x	x <sup>1)</sup>	x		
	1003	CDS4C12GTA	SOD-323		x	x <sup>1)</sup>								x			x	x <sup>1)</sup>	x		
Array standard	0508	CDA4C20GTA	-		x <sup>1)</sup>	x	x			x <sup>1)</sup>	x <sup>3)</sup>			x			x	x <sup>1)</sup>	x		
	0612	CDA5C20GTA	-		x <sup>1)</sup>	x	x			x <sup>1)</sup>	x <sup>3)</sup>			x			x	x <sup>1)</sup>	x		
Single high-speed	0402	CDS2C05HDMI1	SOD-723			x	x				x	x	x								
	0402	CDS2C15GTH	SOD-723	x		x		x <sup>1)</sup>	x	x		x	x			x	x	x	x	x	
	0402	CDS2C16GTH	SOD-723	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	0603	CDS3C16GTH	SOD-523	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	0603	CDS3C30GTH	SOD-523	x		x		x <sup>1)</sup>	x	x	x	x	x	x	x	x	x	x	x	x	
Array high-speed	1003	CDS4C16GTH	SOD-323	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	0508	CDA4C16GTH	-		x		x		x <sup>1)</sup>	x	x	x	x	x	x	x	x	x	x	x	
	0612	CDA5C16GTH	-		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	1012	CDA6C05GTH	SOT-23 6L	x		x				x	x	x	x	x	x	x	x	x	x	x	

<sup>1)</sup> Small data rates only

<sup>2)</sup> Power line

<sup>3)</sup> USB 1.1 only

Customer has to test and approve parts for the application.

