

### **ESD Protection Diode**

#### **Application Note**

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### **ESD Introduction**

ESD is the discharge of static electricity. Static electricity is an excess or deficiency of electrons on one surface with respect to another surface or to ground. A surface exhibiting an excess of electrons is negatively charged, and an electron deficient surface is positively charged. Static electricity is measured in terms of voltage (volts) and charge (coulombs).

Electrostatic Discharge (ESD) frequently occurs in nature, as well in Manufacturing environments and in-use finished electronic equipments.

The Discharge occurs at our fingertips when our body is electrically charged and is in close proximity of contact points attached to electronics devices.

The latest IC technology is becoming more sensitive to these events due to the extreme complexity of circuits, and the size of the semiconductor structures used so, circuit designers must provide an effective ESD Protection.

### Implications of ESD on IC industry

#### Major reliability threat in IC industry :

-Cause of approximately 1/3 of IC failures

-ESD protection is very challenging against rapidly changing technologies

#### Standard model is used to characterize ESD :

- Human Body Model (HBM)
- Machine Model (MM)
- Charged Device Model (CDM)

#### ESD control is indispensable throughout devices' life :

- Eliminating static charges from the workplaces
- Proper handling from manufacturing, shipping and field handling
- On-chip protection (clamp input voltage and bypass ESD current)

### ESD Requirements (U.S.A.)

#### Human Body Model

- +/- 2 kV Required by most customers Waivers given at 1 KV in some cases
- +/- 4 kV Delco (Auto Manufacturer)
- +/- 8 kV On Special Automotive Pins (Power Outputs)

#### **Machine Model**

No Standard for reliable testing Waivers given to 100 V in some cases



### **Protection Schemes**

#### The solutions for avoiding or reducing ESD failures

- 1) identifying and rectifying possible ESD sources.
- 2) identifying and undertaking adequate prevention measures while handling the ESD sensitive devices.
- 3) incorporating built-in ESD protection networks in devices.
- 4) providing awareness and training to users at all levels.

#### Two ways to reduce IC failures under ESD conditions :

**The first approach** focuses on reducing the amount of ESD induced charges and redistributing them through proper handling of devices and controlling the handling environments.

**The second approach** is to implement on-chip protection circuits in order to improve the circuit robustness against ESD events by improving ESD performance of the individual circuit components.

### **Typical Generated ESD Voltages**

Examples of Static Generation Typical Voltage Levels				
Means of Generation	10-25% RH	65-90% RH		
Walking across carpet	35,000V	1,500V		
Walking across vinyl tile	12,000V	250V		
Worker at bench	6,000V	100V		
Poly bag picked up from bench	20,000V	1,200V		
Chair with urethane foam	18,000V	1,500V		



### International ESD Models

The ESD events are modeled under several industry standards, where the Most representatives and accepted are:

- IEC 61000-4-2 (Recognized internationally)
- MIL STD 883
- JEDEC A114 and A115

Standard	Model	C, pF	R, Ohms
IEC61000-4-2	НВМ	150	330
MIL STD 883	НВМ	100	1500
JEDEC A115	ММ	200	0



### Human Body Model (HBM)





### Machine Model (MM)

#### **Typical MM Current Waveform**





### Electrostatic Discharge (ESD) IEC 61000-4-2



LEVEL	Test Voltage Aie Discharge (kV)	Test Voltage Contact Discharg e (kV)	First Peak Current (A)	Peak Current at 30ns (A)	Peak Current at 60ns (A)
1	2	2	7.5	4	2
2	4	4	15	8	4
3	8	6	22.5	12	6
4	15	8	30	16	8



### Electrical Fast Transient (EFT) IEC 61000-4-4



EFT Burst

	Peak Amplitude			
	Power Supply Port		I/O, Signal, Data & Control Lines	
Level	V <sub>OC</sub> (kV)	I <sub>SC</sub> (A)	V <sub>OC</sub> (kV)	I <sub>SC</sub> (A)
1	0.5	10	0.25	5
2	1	20	0.5	10
3	2	40	1	20
4	4	80	2	40



### Surge immunity (Lighting) IEC 61000-4-5





### **Transient Suppression**

- •Constant advances in semiconductor process technologies make the design of protection very challenging.
- •Protection circuit must *divert transient current and clamp transient voltage* below the failure threshold of the protected.





### **ESD Testing Setup**





#### **Contact Discharge Tip**



Air Discharge Tip













### ESD Protection Diode Application Field

Digital Photography	Gadgets	Game Controllers	Graphics & Sound	Input Devices
<ul> <li>Digital Photo Frames</li> <li>Digital Cameras</li> <li>Portable Web cams</li> <li>Web cams</li> </ul>	•PDA •GPS •NES	•Gaming Pads •Joysticks •Steering Wheels •PS2/PSP/XBOX	<ul><li>Audio headsets</li><li>Microphones</li><li>Speakers</li><li>TV Tuners</li><li>Video Capture</li></ul>	•Mice •Wireless Keyboard •Remote Control •Digitizing Tablets •Trackballs
Modems	Notworking	Dortoblo Audio	<b>C</b> t and <b>u</b> a	Delectore
& Telephony	Networking	Video	Storage	Printers & Scanners

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GS78050 F8FAS

GS393S F8DXN

### ESD Protection Diode for Ethernet

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GS78050 F8FAS

320x



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S

GSE0504 SOT-363



GSE0514 SOT-563



GS393S F8DXN

> GSE0505 SOT-23-6L



**Gigabit Ethernet Protection** 







### ESD Protection for Cell Phone / Smart Phone





GSE0514 SOT-563



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# ESD Protection Diode



GS78050



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GSE0521 SOD-523





GS393S F8DXN

GSE0572 SOD-723





### ESD Protection Diode for Cell Phone / Smart Phone





GSE0562 SOD-323



Battery Management Controller 5V



GSE6V8UW SOT-363





### ESD Protection Diode for LCD TV/DVD/Set-Top Box





GSE6V8UD DFN-10







GSE6V8UH MSOP-10L



### ESD Protection Diode for Notebook / i-Pad

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GS78050 F8FAS

GS393S F8DXN





YOUR BEST POWER PARTNER

### Thank you