

# Component Reliability

The CR Marketplace Compliance Test Solution Products and the Markets They Address

The world leader in serving science

- Component Reliability refers to the testing of components, rather than complete systems, as is the case with Thermo Scientific<sup>™</sup> Electromagnetic Compatibility (EMC) products.
  - Components that our systems are used to test:
    - Integrated Circuits (ICs)
    - Diodes / Light Emitting Diodes (LEDs)
    - Transistors
    - Modules or Sub-assemblies

## **Component Reliability Overview**

- Thermo Scientific manufactures test instruments that are used by manufacturers of electronic components to test for the effects of:
  - Electrostatic Discharges ESD (static)
    - HBM / MM / CDM
  - Electrical Over Stresses Latch-up Testing
  - Transmission Line Pulsing TLP
- Our testers allow manufactures to evaluate their designs, so they can understand the level of susceptibility of their devices to these different events. If their part is susceptible to these events, they can redesign it before shipping to their customers, there by avoiding unnecessary and cost and of course, unhappy customers!!
- Although there are standards that specify how these tests should be performed, the biggest reasons for companies to perform this testing is to provide the best products they can. This of course also relates to what they can charge for their products!!



- Because we all want things to be faster and smaller, and of course, cheaper....
- Computers, HD TVs, cell phones, I-Pods, X-Box, etc...
- This means the integrated circuits that make these devices possible, need to be smaller and faster, and because they're smaller and faster, they're much more sensitive to outside influences...such as ESD (Electrostatic Discharge)
- We all want reliable products!!



- Your wireless telephone doesn't turn off when ever you touch the key pad and feel a *"ZAP" (ESD event)!*
- Your TV or cable box doesn't shut off or worse yet, doesn't turn on when you walk across your living room carpet and touch the controls – of course this would only occur if you weren't using your remote!!
- The radio in your car works, even after you slide across the seat, touch the controls and feel that dreaded "ZAP"!
- Worse yet, suppose you car's electronically controlled breaking system could be damaged by you touching a control on the dashboard, today's car electronics are tested using our systems!



### Standards we address

#### • Electrostatic Discharge Association (ESDA)

ESDA STM5.1

- Human Body Model (HBM)
- Superseded by JS-001-2010
- ESDA STM5.2 Machine Model (MM)
- ESDA STM5.3.1 Charged Device Model (CDM)
- ESDA SP5.3.2 Socketed Charged Device Model (SCDM)
- ESDA SP5.4 Transient Latch-up (TLU)
- ESDA SP5.5
   Transmission Line Pulse (TLP/VF-TLP)
- ESDA SP5.6 Human Metal Model (HMM) 2 pin testing
- ESDA 14.3 System Level / Cable Discharge Event

#### Joint Electron Device Engineering Council (JEDEC)

- JEDEC JESD22-A114
- Human Body Model (HBM)
- Superseded by JS-001-2010
- JEDEC JESD22-A115
- Machine Model (MM) Charged Device Model (CDM)
- JEDEC JESD22-C101JEDEC JESD78
  - Latch-u
    - Latch-up

#### Joint JEDEC and ESD Association standard

• JS-001-2010

Human Body Model (HBM)

- Automotive Electronics Council (AEC)
  - AEC-Q100-002
  - AEC-Q100-003
  - AEC-Q100-011
  - AEC-Q100-004

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



#### ESD - <u>E</u>lectro-<u>S</u>tatic <u>D</u>ischarge ZAP!!

Equalization of different electrostatic potentials between two or more objects

Rapid discharge of a limited amount of energy

#### EOS - <u>E</u>lectrical <u>O</u>ver-<u>S</u>tress (Latch-up)

An electrical event that exceeds the data sheet maximums of the device under test

Supply overvoltage and fast slew rates, ground dip, incorrect supply sequencing and data line transients can damage CMOS IC's.

EOS most often causes functional failures.



- Both will damage devices by:
  - Rapid localized heating of the semiconductor material
  - Creating capacitive displacement currents internal to the device due to strong electrical field transients
- Even very small discharges or over-stresses can be fatal or cause latent failures

The following slides show just how these failures can appear on an integrated circuit under magnification or under the human eye on a Printed Circuit Board (PCB).





ESD event which caused excessive heating damaging the device!!





ESD event which caused small holes to develop between layers on the device, subsequently damaging it!!





EOS event which caused a hole to develop between layers on the device, subsequently damaging it!!





EOS event which caused excessive amount of current to be drawn by the device, so much so that it actually caught fire!!



## Electrostatic Discharge - ESD

A person or charged object discharging into a sensitive electronic component or circuit can cause a device to fail or circuit to be upset.

- The threshold of feeling is 2kV to 4kV
- Everyone can feel 5kV\*
- 15kV is a <u>memorable</u> event!!!



Human Body Model Event (HBM)



It really *is* a miniature lightning bolt!!

\*Why will 110 volts kill me if I put my finger in a light socket when 5,000 volts of static won't?

Static electricity does not have sufficient current to hurt you, although it can damage electronics!!

Machine Model Event (MM)



Charged Device Model Event (CDM)



- EOS or Latch-up events are Voltage or Current transients on power lines, telecom or other I/O lines that are connected to a device through either the PCB it is mounted on or the event maybe caused by plugging a printer cable into a PC when the PC is turned on.
- These events can cause the device to go into an unexpected condition, where it may draw excessive current from the power supply. In the worse case, should the power not be removed, the device can actually catch fire (as shown on slide 12) or simply "blow" it's top off. Either case is not good, especially if this device is say controlling your car or the plane you are flying on!!
- Our Latch-up testers allow manufactures to evaluate their designs, so they can
  understand the level of susceptibility of their devices to latch-up events. If their
  part is susceptible to these events, they can redesign it before shipping to their
  customers, there by avoiding unnecessary and cost and of course, unhappy
  customers!!



# • The ESD Latch-up Simulators are:

- The MK.4 2304 pin tester for production/high throughput testing of high pin count devices
  - Combined ESD and Latch-up system
  - Small footprint 4' tall, 3' wide and 3', 6" deep
  - 2304 max channels, offerings include 1152, 1728 and 2304
  - 8 Matrix VI channels, high speed matrix matched supplies
    - 100VA V/I power supply
  - Pin conditioning (vectoring) on every pin
    - 256K deep / Drive and Readback
    - 6 different drive levels
  - High Speed E/M matrix based on 96 channel matrix design
  - New physical architecture. Principle well proven
  - Enhanced parallelism, Zap and Trace. Estimate at least 5x throughput improvement





# • The ESD Latch-up Simulators are:

- The MK.2 768 pin production tester for testing multiple low pin count devices or devices in the 768 pin range
  - Combined ESD and Latch-up system
  - 768 max channels, offerings include 128, 256, 384, 512 and 768
  - 6 Matrix VI channels, high speed matrix matched supplies
    - Dual Range 30V/5A, 100V/1A power supplies
  - Pin conditioning (vectoring) on every pin
    - 64K deep / Drive and Readback
    - Single drive level
  - High Speed E/M matrix based on 16/8 channel matrix design
  - Enhanced parallelism allowing Zapping of up to 8 devices simultaneously





## ESD and Latch-up Simulators

# • The ESD Latch-up Simulators are:

- The MK.1 Low Pin Count (256 pin) production tester for testing multiple low pin count devices or devices in the 256 pin range
- The MK.1 features:
  - Direct ZapMaster replacement
  - ESD HBM and MM testing as standard
    - · Centrally located HBM pulse sources deliver exceptional waveforms
    - MM pulse sources on each matrix to deliver consistent waveforms across the system
    - · Software selectable no need to switch waveform networks
  - Latch-up testing capabilities optional
  - Curve Tracing for failure detection as standard
    - Spot measurements for failure detection also standard
    - · Bias supplies for powering the device during curve tracing optional
  - Relay based architecture providing unsurpassed testing through- put
    - Fixtures with multiple sockets can be tested sequentially
  - Limited mechanical movement no wear and tear
    - Only movement is to lower the test fixture onto the test head
  - Pin count expandability (64pins to 256pins)
  - Small foot print won't take up valuable test floor space
  - Test Fixture board compatibility uses existing ZapMaster fixtures directly



### NEW ESD Manual Simulator:

- Pegasus is a NEW system designed to meet the Human Metal Model testing requirements up to 12kV
  - It also offers Human Body Model (HBM) to 12kV
  - More of a manual tester than say the MK.x series of testers
  - Allows testing of 2 pins only and can be used to test components (devices), at Wafer or on system level applications.
  - Also provides curve tracing for failure analysis







# **ESD CDM Simulator**

- Orion2 Charged Device Model (CDM) Simulator
  - Orion2 CDM test system: which meets today's industry standards for testing devices to understand their vulnerability to a charged device discharge event
    - Provides testing to all of today's Field Induced CDM standards
      - Also provides a path for the future!
    - Dual High Resolution color cameras make device outline creation and alignment easy!
    - Enclosed interlocked test chamber allows control of the testing environment!
    - Windows based software provides flexibility for test creation and waveform verification using our integrated scope interface!
    - Highly accurate mechanism makes testing of high density devices possible!
    - Large device test area allows testing of today's high pin count devices as well!
    - Vacuum and variable alignment plate allows testing of most devices without the need for special fixturing!
    - Discharge event detector helps ensure your testing is correct!
    - Also, ready for the future of CDM testing
      - CDM<sup>2</sup> A new method for controlled CDM testing

CDM<sup>2</sup> is a new approach to CDM testing which eliminates FICDM testing issues, such as air discharge and environmental impacts on waveform / testing integrity!





## TLP (Transmission Line Pulse) Testing

- TLP testing is different from ESD and Latch-up testing
  - Generally it is a non destructive test, however it can be used to cause a device to fail
  - It provides more information for design engineers than just the failure threshold information that is gathered from ESD and Latch-up testing
  - Testing can be performed either at the packaged IC level or at Wafer level, which can speed up the release of a device to production – which means \$\$ for the device manufacturer



# TLP (Transmission Line Pulse) Testing

#### Our Transmission Line Pulse (TLP) test systems

#### Celestron TLP Test System

Used for characterizing ESD protection structures. By providing a controlled TLP square wave pulse and gathering information from the reflections of the pulse, the ESD structure characteristics can be thoroughly analyzed by designers. VI Curve Tracing can also be performed.



System offers:

- Wafer and Package testing
- Bench top TLP system
- Pulsed I-V Curve generation
- DC Curve Tracing
- Protection Structure Studies
- Design engineering flexibility

- Various optional modes available (TDR style testing is standard)
- Optional VF-TLP
- Optional HBM and MM ESD testing

