# Static Can Damage Electronic Components

#### Presented by K6RFT July 2012

# Damage to Components

How to damage electronic devices

- Over stress
- Static

Let's Focus on Static

ESD = ElectroStatic Discharge

### Static Historically

- Ignition of black powder in 1400s
- Paper mills had static problems in 1860s
- Ether as an anesthetic was susceptible to ignition by static discharge
- Solid State electronics susceptible to static electricity discharge
- Electronics even more susceptible due to the shrinking sizes

# Static Damage



# **Static Damage**

Lightning is the ultimate natural static discharge

# Local Transfer of Charge



Static Discharges we have experienced

# **Safety Note**

Static ignition during refueling of vehicles

# **Static Discharge Events**



#### Unwrapping a Rocket

# **Satellite Failures**



### What is Static?

 Static electricity is defined as an imbalance of electrons on the surfaces of materials

 Electrostatic discharge, (ESD), is the transfer of charges at different electrical potentials

# Can I Feel All Discharges?

#### No!

#### ■ 1500 volts discharge necessary to feel

Some devices sensitive to less than 100 V

# Two Damage Types

- Catastrophic failures are the type most easily detected
  - The device malfunctions, or just quits (dies)

- Latent failures cause degradation without immediately failure
  - Difficult to prove or detect
  - Failure may occur in the future (walking wounded)

# Catastrophic Damage

Immediate Failure

Fails to function

 Fails a specification, eg., gain low, forward and reverse resistance changes

## Latent Damage

 Damaged but still functions, eg., Lower gain than typical but still in specification

May not appear immediately

Walking Wounded future failure expected

# Show Me the Damage



 A trace on an Integrated Circuit

# Show Me More Damage



### How to Make Static

Contact and separation of two materials

• Example: Unrolling adhesive tape

## **Triboelectric Generation**

Walking across the floor

Devices sliding into or out of a bag

Sliding into or out of a chair OR a vehicle

# Discharging by Contact

#### Charged object shares its charge

#### Charged body shares its charge

# Induction

Possible to acquire a charge by just being in an electrostatic field, without making physical contact

Infrequent occurrence

### Some Factors Affecting Generation

Area of contact

Speed of separation

Relative humidity

Chemistry of materials

# **Please Control ESD**

Understand charging

Prevent charging

Draining charges



# Controlling ESD

 One Documented Professional Control Program :

- 122 pages with 15 sections,
- Plus 20 appendices

Includes the following items:

# Professional ESD Control

- Have a control program
- Documentation
- Training
- Identifying sensitive devices
- Areas to protect
- Personnel grounding
- Packaging & Labeling
- Operating and Testing
- Audits and Record Keeping
- How to guidance

# What is an Amateur to Do?

#### Four Possible Amateur ESD Control Programs

Approach One:

Ignore Static

- Do anything
- Do no prevention
- Accept risk of component failure
- Replace or Repair as needed
- Keep your wallet handy

Approach Two

- Keep the covers on the gear
- Don't handle or touch components
- Follow all manufacturer's warnings regarding static
- Very safe method

Approach Three:

 Go all out; employ every possible control mechanism known to mankind

Emulate industry's program

Go broke quickly

#### Approach Four:

- Employ a wrist strap when handling ESD sensitive components or assemblies
- Use a antistatic work mat
- Use an ESD safe soldering iron
- Ground the work mat and wrist strap

# Suggested Amateur Practices

- Strap up at an ESD safe work station
- Use an ESD safe soldering iron
- Trash ESD hazardous packing materials upon receipt

 Store parts in ESD safe packaging (not plastic drawers or bags, unless ESD safe)

### Wrist Straps

Many different types available
Note the cloth silver threaded types will likely fail 30% of the time
AgS is a non-conductor
AgS forms from skin contaminants
Recommends stainless steel wrist bands
Some people are allergic to metals

# A Wrist Strap



### Wrist Straps

Verify (by measuring) 1 Megohm resistance from the ground connection to the wrist strap

Don't use the wrist strap when exposed to high voltages

# Worksurface

The worksurface should be static dissipative

Don't use a bare metal work surface

The worksurface should be connected to ground

### How to Wire a Work Bench



# Labels







# **Plastic Containers**

 Don't store ESD sensitive components in any ole plastic container

Use static dissipative containers or Faraday shielding bags

Plastic anti-static properties can decay with time

# Humidity & Static

- Relative Humidity-----10-25% 65-90%
- □ Walking across vinyl tile 12KV 250 V
- Worker at bench 6KV 100V
- Polybag picked from bench 20KV 1.2 KV
- Walking across carpet 35KV 1.5 KV
- Chair with urethane foam 18 KV 1.5KV

# Added Facts

Static charges remain on the surface of insulators

Positive and negative charges can be on the same surface

Static charges can be generated on isolated conductors

### Sensitivity Levels

Military has defined classes of sensitivity

 All ESD sensitive products equally sensitive (reduces complexity)

Suggest amateurs use the latter approach

# **ESD** Susceptable Components

Active Devices

- Transistors, Diodes, Integrated Circuits
- Precision Resistors
- Assemblies with above components

#### Vacuum Tubes are NOT ESD sensitive

### Areas to Protect

• Amateurs might protect :

 Work bench and troubleshooting areas (areas used to disassemble equipment)

Storing and handling ESD sensitive components and assemblies

## **Reduce Generation**

 Amateurs might declare a workbench area to be an ESD Safe workstation

□ Then remove all ESD hazards

- Insulators
- Plastics
- Adhesive Tapes
- Foam cups

### **Protect Products**

Treat gear with ESD consideration to prevent damage

One hopes amateur gear is designed to be operated without need for ESD countermeasures

### ESD Control Equipment and Material

- Wrist straps
- Worksurface
- ESD Safe Soldering Iron
- Shoes and Grounders
- Chairs and Casters
- Clothing (smocks)
- Flooring
- Packaging
- Symbols

# Info Resources

#### • Ask the presenter

#### Search the web

# The END

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