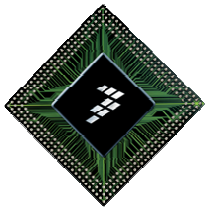
June 30, 2010

# ESD Training

*Version for INSTRUCTOR*

## Principles of correct handling with ESD sensitive items



**Ludek Pavlus**



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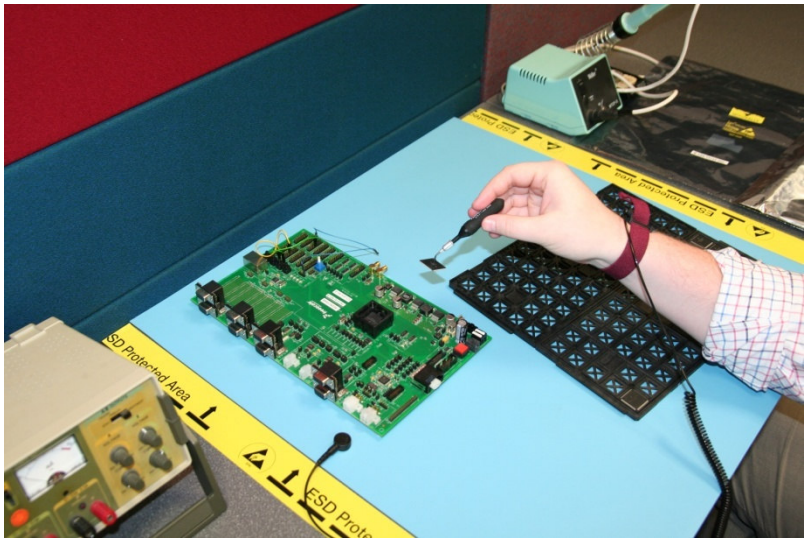
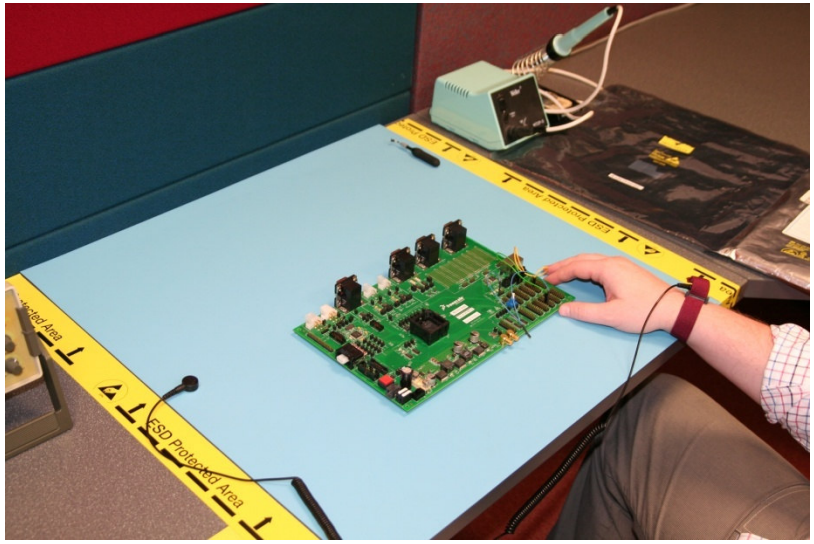
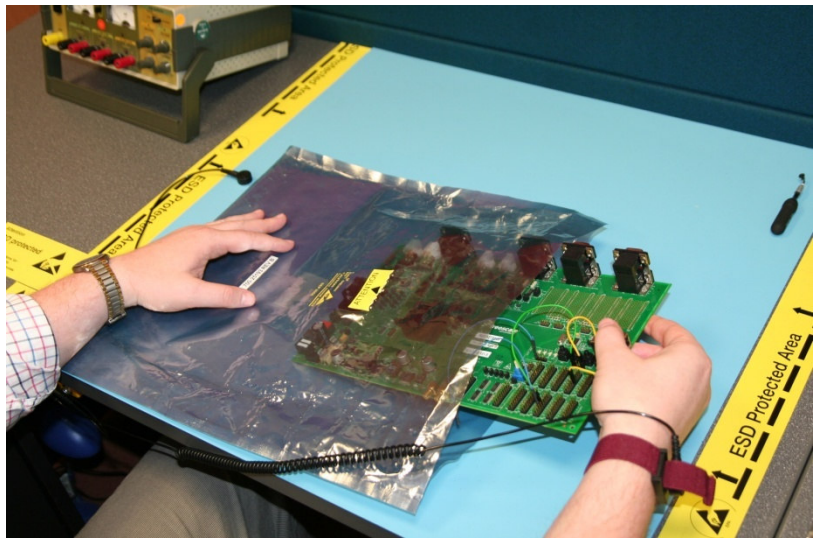
# Target of the training

- Learning of ESD Fundamentals
- Recognition of possible hazards
- Acquiring of correct practices





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# ESD Fundamentals - History

Static electricity has been a serious industrial problem for centuries. As early as the 1400's, European and Caribbean forts were using static control procedures and devices to prevent electrostatic discharge ignition of **black powder stores**.

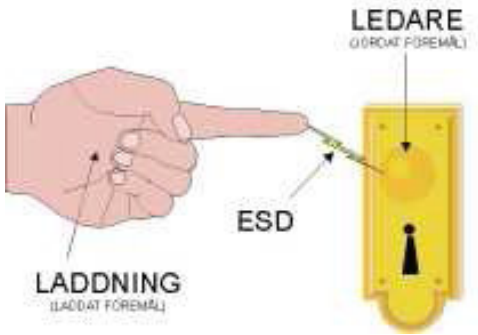
By the 1860's, U.S. **paper mills** introduced basic grounding, flame ionization techniques, and steam drums to dissipate static electricity from the paper web as it traveled through the drying process.

In the late 1970's, the introduction of semiconductors in **electronics industry** brought new problems associated with static electricity and electrostatic discharge. Semiconductor components are very sensitive to static electricity and could be seriously damaged, when handled improperly without respect to possible electrostatic discharge!

# ESD Fundamentals - Background

►**Electrostatics:**
Static charge buildup (- or +) from the "triboelectric" effect that occurs when two not similar materials are in contact and than separated.
Example: *A* person walking *across a carpet can produce electrostatic charges on the human body up to 35,000 volts.*

►**Electrostatic Discharge (ESD)**:
Electrostatic charge buildup that is dissipated to another object that has less or no charge or a different polarity charge.
Example: *When touching a metal doorknob after walking across a carpeted room.*





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# ESD Fundamentals - How much we generate?

| Source of generation | 10-20% RH | 65-90% RH |
|---|---|---|
| Walking on a carpet | 35,000V | 1,500V |
| Walking on a ethylene plastic floor | 12,000V | 250V |
| Working at a worktable | 6,000V | 100V |
| Take out DIP dice from plastic tube | 2,000V | 200V |
| Pick up a plastic bag | 20,000V | 1,200V |
| On a work chair with urethane spume mat | 18,000V | 1,500V |

**Relative Humidity** is a key factor that affects Static charge buildup.





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# ESD Fundamentals - How much they withstand?

## Susceptibility ranges of devices exposed to ESD (HBM)

| | |
|---|---|
| MOSFET | **100 - 200V** |
| GaAsFET | **100 - 300V** |
| EPROM | **100 - 200V** |
| SAW | **150 - 500V** |
| ECL | **500 - 1,500V** |
| VMOS | **100 - 1,800V** |
| Op Amp | **190 - 2,500V** |
| Schottky diodes | **300 - 2,500V** |
| CMOS | **250 - 3,000V** |
| JFET | **140 - 7,000V** |
| Bipolar transistors | **380 - 7,000V** |





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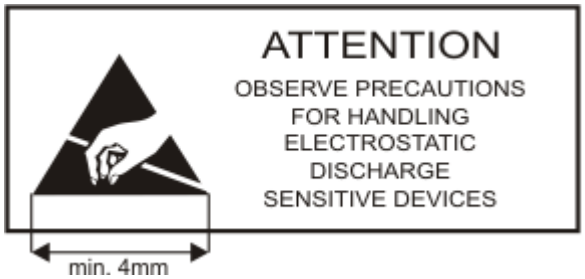
# ESD Fundamentals - Abbreviations and Labels

**ESD** – **E**lectro**s**tatic **D**ischarge
**ESDS** – **ESD s**ensitive
(components ,parts …)

**EPA** – **E**SD **P**rotected **A**rea
**EBP** – **E**arth **B**onding **P**oint





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# ESD Fundamentals - Materials

- **Insulant:** *surface resistivity > $10^{14}$ Ω/cm²*. Static charges remain in place on these materials for a very long time.
- **Antistatic:** *$10^{14}$ Ω/cm² > surface resistivity > $10^{9}$ Ω/cm²*. Inhibits the generation of static due to triboelectric charging. Does not dissipate electrostatic charge effectively.
- **Static-dissipative:** *$10^{9}$ Ω/cm² > surface resistivity > $10^{5}$ Ω/cm²*. Dissipate electrostatic charge, but slowly than conductive materials.
- **Conductive:** *$10^{5}$ Ω/cm² > surface resistivity > $10^{3}$ Ω/cm²* . Allowing the charge to quickly distribute itself through material.
- **Shielding:** *surface resistivity < $10^{3}$ Ω/cm²*. Material providing a Faraday cage protection, limits the passage of current and attenuates the energy resulting from an electrostatic discharge.





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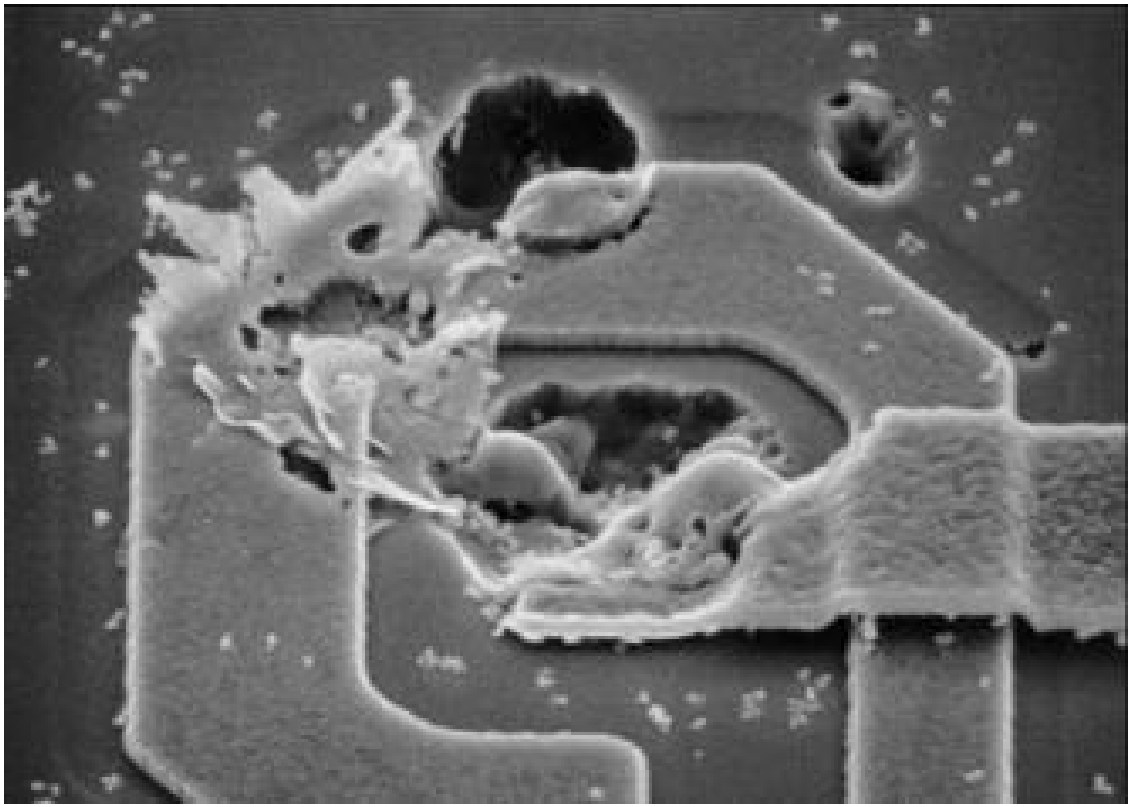
# Recognition of possible hazards

**ESD can damage your unprotected electronics parts really badly.**

The ESD event may have caused a **metal melt**, **junction breakdown**, or **oxide failure**. The device's circuitry is permanently damaged causing the device malfunction or fail.



**All of this happens completely imperceptible in just a blink of an eye!**





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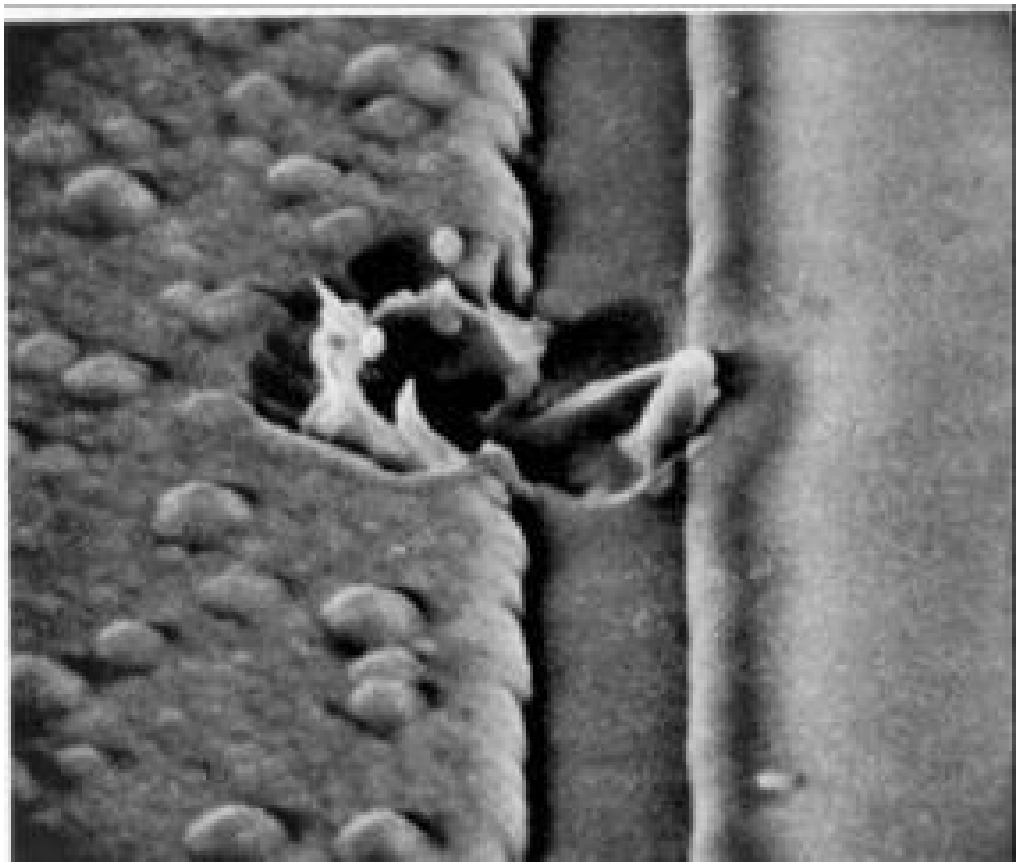
# Recognition of possible hazards

►**ESD Damage**

Electrostatic damage to electronic devices can occur **at any point** from manufacture to field service. Damage results from handling the devices in uncontrolled surroundings or when poor ESD control practices are used.

ESD damage will cause **Catastrophic** or **Latent Defect** of device.







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# Recognition of possible hazards

►**Catastrophic Defect**

When an electronic device is exposed to an ESD event, it may no longer function. The device's circuitry is permanently damaged causing the device fail.

►**Latent Defect**

A latent defect is very difficult to identify. A device that is exposed to an ESD event may be **partially degraded**, yet continue to perform its intended function. However, the operating life of the device may be **reduced dramatically**. A product incorporating devices with latent defects may experience **premature failure** after the user places them in service. Such failures are usually costly to repair and in some applications may create personnel hazards. Latent defects are extremely difficult to prove or detect using current technology, especially after the device is assembled into a finished product.

# Acquiring correct practices

- How to use personal grounding toolkit
- How to arrange your workbench EPA
- How to operate within EPA
- Correct packaging for components/boards
- How to test your personal grounding toolkit





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# Your personal grounding kit

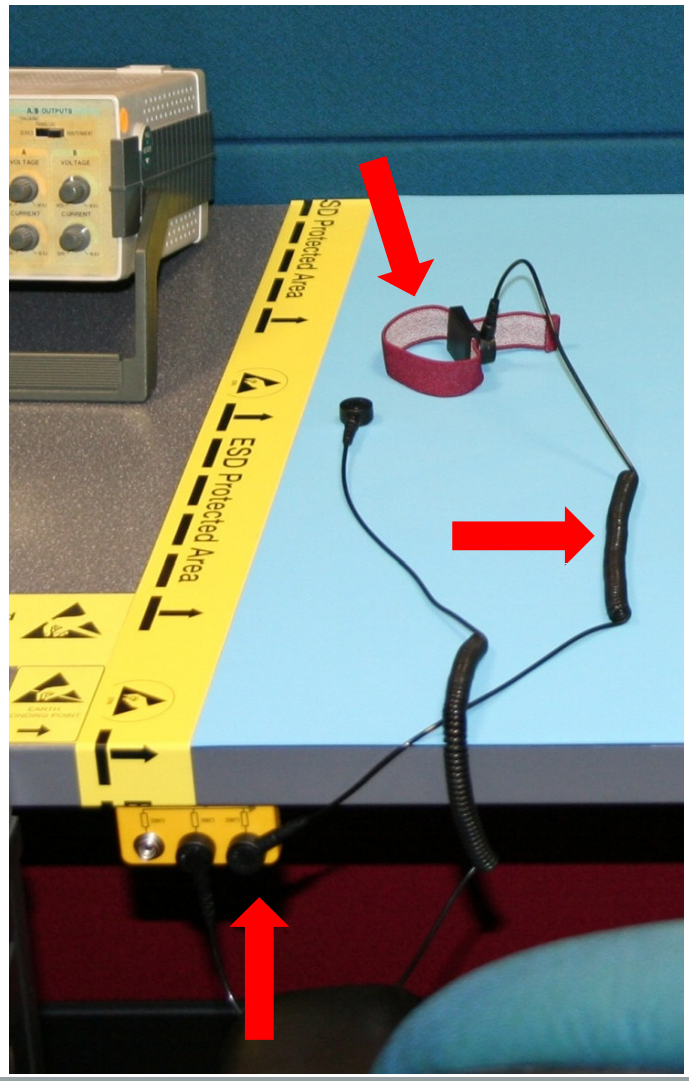
**Your personal grounding kit consists of following parts:**

►**Wrist Strap** – Connects grounding kit to your body. ***Dress it on your right hand.***

►**Coil Cord** – Connects wrist strap to grounding. ***Connect it to EBP.***

You are grounded to earth potential now. Every electrostatic charge you generate is leaded to ground. The same states for antistatic mat. Now, you have the same potential as components lying on the mat.

**This is the principle of ESD protection.**





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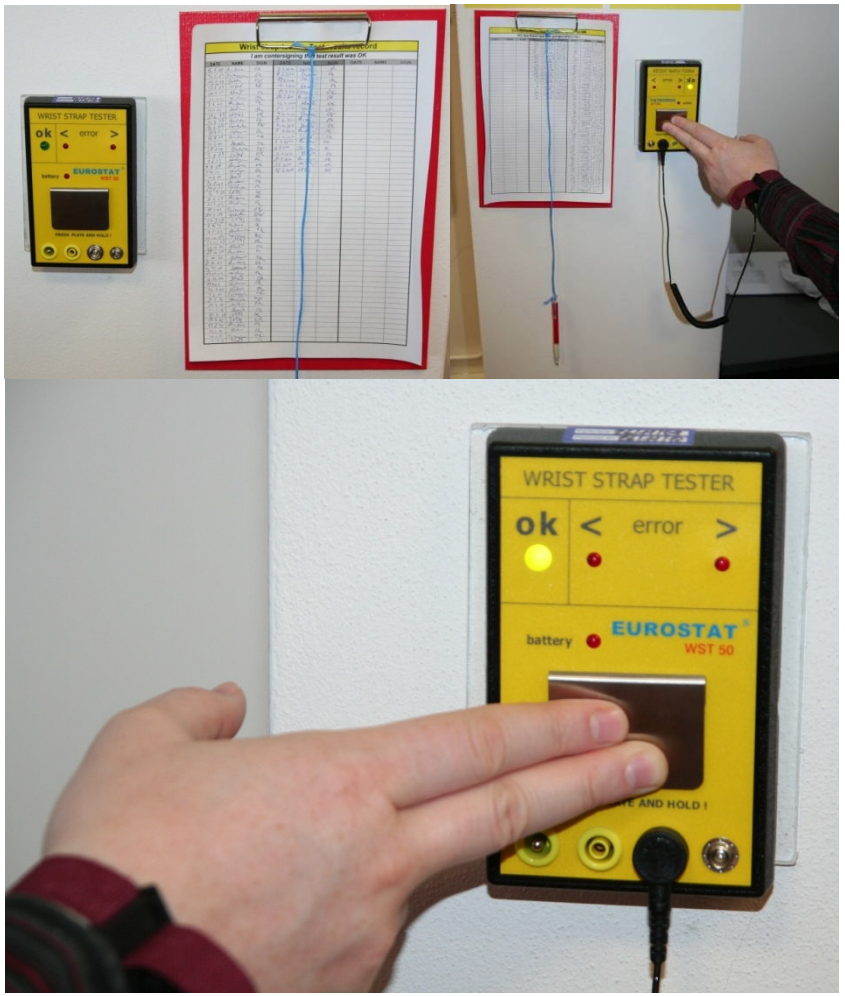
# How to test your personal grounding kit

**Test your personal grounding kit every day before you start working on EPA !**

- ►Dress the wrist strap on your hand
- ►Connect coil cord to the strap
- ►Go to the testing station
- ►Connect coil cord to the tester
- ►Press test button with finger(s) and wait for test result
- ►**Green** LED shines when **OK**,
- ►**Red** indicates **wrong** personal grounding kit
- ►Make a record and sign it





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# Correct packaging of ESDS devices/boards

►Clear or tinted (pink, blue, green) polyethylene bags

Can be used within EPA **only for packaging of non-ESD sensitive** items. **Not allowed for ESD sensitive items!**

►Metalized semi-transparent polyester bags. **Preferred solution**. Can be used within EPA for packaging of ESD sensitive items

►Every ESD protective package **must contain warning symbol** for ESD sensitive items





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# How to arrange your workbench EPA

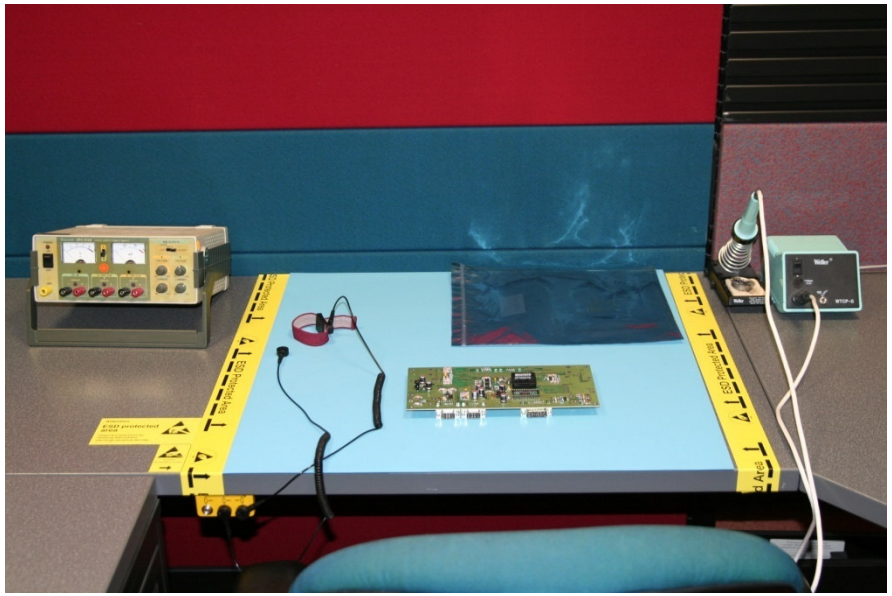
►Dimensions of your workbench EPA are defined by your antistatic protective mat (light blue area)

►Your workbench EPA is marked by yellow tape indicating presence of ESD sensitive devices

►EPA is equipped with Earth Bonding point. Antistatic mat and grounding kit are connected to it

►Keep your EPA clean

►Keep Test and Measuring equipment and Soldering station outside of your EPA





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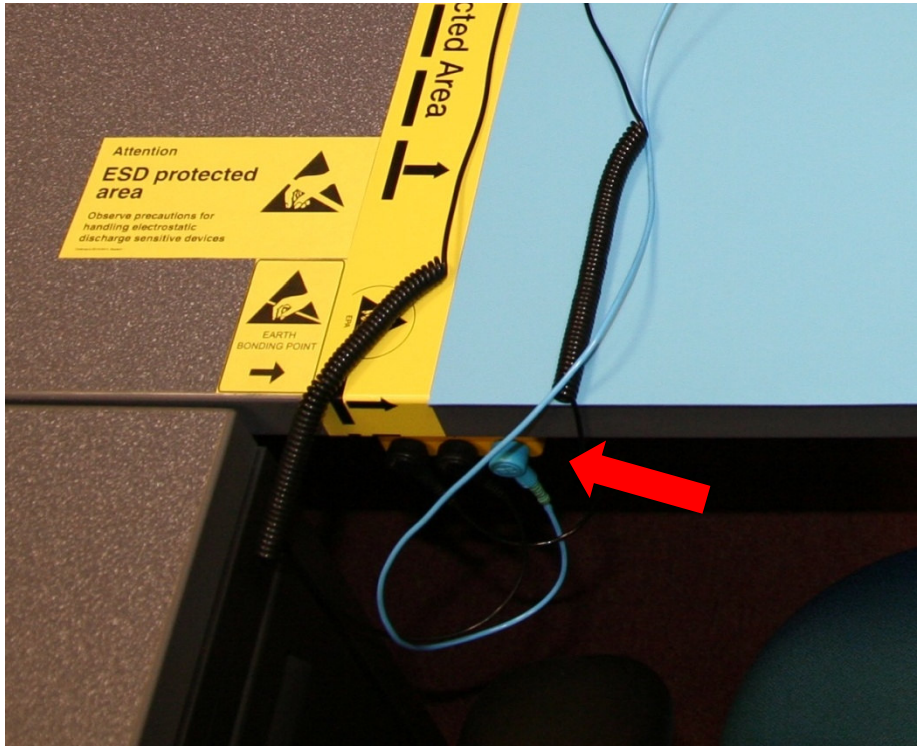
# How to arrange your workbench EPA

►When using Soldering station to solder components at EPA, you must ground soldering station to Earth Bonding Point (EBP) first !



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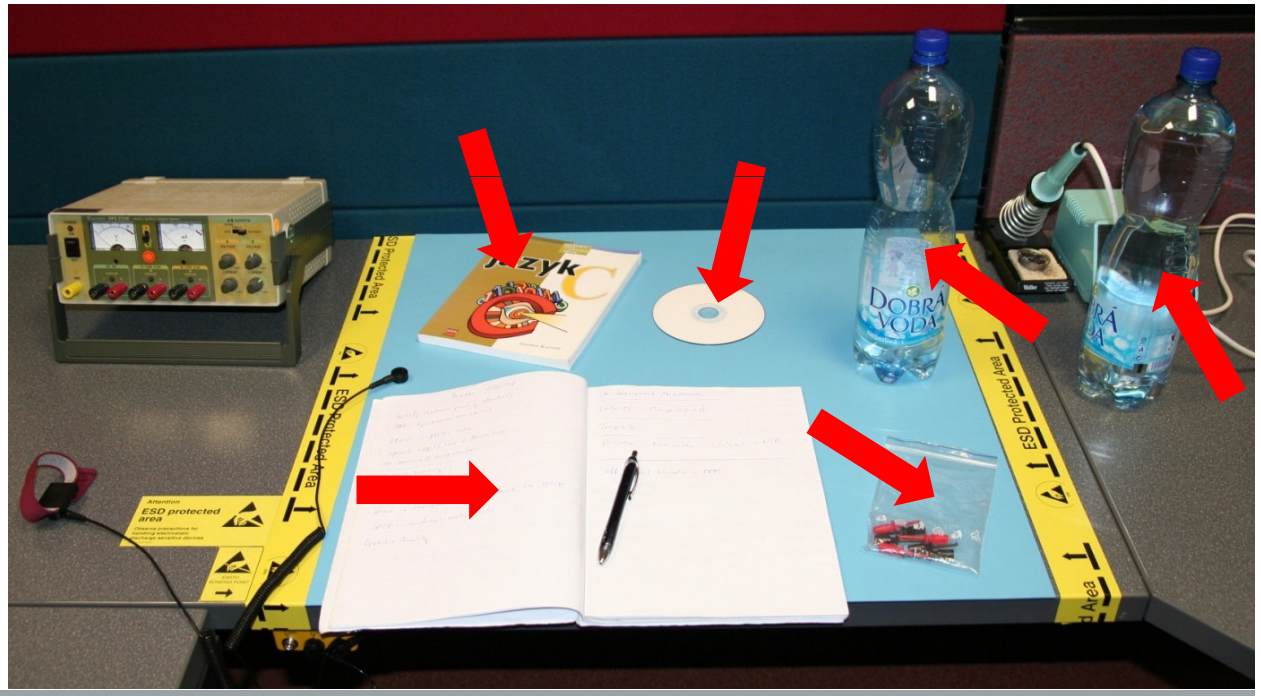
# How to use your workbench EPA

►Use your EPA **only** for handling of ESD sensitive components/parts and **not for other activities !**

►Remove all components that are not antistatic from EPA and its vicinity (30cm) !

**Remove paper notebook and guide !**

**Remove plastic components from EPA and its vicinity (30cm) !**





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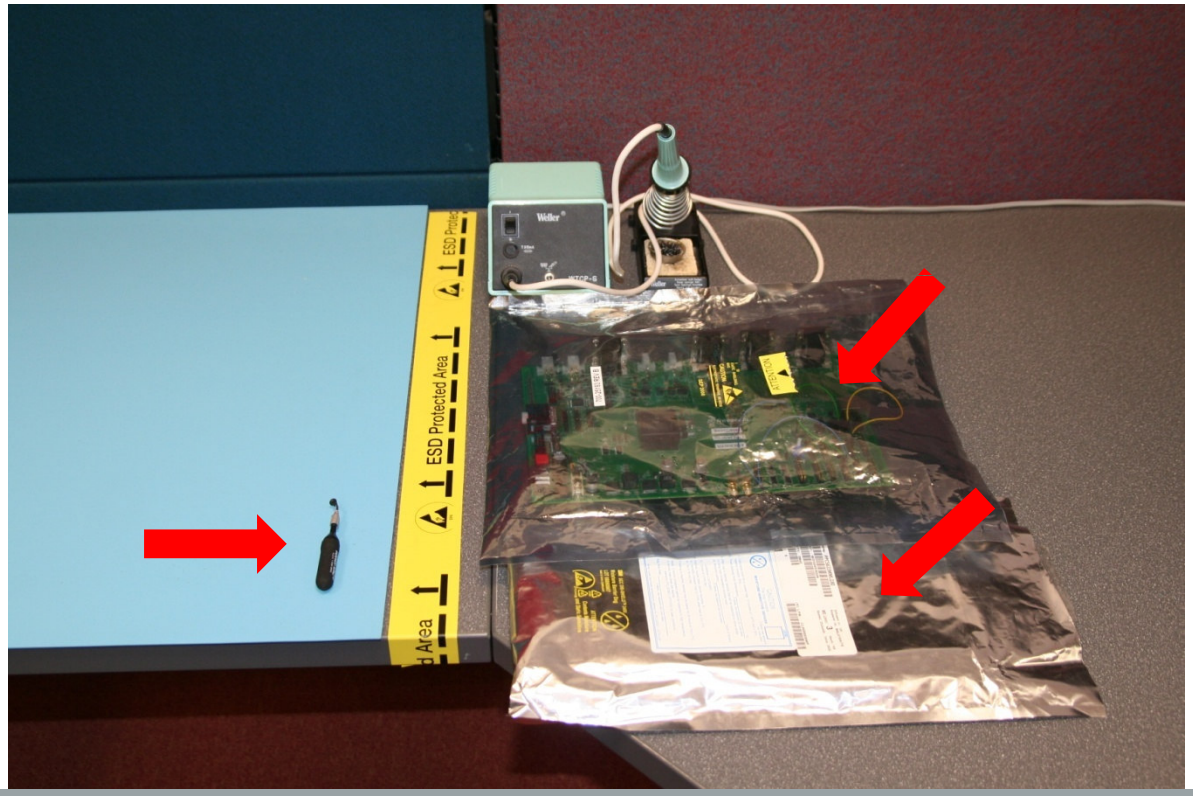
# How to handle ESDS items at your EPA

►Before handling, ESDS items are stored in ESD protecting covers (bags) outside EPA

►Tools which will be used for manipulation are lying on the mat





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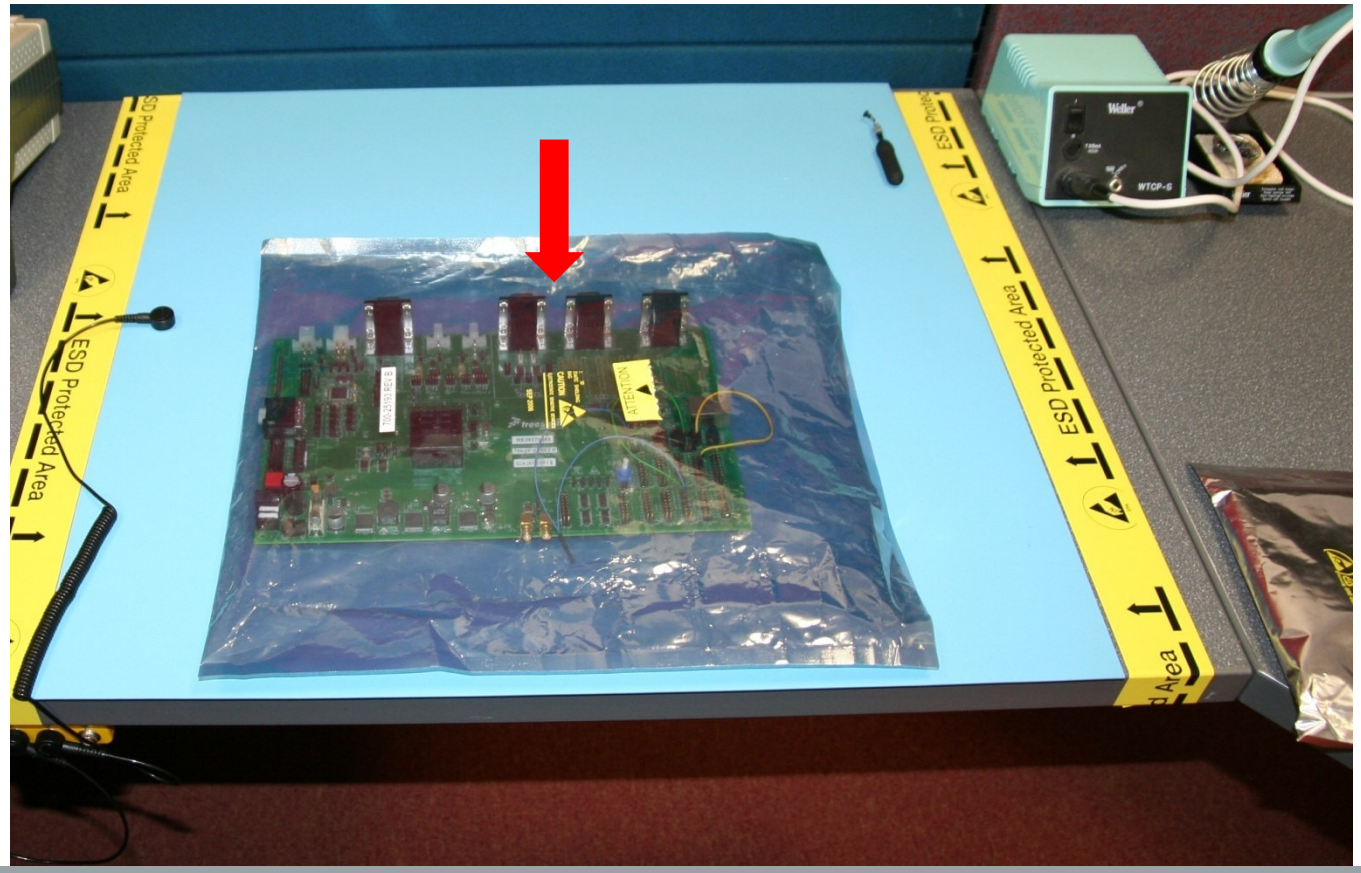
# How to handle ESDS items at your EPA

- ►Put the ESDS item on light blue protective mat inside EPA
- ►Wait 15 seconds for charge balance





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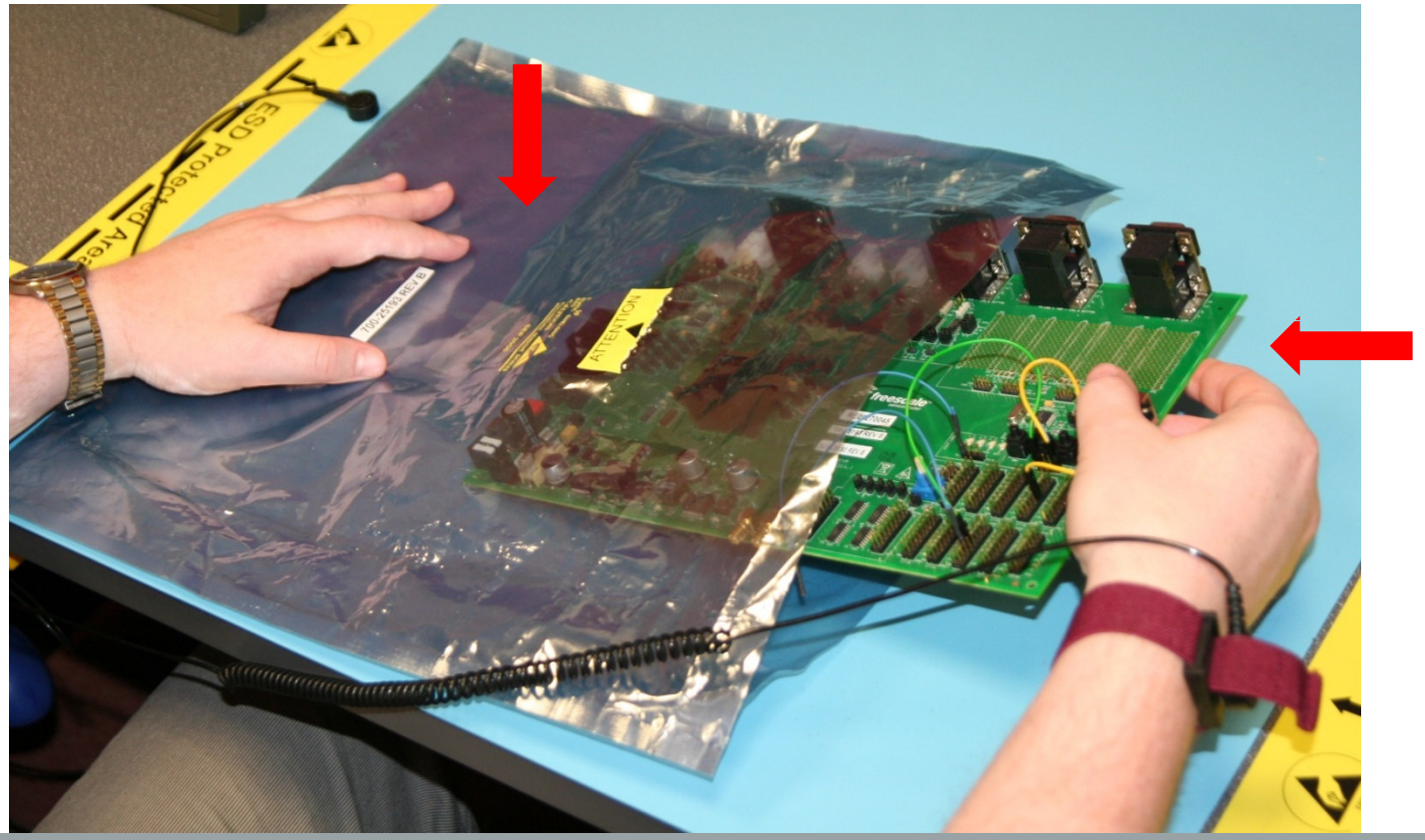
# How to handle ESDS items at your EPA

- ►Remove the ESDS item (PCB board) from protective bag
- ►During removal the bag is laying on the antistatic mat





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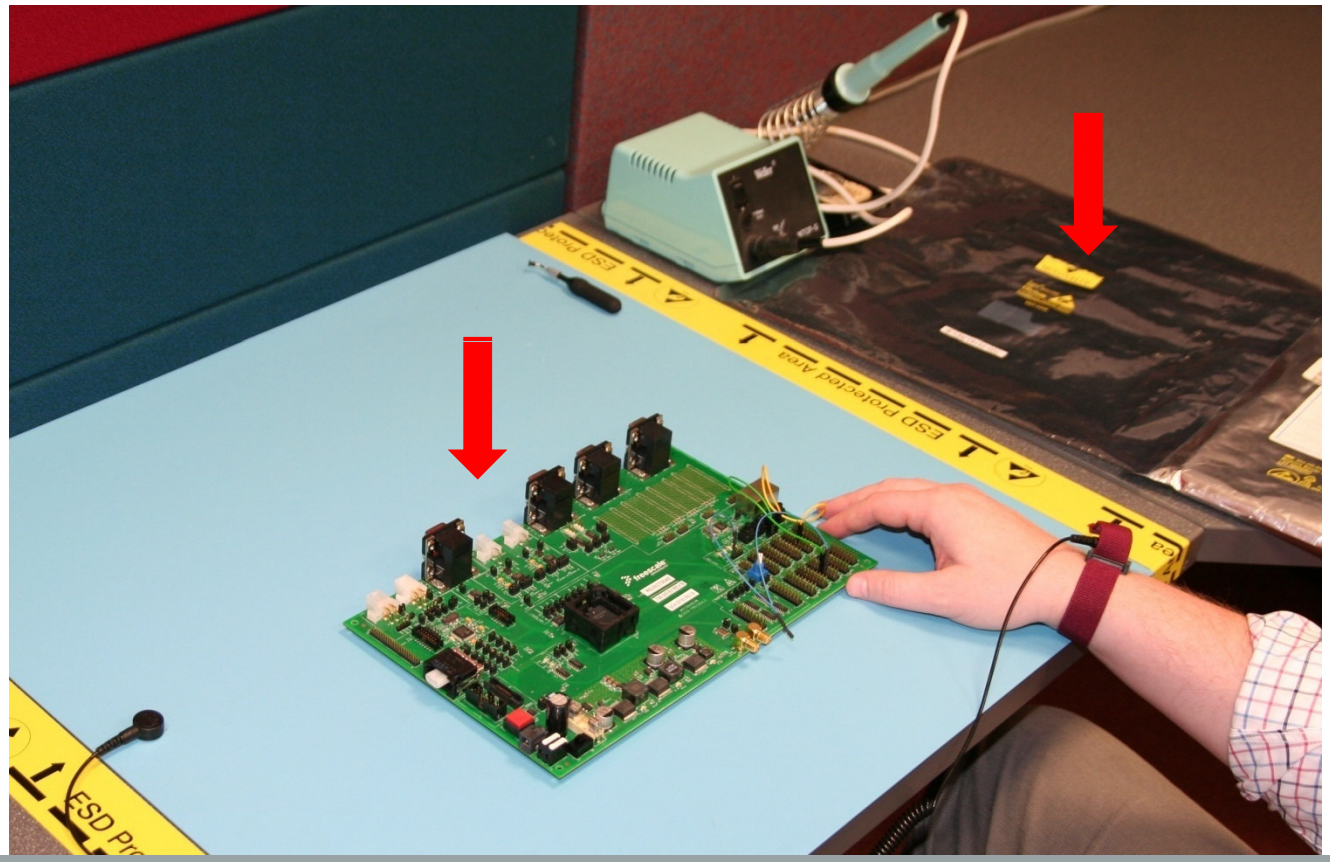
# How to handle ESDS items at your EPA

- Put the ESDS item (PCB board) on EPA's protective mat
- Put protective bag outside of the mat





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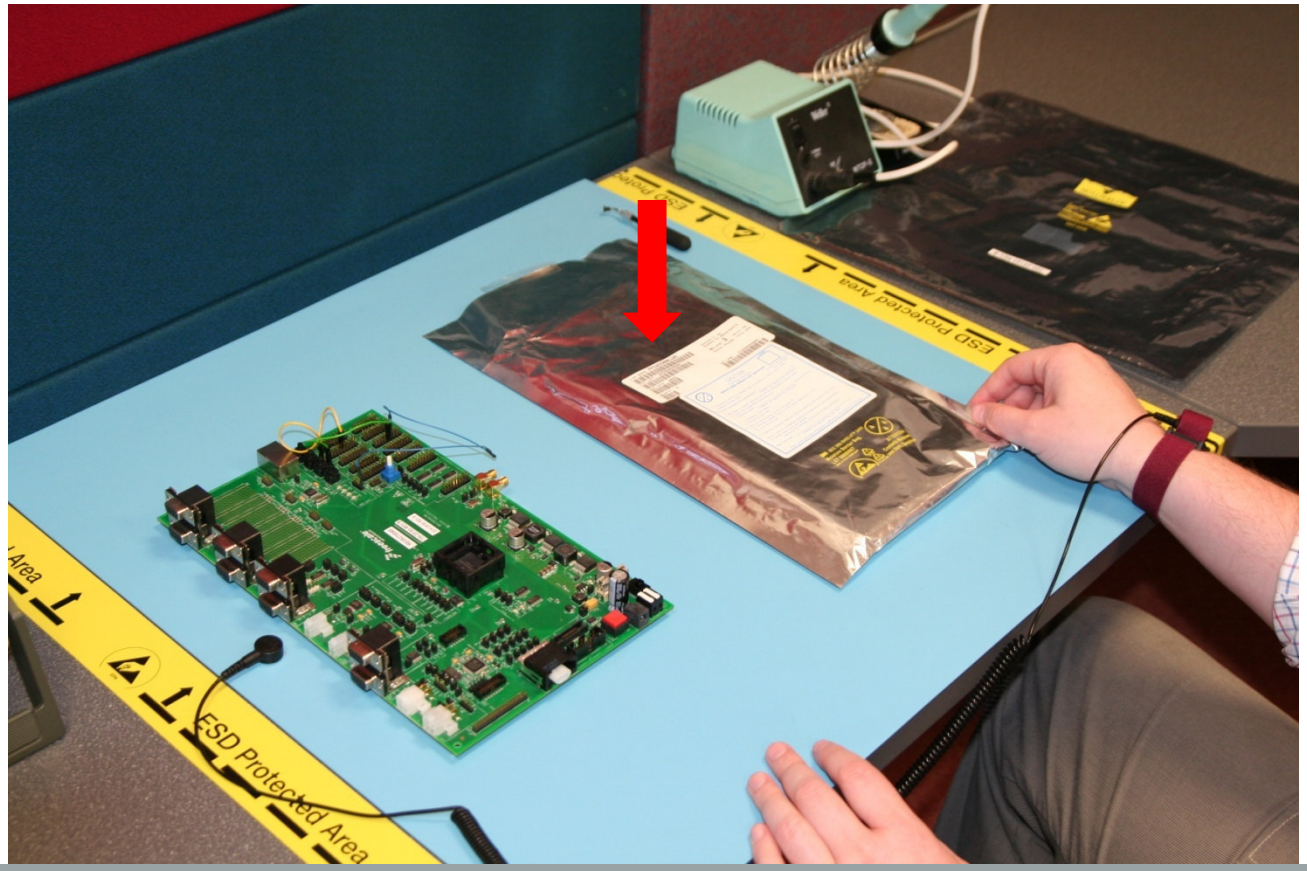
# How to handle ESDS items at your EPA

- ►Put the ESDS item (Integrated Circuits) on EPA's protective mat
- ►Wait 15 seconds for charge balance





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# How to handle ESDS items at your EPA

- ►Remove the ESDS item (Integrated Circuits) from protective bag
- ►During removal the bag is laying on the protective mat






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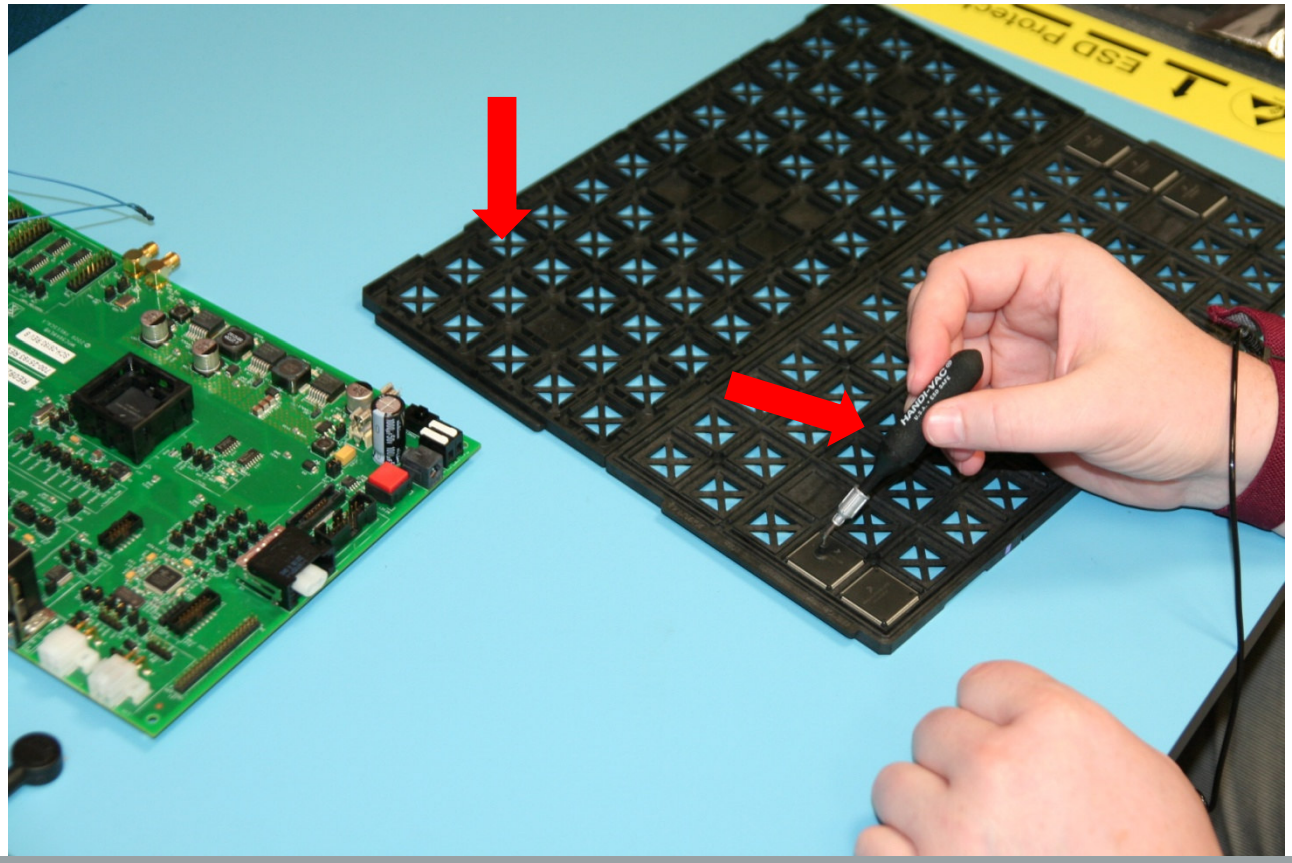
# How to handle ESDS items at your EPA

- ►Put the ESDS item (ICs in container) on EPA's protective mat
- ►For ICs handling use ESD safe vacuum tool only







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# How to operate within EPA - Golden rules

►Remove all insulants **at least to 30 cm from EPA**
►Dress Wrist strap with Coil Cord **first!**
►Check the Wrist strap impedance using **Wrist Strap tester**
►Connect Coil Cord from strap to Earth Bonding Point and **wait 15 seconds** for charge balance
►Unpack incoming PCBA's for identification, inspection, testing or inventory control **only at EPA**
►Assume that all active components are sensitive to ESD
►Handle electronic components at ESD protected area (EPA) only and only when you are properly grounded using your personal kit
►Store and transport the ESD-sensitive items in ESD protective bags and containers
►Take in evidence the principle "**No Charge/No discharge**"

# Keep the “Daily use of Golden rules”

►Keep the described rules and procedures in **daily use**

►Use **approved** ESD protective tools **only**

►Do not use **damaged or failed** ESD protective tools

►If you find any **nonconformance** to described rules and procedures, inform ESD program manager immediately

►If any **ESD damage** (damage or failure suspected to be caused by ESD) occurs on boards or components you are working with, inform ESD program manager immediately

►**Violation against described rules and procedures is to be considered as violation against working order with all consequences !**





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