Static – its haunts and habits

David Glenmere

Static electricity is ever-present in our everyday environment and activities – a fact too few people are conscious of. The fields alone generated by static charge on your body, or objects around you, can damage electronic components, quite insidiously. In this article, our correspondent – a specialist in the field – outlines just how and where static causes problems and how its effects can be controlled and minimised in everyday electronic work.

TEN YEARS AGO only a small percentage of people in Australia would have come across the term ESD. The control of static electricity in electronics was mostly confined to the larger computer companies and the military. Today static damage can affect any industry that uses ICs. The computer industry is often at the forefront of control measures – hardly surprising since they use the newer technologies, but things happen very quickly in electronics. After all, how much CMOS was used outside the computer industry ten years ago, or even five years ago? Component technology advances at a phenomenal rate and each new generation is more sensitive to 'static' than its predecessor.

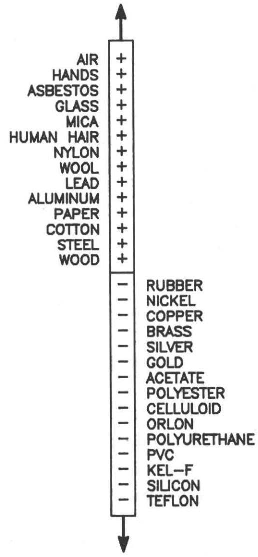
The term "ESD" was once used to describe *Electrostatic Discharge* but nowadays the term commonly applies to *Electrostatic Damage,* after all a very large proportion of todays components are Field Effect types and FET's can be damaged by voltage fields *overstressing* the oxide layers.

Classes of static damage

Static damage to components can be divided into two classes, *catastrophic* and *degradation.* Catastrophic failure is benevolent – the device just stops working and is easy to locate. Degradation however, is a far more serious problem since degraded components will generally not show on testing but will at some stage in the future start to give problems – unfortunately, that stage is generally after manufacture or repair when the customer is using the product!

Catastrophic failure accounts for 5 to 10% of damage, and degradation 90 to 95%! It does not matter what the end product is, it is always cheaper to repair a fault at the manufacturing stage. Degraded components are disasters waiting to happen, they may not actually fail in the field but instead create intermittent problems which are even more difficult to detect and the product then goes back and forth between the customer and the service department to the frustration of both. Small wonder that some companies consider staff that disobey static control measures as being wilfully negligent and treat them accordingly.

THE TRIBOELECTRIC SERIES



Anytime two dissimilar materials come into contact and are then separated, a charge will arise that can lead to an "ESD event". As you can see from the diagram, just waving a common item made from a plastic, such as polyester, in the air can generate a static charge!

Repairing a fault when the customer has found the problem is not only more expensive it also causes the customer to lose confidence as the failure of your equipment may cost him money! This can be expensive to you when the customer decides not to re-order your product.

Generation

Since static electricity causes so many problems we had better look at how it is generated, how it causes problems and how we can control it.

Static electricity can be generated in many ways. However,

Reported Susceptibility Ranges of Various Devices Exposed to Electrostatic Discharge From a Person or Electronic Equivalent

Device Type	Range of ESD Susceptibility (Volts)
VMOS	30 -1,800
MOSFET	100 - 200
GaAsFET	100 - 300
EPROM*	100
JFET	140 -7,000
SAW	150 - 500
OP-AMP	190 -2,500
CMOS	250 -3,000
SCHOTTKY DIODES	300 -2,500
FILM RESISTORS (THICK, THIN)	300 -3,000
BIPOLAR TRANSISTORS	380 -7,000
ECL	500*-1,500
SCR	680 -1,000
SCHOTTKY TTL	1,000 -2,500

*PC board level

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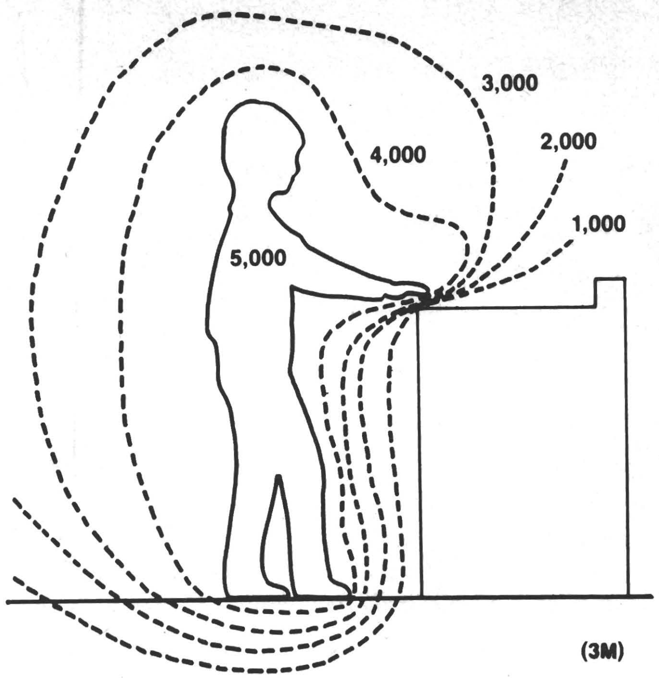


"Typical" electric field surrounding a statically charged person. Note the concentration of the field lines around the fingertips!

the greater proportion of charges originate from *triboelectric* charge generation – often referred to as frictional charging. This term basically states that anytime two materials are in contact and are separated a charge will be generated. The purist might argue that the term should include 'dissimilar' materials, however this is open for discussion as many insulator materials will quite easily generate a charge when separated from themselves.

The magnitude of the charge is determined by the materials themselves, the intimacy of contact and the speed and method of separation and the process is modified by humidity. The triboelectric series (see the accompanying chart) gives us a hierarchical order of whether a material will become positively or negatively charged. We could imply that some materials are positive in that they attract electrons and thus become negatively charged whereas some materials will easily give up electrons. The true reasons for this method of charging are still the subject of much discussion and research. However, the fact is that it happens!

Every electron moving from one material to another will create a negative charge and leave a positive charge behind. Sometimes these charges are very small and need metering equipment to detect – at other times they are often large enough to be seen or felt by us.

ANTISTATIC?

The word 'Antistatic' is consistently misused as a generic term for all static control products – it should be used to describe a material that 'minimises' triboelectric charging – not controls it. In the past, the 'antistat' properties of a material were described by its resistivity range. This is no longer considered appropriate. In fact, the U.S. EIA no longer includes 'antistatic' in its material resistivity range because "the antistatic property of a material is not necessarily correlated with it's resistivity." Most antistat treatments are chemicals (agents), either added to a product at the manufacturing stage or sprayed on objects (topical).

The former tends to be permanent, while the latter is temporary. At best, when first applied they offer some protection but will eventually wear off or degrade with time and humidity. Their effectiveness is difficult to measure and their performance degrades immediately they are applied. At best, they minimise charge generation. At worst, they do little to an already existing charge and offer a false sense of security. 'Antistatic' products can be used in certain areas, but with caution – especially pink poly bags and bubble wrap as they provide little or no shielding. The only universally accepted antistatic product is the inner layer of a shielding bag.

The effect on components

Once charged, an object has the ability to discharge to another object that is at a lower potential. Charged objects also exhibit voltage fields – the very factor that makes a FET function. The last thing a sensitive device needs is a miniature bolt of lightning injected into it or a FET being subjected to a voltage field greater than the oxide layer(s) can withstand – no actual discharge required!. If the discharge or voltage field is greater than the 'withstand' capabilities of the device then some damage is going to occur, either in the form of destruction or alteration (degradation) to its operating characteristics.

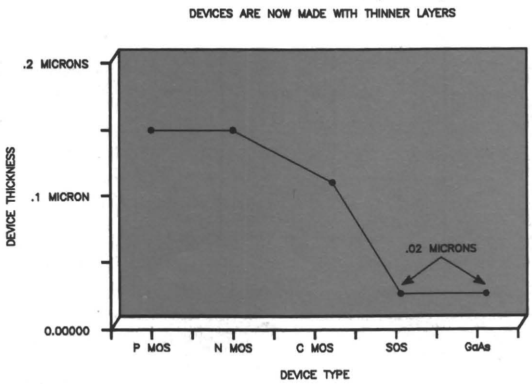
Many devices are rated according to the 'family' they belong to and component sensitivity varies according to complexity, geometry and the material from which it is constructed.

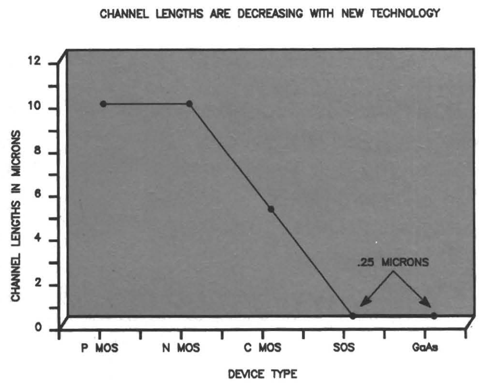
Device susceptibility rating is normally obtained from subjecting successive pins combinations to discharges and finding the lowest value that will destroy the device. This could mean that a device rated at 100 volts may only be that sensitive at two pin combinations and may be fairly insensitive at other combinations – try guessing which! General handling and pure luck may mean that a person charged with greater than 100 volts may never touch the sensitive combination or only touch them infrequently.

The damage level of a device is not the degradation level, research by McDonnell Douglas indicates that degradation can start to occur at only 25% of the destruct level.

The problem with most static damage is that, unless you have a big research budget and sophisticated facilities and can actually strip down components layer by layer, you can't see it. Fortunately, there is overwhelming evidence from ▷

As solid-state devices become thinner, are built with smaller channels and operate with less power, the need for static control will increase, rather than decrease.





existing research that not only shows how the damage occurs – but how to avoid it.

Much static damage is often wrongly attributed to general failures whereas research indicates that up to 50% of high level IC failures are directly attributable to static damage.

There are some popular myths that have grown up around the industry and it is perhaps wise to correct them. The first is that *"If an assembly passes final test – it must be OK."* Truth is, you had better look at the history of the unit for up to two years to make sure degradation hasn't affected its performance.

"Components are safe on a pc board" – in fact, they can be more at risk since tracks can act as antenna and good paths for discharges and voltage fields.

"Components have input protection" – most components and boards with protection 'tend' to have less problems. However, they still have problems.

"Higher humidity will solve the problem" – the best humidity will do is minimise an existing problem. Increasing humidity will cause other problems with equipment corrosion, unhappy staff and soldering difficulties.

Controlling the problem

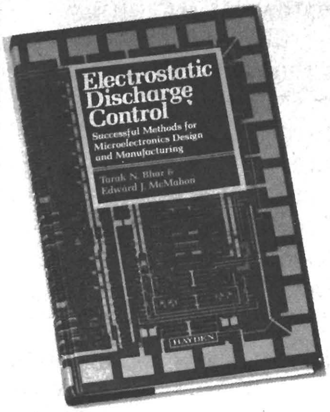
Static damage is caused by charged objects! Therefore, if objects were not charged the problem would be eliminated. An ideal situation would exist if triboelectric charging did not occur. At best, we can modify the behaviour of some materials and make them less prone to charge generation with the use of 'antistatic' products.

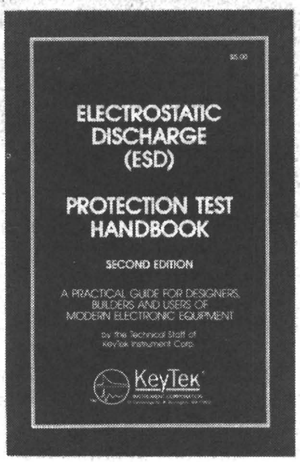
Minimising charges is difficult and very much a hit and miss exercise. The electronics industry accepts that charges will constantly be generated and these charges should be controlled. Static sensitive items can be protected by removing charges from objects with which they come into contact or proximity to or, when this is not possible, by "shielding" them from the charges.

Charged objects fall into two categories, either they are conductors or non-conductors. Charge can be removed from conductors by grounding and from non-conductors with ionised air. When sensitive items are in transit or storage they should be shielded. This gives us three basic methods of control:

3M looms large in the ESD control field, manufacturing and distributing a huge range of products. This static-dissipative Portable Field Service Kit, Model 8501, is designed for servicing electronic equipment in the field. It provides a static-free surface upon which to lay parts and to work. Included are two 3M Charge-Guard 2200 Series wrist bands and a 3051 Ground Cord.

The kit drains away any existing charges on the user or conductive parts or tools laid on the mat and prevents the accumulation of any new charge.





LITERATURE

Two books on Electrostatic Discharge are available locally, from two separate firms, one in Melbourne, the other in Adelaide.

Electrostatic Discharge (ESD) Protection Test Handbook, produced by the technical staff of the US Keytek Instrument Corp., was written specifically for people involved with testing equipment and circuits for ESD susceptibility. In 65 pages, the book covers basic ESD phenomena, various test specifications, design alternatives and test methods. This is the second edition and new sections describe recently acknowledged effects such as hand capacitance for fast-rising currents and the importance of approach speed in accurately simulating human ESD. The book is available on request from **The Dindima Group P/L, PO Box 106, Vermont 3133 Vic. (03)873 4455.**

Described as "the definitive text on ESD control", the 194-page hard cover tome, *Electrostatic Discharge Control,* by Tarak N. Bhar and Edward J. McMahon, reviews ESD theory and failure modes of electronic devices and discusses various protective equipment and test methods. To round out the narrative, the authors provide a description of how to establish an effective ESD control program in your business or workplace. Published by Hayden, it is available through **Componentronics P/L, 64 Sturt St, Adelaide 5000 S.A. (08)212 5999.**

GROUNDING,

IONISING, and

SHIELDING.

Over the years, two basic handling rules have evolved. The first is:

HANDLE STATIC SENSITIVE ITEMS IN A STATIC SAFE WORK AREA,

and the second is:

TRANSPORT ALL STATIC SENSITIVE ITEMS IN SHIELDING CONTAINERS OR MATERIALS.

A static safe handling area controls charges on all objects including people that are in, or enter the work area, by reducing static charges to levels that are harmless to exposed components. Shielding acts to provide a Faraday cage to components in transit and storage by reducing to harmless levels the electrostatic fields to which devices are subjected. There are literally hundreds of products available that can ground, ionise and shield – welcome to the minefield of electrostatic product supply! And a minefield it is, with conflicting vendor claims, often misleading specifications and buyers who often do not have the ability to test the products supplied.

The work area is the critical part of any operation and there are certain basic rules that apply here – ground conductors and ionise non-conductors. Simple rules, maybe, but with a multitude of different products available.

Grounding

The single most lethal conductor in the workplace is people! about 70% of damage is caused by incorrectly or ungrounded ▷

STATIC GENERATED BY:	POTENTIAL MAXIMUMS GENERATED IN Low Humidity (10-20% R.H.)	High Humidity (65-90% R.H.)
Walking across carpet	35 000 V	1500 V
Walking on vinyl floor	12 000 V	250 V
Working at bench	6000 V	100 V
Handling vinyl job packet	7000 V	600 V
Picking up poly bag	20 000 V	1200 V
Moving padded chair	18 000 V	1500 V

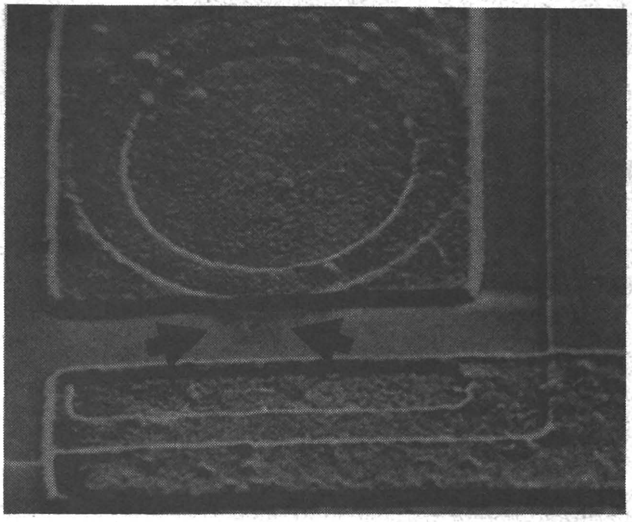
personnel. People are great static generators. We all have to move as we work, which means that triboelectric charge generation is occurring constantly – our feet are contacting floor materials, our clothes are in contact with other clothing materials, our skin and our hands are constantly in contact with other objects. Any movement means separation of materials in contact and this generates static charges.

When charged, we have an excellent set of probes in the shape of fingers! When we are not discharging to components we are subjecting them to voltage fields from our hands or body. People are the greatest hazard – they are also the easiest to control!

Your body is, in effect, a variable capacitor that constantly changes its size according to its shape and proximity to other objects and we are constantly feeding charge into that capacitor. Since we can't stop the charges being fed to the capacitor and since we can't eliminate the capacitor, we can do the next best thing electrically – ground the capacitor. If we ground it properly we can virtually dissipate charges to ground at the same speed they are being generated, the key word is do it properly!

Research has confirmed theory. Namely, that the maximum charge that can be retained on the human body is a function of the total resistance path that exists to ground. At one megohm our maximum retained voltage is less than two volts, at 10 megohms the figure is 11 volts and at 100 megohms it is 80 volts.

If we are handling components that could be degraded at 15 volts then obviously we need to keep the maximum resistance level to 10 megohms. The easiest and time proven method of operator grounding is through a wrist strap assembly (see illustration), since the wrist band can remain in good electrical contact with the skin and the assembly can be checked easily.



This picture shows the degraded base-emitter junction of the input transistor in an LM101AH (mil-spec. LM301!) which failed due to ESD. (JPL).

There are many 'wrist strap checkers' on the market these day's, they are also misnamed items as they check more than the wrist strap – they also check the electrical connection with the operator. They act as low voltage meggers, usually operating between 10 and 20 volts, and test the product and operator as a circuit and give 'go', 'no go' indications within an operational "window" of resistance.

Other methods of grounding personnel are through contact with conductive or dissipative flooring. This works, providing that contact is permanently maintained through a similar resistance level as that of the wrist strap – not so easy with certain footwear and the high resistance levels of some flooring. In fact, the primary object of most flooring is to offer a safety net by lowering overall charge levels present in the environment, and to let the wrist strap assembly take the operator down to a predetermined voltage level – and hold them there.

The most critical surface in any safe handling area is the actual workbench surface and there are dozens of different types of material available ranging from soft cushioned materials to hard laminates. The work surface material has one basic function – it MUST control static charges. The material should not only be able to remove charge from conductive objects on its surface it must also not retain any charges. ▷

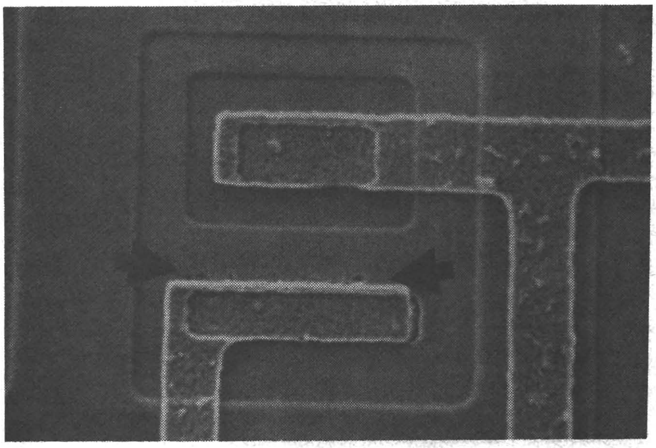
BASIC RULES FOR STATIC PROTECTION

Handle all static sensitive items in a static safe work area

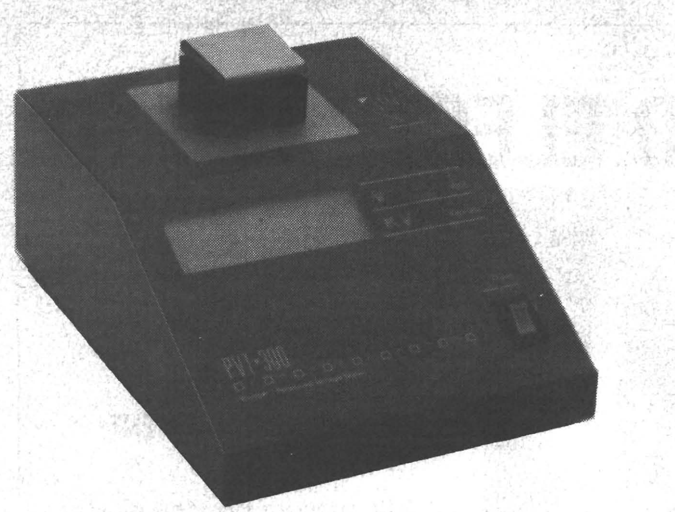
A static safe work area controls charges on people and objects in the work area

When working in an unprotected environment, ground yourself to the equipment before commencing work and at all times while working

Transport and store all static sensitive items in static shielding materials or containers



Even voltage regulator ICs can suffer electrostatic damage! This picture (900x mag.) shows degradation due to static incurred inside a common LM723. Cracks are visible in the oxide layer atop the 'inverted-L' track, which is the base of a transistor. (JPL).



In any situation where you need to know the effectiveness of static control measures, or where static generation on personnel needs to be checked, there's only one sure way to get your answers – and that's to measure the charge any person may accumulate.

The Voyager PVT-300 Personal Voltage Tester is just built for this job. Walk up, touch your finger to the terminal on the top and it gives an instant voltage reading on the 3[1/2] digit display. The twin-range display shows up to 1800 volts (1 V resolution), and up to 9.99 kV (10 V resolution). With it, you can test the "before" and "after" effectiveness of conductive wrist and ankle straps, etc, as well as other ESD control measures. It is available from CLC Agencies, 51 Armitree St, Kingsgrove 2208 NSW. (02)750 4005.

Quite simply, we could make a work surface from a grounded steel plate and many years ago most surface coverings actually had similar electrical properties to steel. However, times have changed and conductive bench coverings are now a definite no-no (except in special circumstances). Power-up testing is both difficult and dangerous, high impedance and other circuitry can be affected by the large groundplane beneath it, and conductive materials 'encourage' discharges from charged objects in proximity, thereby creating troublesome localised RF signals.

Since most people do not expect to find this type of material in the workshop, there is the possibility that anyone working in a new area and 'powering-up' equipment on the bench could cause damage not only to equipment but also to themselves.

Work surfaces need to be conductive enough to drain static charges quickly, yet insulative enough to allow power-up testing and a large measure of protection to personnel, hence the development of dissipative materials. These are materials that are electrically between conductors and insulators and in theory offer the benefits of both. The U.S. Milspec 263 defines dissipative materials as having resistive ranges of 10^5 to 10^9 whilst the EIA specifies materials up to 10^{12} Ohms as dissipative – that it is a very large electrical range! Interestingly, engineers who would normally be quite horrified if they received a resistor a few percent outside specification will blandly specify a 'dissipative' material that 'could' have a specification between 100 000 Ohms and 1000 gigOhms!

The speed at which a surface covering material will remove charge is determined by the total resistance path that exists to ground. Typically, it needs to be greater than 10 megohms (to allow protection for power-up test situations) and less than 1000 megohms (otherwise charge drainage takes too long). In fact, some material users specify top limits below 200 megohms – all these figures are a far cry from the 0.1 to 1 000 000 megohms that the dissipative range encompasses. The speed of discharge is determined by the formula:

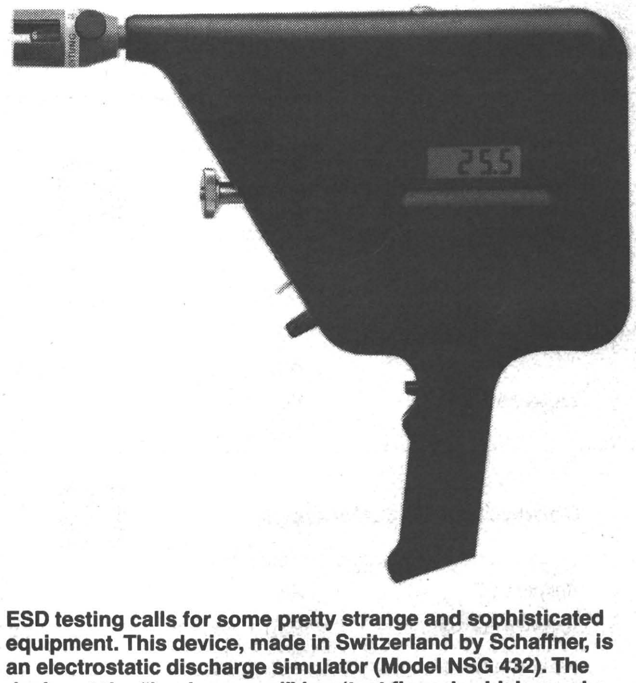
$$\text{Time} = l_n \frac{\text{(Initial Voltage)}}{\text{(Target Voltage)}} \times \begin{matrix}\text{Capacitance of} \\ \text{Charged Object} \\ \text{(in Farads)}\end{matrix} \times \begin{matrix}\text{Resistance} \\ \text{to ground}\end{matrix}$$

Most operations prefer that the target voltage is achieved in less than one second. Here are two equations one for a material with a resistance to ground of 200 megohms and the other for a material with 3000 megohms resistance. We will assume that the charged object is a conductive tote box with a capacitance of 300 picofarads and the start voltage is 5000, which we wish to reduce to our safe level of just 10 volts.

$$l_n (5000/10) \times 300\text{ pF} \times 2 \times 10^7 \text{ Ohms} = 0.37 \text{ seconds}$$

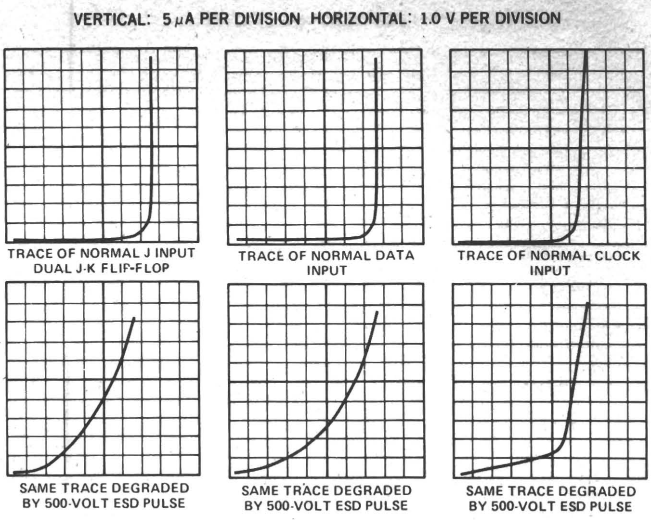
$$l_n (5000/10) \times 300\text{ pF} \times 3 \times 10^9 \text{ Ohms} = 5.59 \text{ seconds}$$

Quite plainly, the second material is providing unacceptable discharge times since a grounded technician will have to wait almost six seconds before reaching for the container. If the contents are touched before then, there is a very good chance of discharge occurring through the operator. In fact it may be even worse than the equation suggests, since high



ESD testing calls for some pretty strange and sophisticated equipment. This device, made in Switzerland by Schaffner, is an electrostatic discharge simulator (Model NSG 432). The device at the "business end" is a 'test finger', which may be charged anywhere in the range from 2 kV to 25 kV!

The device comprises a power supply, a pistol-shaped handheld unit (which you see here) with controls and display, a dc-dc converter and the 'test finger' which is exchangeable with other special test fittings. It is distributed by Westinghouse Systems P/L, PO Box 267, Williamstown 3016 Vic. (03)397 1033.



ESD effects are not always catastrophic, but can cause degradation in a device's performance, as these pictures of a dual J-K flip-flop performance show, following a non-destructive ESD event.

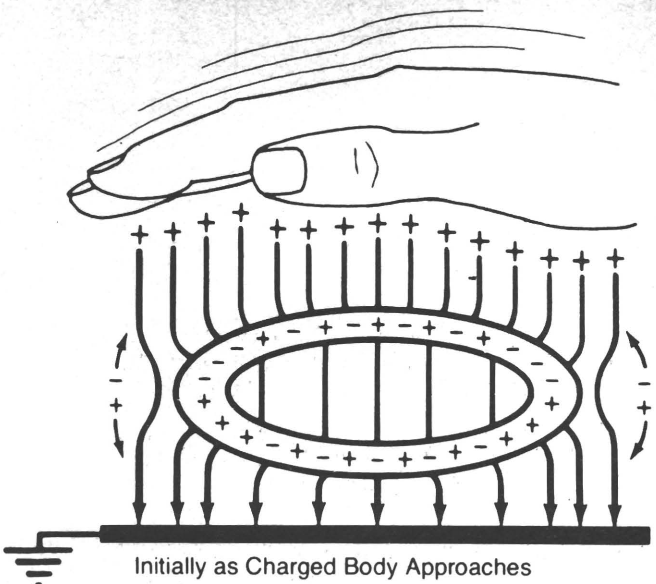
Conductive flooring is widely used as a static control measure in many offices and workplaces where electronic and computer equipment is installed. The flooring in this Swiss Hewlett Packard office is PVC conductive flooring made by DLW in Germany. Local enquiries should be directed to DLW Flooring Systems P/L, 133 Alexander St, Crows Nest 2065 NSW. (02)439 5488.

resistance materials tend to provoke voltage suppression (the old Q = CV formula) sometimes by a factor of eight!

Very few vendors will even mention voltage suppression or the other bug-bear of these materials – contact resistance. Dissipative material specifications are normally quoted as volume and surface resistivity with several manufacturers now quoting resistance to ground measurements.

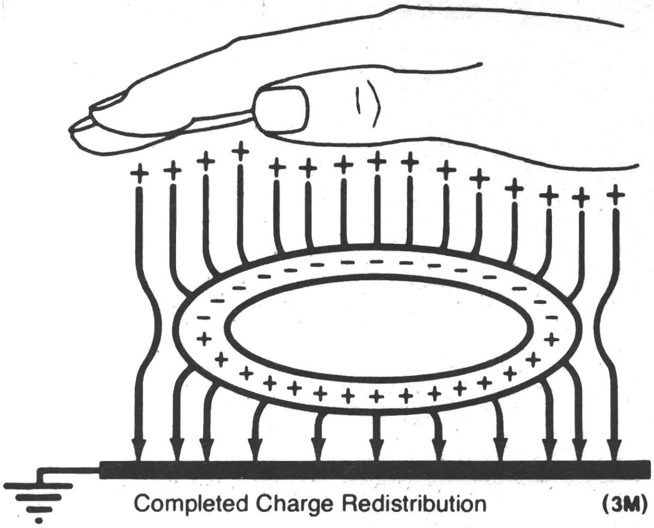
Surface resistivity is a guide only to current flow resistance on the surface. Beware – the Ohms per square measurement, which states that the resistivity should be the same regardless of the size of the square, does not hold good for some materials! Volume resistivity, again, is only a guide and some materials with complex multi-layer construction defy proper description in this category.

Resistance to ground is the only true performance indicator available and figures are normally obtained by 'megger- ▷



Initially as Charged Body Approaches

How charge is redistributed on a conductive container when a charged body (i.e: your hand!) approaches.



Completed Charge Redistribution **(3M)**

This principle is exploited with shield bags, pc board 'tote' boxes and conductive IC tubes.

ing' an industry acceptable electrode to the ground point of the material. Using two electrodes on the material surface will also indicate surface resistance. These tests simulate the real world environment of these materials – not their laboratory measurements. Determine the specification you need and test the material not only when new but during its working life to ensure its continued performance. Testing can be accomplished with low voltage meggers or with special test equipment available for the purpose.

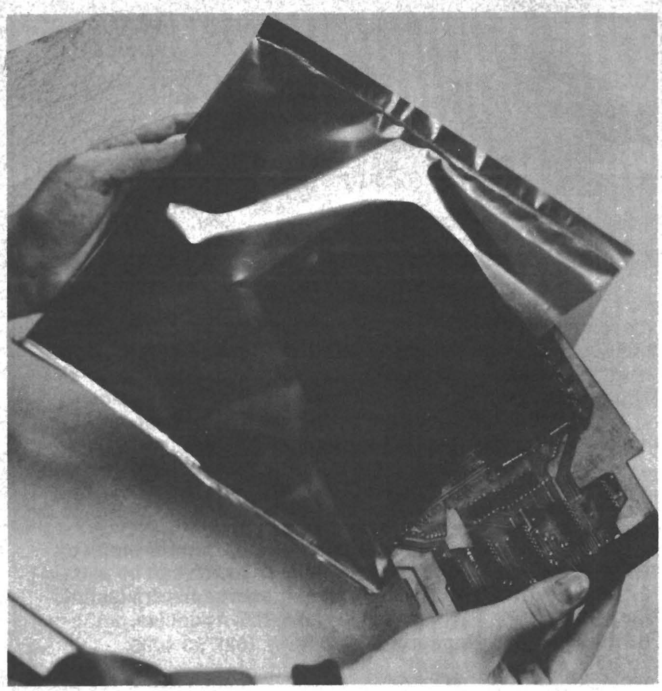
Ionising

Non-conductors in the work area pose their own special threat. By nature, these materials do not allow free electron movement and cannot be grounded. Non-conductors exhibit voltage fields and can retain their charge for long periods. Where possible, they should not even be in the work-area. However, in the real world there will always be some of these materials in the workplace including tools, inspection equipment, etc. The only effective method of neutralising the charge on these materials is with ionised air comprised of positive and negative ions.

The American EOS/ESD Association recently produced a draft standard for evaluating and testing ionising devices. This draft has already achieved the status of de facto standard. Why? Because very few users actually understand how these products work and many vendors have for years been making unsubstantiated claims.

The two most important criteria for any ioniser is "does it produce balanced ionised air". If the ioniser is out of balance it may create more problems than it solves. The second is, "How effectively does it discharge a charged object." Note this is not how much ionised air is being generated, but how much is being delivered to a charged object, which is far more important.

Electrical generation of ionised air will always create some imbalance, which is commonly referred to as "offset voltage." Significantly, it should be less than plus or minus 30 volts. Performance is determined by measuring the charge decay of an object in the path of the air flow. Potential users of ionising devices should look for a specification that quotes the offset voltage and an isolated plate decay time, together



Shielding bags are widely used for the protection of pc boards during storage and transporting. They have three layers: an inner layer which is antistatic which allows objects to move inside without generating a charge, a middle layer which is dielectric (a plastic) that prevent current flow from outside to inside, and an outer layer which is conductive and forms a Faraday cage.

with ozone and EMI levels. Most other specifications are superfluous.

Shielding

Every time static sensitive items leave a static safe handling area they should be *shielded*. Shielding encompasses a variety of products from rigid containers to flexible materials.

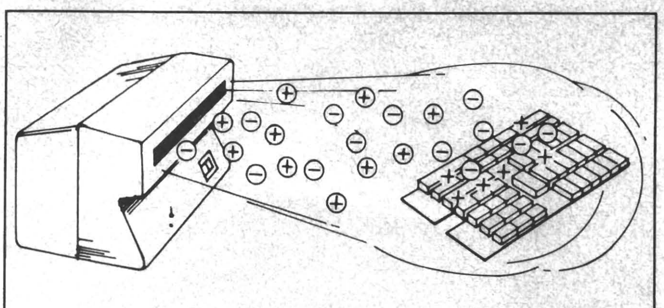
There are many different types of conductive plastics available – not all perform the same electrically. The EIA specification for shielding encompasses materials falling below 10^4 Ohms/square surface resistivity and 200 Ohms/cm volume resistivity.

Shielding is a complex function determined by both the conductivity of the material and its volume and many tests have been developed to actually determine the true performance of these materials. The most common shielding material is the static shielding bag. This product has three primary requisites – it should have an "antistatic" inner layer (this term is defined as being "antistatic" in accordance with the normal contents of the bag) which minimises charge generation as the contents move around inside. It should have a dielectric layer to prevent external current penetrating the material and also allow the transport of battery backed boards; it must have a conductive layer to provide shielding.

Shielding bag vendors make more promises than politicians at election time! Everybody's bag is "'better and cheaper" than someone else's, and some manufacturers are into gimmickery construction and fancy colours.

Shielding and bag performance are relative terms – you get what you pay for and that's a combination of performance and durability. If you want ultimate performance and are prepared to pay for it – buy the industry benchmark, the 3M 2100-series material. If you don't need super performance or durability, there are many other manufacturers to choose ▷

To quickly identify the source and level of electrostatic charge, Rheem Protective Packaging Products supply this US- made handheld "Autostat" Electrostatic Locator, Model 224CL. It provides indication up to ±25 kV in three scales of 5, 10 and 25 kV. Contact Rheem Protective Packaging Products, 3 Burrows Rd, Alexandria 2015 NSW. (02)519 4211.



It's relatively easy to get rid of static charge on a conductor, but what about non-conductors? The only effective method is to "neutralise" charged non-conductors using ionised air. This is done by employing an "ionised air blower" which supplies a constant stream of both positive and negative air ions. Any charged non-conductor then attracts the oppositely-charged ions to its surface, thus quickly neutralising the charge, as illustrated above.

Shown below is a commercial ionised air blower made by Simco, the Aerostat XT, a 'portable' unit which can be placed in any work area requiring ionised air charge neutralisation for ESD control. Further details from CLC Agencies, 51 Armitree St, Kingsgrove 2208 NSW. (02)750 4005.

from, including Simco, Richmond, Thomas & Betts and Static Inc.

When choosing a shielding bag, make sure it is labelled. If the manufacturer is not prepared to put his name on it, ask why? For performance, look for 'testing' in accordance with EIA IS 5A standards as this organisation has developed tests that simulate a 'real world' environment.

This article, by nature, has had to be compressed and many of the subjects by themselves could fill this magazine. However, readers may be aware that static control has changed over the past few years – and it is constantly changing as new technologies appear and research highlights new problem areas.

Awareness of the problem is the keynote as 'awareness' provides much of the solution both to decision making management and staff actually handling sensitive items. Overseas

◀ **Electrostatic discharge simulators are widely used to check the effectiveness of ESD control measures. The Keytek Instrument Corp. specialises in making calibrated ESD simulators which are claimed to duplicate "real world" ESDs.**

Keytek's MiniZap range of simulators provide accurate selection of voltage levels up to 15 kV and duplicate the rise time, intensity and stress levels of real ESD, the makers claim. They are distributed by The Dindima Group, PO Box 106, Vermont 3133 Vic. (02)873 4455.

computer manufacturers and Australian corporations such as STC, Telecom and Defence, and many companies, already incorporate programmes, but there are still areas where companies believe the problem either does not, or will not, affect them. If you work in electronics and believe the problem is going to pass you by then you had better go back to valves! To those that know and recognise the problem most controversy now revolves around true material performance and handling procedures.

Australia now has its own trade Association, the Australian Electrostatic-Discharge-Overstress Association. This Association is attempting to accomplish what the American EOS/ESD has done – namely, educate the market and set material performance and handling guidelines that are relative to Australia to enable our electronics industry to 'compete' static-wise with the rest of the world.

Win this Static-Dissipative Portable Field Service Kit from 3M and save those sensitive semis!

3RD BIRTHDAY CONTEST No.3.

Prize kindly donated by 3M Australia.

Savvy serviceman or Sunday solderer – you need this!

The 3M 8501 kit is designed for electrostatic protection of static-sensitive components during field service calls. Static damage can occur anywhere microelectronics are used, but they are particularly susceptible during servicing. The kit comprises two 3M CHARGE-GUARD 2200 Series wrist bands, a 56 x 61 cm flexible static-dissipative work surface with two pockets, and a coiled cord system to attach the operator to the work surface and the work surface to a suitable ground. The cords contain built-in one megohm resistors to ensure operator safety.

The Field Service Kit provides a safe area on which to service sensitive components and assemblies, while reducing the risk of sparking or shorting which can occur with other, highly conductive mats.

1) What does triboelectric mean?

2) 3M are famous for their 'Post-it Notes' how did this marvellous invention eventuate?

3) '3M' is a strange name for a company. What does it actually stand for?

Now tell us in 25 words or less how and/or where you would use this prize

I have read the rules of the contest and agree to abide by their conditions.

Signature: ______________________

Name: ______________________

Address: ______________________

______________________ P/Code: __________

Phone: (____) ______________________