

Electrostatics —

Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide

ICS 17.220.99; 29.020; 31.020

National foreword

This Published Document is the UK implementation of CLC/TR 61340-5-2:2008. It is identical to IEC/TR 61340-5-2:2007, incorporating corrigendum May 2009. It supersedes BS EN 61340-5-2:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/101, Electrostatics.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 May 2008

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ISBN 978 0 580 68599 6

Amendments/corrigenda issued since publication

Date	Comments
30 June 2011	Implementation of IEC corrigendum May 2009: correction to 4.7.5.3

English version

**Electrostatics -
Part 5-2: Protection of electronic devices
from electrostatic phenomena -
User guide
(IEC/TR 61340-5-2:2007)**

Electrostatique -
Partie 5-2: Protection des dispositifs
électroniques contre les phénomènes
électrostatiques -
Guide d'utilisation
(CEI/TR 61340-5-2:2007)

Elektrostatik -
Teil 5-2: Schutz von elektronischen
Bauelementen gegen elektrostatische
Phänomene -
Benutzerhandbuch
(IEC/TR 61340-5-2:2007)

This Technical Report was approved by CENELEC on 2008-02-15.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of the Technical Report IEC/TR 61340-5-2:2007, prepared by IEC TC 101, Electrostatics, was submitted to the vote in accordance with the Internal Regulations, Part 2, Subclause 11.4.3.3 (simple majority) and was approved by CENELEC as CLC/TR 61340-5-2 on 2008-02-15.

This Technical Report supersedes EN 61340-5-2:2001.

The main changes with respect to EN 61340-5-2:2001 are listed below:

CLC/TR 61340-5-2:2008 has been modified to provide guidance for users of EN 61340-5-1. The text has been arranged to follow the requirements of EN 61340-5-1 as closely as possible as well as providing specific guidance on each of the requirements of EN 61340-5-1.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the Technical Report IEC/TR 61340-5-2:2007 was approved by CENELEC as a Technical Report without any modification.

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INTRODUCTION

This user guide and has been produced for individuals and organizations that are faced with controlling electrostatic discharge (ESD). It provides guidance that can be used for developing, implementing and monitoring an electrostatic discharge control program in accordance with IEC 61340-5-1.

This user guide applies to activities that: manufacture, process, assemble, install, package, label, service, test, inspect or otherwise handle electrical or electronic parts, assemblies and equipment susceptible to damage by electrostatic discharges greater than or equal to 100 V using the human body model (HBM). The 100 V HBM limit was selected for IEC 61340-5-1 as the baseline susceptibility threshold, since a large majority of the ESD products on the market have a sensitivity of greater than 100 V.

The limits established for each of the ESD control items are specified for an ESD program designed for 100 V HBM devices. The 100 V value is predicated on maximum voltage levels attainable on an individual when they are grounded via techniques accepted throughout the electronics industry as outlined in IEC 61340-5-1.

For organizations concerned with charged device model damage, IEC 61340-5-1 establishes requirements concerning the use of insulators in the ESD protected area (EPA) based on maximum electrostatic field limits. This topic is addressed in more detail in 4.6.

The general principals described in IEC 61340-5-1 are not limited in their applicability to ESDS with ESD sensitivities of 100 V or greater. For companies that handle ESDS with sensitivities of less than 100 V (HBM), the general principals of IEC 61340-5-1 can still be used. The organization may have to modify some of the required limits specified in Tables 2 to 4. The program documentation would then identify that ESDS with sensitivities of less than 100 V HBM were being handled and that this required a change to the limits established in IEC 61340-5-1.

The fundamental ESD control principles that form the basis of IEC 61340-5-1 are as follows:

- a) Avoid a discharge from any charged, conductive object (personnel, equipment) into the device:

This can be accomplished by bonding or electrically connecting all conductors in the environment, including personnel, to a known ground or contrived ground (as on shipboard or on aircraft). This attachment creates an equipotential balance between all items and personnel. Electrostatic protection can be maintained at a potential different from “zero” voltage ground potential, as long as all items in the system are at the same potential.

- b) Avoid a discharge from any charged ESD sensitive device (the charging can result from direct contact and separation or can be field induced):

Necessary insulators in the environment cannot lose their electrostatic charge by attachment to ground. Ionization systems provide neutralization of charges on these necessary insulators (circuit board materials and some device packages are examples of necessary insulators). Assessment of the ESD hazard created by electrostatic charges on the necessary insulators in the work place is required to ensure that appropriate actions are implemented, according to the risk.

- c) Once outside of an electrostatic discharge protected area (hereafter referred to as an EPA) it is often not possible to control the above items, therefore, ESD protective packaging may be required.

ESD protection can be achieved by enclosing ESD sensitive products in static protective materials, although the type of material depends on the situation and destination.

an EPA, low charging and static dissipative materials may provide adequate protection. Outside an EPA, low charging and static discharge shielding materials are recommended. While all of these materials are not discussed in this standard, it is important to recognize the differences in their application.

ELECTROSTATICS –

Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide

1 Scope

This technical report has been developed to support IEC 61340-5-1.

The controls and limits referenced in this standard were developed to protect devices that are susceptible to discharges of 100 V or greater using the human body model test method. However, the general concepts are still valid for devices that are susceptible to discharges of less than 100 V.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60749-26, *Semiconductor devices – Mechanical and climatic test methods – Part 26: Electrostatic discharge (ESD) sensitivity testing – Human body model (HBM)*

IEC 61340-2-1 – *Electrostatics – Part 2-1: Measurement methods – Ability of materials and products to dissipate static electric charge*

IEC 61340-2-3 – *Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid planar materials used to avoid electrostatic charge accumulation*

IEC 61340-4-1 – *Electrostatics – Part 4-1: Standard test methods for specific applications – Electrostatic resistance of floor coverings and installed floors*

IEC 61340-4-3 – *Electrostatics – Part 4-3: Standard test methods for specific applications – Footwear*

IEC 61340-4-5 – *Electrostatics – Part 4-5: Standard test methods for specific applications – Methods for characterizing the electrostatic protection of footwear and flooring in combination with a person*

IEC 61340-5-1, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

ANSI/ESD STM2.1, *Standard Test Method for the protection of electrostatic discharge susceptible items – Garments*

ANSI/ESD STM3.1, *Standard Test Method for the electrostatic discharge susceptible items - Ionization*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 61340-5-1 apply.

4 ESD control program plan

This clause outlines a step-by-step approach that can be used to establish an ESD control Program.

4.1 Developing an ESD control program plan

4.1.1 Assignment of an ESD coordinator

In order to have a well thought out and implemented ESD program an ESD coordinator must be assigned. The ESD coordinator is responsible for all aspects of ESD in the facility. In order to be effective the ESD coordinator needs:

- a) the full support of management;
- b) a good understanding of electrostatics and how ESD sensitive devices can be damaged. The ESD coordinator will often need to attend educational classes or seminars related to ESD in order to maintain or update their knowledge;
- c) a thorough understanding of IEC 61340-5-1 and all of the organization's processes related to the handling of ESD sensitive devices.
- d) access to measuring equipment for the purposes of performing compliance verification audits as well as testing new ESD products and materials for use in the ESD program;
- e) depending on the size of the facility, the ESD coordinator might also need to have auditors assigned to conduct the ESD audits.

Finally, management must provide the ESD coordinator with the authority and funding necessary to ensure that the ESD control program is maintained and enforced.

4.1.2 Determination of part ESD sensitivity

The next step in developing an ESD control program plan is to determine the part, assembly or equipment sensitivity level under which the plan is to be developed. Although the requirements outlined in IEC 61340-5-1 are effective for handling parts sensitive to 100 V HBM or higher, the organization may choose to develop an ESD program based on ESD sensitivities that are greater or less than 100 V HBM. In this situation, the organization must develop an ESD control program plan that clearly states the ESD sensitivity that the program is based on.

The organization can use various methods to determine the ESD sensitivity of the products that are to be handled. Some of the methods include:

- assumption that all ESD products have an HBM sensitivity of 100 V;
- actual testing of ESD sensitive devices to establish the ESD sensitivity thresholds using IEC 60749-26;
- referencing ESD sensitivity data in published documents such as manufacturer's published data sheets.

4.1.3 Initial process and organizational assessment

Before the ESD control program plan can be developed, an initial assessment of the processes and organizations impacted by an ESD control program should be conducted. Organizations and processes that might be affected include:

- purchasing;

- design engineering;
- receiving inspection;
- quality assurance;
- manufacturing;
- testing;
- maintenance;
- packaging and shipping;
- field service;
- failure analysis;
- repair services;
- spare parts storage;
- material handling and parts conveyance;
- receiving.

An assessment of each area where ESDS parts are handled should be conducted in order to determine ESD hazards and possible ESD process procedures. The information accumulated throughout these steps forms the basis for developing the ESD control program plan.

4.1.4 Documentation of ESD control program plan

After gathering the above information, the organization is in a position to begin documenting the program plan. The plan should state the scope of the program which includes the tasks, activities and procedures necessary to protect the ESD sensitive items at or above the ESD sensitivity level chosen for the plan. Although the primary focus of the plan is to outline strategies for meeting the administrative and technical elements of IEC 61340-5-1, other items may be beneficial to incorporate as well. These additional items might include:

- organizational responsibilities;
- defined roles and responsibilities between the organization and subcontractors and suppliers;
- strategies for monitoring product yields and processes that might be important in determining the effectiveness of ESD control measures currently in place or in assessing whether additional measures should be taken;
- approaches for ensuring continual improvement of the ESD program;
- a list of approved ESD control products and materials.

The administrative and technical elements of IEC 61340-5-1 that need to be addressed in the plan (unless tailored) include:

- training plan;
- compliance verification plan;
- technical requirements;
- grounding/bonding systems;
- personnel grounding;
- protected areas;
- packaging;
- marking.

4.1.5 Tailoring

It is possible that portions of IEC 61340-5-1 may not apply to all areas within an organization. In these situations it is acceptable for the organization to document an exception to one or more of the required elements of IEC 61340-5-1 as long as there is a valid, substantiated and documented justification for the exception. An example of an acceptable exception to IEC 61340-5-1 can be found in the sample ESD program at the end of this standard.

4.2 Development of a training plan

4.2.1 Personnel training

Personnel training is a critical element in the implementation of an ESD control program. A sustained commitment and mindset among all personnel that ESD prevention is a valuable, on-going effort by everyone is one of the primary goals of training.

One of the first decisions that must be made is who will be required to take the ESD training course. IEC 61340-5-1 requires that, at a minimum, initial and recurrent ESD training shall be provided to all personnel that handle or otherwise come into contact with ESD sensitive items. This decision seems straight-forward but care shall be taken to ensure that all people that handle ESD sensitive devices receive adequate training. One example is the finance department. Many people will immediately state that this group should be exempt from ESD training. However, in some companies the finance department personnel are involved in the annual physical inventory where parts are counted. In these situations, the finance employees are touching ESD sensitive parts and therefore must receive ESD training in order for the organization to be in compliance with IEC 61340-5-1.

Although it is not a requirement of IEC 61340-5-1, the organization may want to consider providing some form of ESD training to personnel who do not handle ESD sensitive parts such as:

- managers, who may need to understand the implications of, and necessity for ESD prevention;
- cleaning and maintenance personnel who may need to work within the EPA; and
- purchasing personnel responsible for buying ESD susceptible parts and ESD equipment.

For visitors to the EPA, the person escorting the visitor is responsible for ensuring that they are wearing the ESD equipment required by the organization and that they understand what they may and may not do within the EPA.

Although personnel training can take several forms (i.e. instructor, computer based, etc.), the preferred technique for initial training is through the use of an instructor. Special care should be exercised in finding a "suitable" instructor. The instructor should have a good understanding of ESD theory and the organization's ESD control program and the processes, procedures and materials prescribed within. In addition, if manufacturing spans more than one culture, careful consideration shall be given to customs and religious beliefs. Besides cultural differences, other factors such as education, experience and age should be considered. All training should be carried out in a secure, non-threatening environment.

One of the first steps is to determine the type(s) of ESD training methods that will work best for the organization. Some possible training methods include:

- in-house, instructor-led ESD class;
- in-house, consultant-led class;
- computer based training;
- industry symposia, tutorials and workshops.

The initial training program should cover the fundamentals of ESD, the details of the organization's ESD control program plan, and each person's role in the ESD program. The training program should answer the following basic questions:

- what is static electricity?
- how does it occur?
- how does ESD affect product quality?

A careful explanation of the protection process as part of company policy should be included. No matter which type of training method is chosen, the program should be designed so that all trainee questions that arise can be answered. In addition, a knowledgeable person in the organization should be available to answer trainee questions once they have begun working. Opening the lines of communication is the beginning of a successful ESD training program. This type of communication should continue in the workplace and form the basis for an ongoing education process. It is a requirement in IEC 61340-5-1 that initial ESD training is provided before personnel handle ESD sensitive devices.

Because ESD control programs cover such a variety of job disciplines and educational levels, it may be necessary to develop special job specific training modules. Advanced modules should emphasize the main concerns of each discipline. Course emphasis should be tailored to each group's specific needs. For example, the modules developed for management, engineering, technicians, cleaning staff and field service could differ significantly because their day-to-day concerns and responsibilities are much different.

Ongoing or refresher training is also vital to any organization's training plan. It should reinforce the basic fundamentals taught during initial training, but also should incorporate program updates and changes and the reasons for those changes. As with the initial training, the organization shall decide which type of training will be used and how frequently the recurring training will be required. The method chosen should keep everyone informed, renewing his or her commitment to the total ESD effort. Recurring training is also a good feedback loop for monitoring the program's effectiveness. Personnel should be encouraged to discuss issues, and make suggestions for improvement in these sessions. Actions can then be assigned to improve the organization's overall ESD control program.

After training (initial or recurring) sessions have been completed, it is important to ensure that the trainee understands and has retained the ESD control program concepts taught during these sessions. IEC 61340-5-1 requires that an objective evaluation technique be incorporated as part of the training plan. This can be accomplished in a number of ways that include written tests, question and answer sessions with an instructor or multiple choice questions at the conclusion of a computer based training session. Regardless of the method selected, the organization should establish a pass/fail criterion for the testing to ensure adequate training has been accomplished. Records of all test results should be maintained. The test records should be stored such that they are readily available to management and customers who want objective evidence that the training portion of the ESD control program plan is being adhered to.

Finally, since IEC 61340-5-1 requires recurring or "refresher" training, a system should be established to highlight when employees are due for retesting and/or recertification.

A repository or central information source of educational ESD control materials should be kept for reference at anytime by organization employees. This repository might include:

- material from initial and recurring training sessions;
- ESD bulletins or newsletters;
- videos or CDs;
- computer-based training materials;
- technical papers, studies, standards and specifications;

- ESD control material and equipment product sheets.

4.3 Development of a compliance verification plan

4.3.1 Introduction

This subclause will discuss the importance of having a properly implemented compliance verification plan and its role in maintaining a successful ESD control program.

In order for the ESD control program to be successful it is essential to develop a plan for on-going surveillance. The plan shall identify

- the ESD control items that will be used,
- how often the item will be checked to ensure that it meets specification and the type of audits,
- the acceptable limits for each ESD control item used,
- the test methods that will be used by the auditors to verify that each ESD control item is within established parameters,
- the equipment that will be used to check the various ESD control items,
- who will make the audit measurements,
- what will be done if an out of compliance situation occurs.

4.3.2 ESD control items

There are many ways to establish an ESD control program. A program can range from a very simple, low cost or basic system to a highly complex control program that uses a variety of control items that provide redundancy in the event that the primary ESD control element(s) were to fail.

A basic ESD control program might include the following items:

- a) a grounded work surface;
- b) personnel grounded through a wrist strap system;
- c) ESD protective packaging to move ESDS from one process step to the next.

A complex ESD control program might include the following items:

- 1) grounded work surfaces;
- 2) personnel grounded through constant wrist strap monitor;
- 3) personnel grounded to a static control floor through ESD footwear;
- 4) personnel wearing grounded ESD garments;
- 5) air ionization at each workstation.

The decision to use a basic versus a complex ESD control program is a matter of company choice. Some of the considerations are: value of the products being manufactured, product reliability requirements imposed by the customer and the ESD sensitivity of the devices being handled. One type of program is not necessarily any better than the other as each can be effective in protecting ESD sensitive devices.

Once the ESD control items have been defined and implemented, the organization should develop an audit checklist. In order to establish meaningful data concerning improving or deteriorating ESD program trends, it is necessary for auditors to audit each area consistently every time. Many organizations find that properly designed checklists help improve audit consistency.

4.3.3 Verification frequency

The frequency for checking the function of ESD control elements is dependent on a number of factors such as how often the item is used, the item's durability and the impact on the ESD control program if the control item were to fail. As an example, wrist straps are often used as the primary ground for personnel. A wrist cord, whilst being worn, is subjected to thousands of stretch/bend cycles each day and the conductive wire(s) in the wrist cord will eventually break. The typical verification frequency, used by industry, for wrist cords is once per shift due to the wrist cord's importance to the success of the program and the likelihood of failure.

Some organizations may want to increase the time between verifications of an ESD control item after it has been in use for a period of time. This is typically done by monitoring the failures of the ESD control item. Once the organization has evidence that there is an acceptable period of time where no failures were found, the time between verifications can be increased. The new verification interval is then monitored. If an unacceptable level of failures is identified, then the verification frequency should revert back to the previous level.

4.3.4 Type of verifications

There are several types of verifications in use by industry today. These verifications are often used in combination to maximize the effectiveness of the ESD program.

4.3.4.1 Visual verifications

Visual verifications are used by companies to check the general state of the EPA. They can be used by employees at the start of the shift to ensure that all ground wires are in place and that unnecessary static generators have been removed from the workplace. Visual verifications can also be used by management and supervisory personnel to ensure that employees are following organization guidelines with respect to daily testing of wrist straps, the proper wearing of ESD garments and the correct wearing of wrist straps and ESD footwear. A visual verification is often a good indication of whether or not an ESD program is being followed.

4.3.4.2 Measurement verifications

Most organizations rely on verifying that the ESD control elements function through the use of actual measurements. These types of verifications are carried out by specially trained auditors using equipment that has been selected to properly measure each ESD control element. Some organizations measure 100 % of each control element in use throughout the factory while others perform verifications on a sample basis. The type of verification used is up to the organization implementing IEC 61340-5-1 as long as it proves to be effective.

4.3.5 ESD control item limits

In the past, many companies were forced to develop their own test procedures and establish the limits for the ESD control items that they used. However, ESD control has advanced to the point where there are generally accepted limits for many of the ESD control items that are used. Establishing an ESD program around the limits found in IEC 61340-5-1 will drastically reduce the possibility that 100 V (HBM) sensitive devices will be damaged by an ESD event.

There might be instances where the limits must be tightened. An example of this situation occurs when the organization designs an ESD program around a device with an ESD sensitivity of less than 100 V.

4.3.6 Test methods

In order to implement IEC 61340-5-1, it is a requirement that the organization follows the test methods or standards specified in Tables 1 to 4 of IEC 61340-5-1. It is recognized that some organizations have developed their own test methods or use other standard methods for verifying some of the ESD control elements. This is allowed under IEC 61340-5-1.

organization does not use the standards referenced in IEC 61340-5-1, a tailoring statement shall be included in the ESD control program plan that describes the reason for not using the referenced standards. The organization shall also be able to reliably demonstrate that the test methods used are suitable.

The test methods listed in the tables are intended primarily for qualifying products and materials for use by an organization. A modified version of the test method is often used by the organization for making audit measurements that comply with IEC 61340-5-1.

It is very important that everyone involved in auditing the ESD control program understands how the audit measurements are to be made. The organization shall develop procedures for making each of the audit measurements. The organization shall also ensure that everyone involved in taking measurements understands the audit procedures.

4.3.7 Test equipment

It is very important that the organization selects the proper equipment for making compliance verification measurements. It is best to select equipment that complies with the equipment specified in the individual IEC test methods or standards referenced in Tables 1 through 4 of IEC 61340-5-1. Each of the auditors shall be trained in how to properly use the measuring equipment.

4.3.8 Auditor skills

As part of developing an ESD program that is compliant with IEC 61340-5-1, it is important that the right people be selected to audit the ESD program. Some considerations for selecting internal auditors include the following:

- The internal auditor shall be familiar with IEC 61340-5-1 as well as the organization's specific ESD program.
- The internal auditor should also understand how the ESD control program fits into the organization's quality management system. ESD audit findings are one example. How does the organization handle non-conformances found during audits? How are ESD audit findings documented? Are corrective action reports generated? Prior to closing a corrective action, does the auditor verify that the audit finding has been corrected?
- It is preferred that the internal auditor has received training on how audits are conducted. ISO 9000¹ auditor training provides a good basis for all process auditors.
- The ESD auditor should have a good understanding of the manufacturing processes that they will be auditing.

4.3.9 Reporting of audit findings

It is important to keep management informed about the status of the ESD program. This can be accomplished through issuing reports at the completion of an audit. The ESD coordinator will need to classify the severity of each non-conformance. Major non-conformances should be addressed before those considered to be minor in nature. For significant ESD non-compliance issues, management should be notified immediately so that proper resources can be assigned to correct the problem.

There are many ways to make management aware of the ESD findings. Audit charts are commonly used to report the audit results. The chart, at a minimum should identify:

- the number of audit findings;
- the type of finding;
- the area audited.

¹ ISO 9000, *Quality management systems – Fundamentals and vocabulary*.

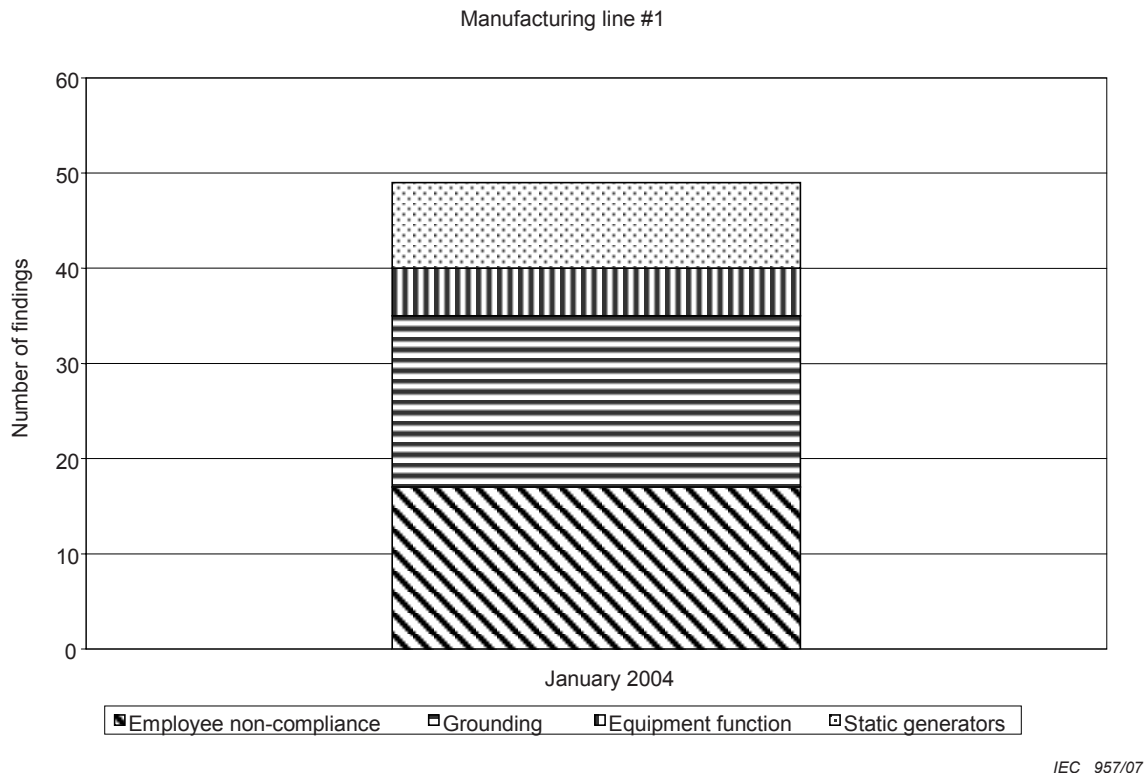
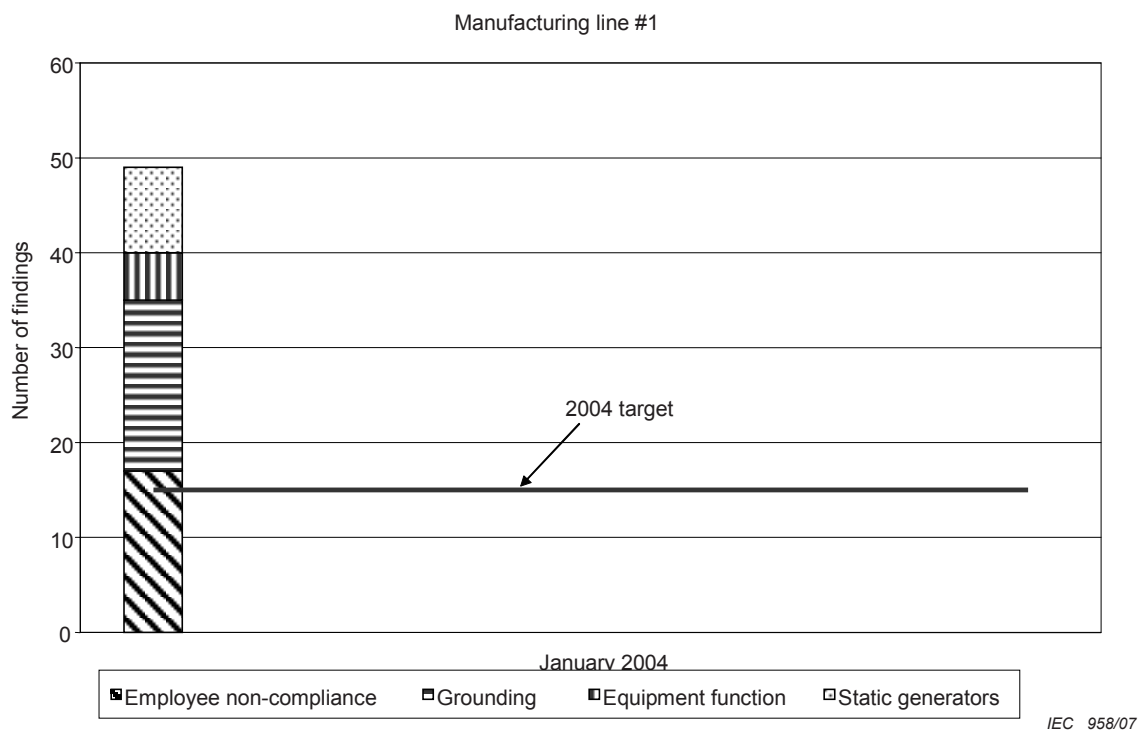
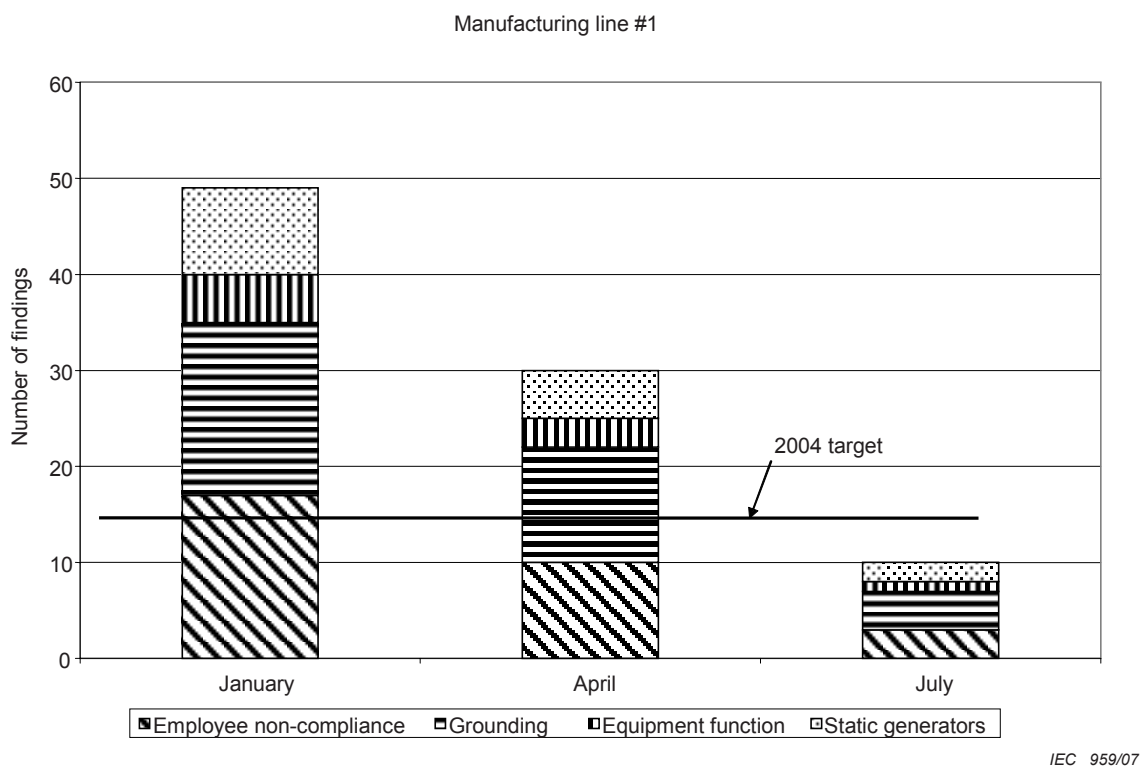


Figure 1 – Example audit report showing current status of ESD program

The information contained in Figure 1 shows management the current status of the ESD program and the items that are the largest source of non-conformances. However, Figure 1 does not tell management whether the program is being adhered to. Many organizations establish audit targets for the total number of findings allowed in a given area. Figure 2 includes targets for the manufacturing line. As can be seen in Figure 2, the manufacturing line has greatly exceeded the established ESD targets. This information further assists management in determining whether or not the ESD program is being followed.

A final enhancement to the report is an audit trend report. This information shows management the status of the audited area over time. An example of a trend chart can be found in Figure 3.

**Figure 2 – Example audit report showing target for manufacturing line****Figure 3 – Example audit report showing audit trend report**

4.4 Grounding/bonding systems

4.4.1 Introduction

The protection of ESDS is accomplished by providing a ground path to bring ESD protective materials and personnel to the same electrical potential. All conductor and dissipative items in the environment, including personnel, shall be bonded or electrically connected to a known ground or common connection point. This connection results in a sharing of charge which equalizes the voltage across all items and personnel and eliminates the chances of an ESD event to ESD sensitive devices. Electrostatic protection can be maintained at a potential different from a "zero" voltage ground reference as long as all items in the system are at the same potential.

NOTE It is important to understand that insulators cannot lose their electrostatic charge by connection to ground. The handling of insulators is dealt with in 4.6 d).

This subclause provides guidance and procedures needed to establish an effective path to ground. This discussion is limited to grounding for ESD purposes.

4.4.2 Basic grounding requirements

The first step in ensuring that everything in an EPA is at the same electrical potential is to ground all conductive components of the work area (work surfaces, people, equipment, etc.) to one of the following points.

4.4.2.1 Protective earth or functional ground

The electrical ground reference (protective earth) for ESD purposes utilizes the equipment grounding conductor which is a part of the electrical power system. Using protective earth as a ground reference for ESD control items ensures that the ESD control items and all powered electrical equipment are at the same potential. The following diagrams (Figures 4a, 4b and 4c) show the equipment grounding conductor as it is used in three different electrical power systems. When using this type of ground reference, the ESD control items used by an organization are connected to the equipment grounding conductor.

In situations where the organization does not wish to use the equipment grounding conductor or an equipment grounding conductor is not available, a functional ground can be used. The functional ground is a separate earth grounding electrode that is used as the ground reference for all the ESD control items used by the organization. It is recommended that, if possible, the functional ground system be bonded to the electrical ground system (when available) in order to eliminate differences in potential between the two grounding systems.

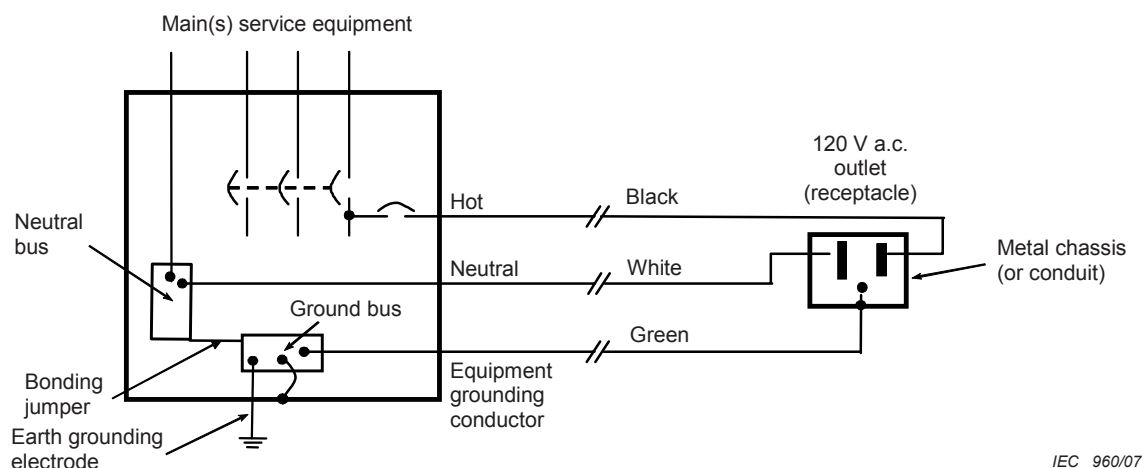


Figure 4a – North American electrical power system

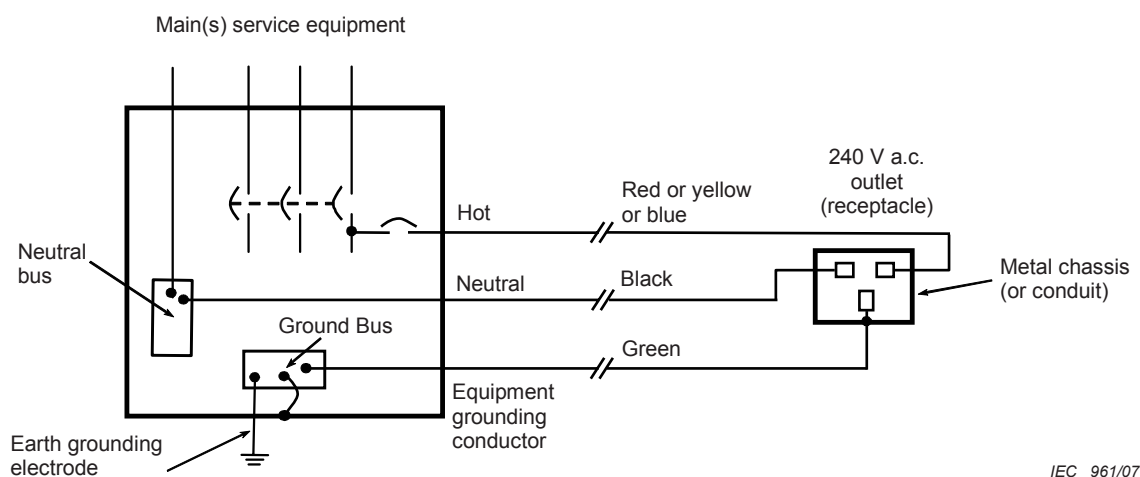


Figure 4b – Malaysia electrical power system

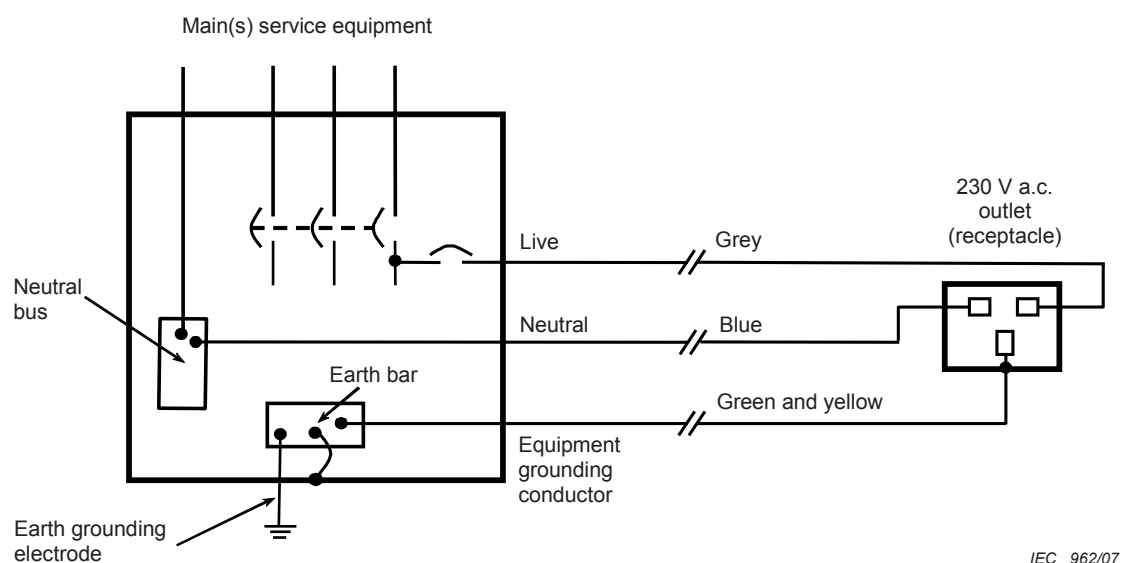


Figure 4c – UK electrical power system – Single phase system

Figure 4 – Country-specific electrical power systems

4.4.2.2 Common connection point (equipotential bonding)

Where a ground system is not available, an ESD control program can still be established by connecting all of the ESD control items and other large conductors together at a common connection point. The common connection point is not connected to ground, but the items attached to the common connection point will all be at the same potential, which minimizes the chance of the ESDS being damaged. The common connection point can be a single conductive point where the grounding wires of each of the ESD control items are attached or it can be a large conductive element such as the metal frame of a workstation.

A real life example of this is often observed in office equipment field service operations. For safety reasons, the service technician will often disconnect the AC power cord which detaches the equipment from ground. In order to install ESD sensitive boards or components into the equipment it is necessary to electrically connect or bond together the service technician, the equipment frame and the ESD sensitive product. Once bonded together, an ESD event will not occur between bonded items when the technician handles the product or installs it in the office equipment.

4.4.3 Additional grounding considerations

Aircraft, ships and surface vehicles typically have a ground bus or ground conductor that is suitable for use as an ESD ground. This scenario is similar to the equipotential bonding situation.

It is a good practice for each grounded work surface to be directly connected to ground. Figure 5 is an example of the recommended method. Many companies however connect work surfaces to ground in series as shown in Figure 6. Connecting the work surfaces together in series can lead to a situation where multiple work surfaces become detached from ground if the single grounding wire breaks and therefore this type of grounding method is not recommended.

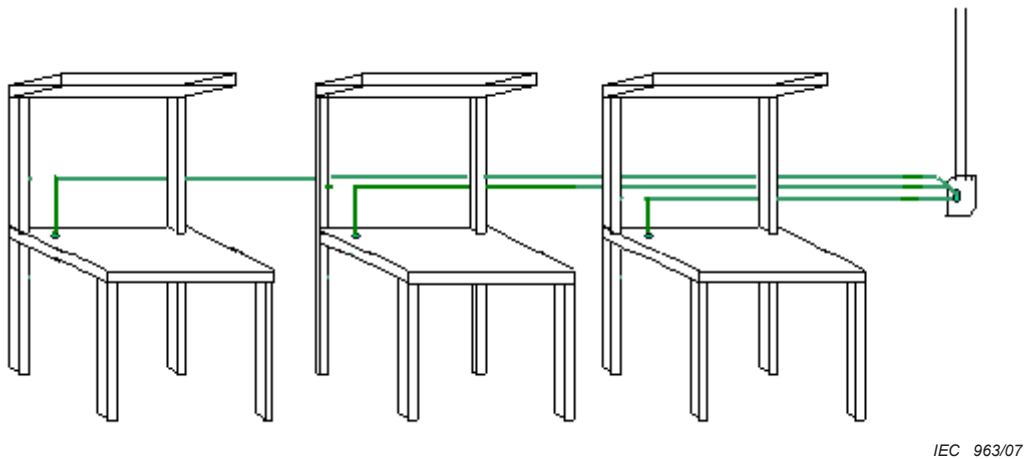


Figure 5 –Example of individually grounded benches – Recommended

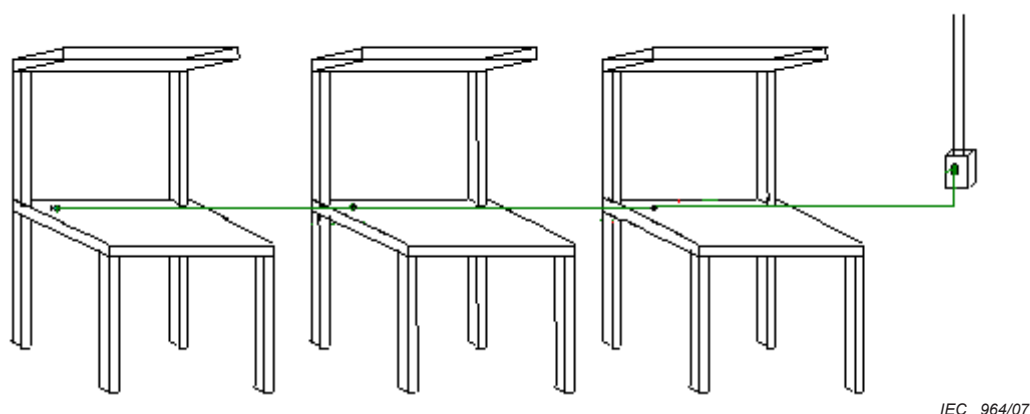


Figure 6 – Example of a series ground connection of benches – Not recommended

4.4.4 Verification of ESD grounding system

4.4.4.1 Protective earth

For ESD control programs that use the equipment grounding conductor to ground the ESD control items it is necessary to verify the integrity of the electrical system. The values used can vary depending on the electrical code requirements in each country. However, there are certain items that should be checked for any ESD control program that uses the equipment grounding conductor.

- The impedance of the equipment grounding conductor should meet national electrical code requirements.
- The electrical system is correctly wired to ensure that the ESD control items are attached to ground and not an energized portion of the electrical system.

4.4.4.2 Functional ground

When a functional ground is used it is necessary to verify that the ground rod system meets national electrical codes for such systems. Some of the items that might require testing include:

- soil resistivity;
- resistance to ground;
- resistance of the grounding electrode.

4.4.4.3 Equipotential bonding

Where an equipotential bonding system is used, it is important to verify that the common connection point is sufficiently conductive. The resistance of the common connection point between any two ESD control item connections should be less than 1 Ω when measured using a DC ohmmeter capable of measuring resistance from 0,1 Ω through 1×10^6 Ω with a minimum open circuit voltage of 1,5 V.

4.4.5 Verification of proper installation of ESD control items

Once the ESD ground reference has been verified it is important to ensure that each of the ESD control items used is connected to the ground reference. First ensure that each ESD control item is connected to the ground reference. Next, using the test method or standard and limits for each ESD control item given in Tables 2 and 3 of IEC 61340-5-1, verify that the resistance to ground (or to the common connection point) meets the required limit.

4.5 Personnel grounding

Personnel grounding is a critical technical element required in IEC 61340-5-1 and shall be addressed any time personnel are involved with the handling of unprotected ESD sensitive devices. There are two means by which this requirement can be met. The first is by use of a wrist strap system and the second is by use of a flooring/footwear system. The choice is dependent on several factors that include the physical actions and surroundings of the individual as well as the potential cost of each alternative. Both system techniques include the person, the control items (i.e. wrist strap, flooring, and footwear) and the connection to ground. Wrist strap, flooring and footwear types, uses, and other key information about each are described in 4.5.2 and 4.5.3.

4.5.1 System requirements

Electrostatic charge can accumulate on the body through movement. The charge results in an electrostatic potential or voltage between the body and ground. This can be damaging if discharged to ESDS. The procedures outlined in IEC 61340-5-1 are designed to protect devices sensitive to human body model voltages of 100 V or greater. To maintain a person's body voltage to less than 100 V, the body shall be electrically connected to ground or differences in potential shall be eliminated by bonding all of the ESD control elements together.

With a grounded system, there shall be some degree of assurance that the body voltage remains below 100 V when connected in series with a resistance to ground. This resistance is a key factor in limiting the voltage observed on the body. For a given body movement, the voltage achieved increases with resistance. Tests conducted by IEC technical committee 101 have shown that a resistance of $3, 5 \times 10^7 \Omega$ or less is necessary to limit body voltage to less than 100 V. Figure 7 shows the relationship between body voltage and resistance to ground.