FREQUENTIS

SAFETY GUIDELINES

00A46 E500.12

History Chart

Rev.	Date	Changed Page(s)	Cause of Change	Implemented
1.0	00-11-29	All sections	New Document	S. Meisel
1.1	01-07-20	All sections	Wording & Corrections	S. Meisel
1.2	04-02-01	D-1, 5, 6, 8, 9, 34, 35	UL- & EN-Requirements; VCS >> "system"	S. Meisel

No.	Action	Name	Signature	Date	Department
1	Prepared	S. Meisel		04-07-12	TCI
2	Approved	G. Herndl		04-07-16	SSG
3	Approved	H. Schiptl		04-07-13	TQC
4	Released	F. Kalwitz		04-07-16	TCI

The information in this document is subject to change without notice.

Confirmed by the CE-label, the system complies with following EC-directives and EC-standards:

- 73/23/EC “Low Voltage”
- 89/336/EEC “Electromagnetic Compatibility”
- 99/5/EC “R&TTE” (Annex 2 Class I Equipment)
- EN 60950-1 (01)
- EN 55022 (98)
- EN 55024 (98)

The system complies with Part 15 of the FCC Rules. Operation is subject to the following 2 conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

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1. Introduction

Only trained personnel authorised by the customer and/or FREQUENTIS may handle the system.
Always read this manual carefully before starting to install or service the system.
For easy access, keep the *Safety Guidelines* at hand on site.

1.1. Purpose

These *Safety Guidelines* explain the precautions and basic information required for correct handling of a system from the range of released products of FREQUENTIS (e.g. VCS 3020 Series, VCX, DICORA). For details of the actual configuration, please refer to the *System Configuration* document.
These *Safety Guidelines* are concerned with workplace and equipment safety not including the reliability of the system.

1.2. Target Group

The *Safety Guidelines* contain precautions to be taken by the trained installation and/or maintenance staff when servicing the system. They are intended for everyone involved in preparing for the infrastructure, installing the system and/or maintaining its components. Moreover, this manual is aimed at anyone who deals physically with the system.

The staff is expected to be aware of obvious hazards. Furthermore, they have to be appropriately trained for and experienced enough to recognise hazards in their daily work, and to minimise risks to themselves and others.

The staff must be trained and observe, among others, appropriate ESD-practices and procedures for handling the cabinets, boards and cabling. A FREQUENTIS training course covering the technical part (basics and maintenance) of the system is essential to achieve the correct handling of the system.

1.3. Requirements Concerning Warranty

Only trained personnel authorised by the customer and/or FREQUENTIS may prepare the site, install, put into operation and maintain the system.

All warnings and instructions contained in the applicable documents supplied must be observed. The meaning of the warning symbols used is described in chapter 1.4. Major warnings e.g. concerning risks of injuries or damage to the equipment are listed in chapter 1.6.

Violation or non-observance of the *Safety Guidelines* in this document cancels or restricts the warranty provided by FREQUENTIS. In particular, FREQUENTIS shall not be responsible for any resultant operational errors or any damages caused to persons, properties or whatsoever.

	**If the customer wishes to make major changes to the system (i.e. any system modification not described in the relevant revision of the *System Configuration* document, *Installation Manual* or *Maintenance Manual*), for instance, if the customer wants** ● **to move the system or parts of the core system to different locations,** ● **to extend, reduce or modify the system configuration,** ● **to connect third-party equipment to the system supply circuits,** ● **to change to power supplies not delivered by FREQUENTIS,** ● **to change the grounding concept,** **FREQUENTIS must be informed in writing giving sufficient advance notice. The customer then has to wait for written permission from FREQUENTIS before carrying out such changes.**[1)]

1.4. Description of the Warning Symbols

The *Safety Guidelines* and the other User Documentation contain warnings, recommendations and safety precautions as defined in ISO 3864-1984 (E).

	**Disallowed - Interdict - Prohibition!**
	**Risk of an electric shock.**
	**Risk of serious injury or of severe damage to equipment.**
	**Risk of severe damage to electrostatic sensitive devices.**
	**Mandatory for operation.**
	This symbol emphasises extra information.

[1)] Any change of the system configuration must be incorporated adequately in the accompanying system- and user-documentation without delay agreed with FREQUENTIS.

1.5. Definition of Terms and Synonyms

Handling Dealing with or manipulating the system or its components in a technical context.

Installation Initial set-up of the system hardware or parts of it, and operating system configuration.

Maintenance Any action for keeping the system in working order (acc. to the relevant maintenance level).

Service All actions taken to set-up or to keep the system in good operating condition, including monitoring of the technical infrastructure, maintenance and repair work.

Because of potential inconsistency in terminology, the following terms on the left can be considered as synonyms for the terms on the right:

A/G-Communication	~	Radio Communication
G/G-Communication	~	Telephone Communication
Operator Position (OP)	~	Controller Working Position (CWP)
Project Specification	~	*System Configuration Document*
Documentation, DOC, (output)	~	Recording, REC, (output)

1.6. Major Warnings

The following warnings and precautions have to be observed strictly:

	**Some of the devices (e.g. power supplies and panels) operate at lethal voltages.**
	**Do not work on live system parts. De-energise all power supplies first then follow the appropriate procedures.**
	**The equipment is to be installed in Restricted Access Areas only (dedicated equipment rooms, wall-mounting equipment cabinets, or the like) in accordance with National Electric Code, ANSI/NFPA 70 (110-16 to 18). It is suitable for mounting on concrete or other non-combustible surfaces only.**
	**Only persons who are properly trained and capable of handling electronic devices may service the system.** **Observe the ESD- and EMC-regulations (refer to section 3 and 5).**
	**Do not utilise non-released SW or HW additional to or instead of SW resp. HW of the system configuration released by FREQUENTIS.** **Do not apply wrong supply voltages.**

---------- END OF SECTION ----------

2. Safety Instructions

Above all, basic prerequisites must be considered concerning safety instructions, protection against electrostatic discharge, overvoltage caused by electrical transients or lightning, electromagnetic compatibility, infrastructure planning, site survey and area identification.

This section covers the safety-critical service phases: personal safety, fire hazards, electrical shocks, injuries, handling safety and equipment safety.

2.1. Safety-Critical Phases of Installation and Maintenance

Only a fully trained technical crew may service the system as the crewmembers may be exposed to potential hazards of various types while performing their duties. These hazards must be eliminated or reduced to ensure that the staff is at minimum risk.

All installation personnel shall be briefed on the potential hazards involved in installing the system. Awareness of these hazards shall be promoted by the site safety officer (person responsible for safety at the site), who shall be present during all **safety-critical phases of installation**:

1) Unloading of equipment on site
2) Transport of equipment to final location
3) Installation of heavy system parts
4) Initial power application to fully-installed system
5) Changing of boards

The service life cycle consists of the following phases:

1) (Trans)shipment to site
2) Unloading on-site
3) Transport to final location
4) Erection and mechanical assembly at the final location
5) Cabling at the final location
6) Initial equipment power-up
7) Test and integration of fully powered system
8) Adding, changing or removing components

Each of these phases contains some or all of the hazards identified in the following chapters. Detailed countermeasures are described for each type of hazard.

The staff have to be aware of the typical hazards already identified and the action required. The list is in no way conclusive and unforeseen hazards may occur at any time. Each crewmember is responsible for identifying further hazards and reporting them to the site safety officer.

2.2. Personal Safety

It is of utmost importance not to expose the personnel to unnecessary risks during their work. Where essential activities involve a safety risk of any kind, the site safety officer has to be informed. The site safety officer has to take measures to provide adequate precautions against the hazard, such as fire extinguishers or medical supervision. The following hazards are predictable:

- **Fire hazard** Chapter 2.2.1
- **Electrical shock** Chapter 2.2.2
- **Injuries** (e.g. tripping over cables or cuts from sharp objects) Chapter 2.2.3

2.2.1. Fire Hazard

Fire hazards can never be totally eliminated, but preventive measures should ensure that any damage or injury is avoided.

- In particular, the correct type of fire extinguisher always has to be available in the vicinity of current activities. The personnel shall be instructed by the person responsible for site safety on the correct use of an extinguisher in an emergency, the various types and their physical location.
- Burns and/or inhalation of fumes caused by fire must be reported immediately for treatment by the medical staff.
- Smoking in the facility during the service period is not permitted.

To reduce the risk of fire, use only No. 26 AWG (>0.4 mm ∅) or larger wires for telecommunication lines.

2.2.2. Electric Shock

Despite the care taken by skilled personnel at work, exposure to electric shock due to unpredictable events can, however, never be excluded. Line driving and ringing voltage are health hazards to the personnel. They therefore have to work with special care during and after the initial power-up, particularly at the backplanes of the core and interface racks.

Though the following safety precautions should prevent such potential hazards, the power may be turned on inadvertently by third parties or electrical power may already be available in other parts of the system.

- Each system component must be correctly connected to ground to minimise personnel exposure to shock hazards. This must be completed before power of any voltage is applied. The facility power engineer must ensure that all grounding points are properly connected to the central bonding rail (the building's earth).
- Service activities after connection of the system to the main facility power shall be co-ordinated by means of mobile communication between the crewmembers and the facility power engineer, who is responsible for ensuring that power application at a particular location does not affect other locations.

- Medical supervision should be provided, but first-aid counter-measurements will provide the most effective treatment for electrical shock victims. Artificial respiration is the prime recognised means of resuscitating an electrical shock victim. All crewmembers must be trained in this method.
- A victim must be separated from live power contacts before resuscitation measures are employed. If the source of power cannot be accessed or turned off, a dry, insulated object, such as a broom, must be used to minimise the risk that the person providing aid is not similarly exposed to the same hazard.
- Qualified medical attention must be sought in all cases of electrical shock exposure to ensure that no symptoms remain. The site safety officer must be immediately informed of an accident to notify the appropriate authorities.
- Provision must be made in the grounding system to protect the personnel from live circuitry due to carelessness or equipment failure. A survey must be performed of the available voltage sources that could be encountered at the equipment area to provide adequate protection from electrical hazards.

The equipment may have more than one power supply cord! To avoid electric shock, disconnect all power supplies before servicing the system.

2.2.2.1. Causes and Prevention of Electric Shock

Causes of Electric Shock	Prevention
Contact with parts normally at hazardous voltage.	Prevent access to parts at hazardous voltage by fixed or locked covers, interlocks, etc. Discharge capacitors at hazardous voltages.
Breakdown of insulation between parts normally at hazardous voltage and accessible conductive parts.	● Connect the accessible conductive parts to earth to limit the voltage to safe values and the circuit breaker will disconnect the parts having low impedance faults. ● Use double or reinforced insulation between accessible conductive parts and parts which are at hazardous voltages in normal use.
Breakdown of insulation between parts at hazardous voltages, applying it to accessible parts.	Segregate hazardous voltage circuits. Separate by earthed metal screens or reinforced insulation. Earth any circuits capable of carrying fault currents.
Breakdown of insulation guarding parts at hazardous voltage.	Insulation for parts at hazardous voltage accessible to the authorised representative must have adequate mechanical/electrical strength
Leakage current from parts at hazardous voltage to the casing. Failure of PE-connection.	Limit leakage current to body to a safe value, or provide high integrity protective earth connection.

Tab. 2-1: Causes and Prevention of Electric Shock

2.2.2.2. Inspection to Prevent Electric Shock

Check, that

1) Protective devices comply with the site-specific requirements in accordance with the (inter)national regulations.
   - Protective earthing (PE) and equipotential bonding conductors meet the required minimum cross-sections.
   - PE- and neutral(N)-conductors are marked suitably and unmistakably.
   - PE-conductors contain no switches, fuses or circuit breakers.
   - Protective contacts of all plug-and-socket connections work efficiently.
   - PE or neutral connection and disconnect points are identified.
2) Cross-sections of cords and cabling are appropriate to current consumption at maximum load.
3) Connections are made in accordance with to the regulations.
4) Disconnect devices are implemented and suitably placed.
5) Inspection of the appliances shows no obvious lapse from safety provisions.
   - All appliances meet the site specific environmental conditions and safety requirements.
   - All appliances are easily accessible for operation and maintenance.
   - Warning labels for multiple supplies and/or multiple disconnection are applied according to the respective appliances.
6) Personnel must be prevented from accessing
   - bare parts normally operating at ELV or hazardous voltages and
   - operational or basic insulation of such parts or wiring.
7) Generally, between an unearthed accessible conductive part and a primary circuit double or reinforced insulation must be applied.
8) Conductive handles or their shafts, which are manually moved and earthed only through a pivot or bearing must be separated from hazardous voltages
   - by creepage distances and clearances of double or reinforced insulation,
   - by supplementary insulation over accessible parts.
9) Insulation of internal wiring at hazardous voltages accessible to personnel must not be
   - subject to damage or stress,
   - needed to be handled in normal operation routines,
   - routed or fixed in such a way that unearthed metal parts are touchable.
10) Conductive parts of the equipment exposed to hazardous voltage in the event of a single insulation fault must be reliably connected to a PE-terminal resistant to significant corrosion.
11) Fire enclosures and fire prevention sheets are applied according to the regulations.
12) Documentation for installation and maintenance is available at site.

2.2.3. Injuries

Whenever installation or maintenance work is performed, there is a risk of injury due to mechanical parts. These injuries might be caused by moving parts, falling items, tripping over cables, tools, sharp edges or working in confined spaces.

- Incautious or accidental movements can result in cuts, bruises and abrasions. At all times crewmembers must be aware of their environment, the objects in their vicinity and the presence or proximity of their team colleagues.
- When someone is working in a confined space, such as inside a controller working position or under the raised false floor, a second person must be present to supervise the inaccessible person, to check regularly his/her physical condition and react quickly if there is any suspicion of injury.
- First-aid treatment of physical injuries shall be the prime defence against further deterioration of the victim's condition. A first-aid box shall be made available to the personnel on-site.
- Qualified medical attention must be sought in all cases of physical injury to ensure that there is no risk of contamination or infection of a wound. To this effect, the site safety officer shall be immediately informed of an accident and he will notify the appropriate authorities.

2.3. Handling Safety

Moving parts of the equipment must not lead to injury under normal conditions. In the case of parts accessible to personnel, constructive precautions have to provide that -

- **hazardous** parts cannot be mounted with any enclosure part removed,
- **enclosure** parts are secured to the assembly requiring a tool for removal,
- **interlocks** protect against access to the potential hazard.

A suitable warning label protects from an obvious hazard caused by the moving part. De-energising means have to carry warnings readily visible in a prominent position where the risk of injury is highest.

In particular hard hats, heavy-duty leather gloves and steel-capped safety boots shall be worn during all activities involving manhandling of corresponding equipment. The phases of installation/maintenance intended for manhandling activities are as described in chapter 2.1. No crewmember present in the zone of operation shall be permitted to perform his/her tasks without taking these precautionary measures:

- At all times during these phases, precautions shall be taken against human strain. Sufficient manpower shall be secured when off-loading heavy equipment, such as the racks, to ensure that no individual is overburdened.
- All individually transportable units must bear a label clearly indicating the weight of that item, in order to enable the crew to identify the manhandling resources necessary for that item. The crewmembers must always take notice of the weight indications attached to the transport items.
- No person must lift equipment that is heavier than 20 kg. Several persons may lift more than 20 kg, but their individual portion of the total load may not exceed this weight.

- Lifting gear must be employed in all cases where the total load exceeds 50 kg. Where lifting gear is used, the immediate vicinity must be cleared of all personnel except the authorised representative, to ensure that no hazards exist due to incorrect loading.
- If the item is to be lifted by the eyebolts mounted on top of the racks, care shall be taken to ensure that these are completely screwed in.
- Where pallets are used, the load shall be equally distributed over the available pallet area to reduce the risk of accidental shifting. No personnel, apart from the authorised representatives, are permitted to accompany the equipment being transported, such as riding on a forklift truck, crane or hoist.

2.4. Equipment Safety

2.4.1. Mechanical Requirements

Mechanical equipment safety hazards can be caused by:

- **Damage** to the equipment **during transport** causing unexpected behaviour.
- **Access** to internal components using **incorrect tools.**
- **Incorrect** mechanical **mating** of connectors.

These safety hazards can be mitigated by applying the following rules:

- The equipment must be adequately secured during shipment/transport using retaining lines and pallets if necessary. Smaller units must be packed to prevent denting or perforation of the unit itself.
- All units must be inspected for obvious damage on arrival at the facility. Those units with damaged packing shall be reported to the team leader, who will initiate any insurance claims and further inspection of the damaged item. At his discretion, the item may be released for installation or returned to the company for replacement.
- Access to internal system components for adjustment purposes must always be performed with the correct tools. For instance, a potentiometer may only be accessed through perforated covers with an insulated screwdriver.
- Connectors can easily be damaged during mechanical mating activities. In order to prevent this, both pin and socket (or both sides) connector halves must be manually inspected for damage before attempting the mate.
- If a connector, its pins or sockets are damaged in any way, no attempt must be made to connect the connector. This fact must be reported to the team leader, who will initiate repair actions.
- If no damage is visible, both connector halves must be gently brought together in such a way that the keying (if applicable) is lined-up. Mating is achieved by constant pressure to the connector shell evenly over the mating area until further movement is no longer possible and the connector can be secured.
- If a connector is applied to the wrong connection point, serious damage may occur to the equipment. For this reason, the cable label must match the destination point. However, insert the connector to its destination shell with care. If a mismatch is suspected, the mating operation must be stopped for further technical investigation.

2.4.2. Electrical Requirements

	The *Installation Manual* provides the required information to set-up the system for safe and reliable operation, including the power supply concept and the equipotential bonding and grounding concept.

2.4.2.1. Safety Requirements

Installation and construction of the power supply system must comply with the international standards and national regulations.

	**Installation of the building's power supply system must at least observe the requirements in IEC 60364 or equivalent national regulations (for instance, VDE 0100 in Germany, and ÖVE/ÖNORM E 8001 in Austria).**

Subject to the specific national regulations, the equipment must still be connected in accordance with (i.e. not contravening) IEC 60950, so that compliance with the standard is maintained.

- If a plug on a power supply cord is used for disconnection, the according socket with earthing contact must be located near the system and easily accessible. The supply plug, if used as the **disconnect device**, must connect the PE earlier than the supply connections and must break it later than the supply connections. **Device inlets** must meet the following conditions, compliant to IEC 60320:
  - Hazardous voltages are not accessible during handling with connectors.
  - Connectors can be inserted easily.
  - Sockets are not used for mechanical securing.
  - The PE-terminal for each appliance is connected to the PE-terminal inside the equipment.
- Power supply cords shall not be exposed to sharp points or cutting edges.The conductors have to be relieved from strain, including twisting. Compression bushings must not be used as **cord anchorage**. If the flexible cord should slip in its anchorage, causing the conductors to be strained, the protective earthing conductor, if any, must be the last to take the strain.
- Cords must not be clamped by screws; knots must not be applied. When an anchorage is made of conducting material, it must be supplementary insulated from accessible metal parts. The insulation of the conductors must be protected from abrasion.
- For equipment with a non-detachable power supply cord, which is intended to be moved while in operation, **cord guards** of insulating material must be applied at the power supply cord inlet opening, protecting against excessive bending for at least five times the cross-section of the whole cable.
- Screws and nuts, which clamp external power supply conductors, must comply with standards ISO 261 or 262 and the like, fixing not any other component. Terminal strands must not be able to contact unearthed conductive parts, even when these parts are separated by basic insulation from other accessible conductors.

- Where cord terminals are used for permanently connected equipment (non-detachable power supply cords), the cord cross sections must fit the respective clamps, otherwise, appropriate adapters must be applied (e.g. in the case of increased WCS for long distances). Terminals must clamp with sufficient contact pressure without damaging the conductor when tightened or loosened, but so that the conductor cannot slip out, the terminal itself does not work loose and the internal wiring is not subjected to stress (this aspect has to be taken into account especially at the operator positions).
- Power supply cords consist of -
  - a green/yellow PE-conductor electrically connected to the PE-terminal inside the equipment and connected to the PE-contact of the plug, if applicable, and
  - conductors with minimum **cross-sectional** areas compliant to the standards (see Tab. 9-4 and Tab. 9-5), corresponding to the maximum possible current consumption (for examples refer to Tab. 9-5 in the Appendix).

Protective Devices

- Protective devices against excess current, short circuits and earth faults in primary circuits, have to be included as integral parts of the equipment, or part of the building installation.
- Where more than one phase conductor of a supply is used, any protective device breaking the neutral conductor must break all phase conductors, too. Devices for different conductors of the same supply shall be located together.
- For commercial (single-phase) equipment connected to standard supply outlets, the building's installation is regarded as providing protection in accordance with the rating of the wall outlet.
- Fuses must be marked so that it is obvious to which circuit the fuse applies, including its type, rated current, and voltage. Special fusing characteristics must also be indicated.

In any case, AC or DC power supplies must be installed and maintained according to the respective national regulations.

2.4.2.2. Redundancy Requirements (if applicable)

The system is designed for highest redundancy and availability. Therefore, systems are typically installed with resilience against any single failure. This redundancy concept is fully supported by the power supply concept.

The system provides the connections to two separate supply lines provided by the site. If one power unit (or whole circuit) fails, alternate power units supply the system without any malfunction or loss of performance during the downtime of the failed supply.

Power distribution systems are usually structured radially and circuit breakers have to be added at any point where the wire cross section is reduced.

	**The resulting series connection of overcurrent circuit breakers shall be selective, which means that only the device next to the fault is triggered. In addition, unwanted triggering of the main ground fault interrupters must be avoided to ensure that other branches maintain energy flow.**

General Rules

- Several branches with overcurrent circuit breakers connected to one ground fault interrupter consider that a single defective unit can power down all systems connected.
- Series connections of ground fault interrupters or overcurrent circuit breakers operating on magnetic principles are not recommended because selectivity is not ensured except under special conditions.
- Use slow blow fuses or special circuit protectors for heavy loads as the main overcurrent protectors.
- Selectivity also depends on the characteristics of the (magnetic) circuit breakers or the pre-arcing I^2t of the fuses (Joule heat value), therefore always follow the manufacturers instructions.
- Preferably, use combined ground fault/overcurrent circuit breakers.

	**Set up the power distribution system with utmost care regarding availability. Especially, the redundant supplies A and B for the core component cabinets must not both fail due to a single fault, i.e.** ● **they must not be disconnected simultaneously.** ● **no other equipment must be connected to the system's supplies**

2.4.2.3. Protective Earthing

According to the safety standards, accessible conductive parts of the equipment, that might assume a hazardous voltage in the case of a single insulation fault, must be -

- reliably connected to a protective earthing terminal within the equipment, or
- at a fail-safe distance from these voltages by reinforced insulation.

The earthing conductors must be used on the power supply cords to protect the personnel against electrical hazards from the cabinet equipment. Each power supply must have its own grounding (protective earthing) in accordance with EN 60950 or IEC 60950 (and the respective national regulations, if required). The resistance of the **earthing** connection between the central earth connection point, and each part required to be earthed must not exceed 0.1 Ω (without the PE-resistance of the power supply cord).

	**Warning labels have to indicate to the personnel all the non-earthed parts that have to be checked for hazardous voltages before being touched. Vice versa, all parts of the system labelled with the earthing symbol must remain permanently connected to the grounding system (together with their subordinate components).**

---------- END OF SECTION ----------

3. Electrostatic Discharge (ESD)

3.1. Definition

Electrostatic sensitive devices are components and assemblies, which can be damaged, latently damaged or even destroyed by **E**lectro**s**tatic **D**ischarge (ESD).

ESD is the fast discharge of electrical energy created by static sources. A device sensitive to electrostatic discharge is affected by these high-energy surges, dependent upon its construction and materials. In assembly areas, where, unprotected electronic assemblies are attached to the electrostatic sensitive components, future system failures may be caused by ignoring the basic protective measures.

The damage due to ESD occurring during handling (e.g., see Tab. 9-2) or processing can be the same as from electrically powered processes. Affected components can fail to operate immediately or latently to operate or change in value. The consequences of latent failure are the most serious, because the product may fail after delivery although it passed the inspection.

Common materials such as plastic bags or containers are serious static generators. Do not use these materials (e.g., see Tab. 9-1) in especially static safe operating areas. Peeling an adhesive tape from a roll can generate 20 kV. Even compressed air over insulating surfaces generates charges.

Static charges can be induced on nearby conductors (like human skin), and discharged into other conductors (like boards). Electrostatic discharges are normally too low to be felt (less than 3.5 kV), but still able to damage sensitive components.

When working with boards, observe the following precautions for handling devices sensitive to electrostatic discharge (ESDS-components).

1) **ESD sensitive devices are labelled with the symbol, shown left.**
2) **Special training is required for working with ESD sensitive devices.**
3) **Do not touch boards without taking ESD-precautions.**
4) **Transport and packaging must also provide full ESD-protection.**
5) **Improper handling cancels warranty and liability on the part of FREQUENTIS.**

3.2. ESD-Protection of Sensitive Assembly Parts

When built-in, each part of the system resists electrostatic discharge (no damage, no malfunction, and no loss of performance). Sensitive spare parts (e.g. interface or microprocessor boards) will be delivered in conducting packing material that prevents damage caused by electrostatic discharge.

All electronic assemblies of systems from FREQUENTIS are tested in accordance with EN 61000-4-2 with 4 kV contact discharge. Parts, which are touched by personnel (e.g. touch panels) are additionally tested with 8 kV air discharge.

3.3. Handling of Devices Sensitive to Electrostatic Discharge

Before handling or processing electrostatic discharge sensitive (ESDS) components, tools and equipment need to be tested carefully to ensure that they do not generate damaging energy, including spike voltages. As required by most ESD-specifications, periodic testing is recommended as a precaution because equipment performance may degrade with use over time. The best ESD-damage prevention is

- first to prevent, and
- then eliminate static charges if they do occur.

The amount of electrostatic energy generated depends on the characteristics of the source, and many factors such as material, relative motion by contacting, separation, or rubbing of the material, humidity etc...

3.3.1. General Rules for Handling Electronic Assemblies

1) Personnel must be trained in and follow the appropriate ESD-practices.
2) Minimise the handling of electronic components to prevent damage.
3) Keep workplaces clean. Avoid any food; do not smoke in the equipment area.
4) In general, handle electronic assemblies with clean hands or gloves (not common plastics). Touch the board only at the edges and with full ESD-protection. Do not use hand creams or lotions containing silicone since they can cause solderability problems and conformal coating adhesion problems. When gloves are used, they need to be changed frequently.
5) Solderable surfaces are not to be handled with bare fingers. Lotions reduce solderability, promote corrosion and dendritic growth. They can also cause poor adhesion of subsequent coatings or encapsulates.
6) Never stack electronic assemblies because physical damage may occur. For temporary storage, special racks need to be provided in assembly areas.
7) Do not take ESDS-components close to display screens.
8) Always assume the items are ESDS-components even if they are not marked.
9) Never transport ESDS-components unless proper packaging is applied.

If there is any doubt about the sensitivity of an assembly, it must be handled as a sensitive device until it is determined otherwise.

3.4. ESD-protection at the Equipment Area

ESDS-components must only be handled on condition that the floor conductivity is sufficient (acc. to IEC 61340-4-1) when

1) a grounding strip is worn around the wrist
2) and/or ESD-shoes (which have to be checked before handling) are worn,

or when

3) the component/assembly is located on an ESD-protected workplace.
4) In addition, wearing a cotton coat it is recommendable.

EN 100015-1 specifies: The leakage resistance of respective parts must be in the range between 1 MΩ and 35 MΩ, otherwise suitable action must be taken (e.g. ESD-shoes, ESD-carpet).

For correct handling of ESDS-components, FREQUENTIS cabinets have a dedicated grounding point (for the path-to-ground). These earth bonding points are usually located at the front of the cabinet frame as shown in Fig. 3-2.

Fig. 3-1: Layout of Markings for Earth Bonding Points (Examples)

Fig. 3-2: Earth Bonding Point at the Front of a Cabinet (Example)

When removing boards from the system, first connect the wrist cable to the grounding point as shown in Fig. 3-3. If no dedicated grounding point is available, for instance, if a component is to be handled outside the cabinet(s), ESD-shoes must be worn in all cases (proper floor conductivity must be provided).

Moving Electronic Assemblies

Handling assemblies with bare fingers contaminates the board/component and causes soldering and coating problems. Fingerprints are hard to remove and will often show up after exposure to humidity. Body oils and acids reduce solderability, promote corrosion and dendritic growth, causing poor adhesion of subsequent coatings or encapsulants. The best solution is to use gloves or other protective handling devices to prevent such contamination.

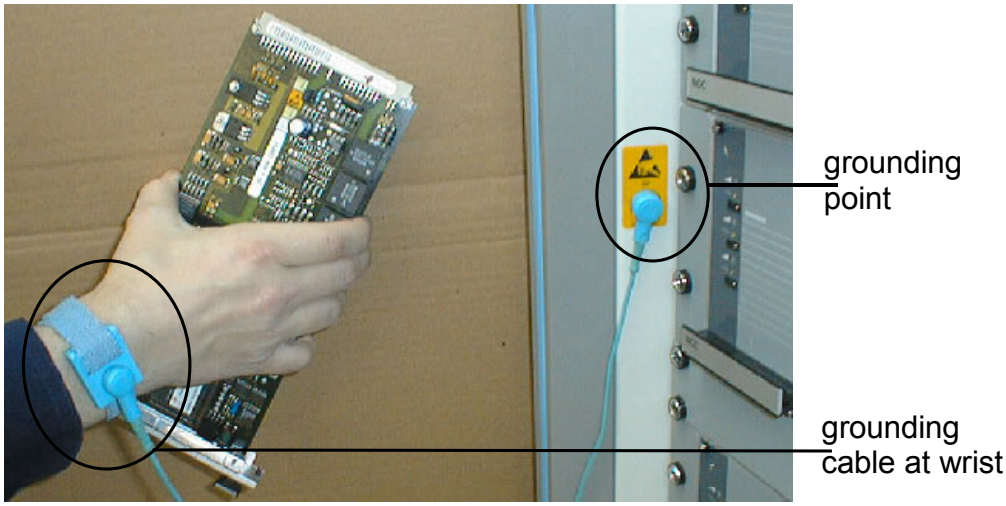


Fig. 3-3: Wrist Cable Connected to Grounding Point

3.5. ESD-Protected Workplace

Soldering irons, solder extractors and testing instruments can emit sufficient energy to destroy ESDS-components or seriously degrade them. An ESD-protected workplace is capable of preventing ESD-damage to ESDS-components by providing –

- a line to earth for neutralising and draining off surges,
- static dissipative or antistatic working plates connected to a common ground,
- a wrist strap to drain off charges generated on the operator's skin or clothing.

Provisions in the grounding system commonly succeed (through resistance in line with the ground path) in slowing down the charge decay time preventing sparks or surges of energy from static charged sources. Values for maximum allowable resistance and discharge times are given in Tab. 9-3).

Ensure personnel safety.
Consider an adequate decay or discharge time for ESD-potentials.
Keep any workplace free of static generating materials, especially untested domestic appliances (see Tab. 9-1).

1) Periodically check ESD-protected workplaces to make sure they work.
2) Periodically check and maintain tools and equipment to avoid EOS/ESD-hazards for assemblies or personnel caused by improper grounding methods or oxide on grounding connectors.

In the case of DC-circuits, a floating neutral can have a potential of 80 to 100 V instead of workbench or earth potential, and can damage ESDS-components or even put someone's life at risk.

3) Therefore, use earth-fault protected electrical outlets at ESD-protected workplaces.

3.6. ESD-Protection during Shipping and Storage

Devices, which are sensitive to electrostatic discharge (boards, sub-boards, position electronics etc.) must be covered for transport or storage by conducting protective sheathing (ESD-boxes).

When leaving devices on an ESD-protected workplace, they must be packed with static shielding (e.g. shielded bags with ESD protection marking).

Exceptions from this regulation are products housed within closed conducting cases, mechanical parts and cables.

1) Use enclosures with full ESD-protection when moving ESDS-components.

ESDS-components must always be protected from static sources when they are not at ESD-protected workplaces. This protection can be conductive static shielding boxes, bags or wraps. ESDS-components may only be pulled out of their protective enclosures at ESD-protected workplaces.

3.6.1. Packaging of Electronic Assemblies

There are three different types of protective enclosure material:

- static shielding (or barrier packaging)
- antistatic materials
- static dissipative materials

Static shielding packaging prevents an electrostatic discharge from passing through the package and into the assembly causing damage.

Antistatic packaging materials are used to provide inexpensive cushioning and intermediate packaging for ESDS-components. Antistatic materials do not generate charges when motion is applied. However, if an electrostatic discharge occurs, it could pass through the packaging and into the component or assembly, causing ESD-damage.

Static dissipative materials provide sufficient conductivity to dissipate applied charges over the surface avoiding energy spots.

2) For transport or storage, any device sensitive to electrostatic discharge (boards, sub-boards, position electronics etc.) must be covered by conducting protective sheathing (ESD-boxes).

3) Parts leaving an ESD-protected workplace must be packed static shielded. Complete the protection with static dissipative and antistatic materials inside.

3.7. ESD-Regulations for Visitors

Visitors to ESD-protected areas shall be provided with cotton coats. They have to be informed about the ESD-regulations and must follow all the procedures mentioned above.

---------- END OF SECTION ----------

4. Overvoltage Caused by Electrical Transients / Lightning

International standards for voice communication systems were applied during the development of FREQUENTIS systems. Third-party components (e.g. monitors) have to meet the respective industrial standards. To protect the system against malfunction and destruction caused by indirect stroke, a combination of both voltage and current limiting devices is implemented. FREQUENTIS offers operational reliability for the following environmental operating conditions. There are always two steps in protection:

- **Coarse protection:** All telecommunication cables leaving the building have to be supplied with arresters, usually gas-filled protectors, against transient overvoltages. Rating and design must meet the local requirements, and must be state-of-the-art.

Coarse protection is not included in the scope of the delivery and has to be provided by the customer for each site. The overvoltage arresters have to support a rated spark-over voltage of at least 150 V (up to 230 V).

- **Fine protection:** All FREQUENTIS system interfaces are equipped with both voltage and current limiters connected on the load side of the coarse protection, to minimise the residual energy of an indirect stroke, so that the subsequent connected electronics are not damaged.

Using specially designed power supplies, the FREQUENTIS equipment is able to resist surge pulses according to ITU-T recommendation K.21 (EN 61000-4-5).

Overvoltage protectors in interfaces correspond to ITU-T recommendation G.703.

Lightning protective measures have to be adjusted to the earthing concept in compliance with national regulations.

---------- END OF SECTION ----------

5. Electromagnetic Compatibility (EMC)

Electromagnetic Compatibility (**EMC**) is the satisfactory working of an apparatus, an installation or a system in an electromagnetic environment without causing electromagnetic disturbances, which are unacceptable for other devices in this environment.

Electromagnetic Immunity (EMI) from disturbance is the capability of equipment to continue operating normally when an electromagnetic disturbance occurs.

5.1. Generic Electromagnetic Compatibility Requirements

The FREQUENTIS system equipment is produced in accordance with the regulations of the European community, i.e. the system do not generate an environment that is dangerous to the personnel.

For EMC, the EC Directive 89/336 *Electromagnetic Compatibility* amended by EEC Directive 92/31 and EEC-Directive 93/68, and Part 15 of the FCC Rules, apply. All the equipment therefore meets the European standards EN 55022 (Radio disturbance characteristics measurement) as well as EN 55024 (*Immunity characteristics measurement)*.

5.2. Specific Electromagnetic Compatibility Requirements

Compliance with EMC-limits no longer applies when –

- any door or enclosure part of an EMC-cabinet is opened,
- components not supplied by FREQUENTIS are installed in an EMC-cabinet supplied by FREQUENTIS (e.g. supplementary installations to increase/filter the airflow),
- racks and interfaces are not installed in an EMC-cabinet (e.g. non-protected cabinet or stand-alone, i.e. non-FREQUENTIS cabinets).

Any modification of a FREQUENTIS-released system configuration cancels EMC and EMI assured by FREQUENTIS.

Only cabinets supplied by FREQUENTIS may be used for the FREQUENTIS core and interface equipment.

The cabinet doors must be closed to ensure EMC and EMI in the system.

When opening a cabinet or rack (e.g. for service purposes), first check the operational state of adjacent equipment for potential risks due to electromagnetic interferences.

5.2.1. Electromagnetic Fields Emitted by Visual Display Units

The only visual display unit (VDU), which might be equipped with a Cathode Ray Tube (CRT) is/are the monitor(s) of the TMCS.

	**The TMCS-monitors are commercial off-the-shelf units, which meet the requirements listed above (e.g. TCO 99) and the specific national standards.**

The other VDUs are equipped with non-CRT devices (flat screen displays, e.g. colour active matrix LCD-modules incorporating amorphous silicon TFT [Thin Film Transistor], TFD [Thin Film Diodes] or passive LCD [Liquid Crystal Display], all with backlights and resistive touch surface). These VDUs do not therefore emit substantial electromagnetic fields.

5.2.2. Check of Aerials and Receivers Adjacent to the Equipment

Type and characteristics of aerials / receivers adjacent to the system, their sensitivity and the applied frequencies have to be identified. Check the potential risks due to disturbance of these third-party appliances.

	**To avoid potential interference problems do not install receiving or emitting aerials and highly sensitive receivers within a certain distance of the system's equipment, in particular closer than 50 m to the position electronics and interface cabling.**

---------- END OF SECTION ----------

6. Equipment Labelling

Equipment labelling of the delivered system is essential for identifying the system state.

The hardware can be traced back down to component level by means of serial numbers while the software/firmware can be traced back down to module level by means of the label and version number.

	**If any equipment labels get damaged during operation, the customer is responsible for replacing them with intact ones in the same positions.** **To comply with the relevant standards (specific colours, materials or font sizes), use original labels in all cases.**

Safety instructions and the respective equipment marking must be durable and legible, and in the customary language. Marking in English is acceptable for equipment accessible to maintenance only. Labels must not be placed on removable parts so that the marking is not ambiguous when the part is removed.

Generally, the equipment must be marked with the power rating for selecting the correct voltage, frequency and current-carrying capacity. If the device can be operated at several voltage ranges, the switch conditions must be described.

Labels not visible from outside the equipment must be directly visible when a door or enclosure is opened, attached to the equipment to clearly indicate the location of the marking. Devices not to be connected directly to the main supply need not be marked with their rated current.

6.1. Adhesive FREQUENTIS Equipment Labels

Quality control labels are applied to the specific FREQUENTIS-components. Checked samples are signed manually.

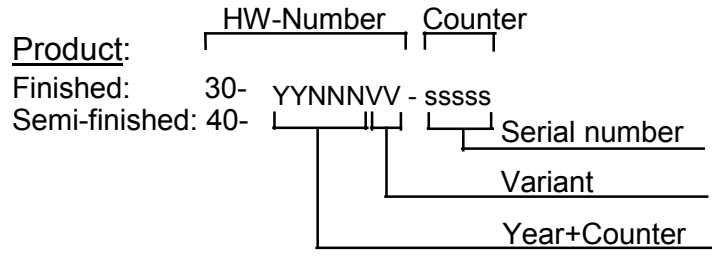
Serial Numbers	
	The ESD-sensitivity symbol is used to indicate that an electrical or electronic device or assembly is susceptible to damage from an ESD-event. Each ESDS-component (board, PCB, module,…) is marked with this label.[2]

Fig. 6-1: ESD-Label and Structure of Serial Numbers

[2] The ESD-symbol may also be integrated in the marking of the earth bonding points (see Fig. 3-1).

The serial numbers of racks and boards are labelled on the components in plain text and as a barcode (code 128) (see Fig. 6-2). The serial numbers of power supplies are printed on the rear of the components.

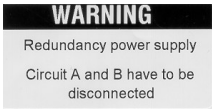
Fig. 6-2: Serial Number Label of a Board

6.1.1. Labels Indicating Product Categories

Label	Component / Description of Labelling
PIP 02.00 30-960600 198 REV:02 QC Test	**Sub-boards**: The drawing number of the PCB-layout is used for identifying of small PCBs (no label). Minimum identification if an appropriate label fits on the sub-board: Serial number, revision and bar code (128 Bit). For larger sub-prints, the product name and the FREQUENTIS Logo are usually added.
40-9705101-889 TEST REV.: 02 QC 4CPPC 02.00	**Boards**: Label with serial number
FREQUENTIS Produktnummer: 1998002130 Bezeichnung: POS 3025 00	**Boards and modules**: Label with product number
Module FREQUENTIS 30-9204503-006 SPM20.21 Test Rev.:01 QC	For both, serial and product numbers, the last two digits of the product number identifying the product revision, have to be filled into the first box after "Rev.". If the revision is increased (e.g. change of software/firmware), the new revision number is entered in the next box.
Rack FREQUENTIS 30-9515502-006 BGT DATA 02 Rev.:00 QC	
Cabinets	If there is no specific definition in the *System Configuration* on customer request, the board's identification system is applied.
Firmware FREQUENTIS WIEN T0 V 1.2 H '1CE03B'	Name, version, checksum on EPROM and/or EPLD
Cables 1.007 CAB1/21/X29 CAB1/18/X103 108-K-15 (1)	Label with type and length of cable. In the case of outsourcing included in the order (see chapter 6.2).

Tab. 6-1: Labels Indicating Product Categories

6.1.2. Labels Indicating Standards

Label (Example)	**Description**
PE (Protective Earth) ⏚	**Main earth connection** point of the FREQUENTIS-cabinets. This symbol is reserved for the protective earth only.
Earth connection point ⏚	Earth terminal of each C-Box and each *PowerPanel*. All other sub-ordinate FREQUENTIS earth connection points remain unmarked.
FREQUENTIS VCS 3025 230 V ~ 50 Hz Nominal current: 3 A	The **power rating** marking as well as the disconnection warning must be applied near the connecting supply terminal. 
HIGH LEAKAGE CURRENT Earthing is essential before connecting supply	**Leakage Current** exceeding 3.5 mA must carry a warning label like this (acc. to IEC 60364-7-707).
230 V ~ 50 Hz Maximum Load 500 W	Power supply outlet sockets accessible to the operator must be marked with the maximum connectable load.
Plugs & Switches OFF ○ Stand-by ⏻ ON | Push/push ⏼	IEC 60417, 5007…10-a require adjacent marking of switches clearly indicating their function, using the following symbols: **O** and **|** may be used as OFF and ON markings on any primary power switches, including isolating switches. If figures are used to indicate different status, OFF is indicated by **0** (zero). **'+'** and **'–'** are used to indicate in/decreasing adjustment values.
	The symbol for separate collection of electric and electronical devices marks components, which require special disposal according to Directive 2002/96/EC.
CE-Labelling (LVD-, EMC- and R&TTE-Compliance)	For all systems delivered in Europe, the **CE-conformity** must be marked by the CE-label representing the DOC issued by FREQUENTIS. The label is applied nearby the connecting supply terminal on the resp. cabinet.
PSTN-Label (if applicable)	System approval numbers (outside EC) specific to national standards are placed on the cabinet(s) or on one of the racks. If only parts of the system are approved, relevant interface approval numbers are placed on each board, if applicable.
 	**FCC-Label** (USA): The equipment complies with Part 68 of the FCC (US Federal Communications Commission) rules. A label is located on the rear of the unit containing the FCC registration number and/or the Ringer Equivalence Number (REN)[3]. For instance, the following information is provided to the local telephone company on request:

Loopstart	Leased line	DSU
FIC 02LS2 (BCB)	FIC Metallic (ERIF)	FIC 04DU5-64 (NI64)
JT RJ11C	SOC 7.0Y	SOC 6.0N
REN 1.1B AC, 0.3 DC	JT RJ48S	JT RJ48S

Tab. 6-2: Labels Indicating Standards

[3] The REN determines the quantity of devices, which may be connected to the telephone line. Excessive RENs on the telephone line may result in the devices not ringing in response to an incoming call. In most, but not all areas, the sum of RENs should not exceed five (5.0). To be certain of the number of devices that may be connected to a line, as determined by the total RENs, contact the local PSTN.

6.2. Cable Identification

6.2.1. Cable Identifier Tags

All cables (except earthing wires, peripheral TMCS-cables and those to footswitches) are labelled at both ends close to the connectors with identifier tags containing the following information:

1st line Particular project specific cable number (column 10 in the *Cabling List*)

2nd line Destination of cable at connector 1 (columns *FROM* in the *Cabling List*) (Cabinet Number / Cabinet Level / Connector name on target component)

3rd line Origin of cable at connector 2 (columns *TO* in the *List of Cables*)

4th line Type of cable with the length in the unit [dm = 10 cm]. The connector number as used in the *System Configuration* is given in parentheses.

1.007 CAB1/21/X291 CAB1/18/X103 108-K-15 (1)	1.007 CAB1/18/X103 CAB1/21/X291 108-K-15 (2)

Fig. 6-3: Example of the Two Cable Identifiers for One Cable

Ensure that the correct cable end is attached to the corresponding connector. Wrong connection can lead to a fault or damage of the connected equipment.

6.2.2. Cable Types

Cables of the same physical configuration are identified by a unique term:

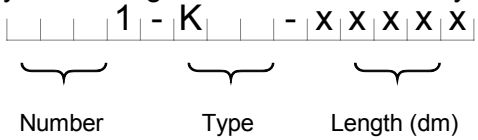


Fig. 6-4: Complete Cable Designation

- **Number** each cable type different in the used components (parts list), connector plan or wiring list is numbered consecutively.
- **Type** reflects the safety category:
  - K Cable with standard PVC-Insulation
  - S Special cable (e.g. variant of a standard cable for special use)
  - LSF Low inflammable, halide-free insulation (Low Smoke and Fume)
  - HLF Halide-free insulation
- **Length** is the length of the particular cable in [dm].

The *Connector Plan*, *Wiring List* and *Parts List* form part of the standard FREQUENTIS *Hardware Documentation*, which is available on request. All information necessary for proper connection of the pre-assembled cabling supplied is covered by the *System Configuration Document*.

The identifier tags must be applied so that they can be read easily as shown in Fig. 6-5 (reading direction towards the viewer, app. four cm from the connector).

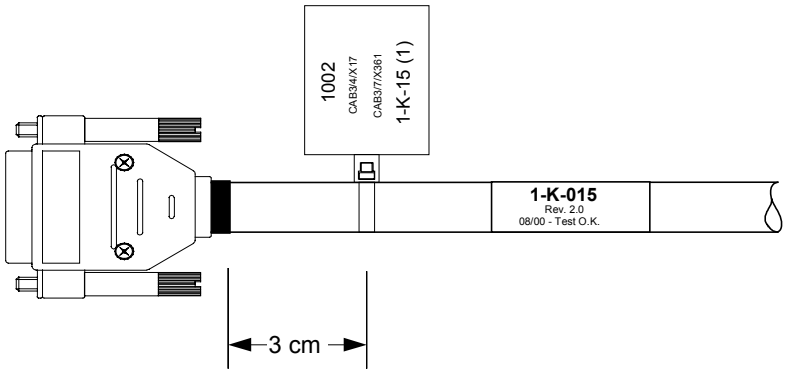


Fig. 6-5: Position of a Cable Identifier Tag

6.2.2.1. Connector Plan

The pinning of a 9-pin Min-D socket to a quadruple paired cable is shown as an example (A and B are not exchangeable):

1	1	A	6	1	B
2	2	A	7	2	B
3	3	A	8	3	B
4	4	A	9	4	B
5					

6.2.2.2. Wiring List

The *Wiring List,* part of the FREQUENTIS *Hardware Documentation,* describes the circuit interconnection wiring for all connectors on the respective cable according to the *Connector Plan*, including the wire cross sections in mm^2.

No.	*Cross Section*	*From*	*Pin*	*To*	*Pin*	*Comment*
1	twisted pair 0.14	ST1	1, 6	ST2	1, 6	

Additional cable layer plans can be provided for cables that split up into several connectors at one side.

6.2.3. Labelling with Printed Sheathing

This non-abrasive labelling is applied along the cable coating. It is acid- and grease-proof, and includes all information mentioned above.

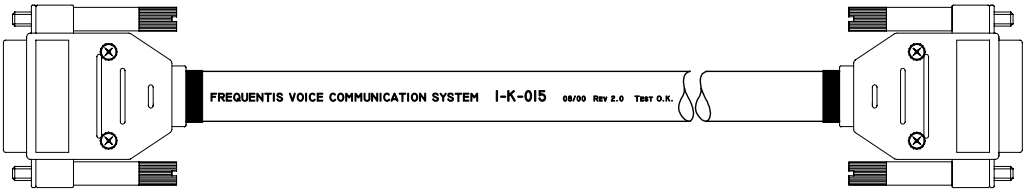


Fig. 6-6: Cable Sheath Printing

---------- END OF SECTION ----------

7. Handling of Equipment

Boards of the same type can be replaced only if they have the same jumper settings (see *Maintenance Manual)* and the same firmware (see *System Configuration* document*)*.

When working with boards, remember the following precautions for handling components sensitive to electrostatic discharge:

1) **ESD sensitive devices are labelled with the symbol shown left.**
2) **Special training is required for working with ESD sensitive devices.**
3) **Do not touch boards without taking ESD-precautions.**
4) **Transport and packaging must also provide full ESD-protection.**
5) **Improper handling cancels warranty and liability on the part of FREQUENTIS.**

For detailed information, please refer to Section 3

7.1. Required Tools

Check the availability of the required tools (no special tools or test equipment are required to set up the system, except for safety and test purposes):

Standard Tools	(all tools insulated complying with ESD-requirements)
Operational Maintenance	Screwdrivers of several sizes Philips screwdrivers of several sizes Wrenches of several sizes
Intermediate Maintenance	Various (diagonal cutting) pliers Soldering iron Solder extraction tool Soldering tin
ESD Field Service Kit (recommended) 1 ESD-blanket with 1 spiral-shaped cable and 1 wrist strap with cable clip 1 connecting cable to the protective contact of a 2-pole and earth-socket outlet 1 connecting cable with crocodile clip	

Fig. 7-1: ESD Field Service Kit

---------- END OF SECTION ----------

8. Abbreviations

AC	Alternating Current
acc.	according
approx.	approximately
AWG	American Wire Gauge
BCB	Battery Central Type B; analog 2-wire interface connecting to telephone line
CAB	Cabinet
CE	Conformité Européene; European conformity
CRT	Cathode Ray Tube
CSA	Canadian Standardization Association
CWP	Controller Working Position
D/A	Digital to Analog
DC	Direct Current; Data Coupler
DICORA	Dispatcher Communication Railway
DOC	Output for recording (summarised context for the use of recording outputs); Declaration of Conformity
DSU	Data/Digital Service/Signalling Unit
e.g.	exempli gratia; for instance
EBP	Earth Bonding Point
EC	European Community
EEC	European Economic Community
ELV	Extra Low Voltage
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Immunity; Electromagnetic Interference
EN	European Norm
EOS	Electrical Overstress
EPLD	Electrically (EPROM based) Programmable Logic Device
EPROM	Erasable Programmable Read Only Memory
ERIF	Extended Radio Interface (analog 4-wire interface)
ESD	Electrostatic Discharge; Electrostatic Damage
ESDS	Electrostatic Discharge Sensitive (components)
FCC	Federal Communications Commission (US)
FIC	Facility Interface Code
FRQ	FREQUENTIS
G/G	Ground to Ground communication
HLF	Halide-Free Insulation
HW	Hardware
IEC	International Electrotechnical Commission

IF	Interface
ISDN	Integrated Services Digital Network
ISO	International Standardisation Organisation
ITU-T	International Telecommunications Union - Telecommunications Sector
JT	Jack Type
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LSF	Low Smoke and Fume (low inflammable, halide-free insulation)
LVD	Low Voltage Directive
NI64	Network Interface, 64 kBit/s
NFPA	National Fire Protection Association
ÖNORM	Österreichische Norm; Austrian standard
OP	Operator Position
ÖVE	Österr. Verband für Elektrotechnik; Austrian electrical engineering association
PCB	Printed Circuit Board
PE	Protective Earth
PS	Power Supply
PSTN	Public Switched Telephone Network
R&TTE	Radio and Telecommunications Terminal Equipment
REC	Recording (output)
REN	Ringer Equivalent Number (US)
resp.	respectively
Rev.	Revision
SI	Système International; international system for measurement units
SOC	Service Ordering Code
STxx	Stecker xx; Connector XX
SW	Software
TCO	Tjänstemännens Central Org. (Swedish Confederation of Professional Employees)
TFD	Thin Film Diodes
TFT	Thin Film Transistors
TMCS	Technical Monitoring and Control System
VCS	Voice Communication System
VCX	Voice Communication Exchange
VDE	Verband Deutscher Elektrotechniker; German Association of Electrotechnicians
VDU	Visual Display Unit
WCS	Wire Cross Section

---------- END OF SECTION ----------

9. Appendix

The contents of this section are for information only.

9.1. References to Standards

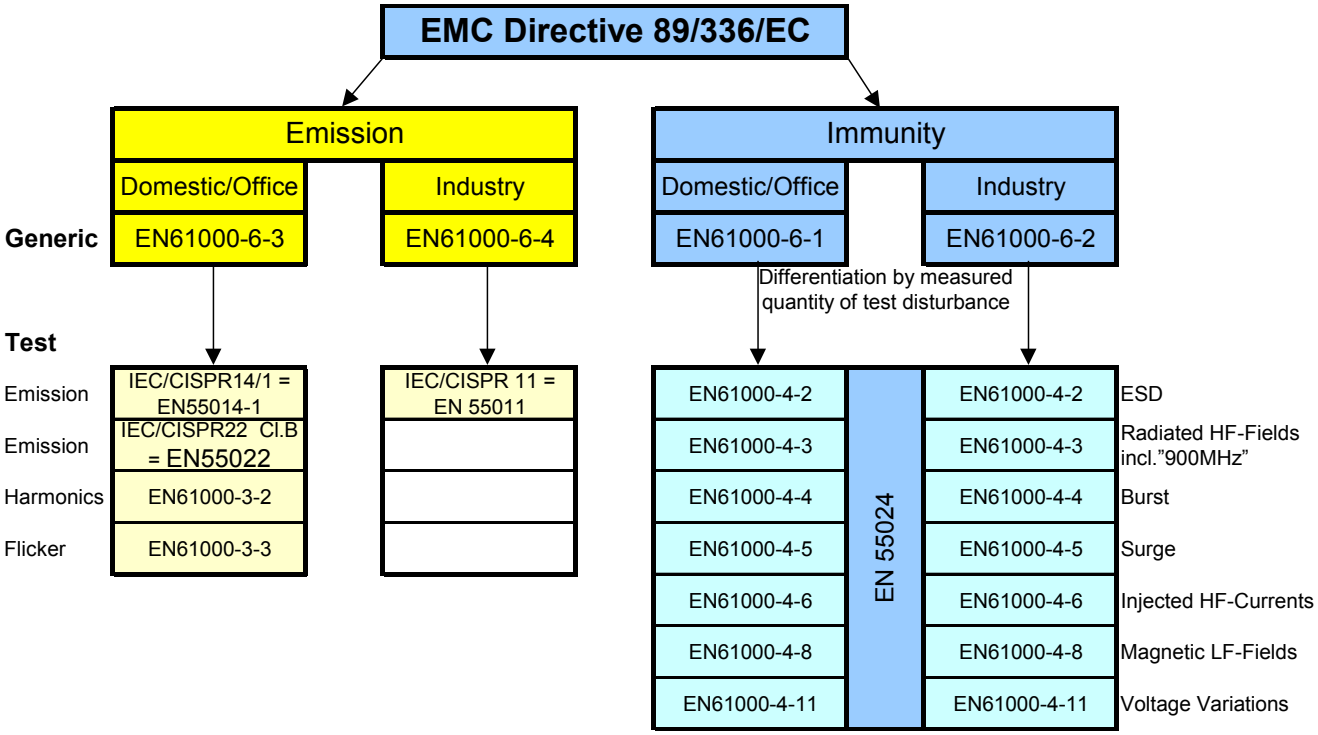


Fig. 9-1: Structure of EN Standards (Example)

Connection between the respective International (IEC), European (EN) and German (VDE) regulations (if applicable):

IEC 1000-4-x = EN 61000-4-x = VDE 0847-x

Directive 73/23/EEC	on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.	19 February 1973
	amended by Directive 93/68/EEC	22 July 1993
Directive 89/336/EEC	on the approximation of the laws of the Member States relating to electromagnetic compatibility.	3 May 1989
	amended by Directive 92/31/EEC	26 April 1992
	and by Directive 93/68/EEC	22 July 1993
Directive 99/5/EC	on Radio equipment and telecommunications terminal equipment (R&TTE) and the mutual recognition of their conformity.	9 March 1999
ANSI/NFPA 70	National Electric Code, 110-16 to 18;	1999
CAN/CSA C22.2 No.950-95	Safety of information technology equipment	1995
EN 55022	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement.	1998.

EN 55024	Information technology equipment - Immunity characteristics - Limits and methods of measurement 1998
EN 60950	Safety of information technology equipment including electrical business equipment. 1999
EN 61000-4-2	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test. 1995
EN 100015-1	Harmonised system of quality assessment for electronic components. Basic specification: Protection of electrostatic sensitive devices. General requirements. 6/93
IEC 60320	Appliance couplers for household and similar general purposes - Part 1: General requirements 6/94 Part 2-2: Interconnection couplers for household and similar equipment 8/98
IEC 60364-5	Electrical installation of buildings – Selection and erection of electrical equipment 02/82 – 08/01
IEC 60364-7	Electrical installations of buildings. Part 7: Requirements for special installations or locations. 12/84 – 02/01
IEC 60417	Graphical symbols for use on equipment. 8/98 – 10/00
IEC 61340-4-1	Electrostatics – Part 4: Standard test methods for specific applications – Section 1: Electrostatic behaviour of floor coverings and installed floors. 1995
IEC 61340-5-1	Protection of electronic devices from electrostatic phenomena - General requirements. Dec. 98
IEC 61340-5-2	Protection of electronic devices from electrostatic phenomena - User guide. Feb. 99
IEC 60950	Safety of information technology equipment. 4/99
ISO 261	ISO general-purpose metric screw threads - General plan. 1998
ISO 262	ISO general-purpose metric screw threads - Selected sizes for screws, bolts and nuts. 1998
ISO 3864	Safety colours and safety signs. 1984
ITU-T Recommendation G.703	General aspects of digital transmission systems. Terminal equipment. Physical/electrical characteristics of hierarchical digital interfaces. 1991
ITU-T Recommendation K.21	Resistibility of subscriber's terminal to overvoltages and overcurrents. 10/96
ÖVE/ÖNORM E 8001	Erection of electrical installations with nominal voltages of up to 1000 V AC and 1500 V DC. 2000
TCO 99	Ergonomics, safety, energy consumption and environmental compatibility of displays and other PC equipment 1999
VDE 0100	Power installations with nominal voltages of up to 1 kV 1994
UL 1950, 3rd Edition	Safety of information technology equipment 1995

9.2. Tables Concerning Safety Regulations

This chapter gives examples for recommended electrical and mechanical guidelines based on the standards EN 100015, IEC 61340-5-x and EN 60950.

Category	Examples
Work surfaces	Waxed, painted or varnished surfaces, untreated vinyl and plastics, glass
Floors	Sealed concrete, waxed/finished wood, tile and carpeting
Clothes and personnel	Non-ESD overalls and shoes, synthetic materials, hair
Chairs	Finished wood, vinyl, fibreglass, non-conductive wheels
Packaging and handling materials	Plastic bags, wraps, envelopes, foam, non-ESD trays, boxes, parts, bins
Assembly tools and materials	Pressure sprays, compressed air, synthetic brushes, heat guns, blowers, copiers, printers

Tab. 9-1: Typical Static Charge Sources

Air Humidity	10-20%	65-90%
Process	[V]	[V]
Walking on carpet	35000	1500
Walking on vinyl flooring	12000	250
Operator at a bench	6000	100
Vinyl envelopes (e.g. *Installation Manual*)	7000	600
Plastic bag picked up from a workbench	20000	1200
Work chair with foam pad	18000	1500

Tab. 9-2:Typical Static Voltage Generation

From Operator through	Maximum Tolerable Resistance	Maximum Acceptable Discharge Time
	[MΩ]	[s]
Floor mat to ground	1000	< 1
Table mat to ground	1000	< 1
Wrist strap to ground	100	< 0.1

Tab. 9-3:Maximum Resistance vs. Discharge Time for Static Safe Operations

Rated Current	Nominal Cross-sectional Area
[A]	[mm^2]
6	0.75
10	1.00
13	1.25
16	1.5
25	2.5
32	4
40	6
63	10
80	16
100	25
125	35
160	50

Tab. 9-4: Minimum Sizes of Conductors in Power Supply Cords

Max. Rated Current	Nominal Cross-sectional Area [mm^2]	
[A]	Flexible Cables	Other Cables
3	0.5 to 0.75	1 to 2.5
6	0.75 to 1	1 to 2.5
10	1 to 1.5	1 to 2.5
13	1.25 to 1.5	1.5 to 4
16	1.5 to 2.5	1.5 to 4
25	2.5 to 4	2.5 to 6
32	4 to 6	4 to 10
40	6 to 10	6 to 16
63	10 to 16	10 to 25

Tab. 9-5: Ranges of Conductor Cross-Sections

---------- END OF DOCUMENT ----------