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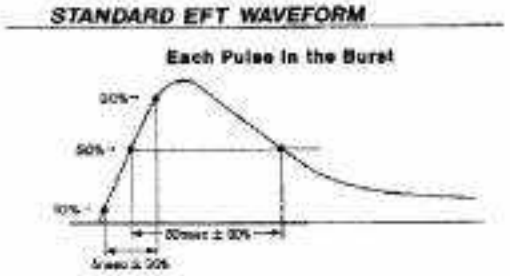
EFT Testing per IEC 1000-4-4

Coupling Methods

Capacitive Coupling via 33nF capacitors is the required coupling method to AC or DC power mains. These coupling capacitors are included as part of a Coupler/ Decoupler (C/D) in commercially available EFT simulators. The design of the decoupling portion of the C/D, which prevents the EFT burst from traveling back onto the power mains, is also specified in IEC 1000-4-4.

A Capacitive Coupling Clamp is used to couple EFT bursts onto data, I/O, and telecommunications lines. Construction of the clamp is shown in Figure 5 of IEC 1000-4-4; however, considerable differences exist in commercially available clamps. Some clamps use higher quality materials and some designs allow for the use of an optional safety interlocked cover.

Waveforms



Waveform Verification

IEC 1000-4-4 requires that the simulator output be verified periodically. A 50 ohm load and attenuator rated for high voltage is required and the measurement must be made using an oscilloscope with at least 400MHz bandwidth.

One problem noted with IEC 1000-4-4 is that simulator designs can be quite different and although each has a 50 ohm source impedance and provides the specified pulse into a 50 ohm termination, some simulators provide significantly more or less energy than others into loads that are not 50 ohms - the AC power input of most electronic products is something other than 50 ohms. To deal with the problems, changes to the standard were proposed to require waveforms be verified into a 1000 ohm load. Unfortunately, these changes were not accepted; however, this and other proposed improvements to IEC 1000-4-4 will be included in a forthcoming Annex.

Test Execution

According to IEC 1000-4-4, testing must be carried out according to the manufacturer's test plan, which shall specify:

Type of test	Test levels
Polarity *(+ & - required)*	Test duration (1 minute minimum)
Number of Voltage tests	EUT ports
EUT operating condition	Sequence to tests to ports, etc.
Auxiliary equipment	

EUT Performance Criteria

For EFT tests, the Generic Immunity Standards and Household Appliances Product Family Standard require that products operate as intended after the test. No degradation or loss of function is allowed below a performance level specified by the manufacturer. During the test, degradation is allowed, but not a change in the actual operating status or data storage. Refer to the tables located in the Generic, Product and Product Family Standards for specific Performance Criteria. The product cannot become unsafe under any conditions.

EFT Simulators

EFT Simulators produced by KeyTek Instrument Corporation meet all the simulator requirements of IEC 1000-4-4, including discharge pulse energy, output type, dynamic source impedance, and all waveform characteristics. Additionally, KeyTek simulators meet the requirements for coupling/decoupling networks for AC and DC mains as described in paragraph 6.2 of IEC 1000-4-4. Contact KeyTek for details.

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KeyTek Application Note

ESD Accessories for Testing Beyond IEC 1000-4-2

Real World Testing

ESD is the most common cause of failure in computer based equipment. It accounts for hundreds of millions of dollars in downtime and repair costs each year.

Fortunately, catastrophic failures are preventable and many manufacturers have R&D and manufacturing programs to insure that their products are ESD resistant when shipped. The European Union's EMC Directive requires that virtually all electronic and electrical products be tested for a minimum level of ESD immunity.

However, experience by manufacturers has shown that the characteristics of real ESD vary somewhat from the test pulses required by mandatory standards. Current rise times are much faster and fields associated with discharges are more significant than thought.

In order to insure that products are immune to real ESD events, it is necessary to test beyond the requirements of the mandatory standards using different discharge tips, coupling planes and other accessories.

Applicable Standards

Generic Immunity Standards, Product Standards and Product Family Standards require that ESD tests be performed in accordance with specific Basic Test Standards: IEC 801-2, IEC 1000-4-2 or EN 61000-4-2.

KeyTek's Application Note "EMC Standards Overview" provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and lists sources for procuring copyrighted documents.

Basic EMC Standards

The Basic EMC Standards for ESD define methods of generating consistently reproducible electrical stresses for test purposes. (Refer to ESD Testing per IEC 1000-4-2 Application Note.)

Applying Discharges

ESD is applied both directly to the Equipment Under Test (EUT) and indirectly, via horizontal and vertical coupling planes.

Direct coupling is performed with either a contact mode discharge to metal surfaces of the EUT (preferred method), or via an air discharge. In both cases, discharges must be made to all points and surfaces accessible to personnel during normal usage. Tests are performed using 10 single discharges per test point in the most sensitive polarity.

Indirect discharges are performed to simulate radiated ESD events to the EUT. Using the vertical coupling plane (VCP), at least 10 discharges to the center of the edge of the plane are required with the VCP positioned to completely radiate towards four faces of the EUT.

The horizontal coupling plane (HCP) is on the surface of the work table and is covered with a material to electrically insulate it from the EUT. Currently, a discharge is made to the surface of the HCP at a distance of 0.1m from each side of the EUT, however, an amendment is in process to modify this procedure and require discharges to be made to the center of the edge of the HCP.

Test Set-Up

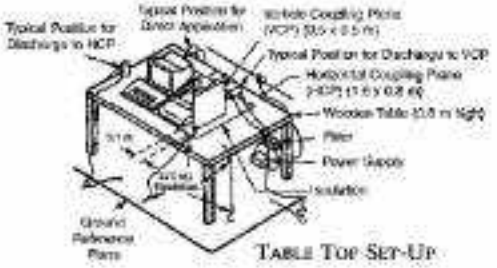
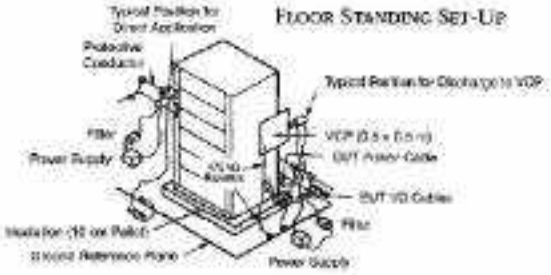


Table Top Set-Up



Floor Standing Set-Up



ESD Accessories for Testing Beyond IEC 1000-4-2

CM-ESD and PRO-ESD Tips

Simulator tips are included with CM-ESD and PRO-ESD for both contact mode testing (TPC-3) and air discharge testing (TPA-2) in accordance with IEC 1000-4-2. For very fast, real-world rise times, the TPA-1 for air discharge will provide rise times on the order of 0.4ns or faster.

A method used successfully for locating ESD and RF susceptibility problems is self-discharge: producing the spark associated with an air discharge, but without actually discharging to the equipment under test. This is done using the TPF-1 self-discharge tip in the vicinity of suspect cables, connectors, shields and the like.

Another useful tool is the 50-MZ standoff spacer for air-discharge testing. This allows the user to set the precise distance between the tip and the target equipment, useful for investigative work.

When trying to determine the real cause of an ESD immunity problem, it is useful to separate E-Field and H-Field effects. This is easily accomplished with the MZT-11 E-Field and MZT-12 H-Field Simulator Tip Assemblies.

In order to determine if fields are being generated and to observe the relative levels of those fields, the FCS-1 Field and Corona Sensor Group was developed. This option includes a basic monitor unit, HEC-1, H-Field Sensor, HFS-1, E-Field Sensor, EFS-1, and Pre-discharge Corona Sensor, CCS-1.

Coupling Planes

Two coupling planes, one horizontal and one vertical, are required for product testing in accordance with IEC 1000-4-2. The Horizontal Coupling Plane, a model HCP-1, is placed on a non-conductive table below the equipment being tested. A discharge to the HCP-1 will then cause a horizontally polarized field to be radiated up into the product being tested. A Vertical Coupling Plane, model VCP-1, is oriented at a fixed distance from the product being tested. A discharge is made to the edge of the VCP-1 causing a vertically polarized field to be radiated towards the product. All four sides of the product must be tested in this manner.

Another type of plane available as an accessory to the CM-ESD and PRO-ESD is the TP-3, a 1.5m x 1.5m Target Plane used with the CTC-3 ESD target for waveform verification. The CTC-3 is mounted in the center of the plane and the ESD current is monitored on an oscilloscope which is installed inside a Faraday cage.

Other Accessories

In order to obtain an independent measurement of the ESD voltage on the tip of the CM-ESD and PRO-ESD, a calibrated attenuator, such as the DCA-2 is required. With the attenuator in place, the output voltage can be read using any DC attenuator.

For customers planning to ship the CM-ESD and PRO-ESD between facilities on a regular basis, the MCA-1 Hard Carrying Case is recommended. No additional shipping materials are required. Secure the unit in the MCA-1, affix the proper labels, and call the shipper.

Some corporate standards require testing with hundreds or even thousands of discharges to a point on the equipment under test. A non-conducting tripod, such as the T-2, allows the CM-ESD and PRO-ESD simulator to be held steady against the equipment being tested, without interfering with the test results.

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KeyTek Application Note

ESD Testing per IEC 1000-4-2

ESD Background

Electrostatic Discharge (ESD) is the abrupt release of charge from one object (often a person) to another. Such a discharge can permanently damage or otherwise upset the function of sensitive electronic circuits.

Electronic products are tested for ESD immunity to insure their continued reliable operation if subjected to realistic levels of ESD after being placed in service. The European Union's EMC Directive mandates ESD immunity testing for virtually all electrical and/or electronic products as a condition for obtaining the CE Mark before shipping to a member state of the European Union.

Applicable Standards

Generic Immunity Standards, Product Standards and Product Family Standards require that ESD tests be performed in accordance with specific Basic EMC Standards: IEC 801-2, IEC 1000-4-2, or EN 61000-4-2. KeyTek's Application Note, "EMC Standards Overview," provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and lists sources for procuring copyrighted documents.

Basic EMC Standard

The Basic EMC Standards for ESD define methods of generating consistently reproducible electrical stresses for test purposes. They specify capacitances and resistances to model the human body's charge storing capability and discharge impedance, respectively. This model results in a current waveform, defined in the Standards. While the Basic EMC Standard also specifies how to perform ESD testing, the Generic, Product and Product Family Standards specify the test levels and pass/fail Performance Criteria.

Test Levels

Standard	Applicability	Contact Discharge Test Voltage	Air Discharge Test Voltage
EN 50082-1	Generic Immunity - Residential, Commercial and Light Industrial	N/A	8kV
EN 50082-1 Draft	Generic Immunity - Residential, Commercial and Light Industrial	4kV	8kV
EN 50082-2	Generic Immunity - Industrial Environment	4kV	8kV
EN 50082-2 Draft	Generic Immunity - Industrial Environment	4kV	8kV
EN 55104	Immunity for Household Appliances, Tools and Similar Apparatus	4kV	8kV

Test Set-Up

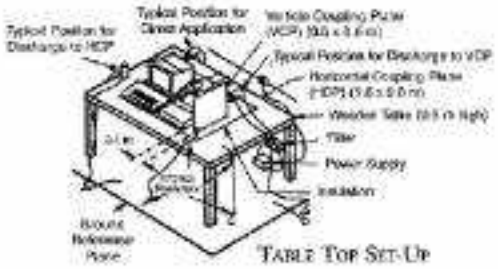
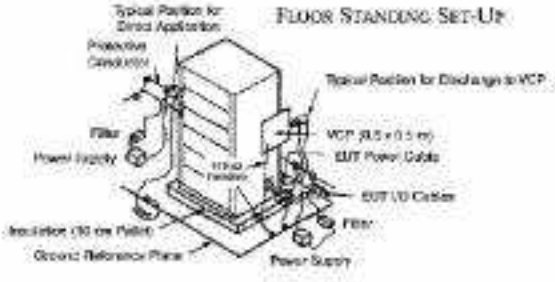


Table Top Set-Up



Floor Standing Set-Up

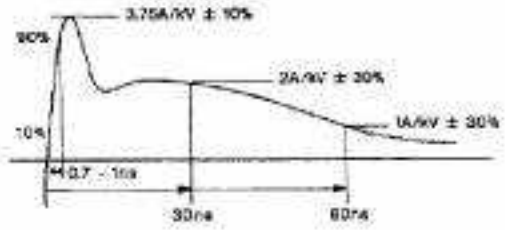
ESD Testing per IEC 1000-4-2

Coupling Methods

Direct Coupling is a discharge directly to the Equipment Under Test (EUT), either in an Air Discharge mode, necessary for products having few or no metal surfaces, or via Contact mode, the preferred method. In the "air discharge" mode, the ESD event is initiated when the test simulator output is brought into close proximity with the EUT until a spark is initiated. The resulting stress is influenced by various environmental factors. In the preferred "contact discharge" mode, the test simulator output is first brought into physical contact with the EUT, then the ESD event is initiated under controlled conditions within the simulator.

Indirect Coupling simulates an ESD event which causes a radiated field to be emitted in the vicinity of the victim equipment. This is accomplished using Vertical Coupling Planes (VCP's) and Horizontal Coupling Planes (HCP's). Current standards require discharges be made to the edge of the VCP and surface of an HCP.

Waveforms



Waveform Verification

IEC 1000-4-2 requires the simulator output be verified periodically. A Model CTC-3 measurement target and target plane is required. The ESD current measurement is then made using a measurement system having a 1GHz or greater bandwidth. It is necessary to place the oscilloscope inside a shielded enclosure during the measurement to reduce the effects of radiated ESD directly to the measurement instrument.

Recent work by the Working Group 14.0 of the ESD Association has found that some simulators produce waveforms that are in compliance with IEC 1000-4-2, but have considerable ringing and high frequency components that do not show up with 1GHz instrumentation. These simulators may cause failures in products which would not occur if tested with a KeyTek simulator. Working Group 14.0 is preparing a document to describe waveform verification methods to allow manufacturers to verify the ESD current from simulators using high bandwidth instrumentation.

Number and Rate of Discharges

The manufacturer is required to develop a test plan identifying the EUT's most sensitive operating mode and appropriate test points. A minimum of 10 discharges are then made to each test point in either Contact Discharge or Air Discharge, according to the test plan. A recommended time interval of 1 second between tests should be used, but a longer interval is allowed if necessary to determine if a system failure has occurred.

For the indirect tests, 10 discharges are required to the Vertical Coupling Plane at each of 4 equipment faces (40 discharges) and then 10 discharges are required to the Horizontal Coupling Plane at 4 sides of the EUT (40 discharges).

EUT Performance Criteria

For ESD tests, the Generic Immunity Standards and Household Appliances Product Family Standard require that products operate as intended after the test. No degradation or loss of function is allowed below a performance level specified by the manufacturer. During the test, degradation is allowed, but not a change in the actual operating state or stored data. Refer to the tables located in the Generic, Product and Product Family Standards for specific Performance Criteria. The product cannot become unsafe under any conditions.

ESD Simulators

ESD Simulators produced by KeyTek Instrument Corporation meet all the simulator requirements of IEC 1000-4-2, including discharge network characteristics, discharge tips, and waveforms. Numerous accessories and discharge tips are available from KeyTek for those manufacturers requiring additional test capability and flexibility. Contact KeyTek for details.

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KeyTek Application Note

Standard Selector Guide

Product and Product Family Standards

As of January 1, 1996, all electrical or electronics products shipped into the European Union that could either cause electromagnetic interference (EMI) or could be susceptible to EMI, must be tested to ensure adherence to the EMC Directive. (If a manufacturer believes that a product does not cause EMI and is not affected by EMI, the onus is on the manufacturer to substantiate his claims.)

In order to comply with the EMC Directive, the following products listed must conform to applicable Product or Product Family Standards. If no Product or Product Family Standards exist, the product must comply with the Generic Immunity and Emissions standards. These generic standards are divided into two areas:

Environment	Generic Emissions	Generic Immunity
Residential, commercial, and light industrial	EN 50081-1	EN 50082-1
Industrial	EN 50081-2	EN 50082-2

Residential, Commercial and Light-Industrial Environments

EN 50081-1, the generic emission standard for residential, commercial and light industrial states that:

"The environments encompassed by this standard are residential, commercial and light-industrial locations, both indoor and outdoor. The following list, although not comprehensive, gives an indication of locations, which are included:

- residential properties, e.g. houses, apartments
- retail outlets, e.g. shops, supermarkets
- business premises, e.g. offices, banks
- areas of public entertainment, e.g. cinemas, public bars, dance halls
- outdoor locations, e.g. petrol stations, car parks, amusement and sports centres
- light-industrial locations, e.g. workshops, laboratories, service centres

Locations which are characterized by being supplied directly at low voltage from the public mains network are considered to be residential, commercial or light industrial."

Industrial Environment

EN 50081-2, the generic emission standard for the industrial environment states that:

"Apparatus covered by this standard is not intended for connection to the public mains network but is intended to be connected to a power network supplied from a high or medium-voltage transformer dedicated for the supply of an installation feeding manufacturing or similar plant."

Industrial locations are characterized by the existence of one or more of the following conditions:

- industrial, scientific and medical (ISM) apparatus
- heavy inductive or capacitive loads are frequently switched
- currents and associated magnetic fields are high

These are the major contributors to the industrial electromagnetic environment and as such distinguish the industrial from other environments.

ISM equipment is defined in EN 55011, Annex A as:

"... suitable for use in all establishments other than domestic and those connected to a low voltage power supply network which supplies buildings used for domestic purposes."

Some examples from Appendix A of EN 55011 for ISM equipment include: signal generators, measuring receivers, spectrum analyzers, chemical analysis machines and switched mode power supplies. Examples of general equipment include: industrial induction heating equipment, industrial microwave heating equipment, medical apparatus (specifically short-wave therapy equipment and microwave therapy equipment), spark erosion equipment, and spot welders.

Some overlap exists in the definitions of the two categories and it is up to the manufacturer to use the best judgement in selecting the appropriate category. The manufacturer always has the final responsibility in assuring compliance with the directive.

Standard Selector Guide

	Emissions			Immunity
Product Category	**AC Power harmonic currents**	**Voltage Flicker**	**RF Emissions**	**ESD, EFT, Surge, and RF Immunity**
Audio equipment	EN 60555-2 will become EN 61000-3-2	EN 60555-3 will become EN 610003-3	EN 55013	EN 50082-1
Household appliances and portable tools, e.g. vacuum cleaners, washing machines, heating and cooking appliances, dimmers	EN 60555-2 will become EN 61000-3-2	EN 60555-3 will become EN 610003-3	EN 55014	EN 55104
Industrial electronic power and control equipment	EN 61000-3-2	EN 61000-3-3	EN 50081-2	EN 50082-2
Industrial non-electronic equipment e.g. commutator motors	EN 61000-3-2	EN 61000-3-3	EN 50081-2	EN 50082-2
Industrial, Scientific and Medical (ISM) equipment designed to generate radio frequency energy	EN 61000-3-2	EN 61000-3-3	EN 55011	EN 50082-1 or EN 50082-2
Information Technology Equipment (ITE)	EN 61000-3-2	EN 61000-3-3	EN 55022	EN 50082-1 or EN 50082-2
Lifts	---	---	prEN 12015	prEN 12016
Lighting equipment	EN 60555-2 will become EN 61000-3-2	EN 61000-3-3 for disco lighting etc.	EN 55015	EN 50082-1 will be EN 61547 in the future
Medical Equipment	---	---	EN 60601-1-2	EN 60601-1-2
Power Mains signalling equipment	EN 61000-3-2	---	EN 50065-1	EN 50082-1
Professional Audio Visual Equipment	---	---	prEN 55103-1	prEN 55103-2
Residential and Light Industrial equipment	EN 61000-3-2	EN 61000-3-3	EN 50081-1	EN 50082-1
TV and Radio Receivers	EN 60555-2 will become EN 61000-3-2	EN 60555-3 will become EN 610003-3	EN 55013	EN 55020

Product and Product Family Standards for Immunity Maximum Required Test Levels

IEC	ESD	EFT	Surge Combination Wave	Surge Telecom Wave	Power Frequency Magnetic Field	Pulse Magnetic Field	Dips & Interrupts	100kHz Ring Wave
EN 50082-1: Jan 92 Generic Immunity – Residential, Commercial, and Light Industrial	8kV air discharge	1kV	–	–	–	–	–	–
prEN 50082-1: Oct 96 Generic Immunity – Residential, Commercial, and Light Industrial	4kV contact mode 8kV air discharge	1kV	2kV common mode 1kV differential mode	– –	3A/m –	– –	40% and 70% Dips; Interrupts to 0	–
EN 50082-2: 1995 Generic Immunity – Industrial Environment	4kV contact mode 8kV air discharge	2kV	– 1kV differential mode	– –	30A/m –	– –	–	–
prEN 50082-2: Aug 96 Generic Immunity – Industrial Environment	4kV contact mode 8kV air discharge	2kV	4kV common mode 2kV differential mode	– –	30A/m –	– –	40% and 70% Dips; Interrupts to 0	–
EN 55104 Immunity – Household Appliances, Tools and Similar Apparatus	4kV contact mode 8kV air discharge	1kV	2kV common mode 1kV differential mode	– –	– –	– –	40% and 70% Dips; Interrupts to 0	–

Drop

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KeyTek Application Note

EMC Standards Overview

An Overview

The European Union's EMC Directive requires that virtually all electronic and electrical products be tested for immunity to both man-made and natural phenomena and to insure that products do not emit unintentional signals that may interfere with the continued, reliable operation of other products.

In order to accomplish this objective, CENELEC (an acronym for Comité Européen de Normalisation Electrotechnique) was tasked with identifying the standards to be applied. CENELEC in conjunction with the IEC (International Electrotechnical Commission) and CISPR (Comité International Spécial des Perturbations Radioélectroniques) have defined a series of Product Standards, Product Family Standards, and Basic EMC Standards for use in complying with the EMC Directive.

Compliance with the EMC Directive will require products be tested in accordance with European Norms, or ENs, issued by CENELEC. These ENs are not developed by CENELEC but are IEC and CISPR standards redesignated as ENs. For example, Basic EMC Standard IEC 1000-4-2 becomes EN 61000-4-2; Basic EMC Standard CISPR 22 becomes EN 55022.

The IEC

The IEC or International Electrotechnical Commission is a worldwide standards writing organization. Membership includes most industrialized nations and is open to any nation that wishes to contribute and supply a technical expert.

Within the IEC are Technical Committees, each tasked with developing and maintaining specific types of standards. Most Basic EMC Standards for immunity are developed by the IEC, as are most Product and Product Family Standards.

CISPR

CISPR is a special part of the IEC tasked with the development of standards dealing with unwanted radiated emissions in the RF (radio frequency) spectrum. The objective of CISPR standards is to limit the amount of undesirable RF emanating from electrical and electronic products, and therefore limit the amount of interference to other electronic products. Most Basic EMC Standards for radiated emissions are written by CISPR Technical Committees.

The Standards

There are three types of EMC Publications:

Product Standards
Product Family Standards (including Generic Standards)
Basic EMC Publications

EMC Standards Overview

Product Standards

Product EMC Standards relate to a particular type of product, system or installation for which specific conditions must be considered. Product EMC Standards include:

- Resistance Welding equipment
- Measuring Relays and Protection equipment

Product Standards have priority over Product Family and Generic Standards; however, where no Product Standard or Product Family Standard exists for a particular product, the relevant Generic Standard will apply.

Product Family Standards

Product Family Standards apply to products of a particular category such as:

- Household appliances and portable tools
- ITE (Information Technology Equipment)
- Audio, video, audio-visual and entertainment lighting control apparatus for professional use

Product Family Standards have priority over Generic Standards; however, where no Product Family EMC Standard exists for a particular product family, the relevant Generic Standard will apply.

Generic Standards

Generic EMC Standards are a special type of Product Family Standard which apply to products operating in a particular environment for which no dedicated Product or Product Family Standard exists. They specify a set of essential requirements, test procedures and generalized performance criteria applicable to products or systems operating in this environment.

The Generic EMC Standards include: EN 50082-1, EN 50082-2, EN 50081-1 and EN 50081-2 which cover immunity and emissions testing for commercial, residential and light industrial environments, as well as for industrial environments.

Basic EMC Publications

Basic EMC Publications may be standards or technical reports which, by definition, are NOT dedicated to specific product families, products, systems or installations. They may concern:

- Terminology
- Descriptions of electromagnetic phenomena
- Specification of compatibility levels (NOT compliance levels)
- General requirements for the limitation of emissions
- Recommendations for test levels for immunity
- Measurement and test techniques
- Descriptions and classification of the environment

Basic EMC Publications include Basic EMC Standards such as the IEC 1000-4-X Series, CISPR 22, CISPR 11, and others. (IEC 1000-4-X Series will become IEC 61000-4-X as new standards are developed and current ones revised.)

Other Directives

In addition to the EMC Directive, there are other directives to which manufacturers of electrical and electronic products may have to comply:

Safety Directives: Machinery Directive
Low Voltage Directive

Each product must comply with the safety directive that is most applicable. Products which can be classified as machinery should comply with the Machinery Directive, and those products that can be classified as electrical or electronic products will have to meet the Low Voltage Directive. The manufacturer is required to determine which is most applicable for each product.

Other directives include:

- Toy Directive (already in force)
- Medical Devices Directive (medical electronics)
- Telecommunications Directive (telecom products)
- Automotive Directive (vehicles and vehicle electronics)

Standard Document Sources

Standards may be obtained directly from the issuing body - the IEC or CENELEC, or from your national standards organization. In the United States it is the American National Standards Institute (ANSI) at + (1) 212-642-4900; in the United Kingdom it is the British Standards Institute (BSI). Commercial sources include The Document Center in the United States at + (1) 415-591-7600.

In order to maintain an up-to-date Standards file, contact ERA Technology Ltd. in the United Kingdom at +(44) 1372 367018 and request a subscription to the Safety and EMC newsletter.

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KeyTek Application Note

Surge Testing per IEC 1000-4-5

Surge Background

Surges occur on the AC power mains as a result of switching operations in the power grid and from nearby lightning strikes, either directly to the power distribution system or to nearby ground. Radiated coupling of surges into I/O lines generally occurs only when the lines are very long.

Electronic products are tested for Surge immunity to insure their continued reliable operation if subjected to realistic levels of surge voltages. The European Union's EMC Directive currently mandates Surge testing for some products; however, it is expected that virtually all electrical and electronic products will have to be tested for Surge immunity in the near future as a condition for obtaining the CE Mark before shipping products to a member state of the European Union.

Applicable Standards

Generic Immunity, Product and Product Family Standards require Surge tests be performed in accordance with Basic EMC Standards: IEC 801-5, IEC 1000-4-5 or EN 61000-4-5. KeyTek's Application Note, "EMC Standards Overview," provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and lists sources for procuring copyrighted documents.

Basic EMC Standard

The Basic EMC Standard for Surge defines the methods of generating consistently reproducible surge voltages for test purposes. They specify generator and coupler/decoupler design and performance in sufficient detail to produce correlatable results between test sites.

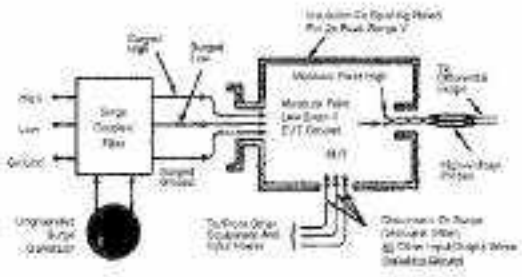
While the Basic EMC Standard specifies how to perform Surge testing, the Generic, Product and Product Family Standards specify the test levels and pass/fail performance criteria.

Test Levels

Standard	Applicability	Common Mode	Differential Mode
EN 50082-1	Generic Immunity - Residential, Commercial and Light Industrial	N/A	N/A
EN 50082-1 Draft	Generic Immunity - Residential, Commercial and Light Industrial	2kV	1kV
EN 50082-2	Generic Immunity - Industrial Environment	N/A	N/A
EN 50082-2 Draft	Generic Immunity - Industrial Environment	4kV	2kV
EN 55104	Immunity for Household Appliances, Tools and Similar Apparatus	2kV	1kV

Safety

When performing Surge tests, safety is a primary concern. Surge voltages and currents must be contained to insure they will not appear where they can cause damage to other instruments in the test area. The test pulses used for Surge testing are of sufficient energy to cause components to fragment under fault conditions and become hazardous to personnel in unprotected environments.



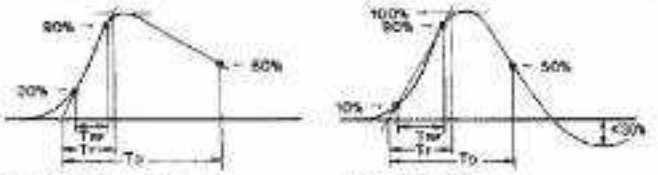
Surge Testing per IEC 1000-4-5

Coupling Methods

Capacitive Coupling via 9μF (Line to earth) or 18μF (line to line) capacitors is required for coupling surges to AC or DC power mains. These coupling capacitors are typically included as part of a Coupler/Decoupler (C/D) in commercially available Surge simulators. The C/D provides both coupling to the EUT power mains and a decoupler to prevent the surge from appearing on the ac mains connected to other equipment in the lab.

Capacitive Coupling via .5μF capacitors, as well as via alternative devices such as surge arrestors, are used to couple surges onto data, I/O and telecommunication lines. Surge arrestors are the preferred coupler device due to the undesirable loading effects of capacitors particularly at frequencies greater than a few kilohertz. A decoupler is included to prevent the surge from appearing at, and potentially damaging, the auxiliary equipment.

Waveforms

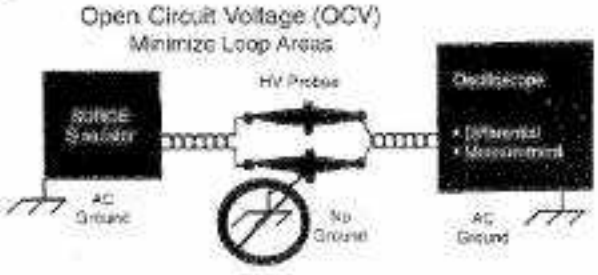


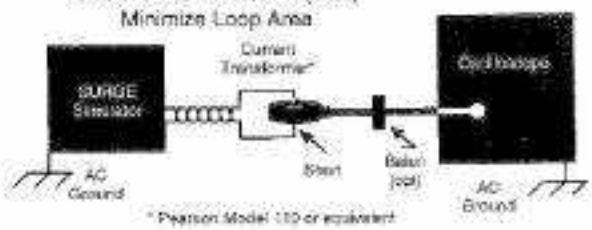
Open Circuit Voltage 1.2 x 50
Rise Time: Tr = 1.67 x T = 1.0μsec ± 30%
Duration: To = Virtual Start to 50% = 50μsec ±30%

Short Circuit Current 8 x 20
Rise Time: Tr = 1.25 x T = 8μsec ± 20%
Duration: To = Virtual Start to 50% = 20μsec ± 20%

Waveform Verification

IEC 1000-4-5 requires that the simulator output be verified periodically. High voltage differential surge probes are required for verifying the open-circuit voltage, and a suitable current transformer (Pearson Model 110 or equivalent) is required for verification of the short-circuit current. A digital or storage oscilloscope with 100MHz bandwidth is sufficient for measuring the surge voltage and current waveforms and peaks.





Test Execution

According to IEC 1000-4-5, testing must be carried out according to the manufacturer's test plan, which shall specify:

- Generator & other equipment
- Generator Source Impedance
- Repetition rate (one per minute maximum)
- Sequence of application of the surge
- Installation conditions
- Operating conditions of EUT
- Number of tests (at least five positive and five negative at each point)
- Test levels
- Polarity
- Inputs/outputs tested
- Phase angle of coupling to ac mains
- Internal or external trigger

EUT Performance Criteria

For Surge tests, the Generic Immunity Standards and Household Appliances Product Family Standard require that products operate as intended after the test. No degradation or loss of function is allowed below a performance level specified by the manufacturer. During the test, degradation is allowed, but not a change in the actual operating status or data storage. Refer to the tables located in the Generic, Product and Product Family Standards for specific Performance Criteria. The product cannot become unsafe under any conditions.

Surge Simulators

Surge Simulators produced by KeyTek Instrument Corporation meet all the simulator requirements of IEC 1000-4-5, including dynamic source impedance, all waveform characteristics, and coupler/decoupler design. Contact KeyTek for details.

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KPS-666-A-10-97

KeyTek Application Note

Dips and Interrupts Testing per IEC 1000-4-11

Dips and Interrupts Background

Dips and interrupts can occur on the AC power mains as a result of a fault in the distribution system such as an open circuit breaker or a sudden large load being turned on in the immediate vicinity. A power distribution system fault can cause a switch in the distribution grid to open and close a number of times, resulting in multiple interrupts to electrical and electronic equipment.

Electronic products are tested for immunity to dips and interrupts to insure their continued reliable operation if subjected to dips and/or interrupts on the AC power mains. The European Union's EMC Directive mandates dips and interrupts testing for virtually all electrical and electronic products as a condition for obtaining the CE Mark before shipping products to member states of the European Union.

Applicable Standards

Generic Immunity Standards, Product Standards and Product Family Standards require that dip and interrupt tests be performed in accordance with Basic EMC Standards: IEC 1000-4-11 and EN 61000-4-11[1]. KeyTek's Application Note, "EMC Standards Overview," provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and lists sources for procuring copyrighted documents.

[1] IEC 1000-4-11 and EN 61000-4-11 are virtually identical standards.

Basic EMC Standard

The Basic EMC Standard for Dips and Interrupts defines methods of generating consistently reproducible electrical dips and interrupts for test purposes. They specify characteristics of the AC mains to the EUT such as peak inrush current, transition times and durations.

While the Basic EMC Standard specifies how to perform Dips and Interrupts testing, the Generic, Product and Product Family Standards specify the test levels and pass/fail Performance Criteria.

Test Levels

Standard	Applicability	Levels
EN 50082-1	Generic Immunity - Residential, Commercial and Light Industrial	Not required
EN 50082-1 Draft	Generic Immunity - Residential, Commercial and Light Industrial	0%, 40%, 70% & 100%
EN 50082-2	Generic Immunity - Industrial Environment	Not required
EN 50082-2 Draft	Generic Immunity - Industrial Environment	0%, 40%, 70% & 100%
EN 55104	Immunity for Household Appliances, Tools and Similar Apparatus	0%, 40%, 70% & 100%

Dips and Interrupts Testing per IEC 1000-4-11

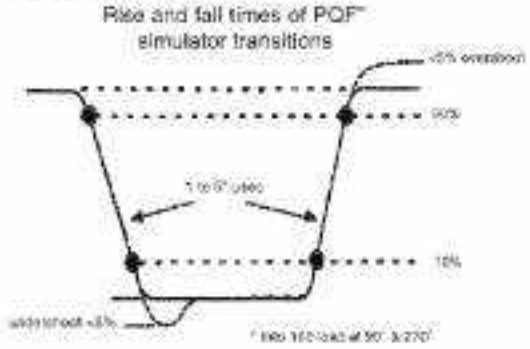
Peak Inrush Current

IEC 1000-4-11 requires the simulator be capable of supplying peak inrush currents of up to 500A for 220V to 240V mains, and up to 250A for 100V to 120V mains. Additionally, the Standard requires this capability be measured using a bridge rectifier connected via a switch to a discharged 1700µF capacitor. The parallel discharge resistance should be chosen to allow several RC time constants between tests. An example in Annex A (normative) uses a 10k ohm resistance, providing a time constant of 17 s, "...so that a wait of 1.5 to 2 minutes should be used between inrush drive capability tests."

The test for inrush current is performed by switching the generator from 0% to 100% at both 90° and 270° to insure sufficient peak inrush current drive capability for both polarities.

Waveform Verification

IEC 1000-4-11 requires that the simulator output be verified periodically. For Dip and Interrupt test simulators, it is necessary to verify the voltage transition levels, transition times to 100%, and the inrush current capability. Most modern oscilloscopes are capable of observing the voltage levels and transition times. For verifying the inrush current, a bridge rectifier, suitably rated 1700µF capacitor and appropriate current transformer are required.



Test Execution

According to IEC 1000-4-11, tests must be performed in compliance with the manufacturer's test plan, which shall specify:

- Input power of the EUT
- Performance Criteria
- Operation modes of the EUT
- Test set-up description
- Type of designation of the EUT
- Information on possible connections, cables, peripherals, etc.

After each group of tests, a complete functional test must be performed.

EUT Performance Criteria

For Dip and Interrupt tests, Performance Criteria varies in some standards depending on the duration or severity of the dip and/or interrupt. Under some conditions, loss of function is allowed, provided that the function is self-recoverable or can be restored by the control operations. Under less severe conditions, degradation of performance is allowed during the test, however, the unit must continue to operate as intended after the test. Refer to the tables located in the Generic, Product and Product Family Standards for specific Performance Criteria. The product cannot become unsafe under any conditions.

Dip and Interrupt Simulators

Dip and Interrupt Simulators produced by KeyTek Instrument Corporation meet all the simulator requirements of IEC 1000-4-11, including those for peak inrush current. Additionally, KeyTek simulators meet the fast switching time requirements not only to 100% as required by the standards, but from any level to any other level. Contact KeyTek for details.

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KPS-669-A-10-97

KeyTek Application Note

ESD Testing per IEC 1000-4-2

ESD Background

Electrostatic Discharge (ESD) is the abrupt release of charge from one object (often a person) to another. Such a discharge can permanently damage or otherwise upset the function of sensitive electronic circuits.

Electronic products are tested for ESD immunity to insure their continued reliable operation if subjected to realistic levels of ESD after being placed in service. The European Union's EMC Directive mandates ESD immunity testing for virtually all electrical and/or electronic products as a condition for obtaining the CE Mark before shipping to a member state of the European Union.

Applicable Standards

Generic Immunity Standards, Product Standards and Product Family Standards require that ESD tests be performed in accordance with specific Basic EMC Standards: IEC 801-2, IEC 1000-4-2, or EN 61000-4-2. KeyTek's Application Note, "EMC Standards Overview," provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and lists sources for procuring copyrighted documents.

Basic EMC Standard

The Basic EMC Standards for ESD define methods of generating consistently reproducible electrical stresses for test purposes. They specify capacitances and resistances to model the human body's charge storing capability and discharge impedance, respectively. This model results in a current waveform, defined in the Standards. While the Basic EMC Standard also specifies how to perform ESD testing, the Generic, Product and Product Family Standards specify the test levels and pass/fail Performance Criteria.

Test Levels

Standard	Applicability	Contact Discharge Test Voltage	Air Discharge Test Voltage
EN 50082-1	Generic Immunity - Residential, Commercial and Light Industrial	N/A	8kV
EN 50082-1 Draft	Generic Immunity - Residential, Commercial and Light Industrial	4kV	8kV
EN 50082-2	Generic Immunity - Industrial Environment	4kV	8kV
EN 50082-2 Draft	Generic Immunity - Industrial Environment	4kV	8kV
EN 55104	Immunity for Household Appliances, Tools and Similar Apparatus	4kV	8kV

Test Set-Up

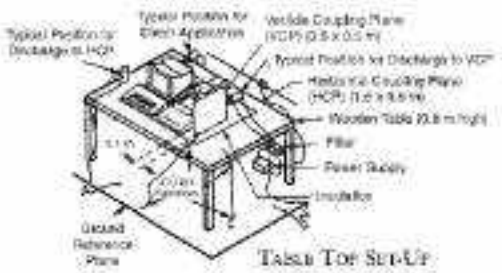
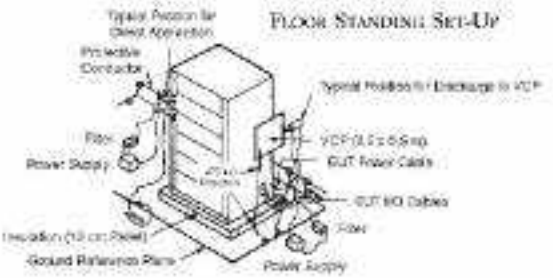


Table Top Set-Up



Floor Standing Set-Up

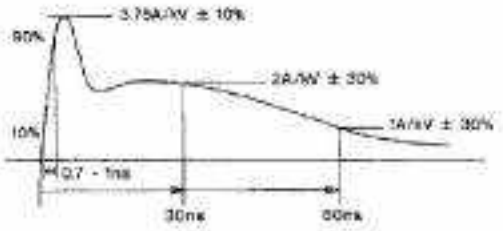
ESD Testing per IEC 1000-4-2

Coupling Methods

Direct Coupling is a discharge directly to the Equipment Under Test (EUT), either in an Air Discharge mode, necessary for products having few or no metal surfaces, or via Contact mode, the preferred method. In the "air discharge" mode, the ESD event is initiated when the test simulator output is brought into close proximity with the EUT until a spark is initiated. The resulting stress is influenced by various environmental factors. In the preferred "contact discharge" mode, the test simulator output is first brought into physical contact with the EUT, then the ESD event is initiated under controlled conditions within the simulator.

Indirect Coupling simulates an ESD event which causes a radiated field to be emitted in the vicinity of the victim equipment. This is accomplished using Vertical Coupling Planes (VCP's) and Horizontal Coupling Planes (HCP's). Current standards require discharges be made to the edge of the VCP and surface of an HCP.

Waveforms



Waveform Verification

IEC 1000-4-2 requires the simulator output be verified periodically. A Model CTC-3 measurement target and target plane is required. The ESD current measurement is then made using a measurement system having a 1GHz or greater bandwidth. It is necessary to place the oscilloscope inside a shielded enclosure during the measurement to reduce the effects of radiated ESD directly to the measurement instrument.

Recent work by the Working Group 14.0 of the ESD Association has found that some simulators produce waveforms that are in compliance with IEC 1000-4-2, but have considerable ringing and high frequency components that do not show up with 1GHz instrumentation. These simulators may cause failures in products which would not occur if tested with a KeyTek simulator. Working Group 14.0 is preparing a document to describe waveform verification methods to allow manufacturers to verify the ESD current from simulators using high bandwidth instrumentation.

Number and Rate of Discharges

The manufacturer is required to develop a test plan identifying the EUT's most sensitive operating mode and appropriate test points. A minimum of 10 discharges are then made to each test point in either Contact Discharge or Air Discharge, according to the test plan. A recommended time interval of 1 second between tests should be used, but a longer interval is allowed if necessary to determine if a system failure has occurred.

For the indirect tests, 10 discharges are required to the Vertical Coupling Plane at each of 4 equipment faces (40 discharges) and then 10 discharges are required to the Horizontal Coupling Plane at 4 sides of the EUT (40 discharges).

EUT Performance Criteria

For ESD tests, the Generic Immunity Standards and Household Appliances Product Family Standard require that products operate as intended after the test. No degradation or loss of function is allowed below a performance level specified by the manufacturer. During the test, degradation is allowed, but not a change in the actual operating state or stored data. Refer to the tables located in the Generic, Product and Product Family Standards for specific Performance Criteria. The product cannot become unsafe under any conditions.

ESD Simulators

ESD Simulators produced by KeyTek Instrument Corporation meet all the simulator requirements of IEC 1000-4-2, including discharge network characteristics, discharge tips, and waveforms. Numerous accessories and discharge tips are available from KeyTek for those manufacturers requiring additional test capability and flexibility. Contact KeyTek for details.

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KPS-684-A-10-97

KeyTek Application Note

ESD Accessories for Testing Beyond IEC 1000-4-2

Real World Testing

ESD is the most common cause of failure in computer based equipment. It accounts for hundreds of millions of dollars in downtime and repair costs each year.

Fortunately, catastrophic failures are preventable and many manufacturers have R&D and manufacturing programs to insure that their products are ESD resistant when shipped. The European Union's EMC Directive requires that virtually all electronic and electrical products be tested for a minimum level of ESD immunity.

However, experience by manufacturers has shown that the characteristics of real ESD vary somewhat from the test pulses required by mandatory standards. Current rise times are much faster and fields associated with discharges are more significant than thought.

In order to insure that products are immune to real ESD events, it is necessary to test beyond the requirements of the mandatory standards using different discharge tips, coupling planes and other accessories.

Applicable Standards

Generic Immunity Standards, Product Standards and Product Family Standards require that ESD tests be performed in accordance with specific Basic Test Standards: IEC 801-2, IEC 1000-4-2 or EN 61000-4-2.

KeyTek's Application Note "EMC Standards Overview" provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and lists sources for procuring copyrighted documents.

Basic EMC Standards

The Basic EMC Standards for ESD define methods of generating consistently reproducible electrical stresses for test purposes. (Refer to ESD Testing per IEC 1000-4-2 Application Note.)

Applying Discharges

ESD is applied both directly to the Equipment Under Test (EUT) and indirectly, via horizontal and vertical coupling planes.

Direct coupling is performed with either a contact mode discharge to metal surfaces of the EUT (preferred method), or via an air discharge. In both cases, discharges must be made to all points and surfaces accessible to personnel during normal usage. Tests are performed using 10 single discharges per test point in the most sensitive polarity.

Indirect discharges are performed to simulate radiated ESD events to the EUT. Using the vertical coupling plane (VCP), at least 10 discharges to the center of the edge of the plane are required with the VCP positioned to completely radiate towards four faces of the EUT.

The horizontal coupling plane (HCP) is on the surface of the work table and is covered with a material to electrically insulate it from the EUT. Currently, a discharge is made to the surface of the HCP at a distance of 0.1m from each side of the EUT, however, an amendment is in process to modify this procedure and require discharges to be made to the center of the edge of the HCP.

Test Set-Up

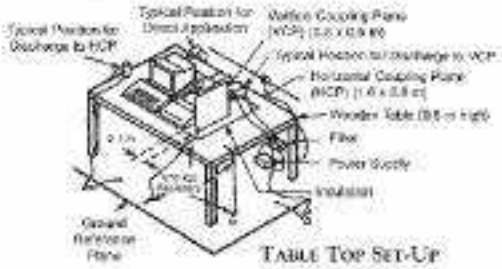
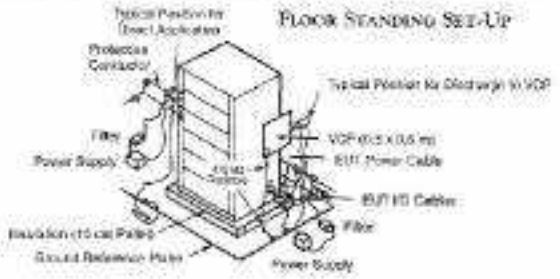


Table Top Set-Up



Floor Standing Set-Up

ESD Accessories for Testing Beyond IEC 1000-4-2

CM-ESD and PRO-ESD Tips

Simulator tips are included with CM-ESD and PRO-ESD for both contact mode testing (TPC-3) and air discharge testing (TPA-2) in accordance with IEC 1000-4-2. For very fast, real-world rise times, the TPA-1 for air discharge will provide rise times on the order of 0.4ns or faster.

A method used successfully for locating ESD and RF susceptibility problems is self-discharge: producing the spark associated with an air discharge, but without actually discharging to the equipment under test. This is done using the TPF-1 self-discharge tip in the vicinity of suspect cables, connectors, shields and the like.

Another useful tool is the 50-MZ standoff spacer for air-discharge testing. This allows the user to set the precise distance between the tip and the target equipment, useful for investigative work.

When trying to determine the real cause of an ESD immunity problem, it is useful to separate E-Field and H-Field effects. This is easily accomplished with the MZT-11 E-Field and MZT-12 H-Field Simulator Tip Assemblies.

In order to determine if fields are being generated and to observe the relative levels of those fields, the FCS-1 Field and Corona Sensor Group was developed. This option includes a basic monitor unit, HEC-1, H-Field Sensor, HFS-1, E-Field Sensor, EFS-1, and Pre-discharge Corona Sensor, CCS-1.

Coupling Planes

Two coupling planes, one horizontal and one vertical, are required for product testing in accordance with IEC 1000-4-2. The Horizontal Coupling Plane, a model HCP-1, is placed on a non-conductive table below the equipment being tested. A discharge to the HCP-1 will then cause a horizontally polarized field to be radiated up into the product being tested. A Vertical Coupling Plane, model VCP-1, is oriented at a fixed distance from the product being tested. A discharge is made to the edge of the VCP-1 causing a vertically polarized field to be radiated towards the product. All four sides of the product must be tested in this manner.

Another type of plane available as an accessory to the CM-ESD and PRO-ESD is the TP-3, a 1.5m x 1.5m Target Plane used with the CTC-3 ESD target for waveform verification. The CTC-3 is mounted in the center of the plane and the ESD current is monitored on an oscilloscope which is installed inside a Faraday cage.

Other Accessories

In order to obtain an independent measurement of the ESD voltage on the tip of the CM-ESD and PRO-ESD, a calibrated attenuator, such as the DCA-2 is required. With the attenuator in place, the output voltage can be read using any DC attenuator.

For customers planning to ship the CM-ESD and PRO-ESD between facilities on a regular basis, the MCA-1 Hard Carrying Case is recommended. No additional shipping materials are required. Secure the unit in the MCA-1, affix the proper labels, and call the shipper.

Some corporate standards require testing with hundreds or even thousands of discharges to a point on the equipment under test. A non-conducting tripod, such as the T-2, allows the CM-ESD and PRO-ESD simulator to be held steady against the equipment being tested, without interfering with the test results.

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KPS-674-A 4-98

KeyTek Application Note

EFT Testing per IEC 1000-4-4

EFT Background

Electrical Fast Transients (EFT) are caused anytime a gaseous discharge occurs (a spark in air or other gas), the most common being the opening of a switch through which current is flowing. As the switch is opened, arcing occurs between the contacts; first at a low voltage and high frequency while contacts are close together, and later at a higher voltage and lower frequency as the contacts become separated. Coupling of the EFT into electronic products occurs when power cables handling high currents are run in close proximity to power, data, and/or I/O cables.

Electronic products are tested for EFT immunity to insure their continued reliable operation if subjected to realistic levels of fast transients. The European Union's EMC Directive mandates EFT testing for virtually all electrical and electronic products as a condition for obtaining the CE Mark before shipping to a member state of the European Union.

Applicable Standards

Generic Immunity, Product and Product Family Standards require that EFT tests be performed in accordance with Basic EMC Standards: IEC 801-4, IEC 1000-4-4 or EN 61000-4-4[1]. KeyTek's Application Note, "EMC Standards Overview," provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and lists sources for procuring copyrighted documents.

[1] IEC 801-4, IEC 1000-4-4 and EN 61000-4-4 are essentially the same for test voltages and levels.

Basic EMC Standard

The Basic EMC Standards for EFT define methods of generating consistently reproducible fast transients for test purposes. They specify generator and coupler/decoupler design and performance in an attempt to produce correlational results between test sites. The Basic EMC Standard specifies how to perform EFT testing, the Generic, Product and Product Family Standards specify the test levels and pass/fail performance criteria.

Test Levels

Standard	Applicability	Test Voltage
EN 50082-1	Generic Immunity - Residential, Commercial and Light Industrial	1kV
EN 50082-1 Draft	Generic Immunity - Residential, Commercial and Light Industrial	1kV
EN 50082-2	Generic Immunity - Industrial Environment	2kV
EN 50082-2 Draft	Generic Immunity - Industrial Environment	2kV
EN 55104	Immunity for Household Appliances, Tools and Similar Apparatus	1kV

Test Set-Up

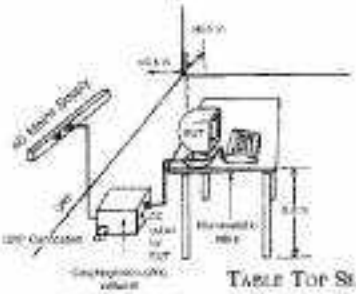
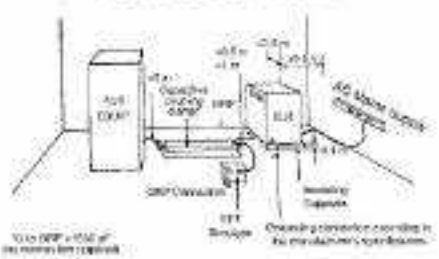


Table Top Set-Up

Floor Standing Set-Up



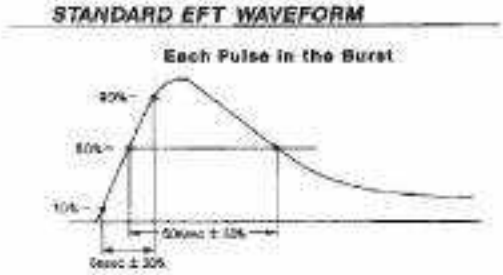
EFT Testing per IEC 1000-4-4

Coupling Methods

Capacitive Coupling via 33nF capacitors is the required coupling method to AC or DC power mains. These coupling capacitors are included as part of a Coupler/ Decoupler (C/D) in commercially available EFT simulators. The design of the decoupling portion of the C/D, which prevents the EFT burst from traveling back onto the power mains, is also specified in IEC 1000-4-4.

A Capacitive Coupling Clamp is used to couple EFT bursts onto data, I/O, and telecommunications lines. Construction of the clamp is shown in Figure 5 of IEC 1000-4-4; however, considerable differences exist in commercially available clamps. Some clamps use higher quality materials and some designs allow for the use of an optional safety interlocked cover.

Waveforms



Waveform Verification

IEC 1000-4-4 requires that the simulator output be verified periodically. A 50 ohm load and attenuator rated for high voltage is required and the measurement must be made using an oscilloscope with at least 400MHz bandwidth.

One problem noted with IEC 1000-4-4 is that simulator designs can be quite different and although each has a 50 ohm source impedance and provides the specified pulse into a 50 ohm termination, some simulators provide significantly more or less energy than others into loads that are not 50 ohms - the AC power input of most electronic products is something other than 50 ohms. To deal with the problems, changes to the standard were proposed to require waveforms be verified into a 1000 ohm load. Unfortunately, these changes were not accepted; however, this and other proposed improvements to IEC 1000-4-4 will be included in a forthcoming Annex.

Test Execution

According to IEC 1000-4-4, testing must be carried out according to the manufacturer's test plan, which shall specify:

Type of test	Test levels
Polarity *(+ & - required)*	Test duration (1 minute minimum)
Number of Voltage tests	EUT ports
EUT operating condition	Sequence to tests to ports, etc.
Auxiliary equipment	

EUT Performance Criteria

For EFT tests, the Generic Immunity Standards and Household Appliances Product Family Standard require that products operate as intended after the test. No degradation or loss of function is allowed below a performance level specified by the manufacturer. During the test, degradation is allowed, but not a change in the actual operating status or data storage. Refer to the tables located in the Generic, Product and Product Family Standards for specific Performance Criteria. The product cannot become unsafe under any conditions.

EFT Simulators

EFT Simulators produced by KeyTek Instrument Corporation meet all the simulator requirements of IEC 1000-4-4, including discharge pulse energy, output type, dynamic source impedance, and all waveform characteristics. Additionally, KeyTek simulators meet the requirements for coupling/decoupling networks for AC and DC mains as described in paragraph 6.2 of IEC 1000-4-4. Contact KeyTek for details.

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KPS-665-A-10-97

KeyTek Application Note

EMC Standards Overview

An Overview

The European Union's EMC Directive requires that virtually all electronic and electrical products be tested for immunity to both man-made and natural phenomena and to insure that products do not emit unintentional signals that may interfere with the continued, reliable operation of other products.

In order to accomplish this objective, CENELEC (an acronym for Comité Européen de Normalisation Electrotechnique) was tasked with identifying the standards to be applied. CENELEC in conjunction with the IEC (International Electrotechnical Commission) and CISPR (Comité International Spécial des Perturbations Radioélectroniques) have defined a series of Product Standards, Product Family Standards, and Basic EMC Standards for use in complying with the EMC Directive.

Compliance with the EMC Directive will require products be tested in accordance with European Norms, or ENs, issued by CENELEC. These ENs are not developed by CENELEC but are IEC and CISPR standards redesignated as ENs. For example, Basic EMC Standard IEC 1000-4-2 becomes EN 61000-4-2; Basic EMC Standard CISPR 22 becomes EN 55022.

The IEC

The IEC or International Electrotechnical Commission is a worldwide standards writing organization. Membership includes most industrialized nations and is open to any nation that wishes to contribute and supply a technical expert.

Within the IEC are Technical Committees, each tasked with developing and maintaining specific types of standards. Most Basic EMC Standards for immunity are developed by the IEC, as are most Product and Product Family Standards.

CISPR

CISPR is a special part of the IEC tasked with the development of standards dealing with unwanted radiated emissions in the RF (radio frequency) spectrum. The objective of CISPR standards is to limit the amount of undesirable RF emanating from electrical and electronic products, and therefore limit the amount of interference to other electronic products. Most Basic EMC Standards for radiated emissions are written by CISPR Technical Committees.

The Standards

There are three types of EMC Publications:

Product Standards
Product Family Standards (including Generic Standards)
Basic EMC Publications

EMC Standards Overview

Product Standards

Product EMC Standards relate to a particular type of product, system or installation for which specific conditions must be considered. Product EMC Standards include:

- Resistance Welding equipment
- Measuring Relays and Protection equipment

Product Standards have priority over Product Family and Generic Standards; however, where no Product Standard or Product Family Standard exists for a particular product, the relevant Generic Standard will apply.

Product Family Standards

Product Family Standards apply to products of a particular category such as:

- Household appliances and portable tools
- ITE (Information Technology Equipment)
- Audio, video, audio-visual and entertainment lighting control apparatus for professional use

Product Family Standards have priority over Generic Standards; however, where no Product Family EMC Standard exists for a particular product family, the relevant Generic Standard will apply.

Generic Standards

Generic EMC Standards are a special type of Product Family Standard which apply to products operating in a particular environment for which no dedicated Product or Product Family Standard exists. They specify a set of essential requirements, test procedures and generalized performance criteria applicable to products or systems operating in this environment.

The Generic EMC Standards include: EN 50082-1, EN 50082-2, EN 50081-1 and EN 50081-2 which cover immunity and emissions testing for commercial, residential and light industrial environments, as well as for industrial environments.

Basic EMC Publications

Basic EMC Publications may be standards or technical reports which, by definition, are NOT dedicated to specific product families, products, systems or installations. They may concern:

- Terminology
- Descriptions of electromagnetic phenomena
- Specification of compatibility levels (NOT compliance levels)
- General requirements for the limitation of emissions
- Recommendations for test levels for immunity
- Measurement and test techniques
- Descriptions and classification of the environment

Basic EMC Publications include Basic EMC Standards such as the IEC 1000-4-X Series, CISPR 22, CISPR 11, and others. (IEC 1000-4-X Series will become IEC 61000-4-X as new standards are developed and current ones revised.)

Other Directives

In addition to the EMC Directive, there are other directives to which manufacturers of electrical and electronic products may have to comply:

Safety Directives: Machinery Directive
Low Voltage Directive

Each product must comply with the safety directive that is most applicable. Products which can be classified as machinery should comply with the Machinery Directive, and those products that can be classified as electrical or electronic products will have to meet the Low Voltage Directive. The manufacturer is required to determine which is most applicable for each product.

Other directives include:

- Toy Directive (already in force)
- Medical Devices Directive (medical electronics)
- Telecommunications Directive (telecom products)
- Automotive Directive (vehicles and vehicle electronics)

Standard Document Sources

Standards may be obtained directly from the issuing body - the IEC or CENELEC, or from your national standards organization. In the United States it is the American National Standards Institute (ANSI) at + (1) 212-642-4900; in the United Kingdom it is the British Standards Institute (BSI). Commercial sources include The Document Center in the United States at + (1) 415-591-7600.

In order to maintain an up-to-date Standards file, contact ERA Technology Ltd. in the United Kingdom at +(44) 1372 367018 and request a subscription to the Safety and EMC newsletter.

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KeyTek Application Note

Standard Selector Guide

Product and Product Family Standards

As of January 1, 1996, all electrical or electronics products shipped into the European Union that could either cause electromagnetic interference (EMI) or could be susceptible to EMI, must be tested to ensure adherence to the EMC Directive. (If a manufacturer believes that a product does not cause EMI and is not affected by EMI, the onus is on the manufacturer to substantiate his claims.)

In order to comply with the EMC Directive, the following products listed must conform to applicable Product or Product Family Standards. If no Product or Product Family Standards exist, the product must comply with the Generic Immunity and Emissions standards. These generic standards are divided into two areas:

Environment	Generic Emissions	Generic Immunity
Residential, commercial, and light industrial	EN 50081-1	EN 50082-1
Industrial	EN 50081-2	EN 50082-2

Residential, Commercial and Light-Industrial Environments

EN 50081-1, the generic emission standard for residential, commercial and light industrial states that:

"The environments encompassed by this standard are residential, commercial and light-industrial locations, both indoor and outdoor. The following list, although not comprehensive, gives an indication of locations, which are included:

- residential properties, e.g. houses, apartments
- retail outlets, e.g. shops, supermarkets
- business premises, e.g. offices, banks
- areas of public entertainment, e.g. cinemas, public bars, dance halls
- outdoor locations, e.g. petrol stations, car parks, amusement and sports centres
- light-industrial locations, e.g. workshops, laboratories, service centres

Locations which are characterized by being supplied directly at low voltage from the public mains network are considered to be residential, commercial or light industrial."

Industrial Environment

EN 50081-2, the generic emission standard for the industrial environment states that:

"Apparatus covered by this standard is not intended for connection to the public mains network but is intended to be connected to a power network supplied from a high or medium-voltage transformer dedicated for the supply of an installation feeding manufacturing or similar plant."

Industrial locations are characterized by the existence of one or more of the following conditions:

- industrial, scientific and medical (ISM) apparatus
- heavy inductive or capacitive loads are frequently switched
- currents and associated magnetic fields are high

These are the major contributors to the industrial electromagnetic environment and as such distinguish the industrial from other environments.

ISM equipment is defined in EN 55011, Annex A as:

"... suitable for use in all establishments other than domestic and those connected to a low voltage power supply network which supplies buildings used for domestic purposes."

Some examples from Appendix A of EN 55011 for ISM equipment include: signal generators, measuring receivers, spectrum analyzers, chemical analysis machines and switched mode power supplies. Examples of general equipment include: industrial induction heating equipment, industrial microwave heating equipment, medical apparatus (specifically short-wave therapy equipment and microwave therapy equipment), spark erosion equipment, and spot welders.

Some overlap exists in the definitions of the two categories and it is up to the manufacturer to use the best judgement in selecting the appropriate category. The manufacturer always has the final responsibility in assuring compliance with the directive.

Standard Selector Guide

	Emissions			Immunity
Product Category	AC Power harmonic currents	Voltage Flicker	RF Emissions	ESD, EFT, Surge, and RF Immunity
Audio equipment	EN 60555-2 will become EN 61000-3-2	EN 60555-3 will become EN 610003-3	EN 55013	EN 50082-1
Household appliances and portable tools, e.g. vacuum cleaners, washing machines, heating and cooking appliances, dimmers	EN 60555-2 will become EN 61000-3-2	EN 60555-3 will become EN 610003-3	EN 55014	EN 55104
Industrial electronic power and control equipment	EN 61000-3-2	EN 61000-3-3	EN 50081-2	EN 50082-2
Industrial non electronic equipment e.g. commutator motors	EN 61000-3-2	EN 61000-3-3	EN 50081-2	EN 50082-2
Industrial, Scientific and Medical (ISM) equipment designed to generate radio frequency energy	EN 61000-3-2	EN 61000-3-3	EN 55011	EN 50082-1 or EN 50082-2
Information Technology Equipment (ITE)	EN 61000-3-2	EN 61000-3-3	EN 55022	EN 50082-1 or EN 50082-2
Lifts	—	—	prEN 12015	prEN 12016
Lighting equipment	EN 60555-2 will become EN 61000-3-2	EN 61000-3-3 for disco lighting etc	EN 55015	EN 50082-1 will be EN 61547 in the future
Medical Equipment	—	—	EN 60601-1-2	EN 60601-1-2
Power Mains signaling equipment	EN 61000-3-2	—	EN 50065-1	EN 50082-1
Professional Audio Visual Equipment	—	—	prEN 55103-1	prEN 55103-2
Residential and Light Industrial equipment	EN 61000-3-2	EN 61000-3-3	EN 50081-1	EN 50082-1
TV and Radio Receivers	EN 60555-2 will become EN 61000-3-2	EN 60555-3 will become EN 610003-3	EN 55013	EN 55020

Product and Product Family Standards for Immunity Maximum Required Test Levels

IEC	ESD	EFT	Surge Combination Wave	Surge Telecom Wave	Power Frequency Magnetic Field	Pulse Magnetic Field	Dips & Interrupts	100kHz Ring Wave
EN 50082-1: Jan 92 Generic Immunity – Residential, Commercial, and Light Industrial	8kV air discharge	1kV	–	–	–	–	–	–
prEN 50082-1: Oct 96 Generic Immunity – Residential, Commercial, and Light Industrial	4kV contact mode 8kV air discharge	1kV	2kV common mode 1kV differential mode	– –	3A/m –	– –	40% and 70% Dips; Interrupts to 0	–
EN 50082-2: 1995 Generic Immunity – Industrial Environment	4kV contact mode 8kV air discharge	2kV	– 1kV differential mode	– –	30A/m "	– "	–	–
prEN 50082-2: Aug 96 Generic Immunity – Industrial Environment	4kV contact mode 8kV air discharge	2kV	4kV common mode 2kV differential mode	– –	30A/m –	– –	40% and 70% Dips; Interrupts to 0	–
EN 55104 Immunity – Household Appliances, Tools and Similar Apparatus	4kV contact mode 8kV air discharge	1kV	2kV common mode 1kV differential mode	– –	– –	– –	40% and 70% Dips; Interrupts to 0	–

Drag

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KeyTek Application Note

Power Frequency Magnetic Field Testing per IEC 1000-4-8

Power Frequency Magnetic Field Background

Electronic products are often subjected to magnetic fields at AC mains frequencies. These fields are frequently produced in the vicinity of power transformers and can cause problems with video displays, Hall effect sensors, and other electronic products having a sensitivity to magnetic fields.

Electronic Products are tested for immunity to power frequency magnetic fields to insure their continued reliable operation when placed in service. The European Union's EMC Directive currently mandates power frequency magnetic field testing for certain categories of equipment as a condition for obtaining the CE Mark before shipping products to member states of the European Union.

Applicable Standards

Generic Immunity, Product and Product Family Standards require that Power Frequency Magnetic Field tests be performed in accordance with Basic EMC Standards: IEC 1000-4-8 and EN 61000-4-8. KeyTek's Application Note, "EMC Standards Overview," provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and list sources for procuring copyrighted documents.

Basic EMC Standard

The Basic EMC Standard for Power Frequency Magnetic Field defines methods of generating consistently reproducible magnetic fields for test purposes. Although higher magnetic field levels are described, compliance to the Generic Immunity Standard for residential and commercial products is 1A/m or 3A/m. Currently applicable only to apparatus containing devices susceptible to magnetic fields, testing of other products may be required to make that determination. While the Basic EMC Standard specifies how to perform Power Frequency Magnetic Field testing, the Generic, Product and Product Family Standards specify the test levels and pass/fail performance criteria.

Test Levels

Power Frequency Magnetic Field testing is required for products that could be affected by magnetic fields, including CRTs and Hall Effect Sensors and is strongly recommended for all products.

Standard	Applicability	Magnetic Field Level
EN 50082-1	Generic Immunity - Residential, Commercial and Light Industrial	Not required
EN 50082-1 Draft	Generic Immunity - Residential, Commercial and Light Industrial	3A/m
EN 50082-2	Generic Immunity - Industrial Environment	30A/m
EN 50082-2 Draft	Generic Immunity - Industrial Environment	30A/m
EN 55104	Immunity for Household Appliances, Tools and Similar Apparatus	Not required

Test Set-Up

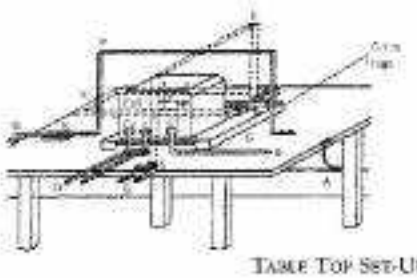
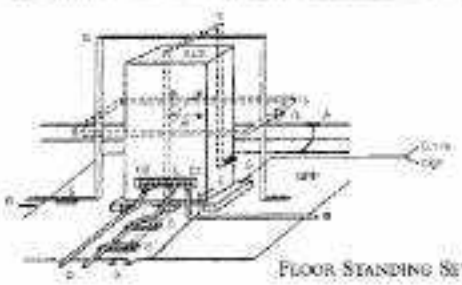


Table Top Set-Up



Floor Standing Set-Up

Power Frequency Magnetic Field Testing per IEC 1000-4-8

Coupling Methods

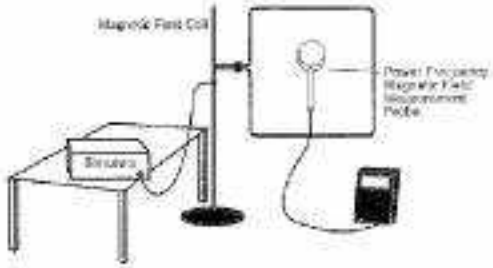
An Induction Coil having standard dimensions of 1 meter per side for a rectangular coil, or 1 meter diameter for a circular coil, is to be used for testing small equipment. For large equipment, larger dimensions may be used; however, the coil shall be able to envelop the EUT and the coil dimensions must give a minimum distance of coil conductors to EUT walls equal to 1/3 of the dimension of the EUT being tested.

Waveforms



Waveform Verification

IEC 1000-4-8 requires that the simulator output and magnetic field be verified periodically. Any oscilloscope is capable of verifying the power frequency AC current to the coil. Monitoring the actual field requires an AC field probe and monitor, such as the CM-HMON available from KeyTek.



Test Execution

According to IEC 1000-4-8, tests must be performed in compliance with the manufacturer's test plan, which shall specify:

- How the test is carried out
- Verification of the laboratory reference conditions
- Preliminary verification of the correct operation of the EUT
- An evaluation of the test results

EUT Performance Criteria

For Power Frequency Magnetic Field tests, the Generic Immunity Standards require that the product continue to operate as intended during the test, however, CRT interference is allowed above 1A/m in the residential, commercial and light industrial draft standard, and above 3A/m in the industrial standard. No degradation or loss of function is allowed below a performance level specified by the manufacturer. The performance level may be replaced by a permissible loss of performance. Refer to the tables located in the Generic, Product and Product Family Standards for specific Performance Criteria. The product cannot become unsafe under any conditions.

Power Frequency Magnetic Field Simulators

Power Frequency Magnetic Field Simulators and standard coils provided by KeyTek Instrument Corporation meet all the minimum requirements for performing tests to >3A/m in compliance with the applicable Generic and Product Family Standards.

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KeyTek Application Note

Pulse Magnetic field Testing per IEC 1000-4-9

Pulse Magnetic Field Background

Pulse Magnetic Fields are produced as a result of a large current impulse through a conductor. An example is lightning current flowing through a grounding conductor at a power sub-station. Pulse magnetic fields can also occur in heavy industrial areas where very large current impulses are used in a manufacturing process.

Electronic products are tested for immunity pulse magnetic fields to insure their continued reliable operation when placed in service in a very harsh environment. Although most electrical and electronic products will not have to be tested for pulse magnetic field immunity, the European Union's EMC Directive may mandate this testing as a condition for obtaining the CE Mark under special circumstances and for specific products before shipping to a member state of the European Union.

Applicable Standards

Although not currently required by Generic Immunity, Product specific, or Product Family Standards, future standards may require Pulse Magnetic Field tests be performed in accordance with Basic EMC Standards: IEC 1000-4-9 and EN 61000-4-9*. KeyTek's Application Note, "EMC Standards Overview," provides an overview of European Standards for electromagnetic compatibility, describes how the Standards relate to one another, and lists sources for procuring copyrighted documents.

* IEC 1000-4-9 and EN 61000-4-9 are virtually identical standards.

Basic EMC Standard

The Basic EMC Standard for Pulse Magnetic Field defines methods of generating consistently reproducible current impulses for test purposes. Field amplitudes required by these standards range from 100 - 1000 Amps per meter. Although applicable only to apparatus containing devices susceptible to magnetic fields, testing may be required to make that determination.

Test Levels

Installation Environment	IEC 1000-4-9 Level	Field Strength A/m
Environment where sensitive devices using electron beams can be used	1	N/A
Residential, office and hospital areas far away from earth conductors of lightning protection systems	2	N/A
Commercial areas, control building, field of industrial plants with lightning protection system or metallic structures nearby	3	100
Heavy industrial and power plants and H.V. sub-station control rooms	4	300
Switchyard areas of heavy industrial plants	5	1000
Higher or lower environmental levels than those described above	X	X

Test Set-Up

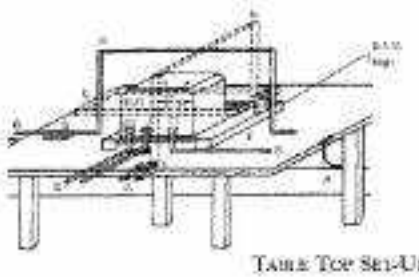
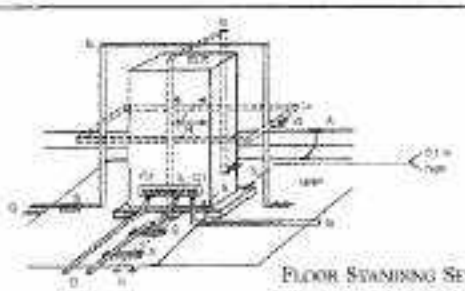


Table Top Set-Up



Floor Standing Set-Up

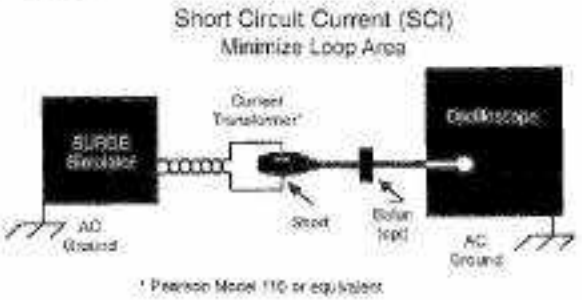
Pulse Magnetic Field Testing per IEC 1000-4-9

Coupling Methods

An Induction Coil having a standard dimension of 1 meter per side for a rectangular coil, or 1 meter diameter for a circular coil, is to be used for testing small equipment. This coil has a test volume of 0.6m x 0.6m x 0.5m (h). For floor standing equipment, larger dimensions can be used; however, the coil shall be able to envelop the EUT and the coil dimensions must give a minimum distance of coil conductors to EUT walls equal to 1/3 of the dimension of the EUT being tested.

Waveform Verification

Basic test standards require that the simulator output be verified periodically. In the case of the Pulse Magnetic Field, verification is accomplished by verifying the amplitude of the 8/20μs current pulse driving the coil. An appropriate current transformer (Pearson Model 110 or equivalent) and an oscilloscope with a bandwidth of >100MHz capable of displaying a single pulse are required.



Test Execution

According to IEC 1000-4-9, tests must be performed in compliance with the manufacturer's test plan, which shall specify:

- How the test is performed
- Verification of the laboratory reference conditions
- Preliminary verification of the correct operation of the EUT
- An evaluation of the test results

Test Applicability

According to Annex A of IEC 1000-4-9, test levels shall be selected in accordance with the most realistic installation and environmental conditions. Tests are recommended for equipment operating in areas characterized by proximity of conductors of lightning protection systems and or structures, or the proximity of conductors, bus-bars or medium to high voltage lines carrying tens of kA.

Pulse Magnetic Field Simulators

Pulse Magnetic Field Simulators and standard coils provided by KeyTek Instrument Corporation meet the pulse waveform and amplitude requirements for testing to >1000A/m in accordance with IEC 1000-4-9. Consult KeyTek for larger coils used for testing floor standing equipment. Contact KeyTek for details.

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PULSED EMI

Models CM-ESD and PRO-ESD ACCESSORIES

Electrostatic Discharge



ESD accessories for Electrostatic Discharge (ESD) testing beyond IEC 1000-4-2 with the CEMASTER® and EMCPro™ Compliance-Level Immunity Test Systems.

CM-ESD and PRO-ESD ACCESSORIES

Diagnostic E and H-Field Simulation

- **MZT-11** – E-Field Simulation Tip:
  Provides repeatable, local **static** E-Field simulation for interrogating high-impedance circuits for upsets due to various levels of fixed or slowly changing electric fields.

  Provides repeatable, fast rise time, local **dynamic** E-Field simulation, while simultaneously minimizing the effects of local ESD-generated H-Fields. The purpose is to isolate circuits sensitive to real-world ESD E-Fields, which often have sub-nanosecond edges.

- **MZT-12** – H-Field Simulation Tip provides repeatable, local dynamic H-Field simulation, while simultaneously minimizing the magnitude of local ESD-generated E-Fields. Analogous with dynamic E-Field simulation, the purpose of diagnostic H-Field simulation is to isolate circuits sensitive to real-world ESD H-fields, which often have super-fast rise times.

Vertical & Horizontal Coupling Plane For Indirect ESD Testing

- **VCP-1** – Vertical Coupling Plane for indirect ESD tests per IEC 1000-4-2 is used to simulate the effects of human body ESD events to metal objects adjacent to an EUT. The specified 0.5 x 0.5m vertical coupling plane includes: insulation at back of plane for personal protection, convenient bench stand for hands-off testing, handles and camera tripod mount to facilitate off-bench use.

- **HCP-1** – Horizontal Coupling Plane for indirect ESD tests per IEC 1000-4-2 is used to simulate the effects of human body ESD events to a metal bench or desk on which the EUT may be resting. The specified 1.6 x 0.8m horizontal coupling plane includes a roll of <.5mm thick, static-dissipative sheet insulator for use above the plane for personal protection (meets IEC 1000-4-2 insulation thickness requirements).

Models CM-ESD and PRO-ESD ACCESSORIES

Air Discharge and Contact Mode Testing

TPC-3: Replacement contact mode tip for direct ESD tests in accordance with the rise times specified in IEC 1000-4-2 (0.7 - 1ns)

TPA-2: Replacement air discharge tip for ESD tests in accordance with IEC 1000-4-2

Calibration Testing

CTC-3: Coaxial current monitor: IEC 1000-4-2 coax monitor for ESD current waveform, with 1GHz capability. Includes high-peak-power attenuator and low loss scope cable. IEC and ANSI require mounting the target in a 1.5m x 1.5m plane. See TP-3 accessory

FCS-1: Field and Corona Sensor Group: Common Monitor Unit HEC-1, H-Field sensor HFS-1, E-Field sensor EFS-1 and Pre-Discharge corona sensor CCS-1

DCA-2: DC Output Calibration Attenuator for an independent measurement of the ESD voltage on the tip of the CM-ESD

Additional Options

TP-3: Full, 1.5m x 1.5m (59" x 59") IEC 1000-4-2 and ANSI C63.16 Target Plane, for mounting the CTC-3 coaxial target

T-2: A non-conducting tripod which holds the CM-ESD or PRO-ESD simulator steady against equipment being tested with hundreds of discharges at a single point, without interfering with the test results

MCA-1: Hard Carry Case (does not include space for VCP-1, HCP-1, T-2 or TP-3)

Minimum System Requirements

CE*MASTER*: CM-BASE and CM-ESD with CM-SW or CM-FP

EMC*PRO*: PRO-BASE and PRO-ESD

For additional **CE*MASTER*®** *and* **EMC*Pro*™** *literature, call, email or fax the KeyTek sales department.*

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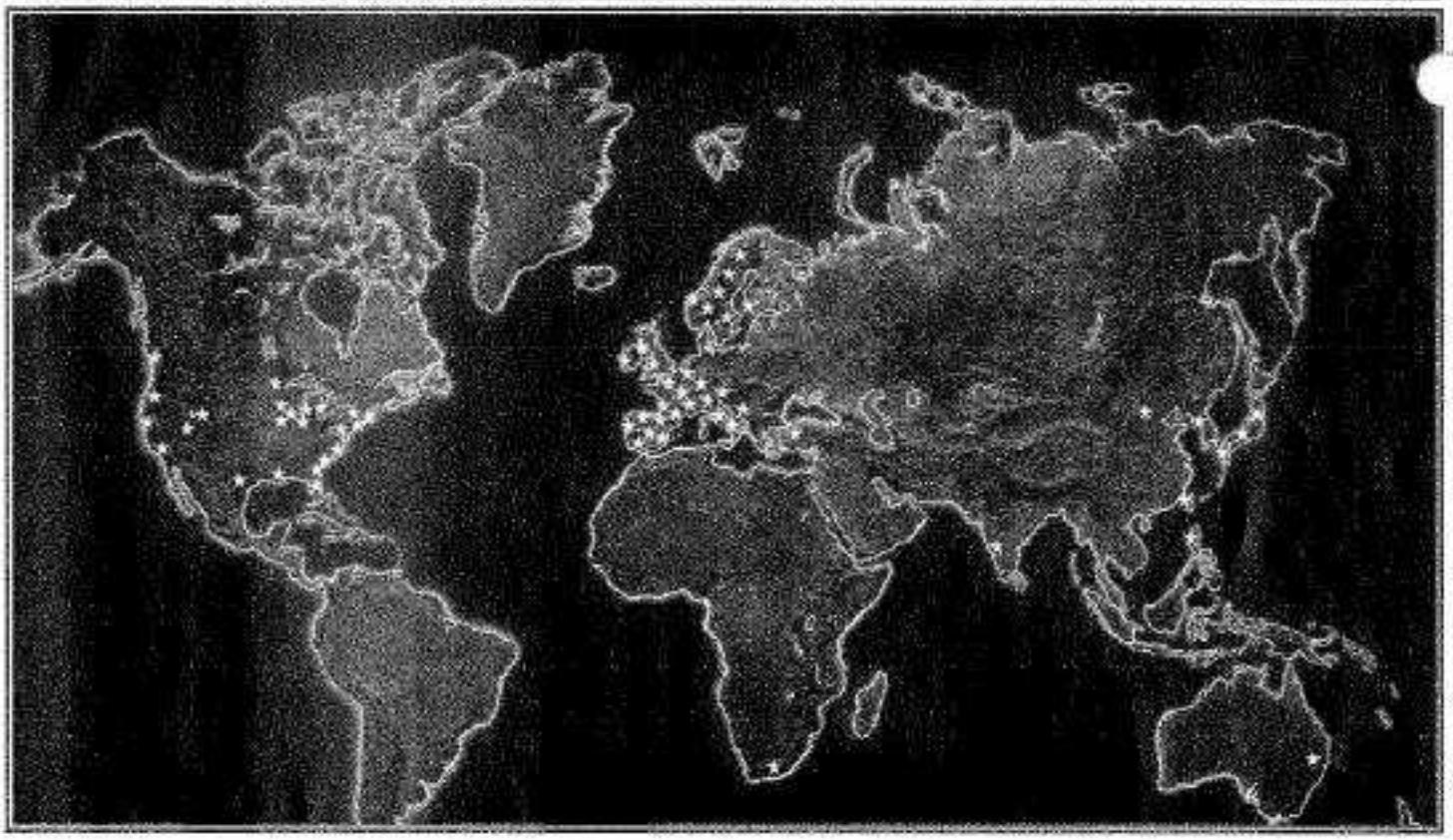
KeyTek EMC Immunity Test System

SELECTOR GUIDE

Standards	Test Purpose & Description	MiniZap®	CERMASTER®	EMCPro®	ECAT®	G-STAR®	XCELL®
IEC 1000-4-2 Electrostatic Discharge	Requirements for simulating human ESD. Contact mode preferred for direct ESD; contact mode only for indirect ESD	15kV air 8kV contact	8.8kV air 4.4kV contact	8.8kV air 4.4kV contact	16kV air 8kV contact	*	*
IEC 1000-4-3	Radio frequency radiated immunity test (pre-compliance)	*	*	*	*	450MHz to 1GHz to 20V/m	*
IEC 1000-4-3	Radio frequency radiated immunity test (compliant)	*	*	*	*	*	26 MHz to 1GHz to 20V/m
IEC 1000-4-4 Electrical Fast Transients	Requirements for simulating "antiseal" showering arc, on both power and I/O (data and signal) lines	*	2.5kV	4.4kV	8kV	*	*
IEC 1000-4-5 ANSI C62.41 Surge 1.2/50us, 8/20us Combination Wave Category B	Requirements for simulating surges on both power and I/O (data and signal) lines	*	2.5kV	6kV	22kV	*	*
IEC 1000-4-5 Surge 10/700µs Telecom Wave	Requirements for simulating surges on telecommunication lines	*	*	6.6kV	7kV	*	*
IEC 1000-4-6	Radio frequency conducted immunity test (compliant)	*	*	*	*	IEC levels 1, 2 & 3 to 10V	*
IEC 1000-4-8 Power Frequency Magnetic	Magnetic fields generated by AC power mains	*	4A/m	4A/m	*	*	*
IEC 1000-4-9 Pulse Magnetic Fields	Simulates pulsed fields found in power stations, substations and other environments where very high transients occur	*	800A/m	1000A/m	> 1000A/m	*	*
IEC 1000-4-11 Dips and Interrupts	Simulates voltage fluctuations of the mains	*	70%, 40%,	70%, 40%, 0% short and open	150%, 120%, Dips 110%, 100%, 90%, 80%, 70%, 40%, 0% short and open	*	*
ANSI C62.41 Surge Ring Wave Category A, B	Requirements for simulating 100kHz ring wave	*	*	6.6kV	6.6kV	*	*
EN55011, EN55022, EN55014, FCC Part 15	Radio frequency radiated emission testing (pre-compliance)	*	*	*	*	100kHz to 1GHz	26MHz to 1GHz
CCITT Rec. K.17, K.20, K.21 Surge 10/700µs Telecom Wave	For qualifying telecom repeaters, central office and station (i.e., subscriber) equipment	*	*	6.6kV	7kV	*	*
UL 1449 Surge Combination Waves	Qualification tests for AC powerline protectors. Three levels of 6kV combination wave required: 3kA, 250A and 500A	*	*	3kA	3kA, 250A, 500A	*	*
FCC Part 68 Telecom	For qualifying telecom equipment; specifies surge tests on telecom lines	*	*	*	10/160µs waveform, 1500V; 10/560µs waveform, 800V	*	*
FCC Part 68 Power Lines	For qualifying telecom equipment; specifies surge tests on power lines	*	*	*	2/10µs waveform, 2500V	*	*
GR-1089-CORE Purpose	Surge test requirements for telecom equipment installed in various locations	*	*	*	2/10µs waveform, 800V, 1500V, 5000V (AC mains) 10/360µs waveform 1000V 10/1000µs waveform 600V, 1000V, 1500V	*	*

* Not applicable

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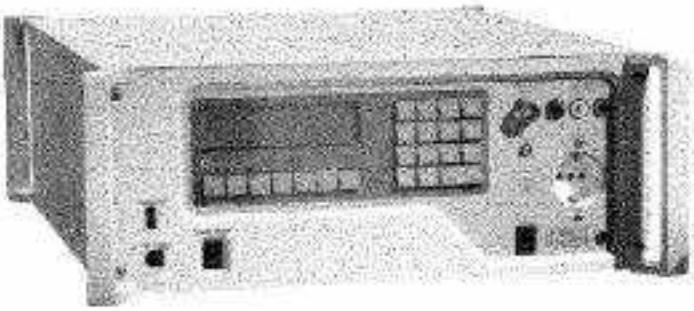
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CE*MASTER*®

Model CM-HPWR

Power Frequency Magnetic Field



Provides Power Frequency Magnetic Field test capability to IEC 1000-4-8 for the CE*MASTER*® Compliance-Level Immunity Tester.

FEATURES

- **Provides compliance-level** testing to meet the requirements of the EMC Directive and obtain the CE Mark.
- **Exceeds test levels** outlined in the Generic Immunity and Product Family Standards for power frequency magnetic fields.
- **Generates 50 or 60Hz fields** independent of input mains frequency.
- **Configurable** with any combination of 5 additional immunity test standards in a single tester.
- **Computer control** via software or front panel.
- **Predefined IEC test routines** from both software and front panel control.
- **Windows®** 3.1 and 95 based application software and/or front panel keypad and graphics display.
- **Optional** low cost coil (CM-HCOIL) is calibrated to the CE*MASTER*.

SYSTEM BENEFITS

- **Batch IEC test sequences** significantly reduce test throughput times by running entire IEC test sequences in a single pass.
- **Pre-programmed IEC 1000-4-8 test routines** save time and decrease the potential for human error.
- **Automatic compliance report generation, using option CE*Ware*™**, provides Power Frequency Magnetic Field test results in a format suitable for archiving CE Mark test records.
- **Light weight, ergonomic design** provides maximum flexibility for operating the CE*MASTER* from a table top, floor or within a 19-inch rack.
- **Portable architecture** with rugged handles and optional transit case enables users to transport the tester between test departments or to remote facilities.

Model CM-HPWR

OUTPUT SPECIFICATIONS AND TOLERANCES

Electrical

Field Frequency:	50/60Hz
Field Amplitude:	0.5 to 4.0A/m in 0.25A steps, ±10% accuracy (with CM-HCOIL)
Coil Factor:	0.65 to 1.00 (Maximum output 4.0A/m with coil factor 0.8 linearly derated to 3.25A/m with coil factor 0.65)
Coil Resistance:	0.05Ω maximum
AC Source:	Internal to CE*MASTER*

Waveform Verification

Basic test standards require that the simulator output be verified periodically. For magnetic fields, it is only the amplitude that needs to be verified. This is accomplished with KeyTek's CM-HMON or other commercially available magnetic field probe and monitor.

Minimum System Requirements

CM-BASE with CM-SW or CM-FP

AVAILABLE OPTIONS

CM-HCOIL:	1m by 1m coil used to produce the magnetic fields
CM-HMON:	Magnetic field measurement instrument for verifying the amplitude of the magnetic fields produced by the CM-HPWR Module
HPOWER-EXT:	External generator for power frequency magnetic field to 30A/m

AN AFFORDABLE EMC IMMUNITY TESTER THAT DOES IT ALL

The CE*MASTER*® is designed from the ground up to provide compliance-level testing to the standards manufacturers must meet in order to compete in today's international marketplace.

Each CE*MASTER* is custom configured to meet your specific needs and budget requirements. When completely configured, the CE*MASTER* provides compliance-level testing to IEC 1000-4-X Series Immunity Standards for:

- IEC 1000-4-2 ESD
- IEC 1000-4-4 EFT
- IEC 1000-4-5 Surge
- IEC 1000-4-8 Power Frequency Magnetic Field
- IEC 1000-4-9 Pulse Magnetic Field
- IEC 1000-4-11 Dips & Interrupts

CE*MASTER* Platform (CM-BASE)

Ratings and Power Requirements

Coupler/Decoupler

AC Voltage:	50 to 250V, 50/60Hz
AC Current:	16A continuous
DC Voltage:	0 to 100V
DC Current:	10A continuous
EUT Connectors:	NEMA 5-15, CEE7 ("Schuko") or BS 1363 (British Standard)

Power Requirements

Input Voltage:	90-250VAC, 50/60Hz
Input Current:	1A at 120VAC; 0.5A at 240VAC

For additional CE*MASTER*® *literature, call, email or fax the KeyTek sales department.*

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KPS-108B-11/97

CE*MASTER*®

Model CM-ESD

Electrostatic Discharge



Provides Electrostatic Discharge (ESD) test capability to IEC 1000-4-2 for the CE*MASTER *Compliance-Level Immunity Tester.

FEATURES

- **Provides compliance-level** testing to meet the requirements of the EMC Directive and obtain the CE Mark.
- **LED voltage display** directly samples and indicates actual tip voltage.
- **Configurable** with any combination of 5 additional immunity test standards in a single tester.
- **Predefined IEC test routines** from both software and front panel control.
- **Windows**® 3.1 and 95 based application software and/or front panel keypad and graphics display.
- **Built-in shot counter and timer**
- **Premium storage case** for ESD simulator and accessories.
- **Portable**, light weight design for ease of use.

SYSTEM BENEFITS

- **Batch IEC test sequences** significantly reduce test throughput times by running entire IEC test sequences in a single pass.
- **Pre-programmed IEC 1000-4-2 test routines** save time and decrease the potential for human error.
- **Automatic compliance report generation, using option CE*Ware***™, provides ESD test results in a format suitable for archiving CE Mark test records.
- **Built-in shot counter and timer** provides optimum control over the number of shots delivered to the EUT and time between test events.
- **Light weight, ergonomically designed** CM-ESD provides a comfortable, easy to use device capable of continuous testing.

Model CM-ESD

OUTPUT SPECIFICATIONS AND TOLERANCES

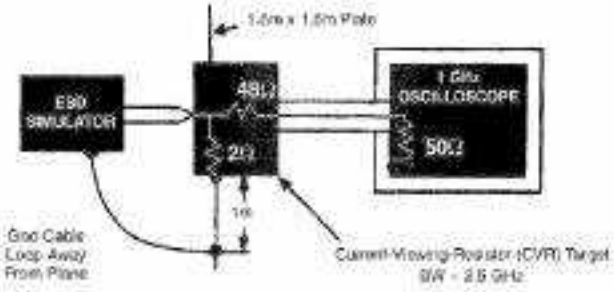
CM-ESD

ELECTRICAL

Peak Air Discharge:	500V to 8.8kV; 1V resolution, ±5% accuracy
Peak Contact Discharge:	500V to 4.4kV; 1V resolution, ±5% accuracy
Rise Time:	0.7 to 1ns
Repetition Rate:	Single-shot, 1 pulse/second and 20 pulses/second
Accessories:	See ESD Accessory Sheet

WAVEFORM VERIFICATION

The basic test standards require that the simulator output be verified periodically. A Model CTC-3 measurement target and target plane is required for ESD current waveform verification. The ESD current measurement is then made using an oscilloscope having a 1GHz or greater bandwidth.



MINIMUM SYSTEM REQUIREMENTS

CM-BASE with CM-SW or CM-FP

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- IEC 1000-4-4 EFT
- IEC 1000-4-5 Surge
- IEC 1000-4-8 Power Frequency Magnetic Field
- IEC 1000-4-9 Pulse Magnetic Field
- IEC 1000-4-11 Dips & Interrupts

CE*MASTER* PLATFORM (CM-BASE)

RATINGS AND POWER REQUIREMENTS

Coupler/Decoupler

AC Voltage:	50 to 250V, 50/60Hz
AC Current:	16A continuous
DC Voltage:	0 to 100V
DC Current:	10A continuous
EUT Connectors:	NEMA 5-15, CEE7 ("Schuko"), BS 1363 (British Standard)

Power Requirements

Input Voltage:	90-250VAC, 50/60Hz
Input Current:	1A at 120VAC; 0.5A at 240VAC

For additional **CE*MASTER*®** *literature, call, email or fax the KeyTek sales department.*

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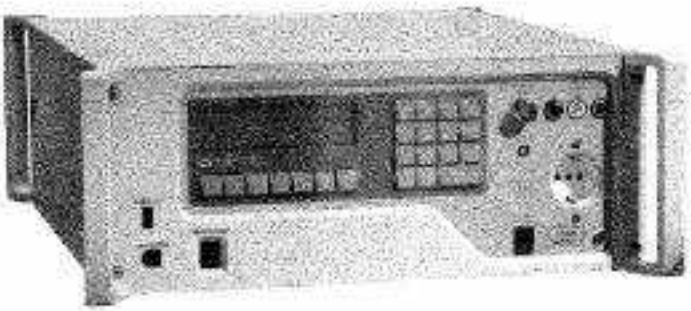
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CE*MASTER*®

Model CM-HPULSE

Pulse Magnetic Field



Provides Pulse Magnetic Field test capability to IEC 1000-4-9 for the CE*MASTER *Compliance-Level Immunity Tester.

FEATURES

- **Provides compliance-level** testing to meet the requirements of the EMC Directive and obtain the CE Mark.
- **Exceeds test levels** outlined in the Generic Immunity and Product Family Standards for pulse magnetic fields.
- **Configurable** with any combination of 5 additional immunity test standards in a single tester.
- **Optional low cost coil** (CM-HCOIL) is fully calibrated to the CE*MASTER*.
- **Predefined IEC test routines** from both software and front panel control.
- **Windows®** 3.1 and 95 based application software and/or front panel keypad and graphics display.

SYSTEM BENEFITS

- **Batch IEC test sequences** significantly reduce test throughput times by running entire IEC test sequences in a single pass.
- **Pre-programmed IEC 1000-4-9 test routines** save time and decrease the potential for human error.
- **Automatic compliance report generation, using option CE*Ware*™**, provides Pulse Magnetic Field test results in a format suitable for archiving CE Mark test records.
- **Light weight, ergonomic design** provides maximum flexibility for operating the CE*MASTER* from a table top, floor or within a 19-inch rack.
- **Portable architecture** with rugged handles and optional transit case enables users to transport the tester between test departments or to remote facilities.

Model CM-HPULSE

OUTPUT SPECIFICATIONS AND TOLERANCES

Electrical

Current Waveform:	8/20µs
Field Amplitude:	50A/m to 800A/m[1] ±10% accuracy ([1]Based on coil factor of .72 or greater)

Waveform Verification

Basic test standards require that the simulator output be verified periodically. For the magnetic fields, verification is accomplished by verifying the amplitude of the 8/20µs current pulse driving the coil. An appropriate current transformer (Pearson Model 110 or equivalent) and an oscilloscope with a bandwidth of >100MHz capable of displaying a single pulse are required.

Minimum System Requirements

CM-BASE with CM-SW or CM-FP, CM-SURGE

AVAILABLE OPTIONS

CM-HMON:	Measurement probe for power frequency magnetic fields
CM-HCOIL:	1m by 1m coil used to produce the magnetic fields

CE*MASTER* Platform (CM-BASE)

Ratings and Power Requirements

Coupler/Decoupler

AC Voltage:	50 to 250V rms
AC Current:	16A continuous
DC Voltage:	0 to 100V
DC Current:	10A continuous
EUT Connectors:	NEMA 5-15, CEE7 ("Schuko"), or BS 1363 (British Standard)

Power Requirements

Input Voltage:	90-250VAC, 50/60Hz
Input Current:	1A at 120VAC; 0.5A at 240VAC

For additional CE*MASTER® literature, call, email or fax the KeyTek sales department.*

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- IEC 1000-4-2 ESD
- IEC 1000-4-4 EFT
- IEC 1000-4-5 Surge
- IEC 1000-4-8 Power Frequency Magnetic Field
- IEC 1000-4-9 Pulse Magnetic Field
- IEC 1000-4-11 Dips & Interrupts

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CE*MASTER*®

Model CM-PQF

Dips & Interrupts



Provides Dips and Interrupts test capability to IEC 1000-4-11 for the CE*MASTER® *Compliance-Level Immunity Tester.

FEATURES

- **Provides compliance-level** testing to meet the requirements of the EMC Directive and obtain the CE Mark.
- **Meets all test levels** outlined in the Generic Immunity and Product Family Standards for dip and interrupt testing.
- **Configurable** with any combination of up to 5 immunity standards in a single tester.
- **Includes built-in transformer** for fast, reliable operation. No external hardware required.
- **Built-in, high-speed** tap switching allows custom test routines where high speed switching between levels is required - not just to 100%.
- **Predefined IEC test routines** controlled from either software or front panel.
- **Windows®** 3.1 and 95 based application software and/or front panel keypad and graphics display.

SYSTEM BENEFITS

- **Batch IEC test sequences** significantly reduce test throughput times by running entire IEC test sequences in a single pass.
- **Pre-programmed IEC 1000-4-11 test routines** save programming time and decrease the potential for human error.
- **Automatic compliance report generation, using option CE*Ware*™**, provides Dips and Interrupts test results in a format suitable for archiving CE Mark test records.
- **Light weight, ergonomic design** provides maximum flexibility for operating the CE*MASTER* from a table top, floor or within a 19-inch rack.
- **Portable architecture** with rugged handles and optional transit case enables users to transport the tester between test departments or to remote facilities.

Model CM-PQF

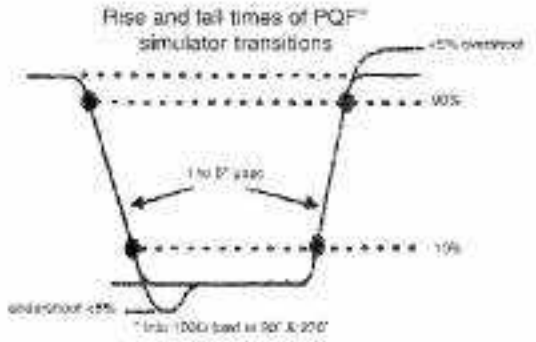
OUTPUT SPECIFICATIONS AND TOLERANCES

Electrical

Dips:	To 70% and 40% of nominal
Interrupts:	0% short or open
Transition Time:	1µs to 5µs into 100Ω
Inrush Current:	>250A at 120V; >500A at 240V
Minimum Event:	10°, 460 - 555µsec (based on 50/60 cycles)
AC Voltage:	50 to 250V, 50/60Hz
AC Current:	16A continuous

Waveform Verification

The basic test standards require that the simulator output be verified periodically. For Dip & Interrupt test simulators, it is necessary to verify the voltage levels, transition times, and the inrush current capability. Most modern oscilloscopes are capable of observing the voltage levels and transition times. For verifying the inrush current, a bridge rectifier, suitably rated 1700µF capacitor, and appropriate current transformer are required, Model PQF-QUAL.



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- IEC 1000-4-4 EFT
- IEC 1000-4-5 Surge
- IEC 1000-4-8 Power Frequency Magnetic Field
- IEC 1000-4-9 Pulse Magnetic Field
- IEC 1000-4-11 Dips & Interrupts

Minimum System Requirements

CM-BASE with CM-SW or CM-FP

AVAILABLE OPTIONS

CM-3PQF:	16 Amp, 3-phase Dip/Interrupt selector.
PQF-QUAL:	External circuit per IEC 1000-4-11 for testing any PQF generator's inrush capability.

CE*MASTER* Platform (CM-BASE)

Ratings and Power Requirements

Coupler/Decoupler

AC Voltage:	50 to 250V, 50/60Hz
AC Current:	16A continuous
DC Voltage:	0 to 100V
DC Current:	10A continuous
EUT Connectors:	NEMA 5-15, CEE7("Schuko"), or BS 1363 (British Standard)

Power Requirements

Input Voltage:	90-250VAC, 50/60Hz
Input Current:	1A at 120VAC; 0.5A at 240VAC

For additional **CE*MASTER*®** *literature, call, email or fax the KeyTek sales department.*

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KPS-118B-11/97

PULSED EMI

Models CM-3CD-16 and CM-3CD-32

Combined EFT and Surge Mains Coupler/Decouplers



Semi-automatic, three-phase AC/DC mains coupler/decouplers for EFT and Surge as specified by IEC 1000-4-4 and IEC 1000-4-5.

FEATURES

- **AC voltages** to 433V rms, DC to 100V.
- **Continuous AC line currents** to 32A/phase.
- **Compatible with KeyTek's CE*MASTER*® and EMC*Pro*™** for Surge and EFT, or any EFT simulator with user supplied cables.
- **Low cost, standalone** design.
- **Comprehensive front panel design** for easy mode selection.

SYSTEM BENEFITS

- **Semi-automatic operation** when used with KeyTek's **CE*MASTER*** or **EMC*Pro*** simulators reduces the possibility of test sequence errors by prompting the user to make coupling mode selections.
- **Pre-programmed IEC test routines** save time and decrease the potential for human error.
- **Automatic compliance report generation,** using option **CE*Ware*™**, provides three-phase AC/DC line coupler/decoupler test results in a format suitable for archiving CE Mark test records.
- **Ergonomic design** provides maximum flexibility for operating from a table top or within a 19-inch rack.
- **Portable architecture** with rugged handles and optional transit case enables users to transport the unit between departments or remote facilities.

Models CM-3CD-16 and CM-3CD-32

SPECIFICATIONS AND TOLERANCES

Electrical

Waveforms:

EFT:	5/50ns, per IEC 1000-4-4
Surge:	Combination wave: 1.2/50µs open-circuit voltage, 8/20µs short-circuit current, per IEC 1000-4-5

Maximum Surge Voltage & Current: 6.6kV, 3.3kA

Maximum EFT Voltage: 4.4kV

Coupling Modes:

EFT:	L1, L2, L3, N or PE
Surge Hi:	L1, L2, L3 or N
Surge Lo:	L1, L2, L3, N or PE

Coupler/Decouplers

AC Voltage: 50 to 250V, 50/60Hz line to ground, 50 to 433V line to line

AC Current:

CM-3CD-16	16A/phase continuous
CM-3CD-32	32A/phase continuous

DC Current:

CM-3CD-16:	16A	up to	48V
	8A	up to	110V
	1.2A	up to	220V
	0.3A	up to	440V
CM-3CD-32:	25A	up to	48V
	8A	up to	220V
	1.2A	up to	220V
	0.3A	up to	440V

EUT Mains Output Connectors: Safety Sockets

Power Requirements

Input Voltage: 90-250VAC, 50/60Hz

Input Current: 1A at 120VAC; 0.5A at 240VAC

Physical

Height:	18cm (7")
Width:	47cm (18.5")
Depth:	56cm (22")
Weight:	
CM-3CD-16	17kg (38 lbs)
CM-3CD-32	24kg (52 lbs)

Minimum System Requirements

CE*MASTER*, EMC*Pro* or any simulator with EFT test capability

For additional Pulsed EMI literature, call, email or fax the KeyTek sales department.

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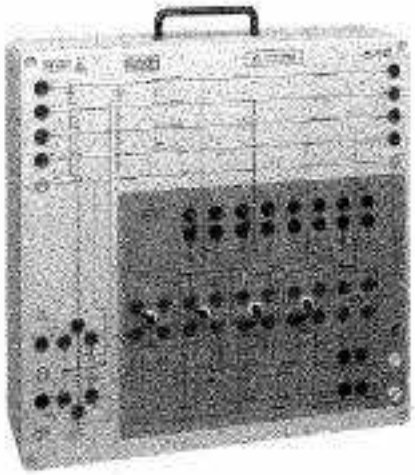
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KPS-757B-11/97

PULSED EMI

Model CM-TELCD

Telecom Line Coupler/Decoupler



Provides the ability to couple both the telecom wave and combination wave per IEC 1000-4-5.

FEATURES

- **Fully compliant** with IEC 1000-4-5 requirements for telecom line coupler/decouplers.
- **Permits compliance level** testing of telecom lines to Generic Immunity and Product Family Standards.
- **Built-in user selectable clamping circuit** provides additional protection for sensitive and costly auxiliary equipment.
- **Built-in multiple coupling devices**, including resistors for both 1.2/50μs and 10/700μs generators, 90V & 300V gas arresters and 0.1μF capacitors.
- **Symmetric** coupling per IEC 1000-4-5 for telecommunication lines.
- **Data rates to greater than 100kHz**
- **Comprehensive front panel** wiring aids.

SYSTEM BENEFITS

- **Semi-automatic operation when used with KeyTek simulators** reduces the possibility of test sequence errors by prompting the user to make the correct selections.
- **Portable architecture** enables users to easily transport the unit between test departments or remote facilities.
- **Standard CM-TELCD design** ensures high speed transmission.
- **Air core decoupling chokes** allow use of DC signals without problems due to core saturation.

Model CM-TELCD

SPECIFICATIONS AND TOLERANCES

ELECTRICAL

Waveforms:	Designed to couple 1.2/50µs combination or 10/700µs telecom waves.
Telecom Line Frequency:	To 100kHz without significant degradation
Number of Lines:	Up to four lines - one or two pairs of balanced Telecom lines
Maximum Surge Voltage:	4.4kV
Maximum Signal Line Voltage:	200V
Maximum Signal Line Current:	1A AC or DC
Clamping:	Selectable built-in clamps of 20V and 225V: external bias input for other clamp levels

PHYSICAL

Height:	12.2cm (4.8")
Width:	40.1cm (15.8")
Depth:	40.4cm (15.9")
Weight:	53.9kg (24.5 lbs.)

MINIMUM SYSTEM REQUIREMENTS

EMC*Pro* with PRO-SURGE, PRO-TELECOM or with any IEC 1000-4-5 or CCITT Rec. K.17 10/700µs waveform simulator

For additional Pulsed EMI literature, call, email or fax the KeyTek sales department.

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KPS-785B-11/97

CE*MASTER*®

Model CM-BASE

Platform



A customer configured Immunity Tester for compliance testing to:

IEC 1000-4-2	***ESD***
IEC 1000-4-4	***EFT***
IEC 1000-4-5	***Surge***
IEC 1000-4-8	***Power Frequency Magnetic Field***
IEC 1000-4-9	***Pulse Magnetic Field***
IEC 1000-4-11	***Dips & Interrupts.***

FEATURES

- **A cost-effective, compliance-level** tester to be used as a primary test station, or to augment other test capabilities and stations in large facilities.
- **Customer configurable** Immunity Tester provides from one to six immunity tests in a single unit.
- **Windows**® 3.1 and 95 based application software and/or front panel keypad and graphics display.
- **Pre-programmed IEC test routines** from both software and front panel control.
- **Portable**, light weight design.
- **Optional** transport case.
- **Optional** 19" rack mount kit.

SYSTEM BENEFITS

- **Low cost, multi-standard** test system provides manufacturers with a single, stand-alone system solution.
- **Light weight, ergonomic design** provides maximum flexibility for operating the **CE*MASTER*** from a table top or within a 19-inch rack.
- **Portable architecture** with rugged handles and optional transit case enables users to transport the tester between test departments or remote facilities.
- **Automatic compliance report generation**, using option **CE*Ware***™, provides test results in a format suitable for archiving CE Mark test records.



Typical Software Screen Operating under Windows®

Model CM-BASE

SPECIFICATIONS AND TOLERANCES

CE*MASTER* Immunity Test Levels

IEC 1000-4-2	500V - 8.8kV Air Discharge 500V - 4.4kV Contact Mode
IEC 1000-4-4	250V - 2.5kV; 1- 100kHz
IEC 1000-4-5	250V - 2.5kV; 125A - 1.25kA
IEC 1000-4-8	0.5 - 4A/m AC H-Field
IEC 1000-4-9	50 - 800A/m Pulse Field
IEC 1000-4-11	100, 70, 40 and 0% short or open; inrush >250A @ 120V, and >500A @ 240V

Ratings and Power Requirements

Coupler/Decoupler

AC Voltage:	50 to 250V, 50/60Hz
AC Current:	16A continuous
DC Voltage:	0 to 100V
DC Current:	10A continuous
EUT Connectors:	NEMA 5-15, CEE7 ("Schuko"), or BS 1363 (British Standard)

Power Requirements

Input Voltage:	90-250VAC, 50/60Hz
Input Current:	1A at 120VAC; 0.5A at 240VAC

Physical

Height:	17.8cm (7")
Width:	47cm (18.5")
Depth:	56cm (22")
Weight:	29kg (64 lbs.)

Environmental

Operating Limits

Temperature:	15 - 40°C
Humidity:	10 - 75%, non-condensing
Altitude:	8000 feet max.

Storage Limits

Temperature:	0 - 60°C
Humidity:	10 - 90%, non-condensing
Altitude:	8000 feet max.

Minimum System Requirements

CM-BASE with CM-SW or CM-FP and at least one immunity test capability

AVAILABLE OPTIONS

Immunity Test Capabilities

CM-ESD:	Electrostatic Discharge (IEC 1000-4-2)
CM-EFT:	Electrical Fast Transient (IEC 1000-4-4)
CM-SURGE:	Surge (IEC 1000-4-5)
CM-HPWR:	Power Frequency Magnetic Field (IEC 1000-4-8)
CM-HPULSE:	Pulse Magnetic Field (IEC 1000-4-9)
CM-PQF:	Dips and Interrupts (IEC 1000-4-11)

Control Functions

CM-SW:	Windows® based application software (CEWare™) provides the ability to run any sequence of predefined IEC routines or user defined immunity tests. User must purchase either CM-SW, CM-FP or both.
CM-FP:	Front Panel keypad and graphics display for manual operation or automatic control using predefined IEC routines. User must purchase either CM-SW, CM-FP or both.
CM-SW/FP:	Combines both software (CM-SW) and front panel (CM-FP) control functions.

Other

CM-RMK:	19" Rack Mount Kit
CM-CASE:	Transportation case for the CE*MASTER* and accessories

For additional **CE***MASTER*® *literature, call, email or fax the KeyTek sales department.*

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KPS-653C-11/97

CE*MASTER*®

Model CM-EFT

Electrical Fast Transient



Provides Electrical Fast Transient (EFT) test capability to IEC 1000-4-4 for the CE*MASTER *Compliance-Level Immunity Tester.

FEATURES

- **Provides compliance-level** testing to meet the requirements of the EMC Directive and obtain the CE Mark.
- **Exceeds the maximum test levels** outlined in the Generic Immunity and Product Family Standards.
- **Configurable** with any combination of 5 additional immunity test standards in a single tester.
- **Includes built-in** single phase mains coupler/decoupler for EUT's to 16A AC and to 10A DC.
- **Predefined IEC test routines** from both software and front panel control.
- **Windows**® 3.1 and 95 based application software and/or front panel keypad and graphics display.

SYSTEM BENEFITS

- **Batch IEC test sequences** significantly reduce test throughput times by running entire IEC test sequences in a single pass.
- **Pre-programmed IEC 1000-4-4 test routines** save time and decrease the potential for human error.
- **Automatic compliance report generation, using option CE***Ware*™, provides EFT test results in a format suitable for archiving CE Mark test records.
- **Light weight, ergonomic design** provides maximum flexibility for operating the CE*MASTER* from a table top, floor or within a 19-inch rack.
- **Portable architecture** with rugged handles and optional transit case enables users to transport the tester between test departments or to remote facilities.

Model CM-EFT

OUTPUT SPECIFICATIONS AND TOLERANCES

ELECTRICAL

Peak Voltage:	250V to 2.5kV; 1V resolution, ±10% accuracy
Waveform:	5ns/50ns impulse per IEC 1000-4-4
Burst Period:	300ms
Burst Duration:	15ms@ 1-5kHz, 0.75ms @ > 5kHz
Frequency:	1 - 100kHz in .5kHz steps, ±10% accuracy

WAVEFORM VERIFICATION

The basic test standards require that the simulator output be verified periodically. For EFT, a high voltage 50 ohm load is required, and the measurement must be made using an oscilloscope with at least 400MHz bandwidth.

MINIMUM SYSTEM REQUIREMENTS

CM-BASE with CM-SW or CM-FP

AN AFFORDABLE EMC IMMUNITY TESTER THAT DOES IT ALL

The **CE*MASTER*®** is designed from the ground up to provide compliance-level testing to the standards manufacturers must meet in order to compete in today's international marketplace.

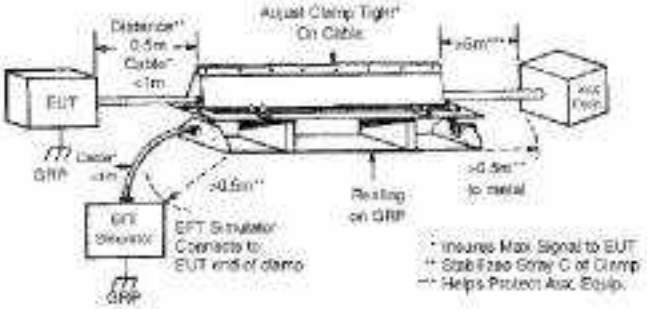
Each **CE*MASTER*** is custom configured to meet your specific needs and budget requirements. When completely configured, the **CE*MASTER*** provides compliance-level testing to IEC 1000-4-X Series Immunity Standards for:

- IEC 1000-4-2 ESD
- IEC 1000-4-4 EFT
- IEC 1000-4-5 Surge
- IEC 1000-4-8 Power Frequency Magnetic Field
- IEC 1000-4-9 Pulse Magnetic Field
- IEC 1000-4-11 Dips & Interrupts

AVAILABLE OPTIONS

CM-3CD-16/32: 16 or 32 Amp, 3-phase EFT and Surge coupler/decoupler

CM-CCL: Capacitive Coupling Clamp for coupling EFT transients to data lines in accordance with IEC 1000-4-4.



CM-CCLC: Interlocked Capacitive Coupling Clamp Cover and cables to be used with Model CM-CCL for increased safety.

EFT-ATTN: External EFT attenuator for oscilloscope monitoring of EFT pulses up to 4.4kV, 50 and 2K ohm input impedances. (Requires CM-EFT capability).

CE*MASTER* PLATFORM (CM-BASE)

RATINGS AND POWER REQUIREMENTS

Coupler/Decoupler

AC Voltage:	50 to 250V, 50/60Hz
AC Current:	16A continuous
DC Voltage:	0 to 100V
DC Current:	10A continuous
EUT Connectors:	NEMA 5-15, CEE7 ("Schuko") or BS 1363 (British Standard)

Power Requirements

Input Voltage:	90-250VAC, 50/60Hz
Input Current:	1A at 120VAC; 0.5A at 240VAC

For additional **CE*MASTER*®** *literature, call, email or fax the KeyTek sales department.*

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