Category 6 Cabling:

Static Discharge Between LAN Cabling and Data Terminal Equipment

Published by the Category 6 Consortium

Telecommunications Industry Association

December 2002

Overview

The following white paper was produced by participants of the Category 6 Consortium. This consortium — focused on category 6 cabling systems — has assisted in development of generic standards primarily for balanced twisted-pair cabling systems. These standards cover balanced twisted-pair cable and associated connecting hardware specifications, including test procedures, performance requirements and test instrument requirements. In development of these standards, theoretical models and controlled experimentation were used to validate link and channel specifications via component requirements.

On June 20, 2002 TIA published the category 6 addition to the TIA-568 standard, which has the official document number of ANSI/TIA/EIA-568-B.2-1. Following its passage, the Category 6 Consortium has been formed to promote the adoption of category 6. As part of the mission to provide user education, the Category 6 Consortium is releasing this document to give industry participants additional information on electrostatic discharge (ESD) - what it is, how it affects telecommunications cabling and equipment, and what is being done to protect equipment from damage due to ESD. It is important to note that any opinions expressed in this white paper are those of the participants of the Category 6 Consortium and are not necessarily those of the entire TIA membership.

For more information about category 6, please visit the Category 6 Consortium Web site at www.category6.org or contact TIA at (703) 907-7472.

What is Electrostatic Discharge?

Electrostatic charges are generated when different materials come into contact and are then separated. When materials come into contact, a chemical bond of varying strength is formed between the two materials. The chemical bond involves a migration of electrons from one material to the other. When this bond is broken, some of the electrons may be left behind and result in an excess negative or excess positive charge on the materials. This charging effect caused by contact is made even greater by friction such as rubbing the two materials together. This phenomenon is called "triboelectric effect," or "triboelectric charging."

The amount of charge that is generated can be significant, in many cases tens of thousands of volts. The amount of charge, and hence the voltage that can be supported by a material, is governed by its bulk resistance or insulation properties. A capacitor is a device designed to store charge that has a good insulator sandwiched between two good conductors. The charge is stored in the insulator. A good conducting path will allow this stored charge to dissipate rapidly. This is called electrostatic discharge, or ESD. "Rapidly" is the key word because this quick discharge of large amounts of potential energy can cause damage. A slow or controlled discharge is one of the more useful ESD protection strategies.

How Does ESD Affect Telecommunications Cabling and Equipment?

Any users (installers, administrators, end users, etc.) that touch equipment or cabling become a potential source of ESD into communications equipment. For example, a person can become charged by triboelectric effect by walking across a carpeted floor. The international standard IEC/EN 61000-4-2 specifies test levels and procedures for manufacturers to verify equipment immunity to discharge from a human body. It also includes guidelines for the manufacturer to specify for the installation and handling of equipment.

Another subtler source of ESD is from charged cabling. The IEEE 802.3 standards identify this problem, but do not provide any guidance or testing methods for manufacturers. Generally, users become a source of ESD to the cabling (which is of course totally immune to ESD), and the charged cabling then becomes a source of ESD to the communications equipment. Cables can acquire a charge during installation when they are unreeled from a cable reel, or dragged across a floor. There also have been reports of cables developing their own charge from moving air or from building occupants walking over floor ducts. If the cables are not connected to earth ground, the electrostatic charges can remain for a long time, especially in dry conditions.

What Precautions Are Necessary to Avoid Equipment Damage?

The IEEE has warned about the effects of ESD on equipment by incorporating guidelines in *802.3i-1990 Twisted-Pair MAU and Baseband Medium, Type 10BASE-T* since 1990. The same guidelines continue to be incorporated in subsequent applications, including *802.3u-1995 Type 100BASE-T, 802.3x-1997, 802.3y-1997 (100BASE-T2), 802.3ab-1999, Type 1000BASE-T*. The following is a direct quote from section 14.7.2 of the 10BASE-T document:

> ***"14.7.2 Network Safety:***
> *(2) Static charge buildup on LAN cables and components. Such electrical safety hazards must be avoided or appropriately protected against for proper network installa-*

tion and performance. In addition to provisions for proper handling of these conditions in an operational system, special measures must be taken to ensure that the intended safety features are not negated during installation of a new network or during modification or maintenance of an existing network."

Although these guidelines are written for the manufacturer, the intent is that they be incorporated into the manufacturer's product documentation as well. With properly designed equipment and good installation practices, the numbers of ESD problems that have been reported over the last ten years have been very limited.

Are Category 6 Cables Worse Than Category 5 Cables for ESD Effects?

A cable's capacitance to ground determines how much charge a cable will hold. Once a cable is charged, its capacitance to ground and the relative humidity typically determine how fast the charge will dissipate. Generally, dielectric materials and the capacitances associated with category 5e and category 6 cable designs are the same as those associated with category 5 cables. Hence, the ESD discharge properties of these cables are not significantly different. This was confirmed by laboratory measurements of discharge patterns as outlined in the following experiment.

A Human Body Model ESD generator, of the kind described in IEC 61000-4-2, was used to inject an 8KV contact-discharge pulse into one end of a conductor pair of an assortment of category 5 and category 6 UTP cables, each about 56 meters in length. After charging, a cable discharge waveform was then measured into a high-speed waveform recorder. These discharges were recorded as a function of the time interval between the charging and the discharging of the conductor pair so that a charge retention profile was also recorded for each cable. To ensure repeatability and a fair comparison, each cable was laid directly on a ground plane for its entire length. This also maximizes its capacitance to ground. (*See Figures 1, 2 and 3).*

Figure 1: Charging Point

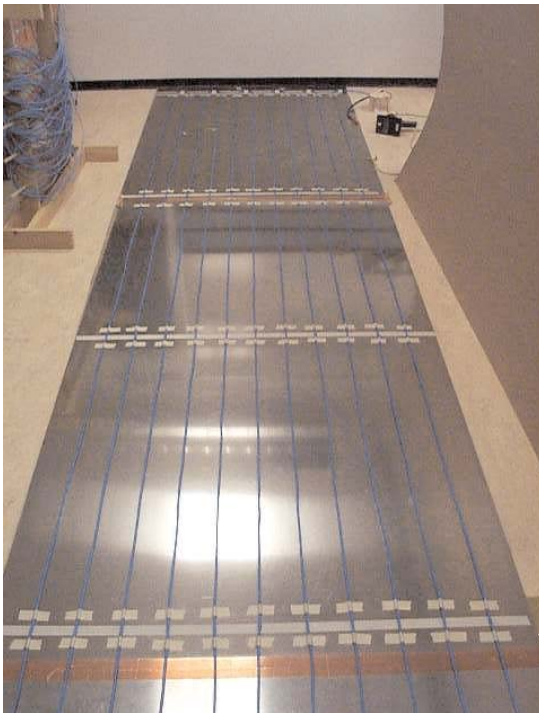

Figure 2: Cable Layout

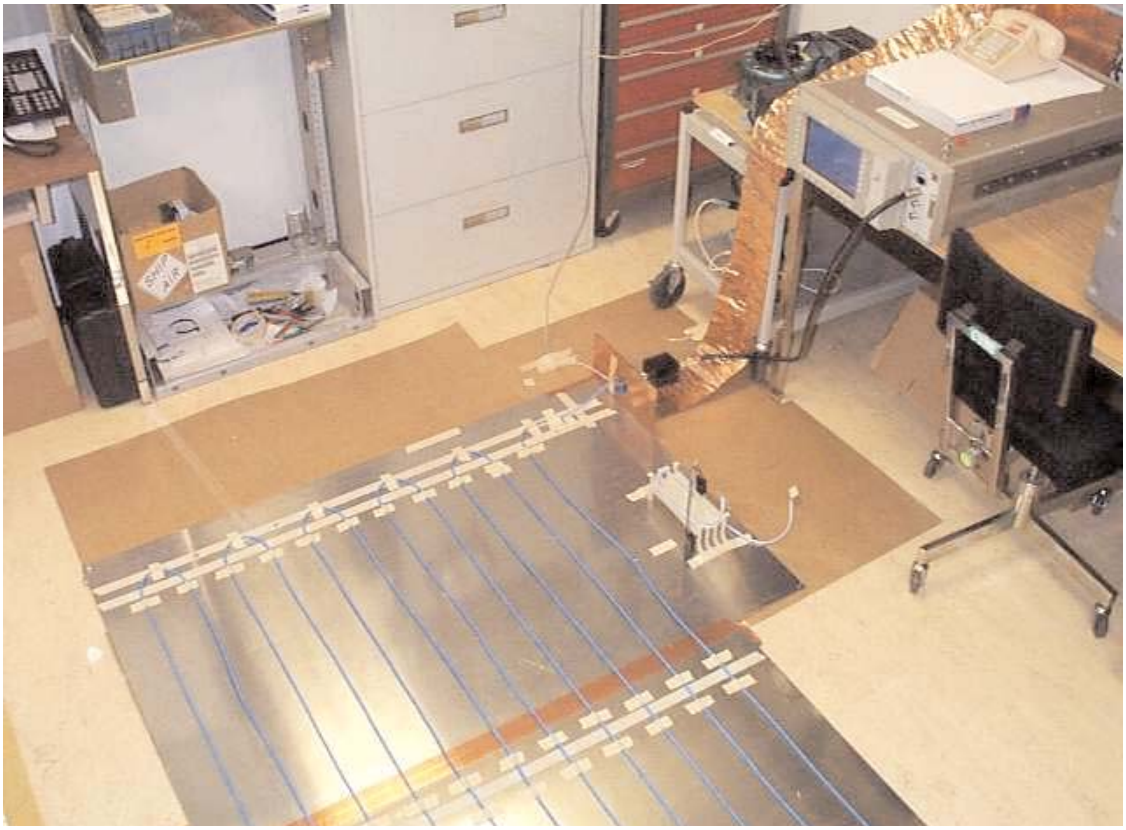

Figure 3: Discharging Point

What was found? It was readily apparent that the humidity level was a very important factor in the charge retention properties for all of the cables tested. After correcting for the effects of changes in the relative humidity, a comparison of these time-dependent discharge profiles shows very little difference in the charge retention and discharge properties of different cables (see figure 4).

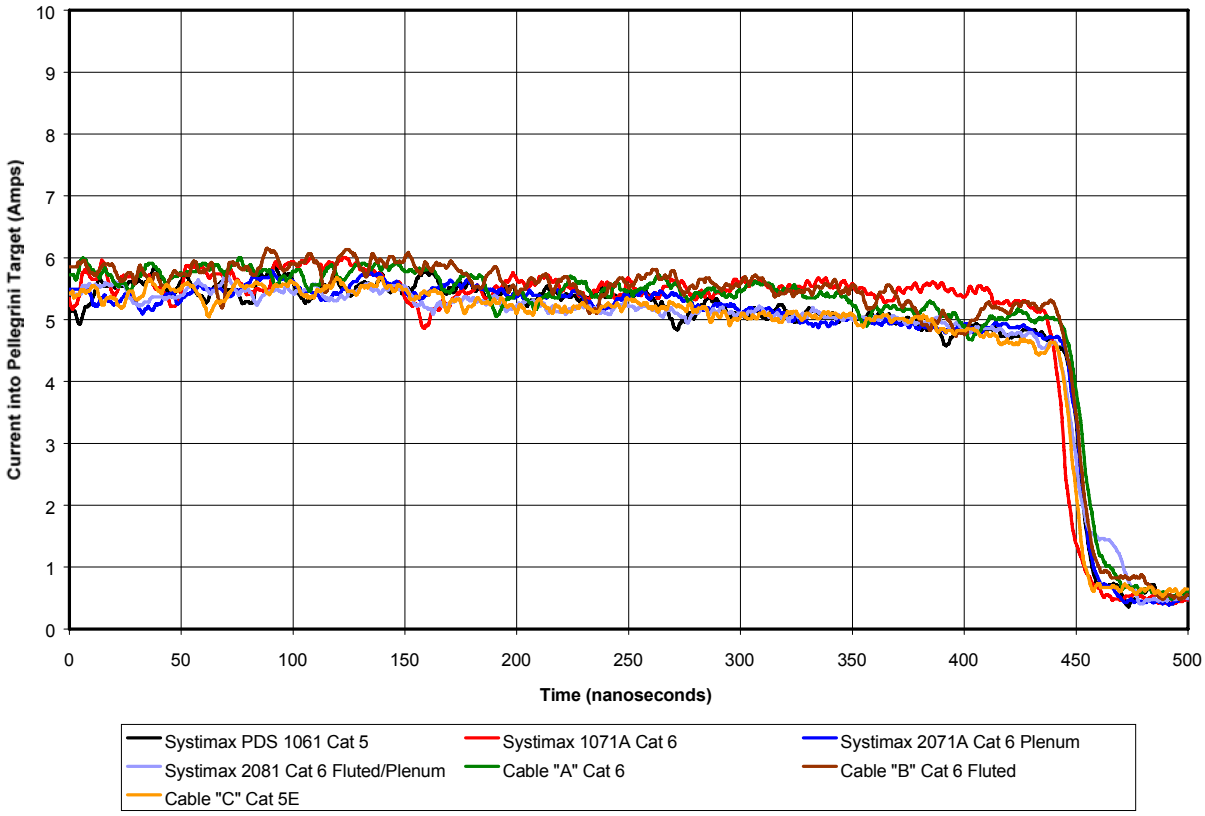

Figure 4: Discharge waveforms for t=4 hours time interval (with unused pairs floating) after correction for humidity.

What are IEEE and TIA Doing?

Based on an official liaison request from IEEE, the TIA TR-42.7 Subcommittee is conducting a study to develop installation guidelines to reduce the chances of ESD damage to equipment. These guidelines will be published as a Technical Systems Bulletin around the second quarter of 2003 and will provide installers of cabling and equipment specific recommendations for how to avoid static discharge into equipment. As part of the study, the TR-42.7.2 working group has already provided relevant parameters and models to simulate the magnitude of static discharge responses for varying lengths of cables charged to different voltages.

Additionally, it is important that the study review the various ESD models specified in IEC 61000 to use an existing model or a variant that is applicable for characterizing ESD in premises cabling. Initial results of the study indicate that an equipment-based ESD model will be proposed to create static discharges from cabling into equipment up to 500V. The requirement would be for

equipment to withstand cable discharge events and return to normal function. IEEE and TIA have started the dialogue to begin this project, and it is expected that ESD effects on cabling, equipment, and installation practices will be better controlled.

Cabling Guidelines for ESD

Meanwhile, the following guidelines should be considered to avoid ESD problems:

- Examine the equipment manufacturer's specification sheet.

- Look for what test level of ESD Immunity is provided for in accordance with the International Standard IEC/EN 61000-4-2.

- If you can't find an Immunity Section in the manufacturer's specification sheet, inquire about ESD performance or compliance with the requirements of IEC/EN 61000-4-2.

- Familiarize yourself with all of the equipment manufacturer's warnings to be certain that it is installed and used according to specifications and guidelines.

- Assess your site's susceptibility to ESD. Low humidity and static generating building materials are the primary cause of ESD phenomena. Mitigation techniques such as anti-static flooring and humidity control are very important for critical installations. Anti-static materials minimize the generation of charges, and higher humidity provides for slow controlled discharges. ANSI/TIA/EIA-569 recommends that the humidity in telecommunications spaces housing equipment be maintained between 30 and 55 percent.

- Before connecting equipment to installed cabling, it is good practice to use a "grounding patch cord" to discharge the static charges in the cabling to earth ground using an approved grounding conductor (such as a rack, telecommunications grounding bus bar or building metal).

- Leave the equipment connected to the cabling so that there is no build up of static charges in the cabling.

Summary

ESD is a common natural phenomenon that has been effectively controlled by proper manufacturing, packaging, installation and operation procedures. There have been a few recent incidents where equipment was damaged when connected to premises cabling. This is more the exception than the rule, and both IEEE and TIA are cooperating to reduce the risks of this happening by developing specific recommendations on installation practices. The materials and construction used in category 5, 5e and 6 are very similar and should not lead to differences in ESD, if IEEE standards and manufacturers installation guidelines are followed.

Category 6 Consortium Participant URLs for Product Information

Company	URL
3M*	http://www.3m.com/
Anixter**	http://www.anixter.com/
Avaya*	http://www.connectivity.avaya.com/
Commscope*	http://www.commscope.com/
Corning*	http://www.corning.com/
Draka Comteq**	http://www.drakacomteq.com/
Intertek Testing Services ETL Semko*	http://www.etlsemko.com/
Fluke Networks*	http://www.fluke.com/
General Cable*	http://www.generalcable.com/
Graybar*	http://www.graybar.com/
Hellermann Tyton*	http://www.hellermann.tyton.com/
Hitachi Cable Manchester Inc.**	http://www.hcm.hitachi.com/
Hubbell**	http://www.hubbell-premise.com/
Ideal Industries*	http://www.idealindustries.com/
Krone*	http://www.krone.com/
Leviton*	http://www.levitonvoicedata.com/
Mohawk/CDT**	http://www.mohawk-cdt.com/
Molex**	http://www.molexpn.com/
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The Siemon Company*	http://www.siemon.com/
Superior Essex**	http://www.superioressex.com/
Superior Modular Products**	http://www.superiormod.com/
Suttle*	http://www.suttleonline.com/
Tyco Electronics/AMP NETCONNECT*	http://www.ampnetconnect.com
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