Introduction

The International Telecommunications Union (ITU-T) developed its ITU-T K Series Recommendations to help designers determine the resistibility of telecommunication equipment to withstand the effect of overvoltage or overcurrent events based on a defined level, and to meet specified criterion. These recommendations cover every aspect of the telecommunications system including the components within the system.

The most familiar ITU-T K Series Recommendations are K.20, K.21 and K.45. In addition to these resistibility tests, there are others that are important to ensure telecom equipment designs are compliant. Therefore, consideration must be given to the selection of the right components in the design of the protection scheme for telecom equipment. Beyond the tests included in the standards, there are many more resources offered by ITU-T that developers may not be aware of.

This paper provides an overview of ITU-T Recommendations of resistibility tests for overvoltage and overcurrent events in telecom equipment installed in telecommunication centers, customer premises and in access and trunk networks. To provide further assistance to developers, this paper also presents general protection design guidelines, and solutions available for a particular application. This document introduces the relevant recommendations referring to telecommunication equipment. All recommendations issued by ITU-T are written by experts in the field, and are free for download.

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CO</td>
<td>Central Office</td>
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<td>CPE</td>
<td>Customer Premises Equipment</td>
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<td>GDT</td>
<td>Gas Discharge Tube</td>
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<td>ICT</td>
<td>Information and Communication Technologies</td>
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<td>POTS</td>
<td>Plain Old Telephone Service</td>
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<td>SG</td>
<td>Study Group</td>
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<td>SPD</td>
<td>Surge Protective Device</td>
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<td>QoS</td>
<td>Quality of Service</td>
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About ITU-T and Regional Applicability

The ITU-T organization is responsible for studying technical operating and tariff questions and issuing recommendations in these areas with the goal of standardizing telecommunications worldwide. There are many different study groups active in ITU-T, where experts from around the world develop international standards known as ITU-T Recommendations. The recommendations issued by different groups have different prefixes. For the resistibility topics, the Study Group 5 (SG5) work is relevant. This group covers studies on methodologies for evaluating ICT (Information and Communication Technologies) effects on climate change and publishes guidelines for using ICTs in an eco-friendly way.

SG5’s four main objectives are to:
- Protect telecommunication equipment and installations against damage and malfunction due to electromagnetic disturbances, such as those from lightning.
- Ensure the safety of personnel and users of networks against current and voltages used in telecommunication networks.
- Avoid health risks from electromagnetic fields (EMFs) produced by telecommunication devices and installations.
- Guarantee a good quality of service (QoS) for high speed data services by issuing requirements on characteristics of copper cables and on the coexistence of services delivered by different providers.

Topics for the term “circuit protection” are found in recommendations from the K series.
**Recommendations and the Structure**

When reviewing the structure of recommendations, it is important to note that the letter designation reflects the time of issue (the higher the letter, the more recent the recommendation was published). Plus, the recommendations are regularly reworked where new issues are added to the existing K designation. A short overview of select recommendations relevant to circuit protection are shown in the following table.

<table>
<thead>
<tr>
<th>K Number</th>
<th>K Title</th>
<th>Description / Related to</th>
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<tbody>
<tr>
<td>K.20</td>
<td>Resistibility of telecommunication equipment installed in a telecommunication center to overvoltages and overcurrents</td>
<td>Tests applicable for CO</td>
</tr>
<tr>
<td>K.21</td>
<td>Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents</td>
<td>Tests applicable for CPE</td>
</tr>
<tr>
<td>K.45</td>
<td>Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents</td>
<td>Tests applicable for access and trunk equipment</td>
</tr>
<tr>
<td>K.44</td>
<td>Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation</td>
<td>Gives details and test setup diagrams for the above three (CO, CPE and access network)</td>
</tr>
<tr>
<td>K.12</td>
<td>Characteristics of gas discharge tubes for the protection of telecommunications installations</td>
<td>General tests for characterization of GDTs</td>
</tr>
<tr>
<td>K.50</td>
<td>Safe limits for operating voltages and currents of telecommunication systems powered over the network</td>
<td>Provides guidance on voltages and currents that may safely be used to power telecommunication systems that are part of the telecommunications service providers' network</td>
</tr>
<tr>
<td>K.51</td>
<td>Safety criteria for telecommunication equipment</td>
<td>Provides guidance on safety criteria for telecommunication network infrastructure equipment</td>
</tr>
<tr>
<td>K.99</td>
<td>Surge protective component application guide - Gas discharge tubes</td>
<td>GDT application guide</td>
</tr>
<tr>
<td>K.67</td>
<td>Expected surges on telecommunications and signalling networks due to lightning</td>
<td>Discusses different lightning events as this threat relates to all three types of the equipment installed (CO, CPE and access network)</td>
</tr>
<tr>
<td>K.98</td>
<td>Overvoltage protection guide for telecommunication equipment installed in customer premises</td>
<td>Provides methodology for evaluating the need to protect users of telecommunication equipment in CPE</td>
</tr>
<tr>
<td>K.102</td>
<td>Parameters of fixed-voltage thyristor overvoltage protector components used for the protection of telecommunication installations</td>
<td>Provides fixed-voltage thyristor parameters to ease the choice for designers</td>
</tr>
<tr>
<td>K.103</td>
<td>Surge protective component application guide - Silicon PN junction components</td>
<td>Guide to selecting PN junction components</td>
</tr>
<tr>
<td>K.117</td>
<td>Primary protector parameters for the surge protection of equipment Ethernet ports</td>
<td>This recommendation should be used for the harmonization of existing or future specifications issued by Ethernet surge protective device (SPD) manufacturers, telecommunication equipment manufacturers, administrations or network operators</td>
</tr>
<tr>
<td>K.118</td>
<td>Requirements for lightning protection of fiber to the distribution point equipment</td>
<td>Provides the necessary information to enable the protection of the equipment in customer premises implementing gigabit broadband access technology that exploits the existing infrastructure of wire pairs that were originally deployed for plain old telephone service (POTS) services.</td>
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</table>
ITU-T K-Numbers Explained

Below are descriptions of popular recommendations listed in the previous table.

- **K.20**: “Resistibility of telecommunication equipment installed in a telecommunication center to overvoltages and overcurrents”

The ITU-T K.20 Recommendation specifies resistibility requirements and test procedures for telecommunication equipment that is attached to, or installed within a telecommunication center and Central Office (CO). Overvoltage and overcurrent events that are covered by this recommendation include surges due to lightning on or near the line plant, short-term induction from adjacent AC power lines or railway systems, earth potential rise due to power faults, direct contact between telecommunication lines and power lines, and electrostatic discharges (ESDs).

Test requirements given by this recommendation are somewhat less severe than the tests required for the customer premises equipment ITU-T K.21. The reason is that CO installations typically are well-planned and the personnel working there are trained, making this environment more controllable.

- **K.21**: “Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents”

The ITU-T K.21 Recommendation specifies resistibility requirements and test procedures for telecommunication equipment that is attached to or installed within the customer premises. The scope of this recommendation is for the overvoltage and overcurrent events just as in the previously cited ITU-T K.20.

- **K.45**: “Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents”
The ITU-T K.45 Recommendation specifies resistibility requirements and test procedures for telecommunication equipment installed between telecommunication centers and between a telecommunication center and the customer premises. It, too, covers overvoltages or overcurrents; only the placement of the equipment is different.

The above three recommendations are not complete. There are tests defined, and the setup for performing the tests and an exhaustive explanation of how to perform the tests is in the K.44 Recommendation.

- **K.44:** “Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation”

The ITU-T K.44 Recommendation seeks to establish fundamental test methods and criteria for the resistibility of telecommunication equipment to overvoltages and overcurrents. Overvoltages or overcurrents covered by this recommendation include surges due to lightning on or near the line plant, short-term induction of alternating voltages from adjacent electric power lines or electrified railway systems, earth potential rise due to power faults and direct contact between telecommunication lines and power lines.

There are other recommendations from the K series which complement the approach to the resistibility tests of the telecommunication equipment. The additional K series recommendations supply guidelines on possible scenarios and also offer insights on component selection for protection of telecommunication equipment, such as application guides for surge protective components and surge protective devices.

To name just two:
- **K.12:** “Characteristics of gas discharge tubes for the protection of telecommunications installations”
- **K.99:** “Surge protective component application guide - Gas discharge tubes”

These recommendations describe the test for characterization and application of Gas Discharge Tubes (GDTs). GDTs are often used for primary protection of telecom applications due to their robustness and low capacitance.
Additional details on characteristics (waveshapes and peak values) of expected surges due to lightning on telecommunication lines of the access network and on signaling lines at the customer premises using metallic conductors are given in:

- K.67: “Expected surges on telecommunications and signaling networks due to lightning”

The ITU-T K.67 and K.98 recommendations can be used as a guide on how to protect telecommunication equipment from overvoltage damage due to lightning strikes to the power and telecommunication lines/cables.

- K.98: “Overvoltage protection guide for telecommunication equipment installed in customer premises”

Further recommendations that offer application guides on protection components are:

- K.102: “Parameters of fixed-voltage thyristor overvoltage protector components used for the protection of telecommunication installations”
- K.103: “Surge protective component application guide - Silicon PN junction components”

In addition to components used for protection, there are recommendations to assist with ITU-T compliance in other areas of the equipment design. For instance, components tested to fulfill certain functionality, and thus to protect equipment. The ITU-T has tests for Ethernet ports that can be especially sensitive and require added protection:

- K.117: “Primary protector parameters for the surge protection of equipment Ethernet ports”
- K.118: “Requirements for lightning protection of fiber to the distribution point equipment”

Safety recommendations are also included:

- K.50: “Safe limits for operating voltages and currents of telecommunication systems powered over the network”

The ITU-T K.50 Recommendation provides guidance on voltages and currents that may safely be used to power telecommunication systems that are part of the telecommunications service providers’ network.

- K.51: “Safety criteria for telecommunication equipment”

The ITU-T K.51 Recommendation supplies guidance on safety criteria for telecommunication network infrastructure equipment. ITU-T K.51 Recommendation specifies requirements intended to reduce risks of fire, electric shock or injury for specified classes of persons who may come into contact with the equipment. These recommendations refer to the IEC safety standards IEC 60950-1 and IEC 62368-1 and provide additional requirements when these are not covered by the IEC standards.
Bourns ITU-T Solutions

As innovators of circuit protection products, Bourns offers a wide range of circuit protection components and solutions for telecom equipment. These products have been proven in ITU-T compliant applications. Bourns delivers quality protection solutions that match a diverse set of functionality and technology requirements.

Bourns® Gas Discharge Tubes (GDTs) provide primary and secondary protection to withstand multiple high current energy surges of 25 kA. Bourns offers standard 8 mm GDTs and a 5 mm mini series GDT in two and three electrode versions. These feature long service life, low capacitance and low insertion loss. An optional, proprietary Switch-Grade Fail-Short is offered on the three-electrode version.

Bourns® Thyristor Surge Protectors are dual or single, unidirectional and bidirectional thyristor surge protectors. Quad and programmable/adjustable gated thyristor surge protectors are also available.

Bourns® Diodes family include a full range of products, from small signal high speed switching diodes with low capacitance and leakage current to power and Schottky diodes for reliable surge protection and voltage rectification. Voltage clamping products are suitable for various applications and packaging, with low power signal rectification.

References

ITU Telecommunication Standardization Sector web portal
https://www.itu.int/en/ITU-T/Pages/default.aspx

ITU Telecommunication Standardization Sector Study Group 5 web portal
https://www.itu.int/en/ITU-T/studygroups/2017-2020/05/Pages/default.aspx


ADDITIONAL RESOURCES

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