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Parameters of thyristor-based surge protective devices for the protection of telecommunication installations

Recommendation ITU-T K.28



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Parameters of thyristor-based surge protective devices for the protection of telecommunication installations

Summary

Recommendation ITU-T K.28 defines the parameters, test circuits and performance values of thyristor-based surge protective devices (SPDs) used for the protection of telecommunication installations (for example, exchange equipment, access equipment, telecommunication lines and subscriber or customer equipment).

This Recommendation should be used for the harmonization of existing or future specifications issued by thyristor-based SPD manufacturers, telecommunication equipment manufacturers, administrations or network operators.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T K.28	1991-03-18	V
2.0	ITU-T K.28	1993-03-12	V
3.0	ITU-T K.28	2012-05-29	5

Keywords

In-line SPD, leakage resistance, overvoltage protector, surge protective device, SPD, thyristor.

FOREWORD

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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Introduction

Thyristor overvoltage protectors are often likened to the solid-state equivalent of gaseous discharge overvoltage protectors like the gas discharge tube (GDT) [b-ITU-T K.12]. While the general protection principles of thyristors and GDTs are similar, the test circuits for parametric measurement are often not the same due to technology differences. Thyristors require significant current to transition from a voltage limiting condition into low-voltage conduction and have a lower inherent surge current capability. Thyristor overvoltage protectors are used in environments where the surge levels are known and a well-defined voltage limiting level is needed.

Recommendation ITU-T K.28

Parameters of thyristor-based surge protective devices for the protection of telecommunication installations

1 Scope

This Recommendation applies to thyristor-based surge protective devices (SPDs) to be used for primary protection against surges due to lightning or power disturbances on telecommunication circuits, in accordance with [b-ITU-T K.11]. It covers the following device parameters:

- a) Characteristics
 - 1. Overvoltage function
 - i. Impulse limiting voltage
 - ii. Leakage current and insulation resistance
 - iii. Holding current
 - 2. Series element
 - i. Hold current
 - ii. Trip current
 - iii. Time-to-trip
 - iv. Impulse let-through current
 - 3. Signal
 - i. Capacitance
 - ii. Longitudinal conversion loss (LCL)
 - iii. Insertion loss
 - iv. Return loss
- b) Ratings
 - 1. Rated peak impulse current
 - 2. Impulse durability
 - 3. AC durability
- c) Overload parameters
 - 1. High impulse current
 - 2. Power fault
- d) Identification and marking.

This Recommendation does not deal with:

- a) mountings for SPDs and their effect on arrester characteristics;
- b) hybrid SPDs where the thyristor voltage limiting is augmented by other technologies;
- c) mechanical dimensions;
- d) quality assurance requirements;
- e) units containing heat-coils.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T K.20] Recommendation ITU-T K.20 (2011), *Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents*.
- [ITU-T K.21] Recommendation ITU-T K.21 (2011), *Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents*.
- [ITU-T K.45] Recommendation ITU-T K.45 (2011), *Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents*.
- [ITU-T K.82] Recommendation ITU-T K.82 (2010), *Characteristics and ratings of solid-state, self-restoring overcurrent protectors for the protection of telecommunications installations*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 electronic current limiter (ECL) [ITU-T K.82]: A device based on transistor and related technology that automatically restricts the current amplitude when it exceeds a predetermined threshold level.

3.1.2 fault current, I_{fault} [b-IEC 62319-1]: Current used when measuring time-to-trip.

3.1.3 hold current (self-restoring overcurrent limiter), I_{H} [ITU-T K.82]: Maximum current at specified ambient temperature, which will not cause the trip event.

NOTE – Sometimes known as rated or non-tripping current.

3.1.4 holding current (thyristor overvoltage limiter), I_{h} [b-IEC 61643-341]: Minimum anode, principal, or thyristor current that maintains the thyristor in the on-state.

NOTE – The holding current test is the thyristor equivalent of the holdover test of a gas discharge tube.

3.1.5 impulse generator charge voltage, V_{C} [ITU-T K.82]: Value of impulse generator charging voltage.

3.1.6 insertion loss (of a two-port device) [b-IEV 702-07-08]: The ratio, generally expressed in decibels, of the apparent power at a point in a transmission channel to the power at the same point after insertion of a given two-port device into the transmission channel immediately ahead of this point.

NOTE – If the ratio defining the insertion loss is less than one, its decibel value is negative, and its converse or opposite decibel value called "insertion gain" may be used.

3.1.7 longitudinal conversion loss (LCL) [b-CISPR 16-1-2]: In a one- or two-port network, a measure (a ratio expressed in dB) of the degree of unwanted transverse (symmetric mode) signal produced at the terminals of the network due to the presence of a longitudinal (asymmetric mode) signal on the connecting leads.

3.1.8 port [b-IEV 131-12-60]: Access to a device or network where electromagnetic energy or signals may be supplied or received or where the device or network variables may be observed or measured.

NOTE – An example of a port is a terminal pair.

3.1.9 reflection loss factor [b-IEV 131-12-65]: Ratio of the apparent power that a specified source would deliver to a load with zero reflection factor at its interface with the source, to the apparent power delivered by the same source to a directly connected given load.

3.1.10 return loss [b-IEV 702-07-25]: The modulus of the reciprocal of the reflection factor, generally expressed in decibels.

NOTE – When impedances can be defined, the return loss is given by the formula:

$$-20\lg(r) = 20 \left| \frac{(Z - Z')}{(Z + Z')} \right|$$

where Z is the characteristic impedance of a transmission line ahead of a discontinuity, or the impedance of a source, and Z' is the impedance after the discontinuity or the load impedance seen from the junction between the source and the load.

3.1.11 surge protective device (SPD) [b-ITU-T K.72]: Device that restricts the voltage of a designated port or ports, caused by a surge, when it exceeds a predetermined level.

NOTE 1 – Secondary functions may be incorporated, such as a current-limiting device to restrict a terminal current.

NOTE 2 – Typically, the protective circuit has at least one non-linear voltage-limiting surge protective component.

NOTE 3 – An SPD is a combination of a protection circuit and holder.

3.1.12 time-to-trip (PTC thermistor) t_{trip} [ITU-T K.82]: Under specified ambient conditions, starting from the time the fault current (I_{fault}) is applied, the time-to-trip is the time required for a device to transition into a tripped state.

NOTE – An overcurrent protector shall have passed into the tripped condition as indicated by the measured voltage exceeding 90% of the supply open-circuit voltage.

3.1.13 trip current (self-restoring overcurrent limiter), I_t [ITU-T K.82]: Lowest current which will cause a trip event at a specified temperature and within a time specified in the product specification.

3.1.14 trip event (self-restoring overcurrent limiter) [ITU-T K.82]: Event of rapid increasing resistance in response to an overcurrent surge.

3.1.15 two-port [b-IEV 131-12-65]: Device or network with two separate ports.

3.1.16 user agreed values [ITU-T K.82]: Test parameters and circuits agreed between major stakeholders (e.g., user and manufacturer) for a specific application.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 impulse limiting voltage, V_P : Highest value of voltage across the terminals of the SPD during the application of a specified impulse.

NOTE – Also called voltage protection level or measured limiting voltage.

3.2.2 in-line SPD: A two-port SPD connected in series with the service feed.

3.2.3 insulation resistance (effective): Quotient of the voltage applied to a designated terminal pair, V_{IR} , by the current, I_{IR} , drawn from the applied voltage.

3.2.4 let-through current: In-line SPD peak short-circuit output current when a specified impulse is applied to the SPD input.

3.2.5 rated peak impulse current: Maximum value of peak impulse current of specified amplitude and waveshape that may be applied without causing degradation.

3.2.6 semiconductor arrester assembly (SAA): A surge protective device (SPD) that uses thyristor technology as the main overvoltage limiting element.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
ADSL	Asymmetric Digital Subscriber Line
CMI	Common Mode Injector
DC	Direct Current
DSL	Digital Subscriber Line
ECL	Electronic Current Limiter
GDT	Gas Discharge Tube
LBB	Longitudinal Balanced Bridge
LCL	Longitudinal Conversion Loss
POTS	Plain Old Telephone Service
PTC	Positive Temperature Coefficient
PVC	Polyvinyl Chloride
SAA	Semiconductor Arrester Assembly
SPD	Surge Protective Device
VDSL	Very high speed Digital Subscriber Line

5 Conventions

The original version of ITU-T K.28 [b-ITU-T K.28] mainly used material from the United States of America standards available at that time. The definition of a semiconductor arrester assembly (SAA) was intended to denote a surge protective device (SPD) that used thyristor technology as the main overvoltage limiting element. Unfortunately, the term "semiconductor" covers a large range of voltage limiting components other than just a thyristor component. For this reason this version of ITU-T K.28 uses thyristor-based SPD (or simply SPD for brevity) rather than SAA.

For the protection of twisted pair cables an SPD can be connected in shunt (Figure 1-a) or in-line (Figure 1-b) with the cable. Shunt SPDs can be tested in the in-line SPD test circuits by shorting the corresponding port input and output terminals together. In-line SPDs can incorporate series overcurrent protectors, either temperature or current operated (Figure 1-c). Additional tests are required to measure the overcurrent protection element operation, surge withstand and surge current let through.