SKMM FTS OPD
Rev. 1.01:2007

TECHNICAL SPECIFICATION
FOR
OVERVOLTAGE PROTECTIVE DEVICES

Suruhanjaya Komunikasi dan Multimedia Malaysia
Off Pesiaran Multimedia, 63000 Cyberjaya, Selangor Darul Ehsan, Malaysia

FOREWORD

This Technical Specification was developed under the authority of the Malaysian Communications and Multimedia Commission (SKMM) under the Communications and Multimedia Act 1998 (CMA 98) and the relevant provisions on technical regulation of Part VII of the CMA 98. It is based on recognised International Standards documents.

This Technical Specification specifies the specifications to conform for approval of telecommunications devices.

NOTICE

This Specification is subject to review and revision

CONTENTS

OVERVOLTAGE PROTECTIVE DEVICES

1. Scope

This Technical Specification defines the Malaysian Communication & Multimedia Commission (SKMM) requirements for overvoltage protective devices which are used by telecommunication network operators to protect telephone subscribers, trunk or junction lines from the effects of lightning and/or power induction.

1.1 Overvoltage and overcurrent conditions

Aspects of overvoltage or overcurrent covered by this specification are:

a) surges due to lightning strikes on or near to the line plant;

b) large currents in common wiring or components when overvoltages or overcurrents occur simultaneously on a number of lines;

c) large currents flowing into the equipment when high current carrying protective components, which eliminate the need for primary protective, are integral to the equipment;

d) short-term induction of alternating voltages form adjacent electric power lines or electrified railway systems, usually when these lines or systems develop faults;

e) earth potential rise due to power faults;

f) direct contacts between telecommunication lines and mains power lines;

g) transient surges on mains-voltage lines; and

h) the potential difference which can occur between a TT or IT Power system and the Telecommunication system.

2. Normative references

The following normative references are indispensable for the application of this Technical Specification. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

See Annex A.

3. Definition

3.1 Overvoltage protective device (OPD)

A device that is intended to mitigate surge overvoltages and overcurrents of limited durations. It may consist of a single component or have a more complex design, where several functions are integrated. It contains at least one non-linear components.

3.2 Telecommunication network

A telecommunication network is a network of telecommunications links and nodes arranged so that messages may be passed from one part of the network to another over multiple links and through various nodes.

4. General requirements

4.1 Types of protective devices

4.1.1 Air-gap protectors with carbon or metallic electrodes

Usually connected between each wire of a line and earth, they limit the voltage, which can appear between their electrodes. They are inexpensive but their insulation resistance can fall appreciably after repeated operation and they may require frequent replacement.

4.1.2 Gas discharge tubes

Usually connected between each wire of a line and earth or as 3-electrode units between a pair and earth. Their performance may be specified to precise limits to meet system requirements. The protectors are compact and will operate frequently without attention.

Detailed requirements for gas discharge tubes appear in ITU-T Recommendation K.12.

4.1.3 Semi-conductor protective devices

Developments in the technology of these devices have produced some units which may be used as primary protectors and others which should be used as secondary protectors only.

Primary and secondary protective should always be coordinated correctly.

a) Primary protective devices

A widespread trial of these devices is taking place in which the units are being used to replace carbon electrode protectors and gas discharge tubes. The outcome of the trials may depend on both technical and commercial factors.

Typically, the benefits which may be provided over carbon electrodes may be the elimination of circuit noise and lower operating levels, while the disadvantages may be higher costs and self-capacitance with lower current handling capability.

In the case of gas discharge tubes, benefits may arise from the elimination of spark discharges while the higher self-capacitance and the lower current handling capability may be considered to be disadvantageous.

The trials are continuing and further developments of this technology may arise.

b) Secondary protective devices

Depending on their location in a circuit, they may be designed to have overvoltage operation levels as low as 1 V. They are precise and fast-acting, but may be damaged by excessive currents unless coordinated correctly.

Detailed requirements for semi conductor protective devices appear in ITU-T Recommendation K.28.

4.1.4 Fuses

These are connected in series with each wire of a line to disconnect when excessive current flows. Simple fuses have a uniform wire which melts. Slow-acting fuses have a uniform wire which melts quickly when a large current flows, and a spring-loaded fusible element which melts gradually and disconnects when lower currents flow for a prolonged time. High level currents of 2 A and prolonged currents of 250 mA are typical operating levels. Fuses should not sustain an arc after operation. Fuses do not give protective against lightning surges and in districts where such surges are common, fuses of a high rating (up to 20 A) may be necessary to avoid trouble from fuse failures. Such fuses may not give adequate protective against power line contacts. Fuses can also be a source of noise and disconnection faults.

Detailed requirements for fuses appear in ITU-T Recommendation K.30.

4.1.5 Heat coils

Fitted in series with each wire of a line, heat coils either disconnect the line, earth it, or do both, with the earth extended to line. Heat coils have some fusible component and operate when currents of, typically, 500 mA flow for some 200 s. Such heat coils may not give adequate protective.

4.1.6 Self-restoring current-limiting devices

These are placed in series with each wire of a line and operate to limit excessive a.c. currents as an open circuit. Fuses and heatcoils permanently interrupt a circuit when operated and it is necessary to replace them manually. Certain variable impedance deviced are available which, when heated by overload currents, increase their electrical resistance to a very high value. When the overload is removed the devices will return to their normal condition and permit operation of the line. Detailed requirements for such devices appear in ITU-T Recommendation K.30.

4.1.7 Fusible links

Fuseless overvoltage protector assemblies installed on telecommunication lines can be protected against the risk of overheating in the event of a prolonged contact between the telecommunication line and a power distribution line by means of a fusible link.

A fusible link usually consists of insulated conductors in series with the telecommunication line and located between the exposure to the power line and the protector assembly. The conductors are usually at least two wire gauges smaller than the conductors terminated on the protector assembly and are of a suitable length to avoid a sustained arc if the power system does not de-energize promptly and the conductors fuse. If the fusible link or part of it is installed in a building or other location where a fire hazard might occur, it is enclosed within a cable sheath, splice enclosure, or other suitable enclosure to contain any arcing that may result if the conductors fuse.

4.2 Residual effects

The essential purpose of protective measures is to ensure that the major part of the electrical energy arising from a disturbance is not dissipated in a vulnerable part of the installation and does not reach personnel. However, no device exits which has characteristics for suppressing ideally all voltages or currents connected with disturbances, for the following reasons:

4.2.1 Residual overvoltages

Account should be taken of:

a) voltages which are unaffected by the protective device because they are below its operating level;

b) transients which pass before the device operates;

c) residuals which are sustained after the device operates; and

d) transients produced by the operation of the device.

4.2.2 Transverse voltages

Protective devices on the two wires of a pair may not operate simultaneously and so a transverse pulse may be produced. Under certain conditions, particularly if the equipment to be protected has a low impedance, operation of one protective device may prevent the operation of the other one and a transverse voltage may remain as long as the longitudinal voltages are on the line.

4.2.3 Effect on normal circuit operation – Coordinated design

Sufficient separation should be allowed between the operating voltage of the protective devices and the highest voltage occurring on the line during normal operation.

Likewise the normal characteristics (internal impedances) of the protective elements shall be compatible with the normal functioning of the installations, which shall take account of their possible presence.

4.2.4 Modifying effects

A protective device may safeguard one part of a line at the expense of another, e.g. if a main distribution frame (MDF) fuse operates due to a power line contact, the voltage on the line may rise to full power line voltage when the fuse disconnects the telecommunication's earth.

Likewise the operation of a protector may greatly reduce the equivalent internal impedance of a circuit relative to equipment connected to it, thus permitting the circulation of currents which may cause damage.

4.2.5 Coordination of primary and secondary protective

For the protective of sensitive equipment it is sometimes necessary to use more than one protective device, e.g. a fast-operating, low-current device such as a semiconductor and a slower-operating, high-current device such as a gas-discharge tube. In such cases steps must be taken to ensure that in the event of a sustained overvoltage, the low-current device does not prevent the operation of the high-current device since, if this happens, the smaller device may be damaged, or the interconnecting wiring may conduct excessive current.

4.2.6 Temperature rise

Protective components should be designed and positioned in such a way that the rise in temperature which occurs when they operate is unlikely to cause damage to property or danger to people.

4.2.7 Circuit availability

The circuit being protected may be temporarily or permanently put out of service when a protective device operates.

4.2.8 Fault liability

The use of protective devices may cause maintenance problems due to unreliability. They may also prevent some line and equipment testing procedures.

4.3 Decision on protective

4.3.1 In considering the degree to which a telecomunications network should withstand overvoltages, two classes of failure may be recognized:

- Minor failures affecting only small parts of the system. These may be allowed.

- Major breakdowns, fires, exchange failures, etc., which shall, so far as possible, be avoided completely.

Examples of conditions which may be permitted to cause minor failures but not major breakdowns are given in ITU-T Recommendation K.20. It is desirable also that failure of a single protective device should not cause a major breakdown.

4.3.2 Particular attention should be given to overvoltage and overcurrent protective for new types of exchange or subscribers' equipment to ensure that the benefits of its improved facilities are not lost due to unacceptable failures arising from exposure to overvoltages or overcurrents. Such equipment may be inherently sensitive to these conditions and damage or malfunction may affect large parts of a system.

4.3.3 It should be noted that over-protective, by the provision of unnecessary protective devices, is not only uneconomic but may actually worsen system performance since the devices themselves may have some liability to cause failures.

To avoid disturbances in telecommunication circuits caused by activated protective devices, the striking voltage values and the numbers of arrestors should be considered.

4.3.4 A decision should be made on the protective to be provided in all parts of the system. Account should be taken of commercial considerations such as the cost of protective measures, the cost of repairs, relations with customers and the probable frequency of faults due to overvoltage and overcurrent relative to the fault rate due to other causes.

The responsibility for making this decision and for ensuring the provision of any protective devices needed to coordinate lines and equipment should be clearly laid down.

It is necessary for manufacturers of equipment to know from the operating administration the conditions the equipment will need to resist and for line engineers to know the resistibility of the equipment which will be connected to the lines. The line engineer should also define the constraints which equipment connected to the line will encounter, depending on the standards of line protective provided. Where parts of the network, such as subscribers' apparatus, lines and switching centres may be under different ownership, this coordination may require formal procedures such as the production of local standards. ITU-T Recommendations K.20 and ITU-T Recommendations K.21 give guidance for the preparation of these standards.

4.4 Use of protective devices

The use of protective devices may be desirable in the following circumstances:

4.4.1 The cost of maintenance should not be overlooked since protective devices inevitably incur some maintenance expenditure whereas special cables, screening, etc., though initially expensive, usually incur no continuing costs.

4.4.2 Cables with extra thick insulation may themselves be undamaged by overvoltages or overcurrents but they can nevertheless conduct such conditions to other more vulnerable parts of the network. Extra protective is then required for the more vulnerable cables and is particularly important if these are large underground cables which are expensive to repair and affect service to many customers.

4.4.3 Induced overvoltages from power or traction line faults may still exceed levels permitted by the *Directives* even after all practicable avoidance measures have been followed.

4.5 Installation of protective devices

4.5.1 To protect conductor insulation it is beneficial to bond all metal sheaths, screens, etc., together, and to connect overvoltage protectors between the conductors and this bonded metal which should be connected to earth. This technique is particularly useful in districts of high soil resistivity as it avoids the need for expensive electrode systems for the protector earth connection.

4.5.2 Where protectors are used to reduce high voltages appearing in telecommunication lines due to induction from power line fault currents, they should be fitted to all wires at suitable intervals and at both ends of the affected length of line, or as near to this as practicable.

4.5.3 To protect underground cables against lightning surges protective devices may be placed at the points of connection to overhead lines. The protective devices fitted at the MDF and at subscribers' terminals reduce the risk of damage to lines but their main function is to protect components having lower dielectric strength than the cables. See ITU-T Recommendations K.20 and ITU-T Recommendations K.21.

4.5.4 Connections for lines and earth to overvoltage protectors used against lightning should be as short as possible to minimize surge voltage levels between lines and the equipotential bond point.

4.6 Planning of works

To the greatest extent possible it is recommended that the protective measures applied to the line should be decided at the outset of a project and should depend on the environment. It may be difficult and expensive to achieve a satisfactory standard of reliability from a line provided initially with insufficient protective.

4.7 Protective of exchange and transmission equipment

4.7.1 Need for protective external to the equipment

Operating organizations should take account of the possible need to fit protective external to the equipment, bearing in mind the following considerations:

4.7.1.1 A telecommunication line will give some protective to equipment under certain conditions, e.g.:

- a conductor may melt and disconnect an excessive current;
- conductor insulation may break down and reduce an overvoltage; and
- air-gaps in connection devices may break down and reduce overvoltages.

4.7.1.2 The increased robustness of plastic insulated cables has the effect of increasing the levels of overvoltages and overcurrents which can circulate in the lines and be applied to equipment. By contrast the use of miniature electronic components in exchange and transmission equipment tends to increase its vulnerability to electrical disturbances.

For these reasons, in districts exposed to frequent and serious disturbances (lightning, power lines, soil of low conductivity), it is usually necessary to interpose protective devices of the types described in 4.1 between the cable conductors and the equipment to which they are connected, preferably on the MDF. This will prevent cables from the MDF to equipment from having to carry heavy overcurrents.

The protective devices are fitted to the line side of the MDF to avoid the need to carry discharge currents in the MDF jumper field and to expose as little of the MDF wiring and terminal strips as possible to mains voltage in the event that a mains voltage line contact causes a series protective device to disconnect the line.

4.7.1.3 In less exposed locations it may be that disturbances (voltages and currents) have statistical characteristics of level and frequency so low that in practice the risks do not exceed those resulting from the residual effects indicated in 4.2 for exposed regions. Protective devices then serve no purpose and are an unnecessary expense.

4.7.2 Need for equipment to have a minimum level of electrical robustness

In locations where lines are exposed and protective devices are provided, the residual effects considered in clause 1 can cause overvoltages and overcurrents to appear in the equipment. In less exposed environments the disturbances described in 4.7.1.3 can cause similar effects. It is necessary for equipment to be designed to withstand these conditions and detailed recommendations on the resistibility which equipment should possess are given in ITU-T Recommendation K.20.

4.7.3 Effect of switching conditions

Since the configuration and interconnection of equipment connected to a given line is required to vary during the successive stages of connecting a call, it is important not to limit the study of protective solely to individual line equipments. Much equipment is common to all lines and can be exposed to disturbances when connected to a particular line.

The effectiveness of the protective provided can be influenced by the reduction in the probability of exposure if the effective duration of the connection to lines is short. On the other hand common equipment should be better protected since its failure risks more serious degradation in the performance of the exchange or the district.

4.8 Protective of subscribers' terminal equipment

The protective methods already set out for exchange equipment can often be usefully applied to subscribers' equipment. Detailed tests to determine the resistibility of subscriber equipment are given in ITU-T Recommendation K.21. It is also appropriate to consider the specific aspects described below.

4.8.1 Use of protectors

4.8.1.1 Use of voltage limiting devices

Where telephone lines are exposed to frequent and severe disturbances from power line faults or lightning, the voltage of the lines relative to local earth potential should be limited by connecting protective devices of the types described in 4.1 between the line conductors and the earth terminal.

The terminal equipment dielectric strength should be chosen taking account of the breakdown voltage of the protective device and the impedance of the protector-line to earth connection.

4.8.1.2 Use of high voltage isolation devices

Where telecommunication lines, protected as in 4.8.1.1 above:

a) exhibit excessive trouble reports due to lightning activity; or

b) cannot have protective to 4.8.1.1 installed for whatever reason; or

c) when access to the subscriber premise by plant maintenance personnel is difficult.

then high voltage (to 50 kV) isolation, together with other suitable measures such as protective to 4.8.1.1 applied at the drop point from the telecommunications cable, may well be considered.

The isolation elements should be installed as close as possible to the subscriber premise on the outside. They shall not be mounted inside buildings.

Isolation techniques may also be helpful at the telecommunications input to high-voltage plant (for example by means of isolation transformers), and in other situations where communications are vital and high plant-voltages probable.

5. Technical requirements

5.1 Air-gap protectors with carbon or metallic electrodes	Detailed testing requirements for air gap protectors with carbon or metallic electrodes appear in ITU-T Recommendations K.20, ITU-T Recommendations K.21 and ITU-T Recommendations K.44.
5.2 Gas discharge tubes	Detailed testing requirements for gas discharge tubes appear in Recommendation ITU-T Recommendations K.12, ITU-T Recommendations K.20, ITU-T Recommendations K.21 and ITU-T Recommendations K.44.
5.3 Semi-conductor protective devices	Detailed testing requirements for semi-conductor protective devices appear in Recommendation ITU-T Recommendations K.20, ITU-T Recommendations K.21 and ITU-T Recommendations K.44.

5.4 Fuses	Detailed testing requirements for fuses appear in Recommendation ITU-T Recommendations K.20, ITU-T Recommendations K.21 and ITU-T Recommendations K.44.
5.5 Heat coils	Detailed testing requirements for heat coils appear in Recommendation ITU-T Recommendations K.20, ITU-T Recommendations K.21 and ITU-T Recommendations K.44.
5.6 Self-restoring current-limiting devices	Detailed testing requirements for self-restoring current-limiting devices appear in Recommendation ITU-T Recommendations K.20, ITU-T Recommendations K.21 and ITU-T Recommendations K.44.
5.7 Fusible links	Detailed testing requirements for fusible links appear in Recommendation ITU-T Recommendations K.20, ITU-T Recommendations K.21 and ITU-T Recommendations K.44.

Annex A

(normative references)

ITU-T Recommendation K.5	Joint use of poles for electricity distribution and for telecommunications
ITU-T Recommendation K.6	Precautions at crossings
ITU-T Recommendation K.7	Protection against acoustic shock
ITU-T Recommendation K.8	Separation in the soil between telecommunications cables and earthing system of power facilities
ITU-T Recommendation K.9	Protection of telecommunication staff and plant against a large earth potential due to a neighbouring electric traction line
ITU-T Recommendation K.10	Low frequency interference due to unbalance about earth of telecommunication equipment
ITU-T Recommendation K.11 (1993)	Principles of protective against overvoltages and overcurrents
ITU-T Recommendation K.12 (2000)	Characteristic of gas discharge tubes for the protective of telecommunications installation
ITU-T Recommendation K.13	Induced voltages in cables with plastic-insulated conductors
ITU-T Recommendation K.14	Provision of a metallic screen in plastic-sheathed cables
ITU-T Recommendation K.18	Calculation of voltage induced into telecommunication lines from radio station broadcasts and methods of reducing interference
ITU-T Recommendation K.19	Joint use of trenches and tunnels for telecommunication and power cables
ITU-T Recommendation K.20	Resistibility of telecommunication equipment installed in a telecommunications centre to overvoltages and overcurrents
ITU-T Recommendation K.21 (2003)	Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents
ITU-T Recommendation K.23	Types of induced noise and description of noise voltage parameters for ISDN basic user networks

ITU-T Recommendation K.24	Method for measuring radio-frequency induced noise on telecommunications pairs
ITU-T Recommendation K.25	Protective of optical fibre cables
ITU-T Recommendation K.26	Protective of telecommunication lines against harmful effects from electric power and electrified railway lines
ITU-T Recommendation K.27	Bonding configurations and earthing inside a telecommunication building
ITU-T Recommendation K.28	Characteristics of semi-conductor arrester assemblies for the protection of telecommunications installations
ITU-T Recommendation K.29	Coordinated protective schemes for telecommunication cables below ground
ITU-T Recommendation K.30	Self-restoring overcurrent protectors
ITU-T Recommendation K.31	Bonding configurations and earthing of telecommunication installations inside a subscriber's building
ITU-T Recommendation K.33	Limits for people safety related to coupling into telecommunication system from a.c. electric power and a.c. electrified railway installations in fault conditions
ITU-T Recommendation K.34	Classification of electromagnetic environmental conditions for telecommunication equipment – Basic EMC Recommendation
ITU-T Recommendation K.35	Bonding configurations and earthing at remote electronic sites
ITU-T Recommendation K.36	Selection of protective devices
ITU-T Recommendation K.37	Low and high frequency EMC mitigation techniques for telecommunications installations and systems – Basic EMC Recommendation
ITU-T Recommendation K.38	Radiated emission test procedure for physically large systems
ITU-T Recommendation K.39	Risk assessment of damages to telecommunication installations and systems – Basic EMC Recommendation
ITU-T Recommendation K.38	Radiated emission test procedure for physically large systems
ITU-T Recommendation K.39	Risk assessment of damages to telecommunication sites due to lightning discharges

ITU-T Recommendation K.40	Protective against LEMP in telecommunication centres
ITU-T Recommendation K.42	Preparation of emission and immunity requirements for telecommunication equipment – General principles
ITU-T Recommendation K.43	Immunity requirements for telecommunication equipment
ITU-T Recommendation K.44	Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation
ITU-T Recommendation K.45	Resistibility of telecommunication equipment exposed to overvoltages and overcurrents
ITU-T Recommendation K.46	Protection of telecommunication lines using metallic symmetric conductors against lightning-induced surges
ITU-T Recommendation K.47	Protective of telecommunication lines using metallic symmetric conductors against direct lightning discharged
ITU-T Recommendation K.48	EMC requirements for telecommunication equipment – Product family Recommendation
ITU-T Recommendation K.49	Test requirements and performance criteria for voice terminal telephones subject to disturbance from digital mobile telecommunications systems
ITU-T Recommendation K.50	Safe limits of operating voltages and currents for telecommunication systems powered over the network
ITU-T Recommendation K.51	Safety criteria for telecommunication equipment
ITU-T Recommendation K.52	Guidance on complying with limits for human exposure to electromagnetic fields
ITU-T Recommendation K.53	Values of induced voltages on telecommunication installations to establish telecom and a.c power and railway operators responsibilities
ITU-T Recommendation K.54	Conducted immunity test method and level at fundamental power frequencies
ITU-T Recommendation K.55	Overvoltage and overcurrent requirements for insulation displacement connectors (IDC) terminations
ITU-T Recommendation K.56	Protective of radio base stations against lightning discharges
ITU-T Recommendation K.57	Protective measures for radio base stations sited on power line towers

ITU-T Recommendation K.58	EMC, resistibility and safety requirements and procedures for co-located telecommunication installations
ITU-T Recommendation K.59	EMC, resistibility and safety requirements and procedures for connection to unbundled cables
ITU-T Recommendation K.60	Emission limits and test methods for telecommunication networks
ITU-T Recommendation K.61	Guidance to measurement and numerical prediction of electromagnetic fields for compliance with human exposure limits for telecommunication installations
ITU-T Recommendation K.62	System level radiated emissions compliance using mathematical modeling
ITU-T Recommendation K.63	Maintaining the suitability of production telecommunications equipment to its intended electromagnetic environment
ITU-T Recommendation K.64	Safe working practices for outside equipment installed in particular environments
ITU-T Recommendation K.65	Overvoltage and overcurrent requirements for termination modules with contacts for test ports or SPDs
ITU-T Recommendation K.66	Protective of customer premises from voltages
ITU-T Recommendation K.67	Expected surges on telecommunications and signaling networks due to lightning
ITU-T Recommendation K.68	Management of electromagnetic interference on telecommunication systems due to power systems
ITU-T Recommendation K.69	Maintenance of protective measures
CEI IEC 1000-4-5	Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test
MS IEC 61643-1:2004	Surge protective devices connected to low-voltage power distribution systems – Part 1: Performance requirements and testing methods (IEC 61643-3:2002 and its amendment 1:2001, IDT)