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SERIES K: PROTECTION AGAINST INTERFERENCE

Requirements for lightning protection of fibre to the distribution point equipment

Recommendation ITU-T K.118

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Summary

Recommendation ITU-T G.9701 specifies a gigabit broadband access technology that exploits the existing infrastructure of wire pairs that were originally deployed for plain old telephone service (POTS) services. Equipment implementing this Recommendation can be deployed from fibre to the distribution point (FTTdp) located very near the customers' premises.

Recommendation ITU-T K.118 contains the necessary information to enable the protection of a distribution point (DP) node in the access network and the associated equipment in the customers' premises. It includes information on the resistibility requirements of the equipment, the rating of the lightning protection, when the installation of protection is necessary and on how to install this protection.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.118	2016-12-14	5	11.1002/1000/13134

Keywords

EPR, GDT, lightning protection, MOVs, MSPDs, power contact and SPDs.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Introduction

Fibre to the distribution point (FTTdp) supports one or more high-speed copper drops into customer premises and uses a gigabit (or faster) fibre link to backhaul user data to a high order node (HON). A key aspect of the new node type is the ability for it to be reverse power fed from one or more copper drop pairs. To reverse power feed (RPF), there needs to be power supply functionality at the customer's premises. To this end a new node type, the distribution point unit (DPU), is defined. This node is typically positioned at the distribution point (DP).

To maintain the reliability of the network it is necessary to ensure that this equipment has the required level of resistibility and that the necessary lightning protection is installed when needed.

Recommendation ITU-T K.118

Requirements for lightning protection of fibre to the distribution point (FTTdp) equipment

1 Scope

This Recommendation applies to the equipment installed at the distribution point (DP) node and the associated equipment installed at the customers' premises.

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.12] Recommendation ITU-T K.12 (2010), *Characteristics of gas discharge tubes for the protection of telecommunications installations*.

[ITU-T K.21] Recommendation ITU-T K.21 (2016), *Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents*.

[ITU-T K.35] Recommendation ITU-T K.35 (1996), *Bonding configurations and earthing at remote electronic sites.*

[ITU-T K.44] Recommendation ITU-T K.44 (2016), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation.*

[ITU-T K.45] Recommendation ITU-T K.45 (2016), *Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents.*

[ITU-T K.65] Recommendation ITU-T K.65 (2011), *Overvoltage and overcurrent requirements for termination modules with contacts for test ports or surge protective devices*.

[ITU-T K.66] Recommendation ITU-T K.66 (2011), *Protection of customer premises from overvoltages.*

[ITU-T K.75] Recommendation ITU-T K.75 (2016), *Classification of interface for application of standards on resistibility and safety of telecommunication equipment.*

[ITU-T K.85] Recommendation ITU-T K.85 (2011), *Requirements for the mitigation of lightning effects on home networks installed in customer premises*.

[ITU-T K.98] Recommendation ITU-T K.98 (2014), *Overvoltage protection guide for telecommunication equipment installed in customer premises.*

[ITU-T K.108] Recommendation ITU-T K.108 (2015), *Joint use of poles by telecommunication and solidly earthed power lines.*

[ITU-T K.109] Recommendation ITU-T K.109 (2015), *Installation of telecommunication equipment on utility poles.*

[IEC 60950-1] IEC 60950-1:2005+AMD1:2009+AMD2:2013 CSV, *Information technology equipment – Safety – Part 1: General requirements.*

[IEC 61643-311] IEC 61643-331:2013, *Components for low-voltage surge protective devices – Part 311: Performance requirements and test circuits for gas discharge tubes (GDT).*

[IEC 61643-331] IEC 61643-331:2003, *Components for low-voltage surge protective devices – Part 331: Specification for metal oxide varistors (MOV).*

[IEC 62305-2] IEC 62305-2 Ed. 2.0 (2010), *Protection against lightning – Part 2: Risk management.*

[IEC 62368-1] IEC 62368-1 Ed. 2.0 (2014), *Audio/video, information and communication technology equipment – Part 1: Safety requirements.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 high current carrying protection components [ITU-T K.44]: A high current carrying protection component is an SPD which, when activated by the surge, conducts/diverts the majority of the surge away from the circuit it is protecting. High current carrying protection components are mainly used as primary protection components, but in some cases may be integrated into the equipment as inherent protection.

3.1.2 inherent protection [ITU-T K.44]: Inherent protection is protection that is provided within the equipment either by virtue of its intrinsic characteristics, by specific design, or by suitable protection components.

3.1.3 primary protection [ITU-T K.44]: Means by which the majority of the surge stress is prevented from propagating beyond a designated location (preferably the building entrance point).

3.1.4 spark-overvoltage [ITU-T K.12]: The voltage which causes spark-over when applied across the terminals of a gas discharge tube.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 thermal protection: integral switch function of a surge protective component (SPC) that operates when the component temperature exceeds a pre-set value.

NOTE 1 – A thermally protected gas discharge tube (GDT) has a normally open thermal switch connected in parallel with the electrodes, which shorts out the GDT when the component temperature exceeds a pre-set value.

NOTE 2 – A thermally protected metal oxide varistor (MOV) has a normally closed thermal switch connected in series with MOV element, which disconnects the MOV when the component temperature exceeds a pre-set value.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

a.c. alternating current

d.c. direct current

DP Distribution Point

DPU Distribution Point Unit

EPR Earth Potential Rise

ES1 Electrical Energy Source class 1

ES2 Electrical Energy Source class 2

FTTdp Fibre To The distribution point

GDT Gas Discharge Tube

HON High Order Node

MEB Main Electrical Board

MOV Metal Oxide Varistor

MSPD Multi-service Surge Protective Device

PE Protective Earth

RPF Reverse Power Feeding

SELV Safety Extra Low Voltage

SPC Surge Protective Component

SPD Surge Protective Device

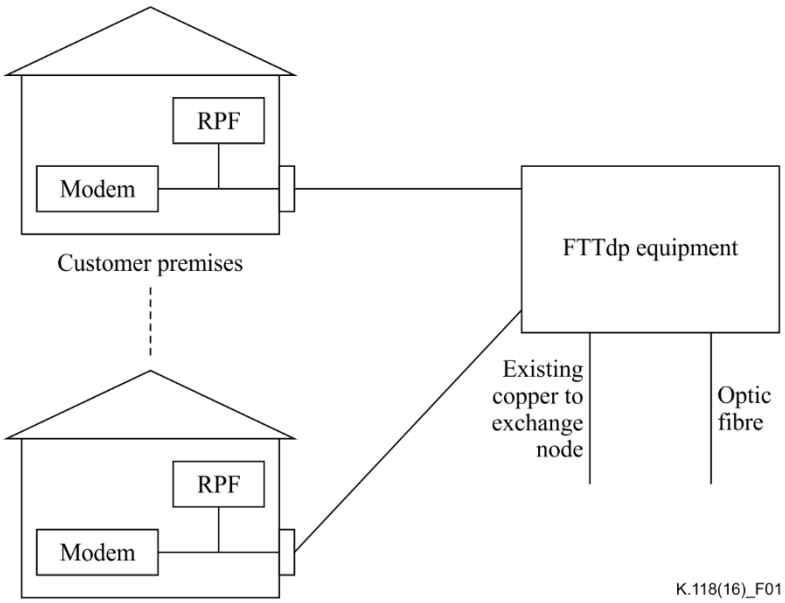
VoIP Voice over Internet Protocol

5 Conventions

None.

6 Elements of protection

Fibre to the distribution point (FTTdp) supports one or more high-speed copper drops into customer premises and uses a gigabit (or faster) fibre link to backhaul user data to a high order node (HON). A key aspect of the new node type is the ability for it to be reverse power fed from one or more copper drop pairs. To reverse power feed (RPF), there needs to be power supply functionality at the customer premises. To this end a new node type, the distribution point unit (DPU), is defined. This node is typically positioned at the distribution point (DP).



In some implementations the FTTdp equipment may be connected to the existing copper cable from the exchange node until all customers are converted to VoIP.

Figure 1 – Fibre to the distribution point (FTTdp)

There are many different methods of supplying the RPF to the FTTdp equipment at the DP. In some applications the modem signal will share the copper pair and in other applications separate pairs will be used. These options are described in [b-ETSI TS 101 548].

To ensure that adequate lightning protection is installed, or can be installed, it is necessary to consider a number of issues. These are:

1 correct classification and use of ports

2 equipment design considerations

3 equipment resistibility

4 primary protection

5 requirements for earthing and bonding

6 risk assessment

7 responsibility

8 A.C. earth potential rise (EPR).

6.1 Correct classification and use of ports

Correct classification and use of ports: It is necessary that the equipment ports have been correctly classified, designed and used in accordance with [ITU-T K.75].

For the RPF equipment installed in the customer premises both the mains and the power feed ports need to be "external ports".

For the DP equipment all ports need to be "external ports".

6.2 Equipment design considerations

Where lightning protection above the inherent resistibility level of 1.5 kV is required, there are two options:

– Add primary protection outside the equipment when a risk assessment indicates that protection should be installed.

– Design the equipment with integral high current carrying protection components (e.g., gas discharge tubes (GDTs)) as part of the inherent protection. Typically, this is only implemented for access network equipment.

In both cases the protection could be used as bypass protection or the protection could be earthed. Bypass and earthed protection is shown pictorially in Figure 2.

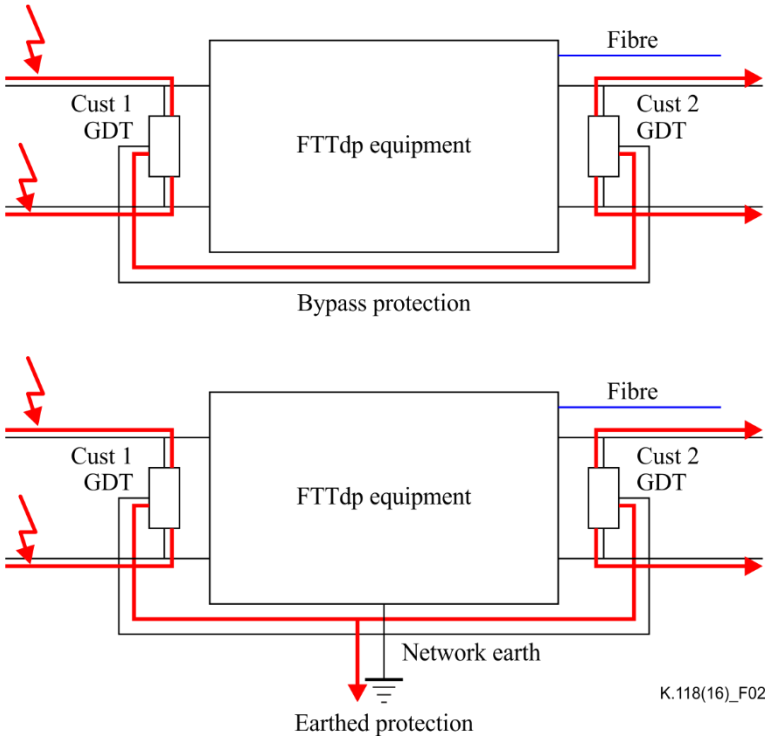


Figure 2 – Pictorial illustration of bypass and earthed protection

6.2.1 Floating equipment

This is equipment that does not require a protective earth (PE) and it is powered from an SELV, ES1 or ES2 circuit, or has a double insulated power supply.

If the DPU will not be earthed it is a good idea to ensure that a flashover to earth is unlikely. A figure of 20 kV of isolation is probably a good figure to achieve. While it is possible for a telecommunications cable to conduct 100 kV surges, joints will break down at lower voltages. At the breakdown point of the joint an EPR will occur and the voltage on the cable can still be more than the breakdown voltage of the joint. The more joints that break down the lower the cable voltage will be. Further information on the surge voltage in a cable is provided in [ITU-T K.98].

[ITU-T K.109] has additional requirements for installations on power poles.

6.2.2 Earthed equipment

This equipment requires a PE connection.

[ITU-T K.109] has additional requirements for installations on power poles.

6.2.3 Equipment with integral high current carrying protection components

This is equipment with integral high current carrying protection components. The "enhanced requirement" in [ITU-T K.21] and [ITU-T K.45] requires that the current carrying capacity of the printed circuit tracks needs to be 5 kA 8/20 µs per conductor and 30 kA 8/20 µs for the conductors carrying the sum of the single conductor currents.

NOTE – Printed circuit tracks, particularly the track conducting the sum of the currents, will need to be thicker and wider than normal tracks. This ensures compatibility with good quality filled cable connectors (grease or gel filled) which can safely conduct 5 kA 8/20 µs currents.

6.3 Equipment resistibility

6.3.1 Network equipment installed in the network

For **network equipment installed in the network** the requirements should be as recommended in [ITU-T K.45]. The "Enhanced" test levels are suggested to ensure reliable equipment, particularly for equipment which contains high current carrying protection components within the equipment to eliminate the need for primary protection.

6.3.2 Network equipment installed in customer premises

For **network equipment installed in customer premises** the requirements should be as recommended in [ITU-T K.21]. The "Enhanced" test levels are suggested to ensure reliable equipment.

NOTE – For "floating equipment", with no connection to PE, the line to earth resistibility requirement is 6 kV for the "Enhanced" test level and this ensures a far more robust product.

6.4 Primary protection and MSPDs

Refer to clause 6.6 on performing a risk assessment to determine when primary protection is necessary. Refer to clause 6.7 regarding the responsibility for installing lighting protection.

6.4.1 Requirements of the SPDs

6.4.1.1 Multi-service surge protective devices (MSPDs)

MSPDs shall comply with [IEC 60950-1] or [IEC 62368-1]. The protection components shall comply with [IEC 61643-331] for MOVs and [IEC 61643-311] for GDTs. Ideally, the MOVs should have a minimum of a 5kA rating and the GDTs should have a minimum of a 5 kA rating per side, (i.e., 10 kA in the centre electrode for a 3 electrode type).

6.4.1.2 GDTs at the DPU

This applies to GDTs within the equipment or those installed in a protection frame. The GDTs should have a minimum of a 5 kA rating per side (i.e., 10 kA in the centre electrode for a 3 electrode type). The spark-over voltage will be as agreed by the equipment manufacturer and the network operator. Guidance is provided in [ITU-T K.12]. Refer to clause 6.4.1.5 for power contact and fire considerations.

6.4.1.3 GDTs at customer premises

The GDTs should have a minimum of a 5 kA rating per side, (i.e., 10 kA in the centre electrode for a 3 electrode type). The spark-over voltage will be as agreed by the equipment manufacturer and the network operator. Guidance is provided in [ITU-T K.12]. National regulations of the country may have specific requirements. Refer to clause 6.4.1.5 for power contact and fire considerations.

6.4.1.4 Mains SPDs at customer premises

Ideally, the SPD should have a minimum of a 40 kA 8/20 µs rating. In extreme situations, e.g., long rural power lines, an SPD with a 100 kA 8/20 µs rating should be considered.

6.4.1.5 Fire consideration

Consideration should be given to the possibility of a power contact to the telecommunications line causing the GDT to overheat and resulting in a fire. A fire can be prevented by selecting the voltage limiter threshold voltage to be above the mains voltage or by the use of thermal protection to prevent the GDT from overheating.

Where the GDT is an integral part of the equipment the requirements are contained in [ITU-T K.21] and [ITU-T K.45] as applicable and in [IEC 62368-1]. Where the GDT is installed in a protection frame the requirements are given in [ITU-T K.65].

6.4.2 Installation

6.4.2.1 DPU

When needed, GDTs could be installed outside the equipment or the equivalent of primary protection included in the equipment design as inherent protection. The GDT requirements are provided in [ITU-T K.12]. The protection holder requirements are provided in [ITU-T K.65].

NOTE – When the equivalent of primary protection is included in the equipment design as inherent protection, primary protection is not required.

6.4.2.2 Customer premises

Overvoltage protection, when required, should be installed according to [ITU-T K.66]. This includes the use of both MSPDs and primary protectors for both the mains and telecommunications services.

An MSPD should be the first level of protection for equipment installed in the customers' premises to protect the RPF equipment. The requirements for installing MSPDs are provided in [ITU-T K.66].

To prevent possible problems both the RPF equipment, the modem and any nearby equipment such as a computer or mains powered telephone plugged into the modem, need to be powered from this MSPD. Ideally, if mains powered telephones are used remotely from the modem the "internal" port of the modem needs to be protected to prevent both damage to the modem and possible damage to the RPF equipment. This is described in [ITU-T K.66]. However, as an MSPD with the necessary internal port protection does not exist, this protection cannot be easily provided. Responsibility for the decision to install, or when to install, an MSPD needs to be allocated.

In lightning-prone areas primary protection may also need to be installed. This would include an SPD in the main electrical board (MEB) and GDTs on the cable from the DP. This is to protect the MSPD.

6.5 Requirements for earthing and bonding

For customer premises the earthing and bonding practices should comply with [ITU-T K.66]. Earthing is the connection of the earth bar to earth, usually via an installed earth electrode. Bonding is the interconnection of earth electrodes and metallic parts to minimise potential differences.

For the DPU the earthing and bonding practices should comply with [ITU-T K.35] if earthing is provided. The value of the resistance of the earthing electrode depends on its function. If required for functional reasons a single earth electrode is all that is required. If the earth is required to protect against a direct strike to the pole a 10 Ω earth is a nominal requirement. As this may be difficult to achieve, a higher value may need to be accepted. [ITU-T K.109] has additional requirements for installations on power poles.

6.6 Risk assessment

To determine the risk of lightning damage for different installations [IEC 62305-2] can be used to perform a risk assessment. This would determine when MSPDs and primary protection are required. Examples of such risk assessments are provided in [ITU-T K.85].

6.6.1 DPU

If the DPU equipment has integral high current carrying protection components (e.g., GDTs) as part of the inherent protection, the equivalent of primary protection is effectively always provided.

If primary protection is added to a protection frame when necessary, either the equipment provider, installer or network operator has to decide when primary protection is required and take the necessary steps to ensure that it is installed.

6.6.2 Customer premises

At the customer's premises, it is necessary to decide when to:

1 install an MSPD to protect the RPF equipment and associated equipment;

2 install primary protection on both the telecommunications and power services. Note, some services may already have an SPD for the power service to protect computer-controlled equipment such as washing machines, etc.

6.7 Responsibility

To ensure that the required level of protection is provided it is necessary that the parties involved agree on the breakdown of responsibility. Proposals for the sharing of this responsibility are provided in [ITU-T K.66] and [ITU-T K.85].

6.8 A.C. earth potential rise (EPR)

Avoiding an a.c. EPR in the network is outside the scope of this document but it is an issue which needs consideration when installing DPUs. [ITU-T K.109] has requirements for installations on power poles.

Appendix I

Level of protection

(This appendix does not form an integral part of this Recommendation.)

Three levels of protection can nominally be provided.

I.1 Protection against surges induced into external cables

The equipment inherent resistibly level of 1.5 kV is meant to provide protection against approximately 95% of induced surges. However, this is not an indication of how often damage may occur. [IEC 62305-2] can be used to determine the frequency of damage. [IEC 62305-2] nominally calculates loss but without understanding the implications that it can result in an incorrect conclusion.

I.2 Protection against direct strikes to the power or telecommunications cables or lines more than 100 m away from the DPU

The installation of an MSPD at customers' premises will protect the equipment in the majority of cases. The use of MSPDs in suburban areas would ensure that overvoltage damage is kept to a low level. The installation of primary protection in the main electrical switchboard and in the telecommunications termination box will enhance this protection particularly against surges entering on the mains conductors. Primary protection is probably unnecessary for most installations except in known lightning-prone areas.

The use of primary protection at the DPU or the use of a DPU with inherent protection equivalent to primary protection will protect the equipment in the majority of cases.

Both of the above statements are based on the data in [ITU-T K.98].

I.3 Protection against direct strikes

This would mean protection against direct strikes to the houses, to the pole and even the cable in high lightning-prone areas. It would require direct strike protection of the building and a 10 ohm earth for each structure. Protection to this level would incur significant expense and is not practical.

Bibliography

[b-ITU-T G.9701] Recommendation ITU-T G.9701 (2014), *Fast access to subscriber terminals (G.fast) – Physical layer specification.*

[b-ETSI TS 101 548] ETSI TS 101 548 V2.1.1 (2016), *Access, Terminals, Transmission and Multiplexing (ATTM); European Requirements for Reverse Powering of Remote Access Equipment.*

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