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**ITU-T**

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OF ITU

**K.41**

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SERIES K: PROTECTION AGAINST INTERFERENCE

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**Resistibility of internal interfaces of  
telecommunication centres to surge  
overvoltages**

ITU-T Recommendation K.41

(Previously CCITT Recommendation)

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ITU-T K-SERIES RECOMMENDATIONS  
**PROTECTION AGAINST INTERFERENCE**

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## **ITU-T RECOMMENDATION K.41**

### **RESISTIBILITY OF INTERNAL INTERFACES OF TELECOMMUNICATION CENTRES TO SURGE OVERVOLTAGES**

#### **Summary**

This Recommendation specifies test methods and levels for the resistibility test against surge overvoltages on internal interface lines within a telecom centre interconnecting the several system blocks. The tests simulate surge overvoltages caused by magnetic fields from lightning strokes in or near the telecom building.

#### **Source**

ITU-T Recommendation K.41 was prepared by ITU-T Study Group 5 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 15th of May 1998.

## 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.

## NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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## **Introduction**

External telecom lines entering a telecom building may be subjected to overvoltages due to induction by lightning currents. However, not only external cables are affected by lightning but also internal lines interconnecting telecom equipment installed inside a telecom building. The protection of ports connected to external lines is covered by Recommendation K.20 while that of ports connected to internal lines is covered in this Recommendation.

The sources for overvoltages in internal lines are mainly magnetic fields caused by lightning currents penetrating the telecom building. The amplitude and waveshape of the overvoltages depend on several factors (see Appendix I).

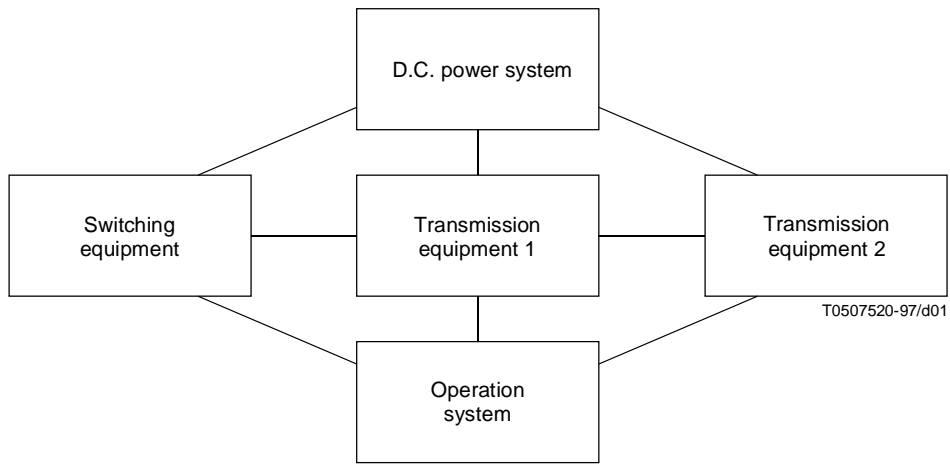
**Recommendation K.41**

**RESISTIBILITY OF INTERNAL INTERFACES OF TELECOMMUNICATION CENTRES TO SURGE OVERVOLTAGES**

*(Geneva, 1998)*

**1 Scope**

The Recommendation relates to internal interfaces within a telecom building interconnecting several system blocks of this telecom centre, for example switching equipment, different transmission equipment, operation system and power supply (see Figure 1).



**Figure 1/K.41**

The tests of this Recommendation simulate overvoltages caused by magnetic fields from direct lightning strikes to the lightning protection system of the telecom building or from lightning strokes nearby the telecom building.

The internal cables, which includes symmetrical and coaxial telecommunication lines, signal lines and DC power lines, may extend hundreds of meters but do not leave the building.

The requirements of this Recommendation relate to the inherent resistibility of the input and output ports of the tested equipment. It is presumed that a Minimum Common Bonding Network has been installed according to Recommendation K.40 and that the earthing and bonding network is either a Mesh-BN configuration or a Mesh-IBN with a bonding mat configuration as described in Recommendation K.27. In cases which do not fulfil these conditions, additional protection measures or equipment with higher resistibility levels may be necessary.

Peripheral equipment which is not defined to be telecommunication equipment (e.g. personal computers and printers) is not within the scope of this Recommendation.

This Recommendation only covers the situation where one of the power supply inputs is earthed at the equipment under test.

## 2 References

The following ITU-T Recommendations and other references contain provisions which, through referenced 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; all 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.

- ITU-T Recommendation K.27 (1996), *Bonding configurations and earthing inside a telecommunication building*.
- ITU-T Recommendation K.40 (1996), *Protection against LEMP in telecommunications centres*.
- IEC Standard 61000-4-5: 1995, *Electromagnetic Compatibility (EMC) – Part 4: Testing and measurement techniques, Section 5: Surge immunity test*.

## 3 Test conditions

Following test conditions are valid:

- The tests are type tests.
- The equipment shall be powered and fully operational at the time the test pulse is applied.
- The input and output ports of the equipment at which the test is to be applied should be identified by the manufacturer.
- The untested ports are terminated as agreed by the manufacturer and the operator.
- The normal operation of the equipment is examined after the test.
- In all cases where a maximum voltage ( $U_{(\max)}$ ) is specified, tests should also be made at lower voltages if this is necessary to confirm that the equipment will resist any voltage up to the maximum value specified.
- Each test should be applied at least five times in positive and in negative polarity. The time interval between two pulses shall be at least 1 minute.
- The test should be carried out at ports as described in Table 1.
- The length of the interface cable used for tests applied to shielded lines shall be 20 m.
- The type of the cable shall be agreed by the manufacturer and the operator. EMC performance will usually be the major consideration.

## 4 Test criterion

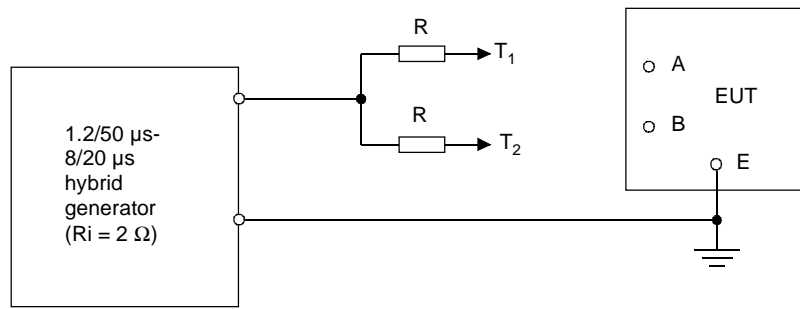
The equipment under test shall withstand the test without damage or other disturbance (such as corruption of software, data held in memory or misoperation of fault protection facilities) and shall operate properly within the specified limits after the test. It is not required to operate correctly while the test condition is present.

## 5 Test requirements

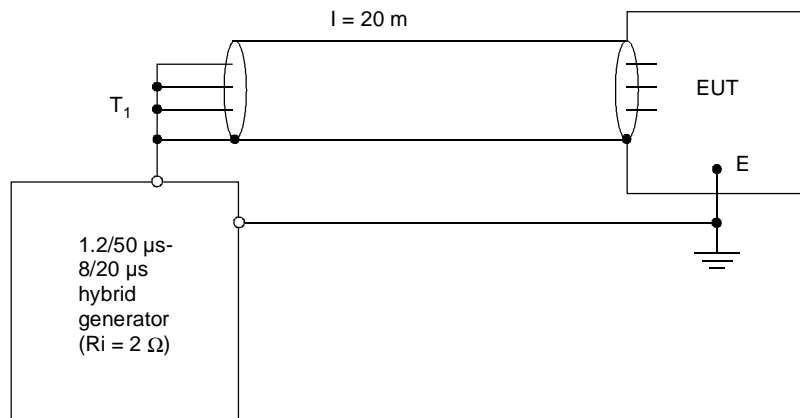
### 5.1 Test circuit

The circuit diagram, waveform and other parameters of the hybrid generator are defined in the Standard IEC 61000-4-5. The test generator is connected with the tested ports as shown in Figure 2. Measures may need to be taken during telecommunication and signal port tests to ensure that normal operation of the equipment is not interfered with. For the test of the DC power port, coupling/decoupling elements according to Figure 2 c) are used. An example of a Decoupling network can be found in the standard mentioned above.



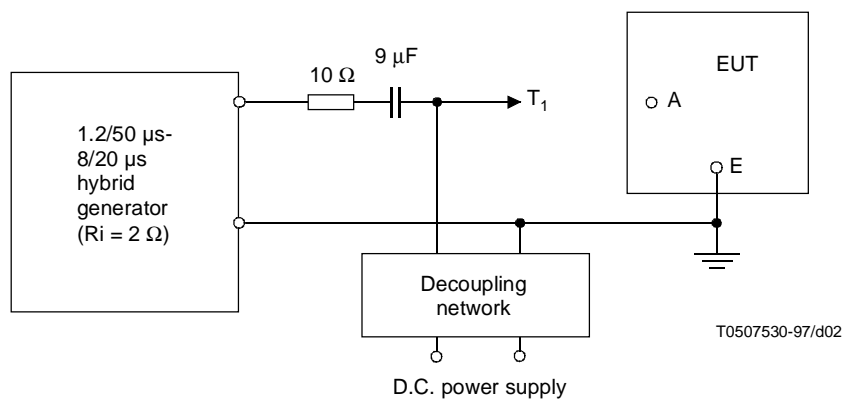


a) Telecommunication and signal-ports for unshielded cables



For repeatability of measurement, it is recommended that the test be performed on an earth reference plane, with the cable laid on the ground plane in a snake pattern. All conductors are connected together and with the shield. (Reason: in worst case, inserted protective elements in the counterpart equipment – not included in this test set-up – can cause short circuit termination.)

b) Telecommunication and signal-ports for shielded cables



c) D.C. power-interfaces

Figure 2/K.41 – Test circuits

## 5.2 Test levels

See Table 1.

**Table 1/K.41**

No.	Interface	Test circuit	Differential mode		Common mode	
			$U_{(max)}$	Terminal connections	$U_{(max)}$	Terminal connections
1	Unshielded with signal line unsymmetrical	Figure 2 a) $R = 10 \Omega$	500 V	$T_1$ and A	N.A.	N.A.
2	Unshielded with signal line symmetrical	Figure 2 a) $R = 10 \Omega$	N.A.	N.A.	500 V	$T_1$ and A; $T_2$ and B
3	Shielded with signal line unsymmetrical or symmetrical	Figure 2 b)	N.A.	N.A.	500 V ( $\leq 250$ A)	$T_1$ with shield and all conductors
4	D.C. power line	Figure 2 c)	500 V	$T_1$ with A	N.A.	N.A.
N.A. Not applicable						

## Appendix I

### I.1 Shape of surge voltages on internal lines of telecom centres and their reduction by shielding

For establishing resistibility test for equipment connected to internal lines, the magnitude and shape of induced lightning surges to be expected has to be known. The overvoltage in unshielded lines caused by lightning currents penetrating the telecom building is proportional to the differential quotient of the lightning current versus time and to the mutual inductivity between the line and the bonding network:

$$U = M \cdot di/dt$$

This means that the overvoltage is strongly depending on the rise time of the lightning current. The rise time determines mainly the duration and the amplitude of the surge voltage. Short and high surge voltages are generated by lightning surge currents with a very short front time. However, the energy content of these surges may be comparatively low.

Bonding networks with a mesh-structure are most effective in reducing surge voltages caused by lightning currents on the earthing system. By using a mesh structure, the lowest effective inductivity of the bonding network can be achieved. Therefore it is assumed that the earthing and bonding configurations of the telecom centre fulfil the requirements of Recommendation K.27.

For shielded lines, a part of the lightning current flows over the shield. The overvoltage on the shielded lines begins delayed and the rise time is longer.

The overvoltages on internal lines are reduced effectively by using appropriate shields. It is assumed that the shields are earthed at both ends. In principle, two types of cables shields with quite different shielding performance are used:

- One type is less expensive and widely used. The screen consists of a thin metal tape around the cable core, the conductivity of which is improved by a longitudinal wire. With this type of cables, the overvoltages can be reduced at least by a factor 2.
- Cables with a braided screen reduce the values of surge voltages by a factor 10.

## **I.2 General measures**

The amplitude of the surge overvoltage can vary by a factor 100 and more depending on the shielding of the building, on the size of the effective loops (take into account also the loops between telecommunication lines and power lines), on the length of the internal cables and on the kind of used cable ducts. As mentioned in the main part of this Recommendation, the test levels were established for equipment installed in a telecom building with a Minimum Common Bonding Network (MCBN). MCBN means according to Recommendation K.40 that:

- A ring conductor is along the inside perimeter of the building at each floor.
- There are connections between the ring conductor of each floor with vertical bonding conductors, approximating a Faraday cage; the distance between the vertical conductors should not be greater than 5 m.
- At the ground floor is a connection of the ring conductor to the ring earth electrode.

## **I.3 Additional protection measures**

Additional protection measures are under study in Study Group 5.



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