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Electromagnetic compatibility requirements of electromagnetic disturbances from lighting equipment located in telecommunication facilities

Recommendation ITU-T K.132

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Summary

Recommendation ITU-T K.132 specifies limits and measurement methods of electromagnetic disturbances from lighting equipment for installation in telecommunication facilities. The requirements in Recommendation ITU-T K.132 are based on CISPR 15 and CISPR 32 for continuous electromagnetic disturbances. Furthermore, Recommendation ITU-T K.132 specifies the limit of transient conducted current and measurement methods.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.132	2018-01-13	5	11.1002/1000/13455

Keywords

Disturbance, lighting equipment, transient.

* 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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Electromagnetic compatibility requirements of electromagnetic disturbances from lighting equipment located in telecommunication facilities

1 Scope

This Recommendation specifies limits and measurement methods for electromagnetic disturbances from lighting equipment for installation in telecommunication facilities.

The electromagnetic disturbances specified in this Recommendation are continuous conducted and radiated disturbances emitted when lighting equipment is operating, and conducted transient disturbances generated when it is switched on and off. The frequency range of continuous conducted disturbances, from 9 kHz to 30 MHz, and continuous radiated disturbances, in the frequency range 30 MHz to 1 GHz, lie within the scope of this Recommendation.

Additionally, this Recommendation specifies the limit of conducted transient disturbances to prevent malfunctions in telecommunication equipment that transmits signals below 30 MHz, such as the integrated service digital network (ISDN), asymmetric digital subscriber line (ADSL) and very high bit rate digital subscriber line (VDSL).

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.48] Recommendation ITU-T K.48 (2006), *EMC requirements for telecommunication equipment – Product family Recommendation*.

[CISPR 15] CISPR 15:2015, *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*.

[CISPR 16-1-2] CISPR 16-1-2:2017, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*.

[CISPR 32] CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 conducted disturbance [b-IEC 60050], 161-03-27: Electromagnetic disturbance for which the energy is transferred via one or more conductors.

3.1.2 electromagnetic disturbance [b-IEC 60050], 161-01-05: Any electromagnetic phenomenon which can degrade the performance of a device, equipment or system, or adversely affect living or inert matter.

3.1.3 port [b-IEC 60050], 161-01-27: Particular interface of an equipment which couples this equipment with the external electromagnetic environment and through which the equipment is influenced by this environment.

3.1.4 radiated disturbance [b-IEC 60050], 161-03-28: Electromagnetic disturbance for which the energy is transferred through space in the form of electromagnetic waves.

3.1.5 transient [b-IEC 60050], 161-02-01: Pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady states during a time interval short compared with the timescale of interest.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 telecommunication facility: A facility that mainly houses telecommunication equipment, such as telecommunication equipment rooms or remotely located telecommunication sites.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ADSL Asymmetric Digital Subscriber Line

CDN Coupling and Decoupling Network

CRC Cyclic Redundancy Check

EUT Equipment Under Test

ISDN Integrated Service Digital Network

LED Light-Emitting Diode

OATS Open-Air Test Site

PC Personal Computer

RBW Resolution Bandwidth

SAC Semi-Anechoic Chamber

VDSL Very high bit rate Digital Subscriber Line

5 Conventions

None.

6 Limits

The limits of disturbance from telecommunication equipment are specified in [ITU-T K.48] and [CISPR 32]. In order to harmonize the levels of disturbances from telecommunication equipment and lighting equipment that are installed in a telecommunication equipment room, the disturbance from lighting equipment should be the same or lower than that from telecommunication equipment.

In this Recommendation, the limits of continuous conducted and radiated disturbances in the frequency range 9 kHz to 300 MHz from lighting equipment are specified with reference to [CISPR 15]. The limits of radiated continuous disturbance above 300 MHz to 1 GHz are specified with reference to [CISPR 32]. The limit is set also between 300 MHz and 1GHz, since radiated disturbance in this frequency range is observed in commercially available light sources, as shown in Appendix I. Moreover, a limit for transient disturbance is required in this Recommendation, since malfunctions in transmission systems have been reported caused by transient disturbance generated

by lighting equipment switching operations in telecommunication equipment rooms, as shown in Appendix II.

6.1 Limits for conducted disturbances at mains ports

Disturbances measured by a quasi-peak and average detector at the mains ports shall not be greater than the values in Table 1.

Table 1 – Test methods and limits for conducted disturbance voltage at main ports (from [CISPR 15])

Frequency range	Test methods	Limits (dBμV)	
	Reference standard	Quasi-peak	Average
9 kHz to 50 kHz	[CISPR 15]	110	–
50 kHz to 150 kHz		90 to 80	–
150 kHz to 0.5 MHz		66 to 56	56 to 46
0.5 MHz to 5.0 MHz		56	46
5 MHz to 30 MHz		60	50

NOTE 1 – 1 μV is taken to be 0 dBμV.

NOTE 2 – If the quasi-peak value of measurement is less than the limit specified for average value detection, the equipment shall be deemed to meet both limits and there is no need to measure the average value.

NOTE 3 – The lower limit shall apply at transition frequency.

NOTE 4 – The limit shall decrease linearly with the logarithm of frequency.

NOTE 5 – For electrode-less lamps and luminaires, the limit in the frequency range 2.51 to 3.00 MHz is not applied in this Recommendation.

6.2 Limits for radiated disturbances

The limit values of radiated disturbances shall not be greater than the values at the specified distance given in Table 2.

Table 2 – Test methods and limits for radiated disturbances (10 m)

Frequency range (MHz)	Test methods		Quasi-peak limit (dBμV/m)
	Measurement facility	Reference standard	
30-230	Semi-anechoic chamber (SAC) or open-air test site (OATS) 10 m distance	[CISPR 15]	30
230-300			37
300-1000		[CISPR 32]	37

NOTE 1 – 1 μV/m is taken to be 0 dBμV/m.

NOTE 2 – The lower limit shall apply at the transition frequency.

NOTE 3 – Add 10 dB to the limit when measurement distance is 3 m. Subtract 10 dB from the limit when the measurement distance is 30 m.

NOTE 4 –The coupling and decoupling network (CDN) measurement method described in Annex B of [CISPR 15] is not applied in this Recommendation, because the measurement method has not yet been established.

6.3 Limits for transient currents at mains port

The limit for transient currents that arise at a mains port when a piece of lighting equipment is turned on and off is shown in Table 3.

Table 3 – Test method and limit for transient current

Test methods	Limit
Annex A	5 A_{p-p}

7 Measurement methods

This clause describes the measurement methods for electromagnetic disturbances emitted from lighting equipment.

7.1 Conducted disturbance at mains ports

1) Measurement arrangement and procedures

   Measurement arrangement and procedure shall comply with [CISPR 15].

2) Components of lighting equipment and operating conditions

   The equipment under test (EUT) for the emission test shall consist of all components based on the manufacturer's specification for the equipment. If the lighting equipment is of the twin tube type, measurement shall be carried out with the two tubes attached.

   Operating conditions of the lighting equipment shall comply with clause 6 of [CISPR 15].

3) Measurement instruments and test site

   Measurement instruments and test site shall comply with [CISPR 32].

7.2 Radiated disturbances

1) Measurement arrangement and procedures

   Measurement arrangement and procedure shall comply with [CISPR 32]. General measurement arrangements and test procedures are given in [CISPR 15].

2) Components of lighting equipment and operating conditions

   The EUT for the emission test shall consist of all components based on the manufacturer's specification for the equipment. If the lighting equipment is of the twin tube type, measurement shall be carried out with the two tubes attached. Operating conditions shall comply with clause 6 of [CISPR 15].

3) Measurement instruments and test site

   Measurement instruments and test site shall comply with [CISPR 32].

7.3 Transient currents at mains port

1) Measurement arrangement and procedures

   Measurement arrangement and procedure shall comply with Annex A.

2) Components of lighting equipment and operating conditions

   Components of lighting equipment shall be based on normal conditions provided by the manufacturer. If the lighting equipment is of the twin tube type, measurement shall be carried out with the two tubes attached.

   Operating conditions shall comply with clause 6 of [CISPR 15].

3) Measurement instruments and locations

   Measurement instruments and locations shall comply with Annex A.

Annex A

Transient current measurement method at a mains port

(This annex forms an integral part of this Recommendation.)

A.1 General

This clause specifies the measurement method for transient currents at mains ports that arise when lighting equipment is switched on or off in an environment in which the lighting equipment is connected to the mains network and the supply is switched electronically or mechanically.

A.2 Measurement system layout

The measurement system is shown in Figure A.1. One of the phase lines of the power supply to the EUT is clamped by a current probe. The transient current on the phase line is measured when the switch is turned on and off using an oscilloscope. In addition, a differential voltage probe is connected between the lines of the power supply to the EUT. The power switch is turned on or off using a switch that can operate at a specific phase of the power supply voltage. A circuit that simulates the power impedance is inserted between the EUT and the programmable switch. The length of the line between the EUT and the power impedance simulation circuit shall be 0.8 m. The current probe should be set to the phase line of the power supply to the EUT at a distance of 0.1 m from the EUT. The mains power outlet at the measuring site can be used, but a correction capacitor shall be inserted between the power line and the mains port of the switch. The external trigger port of the oscilloscope shall be connected to the synchronization signal output port of the switch. If the programmable switch does not have a trigger signal output, the output of the differential voltage probe can be used as a triggering signal.

The EUT, the programmable switch, the correction capacity and the power impedance simulation circuit shall be placed on a table of an insulating material at a height of 0.4 m above the reference ground plane. The reference ground plane shall be made of metal extending more than 0.5 m from the edge of the EUT and 2 m × 2 m in size or larger. If the EUT has an earthing port, it shall be connected to the reference ground plane with as short a conducting wire as possible. An artificial mains network, which is used to measure the continuous conducted disturbances, and the load except for the EUT shall not be connected to the transient current measurement system.

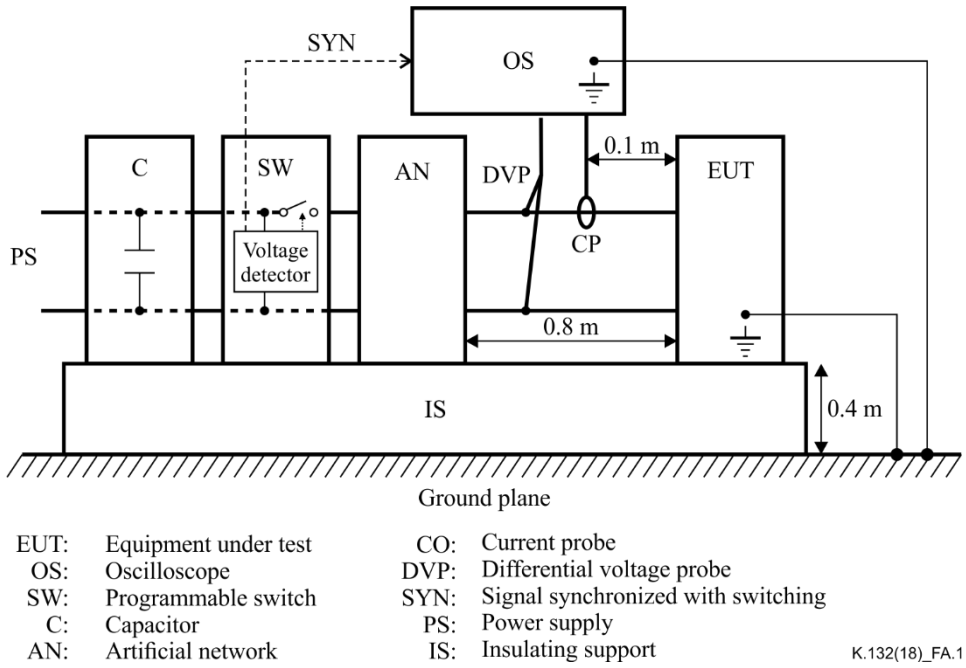

Figure A.1 – Transient current measurement system

A.3 Measurement instruments

The basic configuration of the system for transient current measurement is shown in Figure A.1. Measurement instruments used for the system are specified in clauses A.3.1 to A.3.6.

A.3.1 Oscilloscope

An oscilloscope that can take more than 250 million samples per second and can start sampling with an external trigger shall be used. There shall be at least two input channels for waveform monitoring and another channel for trigger input. A peak detection mode may be selected in order to record the true peak value.

A.3.2 Programmable switch (electronic switch for the on/off control of the power supply)

An electronic switch that can detect the phase of the power supply voltage and can switch the power on or off when the phase is 90° or 270° shall be used. An electronic switch shall be able to output a signal to the external trigger input of an oscilloscope at an instant when the power is switched on or off in order to measure the current waveform in synchronization with the power switching operation. However, if a programmable switch cannot be acquired, the peak level of the transient current may be obtained by turning a hand-operated switch on and off 30 times.

A.3.3 Current probe

The current probe for measurement shall conform to [CISPR 16-1-2], and the measurement frequency shall cover the range 30 Hz to 100 MHz, and shall measure a peak current of around 30 A.

A.3.4 Differential voltage probe

A differential voltage probe shall be able to measure the supply voltage of the mains. This probe is mainly used to verify that the timing of switching is at the maximum and minimum of the power supply voltage.

If the programmable switch does not have a function to output the trigger signal, the probe can be used as trigger detection.

A.3.5 Compensation capacitor

In this test, the commercial mains are also used to supply power to the lighting equipment. However, the impedance of commercial mains changes depending on the measurement site. A capacitor (with a capacitance of 10 μF) shall be inserted between the mains port of the programmable switch and the power cable to eliminate the effect of the mains' impedance at the measurement site. The capacitors may be connected in parallel to obtain the necessary capacitance and a withstand voltage of 440 V or higher is desirable.

A.3.6 Power impedance simulation circuit

The power impedance simulation circuit shall have the impedance characteristics shown in Figure A.2 in the frequency range 1 kHz to 10 MHz. The impedance of the circuit shall be measured at the port of the EUT when the port on the programmable switch side is shorted.

The allowable deviation of the impedance shall be ±20%, and that of the impedance phase angle ±10°.

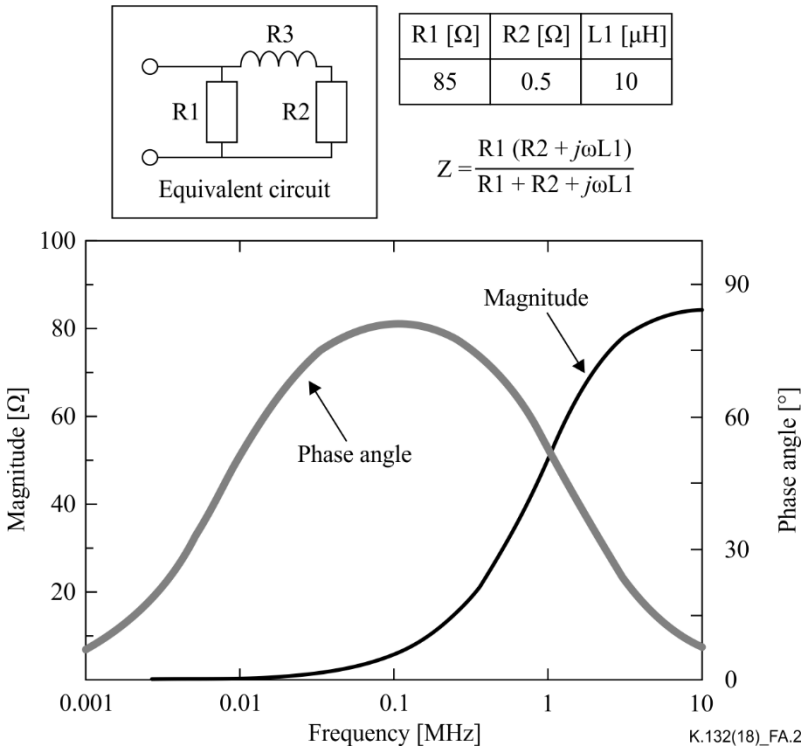

Figure A.2 – Impedance characteristics of a power impedance simulation circuit

A.4 Test site

A shielded room shall be used for the measurement of transient currents so that transient currents from the EUT can be isolated from ambient noise. The ambient noise measured at the site while the power switch is off (i.e., when no disturbances are emitted by the EUT) shall be small enough not to influence the measurement.

A.5 Measurement procedure

The transient voltage shall be measured at both lines of power supply to the EUT. It is necessary to measure transient currents of each of the two power wires at the time of switching on and switching off when the phase of the mains voltage is 90° and 270° as shown in Figure A.3. In other words, transient currents shall be measured under a total of eight conditions. The timing of the switch operation shall be verified by measuring the waveform of the mains with the differential voltage probe.

The peak levels of the transient current can be observed several microseconds or several seconds after the switching on or off of the power. An appropriate time span or triggering delay time shall be determined by checking the transient current waveforms so that the peak value of the current shall be overlooked. The recording length of the oscilloscope shall be 50 thousand samples or greater.

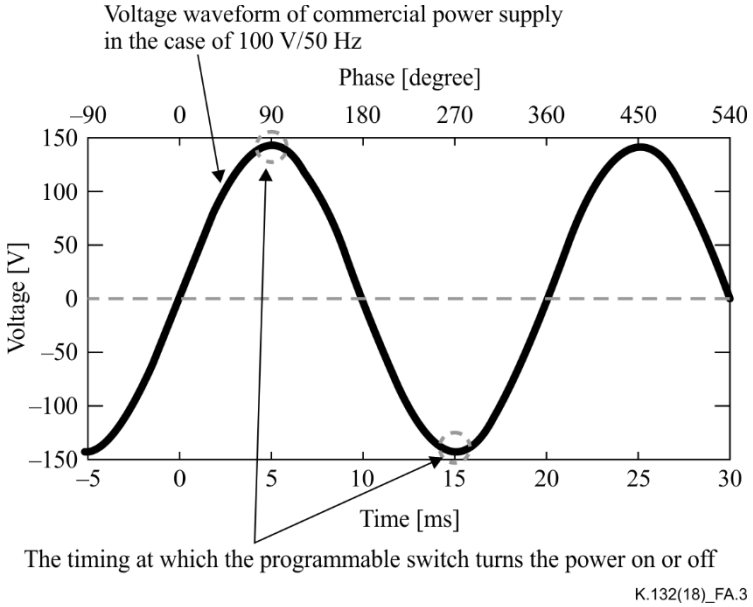

Figure A.3 – Example of a voltage waveform

Appendix I

The measurement example of radiated disturbance over 300 MHz from lighting equipment

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

This appendix provides an example of measurement of a radiated disturbance from lighting equipment with a frequency over 300 MHz.

I.1 Measurement method

Since [CISPR 15] specifies the measurement method for radiated disturbances below 300 MHz from the lighting equipment, the radiated disturbance is measured with reference to [CISPR 32] [test distance: 10 m; detection: quasi peak; resolution bandwidth (RBW): 120 kHz]. In this measurement, the EUT (power source: single phase AC 100 V, power consumption: 7 W) was selected from commercially available light-emitting diode (LED) sources. A biconical antenna was used for measurement in the frequency range 30 MHz to 300 MHz and log-periodic antenna was used for frequencies over 300 MHz.

I.2 Measurement results

Figure I.1 shows radiated disturbance measurement results, in which the red line represents the vertically polarized wave and the blue line represents the horizontally polarized wave. The result for the vertically polarized wave exceeds the quasi-peak limit in the frequency range lower than 300 MHz. Although radiated disturbance is higher, the limit was observed even at a frequencies higher than 300 MHz; no limit is currently specified in [CISPR 15]. Therefore, radiated disturbances in the frequency range 300 MHz to 1 GHz from lighting equipment located in a telecommunication equipment room is specified in this Recommendation.

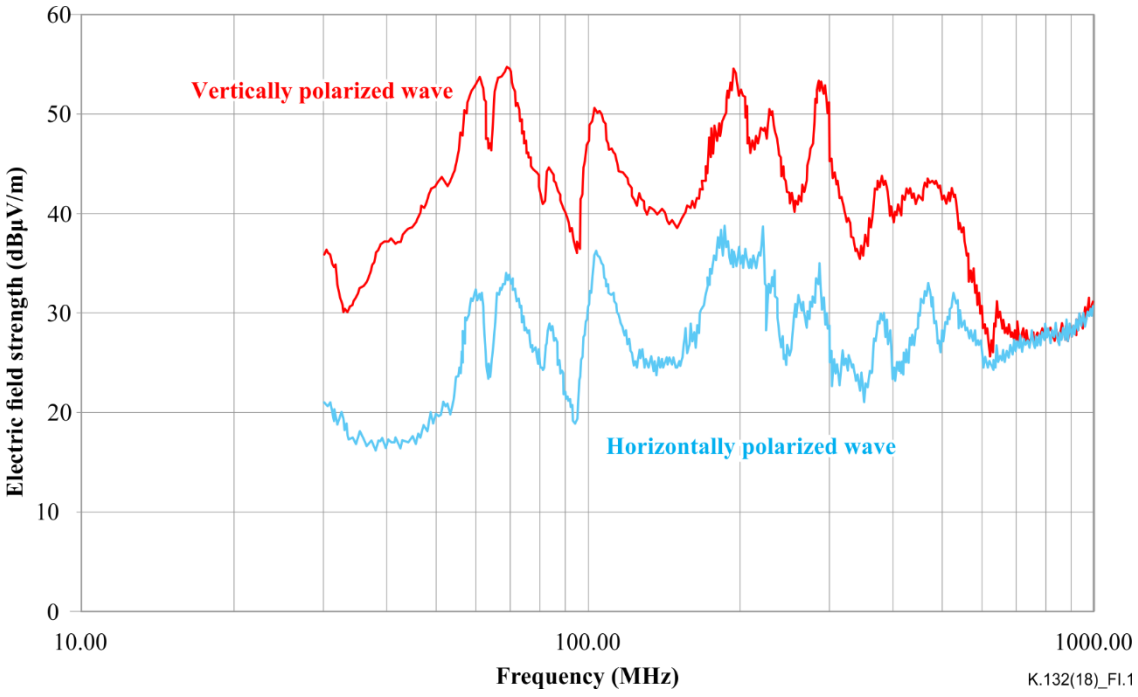

Figure I.1 – Measured continuous radiated disturbance using a light-emitting diode source as an example

Appendix II

An example of a malfunction caused by a transient disturbance on switching on lighting equipment

II.1 An example of actual condition

When a fluorescent lamp was turned on at an office in which an ADSL communication environment had been installed, a session time-out of the telecommunication system occurred.

Figure II.1 shows the connection configuration of the communication system at the office. Some personal computers (PCs) are connected to an ADSL modem through router and hub.

Figure II.2 illustrates the unsymmetrical voltages of the communication line and the power line of the ADSL modem measured with an oscilloscope when a fluorescent lamp is turned on. The disturbances in the communication line and the power line of the ADSL modem appear at the time of switching on the fluorescent lamp. The unsymmetrical voltage when the fluorescent lamp of the glow starter type was turned on was larger than that of other types and was about 10 V_{p-p} on the communication line, about 20 V_{p-p} on the power line. The ping test to head office system from the PC of the office connected to the ADSL was not confirmed, and session time-out occurred.

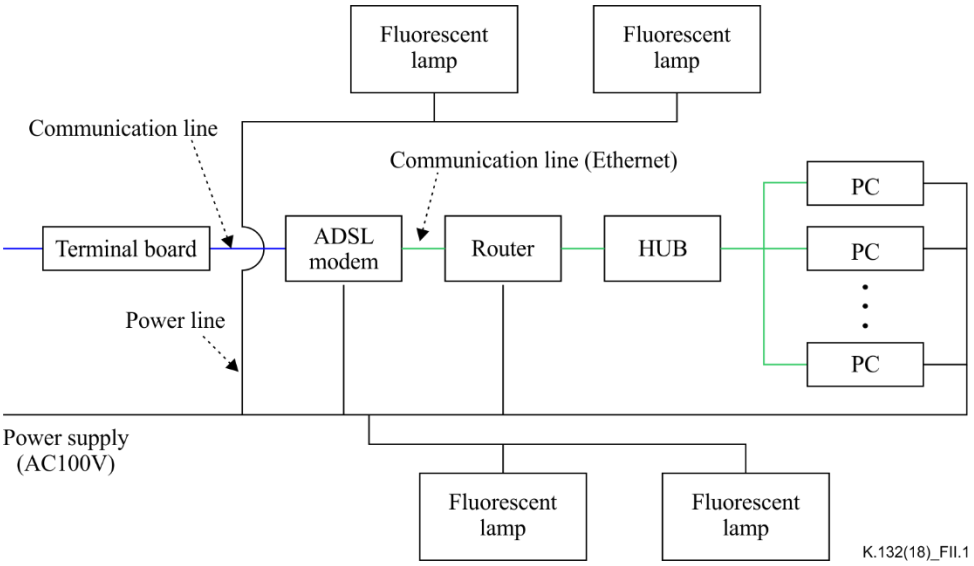

Figure II.1 – Connection architecture of the office communication system

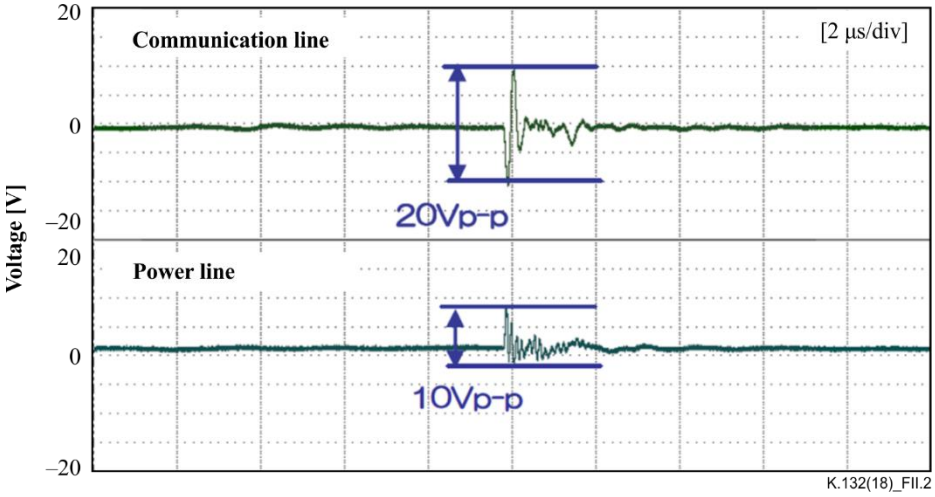

Figure II.2 – Measurement result of ADSL modem at the office

II.2 An example of measurement in a laboratory

An experimental configuration using the VDSL system and an inverter-type fluorescent lamp in the laboratory is shown in Figure II.3. The power line of the lighting equipment runs side by side with the communication line of the VDSL system for approximately 10 m.

Figure II.4 depicts a differential mode voltage on the communication line and a common mode current on the power line of the fluorescent lamp when it was turned on. The observed conducted disturbance was about 28 $V_{p\text{-}p}$ on the communication line and about 9 $A_{p\text{-}p}$ in the power line of the fluorescent lamp. A cyclic redundancy check (CRC) error was observed at the timing of turning on the fluorescent lamp by a line monitor function of the VDSL system with the PC.

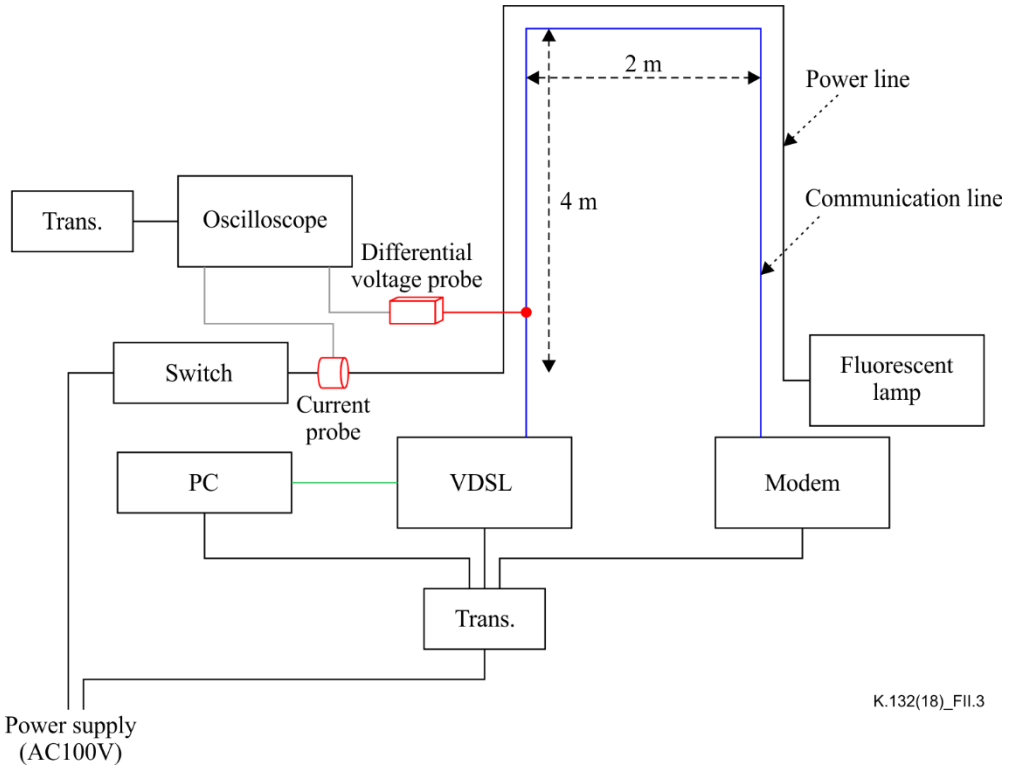

Figure II.3 – Experiment system

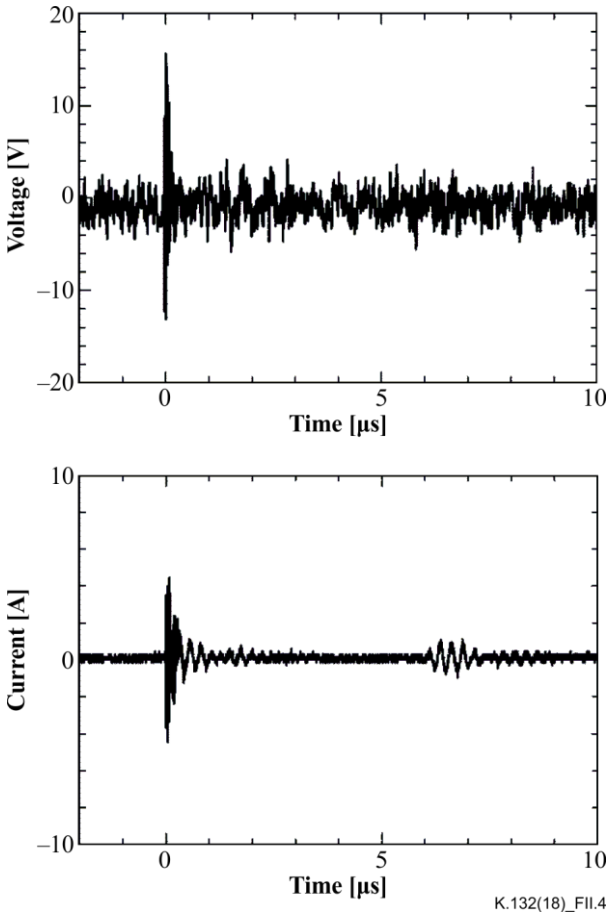

Figure II.4 - Experimental result

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[b-IEC 60050] IEC 60050, *International Electrotechnical Vocabulary*.
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