International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.137

(01/2022)

SERIES K: PROTECTION AGAINST INTERFERENCE

Electromagnetic compatibility requirements and measurement methods for wireline telecommunication network equipment

Recommendation ITU-T K.137

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Electromagnetic compatibility requirements and measurement methods for wireline telecommunication network equipment

Summary

Recommendation ITU-T K.137 specifies the electromagnetic compatibility (EMC) common requirements and test methods for wireline telecommunication network equipment, used in public telecommunication networks to provide telecommunication services, including voice, data, audio and video to end-users, using all applicable media and all types of wireline access technologies, such as digital subscriber line (DSL), plain old telephone service (POTS), Ethernet, E1 and fibre.

Test conditions for all types of wireline telecommunication network equipment are described, e.g., access equipment, router and switching equipment, optical transmission equipment, data centre and cloud computing equipment.

This Recommendation describes the specific testing levels to be applied to wireline telecommunication environments such as telecommunication centres, customer premises and outdoor locations.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.137	2018-11-13	5	11.1002/1000/13716
2.0	ITU-T K.137	2022-01-13	5	11.1002/1000/14936

Keywords

EMC, network, wireline.

* 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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Table of Contents

Recommendation ITU-T K.137

Electromagnetic compatibility requirements and measurement methods for wireline telecommunication network equipment

1 Scope

This Recommendation applies to wireline telecommunication equipment with a rated root mean square (RMS) alternating current (AC) or direct current (DC) supply voltage not exceeding 600 V.

This Recommendation specifies the electromagnetic compatibility (EMC) common requirements and test methods for wireline telecommunication network equipment, used in public telecommunication networks to provide telecommunication services such as: voice, data, audio and video to end-users, using all applicable media and all types of wireline access technologies.

[ITU-T K.136] applies to radio functions of wireline equipment.

Test conditions for the following types of wireline telecommunication network equipment, as described in Annex C, are defined:

– Access equipment;

– IP equipment: router and switching;

– Optical transmission network equipment;

– Data centre and cloud computing equipment;

– Switching equipment.

Telecommunication network equipment incorporating secondary radio functions (e.g., for equipment configuration, network management) are also covered by this Recommendation.

NOTE – The requirements applicable to radio interfaces of telecommunication network equipment are defined in [ITU-T K.136]

Equipment may provide different functions, i.e., switching equipment may also provide transmission functions and transmission equipment may provide storage capabilities etc. All available functions of the equipment under test (EUT), as described in Annexes D to H, are to be tested.

The environmental classification locations used in this Recommendation refer to [ITU-T K.34].

This Recommendation defines the specific immunity testing levels and performance criteria to be applied to wireline network telecommunication equipment in the following environments:

– Telecommunication centres; see clauses 6.1.1 and 6.1.2 of [ITU-T K.34]

– Outdoor locations (e.g., streets, rooftop parking, towers, poles): see clause 6.2 of [ITU-T K.34]

– Customer premises (residential, commercial or light-industrial environment): see clause 6.3 of [ITU-T K.34].

The immunity requirements of this Recommendation have been selected to ensure an adequate level of immunity; extreme cases of disturbances with a low probability of occurrence are not considered. In special cases, situations may arise where the levels of disturbance may exceed the immunity test levels defined in this Recommendation. In these conditions, special mitigation measures or protection may have to be implemented.

The emission requirements of this Recommendation refer to the classification provided in [CISPR 32].

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 G.783] Recommendation ITU-T G.783 (2006), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*.

[ITU-T G.798] Recommendation ITU-T G.798 (2017), *Characteristics of optical transport network hierarchy equipment functional blocks*.

[ITU-T G.812] Recommendation ITU-T G.812 (2004), *Timing requirements of slave clocks suitable for use as node clocks in synchronization networks*.

[ITU-T G.813] Recommendation ITU-T G.813 (2003), *Timing Characteristics of SDH Equipment Slave Clocks (SEC)*.

[ITU-T K.27] Recommendation ITU-T K.27 (2015), *Bonding configurations and earthing inside a telecommunication building*.

[ITU-T K.34] Recommendation ITU-T K.34 (2020), *Classification of electromagnetic environmental conditions for telecommunication equipment – Basic EMC Recommendation*.

[ITU-T K.38] Recommendation ITU-T K.38 (1996), *Radiated emission test procedure for physically large systems*.

[ITU-T K.136] Recommendation ITU-T K.136 (2018), *Electromagnetic compatibility requirements for radio telecommunication equipment*.

[ITU-T O.150] Recommendation ITU-T O.150 (1996), *General requirements for instrumentation for performance measurements on digital transmission equipment*.

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[IEC CISPR 16-1-2] IEC CISPR 16-1-2:2014, A1:2017, *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*.

[IEC CISPR 16-1-4] IEC CISPR 16-1-4:2019, A1:2020, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*.

[IEC CISPR 16-2-1] IEC CISPR 16-2-1:2014 and Cor1, A1:2017, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*.

[IEC CISPR 16-2-3] IEC CISPR 16-2-3:2016, A1:2019, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*.

[IEC CISPR 32] IEC CISPR 32:2015, A1:2019, *Electromagnetic compatibility of multimedia equipment – Emission requirements*.

[IEC 61000-3-2] IEC 61000-3-2:2018, A1:2020, *Electromagnetic compatibility (EMC – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤16 A per phase)*.

[IEC 61000-3-3] IEC 61000-3-3:2013, A1:2017, A2:2021, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection*.

[IEC 61000-3-11] IEC 61000-3-11:2017, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤75 A and subject to conditional connection*.

[IEC 61000-3-12] IEC 61000-3-12:2011, ISH1:2012, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤ 75 A per phase*.

[IEC 61000-4-2] IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*.

[IEC 61000-4-3] IEC 61000-4-3:2020, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*.

[IEC 61000-4-4] IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*.

[IEC 61000-4-5] IEC 61000-4-5:2014, A1:2017, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*.

[IEC 61000-4-6] IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*.

[IEC 61000-4-8] IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*.

[IEC 61000-4-11] IEC 61000-4-11:2020, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase*.

[IEC 61000-4-29] IEC 61000-4-29:2000, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests*.

[IEC 61000-4-34] IEC 61000-4-34:2005, A1:2009 and COR1:2009, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with mains current more than 16 A per phase*.

[ISO/IEC 17025] ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*.

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3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 AC mains power port [b-ITU-T K.123]: Port used to connect to the mains supply network.

NOTE – Equipment with a DC power port which is powered by a dedicated AC/DC power converter is defined as AC mains powered equipment.

3.1.2 commercial, public and light-industrial location [ITU-T K.34]: Location which exists as areas of the city centre, offices, public transport systems (road/train/underground), and modern business centres containing a concentration of office automation equipment (PCs, fax machines, photocopiers, telephones, etc.), and characterized by the fact that equipment is directly connected to a low-voltage public mains network or connected to a dedicated DC source which is intended to interface between the equipment and the low-voltage mains network.

Examples of commercial, public or light-industrial locations are:

– retail outlets, for example shops, supermarkets;
– business premises, for example offices, banks, hotels, data centres;
– areas of public entertainment, for example cinemas, public bars, dance halls;
– places of worship, for example temples, churches, mosques, synagogues;
– petrol stations, car parks, amusement and sports centres;
– general public locations, for example park, amusement facilities, public offices;
– hospitals, educational institutions, for example schools, universities, colleges;
– public traffic area, railway stations, and public areas of an airport;
– light-industrial locations, for example workshops, laboratories, service centres.

3.1.3 DC network power port [b-ITU-T K.123]: Port, not powered by a dedicated AC/DC power converter and not supporting communication that connects to a DC supply network.

NOTE 1 – Equipment with a DC power port which is powered by a dedicated AC/DC power converter is considered to be AC mains powered equipment.

NOTE 2 – DC power ports supporting communications are considered to be wired networks ports.

3.1.4 electromagnetic disturbance [b-ITU-T K.123]: Any electromagnetic phenomenon which can degrade the performance of a device, equipment or system, or adversely affect living or inert matter.

3.1.5 electromagnetic emission [b-ITU-T K.114]: The phenomenon by which electromagnetic energy emanates from a source.

3.1.6 electromagnetic interference (EMI) [b-ITU-T K.114]: Degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance.

3.1.7 enclosure port [ITU-T K.136]: Physical boundary of the EUT through which electromagnetic fields may radiate or may enter.

3.1.8 equipment under test (EUT) [b-ITU-T K.114]: The equipment (devices, appliances and systems) subjected to EMC (emission) compliance (conformity assessment) tests.

3.1.9 immunity (to a disturbance) [b-ITU-T K.114]: The ability of a device, equipment, or system to perform without degradation in the presence of an electromagnetic disturbance.

3.1.10 port [b-ITU-T K.114]: Particular interface of the specified equipment with the external electromagnetic environment (see Figure 1).

NOTE – An interface, which uses optical fibre, is not a port for the purposes of testing because it does not interact with the electromagnetic environment within the frequency range. An optical fibre interface may still be used in the assessment of performance.

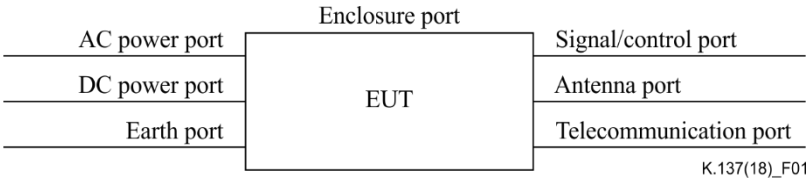


Figure 1 – port

3.1.11 primary protection [b-ITU-T K.144]: Means by which the majority of the surge stress is prevented from propagating beyond a designated location (preferably the building entrance point).

3.1.12 residential location [ITU-T K.34]: Location which exists as an area of land designated for the construction of domestic dwellings, and is characterized by the fact that equipment is directly connected to a low-voltage public mains network or connected to a dedicated DC source which is intended to interface between the equipment and the low-voltage mains network. Examples of residential locations are houses, apartments and, and farm buildings used for living.

3.1.13 throughput [b-ITU-T K.88]: The maximum rate at which none of the offered frames are dropped by the device.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 analogue equipment: Equipment with one or more analogue voice interface(s).

3.2.2 customer premises environment: Physical location in the residential, commercial, public and light-industrial locations where telecommunication equipment is installed or used. In this environment the electromagnetic disturbance protection and earthing and bonding conditions might be uncontrolled.

3.2.3 HVDC port: A DC network power port which supplies a voltage between 240 V DC and 400 V DC.

3.2.4 outdoor locations: An environment where equipment is exposed to the atmosphere and hosts telecommunication equipment. Examples of this environment: street sides, roofs or external sides of building, tower, and poles.

3.2.5 professional equipment: Equipment for use in trades, professions or industries which is not intended for sale to the general public.

3.2.6 professional installation: Installation and maintenance of equipment by professional(s) with sufficient knowledge to employ EMC mitigation measures according to the installation instructions.

3.2.7 quiescent level: Steady state condition of an equipment functionality prior to the application of any disturbance signal for immunity testing.

3.2.8 telecommunication centre environment: Physical location hosting telecommunication equipment which is managed and operated exclusively by the telecom operator and other business entities. This definition includes the data centres. This environment is dedicated to telecommunication network equipment and is better controlled in terms of electromagnetic disturbance protection and earthing and bonding.

3.2.9 telecommunication port: A point of connection for voice, data and signalling transfers intended to interconnect widely distributed systems via such means as direct connection to multiuser telecommunications networks (e.g., public switched telecommunications networks-PSTN, x-type digital subscriber lines-xDSL, local area networks-LAN, wide area network-WAN) or is intended to aggregate business to higher layer equipment of the telecommunication network.

NOTE – A port generally intended for intra-system connection of components of the EUT (e.g., high-definition multimedia interface-HDMI, universal serial bus 3.0 (USB 3.0 Type-C), IEEE 1394™ [i.29] ("Fire Wire")) and used in accordance with its functional specifications (e.g., for the maximum length of cable connected to it), is not considered to be a telecommunications/network port under this definition.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
AE	Associated Equipment
AM	Amplitude Modulation
AMN	Artificial Mains Network
ATM	Asynchronous Transfer Mode
ATN	Access Transport Network
BER	Bit Error Rate
CDN	Coupling and Decoupling Network
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DC	Direct Current
DSL	Digital Subscriber Line
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FC	Fibre Channel
FE	Fast Ethernet
FPGA	Field Programmable Gate Array
FSOATS	Free Space Open Area Test Site
GE	Gigabit Ethernet

GPU	Graphical Processing Unit
HVDC	High-Voltage Direct Current
IB	Infinite Band
ISDN	Integrated Services Digital Network
ISN	Impedance Stabilization Network
MSTP	Multiservice Transmission Platform
NFV	Network Functions Virtualization
NVMe	Non-Volatile Memory express
PCI-e	Peripheral Component Interconnect express
PD	Powered Device
PDH	Plesiochronous Digital Hierarchy
PER	Packet Error Rate
PLR	Packet Loss Rate
PoE	Power over Ethernet
PON	Passive Optical Network
POTS	Plain Old Telephone Service
PRBS	Pseudo-Random Bit Sequence
PSE	Power Sourcing Equipment
PSTN	Public Switched Telecommunication Network
PV	Photovoltaic
QoS	Quality of Service
RMS	Root Mean Square
RAID	Redundant Array of Independent Disks
RAM	Random Access Memory
RF	Radio-Frequency
ROM	Read-Only Memory
SAC	Semi-Anechoic Chamber
SAS	Serial Attached SCSI
SATA	Serial Advanced Technology Attachment
SCSI	Small Computer System Interface
SDH	Synchronous Digital Hierarchy
SDN	Software-Defined Networking
SIR	Signal-to-Interference Ratio
SPL	Sound Pressure Level
TDM	Time Division Multiplexing
UPS	Uninterruptible Power Supply
WDM	Wavelength Division Multiplexing

5 Conventions

None.

6 Wireline telecommunication network equipment description

Wireline telecommunication network equipment can be classified or grouped in several ways. In this Recommendation, the equipment is grouped into several types according to its network functions as described in Annex C.

7 Test methods and limits

7.1 Emission

7.1.1 General emission requirements

The general requirements for test methods according to [IEC CISPR 32] should be applied; the limits shown in Tables A.1 and A.2 are recommended for equipment in telecommunication centres, customer premises and outdoor locations.

The measurement method described in [ITU-T K.38] can be applied for radiated emission measurements on large equipment.

Radiated emissions from the enclosure and from cables refer to the frequency components which come from unintentional radiators of a product. This means the emissions are mostly from switching power supply, analogue or digital circuits of the system which may include, but are not limited to, the following: clocks, central processing units (CPUs), data buses, optical transceiver modules, field programmable gate array (FPGA)/random access memory (RAM)/read-only memory (ROM) (FPGA/RAM/ROM) chips, digital modulation modules, etc.

Radiated emission from equipment should be measured to the highest frequency band; Table 1 shows the necessary highest frequency up to which radiated emission tests should be performed.

Table 1 – Required highest frequency for radiated emission test

Highest internal frequency (F_x)	Measured up to highest frequency
$F_x \leq 108$ MHz	1 GHz
108 MHz < $F_x \leq 500$ MHz	2 GHz
500 MHz < $F_x \leq 1$ GHz	5 GHz
$F_x > 1$ GHz	$5 \times F_x$ up to a maximum of 40 GHz
F_x: highest fundamental frequency generated or used within the EUT or highest frequency at which it operates.	

Conducted emission measurements at AC or DC power input and/or output port should be performed using the artificial mains network (AMN) according to [IEC CISPR 16-1-2] at each port.

If the DC power cable is not intended for connection to a local DC power network (e. g. connected to a local battery or a dedicated power equipment) and the length of the DC power cable is limited to 30 m, as defined in the product documentation, the conducted emission measurements may be exempted. Conducted emission measurements from wired-network ports should be performed using the test methods defined in Annex C, clause C.4.1.6 of [IEC CISPR 32]. The characteristics of impedance stabilization networks (ISNs) are defined in Annex C, clause C.4.1.2 of [IEC CISPR 32].

Where not specified in this Recommendation, the equipment under test (EUT) should be configured, installed, arranged and operated in a manner consistent with typical applications and normal operations.

7.1.2 Emission for equipment with a special port

7.1.2.1 HVDC port (see Annex H)

Conducted emission measurements at an HVDC power port should be performed in the same way as a DC power port using AMN as specified in [IEC CISPR 16-1-2] and the test configuration should refer to Annex H.

7.1.2.2 Power over Ethernet port

The power over Ethernet (PoE) port should be considered to be a wired-network port to conduct the conducted emission measurements as described in Annex I.

7.1.3 Harmonic

The appropriate requirements of [IEC 61000-3-2] for harmonic current emissions apply to any equipment covered by the scope of this Recommendation with an input current up to and including 16 A per phase. For equipment with an input current greater than 16 A and less than 75 A per phase, [IEC 61000-3-12] applies.

7.1.4 Flicker

The appropriate requirements of [IEC 61000-3-3] for voltage fluctuations and flicker apply for equipment covered under the scope of this Recommendation with an input current up to and including 16 A per phase. For equipment with an input current greater than 16 A and less than 75 A per phase, [IEC 61000-3-11] applies.

7.2 Immunity

7.2.1 General

Test levels for wired-network equipment are shown in Annex B, Tables B.1, B.2 and B.3, for different environmental classifications. Where reference is made in this Recommendation to specific "test levels" to be used for the tests, it is implicitly required that the EUT should also fulfil the compliance criteria when tested at "test levels" lower than those specified.

Radiated immunity tests should be applied up to 6 GHz considering that high-frequency bands, for example, 3.5 GHz for cellular mobile systems and 5.8 GHz for wireless fidelity (Wi-Fi), have been used. The test method should be in accordance with [IEC 61000-4-3].

Conducted immunity tests should be applied to one port at a time and the tests should be performed on power input ports, power output ports and on all signal ports to which cables are permanently connected in the normal intended use. For an EUT with multiple power ports intended to be connected to the same power source, conducted immunity tests can be applied to all ports at the same time. If in normal installation practice multipair cables (e.g., 64 × balanced pairs) and composite cables (e.g., a combination of fibre and copper) are used, they may be tested as one port.

For multipair cables, conducted immunity tests where multipair coupling and decoupling network (CDN) does not exist, the test should be applied to a single pair using an appropriate CDN. The remaining pairs should be tested one by one. A conducted immunity test of multipair cables can also be performed using the current clamp or electromagnetic (EM) clamp method according to [IEC 61000-4-6].

When performing a surge immunity test on a power port, the EUT and all signal ports should comply with the given compliance criteria during and after the surge test. When performing a surge test to signal port, the tested port should be checked against the compliance criteria after the surge test has been applied. If requested, it is allowed to test equipment with primary protection installed, and the test conditions should be recorded in the test report.

The basic-level requirements in Annex B, Tables B.1, B.2 and B.3, have been selected to ensure an adequate level of immunity for the telecommunication equipment with a normal quality of service (QoS)

level; and if a high QoS level is requested, the enhanced level requirements in Tables B.1, B.2 and B.3 could be selected.

8 Test conditions

8.1 Operational conditions

The testing arrangement of the EUT, local associated equipment (AE) and associated cabling should refer to [IEC CISPR 32], Annex D.

The earthing of the EUT should be in accordance with the normal intended use and with product documentation.

The measurement should be made at the nominal power voltage of the EUT; if an EUT supports a wide range of supply voltage, then the typical operating voltage, and mains frequency, for example 110 V or 230 V and 50 Hz or 60 Hz, is recommended for the measurement. Equipment with a DC power port powered by a dedicated AC/DC power converter is considered to be AC mains powered equipment and should be measured with the power converter defined for that product. Where the power converter is provided by the manufacturer, the converter provided should be used.

The environmental parameters (temperature, humidity and atmospheric pressure) should comply with the values defined in basic EMC standards and be limited to the environmental class conditions of the EUT, and it is not necessary to repeat measurements at more than one set of these environmental parameters.

The loading status of the power supply and/or the bit rate of the interface should be representative of the typical use of the EUT. One or more measurements may be repeated to adequately assess the emission or immunity of the EUT. For digital interfaces, it is acceptable to measure at the highest bit rate.

All ports should be exercised in a manner which is representative of a system in as normal operation as possible. For example, the ports are high-speed driven as is specified, and the line attenuation is simulated as close to the actual length as possible.

The exercising signal should be selected to simulate the intended function and the correct operation of the equipment, for example, the data rate and packet length.

Special exercising equipment and/or software may be used with the object of reducing test time and simulating traffic conditions, and the actual situation of the test should be recorded in the test report.

8.2 Test configuration

The EUT should be configured to the maximize emission of disturbances (worst case) and at the minimum of its immunity based on a representative configuration of real applications when used as intended.

Equipment may provide different functions; all available functions of the EUT should be tested, i.e., switching or router network equipment may provide electrical and optical transmission functions.

For equipment supporting multitype line cards and supporting several combinations of these line cards to achieve different marketing configurations, for example, the gigabit Ethernet (GE) card, 10 GE card, of optical or electrical interface, for uplink or downlink, then each type of the functional line card should be selected for the test configuration. A combination of the test configuration to cover all the different line cards may be considered to maximize the emission. In principle, every type of line card should be assessed.

Where there are multiple line cards of the same type, the manufacturer should determine whether to load these additional cards, considering:

– a representative configuration;

– reproducibility;
– maximization of the emission levels, for example, when adding additional cards or cables does not significantly affect the emission level (e.g., varies less than 2 dB), it can be assumed that a maximum has occurred.

This process may also be applied to establishing the number of similar elements (e.g., plugin modules, internal memory) within the EUT.

Where the EUT has more than one analogue/digital data port, ports should be included in the measurement arrangement for conducted emission and conducted immunity as follows:

– If there are multiple same ports on the same card or module type, then it is acceptable to test one port of each type;
– Where there are ports of the same type on different card or module types, then it is acceptable to assess one port on each card or module types.

The test report should identify the tested ports.

8.3 Test conditions for equipment with a special port

Test conditions for a PoE port should be in accordance with Annex I.

8.4 Test conditions for equipment with a specific communication function

Test conditions for a specific communication function, such as access, switching and transmission, should be tested according to the test conditions described in Annexes D to I.

9 Performance assessment

9.1 General

Unless otherwise specified, the performance during the test should be monitored and should be checked again after the test.

The performance may be assessed by bit error rate (BER), packet loss rate (PLR), throughput, time-delay, signal-to-interference ratio (SIR), or communication linkage breakdown and alarms and power recovery, etc.

10 Performance criteria

If the minimum performance level or permissible performance loss is not specified in the following clauses or by the manufacturer, then either of these may be deduced from the product description and documentation, and what the user may reasonably expect from the apparatus if used as intended.

10.1 General performance criteria

The general performance criteria apply for those ports for which no specific performance criteria are defined (e.g., auxiliary ports) in this Recommendation.

Where specific immunity criteria are not relevant or are inappropriate, relevant justification should be included in the test report highlighting how the EUT was fully exercised and met the general immunity criteria defined in this clause.

10.1.1 Performance criterion A (continuous phenomena)

The apparatus should continue to operate as intended during the exposure to an electromagnetic phenomenon. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer when the apparatus is used as intended. In some cases, the performance level may be replaced by a permissible loss of performance. If the minimum

performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be deduced from the product description and documentation and what a user may reasonably expect from the apparatus if used as intended.

10.1.2 Performance criterion B (transient phenomena)

During the exposure to an electromagnetic phenomenon, degradation of performance is allowed. The apparatus should continue to operate as intended after the test. No change of actual operating state or stored data is allowed to persist after the test. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be deduced from the product description and documentation and what a user may reasonably expect from the apparatus if used as intended.

10.1.3 Performance criterion C

Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

10.2 Specific performance criterion

The specific performance criteria for a PoE port should be in accordance with Annex I.

The specific performance criteria for different communication functions should be in accordance with Annexes D to H.

11 Report

General requirements for compiling a test report should refer to section 7.8 of [ISO/IEC 17025].

Sufficient details should be provided to facilitate reproducibility of the measurements. The following should be included in the test report where appropriate:

– General information about the product description, for example, weight, size, power supply, appearance, boards and subassemblies;
– System configuration during EMC testing, for example, test configurations, test connections, auxiliary equipment used to exercise the EUT, ports and cables used;
– How the performance of a port or function was monitored during testing;
– Criteria for each function or port being assessed;
– Test methods used and justification of any deviation;
– Response of the EUT to the specified test level during the immunity test and the conclusion as to whether or not the criteria was met;
– Test instruments used and the calibration status;
– The measurement uncertainty;
– Photographs of the test setup;
– The electromagnetic interference (EMI) test result together with the conclusion concerning emission limit;
– Summary of the test result;
– Applied product standards and basic standards;
– Environmental conditions, for example, temperature, humidity and pressure.

For each EMI test result, the test report should include the measurement results of at least the six highest emissions relative to the limit for each detector type, or two emissions unless the emissions are below the measurement system noise floor, or 10 dB or more below the limit.

Annex A

Emission test level

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

Table A.1 – Equipment for telecommunication centre

	Frequency	Receiver Detector	Limit	Test method	Remarks
Enclosure port					
Radiated disturbance Field	30 to 230 MHz	Quasi-peak	40 dB (μV/m)	[IEC CISPR 16-1-4] [IEC CISPR 16-2-3]	Physically large systems should refer to [ITU-T K.38] (Note 1)
	230 to 1000 MHz	Quasi-peak	47 dB (μV/m)		
	1 to 3 GHz	Peak Average	80 dB (μV/m) 60 dB (μV/m)		(Note 2)
	3 to 6 GHz	Peak Average	80 dB (μV/m) 60 dB (μV/m)		
	6 to 26.5 GHz	Average	60 dB (μV/m)		(Note 2)
	26.5 to 40 GHz	Average	60 dB (μV/m) or 69 dB (μV/m)		(Note 2) (Note 3)
Telecommunication ports					
Conducted disturbance	0.15 to 0.5 MHz	Quasi-peak Average or Quasi-peak Average	97 to 87 dB (μV) 84 to74 dB (μV) or 53 to 43 dB (μA) 40 to 30 dB (μA)	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	(Note 4) (Note 5)
	0.5 to 30 MHz	Quasi-peak Average or Quasi-peak Average	87 dB (μV) 74 dB (μV) Or 43 dB (μA) 30 dB (μA)		(Note 4) (Note 5)
AC mains power ports					
Conducted disturbance voltage	0.009 to 0.05 MHz	Quasi-peak	120.5 dB (μV) to 110 dB (μV)	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	(Note 6)
	0.05 to 0.15 MHz	Quasi-peak	104 dB (μV) to 80 dB (μV)		
	0.15 to 0.5 MHz	Quasi-peak Average	79 dB (μV) 66 dB (μV)		
	0.5 to 30 MHz	Quasi-peak Average	73 dB (μV) 60 dB (μV)		
Harmonic current emissions	See [IEC 61000-3-2]			[IEC 61000-3-2]	(Note 7)
	See [IEC 61000-3-12]			[IEC 61000-3-12]	(Note 8)
Voltage fluctuations and flicker	See [IEC 61000-3-3]			[IEC 61000-3-3]	(Note 7)
	See [IEC 61000-3-11]			[IEC 61000-3-11]	(Note 8)
DC power ports					

Table A.1 – Equipment for telecommunication centre

	Frequency	Receiver Detector	Limit	Test method	Remarks
Conducted disturbance voltage	0.009 to 0.05 MHz		Under study	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	(Notes 9, 10)
	0.05 to 0.15 MHz		Under study		
	0.15 to 0.5 MHz	Quasi-peak Average	79 dB (μV) 66 dB (μV)		
	0.5 to 30 MHz	Quasi-peak Average	73 dB (μV) 60 dB (μV)		

NOTE 1 – The limits are given for 10 m measurement distance in SAC; a converted limit can also be applied for 3 m.

NOTE 2 – The limits are given for 3 m measurement distance in free space open area test site (FSOATS). [IEC CISPR 16-1-4] and [IEC CISPR 16-2-3] define the test instrumentation and the test method up to 18 GHz, respectively. For test instrumentation and test method in the frequency range from 18 GHz to 40 GHz, the [b-IEEE/ANSI C63.4] shall apply.

NOTE 3 – The limits are given for 1 m measurement distance in FSOATS.

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

NOTE 5 – Equivalent current limit can be applied.

NOTE 6 – Conducted emissions requirements in the frequency range 9 kHz to 150 kHz are provisional requirements and will be aligned with CISPR limits when approved. Furthermore, these limits will be only applicable to ICT equipment used in telecommunication centres with direct power connection to a low-voltage power public network (without transformer on the AC power input and without an uninterruptible power supply (UPS)).

NOTE 7 – It is applicable to electrical and electronic equipment with a rated input current up to and including 16 A per phase.

NOTE 8 – It is applicable to electrical and electronic equipment with a rated input current exceeding 16 A and up to and including 75 A per phase.

NOTE 9 – Telecommunication equipment intended to be connected to DC power sources where equipment with analogue telephone interface may be connected shall comply to the emission requirements below 3 kHz defined in [b-ITU-T K.76].

NOTE 10 – DC power port may be a DC power input or output port, connecting to a local DC power network or to a power generating equipment (battery, PV system or oil generator) with a cable length exceeding 30 m.

Table A.2 – Equipment for customer premises and outdoor installations (equipment in commercial and light-industrial locations used in professional installation may comply to Table A.1 requirements)

	Frequency	Receiver detector	Limit	Basic standard	Remarks
Enclosure port					
Radiated electromagnetic field	30 to 230 MHz	Quasi-peak	30 dB (μV/m)	[IEC CISPR 16-1-4] [IEC CISPR 16-2-3]	Physically large systems should refer to [ITU-T K.38] (Note 1)
	230 to 1000 MHz	Quasi-peak	37 dB (μV/m)		
	1 to 3 GHz	Peak Average	74 dB (μV/m) 54 dB (μV/m)		(Note 2)
	3 to 6 GHz	Peak Average	74 dB (μV/m) 54 dB (μV/m)		
	6 to 26.5 GHz	Average	54 dB (μV/m)		(Note 2)
	26.5 to 40 GHz	Average	54 dB (μV/m) or 64 dB (μV/m)		(Note 2) (Note 3)
Telecommunication ports					

Table A.2 – Equipment for customer premises and outdoor installations (equipment in commercial and light-industrial locations used in professional installation may comply to Table A.1 requirements)

	Frequency	Receiver detector	Limit	Basic standard	Remarks
Conducted disturbance	0.15 to 0.5 MHz	Quasi-peak Average or Quasi-peak Average	84 to 74 dB (µV) 74 to 64 dB (µV) or 40 to 30 dB (µA) 30 to 20 dB (µA)	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	(Note 4) (Note 5)
	0.5 to 30 MHz	Quasi-peak Average or Quasi-peak Average	74 dB (µV) 64 dB (µV) or 30 dB (µA) 20 dB (µA)		(Note 4) (Note 5)
AC mains power ports					
Conducted disturbance voltage	0.009 to 0.05 MHz	Quasi-peak	120.5 dB (µV) to 110 dB (µV)	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	(Note 6)
	0.05 to 0.15 MHz	Quasi-peak	104 dB (µV) to 80 dB (µV)		
	0.15 to 0.5 MHz	Quasi-peak Average	79 dB (µV) 66 dB (µV)		
	0.5 to 5 MHz	Quasi-peak Average	56 dB (µV) 46 dB (µV)		
	5 to 30 MHz	Quasi-peak Average	60 dB (µV) 50 dB (µV)		
Harmonic current emissions	See [IEC 61000-3-2]			[IEC 61000-3-2]	(Note 7)
	See [IEC 61000-3-12]			[IEC 61000-3-12]	(Note 8)
Voltage fluctuations and flicker	See [IEC 61000-3-3]			[IEC 61000-3-3]	(Note 7)
	See [IEC 61000-3-11]			[IEC 61000-3-11]	(Note 8)
DC power ports					
Conducted disturbance voltage	0.009 to 0.05 MHz		Under study	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	(Note 9)
	0.05 to 0.15 MHz		Under study		
	0.15 to 0.5 MHz	Quasi-peak Average	79 dB (µV) 66 dB (µV)		
	0.5 to 30 MHz	Quasi-peak Average	73 dB (µV) 60 dB (µV)		

NOTE 1 – The limits are given for 10 m measurement distance in SAC; a converted limit can also be applied for 3 m.

NOTE 2 – The limits are given for 3 m measurement distance in FSOATS. [IEC CISPR 16-1-4] and [IEC CISPR 16-2-3] define the test instrumentation and the test method, respectively, up to 18 GHz. For test instrumentation and test method in the frequency range from 18 GHz to 40 GHz, [b-IEEE/ANSI C63.4] shall apply.

NOTE 3 – The limits are given for 1 m measurement distance in FSOATS.

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

NOTE 5 – Equivalent current limit can be applied.

NOTE 6 – Conducted emissions requirements in the frequency range 9 kHz to 150 kHz are provisional requirements and will be aligned with CISPR limits when approved.

NOTE 7 – It is applicable to electrical and electronic equipment with a rated input current up to and including 16 A per phase.

NOTE 8 – It is applicable to electrical and electronic equipment with a rated input current exceeding 16 A and up to and including 75 A per phase.

NOTE 9 – DC power port may be a DC power input or output port, connecting to a local DC power network or to a power generating equipment (battery, or PV system, or oil generator) with a cable length exceeding 30 m.

Annex B

Immunity test level

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

Basic levels and enhanced levels are given in Tables B.1, B.2 and B.3 for equipment which is intended for use in a telecommunication centre, customer premise and outdoor locations.

Test levels have been selected taking into account the following:

– Different installation sites can have different environmental conditions;

– Environmental characteristic severity levels may be exceeded with a low probability;

– The required safety margin should reflect the equipment failure consequences.

When a certain equipment type may be installed in several, different environments, it is recommended that test levels are selected such that the more severe conditions are covered.

The basic level should be selected if the equipment has moderate failure consequences. An equipment has moderate failure consequences when:

– A failure causes limited inconvenience;

– Repairs may be made without compromising the responsibilities of the network operator.

The enhanced level should be selected if the equipment has severe failure consequences. A piece of equipment has severe failure consequences when:

– Failure compromises the function of vital, centralized systems, or services of commercially sensitive or security related nature;

– Repair or restoration costs are high, or the time the equipment is out of service is unacceptably long;

– Corruption of charging or billing information occurs.

Table B.1 – Equipment for telecommunication centre

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
Enclosure port						
Electrostatic discharge	kV	4 (contact) 4 (air)	6 (contact) 8 (air)	[IEC 61000-4-2]	B	
Radio-frequency electromagnetic field	MHz V/m %AM (1 kHz)	80~690 3 80	80~690 10 80	[IEC 61000-4-3]	A	
		690~6000 10 80	690~6000 20 80			
Power-frequency magnetic field	Hz A/m (RMS)	–	50 3	[IEC 61000-4-8]	A	(Note 1) (Note 2)
Outdoor telecommunication ports (Note 3)						
Electrical fast transients/bursts	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	1 5/50 5	[IEC 61000-4-4]	B	(Note 4)

Table B.1 – Equipment for telecommunication centre

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 5) (Note 6)
Surges	(T_r/T_h) µs kV kV	1.2/50 0.5 (line to line) 1 (line to ground)	1.2/50 0.5 (line to line) 1 (line to ground)	[IEC 61000-4-5]	B	(Note 7) (Note 8)
		10/700 0.5 (line to line) 1 (line to ground)	10/700 0.5 (line to line) 1 (line to ground)			(Note 9)
Indoor telecommunication ports						
Electrical fast transients/bursts	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	1 5/50 5	[IEC 61000-4-4]	B	(Note 10) (Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 10) (Note 5) (Note 6)
Surges	(T_r/T_h) µs kV	1.2/50 (8/20) 0.5 (line to ground)	1.2/50 (8/20) 0.5 (line to ground)	[IEC 61000-4-5]	B	(Note 7) (Note 11)
AC power port						
Electrical fast transients/bursts	kV (T_r/T_h) ns kHz	1 5/50 5	2 5/50 5	[IEC 61000-4-4]	B	
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 5) (Note 6)
Surges	(T_r/T_h) µs kV kV	1.2/50 (8/20) 0.5 (line to line) 1 (line to ground)	1.2/50 (8/20) 1 (line to line) 2 (line to ground)	[IEC 61000-4-5]	B B	
Voltage dips and interruption	% reduction Cycle period	>95 0.5	>95 0.5	[IEC 61000-4-11]	B	(Note 12)
		>95 1	>95 1		B	
		30 25/30 at 50 Hz/60 Hz	30 25/30 at 50 Hz /60 Hz		C	
		>95 at 50 Hz/60 Hz	>95 at 50 Hz/ 60 Hz		C	

Table B.1 – Equipment for telecommunication centre

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
	% reduction Cycle period	>95 0.5	>95 0.5	[IEC 61000-4-34]	B	(Note 13)
		>95 1	>95 1		B	
		30 25/30 at 50 Hz/60 Hz	30 25/30 at 50 Hz /60 Hz		C	
		>95 250/300 at 50 Hz/60 Hz	>95 250/300 at 50 Hz/ 60 Hz		C	
DC power port						
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	1 5/50 5	[IEC 61000-4-4]	B	(Note 10) (Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 10) (Note 5) (Note 6)
Surges	(T_r/T_h) µs kV kV	–	1.2/50 (8/20) 0.5 (line to line) 1 (line to ground)	[IEC 61000-4-5]	B B	
Voltage dips, Voltage interruption, Voltage Variation		Residual voltage %U_T	Duration time s	[IEC 61000-4-29]	–	
	Voltage interruption	0	0.004		A	(Note 15)
			0.01		C (Note 14) (Note 16) (Note 17)	
			0.1			
	Voltage Variation	From 0 to 90	1		C	(Note 18)
		From 110 to 125	1			
	Abnormal Voltage	From 100 to 90	2		A	
		From 100 to 110	2			

NOTE 1 – This test applicable only to equipment containing devices susceptible to magnetic fields, such as cathode ray tube (CRT) monitors, Hall elements, electrodynamic microphones and magnetic field sensors.

NOTE 2 – For CRTs the acceptable jitter depends upon the character size and is computed for a test level of 1 A/m as follows:

Jitter (mm) = (3 − character height in mm 1)/40.

As jitter is linearly proportional to the magnetic field strength tests can be carried out at other test levels extrapolating the maximum jitter level appropriately.

NOTE 3 – Outdoor lines carrying DC power with superimposed signals should be treated as outdoor signal lines.

NOTE 4 – The repetition rate for xDSL port should be 100 kHz. Re-testing of equipment tested according to the earlier version of the basic standard with the repetition rate of 5 kHz is not required.

NOTE 5 – The test level can be defined as equivalent current into 150 Ω.

NOTE 6 – The test for enhanced level is 10 V except for the ITU-T broadcast frequency band: 47 MHz to 68 MHz, where the test level should be 3 V.

Table B.1 – Equipment for telecommunication centre

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
NOTE 7 – This test may not be applied for unscreened cable when appropriate CDN does not exist. NOTE 8 – This test applies to symmetrical/unsymmetrical screened and unscreened cables and to coaxial cables however: Line-to-Line test does not apply to symmetrical unshielded cables and to shielded cables (including coaxial cables). NOTE 9 – This test applies to symmetrical and unsymmetrical unscreened cables. NOTE 10 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 3 m. NOTE 11 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 10 m. NOTE 12 – This test applies to equipment with a rated input current not exceeding 16 A per phase. NOTE 13 – This test applies to equipment with a rated input current of more than 16 A per phase. NOTE 14 – In some sensitive equipment, momentary and temporary interruption of the service may occur as a result of such transients. Lengthening of the interruption to service (equipment is not functioning as intended) due to the recovery of software should be taken into account. More detailed information about the service interruption should be provided by the manufacturer on the request of the operator. NOTE 15 – The test should be carried out at both high and low output impedance of test generator. EUT with dual power feeding shall be tested with the second power feeding connected directly to the power source while the other power feeding is tested. NOTE 16 – To prevent system malfunctioning, additional arrangements concerning the power supply system may be necessary. For example: – Dual feeding system; – High ohmic distribution system; – Independent power distribution. NOTE 17 – This test is applicable only to equipment in which the battery backup is not permanently connected to the DC distribution system. NOTE 18 – The test simulates a change in the DC voltage from the nominal value to a lower value or to a higher value.						

Table B.2 – Equipment for customer premises

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
Enclosure port						
Electrostatic discharge	kV kV	6 (contact) 8 (air)	8 (contact) 15 (air)	[IEC 61000-4-2]	B	
Radio-frequency electromagnetic field	MHz V/m %AM (1 kHz)	80~690 3 80	80~690 10 80	[IEC 61000-4-3]	A	
		690~6000 10 80	690~6000 20 80			
Power-frequency magnetic field	Hz A/m (RMS)	–	50 3	[IEC 61000-4-8]	A	(Note 1) (Note 2)
Outdoor telecommunication ports (Note 3)						
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	1 5/50 5	[IEC 61000-4-4]	B	(Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 5)

Table B.2 – Equipment for customer premises

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
Surges	(T_r/T_h) µs kV kV	1.2/50 0.5 (line to line) 1 (line to ground)	1.2/50 0.5 (line to line) 1 (line to ground)	[IEC 61000-4-5]	B	(Note 6) (Note 7)
		10/700 0.5 (line to line) 1 (line to ground)	10/700 0.5 (line to line) 1(line to ground)			(Note 8)
Indoor telecommunication ports						
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	1 5/50 5	[IEC 61000-4-4]	B	(Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15 to 80 10 80	[IEC 61000-4-6]	A	(Note 9) (Note 5)
Surges	(T_r/T_h) µs kV	1.2/50 (8/20) 0.5 (line to ground)	1.2/50 (8/20) 1 (line to ground)	[IEC 61000-4-5]	B	(Note 6) (Note 10) (Note 11)
AC power port						
Fast transients	kV (T_r/T_h) ns kHz	1 5/50 5	2 5/50 5	[IEC 61000-4-4]	B	(Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 5)
Surges	(T_r/T_h) µs kV kV	1.2/50(8/20) 1 (line to line) 2 (line to ground)	1.2/50(8/20) 2 (line to line) 4 (line to ground)	[IEC 61000-4-5]	B B	
Voltage dips and interruption	% reduction Period	>95 1	>95 1	[IEC 61000-4-11]	B	(Note 12)
		30 25/30 at 50 Hz/60 Hz	30 25/30 at 50 Hz/60 Hz		C	
		>95 250/300 at 50 Hz/60 Hz	>95 250/300 at 50 Hz/60 Hz		C	
		>95 1	>95 1	[IEC 61000-4-34]	B	(Note 13)
		30 25/30 at 50 Hz/60 Hz	30 25/30 at 50 Hz/60 Hz		C	
		>95 250/300 at 50 Hz/60 Hz	>95 250/300 at 50 Hz/60 Hz		C	

Table B.2 – Equipment for customer premises

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
DC power port						
Fast transients	kV (T_r/T_h) ns repetition rate kHz	1 5/50 5	2 5/50 5	[IEC 61000-4-4]	B	(Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 9) (Note 5)
Surges	(T_r/T_h) µs kV kV	–	1.2/50 (8/20) 0.5 (line to line) 1 (line to ground)	[IEC 61000-4-5]	 B B	
Voltage dips, Voltage interruption, Voltage variation, Abnormal voltage		Residual voltage %U_T	Duration time s	[IEC 61000-4-29]	–	
	Voltage interruption	0	0.004		A	(Note 14)
			0.01		C (Note 15) (Note 16) (Note 17)	
			0.1			
	Voltage Variation	From 0 to 90	1		C	(Note 18)
		From 110 to 125	1			
	Abnormal Voltage	From 100 to 90	2		A	
		From 100 to 110	2			

NOTE 1 – This test applicable only to equipment containing devices susceptible to magnetic fields, such as CRT monitors, Hall elements, electrodynamic microphones, magnetic field sensors, etc.

NOTE 2 – For CRTs the acceptable jitter depends upon the character size and is computed for a test level of 1 A/m as follows:

Jitter (mm) = (3-character height in mm 1)/40.

As jitter is linearly proportional to the magnetic field strength, tests can be carried out at other test levels extrapolating the maximum jitter level appropriately.

NOTE 3 – Outdoor lines carrying DC power with superimposed signals should be treated as outdoor signal lines.

NOTE 4 – The repetition rate should be 100 kHz. Re-testing of equipment tested according to the earlier version of the basic standard with the repetition rate of 5 kHz is not required.

NOTE 5 – The test level can be defined as equivalent current into 150 Ω.

NOTE 6 – This test may not be applied for unscreened cable when appropriate CDN does not exist.

NOTE 7 – This test applies to symmetrical/unsymmetrical screened and unscreened cables and to coaxial cables, however, line-to-line test does not apply to symmetrical unshielded cables and to shielded cables (including coaxial cables).

NOTE 8 – This test applies to symmetrical and unsymmetrical unscreened cables.

NOTE 9 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 3 m.

NOTE 10 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 30 m.

NOTE 11 – The EUT should not be reset when the powered surge test is conducted for PoE.

NOTE 12 – This test applies to equipment with a rated input current not exceeding 16 A per phase.

NOTE 13 – This test applies to equipment with a rated input current of more than 16 A per phase.

NOTE 14 – The test should be carried out at both high and low output impedance of the test generator. EUT with dual power feeding shall be tested with the second power feeding connected directly to the power source while the other power feeding is tested.

NOTE 15 – In some sensitive equipment, momentary and temporary interruption of the service may occur as a result of such transients. Lengthening of the interruption to service (equipment is not functioning as intended) due to the recovery of software should be taken into account. More detailed information about the service interruption should be provided by the manufacturer on the request of the operator.

Table B.2 – Equipment for customer premises

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
NOTE 16 – To prevent system malfunctioning, additional arrangements concerning the power supply system may be necessary. For example: – Dual feeding system; – High ohmic distribution system; – Independent power distribution. NOTE 17 – This test is applicable only to equipment in which the battery backup is not permanently connected to the DC distribution system. NOTE 18 – The test simulates a change in the DC voltage from the nominal value to a lower value or to a higher value.						

Table B.3 – Equipment for outdoor locations

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
Enclosure port						
Electrostatic discharge	kV	6 (contact) 8 (air)	8 (contact) 15 (air)	[IEC 61000-4-2]	B	
Radio-frequency electromagnetic field	MHz V/m %AM(1 kHz)	80~690 3 80	80~690 10 80	[IEC 61000-4-3]	A	
		690~6000 10 80	80~690 20 80			
Power-frequency magnetic field	Hz A/m (RMS)	–	50 3	[IEC 61000-4-8]	A	(Note 1) (Note 2)
Outdoor telecommunication ports (Note 3)						
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	1 5/50 5	[IEC 61000-4-4]	B	(Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 5)
Surges	(T_r/T_h) µs kV kV	10/700 µs 0.5 (line to line) 1 (line to ground)	10/700 µs 0.5 (line to line) 1 (line to ground)	[IEC 61000-4-5]	B	(Note 6) (Note 7)
		1.2/50 µs 0.5 (line to line) 1 (line to ground)	1.2/50 µs 1 (line to line) 2 (line to ground)			(Note 6) (Note 8)
AC power port						
Fast transients	kV (T_r/T_h) ns kHz	1 5/50 5	2 5/50 5	[IEC 61000-4-4]	B	(Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 5)

Table B.3 – Equipment for outdoor locations

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
Surges	(T_r/T_h) µs kV kV	1.2/50 (8/20) 1 (line to line) 2 (line to ground)	1.2/50 (8/20) 2 (line to line) 4 (line to ground)	[IEC 61000-4-5]	B B	
Voltage dips & interruption	% reduction Cycle period	>95 0.5	>95 0.5	[IEC 61000-4-11]	B	(Note 9)
		>95 1	>95 1		B	
		30 25/30 at 50 Hz/60 Hz	30 25/30 at 50 Hz/60 Hz		C	
		>95 250/30 at 50 Hz/60 Hz	>95 250/300 at 50 Hz/60 Hz		C	
		>95 0.5	>95 0.5	[IEC 61000-4-34]	B	(Note 10)
		>95 1	>95 1		B	
		30 25/30 at 50 Hz/60 Hz	30 25/30 at 50 Hz/60 Hz		C	
		>95 250/300 at 50 Hz/60 Hz	>95 250/300 at 50 Hz/60 Hz		C	
DC power port						
Fast transients	kV (T_r/T_h) ns repetition rate kHz	1 5/50 5	2 5/50 5	[IEC 61000-4-4]	B	(Note 11) (Note 4)
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	0.15~80 10 80	[IEC 61000-4-6]	A	(Note 11) (Note 5)
Surges	(T_r/T_h) µs kV kV	1.2/50 (8/20) 1 (line to line) 2 (line to ground)	1.2/50 (8/20) 2 (line to line) 4 (line to ground)	[IEC 61000-4-5]	B B	(Note 12)
Voltage dips, Voltage interruption, Voltage Variation, Abnormal Voltage		Residual voltage %U_T	Duration time s	[IEC 61000-4-29]	–	
	Voltage interruption	0	0.004		A	(Note 13)
			0.01		C (Note 14) (Note 15) (Note 16)	
			0.1			
	Voltage Variation	From 0 to 90	1		C	(Note 17)
		From 110 to 125	1			
	Abnormal Voltage	From 100 to 90	2		A	
		From 100 to 110	2			

Table B.3 – Equipment for outdoor locations

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		Basic level	Enhanced level			
NOTE 1 – This test applicable only to equipment containing devices susceptible to magnetic fields, such as CRT monitors, Hall elements, electrodynamic microphones, magnetic field sensors, etc. NOTE 2 – For CRTs the acceptable jitter depends upon the character size and is computed for a test level of 1 A/m as follows: Jitter (mm) = (3 character height in mm 1)/ 40. As jitter is linearly proportional to the magnetic field, strength tests can be carried out at other test levels extrapolating the maximum jitter level appropriately. NOTE 3 – Outdoor lines carrying DC power with superimposed signals should be treated as outdoor signal lines. NOTE 4 – The repetition rate should be 100 kHz. Re-testing of equipment tested according to the earlier version of the basic standard with the repetition rate of 5 kHz is not required. NOTE 5 – The test level can be defined as equivalent current into 150 Ω. NOTE 6 – This test may not be applied for unscreened cable when appropriate CDN does not exist. NOTE 7 – This test applies to symmetrical/unsymmetrical metrical screened cables and to coaxial cables. NOTE 8 – This test applies to symmetrical/unsymmetrical screened and unscreened cables and to coaxial cables, however, line-to-line test does not apply to symmetrical unshielded cables and to shielded cables (including coaxial cables). NOTE 9 – This test applies to equipment with a rated input current not exceeding 16 A per phase. NOTE 10 – This test applies to equipment having a rated input current of more than 16 A per phase. NOTE 11 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 3 m. NOTE 12 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 10 m. NOTE 13 – The test should be carried out at both high and low output impedance of test generator. EUT with dual power feeding shall be tested with the second power feeding connected directly to the power source while the other power feeding is tested. NOTE 14 – In some sensitive equipment, momentary and temporary interruption of the service may occur as a result of such transients. Lengthening of the interruption to service (equipment is not functioning as intended) due to the recovery of software should be taken into account. More detailed information about the service interruption should be provided by the manufacturer on the request of the operator. NOTE 15 – To prevent system malfunctioning, additional arrangements concerning the power supply system may be necessary. For example: – Dual feeding system; – High ohmic distribution system; – Independent power distribution. NOTE 16 – This test is applicable only to equipment in which the battery backup is not permanently connected to the DC distribution system. NOTE 17 – The test simulates a change in the DC voltage from the nominal value to a lower value or to a higher value.						

Annex C

Equipment within the scope this Recommendation

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

This Recommendation covers types of wireline telecommunication equipment as set out below.

C.1 Access equipment

Access equipment may provide multiservice access functions, such as:

– Optical access equipment using gigabit passive optical network (GPON), Ethernet passive optical network (EPON), 10G-GPON, 10G-EPON;

– Copper access equipment using xDSL, E1, plain old telephone service (POTS), 1000BASE-T;

The typical access network equipment may include:

– Optical line terminal (OLT);

– Optical network unit (ONU);

– Multiservice access node (MSAN);

– Digital subscriber line access multiplexer (DSLAM);

– Private branch exchange (PBX).

C.2 IP equipment: router and switching

Packet switching equipment creates the network and ties multiple networks together through data packet routing and forwarding, enabling network devices to communicate with one another. Nowadays, switching equipment typically has an aggregation function to allow the trunk to obtain higher data speeds.

A core switch is a high-capacity switch generally positioned within the backbone or physical core of a network. Core switches serve as gateways of wide area networks (WANs) or the Internet. They provide the final aggregation point for the network and allow multiple aggregation modules to work together.

The typical equipment includes:

– Layer 2 or layer 3 LAN switch;

– Edge router;

– Core router;

– Access transport network (ATN).

C.3 Optical transmission network equipment

Optical transmission equipment includes: wavelength division multiplexing (WDM) and multiservice transmission platform (MSTP).

MSTP is a platform based on the synchronous digital hierarchy (SDH) platform, capable of accessing, processing and transmitting time division multiplexing (TDM) services, asynchronous transfer mode (ATM) services, Ethernet services etc., and providing unified management of these services.

WDM equipment achieves a transparent transmission with multiple services and large capacity.

C.4 Data centre and cloud computing equipment

Data centre network equipment generally includes: server, storage and core network equipment.

Server and storage equipment are products for processing existing storage applications. They provide the function of mass data storage, speed data access and process. They typically consist of a controller enclosure or controller enclosure and disk enclosure and are used within telecommunication network infrastructure.

Core network equipment may compromise computing node, exchange boards and extra storage nodes.

C.5 Switching equipment

Switching equipment include local telephone exchanges, remote switching concentrators, base station controllers and radio network controllers.

Annex D

Test guide for access equipment

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

D.1 Introduction

Access network equipment included in Annex C should be tested according to this annex.

D.2 Operational conditions

The general operational conditions in clause 8.1 apply.

The operational conditions of access equipment should refer to requirements given in Table D.1.

Table D.1 – Access network product service port working state reference table

Service / Port type	Traffic requirements
ADSL2 + (Note 1)	No less than 80% of activation rate, packet length: 1500 Bytes.
VDSL2 (Note 2)	No less than 80% of activation rate, packet length: 1500 Bytes.
G.fast (Note 3)	No less than 80% of activation rate, when the data rate is limited by uplink throughput of the equipment, appropriate data rate reduction can be considered, packet length: 1500 bytes.
POTS	In calling state.
E1	Data rate: 2.048 Mbit/s.
xPON	No less than 90% of the data rate, when the data rate is limited by uplink throughput of the equipment, appropriate data rate reduction can be considered, packet length: 1500 bytes.
NOTE 1 – ADSL2+ is defined in [b-ITU-T G.992.5]. NOTE 2 – VDSL2 is defined in [b-ITU-T G.993.5]. NOTE 3 – G.fast is defined in [b-ITU-T G.997.2].	

The measurements should be made with the digital transmission system trained up and operating at its nominal transmission rate such that the full frequency spectrum used by the system is utilized. If the system can be operated in asymmetrical and symmetrical modes, then testing should be carried out for each of these modes of operation.

Immunity testing should be performed at nominal values of all signal conditions and with a value of the line attenuation (i.e., using real cable or line simulator providing an equivalent line attenuation value measured at 300 kHz), as defined in Table D.2, such that the system will be operating at its minimum acceptable noise margin, for example, 6 dB noise margin relative to the system's nominal bit error ratio of 1E-7, and 12 dB noise margin for G.fast.

D.3 Test configurations

The general test configurations in clause 8.2 apply.

The EUT should be configured according to the normal application which is specified in Table D.2 (see also Figure D.1).

There may be several profiles for an xDSL; each profile supported by the EUT should be assessed. For VDSL, the profile 8b, 17a, 30a, 35b is recommended for testing.

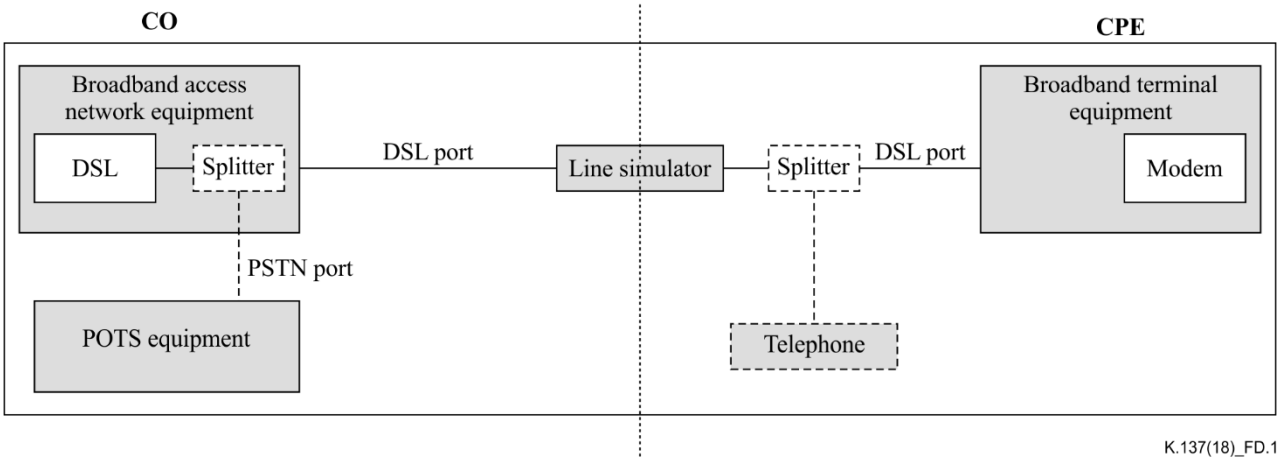


Figure D.1 – DSL access system configuration

For passband systems such as ADSL2+ and VDSL2, both ends of the EUT typically comprise a DSL modem and splitter/filter via which the POTS port is presented. The modem and splitter may be separate units or combined into one unit.

Table D.2 – Interface type and configuration reference table for access network equipment

Service/port type	**Line simulator**	**Port terminating load** (Note 1)
ADSL2+	2 km	Modem or 100 Ω resistance
VDSL2 (Note 2)	600 m	Modem or 100 Ω resistance
	300 m	Modem or 100 Ω resistance
G.fast	100 m	Modem
xPON	N/A	OLT, test instrument or loopback
POTS	N/A	Telephone or 600 Ω resistor
E1	N/A	Loopback or test instrument
NOTE 1 – The number of the ports to be terminated during EMC testing should refer to clause 8.2. NOTE 2 – For VDSL2 profiles 8b and17a, the 600-m line simulator should be selected for testing, and for VDSL2 profiles 30a and 35b, the 300-m line simulator should be selected for testing. The VDSL2 with the vector function should use the same line simulator.		

D.4 Performance criteria

Where the particular performance criteria of the interface is not stated in the clause, then the general performance criteria should apply.

D.4.1 xDSL and G.fast interface

The performance of the equipment should be verified by:

– Measuring the additional errors induced due to the application of any electromagnetic phenomena;

– Testing the functionality of the system at the cessation of the test;

– Ensuring that no software or stored data corruption has occurred.

D.4.1.1 Performance criterion A (continuous phenomena)

The following specifies the criterion requirement for xDSL and G.fast.

During the test sweep, the established connection should be maintained throughout the test and the transfer of information should be without any additional reproducible bit errors or loss of synchronization. If a degradation in performance is observed and the system is adaptive, i.e., has the capability to automatically re-train in the presence of an interfering signal, then for conducted and radiated immunity tests only the procedure should be carried out:

1) For each range of interfering frequencies where a degradation in performance is observed, three frequencies (beginning, middle, end) should be identified.
2) At each of the frequencies identified in 1), the interfering signal should be turned on and the system allowed to re-train. If the system is able to re-train and function without any additional reproducible bit errors or loss of synchronization, then the system's performance is considered acceptable.
3) The frequencies identified in 1) and the data rates achieved in 2) should be recorded in the test report.

D.4.1.2 Performance criterion B (transient phenomena)

The general performance criteria B should apply. However, the application of the test should not cause the system to lose the established connection or delay function (e.g., by re-train). At the cessation of the test, the system should continue to function in the state established prior to the application of the test, without user intervention.

The above performance criteria do not apply to surge testing. For this test, the EUT should not lose the established connection and should operate as intended following the cessation of the exposure.

D.4.1.3 Performance criterion C (interruptions)

The general performance criterion C should apply.

D.4.2 POTS interface

The performance of the equipment should be verified by measuring the audio signal break-through (demodulated 1 kHz) at any POTS port while continuous interference phenomena are applied.

D.4.2.1 Performance criterion A (continuous phenomena)

During the test sweep, the demodulated noise level at the POTS port should be less than −40 dBm at 600 Ω (ignoring the nominal port impedance for practical reasons) if not otherwise stated by the manufacturer. The measurement should be done selectively with a bandwidth ≤ 100 Hz at 1 kHz. As an alternative method the acoustic sound pressure level (SPL) at the receiver of a telephone connected to the two-wire analogue interface should not exceed 55 dB SPL when measured in a bandwidth ≤ 100 Hz at 1 kHz.

D.4.2.2 Performance criterion B (transient phenomena)

The general performance criteria B should apply in that errors are acceptable during the application of the test. However, the application of the test should not cause the system to lose the established connection. At the cessation of the test the system should continue to function in the state established prior to the application of the test, without user intervention.

The above performance criteria do not apply to surge testing. For this test, the EUT should not lose the established connection and should operate as intended following the cessation of the exposure.

D.4.2.3 Performance criterion C (interruptions)

The general performance criterion C should apply.

D.4.3 Digital signal interface

The performance of the equipment should be verified for digital signal ports:

– By measuring the number of induced bit errors on the main signal port during all exposures;

– By testing the functionality of the main signal port and the other signal ports after the exposure;

– By verifying that corruption of software and data held in memory has not occurred.

D.4.3.1 Performance criterion A (continuous phenomena)

During the test sweep, the established connection should be maintained throughout the test and the transfer of information should be without any additional reproducible bit errors or loss of synchronization.

If a degradation in performance is observed and the system is adaptive, i.e., has the capability to automatically re-train in the presence of an interfering signal, then for conducted and radiated immunity tests only the following procedure should be carried out:

1) For each range of interfering frequencies where a degradation in performance is observed, three frequencies (begin, middle, end) should be identified.

2) At each of the frequencies identified in 1), the interfering signal should be turned on and the system allowed to be re-trained. If the system is able to re-train and then function without any additional reproducible bit errors or loss of synchronization, then the system's performance is considered acceptable.

3) The frequencies identified in 1) and the data rates achieved in 2) should be recorded in the test report.

D.4.3.2 Performance criterion B (transient phenomena)

Loss of frame alignment is not allowed during each individual exposure. No alarms should be generated as a result of the electromagnetic stress.

The above does not apply to surge testing where some loss of frame alignment may be expected. For this test, the EUT should operate as intended following the cessation of the exposure.

D.4.3.3 Performance criterion C (interruptions)

The general performance criterion C applies.

Annex E

Test guide for IP equipment: router and switching

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

E.1 Introduction

Router and switching equipment included in Annex C should be tested according to this annex.

E.2 Operational conditions

The general operational conditions in clause 6.1 apply.

All relevant functions should be assessed. The functions and modes of operation during testing should be recorded in the test report. Software-defined networking (SDN) and network functions virtualization (NFV) equipment should be tested in each function of the EUT supported.

An appropriate test signal should be used. The test signal should be stated in the test report. The preferred test signal is the pseudo-random bit sequence (PRBS) appropriate for the bit rate of the channel, according to [ITU-T O.150].

The data traffic should simulate a typical application, for all digital ports; a minimum of 80% of the full expected data rate should be running for each port, unless otherwise limited by the upstream or downstream throughput of the interface.

E.3 Test configurations

The general test configurations in clause 6.2 apply.

Router and switching equipment are typically made up of main processing card/unit, switch and/or route processing card/unit, interface card/unit and power card/module. The equipment should be configured to represent a typical application, for example, in the quantity of interface cards, the ports terminated and the auxiliary equipment used to exercise the EUT.

All Ethernet ports of the EUT, whether electrical or optical, should be terminated (typically loop back) and exercised during the test. If the router equipment supports several operation modes for uplink, for example, 10 GE fibre port or 10 GE electrical port, then each mode should be assessed respectively. The downlink interfaces should be assessed in a similar way as the uplink.

An example of the test configuration is shown in Figure E.1, in which a test signal is derived from an exercising equipment and looped through EUT. If the EUT supports several identical ports, these may be connected in series and the test signal may be looped through all the ports. The test configuration should cover a representative setup of tributary signals within the aggregate interface signals.

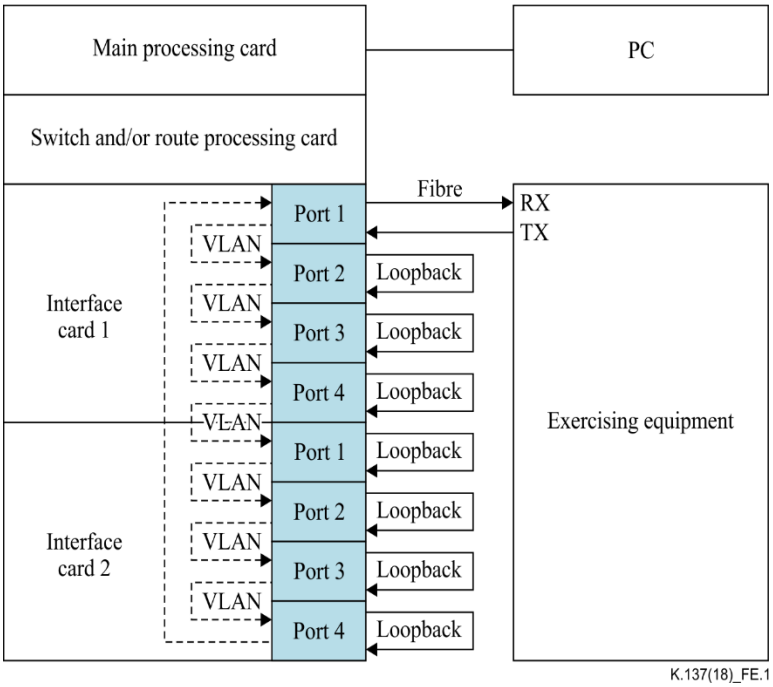


Figure E.1 – Schematic test configuration for router and switching equipment

E.4 Performance criteria

Where particular performance criteria of the interface are not stated in the clause, then the general performance criteria should apply.

E.4.1 Ethernet and packet-data interfaces

The criteria below apply to the interfaces specified in [b-IEEE 802.3af] and [b-IEEE 802.3at].

E.4.1.1 Performance criterion A (continuous phenomena)

For interfaces which are intended for the transmission of third-party data traffic, a selected port shall be connected to test equipment (e.g., a data communications analyser) as a single point-to-point data link. This will avoid excessive failed transmission attempts caused by data collisions and bus contention problems.

The interface shall be suitably exercised and monitored throughout the test period for errored frames.

No more than 5% additional errored frames above the quiescent level shall be permitted during the exposure.

For instance, in a transmission interface of 10 000 frames, a number of errored frames higher than 5% of 10 000 is not allowed.

If a degradation in performance is observed and the system is adaptive, i.e., has the capability to automatically re-train in the presence of an interfering signal, then for conducted and radiated immunity tests only the following procedure should be carried out:

1) For each range of interfering frequencies where a degradation in performance is observed, three frequencies (beginning, middle, end) should be identified.
2) At each of the frequencies identified in 1), the interfering signal should be turned on and the system allowed to re-train. If the system is able to re-train and then function without any additional reproducible bit errors or loss of synchronization, then the system's performance is considered acceptable.
3) The frequencies identified in 1) and the data rates achieved in 2) should be recorded in the test report.

E.4.1.2 Performance criterion B (transient phenomena)

Loss of frame alignment is not allowed during each individual exposure. No alarms should be generated as a result of the electromagnetic stress.

The above does not apply to surge testing where some loss of frame alignment may be expected. For this test, the EUT should operate as intended following the cessation of the exposure.

E.4.1.3 Performance criterion C (interruptions)

The general performance criterion C should apply.

Annex F

Test guide for optical transmission network equipment

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

F.1 Introduction

Optical transmission network equipment included in Annex C should be tested according to this annex.

F.2 Operational conditions

The general operational conditions in clause 8.1 should apply. During the test, the product should operate in the typical condition, consistent with normal applications. All relevant functions should be assessed. The functions and modes of operation during testing should be recorded in the test report.

An appropriate test signal should be used. The test signal should be stated in the test report. The preferred test signal is the PRBS appropriate for the bit rate of the port, according to [ITU-T O.150].

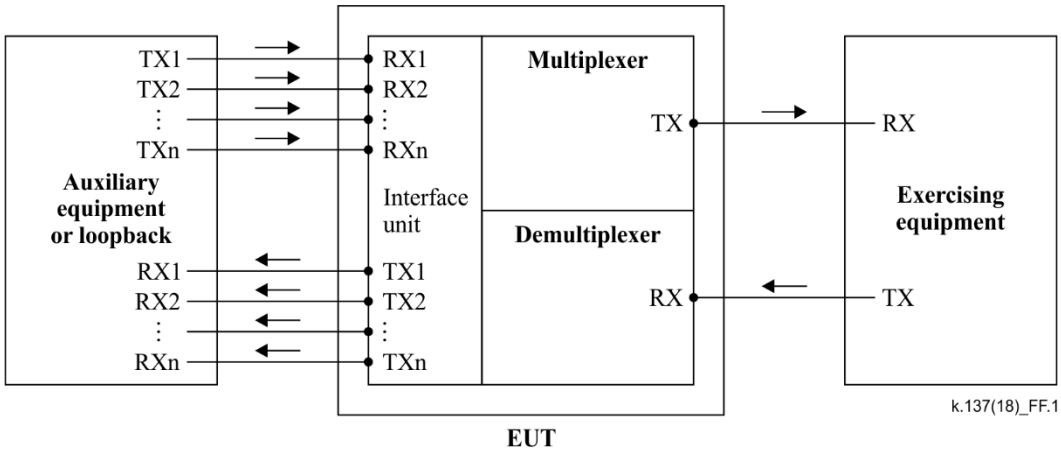
F.3 Test configurations

The general test configurations in clause 8.2 should apply.

The equipment should be configured with a typical application, for example, in the quantity of interface cards, the ports terminated and the auxiliary equipment used to exercise the EUT. The exercising signal is recommended to be looped back between different optical ports within one line card, and also can be in serial between different line cards.

If the EUT can be used with optical transceivers of different types, for example, supporting different transmitting distances, then each type should be assessed respectively.

Typically, the EUT should be configured as shown in Figures F.1 and F.2.



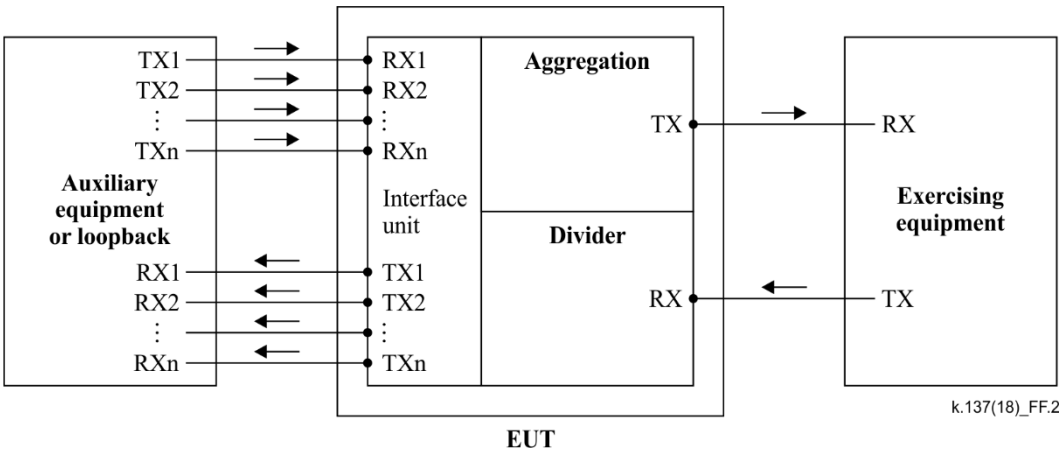
NOTE – The main interfaces of WDM equipment include:

a) Ethernet: GE electrical, GE, 10GE and 100GE optical, etc.

b) SDH: STM-16/ 2.5 Gbit/s optical, STM-64/ 10G optical, etc.

c) OTN: OTU1/2.5 Gbit/s, OTU2/10 GHz, OTU4/100 Gbit/s optical, etc.

Figure F.1 – Schematic test configuration for WDM equipment



NOTE – The main interfaces of MSTP equipment include:

a) Ethernet: Fast Ethernet (FE) and GE electrical, GE and 10GE optical, etc.

b) SDH: STM-1/155 Mbit/s, STM-4/622 Mbit/s electrical or optical, STM-16/2.5 Gbit/s, STM-64/10 Gbit/s optical, etc.

c) Plesiochronous digital hierarchy (PDH): E1/2 Mbit/s, T1/1.5 Mbit/s, E3/34 Mbit/s, and T3/45 Mbit/s electrical, etc.

Figure F.2 – Schematic test configuration for MSTP equipment

F.4 Performance criteria

Where particular performance criteria of the interface are not stated in the clause, then the general performance criteria should apply.

F.4.1 SDH and plesiochronous digital hierarchy interfaces

The criteria specified in this clause apply to the interfaces specified in [b-ETSI EN 300 166] (electrical interface) and [b-ETSI ETS 300 232], [ITU-T G.783] and [ITU-T G.798] (optical interfaces).

F.4.1.1 Performance criterion A (continuous phenomena)

During the exposure, synchronization should not be lost.

If a degradation in performance is observed and the system is adaptive, i.e., has the capability to automatically re-train in the presence of an interfering signal, then for conducted and radiated immunity tests only, the following procedure should be carried out:

1) For each range of interfering frequencies where a degradation in performance is observed, three frequencies (beginning, middle, end) should be identified.

2) At each of the frequencies identified in 1), the interfering signal should be turned on and the system allowed to re-train. If the system is able to re-train and then function without any additional reproducible bit errors or loss of synchronization, then the system's performance is considered acceptable.

3) The frequencies identified in 1) and the data rates achieved in 2) should be recorded in the test report.

F.4.1.2 Performance criterion B (transient phenomena)

Loss of frame alignment is not allowed during each individual exposure. No alarms should be generated as a result of the electromagnetic stress.

The functional performance according to the manufacturer's specification should be verified following cessation of the exposure.

F.4.1.3 Performance criterion C (interruptions)

The general performance criterion C should apply.

F.4.2 Maintenance and alarm interfaces

These interfaces are defined by the manufacturer. For immunity testing, these interfaces should be verified according to the manufacturer's specification following cessation of the electromagnetic exposure on other ports.

F.4.2.1 Performance criterion A (continuous phenomena)

No false alarms should occur during continuous exposure.

F.4.2.2 Performance criterion B (transient phenomena)

No false alarm indications should persist after the exposure.

F.4.2.3 Performance criterion C (interruptions)

The general performance criterion C should apply.

F.4.3 Synchronization interfaces

The performance of slave clocks specified in [ITU-T G.812] and [ITU-T G.813] should be checked with the equipment synchronized with an external source.

F.4.3.1 Performance criterion A (continuous phenomena)

During the exposure, synchronization should not be lost.

F.4.3.2 Performance criterion B (transient phenomena)

No alarm indications should persist after the exposure.

The functional performance according to the manufacturer's specification should be verified following cessation of the exposure.

F.4.3.3 Performance criterion C (interruptions)

The general performance criterion C should apply.

F.4.4 Ethernet and packet-data interfaces

The criteria below apply to the interfaces specified in [b-IEEE 802.3af] or [b-IEEE 802.3at].

F.4.4.1 Performance criterion A (continuous phenomena)

For interfaces which are intended for the transmission of third-party data traffic, a selected port shall be connected to test equipment (e.g., a data communications analyser) as a single point-to-point data link. This will avoid excessive failed transmission attempts caused by data collisions and bus contention problems.

The interface shall be suitably exercised and monitored throughout the test period for errored frames.

No more than 5% additional errored frames above the quiescent level shall be permitted during the exposure.

For instance, in a transmission interface of 10 000 frames, a number of errored frames higher than 5% of 10 000 is not allowed.

The performance criterion for other packet-data interfaces should refer to the errored frames or PER requirement as defined in the relevant specification.

If a degradation in performance is observed and the system is adaptive, i.e., has the capability to automatically re-train in the presence of an interfering signal, then for conducted and radiated immunity tests only the procedure should be carried out:

1) For each range of interfering frequencies where a degradation in performance is observed, three frequencies (beginning, middle, end) should be identified.

2) At each of the frequencies identified in 1), the interfering signal should be turned on and the system is allowed to re-train. If the system is able to re-train and then function without any additional reproducible errored frames or loss of synchronization, then the system's performance is considered acceptable.

3) The frequencies identified in 1) and the data rates achieved in 2) should be recorded in the test report.

F.4.4.2 Performance criterion B (transient phenomena)

Loss of frame alignment is not allowed during each individual exposure. No alarms should be generated as a result of the electromagnetic stress.

The above does not apply to surge testing where some loss of frame alignment may be expected. For this test, the EUT should operate as intended following the cessation of the exposure.

F.4.4.3 Performance criterion C (interruptions)

The general performance criterion C should apply.

Annex G

Test guide for data centre and cloud computing network equipment

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

G.1 Introduction

Data centre and cloud computing equipment included in Annex C should be tested according to this annex.

G.2 Operational conditions

The general operational conditions in clause 8.1 apply.

The digital port should be exercised by typical signal, for example, PRBS for the Ethernet package. The traffic should be no less than 80% of the full data rate.

The pressure of the CPU, memory, storage and peripheral component interconnect express (PCI-e) should be no less the 80%; in a case where the above functional modules have conflicts to reach the required pressure at the same time, then the typical condition should be considered in priority.

G.3 Test configuration

The general test configuration in clause 8.2 should apply.

The equipment should be configured in typical application, for example, in the quantity of line cards, the ports terminated and the auxiliary equipment used to exercise the EUT. The exercising signal is recommended to be looped back between different ports within one line card, and also can be looped back in serial between different line cards.

Test configurations for a typical server and core network equipment are shown in Figure G.1 and Figure G.2, respectively.

The server generally supports a PCI-e card for extension of fibre channel (FC) card, infinite band (IB) card, graphical processing unit (GPU) card, redundant array of independent disks (RAID) card, non-volatile memory express (NVMe) card, etc., and then each extension should be considered to maximize the emission. Where impractical, the highest computing pressure configuration should be tested.

For the server board generally supporting different functional interface, for example, GE or 10GE, a configuration maximizing the emission should be tested.

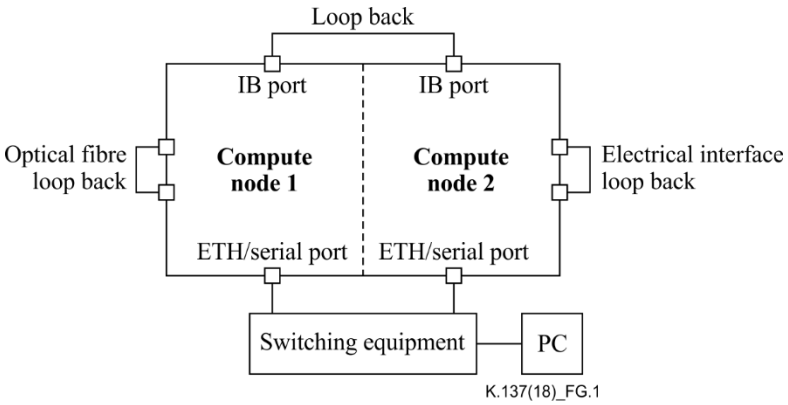


Figure G.1 – Schematic test configuration for server equipment

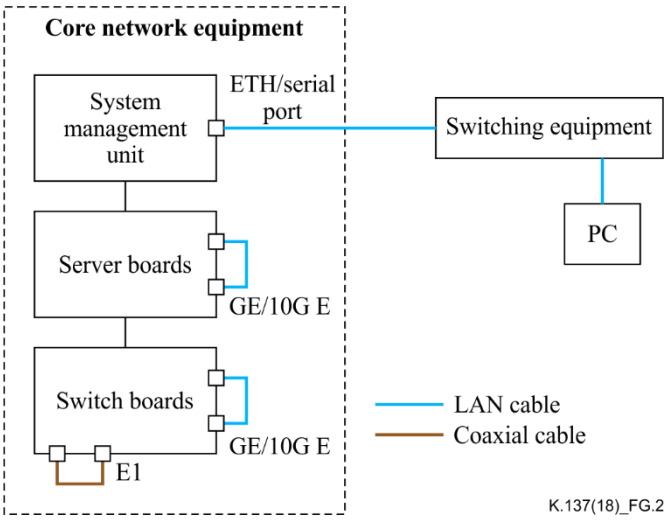


Figure G.2 – Schematic test configuration for core network equipment

G.4 Performance criteria

Where the particular performance criteria of the interface is not stated in the clause, then the general performance criteria should apply.

G.4.1 Serial advanced technology attachment (SATA)/serial attached SCSI (SAS)/small computer system interface (SCSI), PCI-e, IB interface

G.4.1.1 Performance criterion A (continuous phenomena)

The apparatus should continue to operate as intended; no read and write bandwidth descend, transmission delay or bit error is allowed below a performance level specified by the manufacturer as intended during the test. All ports should be monitored throughout the test period.

G.4.1.2 Performance criterion B (transient phenomena)

The apparatus should continue to operate as intended after the test. No change of actual operating state or stored data is allowed. All ports should be monitored throughout the test period.

G.4.1.3 Performance criterion C (interruptions)

The general performance criterion C should apply.

G.4.2 Service and maintenance interfaces

The functional performance of ports of this type is not intended to be permanently connected and therefore is not subjected to immunity testing and should be verified according to the manufacturer's specification following cessation of the electromagnetic exposure.

Annex H

Test guide for switching equipment

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

H.1 Test configuration

For network switching equipment, two separate processes are monitored simultaneously; see Figure H.1. The first is the continuous process of establishing and clearing connections and the second is the stable situation of monitoring signal quality during testing. It is to be considered that at least a part of the set-up for both processes covers the full signal path from subscriber to the network. The signal loop at the network end can either be established by test equipment or by a simple cable loop. In the latter case the simulation of normal grounding and connection practice is required.

The test equipment may be digital or analogue signal analyser as required. The test equipment may also loop back the test signal.

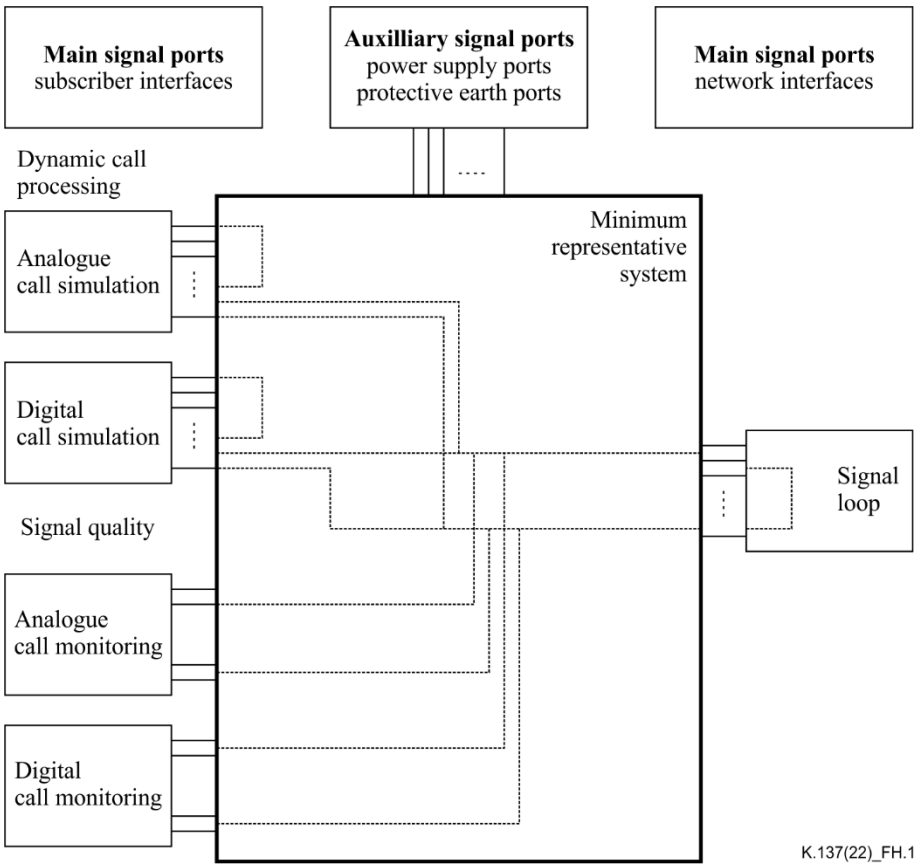


Figure H.1 – Schematic test configuration, switching equipment (reference [ETSI EN 300 386])

If possible, cable harnesses shall be separated, and the cables tested individually.

For base station controller and radio network controller equipment it is not necessary to exercise the continuous process of establishing and clearing connections; a representative configuration with end-to-end system functionality employing either a core network and base station or core network and base station simulators may be tested.

H.2 Operational conditions

For switching equipment with less than 32 subscriber lines (analogue or digital), all the lines shall be driven. For switching equipment with more than 32 subscriber lines (analogue or digital), a choice of at least 32 lines shall be made among the available lines. In this case, as it is impossible to do tests at all ports, single ports of each type shall be selected for the testing. At least one port of each type shall be tested.

The ports shall be configured with their nominal impedance for a connection to another port. Auxiliary equipment or loopback may be used to simulate the functional termination of the ports.

Connections have to be provided which shall be established before the start of the tests and then maintained.

H.3 Specific immunity performance criteria

H.3.1 General

For the switching equipment the following main signal ports are recognized:

- Analogue ports (e.g., analogue subscribers' lines, analogue interfaces to transmission equipment);
- Digital ports (e.g., digital subscribers' lines (ISDN), digital connections to transmission equipment).

The interfaces shall operate as described in the following clauses.

H.3.2 Digital port performance criteria

H.3.2.1 Performance criterion A (continuous phenomena)

During the sweep:

- The established connections shall be maintained throughout testing and the transfer of information shall be within the limits of the manufacturer's specification;
- Loss of frame alignment or loss of synchronization is not allowed during each individual exposure (if applicable).

H.3.2.2 Performance criterion B (transient phenomena)

The established connections shall be maintained throughout testing except in the case of surge immunity testing at 1 kV where disconnection is allowed on the port being tested:

- It shall be possible to establish a connection between two ports after the end of the transient disturbances;
- It shall be possible to clear a connection in a controlled manner after the end of the transient disturbances.

H.3.2.3 Performance criterion C (interruptions)

The general performance criterion C applies.

H.3.3 Analogue port performance criteria

H.3.3.1 Performance criterion A (continuous phenomena)

During the sweep:

- The established connections shall be maintained throughout testing;
- The noise level at a two-wire analogue interface shall be less than −40 dBm at 600 Ω (ignoring the nominal impedance of the port for practical reasons) if not otherwise stated by

the manufacturer. The measurement shall be done selectively with a bandwidth ≤ 100 Hz at 1 kHz;

- Dialling tones shall be available (if applicable).

H.3.3.2 Performance criterion B (transient phenomena)

Established connections shall be maintained throughout testing except in the case of surge immunity testing at 1 kV where disconnection is allowed on the port being tested:

- It shall be possible to establish a connection between two ports after the end of the transient disturbances;
- It shall be possible to clear a connection in a controlled manner after the end of the transient disturbances.

H.3.3.3 Performance criterion C (interruptions)

The general performance criterion C applies.

Annex I

Test guide for PoE port

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

I.1 Introduction

This annex applies to power sourcing equipment (PSE) and powered device (PD) equipment as given in [b-IEEE 802.3af] or [b-IEEE 802.3at] as well as similar equipment providing DC voltage up to 60 V DC. over symmetrical pairs for communication.

PoE equipment can be classified as a PSE or a powered equipment.

This annex also focuses on providing additional guidance for emission and immunity measurements on a PoE port of equipment, especially for the PSE equipment supporting multiple PoE ports.

The guide includes:

– How to exercise the ports to maximize the radiation;

– How to reduce the influence from the auxiliary equipment;

– Monitoring of DC power supply and Ethernet communication performance during immunity test;

– Special coupling and decoupling networks used to facilitate the surge test, considering DC power supply overlapping with the Ethernet signal;

– Loading conditions when performing AC DIP test.

I.2 Operational conditions

The general operational conditions in clause 8.1 should apply.

For a PSE, as many as possible of the PoE ports should be driven or loaded during measurement. The rated output power of the PoE port or a typical load should be configured.

The PoE port of a PSE equipment should be assessed both in powering and in unpowering state for the surge immunity test and should be assessed only in the powering state for conducted immunity test items other than the surge test.

PD should be evaluated in a powered state.

I.3 Test configurations

The general test configurations in clause 8.2 should apply.

The test configuration is recommended as shown in Figure I.1. The oscilloscope is not necessary for the EMI test. The PSE termination equipment may be a PD matrix or a simulator, which provides functions including:

– A splitter of DC power and Ethernet;

– Power dissipation of DC supply through on-board resistive loads;

– Interface for monitoring the supply voltage by using an external oscilloscope or similar instrument;

– RJ45 interface for monitoring the performance of Ethernet by external loopback.

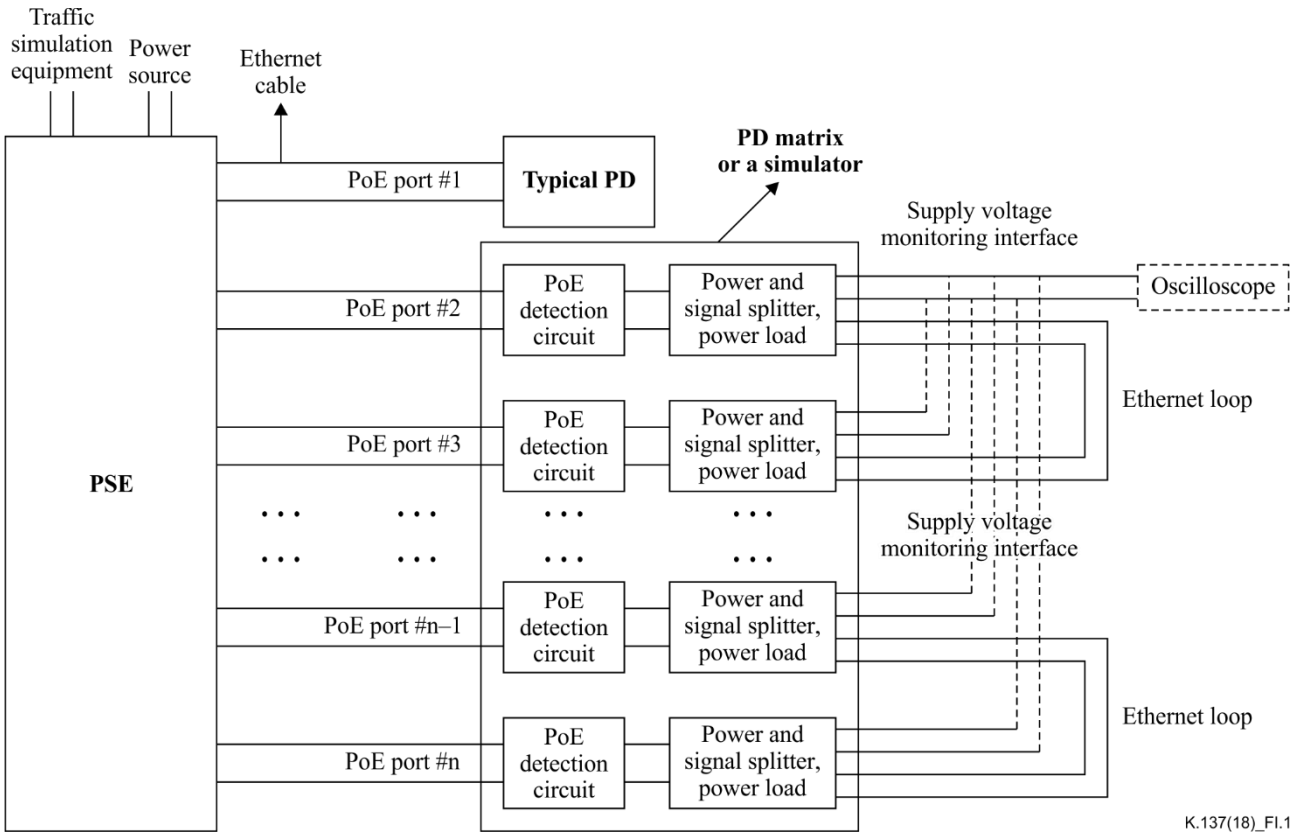


Figure I.1 – Test configuration example for PoE EMC testing

I.4 Test methods

I.4.1 Emission test method

The measurement instruments, test site and test method should follow the requirements of [IEC CISPR32].

The PoE port should be taken as a wired-network port to perform conducted emission measurement, ISN is recommended to be inserted between the PSE and the PD provided that it can withstand the operating voltage and current of the PoE.

Using a PD matrix to drive PSE supporting multi-PoE ports is recommended for radiated emission measurement. However, in some extreme cases, the cable bundle may be so large that exiting the chamber is not easy; a dummy load which integrates the functions of a PD matrix and has a compact volume, as illustrated in Figure I.1, may be a good substitute.

I.4.2 Immunity test method

The PoE port should be considered a signal line port to conduct the immunity test. However, since the differential mode surge between the DC supply pair may be present due to non-concurrent operation of the common mode protection components at the PoE port, it is necessary to perform the differential mode surge test.

The equipment grounding and test configuration should be consistent with the actual application. For PSE equipment with multi-PoE ports, a sufficient number of ports should be selected for testing.

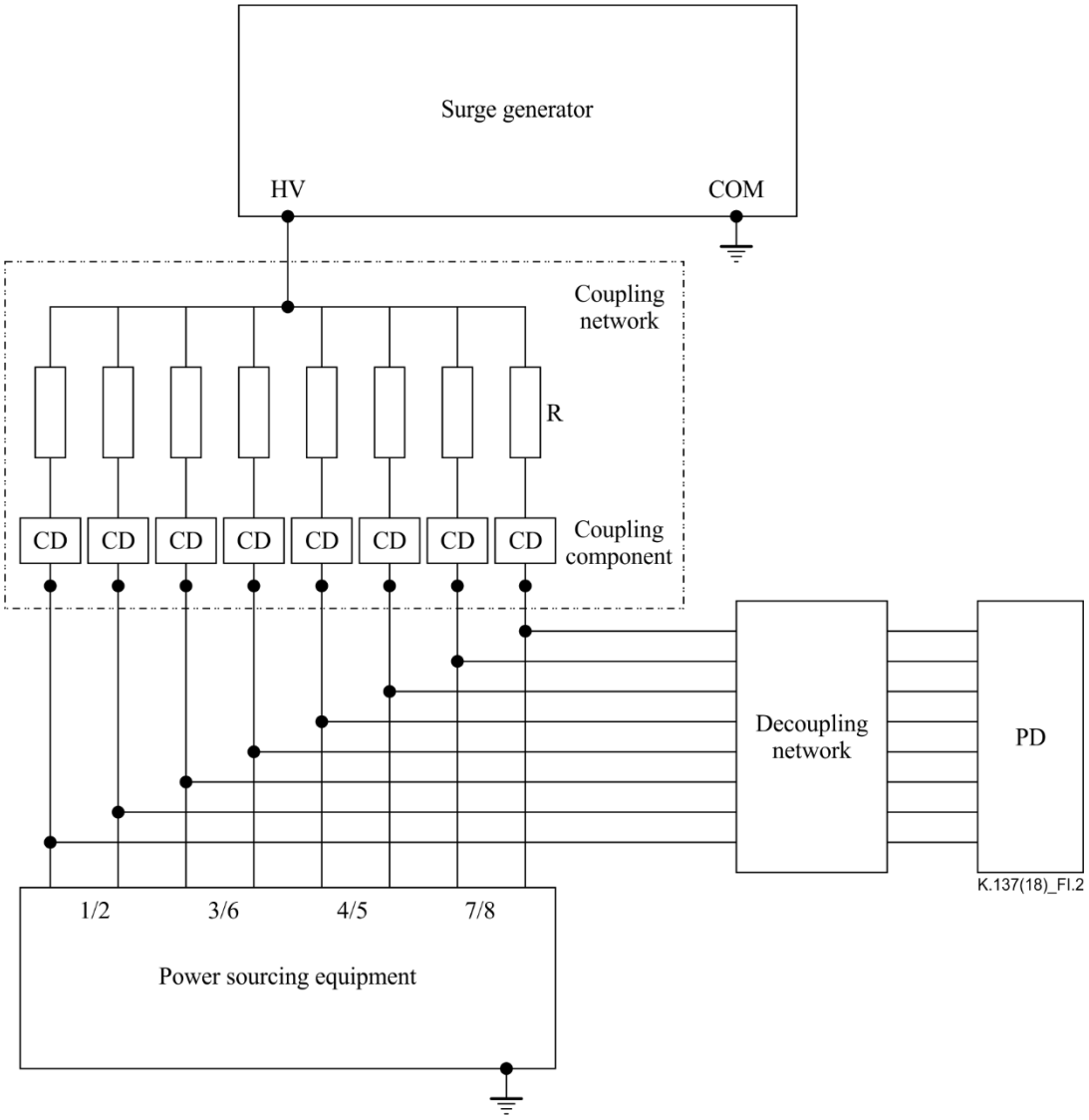
For surge testing of a PoE port in an un-powering state, the PoE port can be directly connected to the surge generator without using a coupling and decoupling network. For surge testing of a PoE port in the powering state, the PoE port should be connected to the surge generator using a suitable coupling and decoupling network. Decoupling network performance should be good enough to not affect test

results. Test methods for shielded PoE cables should be performed in accordance with section 7.6 of [IEC 61000-4-5].

Unshielded PoE ports should be tested for both line-to-line and line-to-ground coupling modes, defined as follows:

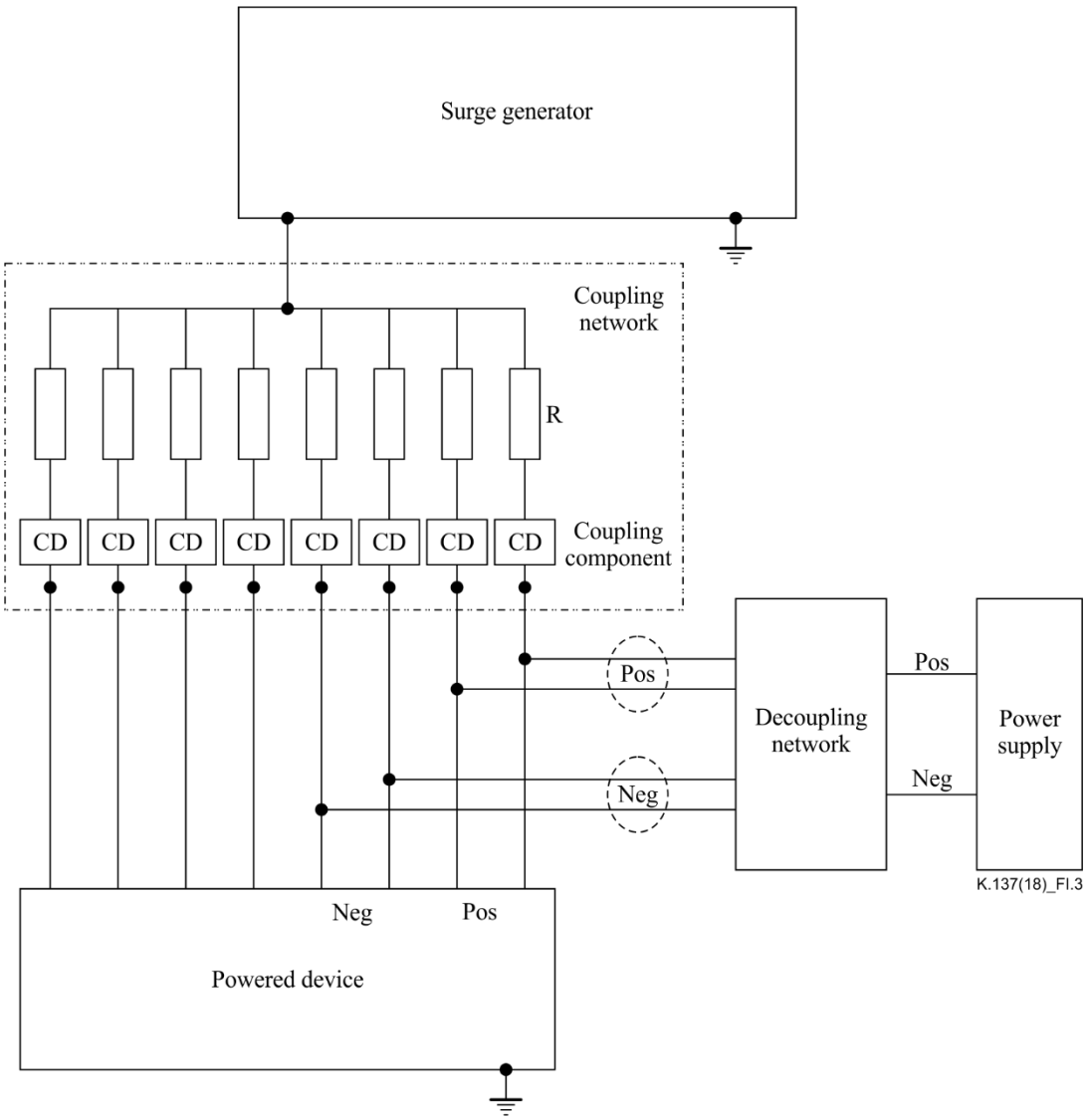
– Line-to-ground coupling all 8 lines to ground simultaneously; the test setups for PSE and PD are given in Figures I.2 and I.3, respectively.

– Line-to-line coupling tests should be performed between the powering pairs, for example 1/2 to 3/6, or 4/5 to 7/8, and the test setups for PSE and PD are given in Figures I.4 and I.5, respectively.



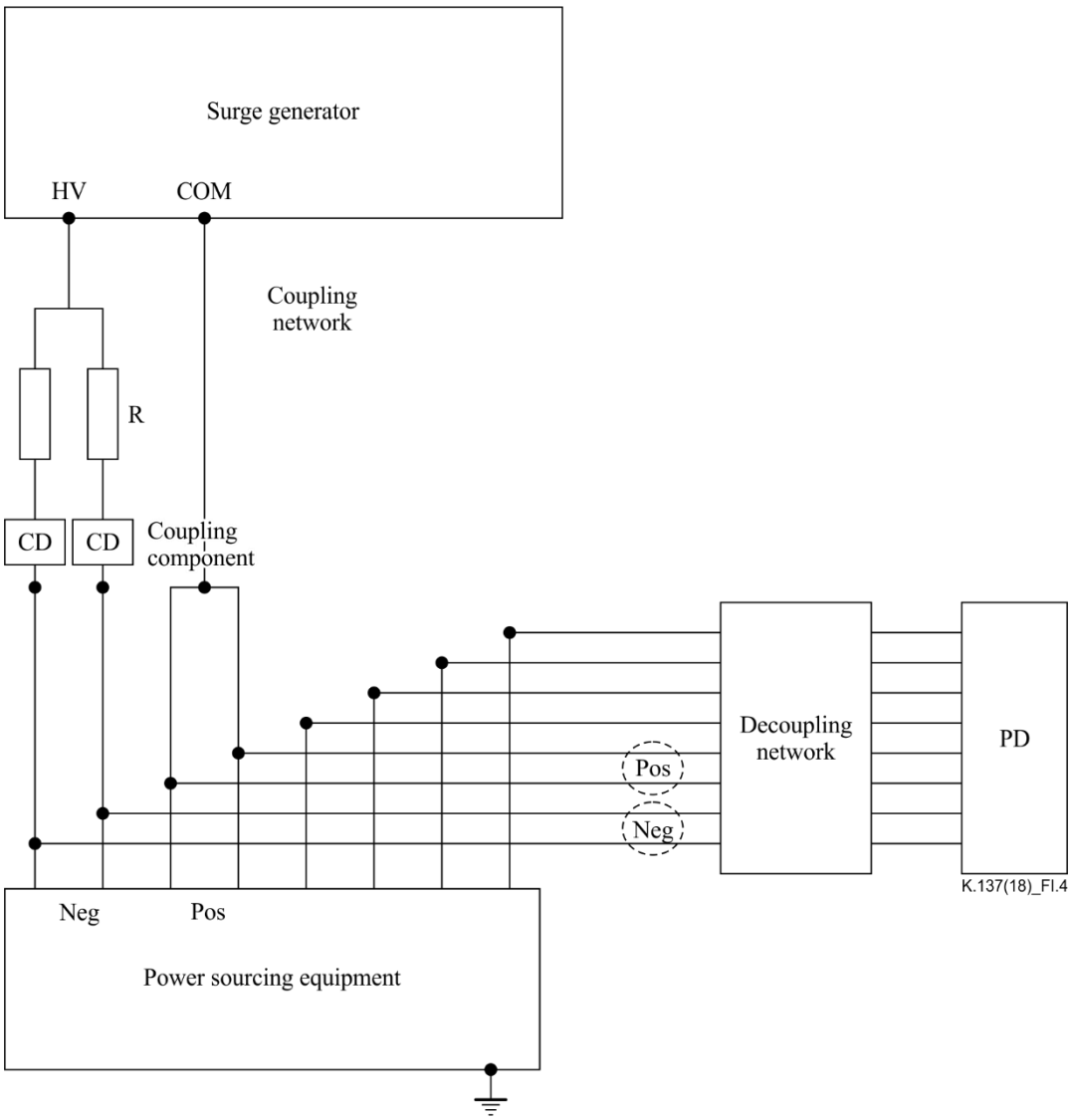
NOTE 1 – For each coupling network, R should not exceed 320 Ω with indoor cable and should be 25 Ω with outdoor cables.
NOTE 2 – Coupling and decoupling network for power lines in [IEC 61000-4-5] should be used.

Figure I.2 – Line-to-ground coupling test configuration for PoE of PSE



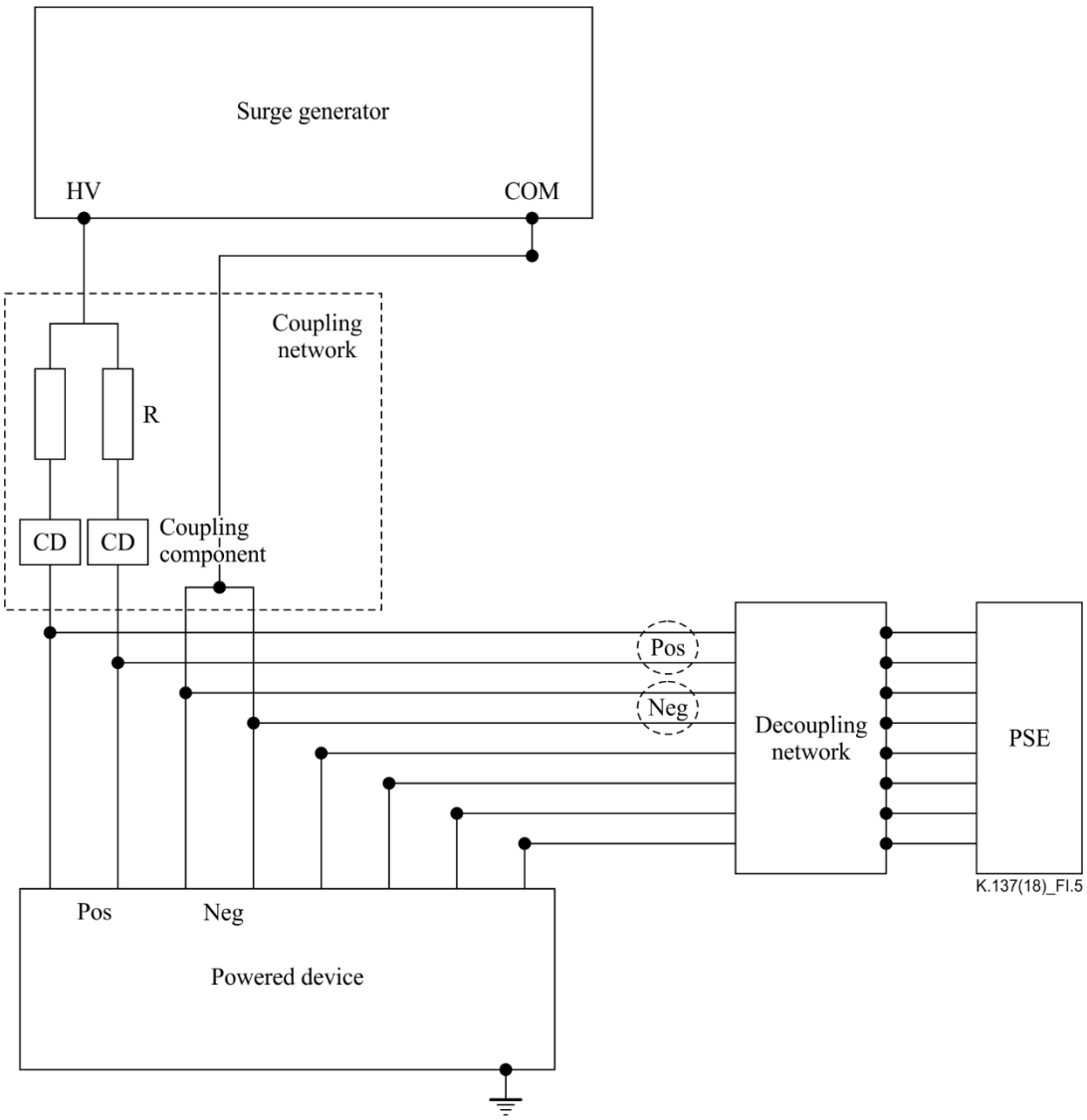
NOTE 1 – For each coupling network, R should not exceed 320 Ω with indoor cable and should be 25 Ω with outdoor cables.
NOTE 2 – Coupling and decoupling network for power lines in [IEC 61000-4-5] should be used.

Figure I.3 – Line-to-ground coupling test configuration for PoE of powered device



NOTE 1 – For each coupling network, R should be 80 Ω with indoor cable and 25 Ω with outdoor cables.
NOTE 2 – Coupling and decoupling network for power lines in [IEC 61000-4-5] should be used.

Figure I.4 – Line-to-line coupling test configuration for PoE of PSE



NOTE 1 – For each coupling network, R should be 80 Ω with indoor cable and 25 Ω with outdoor cables.
NOTE 2 – Coupling and decoupling network for power lines in [IEC 61000-4-5] should be used.

Figure I.5 – Line-to-line coupling test configuration for PoE of powered device

I.5 Performance criteria

When performing a surge test to a PoE port with PoE not supplying the power, the performance should be checked after the test. While performing a surge test to a PoE port with PoE supplying the power, the performance should be checked both during and after the test.

The following specifies the criterion A and criterion B requirements for PoE, and for criterion C the general criterion in clause 10.1 applies.

I.5.1 Performance criterion A (continuous phenomena)

The supply voltage of PSE equipment should be monitored at the input interface of a PD and should be in the range 37–57 V DC as specified by [b-IEEE 802.3af] or [b-IEEE 802.3at] when using a 100 m cable or line simulator. If other line simulators are used, the voltage requirement should be adjusted linearly according to the line resistance and DC current.

No bit error or package loss should occur for PD Ethernet port.

I.5.2 Performance criterion B (transient phenomena)

The application of the test should not cause the system to lose the established connection or reset. At the cessation of the test, the port should continue to function in the state established prior to the application of the test, without user intervention.

The above performance criteria do not apply to surge testing. During a surge test, the voltage of the PoE port should not be interrupted. At the cessation of the test the port should continue to function in the state established prior to the application of the test, without user intervention.

I.5.3 Performance criterion C (interruptions)

The general performance criterion C applies.

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Printed in Switzerland
Geneva, 2022