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**Electromagnetic compatibility requirements and
measurement methods for wireline
telecommunication network equipment**

Recommendation ITU-T K.137

ITU-T

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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, 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 and power supply equipment (including high-voltage direct current (HVDC)).

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

History

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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 having a rated root mean square (r.m.s.) 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.

Wireline telecommunication network equipment with radio functions are not in the scope of this Recommendation. [ITU-T K.136] applies to equipment with radio functions.

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 and power supply equipment (including high-voltage direct current (HVDC)).

This Recommendation describes the specific immunity testing levels, performance criteria as well as limits of emission testing to be applied to wireline network telecommunication in various environments.

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.

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|---------------|---|
| [ITU-T G.783] | Recommendation ITU-T G.783 (2006), <i>Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks.</i> |
| [ITU-T G.798] | Recommendation ITU-T G.798 (2017), <i>Characteristics of optical transport network hierarchy equipment functional blocks.</i> |
| [ITU-T G.812] | Recommendation ITU-T G.812 (2004), <i>Timing requirements of slave clocks suitable for use as node clocks in synchronization networks.</i> |
| [ITU-T G.813] | Recommendation ITU-T G.813 (2003), <i>Timing characteristics of SDH equipment slave clocks (SEC).</i> |
| [ITU-T K.27] | Recommendation ITU-T K.27 (2015), <i>Bonding configurations and earthing inside a telecommunication building.</i> |
| [ITU-T K.34] | Recommendation ITU-T K.34 (2003), <i>Classification of electromagnetic environmental conditions for telecommunication equipment – Basic EMC Recommendation.</i> |
| [ITU-T K.38] | Recommendation ITU-T K.38 (1996), <i>Radiated emission test procedure for physically large systems.</i> |

[ITU-T K.136]	Recommendation ITU-T K.136 (2018), <i>Electromagnetic compatibility requirements for radio telecommunication equipment</i> .
[ITU-T O.150]	Recommendation ITU-T O.150 (1996), <i>General requirements for instrumentation for performance measurements on digital transmission equipment</i> .
[IEC CISPR 16-1-2]	IEC CISPR 16-1-2 (2014), A1 (2017), <i>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</i> .
[IEC CISPR 16-1-4]	IEC CISPR 16-1-4 (2019), <i>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</i> .
[IEC CISPR 16-2-1]	IEC CISPR 16-2-1 (2014), A1 (2017), <i>Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements</i> .
[IEC CISPR 16-2-3]	IEC CISPR 16-2-3 (2016), <i>Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements</i> .
[IEC CISPR 32]	IEC CISPR 32 (2015), <i>Electromagnetic compatibility of multimedia equipment – Emission requirements</i> .
[IEC 61000-3-2]	IEC 61000-3-2 (2018), <i>Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)</i> .
[IEC 61000-3-3]	IEC 61000-3-3 (2013), A1 (2017), <i>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</i> .
[IEC 61000-3-11]	IEC 61000-3-11 (2017), <i>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</i> .
[IEC 61000-3-12]	IEC 61000-3-12 (2011), <i>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</i> .
[IEC 61000-4-2]	IEC 61000-4-2 (2008), <i>Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test</i> .
[IEC 61000-4-3]	IEC 61000-4-3 (2010), <i>Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test</i> .
[IEC 61000-4-4]	IEC 61000-4-4 (2012), <i>Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test</i> .

- [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 (2004), A1 (2017), *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests.*
- [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), *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase.*
- [ISO/IEC 17025] ISO/IEC 17025 (2017), *General requirements for the competence of testing and calibration laboratories.*
- [ISO/IEC/IEEE 8802-3] ISO/IEC/IEEE 8802-3:2017, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 AC mains power port [IEC CISPR 32]: 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 DC network power port [IEC CISPR 32]: 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.

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

3.1.4 electromagnetic emission [b-IEC 60050-161]: The phenomenon by which electromagnetic energy emanates from a source.

3.1.5 electromagnetic interference (EMI) [b-IEC 60050-161]: Degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance.

3.1.6 enclosure port [IEC CISPR 32]: Physical boundary of the EUT through which electromagnetic fields may emanate or on which they may impinge.

3.1.7 equipment under test EUT [IEC CISPR 16-2-3]: The equipment (devices, appliances and systems) subjected to EMC (emission) compliance (conformity assessment) tests.

3.1.8 immunity (to a disturbance) [b-IEC 60050-161]: The ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance.

3.1.9 outside environment [b-ITU-T K.114]: An environment where equipment is exposed to the atmosphere and is more abominable than the customer premises environment, including but not limited to:

- facility on the street side;
- facility on the roof of buildings;
- facility on the outside wall of buildings;
- facility on the pole, etc;
- facility on the towers.

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

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.

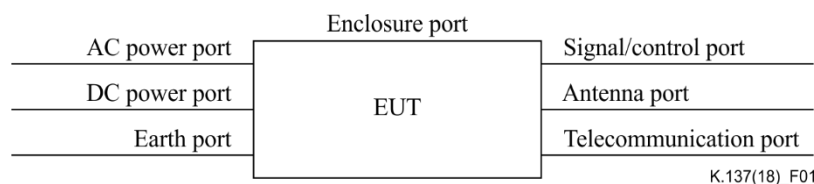


Figure 1 – port

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

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

3.2.2 customer premises environment: A facility in a residential building, where there is no guarantee of good protection, earthing and bonding, and this environment is more abominable than the telecommunication centre, including but not limited to:

- facility in the corridor;
- facility in the weak power wells;
- facility in the distribution room;
- facility in the basement, etc.;
- facility in the lobby of buildings.

3.2.3 telecommunication centre environment: A facility which is managed and operated exclusively by a telecom operator or other business entities. This environment is dedicated for

network equipment and is more normative than the customer premises, and the outside environment is sufficient to guarantee good protection, earthing and bonding, including but not limited to:

- facility in the centre office;
- facility in the data centre.

3.2.4 telecommunication port: Telecommunication port or network port is a point of connection for voice, data and signalling transfers intended to interconnect widely distributed systems via such means as direct connection to multi-user 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
BMC	Baseboard Management Controller
CDN	Coupling and Decoupling Network
CO	Central Office
CPU	Central Processing Unit
DC	Direct Current
DSL	Digital Subscriber Line
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
EUT	Equipment Under Test
FAR	Full Anechoic Room
FC	Fiber Channel
FE	Fast Ethernet
FPGA	Field Programmable Gate Array
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	Multi-Service 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
r.m.s	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
SIR	Signal to Interference Ratio
SPL	Sound Pressure Level
TDM	Time Division Multiplexing
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 their 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 showed in Tables A.1 and A.2 are recommended for equipment in telecommunication centres, customer premises and outside plants.

[ITU-T K.38] should be applied to large equipment tests.

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
$F_x \leq 108 \text{ MHz}$	1 GHz
$108 \text{ MHz} < F_x \leq 500 \text{ MHz}$	2 GHz
$500 \text{ MHz} < F_x \leq 1 \text{ GHz}$	5 GHz
$F_x > 1 \text{ GHz}$	$5 \times F_x$ 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 taken using the artificial mains network (AMN) according to [IEC CISPR 16-1-2] at each port.

If the DC power cable is not connected to a local DC power network, or the length of the cable does not exceed 30 m when connected to a local battery or a dedicated power equipment, the conducted emission measurements may be exempted.

Conducted emission measurements from wired-network ports should be taken using impedance stabilization networks (ISNs), if available, as detailed in Annex C 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 HVDC power port should be taken in the same way as a DC power port using AMN during the measurement. The AMN should be used 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 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 according to [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, output ports and on all signal ports to which cables are permanently connected in usual use. For a single 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 multi-pair 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 multi-pair cables, conducted immunity tests where multi-pair 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, or current clamp/electromagnetic (EM) clamp method could be used for multi-pair cables according to [IEC 61000-4-6].

When performing a surge test to 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 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 preferred, the enhanced level requirements in Tables B.1, B.2 and B.3 could be selected. The levels do not, however, cover extreme phenomena which may occur at any environmental location but with a low probability of occurrence. In special cases, situations may arise where the levels of disturbance may exceed the immunity test levels specified in Tables B.1, B.2 and B.3. In these conditions, special mitigation measures or protection may have to be implemented.

7.2.2 Immunity for equipment with a special port

The PoE port should be tested in accordance with Annex I.

8 Test conditions

8.1 Operational condition

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 that of a normal installation.

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

The environmental parameters (temperature, humidity and atmospheric pressure) should be limited to the installation 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, 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.

For the telecommunication centre, typical facilities inside and characteristics of environment are as follows:

- the internal electrical power distribution is a 48 V DC or high-voltage DC source, e.g., 240V/380V nominal and a 220V/230V/400V, or 127V/220V or 100 V AC nominal 50 Hz or 60 Hz;
- it is assumed that switching of loads on the DC supply seldom occurs and, therefore, has not been taken into account;
- battery backup is available at 48 V DC port;
- it is assumed that there is no separation between DC power cables and signal cables, while internal AC power cables are kept separate at some distance to DC power cables and signal cables in order to reduce mutual coupling. Normal practice is to use grounded, metallic cable supports;

- a dedicated earthing and bonding network is implemented according to [ITU-T K.27]. Also, the AC power distribution inside the building is in accordance with the requirements of [ITU-T K.34].

Some electrostatic discharge (ESD) preventive measures are either incorporated in the building installation (e.g., charge dissipating floors or control of the relative humidity) or through guidelines for handling and operation of the equipment (e.g., use of wrist-straps, charge-dissipating shoes).

Some distance to high-power broadcast or mobile communication transmitters is assumed. In cases where radio communication transmitters are present at the premises, it is assumed that special precautions are taken to prevent exposure of the emitted field. The use of mobile radio equipment such as cell phone, indoor radio distribution system, access point and others are assumed in telecommunication centres. The telecommunication operator or other business entities cannot control the external radio-frequency environment.

8.2 Test configuration

The EUT should be configured to the maximum of its emission (worst case) and at the minimum of its immunity based on a representative configuration of real applications when use 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 multi-type 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 assess one typical port;
- where there are ports of the same type on different card or module types, then it is acceptable to assess one typical port on each card or module types.

The test report should identify the ports assessed.

8.3 Test conditions for equipment with a special port

Test conditions for 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 Annex D to Annex 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), or packet loss rate (PLR), or throughput, or time-delay, or 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 criterion

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 Annex D through Annex 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, if any deviation, justification to be made in the test report;
- response of the EUT to the specified test level during immunity test and the conclusion 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.