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Electromagnetic compatibility requirements and measurement methods for digital cellular mobile communication base station equipment

Recommendation ITU-T K.114

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Electromagnetic compatibility requirements and measurement methods for digital cellular mobile communication base station equipment

Summary

Recommendation ITU-T K.114 specifies the electromagnetic compatibility common requirements and test methods for digital cellular mobile communication base station (BS) equipment, repeaters and associated ancillary equipment that are independent of any kind of wireless access technologies, such as second, third, fourth or fifth generation.

Test conditions for BSs used in variety modality are described, e.g., macro BS, distributed BS, micro BS, pico BS, integral antenna BS, active antenna BS and over the air active antenna BS. Performance criteria for immunity tests are also specified.

Recommendation ITU-T K.114 describes the specific testing levels to be applied to radio communication BSs in various environments, e.g., telecommunication centres, customer premises and outside plants.

History

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Electromagnetic compatibility requirements and measurement methods for digital cellular mobile communication base station equipment

1 Scope

This Recommendation specifies the electromagnetic compatibility (EMC) common requirements and test methods for digital cellular mobile communication base station (BS) equipment, repeaters and associated ancillary equipment which are independent of any kind of wireless access technologies, such as second, third, fourth or fifth generation.

Test conditions for BSs used in variety modality are described, e.g., macro BS, distributed BS, micro BS, pico BS, integral antenna BS, active antenna BS and over the air (OTA) active antenna BS; performance criteria for immunity tests are also specified.

This Recommendation describes the specific testing levels to be applied to radio communication BSs in different environments, such as telecommunication centres, customer premises and outside plants.

Technical specifications relating to unwanted emissions (including spurious emissions and out-of-band emissions) from the enclosure port of radio equipment or from combinations of radio and associated ancillary equipment lie outside the scope of this Recommendation. Such technical specifications are found in [ITU-R SM.329-12].

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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3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 antenna array [ETSI EN 301 489-50]: Group of radiating elements characterized by the geometry and the properties of the array elements.

3.1.2 downlink [ETSI EN 301 489-50]: Unidirectional radio link for the transmission of signals from a UTRAN access point to a UE.

3.1.3 electromagnetic disturbance [b-IEC 60050-161]: Electromagnetic phenomenon that can 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]: Phenomenon by which electromagnetic energy emanates from a source.

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

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

3.1.7 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.

3.1.8 necessary bandwidth [ITU-R SM.329-12]: For a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

3.1.9 NB-IoT guard band operation [ETSI EN 301 489-50]: Operation of NB-IoT guard band utilizing the unused resource block(s) within an E-UTRA carrier's guard-band.

3.1.10 NB-IoT in-band operation [ETSI EN 301 489-50]: Operation of NB-IoT in-band utilizing the resource block(s) within a normal E-UTRA carrier.

3.1.11 NB-IoT standalone operation [ETSI EN 301 489-50]: Operation of NB-IoT standalone utilizing its own spectrum, for example the spectrum currently being used by GERAN systems as a replacement of one or more GSM carriers, as well as scattered spectrum for potential IoT deployment.

3.1.12 operating band [ETSI EN 301 489-50]: Frequency range in which a wireless service operates (paired or unpaired), that is defined with a specific set of technical requirements.

3.1.13 out-of-band emission [ITU-R SM.329-12]: Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

3.1.14 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).

3.1.15 radio configuration (RC) [ETSI EN 301 489-50]: Set of forward traffic channel and reverse traffic channel transmission formats that are characterized by physical layer parameters such as transmission rates, modulation characteristics, and spreading rate.

3.1.16 spurious emission [ITU-R SM.329-12]: Emission on a frequency, or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

3.1.17 TAB port [ETSI EN 301 489-50]: Conducted interface between the transceiver unit array and the composite antenna.

3.1.18 telecommunication centre [ITU-T K.34]: 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.

3.1.19 telecommunications port [b-IEC CISPR 22]: Point of connection for voice, data and signalling transfers intended to interconnect widely-dispersed systems via such means as direct connection to multi-user telecommunications networks (e.g., public switched telecommunications networks (PSTN) integrated services digital networks (ISDN), x-type digital subscriber lines (xDSL)), local area networks (e.g., Ethernet, Token Ring) and similar networks.

NOTE – A port generally intended for interconnection of components of an ITE system under test (e.g., RS-232, IEEE Standard 1284 (parallel printer), Universal Serial Bus (USB), IEEE Standard 1394 ("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.

3.1.20 unwanted emissions [ITU-R SM.329-12]: Consist of spurious emissions and out-of-band emissions.

3.1.21 uplink [ETSI EN 301 489-50]: Unidirectional radio link for the transmission of signals from a UE to a base station, from a mobile station to a mobile base station or from a mobile base station to a base station.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 active antenna system (AAS): A base station system which combines an active transceiver unit antenna array.

NOTE 1 – See Figure 1.

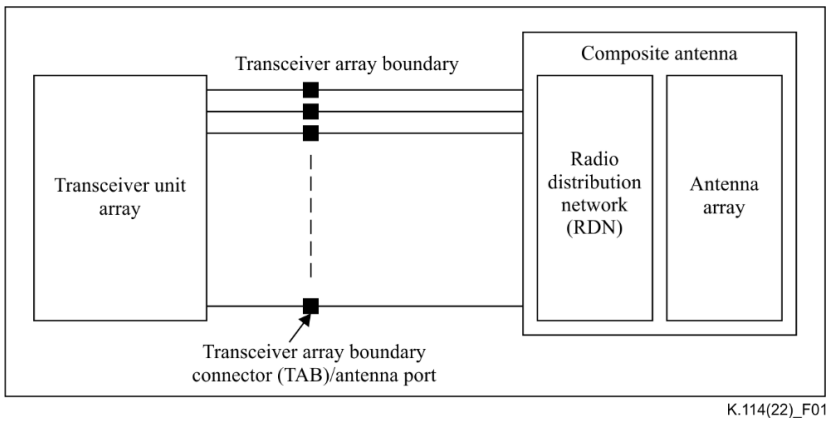


Figure 1 – Radio unit for AAS BS type 1-C or 1-H

NOTE 2 – An AAS may include a remote or radio distributed unit or network.

3.2.2 ancillary equipment: Equipment (modules or apparatus), as the part of main system, used in connection or conjunction with radio receiver or transmitter units to assist the base station (BS) to work normally, or to provide the additional operational features.

NOTE – Ancillary equipment can provide additional operational features, e.g., supervisory control, base band process, backhaul connection, cooling control, antenna sector control. It cannot be functionally independent of a BS. However, it could work stand-alone physically from a transceiver unit of a BS in some scenarios.

3.2.3 base station (BS): A network element in a radio access network, responsible for radio transmission and reception in one or more cells to or from mobile devices.

NOTE 1 – A base station (BS) can have an integrated antenna or be connected to an antenna by feeder cables. A BS is intended for operation at a fixed location and powered directly or indirectly (e.g., via an alternating current/direct current (AC/DC) converter or power supply) by AC mains network, or an extended local DC mains network.

NOTE 2 – See Figures 2 and 3.

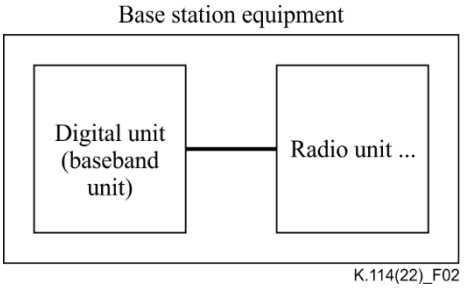


Figure 2 – BS with single enclosure solution

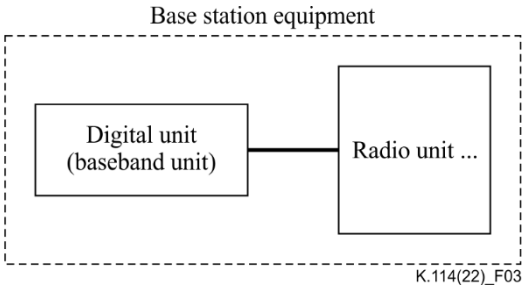


Figure 3 – BS with multiple enclosure solution

3.2.4 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.

3.2.5 distributed base station: A type of base station in which the baseband unit and radio frequency (RF) unit support standalone installation, the baseband unit can be installed in the vicinity of base station or with other network devices centrally, and be connected to the remote RF unit through the fibre.

3.2.6 integral antenna: Antenna which may not be removed during the tests, according to the manufacturer's statement.

3.2.7 integral antenna base station: A type of base station (BS) with an integral antenna that is part of the radio frequency unit. For this type of BS, the antenna port and enclosure ports are equivalent.

3.2.8 intentional radiator: A device that intentionally generates and emits radio frequency energy by radiation or induction to realize its performance or function.

3.2.9 macro base station: A type of base station (BS) in which the power modules, baseband unit and radio frequency (RF) unit are installed in the same cabinet, while the antennas are installed outside of it through RF cables. This type of BS is physically large, can handle high traffic and covers a wide region.

3.2.10 micro base station: A type of base station in which a baseband unit and radio frequency unit are integrated in a box, mainly for coverage of streets, outdoor locations and hot spots that are small in area and have few users.

3.2.11 multi-band base station (MB BS): A type of base station characterized by the ability of its transmitter or receiver to process two or more carriers in common active radio frequency components simultaneously, where at least one carrier is configured at a different non-overlapping operating band to that of the other carrier(s).

3.2.12 multi-standard radio base station (MSR BS): A type of base station characterized by the ability of its receiver and transmitter to process two or more carriers in common active radio frequency (RF) components simultaneously in a declared RF bandwidth, where at least one carrier is of a different radio access technology to the other carrier(s).

NOTE – See Figure 4.

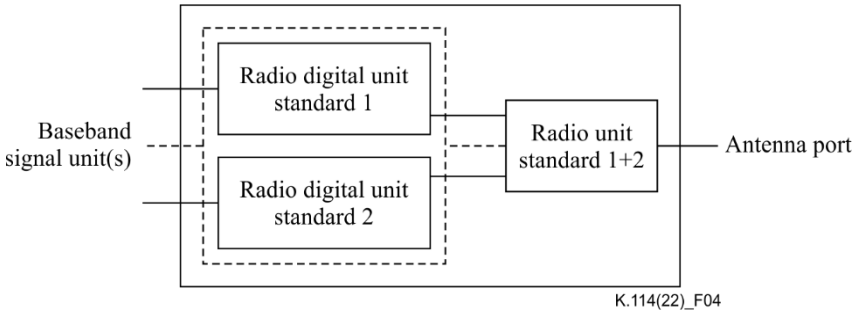


Figure 4 – Multi-standard radio base station

3.2.13 non-integral antenna base station: A type of base station (BS) whose antenna may be removed for the test according to the manufacturer's statement.

NOTE – The antenna is connected to the BS by connector, the waveguide flange, or through a feed device. For this type of BS, antenna port and enclosure ports are separated.

3.2.14 outdoor locations environment: An environment where equipment is exposed to the atmosphere and hosts telecommunication equipment.

NOTE – Examples of this environment: at street sides, on roofs or external sides of buildings, towers and poles.

3.2.15 over the air active antenna system base station (OTA AAS BS): An AAS BS that has ≥8 transceiver units for evolved universal terrestrial radio access (E-UTRA), new radio or multi-standard radio and ≥4 transceiver units for UTRA per cell and has a radiated radio frequency interface only and conforms to the OTA requirements set.

NOTE 1 – OTA ASS BS type1-O is that base station (BS) operating at frequency range 1 (FR1) with a requirement set consisting only of OTA requirements defined at the radiated interface boundary (RIB). OTA ASS BS type 2-O is that BS operating at FR2 with a requirement set consisting only of OTA requirements specified at the RIB.OTA AAS BS has no accessible antenna port.

NOTE 2 – See Figure 5.

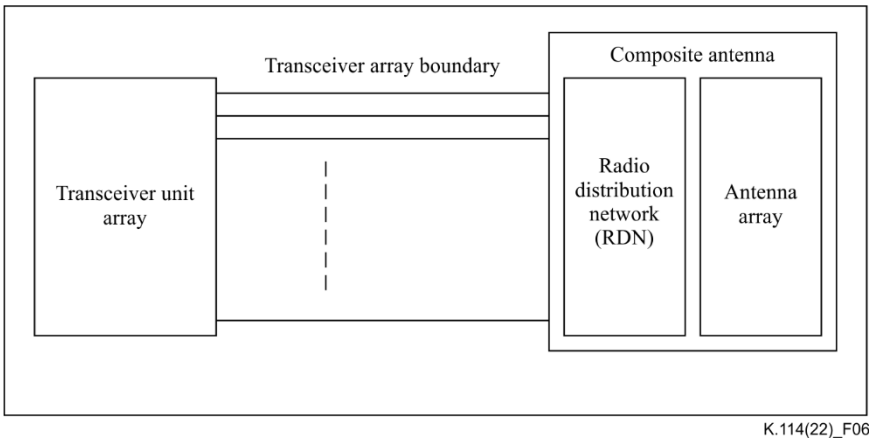


Figure 5 – Radio unit for OTA AAS BS type 1-O or 2-O

3.2.16 pico base station: A derivative of a micro base station; generally, the power source is the mains, the baseband part and the radio frequency part are integrated in a small enclosure, mainly for coverage of indoor areas that are small.

3.2.17 port: Particular interface of the specified equipment with the external electromagnetic environment.

NOTE 1 – 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.

NOTE 2 – See Figure 6.

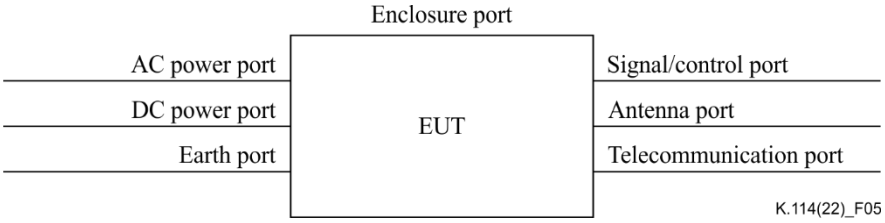


Figure 6 – Port

3.2.18 radio communication equipment: An electrical or electronic product that intentionally emits or receives radio waves for the purpose of radio communication.

NOTE – Radio communications equipment must be completed with an accessory, such as antenna.

3.2.19 repeater: Device with two radio frequency ports, both of which are intended to be connected to antennas, which are capable of receiving, amplifying and transmitting simultaneously.

NOTE – A repeater works in one direction on a signal in a base station system (BSS) transmit band and in the other direction on a signal in the corresponding BSS receive band.

3.2.20 throughput: The number of payload bits successfully received per second for a reference measurement channel under a specified reference condition.

3.2.21 unintentional radiator: A device that intentionally generates radio frequency (RF) energy for use within the device, or that sends RF signals by conduction to associated equipment via connecting wiring, but which emits RF energy by radiation or induction without intention.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAS	Active Antenna System
AC	Alternating Current
AM	Amplitude Modulation
ARFCN	Absolute Radio Frequency Channel Number
BBU	Base Band Unit
BER	Bit Error Ratio
BLER	Block Error Ratio
BS	Base Station
BSS	Base Station System
BSSTE	Base Station System Test Equipment
BTS	Base Transceiver Station
CDMA	Code Division Multiple Access
CDN	Coupling and Decoupling Network
DC	Direct Current
EARFCN	Absolute Radio Frequency Channel Number for E-UTRA carrier
EIRP	Equivalent Isotropically Radiated Power
EMC	Electromagnetic Compatibility
EMF	Electromagnetic Field
EMI	Electromagnetic Interference
EPC	Evolved Packet Core
EUT	Equipment Under Test
E-UTRA	Evolved Universal Terrestrial Radio Access
EVM	Error Vector Magnitude
FDD	Frequency Division Duplex
FE	Fast Ethernet
FER	Frame Error Ratio
FR	Frequency Range
FRC	Fixed Reference Channel
FSOATS	Free Space Open Area Test Site
GERAN	GSM EDGE Radio Access Network

GSM Global System for Mobile

LAA Licence-Assisted Access

MSR Multi-Standard Radio

MB Multi-Band

NB-IoT Narrowband Internet of Things

NR-ARFCN Absolute Radio Frequency Channel Number for an NR carrier

OTA Over The Air

PAMR Public Access Mobile Radio

PC Personal Computer

PD Powered Device

PDSCH Physical Downlink Shared Channel

PoE Power over Ethernet

PSE Power-Sourcing Equipment

PV Photovoltaic

QAM Quadrature Amplitude Modulation

QPSK Quaternary Phase Shift Keying

RAT Radio Access Technology

RC Radio Configuration

RF Radio Frequency

RIB Radiated Interface Boundary

RNC Radio Network Controller

RXQUAL Received Signal Quality

SAC Semi-Anechoic Chamber

sPDSCH short Physical Downlink Shared Channel

TAB Transceiver Array Boundary

TCH/FS Traffic Channel at Full-rate Speech

TDD Time Division Duplex

UE User Equipment

UARFCN Absolute Radio Frequency Channel Number for UTRA carrier

UTRAN Universal Terrestrial Radio Access Network

5 Base station classification

Base station equipment can be classified in several ways. In this Recommendation, the following classifications are used according to:

– application modality: a BS can be classified as macro, distributed, micro, pico or with an integrated antenna;

– number of carriers, a BS can be classified as either single- or multi-carrier;

– number of radio access technologies (RATs) of the transmitter, a BS can be classified as either single-standard radio BS or an MSR;
– number of bands, a BS can be classified as either single-or multi-frequency;
– antenna type, a BS can be classified as either AAS or non-AAS.

6 Test methods and limits

6.1 Emission

6.1.1 Radio frequency emission

The general requirements for test methods according to [IEC CISPR 32] shall be applied; the limits reported 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.

Conducted emissions at power input or output should be measured using the artificial mains network at each port. For output port, the length of cables is over 3 m.

Conducted emissions from telecommunication ports should be measured using impedance stabilization networks, if available, as detailed in Annex C of [IEC CISPR 32].

Radiated emissions from the enclosure and from cables relate to the frequency components that come from unintentional radiators of the BS; this means the emissions are mostly from switching power supply and digital units of the BSS. The digital units include, but are not limited to: clocks, central processing units, data buses, optical modules, field programmable gate array/random access memory/read only memory chips, digital modulation modules. Requirements for radiated emissions are specified in Annex A.

Radiated emissions that are spurious (harmonics, intermodulation, etc.) or out-of-band are called "unwanted" and relate to the frequency components that come from intentional radiator-radio units of the BS and therefore exempted for the limits of this Recommendation. The radio units include, but are not limited to, the: transmitter, receiver, transceiver, power amplifier, RF combiner and RF duplexer. The unwanted emissions shall comply with the requirements of [ITU-R SM.329-12] or corresponding RF performance standards, they lie outside the scope of this Recommendation.

During the electromagnetic disturbance test, the carrier frequency (including the necessary bandwidth) and unwanted emissions (see clause 3.1.20) are exempted from the test results. Usually, the spectrum range of 2.5 times the necessary bandwidth on both sides of the transmitting frequency is used as the boundary of out-of-band emission.

6.1.2 Harmonic

The appropriate requirements of [IEC 61000-3-2] for harmonic current emissions apply to any equipment that lies within 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.

6.1.3 Flicker

The appropriate requirements of [IEC 61000-3-3] for voltage fluctuations and flicker apply for 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 61000-3-11] applies.

6.2 Immunity

For immunity testing, the general test methods in [ITU-T K.43] apply. Test levels for BS equipment are shown in Tables B.1, B.2 and B.3 for different environmental classifications. Radiated immunity tests shall be applied up to 6 GHz considering that high frequency bands, e.g., 3.5 GHz for long-term evolution and 5.8 GHz for wireless fidelity have been used in the mobile system. The test method shall be in accordance with [IEC 61000-4-3].

Conducted immunity tests shall be applied to one port at a time and the tests shall be performed on power input, output ports and on all signal ports to which cables are connected in conventional use. If requested, testing equipment with primary protection installed is permissible. The test conditions should be recorded in the test report. For multi-pair cables where a coupling and decoupling network (CDN) does not exist, the test shall be applied to a single pair using an appropriate CDN, the remaining pairs should be tested indirectly one by one. Alternatively, the current clamp/electromagnetic clamp method could be used for multi-pair cables in accordance with [IEC 61000-4-6].

During the surge test on a power port, the EUT and all signal ports shall comply with the given compliance criteria. For a signal port, the port should be checked against the compliance criteria after the surge test has been applied.

During immunity testing using continuous phenomena, the appropriate exclusion band shall be applied to radio equipment.

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., 240 V/380 V nominal and a 220 V/230 V/400 V, or 127 V/220 V 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 back-up is available at the 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 from DC power cables and signal cables in order to reduce mutual coupling. Normal practice is to use earthed, 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 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. If radio communication transmitters are on the premises, it is assumed that special precautions are taken in order to prevent exposure to the emitted field. The use of mobile radio equipment such as cell phones, indoor radio distribution systems, access points and others are assumed in telecommunication centres. The telecommunication operator cannot control the external RF environment.

6.2.1 Surge for PoE port

The surge test method requirements for a power over Ethernet (PoE) port of the BS shall be executed according to the requirements of this clause.

NOTE – According to Table 33-2 of [IEEE 802.3at], for a PoE port, two conductors such as 1/2, 3/6, 4/5, 7/8 are associated with pairs, and each pair carries the same nominal current in both magnitude and polarity, and the polarity between pairs such as 1/2 and 3/6, or 4/5 and 7/8 are inverse.

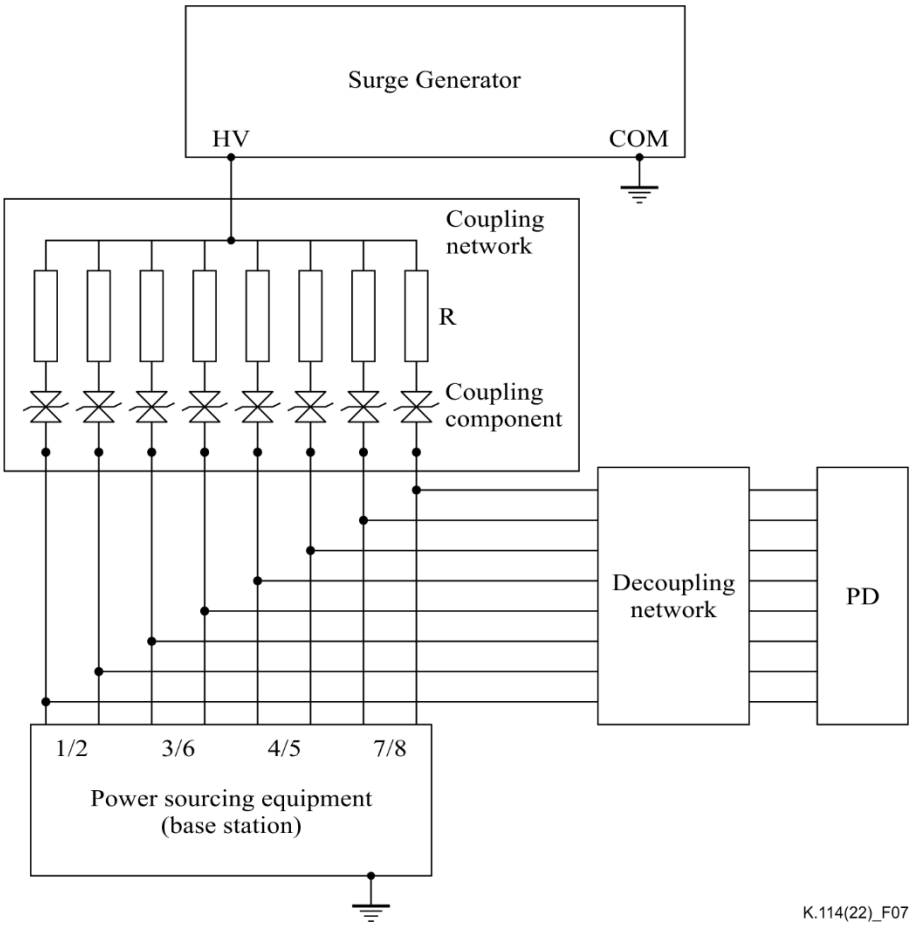
6.2.1.1 Base station – power sourcing equipment

A surge by supplying power shall be applied to the PoE port but not to the powered device (PD). Decoupling network performance shall be good enough not to affect the test results. The equipment earthing should be consistent with the actual application.

Test methods for shielded PoE cables shall be performed in accordance with clause 7.6 of [IEC 61000-4-5]. Test methods for unshielded PoE cables for both line-to-line and line-to-earth coupling are as follows:

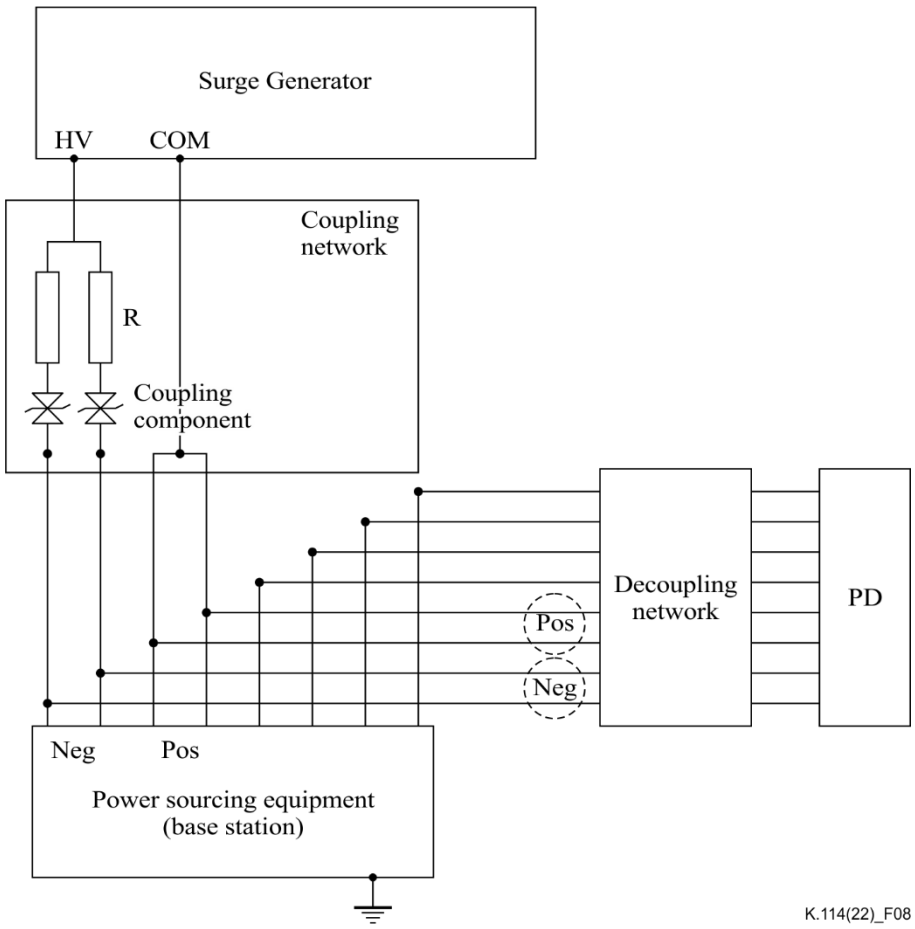
– line-to-earth coupling: All eight lines to the earth simultaneously; the test setup is given in Figure 7.

– line-to-line coupling: Ttests on 1/2 to 3/6, and 4/5 to 7/8, respectively, shall be performed; the test setup is given in Figure 8.



NOTE – For each coupling network, the resistance of resistor R shall not exceed 250 Ω with indoor cables and shall be 25 Ω with outdoor cables.
The CDN for power lines in [IEC 61000-4-5] shall be used.
Tests should be performed again after removing the decoupling network and PD.

Figure 7 – Line-to-earth coupling test configuration for PoE of power sourcing base station



NOTE – For each coupling network, *R* shall be 80 Ω with indoor cable and shall be 25 Ω with outdoor cables.
The CDN for power lines in [IEC 61000-4-5] shall be used.
Tests should be performed again after removing the decoupling network and PD.

Figure 8 – Line-to-line coupling test configuration for PoE of power sourcing base station

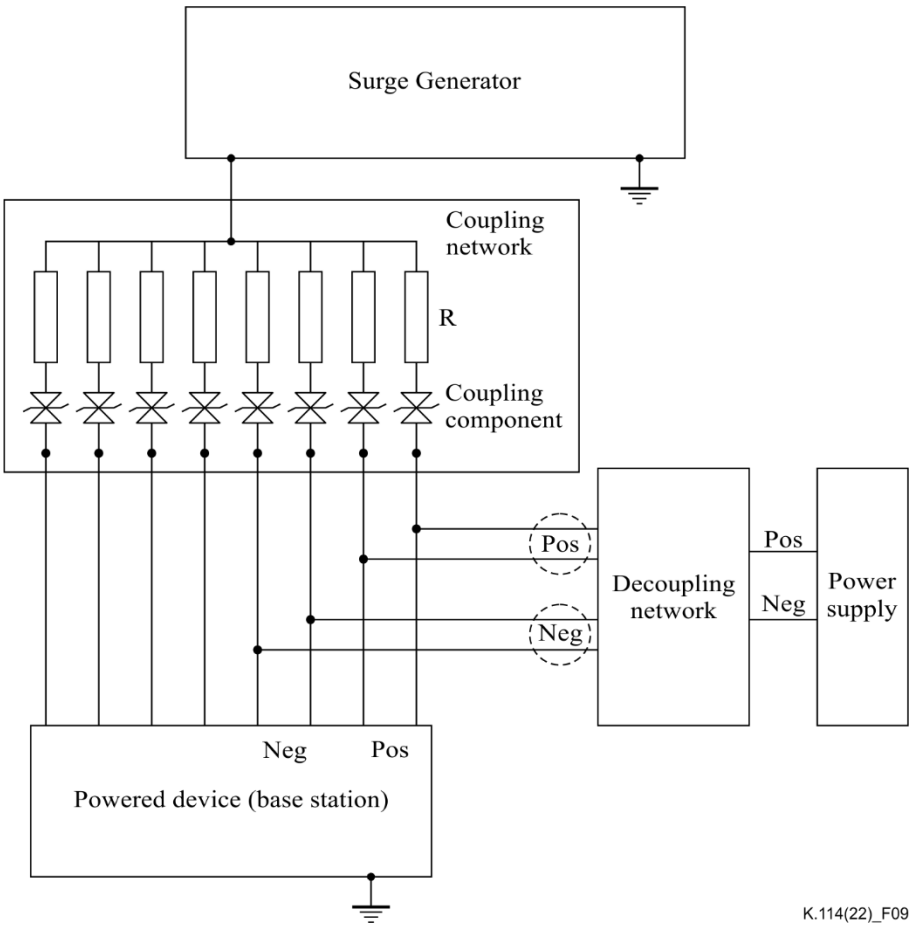
6.2.1.2 Base station – powered device

The BS may be powered either by adapter or by PoE. Surge tests shall be conducted for the following two conditions: PoE powered and PoE powered switch off but powered by adaptor if it is possible. When the powered PoE port is under a surge test, the adapter shall be removed. Decoupling network performance shall be good enough to not affect the test results.

The equipment earthing configuration and connection shall be consistent with the real application.

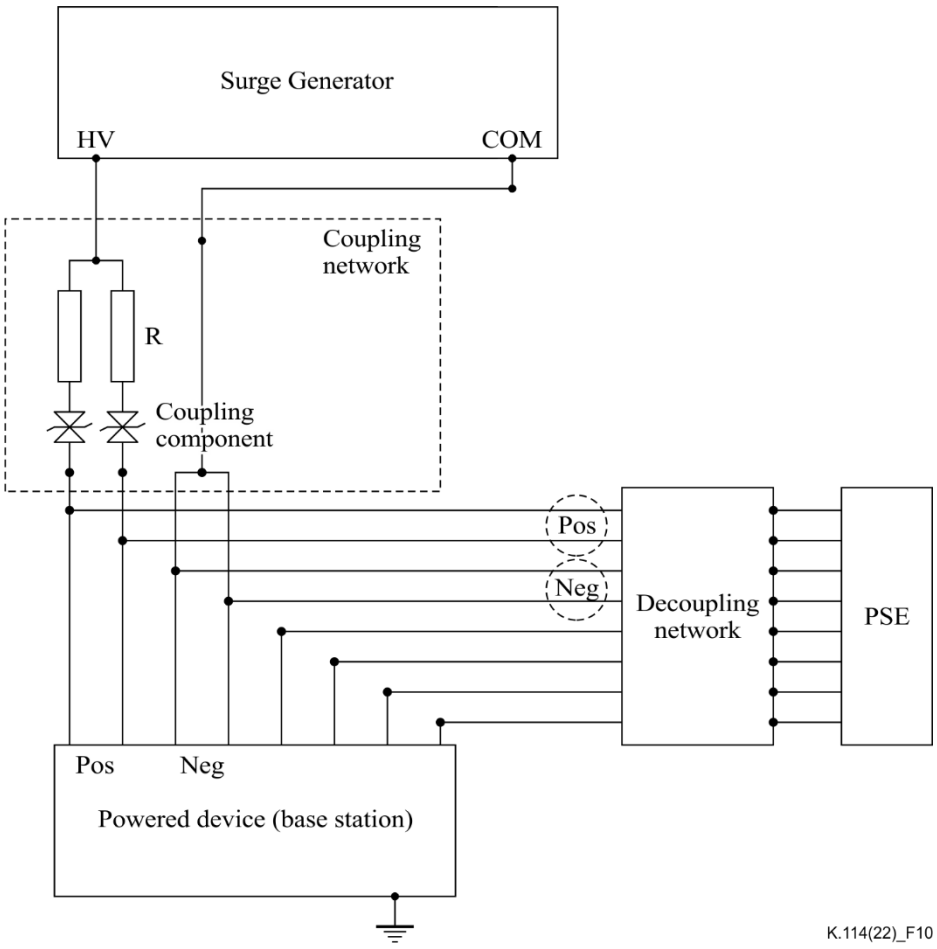
Test methods for shielded PoE cables shall be performed in accordance with clause 7.6 of [IEC 61000-4-5]. Test methods for unshielded PoE cables for both line-to-line and line-to-earth coupling are as follows:

– line-to-earth coupling: All eight lines to the earth simultaneously; the test setup is given in Figure 9.
– line-to-line coupling: Tests on 1/2 to 3/6, and 4/5 to 7/8, respectively, shall be performed, the test setup is given in Figure 10.



NOTE – For each coupling network, the resistance of resistor R shall not exceed 250 Ω with indoor cable and shall be 25 Ω with outdoor cables.
The CDN for power lines in [IEC 61000-4-5] shall be used.
Tests should be performed again after switching off power-sourcing equipment (PSE) but powered by adaptor.

Figure 9 – Line-to-earth coupling test configuration for PoE of powered base station



NOTE – For each coupling network, *R* shall be 80 Ω with indoor cable and shall be 25 Ω with outdoor cables.
The CDN for power lines in [IEC 61000-4-5] shall be used.
Tests should not be performed again after switching off PSE.

Figure 10 – Line-to-line coupling test configuration for PoE of powered base station

7 Test conditions

7.1 General conditions

EUT with different modules mounted in the enclosure should be configured with all radio and ancillary units necessary if it is possible to obtain the worst case of emission or immunity. As an alternative, it is possible not to use the maximum system configuration if it is technically demonstrated that the insertion of other cards or units in the configuration under test do not change the emission level or the grade of immunity of the EUT. The equipment test conditions have to be as close as possible to the actual installation conditions. The test configuration and mode of operation have to represent the intended use. It is suggested that the EUT, BSS and all radio units shall be at full radio power output status.

Wiring should be consistent with the specifications. The signal or control ports have to be correctly terminated, either by ancillary equipment necessary to exercise the ports or in their nominal impedance.

A sufficient number of ports have to be correctly terminated to ensure that the test is representative of normal operating conditions. Only cables that are permanently connected have to be included.

The conditions, test configuration and mode of operation have to be recorded in the test report.

The following information has to be recorded in the test report:

– the primary functions of the equipment to be assessed during and after the EMC exposure;

– the user control functions and stored data that are required for normal operation and the method to be used to assess whether these have been lost after the EMC exposure;

– an exhaustive list of ports, with the maximum cable lengths allowed, classified as either power or telecommunication/signal/control – power ports have to be further classified as AC or DC power;

– the method to be used to verify that a communication link is established and maintained (if appropriate);

– any equipment thermal limitation that prevents continuous testing of the EUT;

– the environment(s) in which the equipment is intended to be used;

– the types of cables connected to the EUT and the types of ports connected to the cables.

For radio equipment, the following information also has to be recorded in the test report:

– the type of modulation, the characteristics of the transmission used for testing (random bit stream, message format, etc.) and the necessary test equipment delivered to enable the assessment of the EUT;

– the operating frequency bands over which the equipment is intended to operate and the necessary bandwidth, the quantity of the carriers which were used by the BS during the test;

– the RAT-specific active RF modules and other hardware firms for a communication link in MSR BS or other BS supporting more than one RAT;

– a common communication link used by more than one RAT shall be assessed on any one RAT;

– the ancillary equipment to be combined with the radio equipment for testing (where applicable).

7.2 General arrangements for test signals

7.2.1 Arrangements for test signals

For the emission test, maxima shall be measured. For the immunity test, the key performances for all bands shall be covered and monitored.

For a BS supporting more than one RAT, including MSR BSs, tests shall be conducted with all RATs in operation one by one or simultaneously. For a BS with only one RAT but supporting more than one band, tests shall be conducted with all the bands in operation one by one or simultaneously.

For a multi-carrier BS, the carrier shall be arranged to highest power. In the maximum RF necessary bandwidth that the manufacturer declares, all carriers shall be spaced equally but the minimum shall cover three frequencies: top, middle and bottom in the test carrier band.

For a single carrier BS, tests on the top, middle and bottom frequencies of the transmit band shall also be arranged.

7.2.2 Arrangements for carrier

The wanted RF signal nominal frequency shall be selected by setting the channel number as follows.

UTRA/E-UTRA/GSM-EDGE/MSR/NB-IoT/NR

– The absolute radio frequency channel number (ARFCN) for an evolved universal terrestrial radio access (E-UTRA) carrier (EARFCN).

– The ARFCN for an UTRA carrier (UARFCN).

– The ARFCN for a GSM/EDGE carrier.

– The ARFCN (combination of ARFCN, UARFCN or EARFCN) for an MSR carrier.

– The ARFCN for the stand-alone narrowband Internet of things (NB-IoT) (EARFCN).

– The ARFCN for an NR carrier (NR-ARFCN).

CDMA

– Set the code division multiple access (CDMA) channel to an appropriate number.

7.2.3 Arrangements for communication link

A communication link shall be set up with a suitable test system capable of evaluating the required performance criteria at the radio interface and telecommunication port/ports (e.g., the S1/I_{ub}/Abis interface).

When the EUT is required to be in the transmit or /receive mode, the following conditions shall be met:

– the EUT shall be set to operate at maximum rated transmit power;

– adequate measures shall be taken to avoid the effect of the unwanted signal on the measuring equipment;

– the wanted RF input signal level shall be set to a level where the performance is not limited by the receiver noise floor or strong signal effects;

– for UTRA, the level of the wanted signal at the input of the receiver shall not be greater than 15 dB above the reference sensitivity level for the EUTs.

  • The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2 of [ETSI TS 125 141] for a frequency division duplex (FDD).

  • The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2 of [ETSI TS 125 142] for a time division duplex (TDD).

  • For a hybrid AAS BS TDD and FDD, the wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2 of [ETSI TS 137 145-1].

  • For OTA AAS BS FDD, the wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2 of [ETSI TS 137 145-2], to ensure a stable communication link is maintained.

– for E-UTRA

  • The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2.5 of [ETSI TS 136 141] for BSs covering different areas.

  • For a hybrid AAS BS the wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2 of [ETSI TS 137 145-1].

  • For OTA AAS BS the wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.3 of [ETSI TS 137 145-2].

– for E-UTRA BS operating in band 46 (licence-assisted access (LAA))

  • The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specifed in clause 7.2.5 of [ETSI TS 136 141] for BSs covering local and medium areas only.

– for E-UTRA with in-band or guard band NB-IoT

  • The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2.5 of [ETSI TS 136 141] for BSs covering different areas.

– for standalone NB-IoT

  • The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2.5 of [ETSI TS 136 141].

– for GSM/EDGE

- The wanted receiver input signal level shall be set to a nominal value of −47 dBm ± 3 dB.

– for CDMA
  - For immunity testing the wanted RF signal level at the input of the EUT shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 3.4.1 of [TIA-97].
  - Set the CDMA channel to an appropriate number. A communication link shall be set up with a suitable mobile station simulator (hereafter called "the test system") according to the radio configuration (RC) supported by the BS (see clause 1.3 of [TIA-97] using full data rate only).

– for MSR
  - The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level for each RAT the levels are specified in clause 7.2 of [ETSI TS 137 141].
  - For a hybrid AAS BS the wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level for each RAT specified in clause 7.2 of [ETSI TS 137 145-1].
  - For OTA AAS BS the wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level each RAT specified in clause 7.2 of [ETSI TS 137 145-2].

– for NR BS type 1-C and 1-H
  - The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 7.2 of [ETSI TS 138 104].

– for NR BS type 1-O
  - The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 10.3 of [ETSI TS 138 104].

– for NR BS type 2-O
  - The wanted signal shall be 15 dB ± 3 dB above the reference sensitivity level as specified in clause 10.3 of [ETSI TS 138 104].

7.2.4 Normal test modulation

A communication link shall be set up with suitable BSS test equipment.

UTRA

The normal test modulation should be a bearer with the characteristics of data rate shown in Table 1.

If the test is not performed using one of these bearers, e.g., none of them are supported by the BS, the characteristics of the bearer used shall be declared by the manufacturer and recorded in the test report.

Table 1 – Bearer information data rate

Bearer information data rate [kbit/s]
12.2
64
144
384

E-UTRA, E-UTRA with LAA, in-band or guard band NB-IoT

The normal test modulation should be a bearer with the characteristics of data rate shown in Table 2.

If the test is not performed using one of these bearers, e.g., none of them are supported by the BS, the characteristics of the bearer used shall be declared by the manufacturer and recorded in the test report.

Table 2 – Bearer information data rate

E-UTRA channel bandwidth [MHz]	Bearer information data rate
1.4	Fixed reference channel (FRC) A1-1 in clause A.1 of [ETSI TS 136 104]
3	FRC A1-6 in clause A.1 of [ETSI TS 136 104] for E-UTRA with NB-IoT in-band operation
5	FRC A1-7 in clause A.1 of [ETSI TS 136 104] for E-UTRA with NB-IoT in-band operation
10	FRC A1-3 in clause A.1 of [ETSI TS 136 104] (see Note 1)
15	FRC A1-3 in clause A.1 of [ETSI TS 136 104] (see Note 1)
20	FRC A1-3 in clause A.1 of [ETSI TS 136 104] (see Note1) FRC A1-9 in clause A.1 of [ETSI TS 136 104] (see Note 2)
NOTE 1 – This is the information data rate of a single instance of the bearer mapped to 25 resource blocks. The performance criteria shall be met for each consecutive application of a single instance of the bearer mapped to disjoint frequency ranges with a width of 25 resource blocks each. NOTE 2 – This is the information data rate of a single instance of the bearer mapped to a single interlace. The performance criteria shall be met for each application of a single instance of the bearer mapped to each single interlace. This reference measurement channel is only applied for LAA band 46.	

GSM/EDGE

The normal test modulation shall be delivered by a suitable mobile station or base station system test equipment (BSSTE), see [ETSI TS 151 021].

CDMA

A communication link shall be set up with suitable BSSTE. The normal test modulation should be set up according to the RC supported by the BS under test using full data rate only (see clause 1.3 of [TIA-97-E-1]).

Standalone NB-IoT

The normal test modulation should be a bearer with the characteristics of data rate shown in Table 3.

If the test is not performed using one of these bearers, e.g., none of them are supported by the BS, the characteristics of the bearer used shall be declared by the manufacturer and recorded in the test report.

Table 3 – Bearer information data rate

NB-IoT Sub-carrier spacing [kHz]	Bearer information data rate
15	FRC A14-1 in Annex A.14 of [ETSI TS 136 104]
3.75	FRC A14-2 in Annex A.14 of [ETSI TS 136 104]

NR

The normal test modulation should be a bearer with the characteristics of data rate shown in Table 4 and Table 5.

If the test is not performed using one of these bearers, e.g., none of them are supported by the BS, the characteristics of the bearer used shall be declared by the manufacturer and recorded in the test report.

Table 4 – Bearer information data rate for FR1

NR channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Bearer information data rate
5, 10, 15	15	G-FR1-A1-1 in clause A.1 of [ETSI TS 138 104]
10, 15	30	G-FR1-A1-2 in clause A.1 of [ETSI TS 138 104]
10, 15	60	G-FR1-A1-3 in clause A.1 of [ETSI TS 138 104]
20, 25, 30, 40, 50	15	G-FR1-A1-4 in clause A.1 of [ETSI TS 138 104]
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5 in clause A.1 of [ETSI TS 138 104]
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6 in clause A.1 of [ETSI TS 138 104]

Table 5 – Bearer information data rate for FR2

NR channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Bearer information data rate
50, 100, 200	60	G-FR2-A1-1 in clause A.1 of [ETSI TS 138 104]
50	120	G-FR2-A1-2 in clause A.1 of [ETSI TS 138 104]
100, 200, 400	120	G-FR2-A1-3 in clause A.1 of [ETSI TS 138 104]

7.2.5 Arrangements for repeaters

For immunity tests of repeaters, the wanted RF input signal shall be coupled to one antenna port at a level that results, when measured, in the maximum rated RF output power per channel, as declared by the manufacturer. The test shall either be repeated with a wanted signal coupled to the other antenna port or a single test shall be performed with the specified input signals being simultaneously coupled to both antenna ports.

7.3 Exclusion band

7.3.1 Transmitter exclusion band

The BSS transmitter exclusion band is the band of frequencies over which no tests of radiated immunity of a transmitter are made. The RF exclusion band applies to radio equipment with an operating frequency up to 6 GHz, or for equipment operating above 6 GHz, but whose RF bandwidth extends to a frequency below 6 GHz.

For equipment operating at frequencies above 6 GHz and whose RF bandwidth does not extend to a frequency below 6 GHz, there is no exclusion band. During the radiated immunity test the following shall apply.

There shall only be a transmitter exclusion band for an OTA type BS (no exclusion band is specified for other BSs). The range of the exclusion band for transmitter (downlink DL) is determined by:

$$F_{DL\_low} - EB < f < F_{DL\_high} + EB$$

where:

F_{DL_low}: the lowest frequency of the downlink operating band;

F_{DL_high}: the highest frequency of the downlink operating band.

Values of F_{DL_low} and F_{DL_high} are specified for each operating band in clause 4.6 of [ETSI TS 137 105] or the operating band specified in the user country.

EB: exclusion band specified according to the type of BS

For OTA type BS for FR1:

The BS transmitter exclusion band is the band of frequencies over which no tests of radiated immunity on transmitter are made.

For a BS with a transmitter operating bandwidth <100 MHz, EB is equal to the BS channel bandwidth or 60 MHz, whichever is greater.

For a BS with a transmitter operating bandwidth ≥100 MHz, EB is equal to the BS channel bandwidth or 200 MHz, whichever is greater.

For an OTA type BS for FR2, there is no exclusion band.

7.3.2 Receiver exclusion band

The BSS receiver exclusion band is the band of frequencies over which no tests of radiated immunity of a receiver are made. The RF exclusion band applies to radio equipment with an operating frequency up to 6 GHz, or for equipment operating above 6 GHz, but whose RF bandwidth extends to a frequency below 6 GHz.

For equipment operating at frequencies above 6 GHz and whose RF bandwidth does not extend to a frequency below 6 GHz, there is no exclusion band.

The range of the exclusion band for receiver (uplink UL) is determined by:

$$F_{UL\_low} - EB < f < F_{UL\_high} + EB$$

where,

F_{UL_low}: the lowest frequency of the uplink operating band;

F_{UL_high}: the highest frequency of the uplink operating band;

EB: exclusion band defined according to the type of BS.

For non-AAS BS, hybrid AAS BS and NR BS Type 1-C

The exclusion bands shall be calculated using the operating bands as set out in clause 4.5 of [ETSI TS 137 104], or the operating band specified in the user country. EB is equal to the BS channel bandwidth or 20 MHz, whichever is greater.

For OTA AAS BS and NR BS Type 1-O

The exclusion bands shall be calculated using the operating bands as set out in clause 4.6 of [ETSI TS 137 105] or the operating band specified in the user country.

For a BS with a receiver operating bandwidth <100 MHz, EB is equal to the BS channel bandwidth or 60 MHz, whichever is greater.

For a BS with a receiver operating bandwidth ≥100 MHz, EB is equal to the BS channel bandwidth or 200 MHz, whichever is greater.

7.3.3 Multi-band BS

For a BS capable of MB operation, the exclusion band shall be the combination of the exclusion bands for each band.

The total exclusion band extends from the lowest frequency of the lowest operating band up to the highest frequency of the highest operating band.

Where the operating bands are separated, the result will be multiple separate exclusion bands.

For example, when separation between the two adjacent operating bands is smaller than one of the single band exclusion bands, the exclusion band of an MB BS shall be calculated (see Figure 11) by:

$$MB\ F_{UL\_low} - SEB_1 < f < MB\ F_{UL\_high} + SEB_x$$

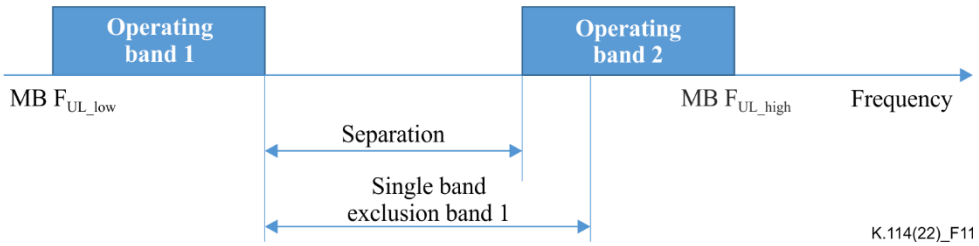


Figure 11 – Calculation of the exclusion band of an MB BS: case 1

When separation between the two adjacent operating bands is larger than the sum of the two single band exclusion bands, the exclusion band of an MB BS shall be calculated (see Figure 12) by:

$$f = (\text{MB } F_{UL\_low} - SEB_1, F_{UL\_OB1\_high} + SEB_1) + \ldots + (F_{UL\_OBx\_low} - SEB_x, \text{MB } F_{UL\_high} + SEB_x)$$

where,

f	exclusion band of multi-band BS;
MB F_{UL_high}	multi-band F_{UL_high};
MB F_{UL_low}	multi-band F_{UL_low};
SEB_x	single band exclusion band for band x;
$F_{UL\_OBx\_low}$	low frequency of operating band x;
$F_{UL\_OBx\_high}$	high frequency of operating band x.

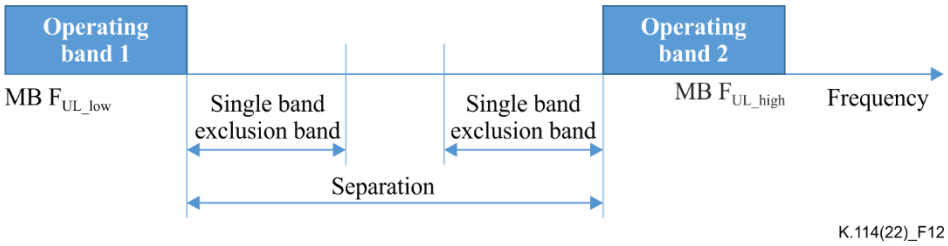


Figure 12 – Calculation of the exclusion band of an MB BS: case 2

7.3.4 Repeater and ancillary RF amplifier exclusion band

The exclusion band for repeaters and ancillary RF amplifiers is the band of frequencies over which no tests of radiated immunity of the EUT are made.

The exclusion band for a repeater or ancillary RF amplifier is the range(s) of frequencies for which at least one of the following conditions is met:

– the gain (measured in either direction between two RF ports) is greater than 25 dB;

– the gain (measured in either direction between two RF ports) is no more than 25 dB below the gain measured at the centre of a manufacturer's declared operating band.

A range of frequencies is only considered to be an operating band if the measured gain at the centre of this band is greater than 0 dB.

7.4 Narrowband responses on receivers

Responses on receivers or duplex transceivers occurring during the immunity test at discrete frequencies that are narrowband responses (spurious responses), are identified by the following method.

– If during an immunity test the quantity being monitored goes outside the specified tolerances (see clause 9), it is necessary to establish whether the deviation is due to a narrowband response or to a wideband (EMC) phenomenon. Therefore, the test shall be repeated with the unwanted signal frequency first increased, and then decreased by an offset, f_{offset}, where

- for UTRA, f_{offset} = 10 MHz;
- for E-UTRA, $f_{offset} = 2 \times BW_{Channel}$, where $BW_{Channel}$ is the channel bandwidth as specified in clause 5.6 of [ETSI TS 136 104];
- for GSM/EDGE, f_{offset} = 400 kHz;
- for CDMA, f_{offset} = 10 MHz, f_{offset} = 12.5 MHz;
- for NB-IoT, f_{offset} = 400 kHz;
- for NR, $f_{offset} = 2 \times BW_{Channel}$.

– If the deviation disappears in either or both of the above offset cases, then the response is considered as a narrowband response.

– If the deviation does not disappear, this may be due to the fact that the offset has made the frequency of the unwanted signal correspond to the frequency of another narrowband response. Under these circumstances the procedure is repeated with the increase and decrease of the frequency of the unwanted signal set to $1.25 \times f_{offset}$.

– If the deviation does not disappear with the increased or decreased frequency, the phenomenon is considered wideband and therefore an EMC problem and the equipment fails the test.

Narrowband responses are disregarded.

For an MSR BS or other BS supporting more than one RAT, the preceding method shall be applied for each RAT supported. For BSs capable of MB operation, all supported operating bands shall be tested for narrow band responses.

8 Specific test configurations

Test configurations that are not included in this clause shall comply with the requirements in clauses 6 and 7.

A BS for transmitter and receiver together (as a system): transmitters and receivers may be tested for immunity as a system when combined as a transceiver or the combined equipment is of a size which allows simultaneous testing. In this case, the transceiver shall be located inside the test environment and shall be exposed simultaneously to the immunity test signals. The test system shall be located outside of the test environment.

For transceivers operating at the same frequency in a TDD system, the wanted output signal of the transmitter may be used via a suitable attenuator and applied to the input of the receiver as the wanted input signal in the emission test.

When performing the test, the communication link shall be established between the air interface (e.g., with the mobile simulator) and the S1/I_{ub}/Abis interface (e.g., with an evolved packet core/radio network controller (EPC/RNC) simulator), as shown in Figure 13 and Figure 14. The antenna ports that do not connect to the test equipment shall be terminated by a non-inductive resistor equal to the value of the nominal impedance or attenuator.

Also in the laboratory environment, considering the monitoring of the throughput in downlink requires the support of the core network equipment, and the core network equipment is very complex, error vector magnitude (EVM) can be used as an alternative monitoring parameter in downlink, since there is a certain relationship between EVM and the throughput for the transmitter. The manufacturer can use test equipment that meets the communication protocol of the BS to activate the function of the BS to monitor EVM in downlink and throughput in uplink, typical test configurations for these different BS types are as shown in Figure 15 to Figure 21.

8.1 General test set up for BS

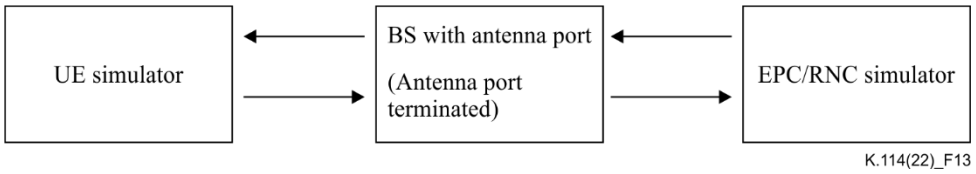


Figure 13 – Communication link set up for BS with antenna port

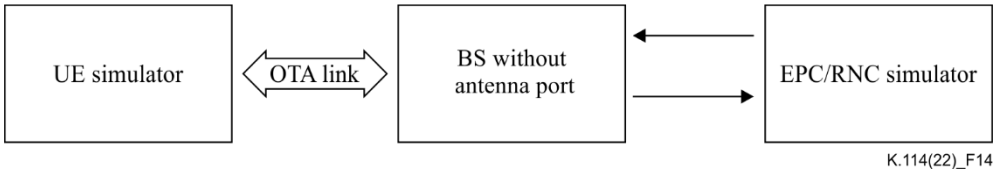
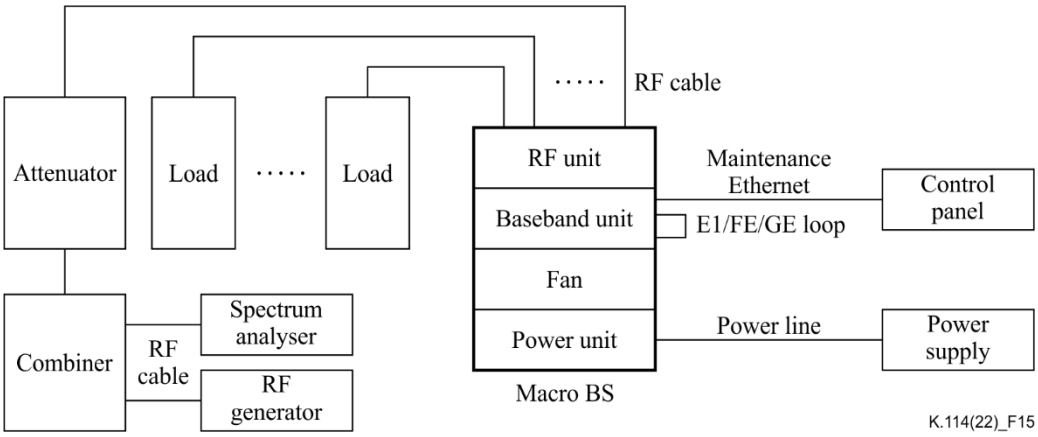


Figure 14 – Communication link set up for BS without antenna port

8.2 Macro base station

See Figure 15.



NOTE – E1/FE/GE ports can be connected using a self-test loop or to auxiliary equipment, as long as business functions can be achieved.

Figure 15 – A typical test configuration for macro base stations

Macro BS cabinets need to be intact without deformation, with each unit well connected in accordance with the product instructions. During the test, the door of cabinet shall be closed.

Macro BSs shall be placed on a 0.1 m insulated support. If it is an inter-unit cable, like the E1/fast Ethernet (FE)/GE cable, where the length is insufficient to reach the horizontal ground reference plane, the excess length of cables shall be bundled at the approximate centre of the cable with the bundles 0.3 m to 0.4 m in length. The bundle shall be positioned in such a way that it is either 0.4 m above the horizontal ground reference plane or at the height of the cable entry or connection point, if this is within 0.4 m of the horizontal ground reference plane.

Antenna ports shall be terminated by a non-inductive resistor equal to the value of the nominal impedance or attenuator, and RF leakage is not permitted.

For emission testing, it is recommended that the maintenance cable be disconnected in order to avoid auxiliary equipment impacting the test result. For immunity testing, cables connected to auxiliary equipment shall be decoupled to prevent it being subjected to interference, and equipment performance shall be appropriately monitored.

8.3 Distributed base station

See Figure 16.

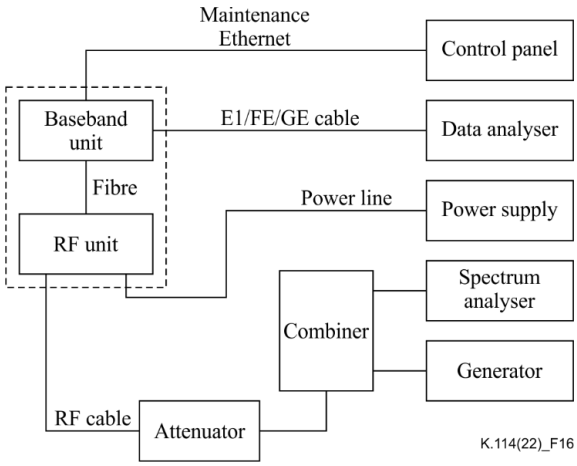


Figure 16 – A typical test configuration for distributed base stations

If the RF unit is the EUT, it shall be hung on a pole away from the horizontal ground reference plane 0.8 m high. The antenna shall be terminated by a non-inductive resistor equal to the value of the nominal impedance or attenuator. Also, RF leakage is not permitted.

If the baseband unit is the EUT, it shall be installed in an open frame away from the horizontal ground reference plane 0.8 m high. The baseband unit can be tested using the communication link set up method as for the RF unit test, or it can be tested individually without communicating with the RF unit; the manufacturer shall provide the method to make it work as normal. For emission testing, it is recommended that the maintenance cable be disconnected in order to avoid auxiliary equipment impacting the test result. For immunity testing, cables connected to auxiliary equipment shall be decoupled to prevent it being subjected to interference, and equipment performance shall be appropriately monitored.

8.4 Micro base station

See Figure 17.

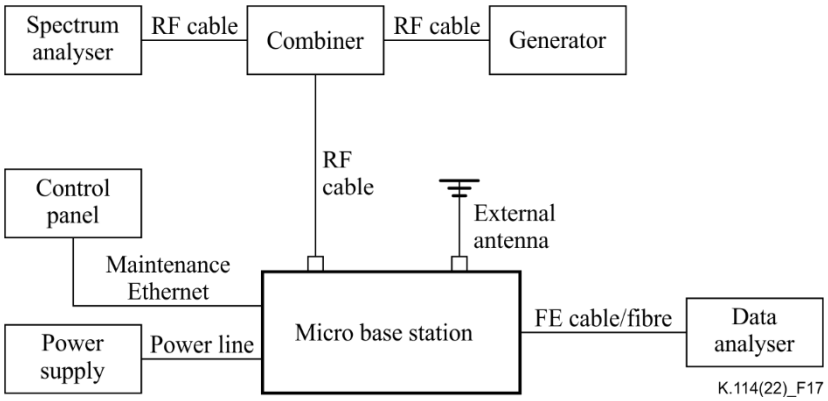


Figure 17 – A typical test configuration for micro base stations

Micro BSs shall be tested as table top equipment.

For emission testing, it is recommended that the maintenance cable be disconnected in order to avoid auxiliary equipment impacting the test result.

A micro BS can be tested with the antenna if the total equivalent isotropically radiated power (EIRP) is less than 5 W.

The antenna port of the micro BS shall match the load if the total EIRP is greater than 5 W and the antenna is detachable. The chassis can be punched for built-in antenna to achieve the antenna port connecting to the test instruments.

If the antenna cannot be separated and the EIRP. is greater than 5 W, for environment protection and test stuff safety, it is recommended that tests should be performed in an anechoic chamber or shielding room. An antenna shall be installed in the anechoic chamber to build an airport signal chain and to connect to measuring instruments outside. During the radiated emission test, a notch filter that has a working frequency exactly in the transmitting band of a BS shall be installed in the emission-receiving path to prevent the receiver overloading. For multi-carrier BSs, an appropriate filter shall be installed in the emission receiving path to prevent the receiver overloading because of intermodulation from multi-carriers through the receiver. Lower power can be used if diminution power influence on the emission measurement results less than 2 dB or does not affect the normal function assessment of the BS.

During immunity testing, cables connected to auxiliary equipment shall be decoupled to prevent it being subjected to interference, and equipment performance shall be appropriately monitored.

8.5 Pico base station

See Figure 18.

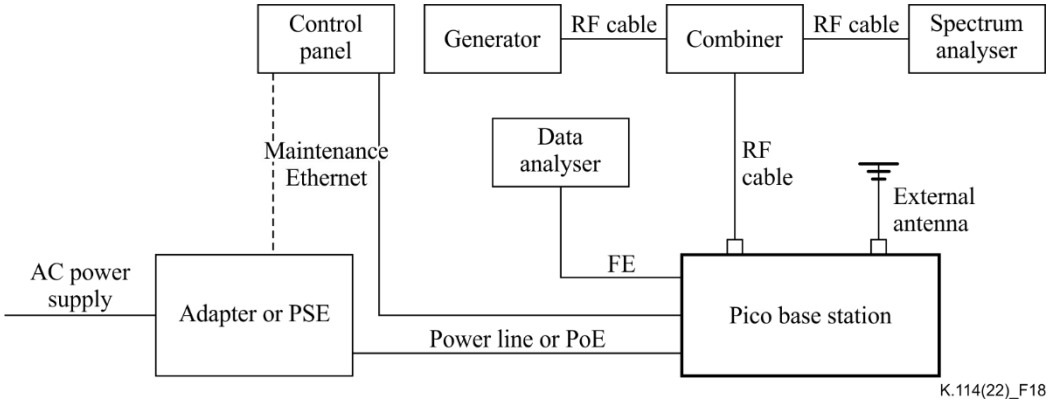
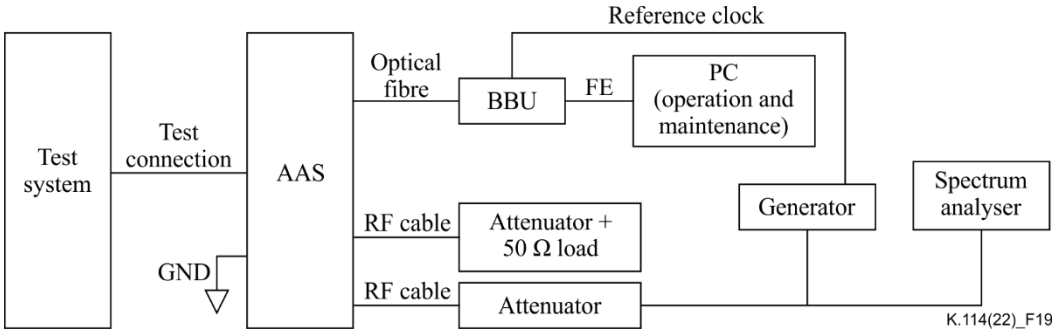


Figure 18 – A typical test configuration for pico base stations

The antenna of pico BSs may be built-in or external, and single-channel or multi-channel. Pico BSs shall be tested as table top equipment, and its EIRP is generally so small that it can be tested with the antenna. It is recommended to create an airport signal loopback by EUT-self.

8.6 Active antenna system base station

See Figures 19 to 21.



BBU base band unit PC personal computer

Figure 19 – A typical test configuration for active antenna system base stations with antenna port

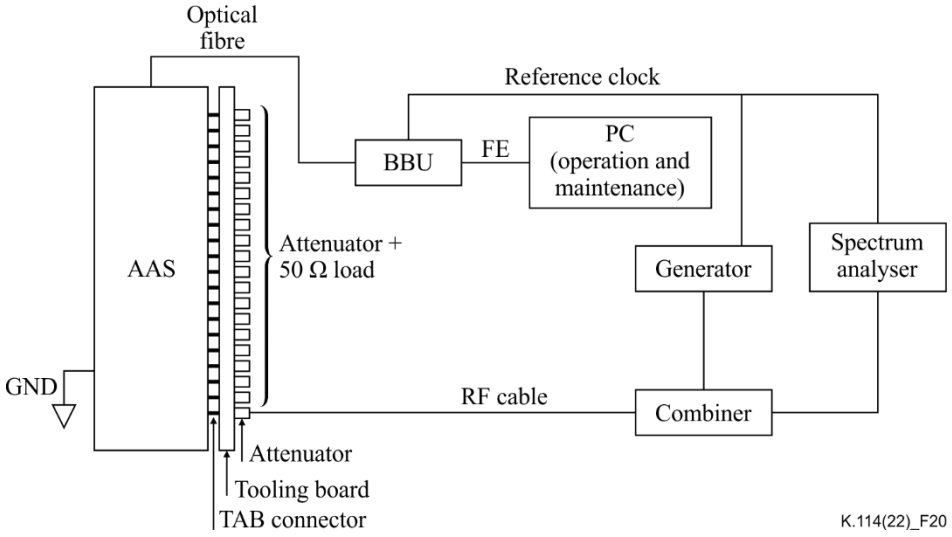


Figure 20 – A typical test configuration for active antenna system base stations with a transceiver array boundary (TAB) connector

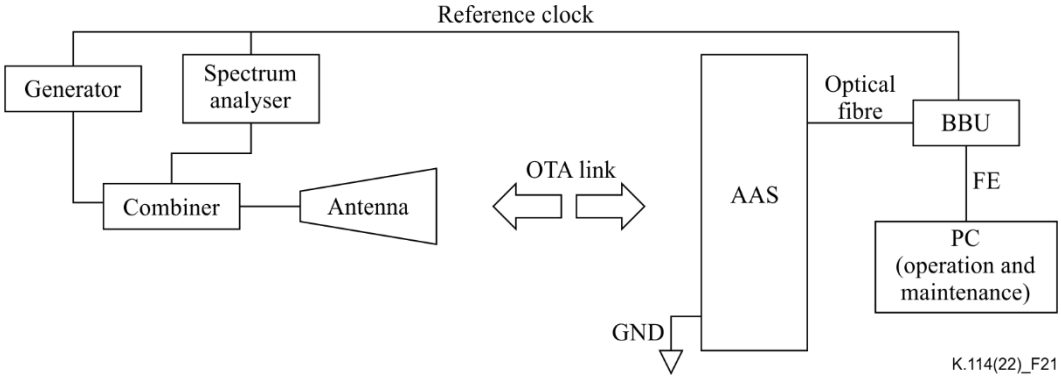


Figure 21 – A typical test configuration for active antenna system base stations without antenna port or TAB connector

An AAS BS shall be hung on a pole and it is away from the horizontal ground reference plane 0.1 m high.

If the antenna cannot be separated and EIRP greater than 5 W, for environmental protection and the safety of test staff, it is recommended that tests be performed in an anechoic chamber or shielding room. An auxiliary antenna shall be installed behind the receiving antenna in the anechoic chamber to build an airport signal chain and to connect to measuring instruments outside or to create an airport

signal loopback by EUT-self. During the radiated emission test, a notch filter, which has a working frequency exactly in the transmitting band of a BS, shall be installed in the emission receiving path to prevent the receiver overloading. For multi-carrier BSs, an appropriate filter shall be installed in the emission-receiving path to prevent the receiver overloading because of intermodulation from multi-carriers through the receiver. Lower power can be used if diminution of power influence on the emission measurement results in less than 2 dB or does not affect the normal function assessment of the BS.

During immunity testing, cables connected to auxiliary equipment shall be decoupled to prevent it being subjected to interference, and equipment performance shall be appropriately monitored. If the antenna can be separated, the antenna port shall be terminated by a non-inductive resistor equal to the value of the nominal impedance or attenuator, and RF leakage is not permitted.

9 Performance assessment

Clause 5 of [ETSI EN 301 489-50] shall apply.

During the immunity test, various performance indicators of EUT operations shall be monitored in real time by appropriate auxiliary equipment, such as bit error ratio (BER), block error ratio (BLER), frame error ratio (FER), throughput (the test method according to [ITU-T K.88]). Auxiliary equipment cannot affect the test result. During exposure, the operating environment, operating status, alarms, etc. shall be detected through the signal or control port.

The performance of the DL can also be assessed by monitoring the modulation quality of the transmitter, in terms of EVM for an alternative of throughput.

9.1 Assessment of BLER/throughput/EVM/BER/FER in downlink

The level of the signal supplied to the equipment should be within the range for which the assessment of BLER/throughput/BER is not impaired. Power control shall be switched off during immunity testing.

For UTRA (BLER)

In order to assess the BLER of the bearer used during the immunity tests, the output of the transmitter shall be connected to equipment that meets the requirements for the BLER assessment of [ETSI TS 125 101] in the case of FDD and [ETSI TS 125 102] in the case of TDD.

For E-UTRA, E-UTRA with LAA, in-band or guard band NB-IoT, Standalone NB-IoT (throughput/EVM)

The output of the transmitter shall be connected to equipment that meets the requirements for throughput assessment in [ETSI TS 136 101] for the bearer used in the immunity tests.

Alternatively, the output of the transmitter shall be connected to equipment that meets the requirements for the EVM assessment of [ETSI TS 136.141] for the bearer used in the immunity tests.

For CDMA (FER)

For immunity testing, the output of the transmitter shall be connected to a test system that meets the requirements for the FER assessment in accordance with 2-1 of [TIA-2000.2] and [TIA-97-E-1]. The level of the signal supplied to the test system shall be attenuated such that it is within the range for which the assessment of FER is not impaired.

For GSM/EDGE (BER)

The BER at the output of the transmitter may be assessed using either of the following techniques.

Assessment of BER using static layer 1 functions

The transmitter under test shall be operated according to the test case in clause 6.1.2 of [ETSI TS 151 021].

The bit sequence from the output of the transmitter shall be monitored by the test system according to the test case in clause 7.1.2 of [ETSI TS 151 021] and the BER of the class 2 bits for a traffic channel at full-rate speech (TCH/FS) assessed. The BER shall not exceed the values specified in clause 6.1.

If the EUT does not support TCH/FS, the manufacturer shall declare the logical channel for which the performance shall be assessed, and the corresponding performance criteria.

Assessment of BER using RXQUAL

The output of the transmitter shall be connected to equipment that meets the requirements of either [ETSI TS 151 010-1] or [ETSI TS 100 607-1] for the assessment of received signal quality (RXQUAL). The RXQUAL shall be monitored during the test. The RXQUAL shall not exceed the values specified in clause 6.1.

NOTE – This equipment can be a global system for mobile (GSM) station with suitable provision for the monitoring of RXQUAL.

For NR (throughput/EVM)

A communication link shall be established between the transmitter (via port for the BS type 1-C and BS type 1-H, or via RIB for the BS type 1-O and BS type 2-O) and the test equipment. Test equipment shall meet the requirements for the throughput assessment specified in [ETSI TS 138 101-4] for the bearer used in the immunity tests. The level of the signal supplied to the equipment should be within the range for which the assessment of throughput is not impaired.

Alternatively, the test equipment shall meet the requirements for the EVM assessment specified in [ETSI TS 138 141-1] [ETSI TS 138 141-2] for the bearer used in the immunity tests.

9.2 Assessment of BLER/throughput/BER/FER in uplink

For UTRA (BLER)

The value of the BLER at the output of the receiver reported by the BS shall be monitored at the I_{ub} interface by using suitable test equipment.

For E-UTRA, E-UTRA with LAA, in-band or guard band NB-IoT, standalone NB-IoT (throughput)

The value of the throughput at the output of the receiver shall be monitored at the S1 interface by using suitable test equipment.

For CDMA (FER)

The value of the FER at the output of the receiver reported by the BS shall be monitored using a suitable test system.

For GSM/EDGE (BER)

The BER at the output of the receiver may be assessed using either of the following techniques.

Assessment of BER using RXQUAL

The value of the RXQUAL reported by the base transceiver station (BTS) or BSS shall be monitored using suitable test equipment.

Assessment of BER using reported BER

The BER of the class 2 bits at the output of the receiver shall be assessed using suitable test equipment.

If the EUT does not support TCH/FS, the manufacturer shall declare the logical channel for which the performance shall be assessed, and the corresponding performance criteria.

NOTE – This can be performed by a test loopback, which uses the transmitter of the BTS to return the data that has been decoded by the receiver back to the test equipment that generated the bit sequence. For immunity tests of signal ports, the test loopback includes an external connection between signal ports.

For NR (throughput)

The value of the throughput at the output of the receiver shall be monitored using suitable test equipment.

9.3 Assessment of RF gain variations of repeaters

The parameter used for the performance assessment of a repeater is the RF gain within the operating frequency band.

10 Performance criteria

10.1 Performance criteria A for continuous phenomena applied to base stations and repeaters

10.1.1 Base stations

For UTRA

The BLER calculation shall be based on evaluating the cyclic redundancy check on each transport block.

During immunity tests of the BS uplink and downlink paths, the observed BLER shall be less than 1×10^{-2} and the BS shall operate as intended. If the uplink and downlink paths are evaluated as one loop, then the criterion is less than 2×10^{-2}.

After each test case, the BS shall operate as intended with no loss of user control functions or stored data; the communications link shall be maintained.

For E-UTRA, E-UTRA with LAA, in-band or guard band NB-IoT

The test should, where possible, be performed using a bearer with the characteristics of data rate and throughput specified in Table 6. If the test is not performed using one of these bearers (e.g., if none of them are supported by the BS), the characteristics of the bearer used shall be recorded in the test report.

The throughput in Table 6 is stated relative to the maximum throughput of the FRC. The maximum throughput for an FRC is equal to the payload size times the number of uplink subframes per second.

The BS uplink and downlink paths shall each meet the performance criteria specified in Table 6 during the test. If the uplink and downlink paths are evaluated as a one loop, then the criteria is two times the throughput reduction shown in Table 6. After each test case, the BS shall operate as intended with no loss of user control function; stored data and the communication link shall be maintained.

Table 6 – BS performance criteria for continuous phenomena for BS

E-UTRA channel bandwidth [MHz]	Bearer information data rate	Performance criteria (see Notes 1 and 2)
1.4	FRC A1-1 in clause A.1 of [ETSI TS 136 104]	Throughput: >95% No loss of service
3	FRC A1-6 in clause A.1 of [ETSI TS 136 104] for E-UTRA with NB-IoT in-band operation	Throughput: >95% No loss of service
5	FRC A1-7 in clause A.1 of [ETSI TS 136 104] for E-UTRA with NB-IoT in-band operation	Throughput: >95% No loss of service
10	FRC A1-3 in clause A.1 of [ETSI TS 136 104] (see Note 3)	Throughput: >95% No loss of service
15	FRC A1-3 in clause A.1 of [ETSI TS 136 104] (see Note 3)	Throughput: >95% No loss of service
20	FRC A1-3 in clause A.1 of [ETSI TS 136 104] (see Note 3) FRC A1-9 in clause A.1 of [ETSI TS 136 104] (see Note 4)	Throughput: >95% No loss of service

NOTE 1 – The performance criteria: throughput of >95%; no loss of service, also apply if a bearer with other characteristics is used in the test.

NOTE 2 – The performance criteria: throughput of >90%; No loss of service, apply instead if the uplink and downlink paths are evaluated as a one loop.

NOTE 3 – This is the information data rate of a single instance of the bearer mapped to 25 resource blocks. The performance criteria shall be met for each consecutive application of a single instance of the bearer mapped to disjoint frequency ranges with a width of 25 resource blocks each.

NOTE 4 – This is the information data rate of a single instance of the bearer mapped to a single interlace. The performance criteria shall be met for each application of a single instance of the bearer mapped to each single interlace. This reference measurement channel is only applied for LAA band 46.

NOTE 5 – The performance criteria shall refer to Table 8 if EVM is used to assess the modulation quality of the transmitter for an alternative of throughput.

An alternative DL performance criterion for continuous phenomena is monitoring the EVM of the transmitter. In this case the EVM of each E-UTRA carrier for different modulation schemes on a physical downlink shared channel (PDSCH) or short physical downlink shared channel (sPDSCH) shall be less than the limits in Table 7.

Table 7 – DL performance assessment if an EVM is used

Modulation scheme for PDSCH or sPDSCH	Required EVM [%]
Quaternary phase shift keying (QPSK)	18.5
16 Quadrature Amplitude Modulation 16QAM	13.5
64QAM	9
256QAM	4.5
1024QAM	3.5

NOTE 1 – EVM requirement, see [ETSI TS 136 141].

NOTE 2 – The highest modulation order supported by BSs shall be selected for continuous phenomena test.

After each test case, the BS shall operate as intended with no loss of user control functions or stored data, the communications link shall be maintained.

For standalone NB-IoT

Uplink and downlink paths shall each meet the performance criteria defined in Table 8.

The throughput in Table 8 is stated relative to the maximum throughput of the FRC. Sub-carrier spacing should be representative of the intended use of the EUT.

If a bearer with other characteristics is used in the test, this should be recorded in the test report.

The maximum throughput for an FRC equals the payload size divided by the product of the number of resource units and the time to send one resource unit.

Table 8 – NB-IoT BS performance criteria for continuous phenomena

NB-IoT Sub-carrier spacing [kHz]	**Reference measurement channel**	**Performance criteria** (see Note)
15	FRC A14-1 in clause A.14 of [ETSI TS 136 104]	Throughput: >95%
3.75	FRC A14-2 in clause A.14 of [ETSI TS 136 104]	Throughput: >95%
NOTE – Applies also if a bearer with another characteristic is used in the test.		

An alternative DL performance criterion for continuous phenomena is monitoring the EVM of the transmitter. In this case. the EVM of each NB-IoT carrier on NB-PDSCH shall be less than the limits in Table 9.

Table 9 – DL performance assessment if a EVM is used

Modulation scheme for NB-PDSCH	**Required EVM [%]**
QPSK	18.5%
NOTE – EVM requirement, see [ETSI TS 136 141].	

For GSM/EDGE

Downlink

The BER of the downlink shall be assessed during the test according to one of the test methods in clause 8.1.

If the test method in clause 8.1.1 is used, the measured BER of the class 2 bits of TCH/FS shall not exceed 1.6% during the test.

NOTE 1 – This BER is the upper limit in [ETSI TS 145 008] for RXQUAL = 3.

If the test method in clause 8.1.2 is used, the value of RXQUAL shall not exceed 3 during the test.

At the conclusion of the test, the EUT shall operate as intended with no loss of user control functions or stored data, and the communication link shall have been maintained.

Uplink

The BER of the uplink shall be assessed during the test according to one of the test methods in clause 8.2.

If the test method in clause 8.2.1 is used, the value of RXQUAL shall not exceed 3 during the test.

If the test method in clause 8.2.2 is used, the measured BER of the class 2 bits of TCH/FS shall not exceed 1.6% during the test.

NOTE 2 – This BER is the upper limit in [ETSI TS 145 008] for RXQUAL = 3.

For a BS, the RXQUAL of the uplink shall not exceed 3 measured during the test sequence.

At the conclusion of the test, the EUT shall operate as intended with no loss of user control functions or stored data, and the communication link shall have been maintained.

For CDMA

During the immunity test, the observed FER of the BS forward link and reverse link shall not exceed 1.0% with 95% confidence (see clause 6.8 of [TIA-97-E-1]), and the BS shall operate as intended. However, in the case of public access mobile radio (PAMR) BSs, the observed FER of the BS forward link and reverse link shall not exceed 2.0% with 95% confidence (see clause 6.8 of [TIA-97-E-1]), and the BS shall operate as intended.

For NR

The test shall be performed using one or more bearers with the characteristics as stated in Tables 10 or 11 and should be representative of the intended use of the EUT.

The throughput in Tables 10 and 11 is stated relative to the maximum throughput of the FRC.

Uplink and downlink paths shall each meet the performance criteria defined in Tables 10 and 11 during the test.

The performance criteria shall refer to Table 12 if EVM is used for assessing the modulation quality of the transmitter.

Table 10 – FR1 performance criteria for continuous phenomena

NR channel bandwidth [MHz]	**Sub-carrier spacing [kHz]**	**Bearer information data rate**	**Performance criteria** (see Note)
5, 10, 15	15	G-FR1-A1-1 in clause A.1 of [ETSI TS 138 104]	Throughput: >95 %
10, 15	30	G-FR1-A1-2 in clause A.1 of [ETSI TS 138 104]	
10, 15	60	G-FR1-A1-3 in clause A.1 of [ETSI TS 138 104]	
20, 25, 30, 40, 50	15	G-FR1-A1-4 in clause A.1 of [ETSI TS 138 104]	
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5 in clause A.1 of ETSI TS 138 104]	
20, 25, 30, 40, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6 in clause A.1 of [ETSI TS 138 104]	
NOTE – Applies also if a bearer with other characteristics is used in the test.			

Table 11 – FR2 performance criteria for continuous phenomena

NR channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Bearer information data rate	Performance criteria (see Note)
50, 100, 200	60	G-FR2-A1-1 in clause A.1 of [ETSI TS 138 104]	Throughput: >95 %, no loss of service
50	120	G-FR2-A1-2 in clause A.1 of [ETSI TS 138 104]	
100, 200, 400	120	G-FR2-A1-3 in clause A.1 of [ETSI TS 138 104]	
NOTE – Applies also if a bearer with other characteristics is used in the test.			

An alternative DL performance criterion for continuous phenomena is monitoring the EVM of a transmitter. In this case, the EVM of each NR carrier for different modulation schemes on PDSCH shall be less than the limits in Table 12.

Table 12 – DL performance criteria for continuous phenomena for FR1andFR2 BS

Modulation scheme for PDSCH	Required EVM (%)	BS type
QPSK	18.5	1-C,1-H,1-O,2-O
16QAM	13.5	1-C,1-H,1-O,2-O
64QAM	9	1-C,1-H,1-O,2-O
256QAM	4.5	1-C,1-H,1-O,2-O
NOTE 1 – EVM requirement, see [ETSI TS 138 141-1] for type 1-C and 1-H BS, and [ETSI TS 138 141-2] for type 1-O and 2-O BS. NOTE 2 – The highest modulation order supported by BS shall be selected for continuous phenomena test, e.g.,256QAM for type 1-C,1-H,1-O,2-O BS.		

10.1.2 Repeaters

The RF gain of the EUT shall be measured throughout the period of exposure to the phenomenon. The RF gain measured during the test shall not deviate from the gain measured before the test by more than ±1 dB.

At the conclusion of the test, the EUT shall operate as intended with no loss of user control functions or stored data.

10.2 Performance criteria B for transient phenomena for base stations and repeaters

10.2.1 Base stations

At the conclusion of each exposure, the EUT shall operate with no user noticeable loss of the communication link.

At the conclusion of the total test comprising the series of individual exposures, the EUT shall operate as intended with no loss of user control functions or stored data, as declared by the manufacturer, and the communication link shall have been maintained.

10.2.2 Repeaters

The RF gain of the EUT shall be measured before the test and after each exposure. At the conclusion of each exposure, the gain of the EUT shall not have changed by more than ±1 dB. At the conclusion of the total test comprising the series of individual exposures, the EUT shall operate as intended with

no loss of user control functions or stored data, as declared by the manufacturer, and the gain of the EUT shall not have changed by more than ±1 dB.

10.3 Performance criteria for ancillary equipment

10.3.1 Performance criteria A for continuous phenomena for ancillary equipment

The EUT shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below the performance level specified by the manufacturer, when the apparatus is used as intended.

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

10.3.2 Performance criteria B for transient phenomena for ancillary equipment

The EUT shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below the performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible performance loss. During the test, degradation of performance is, however, allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation, as well as what the user may reasonably expect from the apparatus if used as intended.

10.3.3 Performance criteria C

Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls, or in the case of switching equipment, by normal subsequent use.

Annex A

Emission test level

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

See Tables A.1 and A.2.

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 3)
	230 to 1 000 MHz	Quasi-peak	47 dB (μV/m)		
	1 to 6 GHz	Peak Average	80 dB (μV/m) 60 dB (μV/m)		(Note 4)
	6 to 26.5 GHz	Average	60 dB (μV/m)		(Note 4)
	26.5 to 40 GHz	Average	60 dB (μV/m) or 69 dB (μV/m)		(Note 4) (Note 6)
Telecommunication ports (outdoor and indoor)					
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 1) (Note 2)
	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 1) (Note 2)
AC mains ports					
Conducted disturbance voltage	0.15 to 0.5 MHz	Quasi-peak Average	79 dB (μV) 66 dB (μV)	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	
	0.5 to 30 MHz	Quasi-peak Average	73 dB (μV) 60 dB (μV)		
Harmonic current emissions	–	–	–	[IEC 61000-3-2]	(Note 7)
	–	–	–	[IEC 61000-3-12]	(Note 8)
Voltage fluctuations and flicker	–	–	–	[IEC 61000-3-3]	(Note 7)
	–	–	–	[IEC 61000-3-11]	(Note 8)

Table A.1 – Equipment for telecommunication centre

	Frequency	Receiver Detector	Limit	Test method	Remarks
DC power ports					
Conducted disturbance voltage	0.15 to 0.5 MHz	Quasi-peak Average	79 dB (μV) 66 dB (μV)	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	(Note 5)
	0.5 to 30 MHz	Quasi-peak Average	73 dB (μV) 60 dB (μV)		
NOTE 1 – The limits decrease linearly with the logarithm of the frequency. NOTE 2 – Equivalent current limit can be applied. NOTE 3 – The limits are given for 10 m measurement distance in a semi-anechoic chamber (SAC), also converted limit can be applied for 3 m. NOTE 4 – The limits are given for 3 m measurement distance in a free space open area test site (FSOATS). [IEC CISPR 16-1-4] and [IEC CISPR 16-2-3] specify 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] applies. NOTE 5 – DC power port may be one for input or output, connecting to a local DC power network or to a power generating equipment (battery, photovoltaic (PV) system or oil generator) with a cable length exceeding 30 m. NOTE 6 – The limits are given for 1 m measurement distance in an FSOATS. NOTE 7 – It is applicable to electrical and electronic equipment having 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.					

Table A.2 – Equipment for customer premises and outside plant

	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 3)
	230 to 1000 MHz	Quasi-peak	37 dB (μV/m)		
	1 to 6 GHz	Peak Average	74 dB (μV/m) 54 dB (μV/m)		(Note 4)
	6 to 26.5 GHz	Average	54 dB (μV/m)		(Note 4)
	26.5 to 40 GHz	Average	54 dB (μV/m) or 64 dB (μV/m)		(Note 4) (Note 6)
Telecommunication ports (outdoor and indoor)					
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 1) (Note 2)
	0.5 to 30 MHz	Quasi-peak	74 dB (μV)		(Note 1)

Table A.2 – Equipment for customer premises and outside plant

	Frequency	Receiver Detector	Limit	Basic standard	Remarks
		Average or Quasi-peak Average	64 dB (μV) or 30 dB (μA) 20 dB (μA)		(Note 2)
AC mains ports					
Conducted disturbance voltage	0.15 to 0.5 MHz	Quasi-peak Average	66 to 56 dB (μV) 56 to 46 dB (μV)	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	
	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	–	–	–	[IEC 61000-3-2]	(Note 7)
	–	–	–	[IEC 61000-3-12]	(Note 8)
Voltage fluctuations and flicker	–	–	–	[IEC 61000-3-3]	(Note 7)
	–	–	–	[IEC 61000-3-11]	(Note 8)
DC power ports					
Conducted disturbance voltage	0.15 to 0.5 MHz	Quasi-peak Average	79 dB (μV) 66 dB (μV)	[IEC CISPR 16-1-2] [IEC CISPR 16-2-1]	(Note 5)
	0.5 to 30 MHz	Quasi-peak Average	73 dB (μV) 60 dB (μV)		

NOTE 1 – The limits decrease linearly with the logarithm of the frequency.

NOTE 2 – Equivalent current limit can be applied.

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

NOTE 4 – The limits are given for 3 m measurement distance in an FSOATS. [IEC CISPR 16-1-4] and [IEC CISPR 16-2-3] specify 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] applies.

NOTE 5 – 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.

NOTE 6 – The limits are given for 1 m measurement distance in an FSOATS.

NOTE 7 – It is applicable to electrical and electronic equipment having 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.

Annex B

Immunity test level

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

See Tables B.1 to B.3.

Table B.1 – Equipment for telecommunication centre

Environmental phenomena	Units	Test levels	Basic standard	Performance criteria	Remarks
Enclosure port					
Electrostatic discharge	kV kV	4 (contact) 4 (air)	[IEC 61000-4-2]	B	
Radio-frequency electromagnetic field	MHz V/m % amplitude modulation (AM) (1 kHz)	80~800 3 80	[IEC 61000-4-3]	A	
		800~960 10 80			
		960~1400 3 80			
		1 400~2 000 10 80			
		2 000~6 000 3 80			
Outdoor telecommunication ports (Note 1)					
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	[IEC 61000-4-4]	B	Note 3
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15 ~ 80 3 80	[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV kV	10/700 µs 0.5 (line to line) 1 (line to earth)	[IEC 61000-4-5]	B	Notes 5 and 7
Indoor telecommunication ports					
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	[IEC 61000-4-4]	B	Note 3

Table B.1 – Equipment for telecommunication centre

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80		[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV	1.2/50(8/20) 0.5 (line to earth)		[IEC 61000-4-5]	B	Notes 5 and 6
AC power port						
Fast transients	kV (T_r/T_h) ns kHz	1 5/50 5		[IEC 61000-4-4]	B	Note 3
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80		[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV kV	1.2/50(8/20) 0.5 (line to line) 1 (line to earth)		[IEC 61000-4-5]	B B	
Voltage dips & interruption	%reduction period	>95 0.5		[IEC 61000-4-11]	B	Note 8
		30 25			C	
		>95 250			C	
DC power port						
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5		[IEC 61000-4-4]	B	Note 3
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80		[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV kV	1.2/50(8/20) 0.5 (line to line) 1 (line to earth)		[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 dip	70	0.01		C (Notes 9, 10 and 13)	
			1			
		40	0.01			
			1			
	Voltage interruption	0	0.001			low and high impedance (output impedance of test generator)
			0.1			
			1			
			0.1		A	

Table B.1 – Equipment for telecommunication centre

<table>
<tr><th>Environmental phenomena</th><th>Units</th><th colspan="2">Test levels</th><th>Basic standard</th><th>Performance criteria</th><th>Remarks</th></tr>
<tr><td rowspan="3"></td><td rowspan="3">Voltage variation</td><td>From 100 to 90</td><td>10</td><td rowspan="3"></td><td rowspan="3"></td><td>The test simulates a change in the DC voltage from the nominal value to a lower value</td></tr>
<tr><td rowspan="2">From 100 to 110</td><td>0.1</td><td rowspan="2">The test simulates a change in the DC voltage from the nominal value to a higher value</td></tr>
<tr><td>10</td></tr>
<tr><td rowspan="2">Abnormal voltage</td><td>0-90</td><td>1</td><td rowspan="2">[IEC 61000-4-29]</td><td rowspan="2">C (Notes 11, 12 and 13)</td><td></td></tr>
<tr><td>110-125</td><td>1</td><td></td></tr>
</table>

NOTE 1 – Outdoor lines carrying DC power with superimposed signals are treated as outdoor signal lines.

NOTE 2 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 3 m.

NOTE 3 – The repetition rate is 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 4 – The test level can be defined as equivalent current into 150 Ω.

NOTE 5 – This test may not be applied for unscreened cable when appropriate CDN does not exist.

NOTE 6 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 10 m.

NOTE 7 – The line-to-line test is required only for unbalanced lines as recommended by [IEC 61000-4-5].

NOTE 8 – This test applies to equipment having a rated input current not exceeding 16 A per phase.

NOTE 9 – 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 is then taken into account. More detailed information about the service interruption is then provided by the manufacturer on the request of the operator.

NOTE 10 – 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 11 – Following the restoration of the supply to the normal voltage range, the power conversion and management systems automatically restore service. The equipment then resumes operation according to its specifications. The abnormal service voltage does not lead to the disconnection of the power supply e.g., by causing circuit breakers, fuses or other such devices to operate.

NOTE 12 – For equipment with a low priority of service, it is acceptable to use the following performance criteria during the test: Loss of function is allowed, the function can be restored by a manual operation of the user in accordance with the manufacturer's instructions. Functions and information protected by a battery backup shall not be lost.

NOTE 13 – This test is applicable only in equipment in which the battery backup is not permanently connected to the DC distribution system.

Table B.2 – Equipment for customer premises

Environmental phenomena	Units	Test levels	Basic standard	Performance criteria	Remarks
Enclosure port					
Electrostatic discharge	kV kV	4 (contact) 8 (air)	[IEC 61000-4-2]	B	
Radio-frequency electro-magnetic field	MHz V/m %AM (1 kHz)	80~800 3 80	[IEC 61000-4-3]	A	
		800~960 10 80			
		960~1400 3 80			
		1400~2000 10 80			
		2000~6000 3 80			
Outdoor telecommunication ports (Note 1)					
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	[IEC 61000-4-4]	B	Note 3
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15 ~ 80 3 80	[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV kV	10/700 us 0.5 (line to line) 1 (line to earth)	[IEC 61000-4-5]	B	Notes 5 and 7
Indoor telecommunication ports					
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5	[IEC 61000-4-4]	B	Note 3
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV	1.2/50(8/20) 0.5 (line to earth)	[IEC 61000-4-5]	B	Notes 5, 6 and 14
AC power port					
Fast transients	kV (T_r/T_h) ns kHz	1 5/50 5	[IEC 61000-4-4]	B	Note 3

Table B.2 – Equipment for customer premises

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80		[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV kV	1.2/50(8/20) 0.5(line to line) 1(line to earth)		[IEC 61000-4-5]	B B	
Voltage dips and interruption	%reduction period	>95 0.5		[IEC 61000-4-11]	B	Note 8
		30 25			C	
		>95 250			C	
DC power port						
Fast transients	kV (T_r/T_h) ns repetition rate kHz	0.5 5/50 5		[IEC 61000-4-4]	B	Note 3
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 10 80		[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV kV	1.2/50(8/20) 0.5 (line to line) 1 (line to earth)		[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 dip	70	0.01		C (Notes 9, 10 and 13)	
			1			
		40	0.01			
			1			
	Voltage interruption	0	0.001			low and high impedance (output impedance of test generator)
			0.1			
			1			
	Voltage variation	From 100 to 90	0.1		A	The test simulates a change in the DC voltage from the nominal value to a lower value
			10			
			0.1			The test

Table B.2 – Equipment for customer premises

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
		From 100 to 110	10			simulates a change in the DC voltage from the nominal value to a higher value
	Abnormal voltage	0-90	1	[IEC 61000-4-29]	C (Notes 11, 12 and 13)	
		110-125	1			

NOTE 1 – Outdoor lines carrying DC power with superimposed signals is be treated as outdoor signal lines.
NOTE 2 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 3 m.
NOTE 3 – The repetition rate is 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 4 – The test level can be defined as equivalent current into 150 Ω.
NOTE 5 – This test may not be applied for unscreened cable when appropriate CDN does not exist.
NOTE 6 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 10 m.
NOTE 7 – The line-to-line test is required only for unbalanced lines as recommended by [IEC 61000-4-5].
NOTE 8–This test applies to equipment having a rated input current not exceeding 16 A per phase.
NOTE 9 – 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 is then be taken into account. More detailed information about the service interruption is then be provided by the manufacturer on the request of the operator.
NOTE 10 – 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 11 – Following the restoration of the supply to the normal voltage range, the power conversion and management systems automatically restore service. The equipment thens resume operation according to its specifications. The abnormal service voltage does not lead to the disconnection of the power supply e.g., by causing circuit breakers, fuses or other such devices to operate.
NOTE 12 – For equipment with a low priority of service, it is acceptable to use the following performance criteria during the test: Loss of function is allowed, the function can be restored by a manual operation of the user in accordance with the manufacturer's instructions. Functions and information protected by a battery backup shall not be lost.
NOTE 13 – This test is applicable only in equipment in which the battery backup is not permanently connected to the DC distribution system.
NOTE 14 – The EUT is not be reset when the powered surge test be conducted for PoE.

Table B.3 – Equipment intended for outdoor locations

Environmental phenomena	Units	Test levels	Basic standard	Performance criteria	Remarks
Enclosure port					
Electrostatic discharge	kV kV	4 (contact) 8 (air)	[IEC 61000-4-2]	B	
Radio-frequency electro-magnetic field	MHz V/m %AM (1 kHz)	80~800 3 80	[IEC 61000-4-3]	A	
		800~960 10 80			
		960~1400 3 80			
		1400~2000 10 80			
		2000~6000 3 80			
Outdoor telecommunication ports (Note 1)					
Fast transients	kV (T_r/T_h) ns repetition rate kHz	1 5/50 5	[IEC 61000-4-4]	B	Note 3
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15 ~ 80 3 80	[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) μs kV kV	10/700 us 0.5 (line to line) 1 (line to earth)	[IEC 61000-4-5]	B	Notes 5 and 7
AC power port					
Fast transients	kV (T_r/T_h) ns kHz	1 5/50 5	[IEC 61000-4-4]	B	Note 3
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80	[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) μs kV kV	1.2/50(8/20) 1 (line to line) 2 (line to earth)	[IEC 61000-4-5]	B B	
Voltage dips and interruption	%reduction period	>95 0.5	[IEC 61000-4-11]	B	Note 8
		30 25		C	
		>95 250		C	
DC power port					
Fast transients	kV (T_r/T_h) ns	0.5 5/50	[IEC 61000-4-4]	B	Note 3

Table B.3 – Equipment intended for outdoor locations

Environmental phenomena	Units	Test levels		Basic standard	Performance criteria	Remarks
	repetition rate kHz	5				
Radio-frequency conducted continuous	MHz V %AM (1 kHz)	0.15~80 3 80		[IEC 61000-4-6]	A	Note 4
Surges	(T_r/T_h) µs kV kV	1.2/50(8/20) 1 (line to line) 2 (line to earth)		[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 dip	70	0.01		C (Notes 9, 10 and 13)	
			1			
		40	0.01			
			1			
	Voltage interruption	0	0.001			Low and high impedance (output impedance of test generator)
			0.1			
			1			
	Voltage variation	From 100 to 90	0.1		A	The test simulates a change in the DC voltage from the nominal value to a lower value
			10			
		From 100 to 110	0.1			The test simulates a change in the DC voltage from the nominal value to a higher value
			10			
	Abnormal voltage	0-90	1	[IEC 61000-4-29]	C (Notes 11, 12 and 13)	
		110-125	1			

NOTE 1 – Outdoor lines carrying DC power with superimposed signals is treated as outdoor signal lines.
NOTE 2 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 3 m.
NOTE 3 – The repetition rate is 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 4 – The test level can be defined as equivalent current into 150 Ω.
NOTE 5 – This test may not be applied for unscreened cable when appropriate CDN does not exist.
NOTE 6 – Only applies when the overall cable length between the EUT and another item of active equipment may be greater than 10 m.
NOTE 7 – The line-to-line test is required only for unbalanced lines as recommended by [IEC 61000-4-5].
NOTE 8 –This test applies to equipment having a rated input current not exceeding 16 A per phase.

Table B.3 – Equipment intended for outdoor locations

Environmental phenomena	Units	Test levels	Basic standard	Performance criteria	Remarks
NOTE 9 – 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 is then taken into account. More detailed information about the service interruption is then provided by the manufacturer on the request of the operator. NOTE 10 – 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 11 – Following the restoration of the supply to the normal voltage range, the power conversion and management systems automatically restore service. The equipment then resumes operation according to its specifications. The abnormal service voltage does not lead to the disconnection of the power supply e.g., by causing circuit breakers, fuses or other such devices to operate. NOTE 12 – For equipment with a low priority of service, it is acceptable to use the following performance criteria during the test: Loss of function is allowed, the function can be restored by a manual operation of the user in accordance with the manufacturer's instructions. Functions and information protected by a battery backup shall not be lost. NOTE 13 – This test is applicable only in equipment in which the battery backup is not permanently connected to the DC distribution system.					

Annex C

Equipment within the scope of this Recommendation

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

This Recommendation covers types of BS digital cellular mobile communication equipment as set out in clauses C.1 to C.7.

C.1 Base station equipment for IMT-2000 CDMA DirectSpread (UTRA)

This Recommendation applies to 3rd Generation Partnership Project (3GPP) (UTRA) radio equipment intended for use in digital cellular mobile radio services. Specifications for BS equipment within the scope of this Recommendation are found in the following functional radio Technical Specifications:

– [ETSI TS 125 104];

– [ETSI TS 125 105];

– [ETSI TS 125 106].

C.2 Base station equipment for E-UTRA, E-UTRA with NB-IoT or Standalone NB-IoT

This Recommendation applies to 3GPP (UTRA) radio equipment intended for use in digital cellular mobile radio services. Definitions for BS equipment within the scope of this Recommendation are found in the following functional radio Technical Specifications:

– E-UTRA BSs meeting the requirements of [ETSI TS 136 104], with conformity demonstrated by compliance with [ETSI TS 136 141];

– E-UTRA repeaters meeting the requirements of [ETSI TS 136 106], with conformity demonstrated by compliance with [ETSI TS 136 143].

C.3 GSM base station, ancillary RF amplifiers, and GSM repeaters meeting Phase 2 and 2+

This Recommendation applies to GSM BSs meeting Phase 2 and 2+ requirements of the GSM digital cellular telecommunications system, and operating in the P-GSM 900 MHz, E-GSM 900 MHz or digital cellular system (DCS) 1 800 MHz bands.

C.4 Other types of GSM base station, ancillary RF amplifiers, and GSM repeaters equipment

This Recommendation is also applicable to:

– equipment that operates in other frequency bands, provided that the performance requirements (other than operating frequency) are the same as the Phase 2 or 2+ GSM requirements;

– equipment that is designed to meet Phase 1 GSM requirements, provided that it also meets the Phase 2 or 2+ GSM requirements.

NOTE – This provision is particularly intended for equipment that is designed to meet either the Phase 1 or the Phase 2 or 2+ GSM requirements by a change of software.

C.5 Multi-standard radio base station equipment

This Recommendation applies to MSR BS equipment intended for use in digital cellular mobile radio services. Definitions for BS equipment within the scope of this Recommendation are found in the following functional radio Technical Specifications:

– the requirements of [ETSI TS 137 104], with conformity demonstrated by compliance with [ETSI TS 137 141].

C.6 CDMA 1x spread spectrum base stations, repeaters and ancillary equipment

This Recommendation covers types of BSs and repeaters using CDMA 1x spread spectrum technology and associated ancillary equipment. Specifications of examples of BS equipment within the scope of this Recommendation are found in the following functional radio specifications:

– IMT-2000 CDMA multi-carrier radio equipment intended for use in digital cellular mobile radio services operating in any of the band classes described in [TIA-97-E-1];

– CDMA-PAMR radio equipment operating in one or more of the band classes specified in [TIA-97-E-1];

– [ETSI EN 301 908-5];

– [ETSI EN 301 908-7];

– [ETSI EN 301 449];

– [ETSI EN 302 426].

C.7 Base station equipment for NR

This Recommendation applies to 3GPP NR equipment intended for use in digital cellular mobile radio services. Specifications for BS equipment within the scope of this Recommendation are found in the following functional radio Technical Specifications:

– NR BSs meeting the requirements of [ETSI TS 138 104], with conformity demonstrated by compliance with [ETSI TS 138 141-1] and [ETSI TS 138 141-2];

Annex D

Test guide of radiated emission for wireless base station

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

The measurement instruments, test site and test methods shall conform to the requirements of [IEC CISPR 32] and the test setup and test arrangement should conform to clauses 7 and 8. This annex gives additional guidance for radiated emission.

D.1 Software of EUT

The software of EUT during the test should fully control the configuration of a BS, which may be considered to include but not limited to:

– work mode of EUT: idle mode or traffic mode;

– radiofrequency channel configuration;

– number of carrier frequencies, number of RATs, number of bands;

– radio power adjustment;

– signal coding, necessary bandwidth and modulation adjustment.

D.2 Reduce overload of test receiver

To reduce the overload by the wireless signal of a BS, the special test auxiliary RF components should be included but not limited to:

– RF coaxial attenuator connected after test antenna to attenuate the receiver power of carriers to reduce the overload effect of the receiver – the attenuator should be 6 dB or more;

– band-block or notching filters connected after antenna if the overload still appears even coaxial attenuator was used – the attenuator for radio power should be 50 dB or more;

– high-pass filters also to reduce the overload effect of the receiver for high test frequency above 1 GHz;

– low-pass filters also to reduce the overload effect of the receiver for high test frequency below 1 GHz.

Annex E of [IEC CISPR 32] provides the procedure for detection of the appearance of overload of the receiver.

D.3 Pre-test for radiated emission

The purposes of a pre-test measurement are to determine the frequencies at which an EUT produces the highest level of emissions and to help select the configuration(s) to be used in the formal measurements.

The pre-test should be performed on various EUT configurations to find the worst-case configurations that produce the highest amplitudes with respect to the limit. These configurations should then be used during final measurements. The number of configurations to be considered is dependent upon the complexity of the BS, including: number of carriers; number of RATs; number of bands; type of work mode: idle or traffic; type of backhaul: wireless or optical; and type of power supply: AC or DC.

This pre-test should also be performed to distinguish radiated emission from unwanted emission including radiated spurious emission and out-of-band emission. Before the test, the test carrier frequencies of the BS should be recorded and most spurious emission can be calculated in advance: harmonic emissions; parasitic emissions; intermediation products; and frequency conversion

products. These spurious emissions reduce rapidly when BSs transfer work mode from traffic to idle or power off the radio unit. Alternatively, if the RF channel of the carrier is changed, the spurious emission frequencies will change synchronously but not for radiated emission frequencies from digital units. The spurious components should be recorded in the pre-test and ignored in the final test.

Therefore, a quick and simple procedure, according to the different kinds of BS, should be established for comparative purposes so that the impact of varying the configuration can be found.

Appendix I

Test guide for the OTA AAS BS

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

I.1 EMF protection during EMC test

The antenna of the OTA AAS BS is integrated on to the printed circuit board, and cannot be removed to use a coaxial cable to connect to a UE simulator. So, during the EMC test, it only can use an air interface to build a communication link with the user simulator equipment. The typical field strength built by radio power transmitted from the antenna of the OTA AAS BS maybe larger than the electromagnetic field (EMF) exposure limit in the front direction that is specified by [b-ICNIRP]. The ICNIRP limit is listed in Table I.1.

Table I.1 – ICNIRP EMF exposure limit

Power density (W/m^2)		
10 to 400 (MHz)	400 to 2 000 (MHz)	2 000 to 10 000 (MHz)
28	$1.375f^{1/2}$	61

For test operator safety, different methods can prevent high EMF exposure.

RE and RS tests are done in an anechoic chamber, where there is no EMF exposure risk. For all the other EMC test items, they can be done in a shielding room or anechoic chamber to avoid EMF exposure. The test operator will perform the EMC test outside the shielding room or anechoic chamber, the test method in a shielding room or anechoic chamber as show in Figure I.1.

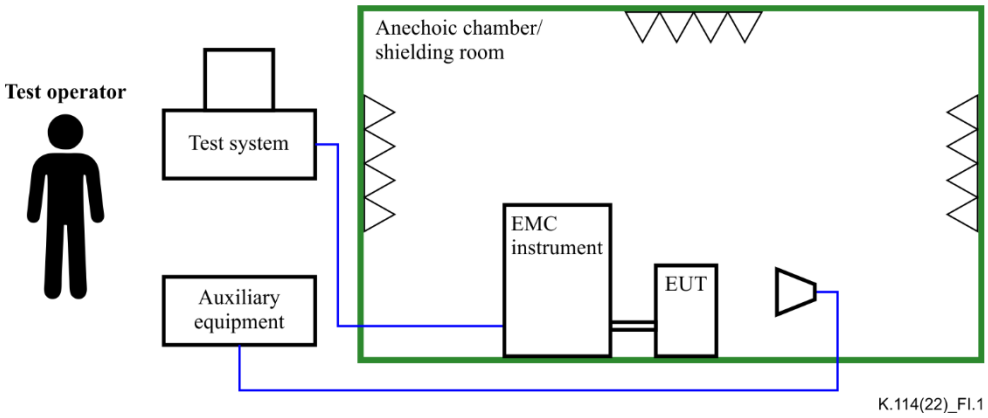


Figure I.1 – Test method in a shielding room or anechoic chamber

Also in some test laboratories the test instrument cannot be moved into the shielding room or anechoic chamber; in this situation, a shielding and absorbing box can be used to cover the antenna array of OTA AAS BS after the BS is connected to the test instrument. The antenna of the OTA AAS BS faces the inside of the box so that the maximum transmit power of the antenna can be shielded and absorbed by it. Outside the box, the operator can use EMF detection equipment to check whether the EMF exposure is under the EMF exposure requirement. See Figure I.2.

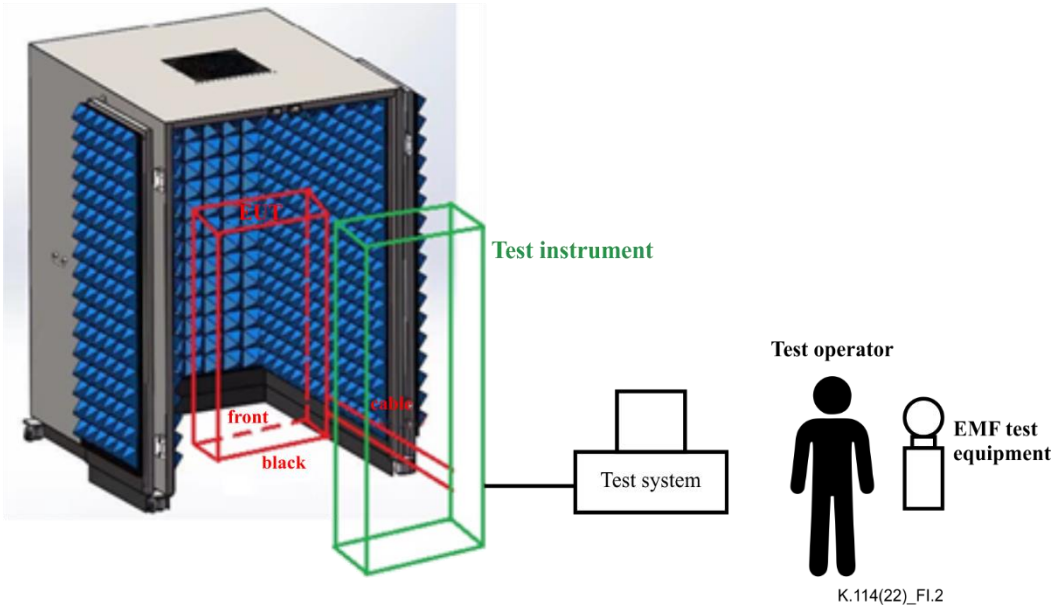


Figure I.2 – Test method in a shielding box

I.2 Receiver protection during radiated immunity test

While an OTA AAS BS undergoes the radiated immunity test, the receiver of the BS may be influenced by the output of the amplifier of the test instrument, in this situation, a high-power notch filter can be added before the output port of the amplifier, which filter band is as same as the exclusion band of the receiver. With this notch filter, the impact of output of the amplifier when it comes into operation can be eliminated or relieved, and cannot influence the receiver of the OTA AAS BS.

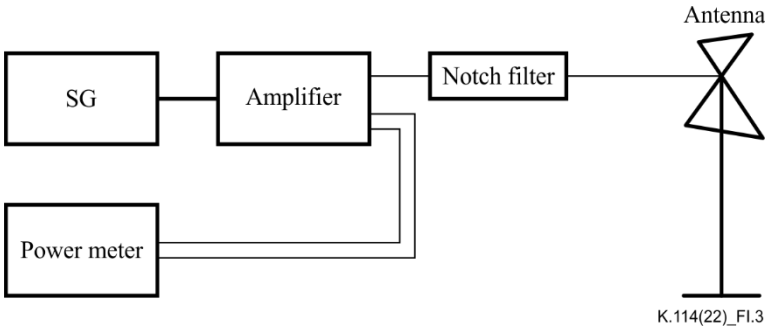


Figure I.3 – Radiated immunity test with notch filter

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[1] Superseded.

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