

ETSI EN 301 489-50 V2.4.1 (2025-09)



**ElectroMagnetic Compatibility (EMC)
standard for radio equipment and services;
Part 50: Specific conditions for Cellular Communication
Base Station (BS), repeater and ancillary equipment;
Harmonised Standard for ElectroMagnetic Compatibility**

Reference

REN/ERM-EMC-410

Keywords

5G, EMC, GSM, harmonised standard, LTE, MSR,
NR, OFDMA, WCDMA, WMAN

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
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Foreword

This Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.15] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

The present document is part 50 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

National transposition dates	
Date of adoption of this EN:	3 September 2025
Date of latest announcement of this EN (doa):	31 December 2025
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 June 2026
Date of withdrawal of any conflicting National Standard (dow):	30 June 2027

Modal verbs terminology

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1 Scope

The present document specifies technical characteristics and methods of measurements in respect of ElectroMagnetic Compatibility (EMC) for the following equipment types:

- 1) digital cellular base station equipment, including BS with antenna ports and BS without antenna ports;
- 2) repeaters;
- 3) associated ancillary equipment.

Including individual and combinations of technologies listed in table 1.

Table 1: Cellular Mobile Communication Technologies

Technology (Air technology)	Technology Generation	Standard SET	ETSI Standard
GSM (GSM/EDGE)	2G/3G	IMT-2000 SC (single carrier)	ETSI EN 301 502 [i.18] ETSI TS 137 104 [20] ETSI TS 137 141 [11]
CDMA 2000	3G	CDMA2000 (IMT-MC multi carrier)	ETSI EN 301 526 [i.2] ETSI EN 301 908-5 [i.7] ETSI EN 301 908-7 [i.8] ETSI EN 301 449 [i.11] ETSI EN 302 426 [i.12]
UMTS (UTRA, W-CDMA)	3G	IMT-2000 Direct Spread	ETSI TS 125 104 [27] ETSI TS 125 105 [28] ETSI TS 125 106 [i.5]
LTE (E-UTRA) (see note 1)	4G	IMT-advanced	ETSI TS 136 104 [5] ETSI TS 136 141 [6] ETSI TS 136 106 [i.6] ETSI TS 136 143 [i.21]
LTE (E-UTRA), AAS (see note 1)	4G	IMT-advanced	ETSI TS 136 104 [5] ETSI TS 137 145-1 [12] ETSI TS 137 145-2 [13]
MSR (see note 2)	4G	IMT-advanced	ETSI TS 137 104 [20] ETSI TS 137 141 [11]
MSR Hybrid AAS (see note 3)	4G	IMT-advanced	ETSI TS 137 105 [i.22] ETSI TS 137 145-1 [12] ETSI TS 137 145-2 [13]
MSR OTA AAS (see note 3)	4G	IMT-advanced	ETSI TS 137 105 [i.22] ETSI TS 137 145-2 [13]
WMAN (OFDMA)	3G	IMT-2000 OFDMA	ETSI EN 301 908-20 [i.19] ETSI EN 301 908-22 [i.20]
NR (1-C, 1-H) (see note 4)	5G	IMT-advanced	ETSI TS 138 104 [19] ETSI TS 138 141-1 [9] ETSI TS 138 141-2 [16]
NR (1-O, 2-O)	5G	IMT-advanced	ETSI TS 138 104 [19] ETSI TS 138 141-2 [16]
Standalone NB-IoT	4G	IMT-2000	ETSI TS 136 104 [5]
NOTE 1: Including LAA, in-band NB-IoT or guard band NB-IoT. NOTE 2: Combination of technologies GSM, W-CDMA, LTE and NR. NOTE 3: Combination of technologies W-CDMA, LTE and NR. NOTE 4: Including in-band NB-IoT.			

Technical specifications related to conducted emission EMC requirements below 9 kHz on the AC mains port of radio equipment are not included in the present document.

NOTE 1: Such technical specifications are normally found in the relevant product family standards for AC mains powered equipment (e.g. EN 61000-3-2 [i.16] and EN 61000-3-3 [i.17]).

Technical specifications related to the antenna port and emissions from the enclosure port of Base Station (BS), combinations of radio and associated ancillary equipment or repeaters are not included in the present document. Such technical specifications are found in the relevant product standards for the effective use of the radio spectrum.

The environmental classification and the emission and immunity requirements used in the present document are as stated in ETSI EN 301 489-1 [1], except for any special conditions included in the present document.

NOTE 2: The relationship between the present document and essential requirements of article 3.1(b) of Directive 2014/53/EU [i.1] is given in Annex A.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

- [1] [ETSI EN 301 489-1 \(V2.2.3\) \(11-2019\)](#): "ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard for ElectroMagnetic Compatibility".
- [2] [ETSI TS 125 141 \(V18.0.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); Base Station (BS) conformance testing (FDD) (3GPP TS 25.141 version 18.0.0 Release 18)".
- [3] [ETSI TS 125 142 \(V18.0.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); Base Station (BS) conformance testing (TDD) (3GPP TS 25.142 version 18.0.0 Release 18)".
- [4] [ETSI TS 145 005 \(V18.0.0\) \(05-2024\)](#): "Digital cellular telecommunications system (Phase 2+) (GSM); GSM/EDGE Radio transmission and reception (3GPP TS 45.005 version 18.0.0 Release 18)".
- [5] [ETSI TS 136 104 \(V18.5.0\) \(05-2024\)](#): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (3GPP TS 36.104 version 18.5.0 Release 18)".
- [6] [ETSI TS 136 141 \(V18.4.0\) \(05-2024\)](#): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing (3GPP TS 36.141 version 18.4.0 Release 18)".
- [7] Void.
- [8] [ETSI TS 151 021 \(V18.0.0\) \(05-2024\)](#): "Digital cellular telecommunications system (Phase 2+) (GSM); Base Station System (BSS) equipment specification; Radio aspects (3GPP TS 51.021 version 18.0.0 Release 18)".
- [9] [ETSI TS 138 141-1 \(V18.5.0\) \(05-2024\)](#): "5G; NR; Base Station (BS) conformance testing Part 1: Conducted conformance testing (3GPP TS 38.141-1 version 18.5.0 Release 18)".
- [10] [ETSI TS 138 101-4 \(V17.12.0\) \(05-2024\)](#): "5G; NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements (3GPP TS 38.101-4 version 17.12.0 Release 17)".
- [11] [ETSI TS 137 141 \(V18.5.0\) \(05-2024\)](#): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; NR, E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) conformance testing (3GPP TS 37.141 version 18.5.0 Release 18)".

- [12] [ETSI TS 137 145-1 \(V18.5.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); LTE; 5G; Active Antenna System (AAS) Base Station (BS) conformance testing; Part 1: conducted conformance testing (3GPP TS 37.145-1 version 18.5.0 Release 18)".
- [13] [ETSI TS 137 145-2 \(V18.5.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); LTE; 5G; Active Antenna System (AAS) Base Station (BS) conformance testing; Part 2: radiated conformance testing (3GPP TS 37.145-2 version 18.5.0 Release 18)".
- [14] Void.
- [15] Void.
- [16] [ETSI TS 138 141-2 \(V18.5.0\) \(05-2024\)](#): "5G; NR; Base Station (BS) conformance testing Part 2: Radiated conformance testing (3GPP TS 38.141-2 version 18.5.0 Release 18)".
- [17] Void.
- [18] Void.
- [19] [ETSI TS 138 104 \(V18.5.0\) \(05-2024\)](#): "5G; NR; Base Station (BS) radio transmission and reception (3GPP TS 38.104 version 18.5.0 Release 18)".
- [20] [ETSI TS 137 104 \(V18.5.0\) \(05-2024\)](#): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; NR, E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception (3GPP TS 37.104 version 18.5.0 Release 18)".
- [21] [ETSI TS 125 101 \(V18.0.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (FDD) (3GPP TS 25.101 version 18.0.0 Release 18)".
- [22] [ETSI TS 125 102 \(V18.0.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (TDD) (3GPP TS 25.102 version 18.0.0 Release 18)".
- [23] [ETSI TS 136 101 \(V18.5.0\) \(06-2024\)](#): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (3GPP TS 36.101 version 18.5.0 Release 18)".
- [24] Void.
- [25] [ETSI TS 151 010-1 \(V13.14.0\) \(06-2024\)](#): "Digital cellular telecommunications system (Phase 2+) (GSM); Mobile Station (MS) conformance specification; Part 1: Conformance specification (3GPP TS 51.010-1 version 13.14.0 Release 13)".
- [26] Void.
- [27] [ETSI TS 125 104 \(V18.0.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); Base Station (BS) radio transmission and reception (FDD) (3GPP TS 25.104 version 18.0.0 Release 18)".
- [28] [ETSI TS 125 105 \(V18.0.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); Base Station (BS) radio transmission and reception (TDD) (3GPP TS 25.105 version 18.0.0 Release 18)".
- [29] [ETSI TS 137 113 \(V18.1.0\) \(05-2024\)](#): "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; NR, E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) Electromagnetic Compatibility (EMC) (3GPP TS 37.113 version 18.1.0 Release 18)".
- [30] [ETSI TS 137 114 \(V18.1.0\) \(05-2024\)](#): "Universal Mobile Telecommunications System (UMTS); LTE; Active Antenna System (AAS) Base Station (BS) Electromagnetic Compatibility (EMC) (3GPP TS 37.114 version 18.1.0 Release 18)".
- [31] [EN 55032:2015 + Amendment A11 \(2020\) + Amendment A1 \(2020\)](#): "Electromagnetic compatibility of multimedia equipment - Emission Requirements", (produced by CENELEC).

- [32] [EN IEC 61000-4-3:2020](#): "Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test", (produced by CENELEC).

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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- [i.1] [Directive 2014/53/EU](#) of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.
- [i.2] ETSI EN 301 526 (V1.1.1) (07-2006): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Harmonized EN for CDMA spread spectrum mobile stations operating in the 450 MHz cellular band (CDMA 450) and 410, 450 and 870 MHz PAMR bands (CDMA-PAMR) covering essential requirements of article 3.2 of the R&TTE Directive".
- [i.3] Void.
- [i.4] Void.
- [i.5] ETSI TS 125 106 (V18.0.0) (05-2024): "Universal Mobile Telecommunications System (UMTS); UTRA repeater radio transmission and reception (3GPP TS 25.106 version 18.0.0 Release 18)".
- [i.6] ETSI TS 136 106 (V18.0.0) (05-2024): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); FDD repeater radio transmission and reception (3GPP TS 36.106 version 18.0.0 Release 18)".
- [i.7] ETSI EN 301 908-5 (V5.2.1) (09-2011): "IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 5: CDMA Multi-Carrier (cdma2000) Base Stations (BS)".
- [i.8] ETSI EN 301 908-7 (V4.2.1) (03-2010): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 7: Harmonized EN for IMT-2000, CDMA TDD (UTRA TDD and E-UTRA TDD) (BS) covering the essential requirements of article 3.2 of the R&TTE Directive".
- [i.9] Void.
- [i.10] Void.
- [i.11] ETSI EN 301 449 (V1.1.1) (07-2006): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Harmonized EN for CDMA spread spectrum base stations operating in the 450 MHz cellular band (CDMA 450) and 410, 450 and 870 MHz PAMR bands (CDMA-PAMR) covering essential requirements of article 3.2 of the R&TTE Directive".
- [i.12] ETSI EN 302 426 (V1.1.1) (09-2006): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Harmonized EN for CDMA spread spectrum Repeaters operating in the 450 MHz cellular band (CDMA450) and the 410 MHz, 450 MHz and 870 MHz PAMR bands (CDMA-PAMR) covering essential requirements of article 3.2 of the R&TTE Directive".
- [i.13] Void.
- [i.14] Void.

- [i.15] [Commission Implementing Decision C\(2015\) 5376](#) final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.
- [i.16] [EN IEC 61000-3-2:2019/A1:2021](#): "Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)", (produced by CENELEC).
- [i.17] [EN 61000-3-3:2013/A2:2021](#): "Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection", (produced by CENELEC).
- [i.18] ETSI EN 301 502 (V12.5.2) (03-2017): "Global System for Mobile communications (GSM); Base Station (BS) equipment; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU".
- [i.19] ETSI EN 301 908-20 (V6.3.1) (05-2016): "IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 20: OFDMA TDD WMAN (Mobile WiMAX™) TDD Base Stations (BS)".
- [i.20] ETSI EN 301 908-22 (V6.1.1) (07-2016): "IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU; Part 22: OFDMA TDD WMAN (Mobile WiMAX™) FDD Base Stations (BS)".
- [i.21] ETSI TS 136 143 (V18.0.0) (05-2024): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); FDD repeater conformance testing (3GPP TS 36.143 version 18.0.0 Release 18)".
- [i.22] ETSI TS 137 105 (V18.4.0) (05-2024): "Universal Mobile Telecommunications System (UMTS); LTE; 5G; Active Antenna System (AAS) Base Station (BS) transmission and reception (3GPP TS 37.105 version 18.4.0 Release 18)".
- [i.23] EN IEC 61000-6-3 (2021): "Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for equipment in residential environments".
- [i.24] IEC TR 61000-2-5 (2017): "Electromagnetic compatibility (EMC) - Part 2-5: Environment - Description and classification of electromagnetic environments".
- [i.25] [EN 55016-2-3:2017/A1:2019](#): "Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity Radiated disturbance measurements", (produced by CENELEC).
- [i.26] [EN IEC 61000-4-6:2023](#): "Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields", (produced by CENELEC).
- [i.27] [EN 61000-4-4:2012](#): "Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test", (produced by CENELEC).
- [i.28] [ETSI TS 145 008 \(V18.0.0\) \(05-2024\)](#): "Digital cellular telecommunications system (Phase 2+) (GSM); GSM/EDGE Radio subsystem link control (3GPP TS 45.008 version 18.0.0 Release 18)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI EN 301 489-1 [1] and the following apply:

active antenna system base station: base station system which combines an antenna array with a transceiver unit array and a radio distribution network

antenna array: group of radiating elements characterized by the geometry and the properties of the array elements

base station: radio equipment intended for operation at a fixed location which is not defined as portable equipment

base station type 1-C: NR base station operating at FR1 with requirements set consisting only of conducted requirements defined at individual antenna port

base station type 1-H: NR base station operating at FR1 with a requirement set consisting of conducted requirements defined at individual TAB connectors and OTA requirements defined at RIB

NOTE: BS type 1-H is treated as a BS type 1-C in EMC assessment. See figure 1b.

base station type 1-O: NR base station operating at FR1 with a requirement set consisting only of OTA requirements defined at the RIB

base station type 2-O: NR base station operating at FR2 with a requirement set consisting only of OTA requirements defined at the RIB

bearer: information transmission path of defined characteristics for transfer of user data or predefined test data

CDMA-PAMR: Public Access Mobile Radio system based on CDMA Spreading Rate 1 specifications

channel bandwidth: RF bandwidth supporting a single E-UTRA RF carrier with the transmission bandwidth configured in the uplink or downlink of a cell

NOTE: The channel bandwidth is measured in MHz and is used as a reference for transmitter and receiver RF requirements.

downlink: unidirectional radio link for the transmission of signals from a UTRAN access point to a UE

hybrid AAS BS: AAS BS which has both a conducted RF interface and a radiated RF interface in the far field and conforms to a hybrid requirements set

NOTE: For NR operation in MSR, a hybrid AAS BS corresponds to NR type 1-H.

hybrid requirements set: complete set of requirements applied to a *hybrid AAS BS* with both conducted and radiated requirements

International Mobile Telecommunications-2000 (IMT-2000): third generation mobile systems which provide access, by means of one or more radio links, to a wide range of telecommunications services supported by the fixed telecommunication networks (e.g. PSTN, ISDN or IP), and to other services which are specific to mobile users

License Assisted Access (LAA): License Assisted Access LTE based base station operating in unlicensed frequency spectrum

maximum throughput: maximum achievable throughput for a reference measurement channel

MB Base Station: base station which is characterized by the ability of its transmitter and/or receiver to process two or more carriers in common active RF components simultaneously, where at least one carrier is configured at a different non-overlapping operating band than the other carrier(s)

MSR Base Station: base station which is characterized by the ability of its receiver and transmitter to process two or more carriers in common active RF components simultaneously in a declared RF bandwidth, where at least one carrier is of a different RAT than the other carrier(s)

multiple unit BS: radio base station consisting of separate radio digital unit and the radio unit

NOTE: See figure 1a.

NB-IoT guard band operation: operation of NB-IoT guard band utilizing the unused resource block(s) within an E-UTRA carrier's guard-band

NB-IoT In-band operation: operation of NB-IoT in-band utilizing the resource block(s) within a normal E-UTRA carrier

NB-IoT standalone operation: 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

operating band: frequency range in which a wireless service operates (paired or unpaired), that is defined with a specific set of technical requirements

OTA AAS BS: AAS BS which has ≥ 8 transceiver units for E-UTRA or MSR and ≥ 4 transceiver units for UTRA per cell and has a radiated RF interface only and conforms to the OTA requirements set

NOTE: OTA AAS BS has no accessible antenna port. See figure 1c. For NR operation in MSR, an OTA AAS BS corresponds to an NR type 1-O BS.

OTA requirements set: complete set of OTA requirements applied to an OTA AAS BS

Radio Configuration (RC): 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

radio digital unit: equipment which contains base band and functionality for controlling Radio unit

NOTE: See figures 1a and 1b.

Radio Distribution Network (RDN): linear passive network which distributes the RF power generated by the transceiver unit array to the antenna array, and/or distributes the radio signals collected by the antenna array to the transceiver unit array

radio equipment: *"An electrical or electronic product, which intentionally emits and/or receives radio waves for the purpose of radio communication and/or radio determination, or an electrical or electronic product which must be completed with an accessory, such as antenna, so as to intentionally emit and/or receive radio waves for the purpose of radio communication and/or radio determination"*, definition from Directive 2014/53/EU [i.1].

NOTE 1: It can be operated with ancillary equipment but if so, is not dependent on it for basic functionality.

NOTE 2: It contains radio digital unit and radio unit.

radio unit: equipment which contains transmitter and receiver

NOTE: See figures 1a and 1b.

repeater: device with two RF ports, both of which are intended to be connected to antennas, which is capable of receiving, amplifying and transmitting simultaneously in one direction a signal in a BSS transmit band and in the other direction a signal in the corresponding BSS receive band

reverse CDMA channel: CDMA channel from the mobile station to the base station

NOTE: From the base station's perspective, the Reverse CDMA Channel is the sum of all mobile station transmissions on a CDMA frequency assignment.

RXQUAL: measure of the received signal quality, which is generated by the base station for use as a criterion in the RF power control and handover processes

NOTE: The characteristics and requirements are specified in ETSI TS 145 008 [i.28], clause 8.2.

TAB port: conducted interface between the transceiver unit array and the composite antenna

throughput: number of payload bits successfully received per second for a reference measurement channel in a specified reference condition

uplink: 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

wired network port: point of connection for voice, data and signalling transfers intended to interconnect widely dispersed systems by direct connection to a single-user or multi-user communication network (for example CATV, PSTN, ISDN, xDSL, LAN and similar networks)

NOTE: These ports may support screened or unscreened cables, if the relevant communication specifications allow (for example IEEE 802.3 af/at/bt, etc.) and may also carry AC or DC power where this is an integral part of the telecommunication specification (for example PoE and similar networks).

Base Station

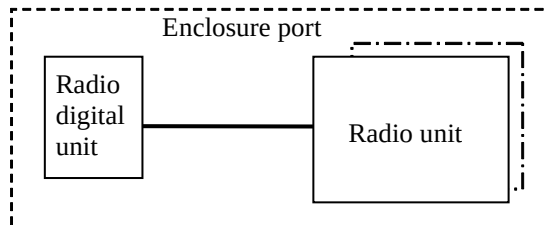


Figure 1a: Example of BS with multiple units

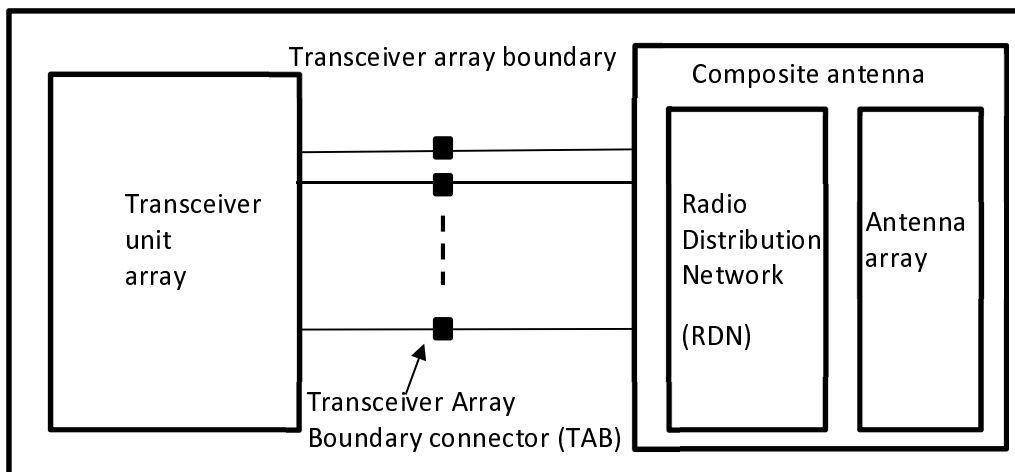


Figure 1b: Radio Unit for AAS BS type 1-C and 1-H

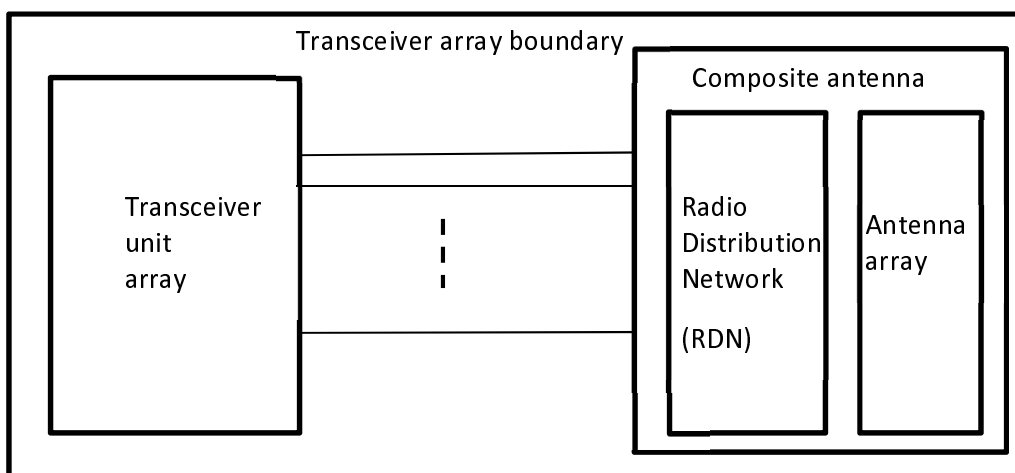


Figure 1c: Radio Unit for OTA AAS BS type and 1-O or 2-O

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI EN 301 489-1 [1] and the following apply:

AAS	Active Antenna System
ARFCN	Absolute Radio Frequency Channel Number
BCCH	Broadcast Control Channel
BER	Bit Error Ratio
BLER	Block Error Ratio
BSC	Base Station Controller
BSS	Base Station System
BTS	Base Transceiver Station
BW _{Channel}	Channel bandwidth
CDMA	Code Division Multiple Access
CRC	Cyclic Redundancy Check
CS	Capability Set
DL	DownLink
EARFCN	E-UTRA Absolute Radio Frequency Channel Number
EPC	Evolved Packet Core
EUT	Equipment Under Test
E-UTRA	Evolved Universal Terrestrial Radio Access
FDD	Frequency Division Duplex
FER	Frame Error Rate
FR1	Frequency range 450 MHz to 6 000 MHz
FR2	Frequency range 24 250 MHz to 52 600 MHz
FRC	Fixed Reference Channel
FSOATS	Free Space Open Area Test Site
GSM	Global System for Mobile communications
HW	HardWare
IMT	International Mobile Telecommunications
IMT-2000	International Mobile Telecommunications 2000
IP	Internet Protocol
ISDN	Integrated Services Digital Network
Iub	Interface between RNC and BS
LAA	License Assisted Access
LTE	Long Term Evolution
MB	Multi-Band
MC	Multi-Carrier
MSR	Multi Standard Radio
NB-IoT	Narrow Band Internet of Things
NR	New Radio
OFDMA	Orthogonal Frequency-Division Multiple Access
OTA	Over The Air
PAMR	Public Access Mobile Radio
PSTN	Public Switched Telephone Network
RAT	Radio Access Technology
RC	Radio Configuration
RDN	Radio Distribution Network
RIB	Radiated Interface Boundary
RNC	Radio Network Controller
RXQUAL	Received signal QUALity
SAC	Semi Anechoic Chamber
SC	Single Carrier
TAB	Transceiver Array Boundary
TCH	Traffic CHannel
TCH/FS	Full rate Speech TCH
TDD	Time Division Duplex

TM	Test Model
TRX	Transceiver
UARFCN	UTRA Absolute Radio Frequency Channel Number
UE	User Equipment
UL	UpLink
UMTS	Universal Mobile Telecommunications System
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial Radio Access Network
WCDMA	Wide Code Division Multiple Access
WMAN	Wireless Metropolitan Area Network

4 Test conditions

4.1 General

For the purpose of the present document, the test conditions of ETSI EN 301 489-1 [1], clause 4, shall apply as appropriate.

The base station, repeater and ancillary equipment shall be tested in the normal test environment as specified below:

- The test shall be performed within the minimum and maximum limits of the conditions stated in table 2.

Table 2: Limits of conditions for Normal Test Environment

Condition (see note)	Minimum	Maximum
Barometric pressure	86 kPa	106 kPa
Temperature	15 °C	35 °C
Relative Humidity excluding ESD test	20 %	85 %
Relative Humidity for ESD test	30 %	60 %
Power supply	Nominal	
NOTE: The ranges of barometric pressure, temperature and humidity represent the maximum variation expected in the uncontrolled environment of a test laboratory.		

Additional product related test conditions are specified in the present document in clauses 4.2.0 to 4.2.5.

4.2 Arrangements for establishing a communication link

4.2.0 Specification of Channel Number

The provisions of ETSI EN 301 489-1 [1], clause 4.2 shall apply, with the following modifications.

The wanted RF signal nominal frequency shall be selected by setting the channel number according to the following:

- The Absolute Radio Frequency Channel Number EARFCN specified in ETSI TS 136 104 [5], clause 5.7.3 for E-UTRA, E-UTRA with LAA carrier or E-UTRA with standalone NB-IoT or guard band NB-IoT carriers.
- The Absolute Radio Frequency Channel Number UARFCN specified in ETSI TS 125 104 [27], clause 5.4.3 for FDD UTRA carriers and defined in ETSI TS 125 105 [28], clause 5.4.3 for TDD UTRA carriers.
- The Absolute Radio Frequency Channel Number ARFCN specified in ETSI TS 145 005 [4], clause 2 for GSM/EDGE carriers.
- The Absolute Radio Frequency Channel Number (combination of ARFCN, UARFCN, EARFCN or NR-ARFCN) for MSR carrier.
- The Absolute Radio Frequency Channel Number (EARFCN) for Standalone NB-IoT.

- The Absolute Radio Frequency Channel Number NR-ARFCN specified in ETSI TS 138 104 [19], clause 5.4.2 for NR, NR with in-band NB-IoT carrier.

A communication link shall be set up with a test system capable of evaluating the required performance criteria for all applicable ports.

Measures shall be taken to avoid the effect of the unwanted signal on the measuring equipment.

4.2.1 Arrangements for test signals at the input of transmitters

The provisions of ETSI EN 301 489-1 [1], clause 4.2.1 shall apply.

4.2.2 Arrangements for test signals at the output of transmitters

The provisions of ETSI EN 301 489-1 [1], clause 4.2.2 shall apply with the following addition.

Transmitter carriers shall be configured as follows:

- UTRA FDD carriers shall be configured according to TM1 as defined in ETSI TS 125 141 [2], clause 6.1.1.1.
- UTRA TDD carriers shall be configured according to table 6.1A as defined in ETSI TS 125 142 [3], clause 6.2.4.1.2.
- E-UTRA carriers shall be configured according to E-TM1.1 as defined in ETSI TS 136 141 [6], clause 6.1.1.1.

For BC3 CS3, BC3 CS16 and BC3 CS17 BS testing, E-UTRA carriers shall be configured according to E-TM1.1_BC3CS3 defined in ETSI TS 137 141 [11], Annex E.

For BC3 CS2 BS testing with NB-IoT in-band and/or guard band, E-UTRA carriers shall be configured according to E-TM1.1_BC3CS3 defined in ETSI TS 137 141 [11], Annex E.

- GSM carriers shall use GMSK modulation as defined in ETSI TS 151 021 [8], clause 6.2.2.
- E-UTRA NB-IoT carriers shall be configured according to N-TM as defined in ETSI TS 136 141 [6], clauses 6.1.3, 6.1.4, 6.1.5 and 6.1.6.
- NR carriers shall be configured according to NR-FR1-TM1.1 as defined in ETSI TS 138 141-1 [9], clause 4.9.2.2.1.
- Base station type 2-O, NR carriers shall be configured according to NR-FR2-TM1.1 as defined in ETSI TS 138 141-2 [16], clause 4.9.2.2.1.
- NR in-band NB-IoT carriers shall be configured according to NR-N-TM as defined in ETSI TS 138 141-1 [9], clauses 4.9.2.2.9.
- MSR BS tests shall be performed with RATs activated according to the test configuration in ETSI TS 137 113 [29], clause 4.5.
- Hybrid and OTA AAS BS tests shall be performed with RATs activated according to the test configuration in ETSI TS 137 114 [30], clause 4.4.
- CDMA BS communication link shall be set up with a mobile station simulator (hereafter called "the test system") according to the Radio Configuration (RC) supported by the base station using full data rate only.

4.2.3 Arrangements for test signals at the input of receivers

The provisions of ETSI EN 301 489-1 [1], clause 4.2.3 shall apply with the following modification.

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 external signal effects. A communication link shall be set up with a base station system test equipment.

To provide a stable communication link, the wanted RF input signal level shall be set to a level above the reference sensitivity level, as specified in table 3 for different technologies.

The reference sensitivity power level P_{REFSENS} is the minimum mean power received at the antenna connector at which a reference performance requirement shall be met for a specified reference measurement channel.

Table 3: Level of the wanted signal at the input of the receiver

Technology	Signal level added to reference sensitivity level	Type of BS	Reference receiver sensitivity level according to the following:
GSM/EDGE	-47 dBm (see note 1)	BS	
CDMA	15 dB	BS	(see note 2)
UTRA	15 dB	FDD TDD Hybrid AAS FDD and TDD OTA AAS FDD	ETSI TS 125 141 [2], clause 7.2.5 ETSI TS 125 142 [3], clause 7.2.5 ETSI TS 137 145-1 [12], clause 7.2.5 ETSI TS 137 145-2 [13], clause 7.3.5
E-UTRA	15 dB	Different area BS Hybrid AAS OTA AAS	ETSI TS 136 141 [6], clause 7.2.5 ETSI TS 137 145-1 [12], clause 7.2.5 ETSI TS 137 145-2 [13], clause 7.3.5
E-UTRA, band 46 (LAA)	15 dB	Medium area BS	ETSI TS 136 141 [6], clause 7.2.5
E-UTRA, in-band or guard band NB-IoT	15 dB	Different area BS	ETSI TS 136 141 [6], clause 7.2.5
MSR	15 dB	BS Hybrid AAS OTA AAS	ETSI TS 137 141 [11], clause 7.2.5 ETSI TS 137 145-1 [12], clause 7.2.5 ETSI TS 137 145-2 [13], clause 7.3.5
OFDMA WMAN	15 dB above the receiver input level for BER of 1×10^{-5}	BS	
NR, in-band NB-IoT	15 dB	1-C and 1-H 1-O 2-O	ETSI TS 138 141-1 [9], clause 7.2.5 ETSI TS 138 141-2 [16], clause 7.2.5 ETSI TS 138 141-2 [16], clause 7.2.5
Standalone NB-IoT	15 dB	BS	ETSI TS 136 141 [6], clause 7.2.5
NOTE 1: For GSM single RAT radio an absolute level is stated.			
NOTE 2: Simple method to establish the required communication link is establish link, reduce the wanted signal power at the EUT to a point of link failure, then increase the wanted signal level by 15 dB.			

4.2.4 Arrangements for test signals at the output of receivers

The provisions of ETSI EN 301 489-1 [1], clause 4.2.4 shall apply.

4.2.5 Arrangements for test signals for repeaters

For immunity tests of repeaters, the wanted RF input signal shall be coupled to one antenna port at a level which will result, when measured, in the maximum rated RF output power per channel. The test shall be performed with the specified input signals being simultaneously coupled to both antenna ports.

4.3 Exclusion bands

4.3.0 General

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

For BS containing different technologies according to table 1, the exclusion band for each radio technology is only applicable if the radio technology is active.

4.3.1 Transmitter exclusion band

The range of the exclusion band for transmitter (downlink DL) is defined as:

$$F_{DL_low} - EB < f < F_{DL_high} + EB$$

Where:

F_{DL_low}	The lowest frequency of the downlink operating band
F_{DL_high}	The highest frequency of the downlink operating band
EB	Exclusion band defined according to the type of BS

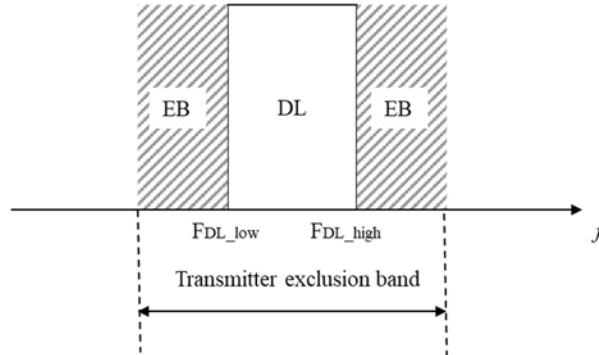


Figure 2: Illustration of transmitter exclusion band

The exclusion bands shall be calculated using the operating bands as set out in ETSI TS 137 104 [20], clause 4.5.

Table 3a: Calculation of EB for transmitter exclusion band

BS type	BS operating bandwidth	EB
OTA AAS BS and NR BS Type 1-O	Transmitter operating bandwidth < 100 MHz	The greater of $BW_{Channel}$ or 60 MHz
	Transmitter operating bandwidth $\geq$ 100 MHz	The greater of $BW_{Channel}$ or 200 MHz
NOTE: The transmitter exclusion band from this table is not applicable for Non-AAS BS, Hybrid AAS BS and NR BS Type 1-C.		

4.3.2 Receiver exclusion band

4.3.2.0 General

The range of the exclusion band for receiver (uplink UL) is defined as:

$$F_{UL_low} - EB < f < F_{UL_high} + EB$$

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

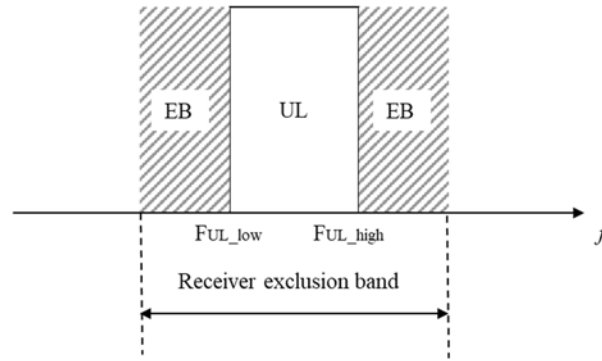


Figure 3: Illustration of receiver exclusion band

The exclusion bands shall be calculated using the operating bands as set out in ETSI TS 137 104 [20], clause 4.5.

Table 3b: Calculation of EB for receiver exclusion band

BS type	BS operating bandwidth	EB
Non-AAS BS, Hybrid AAS BS and NR BS Type 1-C	Receiver operating bandwidth ≤ 200 MHz	The greater of BW_{Channel} or 20 MHz
	$200 \text{ MHz} < \text{Receiver operating bandwidth} \leq 900 \text{ MHz}$	The greater of BW_{Channel} or 60 MHz
OTA AAS BS and NR BS Type 1-O	Receiver operating bandwidth < 100 MHz	The greater of BW_{Channel} or 60 MHz
	Receiver operating bandwidth ≥ 100 MHz,	The greater of BW_{Channel} or 200 MHz

4.3.3 Multi-band BS

For BS capable of multi-band operation, the exclusion band shall be the combination of the exclusion bands for each band, i.e. an exclusion band for each band according to clauses 4.3.1 and 4.3.2, shall be applied.

4.4 Narrow band responses of receivers

Responses on receivers or duplex transceivers occurring during the immunity test at discrete frequencies which are narrow band responses - spurious responses, are identified by the following method:

- If during an immunity test the quantity being monitored goes outside the specified limits (clause 6 in the present document), it is necessary to establish whether the measured result is due to a narrow band response or to a wide band (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, $f_{\text{offset}} = 10 \text{ MHz}$.
 - For E-UTRA and LAA, $f_{\text{offset}} = 2 \times BW_{\text{Channel}}$, where BW_{Channel} is the channel bandwidth as defined in ETSI TS 136 104 [5], clause 5.6.
 - For GSM/EDGE, $f_{\text{offset}} = 400 \text{ kHz}$.
 - For CDMA, $f_{\text{offset}} = 10 \text{ MHz}$ for CDMA (2G), and $f_{\text{offset}} = 12,5 \text{ MHz}$ for CDMA2000 (3G and multi carrier/3 $\times$ RTT).
 - For OFDMA WMAN, $f_{\text{offset}} = 2 \times BW_{\text{Channel}}$, where BW_{Channel} is the channel bandwidth.
 - For NB-IoT, $f_{\text{offset}} = 400 \text{ kHz}$.

- For NR, $f_{\text{offset}} = 2 \times BW_{\text{Channel}}$, where BW_{Channel} is the channel bandwidth as defined in ETSI TS 138 104 [19], clause 5.3.
- If the measured result is now within the specified limit in either or both of the above offset cases, then the response is considered as a narrow band response.
- If the measured result is still outside the specified limit, this may be due to the fact that the offset has made the frequency of the unwanted signal correspond to the frequency of another narrow band response. Under these circumstances, the procedure is repeated with the increase and decrease of the frequency of the unwanted signal set to:

$$1,25 \times f_{\text{offset}}$$

- If the measured result is still outside the specified limit with the increased and/or decreased frequency, the phenomenon is considered wide band and therefore an EMC problem, and the equipment fails the test.

Narrow band responses are disregarded.

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

4.5 Void

4.6 Test configurations

4.6.0 General

The test configuration and mode of operation shall represent the intended use and shall be recorded in the test report. The intended use should be in accordance with the user documentation considering the parameters, e.g. BS class, operating bands and frequency ranges, channel bandwidth, rated output power, spurious emission category, etc.

For multiple unit BS, the test on digital and radio units may be applied separately.

NOTE: During testing, the individual units of a multiple unit BS should not be combined into a single enclosure.

4.6.1 Emission

- Emission tests shall be performed on the entire base station having stable communication link(s).
- Emission tests on the MSR base station shall be performed by activating all supported RATs concurrently.
- The test signal with a test modulation, as defined in the reference measurement channel in table 5 or bearer information data rate in table 4, 7a or 7b for different technologies, should be delivered by a mobile unit (UE) or base station system test equipment.

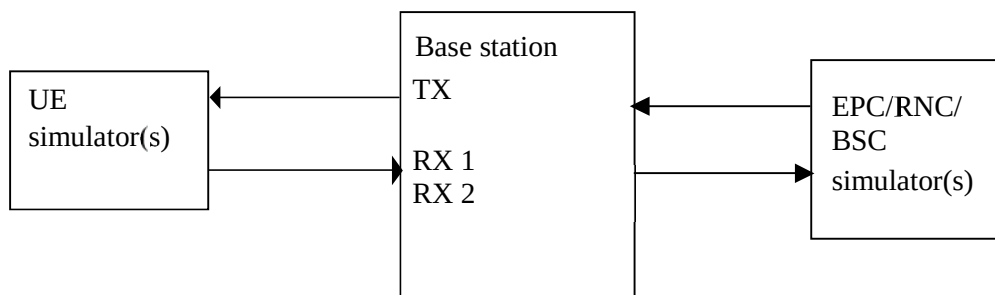


Figure 4a: Communication link set up for emission measurement on base stations with access to antenna ports

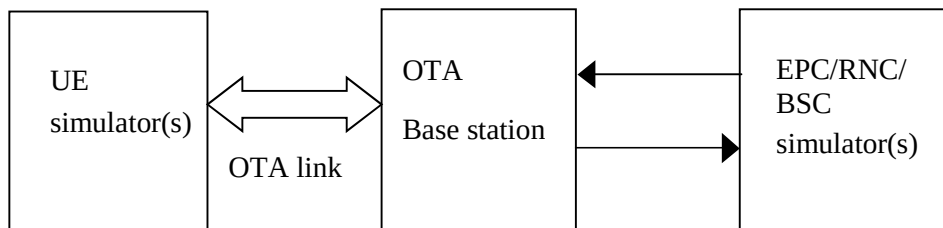


Figure 4b: Communication link set up for immunity test on base OTA stations with antenna ports not accessible

4.6.2 Immunity

- Immunity tests shall be performed on the entire base station having stable communication link(s).
- Immunity tests shall be performed on both the Uplink and Downlink paths.
- Immunity tests on the MSR base station shall be performed by activating all tested RATs concurrently. For MSR BS where radio digital unit employs common active components for supported RATs, a communication link in MSR shall be assessed on one narrow band and one broadband RAT, per operating band, and the selection of RAT follows the following principles.
 - For MSR BS supporting E-UTRA and UTRA, E-UTRA shall be assessed.
 - For MSR BS supporting NR and UTRA, NR shall be assessed.
 - For MSR BS supporting NB-IoT and GSM, NB-IoT shall be assessed.

NOTE: Narrow band RAT refers to GSM or NB-IoT (less than 1 MHz). Broadband RAT refers to UTRA, E-UTRA or NR (more than 1 MHz).

- For MSR BS and AAS BS supporting MSR operation, carriers shall be configured according to the arrangement for test signals in clause 4.2.2.
- Tests shall be performed on one of each type of port, and need not be repeated for each RAT if operating RATs are assessed simultaneously during the test.
- For BS capable of multi-band operation, the requirements in the present document apply for each supported operating band unless otherwise stated. Operating bands and RATs shall be activated according to the arrangement for test signals in clause 4.2.2.

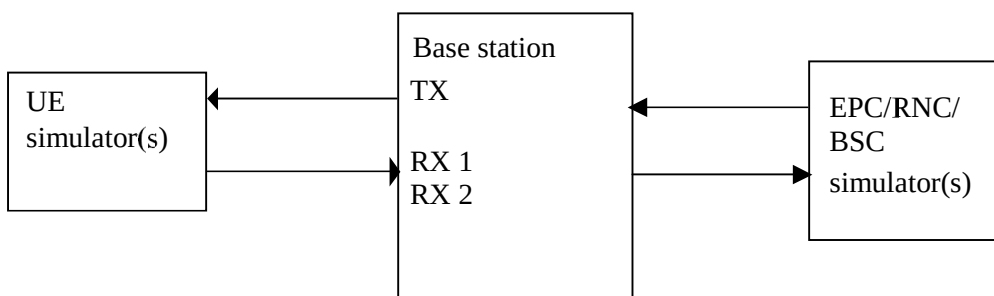


Figure 5a: Communication link set up for immunity tests on base stations with access to antenna ports

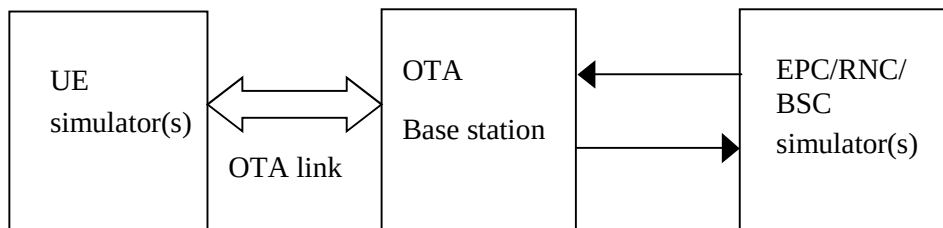


Figure 5b: Communication link set up for immunity test on OTA base stations with antenna ports not accessible

5 Performance assessment

5.0 General

The provision of ETSI EN 301 489-1 [1], clause C.1 shall apply with the following additions:

- Information about the common and/or RAT-specific active RF components and other HW blocks for a communication link in MSR BS or other BS supporting more than one RAT shall be recorded in or annexed to the test report.
- Information about the common and/or band-specific active RF components and other HW blocks for a communication link in BS capable of multi-band operation shall be recorded in or annexed to the test report.
- Where a communication link is used by more than one RAT, it shall be assessed on every tested RAT.
- Where a communication link is used by more than one operating band, it shall be assessed on every operating band.
- A communication link in MSR shall be assessed on one narrow band and one broadband RAT.
- Communication link(s) and/or radio performance parameters for the RATs and operating bands may be assessed either simultaneously or separately for each RAT and band, depending on the test environment capability.

5.1 UTRA

5.1.1 BLER on DL

BLER of the bearer used shall be assessed 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 [21], clause 7.3.1 in case of FDD and ETSI TS 125 102 [22], clause 7.3.1 in case of TDD.

5.1.2 BLER on UL

The value of the BLER at the output of the receiver reported by the BS shall be monitored at the Iub interface.

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

5.2.1 Throughput on DL

The output of the transmitter shall be connected to equipment that meets the requirements for the throughput assessment of ETSI TS 136 101 [23], clause 7.3.1 for the bearer used in the immunity tests.

5.2.2 Throughput on UL

The value of the throughput at the output of the receiver shall be monitored at S1 interface.

5.3 OFDMA WMAN

5.3.1 Throughput on DL

The output of the transmitter shall be connected to equipment which meets the requirements for throughput assessment.

5.3.2 Throughput on UL

The value of the throughput at the output of the receiver shall be monitored at the backhaul interface.

5.4 NR, NR with in-band NB-IoT

5.4.1 Throughput on DL

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 defined in ETSI TS 138 101-4 [10], clauses A.1.1 and A.3.2 for the bearer used in the immunity tests. The level of the signal supplied to the equipment shall be within the range for which the assessment of throughput is not impaired.

5.4.2 Throughput on UL

The value of the throughput at the output of the receiver shall be monitored

5.5 GSM/EDGE

5.5.1 BER on DL

5.5.1.0 General

The BER at the output of the transmitter implementing full rate speech traffic channels shall be assessed using the techniques described in clause 5.5.1.1.

The BER at the output of the transmitter not supporting full rate speech traffic channels shall be assessed using the techniques described in clause 5.5.1.2.

5.5.1.1 Assessment of BER using static layer 1 functions

The present clause applies to BS with full rate speech traffic channel. The transmitter under test shall be configured with the maximum number of TRXs, with ARFCNs which shall be distributed over the entire declared bandwidth of operation for the BSS under test. One TRX shall be configured to support the BCCH. If slow frequency hopping is supported, this shall be enabled.

NOTE: The above paragraph is based on ETSI TS 151 021 [8], clause 6.1.2.

The bit sequence from the output of the transmitter shall be monitored by the test system according to the test case of ETSI TS 151 021 [8], clause 7.1.2, and the BER of the class 2 bits for TCH/FS assessed. The BER shall not exceed the values specified in clause 6.1 of the present document.

5.5.1.2 Assessment of BER using RXQUAL

The output of the transmitter shall be connected to equipment that meets the requirements of ETSI TS 151 010-1 [25], clause 14.2 for the assessment of RXQUAL. The RXQUAL shall be monitored during the test. The RXQUAL shall not exceed the values specified in clause 6.1 of the present document.

NOTE 1: This equipment can be a GSM mobile station fit for purpose for the monitoring of RXQUAL.

NOTE 2: Applicable on EUT which does not support TCH/FS.

5.5.2 BER on UL

5.5.2.0 General

The BER at the output of the receiver implementing full rate speech traffic channels shall be assessed using the techniques described in clause 5.5.2.1.

The BER at the output of the receiver not supporting full rate speech traffic channels shall be assessed using the techniques described in clause 5.5.2.2.

5.5.2.1 Assessment of BER using reported BER

It is applied on BS with full rate speech traffic channel. The BER of the class 2 bits at the output of the receiver shall be assessed.

5.5.2.2 Assessment of BER using RXQUAL

The value of the RXQUAL reported by the BTS or BSS shall be monitored.

5.6 CDMA

5.6.1 FER on DL

For immunity testing, the output of the transmitter shall be connected to a test system which monitors the FER of the EUT. 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.

5.6.2 FER on UL

The value of the FER at the output of the receiver reported by the BS shall be monitored.

5.7 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.

5.8 Ancillary equipment

The provision of ETSI EN 301 489-1 [1], clause 5 shall apply.

5.9 Void

6 Performance criteria

6.1 Performance criteria for continuous phenomena

6.1.0 General

The provision of ETSI EN 301 489-1 [1], clause 6.1 shall apply on all equipment types with the following additions detailed in clauses 6.1.1 and 6.1.2 below.

6.1.1 Base Stations

6.1.1.1 UTRA

Uplink and Downlink paths the observed BLER shall be less than 1×10^{-2} and the BS shall operate as intended.

The BLER calculation shall be based on evaluating the CRC on each transport block.

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

The test shall be performed using one or more bearers with the characteristics as stated in table 4 and should be representative of the EUTs intended use.

Uplink and Downlink paths shall each meet the performance criteria defined in table 4.

The throughput in table 4 is stated relative to the maximum throughput of the specified FRC. The maximum throughput for an FRC is equal to the Payload size $\times$ Number of uplink sub-frames per second. For NB-IoT the Maximum throughput for an FRC equals the Payload size / (Number of resource unit $\times$ Time to send one resource unit).

Table 4: BS Performance Criteria for continuous phenomena

E-UTRA Channel Bandwidth [MHz]	Bearer Information Data Rate	Performance Criteria (see note 3)	
1,4	FRC A1-1 in clause A.1 in ETSI TS 136 104 [5]	Throughput > 95 %	
3	FRC A1-2 in clause A.1 in ETSI TS 136 104 [5]		
	FRC A1-6 in clause A.1 in ETSI TS 136 104 [5] for E-UTRA with NB-IoT in-band operation		
5	FRC A1-3 in clause A.1 in ETSI TS 136 104 [5]		
	FRC A1-7 in clause A.1 in ETSI TS 136 104 [5] for E-UTRA with NB-IoT in-band operation		
10	FRC A1-3 in clause A.1 in ETSI TS 136 104 [5] (see note 1) FRC A1-8 in clause A.1 in ETSI TS 136 104 [5] (see note 2)		
	FRC A1-7 in clause A.1 in ETSI TS 136 104 [5] for E-UTRA with NB-IoT in-band operation		
15	FRC A1-3 in clause A.1 in ETSI TS 136 104 [5] (see note 1) FRC A1-7 in clause A.1 in ETSI TS 136 104 [5] for E-UTRA with NB-IoT in-band operation		
20	FRC A1-3 in clause A.1 in ETSI TS 136 104 [5] (see note 1) FRC A1-9 in clause A.1 in ETSI TS 136 104 [5] (see note 2)		
	FRC A1-7 in clause A.1 in ETSI TS 136 104 [5] for E-UTRA with NB-IoT in-band operation		
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. This reference measurement channel is not applied for Band 46 and Band 49.			
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 Band 46 and Band 49.			
NOTE 3: Applies also if a bearer with another characteristic is used in the test.			

6.1.1.3 Standalone NB-IoT

Uplink and Downlink paths shall each meet the performance criteria defined in table 5.

The throughput in table 5 is stated relative to the maximum throughput of the specified FRC. Sub-carrier spacing should be representative of the EUTs intended use.

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

The Maximum throughput for an FRC equals the Payload size / (Number of resource unit × Time to send one resource unit).

Table 5: 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 in ETSI TS 136 104 [5]	Throughput > 95 %
3,75	FRC A14-2 in clause A.14 in ETSI TS 136 104 [5]	
NOTE: Applies also if a bearer with another characteristic is used in the test.		

6.1.1.4 GSM/EDGE

Downlink

The BER of the downlink shall be assessed during the test according to one of the test methods of clause 5.5.1 in the present document.

If the test method of clause 5.5.1.1 in the present document 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 [i.28], clause 8.2.4 for RXQUAL = 3.

If the test method of clause 5.5.1.2 in the present document 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 of clause 5.5.2 in the present document.

If the test method of clause 5.5.2.1 in the present document is used, the value of RXQUAL shall not exceed 3 during the test.

If the test method of clause 5.5.2.2 in the present document 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 [i.28], clause 8.2.4 for RXQUAL = 3.

For a base station, the RXQUAL of the uplink shall not exceed three (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.

6.1.1.5 CDMA

The observed Frame Error Rate (FER) of the BS forward link and reverse link shall not exceed 1,0 % with 95 % confidence.

In the case of PAMR base stations the observed Frame Error Rate (FER) of the BS forward link and reverse link shall not exceed 2,0 % with 95 % confidence.

The test shall be performed using one or more bearers with the characteristics of data rate and throughput as stated in table 4, they should be representative of the EUTs intended use.

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

Table 6: Mobile OFDMA WMAN

Mobile OFDMA WMAN Channel Bandwidth [MHz]	Performance Criteria (see note)
5	Throughput > 95 %
10	
NOTE: Applies also if a bearer with other characteristics is used in the test.	

6.1.1.6 NR, NR with in-band NB-IoT

The test shall be performed using one or more bearers with the characteristics as stated in tables 7a or 7b and shall be representative of the EUTs intended use.

The throughput in tables 7a, 7b, 7c and 7d is stated relative to the maximum throughput of the specified FRC.

Uplink and downlink paths shall each meet the performance criteria defined in tables 7a, 7b, 7c and 7d during the test.

Table 7a: FR1 performance criteria for continuous phenomena

NR channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Bearer information data rate (see note 1)	Performance criteria (see note 2)
3	15	G-FR1-A1-7 in clause A.1 in ETSI TS 138 104 [19]	Throughput > 95 %
		G-FR1-A1-21 in clause A.1 in ETSI TS 138 104 [19] for NR with NB-IoT in-band operation	
5, 10, 15	15	G-FR1-A1-1 in clause A.1 in ETSI TS 138 104 [19]	
		G-FR1-A1-10 in clause A.1 in ETSI TS 138 104 [19] for NR with NB-IoT in-band operation	
10, 15	30	G-FR1-A1-2 in clause A.1 in ETSI TS 138 104 [19]	
10, 15	60	G-FR1-A1-3 in clause A.1 in ETSI TS 138 104 [19]	
20, 25, 30, 35, 40, 45, 50	15	G-FR1-A1-4 in clause A.1 in ETSI TS 138 104 [19]	
		G-FR1-A1-11 in clause A.1 in ETSI TS 138 104 [19] for NR with NB-IoT in-band operation	
20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100	30	G-FR1-A1-5 in clause A.1 in ETSI TS 138 104 [19]	
20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
NOTE 1: These reference measurement channels are not applied for bands n46, n96 and n102 (See tables 7b and 7c).			
NOTE 2: Applies also if a bearer with other characteristics is used in the test.			

Table 7b: FR1 performance criteria for continuous phenomena for band n46

NR channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Bearer information data rate	Performance criteria (see note)
10	15	G-FR1-A1-12 in clause A.1 in ETSI TS 138 104 [19]	Throughput > 95 %
	30	G-FR1-A1-13 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-3 in clause A.1 in ETSI TS 138 104 [19]	
20	15	G-FR1-A1-14 in clause A.1 in ETSI TS 138 104 [19]	
	30	G-FR1-A1-15 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
40	15	G-FR1-A1-16 in clause A.1 in ETSI TS 138 104 [19]	
	30	G-FR1-A1-17 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
60	30	G-FR1-A1-18 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
80	30	G-FR1-A1-19 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
NOTE: Applies also if a bearer with other characteristics is used in the test.			

Table 7c: FR1 performance criteria for continuous phenomena for bands n96 and n102

NR channel bandwidth [MHz]	Sub-carrier spacing [kHz]	Bearer information data rate	Performance criteria (see note)
20	15	G-FR1-A1-14 in clause A.1 in ETSI TS 138 104 [19]	Throughput > 95 %
	30	G-FR1-A1-15 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
40	15	G-FR1-A1-16 in clause A.1 in ETSI TS 138 104 [19]	
	30	G-FR1-A1-17 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
60	30	G-FR1-A1-18 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
80	30	G-FR1-A1-19 in clause A.1 in ETSI TS 138 104 [19]	
	60	G-FR1-A1-6 in clause A.1 in ETSI TS 138 104 [19]	
NOTE: Applies also if a bearer with other characteristics is used in the test.			

Table 7d: 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 in ETSI TS 138 104 [19]	Throughput > 95 %
50	120	G-FR2-A1-2 in clause A.1 in ETSI TS 138 104 [19]	
100, 200, 400	120	G-FR2-A1-3 in clause A.1 in ETSI TS 138 104 [19]	
NOTE: Applies also if a bearer with other characteristics is used in the test.			

6.1.2 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.

6.2 Performance criteria for transient phenomena

6.2.0 General

The provision of ETSI EN 301 489-1 [1], clause 6.2 shall apply to all equipment types. For repeaters, the additions detailed in clause 6.2.1 of the present document shall also apply.

6.2.1 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, and the gain of the EUT shall not have changed by more than ± 1 dB.

7 Requirements

7.1 Emission

7.1.1 General

The following emission requirements set out in table 8 shall apply.

Table 8: Emission requirements

Phenomenon	Port	Applicability		Reference clause
		Fixed use (e.g. base station equipment)	Vehicular use (e.g. mobile equipment)	
Radiated emission	Enclosure of ancillary equipment	Applicable for standalone testing	Applicable for standalone testing	7.1.2
Conducted emission	DC power input/output port	Applicable	Applicable	ETSI EN 301 489-1 [1], clause 8.3
Conducted emission	AC mains input/output port	Applicable	Not applicable	ETSI EN 301 489-1 [1], clause 8.4
Conducted emission	Wired network port	Applicable	Not applicable	ETSI EN 301 489-1 [1], clause 8.7

7.1.2 Special conditions

The following special conditions specified in table 9 shall apply.

Table 9: Modified emission requirements

Reference to clauses in ETSI EN 301 489-1 [1]	Special product-related conditions, additional to or modifying the test configuration in ETSI EN 301 489-1 [1], clause 8
8.2 Radiated emission from enclosure of ancillary equipment	When applying the radiated emission test of EN 55032 [31]: - for frequencies up to 1 GHz, the SAC defined in clause A1.1, in Table A.1 shall apply. The measurement distance for small EUTs, as defined in EN 55016-2-3 [i.25], is 3 m. For all other cases, a measurement distance of 10 m shall apply. - for frequencies exceeding 1 GHz, the FSOATS defined in clause A1.3 in Table A.1 shall apply.

7.2 Immunity

7.2.1 General

The following immunity requirements set out in table 10 shall apply.

Table 10: Immunity requirements

Phenomenon	Port	Equipment test requirement		Reference clause	Performance Criteria clause
		Fixed use (e.g. base station equipment)	Vehicular use (e.g. mobile equipment)		
RF electromagnetic field (80 MHz to 6 000 MHz) (see note 3)	Enclosure	Applicable	Applicable	7.2.2	6.1
Electrostatic discharge	Enclosure	Applicable	Applicable	7.2.2	6.2
Fast transients common mode	signal, wired network and control	Applicable	Not applicable	ETSI EN 301 489-1 [1], clauses 9.4.1 and 9.4.2	6.2
	DC power	Applicable	Not applicable (see note 1)		6.2
	AC power	Applicable	Not applicable		6.2
RF common mode 0,15 MHz to 80 MHz	signal, wired network and control	Applicable	Applicable	ETSI EN 301 489-1 [1], clauses 9.5.1 and 9.5.2	6.1
	DC power	Applicable	Applicable		6.1
	AC power	Applicable	Applicable		6.1
Transients and surges in vehicle environment	DC power input	Not applicable	Applicable	ETSI EN 301 489-1 [1], clauses 9.6.1 and 9.6.2	6.2 (see note 2)
Voltage dips and interruptions	AC mains power input	Applicable	Not applicable	ETSI EN 301 489-1 [1], clauses 9.7.1 and 9.7.2	6.2
Surges, line to line and line to ground	AC mains power input	Applicable	Not applicable	ETSI EN 301 489-1 [1], clauses 9.8.1 and 9.8.2	6.2
	Wired network	Applicable	Not applicable (see note 1)		6.2

NOTE 1: This requirement is covered by the transients and surges test on DC power input ports.
NOTE 2: For pulses 3a & 3b, the performance criteria for continuous phenomena shall apply (see clause 6.1).
NOTE 3: For immunity tests of EN 61000-4-3 [32]: clauses 6, 7 and 8 apply.

7.2.2 Special conditions

The following special conditions specified in table 11 shall apply.

Table 11: Modified immunity requirements

Reference to clauses in ETSI EN 301 489-1 [1]	Special product-related conditions, additional to or modifying the test configuration in ETSI EN 301 489-1 [1], clause 9.1
9.2 Radio frequency electromagnetic field (80 MHz to 6 000 MHz)	Test level For the frequency range 80 MHz to 690 MHz, test level shall be 3 V/m. For the frequency range from 690 MHz to 6 000 MHz test level shall be 10 V/m.
9.3 Electrostatic discharge	ESD test on OTA radio shall be performed on radio switched on with transmitter function off. (See note)
NOTE: OTA radio is not touchable by general public to trigger ESD when it has been installed and transmitting.	

Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.15] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 301 489-50					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Emissions: Enclosure of ancillary equipment measured on a standalone basis	3.1(b)	7.1.2	U	
2	Emissions: DC power input/output ports	3.1(b)	7.1.1	C	Only where equipment has DC power input and/or output ports or from a vehicle power supply.
3	Emissions: AC mains power input/output ports	3.1(b)	7.1.1	C	Only applies to fixed equipment that has AC mains power input and/or output ports.
4	Emissions: Wired network ports	3.1(b)	7.1.1	C	Only applies to fixed equipment that has wired network ports.
5	Immunity: Radio frequency electromagnetic field (80 MHz to 6 000 MHz)	3.1(b)	7.2.2	U	
6	Immunity: Electrostatic discharge	3.1(b)	7.2.2	U	
7	Immunity: Fast transients common mode	3.1(b)	7.2.1	C	Only applies to fixed equipment that has AC mains power input ports or DC power ports or signal/control ports or wired network ports.
8	Immunity: Radio frequency common mode	3.1(b)	7.2.1	C	Only where equipment has AC mains power input ports or DC power ports or signal/control ports or wired network ports.
9	Immunity: Transients and surges in the vehicular environment	3.1(b)	7.2.1	C	Only where equipment is connected to vehicle power supply.
10	Immunity: Voltage dips and interruptions	3.1(b)	7.2.1	C	Only applies to fixed equipment that has AC mains power input ports.
11	Immunity: Surges, line to line and line to ground	3.1(b)	7.2.1	C	Only applies to fixed equipment that has AC mains power input ports and/or wired network ports.

Key to columns:

Requirement:

No A unique identifier for one row of the table which may be used to identify a requirement.

Description A textual reference to the requirement.

Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

Clause(s) of the present document

Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C Indicates whether the requirement is unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).

Condition Explains the conditions when the requirement is or is not applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (informative): Why testing on cables shorter than 3 m in length is not required

B.1 Background

Historically most EMC standards, including European Norms, have exempted short cables (usually less than 3 m in length) from testing on the basis that testing such cables has no discernible impact on the EMC performance of the EUT.

Investigations were performed to support this approach and justifications are in this annex.

B.2 Emission requirements

Technically, the measurement range for conducted emissions is from 150 kHz to 30 MHz and that a quarter wavelength cable makes an effective radiator. From this, it is assumed that a 3 m cable might be an effective radiator at 25 MHz, however, this can only occur in extremely rare situations outside of the test laboratory. The reason it does not occur in the field is because the above assumption is very simplified. Indeed, the typical use of such long cable is not a straight radiator in free space comparable to a rod antenna. In use, cables are typically laid out in a random manner (not in a straight position) and generally terminated, both of which significantly reduces their effectiveness as an antenna. It is also typically positioned mainly horizontally and relatively close to the ground or other conductive parts. When the cable is curved, the effective length is reduced, causing a lower gain.

All EMC assessment and testing specifications are based on experience from around the world which is gathered by the relevant standardisation organisations (IEC). The exemption of testing is in place since the first publication of Generic Emission standards (e.g. EN 61000-6-3 [i.23]) and EMC product standards (e.g. EN 55032 [31]).

B.3 Immunity requirements

B.3.1 Common rationale

The coupling path to consider from the source to the potential victim is the capacitive coupling from cables to cables installed longitudinally. In this situation, the length of the cable has a significant impact on the coupling factor: only long cables are able to provide a significant coupling factor allowing the transfer of energy from the source to the victim.

In addition, the immunity testing methods requires a minimum length of the cable for inserting coupling devices considering some standardised distances allowing for reproducibility of the test result.

B.3.2 For EN 61000-4-6 tests

The 3 V test level defined is extremely large and would not appear in the typical installation. These levels will only occur close to radio broadcast transmitters or next to a radio amateur station.

For example, without any obstacle (e.g. walls), 3 V/m occurs at 100 m from a 1,5 kW radio amateur station, for lower power ones this drops to just over 20 m. See IEC TR 61000-2-5 (2017) [i.24] table 17. Similarly, 3 V/m occurs at 1,5 km from a 500 kW radio transmitter. See IEC TR 61000-2-5 (2017) [i.24], table 19. Obstacles are likely to reduce the field strength at the victim.

B.3.3 For EN 61000-4-4 tests

For the Electrical Fast Transients (EFT), the threat is noise from the AC mains due to the switching of inductive load. For short cables connected to the EUT, the EFT injection from AC mains cables, being transferred to short signal cable, is covered by the test on the AC main port (see clause B.4.3). There is an additional threat from coupling between the signal cables and an adjacent power cable. This occurs when long cables are very closely coupled, this threat is covered by an additional test on cables longer than 3 m.

B.4 Interactive aspects in EMC Tests

B.4.1 Introduction

EMC tests are interactive, when the equipment is being tested, so are all the cables and all the Associated Equipment (AE). For example, a Coupling Decoupling Network (CDN) is designed to isolate the AE from the EUT, so when an EFT burst is applied, for example, the voltage should only be applied to EUT, however some of the voltage is always applied to the AE.

B.4.2 For EN 61000-4-6 tests

During conducted RF immunity testing to EN 61000-4-6 [i.26], the EUT, AE and associated cables are within the same test loop ($300\ \Omega$), see figure B.1.

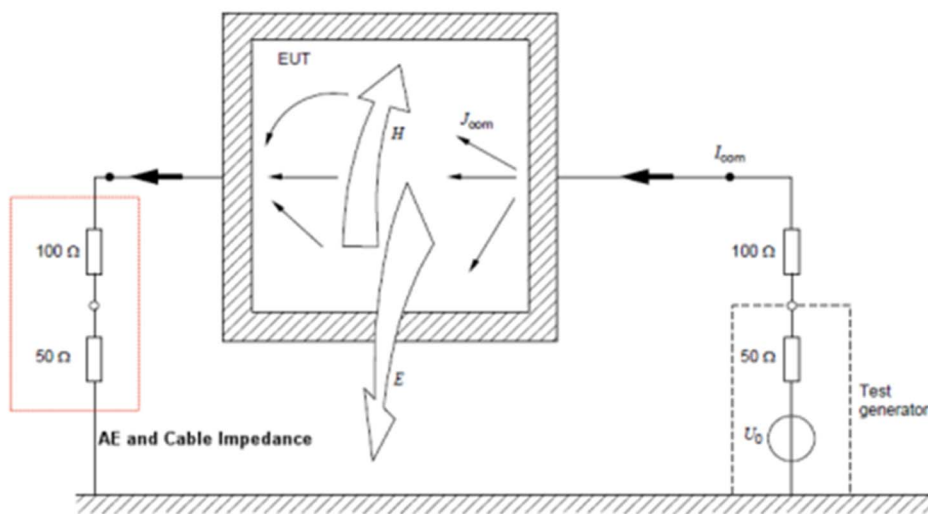


Figure B.1

In all cases cables are terminated using CDNs, this includes any earth cables.

Hence effectively the same voltage/current is applied to the AE and EUT, hence independent of the cable length during the mains testing any associated cabling are also tested. The following are examples of the measured current during a test.

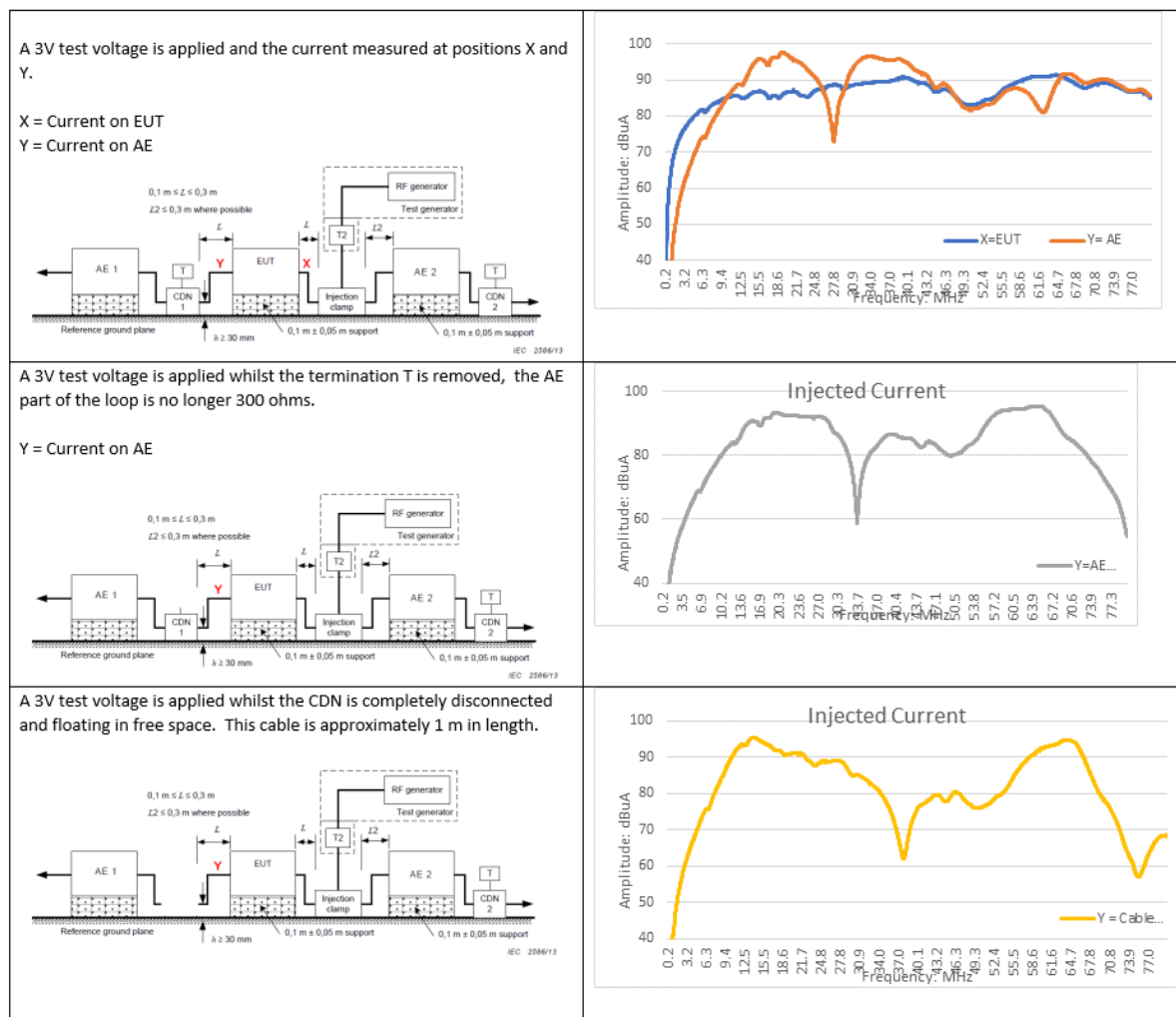


Figure B.2

In addition, close to the EUT a large electric field voltage is created, this voltage will induce signals in any close cable. Using measurement (or calculation) this voltage is significant dependent upon the measurement or calculated voltage. Hence many cables will be exposed to more than the expected 3 V/m.

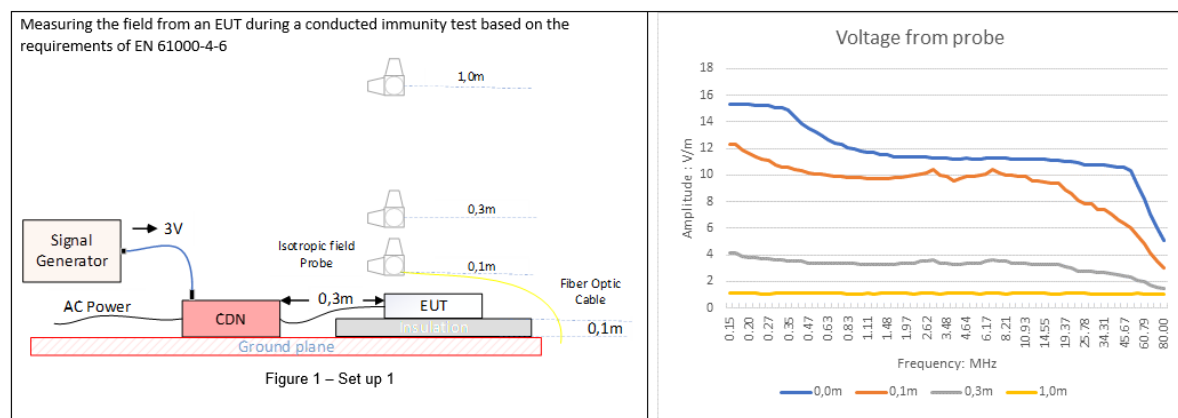


Figure B.3

B.4.3 For EN 61000-4-4 tests

During EFT testing, the voltage is applied to power ports via coupling networks or via a clamp to signal lines. These tests are applied independently. However, because of the close proximity of the power ports with the signal cables and because the signal cables are attached to the same EUT enclosure, the two separate tests become interactive and hence are not independent. When the test is applied to the power port, the signal ports are also tested and vice versa.

The following examples show the voltages which appear on the signal ports when the test is applied to the AC mains port.

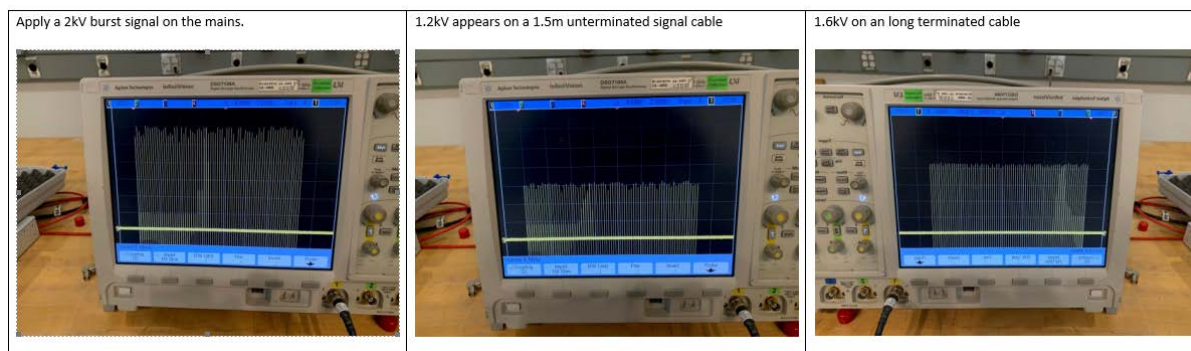


Figure B.3

Typically the voltage applied is for the mains test is 1 kV and for signal cables 500 V, as defined in the present document. In this context, that would be 600 V and 800 V respectively.

B.5 Conclusion

The examples from testing to EN 61000-4-6 [i.26] and EN 61000-4-4 [i.27] clearly show that during mains testing, significant signals appear on the signal and control lines. Therefore, because of the limited direct threat from the environment on short cables, the test which is applied during testing of the main ports are considered adequate and do not need to be tested separately.

Annex C (informative): Change history

Version	Information about changes
V1.2.1	First publication.
	New edition for RED; Updates for multi-band BS.
V2.1.1	Radiated immunity testing to a continuous sweep between 80 MHz and 690 MHz at 3 V/m and 690 MHz and 6 000 MHz at 10 V/m as opposed to the previous frequency range of 80 MHz to 1 000 MHz and 1 400 MHz to 2 700 MHz at 3 V/m in earlier editions.
V2.2.1	Small editorial corrections.
V2.3.1	Updated with requirements for new technologies LTE LAA, LTE with NB-IoT, NB-IoT standalone and NR. Added special requirements for OTA AAS type of BS. Split up RF radiated immunity requirement into two power classes.
V2.4.1	Removed the references to Harmonics and Voltage fluctuation requirements. Added operating conditions for ESD test on OTA radio. Guidance of selection of RATs to be tested for MSR BS is provided for one narrowband RAT and one broadband RAT. NR with in-band NB-IoT is added. Informative Annex C is added.

History

Document history		
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