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Technical Report

**Broadband Radio Access Networks (BRAN);
HIPERACCESS;
Recommendations on essential radio parameters
to be included in EN 302 326
(Harmonized Standard for Multipoint Systems)**

Reference

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Foreword

This Technical Report (TR) has been produced by ETSI Project Broadband Radio Access Networks (BRAN).

Introduction

The present document contains information on essential radio parameters of BRAN HIPERACCESS systems and the present document is mainly intended to be used as input to ETSI TM4 for the generic harmonized EN on digital multipoint radio equipment (EN 302 326 [36]).

The present document is meant to be informative only. It is not the intention of ETSI BRAN to push for any specific form of the inclusion into EN 302 326 [36], however, ETSI BRAN offers its support to ETSI TM4 to assist in the further processing of the present document when requested.

1 Scope

The present document applies to high-performance access systems like HIPERACCESS Access Point (AP) and Access Termination (AT) equipment dealing with essential radio parameters to avoid harmful interference and to provide efficient usage of the spectrum. The radio parameters addressed in the present document were also selected with regards to the essential requirements of Directive 1999/5/EC [1] (R&TTE Directive) article 3.2 (as detailed in Harmonized EN 301 753 [30] and EN 301 997-2 [29]).

The present document is mainly intended to be used as informative input to ETSI TM4 for their work on the generic harmonized EN on digital multipoint radio equipment (EN 302 326 [36]), where it is not the intention of the present document to push for any specific form of the inclusion into EN 302 326 [36].

HIPERACCESS is confined to only the radio subsystem consisting of the *PHYsical (PHY) layer [4]* and the *DLC layer [5]* - which are both core network independent - and several core network specific *convergence sub-layers*. HIPERACCESS specifies a fixed broadband wireless access system with a point-to-multipoint architecture aiming at interoperability between equipment from different vendors. An informative overview of HA is given in annex B.

Table 1: HA frequency bands

Frequency band	Lower sub-band (GHz)	Upper sub-band (GHz)	CEPT/ERC/REC	Ref.
"42 GHz"	40,500 to 41,500	41,500 to 42,500	01-04	[12]
	40,500 to 42,000	42,000 to 43,500	01-04	[12]
"32 GHz"	31,800 to 32,600	32,600 to 33,400	01-02	[13]
"31 GHz"	31,000 to 31,150	31,150 to 31,300	02-02	[35]
"28 GHz"	27,8285 to 28,0525	28,8365 to 29,0605	13-04; 13-02; 01-03 and CEPT/ERC/DEC(00)09	[14]; [15]; [16]; [34]
	28,0525 to 28,4445	29,0605 to 29,4525		[14]; [15]; [16]; [34]
"26 GHz"	24,500 to 25,500	25,500 to 26,500	13-04; 13-02; 00-05	[14]; [15]; [17]

Examples of potential carrier frequencies, provided by CEPT/ECC for FWA are given in table 1. However, the HA standard supports all carrier frequencies from 11 GHz to 43,5 GHz. Therefore, provided that in that range there might be a number of National frequency arrangements and possible future new CEPT allocation and reassignment of bands, the present document is considered applicable also in such cases.

The scope of the present document is as follows:

- It applies to HIPERACCESS products with integral antennas for which all the technical requirements specified in [4], [5] and [33] included in the present document apply. It also applies to HIPERACCESS equipment without integral antennas to which only the relevant technical requirements apply.

- It gives a description of the recommended requirements for the essential radio test suites. It covers basic RF aspects, including the radio frequency channel plans and those other parameters necessary to avoid harmful interference.

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

[2] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).

[3] Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).

[4] ETSI TS 101 999: "Broadband Radio Access Networks (BRAN); HIPERACCESS; PHY protocol specification".

[5] ETSI TS 102 000: "Broadband Radio Access Networks (BRAN); HIPERACCESS; DLC protocol specification".

[6] ETSI EN 300 019 (all parts): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

[7] ETSI EN 301 489-4: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services".

[8] ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".

[9] CENELEC EN 61000-6-1: "Electromagnetic compatibility (EMC); Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments".

[10] CENELEC EN 55022: "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement".

[11] CENELEC EN 60950: "Safety of information technology equipment".

[12] CEPT/ECC/REC 01-04: "Recommended guidelines for the accommodation and assignment of Multimedia Wireless Systems (MWS) in the frequency band 40,5 - 43,5 GHz".

[13] CEPT/ERC/REC 01-02: "Preferred channel arrangement for digital fixed service systems operating in the frequency band 31,8 - 33,4 GHz".

[14] CEPT/ERC/REC 13-04: "Preferred frequency bands for fixed wireless access in the frequency range between 3 and 29,5 GHz".

[15] CEPT/ERC/REC T/R 13-02: "Preferred channel arrangements for fixed services in the range 22,0 - 29,5 GHz".

[16] CEPT/ERC/REC 01-03: "Use of parts of the band 27,5-29,5 GHz for Fixed Wireless Access (FWA)".

[17] CEPT/ERC/REC 00-05: "Use of the band 24,5 - 26,5 GHz for fixed wireless access".

[18] ETSI EN 301 215-2: "Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 11 GHz to 60 GHz band; Part 2: 24 GHz to 30 GHz".

[19] ETSI EN 301 215-3: "Fixed Radio Systems; Point to Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 11 GHz to 60 GHz band; Part 3: Multipoint Multimedia Wireless System in 40,5 GHz to 43,5 GHz".

[20] ETSI EN 301 215-4: "Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for multipoint fixed radio systems in the 11 GHz to 60 GHz band; Part 4: 30 GHz to 40,5 GHz".

[21] ETSI EN 301 213-1: "Fixed Radio Systems; Point-to-multipoint equipment; Point-to-multipoint digital radio systems in frequency bands in the range 24,25 GHz to 29,5 GHz using different access methods; Part 1: Basic parameters".

[22] ETSI EN 301 126-3-2: "Fixed Radio Systems; Conformance testing; Part 3-2: Point-to-Multipoint antennas - Definitions, general requirements and test procedures".

[23] ETSI TR 100 028-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1".

[24] ETSI TR 100 028-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

[25] ETSI EN 301 213-3: "Fixed Radio Systems; Point-to-multipoint equipment; Point-to-multipoint digital radio systems in frequency bands in the range 24,25 GHz to 29,5 GHz using different access methods; Part 3: Time Division Multiple Access (TDMA) methods".

[26] ETSI EG 201 399: "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of candidate Harmonized Standards for application under the R&TTE Directive".

[27] ETSI EN 301 390: "Fixed Radio Systems; Point-to-point and Multipoint Systems; Spurious emissions and receiver immunity limits at equipment/antenna port of Digital Fixed Radio Systems".

[28] CEPT/ERC/REC 74-01: "Spurious emissions".

[29] ETSI EN 301 997-2: "Transmission and Multiplexing (TM); Multipoint equipment; Radio equipment for use in Multimedia Wireless Systems (MWS) in the frequency band 40,5 GHz to 43,5 GHz; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive".

[30] ETSI EN 301 753: "Fixed Radio Systems; Multipoint equipment and antennas; Generic harmonized standard for multipoint digital fixed radio systems and antennas covering the essential requirements under article 3.2 of the Directive 1999/5/EC".

[31] ETSI TR 101 506: "Fixed Radio Systems; Generic definitions, terminology and applicability of essential requirements under the article 3.2 of 99/05/EC Directive to Fixed Radio Systems".

[32] ETSI EG 201 752: "Fixed Radio Systems; Point-to-Point and Point-to-Multipoint Equipment and Antennas; Identification of European standards (EN), applicable to fixed radio systems, for the essential requirements under the article 3.1 of the 1999/5/EC Directive".

[33] ETSI TS 102 123: "Broadband Radio Access Networks (BRAN); HIPERACCESS; Radio Conformance Test Specification".

[34] CEPT/ERC/DEC(00)09: "ERC Decision of 19 October 2000 on the use of the band 27,5 - 29,5 GHz by the fixed service and uncoordinated Earth stations of the fixed-satellite service (Earth-to-space)".

[35] CEPT/ECC/REC 02-02: "Channel arrangements for digital fixed service systems (point-to-point and point-to-multipoint) operating in the frequency band 31 – 31,3 GHz".

[36] ETSI EN 302 326 (all parts): "Fixed Radio Systems; Digital Multipoint Radio Systems".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Access Point (AP): generalized equipment consisting of an Access Point Controller (APC) and several Access Point Transceivers (APT)

cell: geographical area controlled by an Access Point

control zone: part of the DL frame

DL burst: transmission event consisting of a channel-symbol-sequence (preamble and the data symbols) corresponding to a given PHY mode transporting one or several FEC-blocks in the optional TDMA zone of the DL frame

DL MAC frame: structured data sequence with fixed duration of 1 ms

NOTE: It contains a 32-symbol frame preamble, a variable length control zone, a variable length TDM-zone and an optional variable length TDMA-zone.

DownLink (DL): direction from AP to AT

DownLink channel: channel transmitting data from APT to AT

FEC-block: block resulted from the encoding of traffic (up to a maximum number of 216 (downlink)/220 (uplink) bytes) received from the DLC (1, 2, 3 or 4 MAC PDUs when supporting a fixed PDU size DLC)

full-duplex: equipment (e.g. AT) which is capable of transmitting and receiving data at the same time

guard-time: time at the beginning or end of each burst to allow power ramping-up and down

half-duplex: equipment (e.g. AT) which cannot transmit and receive data simultaneously

MAC PDU: data unit exchanged between the DLC and PHY layers, consisting of the MAC PDU header and the MAC PDU payload

Net Filter Discriminator (NFD): ratio between the interfering power and portion of the interfering power falling into the victim Rx filter

non-splitted AP/AT: all parts of AP/AT are built in in a common housing

PHY mode: combination of a signal constellation (Modulation alphabet) and FEC parameters (i.e. inner, outer, block-length, etc.)

power ramping: operation performed during the guard time period for power transition from OFF-level to ON-level and vice versa

preamble: sequence of channel symbols with a given auto-correlation property assisting modem synchronization and channel estimation

sector: geometrical area resulting from the cell-splitting by the use of a Sector Antenna

splitted AP/AT: AP/AT is splitted in an OutDoor Unit (ODU) and an InDoor Unit (IDU)

supplier: organization requesting the conformance test approval

supplier declaration: procedure by which a supplier gives written assurance that a parameter or function conforms to the EN/ETS

Tx/Rx switching time: amount of time required to transition from the PHY reception to the PHY transmission or vice versa for H-FDD AT or TDD AP and AT

UL burst: transmission event consisting of a power ramp-up, channel-symbol-sequence (preamble and the data symbols) corresponding to a given PHY mode transporting DLC traffic and control bytes in the UL TDMA frame and power ramp-down

UL burst concatenation: process for concatenation of several UL bursts, where a unique power ramp-up time shall be used at the beginning of the first burst

UpLink (UL): direction from AT to AP

3.2 Symbols

For the purposes of the present document, the following symbols apply:

B	Channel bandwidth in MHz
B_n	Equivalent Noise bandwidth in MHz
dBi	decibel relative to isotropic radiator
dBm	decibel relative to 1 mW
Δloss	Implementation loss
K	Number of information byte per RS codeword
M	Number of bits transmitted per modulated symbol
NF	Noise Figure in dB
N_o	Noise Spectral density in dBm/Hz
Rxloss	Receiver branching loss
t	Number of error correction capability of a RS code (t=8 here)

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

A/D	Analogue/Digital
AH	Artificial Hop
AP	Access Point
APC	AP Controller
APT	AP Transceiver
AT	Access Termination
ATM	Asynchronous Transfer Mode
ATPC	Automatic Transmit Power Control
AWGN	Additive White Gaussian Noise
BER	Bit Error Rate
CAZAC	Constant Amplitude Zero Auto Correlation
CCF	Channel Centre Frequency
C/I	Carrier to Interference power ratio
CNR	Carrier to Noise power Ratio
CL	Convergence Layer
CW	Continuous Wave
D/A	Digital/Analogue
DAQ	Digital AcQuisition device
DDPC	Dynamic Downlink Power Control
DL	DownLink
DLC	Data Link Control
EIRP	Effective Isotropic Radiated Power
FDD	Frequency Division Duplex
FEC	Forward Error Correction
FWA	Fixed Wireless Access
HA	HIPERACCESS
HD	Half Duplex
H-FDD	Half-duplex Frequency Division Duplex
IDU	InDoor Unit
MAC	Medium Access Control
NA	Not Applicable
NFD	Net Filter Discriminator
ODU	OutDoor Unit
PDU	Protocol Data Unit
PHY	PHYsical (layer)
PSU	Power Supply Unit
R&TTE	Radio and Telecommunications Terminal Equipment
RF	Radio Frequency
RFC	Remote Frequency Control
RMS	Root Mean Square
RPE	Radiation Pattern Envelope
RS	Reed-Solomon
RT	Radio Termination
Rx	Receiver
STC	Symbol Transmit Clock
TDD	Time Division Duplex
TDM	Time Division Multiplex
TDMA	Time Division Multiple Access
Tx	Transmitter
UL	UpLink

4 Void

5 Essential radio parameters

5.1 Environmental specifications

The technical requirements of the present document apply under the environmental profile, for intended operation of the equipment and antennas, declared by the manufacturer.

The environmental profile may be determined by the environmental class of the equipment according to the guidance given in [4].

The equipment and antennas shall comply with all the requirements of the present document at all times when operating within the boundary limits of the declared operational environmental profile.

5.2 Carrier frequencies

5.2.1 Definition

HIPERACCESS shall be targeted for operation in the frequency bands above 11 GHz identified for Fixed Wireless Access (FWA) service use. A list of available frequency bands is reported in table 2.

Other bands which are not specified in the present document can be used for FWA.

The supplier shall declare the frequency band where the equipment is HA compliant.

NOTE: In technology neutral Harmonized EN 301 753 [30] and EN 301 997-2 [29] a further requirement is set when a non standardized Remote Frequency Control (RFC) is implemented; for HA system such operation i.e. a redeployment of the cells/sectors frequency is standardized in a way that prevent any harmful interference to happen. Therefore this is not considered relevant for HA systems.

Table 2: HA frequency bands

Frequency band	Lower sub-band (GHz)	Upper sub-band (GHz)	CEPT/ERC/REC	Ref.
"42 GHz"	40,500 to 41,500	41,500 to 42,500	01-04	[12]
	40,500 to 42,000	42,000 to 43,500	01-04	[12]
"32 GHz"	31,800 to 32,600	32,600 to 33,400	01-02	[13]
"31 GHz"	31,000 to 31,150	31,150 to 31,300	02-02	[35]
"28 GHz"	27,8285 to 28,0525	28,8365 to 29,0605	13-04; 13-02; 01-03 and CEPT/ERC/DEC(00)09	[14]; [15]; [16]; [34]
	28,0525 to 28,4445	29,0605 to 29,4525		[14]; [15]; [16]; [34]
"26 GHz"	24,500 to 25,500	25,500 to 26,500	13-04; 13-02; 00-05	[14]; [15]; [17]

5.2.2 Limits

The transmitted RF carrier centre frequency for the APT shall have an absolute accuracy better than ±8 ppm.

The AT shall be locked in frequency to the APT.

The relative accuracy of the AT in locked state shall be ±1 ppm with respect to the APT.

5.2.3 Conformance

Conformance shall be provided as stated in clause 5.2.2 over temperature and frequency band (L, M, H and B, M, T).

5.3 RF channel and spectrum mask

5.3.1 Definition

The transmitted spectrum shall not exceed the limits given by the spectrum masks defined in clause 5.3.2.

The conformance will be performed both with constant power versus time and with switched power on a burst basis.

5.3.2 Limits

The APT transmit spectrum shall not exceed the mask defined by table 3 (also depicted in figure 1).

The AT transmit spectrum shall not exceed the mask defined by table 4 (also depicted in figure 2).

Table 3: APT spectrum mask definition

Frequency offset (MHz)	13	14	14,4	14,8	22,4	28	56	70
Relative attenuation (dB)	0	-15	-20	-28	-34	-42	-52	-52

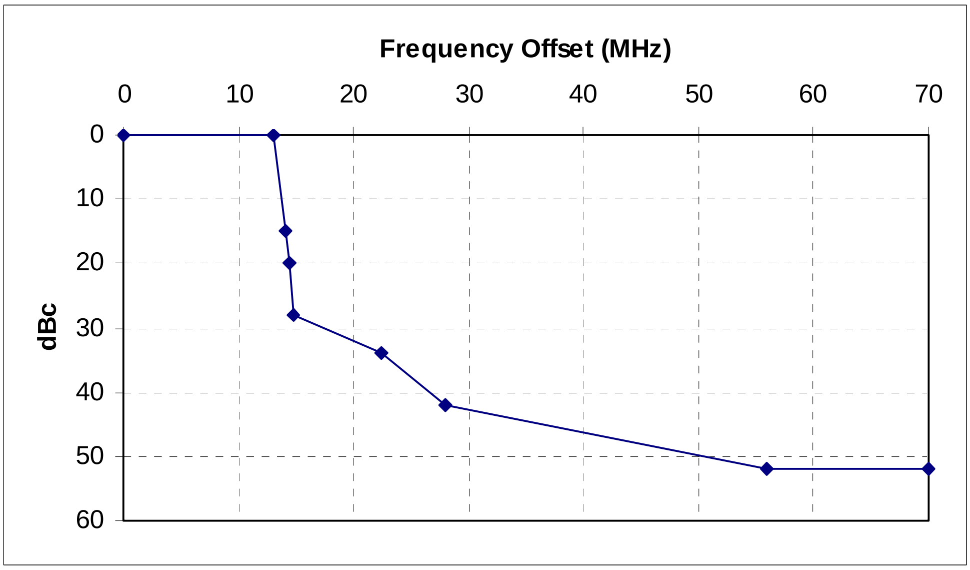

Figure 1: APT spectrum mask

Table 4: AT spectrum mask definition

Frequency offset (MHz)	11,2	13,5	14,5	22,4	28	56	70
Relative attenuation (dB)	0	-7	-17	-32	-37	-52	-52

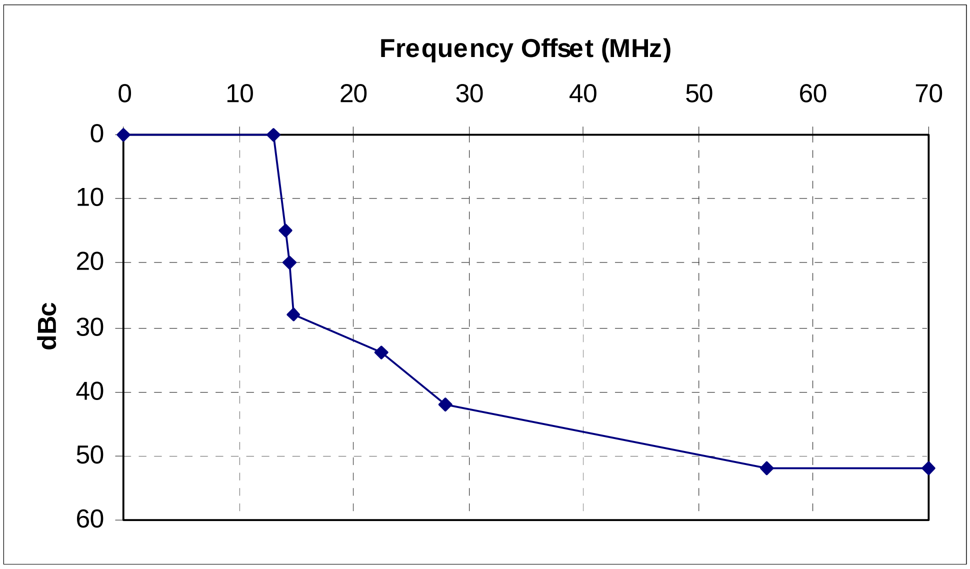

Figure 2: AT spectrum mask

5.3.3 Conformance

Conformance shall be provided as stated in clause 5.3.2 over temperature and frequency band (L, M, H and B, M, T).

5.4 Transmitter output power and tolerance

5.4.1 Definition

The transmitter output power P_{tx} is referred to the RF connection to the antenna (see figure 3), for both the APT (interface A_{AP}) and the AT (interface A_{AT}).

5.4.2 AP

5.4.2.1 Limits

For each set of DL PHY mode the APT shall operate with the maximum output power setting. Tables 5 and 6 summarize the requirements for the two sets of possible DL PHY modes. The naming of PHY modes is according to table B.1.

Table 5: AP maximum transmitter output power (DL set-1)

Set-1 (mandatory)		Output Power $P_{tx,AP}$ (dBm)	Tolerance (dB)
DL-1	4QAM	15	±2
DL-2	4QAM	15	±2
DL-3	16QAM	15	±2
DL-5 (optional)	64QAM	15	±2

Table 6: AP maximum transmitter output power (DL set-2)

Set-2 (optional)		Output Power $P_{tx,AP}$ (dBm)	Tolerance (dB)
DL-1	4QAM	15	±2
DL-2	4QAM	15	±2
DL-4	16QAM	15	±2
DL-6 (optional)	64QAM	15	±2

5.4.2.2 Conformance

Conformance is proved if the output power $P_{tx,AP}$ is within the range of 13 dBm and 17 dBm for all cases listed in tables 5 and 6 over temperature and frequency band (L, M, H and B, M, T).

5.4.3 AT

5.4.3.1 Limits

For each set of UL PHY mode (set-1 and set-2) the AT shall operate with the maximum output power setting. According to the applied modulation different maximum output powers are required. Table 7 summarizes the requirements for the two sets of possible UL PHY modes. The naming of PHY modes is according to table B.2.

Table 7: AT maximum transmitter output power

Set-1		Output Power $P_{tx,AT}$ (dBm)	Tolerance (dB)
UL-1, UL-1S	4QAM	14	±2
UL-2, UL-2S	4QAM	14	±2
UL-3, UL-3S (optional)	16QAM	11	±2
Set-2		**Output Power $P_{tx,AT}$ (dBm)**	**Tolerance (dB)**
UL-1, UL-1S	4QAM	14	±2
UL-2, UL-2S	4QAM	14	±2
UL-4, UL-4S (optional)	16QAM	11	±2
NOTE: 16QAM can be up to 14 dBm, according to supplier declaration.			

5.4.3.2 Conformance

Conformance is proved if the output power $P_{tx,AT}$ is within the range of 12 dBm and 16 dBm in case of 4QAM modulation and within the range of 9 dBm and 13 dBm in case of 16QAM modulation. All cases of table 7 shall be proved over temperature and frequency band (L, M, H and B, M, T).

5.5 Dynamic Downlink Power Control (DDPC)

5.5.1 Definition

DDPC is the dynamic control of the AP transmit power in order to meet possible national regularity requirements. The implementation is optional in HA.

5.5.2 Limits

The AP shall apply first the most robust PHY mode. If this action is not sufficient then DDPC is applied. To verify the rules in case the DDPC is implemented the following tests shall be performed. The maximum AP Tx output power of 15 dBm shall be selected. Depending on the APT-class the dynamic range for AP Tx output power control is different (table 8). The dynamic ranges belonging to the APT-classes shall be swept in 1 dB steps. The duration of the DL power adjustment of a 1 dB step shall not be less than 50 ms. The duration of the whole dynamic range sweep shall not be less than the figures in table 8.

NOTE: Within the frame's duration a change of the Tx power is not allowed.

Table 8: DDPC requirements (optional)

DL PHY Mode 1)	APT-class	Dynamic Range (sweep in ≤ 1 dB steps)	Duration of 1 dB transition step (ms)	Duration of total sweep (s)
Set-1 (mandatory)	class 1	(15 dBm to 11 dBm) ±2 dB	≥ 50	≥ 2,0
		(11 dBm to 15 dBm) ±2 dB	≥ 50	≥ 2,0
	class 2	(15 dBm to 8 dBm) ±2 dB	≥ 50	≥ 3,5
		(8 dBm to 15 dBm) ±2 dB	≥ 50	≥ 3,5
Set-2 (optional)	class 3	(15 dBm to 5 dBm) ±2 dB	≥ 50	≥ 5,0
		(5 dBm to15 dBm) ±2 dB	≥ 50	≥ 5,0
NOTE 1: The most efficient PHY-mode of set-1 (set-2 if applicable) shall be applied. NOTE 2: Within one DL-frame the AP Tx power shall not change!				

5.5.3 Conformance

Conformance is proved if all the requirements in table 8 are met over temperature and frequency band (L, M, H and B, M, T).

5.6 Tx static power setting

5.6.1 Definition

Static DL power setting of the APT is optional. It can be implemented in view of a higher flexibility for the HA system, e.g. different cell size.

5.6.2 Limits

To verify the rules in case of an implemented static DL power setting the following tests shall be performed. The maximum AP Tx output power of 15 dBm shall be decreased in steps of 2 dB down to the minimum of 5 dBm according to the required power setting range of 0 dB to 10 dB. After each power setting the accuracy of the measured Tx output power shall be within the borders given in table 9.

Table 9: Static DL power setting requirements (optional)

AP Tx Output Power	
setting	measured
15 dBm	15 dBm ± 2 dB
13 dBm	13 dBm ± 2 dB
11 dBm	11 dBm ± 2 dB
9 dBm	9 dBm ± 2 dB
7 dBm	7 dBm ± 2 dB
5 dBm	5 dBm ± 2 dB

5.6.3 Conformance

Conformance is proved if all requirements in table 9 are met over temperature and frequency band (L, M, H and B, M, T).

5.7 Automatic Transmit Power Control (ATPC)

5.7.1 Definition

The UL power control functionality, ATPC, is mandatory in HA and is under complete AP control (TS 101 999 [4], clause 5.5.3.5.3).

The Power Control function shall try to minimize the interference. The algorithm (not standardized) shall be implemented in a way forcing each AT to never exceed the minimum Tx power level guaranteeing the achievement of the wanted link performances.

In order to achieve that, the APT shall manage to receive signals coming from every AT with an excess power (with respect to the nominal threshold for BER = 10^{-11}); the gap in dB between actual Rx power and threshold Rx power is called *Rx Power Margin*.

5.7.2 Limits

The value of the *Rx Power Margin* shall belong to the range 4 dB to 8 dB from the nominal threshold for BER = 10^{-11}, in conjunction with the corresponding minimum repetition rate selected, minimum power control performances are fulfilled even considering maximum control loop lag.

For a given implementation, *Rx Power Margin* shall be the same for each PHY mode.

The following rules shall be applied:

- The power control level shall be adjusted in a relative manner.
- The absolute minimum time between ATPC control messages shall never be less than 50 ms, whatever the implementation of the power control algorithm. The actual minimum time can be implementation dependent, and shall belong to the range 50 ms to 200 ms.
- The size of all power control steps shall belong to the range 1 dB to 4 dB, with resolution of 0,5 dB.

5.7.3 Conformance

Conformance shall be provided as defined in clause 5.7.3 over temperature and frequency band (L, M, H and B, M, T).

5.8 Antenna gain and Radiation Pattern Envelope (RPE) and EIRP

5.8.1 Definition

5.8.1.1 All frequency bands

In table 10 the maximum antenna gains and the EIRP values for different APT classes are given. The remaining characteristics of the antennae, e.g. radiation pattern shall be compliant with the EN 301 215-2 [18], EN 301 215-3 [19] and EN 301 215-4 [20]. The manufacturer shall declare their APT antenna gain characteristics according to EN 301 215-2 [18], EN 301 215-3 [19] and EN 301 215-4 [20], where the declared maximum antenna gain shall not exceed the values given in this table.

Each APT class corresponds to a given EIRP value.

The APT classes are frequency band and sector angle-independent.

Table 10: APT classes, maximum antenna gains and maximum EIRP

APT class	Maximum antenna gain (dBi)	Tx maximum output power (dBm)	Maximum EIRP (dBmi)
1	18	+15	+37
2	21	+15	+40
3	24	+15	+43

In case of the AT, antenna gains vary as a function of used frequency band as reported in table 11. Different nominal (and maximum) EIRP values will be available in each frequency band.

Table 11: AT antenna gains and EIRP

Frequency band (GHz)	Nominal antenna gain (dBi)	Tx maximum output power (dBm)	Nominal EIRP (dBmi)	Maximum EIRP (dBmi)	Radiation pattern
42	37	+14	51,0	54,0	TS3; EN 301 215-3 [19]
32	35,5	+14	49,5	52,5	TS3; EN 301 215-4 [20]
28	34,5	+14	48,5	51,5	TS3; EN 301 215-2 [18]
26	33,5	+14	47,5	50,5	TS3; EN 301 215-2 [18]

5.8.1.2 Additional Requirements for EIRP limits for 42 GHz band

In 42 GHz band, CEPT/ECC Recommendation 01-04 [12] set also an EIRP density block-edge mask that in the technology neutral Harmonized EN 301 997-2 [29] is considered relevant to article 3.2 of R&TTE Directive [1].

For HA systems the spectrum masks and the maximum EIRP defined in clauses 5.3 and 5.9.1.1 automatically fulfil such requirement provided that the minimum distance of the CCF from the block-edge is maintained as it is specified in the annex of TS 101 999 [4] Therefore no further conformance procedure is requested provided that the equipment supplier will state this CCF limitation in the User documentation accompanying the equipment.

NOTE: The requested declaration is necessary only for placing equipment on the market. For its deployment it should be further noted that CEPT/ECC Recommendation 01-04 [12] states that:
"..for further enhancing the efficiency, administrations are not expected, after the block assignment procedure, to enforce the block-edge requirements to neighbour operators who will apply mutual co-ordination at the block edge in view to optimize the guard bands. In that case only the maximum "in-block" EIRP/power density apply while the "out-of-block" noise floor will apply only from a "mutually agreed" starting point within the adjacent block".

5.8.2 Limits

The overall EIRP accuracy is the sum of antenna gain and Tx output power accuracy.

The accuracy of antenna gain shall be better than ±1 dB over temperature and ±1 dB over frequency.

Tx power accuracy is considered in clause 6.4. (It shall be better than ±2 dB.)

5.8.3 Conformance

Conformance shall be provided as defined in clause 5.8.2 at ambient temperature (M) and over frequency band (B, M, T).

EIRP is tested splitting power and antenna directivity contributions. Antenna test is addressed here, while Tx power test is considered in clause 5.4.

5.9 Receiver sensitivity

5.9.1 Definition

The receiver sensitivity corresponding to the C/N producing a given BER for an equivalent noise bandwidth B_n and a system noise figure NF is defined as:

$$S_{th} = N_0 + NF + 10\log_{10}(B_n) + \frac{C}{N} + \Delta loss + Rxloss$$

where:

- N_0 is the receiver noise floor;
- Δloss includes all implementation losses;
- Rxloss is the receiver branching filter loss.

For the HA design assumptions of all receiver physical parameters in the above formula see TS 101 999 [4].

5.9.2 Limits

Tables 12 and 13 show the required input level receiver thresholds for BER ≤ 10^{-6} for both AT and APT in case of 4 x MAC PDUs per FEC block (analysis is limited to the fixed size PDU case), as a function of PHY mode and frequency band in AWGN channel. For frequency bands different from the listed ones, the nearest frequency band requirement applies.

Table 12: AT-Receiver sensitivity for different carrier frequencies at BER ≤ 10^{-6}

PHY mode	P_{rx} @ 26 GHz to 28 GHz (dBm)	P_{rx} @ 32 GHz (dBm)	P_{rx} @ 42 GHz (dBm)
DL-0	-88	-87	-86
DL-1	-85	-84	-83
DL-2	-81	-80	-79
DL-3	-75	-74	-73
DL-5	-68	-67	-66
DL-4	-73	-72	-71
DL-6	-66	-65	-64

Table 13: AP-Receiver sensitivity for different carrier frequencies at BER ≤ 10^{-6}

PHY mode	P_{rx} @ 26 GHz to 28 GHz (dBm)	P_{rx} @ 32 GHz (dBm)	P_{rx} @ 42 GHz (dBm)
UL-1S	-86	-85	-84
UL-1	-85	-84	-83
UL-2	-81	-80	-79
UL-3	-75	-74	-73
UL-4	-73	-72	-71

5.9.3 Conformance

Conformance shall be provided as given in clause 5.9.2 shall be carried out over temperature and frequency band (L, M, H and B, M, T).

5.10 Co-channel interference performance

5.10.1 Definition

The co-channel interference is measured as a degradation of non interfered BER threshold due to an interfering modulated signal with the same nominal carrier frequency of the useful signal.

5.10.2 Limits

The limits of co-channel interference (external) shall be as in table 14, giving maximum C/I values for 1 dB and 3 dB degradation of the BER $\leq 10^{-6}$ threshold specified in clause 5.9.

All the PHY modes supported by equipment under test shall be used for the test.

In case using turbo codes the C/I values shall be 2 dB lower than in table 14.

Table 14: C/N and C/I for 1 dB and 3 dB threshold degradation at BER ≤ 10^{-6}

PHY mode	C/I @1dB S_{th} degradation	C/I @3dB S_{th} degradation	Notes
DL-0	11	7	
DL-1; UL-1	14	10	
DL-2; UL-2	18	14	
DL-3; UL-3	24	20	
DL-4; UL-4	26	22	
DL-5	31	27	AT only
DL-6	33	29	AT only

5.10.3 Conformance

Conformance shall be provided as defined in clause 5.10.2 at ambient temperature (M) and over frequency band (B, M, T).

5.11 Adjacent channel interference performance

5.11.1 Definition

The sensitivity of HA system to adjacent channel interference is specified by receiver Net Filter Discrimination (NFD).

One way to test this requirement is to measure the level of the interfering signal positioned at given frequency offset from centre frequency causing a given threshold degradation, and compare it with the level of a co-channel interferer giving the same degradation. The difference between the two level corresponds to the NFD at the offset used.

5.11.2 Limits

The NFD masks typically met by an HA system in downlink and uplink are defined by table 15.

Table 15: Downlink and uplink NFD mask

Offset (MHz)	NFD - DL (dB)	NFD - UL (dB)
28	***35,5***	***29***
31,5	39	34,5
35	42	38,5
38,5	45	41
42	46,5	43
49	49	46,5
56	***51***	***50***
59,5	51,5	51
63	52	51,5
70	52	52
77	52	52
84	52	52

Being the more stringent one, only the values at 28 MHz offset are considered relevant to essential requirements under article 3.2 of the R&TTE Directive [1].

Then the above system requirement at 28 MHz translates in the following requirements suitable for easier testing.

Table 16 reports C/I levels for NFD test (AT and APT Receiver).

Table 16: C/I levels for NFD test at 28 MHz

PHY mode	AT receiver C/I Adj. channel 1dB S_{th} Degradation (dB)	APT receiver C/I Adj. channel 1dB S_{th} degradation (dB)
DL-0	-24,5	-18
DL-1; UL-1	-21,5	-15
DL-2; UL-2	-17,5	-11
DL-3; UL-3	-11,5	-5
DL-4; UL-4	-9,5	-3
DL-5	-4,5	NA
DL-6	-2,5	NA

5.11.3 Conformance

Conformance shall be provided as defined in clause 5.11.2 at ambient temperature (M) and over frequency band (B, M, T).

At least the most efficient PHY Mode supported by equipment according to supplier declaration shall be used for the test.

5.12 CW spurious interference

5.12.1 Definition

This test is designed to identify specific frequencies at which the receiver may have a spurious response, e.g. image frequency, harmonics of the receive filter, etc. The actual test range should be adjusted accordingly.

NOTE: The test is not intended to imply a relaxed specification at all out of band frequencies elsewhere specified in the present document.

5.12.2 Limits

The equipment under test shall be in accordance with EN 301 390 [27]. It states, in particular, for a receiver operating at the input level specified in clause 5.11 (sensitivity) for 10^{-6} BER threshold, the introduction of a CW interferer at a level of +30 dB with respect to the wanted signal and at any frequency formally up to 300 GHz (see note), excluding frequencies either side of the centre frequency of the wanted RF channel by up to 500 % of the co-polar channel spacing, shall not cause a degradation of more than 1 dB of the BER threshold as specified in clause 5.11 (sensitivity).

NOTE: Actual test limitation shall be in accordance with clause 7.1 of EN 301 390 [27] (i.e. for HA frequency bands up to the 2nd harmonic of the highest channel frequency).

5.12.3 Conformance

Conformance shall be provided as defined in clause 5.11.2 at ambient temperature (M) and over frequency band (B, M, T).

5.13 Spurious emissions

5.13.1 Definition

Spurious emissions encompass, for transmitters, any unwanted emission falling in frequency ranges, defined by CEPT/ERC/REC 74-01 [28] separated from the centre frequency of the emission by more than 250 % of the relevant channel separation. Those emissions include harmonic emissions, parasitic emissions, inter-modulation products, and frequency conversion products.

Transmitter spurious emissions are emissions sent to the antenna port by a transmitter.

Receiver spurious emissions are emissions sent backwards to the antenna port by a receiver and are defined in the same range of frequency but without any exclusion band (i.e. the ±250 % of the channel separation.

5.13.2 Limits

Dependent on the frequency position of the HA channel shall meet the different spurious emission limits given in EN 301 390 [27].

In EN 301 390 [27], the requirements for AT are mitigated compared to AP. In case of HA channel positioned below 21,2 GHz the requirements of table 17shall be met for AP transmitter and receiver spurious emissions, whereas the requirements of table 18 shall be met for AT transmitter and receiver spurious emissions. In case of HA channels positioned above 21,2 GHz the requirements of table 19 apply for AP equipment and the requirements of table 20 apply for AT equipment.

Concerning HA channels above 21,2 GHz a mitigation for *continuous wave* emissions is permissible in the two ranges where a requirement of -40 dBm is valid. In both ranges together up to 10 discrete spurious emissions are permitted to exceed the limit of -40 dBm. However, those discrete emissions shall not exceed -30 dBm.

As a general rule, the resolution bandwidth of the measuring receiver for the spurious emissions should be equal to the reference bandwidth as given in tables 17 to 20.

NOTE: In case where the resolution bandwidth of the receiver is different the note at the end of recommend 4 in CEPT/ERC/REC 74-01 [28] shall be considered.

Table 17: AP Tx and Rx (note 4) spurious emissions requirements for CCF below 21,2 GHz

Frequency range		Reference bandwidth	Emission power (dBm)
No.	Definition		
1	30 MHz ≤ f < 1GHz	100 kHz	≤ -50
2	1 GHz ≤ f < CCF - 70 MHz	1 MHz	≤ -50
3	CCF + 70 MHz ≤ f < 21,2 GHz	1 MHz	≤ -50
4	21,2 GHz ≤ f < 26 GHz (see note 1) 21,2 GHz ≤ f < 2nd harmonic (see note 2)	1 MHz	≤ -30
NOTE 1: Upper frequency limit is 26 GHz if 5,2 GHz ≤ CCF < 13 GHz. NOTE 2: Upper frequency limit is the second harmonic of the highest oscillator frequency if 13 GHz ≤ CCF < 150 GHz. NOTE 3: CCF: Channel Centre Frequency. NOTE 4: For RX no exclusion band around CCF is given.			

Table 18: AT Tx and Rx (note 4) spurious emissions requirements for CCF below 21,2 GHz

Frequency range		Reference bandwidth	Emission power (dBm)
No.	Definition		
1	30 MHz ≤ f < 1 GHz	100 kHz	≤ -40
2	1 GHz ≤ f < CCF - 70 MHz	1MHz	≤ -40
3	CCF + 70 MHz ≤ f < 21,2 GHz	1 MHz	≤ -40
4	21,2 GHz ≤ f < 26 GHz (see note 1) 21,2 GHz ≤ f < 2nd harmonic (see note 2)	1 MHz	≤ -30
NOTE 1: Upper frequency limit is 26 GHz if 5,2 GHz ≤ CCF < 13 GHz. NOTE 2: Upper frequency limit is the second harmonic of the highest oscillator frequency if 13 GHz ≤ CCF < 150 GHz. NOTE 3: CCF: Channel Centre Frequency. NOTE 4: For RX no exclusion band around CCF is given.			

Table 19: AP Tx and Rx (note 4) spurious emissions requirements (for CCF between 21,2 GHz and 43,5 GHz)

Frequency range		Reference bandwidth	Emission power (dBm)
No.	Definition		
1	30 MHz ≤ f < 1 GHz	100 kHz	≤ -50
2	1 GHz ≤ f < 21,2 GHz	1 MHz	≤ -50
3	21,2 GHz ≤ f < CCF - 126 MHz (see notes 1 and 4)	1 MHz	≤ -40
4	CCF - 126 MHz ≤ f < CCF - 70 MHz (see note 4)	1 MHz	≤ -30
5	CCF + 70 MHz ≤ f < CCF + 126 MHz (see note 4)	1 MHz	≤ -30
6	CCF + 126 MHz ≤ f < 43,5 GHz (see notes 1 and 4)	1 MHz	≤ -40
7	43,5 GHz ≤ f < 300 GHz (see note 2)	1 MHz	≤ -30
NOTE 1: Up to 10 discrete (continuous wave) spurious emissions are permitted to exceed the limit up to -30 dBm in the whole frequency range no. 3 plus no. 6. CCF: Channel Centre Frequency. NOTE 2: According [x] and [y], actual tests could be limited, for the HA relevant frequency bands (i.e. if 13 GHz ≤ CCF < 150 GHz), to an upper frequency limit equal to the second harmonic of the highest carrier or oscillator frequency implemented. NOTE 3: According [x] and [y], actual tests could be limited, assuming that HA will use a waveguide length equal to at least twice the cut-off wavelength, to a lower frequency 0,7 times the waveguide cut-off frequency. NOTE 4: For RX no exclusion band around CCF is given.			

Table 20: AT Tx and Rx (note 4) spurious emissions requirements (for CCF between 21,2 GHz and 43,5 GHz)

Frequency range		Reference bandwidth	Emission power (dBm)
No.	Definition		
1	30 MHz ≤ f < 1 GHz	100 kHz	≤ -40
2	1 GHz ≤ f < 21,2 GHz	1 MHz	≤ -40
3	21,2 GHz ≤ f < CCF - 126 MHz (see notes 1 and 4)	1 MHz	≤ -30
4	CCF - 126 MHz ≤ f < CCF - 70 MHz (see note 4)	1 MHz	≤ -30
5	CCF + 70 MHz ≤ f < CCF + 126 MHz (see note 4)	1 MHz	≤ -30
6	CCF + 126 MHz ≤ f < 300 GHz (see notes 1 and 4)	1 MHz	≤ -40
7	43,5 GHz ≤ f < 2nd harmonic (see note 2)	1 MHz	≤ -30
NOTE 1: Up to 10 discrete (continuous wave) spurious emissions are permitted to exceed the limit up to -30 dBm in the whole frequency range no. 3 plus no. 6. CCF: Channel Centre Frequency.			
NOTE 2: According [x] and [y], actual tests could be limited, for the HA relevant frequency bands (i.e. 13 GHz ≤ CCF < 150 GHz), to an upper frequency limit equal to the second harmonic of the highest carrier or oscillator frequency implemented.			
NOTE 3: According [x] and [y], actual tests could be limited, assuming that HA will use a waveguide length equal to at least twice the cut-off wavelength, to a lower frequency 0,7 times the waveguide cut-off frequency.			
NOTE 4: For RX no exclusion band around CCF is given.			

5.13.3 Conformance

Conformance is proved if the power of all spurious emissions is below the limits listed in tables 17 to 20 at ambient temperature (M) and over frequency band (B, M, T).

6 Interpretation of the measurement results

The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:

- the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
- the recorded value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures in table 21.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028-1 [23] and TR 100 028-2 [24] and shall correspond to an expansion factor (coverage factor k = 1,96 or k = 2 (which provide confidence level of 95 % and 95,45 %, respectively, in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

The accumulated measurement uncertainties of the test system for the parameters to be measured shall not exceed these given in table 21 taken from TR 100 028-2 [24], annex B. This is in order to ensure that the measurements remain within an acceptable quality.

Table 21: Maximum acceptable measurement uncertainties

Parameter	Uncertainty
RF frequency	$\pm 1 \times 10^{-7}$
RF power	±0,75 dB
Adjacent channel power	±3 dB
Conducted emissions of transmitters	±4 dB
Sensitivity	±3 dB
Conducted emissions of receivers	±4 dB
Radiated emissions of transmitters	±6 dB
Radiated emissions of receivers	±6 dB
Temperature	±5 %
Time	±5 %

7 Verification procedures

7.1 General

The supplier shall demonstrate, for each requirement given in clause 6, the compliance of the equipment under test by means of at least one of the methods reported.

Furthermore, for some RF conformance tests (e.g. spectrum mask, spurious emission, etc.) some needed measurement parameters (e.g. video bandwidth and others) as given in [25] shall be used.

In order to perform all Radio Conformance tests specified below, all basic DLC functionalities required shall be guaranteed.

NOTE 1: Some of the following tests require a null sequence. This sequence can also be replaced by the corresponding MAC-PDU-sequence.

NOTE 2: In some tests of the AT a signal generator is foreseen (e.g. figures 11, 15 and B.1) in order to phase lock to the AP carrier. For this purpose, alternatively, an AP can be used.

Two possibilities for test sequence generation at PHY input are possible, as reported in figure 3:

- Injection of an externally generated sequence, by means of a test pattern generator instrument.
- Self-generated test sequence by means of DLC.

Even if the supplier is free to choose between above possibilities, for the sake of simplicity all figures in the rest of the document will assume the injection of an externally generated sequence.

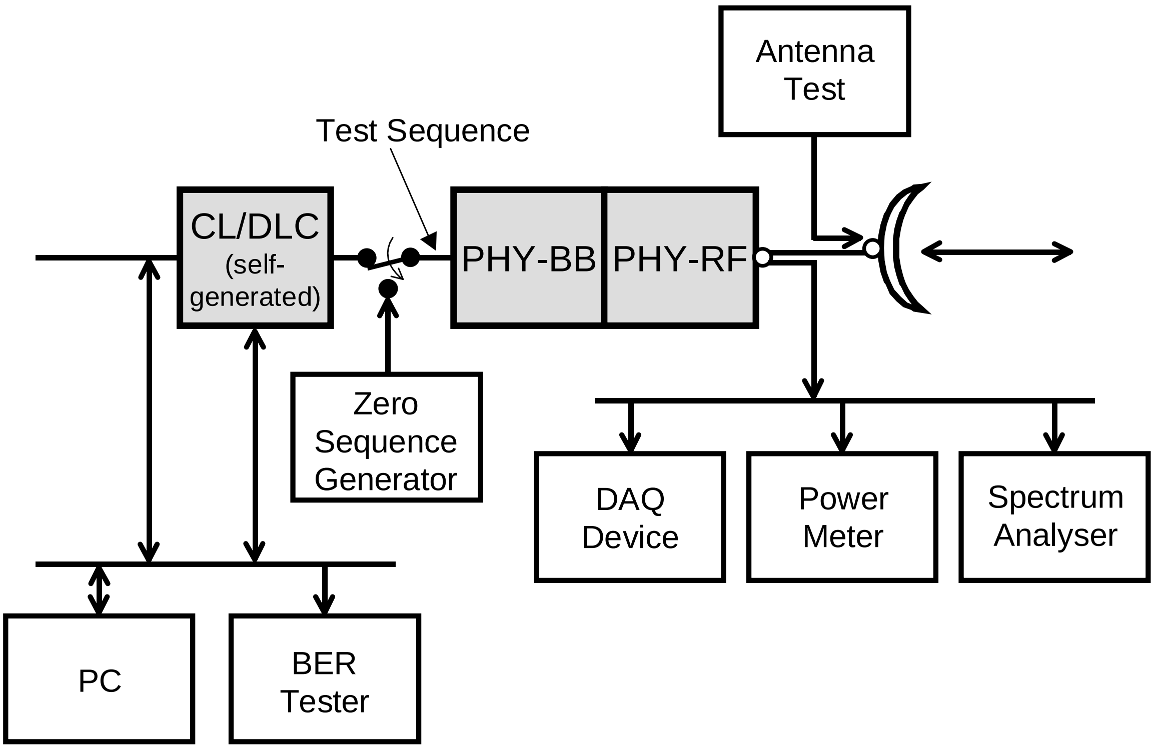

Figure 3: Interconnection of test instruments at test interfaces

In figure 4 the configuration and the test interfaces are detailed.

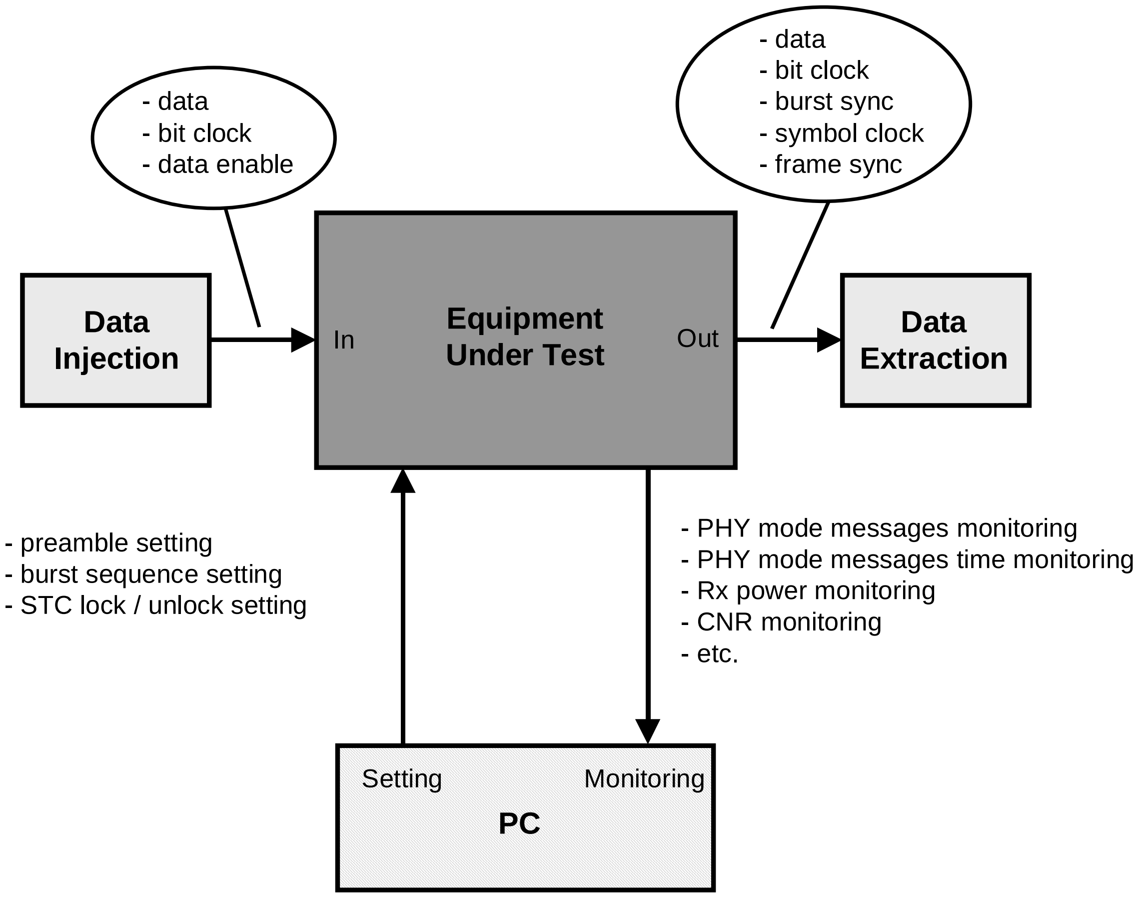

Figure 4: Configuration and measurement test interfaces

7.1.1 Test equipment

The following equipment will be needed for all the test-operations:

- PC for system configuration (parameter setting) and control;
- RF-Adapter;
- Spectrum Analyser;
- Variable RF-Attenuator (equivalent to free space/rain attenuation);
- Power meter, Power sensor;
- Power Supply Unit (PSU);
- IF-Cable;
- BER Test Equipment;
- (Zero sequence generator);
- RF-Synthesizer;
- Oscilloscope;
- Printer, Plotter.

7.1.2 Required tests

7.1.2.1 Specification and tests for wide radio-frequency band covering units and multi-rate/multi-format equipment

A uniform view, among all FWA systems technology, for producing the test report, eventually requested by the R&TTE Directive [1] conformance procedures, is reported in annex B.

7.1.2.2 Summary of required tests

Table 22 lists all the required tests (mandatory and optional).

Table 22: List of tests to be performed to ensure conformance

Reference in the present document	Radio Parameters	Mandatory	Optional
5.2	Carrier frequencies	×	
5.3	RF channel and spectrum mask	×	
5.4	Transmitter output power and tolerance	×	
5.5	Dynamic DL Power Control (DDPC)		×
5.6	Tx static power setting		×
5.7	Automatic Transmit Power Control (ATPC)	×	
5.8	Antenna gain	×	
5.9	Receiver sensitivity	×	
5.10	Co-channel interference performance	×	
5.11	Adjacent channel interference performance	×	
5.12	CW spurious interference	×	
5.13	Spurious emissions	×	

NOTE: A similar table is also given in annex A.

7.1.3 General test platform

The general test platform is depicted in figure 5. The test platform consists mainly of an Artificial Hop (AH), the AP (IDU and ODU), the AT (IDU and ODU) and further test-equipment (see clause 8).

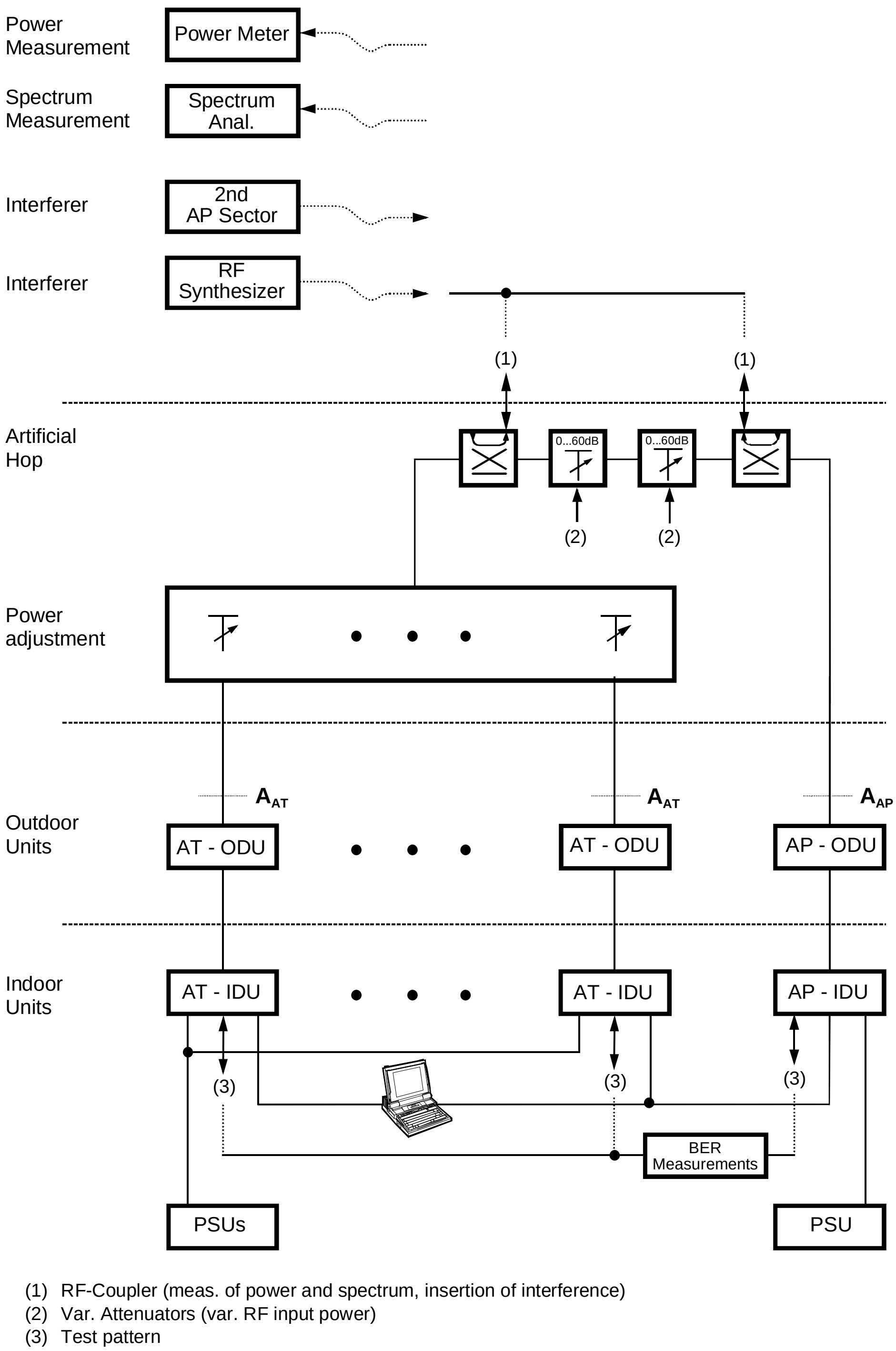

Figure 5: Detailed block-diagram of the test-platform

For major part of the tests it is necessary to perform the disconnection of the antennae from the RF. Therefore, the functional test ports can be connected to an artificial-hop as shown in the detailed block-diagram of the test platform in figure 5. Furthermore, adequate test patterns shall be generated.

7.2 Carrier frequencies

7.2.1 Test set-up

Different set-ups are required for AP and AT, as depicted in figures 6 and 7. Note that in figure 7, the signal generator shall have the same received behaviour as the downlink received signal, i.e. the signal generator can be replaced by a received downlink signal.

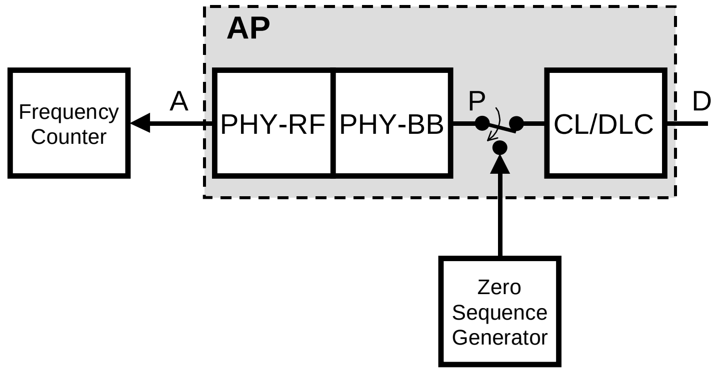

Figure 6: Test set-up for carrier frequency measurement in AP

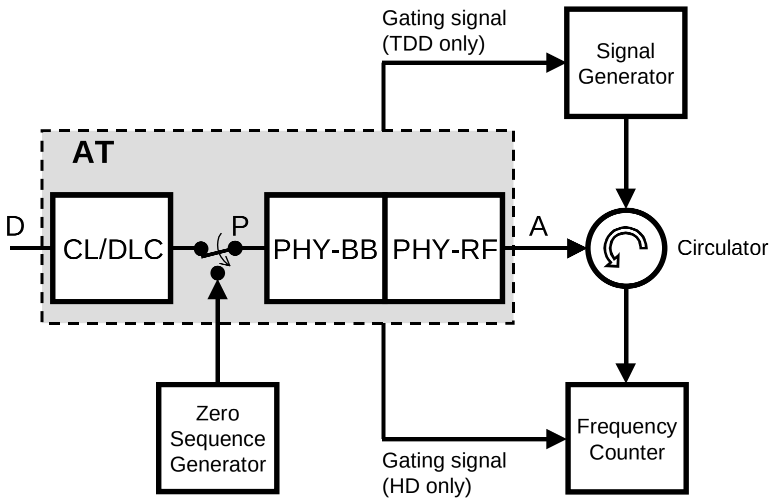

Figure 7: Test set-up for carrier frequency measurement in AT

The AP shall be measured in stand-alone configuration, whereas the AT requires a frequency reference in order to phase lock to the AP carrier; in the latter case the reference is provided by means of a signal generator with injection through a circulator. In case of TDD, the signal generator shall be gated with a suitable enable signal (burst synchronism) provided by the AT, in order to avoid interference between Tx and Rx.

Test instruments:

- Test pattern generator.
- Frequency counter.
- Signal generator and Circulator (for AT only).

Test sequence:

- Suitable to generate CW signal.

7.2.2 Test procedure

The transmitter under test shall be put in CW mode (pure sine wave) when in transmit mode.

The signal generator shall provide to the AT a downlink signal using PHY mode DL-3 (16QAM). The DL preamble shall be present with the same timing as normal operation. In the case of a full duplex FDD AT, the AT shall transmit the CW tone continuously. For a TDD or half-duplex FDD AT, the CW tone shall be transmitted with a 50 % duty cycle (i.e. 50 % of frame), synchronized with the DL preamble.

The carrier shall be measured by means of a Frequency Counter with an accurate frequency reference (recommended two orders of magnitude greater than the allowed limit), internal or external.

If adequate measurement stability cannot be achieved by this method, then the supplier shall make available an appropriate method to place the transmitter in a mode that allows the frequency of the carrier to be measured.

7.3 RF channel and spectrum mask

7.3.1 Test set-up

Different set-ups are required for AP and AT, as depicted in figures 8 and 9. Note that in figure 9 the signal generator shall have the same received behaviour as the downlink received signal, i.e. the signal generator can be replaced by a received downlink signal.

The AP shall be measured in stand-alone configuration, whereas the AT requires a frequency reference in order to phase lock to the AP carrier; in the latter case the reference is provided by means of a signal generator with injection through a circulator. In case of TDD, the signal generator shall be gated with a suitable enable signal (burst synchronism) provided by the AT, in order to avoid interference between Tx and Rx. The AT may also be tested in a stand-alone mode if the AT vendor chooses to implement a test mode that provides a bursted, modulated PN sequence with a burst duty cycle controlled by the PC interface.

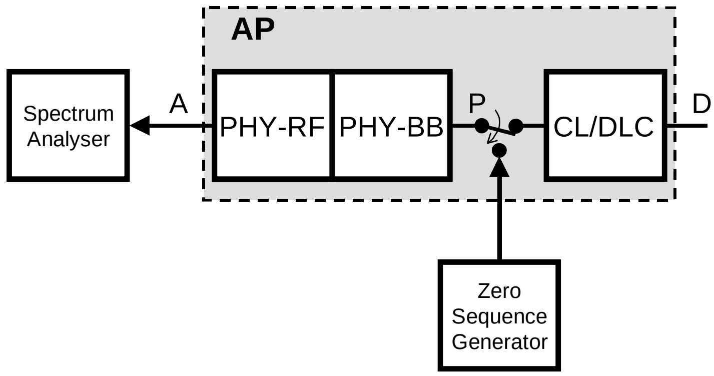

Figure 8: Test set-up for spectrum mask measurement in AP

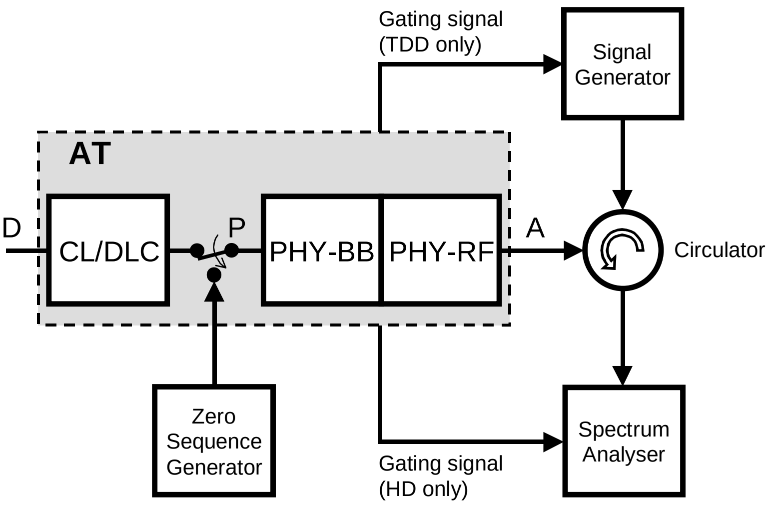

Figure 9: Test set-up for spectrum mask measurement in AT

Test instruments:

- Zero sequence generator.
- Spectrum Analyser.
- Signal generator and Circulator (for AT only).

Test sequence:

- Null sequence.

7.3.2 Test procedure

The transmitter under test shall be set on the maximum power.

The AP shall be measured with continuous power versus time.

The AT shall be measured both with continuous power versus time and with switched power on a burst basis (periodic sequence of one burst on and the following off, as defined in figure 10 and table 23). In the latter case the test shall consider the short signalling burst as well.

The signal generator shall provide to the AT a downlink signal using PHY mode DL-3 (16QAM).

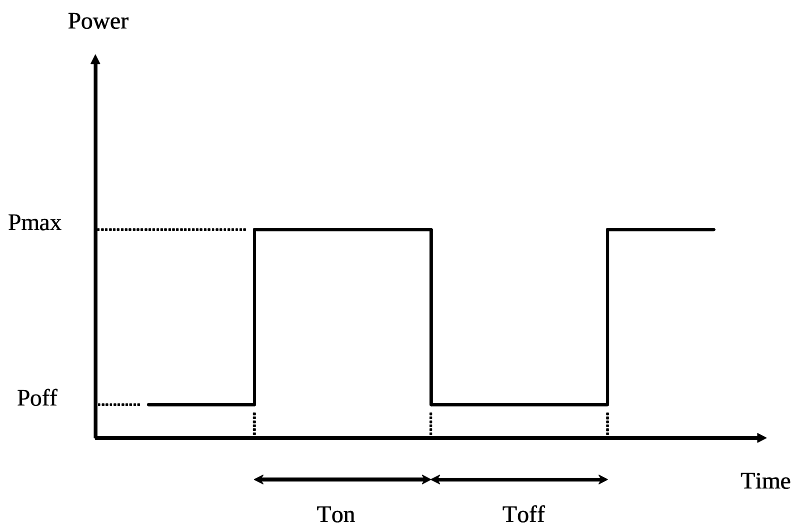

Figure 10: Burst test sequence for spectrum mask measurement in AT

Table 23: Burst test sequence parameters

Parameter	Value
P_{max}	See clause 6.5
P_{off}	See clause 6.10
T_{on}	5 µs (112 symbols)
T_{off}	5 µs (112 symbols)

The settings of the spectrum analyser are to be in accordance with the indications of table 24.

Table 24: Spectrum analyser settings for spectrum mask measurement

Parameter	AP	AT
Centre frequency	Actual	Actual
Span	140 MHz	140 MHz
Scan time	Auto	Auto
Resolution bandwidth	100 kHz	300 kHz
Video bandwidth	0,3 kHz	100 kHz

7.4 Transmitter output power and tolerance

7.4.1 Test set-up

Figures 11 and 13 show the test set-up to measure the maximum output power at AP and AT, respectively. Note that in figure 13 the signal generator shall have the same received behaviour as the downlink received signal, i.e. the signal generator can be replaced by a received downlink signal.

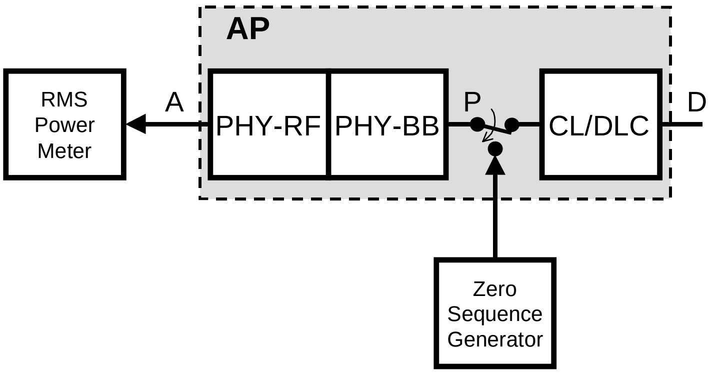

Figure 11: Test configuration for AP transmitter output power measurements

Test instruments:

- Zero sequence generator.
- Average power meter.

Test sequence:

- Null sequence.

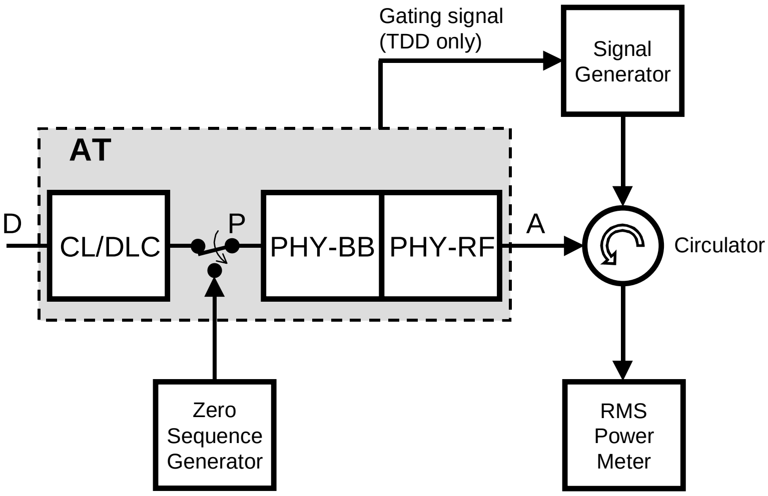

Figure 12: Test configuration for AT transmitter output power measurements

Test instruments:

- Zero sequence generator.
- Average power meter.
- Signal generator.

Test sequence:

- Null sequence.

7.4.2 Test procedure

The test sequence is fed in at interface P. The transmitter shall operate in a continuous mode. According to tables 5 and 6 for the different DL PHY modes the maximum output power is measured at the A-interface of AP. The same procedure is performed for the UL PHY modes according to table 7.

NOTE: The power control shall guarantee the maximum transmit power.

7.5 Dynamic Downlink Power Control (DDPC)

7.5.1 Test set-up

Figure 13 shows the test set-up to verify the Dynamic Downlink Power Control (DDPC).

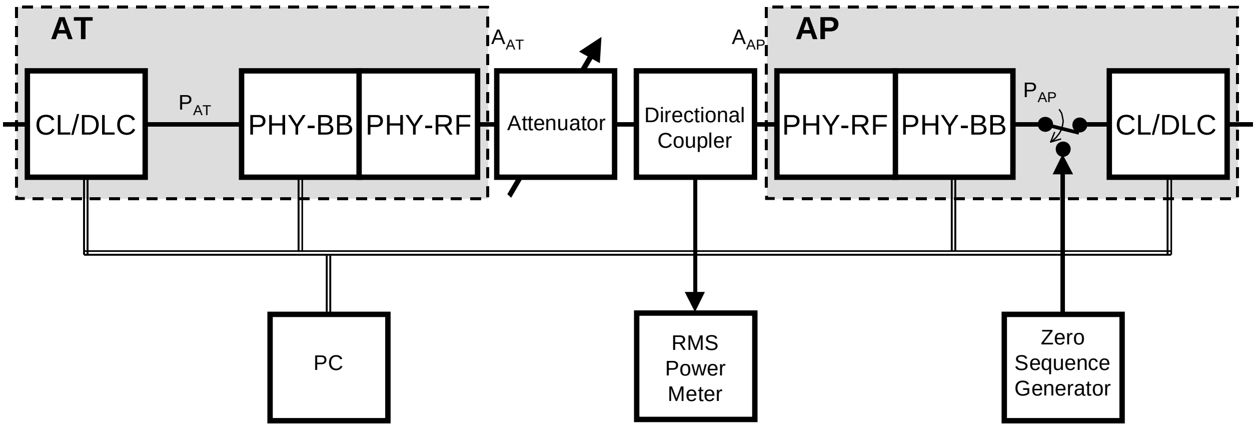

Figure 13: Test configuration for DDPC

Test instruments:

- Zero sequence generator.
- Average power meter.
- Directional coupler.
- Variable attenuator.

Test sequence:

- Null sequence.

7.5.2 Test procedure

DLC functionality required for downlink power control shall be guaranteed.

The test sequence is fed in at interface P_{AP}. The variable attenuator which simulates the RF link attenuation shall be adjusted to 20 dB. After slowly decreasing the attenuation the AP first applies the most efficient PHY mode before the DDPC becomes active. After finding that attenuation the dynamic ranges according to table 8 shall be swept by means of attenuator variation.

Fixed modulation:

- DL-3.
- DL-4 (optional mode).

7.6 Tx static power setting

7.6.1 Test set-up

The test set-up to measure the Tx static power setting of the APT is shown in figure 11 and is the same as for the Tx output power. The same test sequence shall be applied.

7.6.2 Test procedure

The AP Tx output power for the settings of table 9 in clause 5.7.2 are measured.

Fixed modulation:

- DL-3.
- DL-4 (optional mode).

7.7 Automatic Transmit Power Control (ATPC)

7.7.1 Test set-up

Figure 14 shows the test set-up to verify the automatic transmit power control.

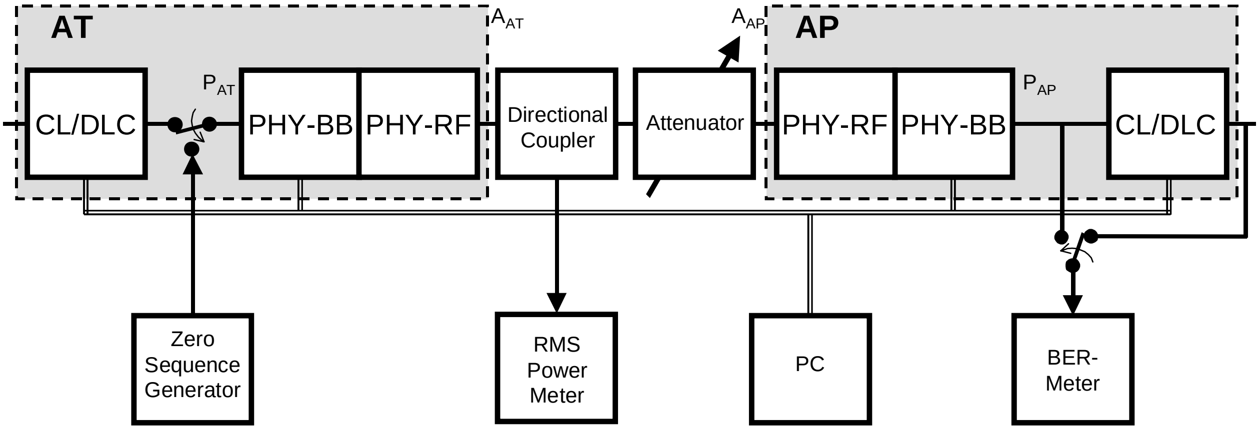

Figure 14: Test configuration for ATPC

Test instruments:

- BER-meter.
- Variable attenuator.
- Directional coupler.
- Average power meter.
- Zero sequence generator.
- PC.

Test sequence:

- Null sequence.

7.7.2 Test procedure

The DLC functionality required for uplink power control (ATPC) shall be guaranteed.

The test sequence is fed in at interface P_{AT}. The verification of correct ATPC is performed in the following three steps:

1) The ATPC is deactivated. The variable attenuator, simulating the RF link attenuation, shall be adjusted in such a way that the BER-Meter at interface P_{AP} indicates 10^{-6}. The nominal Rx power threshold for BER = 10^{-6} can be measured indirectly by the Average power meter considering the losses of attenuator and directional coupler. The ATPC is now activated. The resulting Rx power shall be in the allowed range of Rx power margin (see clause 5.8.2). The transition time, measured by the PC, shall be according to clause 5.8.2.

2) The ATPC is deactivated. The variable attenuator shall be adjusted 10 dB below the attenuation necessary to get BER = 10^{-11}. The ATPC is now activated. The resulting Rx power shall be in the allowed range of Rx power margin (see clause 5.8.2). The transition time, measured by the PC, shall be according to clause 5.8.2.

3) The ATPC is activated. The link attenuation shall be varied ±1 dB resulting in an actual Rx power deviation according to maximally the granularity (see clause 5.8.2).

The test shall be performed for the PHY modes DL-2 and UL-2.

7.8 Antenna gain, Radiation Pattern and EIRP

7.8.1 Test set-up

In order to measure antenna gain different set-ups can be employed, according to EN 301 126-3-2 [22].

7.8.2 Test procedure

Corresponding to the employed set-up, the test procedure is described in EN 301 126-3-2 [22].

7.9 Receiver sensitivity

7.9.1 Test set-up

Figure 15 shows the set-up to measure the receiver sensitivity at AP and AT.

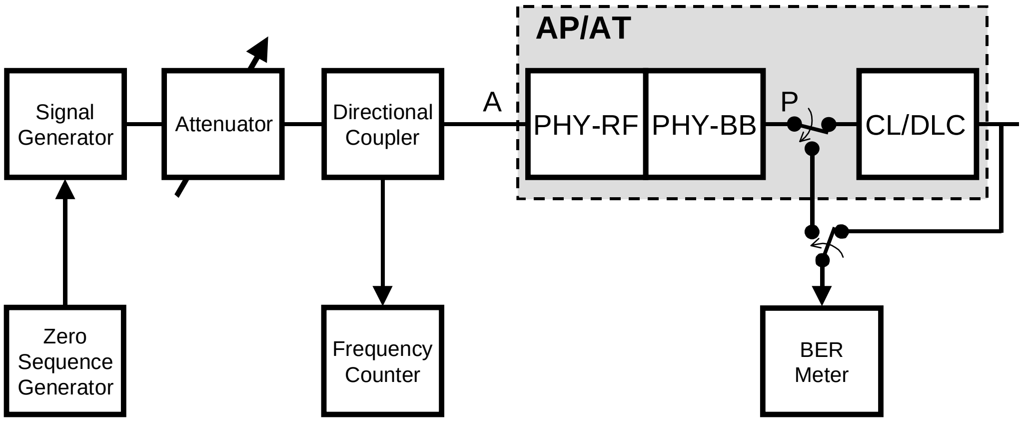

Figure 15: Test set-up for Rx sensitivity measurement

Test instruments:

- Zero sequence.
- BER meter.
- Attenuator.
- Directional coupler.
- Power meter.

Test sequence:

- Periodic repetition of 1 ms sequences, constituted by Preamble (16 or 32 symbols, CAZAC) and Data, according to figure 16.

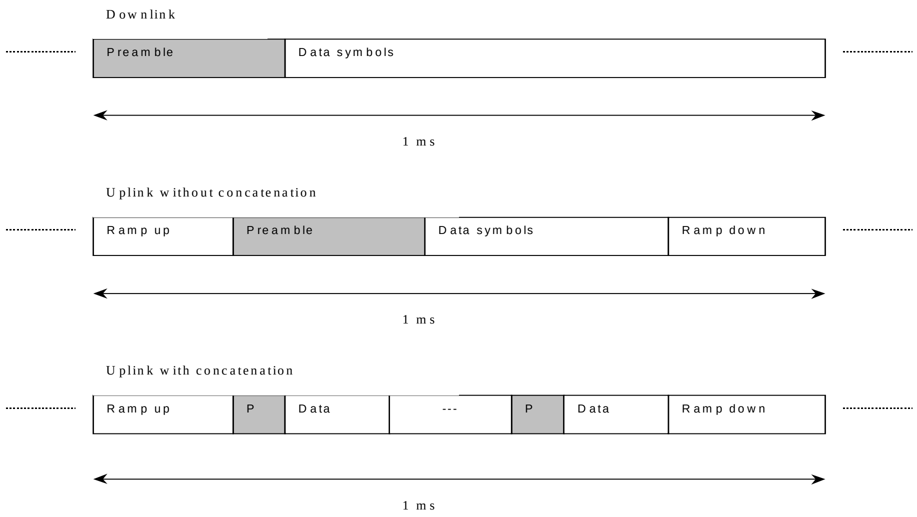

Figure 16: Test sequences for Rx sensitivity measurement

7.9.2 Test procedure

Connect the pattern generator to the transmitter (signal generator). The receiver under test shall send output data, clock and enable (burst synchronism) signals from P interface to the BER meter.

Set the transmitter at a power level within the detection range of the power meter and get the values of the detected power P_{ref} and of the attenuation A_{ref} (calibration of the set-up). For the uplink and TDD downlink measurements, the calibration shall take into account the duty cycle of the burst.

Increase the attenuation to the value A_{fin} for setting the S_{th} required in clause 5.10.2 given by:

$$A_{fin} = P_{ref} + A_{ref} - S_{th}$$

In this condition the BER shall be $\leq 10^{-6}$.

7.10 Co-channel interference performance

7.10.1 Test set-up

Figure 17 shows the set-up to measure the co-channel interference at AP and AT.

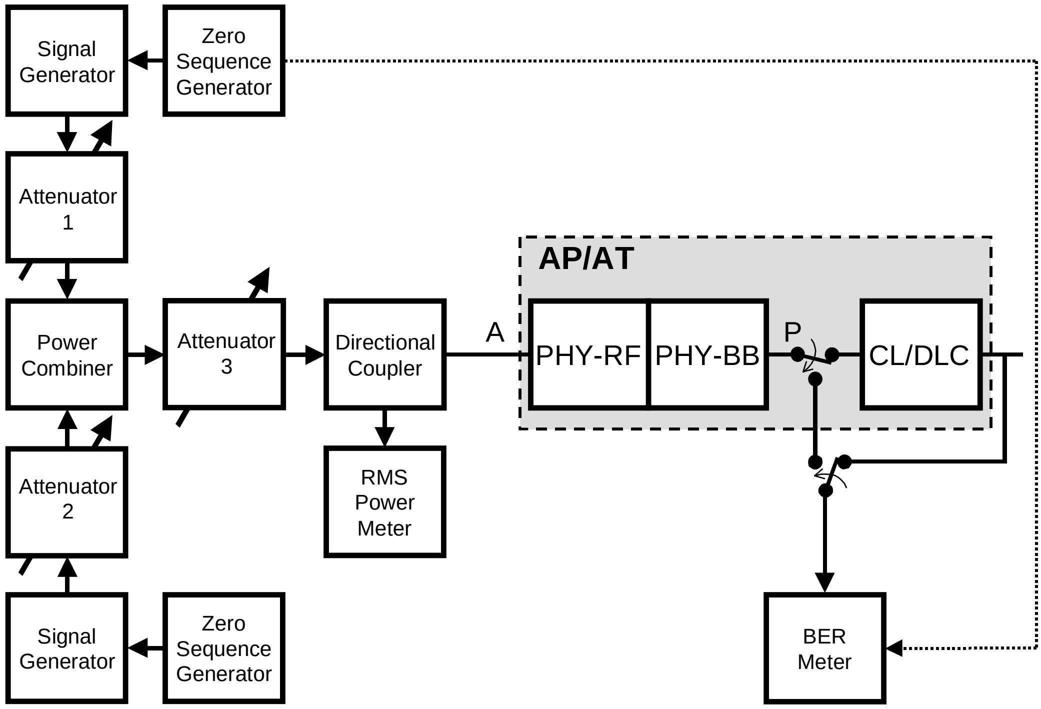

Figure 17: Test set-up for Co-channel interference measurement

Test instruments:

- Zero sequence generators and BER meter.
- Signal generators.
- Attenuators and Power combiner.
- Directional coupler and Power meter.

Test sequence:

- Same as in clause 7.10.1.

7.10.2 Test procedure

During this test both transmitters (wanted signal on Tx 1 and interferer on Tx 2) shall transmit on the same channel and be modulated with signals having the same characteristics. The function of attenuators 1 and 2 is to maintain the correct Carrier to Interference ratio, attenuator 3 can be used to control the absolute signal levels into the receiver. The receiver under test shall send output data, clock and enable (burst synchronism) signals from P interface to the BER meter.

With both transmitters off, set attenuators 1 and 2 to their maximum values. Switch on Tx 1 and adjust attenuator 1 to set the wanted signal to the level required for a BER of 10^{-6}. Decrease attenuator 1 by 1 dB (or 3 dB) and record its setting. Switch off Tx 1.

Switch on both transmitters and reduce attenuator 2 to achieve a BER of 10^{-6} on the BER meter. Record the setting of attenuator 2 and switch off both transmitters.

Switch on Tx 1 and reduce attenuator 1 to produce a wanted signal level within the calibrated range of the power meter. Record the power level and reduction in attenuation. Calculate $\text{Power}_{\text{wanted signal}}$ = Measured power level minus change in attenuation. Switch off Tx 1, switch on Tx 2 and repeat the procedure to calculate the $\text{Power}_{\text{unwanted signal}}$.

The maximum C/I value for 1 dB (or 3 dB) degradation on 10^{-6} is:

$$C/I = \text{Power}_{\text{wanted signal}} / \text{Power}_{\text{unwanted signal}}$$

The procedure shall be repeated for all the supported PHY modes.

7.11 Adjacent channel interference performance

7.11.1 Test set-up

Same as in clause 7.11.

7.11.2 Test procedure

During this test the interferer (or unwanted signal, Tx 2) shall transmit on the first adjacent channel and be modulated with a signal having the same characteristics as the signal modulating the wanted transmitter (Tx 1). The function of attenuators 1 and 2 is to maintain the correct Carrier to Interference Power ratio, attenuator 3 can be used to control the absolute signal levels into the receiver. The receiver under test shall send output data, clock and enable (burst synchronism) signals from P interface to the BER meter.

With both transmitters off, set attenuators 1 and 2 to their maximum values. Switch on Tx 1 and adjust attenuator 1 to set the wanted signal to the S_{th} level required in clause 5.10.2 for a BER $\leq 10^{-6}$. Decrease attenuator 1 by 1 dB and record its setting. Switch off Tx 1.

Switch off Tx 1, switch on Tx 2 and repeat the procedure to set the Power $_{\text{unwanted signal}}$.according the required C/I value for 1 dB degradation on 10^{-6} is:

$$\text{Power}_{\text{unwanted signal}} = S_{th} + 1\text{ dB} - C/I$$

Switch on both transmitters and verify that BER $\leq 10^{-6}$ on the BER meter.

The procedure shall be repeated for all the supported PHY modes.

7.12 CW spurious interference

7.12.1 Test set-up

Figure 18 shows the set-up to measure CW spurious interference at AP and AT.

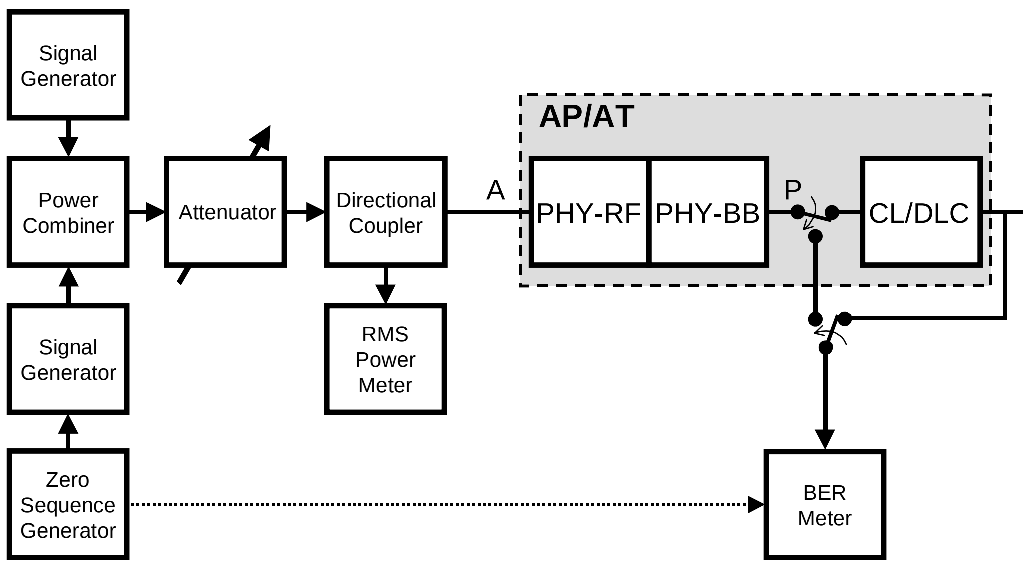

Figure 18: Test set-up for CW spurious interference measurement

Test instruments:

- Zero sequence generator and BER meter.
- Signal generators.
- Attenuator and power combiner.
- Directional coupler and power meter.

Test sequence:

- Same as in clause 7.11.

7.12.2 Test procedure

During this test the interferer (or unwanted signal, Tx 2) shall be non-modulated (CW) and shall have a power +30 dB above the wanted signal (Tx 1) on a frequency of interest over 500 % of the channel spacing from the centre frequency, up to 60 GHz.

With both transmitters off, set the attenuator to its maximum value. Switch on Tx 1 and adjust the attenuation to set the wanted signal to the level (threshold) required for a BER of 10^{-6}. Switch off Tx 1, set Tx 2 to a power of +30 dBc and on the first frequency of interest, switch on Tx 2.

Switch on Tx 1 and verify that the degradation of the threshold is not more than 1 dB.

Repeat the test on all the frequencies of interest.

7.13 Spurious emissions

7.13.1 Test set-up

Figure 19 shows the test configuration for spurious emissions measuring.

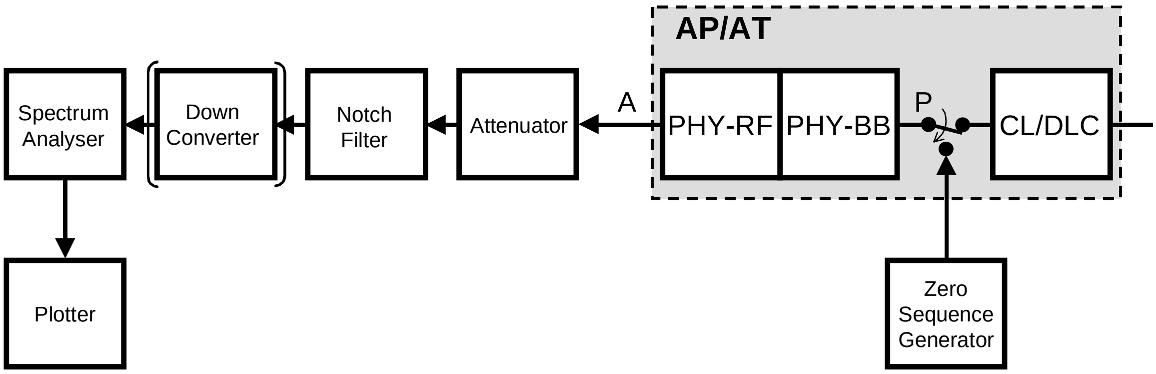

Figure 19: Test configuration for spurious emissions

Test instruments:

- Zero sequence generator.
- Attenuator.
- Notch filter (band-stop in the range CCF - 70 MHz < f < CCF + 70 MHz).
- Down-Converter.
- Plotter.
- Spectrum analyser.

Test sequence:

- Null sequence.

7.13.2 Test procedure

The zero sequence is fed in at interface P. The transmitter shall send with maximum power according to tables 5, 6 and 7 for AP and AT, respectively. The transmitter output port shall be connected via an attenuator and a suitable notch filter to the spectrum analyser. The notch filter and the attenuator limit the power into the front end of the analyser. In those cases, where the upper frequency limit exceeds the basic operating range of the analyser, a suitable mixer will be required. It is important that the circuit between the transmitter and the input to the mixer or spectrum analyser is well known over the frequency range to be measured according to tables 17, 18, 19 and 20. These losses should be compensated at the spectrum analyser in order to ensure that the demanded specification criteria at interface A are met.

The level and frequency of all significant signals are to be measured and plotted throughout the frequency bands quoted in tables 1, 17, 18, 19 and 20 for AP and AT, respectively. Spurious emissions close to the limit should be plotted over a restricted range clearly demonstrating that the signal does not exceed the relevant limit.

Since HA is a duplex equipment using a common port for transmitter and receiver in both, AP and AT, Tx and Rx spurious emissions are measured simultaneously.

Fixed modulation:

- DL-3.
- DL-4 (optional mode).

NOTE: Scrambler shall be active.

Annex A: List of Essential Radio Tests

The list of essential radio tests serves a number of purposes, as follows:

- it provides a tabular summary of all the recommended requirements;
- it shows the status of each requirement, whether it is essential to implement in all circumstances (Mandatory), or whether the requirement is dependent on the supplier having chosen to support a particular optional service or functionality (Optional). In particular it enables the requirements associated with a particular optional service or functionality to be grouped and identified;
- when completed in respect of a particular equipment it provides a means to undertake the static assessment of conformity with the present document.

Table A.1: Proposed Requirements Table

TR Reference		TR 102 271				Comment
No.	**Reference**	**EN-R (see note)**	**Status**			
2	5.2	Carrier frequencies	M			
3 to 4	5.3	RF channel and spectrum mask	M			
5 to 7	5.4	Transmitter output power and tolerance	M			
8	5.5	Dynamic DL Power Control (DDPC)	O			
9	5.6	Tx static power setting	O			
	5.7	Automatic Transmit Power Control (ATPC)	M			
10 to 11	5.8	Antenna gain	M			
12 to 13	5.9	Receiver sensitivity	M			
17	5.10	Co-channel interference performance	M			
15 to 16	5.11	Adjacent channel interference performance	M			
	5.12	CW spurious interference	M			
17 to 20	5.13	Spurious emissions	M			
NOTE: These EN-RTs are justified under article 3.2 of the R&TTE Directive.						

Key to columns:

No Table entry number;

Reference Clause reference number of conformance requirement within the present document;

EN-RT Title of conformance requirement within the present document;

Status Status of the entry as follows:

M Mandatory, shall be implemented under all circumstances;
O Optional, may be provided, but if provided shall be implemented in accordance with the requirements;
O.n this status is used for mutually exclusive or selectable options among a set. The integer "n" shall refer to a unique group of options within the EN-RT. A footnote to the EN-RT shall explicitly state what the requirement is for each numbered group. For example, "It is mandatory to support at least one of these options", or, "It is mandatory to support exactly one of these options".

Comments To be completed as required.

Annex B: Overview of HIPERACCESS

The HA PHY- and the DLC Technical Specification, TS 101 999 [4] and TS 102 000 [5] specify the HIPERACCESS (HA) transmission scheme in order to guarantee ***interoperability*** between equipment developed by different manufacturers. This is achieved by describing all signal processing structures and all protocol issues.

The HA-Radio conformance test specification (HA-RCT) TS 101 999 [4] is intended to specify the interoperability conformance testing procedures and requirements for both direction of each transceiver (i.e. AP and AT).

The general block diagram of the HA transmission system is illustrated in figure B.1 and taken from TS 101 999 [4].

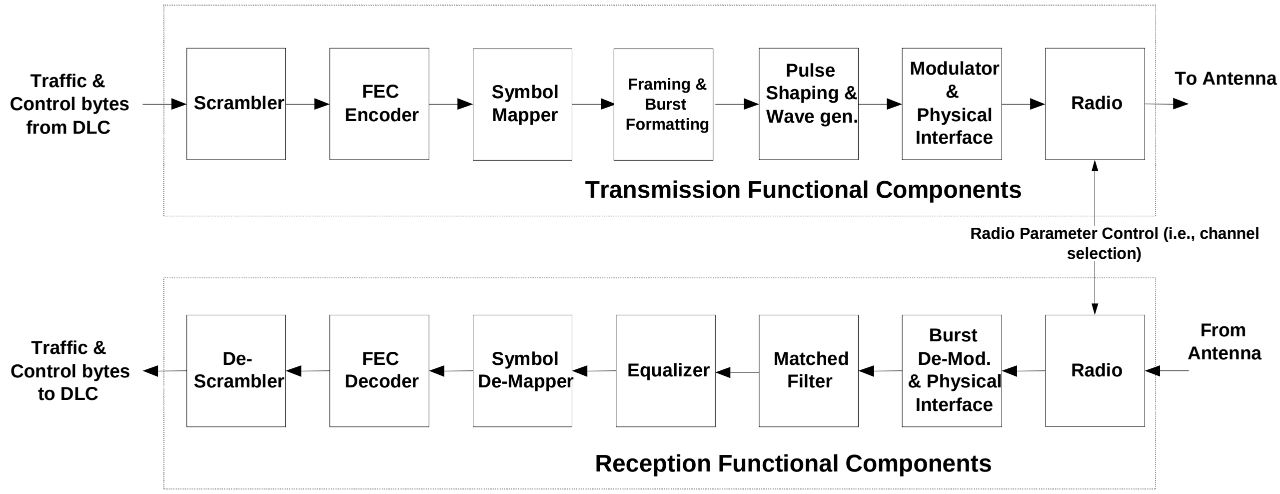

Figure B.1: PHY layer conceptual block diagram

The HA-PHY implementation includes transmission and reception functional components. For the downlink, transmission occurs in the AP and reception in the AT. For the uplink, transmission occurs in the AT and reception in the AP. Although very similar in concept, note that the AP equipment in general handles more than one RF channel and more than one user (AT), hence its actual architecture will be different.

The HA transmission operation from the PHY perspective starts with a stream of traffic and control bytes sent from the DLC layer. These data will be randomized using a scrambler. The resulting data after FEC-coding is then mapped into symbols according to the designated modulation density. These modulated symbols and the corresponding preambles are multiplexed to form a frame or a burst (in the downlink case the preamble exists only at the beginning of the frame or at the beginning of each optional TDMA region). The resulting symbols after framing or burst formatting are pulse shaped and wave formed (i.e. root raised cosine filtered) and are forwarded through a physical interface (i.e. D/A) to the radio transmitter.

The HA reception operation from the PHY perspective starts with receiving an analogue signal from the radio receiver. The physical interface (i.e. A/D) converts the signal to the digital domain and a demodulator identifies the preamble existence and the reception process may properly initiate. A matched filter is used to extract symbol values and an equalizer structure can be used to further enhance signal quality. Symbols are translated to actual bits by constellation de-mapping. A FEC decoder corrects channel errors and may be used to identify data integrity. Any randomization done by the scrambler in the transmission process is removed and finally the received control and traffic bytes are sent to the higher DLC-layer for continued processing.

Main features of HA PHY-layer are:

- single carrier transmission;
- adaptive coding and modulation;
- dynamic power control;
- support of FDD and TDD.

As it was mentioned before, the present document deals with the HA-radio parameters to fulfill the essential requirements of Directive 1999/5/EC [1] (R&TTE Directive) article 3.2. In addition, the present document specifies the test suites relevant for verification of these requirements. Note that some of the radio parameter requirements specified here are valid under **normal** environmental conditions.

Reference test temperatures are named as (see clause A.1.2.1): L: Lowest, M: Medium; H: Highest. These temperatures depend on environmental classes, which is subject to the supplier declaration.

Reference test frequencies are named as: B: Bottom; M: Middle; T: Top, where Bottom means the channel at lowest carrier frequency, Top means the channel at highest carrier frequency and Middle means the nearest channel to the centre of equipment frequency band, which is subject to the supplier declaration.

PHY modes are named according to the labels in the following tables, where:

- the first letters indicate if the mode is for DownLink (DL) or UpLink (UL);
- the following number is progressive with mode efficiency;
- the final letter (only for UL) indicates the length of the mode (S for Short).

Table B.1: DL PHY modes labels

Set	Label	Inner code	Outer code	Modulation	Optional/ Mandatory	Protection goal
Set 1	DL-0	CC1/2	RS (46,30, t=8)	4QAM	Mandatory	DL control zone
	DL-1	CC2/3	RS (232, 216, t=8)	4QAM	Mandatory	4 x MAC PDUs
	DL-2	no	RS (232, 216, t=8)	4QAM	Mandatory	4 x MAC PDUs
	DL-3	CC7/8	RS (232, 216, t=8)	16QAM	Mandatory	4 x MAC PDUs
	DL-5	CC5/6	RS (232, 216, t=8)	64QAM	Optional	4 x MAC PDUs
Set 2	DL-0	CC1/2	RS (46,30, t=8)	4QAM	Mandatory	DL control zone
	DL-1	CC2/3	RS (232, 216, t=8)	4QAM	Optional	4 x MAC PDUs
	DL-2	no	RS (232, 216, t=8)	4QAM	Optional	4 x MAC PDUs
	DL-4	no	RS (232, 216, t=8)	16QAM	Optional	4 x MAC PDUs
	DL-6	no	RS (232, 216, t=8)	64QAM	Optional	4 x MAC PDUs

Table B.2: UL PHY modes labels

Set	Label	Inner code	Outer code	Modulation	Optional/ Mandatory	Protection goal
Set 1	UL-1	CC2/3	RS (236, 220, t=8)	4QAM	Mandatory	4 x MAC PDUs
	UL-1S	CC2/3	RS (28,12, t=8)	4QAM	Mandatory	Short signalling PDU
	UL-2	no	RS (236, 220, t=8)	4QAM	Mandatory	4 x MAC PDUs
	UL-2S	no	RS (28,12, t=8)	4QAM	Mandatory	Short signalling PDU
	UL-3	CC7/8	RS (236, 220, t=8)	16QAM	Optional	4 x MAC PDUs
	UL-3S	CC7/8	RS (28,12, t=8)	16QAM	Optional	Short signalling PDU
Set 2	UL-1	CC2/3	RS (236, 220, t=8)	4QAM	Mandatory	4 x MAC PDUs
	UL-1S	CC2/3	RS (28,12, t=8)	4QAM	Mandatory	Short signalling PDU
	UL-2	no	RS (236, 220, t=8)	4QAM	Mandatory	4 x MAC PDUs
	UL-2S	no	RS (28,12, t=8)	4QAM	Mandatory	Short signalling PDU
	UL-4	no	RS (236, 220, t=8)	16QAM	Optional	4 x MAC PDUs
	UL-4S	no	RS (28,12, t=8)	16QAM	Optional	Short signalling PDU

The general block-diagram with naming of interfaces is given in figure B.2. Such block-diagram is only meant to describe conceptually main system components and interfaces, and does not dictate any implementation.

The following abbreviations have been used:

A: Antenna interface;

D: AT-input (D_{AT}); AP-input (D_{AP});

P: PHY interface;

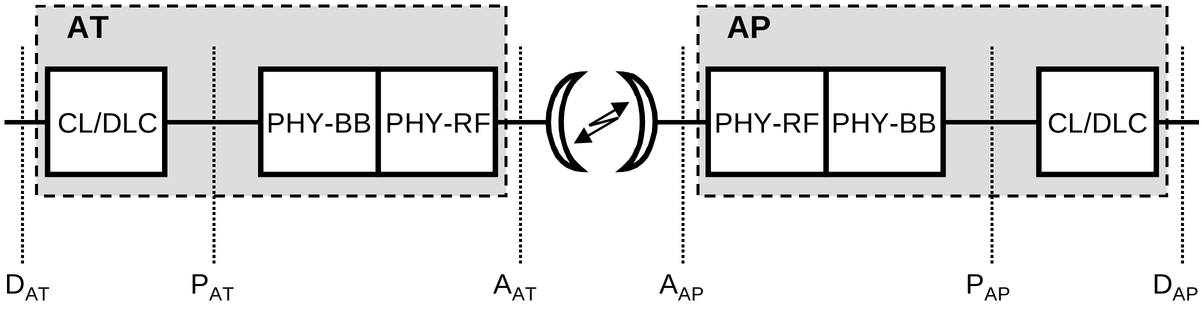

Figure B.2: General Block-diagram

Annex C: Bibliography

ITU-T Recommendation I.356: "B-ISDN ATM layer cell transfer performance".

ETSI EN 301 997-1: "Transmission and Multiplexing (TM); Multipoint equipment; Radio Equipment for use in Multimedia Wireless Systems (MWS) in the frequency band 40,5 GHz to 43,5 GHz; Part 1: General requirements".

ERC Report 99: "The analysis of the coexistence of two FWA cells in the 24,5 - 26,5 GHz and 27,5 - 29,5 GHz bands".

ITU-T Recommendation G.783: "Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks".

ITU-T Recommendation G.825: "The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)".

ITU-T Recommendation G.831: "Management capabilities of transport networks based on the synchronous digital hierarchy (SDH)".

ETSI ETS 300 132-1: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources".

ETSI ETS 300 132-2: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)".

ETSI EN 301 215-1: "Fixed Radio Systems; Point-To-Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 11 GHz to 60 GHz band; Part 1: General aspects".

ITU-R Recommendation P.676-5: "Attenuation by atmospheric gases".

ITU-R Recommendation P.835-3: "Reference standard atmospheres".

ITU-R Recommendation P.452-10: "Prediction procedure for the evaluation of microwave interference between stations on the surface of the Earth at frequencies above about 0,7 GHz".

ETSI EN 301 213-2: "Fixed Radio Systems; Point-to-multipoint equipment; Point-to-Multipoint digital radio systems in frequency bands in the range 24,25 GHz to 29,5 GHz using different access methods; Part 2: Frequency Division Multiple Access (FDMA) methods".

ITU-T Recommendation G.821: "Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network".

ETSI EN 301 126-2-3: "Fixed Radio Systems; Conformance testing; Part 2-3: Point-to-Multipoint equipment; Test procedures for TDMA systems".

ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

ITU-T Recommendation G.827: "Availability parameters and objectives for path elements of international constant bit-rate digital paths at or above the primary rate".

ITU-T Recommendation M.2100 (Series): "Performance limits for bringing-into-service and maintenance of international PDH paths, sections and transmission systems".

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History

Document history		
V1.1.1	April 2004	Publication