ETSI EN 303 316 V1.1.1 (2017-10)

Broadband Direct Air-to-Ground Communications;
Equipment operating in the 1 900 MHz to 1 920 MHz and 5 855 MHz to 5 875 MHz frequency bands;
Beamforming antennas;
Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

Reference

DEN/BRAN-60013

Keywords

aeronautical, broadband, mobile, network, radio

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 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Copyright Notification

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Foreword

This Harmonised European Standard (EN) has been produced by ETSI Technical Committee Broadband Radio Access Networks (BRAN).

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.9] 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.5].

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 technical requirements in the present document reflect, in part, the results of studies undertaken within the CEPT on compatibility between broadband direct air-to-ground systems and other applications operating within, or adjacent to, the frequency bands which are designated for BDA2GC operations. These studies are described in ECC Report 209 [i.1] (for the 1 900 MHz to 1 920 MHz band) and ECC Report 210 [i.2] (for the 5 855 MHz to 5 875 MHz band).

The resulting technical and operational requirements to be applied to BDA2GC systems in the 1 900 MHz to 1 920 MHz band and the 5 855 MHz to 5 875 MHz band are contained within ECC Decision(15)02 [i.3] and ECC Decision(15)03 [i.4] respectively.

National transposition dates	
Date of adoption of this EN:	3 July 2017
Date of latest announcement of this EN (doa):	31 October 2017
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 April 2018
Date of withdrawal of any conflicting National Standard (dow):	30 April 2019

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Executive summary

The present document addresses the Broadband Direct Air to Ground Communications system based on the System Reference Document ETSI TR 101 599 [i.10]. ETSI TR 101 599 [i.10] was used by the ECC, in conjunction with other contributions, to develop technology neutral ECC Decisions on the allocation of European spectrum in the frequency bands 1 900 MHz to 1 920 MHz and 5 855 MHz to 5 875 MHz.

The technical requirements in the present document reflect, in part, the results of studies undertaken within the CEPT on compatibility between broadband direct air-to-ground systems and other applications operating within, or adjacent to, the frequency bands that are designated for BDA2GC operations.

Introduction

The present document has been developed in accordance with the guidelines contained in ETSI EG 203 336 [i.6].

1 Scope

The present document specifies technical characteristics and methods of measurements for radio equipment at the Ground Station and Aircraft Station for Broadband Direct Air-to-Ground communications systems employing beamforming antennas.

These radio equipment types are capable of operating in all or any part of the frequency bands given in table 1.

Table 1: Radiocommunications service frequency bands

	Radiocommunications service frequency bands
Transmit 1	1 900 MHz to 1 920 MHz
Receive 1	1 900 MHz to 1 920 MHz
Transmit 2	5 855 MHz to 5 875 MHz
Receive 2	5 855 MHz to 5 875 MHz

The present document covers the essential requirements of article 3.2 of Directive 2014/53/EU [i.5] under the conditions identified in annex A.

2 References

2.1 Normative references

References are specific, identified by date of publication and/or edition number or version number. Only the cited version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

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

[1] NIMA Technical Report TR8350.2 (1984, including amendment 1 of 03 January 2000 and amendment 2 of 23 June 2004): "Department of Defense World Geodetic System 1984. Its Definition and Relationships with Local Geodetic Systems".

[2] ETSI EN 302 502 (V2.1.1) (03-2017): "Wireless Access Systems (WAS); 5,8 GHz fixed broadband data transmitting systems; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU".

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.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ECC Report 209: "Compatibility/sharing studies related to Broadband Direct-Air-to-Ground Communications (DA2GC) in the frequency bands 1900-1920 MHz / 2010-2025 MHz and services/applications in the adjacent bands".

[i.2] ECC Report 210: "Compatibility/sharing studies related to Broadband Direct-Air-to-Ground Communications (DA2GC) in the frequency bands 5855-5875 MHz, 2400-2483.5 MHz and 3400 3600 MHz".

[i.3] ECC Decision (15)02: "The harmonised use of broadband Direct Air-to-Ground Communications (DA2GC) systems in the frequency band 1900-1920 MHz".

[i.4] ECC Decision (15)03: "The harmonised use of broadband Direct Air-to-Ground Communications (DA2GC) systems in the frequency band 5855-5875 MHz".

[i.5] 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.6] ETSI EG 203 336: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".

[i.7] ETSI TR 100 028 (V1.4.1) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[i.8] ETSI TR 100 028-2 (V1.4.1): " Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

[i.9] 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.10] ETSI TR 101 599 (V1.1.3) (09-2012): "Electromagnetic compatibility and Radio spectrum matters (ERM) System Reference Document (SRDoc); Broadband Direct-Air-to-Ground Communications System employing beamforming antennas, operating in the 2,4 GHz and 5,8 GHz bands".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in Directive 2014/53/EU [i.5] and the following apply:

Network Control Facility (NCF): set of functional entities that, at system level, monitor and control the correct operation of the Ground Station (GS) and Aircraft Station (AS) and, if appropriate, all of the GSs and ASs in a BDA2GC network

transmission disabled state: state which a GS or AS is in when it is not authorized by the NCF to transmit

transmission enabled state: state which a GS or AS is in when it is authorized by the NCF to transmit

3.2 Symbols

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

f_0 Channel centre frequency

3.3 Abbreviations

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

ACS Adjacent Channel Selectivity
AS Aircraft Station

ATPC	Automatic Transmit Power Control
BDA2GC	Broadband Direct Air-to-Ground Communications
BFWA	Broadband Fixed Wireless Access
BW	Bandwidth
CEPT	Conférence Européenne des Postes et des Télécommunications
DA2GC	Direct Air-to-Ground Communications
DAA	Detect and Avoid
ECC	Electronic Communications Committee
EEC	European Economic Community
EIRP	Equivalent Isotropically Radiated Power
EMC	ElectroMagnetic Compatibility
EUT	Equipment Under Test
GNSS	Global Navigation Satellite System
GS	Ground Station
LV	Low Voltage
NCF	Network Control Facility
OFDM	Orthogonal Frequency Division Multiplexing
OOB	Out-Of-Band
PL	Free space Path Loss
QPSK	Quadrature Phased Shift Keying
RF	Radio Frequency
rms	root mean square
STE	Special Test Equipment
TDD	Time Division Duplex

4 Technical requirements specifications

4.1 General

4.1.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be declared by the manufacturer. The equipment shall comply with all the technical requirements of the present document which are identified as applicable in annex A at all times when operating within the boundary limits of the declared operational environmental profile.

4.1.2 General System Characteristics

The main characteristics of a beamforming BDA2GC system to which the present document applies are as follows:

- The system allows for a broadband connection to be established between an aircraft equipped with a BDA2GC Aircraft Station (AS) and a Ground Station (GS). The system operates in TDD mode, using OFDM type modulation with variable modulation and coding to optimize the link performance.
- The system uses automatic transmit power control in both directions (GS to AS and AS to GS) in order to maintain the required signal level at the receiver input.
- Both the AS and the GS employ phased array antennas which produce dynamically shaped and steerable beams such that the Ground Station and the Aircraft Station mutually track each other.
- A given GS can comprise up to four separate integrated radio transceivers/phased array antenna assemblies, enabling each GS to cover the entire visible air space, at all azimuths, from horizon to horizon. However, for reasons of spectrum compatibility with other services, a minimum operational elevation angle needs to be maintained as specified in clause 4.2.6.2.
- Each of the GS integrated antenna arrays is capable of simultaneously producing multiple co-frequency shaped beams so that a number of aircraft can be served from a given GS.

- Each AS operates under the control of the network, which enables handover/beam switching from one GS to another, as the aircraft traverses its flight path and provides a means of ensuring that requirements such as minimum operational elevation angle are met.
- The beamforming process is controlled via software algorithms which also enable the detection and suppression of unwanted interfering signals, by means of signal processing techniques applied at the receiver including the placement of directional nulls in the antenna patterns. Such techniques also enable nulls to be dynamically placed in the transmitted radiation pattern, thereby suppressing the power emitted in given directions.

4.1.3 Additional requirement for the Aircraft Station

For operation in the 5 855 MHz to 5 875 MHz frequency band, the Aircraft Station shall employ Detect-and-Avoid (DAA) techniques in order to protect Broadband Fixed Wireless Access.

For DAA to be effective, the aircraft receiver shall be capable of detecting signals transmitted from BFWA transmitters on the ground before the aircraft transmissions give rise to unacceptable levels of interference at the BFWA receiver. The required detection level is specified in clause 4.2.7.3.2.1.

A number of mechanisms can be employed to achieve the required avoidance of harmful interference when an interfering signal above the required level has been detected. These include antenna nulling, adaptive OFDM spectral power density and ground station diversity (switching the aircraft station transmit beam to point towards a different ground station).

Whichever avoidance mechanism is employed, the essential requirement is that the aircraft station EIRP in the direction of the BFWA receiver is reduced to a sufficiently low level, and sufficiently rapidly, such that the resulting power at the BFWA receiver shall never exceed the BFWA interference criterion. The corresponding maximum AS transmit EIRP density and reaction time is specified in clause 4.2.7.3.2.2 and clause 4.2.7.3.2.3, respectively.

4.2 Conformance requirements

4.2.1 General

Unless otherwise specified, the following requirements apply equally to the Ground Station and the Aircraft Station.

4.2.2 Transmitter EIRP Spectral Density

4.2.2.1 Definition

The transmitter EIRP spectral density is the equivalent isotropic radiated power spectral density emitted by the aircraft station or ground station antenna arrays.

4.2.2.2 Limits

4.2.2.2.1 For operation in the 1 900 MHz to 1 920 MHz frequency band

The transmitter EIRP spectral density for the Ground Station shall not exceed 50 dBm/MHz. This EIRP spectral density limit represents the maximum operational level at all times for a single beam, in the direction of the aircraft.

The transmitter EIRP spectral density for the Aircraft Station shall not exceed 34 dBm/MHz.

4.2.2.2.2 For operation in the 5 850 MHz to 5 875 MHz frequency band

The transmitter EIRP spectral density (per beam) shall not exceed 32 dBm/MHz.

For the Ground Station, the above EIRP spectral density limit represents the maximum operational level at all times for a single beam, in the direction of the aircraft.

In addition, the Ground Station emissions shall not exceed the average EIRP levels shown in figure 1.

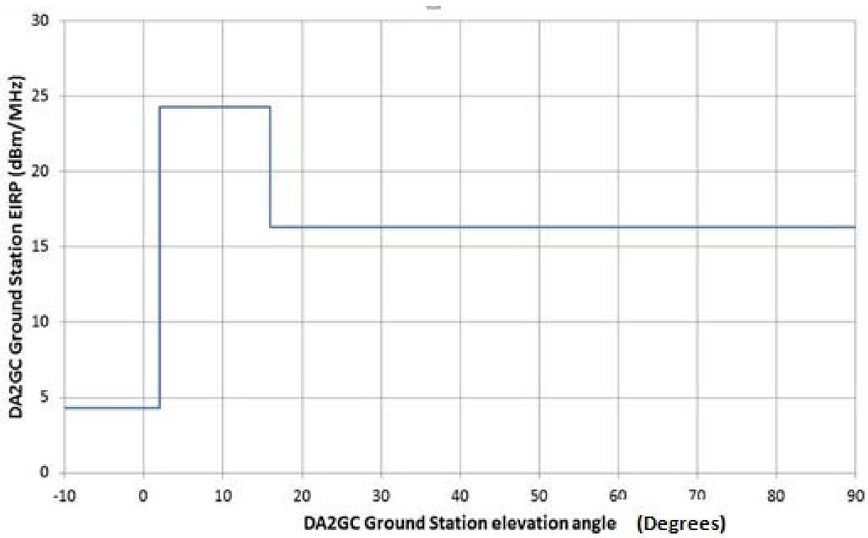

Figure 1: EIRP mask as a function of elevation angle for the Ground Station

The exact values for the three elevation angle ranges are shown in table 2.

Table 2: Ground Station EIRP mask definition

Elevation Angle	Average EIRP level (dBm/MHz)
< 2º	4,3
2º to 16º	24,3
> 16º	16,3
NOTE: These average EIRP levels represent the sum of the powers generated by all beams of the DA2GC Ground Station in any given direction.	

The Aircraft Station emissions shall not exceed the maximum EIRP levels shown in table 3.

Table 3: Aircraft Station EIRP mask

Elevation at ground (degrees)	Aircraft EIRP (dBm/MHz)	Note
0 to 5	29,5 - C	
5 to 27	29,5 - C to 27,0 - C	Straight line interpolation
27 to 28	27,0 - C to 19,5 - C	Straight line interpolation
28 to 90	19,5 - C to 13,0 - C	Straight line interpolation
Where C = 20 x log(10 000 / h) and h = height above ground of the aircraft in metres.		

An example of the Aircraft Station EIRP mask which applies to an aircraft at 10 km height above ground is shown in figure 2.