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**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 for access to radio spectrum**

Reference

REN/BRAN-230017

Keywords

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Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Broadband Radio Access Networks (BRAN), and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

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.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	18 months after doa

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

NOTE: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.5] is given 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 https://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 (V2.1.3) (07-2017): "Wireless Access Systems (WAS); 5,8 GHz fixed broadband data transmitting systems; Harmonised Standard for access to radio spectrum".

2.2 Informative references

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

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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 frequency offset

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
ppm	parts per million
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 4.2.7.4.2.1.

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 are specified in clause 4.2.7.4.2.2 and clause 4.2.7.4.2.3 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.

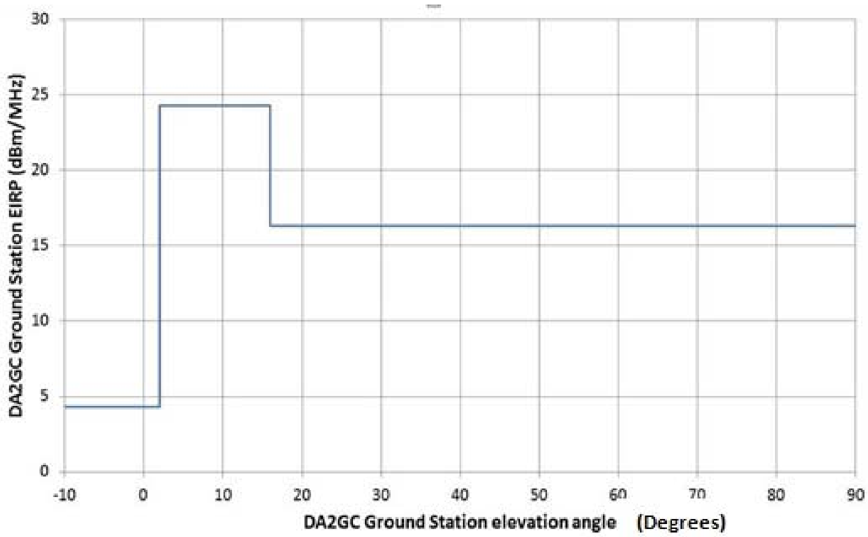


Figure 1: EIRP mask as a function of elevation angle for the Ground Station

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.

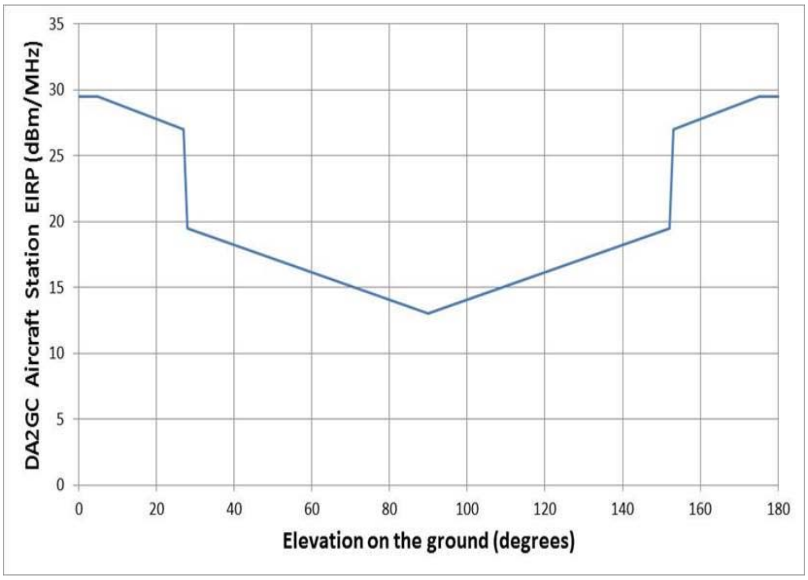


Figure 2: Example of AS EIRP mask for an aircraft height above ground of 10 km

4.2.2.3 Conformance

Conformance tests as defined in clause 5.3.2.2 shall be carried out.

4.2.3 Designation of Centre Frequency

For operation in the 1 900 MHz to 1 920 MHz band, the nominal channel centre frequency is 1 910 MHz.

For operation in the 5 855 MHz to 5 875 MHz band, the nominal channel centre frequency is 5 865 MHz.

4.2.4 Out-of-band EIRP Spectral Density

4.2.4.1 Definition

The Out-Of-Band EIRP spectral density is the equivalent isotropic radiated power spectral density emitted by the Ground Station or Aircraft Station antenna arrays outside the designated channel bandwidth, resulting from the modulation process and non-linearity in the transmitter, but excluding spurious emissions.

4.2.4.2 Limits

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

4.2.4.2.1.1 Maximum Out-Of-Band EIRP spectral density for the Ground Station

The maximum Out-Of-Band EIRP spectral density for the Ground Station is specified in table 4.

Table 4: Maximum Out-Of-Band EIRP spectral density for the Ground Station

Frequency range of OOB emissions	Maximum OOB EIRP level (dBm/MHz)
1 880 MHz to 1 900 MHz	-12,0
1 920 MHz to 1 980 MHz	-23,0
NOTE: The e.i.r.p. levels are specified for the entire hemisphere below the horizontal plane of any installation.	

4.2.4.2.1.2 Maximum Out-Of-Band EIRP spectral density for the Aircraft Station

The maximum Out-Of-Band EIRP spectral density for the Aircraft Station is specified in table 5.

Table 5: Maximum Out-Of-Band EIRP spectral density for the Aircraft Station

Frequency range of OOB emissions	Maximum OOB EIRP level
1 880 MHz to 1 900 MHz	-3,0 dBm/MHz
1 920 MHz to 1 980 MHz	-3,0 dBm/MHz

4.2.4.2.2 For operation in the 5 855 MHz to 5 875 MHz band

The Out-Of-Band EIRP spectral density shall not exceed the following limits:

From 5 250 MHz to 5 850 MHz: -38 - 10 × $\log_{10}$ (20 / BW) dBm/MHz (where BW = transmitter bandwidth (MHz)).

From 5 850 MHz to 5 855 MHz: -8 dBm/MHz.

From 5 875 MHz to 5 925 MHz: -8 dBm/MHz.

4.2.4.3 Conformance

Conformance tests as defined in clause 5.3.2.3 shall be carried out.

4.2.5 Spurious emissions

4.2.5.1 Definition

Transmitter spurious emissions are emissions that are caused by unwanted transmitter effects such as harmonics emission, parasitic emission, intermodulation products and frequency conversion products, but exclude out-of-band emissions. The spurious emissions during transmit mode are defined as unwanted power in the bands from 30 MHz up to Fc - 2,5 × BW and from Fc + 2,5 × BW up to 5 × Fc, where Fc is the carrier frequency and BW is the signal bandwidth.

The spurious level quoted in clause 4.2.5.2 relates to the total conducted power due to spurious emissions delivered to all antennas and antenna elements of a single ground or aircraft station antenna array.

4.2.5.2 Limits

The maximum level of spurious emission shall be:

- -36 dBm/(100 kHz), for 30 MHz ≤ f ≤ 1 GHz
- -30 dBm/MHz, for 1 GHz < f ≤ 26 GHz

4.2.5.3 Conformance

Conformance tests as defined in clause 5.3.3 shall be carried out.

4.2.6 Cessation of emissions

4.2.6.1 Definition

This requirement is expressed as a minimum height above ground, below which the Aircraft Station shall cease transmissions, together with a minimum operational elevation angle between the Ground Station and Aircraft Station.

4.2.6.2 Limits

When the height above ground of the Aircraft Station is less than 3 000 metres it shall automatically cease transmissions and enter into the standby state.

In addition, the broadband DA2GC network shall control the beam switching at the Aircraft Station and at the Ground Station so as to ensure that the operational elevation angle of the beam between the GS and the AS is never less than 5 degrees at all azimuths above the horizontal plane of the GS installation.

4.2.6.3 Conformance

Conformance tests as defined in clause 5.3.4 shall be carried out.

4.2.7 Receiver parameters

4.2.7.1 Receiver sensitivity

4.2.7.1.1 Definition

Receiver sensitivity is defined as the minimum power of the wanted signal at the receiver input to achieve the required performance target in the absence of interference.

4.2.7.1.2 Limits

The receiver sensitivity shall be less than or equal to -87 dBm in a 20 MHz bandwidth.

4.2.7.1.3 Conformance

Conformance tests as defined in clause 5.3.5 shall be carried out.

4.2.7.2 Receiver adjacent channel selectivity

4.2.7.2.1 Definition

The receiver adjacent channel selectivity is a measure of a receiver's ability to achieve minimum throughput requirements in the presence of an adjacent channel signal at a specific frequency offset from the given channel. ACS can strictly be defined as the ratio (in dB) of the receiver filter's attenuation on the assigned channel frequency to the receiver filter attenuation on the adjacent channels.

4.2.7.2.2 Limit

The receiver adjacent channel selectivity shall be equal to or greater than 43,5 dB.

4.2.7.2.3 Conformance

Conformance tests as defined in clause 5.3.6 shall be carried out.

4.2.7.3 Receiver Blocking

4.2.7.3.1 Definition

Receiver blocking is a measure of the capability of the equipment to receive a wanted signal on its operating channel without exceeding a given degradation due to the presence of an unwanted input signal (blocking signal) on frequencies other than those of the operating bands provided in clause 1.

The minimum performance criterion is 95 % of theoretical maximum throughput when using the QPSK modulation scheme. The manufacturer may declare an alternative performance criterion as long as that is appropriate for the intended use of the equipment.

4.2.7.3.2 Limits

While maintaining the minimum performance criterion as defined in clause 4.2.7.3.1, the blocking levels at the receiver input at specified frequency offsets shall be equal to or greater than the limits defined in table 6.

Table 6: Receiver Blocking parameters

Wanted signal mean power (dBm)	Blocking signal frequency offset F_0 (MHz)	Blocking signal power (dBm)	Type of blocking signal
P_{min} + 6 dB	15 MHz< f_0 ≤60 MHz	-42,0	Continuous Wave
P_{min} + 6 dB	60 MHz< f_0 ≤85 MHz	-27,0	Continuous Wave
P_{min} + 6 dB	85 MHz< f_0 ≤215 MHz	-12,0	Continuous Wave
NOTE 1: The wanted signal is the output from the STE set up to emulate the received signal from the ground or aircraft station. NOTE 2: P_{min} is the minimum level of the wanted signal (in dBm) required to meet the minimum performance criterion as defined in clause 4.2.7.3.1 in the absence of any blocking signal.			

4.2.7.3.3 Conformance

Conformance tests as defined in clause 5.3.7 shall be carried out.

4.2.7.4 Detect and Avoid capability

4.2.7.4.1 Definition

Detect and Avoid is a technique whereby the Aircraft Station receiver automatically detects emissions from BFWA transmitting stations on the ground in order that action can then be taken to avoid harmful interference into BFWA by reducing the AS EIRP in the direction of the BFWA receiver.

This requirement only applies to the Aircraft Station when operating in the band 5 855 MHz to 5 875 MHz.

4.2.7.4.2 Limits

4.2.7.4.2.1 Detection level

The Aircraft Station receiver shall be capable of detecting interfering signals within the operating channel at levels greater than -106 dBm in order that avoiding action can be taken to. limit the power transmitted in the direction of the detected interferer to an acceptable level as defined in clause 4.2.7.4.2.2.

4.2.7.4.2.2 Reduced transmit EIRP density

When the aircraft station receiver is in a state indicating that an interfering signal has been detected, the AS transmit EIRP spectral density shall be reduced to a maximum of +6 dBm/MHz in the direction of the detected interfering transmitter.

4.2.7.4.2.3 DAA reaction time

The aircraft station transmit EIRP density level shall be reduced to the maximum level specified in clause 4.2.7.4.2.2 within 100 milliseconds of the equipment entering the interference detect state.

4.2.7.4.3 Conformance

Conformance tests as defined in clause 5.3.8 shall be carried out.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

Tests defined in the present document shall be carried out at representative points within the boundary limits of the declared operational environmental profile.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions (within the boundary limits of the declared operational environmental profile) to give confidence of compliance for the affected technical requirements.

5.2 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 less than the figures in table 7.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028 [i.7], in particular in annex D of the ETSI TR 100 028-2 [i.8].

Table 7 is based on such expansion factors.

Table 7: Maximum measurement uncertainty

Parameter	Uncertainty
Radio frequency	±10 ppm
e.i.r.p.	±6 dB
Out-of-band e.i.r.p.	±6 dB
Spurious emissions	±2 dB
Minimum receiver sensitivity	±1,5 dB
Receiver adjacent channel selectivity	±0,8 dB
Aircraft altitude	±50 m

5.3 Test Methods

5.3.1 General considerations

Formal testing is accomplished under the direction of a test procedure. This test procedure will have been created specifically for testing the exact equipment intended for qualification or certification. The test procedure will describe or provide reference to all expected test conditions and parameters, including cable harness construction details, all equipment set-up, interconnect, placement and configuration details, instructions for operating the device and for determining its proper operation, and any necessary instructions for performing the test measurements.

To enable the performance tests to be carried out, the use of a NCF Control Channel or a Special Test Equipment (STE) made available by the manufacturer may be necessary. Since this STE will be specific for the particular system, it is not possible to provide detailed specifications in the present document. However, the following baseline is provided:

- if the AS requires reception of a modulated carrier from the Ground Station in order to transmit (or vice versa), then special test arrangements are required to simulate the GS or AS signal as appropriate, thus enabling the system to transmit, thereby allowing measurements of radiated parameters to be undertaken. Furthermore, the STE should ensure that the radiated power levels from either the GS or the AS under test correspond to those levels which would be produced by the GS or AS when the system is operating between a GS and an AS mounted on an aircraft flying within the geographic/geometric constraints defined in clause 4.2.5.

Any characteristic of these special test arrangements which may have direct or indirect effects on the parameters to be measured shall be clearly stated by the manufacturer.

The test procedures given in clause 5 may be replaced by other equivalent procedures provided that the results are proven to be as accurate as those obtained according to the specified method. Because each manufacturer's equipment may be different, then different test methods can be suggested and proposed by the manufacturer to account for the different equipment characteristics. Specific test procedures shall be fully documented in the test procedure and test report.

If the Equipment Under Test (EUT) has had hardware and/or software modification(s) performed by the manufacturer for these tests, then full documentation of such modification(s) shall be provided to prove that the modification(s) will simulate the required test condition. Such modification(s) shall be proved to allow the GS or AS to operate without its main characteristics being changed.

All technical characteristics and operational conditions declared by the manufacturer shall be entered in the test report.

5.3.2 EIRP Measurements

5.3.2.1 Common test conditions for radiated power measurements

a) The measurements shall be performed in a suitable test chamber where the size of the chamber is sufficiently large to ensure that the power measurements are carried out in the far field of the radiation pattern.

b) The tests shall be performed in a normal test environment as described in clause B.1.

c) The tests shall be carried out with the EUT (GS or AS) transmitting a simulated operational waveform signal which carries a pseudorandom data stream.

d) The default test signal channel bandwidth for all EIRP measurements shall be the maximum occupied bandwidth of 20 MHz. The default test channel shall be 1 900 MHz to 1 920 MHz or 5 855 MHz to 5 875 MHz, as appropriate.

e) Tests shall be performed using lower bandwidth signals if the equipment is intended for operation in sub-bands within the above frequency ranges. In this case, the signal bandwidths and test channel centre frequencies shall be chosen according to the declared channels of operation.

f) A calibrated receive antenna shall be positioned on a moveable platform allowing for it to be adjusted in height and in angular offset from EUT and while maintaining antenna pointing directly towards the EUT for all positions of the platform.

g) The moveable platform should also allow for the maximum distance possible from the EUT to be maintained as the receive antenna is moved across the required angular range for each test.

h) The output from the calibrated antenna shall be connected to a spectrum analyser with the resolution bandwidth and other settings set to the appropriate values as specified for each test in clause 5.3.2.2 to clause 5.3.2.3. Alternatively, a dedicated measurement receiver with calibrated measurement filters may be used.

5.3.2.2 Transmitter EIRP spectral density

5.3.2.2.1 Ground Station measurement

5.3.2.2.1.1 Ground Station mounting arrangement

For the Ground Station tests described in this clause, the GS shall be mounted on a fixed platform in an orientation representative of the usual operational situation, i.e. where the pointing of the GS transmit/receive beams can be varied in elevation from 5 degrees to 90 degrees above horizontal and at all azimuths from -90 degrees to +90 degrees.

5.3.2.2.1.2 Maximum EIRP spectral density

5.3.2.2.1.2.1 Test conditions

The STE shall be set to simulate the situation where the Aircraft Station is at the maximum possible range from the Ground Station while remaining in conformance with the geographical constraints described in clause 4.2.5 and the main beam produced by the GS is pointing directly towards the Aircraft Station. That is to say that the ATPC shall be disabled.

5.3.2.2.1.2.2 Test method

The maximum EIRP spectral density produced by a single beam from the Ground Station shall be measured as follows:

a) The output from the calibrated antenna shall be connected to a spectrum analyser or measurement receiver with the resolution bandwidth set to be equal to the bandwidth of the signal under test. The detector mode shall be set to rms and the sweep mode set to an appropriate setting, depending on the EUT transmit frame duration and timing, so that an integrated measurement of total power in the test channel can be performed.

b) The calibrated receive antenna shall be positioned at a height relative to the GS assembly whereby an elevation angle of 5 degrees from the horizontal is produced between the GS and the calibrated antenna and the measurement antenna is pointing directly towards the GS.

c) The total power in the 20 MHz bandwidth at the calibrated antenna output shall be measured using the spectrum analyser or measurement receiver and the EIRP spectral density shall then be calculated as follows:

$$\text{EIRP spectral density (in dBm/MHz)} = P - G_r - (10 \times \log(BW)) + PL$$

where: G_r is the boresight gain of the calibrated receive antenna in dBi;

P is the measured power in dBm;
BW is the occupied bandwidth of the transmitted signal in MHz; and

PL is the free space path loss in dB between the GS antenna and the measurement antenna.

5.3.2.2.1.2.3 Test requirement

The results obtained shall be compared to the limits in clause 4.2.2.2.1 (for equipment operating in the 1 900 MHz to 1 920 MHz band) or to the maximum EIRP spectral density limits in clause 4.2.2.2.2 (for equipment operating in the 5 855 MHz to 5 875 MHz band) in order to prove compliance.

5.3.2.2.1.3 Average EIRP density level (5 855 MHz to 5 875 MHz band only)

5.3.2.2.1.3.1 Test conditions

The STE shall be set to simulate the situation where a single GS transceiver/antenna array is continuously and simultaneously tracking three aircraft (via three beams) and where those aircraft are flying along pseudo-random flight paths at varying altitudes and in varying directions. The STE shall also be set to simulate varying data traffic load conditions.

5.3.2.2.1.3.2 Test method

The measurement at each azimuth and elevation shall be carried out over a simulated time frame equivalent to 24 hours of real-time operation. The average EIRP density level shall be determined as follows:

a) The output from the calibrated antenna shall be connected to a spectrum analyser or measurement receiver with the resolution bandwidth set to 20 MHz. The detector mode shall be set to rms and the sweep mode set to an appropriate setting, so that an integrated measurement of average power in the test channel over the simulated 24 hours period can be performed.

b) The measurement platform shall be positioned such that the calibrated measurement antenna is on the same horizontal level as the centre of the GS antenna array.

c) The measurement platform shall be set to an initial position corresponding to an azimuth direction of -90 degrees at the GS antenna.

d) The power spectral density at the calibrated antenna output shall be measured using the spectrum analyser or measurement receiver and integrated over the required time period.

e) The average EIRP spectral density shall be calculated as follows:

$$EPSD_{ave} = PSD_i - Gr + PL$$

where: $EPSD_{ave}$ is the average EIRP spectral density;

PSD_i is the integrated power spectral density;

G_r is the boresight gain of the calibrated receive antenna in dBi; and

PL is the free space path loss in dB between the GS antenna and the measurement antenna.

f) The procedure outlined in d) and e) shall be repeated with the measurement platform adjusted in azimuth (relative to the GS antenna) in 5 degree increments between -89 degrees and +90 degrees inclusive.

g) The series of average EIRP measurements from -90 degrees to +90 degrees azimuth shall then be repeated with the measurement platform adjusted in elevation (relative to the GS antenna) over the range from 1 degree to 15 degrees in 1 degree increments and from 16 degrees to 90 degrees in 5 degree increments.

5.3.2.2.1.3.3 Test requirement

The results obtained shall be compared to the limits given in clause 4.2.2.2.2, table 2 in order to prove compliance.

5.3.2.2.2 Aircraft Station measurement

5.3.2.2.2.1 Aircraft Station mounting arrangement

For the Aircraft Station tests described in this clause, the AS assembly shall be mounted on a ground plane that is representative of the section of an aircraft body where the AS is to be installed.

5.3.2.2.2.2 Maximum EIRP spectral density

5.3.2.2.2.2.1 Test conditions

The STE shall be set to simulate the situation where the Aircraft Station is at the maximum possible range from the Ground Station while remaining in conformance with the geographical constraints described in clause 4.2.5 and the main beam produced by the AS is pointing directly towards the Ground Station. That is to say that the ATPC shall be disabled.

5.3.2.2.2.2.2 Test method

The maximum EIRP spectral density produced by the beam from the Aircraft Station shall be measured as follows:

a) The output from the calibrated antenna shall be connected to a spectrum analyser or measurement receiver with the resolution bandwidth set to be equal to the bandwidth of the signal under test. The detector mode shall be set to rms and the sweep mode set to an appropriate setting, depending on the EUT transmit frame duration and timing, so that an integrated measurement of total power in the test channel can be performed.

b) The calibrated receive antenna shall be placed in a position relative to the AS assembly whereby an elevation angle of 5 degrees from the horizontal is produced between the AS and the calibrated antenna and the measurement antenna is pointing directly towards the AS.

c) The total power in the 20 MHz bandwidth at the calibrated antenna output shall be measured using the spectrum analyser or measurement receiver and the EIRP spectral density shall then be calculated as follows:

$$\text{EIRP spectral density (in dBm/MHz)} = P - G_r - (10 \times \log(BW)) + PL$$

where:

G_r is the boresight gain of the calibrated receive antenna in dBi;

P is the measured power in dBm;

BW is the occupied bandwidth of the transmitted signal in MHz; and

PL is the free space path loss in dB between the AS antenna and the measurement antenna.

5.3.2.2.2.2.3 Test requirement

The results obtained shall be compared to the limits in clause 4.2.2.2.1 (for equipment operating in the 1 900 MHz to 1 920 MHz band) or to the maximum EIRP spectral density limits in clause 4.2.2.2.2 (for equipment operating in the 5 855 MHz to 5 875 MHz band) in order to prove compliance.

5.3.2.2.2.3 EIRP mask (5 855 MHz to 5 875 MHz band only)

5.3.2.2.2.3.1 Test conditions

The requirements in clause 4.2.2.2.2 are expressed as sets of EIRP spectral density values which are dependent on both aircraft height above ground and on the elevation angle as seen from the ground. In order to verify compliance with those requirements, it will therefore be necessary to carry out a series of tests under the following conditions:

a) The STE shall be set to simulate the situation where the Aircraft Station is operating on an aircraft flying at a steady altitude equivalent to 10 000 m height above ground while transmitting to a GS on the ground.

b) To model the situation described in a), the STE shall vary the pointing angle of the AS beam and control the radiated power density to the level which would be required in order to maintain a constant received power level at the GS as the aircraft traverses a route from 5 degrees to 90 degrees in elevation as seen from the GS.

5.3.2.2.2.3.2 Test method

a) The measurement platform shall first be positioned such that the calibrated antenna is pointing directly towards the AS antenna array and is on the same horizontal level, i.e. the effective elevation angle of the AS, as seen from the measurement antenna, is 0 degrees.

b) The variation in EIRP spectral density as the STE varies the beam pointing and transmit power in accordance with clause 5.3.2.2.2.3.1 step b) shall be measured using the spectrum analyser or measurement receiver (values derived as described in clause 5.3.2.2.2.2.2 step c)) and the output shall be recorded.

c) The maximum measured EIRP spectral density value at any point shall be used to determine compliance with the limit shown in table 3 in clause 4.2.2.2.2 for an "Elevation at ground" value of 0 degrees.

d) Step a) to step c) shall be repeated with the measurement platform moved to positions where the effective elevation angle of the AS, as seen from the measurement antenna is incremented by 1 degree intervals from 1 degree to 90 degrees.

e) The complete set of measurements described above shall then be repeated with the STE being set to simulate a range of aircraft altitudes corresponding to the height above ground being varied from 9 000 m to 3 000 m inclusive.

5.3.2.2.2.3.3 Test requirement

The results obtained shall be compared to the limits given in clause 4.2.2.2.2, table 3 in order to prove compliance.

5.3.2.3 Out-of-band EIRP spectral density

5.3.2.3.1 Tests required for 1 900 MHz to 1 920 MHz band only

5.3.2.3.1.1 Ground Station measurement

5.3.2.3.1.1.1 Test conditions

For the following tests, the Ground Station assembly shall be mounted on a platform at a sufficient elevation above the test chamber floor to enable radiated power measurements to be undertaken for negative elevation angles down to -90 degrees (in relation to the GS horizontal pointing direction).

The orientation of the GS shall be as described in clause 5.3.2.2.1.1.

The STE shall be set to simulate the situation where the Aircraft Station is at the maximum possible range from the Ground Station while remaining in conformance with the geographical constraints described in clause 4.2.5 and the main beam produced by the GS is pointing directly towards the Aircraft Station.

The calibrated receive antenna shall be positioned at a height relative to the GS assembly whereby an elevation angle of 0 degrees from the horizontal is produced between the GS and the calibrated antenna and the measurement antenna is pointing directly at the GS.

5.3.2.3.1.1.2 Test method

The OOB EIRP spectral density from the GS shall be measured as follows:

a) The output from the calibrated antenna shall be connected to a spectrum analyser with the resolution bandwidth set to 1 MHz or to a suitable measuring receiver with a calibrated measurement filter bandwidth of 1 MHz. The detector mode shall be set to rms and the sweep mode set to an appropriate setting, depending on the EUT transmit frame duration and timing, so that an integrated measurement of total power in the test channel can be performed.

b) The power spectral density at the calibrated antenna output shall be measured using the spectrum analyser (or measuring receiver) with the filter centre frequency set to 1 880,5 MHz.

c) The EIRP spectral density shall then be calculated as follows:

$$\text{EIRP spectral density (in dBm/MHz)} = P - G_r + PL$$

where: G_r is the boresight gain of the calibrated receive antenna in dBi;

P is the measured power in dBm; and

PL is the free space path loss in dB between the GS antenna and the measurement antenna.

d) Step b) to step c) shall be repeated with the filter centre frequency increased in 1 MHz steps up to a centre frequency of 1 899,5 MHz in order that the maximum value of EIRP spectral density within the band 1 880 MHz to 1 900 MHz can be determined.

e) Step b) to step c) shall then be repeated, beginning with a filter centre frequency of 1 920,5 MHz and increasing the centre frequency in 1 MHz steps up to a centre frequency of 1 979,5 MHz in order that the maximum value of EIRP spectral density within the band 1 920 MHz to 1 980 MHz can be determined.

The above test step a) to step e) shall then be repeated with the measurement platform moved each time such that the elevation angle at which the GS emissions are measured is incremented by 5 degree intervals from -1 degree to -90 degrees (directly under the GS assembly).

5.3.2.3.1.1.3 Test requirement

The results obtained shall be compared with the limits in clause 4.2.4.2.1.1 in order to prove compliance.

5.3.2.3.1.2 Aircraft Station measurement

5.3.2.3.1.2.1 Test conditions

For the following tests, the Aircraft Station assembly shall be mounted on a ground plane that is representative of the section of an aircraft body where the AS is to be installed.

The STE shall be set to simulate the situation where the Aircraft Station is at the maximum possible range from the Ground Station while remaining in conformance with the geographical constraints described in clause 4.2.5 and the main beam produced by the AS is pointing directly towards the Ground Station.

5.3.2.3.1.2.2 Test method

The OOB EIRP spectral density from the AS shall be measured as follows:

a) The calibrated receive antenna shall be positioned at a height relative to the AS assembly whereby an elevation angle of 5 degrees from the horizontal is produced between the AS and the calibrated antenna and the measurement antenna is pointing directly at the AS.

b) The output from the calibrated antenna shall be connected to a spectrum analyser with the resolution bandwidth set to 1 MHz or to a suitable measuring receiver with a calibrated measurement filter bandwidth of 1 MHz. The detector mode shall be set to rms and the sweep mode set to an appropriate setting, depending on the EUT transmit frame duration and timing, so that an integrated measurement of total power in the test channel can be performed.

c) The power spectral density at the calibrated antenna output shall be measured using the spectrum analyser (or measuring receiver) with the filter centre frequency set to 1 880,5 MHz.

d) The EIRP spectral density shall then be calculated as follows:

$$\text{EIRP spectral density (in dBm/MHz)} = P - G_r - (10 \times \log(BW)) + PL$$

where: G_r is the boresight gain of the calibrated receive antenna in dBi;

P is the measured power in dBm;

BW is the bandwidth of the spectrum analyser or calibrated measurement filter; and

PL is the free space path loss in dB between the AS antenna and the measurement antenna.

e) Step c) to step d) shall be repeated with the filter centre frequency increased in 1 MHz steps up to a centre frequency of 1 899,5 MHz in order that the maximum value of EIRP spectral density within the band 1 880 MHz to 1 900 MHz can be determined.

f) Step c) to step d) shall then be repeated, beginning with a filter centre frequency of 1 920,5 MHz and increasing the centre frequency in 1 MHz steps up to a centre frequency of 1 979,5 MHz in order that the maximum value of EIRP spectral density within the band 1 920 MHz to 1 980 MHz can be determined.

5.3.2.3.1.2.3 Test requirement

The results obtained shall be compared with the limits in clause 4.2.4.2.1.2 in order to prove compliance.

5.3.2.3.2 Tests required for 5 855 MHz to 5 875 MHz band only

5.3.2.3.2.1 General

Measurements of EIRP spectral density should be carried out on both the Ground Station and Aircraft Station equipments since the requirements in clause 4.2.4.2.2 apply equally to both.

5.3.2.3.2.2 Test conditions

For the Aircraft Station tests described in this clause, the AS assembly shall be mounted on a ground plane that is representative of the section of an aircraft body where the AS is to be installed.

For both the GS and AS test cases, the STE shall be set to simulate the situation where the Aircraft Station is at the maximum possible range from the Ground Station while remaining in conformance with the geographical constraints described in clause 4.2.5 and the main beams produced by the AS and the GS are pointing directly towards each other.

5.3.2.3.2.3 Test method

The following tests shall be undertaken:

a) The output from the calibrated antenna shall be connected to a spectrum analyser with the resolution bandwidth set to 1 MHz (or to a suitable measuring receiver with a calibrated measurement filter bandwidth of 1 MHz). The detector mode shall be set to rms and the sweep mode set to an appropriate setting, depending on the EUT transmit frame duration and timing, so that an integrated measurement of total power in the test channel can be performed.

b) The calibrated receive antenna shall be positioned at a height relative to the GS (or AS) assembly whereby an elevation angle of 5 degrees from the horizontal is produced between the GS (or AS) and the calibrated antenna.

c) The power spectral density in the band 5 815 MHz to 5 850 MHz at the calibrated antenna output shall be measured using the spectrum analyser (or measuring receiver) with the filter centre frequency set, initially, to 5 815,5 MHz then increasing in 1 MHz steps to a maximum centre frequency of 5 849,5 MHz.

d) The EIRP spectral density in each 1 MHz channel shall then be calculated as follows:

$$\text{EIRP spectral density (in dBm/MHz)} = P - G_r + PL$$

where: G_r is the boresight gain of the calibrated receive antenna in dBi;

P is the measured power in dBm; and

PL is the free space path loss in dB between the EUT and the measurement antenna.

e) Step c) to step d) shall be repeated starting with a filter centre frequency of 5 850,5 MHz then increasing in 1 MHz steps to a maximum centre frequency of 5 854,5 MHz, in order that the maximum value of EIRP spectral density in the band 5 850 MHz to 5 855 MHz can be determined.

f) Step c) to step d) shall then be repeated, starting with a filter centre frequency of 5 875,5 MHz then increasing in 1 MHz steps to a maximum centre frequency of 5 924,5 MHz, in order that the maximum value of EIRP spectral density in the band 5 875 MHz to 5 925 MHz can be determined.

5.3.2.3.2.4 Test requirement

The results obtained shall be compared with the limits in clause 4.2.4.2.2 in order to prove compliance.

5.3.3 Transmitter spurious emissions

5.3.3.1 Initial conditions

1) Test environment: see clause B.1 and clause B.2.

2) Set up the test system according to clause B.3.1.

3) Connect the equipment antenna connector to the measurement equipment using an attenuator or a directional coupler if necessary. Any insertion losses shall be calibrated and taken into account.

4) Measurements shall use a measurement bandwidth of:

   100 kHz, for 30 MHz ≤ f ≤ 1 GHz.

   1 MHz, for 1 GHz < f ≤ 26 GHz.

5) Detection mode: True rms.

5.3.3.2 Procedure

a) Set the equipment to transmit at maximum power.

b) Measure the emission at the specified frequencies with specified measurement bandwidth and note that the measured value does not exceed the specified value.

5.3.3.3 Test requirement

The results obtained shall be compared to the limits in clause 4.2.5.2 in order to prove compliance.

5.3.4 Cessation of emissions

5.3.4.1 Minimum operational altitude

5.3.4.1.1 Test conditions

The tests shall be performed in a normal test environment as described in clause B.1.

The STE shall firstly be set to simulate an aircraft height above ground of 3 000 metres with the Aircraft Station set in the "Transmission enabled" state (for an explanation of how height above ground can be derived from altimeter readings, see annex D).

5.3.4.1.2 Test method

The altitude dependent requirement in clause 4.2.6 shall be tested as follows:

a) The STE shall be adjusted to simulate an aircraft height above ground of 2 950 metres.

b) It shall be verified that the AS enters the "Emissions disabled" state and that it remains in the "Emissions disabled" state when requested to transmit data by the NCF.

5.3.4.2 Minimum operational elevation angle

5.3.4.2.1 Test conditions

The tests shall be performed in a normal test environment as described in clause B.1.

The STE shall be set to simulate the GS tracking an AS as the aircraft flies from a point directly overhead (90 degrees elevation as viewed from the GS) to the horizon (0 degrees elevation).

5.3.4.2.2 Test method

The requirement in clause 4.2.6 for the system to maintain elevation angles of no less than 5 degrees during operation shall be tested as follows:

a) Checks shall be made that the GS beam enters and remains in the "Emissions disabled" state when the elevation angle viewed from the GS falls below 5 degrees.

b) The test described in a) should be performed at a range of azimuth angles, thereby simulating the GS tracking aircraft flying on various flight paths in relation to the orientation of the GS antenna array.

5.3.5 Receiver sensitivity

5.3.5.1 Test conditions

The tests shall be performed in a normal test environment as described in clause B.1.

Set the STE to produce a signal level of -87 dBm at the receiver input.

5.3.5.2 Test Method

Measure the achieved data throughput at the receiver output. Verify that this data throughput meets the required performance target of 95 % of theoretical maximum throughput when using QPSK modulation scheme.

5.3.6 Receiver Adjacent channel selectivity

5.3.6.1 Test conditions

The tests shall be performed in a normal test environment as described in clause B.1.

The system shall be set up according to clause B.3.2.

5.3.6.2 Test method

a) Set the STE or reference signal generator to the appropriate modulation (OFDM).

b) Set the interfering signal generator modulation to the same type as that of the reference signal modulation.

c) Adjust the frequency of the interfering signal to be centred on f_0 - 20 MHz with a bandwidth of 20 MHz.

d) Adjust the level of the interfering signal to be equal to that of the wanted signal.

e) Measure the level of the output signal with and without the interfering signal applied.

5.3.6.3 Test requirement

The results obtained shall be compared with the limits in clause 4.2.7.2.2 in order to prove compliance.

5.3.7 Receiver Blocking

5.3.7.1 Test Conditions

The tests shall be performed in a normal test environment as described in clause B.1.

5.3.7.2 Test method

a) Set the STE to produce the required wanted signal level at the receiver input, as specified in table 6.

b) Adjust the interfering signal generator to the type of interfering signal, levels and frequency offsets as specified in table 6.

c) The CW interfering signal frequency shall be swept with a step size of 1 MHz within each of the specified ranges.

d) Verify that the performance criterion specified in clause 4.2.7.3.1 is met for all combinations of frequency offsets and power levels specified in table 6.

5.3.7.3 Test requirement

The results obtained shall be compared to the limits in clause 4.2.7.3.2 to prove compliance.

5.3.8 Aircraft Station Detect and Avoid capability

5.3.8.0 Applicability

Applies only in the 5 855 MHz to 5 875 MHz band.

5.3.8.1 Test conditions

The tests shall be performed in a normal test environment as described in clause B.1.

For the tests described in this clause, the AS assembly shall be mounted on a ground plane that is representative of the section of an aircraft body where the AS is to be installed.

The STE shall be set up to simulate normal operating parameters whereby the wanted signal from the GS is maintained at a constant level of -87 dBm at the input to the AS receiver. The tests shall be carried out with the GS transmitting a simulated operational waveform signal which carries a pseudorandom data stream.

An interfering signal generator shall be configured to produce a noise-like signal such that 99 % of the power of the signal falls within the band 5 855 MHz to 5 875 MHz, which is representative of a BFWA transmitter operating on the highest 20 MHz channel specified in ETSI EN 302 502 [2]. This signal generator shall be connected to a calibrated antenna mounted on a moveable platform via a programmable switch also connected to a spectrum analyser or measurement receiver with the resolution bandwidth set to 21 MHz, such that a radiated signal can be directed towards the AS receiver from varying off-axis angles in elevation and azimuth relative to the AS antenna boresight position and the same equipment configuration can be used to measure the total power at the calibrated antenna output port when used as a receive antenna.

5.3.8.2 Test method

5.3.8.2.1 Detection level

a) Position the interfering antenna platform such that the antenna is pointing directly towards the AS antenna array and is on the same horizontal level, i.e. the effective elevation and azimuth angle of the AS, as seen from the measurement antenna, is 0 degrees.

b) Set the BFWA simulating signal generator to a centre frequency of 5 865 MHz with a bandwidth of 20 MHz.

c) Starting from an EIRP level of -60 dBm, increase the power level from the BFWA simulating signal generator until the AS receiver state indicates that an interfering signal has been detected.

d) Switch off the wanted signal from the GS.

e) Measure and record the resulting level of the interfering signal at the AS receiver input.

f) Lower the interfering antenna platform and re-point the antenna such that it is pointing towards the AS antenna array at an elevation angle of 2 degrees.

g) Switch on the wanted signal from the GS, then repeat step c) to step e) and record the resulting signal level at the AS receiver input.

h) Repeat step f) to step g) in 4 degree increments over a range from 4 degrees to 32 degrees in elevation.

i) Repeat step a) to step f), moving the interfering antenna position over a range of azimuth angles relative to the AS antenna array between -8 degrees and +8 degrees in increments of 4 degrees.

j) Verify compliance with clause 4.2.7.4.2.1 by comparing the measured interfering signal levels from step e) with the required detection level of -106 dBm.

5.3.8.2.2 Reduced transmit EIRP density

The reduced maximum EIRP spectral density produced by the beam from the Aircraft Station in the direction of an interferer when the AS equipment is in detect state shall be measured as follows:

a) Carry out the procedures specified in clause 5.3.8.2.1, step a) to step c) then, with the equipment in detect state, measure the total power at the calibrated antenna output using the spectrum analyser or measurement receiver with the resolution bandwidth set to be equal to the bandwidth of the signal under test. The detector mode shall be set to rms and the sweep mode set to an appropriate setting, depending on the EUT transmit frame duration and timing, so that an integrated measurement of total power in the test channel can be performed.

b) the EIRP spectral density shall then be calculated as follows:

$$\text{EIRP spectral density (in dBm/MHz)} = P - G_r - (10 \times \log(BW)) + PL$$

where: G_r is the boresight gain of the calibrated receive antenna in dBi;

P is the measured power in dBm;

BW is the occupied bandwidth of the transmitted signal in MHz; and

PL is the free space path loss in dB between the AS antenna and the measurement antenna.

c) Verify compliance with clause 4.2.7.4.2.2 by comparing the calculated value of EIRP spectral density from step b) with the maximum permitted level of +6 dBm/MHz.

d) Repeat step a) to step c) in 4 degree increments over a range from 4 degrees to 32 degrees in elevation.

e) Repeat step a) to step d), moving the interfering antenna position over a range of azimuth angles relative to the AS antenna array between -8 degrees and +8 degrees in increments of 4 degrees.

5.3.8.2.3 DAA reaction time

a) Carry out the procedures specified in clause 5.3.8.2.1, step a) to step c), then switch off the interfering signal whilst retaining the output power setting on the interfering signal generator.

b) Switch the interfering signal back on at the same level and measure the time delay between the switch-on and the resulting drop in EIRP as measured at the calibrated antenna output on the spectrum analyser or measurement receiver.

5.3.8.2.4 Test requirement

The results obtained shall be compared with the limits in clause 4.2.7.4.2.3 in order to prove compliance.

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

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

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

Harmonised Standard ETSI EN 303 316					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Transmitter EIRP Spectral Density	3.2	4.2.2	U	
2	Out-Of-Band EIRP Spectral Density	3.2	4.2.4	U	
3	Spurious emission	3.2	4.2.5	U	
4	Cessation of emissions	3.2	4.2.6	U	
5	Receiver sensitivity	3.2	4.2.7.1	U	
6	Receiver adjacent channel selectivity	3.2	4.2.7.2	U	
7	Receiver blocking	3.2	4.2.7.3	U	
8	Detect and Avoid	3.2	4.2.7.4	U	

Key to columns:

Requirement:

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

Description A textual reference to the requirement.

Essential requirements of Directive

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

Clause(s) of the present document

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

Requirement Conditionality:

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

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

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

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

Annex B (normative): Test specification

B.1 Normal test environment

When a normal test environment is specified for a test, the test should be performed within the minimum and maximum limits of the conditions stated in table B.1.

Table B.1: Limits of conditions for Normal Test Environment

Condition	Minimum	Maximum
Barometric pressure	86 kPa	106 kPa
Temperature	15 °C	30 °C
Relative Humidity	20 %	85 %
Power supply	Nominal, as declared by the manufacturer	
Vibration	Negligible	

The ranges of barometric pressure, temperature and humidity represent the maximum variation expected in the uncontrolled environment of a test laboratory. If it is not possible to maintain these parameters within the specified limits, the actual values shall be recorded in the test report.

B.2 RF Bandwidth

Unless otherwise stated, the bandwidth for test purposes shall be 20 MHz.

B.3 Test Configurations

B.3.1 Transmitter spurious Emissions

The test configuration for transmitter spurious emissions is shown in figure B.1.

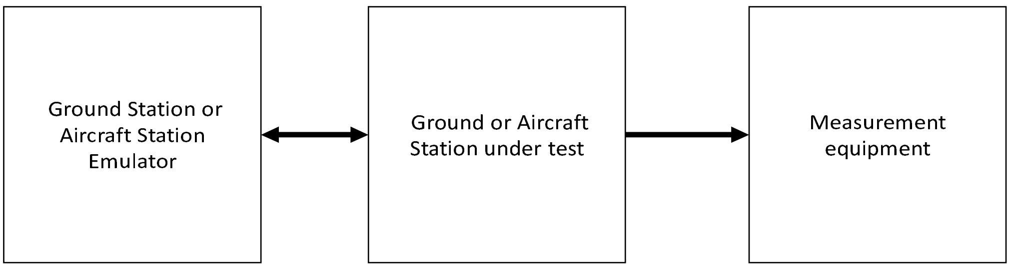
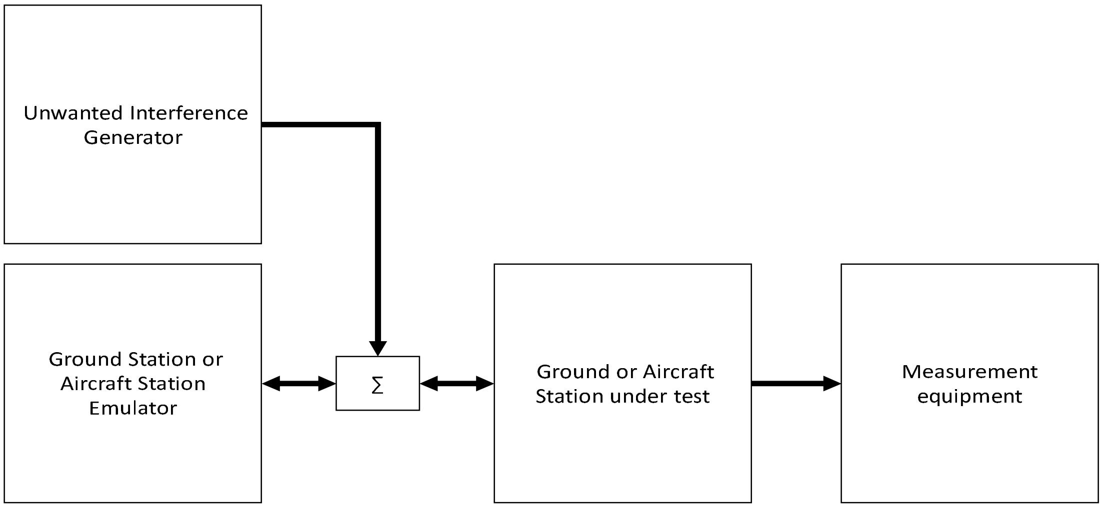


Figure B.1: Measurement system for transmitter spurious emissions

B.3.2 Receiver ACS and Blocking

The test configuration for receiver ACS and blocking measurements is shown in figure B.2.



The insertion loss of the combiner shall be calibrated and taken into account when making measurements.

Figure B.2: Measurement system for receiver ACS and blocking

Annex C (normative): Geographical Data

C.1 Height above Ground

To ensure compliance with the requirement in clause 4.2.6 the system shall be capable of determining the aircraft height above ground at all times during its operation.

When available, the Aircraft Station shall use GNSS height to measure the height of the aircraft. However, if GNSS height is not available barometric altitude may be substituted. Since both methods provide a measurement of height above sea level, the height above ground shall be calculated as follows:

Height above ground = barometric altitude - terrain height

The terrain height shall be measured in metres and shall comply with the World Geodetic System 1984 (WGS84) [1].

Annex D (informative): Bibliography

- Directive 2004/108/EC of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC (EMC Directive).
- Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).
- EUROCAE ED-14G (2011) and Change 1 (2015): "Environmental Conditions and Test Procedures for Airborne Equipment" (Equivalent to RTCA DO-160G).

Annex E (informative): Change History

Version	Information about changes
1.1.1	First published version.
1.2.0	Revised to include changes required by EC to enable citation in the OJEU.

History

Document history			
V1.1.1	October 2017	Publication	
V1.2.0	November 2017	EN Approval Procedure	AP 20180208: 2017-11-10 to 2018-02-08