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Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference document (SRdoc); Broadband Direct-Air-to-Ground Communications System operating in the 5,855 GHz to 5,875 GHz band using 3G technology

Reference
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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

Executive summary

The ever-increasing take-up of broadband services around the globe has led to an explosion of data carried over mobile networks over the last few years, as users increasingly expect and demand to be able to access high-speed internet services on their own mobile devices wherever they travel.

Airline passengers represent a small but important sector of the overall mobile market, since many high-value business customers are frequent travellers and would like to be able to connect to the internet, send and receive e-mails, etc. when travelling on continental, as well as long-haul flights. The provision of information and entertainment services is also a popular service enjoyed by both business and private users during flights. Last but not least, the availability of broadband connections to aircraft in flight can provide additional airline information data to supplement the information already available via existing communications channels. Such usage would be limited to non-safety applications only. In order to meet these user demands, a communications link should be established between the aircraft and the ground which has sufficient capacity to allow for large numbers of passengers to simultaneously access the various services. Up until now, with the exception of two North American service providers, the only means of providing aircraft backhaul has been through the use of satellite links. This has certain disadvantages, including limited bandwidth, cost of capacity and round-trip delays. A broadband Direct Air-to-Ground Communications (DA2GC)) solution overcomes these drawbacks and is highly suitable for use over, or near, land. This provides coverage for virtually all European flights. Work is on-going within CEPT to identify spectrum for such an application. Three DA2GC system proposals have been presented to CEPT. One of these proposals is the system described herein.

The present document describes a broadband DA2G communications system which makes use of 3G TDD technology to provide a robust link between aircraft and the ground network. The system is designed to be capable of operating in the foreseen 20 MHz block of spectrum (4 × 5 MHz or 2 × 10 MHz) within the band 5,855 GHz to 5,875 GHz (currently used for a number of licence-exempt applications).

From the point of view of enabling a timely and cost-effective deployment of the system across Europe, it would be preferable if a licence-exempt or lightly licensed regime could be applied. However, the appropriate regulatory framework will depend on the outcome of studies being carried out within the CEPT.

For the system described in the present document, the 5,8 GHz band is currently considered as a possible band for an early introduction in CEPT countries, and, more specifically, the portion of the band from 5,855 GHz to 5,875 GHz since this upper part of the 5,8 GHz band is not designated for radar use in Europe. (Radar systems operate in the bands immediately below this range, which would present a much more difficult sharing scenario).

Introduction

The present document has been developed as a contribution to the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Postal and Telecommunications Administrations (CEPT).

It is intended to describe the system requirements based on 3G technology for a European system for broadband Direct Air-to-Ground Communications (DA2GC) between a terrestrial ground network and aircraft operating in the band 5,855 GHz to 5,875 GHz. The requirements provide a basis for industry to quickly implement an innovative and efficient system within Europe while avoiding harmful interference with other services and systems.

Target version	**Pre-approval date version (see note)**				
Vm.a.b	**a**	**s**	**m**	**Date**	**Description**
1.1.1	0	0	1	August 2012	Submitted to ETSI BRAN in August 2012 (for the 72nd BRAN meeting)
	0	0	2	12 September 2012	With initial editorial revisions agreed at the 72nd BRAN meeting
	0	0	3	20 September 2012	With further editorial revisions agreed at the 72nd BRAN meeting
	0	0	4	2 November 2012	Updated with comments submitted by correspondence, and taking account of the ETSI/CEPT discussions on SRDoc TR 101 599 [i.9]
	0	0	5	11 January 2013	Updated with amendments as a consequence of comments submitted during the Remote Consensus stage
	0	0	6	18 January 2013	Tightened the unwanted emission limit (clause 7.2.2.4) as a consequence of discussions in CEPT SE44
	0	0	7	7 March 2013	Added comments to clause 4, which were submitted during the "Approval for Publication" phase.
NOTE: See EG 201 788 (V2.1.1) [i.15], clause A.2.					

1 Scope

The present document describes a system designed to provide non-safety of life broadband DA2G communications, which may require a change of the present frequency designation/utilisation within CEPT or some changes to the present regulatory framework for the proposed band(s) regarding either intended or unwanted emissions.

The preferred regulatory approach would be for this system to operate on a non-interference and unprotected basis within the band 5,855 GHz to 5,875 GHz. However, it is recognised that there are important applications (including ITS and BFWA) that are deployed or planned in, or adjacent to, the 5,8 GHz band.

The document includes, in particular:

- Market information;
- Technical information;
- Regulatory issues.

To avoid any misunderstanding, the system described uses 3G TDD technology in the band 5,855 GHz to 5,875 GHz to establish a direct backhaul link between the aircraft and ground network. Passenger equipment is not able to have direct radio access to the link. Network elements providing coverage on-board aircraft, primarily WLANs, as well as service platforms (e.g. for passengers, airlines and aircraft manufacturers) already exist [i.1] and [i.2]. Passenger connectivity is via a suitable access point that itself can utilise the backhaul link.

However, the document does not cover equipment compliance with relevant civil aviation regulations. In this respect, the on-board unit of the DA2GC system is subject to additional national or international civil aviation airworthiness certification, for example to EUROCAE ED-14E [i.3].

While this requirement addresses the band 5,855 GHz to 5,875 GHz, the 3G technology has been successfully tested in the bands 118 MHz to 137 MHz, 1,9 GHz to 2,1 GHz and 5,090 GHz to 5,150 GHz [i.4].

2 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 reference document (including any amendments) 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.

2.1 Normative references

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

Not applicable.

2.2 Informative references

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] Commission Decision of 7 April 2008 on harmonised conditions of spectrum use for the operation of mobile communication services on aircraft (MCA services) in the Community.

[i.2] ECC Decision (06)07 of 1 December 2006 on the harmonised use of airborne GSM systems in the frequency bands 1710-1785 and 1805-1880 MHz, amended in March 2009.

[i.3] EUROCAE ED-14E (2005) (Equivalent to RTCA DO-160E): "Environmental Conditions and Test Procedures for Airborne Equipment".

[i.4] ECC Document FM48(11)043 Annex 6: "Candidate bands for Broadband DA2GC".

[i.5] ITU Radio Regulations (Edition of 2008).

[i.6] ERC Report 25: "The European table of frequency allocations and utilisations in the frequency range 9 kHz to 3000 GHz".

[i.7] FM48(11)038: "Compatibility Analysis between DA2GC(3G) and Systems in the Band 5850-5870 MHz".

[i.8] ETSI TR 103 054: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Broadband Direct-Air-to-Ground Communications operating in part of the frequency range from 790 MHz to 5150 MHz".

[i.9] ETSI TR 101 599: "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".

[i.10] ECC Report 68: "Compatibility studies in the band 5725 - 5875 MHz between Fixed Wireless Access (FWA) systems and other systems".

[i.11] CEPT/ERC/Recommendation 74-01: "Unwanted Emissions in the Spurious Domain".

[i.12] ETSI EN 301 908-6: "IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 6: CDMA TDD (UTRA TDD) User Equipment (UE)".

[i.13] ETSI EN 301 908-7: "IMT cellular networks; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 7: CDMA TDD (UTRA TDD) Base Stations (BS)".

[i.14] ECC Report 140: "Compatibility between RLAN on board aricraft and radars in the bands 5250-5350 MHz and 5470-5725 MHz".

[i.15] ETSI EG 201 788: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guidance for drafting an ETSI System Reference document (SRdoc)".

3 Definitions and abbreviations

3.1 Definitions

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

Aircraft Station (AS): entity on-board aircraft providing the radio, control and telecommunication functionalities for broadband DA2GC

Direct Air-to-Ground (DA2GC): direct radio link between an Aircraft Station (AS) and a Ground Station (GS)

Forward Link (FL): within the DA2GC system the link from the Ground Station (GS) to the Aircraft Station (AS)

Ground Station (GS): entity on the ground providing the radio, control and telecommunication functionalities for broadband DA2GC

Reverse Link (RL): within the DA2GC system the link from the Aircraft Station (AS) to the Ground Station (GS)

3.2 Abbreviations

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

3G	Third Generation (mobile)
AAC	Airline Administrative Communications
APC	Air Passenger Communications
AS	Aircraft Station
ATM	Air Traffic Management
BFWA	Broadband Fixed Wireless Access
BW	BandWidth
CEPT	Conference Européenne des Administrations des Postes et des Télécommunications
DA2GC	Direct Air-to-Ground Communications
DFS	Dynamic Frequency Selection
EC	European Community
ECC	Electronic Communications Committee
EIRP	Equivalent Isotropically Radiated Power
ERC	European Radiocommunication Committee
ERM	Electromagnetic compatibility and Radio spectrum Matters
FL	Forward Link
FSS	Fixed Satellite Service
GNSS	Global Navigation Satellite System(s)
GPS	Global Positioning System
GS	Ground Station
GSM	Global System for Mobile communications
ICT	Information and Communication Technology
IMS	Internet Protocol Multimedia Subsystem
IP	Internet Protocol
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
LTE	Long Term Evolution
NATO	North Atlantic Treaty Organisation
O&M	Operation and Maintenance
RL	Reverse Link
RLS	Radio Location Service
RTTT	Road Transport and Traffic Telematics
SRD	Short Range Devices
TDD	Time Division Duplex
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
WLAN	Wireless Local Area Network

4 Comments on the System Reference Document

4.1 Statements by Netherlands Ministry of Economic Affairs

The Netherlands operates besides a limited number of other EC countries a critical defence system employing a non standard highly sensitive radar system in the proposed frequency range.

The range of this defence system and the method of deployment dictate such a large exclusion range that it is unlikely that the proposed DA2GC system can ever be made compatible with this defence system. For this reason the Netherlands should be excluded from the list of countries where the DA2GC system may be deployed in the future.

NOTE 1: The defence system is also used by the Netherlands in other NATO countries to fulfil the obligation to NATO. The DA2GC system may therefore also jeopardise the safety in those countries. This should be duly made clear to those countries.

NOTE 2: In addition to excluding the system from Dutch territory a coordination zone should be established in neighbouring countries. Size to be determined by compatibility studies.

NOTE 3: These conclusions are based on scientific research performed by an independent research institute in The Netherlands.

Statement in response from the Work Item Rapporteur: It has subsequently been identified that the compatibility studies referred to above relate to the technology proposed in the ETSI System Reference Document TR 101 599 [i.9], rather than the technology proposed in the present document. Consequently it is acknowledged that further studies will be required to identify the compatibility of the DA2GC technology described in the present document, with respect to the defence system referred to above. As a consequence, it is possible that a different exclusion range will be required for this technology, resulting in a different conclusion with regard to the compatibility of this system.

5 Presentation of the system or technology

The importance of connectivity between aircraft and ground for the airline business is growing fast. Passengers have made clear that they would benefit from on-board broadband internet access and that they are prepared to pay for the service provided that the price is considered reasonable. Apart from passenger related applications, airlines would also benefit from a high capacity communications link for non-safety of life operational data. Many applications to reduce operating costs and increase efficiency are denied airlines because of the present costs of providing an adequate link.

There have been previous attempts to provide satellite based connectivity but these have been frustrated mainly due to the cost of deploying and operating the necessary infrastructure; especially the cost of aircraft installation and operation.

Consumer devices, such as smartphones and tablet computers, are developing rapidly and offer easy WLAN connectivity. More and more passengers are carrying pocket devices that are convenient to use during even the shortest of flights.

6 Market information

The potential market for air passenger communications was examined when developing previous System Reference Documents for Broadband DA2G Communications [i.9] and [i.10].

Connectivity to ICT services while travelling has become an expectation of the flying public, and a competitive advantage among airlines attempting to gain or protect market share. Existing satellite-based connectivity solutions for aircraft in L-Band and Ku-Band suffer from high operational cost and from significant weight and effort to install aircraft equipment (especially satellite antennas). Depending on the degree of usage and growing of the market the L Band solutions may run into capacity limitations in the mid-term, especially for high density air traffic over continental areas such as Europe.

An interesting alternative bringing broadband data to continental aircraft fleets is Direct Air-to-Ground Communications (DA2GC). Modern broadband wireless access technologies could be a sound technological basis for a DA2GC solution due to their inherent high spectral efficiency and distinctly reduced infrastructure cost on-board the aircraft compared to satellite systems.

The introduction of broadband DA2GC is expected to be focused on:

- scheduled aviation;
- business aviation.

The main application field will be Air Passenger Communications (APC), e.g. internet/company intranet access, but in addition the system may also support Airline Administrative Communications (AAC). The envisaged broadband DA2GC system is not intended to be used for safety-relevant communications such as Air Traffic Management (ATM) and related services.

7 Technical information

The described broadband DA2G system is intended to provide broadband connectivity between an aircraft and the ground, to enable provision of services to passengers on board (e.g. e-mail, web browsing, infotainment, social networking, and instant messaging). The overall system connectivity also enables the facility to provide non-safety relevant airline information services whilst maintaining complete isolation between such data and the various internet and infotainment services available to passengers in the aircraft cabin.

The system is designed to enable consideration of the option for licence-exempt or lightly licensed operation in the 5,8 GHz band. To enhance spectrum efficiency through frequency reuse the ground stations are designed to have 6 sectors. When not required to service aircraft, the associated sector transmitter may be inhibited. Among other things this reduces any inter-cell interference. However, where only short range coverage is required, for example at airports, it is possible to use a single omni-directional antenna.

7.1 Detailed technical description

The system is essentially based on 3G UMTS TDD standards that have been adapted for operation in the 5,8 GHz band. It uses multi-sector antennas to optimise the ground infrastructure performance by providing coverage when and where required while reducing interference.

Essentially the signal in space is compliant with 3GPP standards apart from the operating frequency.

The overall end-to-end system architecture of the broadband DA2GC system is illustrated in figure 1.

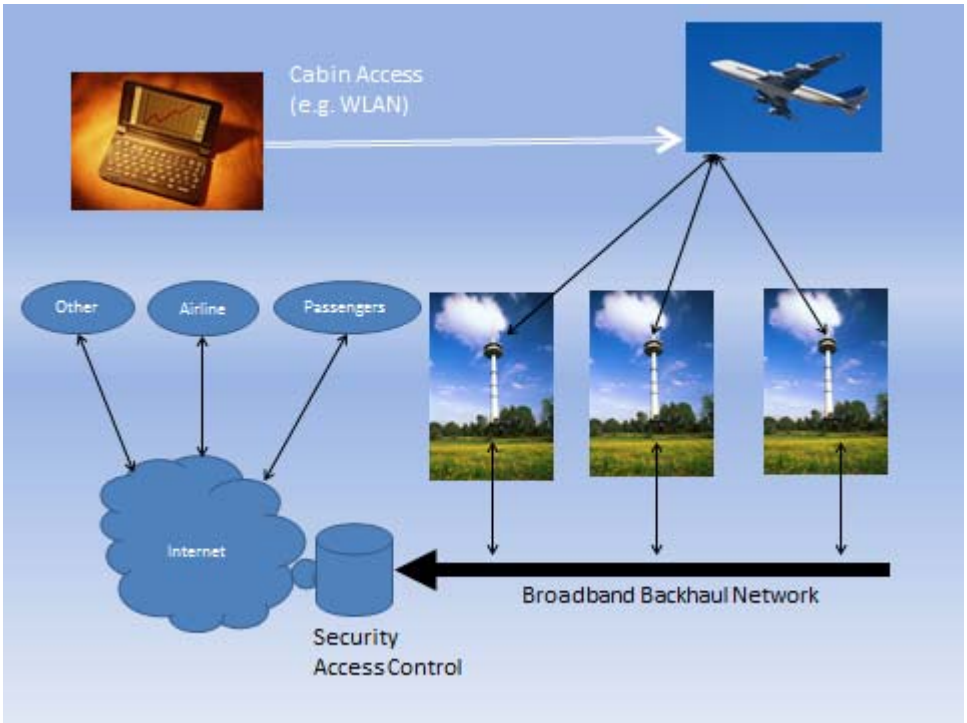


Figure 1: System architecture for broadband DA2GC

The major building blocks of the end-to-end system architecture are:

- service related network infrastructure on-board the aircraft such as WLAN;
- DA2GC infrastructure on-board the aircraft (external antenna, avionics with modem, cabling, interfacing to on-board network);
- terrestrial radio access network for DA2GC with broadband backhaul links, which would preferably be based on existing infrastructure, but with modifications (e.g. with regard to antenna types and ground station implementation) to establish high-performance radio links to aircraft in DA2GC environment;

- mobile core network for session, mobility, subscriber and security management providing IP connectivity to external packet data networks (e.g. intranet, internet, IMS);
- central network components required for O&M, etc. in the DA2GC network;
- various IP-based service delivery platforms e.g. for passenger services or for airline or aircraft repair/manufacturer internal applications.

The system uses standardised equipment (ETSI 3GPP standards) for the DA2GC link. The user equipment (UE) would refer to the DA2GC aircraft station (AS), and the ground station (GS) would refer to the DA2GC ground station (GS).

The airborne equipment is designed to meet the standardisation requirements of EUROCAE ED-14E [i.2].

7.2 Technical parameters and implications on spectrum

7.2.1 Status of technical parameters

7.2.1.1 Current ITU and European Common Allocations

Current ITU and European Common Allocations

As previously indicated, the system has currently been optimized for operation in the frequency band 5,855 GHz to 5,875 GHz. This band is included in the list of candidate bands under consideration in CEPT [i.4].

Current allocation of the candidate bands in the ITU Radio Regulations [i.5] is included in table 1, together with actual usage within the CEPT.

Table 1: ITU Allocations and actual usage within CEPT

Frequency band	ITU allocations in Region 1	Actual usage of the band at national level within CEPT	Actual usage of adjacent bands at national level within CEPT
5,855 GHz to 5,875 GHz	FIXED FIXED-SATELLITE (Earth-to-space) MOBILE	BFWA, ITS, SRDs, FSS (uplink), military systems (on a national level)	RLS, RTTT, BFWA, SRDs, ITS

Current common allocation of the above bands in Europe is given in ERC Report 25 [i.6].

7.2.1.2 Sharing and compatibility studies (if any) already available

At the time of drafting the present document, the sharing and compatibility studies between DA2GC links and other systems are being studied within the CEPT/ECC Spectrum Engineering Working Group.

A compatibility study for a 3G TDD system using similar technical parameters has been undertaken for this system in the band 5,850 GHz to 5,870 GHz [i.7].

7.2.1.3 Sharing and compatibility issues still to be considered

At the time of drafting the present document further compatibility studies are being undertaken within CEPT for the band 5,855 GHz to 5,875 GHz. The present document includes spectrum emission masks to support these studies; one mask (clause 7.2.2.1) gives the emissions in the frequency domain, while emission masks in the elevation domain are also given (clauses 7.2.2.1.2 and 7.2.2.1.3 for the Ground Station and Aircraft Station respectively).

7.2.2 Transmitter parameters

7.2.2.1 Transmitter Output Power / Radiated Power

It is important to note that for any given cell, at any given instant, the system can restrict the total number of active transmitters to one. This can be either the GS or one AS. Hence the actual number of aircraft physically within the cell coverage does not impact the aggregate interference from that cell.

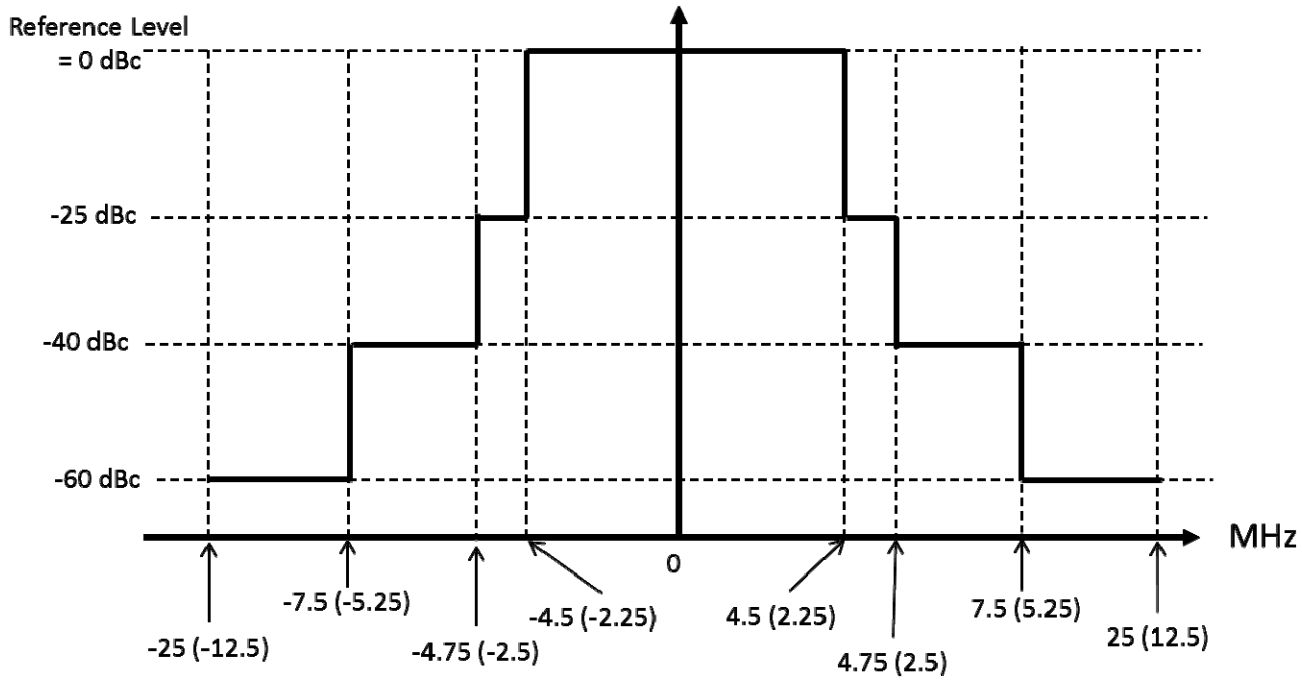
The maximum values of the transmitter parameters are listed in tables 2 and 3.

Table 2:DA2GC Transmitter Characteristics

Parameter	Unit	Value
Bandwidth	MHz	5 or 10
Transmitter Mean Output Power (GS)	dBm	38
Transmitter Mean Output Power (AS)	dBm	36
Transmitter feeder loss (GS)	dB	2
Transmitter feeder loss (AS)	dB	4
Transmitter Mean EIRP (GS)	dBm	60 (for directional antenna) 51 (for sector antenna) 43 (for omnidirectional antenna)
Transmitter Mean EIRP (AS)	dBm	39
Transmitter Duty Cycle Factor	dB	3
Minimum Transmit Power Control (GS) Range	dB	3
Minimum Transmit Power Control (AS) Range	dB	50

The EIRP figures given in table 2 are independent of whether a 5 MHz or 10 MHz bandwidth is used. The system normally uses a 10 MHz bandwidth but 5 MHz may be used for long range coverage (e.g. across a sea).

The spectrum emission mask is given in figure 2.



NOTE 1: 0 dBc Reference Level is the spectral density relative to the maximum spectral power density of the transmitted signal. For example:
i) for a Ground Station with a directional antenna, using a 10 MHz bandwidth, the Reference level (0 dBc) would be 60 dBm/(10 MHz) = 50 dBm/MHz.
ii) for an Aircraft Station using a 5 MHz bandwidth, the Reference level (0 dBc) would be 39dBm/(5 MHz) = 32 dBm/MHz.

NOTE 2: On the Frequency Offset axis, the figures apply to a 10 MHz bandwidth system, whereas the figures in parentheses apply to a 5 MHz bandwidth system.

Figure 2: Spectral Emission Mask for both GS and AS

Figure 2 shows the in-band and out-of-band emissions, and it should be noted that the requirements in clause 7.2.2.4 will also apply.

7.2.2.1.1 Antenna Characteristics

The antenna characteristics are listed in table 3.

Table 3: DA2GC Antenna Characteristics

Parameter	Unit	Value
Max antenna gain (AS)	dBi	7
Max antenna gain (GS Omni)	dBi	7
GS omni antenna up-tilt	degrees	15
Max antenna gain (GS Sector)	dBi	15
GS sector antenna up-tilt	degrees	6
Max antenna gain (GS Directional)	dBi	24
GS directional antenna up-tilt	degrees	3

Different types of antenna may be employed. These include from omni-directional antennas, sector antennas, and directional antennas with amplitude beam forming.

High gain directional antennas are only used when long range coverage is required over water.

7.2.2.1.1.1 Typical Ground Station Antenna Patterns

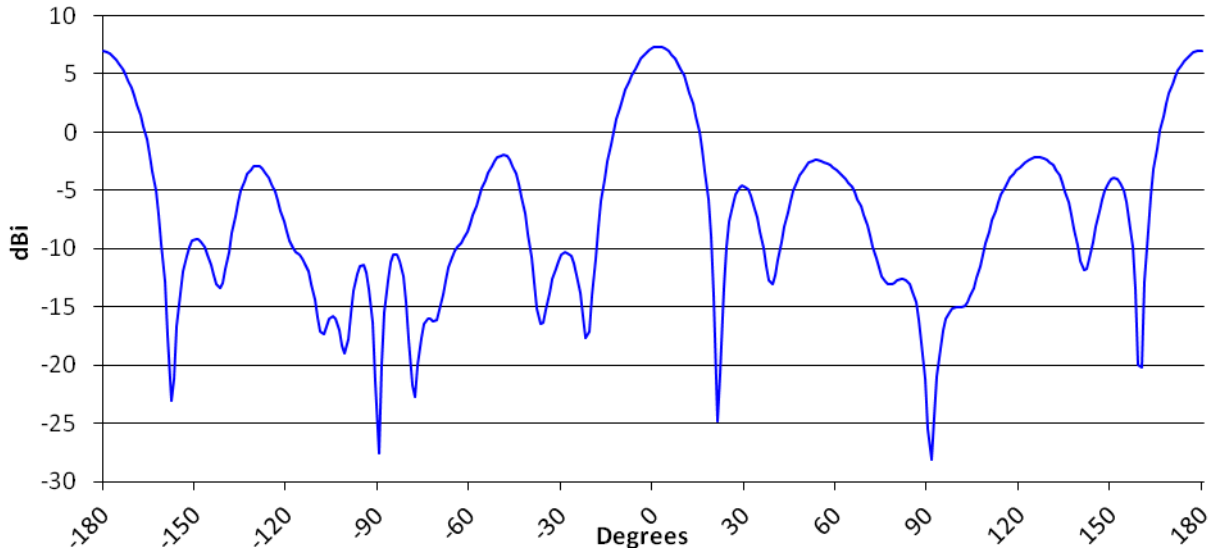


Figure 3: GS Omni Antenna Elevation Pattern

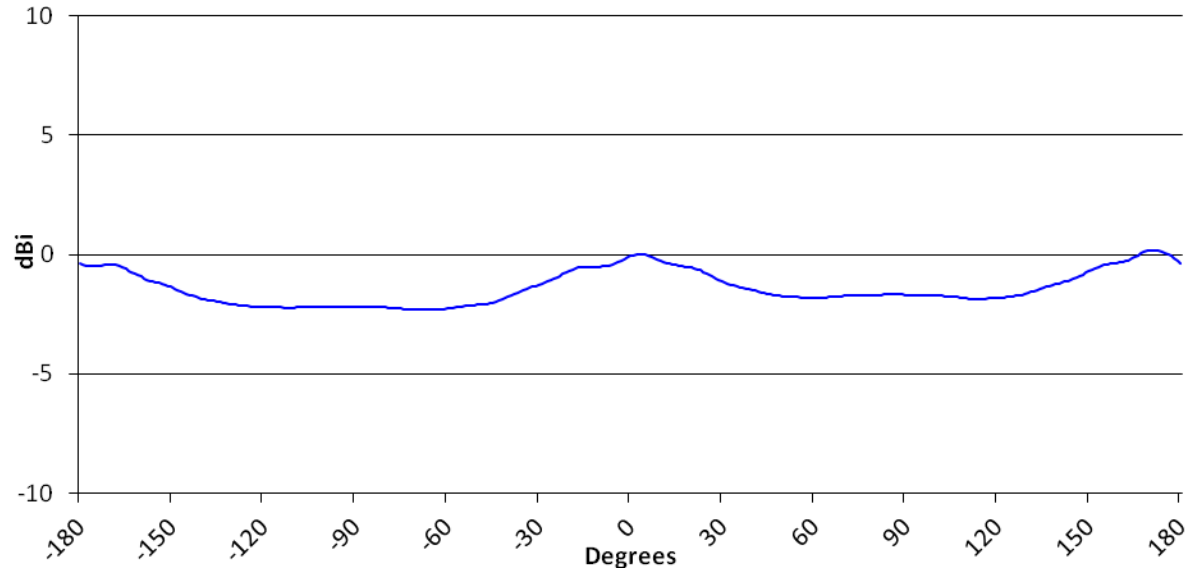


Figure 4: GS Omni Antenna Azimuth Pattern

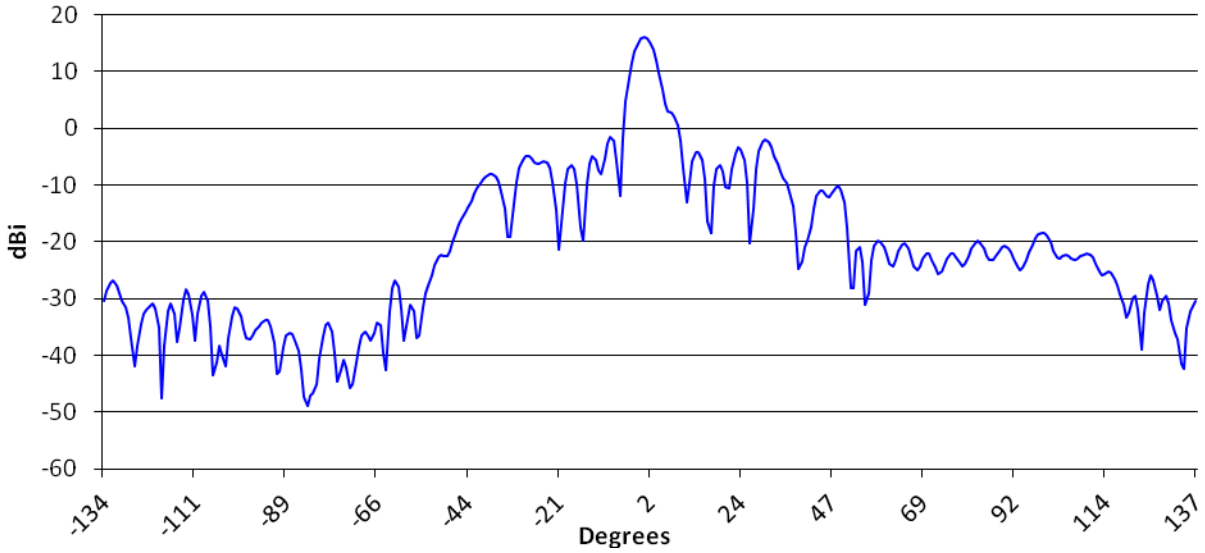


Figure 5: GS Sector Antenna Elevation Pattern

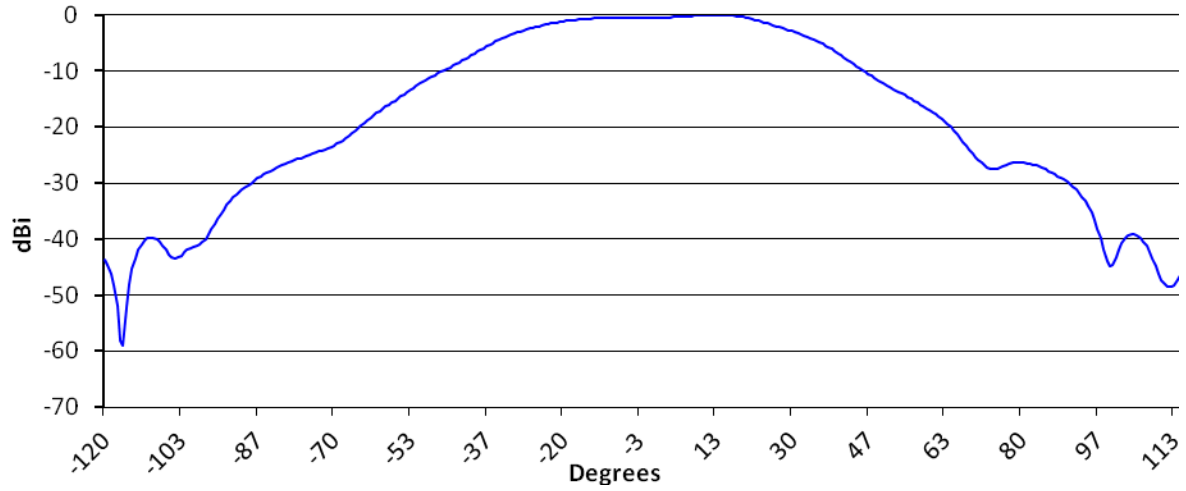


Figure 6: GS Sector Antenna Azimuth Pattern

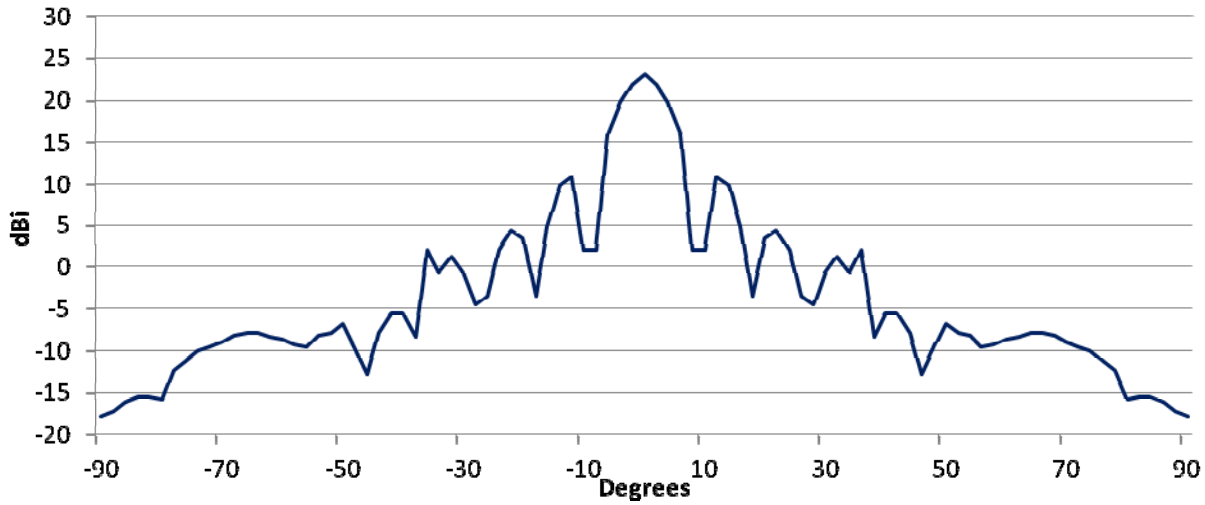


Figure 7: GS Directional Antenna Elevation and Azimuth Pattern

7.2.2.1.1.2 Typical Aircraft Antenna Patterns

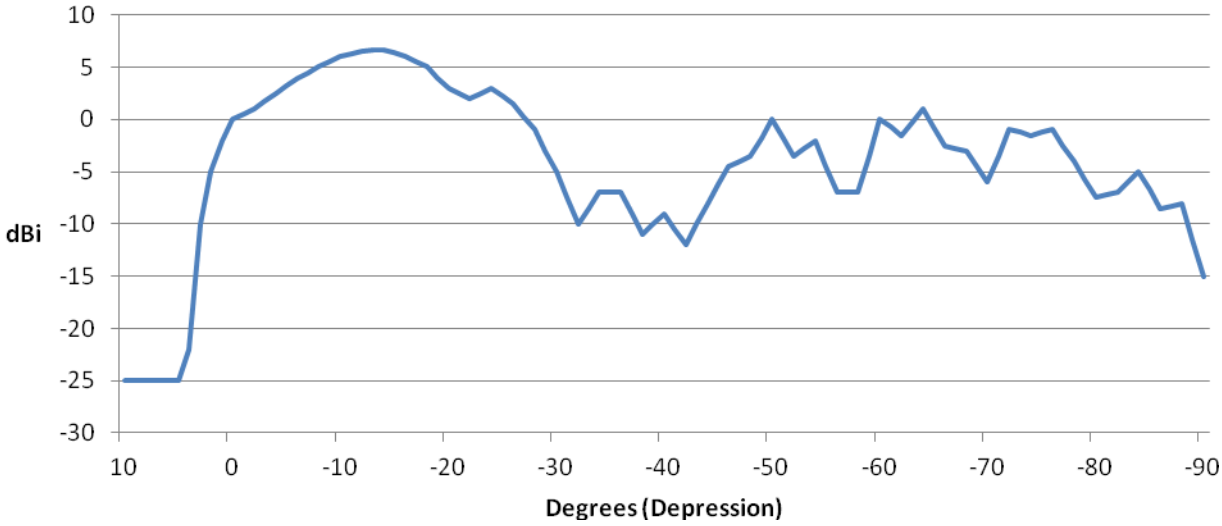


Figure 8: Aircraft Antenna Elevation Pattern

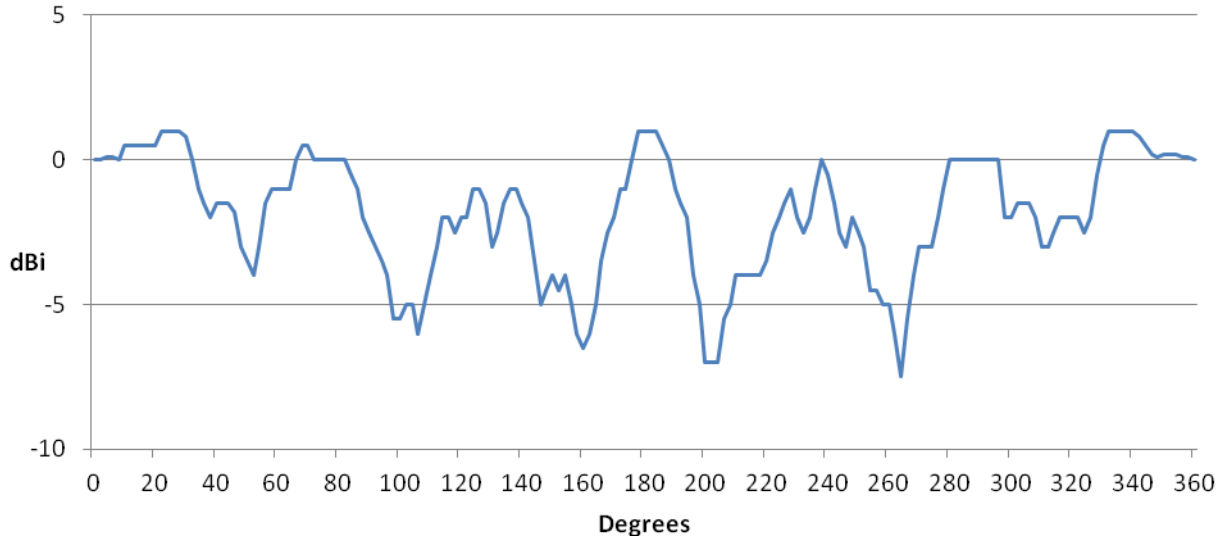


Figure 9: Aircraft Antenna Azimuth Pattern

7.2.2.1.2 Ground Station Elevation EIRP Mask

In order to facilitate sharing studies, figures 10 and 11 are given for the maximum antenna gain and EIRP respectively for the GS, as a function of elevation angle. In those cases where there are no ground based victim systems (e.g. over sea) the maximum EIRP is -1 dBW/(4 kHz).

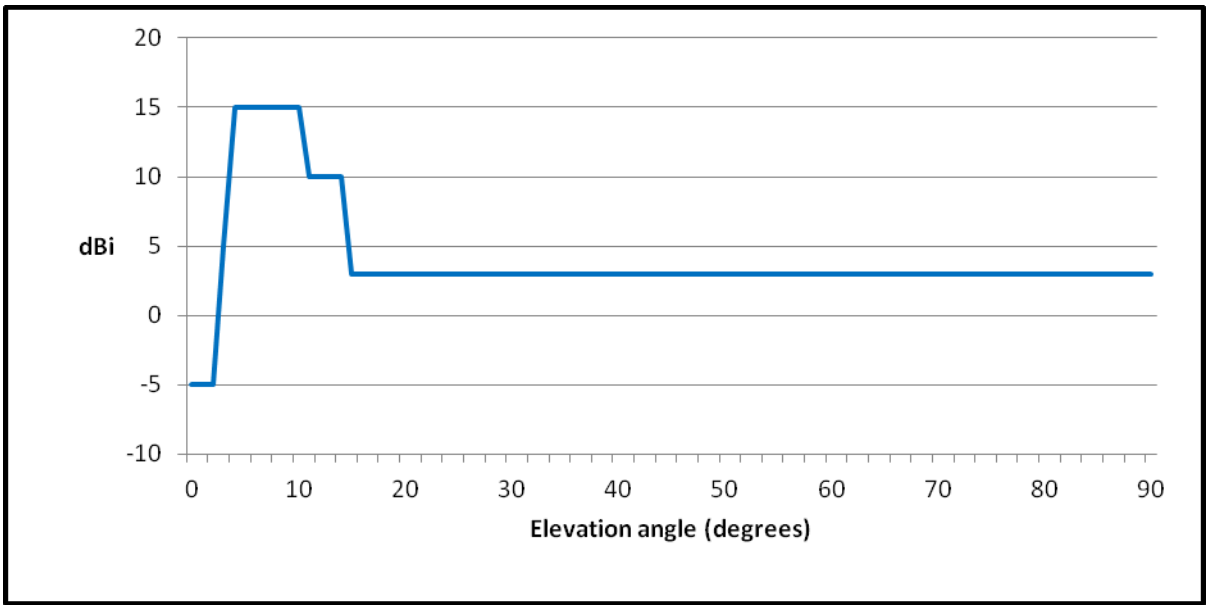


Figure 10: GS Antenna Elevation Mask

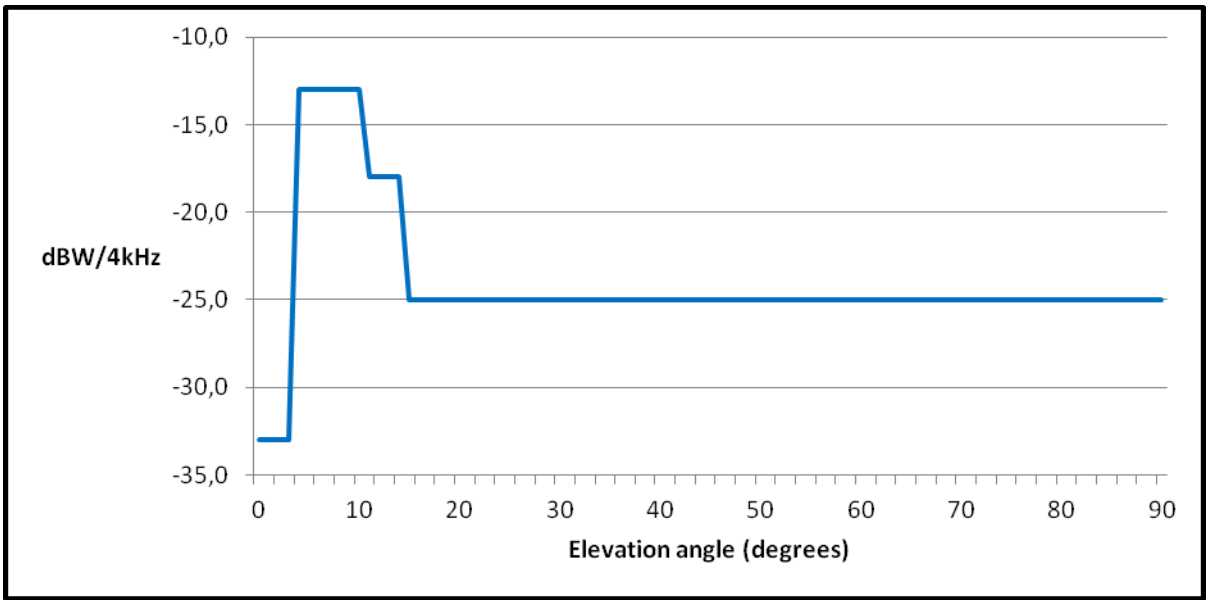


Figure 11: GS Elevation EIRP Mask

7.2.2.1.3 Aircraft Station Elevation Antenna and EIRP Masks

In order to facilitate sharing studies, the following masks are given for the maximum EIRP from the AS, as a function of angle. For angles above the horizontal ("elevation" angles), these include the effect of the shielding due to the fuselage of the aircraft. Angles below the horizontal, are referred to as angles of depression (i.e. 90 degrees is vertically downwards).

ECC Report 140 [i.14] suggests that the attenuation through the skin of the fuselage may be taken as 17 dB. The DA2GC AS antenna is located under the fuselage on the aircraft's centreline under the cargo compartment. Therefore for significant angles of elevation, the radio signals would be pointing through three walls of the fuselage (i.e. the outer skin of the aircraft into the cargo bay, through the floor of the aircraft between the cargo bay and the cabin, and then through the upper roof of the fuselage). Taking these three walls together would give rise to an attenuation in excess of 40 dB. Furthermore, the antenna pattern itself would introduce an attenuation of about 20 dB. Any external coupling around the fuselage would also introduce further attenuation.

Hence the mask may be considered to be conservative.

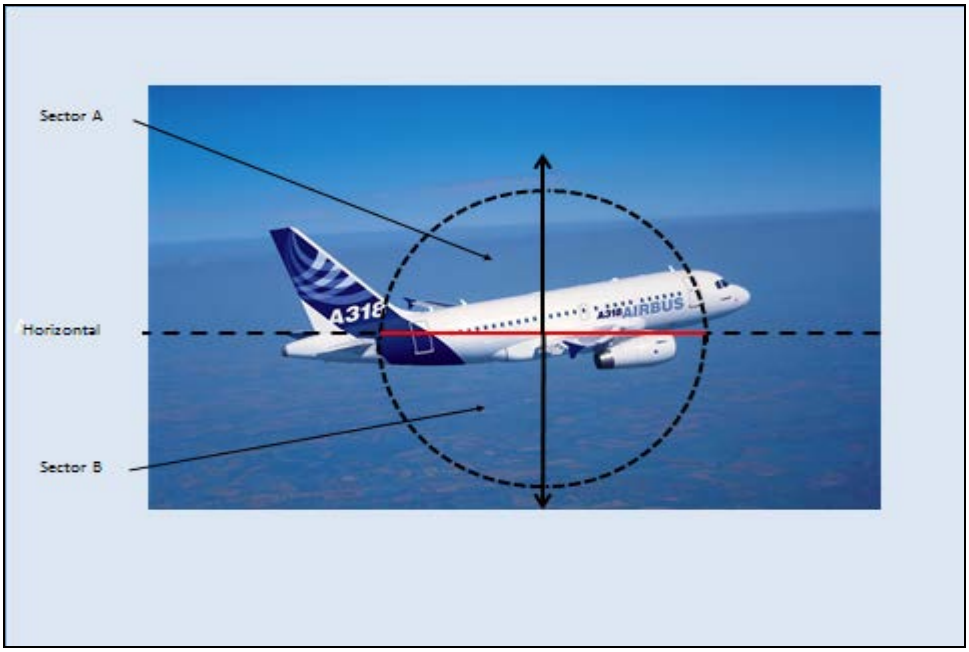


Figure 12: Aircraft EIRP Sectors

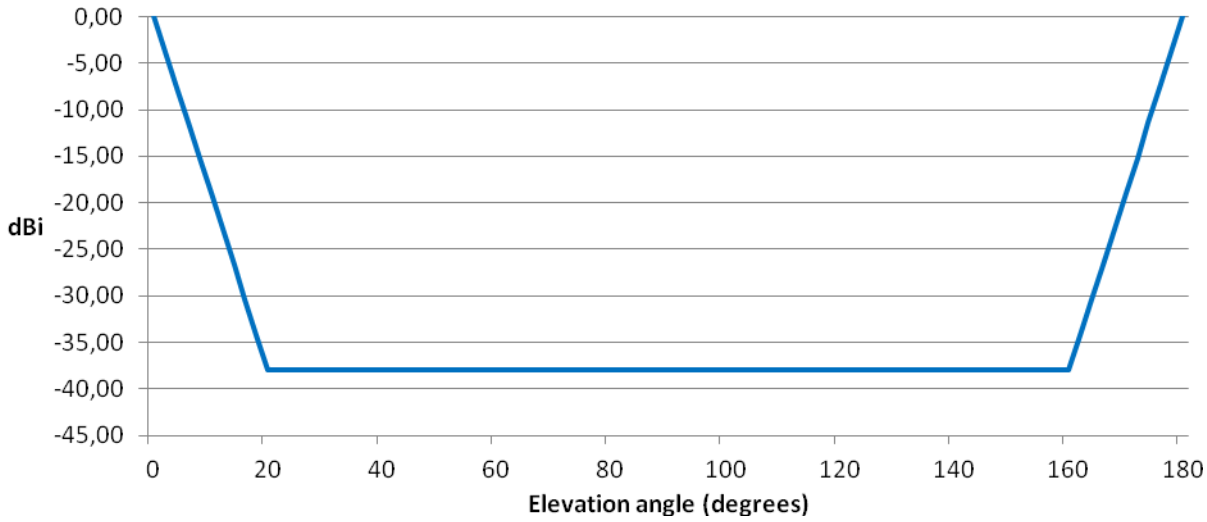


Figure 13: AS Antenna Elevation Mask - Sector A

Table 4: AS Antenna Elevation Mask - Sector A

Angle (degrees)	Gain (dBi)
0	0
20	-38
160	-38
180	0

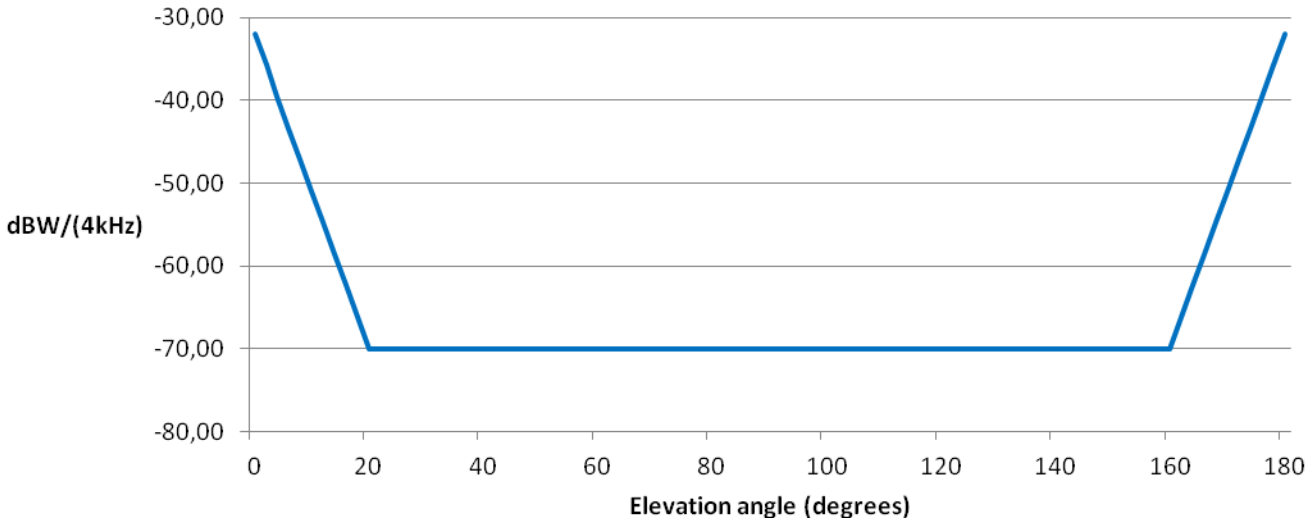


Figure 14: AS Elevation EIRP Mask - Sector A (including aircraft fuselage shadowing)

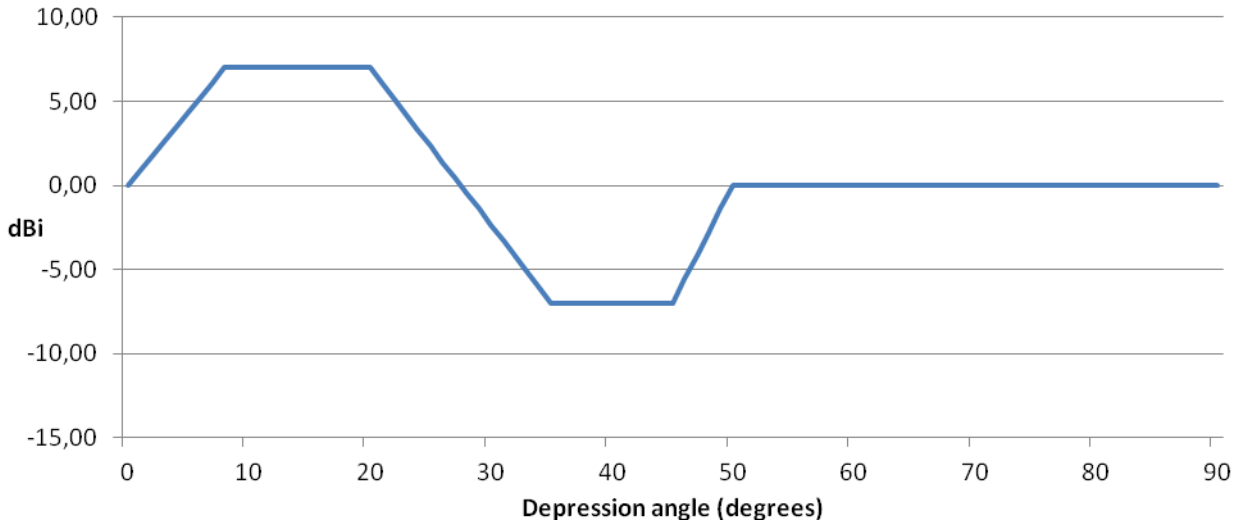


Figure 15: AS Antenna Depression Mask - Sector B

Table 5: AS Antenna Depression Mask - Sector B

Angle (degrees)	Gain (dBi)
0	0
8	7
20	7
35	-7
45	-7
50	0
90	0

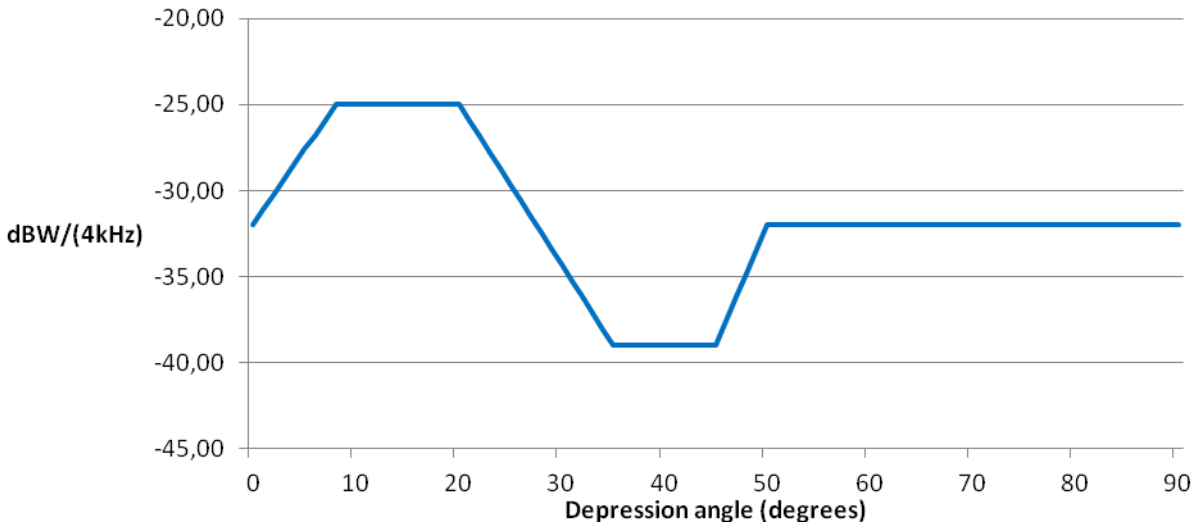


Figure 16: AS Depression EIRP Mask - Sector B

7.2.2.2 Operating Frequency

The system is optimised to operate within the 5,855 GHz to 5,875 GHz band. However, the technology can be adjusted to operate within extended band of 790 MHz to 6 GHz.

7.2.2.3 Bandwidth

The system is designed to operate using a 5 MHz or 10 MHz bandwidth.

The 3G TDD technology used supports a frequency reuse factor of 1. However, factors of 2 or 3 would reduce inter-cell interference and this would be possible using the 5 MHz option.

7.2.2.4 Unwanted emissions

The out-of-band emissions are addressed in clause 7.2.2.1, and the spurious emissions are as defined in CEPT/ERC/Recommendation 74-01 [i.11] Annex 2 ("Reference Number 2.1.1") for Land Mobile Service Terminals and Base Stations.

The spurious emissions from the antenna connector during transmit mode are defined as unwanted power in the bands from 30 MHz up to F_c -2,5*BW and from F_c +2,5*BW up to 5*F_c, where F_c is the carrier frequency and BW is the signal bandwidth (5 MHz or 10 MHz). This frequency band covers both in-band and out-of-band emissions.

The maximum level of spurious emission is:

- -36 dBm/(100 kHz), for 9 kHz $\leq f \leq$ 1 GHz
- -30 dBm/MHz , for 1 GHz < $f \leq$ 26 GHz

The maximum level of unwanted emissions is:

- -50 dBm/MHz, for 5,250 GHz < $f \leq$ 5,850 GHz

7.2.2.5 Synchronisation

The network is synchronised and achieves the necessary timing accuracy using GNSS. In the unlikely event of a temporary loss of the GNSS timing signal, an internal oscillator can maintain synchronisation.

7.2.2.6 Mitigation Characteristics

7.2.2.6.1 Aircraft Station

The in-flight aircraft transmitter output power may be attenuated according to altitude. This significantly increases protection for ground based applications using the same band (for example automated payment systems).

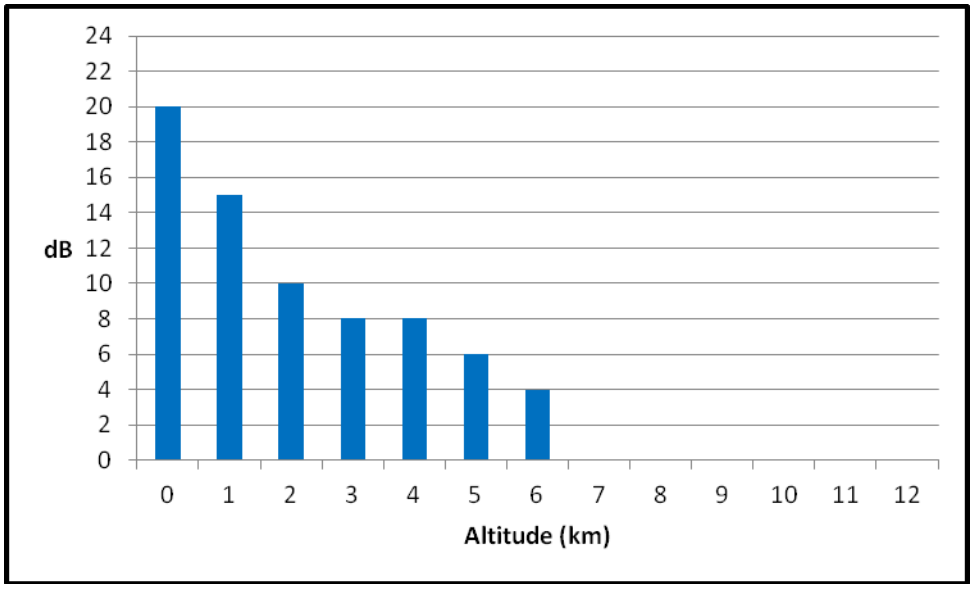


Figure 17: Aircraft Mitigation Attenuation

7.2.2.6.2 Ground Station

Mitigation may be achieved through appropriate sitting of the ground station, antenna up-tilt or by the use of a mechanism that is based upon DFS employed by BFWA systems as described in ECC Report 68 [i.10].

The 3G TDD format uses synchronised 10 ms frames divided into 15 Tx/Rx slots. To achieve the maximum range requires that 2 slots are unused. Slots are dropped from the reverse link thereby maintaining forward link throughput. A consequence of dropping slots is that the entire network (ground and air) is silent for a period every 10 ms. During this period it is possible for the ground station to measure the aggregate level of signals received from other applications such as BFWA.

If this measured signal level exceeds the threshold then the transmitter for that particular sector is inhibited.

7.2.2.6.3 Flight Profile

The different phases of a typical flight profile are shown in figure 18. Transmitter power reduction is applied during take-off, climb, descent and landing as previously described.

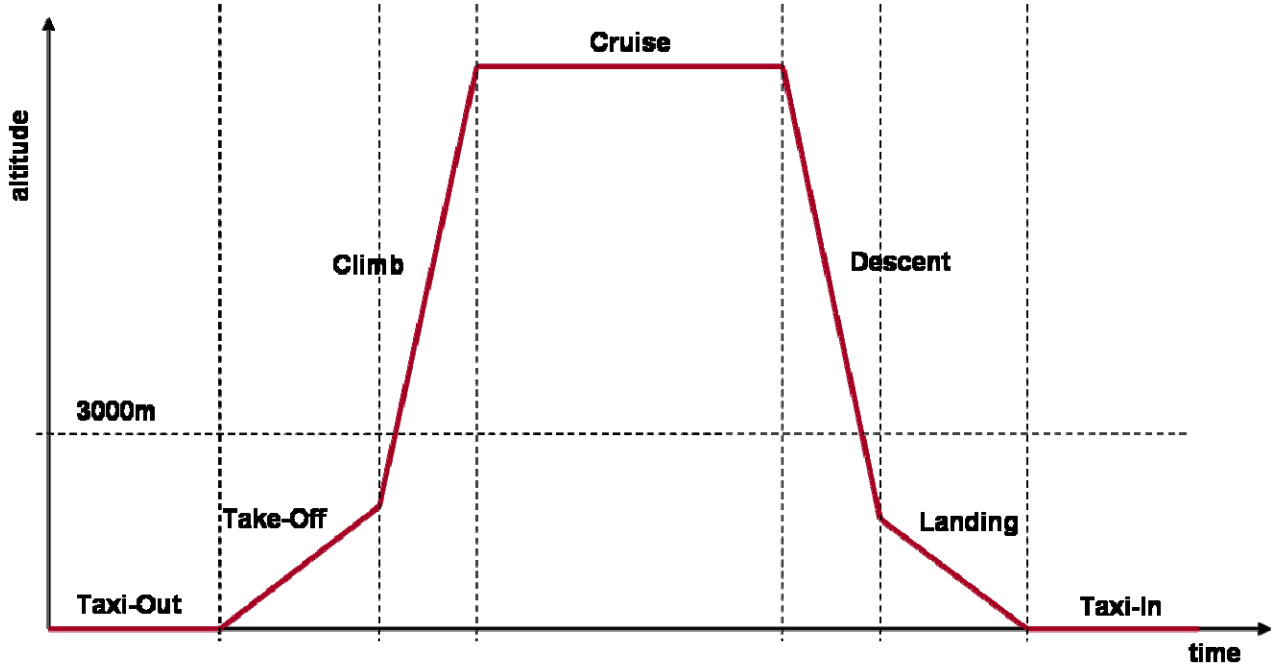


Figure 18: Phases of a typical flight profile

7.2.3 Receiver parameters

The receiver characteristics are listed in table 6.

Table 6: DA2GC Receiver Characteristics

Parameter	Unit	Value
Bandwidth	MHz	5 or 10
Receiver sensitivity	dBm	-106 (5 MHz Bandwidth) -103 (10 MHz Bandwidth)
Receiver feeder loss	dB	1
Receiver interference threshold	dBm/MHz	-113,9

7.3 Information on relevant standard(s)

The system is based on UMTS TDD as specified in EN 301 908-6 [i.12] and EN 301 908-7 [i.13]. However it is recognised that ETSI will need to develop a Harmonized Standard for DA2GC to operate in the 5,8 GHz band.

8 Radio spectrum request and justification

The described broadband DA2G communications system is unlikely to require any dedicated spectrum to be made available, since the features of the technology permit co-frequency sharing with other radio applications with the minimum of constraints (e.g. careful siting of ground stations with workable exclusion zones around each site). This is particularly the case when considering the potential for operation in the spectrum band from 5,855 GHz to 5,875 GHz, which is used for various licence-exempt radio applications.

The system can operate with variable bandwidths in any sub-band within the relevant frequency range. For optimum performance, in TDD mode, the system would require up to 20 MHz of spectrum. This spectrum requirement is driven by the need to supply sufficient capacity to serve passengers and crew on-board the aircraft with the desired range of broadband services and has been noted by the ECC at its 30th meeting in December 2011, based on the information given in [i.8].

9 Regulations

9.1 Current regulations

In Europe, there are currently no frequency bands which are designated for DA2GC use and no specific regulations to facilitate introduction of such services.

9.2 Proposed regulation and justification

It is proposed, after the finalisation of the required sharing and compatibility studies, that an ECC Decision is developed for the designation of spectrum within the frequency band 5,855 GHz to 5,875 GHz for the Broadband DA2GC. Access to the spectrum should be as easy as possible, e.g. based on a light licensing procedure. An ECC Decision would appear to be the most appropriate regulatory instrument, since this would give the highest degree of harmonisation across the CEPT region.

Annex A: Bibliography

- ECC Document FM48(11)024 and its Annex: "Spectrum demand for Broadband Direct Air-to-Ground Communications (DA2GC)".

History

Document history		
V1.1.1	July 2013	Publication