



Electronic Communications Committee (ECC)  
within the European Conference of Postal and Telecommunications Administrations (CEPT)

**PROTECTION OF THE SERVICES ANCILLARY TO PROGRAMME MAKING/SERVICES  
ANCILLARY TO BROADCASTING (SAP/SAB) FROM THE BROADCASTING  
SATELLITE SERVICE TRANSMISSIONS IN THE BAND 620-790 MHz**

**Amstelveen, June 2007**

## EXECUTIVE SUMMARY

This report derives the protection levels required by Services Ancillary to Programme making/Services Ancillary to Broadcasting (SAP/SAB) from co-frequency operated Broadcasting Satellite Service (BSS) systems in the 620-790 MHz band. This report focuses on HEO and GSO BSS systems, which are assumed to use digital transmissions and circular polarisation and to operate with elevation angles (in the BSS coverage areas) above 60° only.

Table 1 below summarises the derived total power flux density (pfd) levels which should not be exceeded by the aggregation of all interfering BSS space stations transmitting in the same band.

It should be noted that the values for minimum field strength and the derived pfd for SAP/SAB have been calculated for their nominal bandwidth. However, the maximum interfering pfd is provided for 8 MHz bandwidth.

**Table 1**  
**Protection requirements of SAP/SAB**

	<b>Radio Microphones</b>	<b>OB Links</b>	<b>Talkback Links</b>
Nominal Bandwidth (kHz)	200	200	25
Minimum field strength (dB $\mu$ V/m)	68	86	31
Derived power flux density (dBW/m <sup>2</sup> )	-77.8	-59.8	-114.8
Receiving antenna polarisation discrimination $D_{pol}$ (dB)	1.25	1.25	1.25
Required protection ratio (dB)	12	43	-14
Maximum interfering power flux density $\Phi_{max\ int}$ (dBW/m <sup>2</sup> ) per 8 MHz	- 88.55	-101.55 (Note 1)	- 99.55

Note 1: The receiving antenna directivity discrimination has not been taken into account.

From this report it can be seen that the protection requirements for SAP/SAB interfered with by BSS in the 620 - 790 MHz are less constraining than those for the protection of the terrestrial Broadcasting interfered with by BSS in the same band, as contained in the ITU-R Report BT.2075.

Consequently, the maximum pfd levels at the surface of the Earth that the BSS satellite transmissions will have to comply with to protect terrestrial broadcasting are sufficient to protect SAP/SAB at the same time.

It should be noted that the report has not addressed the impact on BSS systems in the band 620 - 790 MHz in meeting these required pfd levels.

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**Protection of the Services Ancillary to Programme Making/Services Ancillary to Broadcasting (SAP/SAB) from the  
Broadcasting Satellite Service (BSS) transmissions in the band  
620 – 790 MHz**

## 1 OVERVIEW OF THE CONTEXT

The frequency band 620-790 MHz is allocated to the Broadcasting Satellite Service (BSS) with the provisions of the footnote RR 5.311. Since Resolution 545 (WRC-03) is calling for studies for the protection of terrestrial services in the 620 - 790 MHz band from GSO BSS networks and non-GSO BSS satellite networks or systems planned to operate in this band, it was felt useful to assess the impact from BSS transmissions to the Services Auxiliary to Programming/Services Auxiliary to Broadcasting (SAP/SAB) reception in this band.

SAP/SAB provides services to both broadcasters and programme makers, utilising the spectrum allocated to broadcasting, and as the original provisions were established several years ago, consequently the sharing studies supporting them did not specifically take into account the protection requirements of the SAP/SAB using digital equipment, or the emergence of BSS systems using digital transmissions.

The broadcasting bands IV&V (470 - 862 MHz) provide a vital tuning range for audio SAP/SAB applications, where most of the existing and future SAP/SAB use is concentrated. Currently the bands are identified as a tuning range for professional radio microphones in ERC Recommendation 70-03 and accommodate the majority of national requirements for professional radio microphones. Only some 5 CEPT countries indicated that they do not allow radio microphones in this band. Even with future use of other bands for radio microphones, the pressure on the use of band 470 - 862 MHz is unlikely to decrease significantly, and other categories of audio SAP/SAB links are envisaged in this band, including in-ear monitors and portable audio links. SAP/SAB will continue to be used to support digital television services that will be deployed over a period of many years. It is therefore important to address the impact from BSS into SAP/SAB in this band.

The BSS systems can use both geostationary and non-geostationary orbits, and transmit signals with uniform spectral distribution, that are significantly differing from typical analogue modulations. Annex 1 presents information on these BSS systems.

This report proposes a methodology to study the protection requirements for SAP/SAB, this methodology is presented in Section 2, with Section 4 providing numerical application results of this methodology.

## 2 METHODOLOGY TO DERIVE THE PROTECTION CRITERIA FOR SAP/SAB

The methodology used in this report for assessing the protection criteria of the SAP/SAB from BSS is derived from the general method described in the Geneva 06 Agreement. [Chester Agreement will be soon withdrawn, replaced by the Geneva Agreement that contains the same criteria.]

With Free Space propagation conditions for BSS signals, the assumed protection criteria required for SAP/SAB receivers can be derived by the following formula:

$$E_{\max \text{ int}} = E_{\min} - PR + D_{\text{dir}} + D_{\text{pol}} \quad (1)$$

where:

- $E_{\max \text{ int}}$  is the maximum permissible interfering BSS field strength at the wanted SAP/SAB receiving antenna [dB $\mu$ V/m]
- $E_{\min}$  is the minimum SAP/SAB field strength at the wanted SAP/SAB receiving antenna [dB $\mu$ V/m]
- PR is the appropriate protection ratio [dB]
- $D_{\text{dir}}$  is the SAP/SAB receiving antenna directivity discrimination with respect to the BSS signal [dB]
- $D_{\text{pol}}$  is the SAP/SAB receiving antenna polarisation discrimination with respect to the BSS signal [dB]

With the conversion from field strength  $E$  in  $\text{dB}\mu\text{V}/\text{m}$  to power flux density  $\Phi$  in  $\text{dBW}/\text{m}^2$  expressed as:

$$E = \Phi + 120 + 10 \log_{10}(120\pi) = \Phi + 145.8$$

then the equation (1) becomes:

$$\Phi_{\max \text{ int}} = E_{\min} - 145.8 - PR + D_{\text{dir}} + D_{\text{pol}} \quad (2)$$

where:

$\Phi_{\max \text{ int}}$  is the maximum permissible interfering BSS power flux density at the SAP/SAB receiving antenna in  $\text{dBW}/\text{m}^2$  in the SAP/SAB receiving bandwidth.

### 3 PROTECTION CRITERIA FOR SAP/SAB

Protection criteria for SAP/SAB are provided in the Tables 2 - 4 below, all these tables have been extracted from the Geneva 06 Agreement. All the values for protection ratios and field strength to be protected are derived from measurements that evaluated a number of equipment types. The parameters may be different for future SAP/SAB systems.

For the OB links which have directional antennas a typical antenna gain of 0 dBd had been assumed to derive the field strength value. This means that neither the worst case of interference (into the main beam) nor the best case (far outside the main beam) has been considered, but something in between.

As the protection ratios were derived from the tables for a DVB-T interferer operating in band V, the 8 MHz reference bandwidth applies for the resulting values for maximum interfering field strength and power flux density. It is assumed here that the same protection ratios are valid when BSS is the interferer, as both DVB-T and the BSS system have similar wideband, noise-like signals. However, the signals are not identical. In addition, the time percentages of both signals may be different. So it is not clear whether this assumption is completely correct.

#### 3.1 PROTECTION CRITERIA FOR RADIO MICROPHONES

The field strength to be protected is  $68 \text{ dB}\mu\text{V}/\text{m}$  and the co-channel interference protection ratio is 12 dB. The considered bandwidth for radio microphones is 200 kHz. This gives a maximum interfering field strength of the BSS signal of  $56 \text{ dB}\mu\text{V}/\text{m}$ , this value is related to 8 MHz bandwidth as the difference between the bandwidth of the victim receiver and the interfering DVB-T signal was included in the protection ratio. This corresponds to a maximum interfering pfd of  $-89.8 \text{ dBW}/\text{m}^2$  (in 8 MHz) for the aggregation of all interfering BSS space stations operating in the same band. For indoor operation of radio microphones an even larger pfd value of the BSS signal would be permissible due to additional building loss.

**Table 2**  
**Protection Ratio for Radio microphones from BSS**

<b>Wanted:</b>	Radio microphone (Companded)	Default field strength to be protected ( $\text{dB}\mu\text{V}/\text{m}$ )	68	Default Receiving antenna height (m)	1.5				
Service Identifier	NR8	at Frequency (MHz)	650						
Unwanted	DVB-T/8 MHz								
$\Delta f$ (MHz)		$\pm 12.0$	$\pm 10.0$	$\pm 8.0$	$\pm 6.0$	$\pm 4.2$	$\pm 3.8$	$\pm 3.6$	0.0
PR (dB)		-50.0	-50.0	-45.0	-40.0	-35.0	7.0	12.0	12.0

#### 3.2 PROTECTION CRITERIA FOR OB LINKS

The field strength to be protected is  $86 \text{ dB}\mu\text{V}/\text{m}$  and the co-channel interference protection ratio is 43 dB. The considered bandwidth for OB links is 200 kHz. This gives a maximum interfering field strength of the BSS signal of  $43 \text{ dB}\mu\text{V}/\text{m}$ , this value is related to 8 MHz bandwidth as the difference between the bandwidth of the victim receiver and the interfering DVB-T signal was included in the protection ratio. This corresponds to a maximum interfering pfd of  $-102.8 \text{ dBW}/\text{m}^2$  (in 8 MHz) for the aggregation of all interfering BSS space stations operating in the same band.

**Table 3**  
**Protection Ratio for OB Links from BSS**

<b>Wanted:</b>	OB link (stereo, non-companded)	Default field strength to be protected (dB $\mu$ V/m)			86	Default Receiving antenna height (m)			10
Service Identifier	NS8	at Frequency (MHz)			650				
Unwanted	DVB-T/8 MHz								
$\Delta f$ (MHz)		$\pm 12.0$	$\pm 10.0$	$\pm 8.0$	$\pm 6.0$	$\pm 4.2$	$\pm 3.8$	$\pm 3.6$	0.0
PR (dB)		-18.0	-17.0	-12.0	-9.0	-5.0	36.0	43.0	43.0

### 3.3 PROTECTION CRITERIA FOR TALKBACK LINKS

The field strength to be protected is 31 dB $\mu$ V/m and the co-channel interference protection ratio is -14 dB. The considered bandwidth for talkbacks is 25 kHz. This gives a maximum interfering field strength of the BSS signal of 45 dB $\mu$ V/m, this value is related to 8 MHz bandwidth as the difference between the bandwidth of the victim receiver and the interfering DVB-T signal was included in the protection ratio. This corresponds to a maximum interfering pfd of -100.8 dBW/m<sup>2</sup> in 8 MHz for the aggregation of all interfering BSS space stations operating in the same band.

**Table 4**  
**Protection Ratio for Talkback Links from BSS**

<b>Wanted:</b>	Talkback Links (Non-companded)	Default field strength to be protected (dB $\mu$ V/m)			31	Default Receiving antenna height (m)			1.5
Service Identifier	NT8	at Frequency (MHz)			650				
Unwanted	DVB-T/8 MHz								
$\Delta f$ (MHz)		$\pm 12.0$	$\pm 10.0$	$\pm 8.0$	$\pm 6.0$	$\pm 4.2$	$\pm 3.8$	$\pm 3.6$	0.0
PR (dB)		-97.0	-92.0	-85.0	-80.0	-70.0	-20.0	-14.0	-14.0

## 4 RESULTS FOR THE SAP/SAB REQUIREMENTS

It should be noted that the values for minimum field strength and the derived power flux density for SAP/SAB have been calculated for their nominal bandwidth. However, the maximum interfering power flux density is provided for 8 MHz bandwidth.

**Table 5**  
**Protection Requirements of SAP/SAB**

	<b>Radio Microphones</b>	<b>OB Links</b>	<b>Talkback Links</b>
Nominal Bandwidth (kHz)	200	200	25
Minimum field strength (dB $\mu$ V/m)	68	86	31
Derived power flux density (dBW/m <sup>2</sup> )	-77.8	-59.8	-114.8
Receiving antenna polarisation discrimination $D_{pol}$ (dB)	1.25	1.25	1.25
Required protection ratio (dB)	12	43	-14
Maximum interfering power flux density $\Phi_{max int}$ (dBW/m <sup>2</sup> ) per 8 MHz	-88.55	- 101.55 (see Note 1)	-99.55

Note 1: The receiving antenna directivity discrimination has not been taken into account.

For interactions between the Circular Polarized satellite signal (CP) and the Linear Polarized (LP) SAP/SAB signal in the case of a typical value of axial ratio of 1.5 dB for the CP satellite antenna and a terrestrial LP antenna having a nominal isolation of 15 dB, a polarization loss of 1.25 dB has been assumed.

## 5 MAXIMUM POWER FLUX-DENSITY PRODUCED BY BSS AT THE SURFACE OF THE EARTH

Maximum pfd levels at the surface of the Earth that should not be exceeded by a BSS space station in the band 620 - 790 MHz are provided in Recommendation 705 (WARC 79):

- 129 dB(W/m<sup>2</sup>) for  $\delta \leq 20^\circ$
- 129 + 0.4 ( $\delta - 20$ ) dB(W/m<sup>2</sup>) for  $20^\circ < \delta \leq 60^\circ$
- 113 dB(W/m<sup>2</sup>) for  $60^\circ < \delta \leq 90^\circ$

where  $\delta$  is the angle of arrival above the horizontal plane (degrees);

These were calculated for GSO BSS systems.

In addition, studies were performed to assess pfd levels that would protect broadcasting reception (both analogue and digital) from BSS transmissions in the 620 - 790 MHz that would apply also for non-GSO BSS systems. The results are contained in the ITU-R Report BT.2075 and are summarised below:

**Table 6**  
**Maximum interfering pfd levels at BS receivers**

<b>Broadcasting service and reception type</b>	<b>Maximum interfering pfd level (dBW/m<sup>2</sup>) in 8 MHz, for <math>\delta \leq 20^\circ + x^\circ</math></b>	<b>Maximum interfering pfd level (dBW/m<sup>2</sup>) in 8 MHz, for <math>\delta \geq 60^\circ + x^\circ</math></b>
Fixed reception of the analogue BS, nominal coverage areas	-133	-118
Fixed reception of the analogue BS, fringe coverage areas	-139	-124
Fixed reception of the digital BS	-128	-113
Portable outdoor reception of the digital BS	-121	-121

The values provided depend upon the angle  $\delta$  of incidence of the BSS signal at the BS antenna.

The factor  $x^\circ$  is indicated here as a reminder that the receiving antenna discrimination is obtained using directly Recommendation ITU-R BT.419, hence assuming a typical tilt angle of  $0^\circ$  for these antennas. Investigations have shown that this assumption does not remain valid for instances such as hilly environments. A representative average tilt angle  $x^\circ = 10^\circ$  can be used although some Administrations indicated that a representative tilt angle of  $x^\circ = 15^\circ$  or some other value may be more appropriate to cover this phenomenon.

## 6 CONCLUSION

From this report it can be seen that the protection requirements for SAP/SAB interfered with by BSS in the 620 - 790 MHz are less constraining than those for the terrestrial Broadcasting interfered with by BSS in the same band, as contained in the ITU-R Report BT.2075.

Consequently, the maximum pfd levels at the surface of the Earth that the BSS satellite transmissions will have to comply with to protect terrestrial broadcasting are sufficient to protect SAP/SAB at the same time.

## ANNEX 1: BSS SYSTEMS CHARACTERISTICS

HEO BSS systems may be operated in accordance with RR No. 5.311 in the band 620-790 MHz. This report focuses on HEO and GSO BSS systems, which are assumed to use digital transmissions and circular polarisation and to operate with elevation angles above 60° only.

The following is provided for information on the characteristics envisaged for GSO and HEO BSS systems:

### Satellite antenna and power management

The satellite antenna will be designed to meet a number of requirements during the active transmissions periods:

- Iso-flux transmission over the service area  
The satellite will use an iso-flux antenna to optimize its power requirements and to cope with the power-flux density limits in the service area. It means that the satellite antenna gain within the service area will be such that the power-flux density at the Earth's surface will be kept constant, irrespective of the position of a terminal within the service area.
- Beam zooming  
The solid angle with which a satellite sees the service area will vary with time, as function of its altitude. In order to cope with this "zooming effect" and to reduce the overall power requirements, the satellite will also adjust the power and the shape of its beam as function of its altitude.

Consequently, the pfd on the ground will be kept constant, irrespective of time and location of the terminal within the service area.

### Constellation parameters (for HEO BSS only)

The constellation parameters are optimized to offer satisfactory visibility conditions to all users within the service area. The example below illustrates the case of a Tundra constellation, covering Western European countries with 3 satellites orbiting in a 24 hour period:

- Semi-major axis: 42 164 km
- Eccentricity: 0.2684
- Inclination: 63.4°
- Argument of perigee: 270°
- Right ascension of ascending node: 110°, 230° and 350°
- Mean anomaly: 340°, 220° and 100°

Figure A1.1 illustrates the satellite's ground track on the Earth's surface.

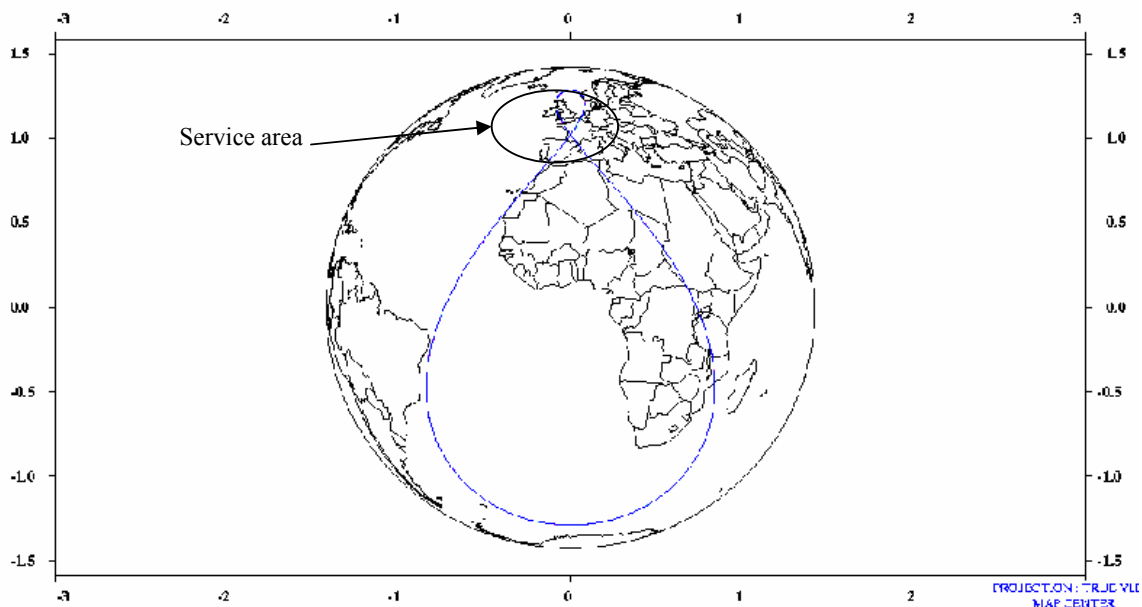


Figure A1.1: HEO constellation ground track



**Times of satellite activity (for HEO BSS only)**

With the orbital parameters of an HEO constellation, a given satellite is in visibility of the service area with an elevation angle better than  $60^\circ$  only 1/3 of the time:

- Over its 24-hour orbit period, the satellite will be in visibility of the service area with an elevation angle better than  $60^\circ$  during a continuous period of 8 hours, after which 16 hours will be spent in “non-visibility”.
- Satellites will be programmed to be inactive during their 16-hour long periods of “non-visibility”. This means that only one satellite will be transmitting towards the service area at a given time.