IC Industrie Canada

SRSP-101
Issue 1
May 2014

Spectrum Management

Standard Radio System Plan

Technical Requirements for Fixed Earth Stations Operating Above 1 GHz in Space Radiocommunication Services and Earth Stations On Board Vessels (ESVs) Operating in the Fixed-Satellite Service

Aussi disponible en français – PNRH-101

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Preface

Issue 1 of SRSP-101 is hereby released.

Issued under the authority of
the Minister of Industry

Marc Dupuis
Director General
Engineering, Planning and Standards Branch

Contents

1. Intent

1.1 This Standard Radio System Plan (SRSP) states the minimum technical requirements for fixed earth stations[1] operating above 1 GHz in any space radiocommunication service, other than mobile-satellite and amateur-satellite services, and also for earth stations on board vessels (ESVs) operating in the fixed-satellite service. This SRSP is intended to be used in evaluating the technical component of applications for new or modified earth stations submitted in accordance with the current issue of Client Procedures Circular CPC-2-6-01, *Procedure for the Submission of Applications to License Fixed Earth Stations and to Approve the Use of Foreign Satellites in Canada.* This SRSP is also to be used for ESVs operating in the fixed-satellite service that are covered under Client Procedures Circular CPC-2-6-06, *Guidelines for the Submission of Applications to Provide Mobile-Satellite Service in Canada.*

1.2 This SRSP replaces the technical requirements set out in Radio Standards Procedures RSP-114, *Licence Application Procedure for Planned Earth Stations in Space Radiocommunication Services*, and RSP-116, *Licence Application Procedure for Planned Television and/or Radio Receive Only (TVRO) Earth Stations in the Fixed-satellite Service*. With the release of Issue 1 of SRSP-101, RSP-114 and RSP-116 are rescinded.

1.3 Existing earth stations which were authorized prior to the issuance of this SRSP may continue to operate with their current technical characteristics. However, new earth stations being deployed or modifications made to existing earth stations will need to conform to the requirements of this SRSP.

1.4 This SRSP specifies system characteristics relating to efficient spectrum usage only and is not to be regarded as a comprehensive specification for equipment design and/or selection.

1.5 The technical requirements stated in Section 4 of this SRSP only apply to earth stations operating within specific space radiocommunication services, as stated for each requirement. In cases where earth stations will operate in a space radiocommunication service where technical requirements of this SRSP do not apply, Industry Canada may establish alternate requirements on a case-by-case basis.

2. General

2.1 Earth stations that conform to these technical requirements will be given priority in licensing over non-standard earth stations operating in the same band.

2.2 The arrangements for non-standard systems are outlined in Spectrum Utilization Policy SP-GEN, *General Information Related to Spectrum Utilization and Radio Systems Policies.*

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[1] In this document, a fixed earth station is an earth station located at a specified fixed point and is not restricted to an earth station in the fixed-satellite service.

2.3 Although an earth station may conform to the requirements of this SRSP, modifications to that earth station may be required whenever harmful interference[2] is caused.

2.4 It should be noted that earth stations may operate in frequency bands which are shared with other stations operating in the same service and other services that operate in accordance with the *Canadian Table of Frequency Allocations* and spectrum utilization policies. Domestic and international coordination with these other stations may be required.

3. Related Documents

The current issues of the following documents are applicable, and are available on the Spectrum Management and Telecommunications website at www.ic.gc.ca/spectrum.

CTFA	*Canadian Table of Frequency Allocations*
RP-008	*Policy Framework for Fixed-Satellite Service (FSS) and Broadcasting Satellite Service (BSS)*
SP-GEN	*General Information Related to Spectrum Utilization and Radio Systems Policies*
SP 1-3 GHz	*Amendments to the Microwave Spectrum Utilization Policies in the 1-3 GHz Frequency Range*
SP 1-20 GHz	*Revisions to Microwave Spectrum Utilization Polices in the Range of 1-20 GHz*
SP 3-30 GHz	*Revisions to Spectrum Utilization Policies in the 3-30 GHz Frequency Range and Further Consultation*
CPC-2-0-03	*Radiocommunication and Broadcasting Antenna Systems*
CPC-2-6-01	*Procedure for the Submission of Applications to License Fixed Earth Stations and to Approve the Use of Foreign Satellites in Canada*
CPC-2-6-02	*Licensing of Space Stations*
CPC-2-6-06	*Guidelines for the Submission of Applications to Provide Mobile-Satellite Service in Canada*

[2] For the purpose of this SRSP, "harmful interference" means interference that endangers the functioning of a radionavigation service or other safety services, or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with regulatory and technical requirements enacted by Industry Canada under the *Radiocommunication Act*.

RSS-GEN *General Requirements and Information for the Certification of Radio Apparatus*

TRC-43 *Designation of Emissions, Class of Station and Nature of Service*

CPC – Client Procedures Circular
RP – Radio Systems Policy
RSS – Radio Standards Specifications
SP – Spectrum Utilization Policy
TRC – Telecommunications Regulation Circular

4. Technical Requirements for Earth Stations

The technical requirements stated in this section only apply to earth stations operating within the space radiocommunication services specified.

4.1 Power Limitations for Space Radiocommunication Services in Frequency Bands Shared With Terrestrial Services in Canada

For space services sharing frequency bands above 1 GHz with terrestrial services, the equivalent isotropically radiated power (e.i.r.p.) transmitted in any direction towards the horizon by an earth station shall not exceed the following limits:

(a) in frequency bands between 1 GHz and 15 GHz
+40 dBW in any 4 kHz band for $\theta \leq 0°$
+40 + 3θ dBW in any 4 kHz band for $0° < \theta \leq 5°$; and

(b) in frequency bands above 15 GHz
+64 dBW in any 1 MHz band for $\theta \leq 0°$
+64 + 3θ dBW in any 1 MHz band for $0° < \theta \leq 5°$;

where θ is the angle of elevation of the horizon viewed from the centre of the radiation of the antenna of the earth station and measured in degrees as positive above the horizontal plane and negative below it.

These limits apply to earth stations operating in any of the space services and frequency bands shown in Table 1, where the frequency bands are shared with equal rights with the fixed or mobile service.

Table 1 – List of Frequency Bands Shared Between Space and Terrestrial Services

Frequency Bands Shared Between Terrestrial and Space Services	Space Services Operating Within Listed Frequency Bands
2025-2110 MHz 5850-7075 MHz 7190-7235 MHz 7900-8400 MHz 12.7-12.75 GHz 12.75-13.25 GHz 17.7-18.1 GHz 22.55-23.15 GHz 27-29.5 GHz	Earth-exploration Fixed-satellite Meteorological-satellite Space operation Space research

Note: Not all the listed space services operate in every listed frequency band.

For angles of elevation of the horizon greater than 5°, there shall be no restriction as to the e.i.r.p. transmitted by an earth station towards the horizon.

4.2 Power Stability for Space Radiocommunication Services

For each earth station, the power output level of the amplifier shall remain within ±1 dB of its nominal setting.

4.3 Frequency Tolerance for Space Radiocommunication Services

For each earth station, the frequency tolerance from nominally assigned frequencies of the earth station shall be within:

±0.002% for frequencies below 2.45 GHz;
±0.005% for frequencies between 2.45 GHz and 10.5 GHz; and
±0.01% for frequencies between 10.5 GHz and 40 GHz.

4.4 Emission Limits for Space Radiocommunication Services

For any frequency removed from the assigned channel centre frequency by more than 250% of the necessary bandwidth, the mean power of emission shall be attenuated by 43 + 10 Log (total mean power in watts) dBc or 60 dBc relative to the full carrier power in the assigned channel in any 4 kHz reference bandwidth, whichever is less stringent. In the case of multiple carriers from a single amplifier, the emission limits apply to each carrier.

The term dBc is the number of decibels relative to the unmodulated carrier power of the emission. In cases where it is not possible to measure the carrier, the reference level equivalent to the dBc level is the number of decibels relative to the mean power.

The emission limits apply to all emissions, including harmonic emissions, intermodulation products, frequency conversion products and parasitic emissions.

The total mean power is the average power in watts supplied to the antenna transmission line by a power amplifier during a sufficiently long interval of time compared with the lowest frequency encountered in the modulation taken under normal operating conditions. When burst transmission is used, the mean power P and the mean power of any spurious domain emissions are measured using power averaging over the burst duration.

4.5 Receiver Spurious Emission Limits for Space Radiocommunication Services

Receiving earth stations may not emit electromagnetic waves that have a field strength greater than that which would occur if the stations were replaced by an isotropic transmitter of five nanowatts.

4.6 Off-Axis e.i.r.p. Density Limits for Earth Stations Operating With Geostationary-Satellite Orbit (GSO) Satellites in the Fixed-Satellite Service

The limits described in Annex A shall apply. Annex C illustrates how to calculate the power density in a reference bandwidth.

4.7 Antenna Gain Patterns for Earth Stations in the Fixed-Satellite Service

The antenna gains described in Annex B shall apply.

5. Coordination

5.1 The coordination of earth stations with respect to space stations of other space networks is addressed when the space networks are coordinated. When the coordination of earth stations is required with terrestrial networks and/or earth stations of other space networks operating in the opposite direction of transmission, the domestic and international coordination requirements are contained in CPC-2-6-01, *Procedure for the Submission of Applications to License Fixed Earth Stations and to Approve the Use of Foreign Satellites in Canada,* and in the case of ESVs, CPC-2-6-06, *Guidelines for the Submission of Applications to Provide Mobile-Satellite Service in Canada.*

5.2 Actual transmit and receive parameters shall be used where possible for coordination with terrestrial networks rather than the envelopes illustrated in annexes A and B.

Annex A – Off-Axis Equivalent Isotropically Radiated Power (e.i.r.p.) Density Limits for Earth Stations Operating With Geostationary-Satellite Orbit (GSO) Satellites in the Fixed-Satellite Service

The following off-axis equivalent isotropically radiated power (e.i.r.p.) density limits, under clear sky conditions, shall be observed (see Note A1). These limits can normally be met by a transmitting antenna whose pattern complies with one of those in Annex B, as appropriate. For antennas not complying with the limits in Annex B, the input power of the station needs to be reduced to meet the limits contained herein. The off-axis angle is defined as the angle between the direction of interest and the axis of the main lobe. The e.i.r.p. density for any angle of rotation about the boresight axis must meet the specified e.i.r.p. density limits. Several notes at the end of this annex provide additional information on the application of these limits.

1. For earth stations installed prior to January 1, 1986, and not modified since that date (see notes A2 and A3):

1.1 For earth stations operating in the band 5925-6425 MHz:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
$35 - 25 \log \phi$ dBW/4 kHz	$1° \leq \phi < 48°$
–7 dBW/4 kHz	$48° \leq \phi \leq 180°$

1.2 For earth stations operating in the band 13.75-14.5 GHz:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
$38 - 25 \log \phi$ dBW/4 kHz	$1° \leq \phi < 48°$
–4 dBW/4 kHz	$48° \leq \phi \leq 180°$

2. For all other earth stations installed or modified on or after January 1, 1986 (see notes A2, A3, A6 and A8):

2.1 For earth stations operating in the band 5925-6425 MHz, other than those considered in Section 2.2 of this annex, the e.i.r.p. density in any direction within ±3° of the geostationary-satellite orbit (GSO) shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
$32 - 25 \log \phi$ dBW/4 kHz	$2.5° \leq \phi < 7°$
11 dBW/4 kHz	$7° \leq \phi < 9.2°$
$35 - 25 \log \phi$ dBW/4 kHz	$9.2° \leq \phi < 48°$
–7 dBW/4 kHz	$48° \leq \phi \leq 180°$

2.2 For earth stations located on board vessels (ESVs) operating in the band 5925-6425 MHz (see notes A4 and A5):

i. For co-polarized signals, the e.i.r.p. density emitted from the ESV in the plane of the GSO shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
$26.3 - 25 \log \phi$ dBW/4 kHz	$1° \leq \phi < 7°$
5.3 dBW/4 kHz	$7° \leq \phi < 9.2°$
$29.3 - 25 \log \phi$ dBW/4 kHz	$9.2° \leq \phi < 48°$
–12.7 dBW/4 kHz	$48° \leq \phi \leq 180°$

ii. For co-polarized signals, the e.i.r.p. density emitted from the ESV in all other directions shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
$29.3 - 25 \log \phi$ dBW/4 kHz	$1° \leq \phi < 48°$
–12.7 dBW/4 kHz	$48° \leq \phi \leq 180°$

iii. For cross-polarized signals, the e.i.r.p. density emitted from the ESV in all directions shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
$16.3 - 25 \log \phi$ dBW/4 kHz	$1.8° \leq \phi < 7°$
–4.7 dBW/4 kHz	$7° \leq \phi \leq 9.2°$

2.3 For earth stations operating in the band 13.75-14.5 GHz other than those considered below in Section 2.4 of this annex, the e.i.r.p. density in any direction within ±3° of the GSO shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
$39 - 25 \log \phi$ dBW/40 kHz	$2.5° \leq \phi < 7°$
18 dBW/40 kHz	$7° \leq \phi < 9.2°$
$42 - 25 \log \phi$ dBW/40 kHz	$9.2° \leq \phi < 48°$
0 dBW/40 kHz	$48° \leq \phi \leq 180°$

2.4 For earth stations located on board vessels operating in the band 14–14.5 GHz (see notes A4 and A5):

i. For co-polarized signals, the e.i.r.p. density emitted from the ESV in the plane of the GSO shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
15 – 25 Log ϕ dBW/4 kHz	$1.25° \leq \phi < 7°$
–6 dBW/4 kHz	$7° \leq \phi < 9.2°$
18 – 25 Log ϕ dBW/4 kHz	$9.2° \leq \phi < 48°$
–24 dBW/4 kHz	$48° \leq \phi \leq 180°$

ii. For co-polarized signals, the e.i.r.p. density emitted from the ESV in all other directions shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
18 – 25 Log ϕ dBW/4 kHz	$1.25° \leq \phi < 48°$
–24 dBW/4 kHz	$48° \leq \phi \leq 180°$

iii. For cross-polarized signals, the e.i.r.p. density emitted from the ESV in all directions shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
5 – 25 Log ϕ dBW/4 kHz	$1.8° \leq \phi < 7°$
–16 dBW/4 kHz	$7° \leq \phi \leq 9.2°$

2.5 For earth stations operating in the band 24.75-25.25 GHz:

i. For co-polarized signals, the e.i.r.p. density in any direction within ±3° of the GSO shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
32.5 – 25 Log ϕ dBW/MHz	$2° \leq \phi < 7°$
11.4 dBW/MHz	$7° \leq \phi < 9.2°$
35.5 – 25 Log ϕ dBW/MHz	$9.2° \leq \phi < 48°$
3.5 dBW/MHz	$48° \leq \phi \leq 180°$

ii. For co-polarized signals, the e.i.r.p. density for all directions other than within ±3° of the GSO shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
35.5 – 25 Log ϕ dBW/MHz	$2° \leq \phi < 7°$
14.4 dBW/MHz	$7° \leq \phi < 9.2°$
38.5 – 25 Log ϕ dBW/MHz	$9.2° \leq \phi < 48°$
6.5 dBW/MHz	$48° \leq \phi \leq 180$

iii. For cross-polarized signals, the e.i.r.p. density in all directions other than within ±3° relative to the GSO shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
22.5 – 25 Log ϕ dBW/MHz	$2° \leq \phi < 7°$
1.4 dBW/MHz	$7° \leq \phi \leq 9.2°$

2.6 For earth stations operating in the band 27.5-30 GHz (see Note A7):

i. For co-polarized signals, the e.i.r.p. density in any direction within ±3° of the GSO shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
18.5 – 25 Log ϕ dBW/40 kHz	$2° \leq \phi < 7°$
–2.63 dBW/40 kHz	$7° \leq \phi < 9.23°$
21.5 – 25 Log ϕ dBW/40 kHz	$9.23° \leq \phi < 48°$
–10.5 dBW/40 kHz	$48° \leq \phi \leq 180°$

ii. For co-polarized signals, the e.i.r.p. density for all directions other than within ±3° of the GSO shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
21.5 – 25 Log ϕ dBW/40 kHz	$3.5° \leq \phi < 7°$
0.37 dBW/40 kHz	$7° \leq \phi < 9.23°$
24.5 – 25 Log ϕ dBW/40 kHz	$9.23° \leq \phi < 48°$
–7.5 dBW/40 kHz	$48° \leq \phi \leq 180°$

iii. For cross-polarized signals, the e.i.r.p. density in all directions relative to the GSO arc shall not exceed the following values:

Maximum e.i.r.p. density	**Off-axis angle, ϕ**
$8.5 - 25 \text{ Log } \phi$ dBW/40 kHz	$2° \leq \phi < 7°$
–12.63 dBW/40 kHz	$7° \leq \phi \leq 9.23°$

Note A1: For operations at frequencies above 10 GHz, earth station operators may exceed the uplink e.i.r.p. density limits specified under the conditions of uplink fading due to precipitation by an amount not to exceed 1 dB above the actual amount of monitored excess attenuation over clear sky propagation conditions. The e.i.r.p. density levels shall be returned to normal as soon as the attenuating weather pattern subsides. The maximum power level for power control purposes shall be coordinated between and among adjacent satellite operators.

Note A2: For any direction outside of ±3° from the GSO, the limits in sections 1.1 and 1.2 of this annex shall apply, unless specified otherwise.

Note A3: For off-axis angles $\phi > 7°$, the limits shall not be exceeded by more than 10% of the earth station antenna side-lobes provided that no individual side lobe exceeds the limits given by more than 3 dB.

Note A4: For non-circular ESV antennas, the major axis of the antenna should be aligned with the tangent to the GSO arc at the target satellite point, to the extent required to meet specified off-axis e.i.r.p. criteria.

Note A5: ESVs are allowed to operate in the specified FSS frequency bands within the limits specified and on the condition that the use of such frequencies shall not cause harmful interference to an authorized station.

Note A6: For systems where more than one earth station is expected to transmit simultaneously in the same bandwidth, the e.i.r.p. density limit should be reduced by $10 \log_{10} (M)$, where M is the maximum number of simultaneously transmitting co-frequency earth stations in the receive beam of the satellite.

Note A7: Earth stations operating in the band 27.5-30 GHz that have lower elevation angles to the GSO will require higher e.i.r.p. density levels relative to the same terminals at higher elevation angles to achieve the same power flux densities at the GSO. This is due to the combined effect of increased distance and atmospheric absorption. Earth stations with low elevation angles may exceed the levels specified in Section 2.6 of this annex by the following amount:

Increase in e.i.r.p. density	**Elevation angle to GSO, ε**
2.5 dB	$\varepsilon \leq 5°$
$3 - 0.1\varepsilon$ dB	$5° < \varepsilon \leq 30°$.

Note A8: For earth stations that operate in bands not shared with terrestrial stations, the e.i.r.p. density limit can be relaxed by 10 dB in the back lobe, i.e. for off-axis angles between 85° and 180°.

Annex B – Antenna Gain Patterns for Earth Stations in the Fixed-Satellite Service

For coordination purposes, it will be assumed that the antenna gain within 3° of the geostationary-satellite orbit (GSO) is described by the following expressions in sections 1 to 3 of this annex. The off-axis angle is defined as the angle between the direction of interest and the axis of the main lobe. The measured radiation pattern for any angle of rotation about the boresight axis must meet the specified radiation pattern envelope. Several notes at the end of this annex provide additional guidelines on the application of these antenna gains.

1. For earth stations that operate in bands shared with terrestrial stations:

Gain	**Off-axis angle, ϕ**
$29 - 25\text{Log}\ \phi$ dBi	$1.5° \le \phi < 7°$
7.9 dBi	$7° \le \phi < 9.2°$
$32 - 25\text{Log}\ \phi$ dBi	$9.2° \le \phi < 48°$
–10 dBi	$48° \le \phi \le 180°$

2. For earth stations that operate in bands not shared with terrestrial stations:

Gain	**Off-axis angle, ϕ**
$29 - 25\text{Log}\ \phi$ dBi	$1.5° \le \phi < 7°$
7.9 dBi	$7° \le \phi < 9.2°$
$32 - 25\text{Log}\ \phi$ dBi	$9.2° \le \phi < 48°$
–10 dBi	$48° \le \phi < 85°$
0 dBi	$85° \le \phi \le 180°$

3. For television receive only (TVRO) earth stations in the band 3700-4200 MHz, the protection antenna pattern requirements are:

Gain	**Off-axis angle, ϕ**
$34.5 - 25\ \text{Log}\ \phi$ dBi	$5° \le \phi < 46°$
–7 dBi	$46° \le \phi \le 180°$

4. For angles more than 3° away from the GSO, the gain will be assumed to be:

Gain	**Off-axis angle, ϕ**
$32 - 25\ \text{Log}\ \phi$ dBi	$1.5° \le \phi < 48°$
–10 dBi	$48° \le \phi \le 180°$

Note B1: Where earth station antennas have gain patterns which are better than those shown (i.e. lower off-axis gain), the actual pattern may be used for coordination purposes.

Note B2: The gain is considered in the plane of the GSO as it appears at the particular earth station.

Note B3: The envelope may be exceeded by no more than 10% of the side-lobes provided that no individual side-lobe exceeds the gain envelope given by more than 3 dB.

Note B4: In the band 3700-4200 MHz, licences to operate protected TVRO earth stations will only be issued if the antenna radiation pattern is such that 90% of the side-lobe peaks fall within the envelope given in Section 3 of this annex.

Annex C – Equivalent Isotropically Radiated Power (e.i.r.p.) Density in a Reference Bandwidth for Digital Carriers

The following equations show how to average an e.i.r.p. density over a different reference bandwidth, as required in Annex A, for a digital carrier.

It may be necessary to convert the e.i.r.p. density value to a different reference bandwidth, e.g. 4 kHz, 40 kHz or 1 MHz. The following methods should be applied, where:

$EIRPD_{W/Hz}$ = e.i.r.p. density, W/Hz, of the digital carrier
B_c = carrier bandwidth, expressed in Hz
B_r = reference bandwidth, which could be 4 kHz, 40 kHz, or 1 MHz, expressed in hertz.

Case 1: $B_c < B_r$

$EIRPD_{W/Br} = EIRPD_{W/Hz} \times B_c$ (watts per reference bandwidth, B_r, e.g. W/4kHz, W/40 kHz, or W/1MHz);

Case 2: $B_c \geq B_r$, then

$EIRPD_{W/Br} = EIRPD_{W/Hz} \times B_r$ (watts per reference bandwidth, B_r).

Note that this assumes that the power of the digital carrier is uniformly spread over the concerned frequency band.