

RECOMMENDATION ITU-R S.1594*

Maximum emission levels and associated requirements of high density fixed-satellite service earth stations transmitting towards geostationary fixed-satellite service space stations in the 30 GHz range**

(Question ITU-R 266/4)

(2002)

The ITU Radiocommunication Assembly,

considering

- a) that the earth stations of various different geostationary (GSO) satellite networks in the fixed-satellite service (FSS) are planning to commence operation in the 30 GHz frequency range in the near future;
- b) that there are both technical and operational differences among these various GSO FSS networks;
- c) that a number of these GSO FSS networks are expected to provide a wide range of services to ubiquitously deployed high density FSS satellite user earth stations;
- d) that these GSO FSS networks, and their associated earth stations, are subject to coordination under various provisions of the Radio Regulations;
- e) that the identification by the ITU-R of technical characteristics for ubiquitously deployed high density earth stations of FSS networks can assist in carrying out sharing studies between these networks and other services;
- f) that some administrations have planned to deploy high density FSS earth stations in certain frequency sub-bands using technical characteristics similar to those found in Annex 1, without the need for individual site coordination;
- g) that this type of deployment needs to take into account sharing with terrestrial services, where such services are allocated on a co-primary basis;
- h) that this type of deployment needs to take into account existing and planned FSS networks with other types of earth stations and characteristics,

recommends

- 1** that the technical characteristics found in Annex 1 may be used as design guidelines and for carrying out sharing studies between high density FSS earth stations and other services;
- 2** that administrations seeking guidance on technical characteristics for high density FSS earth stations may utilize the technical characteristics found in Annex 1.

* *Note by the BR Secretariat* – The title of the Recommendation was amended editorially in September 2006.

** Two administrations are of the opinion that in the absence of a clear definition of “high density fixed-satellite service”, there is no difference between these systems and other fixed-satellite service systems.

ANNEX 1

This Annex contains technical characteristics for FSS earth stations intended to be operated with GSO high density FSS networks in certain portions of the 30 GHz band without the need for individual site coordination. The characteristics of this Annex summarize the maximum unwanted emission requirements for such earth stations both as a function of frequency range and as a function of off-axis direction from the antenna. Certain essential network control functions are also defined.

Each time the expression “earth station” is used in this Recommendation, it refers to a user terminal of a high density FSS network.

This Recommendation applies for earth stations whose antenna diameter does not exceed 1.80 m or equivalent corresponding aperture.

Definitions

Carrier-off state: An earth station is in this state when it is authorized by the network control facility (NCF) to transmit, but when it does not transmit any signal. For earth stations designed for continuous transmission mode there may be no carrier-off state.

Carrier-on state: An earth station is in this state when it is authorized by the NCF to transmit and when it transmits a signal in a continuous or non-continuous mode.

Transmission disabled state: An earth station is in this state when it is not authorized by the NCF to transmit.

Control channel (CC): Channel or channels by which earth stations receive control information from the NCF for their network. Typically the control channel(s) is/are carried via the same satellite as used for transmission of user data and within the internal protocol structure of the broadcast system.

Nominated bandwidth: Bandwidth of the earth station radio frequency transmission nominated by the manufacturer. The nominated bandwidth does not exceed five times the occupied bandwidth and is wide enough to encompass all spectral components of the transmission that have a level greater than the specified radiation levels. The nominated bandwidth is also wide enough to take account of the transmit carrier frequency instability.

Occupied bandwidth: For the purpose of this Recommendation, the width of the signal spectrum 10 dB below the maximum in-band density.

Unwanted radiation: For the purposes of this Recommendation, any radiation outside the nominated bandwidth.

e.i.r.p._{max}: maximum e.i.r.p. capability of the earth station.

e.i.r.p._{nom}: either $e.i.r.p._{max}$ or, when uplink power control is implemented, the maximum required e.i.r.p. of the earth station under clear-sky condition.

1 Unwanted radiation

1.1 Off-axis unwanted radiation

The following specifications apply to the earth station transmitting at e.i.r.p. values up to and including e.i.r.p._{max}.

- The earth station radiated interference field strength over the frequency range from 30 MHz to 1 000 MHz should not exceed the values given in Table 1.

TABLE 1

Levels of radiated field strength at a test distance of 10 m in a 120 kHz bandwidth

Frequency range (MHz)	Quasi-peak levels (dB(μV/m))
30-230	30
230-1 000	37

The lower levels apply at the transition frequency.

- When the earth station is in the “Transmission disabled” state, the off-axis unwanted radiation from the earth station, in any 100 kHz band, should not exceed the levels in Table 2, for all off-axis angles greater than 7°.

TABLE 2

Levels of unwanted radiation – “Transmission disabled” state

Frequency band (GHz)	e.i.r.p. level (dB(pW))
1.0-2.0	40
2.0-10.7	48
10.7-21.2	54
21.2-40	60

The lower levels should apply at the transition frequency.

- For the “Carrier-on” and “Carrier-off” states, the off-axis e.i.r.p. of unwanted radiation in the specified measurement bandwidth from the earth station, should not exceed the levels in Table 3, for all off-axis angles greater than 7°. These levels apply outside the nominated bandwidth.

TABLE 3

Levels of unwanted radiation

Frequency band (GHz)	e.i.r.p. level (dB(pW))	Measurement bandwidth
1.0-2.0	40	100 kHz
2.0-3.4	49	100 kHz
3.4-10.7	55	100 kHz
10.7-21.2	61	100 kHz
21.2-27.35	67	100 kHz
27.35-27.50	85 ⁽¹⁾	1 MHz
27.50-30.00	85 ^{(1), (2)}	1 MHz
30.00-30.15	85 ⁽¹⁾	1 MHz
30.15-40.00	67	100 kHz

⁽¹⁾ This value does not apply in a frequency band which does not exceed 50 MHz, centred on the carrier frequency, provided that the on-axis e.i.r.p. density measured in 100 kHz at the frequency of the considered unwanted signal is 50 dB below the maximum on-axis e.i.r.p. density of the signal measured in 100 kHz.

⁽²⁾ This value does not apply in frequency bands exclusively designated to FSS.

The lower levels apply at the transition frequency.

In the frequency band of 21.2-27.35 GHz, for any 20 MHz band within which one or more unwanted signals exceeding 67 dB(pW/100 kHz) are present, then the power of each of those signals exceeding the level should be added in Watts, and the sum should not exceed 75 dBW.

For earth stations designed to transmit simultaneously several different carriers (multi-carrier operation), the above levels apply to each individual carrier when transmitted alone. Further studies are needed with respect to multi-carrier operation.

1.2 On-axis unwanted radiation for carrier-on state

The following specification applies to the earth station transmitting at e.i.r.p. values up to e.i.r.p._{nom}.

For any e.i.r.p. above e.i.r.p._{nom} (when uplink power control is implemented) the levels below may be exceeded by the difference in dB between that e.i.r.p. and e.i.r.p._{nom}.

In the 27.50-30.00 GHz band the e.i.r.p. spectral density of the unwanted radiation outside the nominated bandwidth should not exceed $4 - 10 \log M$ dBW in any 100 kHz band. M is the maximum number of earth stations, which are expected to transmit simultaneously in the same carrier frequency band; this number should not be exceeded for more than 0.01% of the time.

In any 20 MHz bandwidth where one or more unwanted signals exceed 4 dB(pW/100 kHz), the power of each of those signals exceeding the levels should be added in Watts, and the sum should not exceed 10 dBW.

In a bandwidth of 5 times the occupied bandwidth centred on the carrier centre frequency, the e.i.r.p. spectral density of the unwanted radiation outside the nominated bandwidth should not exceed $18 - 10 \log M$ dBW in any 100 kHz band.

For earth station designed to transmit simultaneously several different carriers (multi-carrier operation), the above levels only apply to each individual carrier when transmitted alone. Further study is required with respect to multi-carrier operation.

2 In-band off-axis e.i.r.p. density

See Recommendation ITU-R S.524, including its notes, for co-polarized signals.

In addition, the maximum e.i.r.p. in any 40 kHz band within the nominated bandwidth of each of the cross-polarized components in any direction φ degrees from the antenna main beam axis within 3° of the GSO should not exceed the following levels:

$$9 - 25 \log \varphi - 10 \log N \quad \text{dBW} \quad \text{for } 2^\circ \leq \varphi \leq 7^\circ$$

$$-12 - 10 \log N \quad \text{dBW} \quad \text{for } 7^\circ < \varphi \leq 9.2^\circ$$

where:

φ : angle (degrees), between the main beam axis and the direction considered

N : number of earth stations in the receive beam of the satellite to which these earth stations are communicating and which are expected to transmit simultaneously in the same 40 kHz band (e.g. for systems employing code division multiple access).

For any direction in the region outside 3° of the GSO, the above levels may be exceeded by no more than 3 dB.

For non-continuous transmission, the above levels may not apply for a specific portion of each burst. This excluded portion shall not exceed 50 μ s or 10% of the burst, whichever is the smaller. Moreover the excluded portion shall have characteristics similar to the remaining part of the burst:

- same symbol rate, same modulation and same or lower maximum amplitude.

In the case of earth stations employing uplink power control, the above levels, for cross-polar components (for co-polar components, see Recommendation ITU-R S.524), apply under clear-sky conditions and these levels include all additional margins above the minimum clear-sky level necessary for the implementations of uplink power control. For earth stations implementing uplink power control, the above levels may be exceeded by up to A dB during fade conditions, where A is the attenuation of the transmit signal relative to clear sky conditions. A should not exceed 20 dB.

3 Control and monitoring functions

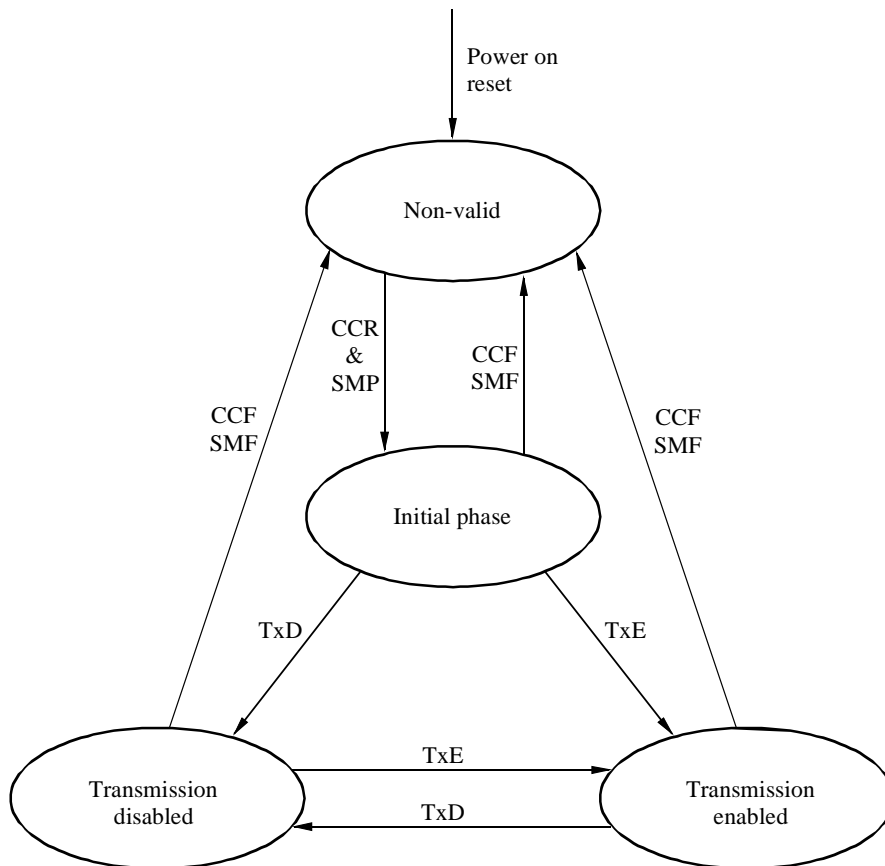
It is important for earth stations to implement control and monitoring functions (CMFs) in order to minimize the probability that they originate unwanted transmissions that may give rise to harmful interference to other systems.

The following provides one example of such CMFs.

For the purpose of the present Recommendation the states of the earth station are (see Fig. 1 for the state transition diagram):

- Non-valid,
- Initial phase,
- Transmission disabled,
- Transmission enabled.

FIGURE 1
State transition diagram of the control and monitoring function of an earth station



CCF: control channel reception failure
 CCR: control channel correctly received
 SMF: system monitoring fail
 SMP: system monitoring pass
 TxD: transmission disable command
 TxE: transmission enable command

Note 1 - From Transmission disabled state a TxE command may also result in a transition toward the Initial phase state.

In the Non-valid state and in the Transmission disabled state the earth station should not transmit. In the Transmission-enabled state the earth station is allowed to transmit. In the Initial phase state the earth station is only allowed to transmit initial bursts.

Under any fault condition when the earth station transmissions are being suppressed the e.i.r.p. levels for the Transmission disabled state applies.

When the earth station transmits several carriers having different frequencies, a state machine as described above may be associated with each carrier or each set of carriers. The events then apply to the subsystem associated with the specific carrier or the specific set of carriers, rather than the whole earth station.

3.1 Processor monitoring

These requirements ensure that the earth station can suppress transmissions in the event of a processor subsystem failure.

The earth station should incorporate a processor monitoring function for each of its processors involved in the manipulation of traffic and in CMF.

The processor monitoring function detects failures of the processor hardware and software. No later than 10 s after any fault condition occurs, the earth station enters the Non-valid state until the processor monitoring function has determined that all fault conditions have been cleared.

3.2 Transmit subsystem monitoring

These requirements ensure the inhibition of transmissions that are potentially harmful to other systems in the event of incorrect operation of the transmit frequency generation subsystem.

The earth station should monitor the operation of its transmit frequency generation subsystem and be able to detect:

- loss of frequency lock (if applicable);
- absence of local oscillator output signal.

No. later than 1 s after any of these fault conditions of the transmit frequency generation subsystem occurs, the earth station should enter the Non-valid state until the transmit subsystem monitoring function has determined that all fault conditions have been cleared.

3.3 Power-on/reset

The earth station should achieve a controlled non-transmitting state following the powering of the unit, or the occurrence of a reset made by a local operator when this function is implemented.

During and following power-on the earth station remains in the Non-valid state.

Following a manual reset (when this function is implemented) the earth station should enter the Non-valid state.

3.4 Initial burst transmission

For systems where no transmission enable command is foreseen without request from the earth station, in the Initial phase state the earth station may transmit initial bursts subject to the following conditions:

- The duty cycle of the burst retransmission should not exceed 0.2%.
- Each burst should not carry more than 256 data bytes excluding the burst preambles and the forward error correction coding bits.

3.5 Receipt of network control/authorization signal

3.5.1 CC reception

These requirements ensure that the earth station cannot transmit unless it correctly receives the CC messages from the NCF.

- The earth station enters the Non-valid state immediately after a period not exceeding 10 s without correct reception of the CC from the NCF.
- The earth station remains in the Non-valid state as long as the CC messages from the NCF are not received.
- From the Non-valid state the earth station may enter the Initial phase state if the following conditions are met:
 - the CC messages from the NCF are correctly receivedand
 - no fault conditions are present.

3.5.2 Network control commands

These requirements ensure that the earth station is capable of retaining a unique identification in the network and receiving commands from the NCF through its control channel(s) and executing those commands.

- The earth station should hold, in non-volatile memory, its unique identification code in the network.
- The earth station should be capable of receiving through its control channels dedicated messages (addressed to the earth station) from the NCF, and which contain:
 - transmission enable commands,
 - transmission disable commands.
- From Initial phase or Transmission enabled states once a transmission disable command is received, within 10 s the earth station should enter into, and remain in, the Transmission disabled state until the transmission disable command is superseded by a subsequent transmission enable command.

4 Antenna pointing accuracy

4.1 Pointing accuracy capability

4.1.1 Main beam pointing accuracy

The antenna subsystem alignment facilities should enable the main beam axis to be adjusted and fixed with a pointing accuracy ($\Delta\phi$) of either:

– 0.1°

or

– a greater value subject to the following restrictions:

- the pointing accuracy ($\Delta\phi$) should not exceed 30% of the antenna transmit main beam half power beam width; and
- the off-axis e.i.r.p. density pattern remains within the mask specified in § 2 when shifted by an angle of $\pm(\Delta\phi - 0.1^\circ)$.

4.2 Polarization angle alignment capability for linear polarization

It should be possible to fix the transmit antenna polarization angle with an accuracy of at least 1°.
