RECOMMENDATION ITU-R SM.329-7

SPURIOUS EMISSIONS*

(Question ITU-R 55/1)

(1951-1953-1956-1959-1963-1966-1970-1978-1982-1986-1990-1997)

The ITU Radiocommunication Assembly,

considering

a) that Recommendation ITU-R SM.328 gives definitions and explanatory notes which should be used when dealing with bandwidth, channel spacing and interference scenarios; when distinguishing between out-of-band emissions and spurious emissions; and when specifying limits for out-of-band emissions;

b) that a difficulty faced in applying the limits for spurious emissions is knowing precisely the value of the necessary bandwidth and exactly where in the spectrum the limits for spurious emissions should begin to apply, particularly for services using broadband or digitally-modulated emissions which may have both noise-like and discrete spurious components;

c) that limitation of the maximum permitted level of spurious emissions at the frequency, or frequencies, of each spurious emission is necessary to protect all radio services;

d) that stringent limits may lead to an increase in size or in complexity of radio equipment, but will in general increase protection of other radio services from interference;

e) that every effort should be made to keep limits for spurious emissions and out-of-band emissions, both for existing and new services, at the lowest possible values taking account of the type and nature of the radio services involved, economic factors, and technological limitations, and the difficulty of suppressing harmonic emissions from certain high power transmitters;

f) that there is a need to define the methods, units of measurements and bandwidth, and the bandwidths to be used for measurement of power at frequencies other than the centre frequency. This will encourage the use of rational, simple, and effective means of reducing spurious emissions;

g) that the relation between the power of the spurious emission supplied to a transmitting antenna and the field strength of the corresponding signals, at locations remote from the transmitter, may differ greatly, due to such factors as antenna characteristics at the frequencies of the spurious emissions, propagation anomalies over various paths and radiation from parts of the transmitting apparatus other than the antenna itself;

h) that field-strength or power flux-density (pfd) measurements of spurious emissions, at locations distant from the transmitter, are recognized as the direct means of expressing the intensities of interfering signals due to such emissions;

j) that in dealing with emissions on the centre frequencies, administrations customarily establish the power supplied to the antenna transmission line, and may alternatively or in addition measure the field strength or pfd at a distance, to aid in determining when a spurious emission is causing interference with another authorized emission, and a similar, consistent procedure would be helpful in dealing with spurious emissions (see Article 18(S15), No. 1813(S15.11), of the RR);

k) that for the most economical and efficient use of the frequency spectrum, it is necessary to establish general maximum limits of spurious emissions, while recognizing that specific services in certain frequency bands may need lower limits of spurious emissions from other services for technical and operational reasons as may be recommended in other ITU-R Recommendations (see Annex 4);

* *Note by the Editorial Committee.* – The terminology used in this Recommendation is in conformity, in the three working languages, with that of Article 1 (S1) of the Radio Regulations (RR) (No. 139 (S1.145)), namely:

– French: rayonnement non essentiel;
– English: spurious emission;
– Spanish: emisión no esencial.

l) that transmitters operating in space stations are increasingly employing spread-spectrum and other broadband modulation techniques that can produce out-of-band and spurious emissions at frequencies far removed from the carrier frequency, and that such emissions may cause interference to passive services, including the radioastronomy service, recognizing however, that spectrum shaping techniques, which are widely used to increase the efficiency of spectral usage, result in an attenuation of side band emissions;

m) that spurious emission limits applicable to transmitters are a function of:

– the radiocommunication services involved and the minimum protection ratio determined in every frequency band;

– the type of environment where transmitters could be found (urban, suburban, rural, etc.)

– the type of transmitter;

– the minimum distance between the transmitter in question and the potential victim radio receiver;

– all possible decouplings between the antenna of the interfering transmitting antenna at the reception frequency and the receiving antenna of the radio receiver including the propagation model, polarization decoupling and other decoupling factors;

– the probability of occurrence of the spurious radiation of the transmitter when the receiver is active;

– the fact that a transmitter is active or idle, or that there are simultaneous active transmitters;

n) that some space stations have active antennas and the measurement of power as supplied to the antenna transmission line cannot cover emissions created within the antenna. For such space stations, the determination of field strength or power flux-density at a distance should be established by administrations to aid in determining when an emission Is likely to cause interference to other authorized services,

recommends

1 Terminology and definitions

The following terms and definitions should be used.

1.1 Spurious emission (Article 1 (S1), No. 139 (S1.145) of the RR)

Emission on a frequency, or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

NOTE 1 – For the purpose of this Recommendation all emissions, including intermodulation products, conversion products and parasitic emissions, which fall at frequencies separated from the centre frequency of the emission by 250% or more of the necessary bandwidth of the emission will generally be considered spurious emissions. For multi-channel or multi-carrier transmitters/transponders, where several carriers may be transmitted simultaneously from a final output amplifier or an active antenna, the centre frequency of the emission is taken to be the centre of the –3dB bandwidth of the transmitter or transponder.

1.1.1 Harmonic emissions

Spurious emissions at frequencies which are whole multiples of the centre frequency emissions.

1.1.2 Parasitic emissions

Spurious emissions, accidentally generated at frequencies which are independent both of the carrier or characteristic frequency of an emission and of frequencies of oscillations resulting from the generation of the carrier or characteristic frequency.

1.1.3 Intermodulation products

Spurious intermodulation products result from intermodulation between:

– the oscillations at the carrier, characteristic, or harmonic frequencies of an emission, or the oscillations resulting from the generation of the carrier or characteristic frequency; and

– oscillations of the same nature, of one or several other emissions, originating from the same transmitting system or from other transmitters or transmitting systems.

1.1.4 Frequency conversion products

Spurious emissions, not including harmonic emissions, at the frequencies, or whole multiples thereof, of any oscillations generated to produce the carrier or characteristic frequency of an emission.

1.1.5 Broadband and narrowband spurious emission

A broadband emission is an emission which has “a bandwidth greater than a particular measuring apparatus or receiver” (see the International Electrotechnical Vocabulary (IEV)/International Electrotechnical Commission (IEC) 161-06-11).

A narrowband emission is an emission which has “a bandwidth less than a particular measuring apparatus or receiver” (see IEV/IEC §. 161-06-13).

1.2 Out-of-band emission (Article 1 (S1), No. 138 (S1.144) of the RR)

Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

NOTE 1 – Any unwanted emission which falls at frequencies separated from the centre frequency of the emission by less than 250% of the necessary bandwidth of the emission will generally be considered out-of-band emission. For multi-channel or multi-carrier transmitters/transponders, where several carriers may be transmitted simultaneously from a final output amplifier or an active antenna, the centre frequency of the emission is taken to be the centre of the –3dB bandwidth of the transmitter or the transponder.

1.3 Unwanted emissions (Article 1 (S1), No. 140 (S1.146) of the RR)

Consist of spurious emissions and out-of-band emissions.

1.4 Necessary bandwidth (Article 1 (S1), No. 146 (S1.152) of the RR)

For a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

For application to multi-channel or multi-carrier transmitters/transponders, where several carriers may be transmitted simultaneously from a final output amplifier or an active antenna, the necessary bandwidth is taken to be the transmitter or transponder bandwidth.

2 Application of limits

2.1 The levels of spurious emissions could be expressed in terms of the peak envelope power or in terms of the mean power supplied by the transmitter to the antenna feeder line at the frequencies of the spurious emission concerned, within a defined reference bandwidth, depending on the nature of the radio service of the transmitter.

2.2 Alternatively the levels of spurious emissions could be expressed in terms of the field strength or power flux-density on the surface of the Earth, at the frequencies of the spurious emission concerned.

2.3 As the limits for out-of-band emissions are covered by Recommendation ITU-R SM.328, the limits given for spurious emissions below should apply only for spurious emissions in accordance with the definition, as generic spurious emission limits. Out-of-band emissions are excluded, but since many newer modulation standards are not included in Recommendation ITU-R SM.328, it is recommended that the emission masks defined in the digital standards be used for out-of-band emissions until Recommendation ITU-R SM.328 is updated. A non-exhaustive list of digital standards and their associated emission designators is provided in Table 7.

2.4 Spurious emission limits apply at frequencies above and below the fundamental transmitting frequency but separated from the centre frequency of the emission by 250% of the necessary bandwidth. However, this frequency separation may be dependent on the type of modulation used, the maximum bit rate in the case of digital modulation, the type of transmitter, and frequency coordination factors. For example, in the case of some digital or broadband systems, the frequency separation may need to differ from the ±250% factor. As the RR forbid any radio service to cause harmful interference outside its allocated band, transmitter frequencies should be determined so that out-of-band emissions do not cause harmful interference outside the allocated band in accordance with RR No. 343 (S4.5).

2.5 Where a transmitting system has more than one carrier, the application of the limits specified in § 3 should apply with all transmitters operating normally in accordance with Appendix 8 to the RR.

2.6 The frequency range of the measurement of spurious emissions is from 9 kHz to 110 GHz or the second harmonic if higher. However for practical measurements spurious emissions up to the fifth harmonic of the fundamental frequency should be measured, provided that this does not exceed 26 GHz. For those systems with a fundamental frequency above 13 GHz, spurious emissions up to only the second harmonic should be measured. Systems utilizing a wave guide section as an antenna connector do not require spurious emission measurements below the waveguide cut-off frequency.

2.7 Spurious emission from any part of the installation, other than the antenna system (the antenna and its feeder) shall not have an effect greater than would occur if this antenna system were supplied with the maximum permissible power at that spurious emission frequency.

3 Limits of spurious emissions

3.1 The limits should improve the operation of radiocommunication services in all bands.

3.2 The different units for expressing spurious emission and the conversion Table given in Annex 1 should be used.

3.3 The limits for spurious emissions will be divided into three categories:

Category A	Recommended maximum spurious emission power levels intended for use with radio equipment for all administrations; these limits are given in Table 1.
Category B	Recommended maximum spurious emission power levels intended for administrations that may need to adopt more stringent limits than those given in Category A; these limits are given in Table 2.
Category C	Radiation limits for ITE specified by CISPR; these limits are given in Table 3.

Tables of emission limits (see *recommends* 4) represent recommended limits for each of these categories by frequency band and type of transmitters for the protection of all radiocommunication services.

4 Tables of emission limits

4.1 Recommended reference bandwidths

A reference bandwidth is a bandwidth in which spurious emission levels are specified. The following reference bandwidths are recommended:

– 1 kHz between 9 and 150 kHz

– 10 kHz between 150 kHz and 30 MHz

– 100 kHz between 30 MHz and 1 GHz

– 1 MHz above 1 GHz.

As a special case, the reference bandwidth of all space service spurious emissions should be 4 kHz.

The reference bandwidths required for proper measurement of radar spurious emissions must be calculated for each particular radar system, and the measurement methods should be guided by Recommendation ITU-R M.1177. Thus, for the three general types of radar pulse modulation utilized for radio-navigation, radio-location, acquisition, tracking and other radio-determination functions, the reference bandwidth values should be:

– for fixed frequency or non-pulse-coded radar, one over the radar pulse length (e.g. if the radar pulse length is 1 μs, then the reference bandwidth is 1/1μs = 1 MHz);

– for fixed frequency, phase coded pulsed radar, one over the phase chip length (e.g. if the phase coded chip is 2 μs long, then the reference bandwidth is 1/2μs = 500 kHz);

– for frequency modulated (FM) or chirped radar, the square root of the quantity obtained by dividing the FM (Hz) by the pulse length (s) (e.g. if the FM is from 1 250 to 1 280 MHz or 30 MHz during the pulse of 10 μs, then the reference bandwidth is $(30 \text{ MHz}/10 \text{ μs})^{½}$ = 1.73 MHz).

4.2 Category A limits

Table 1 indicates the recommended maximum permitted levels of spurious emissions, in terms of power as indicated in the Table, of any spurious component supplied by a transmitter to the antenna transmission line.

Spurious emission from any part of the installation other than the antenna and its transmission line should not have an effect greater than would occur if this antenna system were supplied with the maximum permitted power at that spurious emission frequency.

For technical or operational reasons, more stringent levels than those specified in Table 1 may be applied to protect specific services in certain frequency bands. The levels applied to protect these services should be those agreed upon by the appropriate world radiocommunication conference (WRC). More stringent levels may also be fixed by specific agreements between the administrations concerned. Additionally, special consideration of transmitter spurious emissions is required for protection of radioastronomy and other passive services.

Sample calculations and Category A maximum absolute spurious power levels, derived from Table 1 values, can be found in Annex 6.

TABLE 1

Spurious emission limits – Category A

(Recommended attenuation values used to calculate maximum permitted spurious emission power levels intended for use with radio equipment by all countries)

Service category in accordance with Article 1 (S1) of the RR, or equipment type (1), (2)	Attenuation (dB) below the power (W) supplied to the antenna transmission line
All services except those services quoted below	43 + 10 log *P*, or 70 dBc, whichever is less stringent
Space services (earth stations) (3), (4)	43 + 10 log *P*, or 60 dBc, whichever is less stringent
Space services (space stations) (3), (4)	43 + 10 log *P*, or 60 dBc, whichever is less stringent
Radiodetermination	43 + 10 log *PEP*, or 60 dB, whichever is less stringent
Broadcast television (5)	46 + 10 log *P*, or 60 dB, whichever is less stringent, without exceeding the absolute mean power level of 1 mW for VHF stations or 12 mW for UHF stations. However greater attenuation may be necessary on a case-by-case basis

TABLE 1 (*continued*)

Service category in accordance with Article 1 (S1) of the RR, or equipment type [1], [2]	Attenuation (dB) below the power (W) supplied to the antenna transmission line
Broadcast FM	46 + 10 log *P*, or 70 dBc, whichever is less stringent; the absolute mean power level of 1 mW should not be exceeded
Broadcasting at MF/HF	50 dBc and the absolute mean power level of 50 mW should not be exceeded
SSB from mobile stations [6]	43 dB below PEP
Amateur services operating below 30 MHz (including with SSB) [6]	43 + 10 log *PEP*, or 50 dB, whichever is less stringent
Services operating below 30 MHz, except space, radiodetermination, broadcast, those using SSB from mobile stations, and amateur [6]	43 + 10 log *X*, or 60 dBc, whichever is less stringent where: $X = PEP$ for SSB modulation, $X = P$ for other modulation
Low power device radio equipment [7]	56 + 10 log *P* or 40 dBc, whichever is less stringent
Emergency position-indicating radio beacon (EPIRB) Emergency locator transmitter (ELT) Personal location beacon (PLB) Search and rescue transponder (SART) Ship emergency, lifeboat, and survival craft transmitters Land, aeronautical or maritime transmitters when used in emergency	No limit

P : mean power (W) at the antenna transmission line, in accordance with RR No. 152(S1.158). When burst transmission is used, the mean power *P* and the mean power of any spurious emissions are measured using power averaging over the burst duration.

PEP : peak envelope power (W) at the antenna transmission line, in accordance with RR No. 151(S1.157).

dBc : decibels relative to the unmodulated carrier power of the emission. In the cases which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power *P*.

(1) In some cases of digital modulation and narrowband high power transmitters for all categories of services, there may be difficulties in meeting limits close to ±250% of the necessary bandwidth.

(2) Use the e.i.r.p. method shown in Annex 2, § 3.3, when it is not practical to access the transition between the transmitter and the antenna transmission line.

(3) Spurious emission limits for all space services are stated in a 4 kHz reference bandwidth.

(4) These values are “design objectives” until the 1999 Radiocommunication Assembly, pending further studies, note being taken of the Liaison Statement from Working Party 4A of Radiocommunication Study Group 4 (ITU-R Doc. 1-3/68 dated 7 October 1996) and Question ITU-R **[4/X]** “Out-of-Band and Spurious Emission Limits”. This is based on the understanding that these studies will lead to incorporation of appropriate space service values within this Recommendation or to deletion of this Note from the Recommendation.

(5) For analogue television transmissions, the mean power level is defined with a specified video signal modulation. This video signal has to be chosen in such a way that the maximum mean power level (e.g., at the video signal blanking level for NTSC and PAL) is provided to the antenna transmission line.

(6) All classes of emission using SSB are included in the category “SSB.”

(7) Low power radio device having a maximum output power of less than 100 mW and intended for short range communication or control purposes. (Such equipment is in general exempt from individual licensing.)

4.3 Category B limits

Table 2 indicates the maximum permitted levels of spurious emissions, in terms of power level, of any spurious component supplied by a transmitter to the antenna transmission line for Category B equipment. For all services/systems not quoted in this table, Category A limits are applicable.

TABLE 2

Category B limits*

(Recommended maximum spurious emission power levels intended for administrations that may need to adopt more stringent limits than those given in Category A)

Type of equipment	Limits
Fixed service	–50 dBm for 30 MHz $\le f <$ 21.2 GHz [1] –30 dBm for 21.2 GHz $\le f <$ (see *recommends* 2.6) [1]
Fixed service – Terminal station (out station with subscriber equipment interfaces)	–40 dBm for 30 MHz $\le f <$ 21.2 GHz [1] –30 dBm for 21.2 GHz $\le f <$ (see *recommends* 2.6) [1]
Land mobile service (mobiles and base stations)	–36 dBm for 9 kHz $\le f <$ 30 MHz –36 dBm for 30 MHz $\le f <$ 1 GHz [2] –30 dBm for 1 GHz $\le f <$ (see *recommends* 2.6) [3]
VSAT (Very Small Aperture Terminal)	See limits in Recommendation ITU-R S.726
FM broadcasting	87.5 MHz $\le f \le$ 137 MHz –36 dBm for $P <$ 9 dBW 75 dBc for 9 dBW $\le P <$ 29 dBW –16 dBm for 29 dBW $\le P <$ 39 dBW 85 dBc for 39 dBW $\le P <$ 50 dBW –5 dBm for 50 dBW $\le P$ 30 MHz $< f <$ 87.5 MHz and 137 MHz $< f <$ (see *recommends* 2.6) –36 dBm for $P <$ 4 dBW 70 dBc for 4 dBW $\le P <$ 40 dBW 0 dBm for 40 dBW $\le P$
Radiodetermination (fixed stations only) (wind profiler, mobile aeronautical and mobile maritime radars are excluded)	–30 dBm or 100 dB, whichever is less stringent
Short range device, Radio Local Area Networks, Citizens Band (CB), cordless telephones, and radio microphones	–36 dBm 9 kHz ≤ except frequencies below < 1 GHz –54 dBm f within the bands 47-74 MHz, 87.5-118 MHz, 174-230 MHz, 470-862 MHz –30 dBm 1 GHz $\le f <$ (see *recommends* 2.6)

* These limits are widely used by European and other countries. However, some other countries indicate these limits require further study.

P: mean power (W) at the antenna transmission line, in accordance with RR No. 152(S1.158). When burst transmission is used, the mean power P and the mean power of any spurious emissions are measured using power averaging over the burst duration.

f: frequency of the spurious emissions.

(1) For digital systems, Category B limits should be applied on both sides of the emission from 250% of the necessary bandwidth + 56 MHz. Up to this point, Category A limits should apply, unless a more detailed transition is agreed by administrations.

(2) For digital systems, Category B limits should be applied on both sides of the emission from 250% of the necessary bandwidth + 500 kHz (or 10 times the necessary bandwidth, whichever is the greater). Up to this point, Category A limits should apply, unless a more detailed transition is agreed by administrations.

(3) For digital systems, Category B limits should be applied on both sides of the emission from 250% of the necessary bandwidth + 1 MHz (or 12 times the necessary bandwidth, whichever is the greater). Up to this point, Category A limits should apply, unless a more detailed transition is agreed by administrations.

4.4 Category C limits

Table 3 contains Category C limits for Class A (industrial) and B (domestic) information technology equipment (ITE). Category C equipment is defined as that which combines ITE with a radio transmitting function. If the IT portion can be detached and still operate independently, then each part should be tested separately in conformity with the pertinent ITU-R spurious emission limit or the International Special Committee on Radio Interference (CISPR) limit. If the IT portion cannot be independently operated, then the ITU-R Category A or B limits should be applied while testing in the transmitting mode and the CISPR limits should apply in the standby or idle mode. Values are taken from CISPR Publication 22 for frequencies below 1 GHz. Limits for frequencies above 1 GHz are under consideration within CISPR.

Conversion in terms of equivalent isotropic radiated power (e.i.r.p.) is provided for information by assuming that the maximum field strength is to be measured in a semi-anechoic chamber or in an open area test site according to the CISPR measurement method. This is approximately 4 dB above a measurement with free-space condition (this value is in agreement with CISPR studies).

TABLE 3

(Category C limits)

(Radiation limits for ITE specified by CISPR)

Frequency (MHz)	E_{max} (dB(μV/m))	Distance of measurement (m)	Corresponding e.i.r.p. (dBm)
Class A : applicable to ITE intended for industrial environment			
30-230	40	10	– 49
230-1 000	47	10	– 42
Class B : applicable to ITE intended for a domestic environment			
30-230	30	10	–59
230-1 000	37	10	–52

5 Measurement method

The measurement methods of spurious emissions are described in detail in Annex 2.

6 Protection of radioastronomy service and space services using passive sensors

Protection criteria for the radioastronomy service and Earth exploration-satellite and meteorological satellite services using passive sensors should be taken into account when applying spurious emission limits. All of these services can be particularly sensitive to interference.

6.1 Radioastronomy service

Radioastronomy, because of its passive nature and because of the sensitivity of its measurements, needs special consideration as far as spurious emissions are concerned; radio astronomers routinely encounter signal-to-noise ratios of –30 to – 60 dB using long integration intervals. Administrations are urged, as far as practicable, to take into consideration the need to avoid spurious emissions which could cause interference to radioastronomy operating in accordance with Article 36(S29) of the RR. In bringing new satellite services into operation, administrations are urged to note that transmitters on satellites can cause severe interference to radioastronomy through their spurious and out-of-band emissions, including far sidebands which result from digital modulation techniques. The threshold levels of interference for radioastronomy as given in Recommendation ITU-R RA.769 should be taken into account. An extract from the tables of Recommendation ITU-R RA.769 is contained in Table 5. The levels in this table are listed for reference and are not intended for general application as mandatory limits.

For transmitters on the Earth's surface, if limits on spurious emissions do not afford sufficient protection for radioastronomy, mitigation of interference can, in some cases, be provided, for example, through terrain shielding; by the establishment by administrations of coordination, protection or exclusion zones; and by other provisions of RR Articles 22(S15) and 36(S29) relative to radioastronomy observatories.

6.2 Earth exploration-satellite and meteorological satellite services using passive sensors

Passive remote sensing from satellites is becoming increasingly important for the retrieval of atmospheric parameters including temperature, water vapour content, concentration of ozone and other gases, as well as examination of the surface of the Earth. Recommendation ITU-R SA.1029 contains the threshold levels of interference for satellite passive remote sensing. An extract from the Recommendation ITU-R SA.1029 is contained in Table 6. The levels contained in this table are for reference and are not intended as mandatory limits.

ANNEX 1

Expression and units for spurious emissions

1 Expression of spurious emissions

Spurious emissions levels are generally expressed in terms of power, field strength measured at a given distance, or a pfd also measured at a given distance, all measured in a given bandwidth.

Even if the field strength at a given distance from the transmitting antenna is the more significant value to assess and measure spurious emissions, it is considered sufficient for a while, to identify the power parameters of the transmitters in order to work on radio interference and electromagnetic compatibility.

1.1 Power values

Many expressions related to the radiated power are useful to evaluate spurious emissions. They all present advantages and difficulties, linked to current measurement capabilities as well as to the interpretation of the measured values.

1.1.1 Power supplied to the antenna (p.s.a.)

Often used below 30 MHz and for equipment above 30 MHz having an antenna connector, this power is generally easy to measure except when a transmitter has an integral antenna or for high powered ELF/LF systems.

This power measurement represents the actual capability of the transmitter to feed an antenna with spurious signals, but does not take account of the antenna itself and its capability to radiate radio emissions at frequencies other than those for which it has been designed.

1.1.2 Equivalent isotropic radiated power (e.i.r.p.)

Mainly used above 30 MHz (most of the time above 80 MHz), this power gives a better knowledge of the capability of the transmitter system (including the antenna) to radiate the power of spurious emissions and to possibly produce harmful interference to other radio services. The relation between the power at the antenna port or connector and the e.i.r.p. is not easy to derive, as the characteristics of antennas outside their design band are generally not known.

For equipment having integral antennas, it is the main known power parameter to characterize spurious emissions.

1.1.3 Effective radiated power (e.r.p.)

The only difference from e.i.r.p. is that e.r.p. refers to the radiation of a half wave tuned dipole instead of an isotropic antenna. There is a constant difference of 2.15 dB between e.i.r.p. and e.r.p.

$$\text{e.i.r.p. (dBm)} = \text{e.r.p. (dBm)} + 2.15$$

1.2 Field strength

The interfering field strength, *E*, at the victim receiver antenna is, in principle, the required characteristic for the spurious emission effect to be known. The relation, however, between the e.i.r.p. and the field strength in all possible situations is quite difficult to determine, because of radiowave propagation and other radio coupling phenomena (diffraction from buildings, effects of masks etc..), even if the derivation of spurious limits take into account only some basic/worst case situations that can occur.

Field strength is a value that is usually measured on a test site, at a given distance. For disturbance and interference measurement purposes of non intentionally radiating devices and particularly ITE, CISPR recommends typical field-strength measurements at 10 m on a calibrated Open Area Test Site (OATS) with a reflecting ground plane.

1.3 Power flux-density

Pfd is generally evaluated and measured above 1 GHz, for satellite radio links, and radioastronomy.

2 Units

2.1 Power units

Even though the International System (IS) power unit is the Watt (W), the telecommunication publications express spurious emissions p.s.a., e.i.r.p. or e.r.p. in various units including dBpW, nW, dBm or dBW or equivalent expressions of power density per any reference bandwidth.

2.2 Field-strength units

The field strength unit, *E*, is the V/m. Most of the telecommunication publications express field strength in μV/m or dB(μV/m).

2.3 Power flux-density units

The pfd unit is the W/m^2. Most of the telecommunication publications express pfd in $dB(W/m^2)$ or in mW/cm^2.

3 Relation between power, field strength, *E*, and pfd

A simple relation can be established for perfect, ideal cases (which means free space, far field conditions) between *E* (V/m), *D* distance between the transmitting radio equipment and the point of measurement (m), e.i.r.p. (W) and pfd (W/m^2).

$$E = \frac{\sqrt{30\,(e.i.r.p.)}}{D}$$

A maximum value of *E* can be calculated, representing the maximum reading obtainable on an OATS by adjustment of the measurement antenna height. It is:

$$E_{max} \cong 1.6\,E$$

This represents a site gain of 4 dB. The field strength as E (V/m) can be converted to dB(μV/m) as follows:

$$E\ (\text{dB}(\mu\text{V/m})) = 120 + 20 \log E$$

the pfd (W/m^2) is:

$$pfd = E^2/(120.\pi)$$

and the PFD (dB(W/m^2)) is:

$$PFD = 10 \log pfd$$

Table 4 shows the correspondence between the power values (e.i.r.p., e.r.p.), the field strength (E, E_{max}) and the pfd for different units.

TABLE 4

Correspondence between e.i.r.p., e.r.p., field strength, *E*, and pfd

e.i.r.p. (dBm)	e.i.r.p. (nW)	e.i.r.p. (dB(pW))	e.i.r.p. (dBW)	e.r.p. (dBm)	E field free space (dB(μV/m)) at 10 m	E_{max} OATS (dB(μV/m)) at 10 m	PFD free space (dB(W/m^2)) at 10 m	PFD maximum OATS (dB(W/m^2)) at 10 m
–90	0.001	0	–120	–92.15	–5.2	–1.2	–151.0	–147.0
–80	0.01	10	–110	–82.15	4.8	8.8	–141.0	–137.0
–70	0.1	20	–100	–72.15	14.8	18.8	–131.0	–127.0
–60	1	30	–90	–62.15	24.8	28.8	–121.0	–117.0
–50	10	40	–80	–52.15	34.8	38.8	–111.0	–107.0
–40	100	50	–70	–42.15	44.8	48.8	–101.0	–97.0
–30	1 000	60	–60	–32.15	54.8	58.8	–91.0	–87.0
–20	10 000	70	–50	–22.15	64.8	68.8	–81.0	–77.0
–10	100 000	80	–40	–12.15	74.8	78.8	–71.0	–67.0
0	1 000 000	90	–30	–2.15	84.8	88.8	–61.0	–57.0

ANNEX 2

Methods of measurement of spurious emissions

1 Measuring equipment

1.1 Selective measuring receiver

Either a selective receiver or a spectrum analyser may be used for the measurement of spurious power supplied to the antenna and cabinet radiation.

1.1.1 Weighting functions of measurement equipment

It is recommended that all measurement receivers be procured with both the mean and peak weighting functions.

1.1.2 Resolution bandwidths

As a general rule, the resolution bandwidths (measured at the –3 dB points of the final IF filter) of the measuring receiver should be equal to the reference bandwidths as given in *recommends* 4.1. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the reference bandwidth. When the resolution bandwidth is smaller than the reference bandwidth, the result should be integrated over the reference bandwidth. When the resolution bandwidth is greater than the reference bandwidth, the result for broadband spurious emissions should be normalized to the bandwidth ratio. For discrete (narrowband) spurii, normalization is not applicable.

The resolution bandwidths should be close to the recommended values. A correction factor should be introduced depending on the actual resolution bandwidth of the measuring receiver (e.g. –6 dB resolution bandwidth) and on the nature of the measured spurious emission (e.g. pulsed signal or Gaussian noise).

1.1.3 Video bandwidth

The video bandwidth must be at least as large as the resolution bandwidth, and preferably be three to five times as large as the resolution bandwidth .

1.1.4 Measurement receiver filter shape factor

Shape factor is a selectivity parameter of a band-pass filter and is usually defined as the ratio of the desired rejection bandwidth to the desired pass bandwidth. In an ideal filter this ratio would be 1. However, practical filters have attenuation roll-off far from this ideal. For example, spectrum analysers which approximate Gaussian filters by using multi-tuned filters to respond to signals while in swept mode, typically define a –60 dB to –3 dB ratio ranging from 5:1 to 15:1.

1.2 Fundamental rejection filter

The ratio of the power of the fundamental to the power of the spurious emissions may be of the order of 70 dB or more. A ratio of this order may often result in an input at the fundamental frequency of a sufficient level to generate non-linearities in the selective receiver. Hence, a rejection filter to attenuate the fundamental frequency at the input of the measuring device is usually required (if the spurious emission frequency is not too close to the fundamental frequency). For frequency ranges well above the fundamental frequency (for harmonic frequencies for example), it is also possible to use a band-pass or high-pass filter. The insertion loss of this filter for spurious emission frequencies must not be too high. However, the frequency response of the filter has to be very well characterized.

Typical variable frequency, lumped circuit rejection filters at the VHF/UHF range have only 3-5 dB insertion loss, and less, about 2-3 dB loss above 1 GHz.

Tuneable quarter wave bandpass cavity filters are available for frequency ranges above about 50 MHz because of their physical size and have insertion losses on the order of less than 1 dB. Cavity notch filters will have about the same loss once the frequency of interest is more than about 10% away from the notch frequency.

Receivers that have to cover many bands usually require variable filtering which tracks the tuned frequency of the system being measured. The types of variable filters that are adequate for spurious measurements are either varactor tuners or yttrium-iron-garnet (YIG) filters. These filters have more insertion loss than fixed filters, but have smaller passbands which allows measurement of signals that are closer in frequency to the transmitter frequencies.

Varactor tuners typically are recommended for frequencies between 50 MHz and 1 GHz. They provide a 3 dB bandwidth that is about 5% of the tuned frequency and have about 5-6 dB insertion loss.

YIG filters typically are recommended for frequencies between about 1-18 GHz. They provide a 3 dB bandwidth that is about 15 MHz at 2 GHz RF, and about 30 MHz wide at 18 GHz RF. The insertion loss is about 6-8 dB.

1.3 Coupling device

Measurements are made using a directional coupler capable of handling the power of the fundamental emission. The impedance of this coupler must match the transmitter impedance at the fundamental frequency.

1.4 Terminal load

To measure the power of spurious emissions, while using measurement Method 1, the transmitter shall be connected to a test load or terminal load. The level of spurious emission depends on proper impedance matching between the transmitter final stage, the transmission line and the test load.

1.5 Measuring antenna

Measurements are made with a tuned dipole antenna or a reference antenna with a known gain referenced to an isotropic antenna.

1.6 Condition of modulation

Whenever it is possible, the measurements are made in the presence of the maximum rated modulation under normal operating conditions. It may sometimes be useful to start the measurements without applying the modulation, in order to detect some particular spurious frequencies. In this case, it must be pointed out that all spurious emission frequencies may not be detected and switching the modulation on may produce other spurious frequency components.

2 Measurement limitations

2.1 Bandwidth limitations

The limits of ±250% of the necessary bandwidth establish the start of the measurement frequency band for spurious emissions in accordance with *recommends* 2.4 of this Recommendation. In some cases this is not possible because significant measurement errors may result due to the inclusion of non-spurious emissions. In order to establish a new boundary for the spurious measurement bandwidth, a new frequency separation other than ±250% of the necessary bandwidth can be justified. Alternatively a smaller resolution bandwidth may be used with the ±250% of the necessary bandwidth.

The new boundary and resolution bandwidth are related by the following equation:

$$\text{Resolution BW} \times [(\text{Shape Factor})\text{-}1)] \leq 2\ [(\text{Out-of-band boundary}) - (\text{necessary BW})/2]$$

From the above equation, it is clear that if the resolution bandwidth cannot be changed, then a new out-of-band boundary should be calculated. The opposite case is also true.

Consider a signal with a 16 kHz necessary bandwidth, and a ±250% out-of-band boundary (i.e. 40 kHz) which cannot be changed. If the measuring resolution bandwidth filter has a shape factor of 15:1 and the required rejection of the carrier in-band power is 60 dB then the resolution bandwidth has to be approximately 4.5 kHz, from:

$$\text{Required resolution BW} \leq 2\ \{(\text{Out-of-band boundary}) - (\text{necessary BW})/2\}/\ (\text{shape factor} - 1)$$

therefore:

$$\text{Required resolution BW} \leq 2\ (40 - 16/2)/(15 - 1)$$

therefore:

$$\text{Required resolution BW} < 4.5\ \text{kHz}$$

On the other hand, given the same signal and measurement receiver parameters, if the resolution bandwidth is fixed at 100 kHz then a new out-of-band boundary is calculated by rearranging the above formula and solving for the new out-of-band boundary. In this case, if the resolution bandwidth is fixed at 100 kHz, then the new boundary is 708 kHz.

2.2 Sensitivity limitation

Under certain conditions, the sensitivity of commercially available spectrum analysers, together with transition and cable losses might lead to insufficient measurement sensitivity. This may be overcome by the use of a low noise amplifier.

In extreme cases, typically above 26 GHz and mostly due to the use of external mixers in the test set-up, it still may not be possible to achieve enough sensitivity to verify that the equipment under test (EUT) conforms to the specification requirement under modulated condition. The spurious emission measurement in the CW condition may be corrected, for those emissions that are subject to the modulation process, by an amount equal to the modulation loss of the EUT.

2.3 Time limitations

For any desired signal, where the output amplitude changes with time (e.g. non constant envelope modulation), ten or more averaged measurement may be used for consistency.

3 Methods of measurement

3.1 Introduction

There are two methods for measurement of spurious emissions described in this Annex. Method 2 is described in CISPR Publication 16. Care must be taken with Methods 1 and 2 that emissions from the test do not cause interference to systems in the environment, and care must also be taken to utilize the weighting function (see § 1.1.1 above) that matches the power specified in Categories A, B and C.

– Method 1 is the measurement of spurious emission power supplied to the antenna port of the EUT. This method should be used whenever it is practical and appropriate.

– Method 2 is the measurement of the spurious e.i.r.p., using a suitable test site.

Systems using waveguides should use Method 2, since terminating waveguides in a transition device can cause many testing problems. If the antenna port is a waveguide flange, distant spurious emissions might be greatly attenuated by the waveguide to coaxial transition, unless specific tapered waveguide sections are placed in the measurement line so that Method 1 may be utilized. Similarly, VLF/LF band transmitters should also be measured using Method 2 since the boundary between the transmitter, feeder cable and antenna is not always clearly defined.

3.2 Method 1 – Measurement of the spurious emission power supplied to the antenna port

No particular test site or anechoic chamber is required and EMI should not affect the results of the tests. Whenever it is possible, the measurement should include the feeder cable. This method does not take into account attenuation due to antenna mismatch and radiation inefficiencies presented to any spurii, or the active generation of spurii by the antenna itself. The block-diagram of the measurement set-up for the spurious emission power to the antenna port is shown in Fig. 1.

3.2.1 Direct conducted approach

In this approach, it is required to calibrate all the measuring components individually (filter(s), coupler, cables), or to calibrate these connecting devices as a whole. In either case, the calibration is performed by using a calibrated adjustable level generator at the input of the measurement receiver. At each frequency, f, the calibration factor k_f is then determined as follows:

$$k_f = I_f - O_f$$

where:

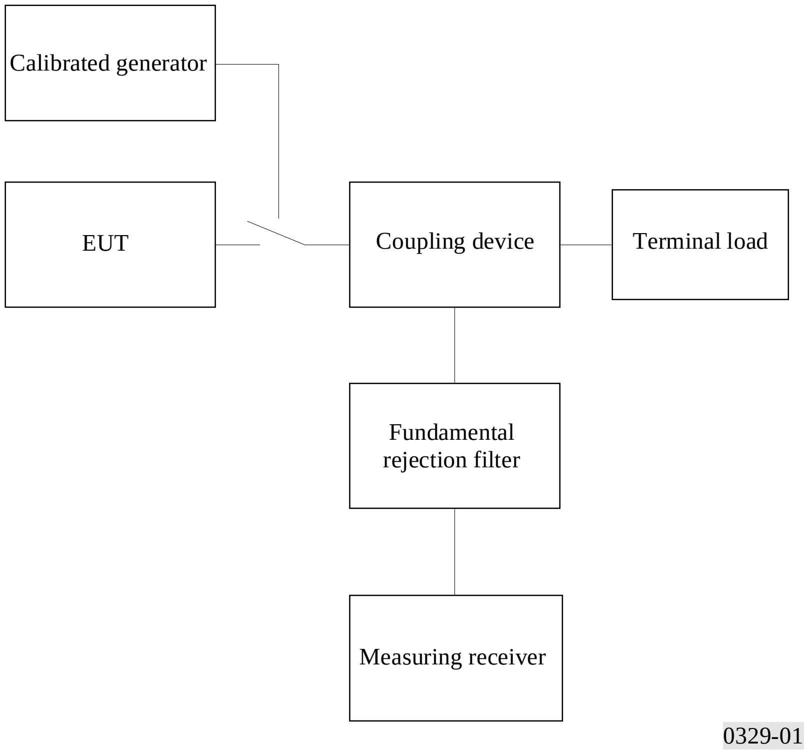
k_f : calibration factor (dB) at the frequency f

I_f : input power (delivered by the calibrated generator) (dBW) or (dBm), at the frequency f

O_f : output power (determined by the measurement receiver) in the same unit as I_f, at the frequency f.

FIGURE 1

Measurement set-up for the spurious emission power to the antenna port



This calibration factor represents the total insertion loss of all the devices connected between the generator and the measurement receiver.

If making individual device calibration measurements, calibration of the whole measurement set-up is derived by using the following formula:

$$k_{ms,\ f} = \sum_i k_{i,f}$$

where:

- $k_{ms,f}$: calibration factor (dB) of the measurement set-up, at the frequency f
- $k_{i,f}$: individual calibration factor (dB) of each device in the measurement chain, at the frequency f.

During measurement of actual spurious levels, $P_{r,f}$ (dBW) or (dBm) is the power (read on the measuring receiver) from the spurious emission at the frequency f, the spurious emission power $P_{s,f}$ (same unit as $P_{r,f}$) at the frequency f is calculated by using the following formula:

$$P_{s,f} = P_{r,f} + k_{ms,f}$$

3.2.2 Substitution approach

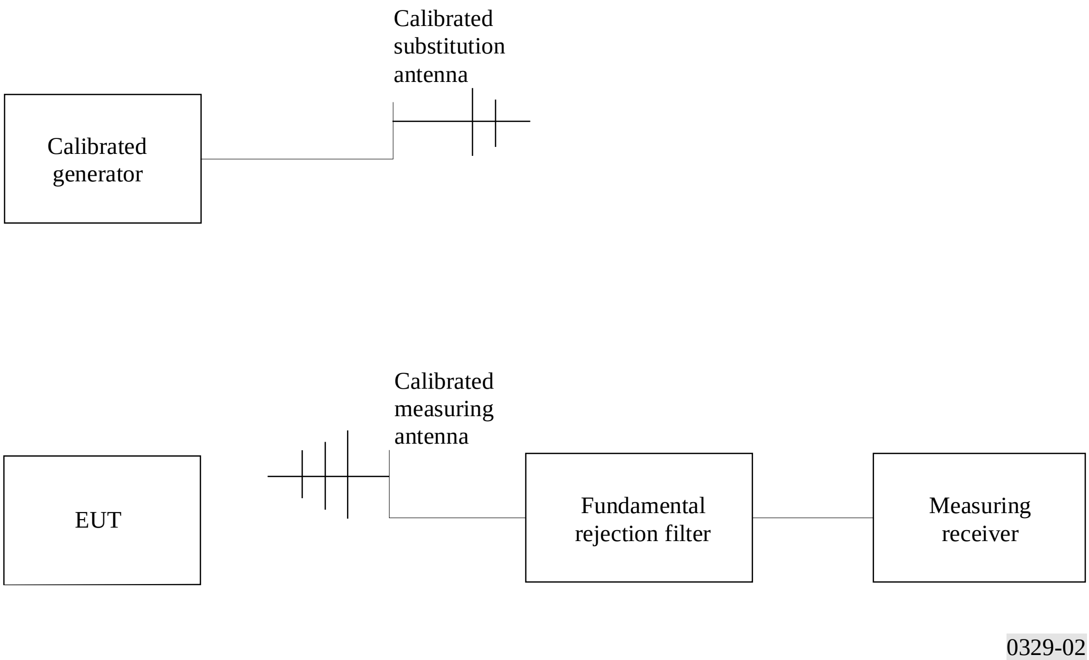
This method does not require calibration of all measuring components. Instead, the spurious output power is recorded from the measuring device. Then this power level is matched by a signal from a calibrated signal generator which is substituted for the EUT. The power supplied by the generator is then equal to the power of the spurious emission.

3.3 Method 2 – Measurement of the spurious e.i.r.p.

The block-diagram of the measuring set-up for the spurious emission e.i.r.p. is shown in Fig. 2.

FIGURE 2

Measuring set-up for the spurious emission e.i.r.p.



The measurements must be made in the far field, which is often difficult for very low frequencies or for certain combinations of frequency and antenna size (e.g. transmissions at 14 GHz using a 1.2 m dish requires about 140 m to reach the far field). The measurements of the e.i.r.p. of the spurious emissions in any direction, in several polarizations and for any frequency could be very time consuming, although techniques to check compliance may reduce this workload. The use of this method to measure radars should be guided by Recommendation ITU-R M.1177.

3.3.1 Measurement site for radiated measurements

Test sites shall be validated by making site attenuation measurements for both horizontal and vertical polarization fields. A measurement site shall be considered acceptable if the horizontal and vertical site attenuation measurements are within ±4 dB of the theoretical site attenuation.

The test site shall characteristically be flat, free of overhead wires and nearby reflecting structures, sufficiently large to permit antenna placement at the specified distance and provide adequate separation between antenna, equipment under test (EUT) and reflecting structures. Reflecting structures are defined as those whose construction material is primarily conductive. The test site shall be provided with a horizontal metal ground-plane. The test site shall satisfy the site attenuation requirements of IEC/CISPR Publication 16-1 for OATS.

Tests may also be conducted in absorber lined shielded room. In that case, the walls of a shielded room are covered with absorber materials that ensure no wave reflection. Validation measurements of such anechoic chambers are very important to ensure that the site attenuation measurements can be performed within the ±4 dB criteria (see also IEC/ CISPR Publication 22).

A conducting ground-plane shall extend at least 1 m beyond the periphery of the EUT and the largest measuring antenna, and cover the entire area between the EUT and the antenna. It should be of metal with no holes or gaps, having dimensions larger than one tenth of the wavelength at the highest frequency of measurement. A larger size conducting ground-plane may be required if the site attenuation requirements of the test site are not satisfied. These requirements are also applicable in the case of semi-anechoic chambers.

Additional equipment is becoming available as the site for spurious emission measurements. These are various chambers, such as stirred mode chambers (SMC), and Transverse Electromagnetic (TEM) or Gigahertz TEM (GTEM) systems. The SMC is described in IEC/CISPR Publication 16 and its use in measuring TVRO equipment is described in ETS 300 457 of November, 1995. These relatively new measurement systems are not universally accepted as yet by all standardization bodies. The techniques used with these systems should be re-examined when this Recommendation is updated in the future, with a view towards incorporating details of their use.

3.3.2 Direct approach

In this approach, it is required to calibrate all the measuring components individually (filter(s), cables), or to calibrate the whole measuring set. See § 3.2.1 on direct approach for the determination of the calibration factor of the measuring set at the frequency *f*.

The spurious emission e.i.r.p., $P_{s,f}$, at the frequency *f*, is given for free space conditions by the following formula:

$$P_{s,f} = P_{r,f} + k_{ms,f} - G_f + 20 \log f + 20 \log d - 27.6$$

where:

- $P_{r,f}$: power of the spurious emission read on the measuring receiver at the frequency *f* (dBW or dBm, same units as $P_{s,f}$)
- $k_{ms,f}$: calibration factor of the measuring set-up at the frequency *f* (dB)
- G_f: gain of the calibrated measuring antenna at the frequency *f* (dBi)
- f: frequency of the spurious emission (MHz)
- d: distance (m) between the transmitting antenna and the calibrated measuring antenna.

3.3.3 Substitution approach

In this approach, a calibrated substitution antenna and a calibrated generator are used, the test source being adjusted for the same received spurious signal.

3.4 Special cabinet radiation measurement

To provide a means of measuring cabinet radiation, Method 2 can be used to measure transmitter cabinet spurious radiation. This method requires replacing the EUT antenna with a calibrated terminal load, and proceeding with the approaches listed above for Method 2, to obtain case e.i.r.p.. The terminating dummy load should be placed in a small, separate shielded enclosure so that re-radiation from the load does not interfere with the measuring of radiation from the cabinet under test. Additionally, connecting cables may radiate and adversely affect the measurements, so care must be taken to prevent this by using double shielded cables or using the shielded enclosure for the cables also.

ANNEX 3

Threshold levels of interference for the radioastronomy service and space services using passive sensors

1 Introduction

Threshold levels of interference for the radioastronomy service, Earth exploration-satellite and meteorological-satellite services using passive sensors can be found in Recommendations ITU-R RA.769 and ITU-R SA.1029. This Annex summarizes the levels provided in these Recommendations.

2 Radioastronomy service (Recommendation ITU-R RA.769)

Table 5 gives the threshold levels of power-flux density and spectral power flux-density for interference detrimental to the radioastronomy service. These are calculated for observations with a single antenna and reception in sidelobes of gain 0 dBi and an integration time of 2 000 s. The values of pfd and spectral power flux-density (spfd) given in Table 5 apply generally, except for geostationary-satellite orbit (GSO) satellites for which the pfd is 15 dB more stringent than shown (see Recommendation ITU-R RA.769).

Annex 1 to Recommendation ITU-R RA.769 describes the methodology for calculating the sensitivity of various radioastronomy systems currently in use. It also provides, for assumed values of system parameters, tabulated levels of aggregate interference which are detrimental to both continuum and spectral-line measurements for various bands allocated to the radioastronomy service.

The assumed parameters used to derive these levels are representative of many types of radioastronomy systems and measurements and are an agreed acceptable standard within the radioastronomy service. However, there may be circumstances in coordination with a specific radioastronomy system, operating at a particular time and location in a particular band, where other values of these parameters may be used with the same methodology to derive a more appropriate level of detrimental interference. In addition, for consideration of interference from specific types of systems (e.g. GSO satellites or multiple-satellite systems) a systematic adjustment of the levels in Recommendation ITU-R RA.769 may be warranted. Accordingly, when the levels contained in Table 5 are applied or referred to, account should be taken of the assumptions used to derive them.

TABLE 5

Threshold levels of power flux-density and spectral power flux-density of interference detrimental to the radioastronomy service

Radioastronomy band (MHz)	PFD (dB(W/m^2))	spfd (dB(W/(m^2.Hz)))
13.36-13.41	–201	–248
25.55-25.67	–199	–249
73.0-74.6	–196	–258
150.05-153.0	–194	–259
322.0-328.6	–204	–258
406.1-410.0	–189	–255
608-614	–185	–253
1 400-1 427	–196	–255
1 610.6-1 613.8	–194	–238
1 660-1 670	–194	–251
2 690-2 700	–177	–247
4 990-5 000	–171	–241
(GHz)		
10.6-10.7	–160	–240
15.35-15.4	–156	–233
22.21-22.5	–162	–233
23.6-24.0	–161	–233

TABLE 5 (*continued*)

Radioastronomy band (MHz)	PFD (dB(W/m²))	spfd (dB(W/(m².Hz)))
(GHz)		
31.3-31.8	–141	–228
42.5-43.5	–153	–227
86-92	–144	–222
105-116	–141	–222
164-168	–136	–216
182-185	–135	–216
217-231	–133	–215
265-275	–131	–213

3 Earth exploration-satellite and meteorological-satellite passive sensing (Recommendation ITU-R SA.1029)

The permissible interference levels given in Table 6 are based on Recommendation ITU-R SA.1029. They refer to power levels at the receiver input and do not include characteristics of the receiving antenna. The gain of the receiving antenna may be inferred from the values of resolution (km) given in Table 2 of Recommendation ITU-R SA.515 and the knowledge that a typical orbital altitude for spaceborne remote sensors can be taken as 500 km. Note that for spaceborne remote sensing, the sensor antenna is normally directed at the Earth’s surface. Note that the levels in Table 6 are described as permissible in the context that they meet the interference criteria of passive sensors. However, use of “permissible” may not necessarily conform with a strict regulatory definition.

TABLE 6

Permissible interference levels at the receiver input for passive sensing

Frequency (GHz)	Interference level (dBW)	Interference reference bandwidth (MHz)
1.4-1.427	–171	27
2.69-2.7	–174	10
4.2-4.4	–161	100
6.5-6.7	–164	100
10.6-10.7	–163	20
15.2-15.4	–166	50
18.6-18.8	–155	100
21.2-21.4	–163	100
22.21-22.5	–160	100
23.6-24	–163	100
31.3-31.8	–163	100
36-37	–156	100

TABLE 6 (*continued*)

Frequency (GHz)	Interference level (dBW)	Interference reference bandwidth (MHz)
50.2-50.4	–161/–166[(1)]	100
52.6-59	–161/–166[(1)]	100
60.3-61.3	–161/–166[(1)]	100
86-92	–153	200
100-102	–160	200
105-126	–160	200
150-151	–160	200
155.5-158.5	–160	200
164-168	–160	200
175-192	–160	200
200-202	–160	200
217-231	–160	200
235-238	–160	200
250-252	–160	200
275-277	–160	200
300-302	–160	200
324-326	–160	200
345-347	–160	200
363-365	–160	200
379-381	–160	200

(1) Second number for pushbroom sensors.

ANNEX 4

List of ITU-R Recommendations concerning spurious emissions related to specific services

Recommendation ITU-R SM.239 Spurious emissions from sound and television broadcast receivers

Recommendation ITU-R S.726 Maximum permissible level of spurious emissions from very small aperture terminals (VSATs)

Recommendation ITU-R RA.611 Protection of the radioastronomy service from spurious emissions

Recommendation ITU-R M.1177 Techniques for measurement of spurious emissions of maritime radar systems

Recommendation ITU-R F.1191 Bandwidths and unwanted emissions of digital radio-relay systems

Recommendation ITU-R BT.803	The avoidance of interference generated by digital television studio equipment
Recommendation ITU-R M.478	Technical characteristics of equipment and principles governing the allocation of frequency channels between 25 and 3 000 MHz for the FM land mobile service

ANNEX 5

Sample list of digital standards

TABLE 7

Digital standards

Digital standards	Emission designator
DIMRS	20K0W7W
TIA/EIA IS-95A (CDMA-800)	1M25F9W
ANSI J-STD 008 (CDMA-1800)	1M25F9W
GSM	271KF7W
DCS1800	271KF7W
DECT	
IS-19 (AMPS)	40K0F8W
IS 54	40K0G7W
IS 136A (TDMA-800/1800)	40K0G7W
Narrowband PCS(1)	33K0F7D or 43K8B8E
IDRA	20K0W7W
Project 25	8K10F1E 5K76G1E
PDC (RCR STD 27)	32K0W7W
PHS (RCR STD 28)	288K0W7W
TETRA	25K0D7W

(1) Only 2 of 8 designators for outbound transmissions are shown.

ANNEX 6

Examples of applying 43 + 10 log *P* to calculate attenuation requirements

All spurious emissions are to be at least *x* dB down from the total mean power *P*, i.e. –*x* dBc. The power *P* (W) is to be measured in a bandwidth wide enough to include the total mean power. The spurious emissions are to be measured in the reference bandwidths given in the Recommendation. The measurement of the spurious emission power is independent of the value of necessary bandwidth. Note that the attenuation of $43 + 10 \log P$ always results in an absolute spurious emission power level of – 43 dBW or –13 dBm. Because this absolute emission power limit can become too stringent for high power transmitters, alternate relative powers are also provided in Table 1.

Example 1:

A land mobile transmitter, with any value of necessary bandwidth, must meet a spurious emission attenuation of 43 + 10 log *P*, or 70 dBc, whichever is less stringent. To measure spurious emissions in the frequency range between 30 and 1 000 MHz, *recommends* 4.1 indicates use of a reference bandwidth of 100 kHz. For other frequency ranges, the measurement must use the appropriate reference bandwidths given in *recommends* 4.1.

With a measured total mean power of 10 W:

Attenuation relative to total mean power = 43 + 10 log 10 = 53 dB

The 53 dBc is less stringent than 70 dBc, so the 53 dBc value is used.

Therefore:

Spurious emissions must not exceed 53 dBc in a 100 kHz reference bandwidth, or converting to an absolute level

Spurious emissions must not exceed 10 dBW – 53 dBc = – 43 dBW in a 100 kHz reference bandwidth.

With a measured total mean power of 1 000 W:

Attenuation relative to total mean power = 43 + 10 log 1 000 = 73 dB

The 73 dBc is more stringent than 70 dBc limit, so the 70 dBc value is used.

Therefore:

Spurious emissions must not exceed 70 dBc in a 100 kHz reference bandwidth, or converting to an absolute level

Spurious emissions must not exceed 30 dBW – 70 dBc = – 40 dBW in a 100 kHz reference bandwidth.

Example 2:

A space services transmitter, with any value of necessary bandwidth, must meet a spurious emission attenuation of 43 + 10 log *P*, or 60 dBc, whichever is less stringent. To measure spurious emissions at any frequency, footnote [(3)] of Table 1 indicates using a reference bandwidth of 4 kHz.

With a measured total mean power of 20 W:

Attenuation relative to total mean power = 43 + 10 log 20 = 56 dB.

The 56 dBc is less stringent than the 60 dBc limit, so the 56 dBc value is used.

Therefore:

Spurious emissions must not exceed 56 dBc in a 4 kHz reference bandwidth or converting to an absolute level

Spurious emissions must not exceed 13 dBW – 56 dBc = – 43 dBW in a 4 kHz reference bandwidth.

TABLE 8

Category A absolute levels of spurious emissions

Service category in accordance with RR Article 1 or equipment type [(1), (2)]	Maximum permitted spurious emission power in the relevant reference bandwidth (see *recommends* 4.1) (dBm) with *P*, *PEP* or *X* (W)	
All services except those services quoted below	–13 dBm 10 log *P* – 40	if *P* ≤ 500 W if *P* > 500 W
All space services [(3), (4)]	–13 dBm 10 log *P* – 30	if *P* ≤ 50 W if *P* > 50 W
Radiolocation/Radionavigation	–13 dBm 10 log *PEP* – 30	if *PEP* ≤ 50 W if *PEP* > 50 W

TABLE 8 (*continued*)

Service category in accordance with RR Article 1 or equipment type [(1), (2)]	Maximum permitted spurious emission power in the relevant reference bandwidth (see *recommends* 4.1) (dBm) with *P*, *PEP* or *X* (W)
Broadcast TV [(5)] VHF transmitters	–16 dBm if $P \le 25$ W $10 \log P - 30$ if $25 \text{ W} < P \le 1000$ W 0 dBm if $P > 1000$ W
Broadcast TV [(5)] UHF transmitters	–16 dBm if $P \le 25$ W $10 \log P - 30$ if $25 \text{ W} < P \le 12000$ W 10.8 dBm if $P > 12000$ W
Broadcast FM	–16 dBm if $P \le 250$ W $10 \log P - 40$ if $250 \text{ W} < P \le 10000$ W 0 dBm if $P > 10000$ W
Broadcast MF/HF	$10 \log P - 20$ if $P \le 5000$ W 17 dBm if $P > 5000$ W
Amateur services operating below 30 MHz (including amateur SSB) [(6)]	–13 dBm if $PEP \le 5$ W $10 \log PEP - 20$ if $PEP > 5$ W
Services operating below 30 MHz and services using SSB (except mobile stations shown below) [(6)]	–13 dBm if $X \le 50$ W $10 \log X - 30$ if $X > 50$ W where: $X = PEP$ for SSB modulation $X = P$ for other modulation
SSB for mobile stations [(6)]	$10 \log PEP - 13$
Low power device radio equipment [(7)]	–26 dBm if $P \le 0.025$ W $10 \log P - 10$ if $0.025 \text{ W} < P < 0.100$ W
EPIRB, ELT, PLB, SART and survival craft two-way radiotelephone	No limit

P: mean power (W) at the antenna transmission line, in accordance with RR No. 152(S1.158). When burst transmission is used, the mean power *P* and the mean power of any spurious emissions are measured using power averaging over the burst duration.

PEP: peak envelope power (W) at the antenna transmission line, in accordance with RR No. 151(S1.157).

(1) In some cases of digital modulation and narrowband high power transmitters for all categories of services, there may be difficulties in meeting limits close to ± 250% of the necessary bandwidth.

(2) Use the e.i.r.p. method shown in Annex 2, § 3.3, when it is not practical to access the transition between the transmitter and the antenna transmission line.

(3) Spurious emission limits for all space services are stated in a 4 kHz reference bandwidth.

(4) These values are "design objectives" until the 1999 Radiocommunication Assembly, pending further studies, note being taken of the Liaison Statement from Working Party 4A of Radiocommunication Study Group 4 (ITU-R Doc. 1-3/68 dated 7 October 1996) and Question ITU-R **[4/X]** "Out-of-band and spurious emission limits". This is based on the understanding that these studies will lead to incorporation of appropriate space service values within this Recommendation or to deletion of this Note from the Recommendation.

(5) For analogue television transmissions, the mean power level is defined with a specified video signal modulation. This video signal has to be chosen in such a way that the maximum mean power level (e.g., at the video signal blanking level for NTSC and PAL) is provided to the antenna transmission line.

(6) All classes of emission using SSB are included in the category "SSB."

(7) Low power radio device having a maximum output power of less then 100 mW and intended for short range communication or control purposes. (Such equipment is in general exempt from individual licensing.)