

International Telecommunication Union

ITU-R
Radiocommunication Sector of ITU

Recommendation ITU-R SM.1045-1
(07/1997)

Frequency tolerance of transmitters

SM Series
Spectrum management



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Foreword

The role of the Radiocommunication Sector is to ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including satellite services, and carry out studies without limit of frequency range on the basis of which Recommendations are adopted.

The regulatory and policy functions of the Radiocommunication Sector are performed by World and Regional Radiocommunication Conferences and Radiocommunication Assemblies supported by Study Groups.

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Series of ITU-R Recommendations

(Also available online at <http://www.itu.int/publ/R-REC/en>)

Series	Title
BO	Satellite delivery
BR	Recording for production, archival and play-out; film for television
BS	Broadcasting service (sound)
BT	Broadcasting service (television)
F	Fixed service
M	Mobile, radiodetermination, amateur and related satellite services
P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
S	Fixed-satellite service
SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

Electronic Publication
Geneva, 2011

RECOMMENDATION ITU-R SM.1045-1*

FREQUENCY TOLERANCE OF TRANSMITTERS

(1994-1997)

Scope

This Recommendation provides the values of frequency tolerance of transmitters for frequency bands and categories of stations.

Keywords

Frequency tolerances, transmitter, peak envelope power

The ITU Radiocommunication Assembly,

considering

- a) that Appendix 2 to the Radio Regulations (RR) specifies permissible frequency tolerances applicable to certain categories of stations in the frequency range from 9 kHz to 40 GHz;
- b) that in many cases tighter frequency tolerances may contribute to a better utilization of the radio-frequency spectrum;
- c) that due to technological progress, transmitters with more stringent frequency stability than required by RR Appendix 2, can be manufactured at reasonable costs;
- d) that it may be desirable to revise RR Appendix S2;
- e) that long-term design objectives for frequency tolerances of transmitters should be developed based on an improvement of radio-frequency spectrum utilization and the operational, technical and economical requirements of the various radio services,

recommends

- 1 that the frequency tolerances given in column 1 of Table 1 should be applied for the installation of new stations;
- 2 that more stringent values than those given in column 1 of Table 1 should be used when operational and technical reasons require;
- 3 that the values given in column 2 of Table 1 for some frequency bands and categories of stations should be taken into consideration as the long-term design objective of transmitters based on advances in technology;
- 4 that further studies should be carried out by Radiocommunication Study Groups and administrations to determine long-term objective values of frequency tolerance for frequency bands and categories of stations for which values cannot be set at present in column 2 of Table 1.

TABLE 1

1 Transmitter frequency tolerance is defined in RR Article 1 and is expressed in parts in 10^6 , unless otherwise indicated $\pm 10^{-6}$.

2 The power shown for the various categories of stations is the peak envelope power (pep) for single-sideband transmitters and the mean power for all other transmitters, unless otherwise indicated. The term "power of a radio transmitter" is defined in RR Article 1.

Frequency bands (lower limits exclusive, upper limits inclusive)	Categories of stations	Frequency tolerance	
		Achievable now (Column 1)	Long-term design objective (Column 2)
9-1 606.5 kHz	Fixed (9-50 kHz)	100	12 Hz
	Fixed (50-240 kHz)	50	
	Fixed (240-535 kHz)	50	
	Land/coast	100 ⁽¹⁾	

* Radiocommunication Study Group 1 made editorial amendments to this Recommendation in the years 2017 and 2019 in accordance with Resolution ITU-R 1.

TABLE 1 (Continued)

Frequency bands (lower limits exclusive, upper limits inclusive)	Categories of stations	Frequency tolerance	
		Achievable now (Column 1)	Long-term design objective (Column 2)
9-1 606.5 kHz (<i>Cont.</i>)	Land/coast – digital selective calling (DSC)	10 Hz	> 200 W, 50)
	Land/aeronautical	100	
	Mobile/ship, emergency, survival	20 Hz ⁽²⁾	
	Mobile/ship – DSC	10 Hz	
	Mobile/aircraft	100	20 Hz
	Land mobile	100	
	Radiodetermination	100	
	Broadcasting	10 Hz	
1 606.5-4 000 kHz	Fixed	15	50
	Fixed – single sideband (SSB) radiotelephony	20 Hz	
	Fixed – frequency shift keying (FSK) radiotelegraphy and data transmission	10 Hz	
	Land/coast, aeronautical, base	50 (≤ 200 W, 100) ⁽¹⁾	
	Land/coast, base – SSB radiotelephony	20 Hz	
	Land/coast – DSC	10 Hz	
	Land/aeronautical – SSB	10 Hz	
	Mobile/ship	20 Hz (A1A, 50) ⁽²⁾	
	Mobile/ship – DSC	10 Hz	50
	Mobile/survival	20 Hz	
	Mobile/aircraft, emergency position-indicating radiobeacons (EPIRBs)	100	
	Mobile/aircraft – SSB	20 Hz	
	Mobile/land	50	
	Mobile/land – SSB radiotelephony, FSK radiotelegraphy	40 Hz	
	Radiodetermination	10 (≤ 200 W, 20)	
	Broadcasting	10 Hz	
4-29.7 MHz	Fixed	10	
	Fixed – SSB radiotelephony	20 Hz	
	Fixed – radio telegraphy and data transmission	10 Hz	
	Land/coast	20 Hz ⁽¹⁾	
	Land/coast – A1A	10	
	Land/coast – DSC	10 Hz	
	Land/aeronautical	50 (≤ 500 W, 100)	
	Land/aeronautical – SSB	10 Hz	
	Land/base	20	
	Land/base – SSB radiotelephony	20 Hz (≤ 500 W, 50 Hz)	
	Mobile/ship	50 Hz ^{(2), (3)}	
	Mobile/ship – A1A	10	
	Mobile/ship – DSC	10 Hz	
	Mobile/survival	50 Hz	
	Mobile/aircraft	100	

TABLE 1 (Continued)

Frequency bands (lower limits exclusive, upper limits inclusive)	Categories of stations	Frequency tolerance	
		Achievable now (Column 1)	Long-term design objective (Column 2)
4-29.7 MHz (<i>Cont.</i>)	Mobile/aircraft – SSB Mobile/land mobile Broadcasting Earth Space	20 Hz 40 ⁽⁴⁾ 10 Hz ⁽⁵⁾ 20 20	
29.7-108 MHz	Fixed Land Mobile Radiodetermination Broadcasting – sound Broadcasting – TV (vision and sound) Earth Space	20 (≤ 50 W, 30) 20 20 (portables ≤ 5 W, 40) 50 2 kHz (≤ 50 W, 3 kHz) 1 kHz ⁽⁶⁾ 20 20	12
108-470 MHz	Fixed Fixed multi-hop radio-relay with direct frequency conversion Land/coast Land/aeronautical Land/base Mobile/ship Mobile/ship on-board outside 156-174 MHz Mobile/survival Mobile/aircraft Mobile/land mobile Radiodetermination Broadcasting – digital sound Broadcasting – TV (vision and sound) Earth Space	5 15 5 (≤ 3 W, 10) 20 5 10 5 50 (156-174 MHz, 10) 30 (channels, 50 kHz, 50) 5 (portables ≤ 5 W, 15) 50 (108-117,975 MHz, 20) ⁽⁸⁾ 1 1 kHz ⁽⁶⁾ 20 20	5 ⁽⁷⁾ 10 5 ⁽⁷⁾
470-960 MHz	Fixed Land Mobile Mobile/aircraft Radiodetermination Broadcasting – TV (vision and sound) Earth Space	15 5 5 (≤ 3 W, 15) 20 500 ⁽⁸⁾ 1 kHz ⁽⁶⁾ 20 20	5 2.5 ⁽⁷⁾ 2.5 ⁽⁷⁾ 10
960-1 215 MHz	Aeronautical radionavigation/land, ship Aeronautical radionavigation/aircraft	20 ⁽⁹⁾ 50 ⁽⁹⁾	

TABLE 1 (*end*)

Frequency bands (lower limits exclusive, upper limits inclusive)	Categories of stations	Frequency tolerance	
		Achievable now (Column 1)	Long-term design objective (Column 2)
1 215-2 450 MHz	Fixed	50	15 ⁽¹⁰⁾
	Land	20	
	Mobile	20	
	Radiodetermination	500 ⁽⁸⁾	
	Broadcasting – terrestrial digital sound	1	10
	Earth	20	
	Space	20	
2 450 MHz-10.5 GHz	Fixed	50	30
	Land	50	
	Mobile	50	
	Radiodetermination	1 250 ⁽⁸⁾	10
	Earth	50	
	Space	50	
10.5-30 GHz	Fixed	100	The frequency tolerance should not be higher than 2% of the bandwidth occupied by the emission
	Land	100	
	Mobile	100	
	Radiodetermination	5 000 ⁽⁸⁾	
	Broadcasting	100	
	Earth	100	
	Space	100	
30-275 GHz	Fixed	150	
	Land	150	
	Mobile	150	
	Radiodetermination	5 000 ⁽⁸⁾	
	Broadcasting	100	
	Earth	100	
	Space	100	

- (1) For coast station transmitters used for direct-printing telegraphy or for data transmission, the tolerance is:
- 5 Hz for narrow-band phase-shift keying (PSK);
 - 10 Hz for FSK.
- (2) For ship station transmitters used for direct-printing telegraphy or for data transmission, the tolerance is:
- 5 Hz for narrow-band PSK
 - 10 Hz for FSK.
- (3) For ship station transmitters in the band 26 175-27 500 kHz, on board small craft, with a carrier power not exceeding 5 W in or near coastal waters and utilizing A3E or F3E and G3E emissions, the frequency tolerance is 40×10^{-6} .
- (4) The tolerance is 50 Hz for SSB radiotelephone transmitters, except for those transmitters operating in the band 26 175-27 500 kHz, and not exceeding a peak envelope power of 15 W, for which the basic tolerance of 40×10^{-6} applies.
- (5) For A3E emissions with carrier power of 10 kW or less the tolerance is 15×10^{-6} and 10×10^{-6} in the bands 4-5.90 MHz and 5.90-29.7 MHz respectively.

- (6) For the case when an offset is used, the frequency tolerance is 500 Hz. For the case when precision offset is used the frequency tolerance of the vision carrier is 1Hz.
 - (7) The long term design objective for channel spacing of 12.5 kHz and below is 3×10^{-6} in frequency bands between 400 and 470 MHz and 1.5×10^{-6} for frequency bands between 470 and 960 MHz.
 - (8) Where specific frequencies are not assigned to radar stations, the bandwidth occupied by the emissions of such stations shall be maintained wholly within the band allocated to the service and the indicated tolerance does not apply.
 - (9) The tolerance for selective identification features (SIF) of secondary surveillance radar (SSR) interrogators is 200 kHz, and for SIF-SSR transponders 3 MHz.
 - (10) The long term design objective for digital radio-relay systems with a capacity higher than 10 Mbit/s is 30×10^{-6} .
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