### § 101.107 Frequency tolerance.

(a) The carrier frequency of each transmitter authorized in these services must be maintained within the following percentage of the reference frequency except as otherwise provided in paragraph (b) of this section or in the applicable subpart of this part (unless otherwise specified in the instrument of station authorization the reference frequency will be deemed to be the assigned frequency):

| Frequency (MHz) | Frequency tolerance (percent) |
|---|---|
| 928 to 929[5] | 0.0005 |
| 932 to 932.5 | 0.00015 |
| 932.5 to 935 | 0.00025 |
| 941 to 941.5 | 0.00015 |
| 941.5 to 944 | 0.00025 |
| 952 to 960[5] | 0.0005 |
| 1,850 to 1,990 | 0.002 |
| 2,110 to 2,200 | 0.001 |
| 2,450 to 2,500[1] | 0.001 |
| 3,700 to 4,200[1] | 0.005 |
| 5,925 to 6,875[1] | 0.005 |
| 6,875 to 7,125[1] | 0.005 |
| 10,550 to 11,700[1 2] | 0.005 |
| 11,700 to 12,200[1] | 0.005 |
| 12,200 to 13,250[4] | 0.005 |
| 14,200 to 14,400 | 0.03 |
| 17,700 to 18,820[3] | 0.003 |
| 18,820 to 18,920[3] | 0.001 |
| 928 to 929[5] | 0.0005 |
| 18,920 to 19,700[3] | 0.003 |
| 19,700 to 27,500[4 7] | 0.001 |
| 29,100 to 29,250 | 0.001 |
| 31,000 to 31,300[6] | 0.001 |
| 31,300 to 40,000[4] | 0.03 |
| 71,000 to 76,000[8]. | |
| 81,000 to 86,000[8]. | |
| 92,000 to 95,000[8]. | |

[1] Applicable only to common carrier LTTS stations. Tolerance for 2450–2500 MHz is 0.005%. Beginning Aug. 9, 1975, this tolerance will govern the marketing of LTTS equipment and the issuance of all such authorizations for new radio equipment. Until that date new equipment may be authorized with a frequency tolerance of .03% in the frequency range 2,200 to 10,500 MHz and .05% in the range 10,500 MHz to 12,200 MHz, and equipment so authorized may continue to be used for its life provided that it does not cause interference to the operation of any other licensee. Beginning March 1, 2005, new LTTS operators will not be licensed and existing LTTS licensees will not be renewed in the 11.7–12.2 GHz band.

[2] *See* subpart G of this part for the stability requirements for transmitters used in the Digital Electronic Message Service.

[3] Existing type accepted equipment with a frequency tolerance of ±0.03% may be marketed until December 1, 1988. Equipment installed and operated prior to December 1, 1988 may continue to operate after that date with a minimum frequency tolerance of ±0.03%. However, the replacement of equipment requires that the current tolerance be met.

[4] Applicable to private operational fixed point-to-point microwave and stations providing MVDDS.

[5] For private operational fixed point-to-point microwave systems, with a channel greater than or equal to 50 KHz bandwidth, ±0.0005%; for multiple address master stations, regardless of bandwidth, ±0.00015%; for multiple address remote stations with 12.5 KHz bandwidths, ±0.00015%; for multiple address remote stations with channels greater than 12.5 KHz bandwidth, ±0.0005%.

[6] For stations authorized prior to March 11, 1997, transmitter tolerance shall not exceed 0.03%.

[7] The frequency tolerance for stations authorized on or before April 1, 2005 is 0.03%. Existing licensees and pending applicants on that date may continue to operate after that date with a frequency tolerance of 0.03%, provided that it does not cause harmful interference to the operation of any other licensee. For analog systems, if the channel bandwidth is greater than 30 MHz up to 50 MHz, the frequency tolerance standard will be 0.03%; if the channel bandwidth is 30 MHz or less, then the frequency tolerance standard will be 0.003%. This analog standard is conditional provided that harmful interference is not caused to digital stations operating within the 0.001% tolerance standards. If harmful interference is caused to stations operating with the more stringent standard, the onus shall be on the operators with the less stringent parameters to develop an engineering solution to the problem. For exceptions, *see* § 101.147 and § 101.507.

[8] Equipment authorized to be operated in the 71,000–76,000 MHz, 81,000–86,000 MHz, 92,000–94,000 MHz and 94,100–95,000 MHz bands is exempt from the frequency tolerance requirement noted in the table of paragraph (a) of this section.

(b) Heterodyne microwave radio systems may be authorized at a somewhat less restrictive frequency tolerance (up to .01 percent) to compensate for frequency shift caused by numerous repeaters between base band signal insertion. Where such relaxation is sought, applicant must provide all calculations and indicate the desired tolerance over each path. In such instances the radio transmitters and receivers used must individually be capable of complying with the tolerance specified in paragraph (a) of this section. Heterodyne operation is restricted to channel bandwidth of 10 MHz or greater.

(c) As an additional requirement in any band where the Commission makes assignments according to a specified channel plan, provisions must be made to prevent the emission included within the occupied bandwidth from radiating outside the assigned channel at a level greater than that specified in § 101.111.

[61 FR 26677, May 28, 1996, as amended at 62 FR 23167, Apr. 29, 1997; 63 FR 6105, Feb. 6, 1998; 63 FR 9448, Feb. 25, 1998; 63 FR 14039, Mar. 24, 1998; 63 FR 36611, July 7, 1998; 66 FR 35110, July 3, 2001; 67 FR 43038, June 26, 2002; 68 FR 4956, Jan. 31, 2003; 69 FR 3266, Jan. 23, 2004; 69 FR 16832, Mar. 31, 2004; 70 FR 4787, Jan. 31, 2005; 76 FR 59572, Sept. 27, 2011; 81 FR 79945, Nov. 14, 2016]

### § 101.109 Bandwidth.

(a) Each authorization issued pursuant to these rules will show, as the emission designator, a symbol representing the class of emission which must be prefixed by a number specifying the necessary bandwidth. This figure does not necessarily indicate the bandwidth actually occupied by the emission at any instant. In those cases

where part 2 of this chapter does not provide a formula for the computation of the necessary bandwidth, the occupied bandwidth may be used in the emission designator.

(b) Stations in this service will be authorized any type of emission, method of modulation, and transmission characteristic, consistent with efficient use of the spectrum and good engineering practice, except that Type B, damped-wave emission will not be authorized.

(c) The maximum bandwidth which will be authorized per frequency assigned is set out in the table that follows. Regardless of the maximum authorized bandwidth specified for each frequency band, the Commission reserves the right to issue a license for less than the maximum bandwidth if it appears that a lesser bandwidth would be sufficient to support an applicant's intended communications.

| Frequency band (MHz) | Maximum authorized bandwidth |
|---|---|
| 928 to 929 | 25 kHz[1 5 6] |
| 932 to 932.5, 941 to 941.5 | 12.5 kHz[1 5 6] |
| 932.5 to 935, 941.5 to 944 | 200 kHz[1] |
| 952 to 960 | 200 KHz[1 5 6] |
| 1,850 to 1,990 | 10 MHz[1] |
| 2,110 to 2,130 | 3.5 MHz |
| 2,130 to 2,150 | 800 or 1600 KHz[1] |
| 2,150 to 2,160 | 10 MHz |
| 2,160 to 2,180 | 3.5 MHz |
| 2,180 to 2,200 | 800 or 1600 KHz[1] |
| 2,450 to 2,483.5 | 625 KHz[2] |
| 2,483.5 to 2,500 | 800 KHz |
| 3,700 to 4,200 | 20 MHz |
| 5,925 to 6,425 | [1]60 |
| 6,425 to 6,525 | 25 MHz |
| 6,525 to 6,875 | 30 MHz.[1] |
| 6,875 to 7,125 | 25 MHz[1] |
| 10,550 to 10,680 | 5 MHz[1] |
| 10,700 to 11,700 | [1]80 |
| 12,200 to 12,700[8] | 500 megahertz |
| 12,700 to 13,150 | 50 MHz |
| 13,200 to 13,250 | 25 MHz |
| 17,700 to 18,140 | 220 MHz[1] |
| 18,140 to 18,142 | 2 MHz |
| 18,142 to 18,580 | 6 MHz |
| 18,580 to 18,820 | 20 MHz[1] |
| 18,820 to 18,920 | 10 MHz |
| 18,920 to 19,160 | 20 MHz[1] |
| 19,160 to 19,260 | 10 MHz |
| 19,260 to 19,700 | 220 MHz[1] |
| 21,200 to 23,600 | 50 MHz[1 4] |
| 24,250 to 25,250 | 40 MHz[7] |
| 29,100 to 29,250 | 150 MHz |
| 31,000 to 31,075 | 75 MHz |
| 31,075 to 31,225 | 150 MHz |
| 31,225 to 31,300 | 75 MHz |
| 71,000 to 76,000 | 5000 MHz |
| 81,000 to 86,000 | 5000 MHz |
| 92,000 to 95,000 | [3] |

[1] The maximum bandwidth that will be authorized for each particular frequency in this band is detailed in the appropriate frequency table in § 101.147. If contiguous channels are aggregated in the 928–928.85/952–952.85/956.25–956.45 MHz, the 928.85–929/959.85–960 MHz, or the 932–932.5/941–941.5 MHz bands, then the bandwidth may exceed that which is listed in the table.

[2] 1250 KHz, 1875 KHz, or 2500 KHz on a case-by-case basis.

[3] To be specified in authorization. For the band 92 to 95 GHz, maximum bandwidth is licensed in one segment of 2 GHz from 92–94 GHz and one 0.9 GHz segment from 94.1 to 95 GHz, or the total of the loaded band if smaller than the assigned bandwidth.

[4] For exceptions, see § 101.147(s).

[5] A 12.5 kHz bandwidth applies only to frequencies listed in § 101.147(b)(1) through (4).

[6] For frequencies listed in § 101.147(b)(1) through (4), consideration will be given on a case-by-case basis to authorizing bandwidths up to 50 kHz.

[7] For channel block assignments in the 24,250–25,250 MHz band, the authorized bandwidth is equivalent to an unpaired channel block assignment or to either half of a symmetrical paired channel block assignment. When adjacent channels are aggregated, equipment is permitted to operate over the full channel block aggregation without restriction.

NOTE TO FOOTNOTE 7: Unwanted emissions shall be suppressed at the aggregate channel block edges based on the same roll-off rate as is specified for a single channel block in § 101.111(a)(1) or in § 101.111(a)(2)(ii) and (iii) as appropriate.

[8] For incumbent private operational fixed point-to-point stations in this band (those not licensed as MVDDS), the maximum bandwidth shall be 20 MHz.

[61 FR 26677, May 28, 1996, as amended at 61 FR 44181, Aug. 28, 1996; 62 FR 23167, Apr. 29, 1997; 62 FR 24582, May 6, 1997; 63 FR 6105, Feb. 6, 1998; 65 FR 17449, Apr. 3, 2000; 65 FR 38329, June 20, 2000; 65 FR 59358, Oct. 5, 2000; 67 FR 43038, June 26, 2002; 68 FR 4956, Jan. 31, 2003; 69 FR 3266, Jan. 23, 2004; 70 FR 29997, May 25, 2005; 75 FR 41771, July 19, 2010; 76 FR 59572, Sept. 27, 2011; 77 FR 54432, Sept. 5, 2012; 81 FR 79945, Nov. 14, 2016]

### § 101.111 Emission limitations.

(a) The mean power of emissions must be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(1) When using transmissions other than those employing digital modulation techniques:

(i) On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 decibels;

(ii) On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 decibels;

(iii) On any frequency removed from the assigned frequency by more than

250 percent of the authorized bandwidth: At least 43 + 10 $Log_{10}$ (mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation.

(2) When using transmissions employing digital modulation techniques (see §101.141(b)) in situations not covered in this section:

(i) For operating frequencies below 15 GHz, in any 4 KHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 50 decibels:

A = 35 + 0.8(P −50) + 10 Log10 B. (Attenuation greater than 80 decibels or to an absolute power of less than −13 dBm/1MHz is not required.) where:

A = Attenuation (in decibels) below the mean output power level.
P = Percent removed from the center frequency of the transmitter bandwidth.
B = Authorized bandwidth in MHz.

NOTE: MVDDS operations in the 12.2–12.7 GHz band shall use 24 megahertz for the value of B in the emission mask equation set forth in this section. The emission mask limitation shall only apply at the 12.2–12.7 GHz band edges and does not restrict MVDDS channelization bandwidth within the band.

(ii) For operating frequencies above 15 GHz, in any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 250 percent of the authorized bandwidth: As specified by the following equation but in no event less than 11 decibels:

A = 11 + 0.4(P−50) + 10 $Log_{10}$ B. (Attenuation greater than 56 decibels or to an absolute power of less than −13 dBm/1MHz is not required.)

(iii) In any 1 MHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 $Log_{10}$ (the mean output power in watts) decibels, or 80 decibels, whichever is the lesser attenuation. The authorized bandwidth includes the nominal radio frequency bandwidth of an individual transmitter/modulator in block-assigned bands. Equipment licensed prior to April 1, 2005 shall only be required to meet this standard in any 4 kHz band.

(iv) The emission mask for LMDS and the 24 GHz Service shall use the equation in paragraph (a)(2)(ii) of this section and apply it only to the band edge of each block of spectrum, but not to subchannels established by licensees. The value of P in the equation is the percentage removed from the carrier frequency and assumes that the carrier frequency is the center of the actual bandwidth used. The emission mask can be satisfied by locating a carrier of the subchannel sufficiently far from the channel edges so that the emission levels of the mask are satisfied. The LMDS or 24 GHz emission mask shall use a value B (bandwidth) of 40 MHz, for all cases even in the case where a narrower subchannel is used (for instance the actual bandwidth is 10 MHz) and the mean output power used in the calculation is the sum of the output power of a fully populated channel. For block assigned channels, the out-of-band emission limits apply only outside the assigned band of operation and not within the band.

(v) The emission mask for the 71–76 GHz, 81–86 GHz, 92–94 GHz, and 94.1–95 GHz bands used in the equation in paragraph (a)(2)(ii) of this section applies only to the edge of each channel, but not to sub-channels established by licensees. The value of P in the equation is for the percentage removed from the carrier frequency and assumes that the carrier frequency is the center of the actual bandwidth used. The value of B will always be 500 MHz. In the case where a narrower sub-channel is used within the assigned bandwidth, such sub-carrier will be located sufficiently far from the channel edges to satisfy the emission levels of the mask. The mean output power used in the calculation is the sum of the output power of a fully populated channel.

(3) For Digital Termination System channels used in the Digital Electronic Message Service (DEMS) operating in the 10,550–10,680 MHz band:

(i) In any 4 KHz band, the center frequency of which is removed from the edge of the DEMS channel by up to and including 1.125 times the DEMS subchannel bandwidth: As specified by the

following equation may in no event be less than 50 + 10 $\log_{10}$ N decibels:

$A = 50 + 0.0333(F - 0.5B) + 10 \log_{10} N$ decibels

Where:

A = Attenuation (in decibels) below means output power level contained within the DEMS channel for a given polarization.
B = Bandwidth of DEMS channel (in KHz).
F = Absolute value of the difference between the center frequency of the 4 KHz band measured and the center frequency of the DEMS channel (in KHz).
N = Number of active subchannels of the given polarization within the DEMS channel.

(ii) In any 4 KHz band within the authorized DEMS band the center frequency of which is removed from the center frequency of the DEMS channel by more than the sum of 50% of the DEMS channel bandwidth plus 1.125 times the subchannel bandwidth: As specified by the following equation but in no event less than 80 decibels:

$A = 80 + 10 \log_{10} N$ decibels

(iii) In any 4 KHz band the center frequency of which is outside the authorized DEMS band: At least 43 + 10 $\log_{10}$ (mean output power in watts) decibels.

(4) For DEMS channels in the 17,700–19,700 MHz band:

(i) In any 4 KHz band, the center frequency of which is removed from the frequency of the center of the DEMS channel by more than 50 percent of the DEMS channel bandwidth up to and including 50 percent plus 500 KHz: As specified by the following equation but in no event be less than 50 + 10 $\log_{10}$ N decibels:

$A = 50 + 0.06(F - 0.5B) + 10 \log_{10} N$ decibels

Where:

A = Attenuation (in decibels) below means output power level contained within the DEMS channel for a given polarization.
B = Bandwidth of DEMS channel (in KHz).
F = Absolute value of the difference between the center frequency of the 4 KHz band measured and the center frequency of the DEMS channel (in KHz).
N = Number of active subchannels of the given polarization within the DEMS channel.

(ii) In any 4 KHz band within the authorized DEMS band, the center frequency of which is removed from the center frequency of the DEMS channel by more than the sum of 50 percent of the channel bandwidth plus 500 KHz: As specified by the following equation but in no event less than 80 decibels:

$A = 80 + 10 \log_{10} N$ decibels

(iii) In any 4 KHz band the center frequency of which is outside the authorized Digital Message Service band: At least 43 + 10 $\log_{10}$ (mean output power in watts) decibels.

(5) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a 12.5 KHz bandwidth, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 2.5 KHz up to and including 6.25 KHz: At least 53 $\log_{10}$ (fd/2.5) decibels;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 6.25 KHz up to and including 9.5 KHz: At least 103 $\log_{10}$ (fd/3.9) decibels;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 9.5 KHz up to and including 15 KHz: At least 157 $\log_{10}$ (fd/5.3) decibels; and

(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 KHz: At least 50 plus 10 $\log_{10}$(P) or 70 decibels, whichever is the lesser attenuation.

(6) When using transmissions employing digital modulation techniques on the 900 MHz multiple address frequencies with a bandwidth greater than 12.5 KHz, the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) in accordance with the following schedule:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in KHz) of more than 5 KHz up to and including 10 KHz: At least 83 $\log_{10}$ (fd/5) decibels;