

§ 87.139 Emission limitations.

(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the frequency bands 1435–1535 MHz and 2310–2390 MHz or digital modulation (G7D) for differential GPS, the mean power of any emission must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least $43 + 10 \log_{10} pY$ dB.

(b) For aircraft station transmitters and for aeronautical station transmitters first installed before February 1, 1983, and using H2B, H3E, J3E, J7B or J9W, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 4.0 kHz, the attenuation must be at least 25 dB.

(2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 4.0 kHz, the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 4.0 kHz for aircraft station transmitters the attenuation must be at least 40 dB; and for aeronautical station transmitters the attenuation must be at least $43 + 10 \log_{10} pY$ dB.

(c) For aircraft station transmitters first installed after February 1, 1983,

and for aeronautical station transmitters in use after February 1, 1983, and using H2B, H3E, J3E, J7B or J9W, the peak envelope power of any emissions must be attenuated below the peak envelope power of the transmitter (pX) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 30 dB.

(2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 38 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 3.0 kHz for aircraft transmitters the attenuation must be at least 43 dB. For aeronautical station transmitters with transmitter power up to and including 50 watts the attenuation must be at least $43 + 10 \log_{10} pX$ dB and with transmitter power more than 50 watts the attenuation must be at least 60 dB.

(d) Except for telemetry in the 1435–1535 MHz band, when the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth for aircraft stations above 30 MHz and all ground stations the attenuation must be at least $43 + 10 \log_{10} pY$ dB.

(e) When using frequency modulation or digital modulation for telemetry or telecommand in the 1435–1535 MHz and 2310–2390 MHz frequency bands with an authorized bandwidth equal to or less than 1 MHz the emissions must be attenuated as follows:

(1) On any frequency removed from the assigned frequency by more than 100 percent of the authorized bandwidth up to and including 100 percent plus 0.5 MHz, the attenuation must be at least 60 dB, when measured in a 3.0 kHz bandwidth. This signal need not be attenuated more than 25 dB below 1 milliwatt.

(2) On any frequency removed from the assigned frequency by more than 100 percent of the authorized bandwidth plus 0.5 MHz, the attenuation

must be at least $55 + 10 \log_{10}$ pY dB when measured in a 3.0 kHz bandwidth.

(f) When using frequency modulation or digital modulation for telemetry or telecommand in the 1435–1535 MHz or 2310–2390 MHz frequency bands with an authorized bandwidth greater than 1 MHz, the emissions must be attenuated as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent of the authorized bandwidth plus 0.5 MHz up to and including 50 percent of the authorized bandwidth plus 1.0 MHz, the attenuation must be 60 dB, when measured in a 3.0 kHz bandwidth. The signal need not be attenuated more than 25 dB below 1 milliwatt.

(2) On any frequency removed from the assigned frequency by more than 50 percent of the authorized bandwidth plus 1.0 MHz, the attenuation must be at least $55 + 10 \log_{10}$ pY dB, when measured in a 3.0 kHz bandwidth.

(g) The requirements of paragraphs (e) and (f) of this section apply to transmitters approved after January 1, 1977, and to all transmitters first installed after January 1, 1983.

(h) For ELTs operating on 121.500 MHz, 243.000 MHz and 406.0–406.1 MHz the mean power of any emission must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is moved from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent of the authorized bandwidth the attenuation must be at least 30 dB.

(i) In case of conflict with other provisions of § 87.139, the provisions of this paragraph shall govern for aircraft earth stations. When using G1D, G1E, or G1W emissions in the 1646.5–1660.5 MHz frequency band, the emissions must be attenuated as shown below.

(1) At rated output power, while transmitting a modulated single carrier, the composite spurious and noise output shall be attenuated by at least:

Frequency (MHz)	Attenuation (dB) ¹
0.01 to 1525	–135 dB/4 kHz
1525 to 1559	–203 dB/4 kHz
1559 to 1585	–155 dB/MHz

Frequency (MHz)	Attenuation (dB) ¹
1585 to 1605	–143 dB/MHz
1605 to 1610	–117 dB/MHz
1610 to 1610.6	–95 dB/MHz
1610.6 to 1613.8	–80 dBW/MHz ³
1613.8 to 1614	–95 dB/MHz
1614 to 1626.5	–70 dB/4 kHz
1626.5 to 1660	–70 dB/4 kHz ^{2 3 4}
1660 to 1670	–49.5 dBW/20 kHz ^{2 3 4}
1670 to 1735	–60 dB/4 kHz
1735 to 12000	–105 dB/4 kHz
12000 to 18000	–70 dB/4 kHz

¹ These values are expressed in dB referenced to the carrier for the bandwidth indicated, and relative to the maximum emission envelope level, except where the attenuation is shown in dBW, the attenuation is expressed in terms of absolute power referenced to the bandwidth indicated.

² Attenuation measured within the transmit band excludes the band ± 35 kHz of the carrier frequency.

³ This level is not applicable for intermodulation products.

⁴ The upper limit for the excess power for any narrow-band spurious emission (excluding intermodulation products within a 30 kHz measurement bandwidth) shall be 10 dB above the power limit in this table.

(2) The transmitter emission limit is a function of the modulation type and symbol rate (SR). Symbol Rate is expressed in symbols per second.

(3) While transmitting a single modulated signal at the rated output power of the transmitter, the emissions must be attenuated below the maximum emission level by at least:

Frequency Offset (normalized to SR)	Attenuation (dB)
$\pm 0.75 \times \text{SR}$	0
$\pm 1.40 \times \text{SR}$	20
$\pm 2.95 \times \text{SR}$	40

Where:

SR = Symbol Rate,

SR = $1 \times$ channel rate for BPSK,

SR = $0.5 \times$ channel rate for QPSK.

The mask shall be defined by drawing straight lines through the above points.

(j) When using G7D for differential GPS in the 112–118 MHz band, the amount of power during transmission under all operating conditions when measured over a 25 kHz bandwidth centered on either of the second adjacent channels shall not exceed –25 dBm and shall decrease 5 dB per octave until –52 dBm.

(k) For VHF aeronautical stations and aircraft stations operating with G1D or G7D emissions:

(1) The amount of power measured across either first adjacent 25 kHz channel shall not exceed 2 dBm.

(2) For stations first installed before January 1, 2002, the amount of power measured across either second adjacent

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channel shall be less than -25 dBm and the power measured in any other adjacent 25 kHz channels shall monotonically decrease at a rate of at least 5 dB per octave to a maximum value of -52 dBm. For stations first installed on or after January 1, 2002,

(i) The amount of power measured across either second adjacent 25 kHz channel shall be less than -28 dBm;

(ii) The amount of power measured across either fourth adjacent 25 kHz channel shall be less than -38 dBm; and

(iii) From thereon the power measured in any other adjacent 25 kHz channel shall monotonically decrease at a rate of at least 5 dB per octave to a maximum value of -53 dBm.

(3) The amount of power measured over a 16 kHz channel bandwidth centered on the first adjacent 25 kHz channel shall not exceed -18 dBm.

(1)(1) For Universal Access Transceiver transmitters, the average emissions measured in a 100 kHz bandwidth must be attenuated below the maximum emission level contained within the authorized bandwidth by at least:

Frequency (MHz)	Attenuation (dB)
± 0.5	0
± 1.0	18
± 2.25	50
± 3.25	60

(2) Universal Access Transceiver transmitters with an output power of 5 Watts or more must limit their emissions by at least $43 + 10 \log (P)$ dB on any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth. Those emissions shall be measured with a bandwidth of 100 kHz. P in the above equation is the average transmitter power measured within the occupied bandwidth in Watts.

(3) Universal Access Transceiver transmitters with less than 5 Watts of output power must limit their emissions by at least 40 dB relative to the carrier peak on any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth.

Those emissions shall be measured with a bandwidth of 100 kHz.

[53 FR 28940, Aug. 1, 1988, as amended at 56 FR 11518, Mar. 19, 1991; 57 FR 45749, Oct. 5, 1992; 58 FR 30127, May 26, 1993; 58 FR 67695, Dec. 22, 1993; 59 FR 35269, July 11, 1994; 63 FR 36607, July 7, 1998; 64 FR 27475, May 20, 1999; 66 FR 26799, May 15, 2001; 67 FR 4676, Jan. 31, 2002; 69 FR 32881, June 14, 2004; 71 FR 70676, Dec. 6, 2006]

§ 87.141 Modulation requirements.

(a) When A3E emission is used, the modulation percentage must not exceed 100 percent. This requirement does not apply to emergency locator transmitters or survival craft transmitters.

(b) A double sideband full carrier amplitude modulated radiotelephone transmitter with rated carrier power output exceeding 10 watts must be capable of automatically preventing modulation in excess of 100 percent.

(c) If any licensed radiotelephone transmitter causes harmful interference to any authorized radio service because of excessive modulation, the Commission will require the use of the transmitter to be discontinued until it is rendered capable of automatically preventing modulation in excess of 100 percent.

(d) Single sideband transmitters must be able to operate in the following modes:

Carrier mode	Level N(dB) of the carrier with respect to peak envelope power
Full carrier (H3E)	$O > N > -6$.
Suppressed carrier (J3E)	Aircraft stations $N < -26$; Aeronautical stations $N < -40$.

(e) Each frequency modulated transmitter operating in the band 72.0 – 76.0 MHz must have a modulation limiter.

(f) Each frequency modulated transmitter equipped with a modulation limiter must have a low pass filter between the modulation limiter and the modulated stage. At audio frequencies between 3 kHz and 15 kHz, the filter must have an attenuation greater than the attenuation at 1 kHz by at least $40 \log_{10} (f/3)$ db where ‘ f ’ is the frequency in kilohertz. Above 15 kHz, the attenuation must be at least 28 db greater than the attenuation at 1 kHz.