

Code of Federal Regulations (CFR)

Title 47 - Telecommunications

Chapter -1; Federal Communications Commission (FCC)
Part - 2; Frequency Allocations and Radio Treaty Matters;

General Rules and Regulations

Subpart C—Emissions

§2.201 Emission, modulation and transmission characteristics.

The following system of designating emission, modulation, and transmission Characteristics shall be employed.

(a) Emissions are designated according to their classification and their necessary bandwidth.

(b) A minimum of three symbols are used to describe the basic characteristics of radio waves. Emissions are classified and symbolized according to the following characteristics:

- (1) First symbol—type of modulation of the main character;
- (2) Second symbol—nature of signal (s) modulating the main carrier;
- (3) Third symbol—type of information to be transmitted.

NOTE: A fourth and fifth symbol are provided for additional information and are shown in Appendix 6, part A of the ITU Radio Regulations. Use of the fourth and fifth symbol is optional. Therefore, the symbols may be used as described in Appendix 6, but are not required by the Commission.

(c) First Symbol—types of modulation of the main carrier:

- (1) Emission of an unmodulated carrierN
- (2) Emission in which the main carrier is amplitude-modulated (including cases where sub-carriers are angle-modulated):

—Double-sidebandA

—Single-sideband, full carrierH

—Single-sideband, reduced or variable level carrierR

—Single-sideband, suppressed carrierJ

—Independent sidebandsB

—Vestigial sidebandC

- (3) Emission in which the main carrier is angle-modulated:

—Frequency modulationF

—Phase modulationG

NOTE: Whenever frequency modulation “F” is indicated, Phase modulation “G” is also acceptable.

(4) Emission in which the main carrier is amplitude and angle- modulated either simultaneously or in a pre-established sequence	D
(5) Emission of pulses:	
—Sequence of unmodulated pulses	P
—A sequence of pulses:	
—Modulated in amplitude	K
—Modulated in width/duration	L
—Modulated in position/phase	M
—In which the carrier is angle- modulated during the period of the pulse.....	Q
—Which is a combination of the foregoing or is produced by other means.....	V
(6) Cases not covered above, in which an emission consists of the main carrier modulated, either simultaneously or in a pre-established sequence, in a combination of two or more of the following modes:	
—Amplitude, angle, pulse	W
(7) Cases not otherwise covered	X
(d) Second Symbol—nature of signal(s) modulating the main carrier:	
(1) No modulating signal	0
(2) A single channel containing quantized or digital information without the use of a modulating sub-carrier, excluding time-division multiplex	1
(3) A single channel containing quantized or digital information with the use of a modulating sub-carrier, excluding time-division multiplex	2
(4) A single channel containing analogue information	3
(5) Two or more channels containing quantized or digital information.....	7
(6) Two or more channels containing analogue information	8
(7) Composite system with one or more channels containing quantized or digital information, together with one or more channels containing analogue information....	9
(8) Cases not otherwise covered	X
(e) Third Symbol—type of information to be transmitted:	
(1) No information transmitted	N
(2) Telegraphy—for aural reception	A
(3) Telegraphy—for automatic reception	B
(4) Facsimile	C
(5) Data transmission, telemetry, telecommand	D
(6) Telephony (including sound broadcasting)	E
(7) Television (video)	F
(8) Combination of the above	W
(9) Cases not otherwise covered	X
(f) Type B emission: As an exception to the above principles, damped waves are symbolized in the Commission's rules and regulations as type B emission. The use of type B emissions is forbidden.	

(g) Whenever the full designation of an emission is necessary, the symbol for that emission, as given above, shall be preceded by the “necessary bandwidth” of the emission as indicated in § 2.202(b)(1).

§ 2.202 Bandwidths.

(a) Occupied bandwidth. The frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission. In some cases, for example multichannel frequency-division systems, the percentage of 0.5 percent may lead to certain difficulties in the practical application of the definitions of occupied and necessary bandwidth; in such cases a different percentage may prove useful.

(b) Necessary bandwidth. For a given class of emission, the minimum value of the occupied bandwidth sufficient to ensure the transmission of information at the rate and with the quality required for the system employed, under specified conditions. Emissions useful for the good functioning of the receiving equipment as, for example, the emission corresponding to the carrier of reduced carrier systems, shall be included in the necessary bandwidth.

(1) The necessary bandwidth shall be expressed by three numerals and one letter. The letter occupies the position of the decimal point and represents the unit of bandwidth. The first character shall be neither zero nor K, M or G.

(2) Necessary bandwidths:

between 0.001 and 999 Hz shall be expressed in Hz (letter H);

between 1.00 and 999 kHz shall be expressed in kHz (letter K);

between 1.00 and 999 MHz shall be expressed in MHz (letter M);

between 1.00 and 999 GHz shall be expressed in GHz (letter G).

(3) Examples:

0.002 Hz—H002

0.1 Hz—H100

25.3 Hz—25H3

400 Hz—400H

2.4 kHz—2K40

6 kHz—6K00

12.5 kHz—12K5

180.4 kHz—180K

180.5 kHz—181K

180.7 kHz—181K

1.25 MHz—1M25

2 MHz—2M00

10 MHz—10M0

202 MHz—202M

5.65 GHz—5G65

(c) The necessary bandwidth may be determined by one of the following methods:

- (1) Use of the formulas included in the table, in paragraph (g) of this section, which also gives examples of necessary bandwidths and designation of corresponding emissions;
- (2) For frequency modulated radio systems which have a substantially linear relationship between the value of input voltage to the modulator and the resulting frequency deviation of the carrier and which carry either single sideband suppressed carrier frequency division multiplex speech channels or television, computation in accordance with provisions of paragraph (f) of this section and formulas and methods indicated in the table, in paragraph (g) of this section;
- (3) Computation in accordance with Recommendations of the International Radio Consultative Committee (C.C.I.R.);
- (4) Measurement in cases not covered by paragraph (c) (1), (2), or (3) of this section.

(d) The value so determined should be used when the full designation of an emission is required. **However, the necessary bandwidth so determined is not the only characteristic of an emission to be considered in evaluating the interference that may be caused by that emission.**

(e) In the formulation of the table in paragraph (g) of this section, the following terms are employed:

B_n = Necessary bandwidth in hertz

B = Modulation rate in bauds

N = Maximum possible number of black plus white elements to be transmitted per second, in facsimile

M = Maximum modulation frequency in hertz

C = Sub-carrier frequency in hertz

D = Peak frequency deviation, i.e., half the difference between the maximum and minimum values of the instantaneous frequency. The instantaneous frequency in hertz is the time rate of change in phase in radians divided by 2

t = Pulse duration in seconds at half-amplitude

t_r = Pulse rise time in seconds between 10% and 90% of maximum amplitude

K = An overall numerical factor which varies according to the emission and which depends upon the allowable signal distortion.

N_c = Number of baseband telephone channels in radio systems employing multichannel Multiplexing

P = Continuity pilot sub-carrier frequency (Hz) (continuous signal utilized to verify performance of frequency-division multiplex systems).

(f) Determination of values of D and B_n for systems specified in paragraph (c)(2) of this section:

(1) Determination of D in systems for multichannel telephony:

(i) The rms value of the per-channel deviation for the system shall be specified. (In the case of systems employing

preemphasis or phase modulation, this value of per-channel deviation shall be specified at the characteristic baseband frequency.)

(ii) The value of D is then calculated by multiplying the rms value of the per-channel deviation by the appropriate factors, as follows:

(2) The necessary bandwidth (B_n) normally is considered to be numerically equal to:

(i) $2M+2DK$, for systems having no continuity pilot subcarrier or having a continuity pilot subcarrier whose frequency is not the highest modulating the main carrier;

(ii) $2P+2DK$, for systems having a continuity pilot subcarrier whose frequency exceeds that of any other signal modulating the main carrier, unless the conditions set forth in paragraph (f)(3) of this section are met.

(3) As an exception to paragraph (f)(2)(ii) of this section, the necessary bandwidth (B_n) for such systems is numerically equal to $2P$ or $2M+2DK$, whichever is greater, provided the following conditions are met:

(i) The modulation index of the main carrier due to the continuity pilot subcarrier does not exceed 0.25, and (ii) In a radio system of multichannel telephony, the rms frequency deviation of the main carrier due to the continuity pilot subcarrier does not exceed 70 percent of the rms value of the per-channel deviation, or, in a radio system for television, the rms deviation of the main carrier due to the pilot does not exceed 3.55 percent of the peak deviation of the main carrier.

(g) Table of necessary bandwidths:

Description of emission	Necessary bandwidth		Designation of emission
	Formula	Sample calculation	
I. NO MODULATING SIGNAL			
Continuous wave emission.			N0N (zero)
II. AMPLITUDE MODULATION			
1. Signal With Quantized or Digital Information			
Continuous wave telegraphy.	$B_n=BK$, $K=5$ for fading circuits, $K=3$ for non-fading circuits	25 words per minute; $B=20$, $K=5$, Bandwidth: 100 Hz	100HA1A
Telegraphy by on-off keying of a tone modulated carrier.	$B_n=BK+2M$, $K=5$ for fading circuits, $K=3$ for non-fading circuits	25 words per minute; $B=20$, $M=1000$, $K=5$, Bandwidth: 2100 Hz=2.1 kHz	2K10A2A
Selective calling signal, single-sideband full carrier.	$B_n=M$	Maximum code frequency is: 2110 Hz, $M=2110$, Bandwidth: 2110 Hz=2.11 kHz	2K11H2B
Direct-printing telegraphy using a frequency shifted modulating sub-carrier single-sideband suppressed carrier.	$B_n=2M+2DK$, $M=B+2$	$B=50$, $D=35$ Hz (70 Hz shift), $K=1.2$, Bandwidth: 134 Hz	134HJ2B
Telegraphy, single sideband reduced carrier.	$B_n=\text{central frequency}+M+DK$, $M=B+2$	15 channels; highest central frequency is: 2805 Hz, $B=100$, $D=42.5$ Hz (85 Hz shift), $K=0.7$ Bandwidth: 2.885 Hz=2.885 kHz	2K89R7B
2. Telephony (Commercial Quality)			
Telephony double-sideband.	$B_n=2M$	$M=3000$, Bandwidth=6000 Hz=6 kHz	6K00A3E
Telephony, single-sideband, full carrier.	$B_n=2M$	$M=3000$, Bandwidth: 3000 Hz=3 kHz	3K00H3E
Telephony, single-sideband suppressed carrier.	$B_n=M - \text{lowest modulation frequency}$	$M=3000$, lowest modulation frequency is 3000 Hz, 2700 Hz Bandwidth: 2700Hz=2.7 kHz	2K70J3E
Telephony with separate frequency modulated signal to control the level of demodulated speech signal, single-sideband, reduced carrier.	$B_n=M$	Maximum control frequency is 2990 Hz, $M=2990$, Bandwidth: 2990 Hz=2.99 kHz	2K99R3E
Telephony with privacy, single-sideband, suppressed carrier (two or more channels).	$B_n=N_c M - \text{lowest modulation frequency in the lowest channel}$	$N_c=2$, $M=3000$ lowest modulation frequency is 250 Hz, Bandwidth: 5750 Hz=5.75 kHz	5K75J8E
Telephony, independent sideband (two or more channels).	$B_n=\text{sum of } M \text{ for each sideband}$	2 channels, $M=3000$, Bandwidth: 6000 Hz=6 kHz	6K00B8E

III-A. FREQUENCY MODULATION

1. Signal With Quantized or Digital Information

Telegraphy without error-correction (single channel).	$B_n=2M+2DK$, $M=B+2$, $K=1.2$ (typically)	$B=100$, $D=85$ Hz (170 Hz shift), Bandwidth: 304 Hz	304HF1B
Four-frequency duplex telegraphy.	$B_n=2M+2DK$, B =Modulation rate in bands of the faster channel. If the channels are synchronized: $M=B+2$, otherwise $M=2B$, $K=1.1$ (typically)	Spacing between adjacent frequencies=400 Hz; Synchronized channels; $B=100$, $M=50$, $D=600$ Hz, Bandwidth: 1420 Hz=1.42 kHz	1K42F7B

2. Telephony (Commercial Quality)

Commercial telephony ...	$B_n=2M+2DK$, $K=1$ (typically, but under conditions a higher value may be necessary)	For an average case of commercial telephony, $M=3,000$, Bandwidth: 16,000 Hz=16 kHz	16K0F3E
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Code of Federal Regulations (CFR)

Title 47 – Telecommunications

Chapter 1 – Federal Communications Commission (FCC)

Part 97 – Amateur Radio Service

Subpart D – Technical Standards

§97.3 Definitions.

(c) The following terms are used in this Part to indicate emission types. Refer to §2.201 of the FCC Rules, *Emission, modulation and transmission characteristics*, for information on emission type designators.

(1) *CW*. International Morse code telegraphy emissions having designators with A, C, H, J or R as the first symbol; 1 as the second symbol; A or B as the third symbol; and emissions J2A and J2B.

(2) *Data*. Telemetry, telecommand and computer communications emissions having (i) designators with A, C, D, F, G, H, J or R as the first symbol, 1 as the second symbol, and D as the third symbol; (ii) emission J2D; and (iii) emissions A1C, F1C, F2C, J2C, and J3C having an occupied bandwidth of 500 Hz or less when transmitted on an amateur service frequency below 30 MHz. Only a digital code of a type specifically authorized in this part may be transmitted.

(3) *Image*. Facsimile and television emissions having designators with A, C, D, F, G, H, J or R as the first symbol; 1, 2 or 3 as the second symbol; C or F as the third symbol; and emissions having B as the first symbol; 7, 8 or 9 as the second symbol; W as the third symbol.

(4) *MCW*. Tone-modulated international Morse code telegraphy emissions having designators with A, C, D, F, G, H or R as the first symbol; 2 as the second symbol; A or B as the third symbol.

(5) *Phone*. Speech and other sound emissions having designators with A, C, D, F, G, H, J or R as the first symbol; 1, 2 or 3 as the second symbol; E as the third symbol. Also speech emissions having B as the first symbol; 7, 8 or 9 as the second symbol; E as the third symbol. MCW for the purpose of performing the station identification procedure, or for providing telegraphy practice interspersed with speech. Incidental tones for the purpose of selective calling or alerting or to control the level of a demodulated signal may also be considered phone.

(6) *Pulse*. Emissions having designators with K, L, M, P, Q, V or W as the first symbol; 0, 1, 2, 3, 7, 8, 9 or X as the second symbol; A, B, C, D, E, F, N, W or X as the third symbol.

(7) *RTTY*. Narrow-band direct-printing telegraphy emissions having designators with A, C, D, F, G, H, J or R as the first symbol; 1 as the second symbol; B as the third symbol; and emission J2B. Only a digital code of a type specifically authorized in this part may be transmitted.

(8) *SS*. Spread-spectrum emissions using bandwidth-expansion modulation emissions having designators with A, C, D, F, G, H, J or R as the first symbol; X as the second symbol; X as the third symbol.

(9) *Test*. Emissions containing no information having the designators with N as the third symbol. Test does not include pulse emissions with no information or modulation unless pulse emissions are also authorized in the frequency band.

§97.301 Authorized frequency bands.

The following transmitting frequency bands are available to an amateur station located within 50 km of the Earth's surface, within the specified ITU Region, and outside any area where the amateur service is regulated by any authority other than the FCC.

(b) For a station having a control operator who has been granted an Amateur Extra Class operator license, who holds a CEPT radio amateur license, or who holds a Class 1 IARP license:

Wavelength band	ITU Region 1	ITU Region 2	ITU Region 3	Sharing requirements, see §97.303, paragraph:
(MF)	(kHz)			
160 m	1810-1850	1800-2000	1800-2000	(a), (b), (c)
(HF)	(MHz)			
80 m	3.50-3.60	3.50-3.60	3.50-3.60	(a)
75 m	3.60-3.80	3.60-4.00	3.60-3.90	(a)
40 m	7.0-7.2	7.0-7.3	7.0-7.2	(a), (t)
30 m	10.10-10.15	10.10-10.15	10.10-10.15	(d)
20 m	14.00-14.35	14.00-14.35	14.00-14.35	
17 m	18.068-18.168	18.068-18.168	18.068-18.168	
15 m	21.00-21.45	21.00-21.45	21.00-21.45	
12 m	24.89-24.99	24.89-24.99	24.89-24.99	
10 m	28.0-29.7	28.0-29.7	28.0-29.7	

§97.305 Authorized emission types.

(a) Except as specified elsewhere in this part, an amateur station may transmit a CW emission on any frequency authorized to the control operator.

(b) A station may transmit a test emission on any frequency authorized to the control operator for brief periods for experimental purposes, except that no pulse modulation emission may be transmitted on any frequency where pulse is not specifically authorized and no SS modulation emission may be transmitted on any frequency where SS is not specifically authorized.

(c) A station may transmit the following emission types on the frequencies indicated, as authorized to the control operator, subject to the standards specified in §97.307(f) of this part.

Wavelength band	Frequencies	Emission Types Authorized	Standards, see §97.307(f), paragraph:
<i>(MF:)</i>			
160 m	Entire band	RTTY, data	(3)
160 m	Entire band	Phone, image	(1), (2)
<i>(HF:)</i>			
80 m 3.500 - 3.600	Entire band	RTTY, data	(3), (9)
75 m 3.600 - 4.000	Entire band	Phone, image	(1), (2)
40 m	7.000-7.100 MHz	RTTY, data	(3), (9)
40 m	7.075-7.100 MHz	Phone, image	(1), (2), (9), (11)
40 m	7.100-7.125 MHz	RTTY, data	(3), (9)
40 m	7.125-7.300 MHz	Phone, image	(1), (2)
30 m	Entire band	RTTY, data	(3)
20 m	14.00-14.15 MHz	RTTY, data	(3)
20 m	14.15-14.35 MHz	Phone, image	(1), (2)
17 m	18.068-18.110 MHz	RTTY, data	(3)
17 m	18.110-18.168 MHz	Phone, image	(1), (2)
15 m	21.0-21.2 MHz	RTTY, data	(3), (9)
15 m	21.20-21.45 MHz	Phone, image	(1), (2)
12 m	24.89-24.93 MHz	RTTY, data	(3)
12 m	24.93-24.99 MHz	Phone, image	(1), (2)
10 m	28.0-28.3 MHz	RTTY, data	(4)
10 m	28.3-28.5 MHz	Phone, image	(1), (2), (10)
10 m	28.5-29.0 MHz	Phone, image	(1), (2)
10 m	29.0-29.7 MHz	Phone, image	(2)

§97.307 Emission standards.

(a) No amateur station transmission shall occupy more bandwidth than necessary for the information rate and emission type being transmitted, in accordance with good amateur practice.

(b) Emissions resulting from modulation must be confined to the band or segment available to the control operator. Emissions outside the necessary bandwidth must not cause splatter or keyclick interference to operations on adjacent frequencies.

(c) All spurious emissions from a station transmitter must be reduced to the greatest extent practicable. If any spurious emission, including chassis or power line radiation, causes harmful interference to the reception of another radio station, the licensee of the interfering amateur station is required to take steps to eliminate the interference, in accordance with good engineering practice.

(d) For transmitters installed after January 1, 2003, the mean power of any spurious emission from a station transmitter or external RF amplifier transmitting on a frequency below 30 MHz must be at least 43 dB below the mean power of the fundamental emission. For transmissions installed on or before January 1, 2003, the mean power of any spurious emission from a station transmitter or external RF power amplifier transmitting on a frequency below 30 MHz must not exceed 50 mW and must be at least 40 Db below the mean power of the fundamental emission. For a transmitter of mean power less than 5W installed on or before January 1, 2003, the attenuation must be at least 30 dB. A transmitter built before April 15, 1977, or first marketed before January 1, 1978, is exempt from this requirement.

(e) The mean power of any spurious emission from a station transmitter or external RF power amplifier transmitting on a frequency between 30-225 MHz must be at least 60 dB below the mean power of the fundamental. For a transmitter having a mean power of 25 W or less, the mean power of any spurious emission supplied to the antenna transmission line must not exceed 25 μ W and must be at least 40 dB below the mean power of the fundamental emission, but need not be reduced below the power of 10 μ W. A transmitter built before April 15, 1977, or first marketed before January 1, 1978, is exempt from this requirement.

(f) The following standards and limitations apply to transmissions on the frequencies specified in §97.305(c) of this Part.

(1) No angle-modulated emission may have a modulation index greater than 1 at the highest modulation frequency.

(2) No non-phone emission shall exceed the bandwidth of a communications quality phone emission of the same modulation type. The total bandwidth of an independent sideband emission (having B as the first symbol), or a multiplexed image and a phone emission, shall not exceed that of a communications quality A3E emission.

NOTE: Refer to § 2.202(g) Table of necessary bandwidths: