(7) The overall receiving system noise temperature (in kelvins) referred to the output of the receiving antenna.

(8) The class of observations to be taken. Class A observations are those in which the sensitivity of the equipment is not a primary factor. Class B observations are those of such a nature that they can be made only with advanced low-noise receivers using the best techniques.

(9) The name and mailing address of the operator.

(b) The permanent discontinuance of observations, or any change to the information above, should also be filed with the Commission.

(c) Observations being conducted on frequencies or frequency bands not allocated to the radio astronomy service should be reported as in paragraph (a) of this section for information purposes. Information in this category will not be submitted for entry in the Master International Frequency Register and protection from interference will not be afforded such operations by stations in other services.

### § 2.108 Policy regarding the use of the fixed-satellite allocations in the 3.6–3.7, 4.5–4.8, and 5.85–5.925 GHz bands.

The use of the fixed-satellite allocations in the United States in the above bands will be governed by footnote US245. Use of the fixed-satellite service allocations in these bands is for the international fixed-satellite service, that is, for international inter-continental communications. Case-by-case electromagnetic compatibility analysis is required with all users of the bands. It is anticipated that one earth station on each coast can be successfully coordinated. Specific locations of these earth stations depend upon service requirements and case-by-case EMC analyses that demonstrate compatible operations.

## 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 carrier | N |
| (2) Emission in which the main carrier is amplitude-modulated (including cases where sub-carriers are angle-modulated):. | |
| —Double-sideband | A |
| —Single-sideband, full carrier | H |
| —Single-sideband, reduced or variable level carrier | R |
| —Single-sideband, suppressed carrier | J |
| —Independent sidebands | B |
| —Vestigial sideband | C |
| (3) Emission in which the main carrier is angle-modulated:. | |
| —Frequency modulation | F |
| —Phase modulation | G |

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:[1]. | |
| —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 muliplex ..... 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:[2]

(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).

[49 FR 48697, Dec. 14, 1984]

### § 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);

[1] Emissions where the main carrier is directly modulated by a signal which has been coded into quantized form (e.g. pulse code modulation) should be designated under (2) or (3).

[2] In this context the word ''information'' does not include information of a constant, unvarying nature such as is provided by standard frequency emissions, continuous wave and pulse radars, etc.

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 | 180.5 kHz—181K |
| 0.1 Hz—H100 | 180.7 kHz—181K |
| 25.3 Hz—25H3 | 1.25 MHz—1M25 |
| 400 Hz—400H | 2 MHz—2M00 |
| 2.4 kHz—2K40 | 10 MHz—10M0 |
| 6 kHz—6K00 | 202 MHz—202M |
| 12.5 kHz—12K5 | 5.65 GHz—5G65 |
| 180.4 kHz—180K | |

(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:

| Number of message circuits | Multiplying factors | Limits of X ($P_{avg}$ (dBmO)) |
|---|---|---|
| More than 3, but less than 12 | 4.47 × [a factor specified by the equipment manufacturer or station licensee, subject to Commission approval]. | |
| At least 12, but less than 60 | $\frac{3.76 \text{ antilog } (X+2 \log_{10} N_c)}{20}$ | X: −2 to +2.6. |
| At least 60, but less than 240 | $\frac{3.76 \text{ antilog } (X+4 \log_{10} N_c)}{20}$ | X: −5.6 to −1.0. |
| 240 or more | $3.76 \text{ antilog } (X+10 \log_{10} N_c)$ | X: −19.6 to −15.0. |

| Number of message circuits | Multiplying factors | Limits of X ($P_{avg}$ (dBmO)) |
|---|---|---|
| | 20 | |

Where X represents the average power in a message circuit in dBmO; $N_c$ is the number of circuits in the multiplexed message load; 3.76 corresponds to a peak load factor of 11.5 dB.

(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. | $B_n$=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 − lowest modulation frequency | M=3000, lowest modulation frequency is 3000 Hz, 2700 Hz Bandwidth: 2700Hz=2.7 kHz | 2K70J3E |

| Description of emission | Necessary bandwidth | | Designation of emission |
|---|---|---|---|
| | Formula | Sample calculation | |
| 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 − 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). | $B_n$=sum of M for each sideband | 2 channels, M=3000, Bandwidth: 6000 Hz=6 kHz | 6K00B8E |
| 3. Sound Broadcasting | | | |
| Sound broadcasting, double-sideband. | $B_n$=2M, M may vary between 4000 and 10000 depending on the quality desired | Speech and music, M=4000, Bandwidth: 8000 Hz= 8 kHz | 8K00A3E |
| Sound broadcasting, single-sideband reduced carrier (single channel). | $B_n$=M, M may vary between 4000 and 10000 depending on the quality desired | Speech and music, M=4000, Bandwidth: 4000 Hz= 4 kHz | 4K00R3E |
| Sound broadcasting, single-sideband, suppressed carrier. | $B_n$=M − lowest modulation frequency | Speech and music, M=4500, lowest modulation frequency=50 Hz, Bandwidth: 4450 Hz=4.45 kHz | 4K45J3E |
| 4. Television | | | |
| Television, vision and sound. | Refer to CCIR documents for the bandwidths of the commonly used television systems | Number of lines=525; Nominal video bandwidth: 4.2 MHz, Sound carrier relative to video carrier=4.5 MHz | 5M75C3F |
| | | Total vision bandwidth: 5.75 MHz; FM aural bandwidth including guardbands: 250,000 Hz | 250KF3E |
| | | Total bandwidth: 6 MHz | 6M25C3F |
| 5. Facsimile | | | |
| Analogue facsimile by sub-carrier frequency modulation of a single-sideband emission with reduced carrier. | $B_n$=C–N÷2+DK, K=1.1 (typically) | N=1100, corresponding to an index of cooperation of 352 and a cycler rotation speed of 60 rpm. Index of cooperation is the product of the drum diameter and number of lines per unit length C=1900, D=400 Hz, Bandwidth=2.890 Hz=2.89 kHz | 2K89R3C |
| Analogue facsimile; frequency modulation of an audio frequency sub-carrier which modulates the main carrier, single-sideband suppressed carrier. | $B_n$=2M+2DK, M=N/2, K=1.1 (typically) | N=1100, D=400 Hz, Bandwidth: 1980 Hz=1.98 kHz | 1K98J3C |
| 6. Composite Emissions | | | |
| Double-sideband, television relay. | $B_n$=2C+2M+2D | Video limited to 5 MHz, audio on 6.5 MHz frequency modulated subcarrier deviation=50 kHz: C=6.5×$10^6$ D=50×$10^3$ Hz, M=15,000, Bandwidth: 13.13×$10^6$ Hz=13.13 MHz | 13M2A8W |
| Double-sideband radio relay system. | $B_n$=2M | 10 voice channels occupying baseband between 1 kHz and 164 kHz; M=164,000 bandwith=328,000 Hz=328 kHz | 328KA8E |

| Description of emission | Necessary bandwidth | | Designation of emission |
|---|---|---|---|
| | Formula | Sample calculation | |
| Double-sideband emission of VOR with voice (VOR=VHF omnidirectional radio range). | $B_n=2C_{max}+2M+2DK$, K=1 (typically) | The main carrier is modulated by: —a 30 Hz sub-carrier—a carrier resulting from a 9960 Hz tone frequency modulated by a 30 Hz tone—a telephone channel—a 1020 Hz keyed tone for continual Morse identification. $C_{max}$=9960, M=30, D=480 Hz, Bandwidth: 20,940 Hz=20.94 kHz | 20K9A9W |
| Independent sidebands; several telegraph channels together with several telephone channels. | $B_n$=sum of M for each sideband | Normally composite systems are operated in accordance with standardized channel arrangements, (e.g. CCIR Rec. 348–2) 3 telephone channels and 15 telegraphy channels require the bandwidth 12,000 Hz=12 kHz | 12K0B9W |
| **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 |
| 3. Sound Broadcasting | | | |
| Sound broadcasting ..... | $B_n$=2M+2DK, K=1 (typically) | Monaural, D=75,000 Hz, M=15,000, Bandwidth: 18,000 Hz=180 kHz | 180KF3E |
| 4. Facsimile | | | |
| Facsimile by direct frequency modulation of the carrier; black and white. | $B_n$=2M+2DK, M=N÷2, K=1.1 (typically) | N=1100 elements/sec; D=400 Hz, Bandwidth: 1980 Hz=1.98 kHZ | 1K98F1C |
| Analogue facsimile ..... | $B_n$=2M+2DK, M=N÷2, K=1.1 (typically) | N=1100 elements/sec; D=400 Hz, Bandwidth: 1980 Hz=1.98 kHz | 1K98F3C |
| 5. Composite Emissions (See Table III–B) | | | |
| Radio-relay system, frequency division multiplex. | $B_n$=2P+2DK, K=1 | Microwave radio relay system specifications: 60 telephone channels occupying baseband between 60 and 300 kHz; rms per-channel deviation 200 kHz; pilot at 331 kHz produces 200 kHz rms deviation of main carrier. Computation of $B_n$: D=(200×10³3×3.76×1.19), Hz=0.895×10⁶, P=0.331×10⁶ Hz; Bandwidth: 2.452×10⁶ Hz | 2M45F8E |

| Description of emission | Necessary bandwidth | | Designation of emission |
|---|---|---|---|
| | Formula | Sample calculation | |
| Radio-relay system frequency division multiple. | $B_n$=2M+2DK, K=1 | Microwave radio relay relay systems specifications: 1200 telephone channels occupying baseband between 60 and 5564 kHz; rms per channel deviation 200 kHz; continunity pilot at 6199 kHz produces 140 kHz rms deviation of main carrier. Computation of $B_n$: D=($20^0$×$10^3$× 3.76×3.63)=2.73×$10^6$; M=5.64×$10^6$ Hz; P=6.2×$10^6$ Hz; (2M+2DK<2P; Bandwidth 16.59×$10^6$ Hz | 16M6F8E |
| Radio-relay system, frequency division multiplex. | $B_n$=2P | Microwave radio relay system specifications: Multiplex 600 telephone channels occupying baseband between 60 and 2540 kHz; continuity pilot at 8500 kHz produces 140 kHz rms deviation of main carrier. Computation of Bn: D=(200×$10^3$×3.76 × 2.565)=1.93×$10^6$ Hz; M=2.54×$10^6$ Hz; 2DK)≤2P Bandwidth: 17×$10^6$ Hz | 17M0F8E |
| Unmodulated pulse emission. | $B_n$=2K÷t, K depends upon the ratio of pulse rise time. Its value usually falls between 1 and 10 and in many cases it does not need to exceed 6 | Primary Radar Range resolution: 150 m, K=1.5 (triangular pulse where t≃$t_r$, only components down to 27 dB from the strongest are considered) Then t=2× range resolution÷velocity of light=2×150÷3×$10^8$=1×$10^{-6}$ seconds, Bandwidth: 3×$10^6$ Hz=3 MHz | 3M00P0N |
| 6. Composite Emissions | | | |
| Radio-relay system ..... | $B_n$=2K÷t, K=1.6 | Pulse position modulated by 36 voice channel baseband; pulse width at half amplitude=0.4 us, Bandwidth: 8×$10^6$ Hz=8 MHz (Bandwidth independent of the number of voice channels) | 8M00M7E |

[28 FR 12465, Nov. 22, 1963, as amended at 37 FR 8883, May 2, 1972; 37 FR 9996, May 18, 1972; 48 FR 16492, Apr. 18, 1983; 49 FR 48698, Dec. 14, 1984]

## Subpart D—Call Signs and Other Forms of Identifying Radio Transmissions

AUTHORITY: Secs. 4, 5, 303, 48 Stat., as amended, 1066, 1068, 1082; 47 U.S.C. 154, 155, 303.

### § 2.301 Station identification requirement.

Each station using radio frequencies shall identify its transmissions according to the procedures prescribed by the rules governing the class of station to which it belongs with a view to the elimination of harmful interference and the general enforcement of applicable radio treaties, conventions, regulations, arrangements, and agreements in force, and the enforcement of the Communications Act of 1934, as amended, and the Commission's rules.

[34 FR 5104, Mar. 12, 1969]

### § 2.302 Call signs.

The table which follows indicates the composition and blocks of international call signs available for assignment when such call signs are required by the rules pertaining to particular classes of stations. When stations operating in two or more classes are authorized to the same licensee for the same location, the Commission may elect to assign a separate call sign to each station in a different class. (In addition to the U.S. call sign allocations listed below, call sign blocks AAA through AEZ and ALA through ALZ have been assigned to the Department of the Army; call sign block AFA through AKZ has been assigned to the Department of the Air Force; and call sign block NAA through NZZ has been assigned jointly to the Department of the Navy and the U.S. Coast. Guard.