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TELECOMMUNICATIONS REGULATION CIRCULAR

NOTES REGARDING DESIGNATION OF EMISSION (INCLUDING NECESSARY BANDWIDTH AND CLASSIFICATION), CLASS OF STATION AND NATURE OF SERVICE

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TELECOMMUNICATION REGULATORY SERVICE

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1. INTRODUCTION

To facilitate spectrum management, radio stations and their emissions are classified into various categories as detailed in this document. A radio station may be classified as to type, nature of service and hours of operation as shown in Section 2. The emission is designated according to the classification as shown in Sections 3, 4 and 5. The method of determining necessary bandwidth is shown in Section 6.

When making an application for a licence to operate a radio station in accordance with the procedures established by the Department, an applicant should as far as possible use the methods and symbols contained in this document.

2. SOME USEFUL DEFINITIONS

The following ITU definitions of operational terminology may assist in the designation of radio emissions.

2.1 Telegraphy: A form of telecommunication which is concerned in any process providing transmission and reproduction at a distance of documentary matter, such as written or printed matter or fixed images, or the reproduction at a distance of any kind of information in such a form. For the purposes of the Radio Regulations, unless otherwise specified therein, telegraphy shall mean a form of telecommunication for the transmission of written matter by the use of signal code.

2.2 Telecommand: The use of telecommunication for the transmission of signals to initiate, modify or terminate functions of equipment at a distance.

2.3 Telemetry: The use of telecommunications for automatically indicating or recording measurements at a distance from the measuring instrument.

2.4 Telephony: A form of telecommunication set up for the transmission of speech or, in some cases, other sounds.

3. CLASS OF STATION AND NATURE OF SERVICE DESIGNATORS

3.1 Class of Station Designators

AL	Aeronautical radionavigation land station
AM	Aeronautical radionavigation mobile station
AT	Amateur station
AX	Aeronautical fixed station
BC	Broadcasting station, sound
BT	Broadcasting station, television
CA	Cargo ship
EA	Space station in the amateur
EB	Space station in the broadcasting-satellite service (sound broadcasting)
EC	Space station in the fixed-satellite service
ED	Space telecommand space station
EG	Space station in the maritime mobile-satellite service
EH	Space research space station
EK	Space tracking space station
EM	Meteorological-satellite space station
EN	Radionavigation-satellite space station
ER	Space telemetering space station
EV	Space station in the broadcasting-satellite service (Television)
EX	Experimental station
FA	Aeronautical station
FB	Base station
FC	Coast station
FL	Land station
FP	Port station

FR Receiving station only, connected with the general network of telecommunications channels

FS Land station established solely for the safety of life

FX Fixed station

GS Station on board a warship or a military or naval aircraft

LR Radiolocation land station

MA Aircraft station

ME Space station

ML Land mobile station

MO Mobile station

MR Radiolocation mobile station

MS Ship station

NL Maritime radionavigation land station

OD Oceanographic data station

OE Oceanographic data interrogating station

PA Passenger ship

RA Radio astronomy station

RC Non-directional radiobeacon

RD Directional radiobeacon

RG Radio direction-finding station

RM Maritime radionavigation mobile station

RT Revolving radiobeacon

SM Meteorological aids station

SS Standard frequency and time signal station

TA Space operation earth station in the amateur-satellite service

TC Earth station in the fixed-satellite service

TD Space telecommand earth station

TE Transmitting earth station

TF Fixed earth station in the radiodetermination-satellite service

TG Mobile earth station in the maritime mobile-satellite service

TH Earth station in the space research service

TI Earth station in the maritime mobile-satellite service at a specified fixed point

TK Space tracking earth station

TL Mobile earth station in the radiodetermination-satellite service

TM Earth station in the meteorological-satellite service

TN Earth station in the radionavigation-satellite service

TP Receiving earth station

TR Space telemetering earth station

TS Television, sound channel

TT Earth station in the space operation service

TV Television, vision channel

3.2 Nature of Service Designators

C Continuous operation during hours shown

CO Station open to official correspondence exclusively

CP Station open to public correspondence

CR Station open to limited correspondence

CV Station open exclusively to correspondence of a private agency

D30° Directive antenna having maximum radiation in the direction of 30° (expressed in degrees from true north, from 0 to 360 clockwise)

GMT Greenwich Mean Time

UTC Coordinated universal time (also referred to as Greenwich Mean Time (GMT))

H Scheduled operation

H8 8 hour service

H16 16 hour service

H24 Continuous throughout the 24 hours

HJ Day service

HN Night service

HT Transition period service

HX Intermittent throughout the 24 hours; or station having no specific service hours

I Intermittent operation during the time indicated

ND Non-directional antenna

OT Station open exclusively to operational traffic of the service concerned.

4. DESIGNATION OF EMISSIONS

Emissions are designated according to their necessary bandwidth and their classification.

In writing the designation of an emission, one first writes 4 characters which describe the necessary bandwidth. These four characters are followed by 3 to 5 additional characters which describe the classification.

Examples of emissions designated in accordance with sections 4 and 5 of this TRC are contained in this document starting on page 11.

5. DESIGNATION OF NECESSARY BANDWIDTH

The necessary bandwidth as determined in accordance with the examples given in this TRC are 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.

Necessary bandwidths:

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

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

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

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

Examples of designated necessary bandwidths would be:

0.002 Hz	= H002	6 kHz	= 6K00	1.25 MHz	= 1M25
0.1 Hz	= H100	12.5 kHz	= 12K5	2 MHz	= 2M00
25.3 Hz	= 25H3	180.4 kHz	= 180K	10 MHz	= 10M0
400 Hz	= 400H	180.5 kHz	= 181K	202 MHz	= 202M
2.4 kHz	= 2K40	180.7 kHz	= 181K	5.65 GHz	= 5G65

6. CLASSIFICATION OF EMISSIONS

A minimum of three symbols are used to describe the basic characteristics of radio waves. These are:

1. The first symbol - indicates the type of modulation of the main carrier;
2. The second symbol - indicates the nature of the signal(s) modulating the main carrier, and:
3. The third symbol - indicates the type of information being transmitted.

In addition a fourth and/or fifth symbol may be used to indicate the following:

4. The fourth symbol - indicates details about the signal(s), and;
5. The fifth symbol - indicates the nature of multiplexing.

Note: When either one or both of the two optional symbols are not used it is usual to replace that symbol with a dash (-).

6.1 First symbol - type of modulation of the main carrier

6.1.1 Emission of an unmodulated carrier	N
6.1.2 Emission in which the main carrier is amplitude-modulated (including cases where sub-carriers are angle-modulated).	
6.1.2.1 Double-sideband	A
6.1.2.2 Single-sideband, full carrier	H
6.1.2.3 Single-sideband, reduced or variable level carrier	R
6.1.2.4 Single-sideband, suppressed carrier	J
6.1.2.5 Independent sidebands	B
6.1.2.6 Vestigial sideband	C
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6.1.5.2 A sequence of pulses	
6.1.5.2.1 modulated in amplitude	K
6.1.5.2.2 modulated in width/duration	L
6.1.5.2.3 modulated in position/phase	M
6.1.5.2.4 in which the carrier is angle-modulated during the period of the pulse	Q
6.1.5.2.5 which is a combination of the fore-going or is produced by other means	V

[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 in 6.1.2 or 6.1.3.

6.1.6 Cases not covered above, 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
6.1.7 Cases not otherwise covered	X
6.2 Second symbol - nature of signal(s) modulating the main carrier	
6.2.1 No modulating signal	0
6.2.2 A single channel containing quantized or digital information without the use of a modulating sub-carrier[1]	1
6.2.3 A single channel containing quantized or digital information with the use of a modulating sub-carrier[2]	2
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6.3.8 Combination of the above	W

[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 in 6.1.2 or 6.1.3.

[2] This excludes time-division multiplex

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

6.3.9	Cases not otherwise covered	X
6.4	Fourth symbol - Details of signal(s)	
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6.4.2	Two-condition code with elements of the same number and duration without error-correction	B
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6.5.2	Code-division multiplex*	C
6.5.3	Frequency-division multiplex	F
6.5.4	Time-division multiplex	T
6.5.5	Combination of frequency-division multiplex and time-division multiplex	W
6.5.6	Other types of multiplexing	X

* This includes bandwidth expansion techniques.

7. DETERMINATION OF NECESSARY BANDWIDTHS

For the full designation of an emission, the necessary bandwidth, indicated in four characters, shall be added just before the classification symbols. When used, the necessary bandwidth shall be determined by one of the following methods:

a. use of the formulae included in the following table which also gives examples of necessary bandwidths and designation of corresponding emissions;

b. computation in accordance with methods detailed in an applicant's submission and subsequently accepted by the Department;

c. measurement, in cases not covered by 1. and 2. above. Such measurements must be conducted in accordance with CCIR Report 324 (latest revision).

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.

In the formulation of the table, the following terms have been 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

M_V = maximum significant frequency in megahertz of the NTSC television signal (frequency to be used is 3.8 MHz)

C = subcarrier frequency in hertz

D = peak 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 2π. For information on the derivation of D refer to Table 1.

D_V = peak video deviation in megahertz

D_S = video deviation in megahertz caused by one or more audio subcarriers

t = pulse duration in seconds at half-amplitude

t_r = pulse rise time in seconds between 10% and 90% amplitude

R = maximum transmission speed in bits per second

S = number of signalling states

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

N_C = number of baseband channels in radio systems employing multichannel multiplexing

P = continuity pilot subcarrier frequency in megahertz. The terms fp and P may be interchanged.

D = main carrier frequency offset due to luminance picture component (at low Average Picture Level) of the 525 line NTSC television signal. This produces the effective carrier for chroma and subcarrier signals. The carrier offset to be used is 0.2 D_V e.g. 0.8 MHz offset for 4 MHz peak deviation.

A = maximum significant sideband frequency caused by FM modulation of the highest FM modulated audio program subcarrier calculated according to the equation:

$$A = fsc + (Ba + 1) \times fa$$

where fsc = highest audio program subcarrier frequency in megahertz

Ba = modulation index for the peak deviation of the subcarrier caused by the top audio signal frequency. The peak deviation is normally considered to be 10 dB greater than the peak deviation caused by a reference audio test tone. The modulation index, Ba, is given by:

$$Ba = \frac{\text{peak audio deviation}}{\text{top audio signal frequency}}$$

fa = top audio signal frequency in megahertz modulating the highest audio program subcarrier frequency.

V_B = video baseband bandwidth in megahertz

E_D = energy dispersal bandwidth in megahertz

8. EXAMPLES OF DESIGNATION OF EMISSIONS

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
I. NO MODULATING SIGNAL			
Continuous wave emission	-	-	NON
II. AMPLITUDE MODULATION			
1. Signal with Quantized or Digital Information			
Continuous wave Telegraphy Morse Code	$B_n = BK$ K = 5 for fading circuits K = 3 for non-fading circuits	25 words per minute; B = 20, k = 5 Bandwidth : 100 Hz	100HA1AAN
Telegraphy by on-off keying of a tone modulated carrier, Morse Code	$B_n = BK + 2M$ K = 5 for fading circuits K = 3 for non-fading circuits	25 words per minute; B = 20, M = 1 000 K = 5 Bandwidth : 2 100 Hz = 2.1 kHz	2K10A2AAN
Selective calling signal using sequential single frequency code, single-sideband, full carrier	$B_n = M$	Maximum code frequency is : 2 110 Hz M = 2 110 Bandwidth : 2 110 Hz = 2.11 kHz	2K11H2BFN
Direct printing telegraphy using a frequency shifted modulating subcarrier, with error correction, single-sideband, suppressed carrier (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$	B = 50 D = 35 Hz (70 Hz shift) K = 1.2 Bandwidth : 134 Hz	134HJ2BCN

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Telegraphy, multi-channel with voice frequency, error-correction, some channels are time-division multiplexed, single-sideband, reduced carrier	B_n = highest central frequency + M + DK M = B/2	15 channels highest central frequency is : 2 805 Hz B = 100 D = 42.5 Hz (85 Hz shift) K = 0.7 Bandwidth : 2 885 Hz = 2.885 kHz	2K89R7BCW
2. Telephony (Commercial Quality)			
Telephony, double-sideband (single-channel)	B_n = 2M	M = 3 000 Bandwidth : 6 000 Hz = 6 kHz	6K00A3EJN
Telephony, single-sideband full carrier (single channel)	B_n = M	M = 3 000 Bandwidth : 3 000 Hz = 3 kHz	3K00H3EJN
Telephony, single-sideband, suppressed carrier (single-channel)	B_n = M - lowest modulation frequency	M = 3 000 lowest modulation frequency is 300 Hz Bandwidth : 2 700 Hz = 2.7 kHz	2K70J3EJN
Telephony with separate frequency modulated signal to control the level of demodulated speech signal, single-sideband, reduced carrier, (Lincompex) (single channel)	B_n = M	Maximum control frequency is 2 990 Hz M = 2 990 Bandwidth : 2 990 Hz = 2.99 kHz	2K99R3ELN

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
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 = 3 000 lowest modulation frequency is 250 Hz Bandwidth : 5 750 Hz = 5.75 kHz	5K75J8EKF
Telephony, independent sideband (two or more channels)	B_n = sum of M for each sideband	two channels M = 3 000 Bandwidth : 6 000 Hz = 6 kHz	6K00B8EJN
3. Sound Broadcasting			
Sound broadcasting double-sideband	$B_n = 2M$ M may vary between 4 000 and 10 000 depending on the quality desired	Speech and music M = 4 000 Bandwidth : 8 000 Hz = 8 kHz	8K00A3EGN
Sound broadcasting, single-sideband, reduced carrier (single channel)	$B_n = M$ M may vary between 4 000 and 10 000 depending on the quality desired	Speech and music, M = 4 000 Bandwidth : 4 000 Hz = 4 kHz	4K00R3EGN
Sound broadcasting, single-sideband, suppressed carrier	B_n = M - lowest modulation frequency	Speech and music, M = 4 500; lowest modulation = 50 Hz; Bandwidth : 4 450 Hz = 4.45 kHz	4K45J3EGN

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
4. Television			
Television, vision and sound	Refer to relevant 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=4.5MHz; Total vision bandwidth : 5.45 MHz; FM sound bandwidth including guardbands : 550 kHz RF channel bandwidth : 6.0 MHz	5M45C3F-- 550KF3EGN
5. Facsimile			
Analogue facsimile by subcarrier frequency modulation of a single-sideband emission with reduced carrier, monochrome	$B_n = C + \frac{N}{2} + DK$ K = 1.1 (typically)	N = 1 100 corresponding to an index of cooperation of 352 and a cylinder rotation speed of 60 rpm. Index of cooperation is the product of the drum diameter and number of lines per unit length. C = 1 900 D = 400 Hz Bandwidth : 2 890 Hz = 2.89 kHz	2K89R3CMN
Analogue facsimile; frequency modulation of an audio frequency subcarrier which modulates the main carrier, single-sideband suppressed carrier	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ K = 1.1 (typically)	N = 1 100 D = 400 Hz Bandwidth : 1 980 Hz = 1.98 kHz	1K98J3C--

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
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, sub-carrier deviation = 50 kHz $C = 6.5 \times 10^6$ $D = 50 \times 10^3$ Hz M = 15 000 Bandwidth : 13.13×10^6 Hz = 13.13 MHz	13M1A8W--
Double-sideband radio-relay system, frequency division multiplex	$B_n = 2M$	10 voice channels occupying base band between 1 and 164 kHz; M = 164 000 Bandwidth : 328 000 Hz =328 kHz	328KA8E--
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 subcarrier - a carrier resulting from a 9 960 Hz tone frequency modulated by a 30 Hz tone - a telephone channel - a 1 020 Hz keyed tone for continual Morse identification C_{max} = 9 960 M = 30 D = 480 Hz Bandwidth : 20 940 Hz = 20.94 kHz	20K9A9WWF

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Independent sidebands; several telegraph channels with error correction together with several telephone channels with privacy; frequency division multiplex	B_n = sum of M for each sideband	Normally composite systems are operated in accordance with standardized channel arrangements (e.g. CCIR-Rec. 348 (latest revision). 3 telephone channels and 15 telegraphy channels require the bandwidth 12 000 Hz = 12 kHz	12K0B9WWF
III FREQUENCY MODULATION			
1. Signal with Quantized or Digital Information			
Telegraphy without error-correction (single channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	B = 100 D = 85 Hz (170 Hz shift) Bandwidth : 304 Hz	304HF1BBN
Telegraphy, narrowband direct printing with error-correction (single-channel)	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	B = 100 D = 85 Hz (170 Hz shift) Bandwidth : 304 Hz	304HF1BCN
Selective calling signal	$B_n = 2M + 2DK$ $M = \frac{B}{2}$ $K = 1.2$ (typically)	B = 100 D = 85 Hz (170 Hz shift) Bandwidth : 304 Hz	304HF1BCN

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Four-frequency Duplex telegraphy	B_n = 2M + 2DK B = Modulation rate in bauds of the faster channel. If the channels are synchronized : M = $\frac{B}{2}$ (otherwise M = 2B) K = 1.1 (typically)	Spacing between adjacent frequencies = 400 Hz; Synchronized channels B = 100 M = 50 D = 600 Hz Bandwidth : 1 420 Hz = 1.42 kHz	1K42F7BDX
2. Telephony (Commercial Quality)			
Commercial telephony	B_n = 2M + 2DK K = 1 (typically, but under certain conditions a higher value may be necessary)	For an average case of commercial telephony, D = 5 000 Hz M = 3 000; Bandwidth : 16 000 Hz = 16 kHz	16K0F3EJN
3. Sound Broadcasting			
Sound broadcasting	B_n = 2M + 2DK K = 1 (typically)	Monaural D = 75 000 Hz, M = 15 000 Bandwidth : 180 000 Hz = 180 kHz	180KF3EGN

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
4. Facsimile			
Facsimile by direct frequency modulation of the carrier; black and white	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ $K = 1.1$ (typically)	N = 1 100 elements/ sec; D = 400 Hz Bandwidth : 1 980 Hz = 1.98 kHz	1K98F1C--
Analogue facsimile	$B_n = 2M + 2DK$ $M = \frac{N}{2}$ $K = 1.1$ (typically)	N = 1 100 elements/ sec; D = 400 Hz Bandwidth : 1 980 Hz = 1.98 kHz	1K98F3C--
5. Composite Emissions (see Table 1)			
Radio-relay system, frequency division multiplex	$B_n = 2P + 2DK$ $K = 1$ (typically)	60 telephone channels occupying baseband between 60 and 300 kHz; rms per-channel deviation : 200 kHz; continuity pilot at 331 kHz produces 100 kHz rms deviation of main carrier. $D = 200 \times 10^3 \times 3.76 \times 2.02 = 1.52 \times 10^6$ Hz $P = 0.331 \times 10^6$ Hz; Bandwidth : 3.702×10^6 Hz = 3.702 MHz	3M70F8EJF

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Radio-relay system; frequency division multiplex having no continuity pilot subcarrier or having a continuity pilot subcarrier whose frequency is not the highest modulating the main carrier.	$B_n = 2M + 2DK$ $K = 1$ (typically)	960 telephone channels occupying baseband between 60 and 4 028 kHz; rms per-channel deviation 200 kHz; $D = 200 \times 10^3 \times 3.76 \times 5.5 = 4.13 \times 10^6$Hz $M = 4.028 \times 10^6$; Bandwidth : 16.32×10^6 Hz =16.3MHz	16M3F8EJF
Radio-relay system; frequency division multiplex having a continuity pilot* subcarrier whose frequency exceeds that of any other signal modulating the main carrier.	$B_n = 2P$ or $B_n = 2M + 2DK$ whichever is the greater	960 telephone channels occupying baseband between 60 and 4 028 kHz; rms per-channel deviation 200 kHz; continuity pilot at 4 715 kHz produces 140 kHz rms deviation of main carrier $D = 200 \times 10^3 \times 3.76 \times 5.5 = 4.13 \times 10^6$Hz $M = 4.028 \times 10^6$; $P = 4.715 \times 10^6$; Bandwith: 16.32×10^6Hz = 16.3Mhz	16M3F8EJF

*These methods of calculating necessary bandwith apply only when the RMS deviation of the main carrier by a continuity pilot subcarrier and/or when the audio subcarrier is small with respect to the main carrier deviation. Typically the RMS deviation of the main carrier by a continuity pilot subcarrier or by audio subcarriers is between 2.5% and 7.5%.

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Radio-relay system; frequency division multiplex having a continuity pilot subcarrier which causes more than 7.5% of the RMS deviation of the main carrier.	$B_n = 2P$	600 telephone channels occupying baseband between 60 kHz and 2 540 kHz; rms per-channel deviation: 200 kHz; continuity pilot at 8 500 kHz produces 140 kHz rms deviation of main carrier. $D = 200 \times 10^3 \times 3.76 \times 4.36 = 3.28 \times 10^6$ Hz; $M = 2.54 \times 10^6$; $K = 1$; $P = 8.5 \times 10^6$; $(2M + 2DK) < 2P$ Bandwidth 17×10^6 Hz = 17 MHz	17M0F8EJF
Stereophonic sound broadcasting with multiplexed subsidiary telephony subcarrier	$B_n = 2M + 2DK$ $K = 1$ (typically)	Pilot tone system M = 75 000; D = 75 000 Hz; Bandwidth : 300 000 Hz = 300 kHz	300KF8EHF
FM/Television Satellite Relay with or without audio programming or continuity pilot subcarriers	$B_n = 2(V_B + D_S + E_D + D_V)$	Video Baseband NTSC 525 line Baseband. Video Deviation = 2.0 MHz Energy Dispersal = 1.0 MHz Peak Deviation = 11.0 MHz Bandwidth: =36.4 MHz	36M4F8FNF

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
FM/Television Relay with or without audio programming or continuity pilot subcarriers *	$B_n = 2(M_V+D_V+0)$ or $B_n = 2(P+0)$ or $B_n = 2(A+0)$ or $B_n = 2(M_V + E_D)$	Highest significant video frequency, 3.8 MHz: Peak deviation of video, 4 MHz. Subcarrier frequencies 6.17 & 6.8 MHz; Modulation of main carrier by subcarrier 200 kHz rms; Reference modulation of subcarrier 100 kHz peak (+8dBM @ 400Hz producing 100 kHz deviation); Top audio program frequency, 15 kHz; Maximum audio transmission level, 10dB above reference of +8dBm; Pilot subcarrier at 8.5 MHz a) B_n=2(3.8+4+0.8) MHz= 17.2MHz b) B_n=2(8.5+0.8) MHz=18.6 MHz c) B_n=2(A+0.8)MHz hence B_n=2(7.131+ 0.8)MHz=15.9 MHz Since B_n of calculating (c) is the greatest bandwidth: = 18.6 MHz	18M6F8FNF

*These methods of calculating necessary bandwith apply only when the RMS deviation of the main carrier by a continuity pilot subcarrier and/or audio subcarrier is small with respect to the main carrier deviation. Typically the RMS deviation of the main carrier by a continuity pilot subcarrier or by audio subcarriers is between 2.5% and 7.5%.

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
Amplitude modulation used to modulate a carrier with digital bit stream.	$B_n = 2BK$ $K = 1$ (typically)	Microwave system is digitally modulated at a rate of 5 megabits per second. The carrier is amplitude modulated and 4 signalling states are used. $B = \frac{R}{\text{Log}_2 4} = \frac{5\ 000\ 000}{\text{Log}_2 4}$ = 2500 kilobaud Bandwidth: 5.0×10^3 kHz=5.0MHz	5M00A1WDN
Phase shift keying is used to modulate a carrier with a digital bit stream	$B_n = 2BK$ $K = 1$ (typically)	a system is digitally modulated at a rate of 10 megabits per second. The carrier is phase shift keyed and 8 signalling states are used. $B = \frac{R}{\text{Log}_2 8} = \frac{10\ 000\ 000}{3}$ = 3333 kilobaud Bandwidth 6.67×10^3kHz=6.67MHz	6M67G1WEN
Frequency shift keying is used to modulate a carrier with a digital bit stream	$B_n = 2DK + B$ $K = 1$ (typically)	a system is digitally modulated at a rate of 10 megabits per second. The carrier is frequency shift keyed and 2 signalling states are used. D = 2000kHz $B = \frac{R}{\text{Log}_2 2}$ = 10 000 kilobaud Bandwidth 14.0×10^3 kHz=14.0MHz	14M0F1WCN

Description of Emission	Necessary Bandwidth		Designation of Emission
	Formula	Sample Calculation	
IV. PULSE MODULATION			
1. Radar			
Unmodulated pulse emission	$B_n = \frac{2K}{t}$ K depends upon the ratio of pulse duration to 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 $t \simeq t_r$, only components down to 27 dB from the strongest are considered) Then $t = \frac{2(\text{range resolution})}{\text{velocity of light}}$ $= \frac{2 \times 150}{3 \times 10^8}$ $= 1 \times 10^{-6}$ seconds Bandwidth : 3×10^6 Hz = 3MHz	3M00PONAN
2. Composite Emissions			
Radio-relay system	$B_n = \frac{2K}{t}$ K = 1.6	Pulse position modulated by 36 voice channel baseband; pulse width at half amplitude = 0.4 usec Bandwidth : 8×10^6Hz = 8 MHz (Bandwidth independent of the number of voice channels)	8M00M7EJT

TABLE 1

MULTIPLYING FACTORS FOR USE IN COMPUTING D, PEAK FREQUENCY DEVIATION IN FM FREQUENCY DIVISION MULTIPLEX (FM/FDM) MULTI-CHANNEL EMISSIONS		
The value of D, or peak frequency deviation, in these formulae for B_n is calculated by multiplying the rms value of per-channel deviation by the appropriate "Multiplying factor" shown below.		
Number of telephone channels, N_C	Multiplying factor[1]	
	(peak factor) x antilog	$\left[\frac{\text{value in dB above modulation reference level}}{20}\right]$
$3 < N_C < 12$	4.47 x antilog	$\left[\frac{\text{a value in dB specified by the equipment manufacturer or station licensee, subject to administration approval}}{20}\right]$
$12 \leq N_C < 60$	3.76 x antilog	$\left[\frac{2.6 + 2 \log N_C}{20}\right]$
$60 \leq N_C < 240$	3.76 x antilog	$\left[\frac{-1 + 4 \log N_C}{20}\right]$
$N_C \geq 240$	3.76 x antilog	$\left[\frac{-15 + 10 \log N_C}{20}\right]$

[1] In the above chart, the multipliers 3.76 and 4.47 correspond to peak factors of 11.5 dB and 13.0 dB, respectively. It is recognized that some systems that carry appreciable quantities of data or information other than voice, may have different loading factors than the preferred ones shown above.