RECOMMENDATION ITU-R BS.450-3*

Transmission standards for FM sound broadcasting at VHF**

(1982-1995-2001)

The ITU Radiocommunication Assembly,

recommends

1 that for FM sound broadcasting in band 8 (VHF) the following transmission standards should be used:

1 Monophonic transmissions

1.1 Radio-frequency (RF) signal

The RF signal consists of a carrier frequency-modulated by the sound signal to be transmitted, after pre-emphasis, with a maximum frequency deviation equal to:

±75 kHz or ±50 kHz.

NOTE 1 – In the West European countries and the United States of America, the maximum deviation is ±75 kHz. In the ex-USSR and in some other European countries, it is ±50 kHz.

1.2 Pre-emphasis of the sound signal

The pre-emphasis characteristic of the sound signal is identical to the admittance-frequency curve of a parallel resistance-capacitance circuit having a time constant of:

50 μs or 75 μs.

NOTE 2 – In Europe, the pre-emphasis is 50 μs. In the United States of America, it is 75 μs.

2 Stereophonic transmissions

2.1 Polar-modulation system

2.1.1 RF signal

The RF signal consists of a carrier frequency-modulated by a baseband signal, known in this case as the "stereophonic multiplex signal", with a maximum frequency deviation equal to:

±75 kHz or ±50 kHz (see Note 1, § 1).

2.1.2 Stereophonic multiplex signal

This signal is produced as follows:

2.1.2.1 A signal *M* is formed equal to one half of the sum of the left-hand signal, *A*, and the right-hand signal, *B*, corresponding to the two stereophonic channels. This signal, *M*, is pre-emphasized in the same way as monophonic signals (see § 1).

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* Radiocommunication Study Group 6 made editorial amendments to this Recommendation in October 2018 in accordance with Resolution ITU-R 1.

** Administrations are invited to supply further information on the system parameters, particularly concerning new tables on frequency tolerances.

NOTE 1 – *M* is a "compatible" signal in the sense that the stereophonic transmission may be received by a monophonic receiver equipped for the same maximum frequency deviation and the same pre-emphasis.

2.1.2.2 A signal *S* is produced equal to one half of the difference between signals *A* and *B* mentioned above. This signal, *S*, is pre-emphasized in the same way as signal *M*. The pre-emphasized signal, *S*, is used for the amplitude modulation of a sub-carrier at 31.25 kHz; the spectrum of the amplitude-modulated sub-carrier is formed so that the sub-carrier amplitude is reduced by 14 dB and the spectral components of the given modulating signal appear to be transformed as follows:

$$\overline{K}(f) = \frac{1 + \mathrm{j}\,6.4\,f}{5 + \mathrm{j}\,6.4\,f}$$

where *f* is equal to each frequency component (kHz).

2.1.2.3 The stereophonic multiplex signal is the sum of:

– the pre-emphasized signal, *M*;

– the sideband spectral components which are the product of amplitude-modulated unsuppressed carrier by a pre-emphasized signal *S* additionally transformed from the law $\overline{K}(f)$;

– the sub-carrier with the amplitude reduced by 14 dB.

2.1.2.4 The amplitudes of the various components of the stereophonic multiplex signal, referred to the maximum amplitude of that signal (which corresponds to the maximum frequency deviation) are:

– signal *M*: maximum value 80% (*A* and *B* being equal, and in phase);

– signal *S*: maximum value 80% (*A* and *B* being equal but of opposite phase);

– reduced sub-carrier at 31.25 kHz; maximum residual amplitude 20%.

2.1.2.5 The frequency modulation is arranged in such a way that positive values of the multiplex signal correspond to a positive frequency deviation of the main carrier and negative values to negative frequency deviation.

2.2 Pilot-tone system

2.2.1 RF signal

The RF signal consists of a carrier frequency-modulated by a baseband signal, known in this case as the "stereophonic multiplex signal", with a maximum frequency deviation equal to:

±75 kHz or ±50 kHz (see Note 1, § 1).

2.2.2 Stereophonic multiplex signal

This signal is produced as follows:

2.2.2.1 A signal *M* is formed equal to one half of the sum of the left-hand signal, *A*, and the right-hand signal, *B*, corresponding to the two stereophonic channels. This signal, *M*, is pre-emphasized in the same way as monophonic signals (see § 1) (see Note 1, § 2).

2.2.2.2 A signal *S* is produced equal to one half of the difference between signals *A* and *B* mentioned above. This signal, *S*, is pre-emphasized in the same way as signal *M*. The pre-emphasized signal, *S*, is used for the suppressed-carrier amplitude modulation of a sub-carrier at 38 kHz ±4 Hz.

NOTE 2 – The same effect is obtained by pre-emphasizing the left-hand signal *A* and the right-hand signal *B* before encoding. For technical reasons this procedure is sometimes preferred.

2.2.2.3 The stereophonic multiplex signal is the sum of:

– the pre-emphasized signal, *M*;

– the sidebands of the suppressed sub-carrier amplitude modulated by the pre-emphasized signal, *S*;

– a "pilot signal" with a frequency of 19 kHz exactly one-half the sub-carrier frequency.

2.2.2.4 The amplitudes of the various components of the stereophonic multiplex signals referred to the maximum amplitude of that signal (which corresponds to the maximum frequency deviation) are:

– signal *M*: maximum value 90% (*A* and *B* being equal and in phase);

– signal *S*: maximum value of the sum of the amplitudes of the two sidebands: 90% (which corresponds to *A* and *B* being equal and of opposite phase);

– pilot signal: 8 to 10%;

– sub-carrier at 38 kHz suppressed: maximum residual amplitude 1%.

2.2.2.5 The relative phase of the pilot signal and the sub-carrier is such that, when the transmitter is modulated by a multiplex signal for which *A* is positive and $B = -A$, this signal crosses the time axis with a positive slope each time the pilot signal has an instantaneous value of zero. The phase tolerance of the pilot signal should not exceed ±3° from the above state. Moreover, a positive value of the multiplex signal corresponds to a positive frequency deviation of the main carrier.

2.2.3 Baseband signal in the case of a supplementary signal transmission

If, in addition to the monophonic or stereophonic programme, a supplementary monophonic programme and/or supplementary information signals are transmitted and the maximum frequency deviation is ±75 kHz, the following additional conditions must be met:

2.2.3.1 The insertion of the supplementary programme or signals in the baseband signal must permit compatibility with existing receivers, i.e. these additional signals must not affect the reception quality of the main monophonic or stereophonic programmes.

2.2.3.2 The baseband signal consists of the monophonic signal or stereophonic multiplex signal described above and having an amplitude of not less than 90% of that of the maximum permitted baseband signal value, and of the supplementary signals having a maximum amplitude of 10% of that value.

2.2.3.3 For a supplementary monophonic programme, the sub-carrier and its frequency deviation must be such that the corresponding instantaneous frequency of the signal remains between 53 and 76 kHz.

2.2.3.4 For supplementary information signals, the frequency of any additional sub-carrier must be between 15 and 23 kHz or between 53 and 76 kHz.

2.2.3.5 Under no circumstances may the maximum deviation of the main carrier by the total base signal exceed ±75 kHz.

3 System parameters

The system parameters used in different countries are given in Annex 1.

ANNEX 1

Current sound broadcasting systems in the bands included in the Radio Regulations (RR) used in different countries/areas in the world

TABLE 1A

Terrestrial FM sound broadcasting (above 30 MHz)

Country/Geographical area	International agreements				Information related to current emission applications																	Transmitter frequency tolerances (RR Article 1)	
					Frequency bands used (MHz)							Modulation characteristics							Polarization				
	□ Geneva 60	□ Stockholm 61	□ Geneva 84	□ Others	□ 66-68	□ 68-73	□ 73-74	□ 76-87.5	□ 87.5-108	□ 88.0-108	□ Others	□ Monophonic	□ Stereophonic	□ Polar-modulation system	□ Pilot-tone system	□ Channel spacing (1) (kHz)	□ Pre-emphasis/ de-emphasis (μs)	□ Maximum frequency deviation (kHz)	□ Horizontal	□ Vertical	□ Mixed	Current requirement	Long-term designed objective
Germany (Federal Republic of)		+	+						+			+	+		+	100	50	±75	+	Except cars			
Aruba										+			+			200	75	±75		+	+		
Australia									+				+		+	200	50	±75	+	+	+		
Bahamas (Commonwealth of the)??										+			+		+	200	75	±75	+				
Bangladesh (People's Republic of)			+						+			+				200	50	±75	+				
Brazil (Federative Republic of)								+	+				+		+	200	50	±75	+	+	+		
Cyprus (Republic of)			+						+				+		+	100	50	±75			+		
Vatican City State		+	+						+				+		+	100	75	±75			+		
Colombia (Republic of)			+							+			+			200	75	±75			+		
Korea (Republic of)			+							+		+	+		+	200	75	±75			+		
Denmark			+						+				+		+	100	50	±75	+				
Ecuador										+			+		+	200		±75		+			
Spain			+						+				+		+	100	50	±75	+	+	+		

(1) For definition see Recommendation ITU-R BS.412. It is not meant the frequency spacing in overlapping service areas or tuning steps of the receiver.

TABLE 1A (*continued*)

Country/Geographical area	International agreements				Information related to current emission applications																Transmitter frequency tolerances (RR Article 1)	
					Frequency bands used (MHz)							Modulation characteristics							Polarization				
	□ Geneva 60	□ Stockholm 61	□ Geneva 84	□ Others	□ 66-68	□ 68-73	□ 73-74	□ 76-87.5	□ 87.5-108	□ 88.0-108	□ Others	□ Monophonic	□ Stereophonic	□ Polar-modulation system	□ Pilot-tone system	□ Channel spacing [1] (kHz)	□ Pre-emphasis/ de-emphasis (μs)	□ Maximum frequency deviation (kHz)	□ Horizontal	□ Vertical	□ Mixed	Current requirement	Long-term designed objective
United States of America											87.8 108	+	+		+	200	75	±75	+	+	+		
Finland			+						+				+		+	100	50	±75	+	+	+		
France			+						+			+	+		+	100	50	±75	+	+		20×10^{-6}	
Gambia (Republic of the)			+							+		+	+		+		75	±75		+			
Hungary			+						+			+	+		+	100	50	±75	+	+	+		
India (Republic of)											100-108	+	+		+	100	50	±75			+		
Iran (Islamic Republic of)			+						+			+	+		+		50	±75	+		+		
Italy			+						+				+		+	100	50	±75			+		
Japan				X							76-95				+	100	50	±75	+	+			
Kuwait (State of)			+						+				+			100	50	±75			+		
Lithuania (Republic of)		+	+		+	+	+		+			+	+	+	+	30 100	50 75	±50 ±75	+	+			
Mali (Republic of)			+						+				+		+	100	50	±75	+	+			
Morocco (Kingdom of)		+	+						+			+	+		+		75	±75	+		+		
Mexico										+		+	+		+	200	75	±75	+	+	+		
Norway		+	+						+				+		+	100	50	±75	+	few	+		
New Zealand				Rec. ITU-R BS.412							88-100		+		+	50	50	±75		+	+		
Oman (Sultanate of)			+						+				+		+	100	50	±75	+	+			
Papua New Guinea			+						+			+	+		+	100	50	±75	+				
Netherlands (Kingdom of the)			+						+			+	+		+	100	50	±75	+	+			

TABLE 1A (*end*)

Country/Geographical area	International agreements				Information related to current emission applications																Transmitter frequency tolerances (RR Article 1)	
					Frequency bands used (MHz)							Modulation characteristics							Polarization				
	□ Geneva 60	□ Stockholm 61	□ Geneva 84	□ Others	□ 66-68	□ 68-73	□ 73-74	□ 76-87.5	□ 87.5-108	□ 88.0-108	□ Others	□ Monophonic	□ Stereophonic	□ Polar-modulation system	□ Pilot-tone system	□ Channel spacing [1] (kHz)	□ Pre-emphasis/ de-emphasis (µs)	□ Maximum frequency deviation (kHz)	□ Horizontal	□ Vertical	□ Mixed	Current requirement	Long-term designed objective
Qatar (State of)										+			+			200	50	±75			+		
Czech Republic									+			+	+		+	100	50	±75	+	+	+		
United Kingdom of Great Britain and Northern Ireland			+						+				+		+	100	50	±75			+		
Rwandese Republic	+		+						+			+				100	50	±75	+				
Senegal (Republic of)			+						+			+	+		+	100	50	±75	+				
Singapore (Republic of)										+			+		+	300	50	±75			+		
Slovenia (Republic of)		+	+						+				+			100	50	±75	+	+	+		
South Africa (Republic of)			+						+				+		+	100	50	±75		+			
Sweden			+						+				+		+	100	50	±75	+				
Switzerland (Confederation of)			+						+				+		+	100	50	±75	+	few	few		
Turkey			+						+				+		+	100	75	±50	+				
Ukraine		+	+			+	+		+			+	+	+	+	30 100	50 75	±50 ±75	+	+	+		

TABLE 1b

Terrestrial FM sound broadcasting (above 30 MHz)

Country/Geographical area	Information related to current receiving applications				Additional information		Remarks
	Recommended or used IF (MHz)	Oscillartor position		Electromagnetic immunity requirements for receivers	Compressor or compander systems	Supplementary information	
		High	Low				
Germany (Federal Republic of)	10.7	+		EN 55 020	Oui	ARI, RDS	Variable pre-emphasis at transmitter site in order to avoid excess of ±75 kHz frequency deviation
Aruba	10.7	+					
Australia	10.7	+				ACS on 57 kHz (RDS) 67 kHz and below 95 kHz	
Bahamas							
Bangladesh (People's Republic of)	10.7	+					
Brazil (Federative Republic of)	10.7					RDS	
Cyprus (Republic of)							
Vatican City State					Compression +10 dB		
Colombia (Republic of)	10.7				No	SCA (67 kHz)	
Korea (Republic of)	10.7	+			Optimod FM 8200	No	
Denmark	10.7	+		EMC	Yes	RDS	
Ecuador	10.7						
Spain	10.7	+				RDS, SCA (67 kHz)	
United States of America	10.7	Not defined		FCC 47 CFR 15	Optional	RBDS (RDS), SCA	
Finland	10.7	+			ORBAN compressor	RDS	

TABLE 1b (*continued*)

Country/Geographical area	Information related to current receiving applications				Additional information		Remarks
	Recommended or used IF (MHz)	Oscillator position		Electromagnetic immunity requirements for receivers	Compressor or compander systems	Supplementary information	
		High	Low				
France	10.7	+			Yes, mainly for local radio	RDS	Synchronous frequency VHF-FM service for motorists in stereophonic mode along motorways. Frequency tolerance among all synchronous transmitters: 10^{-9}
Gambia (Republic of)	10.8	+					
Hungary	10.7	Not defined		EN 55020		RDS	
India (Republic of)	10.7		+			RDS, SCA (experimental transmissions)	
Iran (Islamic Republic of)	10.7	+		No	No	RDS	
Italy	10.7	+			Compressor of deviation control		"ISORADIO" – ISO frequency VHF-FM service for motorists in monophonic mode is introduced along the motorways
Japan	10.7	+				DARC	
Kuwaït (State of)	10.7	+					
Lithuania (Republic of)	10.7	+					
Mali (Republic of)	10.7						
Morocco (Kingdom of)							
Mexico	10.7						

TABLE 1b (*end*)

Country/Geographical area	Information related to current receiving applications				Additional information		Remarks
	Recommended or used IF (MHz)	Oscillator position		Electromagnetic immunity requirements for receivers	Compressor or compander systems	Supplementary information	
		High	Low				
Norway	10.7	+			Yes	RDS	
New Zealand	10.7	+				SCA use being developed	100-108 MHz presently used for domestic services
Oman (Sultanate for)					None	None	
Papua New Guinea					None	None	
Netherlands (Kingdom of the)	10.7	Left to manufacturer		Comply with EEC standards	Yes	RDS, CSI	
Qatar (State of)						No	
Czech Republic	10.7	+			Compression	RDS	
United Kingdom of Great Britain and Northern Ireland	10.7	+		REC, EEC EMC Directive; Radiation EN 55013; Immunity 55020	Yes	RDS	
Rwandese Republic	10.7	+					
Senegal (Republic of)	10.7						
Singapore (Republic of)	10.7	+			Optimod	SCA	
Slovenia (Republic of)	10.7	+			Yes	RDS	
South Africa (Republic of)	10.7	+	+	No	Optimod	RDS, SST	SST still on trial
Sweden	10.7	+		No	Yes, audioprocessing (compression, limiter)	RDS	
Switzerland (Confederation of)	10.7	+				ARI, RDS	
Turkey	10.7		+	No	No	No	
Ukraine	10.7						