International Telecommunication Union

ITU-R
Radiocommunication Sector of ITU

Recommendation ITU-R BS.450-4
(10/2019)

Transmission standards for FM sound broadcasting at VHF

BS Series
Broadcasting service (sound)

International Telecommunication Union

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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R BS.450-4

Transmission standards for FM sound broadcasting at VHF

(1982-1995-2001-2019)

Scope

This Recommendation provides the essential technical characteristics for the analogue FM sound broadcasting system in Band 8 (VHF). It should be noted that for stereophonic purposes, the pilot-tone system has become the *de facto* worldwide standard.

Keywords

FM sound broadcasting, monophonic, stereo, polar system, pilot-tone system, carrier deviation, pre-emphasis, stereophonic multiplex signal, supplementary signals

The ITU Radiocommunication Assembly,

recommends

that for FM sound broadcasting in band 8 (VHF[1]) 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:

$$\pm 75 \text{ kHz or } \pm 50 \text{ kHz}$$

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:

$$50 \text{ μs or } 75 \text{ μs.}$$

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:

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[1] As defined in RR Article **2.1**, band 8 frequencies extend from 30 to 300 MHz.

±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).

NOTE 3 – *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:

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

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 4 – 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.