RECOMMENDATION ITU-R BS.703*,**

Characteristics of AM sound broadcasting reference receivers for planning purposes

(1990)

The ITU Radiocommunication Assembly,

considering

a) that frequency assignment plans must of necessity take into account the characteristics of receivers;

b) that the range of performance of receivers used by the public is very large;

c) that a reference receiver with characteristics based on currently available receivers may be useful in a planning context;

d) that standards for reference receivers should therefore be defined, which can be taken as a basis for frequency planning purposes;

e) that these standards need to be taken into account by receiver manufacturers,

recommends

that the receiver characteristics contained in Annex 1 should be used for AM sound broadcasting planning purposes.

ANNEX 1

In deriving the recommended characteristics, the parameters contained in Annex 2 were also considered.

1 Sensitivity

For planning purposes, "sensitivity" is understood to mean "noise-limited sensitivity", given in terms of field strength, required to achieve a specified signal-to-noise ratio at the audio output.

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* The Director Radiocommunication Bureau, is requested to bring this Recommendation to the attention of the IEC.

** Radiocommunication Study Group 6 made editorial amendments to this Recommendation in 2002 in accordance with Resolution ITU-R 44.

Most commonly available AM receivers are now provided with built-in antennas. In the LF and MF bands, these are usually ferrite antennas (see Note 1). For the HF bands, when included, telescopic rod antennas are frequently used. Therefore, receivers using these types of antennas should be used as a reference, even though a variety of external antennas may occasionally be used to improve reception.

For those Administrations that employ wide-band systems (see Note 2) in the MF band, the use of monopole antennas is preferred as a reference.

Sensitivity should be presented as a single mean figure for each broadcasting band, from which the minimum usable field strength may be calculated taking into account other influences (e.g. man-made noise). The following values are suggested for the minimum sensitivity of an average receiver:

Band 5 (LF): 66 dB(μV/m)

Band 6 (MF): 60 dB(μV/m) (see Note 3)

Band 7 (HF): 40 dB(μV/m) (see Note 4)

These values are based upon an AF signal-to-unweighted noise (r.m.s.) ratio of 26 dB and are related to a modulation of 30%. For other AF signal-to-noise ratios the corresponding minimum sensitivity can be easily calculated (see Annex 2, § 6). The AF signal-to-noise measurement is made according to IEC Publication 60315-3; the field-strength values for the LF and MF band are measured according to IEC Publication 60315-3.

NOTE 1 – A special arrangement of two ferrite rod antennas with their outputs separately received and processed up to the stage of detection has been reported to substantially reduce the effects of fading in the night-time interference zone in band 6 (MF) and 7 (HF).

NOTE 2 – According to present day planning arrangements in the various ITU Regions, in general a "narrow-band system" refers to one in which the system bandwidth is less than 5 kHz. A "wide-band system" refers to one with a system bandwidth greater than 5 kHz.

NOTE 3 – Values of 54 dB(μV/m) and 40 dB(μV/m) were also supported.

NOTE 4 – The WARC HFBC(2), Geneva 1987, adopted this value for DSB and SSB reception.

2 Selectivity

Selectivity of a receiver is a measure of its ability to discriminate between a wanted signal to which the receiver is tuned and unwanted signals entering through the antenna circuit.

The selectivity is understood as an effective selectivity comprising RF selectivity, IF selectivity, demodulator and AF frequency response.

The selectivity shall be sufficient, so that the relative RF protection ratios given in § 2.1, 2.2 and 2.3 are met. Relative RF protection ratios are defined in Recommendation ITU-R BS.560 and should be measured according to Recommendation ITU-R BS.559.

2.1 For LF, MF, HF bands in case of DSB reception in a narrow-band system (see Note 2 of § 1), the relative RF protection ratios of Recommendation ITU-R BS.560, curve D, should be met for a carrier frequency separation ≤ 20 kHz. For a carrier frequency separation > 20 kHz a constant value of –55 dB should be met.

The use of curve D is suitable for a situation where a maximum number of channels is to be planned in a given area and where quality criteria are not considered as a priority factor.

The protection ratio curves of Recommendation ITU-R BS.560 are based on a single receiver selectivity curve. It should, however, be noted that other combinations of 3 dB bandwidth and selectivity roll-off can also meet the relative protection ratio curves shown in Recommendation ITU-R BS.560. (Examples see Annex 2, § 2.)

2.2 For wide-band systems, in the MF band, where a wider bandwidth of the audio-frequency modulating signal is employed, the use of the relative protection ratios of Recommendation ITU-R BS.560, curve A or B, may be more appropriate. However, these curves were based upon the EBU MBF reference receiver.

2.3 For HF bands, in the case of SSB reception (after the transition period) see Report ITU-R BS.1059. The relative protection ratios of Fig. 1 should be met for a carrier frequency separation ≤ 10 kHz. For a carrier frequency separation > 10 kHz a constant value of –57 dB should be met (see also Recommendation ITU-R BS.640).

Relative RF-protection ratios A_{rel} for SSB are given with respect to the frequency difference Δf between the wanted carrier f_w and the interfering carrier f_i: $\Delta f = f_w - f_i$, thus, negative Δf describes interference from the upper adjacent channel.

3 Performance in the presence of strong signals

AM broadcasting receivers overloading by strong input signals may result in:

– desensitization;

– cross-modulation and intermodulation;

– AF signal distortion in the amplifier stages and/or in the demodulator.

Limiting values of maximum input voltage to the receiver to be taken into account in planning, cannot be recommended due to the unavoidable occurrence of the phenomenon in close proximity of AM transmitters.

These difficulties may be alleviated by a careful choice of the transmitter site at the planning stage and/or by implementing case by case solutions (ruggedized receivers) when receiving locations near the transmitting station cannot be avoided.

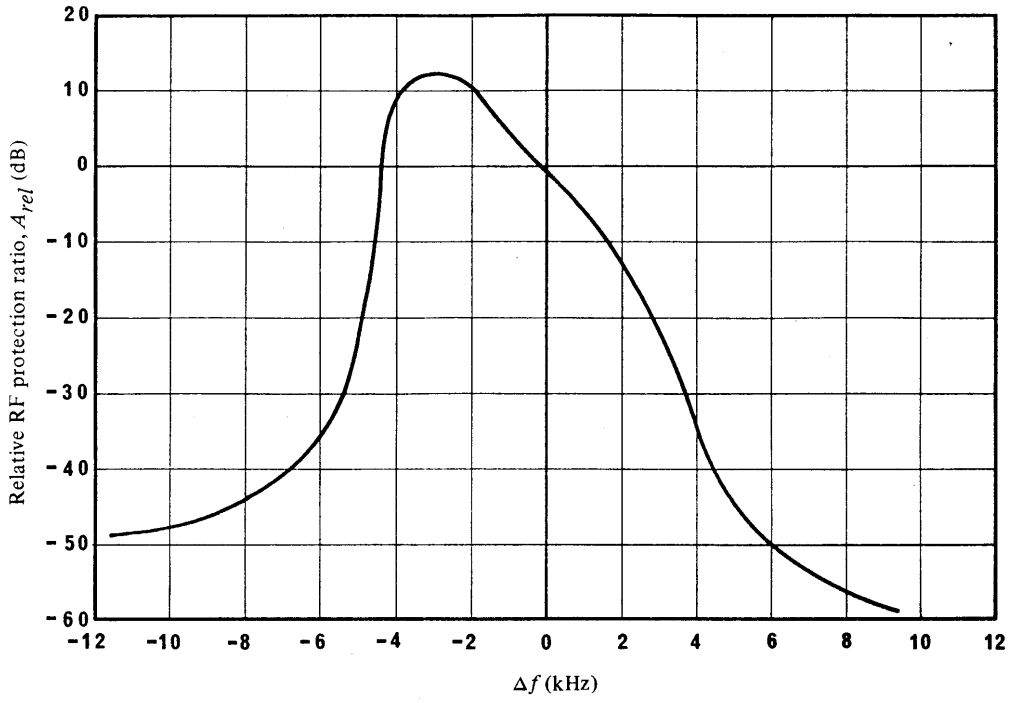

FIGURE 1* – *Relative RF-protection ratios A_{rel} for SSB*

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* The WARC HFBC(1), Geneva, 1984, adopted this curve.

4 Intermediate frequency

The value of image and intermediate frequency rejection ratio and the production of harmonics of the intermediate frequency and/or of the oscillator frequency are factors influencing the choice of intermediate frequency.

If both the carrier frequencies and the intermediate frequency are an integral multiple of the carrier spacing, then all interfering products will also be integral multiples of the carrier spacing. Theoretically, therefore, maximum protection could then be obtained because the frequency difference between any interfering signal of this kind and the wanted carrier frequency, would be zero or a multiple of the channel spacing.

No specific intermediate frequency can be recommended, but the use of frequencies in the range 450-470 kHz is common. However, it should be noted that when such frequencies are used it is then not possible to achieve a sufficient image rejection ratio in the HF bands. For this case the use of much higher intermediate frequency in conjunction with double-conversion should be considered for HF.

4.1 Image rejection ratio

It is assumed that an image rejection ratio of 30 dB can be obtained when measured according to IEC Publication 60315-3.

ANNEX 2

In defining the recommended characteristics given in Annex 1 the possible influence of the following receiver parameters was taken into account.

1 Overall audio-frequency response and system considerations

The overall audio-frequency response has a strong influence on the radio-frequency protection ratio curves.

1.1 Narrow-band systems

The curves defined in Recommendation ITU-R BS.560 are based on the values shown in Table 1.

TABLE 1

Frequency (kHz)	Overall frequency response (dB)
2	–3
5	–24
10	–59

1.2 Wide-band system

In MF broadcasting, using 10 kHz channel spacing a standard preemphasis/deemphasis and 10 kHz bandwidth limitation has been implemented. This produces an emission/reception system with an overall audio frequency response that is essentially flat from 50 Hz to nearly 10 kHz, limited only by the receivers choice of bandwidth. The system reduces interference caused to stations operating ±20 kHz removed in frequency and entirely eliminated undesired high-order dynamic intermodulation products that contribute to noise and interference on the MF band. This system is described in Report ITU-R BS.458. Its impact on relative RF protection ratios and, thus, selectivity of receivers is under study.

2 Relative RF protection ratios versus bandwidth and selectivity

The protection ratio curves shown in Recommendation ITU-R BS.560 for DSB systems can be met with different combinations of bandwidth and roll-off of the selectivity curve of the receiver.

Some examples have been calculated using the numerical method as described in Recommendation ITU-R BS.559 (§ 3).

In all cases the parameters of the transmitter for the narrow-band system corresponded to those of curve D of Recommendation ITU-R BS.560. For the wide-band system a transmitter bandwidth of 10 kHz was assumed.

Five different combinations of receiver bandwidth B_n(–3 dB) and roll-off of the selectivity curve (in dB/kHz at the steepest slope of the overall selectivity curve) have been chosen such that at 9 kHz carrier difference for the narrow-band system, and at 20 kHz carrier difference respectively for the wide-band system a value of A_{rel} = –29.5 dB was reached in all cases. The value of –29.5 dB follows from curve D in Fig. 1 of Recommendation ITU-R BS.560 and from the Rio Agreement, 1981.

The results for a narrow-band system with 9 kHz channel spacing are shown in Fig. 2.

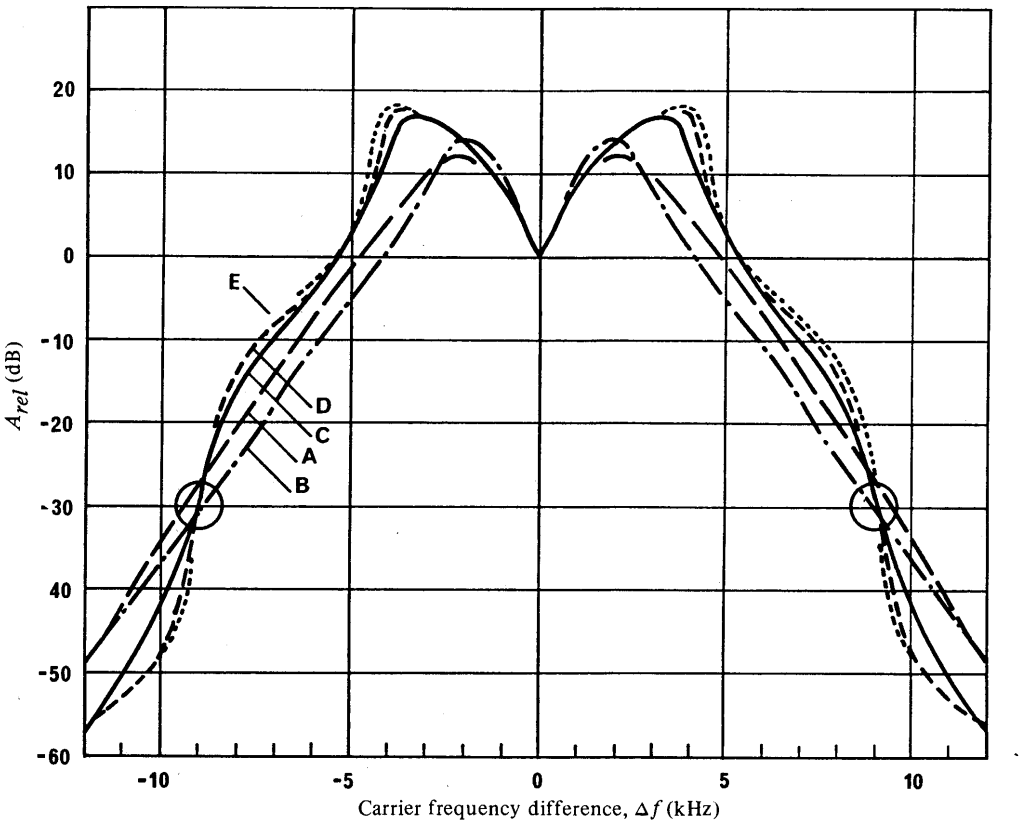

FIGURE 2 – *Relative RF protection ratios A_{rel} (dB) for a narrow-band system*

Combination	B_n (kHz)	Roll-off (dB/kHz)
A	2.0	8
B	2.2	12
C	3.7	16
D	4.0	25
E	4.2	40

B_n: overall bandwidth (–3 dB) of the receiver (kHz)

Roll-off: slope of attenuation of the overall selectivity characteristic of the receiver (dB/kHz at the steepest point of the slope)

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3 Automatic gain control (AGC) performance

Using the sensitivity values given in Annex 1, as a reference, it is assumed that the output level will not change by more than 6 dB for a reduction in signal level of 10 dB. Similarly, the output level will not change by more than 3 dB for an increase in signal level of 20 dB.

It is assumed that the output level of an SSB receiver will not change by more than 3 dB when changing from reception of DSB emissions to SSB emissions with 6 or 12 dB carrier reduction and appropriate "equivalent sideband power" (see Report ITU-R BS.1059).

4 Automatic frequency control of SSB receivers

It is assumed that the SSB receiver is equipped with a synchronous demodulator, using for the carrier acquisition a device which generates a carrier by means of a suitable control loop which phase locks the receiver to the incoming carrier of the SSB emission of which the carrier can be reduced by up to 12 dB (see Report ITU-R BS.1059).

5 Overall total harmonic distortion

It is assumed that the overall total harmonic distortion does not exceed 3% at 80% modulation depth, measured according to IEC Publication 60315-3.

6 AF signal-to-noise ratio at higher input signal levels

It can be assumed that the AF signal-to-noise ratio will improve linearly to at least 40 dB, with increasing input signal level.

7 System effects on stereophonic AM broadcasting

(Under consideration.)

8 Compatibility between the main programme and additional information signals

When additional signals are added, account must be taken of certain interference effects. Receiver designers should consider these in order to avoid interference to the main programme channel.