

RECOMMENDATION ITU-R BS.641*

**Determination of radio-frequency protection ratios
for frequency-modulated sound broadcasting**

(1986)

The ITU Radiocommunication Assembly,

considering

- a) that the radio-frequency protection ratio is closely related to the audio-frequency protection ratio (see Recommendation ITU-R BS.638);
- b) that this relationship depends on a number of technical parameters, including:
 - the frequency separation between the wanted and unwanted carrier;
 - the maximum peak deviation;
 - the energy distribution both with spectrum and time of the modulation signal;
 - the pre- and de-emphasis characteristics;
 - the reception mode (monophonic or stereophonic);
 - the audio characteristics of the human ear (appropriately taken account of by using the weighting network of Recommendation ITU-R BS.468);
 - the receiver input voltage;
- c) that the radio-frequency protection ratio further depends on the receiver characteristics, the most important of which are:
 - the selectivity characteristics;
 - the characteristics of the limiter and the stereo decoder;
 - large signal performance and sensitivity;
 - the audio-frequency response,

recommends

1 that the objective two-signal method of measurement described in Annex 1 should be used for the determination of radio-frequency protection ratios in frequency-modulation sound broadcasting with transmission standards using a maximum frequency deviation of ± 75 kHz and a pre-emphasis of 50 μ s;

2 that the results obtained by this method should be checked by subjective listening tests whenever possible.

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

ANNEX 1

**Objective two-signal method of measurement for transmission standards
using a maximum frequency deviation of ± 75 kHz
and a pre-emphasis of 50 μ s**

1 Measuring method

The objective method for the measurement of RF protection ratios is essentially a psophometric two-signal method in which the interfering transmitter is modulated by a standard coloured noise signal with a given frequency deviation. The interference effect is measured at the audio-frequency output of the receiver by means of an international standard noise voltmeter (psophometer). The reference value used to define the audio-frequency signal-to-interference ratio is that which is measured at the audio-frequency output of the receiver with the same noise voltmeter, when the wanted transmitter is modulated with a sinusoidal tone of 500 Hz, while the interfering transmitter is switched off.

2 Psophometer

The noise voltmeter used to measure the wanted and interfering signals at the output of the receiver consists of a quasi-peak voltmeter with defined dynamic characteristics and an added filter which modifies the interfering frequencies according to their subjective interference effect (see Recommendation ITU-R BS.468). As the noise voltmeter is also used to determine the reference level and to adjust the frequency deviation, it must be possible to disconnect the weighting network. If, instead of the noise voltmeter, only a peak programme meter is available, it should have the same dynamic performance.

3 Noise signal for modulating the interfering signal generator

The standardized coloured noise is described in detail in Recommendation ITU-R BS.559.

The spectrum beyond the required bandwidth of the standardized coloured noise should be restricted by a low-pass filter having a cut-off frequency of 15 kHz and a slope of 60 dB/octave. The audio-frequency amplitude/frequency characteristic of the modulation stage of the signal generator should not vary by more than 2 dB up to the cut-off frequency of the low-pass filter.

4 Measuring arrangement

Figure 1 shows a schematic diagram of the measuring arrangement.

The arrangement is suitable for monophonic and stereophonic transmissions. With stereophonic operation, channel A or B should be measured. The unwanted transmitter is always operated in the monophonic mode, because this gives the more critical disturbing effect.

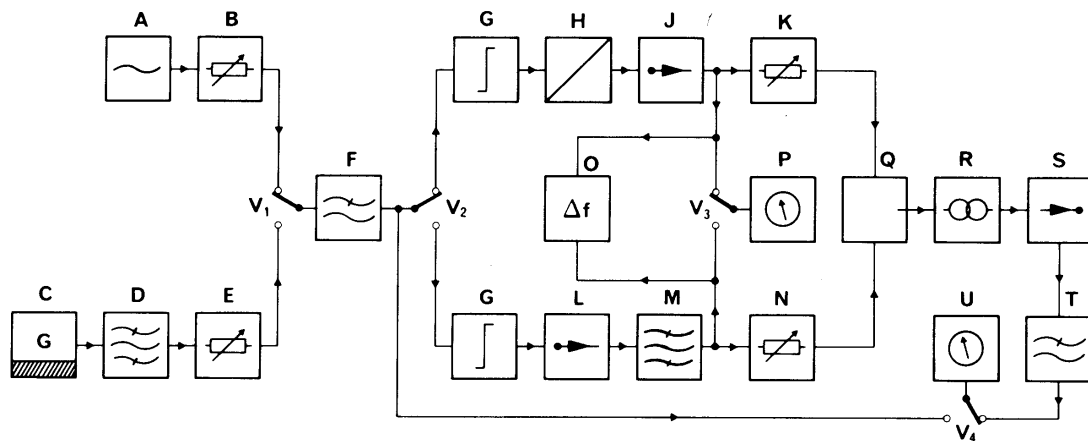


FIGURE 1 – Diagram of the measuring apparatus

A: 500 Hz AF generator (for transmitter line-up procedure)	K: calibrated RF attenuator	T: 15 kHz low-pass filter
B: calibrated AF attenuator	L: signal generator (unwanted signal)	U: psophometer (switchable weighting network)
C: noise generator	M: RF band-pass filter (tuneable)	V ₁ : selector switch for the modulation
D: noise shaping filter complying with Recommendation 559	N: calibrated RF attenuator	V ₂ : selector switch for modulating one or other of the signal generators
E: calibrated AF attenuator	O: frequency-meter for measuring the frequency difference between signal generators J and L	V ₃ : selector switch for the frequency-deviation meter (J and L generators)
F: 15 kHz low-pass filter	P: frequency-deviation meter	V ₄ : selector switch for measuring the AF signal levels
G: pre-emphasis network	Q: coupling device	
H: stereo coder	R: matching network	
J: signal generator (wanted signal)	S: receiver under test	

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It is important that the unwanted transmitter should be relatively free from spurious emissions. For this reason, a tunable bandpass filter with a 3 dB bandwidth of approximately 300 kHz, follows the signal generator. Care should be taken to avoid any interaction between the output stages of the two signal generators. A directional coupler may be used.

The audio-frequency signal-to-interference ratio should be measured at the audio-frequency output of the receiver ahead of the tone-control. If this is not possible, the tone-control should be in a position to assure a flat amplitude/frequency response.

The 19 kHz pilot-tone must be sufficiently suppressed at the audio-frequency output. It is necessary to add to the receiver output a low-pass filter with a 15 kHz cut-off frequency having an attenuation at 19 kHz of at least 40 dB.

5 Frequency deviation of the signal generators

The accuracy of the measurement depends very much on the precision with which frequency deviation of the signal generator can be set; this is especially true for the unwanted transmitter. The line-up procedure therefore should be carried out very carefully.

For the determination of the reference level, the wanted transmitter J is frequency modulated with the aid of the tone-generator A, using a sinusoidal tone of 500 Hz. Attenuator B is then adjusted to obtain a deviation of ± 75 kHz, including the pilot-tone in stereophonic operation. The reading of the noise-meter U, with the weighting network filter switched off, indicates the reference level. During the remaining measurements, the wanted transmitter is unmodulated. In stereophonic operation, only the pilot-tone has to be transmitted.

The unwanted transmitter L is then modulated with a 500 Hz sinusoidal tone obtained from audio-frequency generator A. Attenuator B is then adjusted to obtain a deviation of ± 32 kHz (see Note).

The audio-frequency level at the input of the unwanted transmitter before the pre-emphasis is now measured by means of the noise voltmeter U. The noise-weighting network is switched off. Next, a noise signal C + D replaces the sinusoidal tone, and attenuator E is adjusted to obtain the same peak-reading as before at the noise voltmeter. The (quasi) peak-deviation is thus equal to ± 32 kHz. Since the pre-emphasis has not been included in the level measurement, the actual peak deviation is higher. The described adjustment corresponds to the present-day broadcasting practice.

NOTE – A normal sound-broadcasting programme without compression is simulated by modulating the unwanted transmitter with the standardized coloured noise signal using a frequency deviation of ± 32 kHz. Therefore, the results obtained with this method and this deviation are only valid for sound broadcasting programmes without compression.

6 Radio-frequency wanted-to-interfering signal ratio

By means of attenuator K, the radio-frequency level of the wanted transmitter J is kept as low as possible to avoid non-linear effects in the receiver input stages. However, the level should be such that with the unwanted signal switched off, the audio-frequency signal-to-interference ratio is at least 56 dB.

Attenuator N at the output of the unwanted transmitter is adjusted to obtain an audio-frequency signal-to-interference ratio of 50 dB at the audio-frequency output of the receiver S. In this case, the weighting network at the noise voltmeter U must be switched in. The ratio between the radio-frequency levels of the wanted and unwanted transmitters is the required radio-frequency wanted-to-interfering signal ratio.

The measurement is carried out for channel spacings ranging from 0 to 400 kHz between the wanted and unwanted transmitters. The results should be given in a table or a diagram. If a diagram is drawn, the measuring points should be connected by straight lines. The radio-frequency level of the wanted transmitter and the receiver input impedance should be stated.
