

RECOMMENDATION ITU-R BT.655-7

Radio-frequency protection ratios for AM vestigial sideband terrestrial television systems interfered with by unwanted analogue vision signals and their associated sound signals

(Question ITU-R 56/6)

(1986-1990-1992-1994-1995-1998-2000-2004)

The ITU Radiocommunication Assembly,

considering

a) that accurate protection ratio values are required in order to permit the planning of terrestrial television services in an effective manner,

recommends

1 that the protection ratios given in Annex 1 be used for planning terrestrial television services;

2 that studies should be undertaken to complete the information on protection ratios, in particular with reference to the items identified in § 4 of Annex 1.

NOTE – Systems for the emission of digital terrestrial television services are being developed and the associated protection ratios are given in Recommendation ITU-R BT.1368.

Annex 1**Radio-frequency protection ratios for terrestrial television systems****1 Introduction**

This Annex contains general information related to protection ratios for terrestrial television systems. It also contains a series of Appendices, each containing protection ratios required for the protection of an individual category of system or signal.

Appendices 1 and 2 contain protection ratios for 525- and 625-line analogue television systems, respectively.

Appendix 3 contains protection ratios for the sound signals of analogue television systems.

2 General

The RF protection ratio is the minimum value of wanted-to-unwanted signal ratio, usually expressed in decibels at the receiver input, determined under specified conditions such that a specific reception quality is achieved at the receiver output.

Measurements of protection ratio for the vision signal of a wanted analogue television system should preferably be made with the subjective comparison method with a sine-wave reference interferer described in Recommendation ITU-R BT.1368, Annex 5.

2.1 The values of protection ratio quoted apply to interference produced by a single source. Except where otherwise stated, the ratios apply to tropospheric, T , interference and correspond closely to a slightly annoying impairment condition. They are considered to be acceptable only if the interference occurs for a small percentage of the time, not precisely defined but generally considered to be between 1% and 10%. For substantially non-fading unwanted signals, it is necessary to provide a higher degree of protection and ratios appropriate to continuous, C , interference should be used (see Annex 2). If the latter are not known, then the tropospheric, T , values increased by 10 dB can be applied.

Values applicable to limit of perceptibility, LP , are given for information only.

2.2 Significantly strong wanted input signals can require higher protection ratio values because of non-linear effects in the receiver.

2.3 For 625-line systems, the reference impairment levels are those which correspond to co-channel protection ratios of 30 dB and 40 dB with a frequency-offset between vision carriers close to two-thirds of the line frequency but adjusted for maximum impairment, the precise frequency difference being 10.416 kHz. These conditions approximate to impairment grades 3 (slightly annoying) and 4 (perceptible but not annoying) and apply to tropospheric, T , and continuous, C , interference, respectively.

2.4 It should be noted that the amplitude of a vision-modulated signal is defined as the r.m.s. value of the carrier at peaks of the modulation envelope (taking no account of the chrominance signal in positive-modulation systems), while that of a sound-modulated signal is the r.m.s. value of the unmodulated carrier, both for amplitude modulation and for frequency modulation.

For planning purposes, it may be assumed that the power in the chrominance channel does not exceed a value which is 16 dB lower than the power in the vision carrier during peaks of the modulation envelope.

2.5 The protection ratio values are not affected if digital data are included in the field-blanking interval of the unwanted television signal. However, certain values are affected in the case of a full-field data unwanted signal; in particular, it is not possible to achieve the full advantages of precision offset operation.

2.6 The relationship between the vision carrier frequencies of the wanted and unwanted signal is as follows (see Annex 3):

2.6.1 Non-controlled condition

No special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

2.6.2 Non-precision offset

The difference between the nominal frequencies of the wanted and unwanted carriers is suitably related to the line frequency, the tolerance of the carrier frequencies being ± 500 Hz.

The line synchronization of television receivers must be sufficiently immune to periodic interference if full advantage of carrier offset operation is to be achieved.

2.6.3 Precision offset (see Annex 4 for the case of 625-line systems)

The difference between the nominal frequencies of the wanted and unwanted carriers is suitably related to the line and field frequencies, but with a tolerance of each of the nominal carrier frequencies of the order of ± 1 Hz and stability of the line frequencies equal to or better than 1×10^{-6} . In order to take full advantage of precision offset when the interfering carrier falls in the upper video range (greater than 2 MHz) of the wanted signal, a line-frequency stability of at least 2×10^{-7} is necessary.

3 Synchronized carrier operation

Field and laboratory tests have demonstrated that synchronized carrier television systems allow a similar reduction in co-channel interference to that achieved by use of precision offset techniques, when the same television programme is transmitted. Ratios of wanted-to-unwanted signals of 28 dB and 38 dB were found to correspond to impairment grades of 3.5 and 4.5, respectively.

No degradation of picture quality was observed when the frequency difference between both vision carriers was less than 0.2 Hz and/or the phase fluctuations were less than 20° .

The use of synchronized carrier techniques simplifies the introduction of new television transmitters and transposers into existing networks.

Further studies in this field are required, especially for the case of different television programmes.

4 Further studies

In a number of cases, the available protection ratio values are incomplete. In particular, this applies to:

- data signals,
- out-of-channel response,
- 525-line systems,
- synchronized carrier operation,
- protection ratio values for digital television systems,
- protection ratio values for the protection of analogue television signals against interference from digital television signals.

In addition, it is necessary to establish the relationships between picture quality or impairment grade and protection ratio value. While the information is available for grades 3, 4 and 4.5, it is not yet available for lower grades.

Appendix 1 to Annex 1

Protection ratios for 525-line television systems

1 Protection from co-channel interference

In this section, the protection ratio values between two television signals apply only for interference due to the modulated vision carrier of the unwanted signal.

1.1 Carriers separated by less than 1 000 Hz, non-controlled systems having the same or a different line-standard

Protection ratio: 45 dB, tropospheric interference.

1.2 Carriers separated by parts of the line frequency (f_{line}), systems having the same line-standard, non-precision offset (see Table 1)

TABLE 1

Protection ratio, tropospheric interference carrier separation up to about $\pm 36/12 f_{line}$ (about ± 50 kHz)

Offset of line frequency	1/2, 3/2, 5/2, ...	1/3, 2/3, 4/3, ...
525-line system (dB)	25	28

2 Protection from adjacent-channel interference

The given protection ratios apply to tropospheric interference and are defined in terms of wanted and unwanted vision carrier levels. For continuous interference, the values should be increased by 10 dB.

Adjacent-channel protection ratios cannot be determined directly from the overlapping channel protection ratio curves shown in § 4 because for certain systems the values may be affected by special measures in the receiver, e.g. sound traps.

2.1 Protection from lower adjacent-channel interference, VHF and UHF bands

The worst interference to the picture signal from another signal using the same standard results from the sound signal in the lower adjacent channel. However, an improvement of 2-3 dB can be achieved if the frequency difference between the wanted vision and unwanted sound carriers is an odd multiple of half the line frequency. During periods of no sound modulation, the improvement is as much as 10 dB.

The figure below relates to the case where the separation between the wanted vision carrier frequency and the unwanted sound carrier frequency is 1.5 MHz and the ratio between the unwanted vision and unwanted sound powers is 10 dB.

A correction must be made for different vision to sound power ratios.

Protection ratio: –13 dB.

2.2 Protection from upper adjacent-channel interference, VHF and UHF bands

Protection ratio: –10 dB.

3 Protection from image-channel interference

The protection ratio will depend on the intermediate frequency and image-channel rejection of the receiver, and on the type of unwanted signal falling in the image channel. It can be determined by subtracting the image rejection figure from the required protection ratio for overlapping channels. Table 2 shows image-channel rejection values.

TABLE 2
Image-channel rejection

Image-channel rejection (dB)	VHF	UHF
System M (Japan)	60	45
Other systems		40

4 Protection from overlapping channel interference

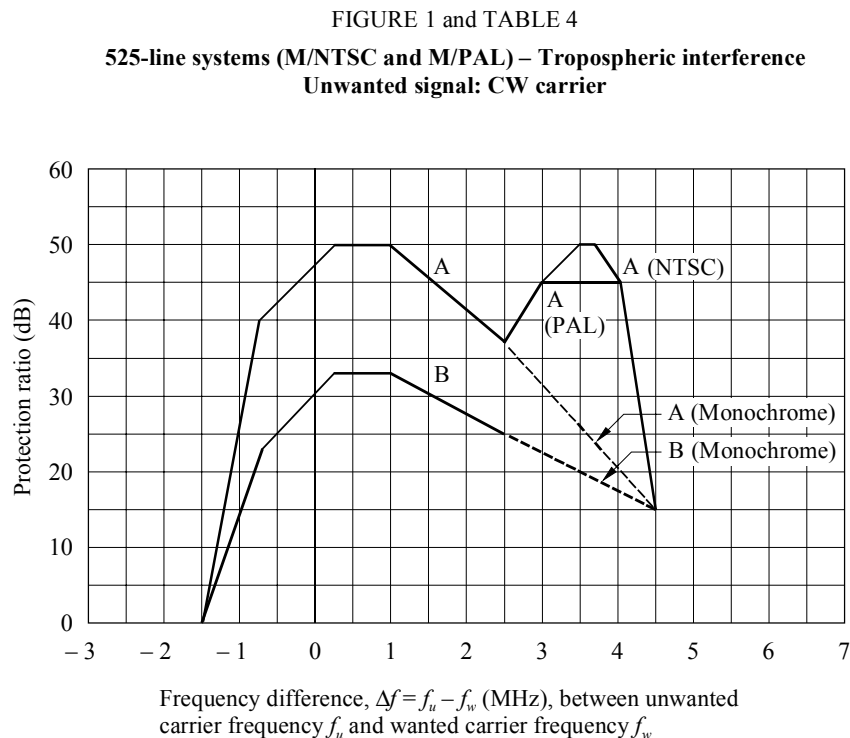
All Figures and Tables in this section give protection ratio values to be applied when a continuous wave (CW) signal lies within the vision channel of the wanted transmission, the wanted vision signal being negatively modulated.

Corrections to be made for other types of interfering signal are given in Table 3.

TABLE 3
Correction values for different unwanted signals

Wanted signal \ Unwanted signal	Correction factors (dB)				
	CW	Vision signal negative modulated	Vision signal positive modulated	FM-sound	AM-sound
Vision signal negative modulated	0	–2	0	0	+4

Figure 1 and Table 4 show protection ratios for tropospheric interference. For continuous interference, the values should be increased by 10 dB. The unwanted signal is a CW carrier. For other types of unwanted signal, the correction factors given in Table 3 should be applied.



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Δf (MHz)		-1.5	-1.0	-0.75	0.3	1.0	2.5	3.0	3.5	3.7	4.1	4.5
A	NTSC (dB)								50	50	45	
A	PAL (dB)	0	30	40	50	50	37	45	45	45		15
A	Monochrome (dB)											
B	Monochrome (dB)	0	15		33	33	25					15
Protection ratio (dB)												

Curves A: non-controlled condition

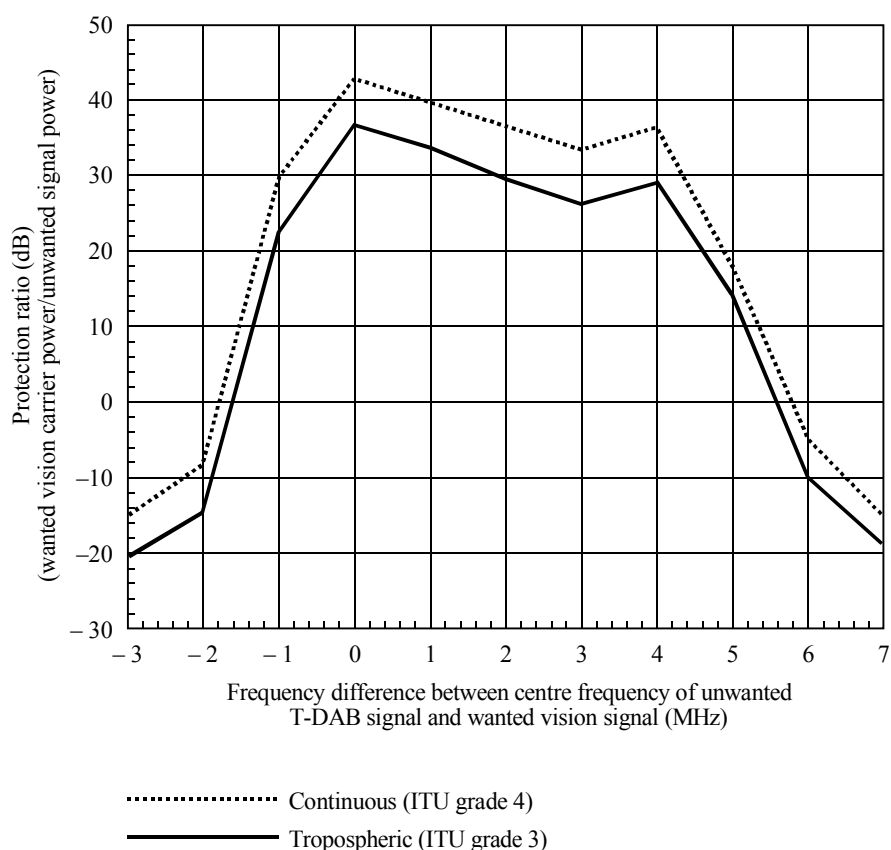
B: non-precision offset condition
(1/3, 2/3, 4/3, 5/3, all of the line frequency)

4.1 Protection ratios for vision signals interfered with by terrestrial digital audio broadcasting (T-DAB)

Figure 2 and Table 5 give protection ratios for negative modulated vision signals interfered with by a 1.5 MHz wide COFDM signal according to the T-DAB system (see Recommendation ITU-R BS.1114).

FIGURE 2

Protection ratios for vision signal interfered with by T-DAB signal



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TABLE 5

Vision signal interfered with by T-DAB

Protection ratio (dB)	Frequency difference between unwanted and wanted carriers (MHz)										
	Luminance range							Chrominance range			
	-3.0	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Tropospheric interference (T)	-20	-15	23	37	34	30	26	29	14	-10	-19
Continuous interference (C)	-15	-9	30	43	40	36	33	36	18	-5	-15

5 Television signal affected by data signals

The inclusion of digital data such as teletext in the field-blanking interval has no effect on the required protection ratios. However, the full improvement resulting from non-precision or precision offset operation is not achievable when the unwanted signal carries a full-field data signal. No information is currently available regarding the protection ratios to be applied to a wanted 525-line system when the unwanted signal is full field teletext.

Appendix 2 to Annex 1

Protection ratios for 625-line television systems

1 Protection from co-channel interference

In this section, the protection ratios between two television signals apply only for interference due to the modulated vision carrier of the unwanted signal. Additional protection may be necessary if the wanted sound carrier is affected, or if the unwanted sound carrier lies within the wanted vision channel (e.g. the unwanted sound carrier of system G lies within the vision channel of system K). For all protection ratio values in this section, the following corrections have to be made:

- when the wanted signal is modulated negatively and the unwanted signal is modulated positively (L/SECAM), the values should be increased by 2 dB;
- when the wanted signal is modulated positively and the unwanted signal is modulated negatively, the values should be reduced by 2 dB.

1.1 Carriers separated by less than 1 000 Hz, non-controlled systems having the same or a different line-standard

Protection ratio: 45 dB, tropospheric interference.

1.2 Carriers separated by multiples of a twelfth of the line frequency up to about $\pm 36/12 f_{line}$ (about ± 50 kHz)

These protection ratio values do not necessarily apply for greater carrier separations.

TABLE 6

Protection ratio between 625-line systems*

Offset (multiples of 1/12 line-frequency) ⁽¹⁾		0	1	2	3	4	5	6	7	8	9	10	11	12
Non-precision offset Transmitter stability ± 500 Hz	Tropospheric interference	45	44	40	34	30	28	27	28	30	34	40	44	45
	Continuous interference	52	51	48	44	40	36	33	36	40	44	48	51	52
	Limit of perceptibility ⁽²⁾	61	60	57	54	50	45	42	45	50	54	57	60	61
Precision offset Transmitter stability ± 1 Hz	Tropospheric interference	32	34	30	26	22	22	24	22	22	26	30	34	38
	Continuous interference	36	38	34	30	27	27	30	27	27	30	34	38	42
	Limit of perceptibility ⁽²⁾	42	44	40	36	36	39	42	39	36	36	40	44	48

* The values shown in Table 6 may also be applied to PALplus signals (both as wanted and/or unwanted).

(1) Value in the first column is only valid for the 0/12 case. All other values between 1/12 and 12/12 are the same by addition or subtraction of integral multiples of 12/12 up to $\pm 36/12$.

(2) Limit of perceptibility – only for information.

2 Protection from adjacent-channel interference

The given protection ratios apply to tropospheric interference and are defined in terms of wanted and unwanted vision carrier levels. For continuous interference, the values should be increased by 10 dB.

Adjacent-channel protection ratios cannot be determined directly from the overlapping channel protection ratio curves shown in § 4 because for certain systems the values may be affected by special measures in the receiver, e.g. sound traps.

2.1 Protection from lower adjacent-channel interference

The worst interference on the picture signal from another signal, using the same standard, results from the sound signal in the lower adjacent channel. However, an improvement of 2-3 dB can be achieved if the frequency difference between the wanted vision and unwanted sound carriers is an odd multiple of half the line-frequency. During periods of no sound modulation, the improvement is as much as 10 dB.

When digital sound is introduced on System B, at a level of –20 dB relative to the vision carrier, interference to D-SECAM is not increased provided that the existing System B FM sound carrier is reduced from –10 to –13 dB relative to the vision carrier. However, further studies on this and other similar cases are needed.

2.1.1 VHF bands

The figures below relate to the cases where the separation between the wanted vision carrier frequency and the unwanted sound carrier frequency is 1.5 MHz and the ratio between the unwanted vision and unwanted sound powers is 10 dB.

A correction must be made for different vision-to-sound power ratios.

Protection ratio: for frequency-modulated sound carrier: –9 dB
for amplitude-modulated sound carrier: –8 dB.

2.1.2 UHF bands

Table 7 gives the protection required by a signal of any system against a lower adjacent-channel signal of the same or any other standard, assuming a vision-to-sound power ratio of 10 dB for unwanted signals of every standard.

A correction must be made for different vision-to-sound power ratios.

2.2 Protection from upper adjacent-channel interference, VHF and UHF bands

Protection ratio: for systems D and K: –6 dB
for other systems: –12 dB.