RECOMMENDATION ITU-R BT.1368*

PLANNING CRITERIA FOR DIGITAL TERRESTRIAL TELEVISION SERVICES IN THE VHF/UHF TELEVISION BANDS**

(Question ITU-R 121/11)

(1998)

The ITU Radiocommunication Assembly,

considering

a) that systems are being developed for the transmission of digital terrestrial television services in the VHF/UHF television bands;

b) that the VHF/UHF television bands are already occupied by analogue television services;

c) that the analogue television services will remain in use for a considerable period of time;

d) that the availability of consistent sets of planning criteria agreed by administrations will facilitate the introduction of digital terrestrial television services,

recommends

1 that the relevant protection ratios given in Annexes 1 and 2, the relevant minimum field strength values given in Annex 3 and the additional information given in Annex 4 be used as the basis for frequency planning for terrestrial digital television services.

Note by the Secretariat to Recommendation ITU-R BT.1368:

This Recommendation modifies also Recommendation ITU-R BT.655-4, therefore renumbers its Tables. Please note that a new version of Recommendation BT.1368 and Recommendation UIT-R BT.655-4 will appear in subsequent publications once approved by Member States.

ANNEX 1

Protection of a digital television (DTV) system

Tables 1 to 5 show protection ratios for different DTV systems.

In Table 1 for wanted DTV B systems the required protection ratios are measured between the inner and outer codes for a BER of 2×10^{-4}, this corresponds at the input of MPEG-2 demultiplexer to a BER of $< 10^{-11}$. For wanted DTV A systems the required BER at input of MPEG-2 demultiplexer is 3×10^{-6}.

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* This Recommendation contains the following five Annexes:

Annex 1 – Protection ratios of wanted DTV systems.

Annex 2 – Protection ratios of wanted analogue TV systems interfered by unwanted digital DTV systems.

Annex 3 – Minimum field strengths for terrestrial digital television.

Annex 4 – Other planning factors.

Annex 5 – Subjective comparison method for protection ratio tests of wanted analogue TV systems.

** In this Recommendation DTV refers to digital terrestrial television broadcasting (DTTB).

TABLE 1

Co-channel interference

Wanted signal			Unwanted interferer (Analogue and Digital TV systems including sound carriers)								
DTV system	BW	Mode	G/PAL	B/PAL	I/PAL	D, K/ PAL	L/ SECAM	D, K/ SECAM	M/ NTSC	DTV B	DTV A
DTV B	6 MHz	M1									
		M2									
		M3									
DTV B	7 MHz	M1		-8[6]						11[5]	
		M2		-3[6]						17[5]	
		M3		6[6]						19[5]	
DTV B	8 MHz	M1	1[2), 3), 4)]		-8[1]					11[5]	
		M2	6[2), 3), 4)]		-4[1]					17[5]	
		M3	9[2), 4)]		4[1]					18[5]	
DTV A	6 MHz								2		15

The protection ratios are given in dB and apply to both continuous and tropospheric interference.

1) Using one unmodulated sound carrier.

2) Using two modulated analogue sound carriers.

3) These values are not measured and are interpolated from the most pessimistic measurements of other modes.

4) BER is measured before Viterbi decoding. Failure limit value corresponds to a BER of 2×10^{-4} after Viterbi decoding for a Gaussian channel. A Gaussian channel is more critical compared with interference from an analogue TV interferer.

5) Values based upon measured C/N results.

6) Using two analogue sound carriers. Worst result of modulated and unmodulated sound carriers is used.

TABLE 2

Lower adjacent channel interference (N - 1)

Wanted signal			Unwanted interferer (Analogue and Digital TV systems including sound carriers)								
DTV system	BW	Mode	G/PAL	B/PAL	I/PAL	D, K/ PAL	L/ SECAM	D, K/ SECAM	M/ NTSC	DTV B	DTV A
DTV B	6 MHz	M1									
		M2									
		M3									
DTV B	7 MHz	M1		-44							
		M2		-41							
		M3		-38							
DTV B	8 MHz	M1			-43						
		M2			-38						
		M3			-34[1]						
DTV A	6 MHz								-48		-42

The protection ratios are given in dB and apply to both continuous and tropospheric interference.

1) Measured using a -25 kHz offset of the unwanted I/PAL signal.

TABLE 3

Upper adjacent channel interference (N + 1)

Wanted signal			Unwanted interferer (Analogue and Digital TV systems including sound carriers)								
DTV system	BW	Mode	G/PAL	B/PAL	I/PAL	D, K/ PAL	L/ SECAM	D, K/ SECAM	M/ NTSC	DTV B	DTV A
DTV B	6 MHz	M1									
		M2									
		M3									
DTV B	7 MHz	M1		-46							
		M2		-42							
		M3		-38							
DTV B	8 MHz	M1			-46						
		M2			-40						
		M3			-38[1)]						
DTV A	6 MHz								-49		-43

The protection ratios are given in dB and apply to both continuous and tropospheric interference.

1) Measured using a -25 kHz offset of the unwanted I/PAL signal.

TABLE 4

Image channel interference

Wanted signal			Unwanted interferer (Analogue and Digital TV systems including sound carriers)								
DTV system	BW	Mode	G/PAL	B/PAL	I/PAL	D, K/ PAL	L/ SECAM	D, K/ SECAM	M/ NTSC	DTV B	DTV A
DTV B	6 MHz	M1									
		M2									
		M3									
DTV B	7 MHz	M1									
		M2									
		M3									
DTV B	8 MHz	M1			-58						
		M2			-50						
		M3			-46						
DTV A N + 14, N + 15	6 MHz								-58		-63

The protection ratios are given in dB and apply to both continuous and tropospheric interference.

TABLE 5

Other out-of-band channels

Wanted signal	Unwanted interferer	Unwanted channels	Protection ratio
DTV A	DTV A	N ± 2 to N ± 8	-58
DTV A	M/NTSC	N ± 2 to N ± 8	-58

The protection ratios are given in dB and apply to both continuous and tropospheric interference.

Notes to Tables 1 to 5

NOTE 1 – It is assumed that because a DTV receiver needs to operate successfully in the presence of high level analogue signal on nearby channels, a high degree of receiver front-end linearity will be required and that impairment due to non-linearity will not be caused by signals on channels other than N, N - 1 and N + 1.

NOTE 2 – Protection ratios for a CW or narrow-band interferer should be provided in the form of a graph.

NOTE 3 – The results shown with DTV as the interfering system are those for the case where the wanted and unwanted signals do not have a common programme source or are not synchronized. Results relevant to SFNs are yet to be developed.

NOTE 4 – All relevant analogue systems should be included.

NOTE 5 – M1, M2, M3 for DTV B systems are representative modes of the system, e.g. portable or fixed reception.

Mode	Modulation	Code rate	C/N[1)]	Bit rate[2)]
M1	16-QAM	1/2	9 dB	≈10 Mbit/s
M2	64-QAM	1/2	15 dB	≈15 Mbit/s
M3	64-QAM	2/3	17 dB	≈20 Mbit/s

1) BER < 10-11 at the input of MPEG-2 demultiplexer for a Gaussian channel with no allowance for implementation margin, typical implementation margins of 2 dB have been measured.

2) For a guard interval fraction of one quarter.

NOTE 6 – All protection ratio values in Tables 1 to 5 are initial figures based upon measurements made on non-consumer receivers.

NOTE 7 – Protection ratios for systems under development (see Annex 2 of Recommendation ITU-R BT.1306) will be presented to Working Party 11C when such systems are fully developed.

ANNEX 2

Protection ratios of wanted analogue TV systems interfered by unwanted digital DTV systems

Introduction

Annex 2 contains a supplement to Recommendation ITU-R BT.655. The numbers of paragraphs and tables in this Annex are taken from the original source and therefore the numbering of sections, figures and tables is not continuous.

RADIO-FREQUENCY PROTECTION RATIOS FOR AM VESTIGIAL SIDEBAND TERRESTRIAL TELEVISION SYSTEMS

ANNEX 1

(to Annex 2 (Recommendation ITU-R BT.655))

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.

Measurements of protection ratios should preferable be made with the subjective comparison method described in Annex 5.

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.

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.

The reference level of the digital signal is defined as the r.m.s. value of the emitted signal power within the channel bandwidth. It should be preferably measured by thermal power meter.

APPENDIX 1

(Recommendation ITU-R BT.655)

Protection ratio for 525-line television systems

6 Protection for vision and sound signals interfered with by digital television system (DTV A)

6.1 Protection for vision signals interfered with by digital television system (DTV A)

In this section the protection ratios for an analogue wanted signal interfered by an unwanted digital signal apply only on the interference to vision and colour carrier.

TABLE 5

Protection ratios for a wanted analogue vision signal (NTSC, 6 MHz) interfered with by unwanted system DTV A

Unwanted digital channel	Tropospheric interference grade 3	Continuos interference grade 4
N - 1 (lower)	-17	
N (co-channel)	34	
N + 1 (upper)	-17	
N + 14 (image)	-33	
N + 15 (image)	-31	
N ± 2 to N ± 8	-24	

6.2 Protection for NTSC sound signals (BTSC and SAP) interfered with by digital television system (DTV A)

In the case of an unwanted upper adjacent digital channel N + 1 the audio signals degrade before the vision signal. The protection ratio value for the interference into the BTSC and SAP sound signals was measured with -12 dB. (Vision protection ratio for N + 1 is -17 dB.) The -12 dB sound protection ratio figure is related to the wanted NTSC vision carrier level.

APPENDIX 2

(Recommendation ITU-R BT.655)

Protection ratio for 625-line television systems

6 Protection for vision signals interfered with by digital television system (DTV B)

In this section the protection ratios for an analogue wanted signal interfered by an unwanted digital signal applies only on the interference to vision and colour carrier.

The given protection ratio figures are related to an out-of-channel spectrum attenuation of the unwanted DTV B transmitter of 40 dB.

6.1 Protection from co-channel interference

TABLE 17

Protection ratios for a wanted analogue vision signal interfered with by unwanted DTV B 8 MHz system

Wanted analogue system	Tropospheric interference	Continuous interference	Interference grade 4.5
G/PAL	34	40	
I/PAL	37	41	45
L/SECAM	37	42	
D, K/SECAM	[35]	[41]	
D, K/PAL			

NOTE – Provisional values still under study.

TABLE 18

Protection ratio for a wanted analogue vision signal interfered with by unwanted DTV B 7 MHz system

Wanted analogue system	Tropospheric interference	Continuous interference	Interference grade 4.5
B/PAL	35	41	

6.2 Protection from lower adjacent channel interference

The protection ratio figures in this chapter have to be verified and for other television systems in use the figures have to be added.

TABLE 19

Protection ratio for a wanted analogue vision signal interfered with by unwanted lower adjacent DTV B 8 MHz system

Wanted analogue system	Tropospheric interference	Continuous interference	Interference grade 4.5
G/PAL	-7	-4	0
I/PAL	-8	-4	
L/SECAM	-9	-7	
D, K/SECAM	[-5]	[-1]	
D, K/PAL			

NOTE – Provisional values still under study.

TABLE 20

Protection ratio for a wanted analogue vision signal interfered with by unwanted lower adjacent DTV B 7 MHz system

Wanted analogue system	Tropospheric interference	Continuous interference	Interference grade 4.5
B/PAL	-11	-4	

6.3 Protection from upper adjacent channel interference

TABLE 21

Protection ratio for a wanted analogue vision signal interfered with by unwanted upper adjacent DTV B 8 MHz system

Wanted analogue system	Tropospheric interference	Continuous interference	Interference grade 4.5
G/PAL	-9	-7	
I/PAL	-10	-6	
L/SECAM	-1	-1	
D, K/SECAM	[-8]	[-5]	
D, K/PAL			

NOTE – Provisional values still under study.

TABLE 22

Protection ratio for a wanted analogue vision signal interfered with by unwanted upper adjacent DTV B 7 MHz system

Wanted analogue system	Tropospheric interference	Continuous interference	Interference grade 4.5
B/PAL	-5	-3	

6.4 Protection from image channel interference

TABLE 23

Protection ratio for a wanted analogue vision signals interfered with by unwanted image channel DTV B 8 MHz systems

Wanted analogue system	Unwanted DTV B channel	Tropospheric interference	Continuous interference	Interference grade 4.5
G/PAL	N + 9	-19	-15	
I/PAL	N + 9			
L/SECAM		[-25]	[-22]	
D, K/SECAM	N + 8	[-16]	[-11]	
D, K/SECAM	N + 9	[-16]	[-11]	
D, K/PAL	N + 8			
D, K/PAL	N + 9			

NOTE – Provisional values still under study.

TABLE 24

Protection ratio for a wanted analogue vision signal interfered with by unwanted image DTV B 7 MHz system

Wanted analogue system	Unwanted DTV B channel	Tropospheric interference	Continuous interference	Interference grade 4.5
B/PAL	N + 10	-22	-18	
B/PAL	N + 11	-21	-18	

6.5 Protection from overlapping interference

TABLE 25

Protection ratios for analogue B/PAL vision signals interfered with by unwanted overlapping DTV B 7 MHz system

Frequency difference between centre of unwanted DTV B and centre of wanted analogue system (MHz)		Protection ratio in dB	
		Tropospheric interference	Continuous interference
-10.0		-16	-11
-7.0	(N - 1)	-11	-4
-6.5		-4	3
-6.0		13	20
-5.5		23	30
-5.0		30	37
-4.0		34	41
-3.0		36	42
-2.0		35	41
-1.0		35	41
-0.5		35	41
0.0	(N)	35	41
0.5		36	41
1.0		36	42
2.0		35	41
3.0		31	38
4.0		26	33
5.0		21	30
6.0		4	9
7.0	(N + 1)	-5	-3
10.0		-5	0

APPENDIX 3

(Recommendation ITU-R BT.655)

Protection ratios for sound signals

In this section, all values quoted refer to the level of the wanted sound carrier.

Table 27 gives protection ratios for a wanted sound signal interfered with by an unwanted analogue or digital signal for a frequency separation of 0 kHz. The values for a wanted FM- or AM-sound signal interfered with by an unwanted AM-signal are derived from Table 26 by calculation; all other values are based on measurements.

The sound quality for tropospheric interference corresponds to grade 3, for continuous interference to grade 4.

The reference signal-to-noise ratios (S/N is peak-to-peak weighted) for analogue sound signals (Recommendation ITU-R BS.468 and Recommendation ITU-R BS.412) are:

– -40 dB (approximates to impairment grade 3) - tropospheric;

– -48 dB (approximates to impairment grade 4) - continuous.

In the case of FM, the reference sound signal level corresponds to the maximum frequency deviation. The maximum deviation of FM-sound carrier is assumed to be ±50 kHz.

The reference bit-error rates for NICAM digital sound signals are:

– -10^{-4} (approximates to impairment grade 3) - tropospheric;

– -10^{-5} (approximates to impairment grade 4) - continuous.

In the case of a two-sound carrier transmission, each of the two-sound signals must be considered separately. Multiple modulated sound signals may require higher protection.

TABLE 27

Protection ratios for a wanted sound signal

Protection ratio (dB) related to wanted sound carrier		Unwanted signal					
Wanted sound signal		FM/CW*	AM*	NICAM*	DAB	DTV B 7 MHz	DTV B 8 MHz
FM	Tropospheric interference	32	36	17	12	6	5
	Continuous interference	39	43	27	20	16	15
AM	Tropospheric interference	49	53	37	33		
	Continuous interference	56	60	44	40		
NICAM System B/G	Tropospheric interference	10	12	12	11		
	Continuous interference	11	13	13	12		
NICAM System I	Tropospheric interference						
	Continuous interference						

* Unwanted signals: 0 kHz frequency separation.

NOTE 1 – In many cases, particularly with precision offsets, the required sound protection ratio can be higher than the ratio required between the vision signals according to Table 6. In such instances increasing the frequency offset by a suitable multiple (one, two or three) of the line frequency will decrease the required sound protection ratio significantly, the vision protection ratio remaining unchanged (see also Table 26).

NOTE 2 – In the case of an L/SECAM signal interfered with by an I/PAL signal with digital sound, the full benefit of precision offset may not be obtained because of interference to the AM-sound signal.

In each co-channel situation the wanted sound signal(s) is (are) directly affected by the unwanted sound signal(s). In addition, the unwanted vision carrier produces a phase modulation of the wanted vision carrier resulting in some sound distortion in receivers using inter-carrier demodulation techniques. It has been shown that an improvement of the sound quality can be reached by increasing the frequency offset by a suitable multiple (one, two or three) of the line frequency (see also Note on Table 26). The weighted S/N will be improved by approximately 8 dB, if, for example, 20/12th line-frequency offset is used instead of 8/12 line-frequency offset.

TABLE 29

Protection ratios for wanted FM sound interfered with by overlapping DTV B 7 MHz signal

Protection ratio (dB)	Frequency difference between 3 dB edge of DTV B and sound carrier	-500 kHz	-250 kHz	-50 kHz	0.0 kHz	50 kHz	250 kHz	500 kHz
Tropospheric interference	Upper edge	0	0	0	5	5	6	6
Continuous interference	Upper edge	9	9	9	14	14	15	16
Tropospheric interference	Lower edge	5	5	4	3	-9	-22	-32
Continuous interference	Lower edge	15	15	14	12	-6	-16	-27

NOTE 1 – The protection ratio figures are related to an out-of-channel spectrum attenuation of 40 dB.

NOTE 2 – The protection ratio figures for other television systems in use have to be added.

ANNEX 3

Minimum field strengths for terrestrial digital television

Two methods are given for the calculation of minimum field strength values. Each of these methods is in widespread use and either method may be used to give the identical minimum field strength values for a given set of parameters.

TABLE 5A

Derivation by the "voltage method"

System: DTV B 8 MHz

Frequency (MHz)	65			200			550			700		
System variant[1)]	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Noise bandwidth, B (MHz)							7.5	7.5	7.5	7.5	7.5	7.5
Receiver noise figure, F (dB)							5	5	5	5	5	5
Receiver noise voltage, U_n[2)] (dB (μV))							8.4	8.4	8.4	8.4	8.4	8.4
Receiver carrier/noise ratio[3)] (C/N) (dB)												
Urban noise (dB)							0	0	0	0	0	0
Minimum receiver input voltage, U_{Min} (dB (μV))[2)]												
Conversion factor[2)] k (dB)							20.5	20.5		24.5	24.5	
Feeder loss, A_f (dB)							3	3		5	5	
Antenna gain, G (dB)							10	10		12	12	
Minimum field strength for fixed reception, E_{min} (dB (μV/m))[2)]												

1) M1, M2, M3 up to three system modes, see Annex 1.

2) Formula see Appendix 1.

3) For noise bandwidth noted above.

TABLE 6A

Derivation by the "power method"

System:

Frequency (MHz)	65			200			500			700		
System variant[1)]	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Equivalent noise bandwidth, B (MHz)												
Receiver noise figure, F (dB)												
Receiver noise power P_n[2)] (dBW)												
Receiver carrier/noise ratio[3)] (C/N) (dB)												
Urban noise (dB)												
Wave length (m)												
Feeder loss (dB)												
Antenna gain G (dB)												
Effective antenna aperture (dB)[2)]												
Power flux-density pfd[2)] (dBW)												
Conversion pfd/ field strength (dB)												
Minimum field strength (dB (μV/m))[2)]												

1) M1, M2, M3 up to three system modes, see Annex 1.

2) Formula see Appendix 1.

3) For noise bandwidth noted above.

APPENDIX 1
(TO ANNEX 3)

	Formulae	in dB
Derivation by the "voltage method"	$P = \frac{U^2}{R}$	
Thermal noise power	kTB	10 log (kTB)
Receiver noise input power	n kTB	10 log (kTB) + F
Thermal noise voltage	$U_T = \sqrt{kTBR}$	
Receiver noise input voltage	$U_N = \sqrt{nkTBR}$	10 log (kTB) + F + 10 log (R)
Minimum receiver input voltage	$U_{\min} = U_N \sqrt{C/N}$	$U_N + \frac{C}{N}$

Relationship between voltage and field strength

$$U = \sqrt{PrR} = \sqrt{\phi AR} = \sqrt{\frac{E^2}{120\pi} 1.64 go \frac{\lambda^2}{4\pi} R}$$

Therefore $U = E\sqrt{\frac{\lambda^2}{480\pi^2} R\, 1.64\ go}$

Conversion factor $K = \frac{E}{U} = \sqrt{\frac{480\pi^2}{1.64 go \lambda^2 R}}$

$K[dB] = 10 \log 480\pi^2 - 20 \log \lambda - 10 \log R - 10 \log 1.64 - G_D + L$

Conversion factor $Ko = \frac{E}{U} = \sqrt{\frac{4\pi^2}{go\lambda^2}}$

$Ko[dB] = 20 \log (2\pi / \lambda) - G_D + L$

$E_{min} = U_{min} + Ko$

(with R = 73 Ω)

Minimum field strength

APPENDIX 2
(TO ANNEX 3)

	Formulae	in dB
Derivation by the "power method"		
Thermal noise	kTB	10 log (kTB)
Receiver noise input power	P_N = n kTB	10 log (kTB) + F
Minimum receiver input power	$P_r = P_N \frac{C}{N}$	$P_r = P_N + \frac{C}{N}$
Relationship between power flux-density (ϕ) and power	$P_r = \phi A$	$P_r = \phi + A$
	$\phi = \frac{P_r}{A}$	$\phi = P_r - A$
Relationship between power flux-density and field strength	$E = \sqrt{120\pi\phi}$	$E\ (dBV/m) = \phi + 10 \log 120\pi$ $E\ (dB\mu V/m) = \phi + 145.76$

APPENDIX 3

(TO ANNEX 3)

Data

k	Boltzman constant = 1.38×10^{-23}
T_o:	290° K
F:	receiver noise figure (dB)
n:	receiver noise figure (factor)
B:	equivalent noise bandwidth (Hz)
C/N:	radio-frequency signal/noise ratio (dB)
f:	frequency (Hz)
G_D:	antenna gain related to half-wave dipole (dB)
L:	cable loss (dB)
ϕ:	power flux-density
go:	gain of receiving antenna system (factor)
A:	effective antenna aperture

Formulae used

thermal noise:	$kT_o B$
receiver noise temperature:	$Tr = T_o (10^{F/10} - 1)$
go:	$10^{(G_D - L)/10}$
n:	$10^{F/10}$
A:	$\frac{1.64 go \lambda^2}{4\pi}$
ϕ:	$\frac{E^2}{120\pi}$

ANNEX 4

Other planning factors

Field strength distribution with location

It is to be expected that the distributions of field strength with location for digital television signals will not be the same as those applicable to analogue television signals and given in Figures 5 and 12 of Recommendation ITU-R P.370.

The results of propagation studies for digital systems are given in Figures 1 and 2 for the VHF and UHF bands, respectively. These results may also be used to derive propagation prediction curves for location percentages other than 50%. Refer to Figures 5 and 12 of Recommendation ITU-R P.370 for the location percentages other than 50% for analogue and digital systems, where the digital system bandwidth is greater than 1.5 MHz.

Reception using portable television equipment

The methods given in Annex 3 may be used to derive the minimum field strength required in the vicinity of a receiving antenna. By convention, field strength predictions are made for a receiving antenna height of 10 m above ground or roof-top level. In the case of reception using a portable receiver, an estimate will be needed of the difference in field strength between that at 10 m or roof-top level and that at the place where the portable receiver is situated. Representative values, including both indoor and outdoor operation, have yet been developed. Recommendation ITU-R P.370 notes that by using Equation (5), a correction to the predicted field strengths can be made for various receiving antenna heights ranging from 1.5 to 40 m above ground.

An approximation for the indoor field strength relative to the ground floor outdoor field strength for the VHF and UHF bands in suburban areas is given by:

$$FS\ (indoor) = FS\ (outdoor\ at\ ground\ level) + 2N - 10$$

where N is the number of the floor where the indoor receiver is located and for N ranging from 0 to 2.

Receiving antenna discrimination

Information concerning the directivity and polarization discrimination of domestic receiving antennas is given in Recommendation ITU-R BT.419.

FIGURE 1

Ratio (dB) of the field strength for a given percentage of the receiving locations to the field strength for 50% of the receiving locations

Frequency: 30 to 250 MHz (Bands I, II and III)

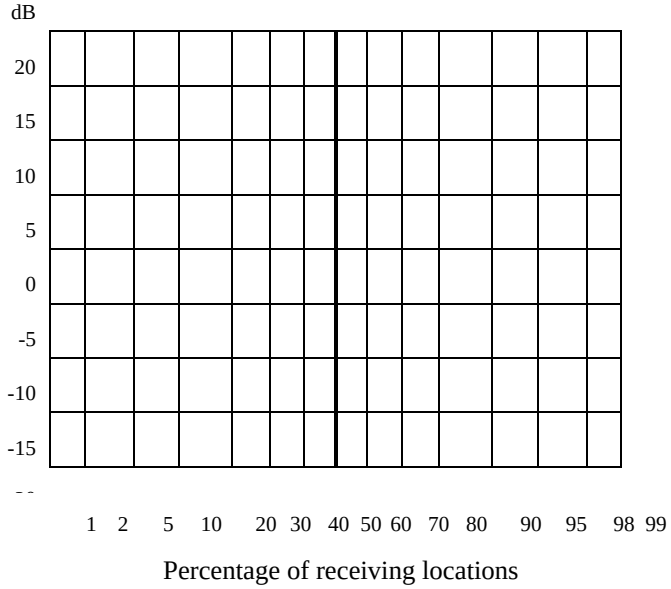
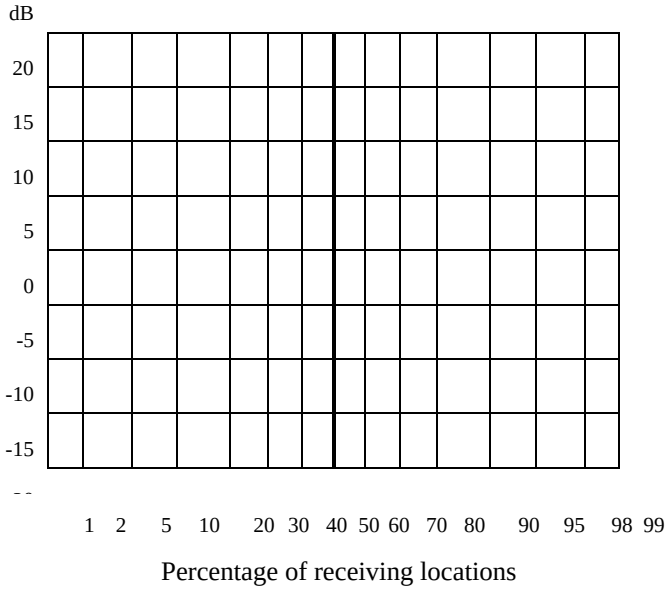


FIGURE 2

Ratio (dB) of the field strength for a given percentage of the receiving locations to the field strength for 50% of the receiving locations

Frequency: 470 to 890 MHz (Bands IV and V)



ANNEX 5

Subjective comparison method (SCM) with reference interferer of assessing protection ratios for analogue television systems

1 Introduction

This annex gives a method of assessing protection ratios for wanted analogue TV systems based on the subjective comparison of the impairment of an interferer with that of a reference interferer. Usable and reliable results are produced with only a small number of observers and one still picture.

Subjective methods for assessment of impairment grades involve extensive tests, are time consuming, require large numbers of observers and consider the full impairment grade range. For assessing protection ratios only three fixed impairment types are necessary, approximately grade 3 for tropospheric, grade 4 for continuous and grade 4.5 for steady interference, see Table 1. The subjective comparison method is appropriate for the evaluation of interference from any unwanted digital or analogue transmission system into a wanted analogue television channel. The application of a defined fixed reference interferer results in a reproducible set of figures with a low deviation (approximately ±1 dB standard deviation). Only a small number of observers - three to five experts or non-experts - are necessary.

There are two reference interferers which may be used:

– sine-wave interference;

– Gaussian-noise interferer.

Tests have shown that for unwanted digital television systems a noise reference interferer can improve the assessment decision by the observer. The use of noise reference interferer shows the same results as the defined sine-wave interferer. The disadvantage is that a more complicated test arrangement may be necessary. Further tests are necessary, especially by fixing the equivalent noise reference.

2 The subjective comparison method (SCM) of assessing protection ratios using sine-wave reference

2.1 General description

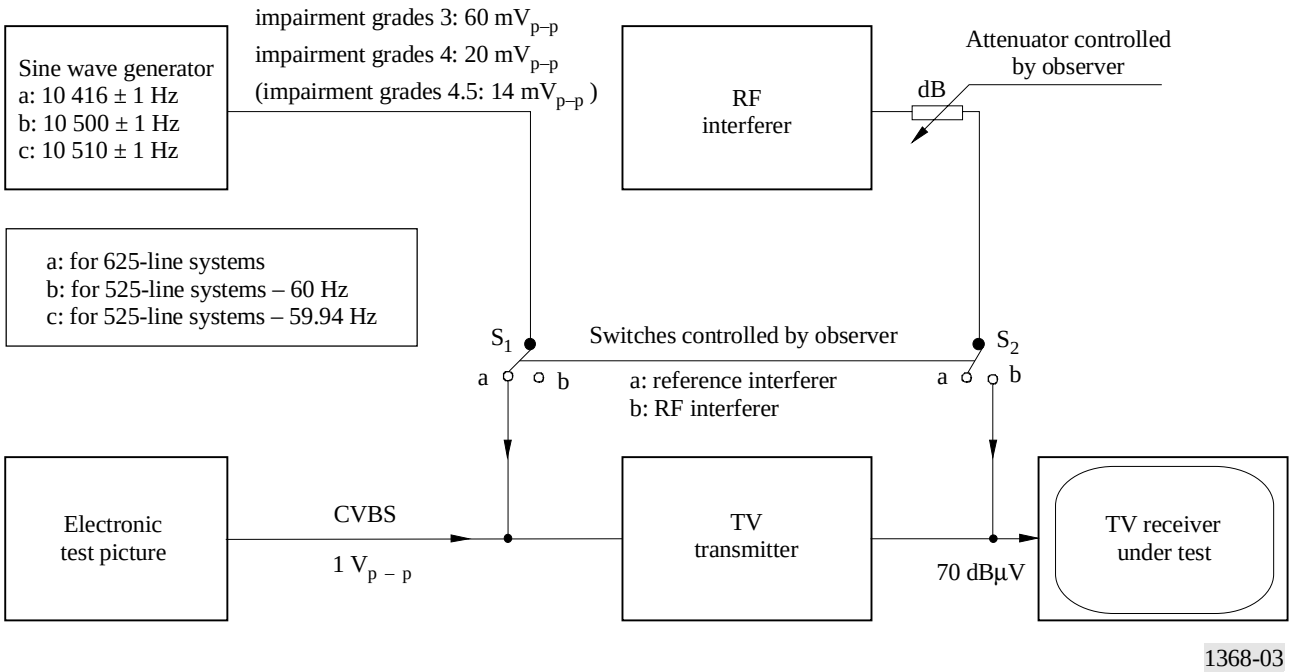
Figure 1 shows the test arrangement for the subjective comparison method with sine-wave interferer. The lower three blocks are the main signal path, the wanted video source, the television transmitter and the TV receiver under test. The reference video interferer is a simple sine-wave signal. The amplitude of the sine-wave generator is switchable between tropospheric interference, continuous interference and steady interferences type. The unwanted RF interferer is added to the wanted signal path. The amplitude and frequency of the interferer are calculated from the RF reference interferer given in Recommendation ITU-R BT.655, Annex 1, § 2.3.

The intensity of the RF interferer can be changed with an attenuator controlled by the observer. The RF interferer is adjusted to produce the same impairment grade as the reference interferer by comparing the interfered pictures on the TV screen.

The RF protection ratio is the difference between the wanted and the unwanted signal levels at the receiver input. The test arrangement can be adjusted in such a way that the value in dB shown at the attenuation box gives directly the protection ratio.

FIGURE 1

Subjective comparison method (SCM) for assessment of protection ratios



2.2 Realization of the reference interferer

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 the wanted and unwanted vision carriers close to two-thirds of the line frequency but adjusted for maximum impairment. The precise frequency difference is 10.416 kHz. These conditions

approximate impairment grades 3 (slightly annoying) and 4 (perceptible, but not annoying) and apply to tropospheric (1% of time) and continuous interference (50% of time), respectively. The impairment grade of the given video baseband reference interferer is independent from the analogue television system and independent from the RF modulation parameters like modulation polarity, residual carrier etc.

The RF reference interferer can be realized as a simple sine-wave signal at baseband frequency as shown in Figure 1. The sine-wave reference interferer has a fixed frequency of 10.416 kHz for 625-line systems or 10.500 kHz for 525-line systems -60 Hz and 10.510 kHz for 525-line systems -59.94 Hz, an amplitude of either 60 mV_{p-p} or 20 mV_{p-p} referring to a black-to-white level of 700 mV_{p-p} or a CVBS level of 1 V_{p-p}. These amplitudes correspond to the RF protection ratios of 30 dB and 40 dB respectively (2/3 line offset). The frequency stability of the sine-wave generator must be within ±1 Hz.

2.3 Test conditions

Wanted video signal:	Only an electronic test picture is required (e.g. FuBK, Philips or others).
Viewing conditions:	As given in Recommendation ITU-R BT.500.
Viewing distance:	Five times the picture height.
Test receiver:	Up to five different domestic sets, not older than five years. For co-channel measurements a professional receiver can be used.
Receiver input signal:	70 dBµV at 75 Ω.
Observers:	Five observers, experts or non-experts, are necessary. For initial tests less then five observers are possible. Each single test should be made with one observer only. Observers should be introduced to the method of assessment.

2.4 Presentation of the results

The results should be presented together with the following information:

– mean and standard deviation of the statistical distribution of the protection ratio values;

– test configuration, test picture, type of picture source;

– number of observers;

– reference interferer type;

– the spectrum of the unwanted signal (RF interferer), including the out-of-channel range;

– the used RF level for the wanted signal at the receiver input (for domestic receivers an input voltage of 70 dBµV should be used);

– when domestic sets are used, type, display size and year of production.

3 Table of important parameters

TABLE 1

Basic terms and relations for the SCM method

Quality impairment	Grade 3	Grade 4	Grade 4.5*
Interference type	tropospheric	continuous	steady
Time allowance	1% to 5% of time	50% of time	100% of time
Subjective impairment	slightly annoying	perceptible, but not annoying	just perceptible limit
Reference interferer	60 mV_{p-p}	20 mV_{p-p}	14 mV_{p-p}
RF protection ratio	30 Db	40 dB	43 dB

* Protection ratio for steady interference is not yet defined.