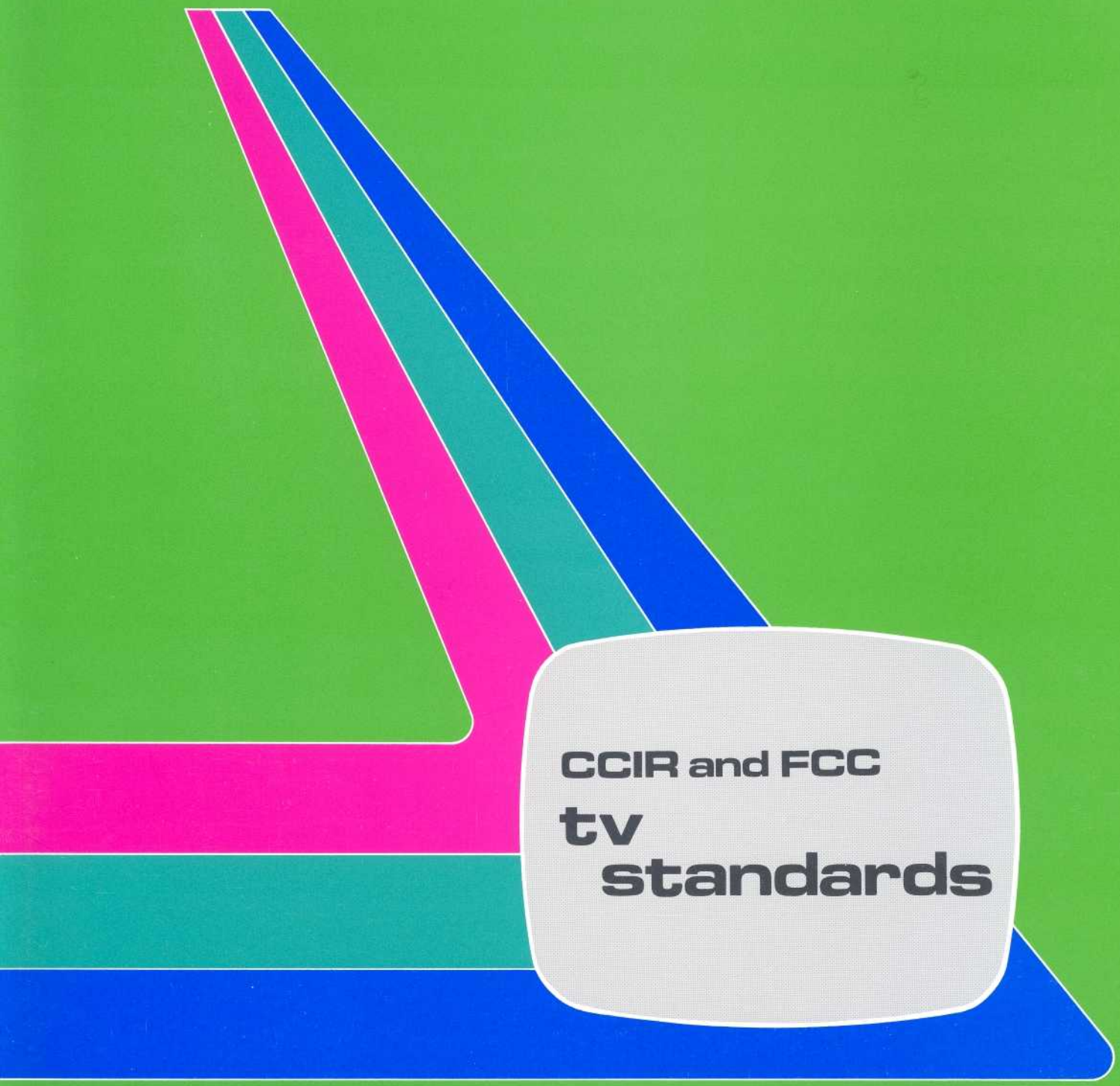
ROHDE & SCHWARZ

SOUND and TV BROADCASTING



CCIR and FCC tv standards

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Abbreviations used

Antiope	Acquisition numérique et télévisualisation d'images organisées en pages d'ecriture
BBC	British Broadcasting Corporation
CATV	Cable Television
CBC	Canadian Broadcasting Corporation
CCETT	Centre Commun d'études de Télédiffusion et Télécommunications
CCIR	Comité Consultatif International des Radiocommunications
CCITT	Comité Consultatif International de Télégraphique et Téléphonique
CEPT	Conférence Européenne des Administrations des Postes et des Télécommunications
Didon	Diffusion de données (par paquets)
DIN	Deutsches Institut für Normung
EBU (UER)	European Broadcasting Union
EIA	Electronic Industries Association
ERP	Effective Radiated Power
FCC	Federal Communications Commission
FDM, TDM	Frequency/Time Division Multiplex
GOST	Normensystem der UdSSR
GPO	General Post Office
IBA	Independent Broadcasting Authority
ITU (UIT)	International Telecommunication Union
KtK	Kommission für den Ausbau des technischen Kommunikationssystems
MAC, (C-)	(Combined) Multiplex Analogue Component
NTSC	National Television System Committee
OIRT	Organisation Internationale de Radiodiffusion-Télévision
PAL	Phase Alternating Line
SABC	South African Broadcasting Corporation
SECAM	Séquentielle à mémoire
TDF	Télédiffusion de France
UER (EBU)	Union der Europäischen Rundfunkorganisationen, Union Européenne de Radiodiffusion
UIT (ITU)	Union Internationale des Télécommunications
WARC	World Administration Radio Conference

The international TV standards

10 international TV standards exist at present, all based on the same principles:

- Physiology of vision
- Line scanning
- Field repetition
- Colour transmission as separate luminance and chrominance components

Vision characteristics

Mean resolution 1′ (angle of sight),
Optimum angle for picture observation without fatigue of eye muscles 10°,

Optimum line number $= \frac{\text{observation angle}}{\text{angle of sight}} = \frac{10°}{1'} = 600$ lines,

Field frequency without motion blurred >12/s.
Field frequency without flicker >50/s.

Number of lines per picture

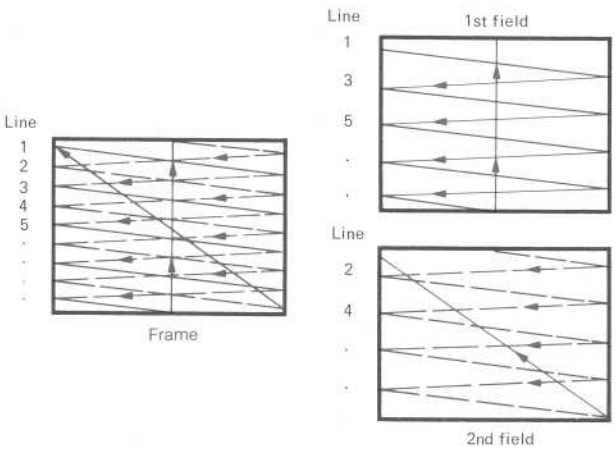
Frames of 525 and 625 lines are still in use. Resolution being too weak at 405 lines and the frequencies required being too high at 819 lines, these values have been superseded by 625 lines.

These apparently odd line numbers derive from the early times of television and are due to the frequency divider and multiplier techniques of the sync signal generators.

Field frequency

The crucial factors were the limit of flicker and the available AC supply frequency (50 or 60 Hz), since the early scanners (Nipkow disc, Weiller wheel and film scanner) were all driven by AC supply-operated synchronous motors. Hum bars resulting from inadequate filtering and other AC line-frequency pickup were thus negligible.

Field frequencies of 50 Hz and 60 Hz in conjunction with 500 to 600 lines per frame led to a video frequency band of more than 10 kHz. This was not acceptable for the frequency channels available for TV transmitters and also because of TV receiver technology and cost. An ingenious trick (F. Schröter, 1927) cut the required frequency band down to half: interlaced scanning of a first field consisting of the odd lines and a second field consisting of the even lines (illustration below). Thus a frequency of 50 field/s (flicker) together with only 25 frames/s (frequeny band) was obtained.



Interlaced scanning with 50 fields (right) with 25 frames (left)

Colour transmission

Three colour TV systems were developed independently of each other regarding the number of lines and field frequency:

NTSC 1948,
PAL 1961,
SECAM 1957.

The luminance signal is necessary for compatibility with the existing monochrome TV receivers. The three primary signals red/green/blue are transmitted in the form of colour difference signals (with reduced bandwidth) relative to the luminance signal. Only two colour difference signals are necessary (the third being produced by electronic calculation in the receiver).

The two colour difference signals modulate a colour subcarrier – simultaneously with AM in the NTSC and PAL systems and successively with FM in the SECAM system. The modulation frequency spectrum of the colour subcarrier is inserted in the frequency spectrum of the luminance signal at the upper end of the video frequency band (half-line or quarter-line offset).

Observation of international TV standards is necessary in view of

international exchange of programs,
design of TV transmitters and transposers,
production of TV receivers,
design of video recorders,
development of measuring instruments and systems.

Basic TV standards

(tables on the following pages)

Two basic standards have been adopted for the international exchange of TV programs:

	FCC standard	CCIR standard
Lines/frame	525	625
Fields/s	60	50
Colour system	NTSC	PAL/SECAM
Video bandwidth	4.2 MHz	5/5.5/6 MHz
Colour subcarrier	3.58 MHz	4.43 MHz

The different video bandwidths of the CCIR standard are not so much due to field and line scanning procedures, but rather to the bandwidth available in the TV transmitter channels (see broadcasting of TV programs, following next double page).

The main problem of **standards conversion** is the conversion of field frequency from 50 Hz to 60 Hz and vice versa. For this purpose, the picture information must be stored and then scanned at the new frequency. The electro-optical analog standards converter uses the screen of a high-resolution display tube of suitable persistence.

Text continued following next double page

Standards for monochrome television

Standard		B/G CCIR	D/K OIRT	H Belgium	I UK	K1[1] FOPTA*)	L France	M FCC	N South America
Frequency		VHF/UHF	VHF/UHF	UHF	VHF/UHF	VHF/UHF	VHF/UHF	VHF/UHF	VHF/UHF
Number of lines per frame		625	625	625	625	625	625	525	625
Field frequency	Hz	50	50	50	50	50	50	60	50
Line frequency	Hz	15 625	15 625	15 625	15 625	15 625	15 625	15 750	15 625
Duration of line sync pulse	μs	4.7	4.7	4.7	4.7	4.7	4.7	5 (4.7)[2]	5
Duration of line blanking pulse	μs	12	12	12	12	12	12	10.8 (11)[2]	10.9
Front porch	μs	1.5	1.5	1.5	1.5	1.5	1.5	1.9 (1.75)[2]	1.9
Field blanking interval	Lines	25	25	25	25	25	25	19 to 21	19 to 25
Video bandwidth	MHz	5	6	5	5.5	6	6	4.2	4.2
RF channel width	MHz	7(B)/8(G)	8	8	8	8	8	6	6
Vision-sound carrier spacing	MHz	+5.5 +5.74[6])	+6.5	+5.5	+6	+6.5	±6.5	+4.5	+4.5
Width of vestigial sideband	MHz	0.75	0.75	1.25	1.25	1.25	1.25	0.75	0.75
Spacing of vision carrier from nearest edge of channel	MHz	+1.25	+1.25	+1.25	+1.25	+1.25	+1.25	+1.25	+1.25
RF sync level	%	100	100	100	100	100	<6	100	100
RF blanking level	%	73[3])	75	75	76	75	30	75	75
RF white level (residual carrier)	%	10	12.5	10	20	10	100 (110)[2]	10	10
Type of vision modulation		C3F neg.	C3F neg.	C3F neg.	C3F neg.	C3F neg.	C3F pos.	C3F neg.	C3F neg.
Type of sound modulation		F3E F3EH[6])	F3E	F3E	F3E	F3E	A3E	F3E	F3E
Frequency deviation	kHz	±50	±50	±50	±50	±50	–	±25	±25
Preemphasis	μs	50	50	50	50	50	–	75	75
Vision/sound power ratio		10:1 to 20:1[4]) 20:1:0.2[6])	10:1 to 5:1	5:1 to 10:1	5:1	10:1	10:1	10:1 to 5:1[5])	10:1 to 5:1

*) Group of territories represented by the French Overseas Post and Telecommunication Agency.

[1]) Also designated K'.
[2]) For colour transmission according to NTSC or SECAM.
[3]) 73% instead of nominal 75% applies for TV transmitters of high linearity also in the sync range (burst, chrominance signal).
[4]) 20:1 in the Federal Republic of Germany as of April 1976 for all TV transmissions of the three programs.
[5]) 6.7:1 and 2.9:1 in Japan.
[6]) For dual-sound or stereo sound in the Federal Republic of Germany (at present in 2nd program).

System Standard	NTSC M	PAL B, G, H	PAL I	PAL M	PAL N	SECAM B, G, H	SECAM D, K, K1	SECAM L
Luminance signal	$E'_Y = 0.3\,E'_R + 0.59\,E'_G + 0.114\,E'_B$							
Colour difference signals (chrominance signals)	$E'_I = -0.27\,(E'_B - E'_Y) + 0.74\,(E'_R - E'_Y)$ $E'_Q = 0.41\,(E'_B - E'_Y) + 0.48\,(E'_R - E'_Y)$	$E'_U = 0.493\,(E'_B - E'_Y)$ $E'_V = 0.877\,(E'_R - E'_Y)$				$D'_R = -1.9\,(E'_R - E'_Y)$ $D'_B = 1.5\,(E'_B - E'_Y)$		
Correction of colour difference signals	—	—				$D'^*_R = A \cdot D'_R$ $D'^*_B = A \cdot D'_B$ $A = \left\lvert \frac{1 + j \cdot \frac{f_R}{85}}{1 + j \cdot \frac{f_B}{255}} \right\rvert$ (f in kHz)		
Composite colour video signal	$E_M = E'_Y + E'_I (\cos \omega_{SC} t + 33°) + E'_Q (\sin \omega_{SC} t + 33°)$	$E_M = E'_Y + E'_U \sin \omega_{SC} t \pm E'_V \cos \omega_{SC} t$				$E_M = E'_Y + G \cdot \cos 2\pi (f_{oR} + D'^*_R \Delta f_{oR}) \cdot t$ or $E'_Y + G \cdot \cos 2\pi (f_{oB} + D'^*_B \Delta f_{oB}) \cdot t$ G = Function of f_o and $f_{R,B}$; see Amplitude of FM chrominance subcarrier		
Type of modulation	Suppressed-carrier amplitude modulation of two subcarriers in quadrature							
Line frequency f_H	15 734.264 ± 0.05 Hz	15 625 ± 0.016 Hz		15734.264 ± 0.05 Hz	15 625 ± 0.016 Hz	15 625 ± 0.016 Hz		
Field frequency	59.94 Hz	50 Hz		59.94 Hz	50 Hz	50 Hz		
Chrominance subcarrier freq. f_{SC}	3 579 545 ± 10 Hz	4433618.75 ± 5 Hz	4433618.75 ± 1 Hz	3575611.49 ± 10 Hz	3582056.25 ± 5 Hz	f_{oR} = 4 406 250 ± 2 000 Hz f_{oB} = 4 250 000 ± 2 000 Hz (f_o = 4 286 ± 20 kHz)		
Relationship between f_{SC} and f_H	$f_{SC} = \frac{455}{2} \cdot f_H$	$f_{SC} = \left(\frac{1135}{4} + \frac{1}{625}\right) \cdot f_H$		$f_{SC} = \frac{909}{4} \cdot f_H$	$f_{SC} = \left(\frac{917}{4} + \frac{1}{625}\right) \cdot f_H$	$f_{oR} = 282 \cdot f_H$, $f_{oB} = 272 \cdot f_H$		
Bandwidth/deviation of colour difference signal	f_{SC} + 620/–1300 kHz	f_{SC} + 570/–1300 kHz	f_{SC} + 1066/–1300 kHz	f_{SC} + 600/–1300 kHz	f_{SC} + 620/–1300 kHz	Δf_{oR} = 280 + 70/–226 kHz, Δf_{oB} = 230 + 276/–120 kHz		
Amplitude of chrominance subcarrier	$\sqrt{(E'_I)^2 + (E'_Q)^2}$	$\sqrt{(E'_U)^2 + (E'_V)^2}$				$M_o \cdot \left\lvert \frac{1 + j \cdot 16F}{1 + j \cdot 1.26F} \right\rvert$ M_o = 11.5% of luminance amplitude; $F = \frac{f_{R,B}}{f_o} - \frac{f_o}{f_{R,B}}$		
Duration of burst	9 ± 1 cycles	10 ± 1 cycles		9 ± 1 cycles		—		
Phase of burst	180°, relative to $(E'_B - E'_Y)$ axis	+ 135° for odd lines in 1st and 2nd fields – 135° for even lines in 1st and 2nd fields + 135° for even lines in 3rd and 4th fields – 135° for odd lines in 3rd and 4th fields				relative to E'_U axis	—	
Identification	–	by E'_V component of burst				for lines D'_R: + 350 kHz deviation at max. 540 mV for lines D'_B: – 350 kHz deviation at max. 500 mV		

E′ and D′ are gamma-precorrected values of chrominance components E and colour difference signals D.

BASIC STANDARDS

The display is picked up like an open scene in the new standard by a camera tube. A digital standards converter converts the picture signal information from analog into digital form, reads it into a digital memory, reads it out with a new scanning rate and reconverts it into analog form.

In the **standards converter for colour television,** the incoming signal must be divided into its luminance and chrominance components, decoded and remodulated onto the other colour carrier. If only the colour system is to be converted, e.g. PAL into SECAM, the number of lines and the field frequency being equal, no picture memory is required. It then suffices to separate and transcode the chrominance signal and to modulate the new carrier as required (transcoder principle).

Broadcasting of TV programs

The public television service is operated by broadcasting picture and sound from picture transmitters and associated sound transmitters in three main frequency ranges in the VHF and UHF bands. By international ruling of the UIT/ITU, these ranges are exclusively allocated to television broadcasting. Subdivision into operating channels and their assignment by location are also ruled by international regional agreement. The Stockholm Plan of 1961 is at present valid in Europe:

Band	Frequency	Channel	Bandwidth
I	(41) 47 to 68 MHz	2 to 4	7 MHz
II	87.5 (88) to 108 MHz	VHF FM sound	
III	174 to 223 (230) MHz	5 to 11 (12)	7 MHz
IV	470 to 582 MHz	21 to 27	8 MHz
V	582 to 790 (860) MHz	28 to 60 (69)	8 MHz
VI	11.7 to 12.5 GHz	satellite TV	
Special channels	68 to 82 (89) MHz	2 (3) S channels	7 MHz
Digital sound	113 to 123 MHz	S 2/3	5 MHz
CATV	125 to 174 MHz	S 4 to S 10	7 MHz
	230 to 300 MHz	S 11 to S 20	7 MHz

Types of modulation

Vision: C3F (vestigial-sideband AM)
vestigial-sideband ratios:
0.75 MHz/4.2 MHz = 1:5.6,
0.75 MHz/5.0 MHz = 1:6.7,
1.25 MHz/5.5 MHz = 1:4.4.

The saving of frequency band is about 40%; **polarity** negative because of the susceptibility to interference of the synchronizing circuits of early TV receivers (exception: positive modulation); residual carrier with negative modulation: 10% (exception: 20%).

Sound: F3E; FM for better separation from vision signal in the receiver (exception: AM).

Sound carrier above vision carrier within RF channel, inversion at IF (exception: standard L in band I).

Dual-sound-carrier systems

System parameters (for standards B/G)

	Channel 1	Channel 2
RF sound carrier		
Frequency	f_{vision} +5.5 MHz (±500 Hz), eqvt. to 352 f_H	f_{vision} +5.7421875 MHz (±500 Hz), eqvt. to 367.5 f_H
Vision/sound power ratio	13 dB	20 dB
Modulation	FM	FM
Frequency deviation	≤±50 kHz	≤±50 kHz
Preemphasis	50 µs	50 µs
AF bandwidth	40 to 15000 Hz	40 to 15000 Hz
Sound modulation		
Mono	mono	mono
Stereo	$\frac{L+R}{2} = M$	R
Dual sound	mono	mono
Identification		
Pilot carrier frequency	–	54.6875 kHz (±5 Hz), eqvt. to 3.5 f_H
Modulation	–	AM (with identification frequency)
Modulation degree	–	50%
Identification frequency		
mono	–	none
stereo	–	117.5 Hz eqvt to f_H/133
dual sound	–	274.1 Hz eqvt to f_H/57
Frequency deviation of transmitter carrier (due to pilot tone)	–	±(2.5 kHz ±0.5 kHz)
Synchronization	–	pilot carrier and identification frequencies phase-locked with f_H

The two **sound channels** arrive from the studio via radio link with 15 kHz bandwidth at the TV transmitter. There matrixing is performed for compatibility; (L+R)/2 for channel 1, R for channel 2. An additional sound modulator is used to modulate the second sound carrier with sound channel 2 and with the AM-modulated pilot carrier.

The mode **identification** is transmitted in (data) line 16 (329) of a normal TV picture from the studio to the dual-sound coder of the TV transmitter via the conventional TV lines (i.e. not the sound lines). From the 13 usable words of this data line the first two bits of word 5 are provided for mode identification in bi-phase code as follows:

Identification	Bit 1	Bit 2
Stereo	1	0
Mono	0	1
Dual sound	1	1
Fault	0	0

Typical characteristics of R&S TV transmitter systems using the dual-sound-carrier technique:

Spurious emissions: >70 dB down in the adjacent channel

Crosstalk (selective measurement)

	40 Hz	500 Hz	15 kHz
Stereo (with deemphasis), deviation 15 kHz/30 kHz	43 dB	50 dB	54 dB
Channel (without deemphasis), deviation 50 kHz	81 dB	90 dB	90 dB

Intercarrier S/N ratio (with deemphasis) measured to CCIR Vol. X, Rec. 468-4

Vision modulation 10 to 75%	44 dB
Test picture	50 dB
Black picture	50 dB

Vision/sound power ratio

3:1/4:1/5:1/10:1/20:1, depending on standard; 5:1 and 10:1 are conventionally used; 20 : 1 is used in the Federal Republic of Germany, its advantage being energy saving and low intermodulation distortion in TV transposers and TV transmitters with common vision-sound amplification and in cable television; 20:1:0.2 for dual-sound broadcasts in the FRG.

Channel bandwidths

Depending on standard; conventional values are 6/7/8 MHz; the previous values 5 MHz and 14 MHz are no longer used.

TV broadcasting standards

Four broadcasting standards are in use at present (see also standards table for monochrome television):

Standard	FCC	CCIR	British	OIRT
Number of lines	525	625	625	625
Field frequency	60 Hz	50 Hz	50 Hz	50 Hz
Standard code	M	B/G	I	D/K
Channel width	6 MHz	7/8 MHz	8 MHz	8 MHz
Vision/sound carier spacing	4.5 MHz	5.5 MHz, 5.74 MHz	6 MHz	6.5 MHz
Vestigial sideband	0.75 MHz	0.75 MHz	1.25 MHz	0.75 MHz (1.25 MHz)
Vision IF	45.75 MHz	38.9 MHz	39.5 MHz	38.9 MHz (38 MHz)
Vision/sound ratio	5:1	10:1, 20:1, 20:1:0.2	5:1	10:1

The British **modification I** of the 625-line CCIR standard, being one of the last systems adopted, represents today the best compromise:

- optimum utilization of 8-MHz channel width,
- increase of vestigial sideband from 0.75 MHz to 1.25 MHz, as a result broadening of Nyquist slope from 1.5 MHz to 2.5 MHz and reduction of group-delay error near carrier to about 60 ns (half-correction); precorrection in the TV transmitter is thus not necessary in this part of the video band,
- bandwidth of upper sideband of chrominance signal increased from 0.57 MHz to 1.07 MHz, thus no "second" vestigial-sideband system is necessary for colour transmission,
- increase of residual carrier from 10% to 20% so that highly saturated colours (yellow) with modulation of the TV transmitter to ultra-white are better reproduced, involving, however, a loss in useful-signal level of 1.5 dB, which can only be compensated for by a 40% increase of transmitter power (eg from 10 kW to 14 kW).

Broadcasting of special services

The following text communication systems using television screen display are now on trial worldwide:

Country	Institute	Year	Via TV channel	Via telephone line
FRG	KtK	1976	Videotext	Bildschirmtext
	DIN-designation	1980	Teletext	Leitungstext
UK			Broadcast teletext	Interactive teletex
	BBC	1972	Ceefax	
	IBA	1973	Oracle	
	GPO	1975		Viewdata/Prestel
F	TDF, CCETT		Antiope, Didon	Antiope, Titan
CDN	CBC		Telidon	
(UIT/ ITU)	CCITT, CEPT		Broadcast videotext	Interactive videotex

Videotext/Teletext Preliminary standard for the 625-line systems B/G (Federal Republic of Germany) and I:

Clock frequency	6.9375 MHz, eqvt. to 444 f_H
Half-amplitude duration	144.14 ns per bit
Data signal	H: 0.462 V_{pp} = 66% picture L: 0 V (blanking level)
Coding	8 bits/word incl. 1 parity bit
Code	NRZ (non return to zero)
Words per line	45; incl. 2 for clock run-in, 1 for framing code, 2 for address code
Transmission time per line	45 words x 8 bits x 0.144 μs = 51.89 μs (TV line without blanking interval: 52 μs)
per page	$\frac{24 \text{ text lines}}{4 \text{ TV lines/picture}} = 6 \times \frac{1}{25}\text{ s} = 0.24\text{ s}$
Wait time, max.	75 text pages x 0.24 s = 18 s
average	approx. 9 s
Lines occupied	1st field: 20/21, 2nd field: 333/334

Bildschirmtext/Viewdata Preliminary standard with text page dialled from subscriber's telephone set and displayed on domestic TV receiver:

Text format	1 page of 24 lines of 40 characters
Coding	10 bits/character (word), incl. 1 ea. parity, start and stop bit
Data load	24 lines x 40 characters x 10 bits = 9600 bits/page
Data flow	1200 bit/s
Transmission time	$\frac{9600 \text{ bits/page}}{1200 \text{ bits/s}} = 8$ s/page
Modulation	F1B (FSK)
in data channel	H: 1300 Hz, L: 2100 Hz,
in return channel	H: 390 Hz, L: 450 Hz

BASIC STANDARDS

Digital coding of colour TV video signals and of sound signals

National and international organizations are attempting at present to establish a uniform digital coding standard or at least an optimal compromise for the following fields:

studio,
transmission and
recording.

For the digital **TV studio** the (Western European) EBU has prepared the following coding standard for video signals:

- Component coding (Y signal and two colour-difference signals);
- Sampling frequencies f_{sample} in the ratio 4:2:2 with 13.5 MHz ($3 \times f_{chrominance}$) for the luminance component and 6.75 MHz for each chrominance component;
- Quantization q is 8 bits/amplitude value;
- Data flow/channel
  13.5×10^6 values/s $\times$ 8 bits/amplitude value
  + 2 (6.75×10^6 values/s $\times$ 8 bits/amplitude value)
  = 108 Mbits/s.
  108 Mbits/s + 2 $\times$ 54 Mbits/s = 216 Mbits/s.
  i.e. the required bandwidth is approximately 100 MHz.

This channel capacity can only be achieved with internal studio links via coaxial cables or fibre optics.

In public communication networks of present-day technology the limits per channel lie at the hierarchical step of 34 Mbits/s for microwave links, later 140 Mbits/s. Therefore great attempts are made at reducing the bit rate with the aim of achieving satisfactory picture quality with 34 Mbits/s per channel.

Terrestrial TV transmitters and coaxial Cu-cable networks are completely unsuitable for transmissions. Satellites with carrier frequencies of about 20 GHz and above may be used.

Recording of complete digital TV signals on magnetic tape is not yet possible at present because of the high bit rates. The TV signal components must be distributed to several parallel channels. As compared to the previous analog methods, the quality has however been improved considerably.

The digital coding of sound signals for **satellite sound broadcasting** and for the digital **sound studio** is more elaborate with respect to quantizing than for video signals.

A quantization q of 16 bits/amplitude value is required to obtain a quantizing signal-to-noise ratio S/N_q of 98 dB [$S/N_q = (6q + 2)$ dB].

The sampling frequency must follow the sampling theorem $f_{sample} \geq 2 \times f_{max}$ (Kotelnikov 1928, Raabe 1936, Nyquist 1941), where f_{max} is the maximum frequency of the baseband.

- Planned sound coding standard:

	f_{sample}	Quantization q	Data flow/channel
Direct satellite sound broadcasting with 16 stereo channels	32 kHz	16 bits/ampl. value	512 kbits/s
Digital sound studio	up to 48 kHz	16 bits/ampl. value	768 kbits/s

Satellite television and sound broadcasting

Communication services via satellite

1. Point-to-point transmissions for fixed services
2. Program distribution for fixed services (communication satellites)
3. Satellite broadcasting for television and sound (broadcasting satellites)

Characteristic data of broadcasting and communications satellites

Parameters	TV-Sat D3, TDF-1 (planned)		Eutelsat I-F1 (ECS 1, Spot West)
Frequency downlink	11.7 to 12.1 GHz 12.1 to 12.5 GHz		10.95 to 11.7 GHz
Channel number	5		2 x 6
Channel spacing	19.18 MHz		83.33 MHz
Channel width	27 MHz		83.33 MHz
Polarization	circular		linear horizontal (X) or vertical (Y)
Sense of rotation	right-hand (1), left-hand (2)		
Type of modulation	FM		FM
Transponder power	250 W (24 dBW)		20 W (13 dBW)
Antenna gain	42 dB		32 dB
ERP	4000 kW (66 dBW)		32 kW (45 dBW)
Power flux density PFD_o	-104 dBW/m²		-118 dBW/m²
Diameter of receiving antenna	0.9 m	1.8 m	3.7 m
Gain	37 dB	43 dB	50 dB
Figure of merit G/T of receiving equipment	6 dB/K	14 dB/K	25 dB/K
Carrier/noise ratio C/N	>15 dB		>18 dB
Video S/N ratio (weighted)	42 dB	48 dB	>50 dB
Time of utilization	≧99%		≧99.9%
Attenuation caused by rain	not considered		3.5 dB

Planned channel occupancy of satellite services

The **frequency allocation plan** for the channels of satellite broadcasting is the result of the World Administration Radio Conference – Satellite Broadcasting WARC-SB 1977 in Geneva and laid down in the Final Acts WARC 77 by ITU/CCIR.

Broadcasting satellites in Europa

Number of countries	19 (channels: 5 each)
Total number of planned channels	95
Satellite positions	37° West – 1x occupied
	31° West – 1x occupied
	19° West – 8x occupied
	7° West – 1x occupied
	1° West – 4x occupied
	5° East – 4x occupied
Frequency range	11.7 to 12.5 GHz
Channel spacing	19.18 MHz
Channel width	27 MHz
Number of channels	40

In spite of an overlapping range of 7.82 MHz, adjacent-channel operation is possible by means of polarization isolation (>20 dB), since the polarization of the odd-numbered channels of the satellites within one orbital group is right-hand circular and that of the even-numbered channels left-hand circular.

Channel occupancy of broadcasting satellites

Country	Orbit pos.	Polarization[1]	Channel number				
Germany, Fed. Rep.	19° West	2	2	6	10	14	18
Austria	19° West	2	4	8	12	16	20
Switzerland	19° West	2	22	26	30	34	38
Italy	19° West	2	24	28	32	36	40
France	19° West	1	1	5	9	13	17
Luxemburg	19° West	1	3	7	11	15	19
Belgium	19° West	1	21	25	29	33	37
Netherlands	19° West	1	23	27	31	35	39
Poland	1° West	2	1	5	9	13	17
Czechoslovakia	1° West	2	3	7	11	15	19
German Dem. Rep.	1° West	2	21	25	29	33	37
Finland	5° East	2	2	6	10	22	26
Norway	5° East	2	14	18	38	28	32
Sweden	5° East	2	4	8	34	30	40
Denmark	5° East	2	24	28	32	36	40
Great Britain	31° West	1	4	8	12	16	20
Yugoslavia	7° West	1	21	25	29	33	37
Monaco	37° West	1	21	25	29	33	37
Hungary	1° West	1	22	26	30	34	38

Channel frequencies of broadcasting satellites

Channel	Vision carrier GHz	Channel	Vision carrier GHz	Channel	Vision carrier GHz
1	11.72748	14	11.97682	27	12.22616
2	11.74666	15	11.99600	28	12.24534
3	11.76584	16	12.01518	29	12.26452
4	11.78502	17	12.03436	30	12.28370
5	11.80420	18	12.05354	31	12.30288
6	11.82338	19	12.07272	32	12.32206
7	11.84256	20	12.09190	33	12.34124
8	11.86174	21	12.11108	34	12.36042
9	11.88092	22	12.13026	35	12.37960
10	11.90010	23	12.14944	36	12.39878
11	11.91928	24	12.16862	37	12.41796
12	11.93846	25	12.18780	38	12.43714
13	11.95764	26	12.20698	39	12.45632
				40	12.47550

Communications (distribution) satellites

Eutelsat 1-F1 (ECS 1), Spot West and Spot East, position	13° East
ECS 2 with similar data, position	7° East
Number of countries	7 (channels: 1 or 2 each)
Available channels	6 + 6
Frequency range	10.95 to 11.2 GHz, 11.45 to 11.7 GHz
Channel spacing and channel width	83.333 MHz for both
Channel occupancy (see table right)	double
Polarization	linear horizontal (X) or vertical (Y)

Channel occupancy of distribution satellites

Channel	Polarization	Vision carrier GHz	Country	Spot
1X		10.99167	Italy	West
2X[2]		11.07500	Germany, Fed.Rep.	East
3X	hori-	11.15833	Netherlands	West
4X	zontal	11.49167	France	West
5X		11.57500	–	East/Atlantic
6X		11.65833	Great Britain	West
7Y		10.99167	Switzerland	West
8Y		11.07500	Luxemburg	East
9Y	verti-	11.15833	Belgium	West
10Y	cal	11.49167	Germany, Fed.Rep.	West
11Y		11.57500	–	Atlantic
12Y		11.65833	Great Britain	West

Satellite sound broadcasting

In a TV channel of the broadcasting and distribution satellites, up to 16 high-quality stereo sound program channels may be accommodated in digital form. Signal-to-noise ratios of 85 to 90 dB can be achieved by quantizing with 14 or 16 bits/amplitude value.

The following communication satellites are presently operating in the K_u-band (10.9 to 11.7 GHz)[3]:

Satellite	Position
Eutelsat 1-F1	13° East
-F2	7° East
Intelsat V F2	1° West
F3	53° West
F4	34° West
F5	63° East
F6	18° West
F7	65° East
Telecom 1-F1	8° West
-F2	5° West
Intelsat VA F10	25° West
F11	27.5° West
F12	60° West

Planned broadcasting satellites

TV-Sat	19° West
TDF	19° West

[1] 1: right-hand circular, 2: left-hand circular.
[2] The Fed. Rep. of Germany uses channel 3 at present, since channel 2 is not operative.
[3] From Cable & Satellite Europe, October 1987.

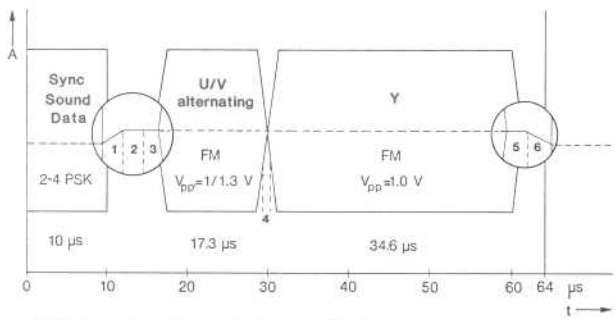
D2/C-MAC-PACKET STANDARD

Satellite colour TV transmission with D2/C-MAC packet signals

Advantage of planned C-MAC system The colour TV systems NTSC, PAL and SECAM introduced for the transmission in frequency division multiplex (FDM) are bound up with the reduced resolution capability and intermodulation effects between luminance and chrominance signal. The only remedy would be the use of a colour TV transmission system operating according to the time division multiplex (TDM) principle as intended for the transmission via (television) broadcasting satellites. With this system, the luminance signal and only one colour-difference signal (eg U component) are completely separated and successively transmitted time-compressed in a line, followed by the luminance signal and colour-difference V component in the next line; advantage: no colour subcarrier. Sync, sound and data signals are additionally provided in each line (illustration to the right).

Between the three signal components within the TV line intervals are provided for clamping (level stabilization), for transitions between the signals and for energy dispersal (to protect terrestrial systems such as microwave links in the same frequency range).

Due to the high clock frequency of 20.25 MHz (see table right), this system can not be distributed to normal cable systems without recoding. The further developed **D2-MAC packet system** uses half (2) the bit rate, the bandwidth being thus reduced to 10.125 MHz and, due to the duobinary modulation (D), further down to about 5.5 MHz, so that it is distinctly below the required video bandwidth of 8.5 MHz. The signal can thus be transmitted in conventional cable systems. Just like with the C-MAC packet, additional information can be transmitted along with the digital sound signals (two stereo channels or four mono channels).



C-MAC packet signal within one TV line

1 0.2 µs Rise time of satellite energy-dispersal signal 25 Hz
2 0.7 µs Clamping of colour-difference signal
3 0.5 µs Transition of clamping to colour-difference signal
4 0.25 µs Transition of colour-difference signal to luminance signal
5 0.3 µs Transition to end of luminance signal
6 0.2 µs Fall time of energy-dispersal signal

C-MAC packet signal

MAC means	multiplexed analogue component
C means	combined FM transmission of vision signals and digital sound signals with 2-4 PSK at the RF
Packet means	the combination of sync, sound and data signals in digital form in a packet at the head of a line

Type of signal	Compression factor	Reduction of required time	Increase of bandwidth
Luminance signal Y	1.5	52 → 35 µs	5.6 → 8.4 MHz
Colour-difference components U, V	3	52 → 17 µs	1.6 → 4.8 MHz
Sync, sound, data signal	–	10 µs	13.5 MHz

Frequency deviation ...	max. ±13.5 MHz
Clock frequency	20.25 MHz (= sampling frequency of 13.5 MHz for digitized video signals x compression factor 1.5)
Clock period	49.38 ns
Clock pulses per line ..	1296

Development and introduction

1973	Timeplex (predecessor of MAC), Technical University Braunschweig
1981 to 1982	Development of MAC, IBA London
1983	C-MAC packet, UER/EBU
1984	C-MAC packet accepted by Denmark, Finland, Great Britain, Norway and Sweden; pending in Italy; the Swedish programs SVT 1 and SVT 2 (broadcast via Intelsat V F2) use at present C-MAC
1988	D2-MAC packet is intended for use with the broadcasting satellites TV-Sat (Fed. Rep. of Germany) and TDF (France).

Systems and standards used in various countries for monochrome and colour television and AC supply data

The information given in the following tables is based on:

1. Green Book of CCIR, Volume XI-1, Broadcasting service (television) XVIth Plenary Assembly Dubrovnik 1986, Report 624-3, pp. 1 to 31, "Characteristics of televison Systems";
2. Green Book of CCIR, Volume X/XI-2, Broadcasting satellite service (sound and television) XVIth Plenary Assembly Dubrovnik 1986, Report 215-6, pp. 8 to 67, "Systems for broadcasting-satellite service" (sound and television);
3. Electric Current Abroad, common AC supply voltages and frequencies compiled by the US Department of Commerce, edition Washington 1984;
4. Technical documentation issued by telecommunication administrations and television and broadcasting organizations.

Some of these documents have become obsolete, some items of other documents are only expressions of intention. An optimum compromise was aimed at in compiling the following table.

Country	Standard for VHF	UHF	Colour	AC supply Nom. voltage V	Freq. Hz
A					
Afghanistan	D		SECAM	220/380	60
Albania	B	G	PAL	220/380	50
Algeria	B	G	PAL	127/220 220/380	50
Angola	I		PAL	220/380	50
Argentina	N		PAL	220/380	50
Australia	B	B	PAL	240/415	50
Austria	B	G	PAL	220/380	50
B					
Bahrein	B	G	PAL	230/400	50/60
Bangladesh	B		PAL	220/380	50
Belgium	B	H	PAL	127/220 220/380	50
Benin	K1	K1	SECAM	220/380	50
Bermudas	M		NTSC	120/208	60
Bolivia	M	M	NTSC	220/380 230/400	50
Botswana	I	I	PAL	220/380	50
Brazil	M	M	PAL	127/220 220/380	60
Brit. Virgin Islands	M		NTSC	230/400	60
Brunei	B		PAL	230/400	50
Bulgaria	D	K	SECAM	220/380	50
Burkina Faso	K1	K1	SECAM	220/380	50
Burma	M		NTSC	230/400	50
Burundi	K1	K1	SECAM	220/380	50
C					
Cameroon	B	G	PAL	127/220 220/380 230/400	50
Canada	M	M	NTSC	120/208 347/600	60
Central African Rep.	K1	K1	SECAM	220/380	50
Chad	K1	K1	SECAM	220/380	50
Chile	M	M	NTSC	220/380	50
China (People's Rep.)	D	D	PAL	220/380	50
Colombia	M	M	NTSC	120/208 150/240 220/380	60
Congo	K1	K1	SECAM	220/380	50
Costa Rica	M	M	NTSC	240/400	60
Cuba	M	M	NTSC	115/200	60
Cyprus	B	G	SECAM	240/415	50
Czechoslovakia	D	K	SECAM	220/380	50
D					
Denmark with Greenland and Faroes	B	G	PAL	220/380	50
Djibouti	K1		SECAM	220/380	50
Dominican Republic	M		NTSC	(127)/220[1]	60
E					
Ecuador	M		NTSC	120/208 127/220	60
Egypt	B	G	SECAM	220/380	50
Equatorial Guinea	B		PAL	220	50
Ethiopia	B	G	PAL	220/380	50
F					
Finland	B	G	PAL	220/380	50
France	L	L	SECAM	115/200 127/220 220/380	50
G					
Gabon	K1	K1	SECAM	220/380	50
German Democratic Republic	B	G	SECAM	220/380	50
Germany, Fed. Rep. of	B	G	PAL	220/380	50
Ghana	B	G	PAL	230/400	50
Gibraltar	B	G	PAL	240/415	50
Great Britain and Northern Ireland		I	PAL	240/415	50
Greece	B	G	SECAM	220/380	50
Guatemala	M		NTSC	240/415	60
Guinea	K1	K1	SECAM	220/380	50
H					
Haiti	M		NTSC	120/208	60
Honduras	M		NTSC	(127)/220[1]	60
Hongkong		I	PAL	200/346	50
Hungary	D	K	SECAM	220/380	50
I					
Iceland	B	G	PAL	220/380	50
India	B		PAL	230/400	50
Indonesia	B		PAL	127/220	50
Iran	B	G	SECAM	220/380	50
Iraq	B	G	SECAM	220/380	50
Ireland	I	I	PAL	220/380	50
Israel	B	G	PAL	230/400	50
Italy	B	G	PAL	127/220 220/380	50
Ivory Coast	K1	K1	SECAM	220/380	50

[1]) Three-phase supply network without neutral conductor.

COUNTRIES

Country	Standard for VHF	UHF	Colour	AC supply Nom. voltage V	Freq. Hz
J					
Jamaica	N		NTSC	220/380	50
Japan	M	M	NTSC	(115)/2001)	50/60
Jordan	B	G	PAL	220/380	50
K					
Kenya	B	G	PAL	240/415	50
Korea (North), Democrat. Rep.	D	K	PAL	200/346 220/380	60
Korea (South), Rep.	M	M	NTSC	200/346 220/380	60
Kuweit	B	G	PAL	240/415	50
L					
Lebanon	B	G	SECAM	110/190 220/380	50
Lesotho	I	I	PAL	220/380	50
Liberia	B		PAL	120/208	60
Libya	B	G	SECAM	127/220 230/400	50
Luxemburg	B	G	PAL	120/208	50
		L	SECAM	220/380	
M					
Madagascar	K1	K1	SECAM	127/220 220/380	50
Malawi	B	G	PAL	230/400	50
Malaysia	B	G	PAL	230/400	50
Maldives	B		PAL	230/400	50
Mali	B		SECAM	220/380	50
Malta	B		PAL	240/415	50
Mauretania	B		SECAM	220/380	50
Mauritius	B		SECAM	230/400	50
Mexico	M	M	NTSC	127/220	60
Monaco	L	G	SECAM	127/220	50
		G	PAL	220/380	
Mongolian People's Rep.	D	K	SECAM	220/380	50
Montserrat	M		NTSC	230/400	60
Morocco	B	G	SECAM	127/220 220/380	50
Mozambique	B	G	PAL	220/380	50
N					
Netherland Antilles	M		NTSC	120/208 127/220 220/380	50/60
Netherlands	B	G	PAL	220/380	50
New Zealand	B	G	PAL	230/400	50
Nicaragua	M		NTSC	240/415	60
Niger	K1	K1	SECAM	220/380	50
Nigeria	B		PAL	230/400	50
Norway	B	G	PAL	230/400	50
O					
Oman	B	G	PAL	240/415	50
P					
Pakistan	B	G	PAL	230/400	50
Panama	M	M	NTSC	(127)/220[1])	60
Papua New Guinea	B	G	PAL	240/415	50
Paraguay	N		PAL	220/380	50
Peru	M	M	NTSC	(127)/220[1])	60
Philippines	M		NTSC	(127)/220[1])	60
Poland	D	K	SECAM	220/380	50
Portugal	B	G	PAL	220/380	50
Q					
Qatar	B	G	PAL	240/415	50
R					
Romania	D	K	PAL	220/380	50
Rwanda	K1	K1	SECAM	220/380	50
S					
Saint Christ. and Nevis	M		NTSC	230/400	60
Saudi Arabia	B	G	SECAM	127/220 230/400	60
Senegal	K1	K1	SECAM	127/220	50
Sierra Leone	B	G	PAL	230/400	50
Singapore	B	G	PAL	230/400	50
South Africa	I	I	PAL	220/380 240/415 250/433	50
Spain	B	G	PAL	127/220 220/380	50
Sri Lanka	B		PAL	230/400	50
Sudan	B		PAL	240/415	50
Surinam	M		NTSC	127/220 230/400	60
Sweden	B	G	PAL	220/380	50
Switzerland	B	G	PAL	220/380	50
Syria	B	G	PAL	220/380	50
T					
Tanzania	B		PAL	230/400	50
Thailand	B	G	PAL	220/380	50
Togo	K1	K1	SECAM	127/220 220/380	50
Tunisia	B	G	PAL/SECAM	127/220 220/380	50
Turkey	B	G	PAL	220/380	50
U					
Uganda	B		PAL	240/415	50
United Arab Emirates	B	G	NTSC	220/380 230/400 240/415	50
Uruguay	N		PAL	(127)/220[1])	50
USA	M	M	NTSC	117/200	60
USSR	D	K	SECAM	220/380	50
V					
Venezuela	M	M	NTSC	240/415	60
Vietnam	D	K	SECAM	127/220 220/380	50
Y					
Yemen (North), Arab Republic	B		PAL	220/380	50
Yemen (South), Democr.Rep.	B		PAL	230/400	50
Yugoslavia	B	G	PAL	220/380	50
Z					
Zaire	K1	K1	SECAM	220/380	50
Zambia	B		PAL	220/380	50
Zimbabwe	B	G	PAL	230/400	50

[1]) Three-phase supply network without neutral conductor.

Group-delay characteristics in TV systems

The group-delay characteristics of TV systems are determined by various amplitude/frequency responses within the transmission path:

1. in cables of extensive length in studios, switching centres and distribution points,
2. in radio relay systems,
3. in TV transmitters, transposers and domestic receivers.

Group-delay errors of **video cables and repeaters** can be precorrected just once with only small residual errors at the professional side of the TV system, using well-known techniques, whilst correction of the errors in the TV transmitter/TV receiver subsystem requires much higher outlay because of the closer band limitation of radio transmission and leads to higher cost because of the great number of receivers involved.

The group-delay error of a **TV transmitter** originates in the vestigial-sideband filter (IF-RF), in the video lowpass filter for limitation of the out-of-band radiation (VF) and in the diplexer combining the vision and sound transmitters (RF). One-time correction to a residual error of 25 to 50 ns – corresponding to a quarter to a half picture element – is possible in modern TV transmitters at reasonable expense.

The largest group-delay errors within the TV system occur in the **domestic receivers** because of the required high selectivity (especially with the occupation of adjacent channels in a fully developed cable television network of the future). These errors are caused by

the Nyquist slope (approx. 180 ns at 0.75 MHz vestigal sideband, approx. 110 ns at 1.25 MHz vestigial sideband),

the sound-carrier attenuation (400 to 800 ns depending on S/N ratio),

the traps for adjacent vision and sound carriers.

Full group-delay correction would imply a prohibitive increase in the price of every individual receiver. The CCIR Plenary Assembly in Warsaw 1956 therefore issued a Recommendation proposing half correction by precorrection of the group-delay characteristic in the transmitter so that only half the error takes effect on the screen.

With the introduction of **colour television**, a group-delay precorrection of −170 ns between the luminance and chrominance signals was adopted on a quasi international level for the standards M/N and B/G.

As group-delay measurements on TV transmitters are complex and require elaborate procedures, it has been laid down in Technical Specifications for **Nyquist demodulators** that they should be switchable to **two group-delay characteristics:**

1. maximally flat for measuring purposes,
2. compensatory for precorrection in the transmitter, using the demodulator as a standard reference receiver to simulate the response of domestic receivers to the TV transmitter.

The following **tables** indicate group-delay characteristics and – as far as known – their tolerance limits for Nyquist demodulators to different standards.

These specifications do not necessarily agree with those of the available R&S equipment (refer to relevant **data sheet**).

Standard B/G

Group-delay characteristics of Nyquist demodulators for use as standard reference receivers;
(half = half correction; full = full correction)

Standard	**B/G,** half		**B/G,** half		**B/G,** half		**B/G,** full		**B/G,** full	
Pre-correction	general		Australia		Denmark		Norway		Sweden (A)	
Frequency MHz	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns
0.1	0	Reference	0	Reference	0	Reference	0	Reference	0	Reference
0.25	−5	±12			−5			±15		±15
0.5			−7							
1.0	−53	±12	−20		−53					
2.0	−90	±12	−56		−75					
2.25			−60							
3.0	−75	±12	−40		−75		0	±15		
3.5			0							
3.6							+20	±20	0	±15
3.75	0	±12			0					
4.0			+90				+50	±30		
4.43	+170	±25	+170	±25	+170		+170	±15	+175	±20
4.8	+400	±90	+230		+430		+350	±100	+400	±75

GROUP DELAY

Standard D/K (left)

Standard Pre-correction	**D/K,** half OIRT, USSR GOST 20532-75		**D/K,** half CCIR Report 308		**D/K,** half OIRT, TK-III-830, Czechoslovakia		**D/K,** half OIRT, TK-III-830, Hungary	
Frequency MHz	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns
0.1	0	Reference	0	Reference	0	Reference	0	Reference
0.25	−5	±15	−5	±12		±10		±10
0.5	−10	|		|		|		|
1.0	−40	|	−53	|	−40	|	−40	|
1.5	−70	|		|		|		|
2.0	−80	|	−87	|	−75	|	−75	±10
3.0	−80	|	−85	|	−90	±10	−90	±15
4.0	−40	|	−50	|	−70	±20	−70	±20
4.43	0	±15	0	±12				
5.0	+80	±50	+90	±30	0	±30	0	±30
5.5							+90	±40
5.8							(+175)	
6.0							(+225)	

Standard Pre-correction	**I,** full BBC system without receiver precorrection		**I,** full SABC, TVT 191.5 demodulator		**I,** full SABC, TVT 12.2 relay receiver	
Frequency MHz	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns
0.01	0	Reference	0	Reference		
0.1	|	±40	|	±12	0	Reference
0.2	|	|	|	|		±12
<3.6	|	±40	|	|		|
>3.6	|	±20	|	|		|
4.0	|	|	|	|	0	±12
4.43	|	|	|	±12	+40	±20
4.8	|	|	0	±50	+100	±30
<5.2	|	±20				
>5.2	|	±80				
5.5	0	±80				

Standard I (left)

In Great Britain no group-delay characteristic for receiver precorrection is specified for standard I and therefore no compensatory characteristic for the Nyquist demodulator. The first column of the table gives the group-delay characteristic of the overall system including the TV transmitter, measured with a demodulator of constant group delay.

Standard L, K1, K′ (below left)

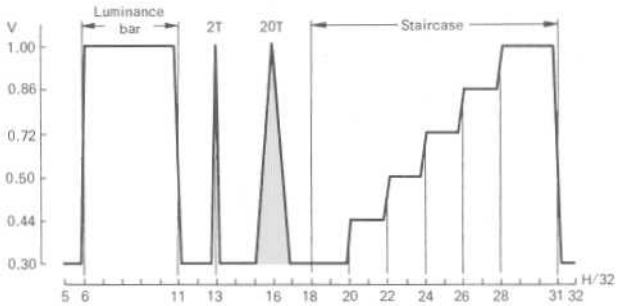
Standards K1 and K′ are used in formerly French Territories especially in central Africa. They are based on standard L.

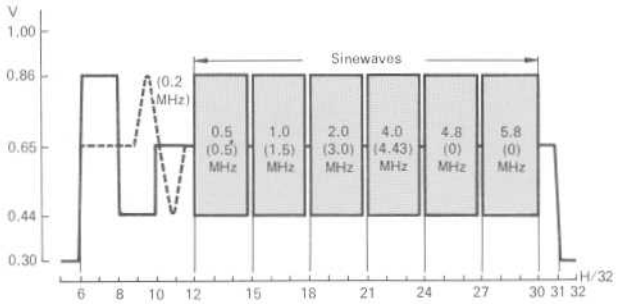
Standard M (below)

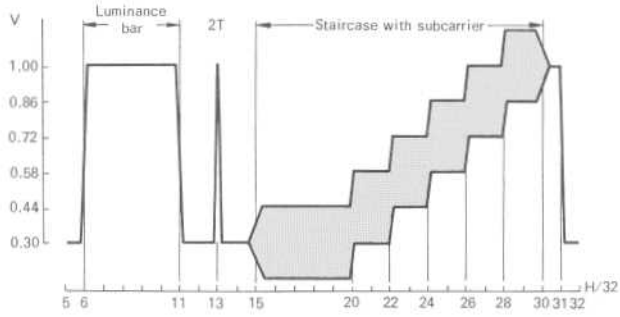
Standard Pre-correction	**L,** full TDF		**K1,** full		**K′,** full Tx.+demodul.	
Frequency MHz	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns
0.1	0	Reference	0	Reference		
0.2	|	±15	|	±15	0	Reference
2	|	|	|	|	|	±30
4	|	|	0	±15	|	|
4.43	|	|	+15	±30	|	±30
4.6	0	±15			|	|
4.8	+20	±35			|	|
5.0	+57.5	±42.5	+90	±50	|	±30
5.2	|	|	|	|	|	±50
5.25	+100	±42.5	+140	+∞/−65	|	|
5.5	>+100				0	±80

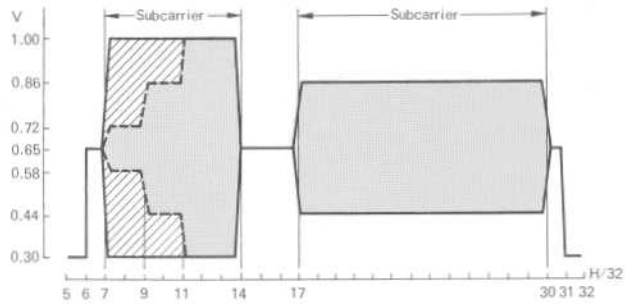
Standard Pre-correction	**M,** full FCC, EIA 1977		**M,** full CBC 1976	
Frequency MHz	Nominal ns	Tolerance ns	Nominal ns	Tolerance ns
0	0	±25	0	±25
0.1	|	Reference	|	Reference
>0.1	|	±25	0	±25
1	|	|	|	|
2	|	|	|	|
3	0	|	0	±25
3.53	+170	±25	+170	±15
3.9	|	|	+264	±200
4.0	+293	±50	|	|
4.18	+346	±100	|	|

Insertion test signals

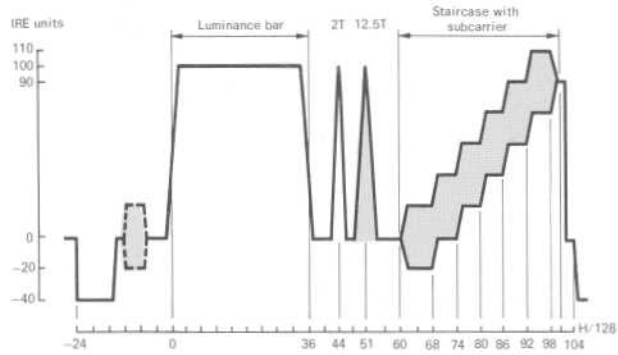


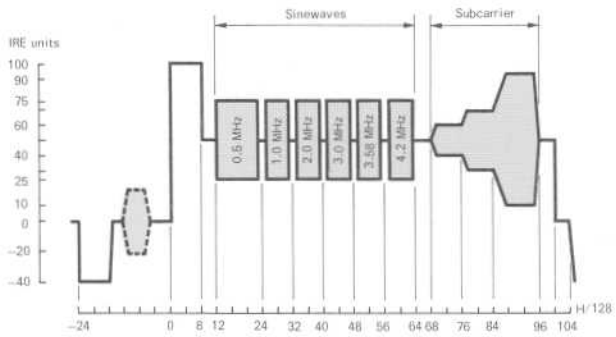




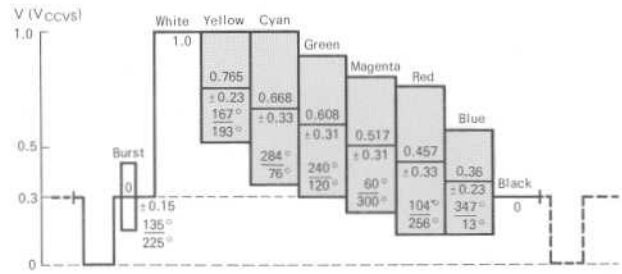


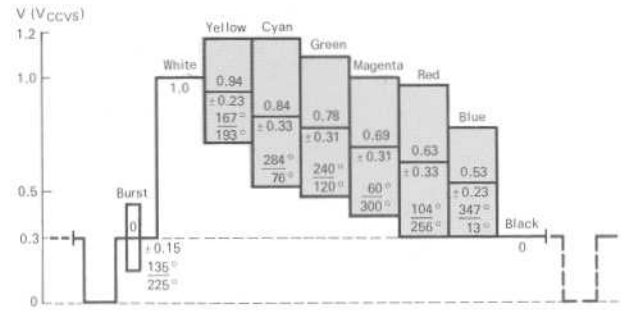
CCIR insertion test signals for (from top to bottom) lines 17 and 18 (in parentheses: frequencies of Insertion Signal Generator SPZF standard model) of 1st field and lines 330 and 331 (with and without staircase) of 2nd field

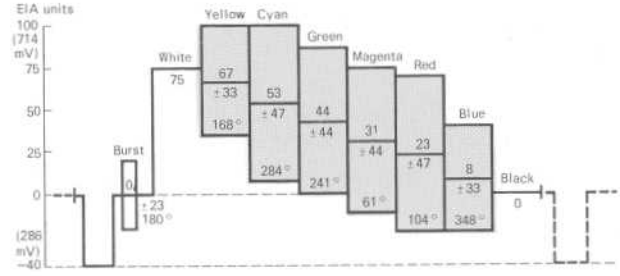




Insertion test signals for standard M; on top for line 17 of 1st field and above for line 17 of 2nd field (corresponds to line 280 of picture)







Colour-bar signals (right)

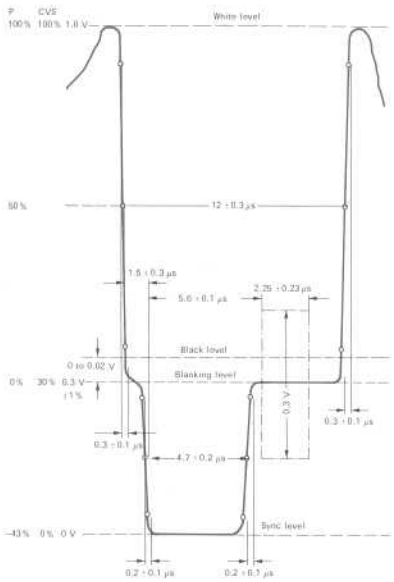
Top: **EBU colour-bar signal** with 100% saturation and 75% amplitude for standard B/G, PAL

Centre: **EBU colour-bar signal** with 95% saturation and 100% amplitude for standard I, PAL

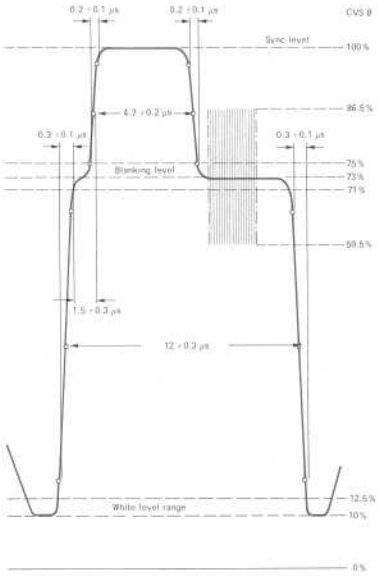
Bottom: **FCC/EIA colour-bar signal** with 100% saturation and 75% amplitude for standard M, NTSC

WAVEFORM STANDARDS/WEIGHTING FILTER

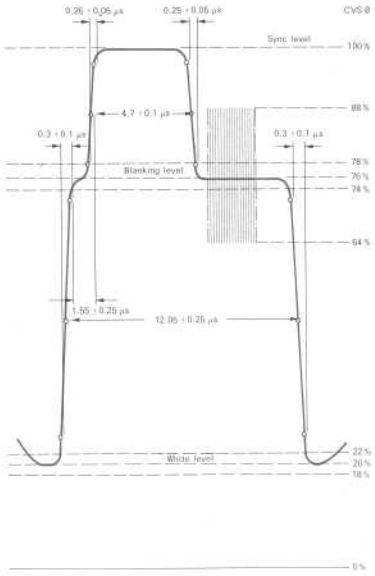
Level patterns



Video level pattern

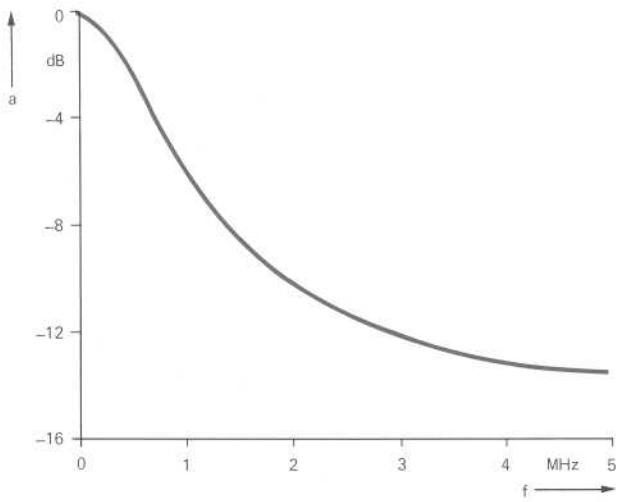


RF level pattern for 10% residual carrier



RF level pattern for 20% residual carrier (standard I)

Noise measurement/weighting filter



Characteristic of **standard-independent weighting filter** (for Video Noise Meters UPSF and UPSF2) in conformity with CCIR Rec. 567

Chroma noise results from amplitude (AM) and phase (φM) variations of the chrominance signals in colour TV systems, because NTSC as well as PAL colour decoders respond to both effects. AM and φM noise exist simultaneously and are equal in magnitude; since they are measured separately, each measured value must be 3 dB below the overall chroma noise power aimed at.

Test signal	75%-saturated red signal (PAL 625 lines, CCIR Rec. 471)
Luminance component	157 mV picture
Chrominance component	664 mV (peak-to-peak)
S/N ratio	$\frac{V_{noise\ (AM+\varphi M)\ rms}}{V_{chrom\ (peak\text{-}to\text{-}peak)}}$ (IEC-TCS 60 B)
Frequency range	approx. 100 to 500 kHz

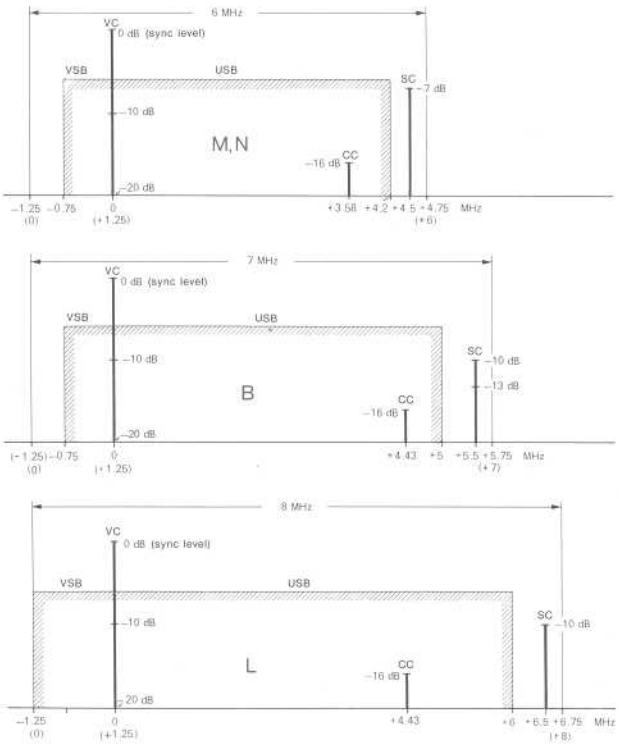
Channel definitions

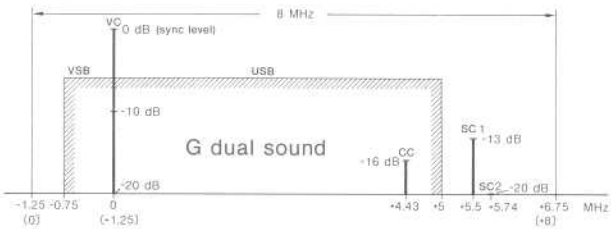
The tables present the definitions of channels for various countries, grouped by standards.

Occupancy of satellite channels see page 7.

Right: Relation of vision, colour and sound carriers (VC, CC, SC) and of vestigial sidebands (VSB) and upper sidebands (USB) within the channels of 6, 7 and 8 MHz bandwidth for various standards

Below: Relation of VC, CC, SC 1 and SC 2 and of VSB and USB for standard G with dual sound





VHF channel definitions

Standard B (7 MHz), Australia

Band	Channel	Channel limits MHz	Vision carrier MHz	Sound carrier MHz
IF	–	33.15 to 40.15	38.9	33.4
	0	45 to 52	46.25	51.75
I	1	56 to 63	57.25	62.75
	2	63 to 70	64.25	69.75
	3	85 to 92	86.25	91.75
(II)	4	94 to 101	95.25	100.75
	5	101 to 108	102.25	107.75
	5A	137 to 144	138.25	143.25
	6	174 to 181	175.25	180.75
	7	181 to 188	182.25	187.75
III	8	188 to 195	189.25	194.75
	9	195 to 202	196.25	201.75
	10	208 to 215	209.25	214.75
	11	215 to 222	216.25	221.75

Standard B (7 MHz), Europe

Band	Channel	Channel limits MHz	Vision carrier MHz	Sound carrier MHz
IF	–	33.15 to 40.15	38.9	33.4
	E 2	47 to 54	48.25	53.75
I	E 3	54 to 61	55.25	60.75
	E 4	61 to 68	62.25	67.75
	E 5	174 to 181	175.25	180.75
	E 6	181 to 188	182.25	187.75
	E 7	188 to 195	189.25	194.75
III	E 8	195 to 202	196.25	201.75
	E 9	202 to 209	203.25	208.75
	E 10	209 to 216	210.25	215.75
	E 11	216 to 223	217.25	222.75
	E 12	223 to 230	224.25	229.75

Standard B (7 MHz), Europe
Special cable TV channels (CATV)

Band	Channel	Channel limits MHz	Vision carrier MHz	Sound carrier MHz
IF	–	33.15 to 40.15	38.9	33.4
	S 2 / S 3	113 to 123		Digital sound broadcasting
	S 4	125 to 132	126.25	131.75
<III	S 5	132 to 139	133.25	138.75
(S_u)[1]	S 6	139 to 146	140.25	145.75
	S 7	146 to 153	147.25	152.75
	S 8	153 to 160	154.25	159.75
	S 9	160 to 167	161.25	166.75
	S 10	167 to 174	168.25	173.75
	S 11	230 to 237	231.25	236.75
	S 12	237 to 244	238.25	243.75
	S 13	244 to 251	245.25	250.75
	S 14	251 to 258	252.25	257.75
>III	S 15	258 to 265	259.25	264.75
(S_o)[1]	S 16	265 to 272	266.25	271.75
	S 17	272 to 279	273.25	278.75
	S 18	279 to 286	280.25	285.75
	S 19	286 to 293	287.25	292.75
	S 20	293 to 300	294.25	299.75

[1]) S_u = lower, S_o = upper (ATV bands).

CHANNEL DEFINITIONS

VHF channel definitions (continued)

Band	Channel	Channel limits MHz	Vision carrier MHz	Sound carrier MHz
Standard B (7 MHz), Italy				
IF	–	33.15 to 40.15	38.9	33.4
I	A	52.5 to 59.5	53.75	59.25
	B	61 to 68	62.25	67.75
(II)	C	81 to 88	82.25	87.75
(III)	D	174 to 181	175.25	180.75
	E	182.5 to 189.5	183.75	189.25
	F	191 to 198	192.25	197.75
	G	200 to 207	201.25	206.75
	H	209 to 216	210.25	215.75
	H_1	216 to 223	217.25	222.75
	H_2	223 to 230	224.25	229.75
Standard B (7 MHz), Marocco				
IF	–	33.15 to 40.15	38.9	33.4
III	M 4	162 to 169	163.25	168.75
	M 5	170 to 177	171.25	176.75
	M 6	178 to 185	179.25	184.75
	M 7	186 to 193	187.25	192.75
	M 8	194 to 201	195.25	200.75
	M 9	202 to 209	203.25	208.75
	M 10	210 to 217	211.25	216.75
Standard B (7 MHz), New Zealand				
IF	–	33.15 to 40.15	38.9	33.4
I	1	44 to 51	45.25	50.75
	2	54 to 61	55.25	60.75
	3	61 to 68	62.25	67.75
III	4	174 to 181	175.25	180.75
	5	181 to 188	182.25	187.75
	6	188 to 195	189.25	194.75
	7	195 to 202	196.25	201.75
	8	202 to 209	203.25	208.75
	9	209 to 216	210.25	215.75
	10	216 to 223	217.25	222.75
Standard D (8 MHz), China (People's Rep.)				
IF	–	31.25 to 39.25	38.0	31.5
I	1	48.5 to 56.5	49.75	56.25
	2	56.5 to 64.5	57.75	64.25
	3	64.5 to 72.5	65.75	72.25
	4	76.0 to 84.0	77.25	83.75
	5	84.0 to 92.0	85.25	91.75
III	6	167 to 175	168.25	174.75
	7	175 to 183	176.25	182.75
	8	183 to 191	184.25	190.75
	9	191 to 199	192.25	198.75
	10	199 to 207	200.25	206.75
	11	207 to 215	208.25	214.75
	12	215 to 223	216.25	222.75

Band	Channel	Channel limits MHz	Vision carrier MHz	Sound carrier MHz
Standard D (8 MHz), OIRT				
IF[1])	–	32.15 to 40.15	38.9	32.4
I	R I	48.5 to 56.5	49.75	56.25
	R II	58 to 66	59.25	65.75
	R III	76 to 84	77.25	83.75
(II)	R IV	84 to 92	85.25	91.75
	R V	92 to 100	93.25	99.75
III	R VI	174 to 182	175.25	181.75
	R VII	182 to 190	183.25	189.75
	R VIII	190 to 198	191.25	197.75
	R IX	198 to 206	199.25	205.75
	R X	206 to 214	207.25	213.75
	R XI	214 to 222	215.25	221.75
	R XII	222 to 230	223.25	229.75
Standard I (8 MHz), Ireland				
IF	–	32.15 to 40.15	38.9[2])	32.9[2])
I	I A	44.5 to 52.5	45.75	51.75
	I B	52.5 to 60.5	53.75	59.75
	I C	60.5 to 68.5	61.75	67.75
III	I D	174 to 182	175.25	181.25
	I E	182 to 190	183.25	189.25
	I F	190 to 198	191.25	197.75
	I G	198 to 206	199.25	205.25
	I H	206 to 214	207.25	213.25
	I J	214 to 222	215.25	221.25
Standard I (8 MHz), South Africa				
IF	–	32.15 to 40.15	38.9	32.9
III	4	174 to 182	175.25	181.25
	5	182 to 190	183.25	189.25
	6	190 to 198	191.25	197.25
	7	198 to 206	199.25	205.25
	8	206 to 214	207.25	213.25
	9	214 to 222	215.25	221.25
	10	222 to 230	223.25	229.25
	11	230 to 238	231.25	237.25
	(12)	238 to 246	not defined	
	13	246 to 254	247.43	253.43
Standard K1 (8 MHz), French Overseas Post and Telecomm. Agency				
IF	–	31.45 to 39.45	32.7	39.2[3])
III	4	174 to 182	175.25	181.75
	5	182 to 190	183.25	189.75
	6	190 to 198	191.25	197.75
	7	198 to 206	199.25	205.75
	8	206 to 214	207.25	213.75
	9	214 to 222	215.25	221.75

Band	Channel	Channel limits MHz	Vision carrier MHz	Sound carrier MHz
Standard L (8 MHz), France				
IF	–	31.45 to 39.45	32.7	39.2[3])
I	A	41 to 49	47.75	41.25
	B	49 to 57	55.75	49.25
	C	57 to 65	63.75	57.25
	C 1	53.75 to 61.75	60.50	54.00
III	1	174.75 to 182.75	176.0	182.50
	2	182.75 to 190.75	184.0	190.50
	3	190.75 to 198.75	192.0	198.50
	4	198.75 to 206.75	200.0	206.50
	5	206.75 to 214.75	208.0	214.50
	6	214.75 to 222.75	216.0	222.50
Standard M (6 MHz), Japan				
IF	–	41.0 to 47.0	38.9	41.25
(II)	J 1	90 to 96	91.25	95.75
	J 2	96 to 102	97.25	101.75
	J 3	102 to 108	103.25	107.75
III	J 4	170 to 176	171.25	175.75
	J 5	176 to 182	177.25	181.75
	J 6	182 to 188	183.25	187.75
	J 7[4])	188 to 194	189.25	193.75
	J 8[4])	192 to 198	193.25	197.75
	J 9	198 to 204	199.25	203.75
	J 10	204 to 210	205.25	209.75
	J 11	210 to 216	211.25	215.75
	J 12	216 to 222	217.25	221.75
Standards M, N (6 MHz), USA				
IF	–	41.0 to 47.0	45.75	41.25
I	A 02	54 to 60	55.25	59.75
	A 03	60 to 66	61.25	65.75
	A 04	66 to 72	67.25	71.75
	A 05	76 to 82	77.25	81.75
	A 06	82 to 88	83.25	87.75
III	A 07	174 to 180	175.25	179.75
	A 08	180 to 186	181.25	185.75
	A 09	186 to 192	187.25	191.75
	A 10	192 to 198	193.25	197.75
	A 11	198 to 204	199.25	203.75
	A 12	204 to 210	205.25	209.75
	A 13	210 to 216	211.25	215.75

[1]) UdSSR: 31.25 to 39.25/38.0/31.5 MHz.
[2]) Gr.-Brit. also 39.5 and 33.5 MHz resp.
[3]) Also 38.9 or 32.7 MHz.
[4]) Channel spacing 4 MHz.

UHF channel definitions

Band	Channel Europe	Channel China	Channel limits MHz	Vision carrier MHz	Sound carrier G, H MHz	Sound carrier I MHz	Sound carrier K, L MHz
Standards G, H, I, K, L (CCIR standard; 8 MHz)							
IF	–		same as VHF for corresponding country				
	21	13	470 to 478	471.25	476.75	477.25	477.75
	22	14	478 to 486	479.25	484.75	485.25	485.75
	23	15	486 to 494	487.25	492.75	493.25	493.75
	24	16	494 to 502	495.25	500.75	501.25	501.75
	25	17	502 to 510	503.25	508.75	509.25	509.75
	26	18	510 to 518	511.25	516.75	517.25	517.75
	27	19	518 to 526	519.25	524.75	525.25	525.75
	28	20	526 to 534	527.25	532.75	533.25	533.75
IV	29	21	534 to 542	535.25	540.75	541.25	541.75
	30	22	542 to 550	543.25	548.75	549.25	549.75
	31	23	550 to 558	551.25	556.75	557.25	557.75
	32	24	558 to 566	559.25	564.75	565.25	565.75
	33	not defined	566 to 574	567.25	572.75	573.25	573.75
	34		574 to 582	575.25	580.75	581.25	581.75
	35		582 to 590	583.25	588.75	589.25	589.75
	36		590 to 598	591.25	596.75	597.25	597.75
	37		598 to 606	599.25	604.75	605.25	605.75
	38	25	606 to 614	607.25	612.75	613.25	613.75
	39	26	614 to 622	615.25	620.75	621.25	621.75
	40	27	622 to 630	623.25	628.75	629.25	629.75
	41	28	630 to 638	631.25	636.75	637.25	637.75
	42	29	638 to 646	639.25	644.75	645.25	645.75
	43	30	646 to 654	647.25	652.75	653.25	653.75
	44	31	654 to 662	655.25	660.75	661.25	661.75
	45	32	662 to 670	663.25	668.75	669.25	669.75
	46	33	670 to 678	671.25	676.75	677.25	677.75
	47	34	678 to 686	679.25	684.75	685.25	685.75
	48	35	686 to 694	687.25	692.75	693.25	693.75
	49	36	694 to 702	695.25	700.75	701.25	701.75
	50	37	702 to 710	703.25	708.75	709.25	709.75
V	51	38	710 to 718	711.25	716.75	717.25	717.75
	52	39	718 to 726	719.25	724.75	725.25	725.75
	53	40	726 to 734	727.25	732.75	733.25	733.75
	54	41	734 to 742	735.25	740.75	741.25	741.75
	55	42	742 to 750	743.25	748.75	749.25	749.75
	56	43	750 to 758	751.25	756.75	757.25	757.75
	57	44	758 to 766	759.25	764.75	765.25	765.75
	58	45	766 to 774	767.25	772.75	773.25	773.75
	59	46	774 to 782	775.25	780.75	781.25	781.75
	60	47	782 to 790	783.25	788.75	789.25	789.75
	61	48	790 to 798	791.25	796.75	797.25	797.75
			other channels with 8-MHz spacing				
	68	55	846 to 854	847.25	852.75	853.25	853.75
	69	56	854 to 862	855.25	860.75	861.25	861.75
	not defined	57	862 to 870	863.25			869.75
		58	870 to 878	871.25			877.75
		59	878 to 886	879.25			885.75
		60	886 to 894	887.25			893.75
		61	894 to 902	895.25			901.75
		62	902 to 910	903.25			909.75

Band	Channel USA Canada	Channel Japan	Channel limits MHz	Vision carrier MHz	Sound carrier MHz
Standards M, N (6 MHz), USA; Standard M (6 MHz), Japan					
IF	–		same as VHF for corresponding country		
	14	13	470 to 476	471.25	475.75
	15	14	476 to 482	477.25	481.75
IV			other channels with 6-MHz spacing		
	41	40	632 to 638	633.25	637.75
	42	41	638 to 644	639.25	643.75
	43	42	644 to 650	645.25	649.75
	44	43	650 to 656	651.25	655.75
	45	44	656 to 662	657.25	661.75
	46	45	662 to 668	663.25	667.75
	47	46	668 to 674	669.25	673.75
	48	47	674 to 680	675.25	679.75
	49	48	680 to 686	681.25	685.75
	50	49	686 to 692	687.25	691.75
	51	50	692 to 698	693.25	697.75
	52	51	698 to 704	699.25	703.75
	53	52	704 to 710	705.25	709.75
	54	53	710 to 716	711.25	715.75
	55	54	716 to 722	717.25	721.75
V	56	55	722 to 728	723.25	727.75
	57	56	728 to 734	729.25	733.75
	58	57	734 to 740	735.25	739.75
	59	58	740 to 746	741.25	745.75
	60	59	746 to 752	747.25	751.75
	61	60	752 to 758	753.25	757.75
	62	61	758 to 764	759.25	763.75
	63	62	764 to 770	765.25	769.75
	64	not defined	770 to 776	771.25	775.75
			other channels with 6-MHz spacing		
	82		878 to 884	879.25	883.75
	83		884 to 890	885.25	889.75
Standard B (7 MHz), Australia					
IF	–		33.15 to 40.15	38.9	33.4
	28		526 to 533	527.25	532.75
	29		533 to 540	534.25	539.75
	30		540 to 547	541.25	546.75
IV	31		547 to 554	548.25	553.75
	32		554 to 561	555.25	560.75
	33		561 to 568	562.25	567.75
	34		568 to 575	569.25	574.75
	35		575 to 582	576.25	581.75
	36		582 to 589	583.25	588.75
	37		589 to 596	590.25	595.75
	38		596 to 603	597.25	602.75
V			other channels with 7-MHz spacing		
	67		799 to 806	800.25	805.75
	68		806 to 813	807.25	812.75
	69		813 to 820	814.25	819.75

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