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

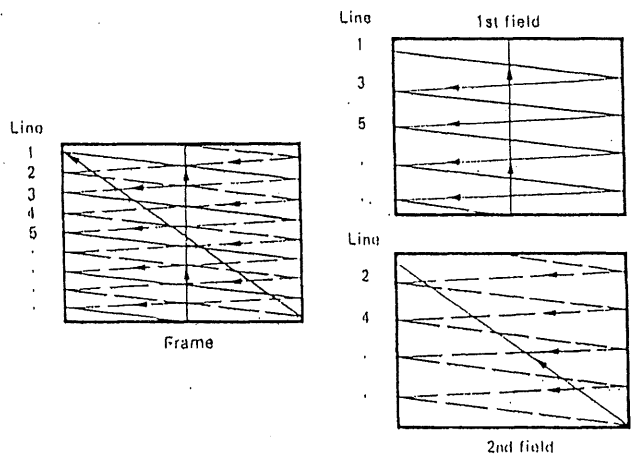
Frames of 525 and 625 lines are still in use. Resolution being too weak at 405 lines and the frequencies required being too high at 819 lines, these values have been superseded by 625 lines.

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	PAL				SECAM		
	M	B, G, H	I	M	N	B, G, H	D, K, K1	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 chrominance subcarrier		
Type of modulation	Suppressed-carrier amplitude modulation of two subcarriers in quadrature					FM		
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.

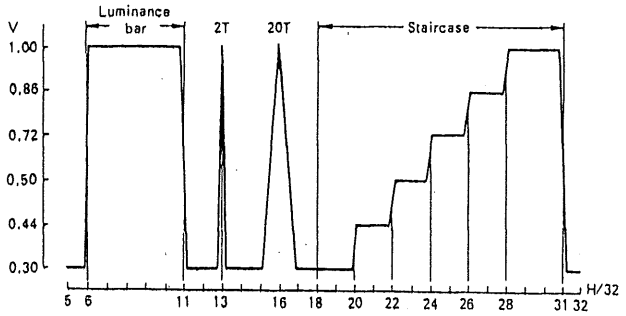
COUNTRIES

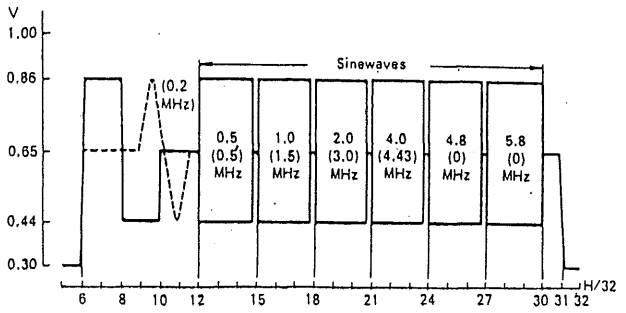
Country	Standard for VHF	UHF	Colour	AC supply Nom. voltage V	Freq. Hz
J					
Jamaica	N		NTSC	220/380	50
Japan	M	M	NTSC	(115)/2001)	50/60
Jordan	B	G	PAL	220/380	50
K					
Kenya	B	G	PAL	240/415	50
Korea (North), Democrat. Rep.	D	K	PAL	200/346 220/380	60
Korea (South), Rep.	M	M	NTSC	200/346 220/380	60
Kuweit	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

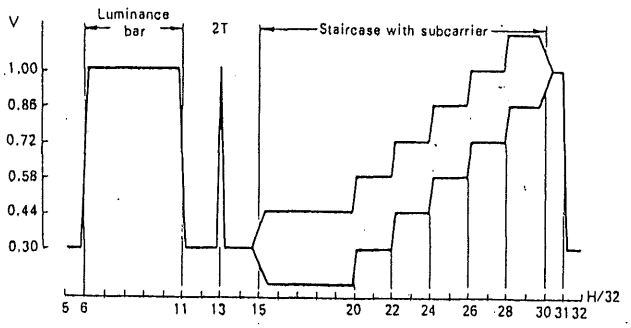
[1]) Three-phase supply network without neutral conductor.

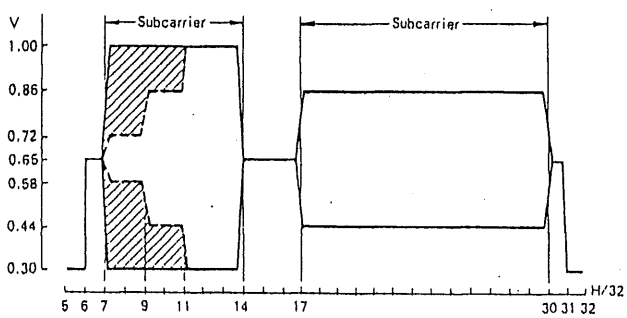
INSERTION TEST/COLOUR BAR SIGNALS

Insertion test signals

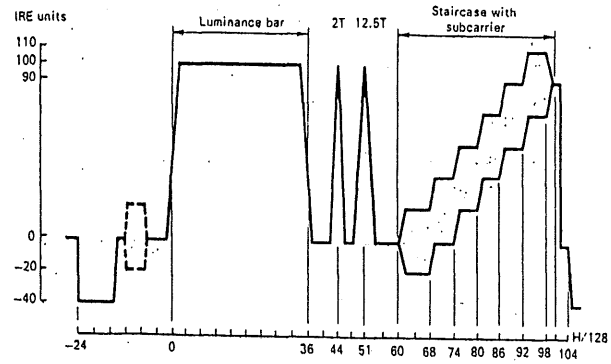


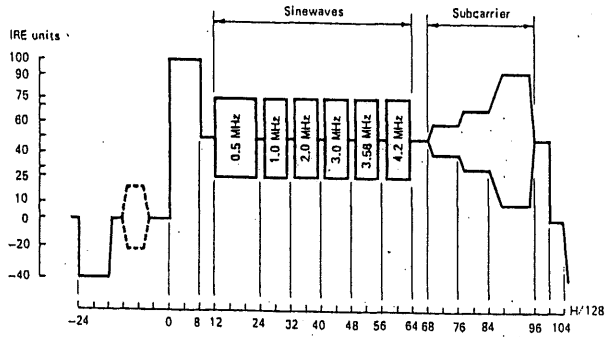




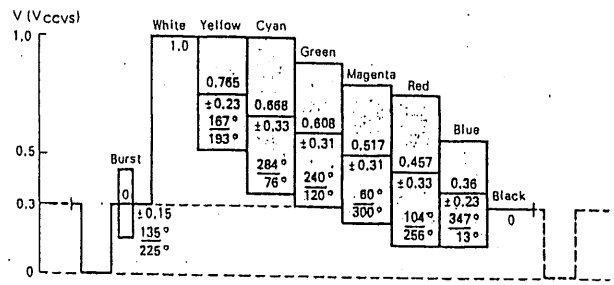


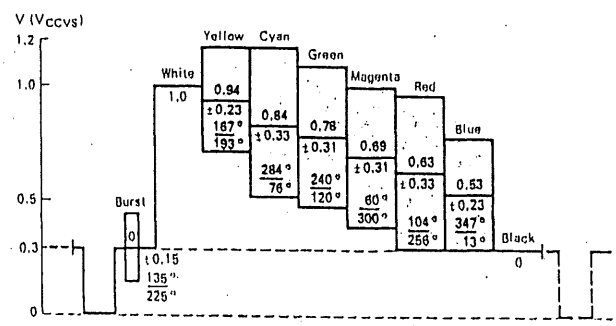
CCIR insertion test signals for (from top to bottom) lines 17 and 18 (in parentheses: frequencies of Insertion Signal Generator SPZF standard model) of 1st field and lines 330 and 331 (with and without staircase) of 2nd field

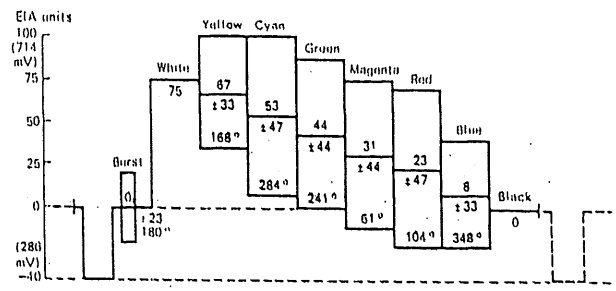




Insertion test signals for standard M; on top for line 17 of 1st field and above for line 17 of 2nd field (corresponds to line 280 of picture)







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

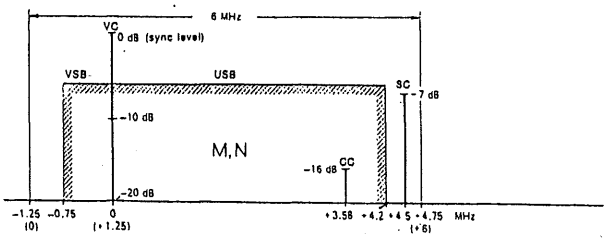
Channel definitions

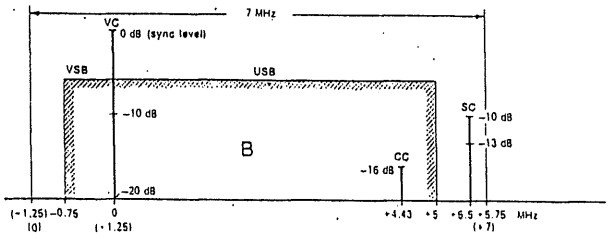
The tables present the definitions of channels for various countries, grouped by standards.

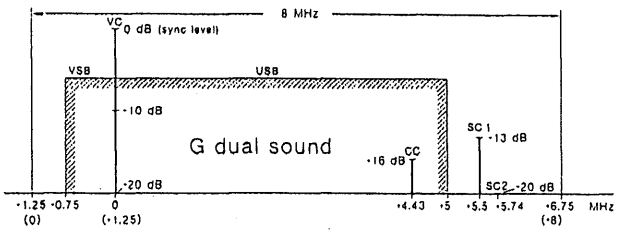
Occupancy of satellite channels see page 7.

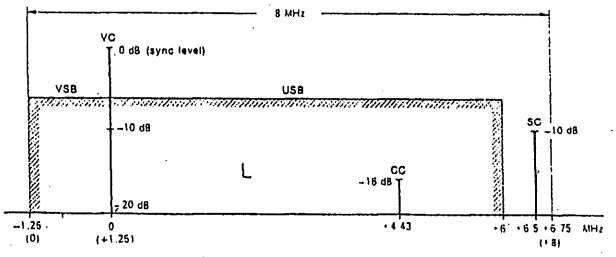
Right: Relation of vision, colour and sound carriers (VC, CC, SC) and of vestigial sidebands (VSB) and upper sidebands (USB) within the channels of 6, 7 and 8 MHz bandwidth for various standards

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	113 to 123		Digital sound broadcasting
	S 3			
	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).