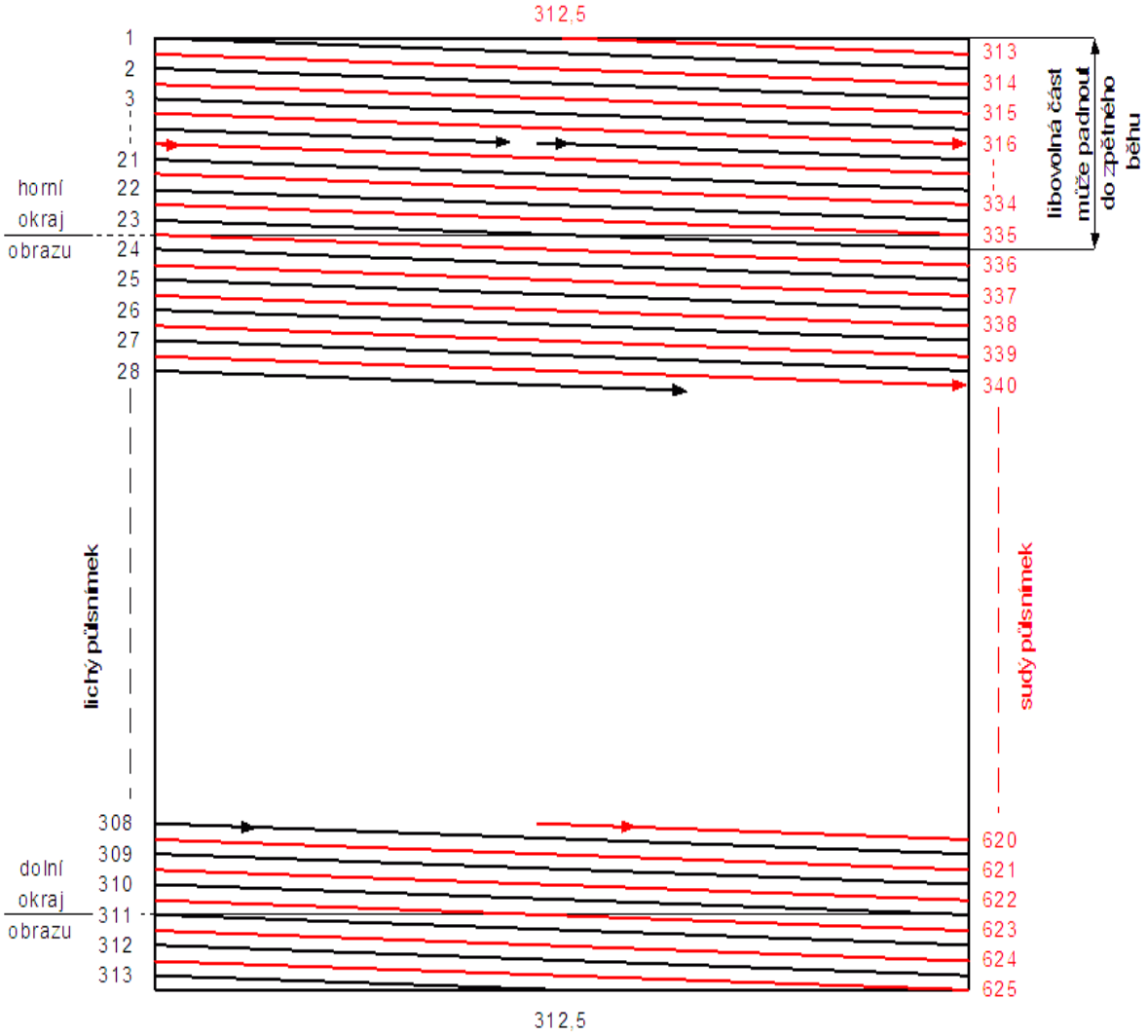
Digitální televize a rozhlas

Analogové televizní soustavy
Digitalizace videosignálu
Digitalní televize – projekt DVB

Analogové televizní soustavy

NTSC, PAL , (SECAM, D2-MAC)

Televizní rozkladový rastr



Evropský televizní standard (PAL)

n = 625 řádek

f_s = 25 snímků/s (50 půlsnímků)

Formát: 4:3

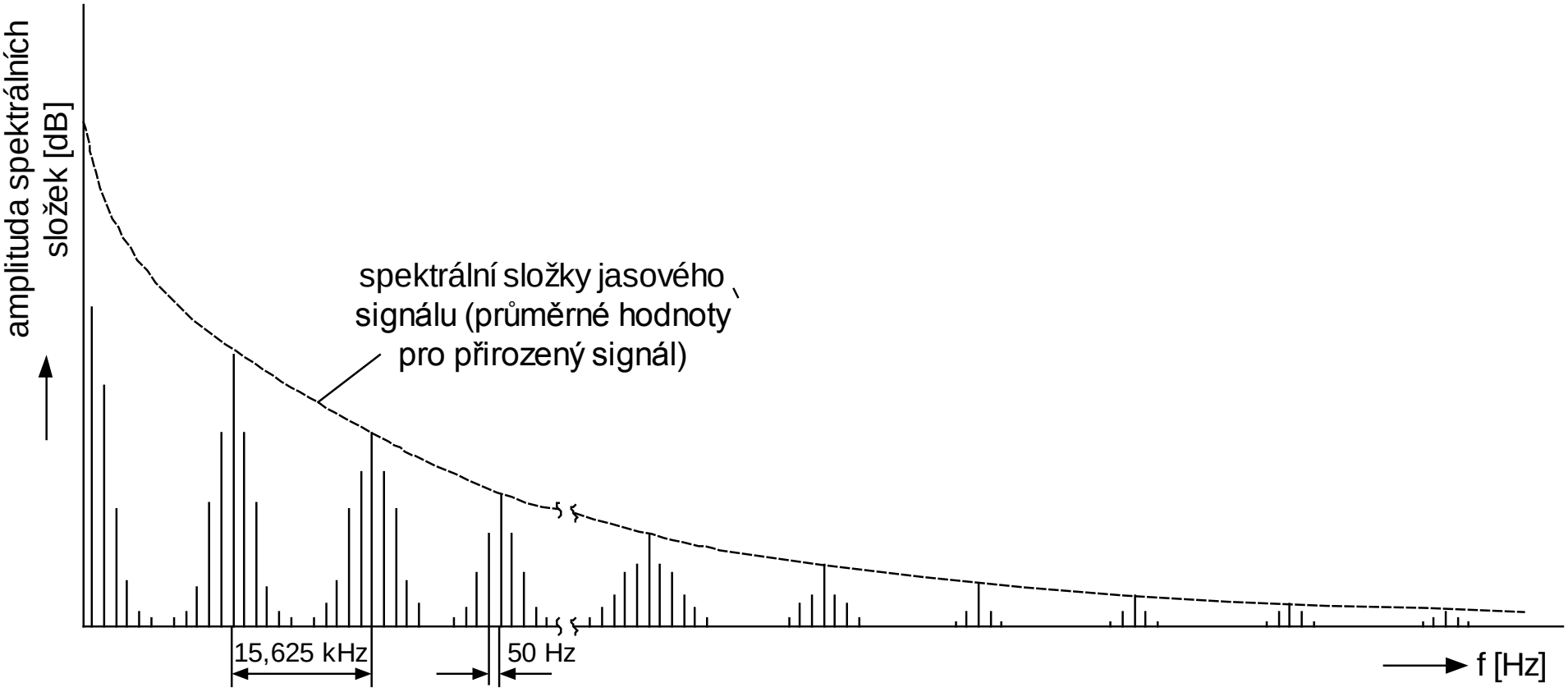
Jasový signál Y

$f_{max} = 1/2 \times n \times 4/3 \times n \times f_s$ [Hz]

$f_{max} \approx 6{,}5$ MHz

Prokládání (Interlacing) - zvýšení frekvence blikání (viz. vlastnosti oka Ferry-Porterův zákon)

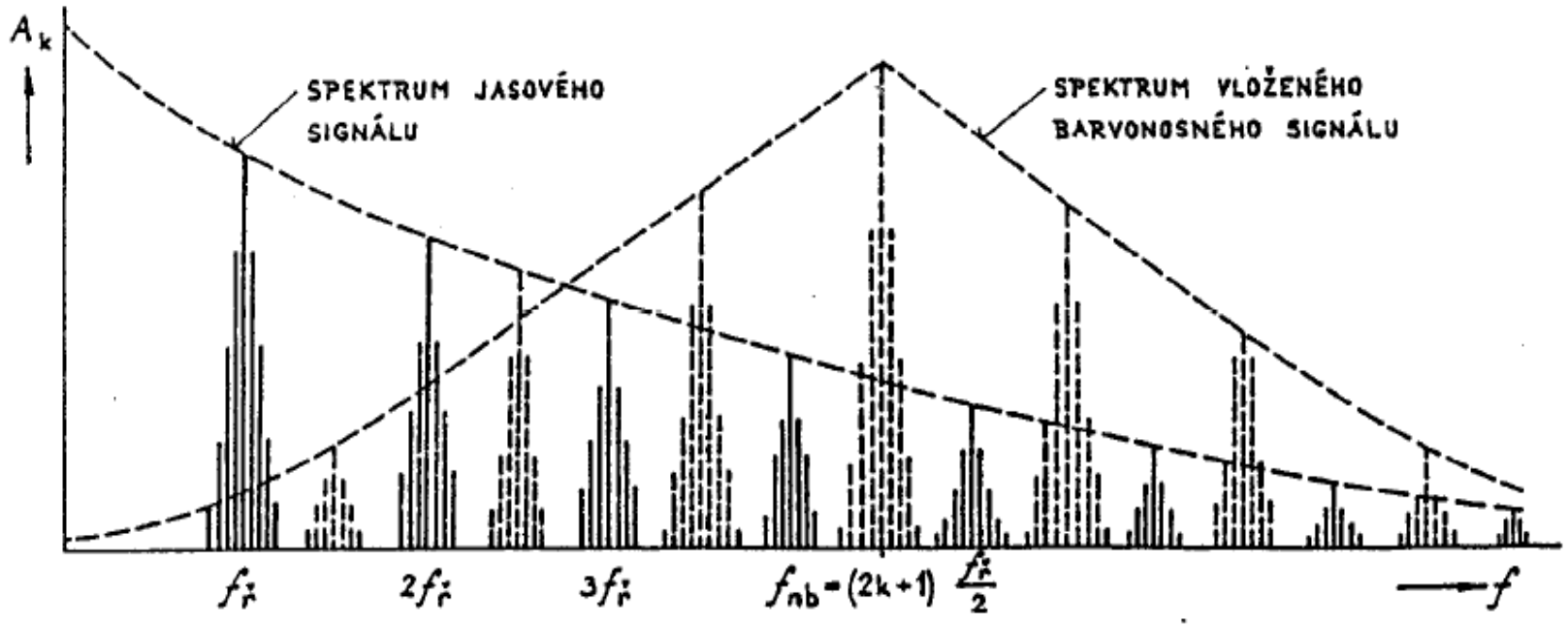
Spektrum ČB videosignálu



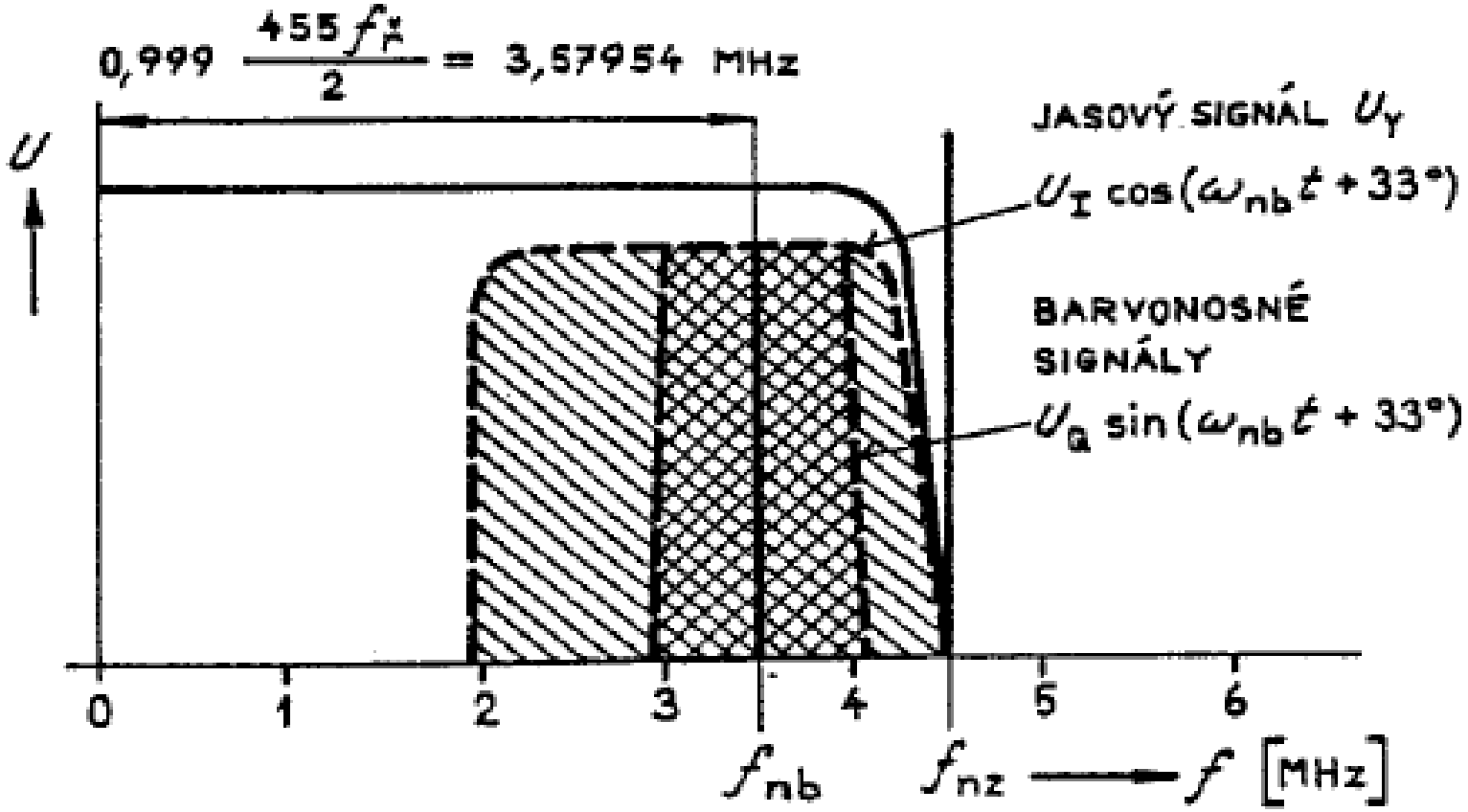
Znázornění kmitočtového spektra černobílého tv. signálu

Soustava NTSC (evrop.)

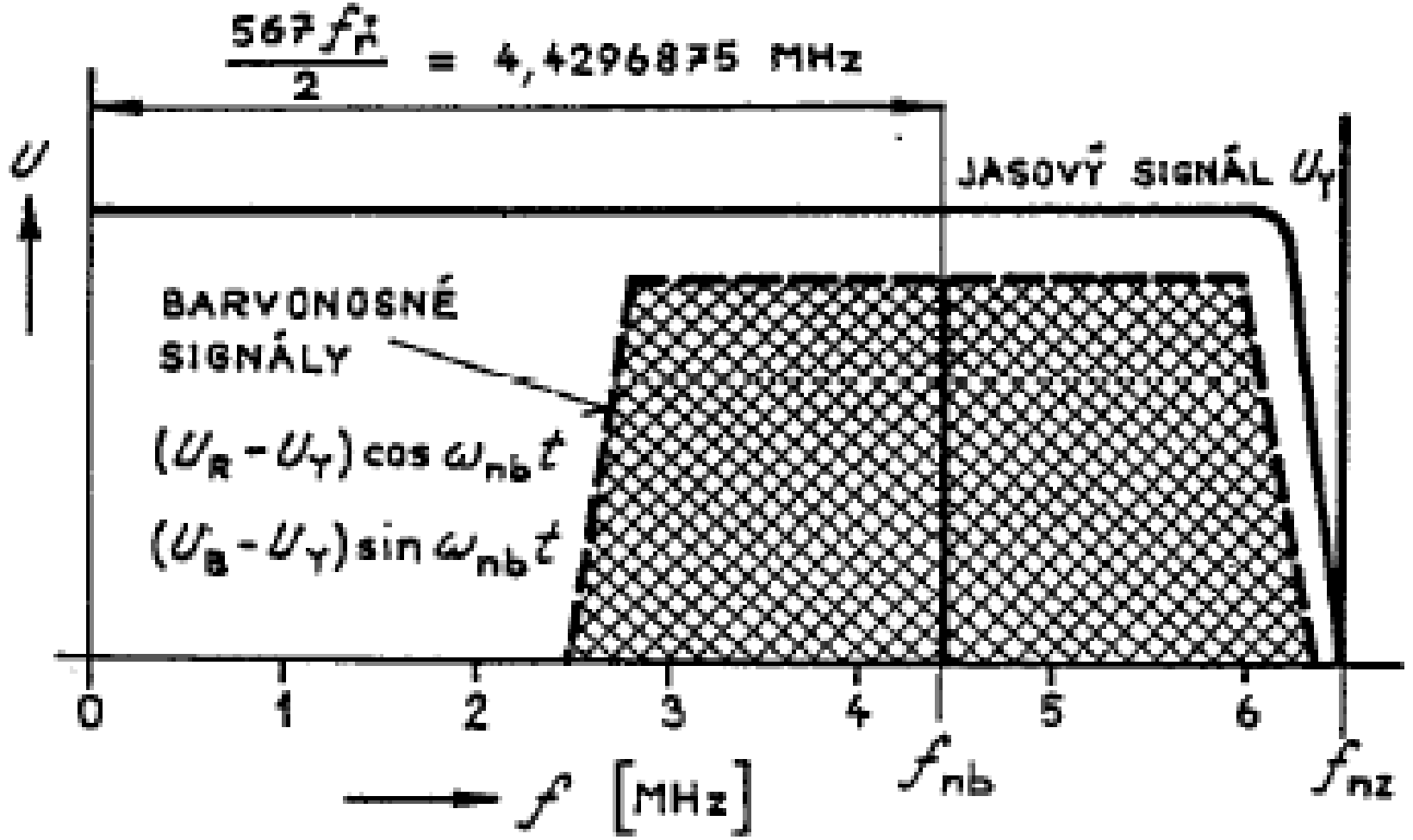
- Využití kvadraturní modulace - modulace fáze a amplitudy barvonosné frekvence



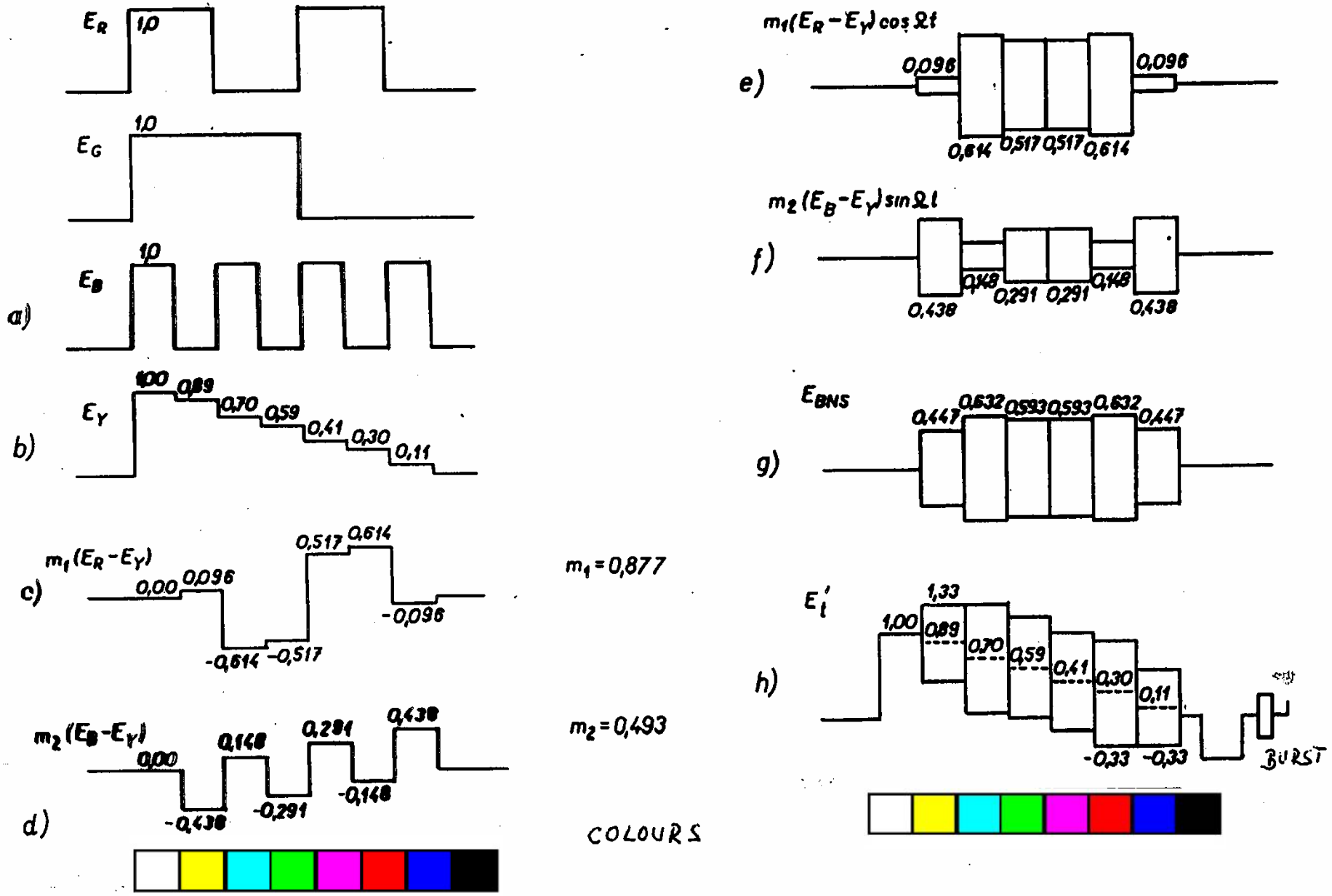
Soustava NTSC



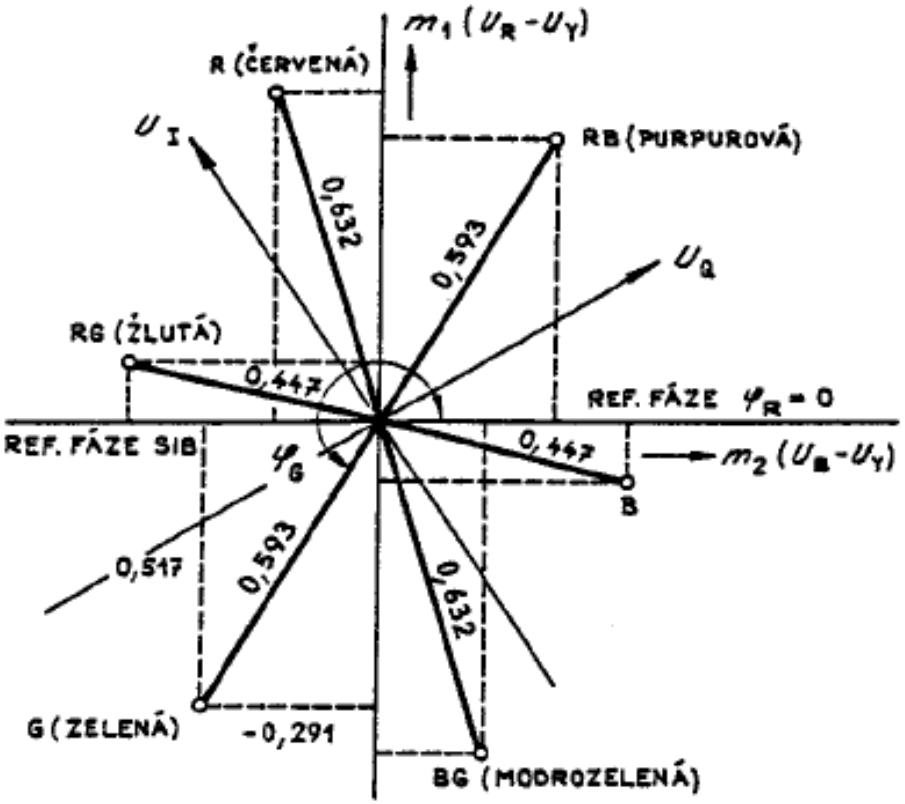
Soustava NTSC (evropská)



Signál barevných pruhů



Vektorový diagram



$$E_{ccvs} = E_Y + E_{Chr}$$

$$E_{Chr} = \sqrt{m_1^2 (E_R - E_Y)^2 + m_2^2 (E_B - E_Y)^2}$$

$$\varphi = arctg\left(\frac{m_1 (E_R - E_Y)}{m_2 (E_B - E_Y)^2}\right)$$

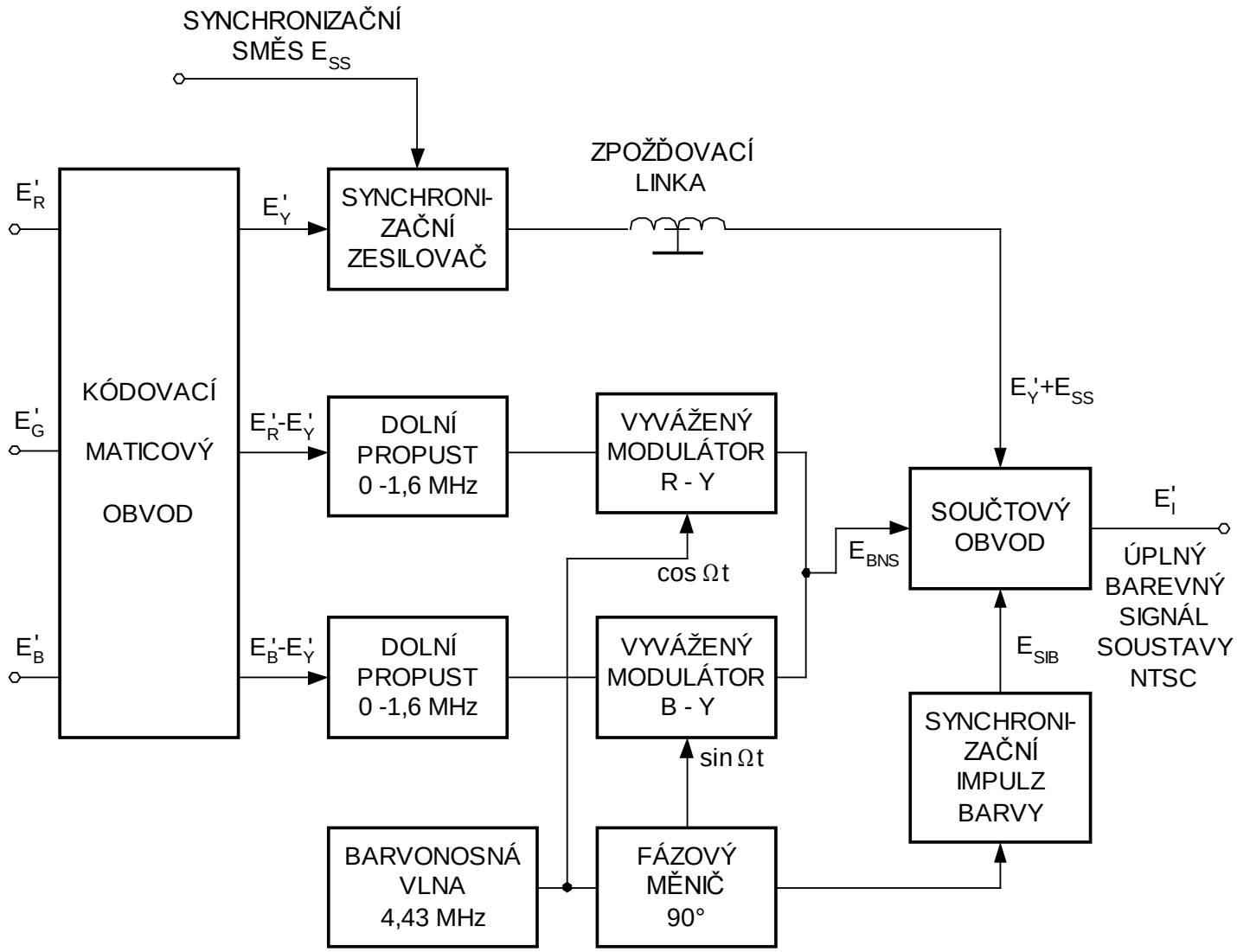
$$m_1 = 0.887, \quad m_2 = 0.493$$

$$E_Y = L_R E_R + L_G E_G + L_B E_B$$

$$L_R = 0.299,\ L_G = 0.587,\ L_B = 0.114,$$

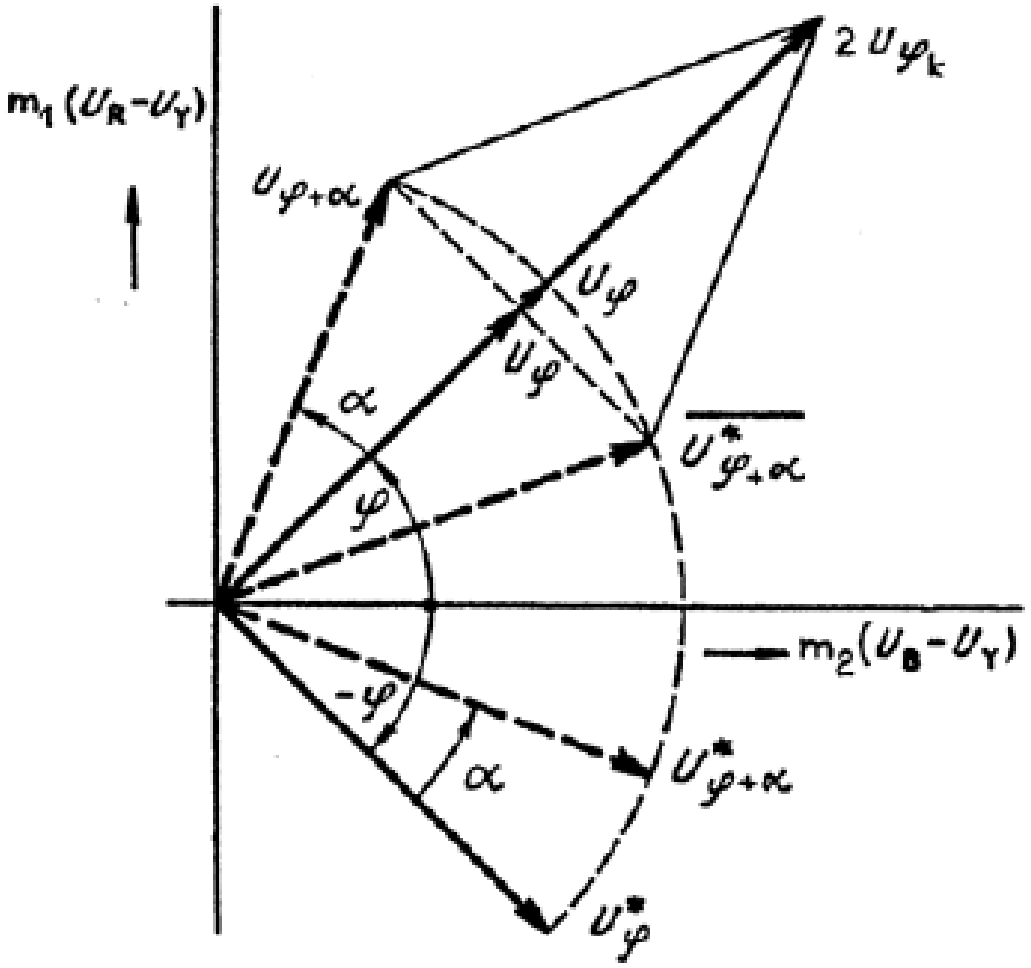
Synchronizace barvy - signál BURST

Kodér NTSC (evrop.)

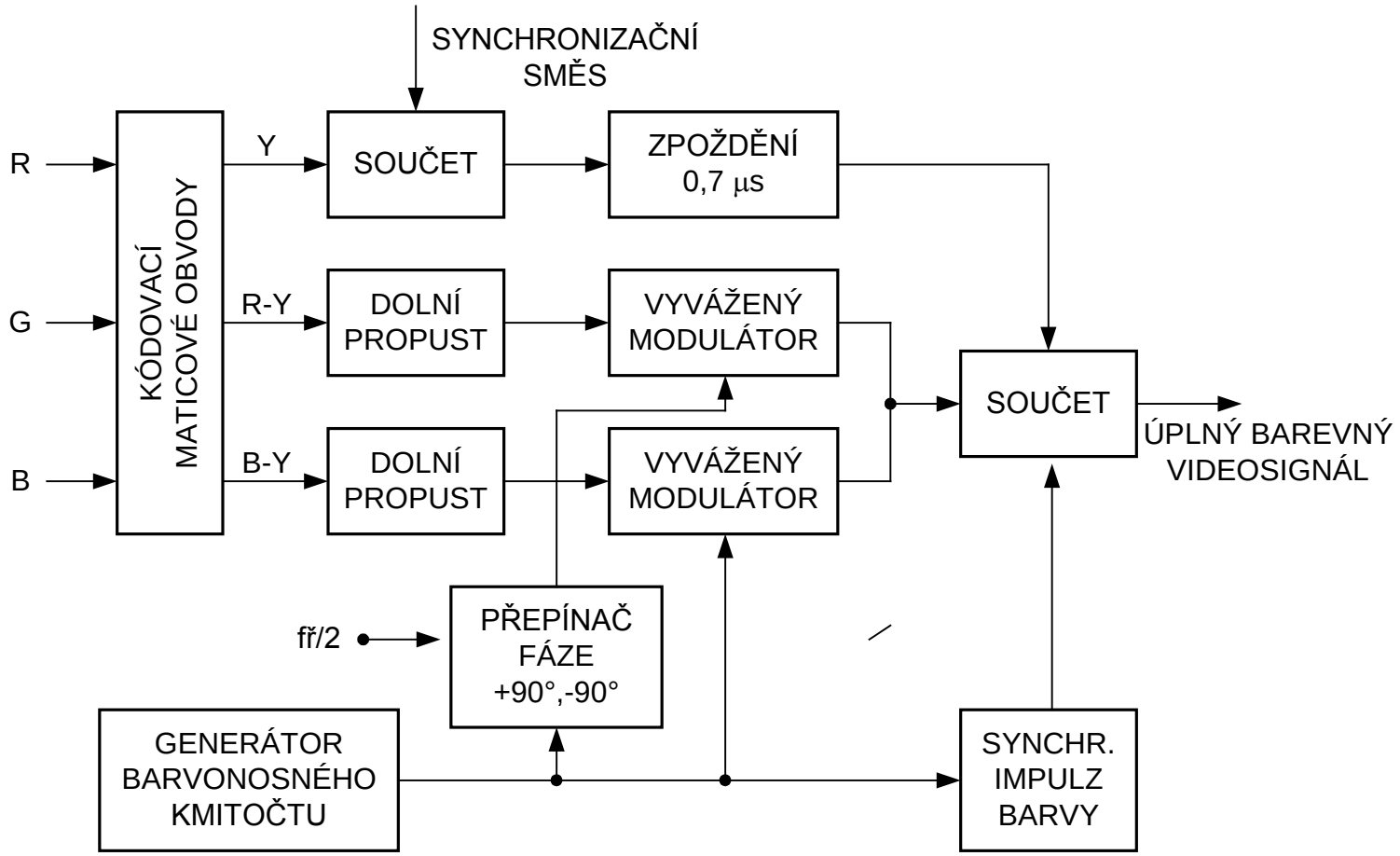


Blokové uspořádání kódovacího zařízení soustavy barevné televize podle normy NTSC

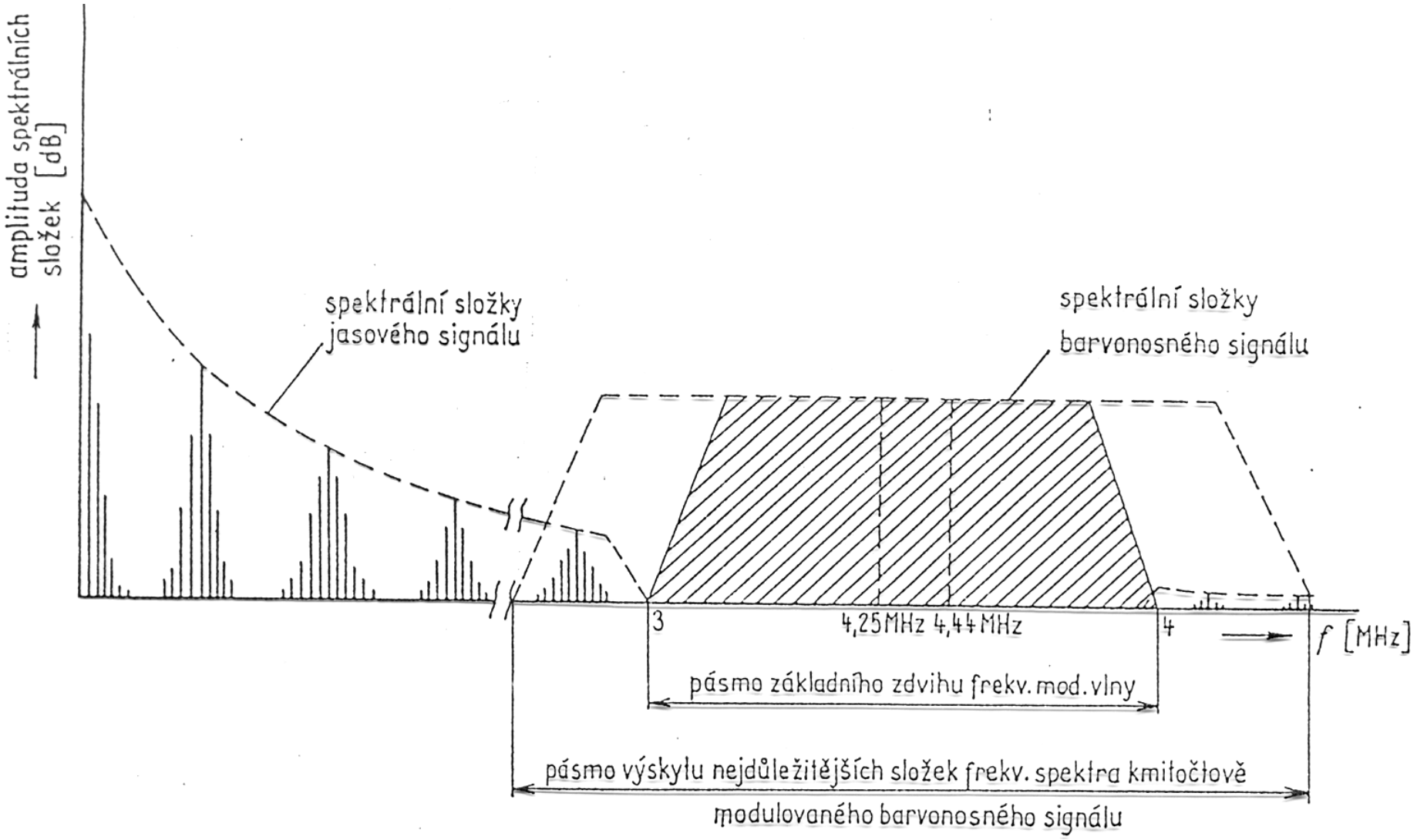
Soustava PAL - kompenzace fázové chyby



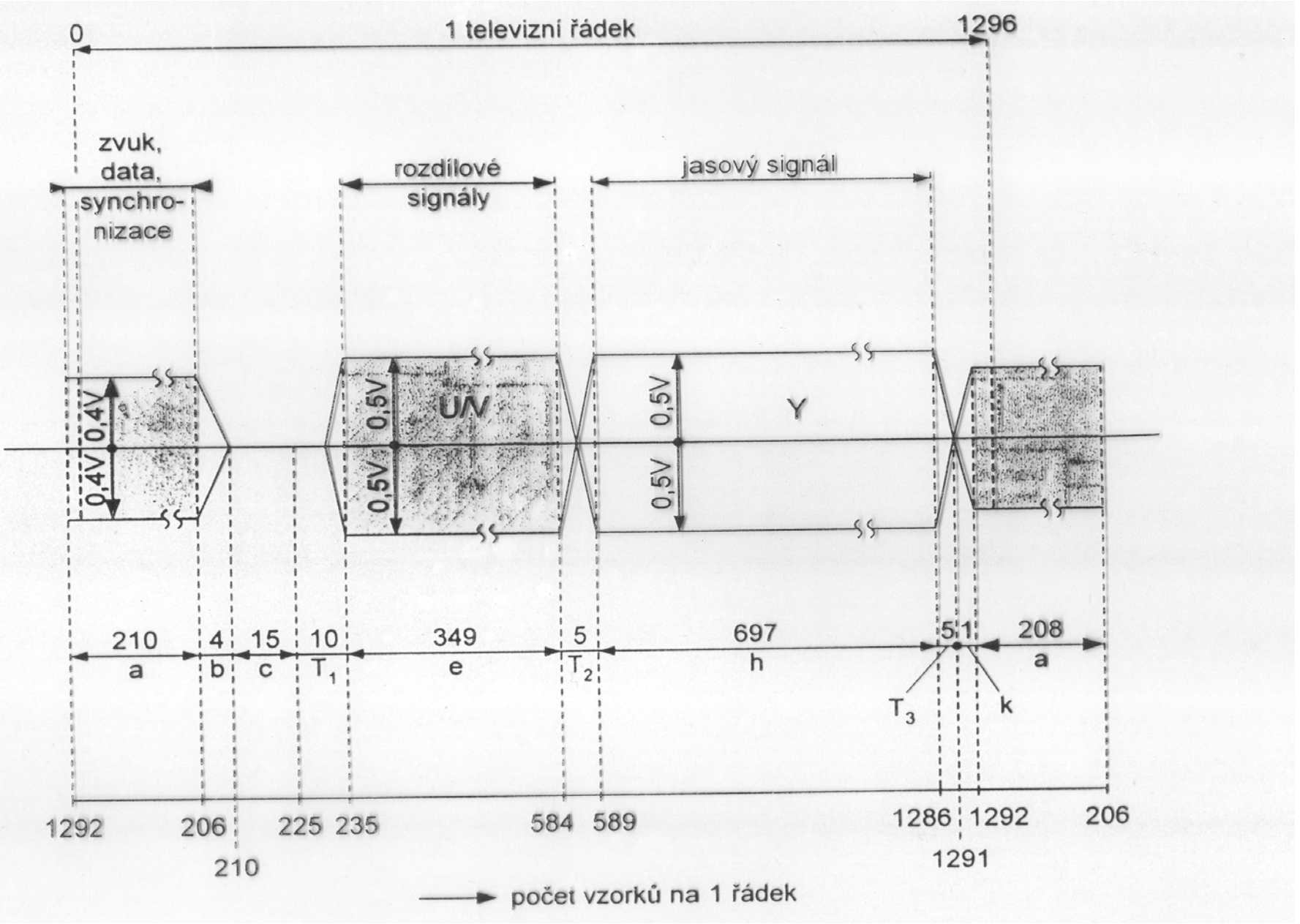
Kodér PAL


SYNCHRONIZAČNÍ
SMĚS
R
G
B
KÓDOVACÍ
MATICOVÉ OBVODY
Y
R-Y
B-Y
SOUČET
DOLNÍ
PROPUST
DOLNÍ
PROPUST
ZPOŽDĚNÍ
0,7 μs
VYVÁŽENÝ
MODULÁTOR
VYVÁŽENÝ
MODULÁTOR
SOUČET
ÚPLNÝ BAREVNÝ
VIDEOSIGNÁL
fř/2
PŘEPÍNAČ
FÁZE
+90°,-90°
GENERÁTOR
BARVONOSNÉHO
KMITOČTU
SYNCHR.
IMPULZ
BARVY

Soustava SECAM



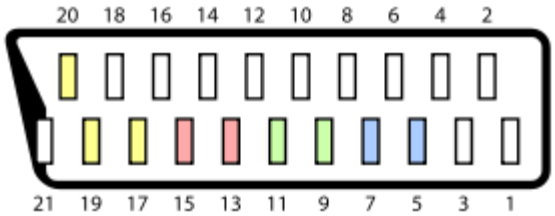
Soustava D2MAC



SCART

1 Audio output (right)
2 Audio input (right)
3 Audio output (left/mono)
4 Audio ground
5 RGB Blue ground
6 Audio input (left/mono)
7 RGB Blue up (S-Video C)
8 Status & Aspect Ratio
9 RGB Green ground
10 Clock
11 RGB Green up
12 Reserved
13 RGB Red ground
14 Pin 12 & pin 16 ground
15 RGB Red up
16 Select [0-0.4V → comp, 1-3V → RGB]
17 Composite video output
18 Composite video input ground
19 Composite video output (S-Video Y output)
20 Composite video input (S-Video Y input)
21 Pin 8 & pin 10 gr

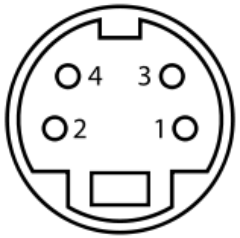
21 pólový konektor pro připojení audio/video zařízení (video a televize), používaný zejména v Evropě.
RGB, kompositní video, S-video, stereo audio,
Často zapojena jen část



Female connector seen from the front

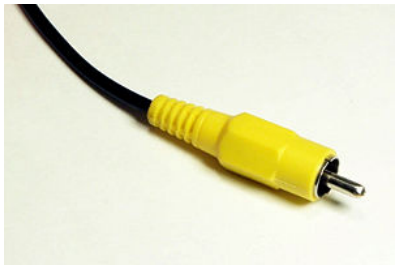
S-Video

1 Ground
2 Ground
3 Luminance (jas)
4 Chrominance (barva)



Video

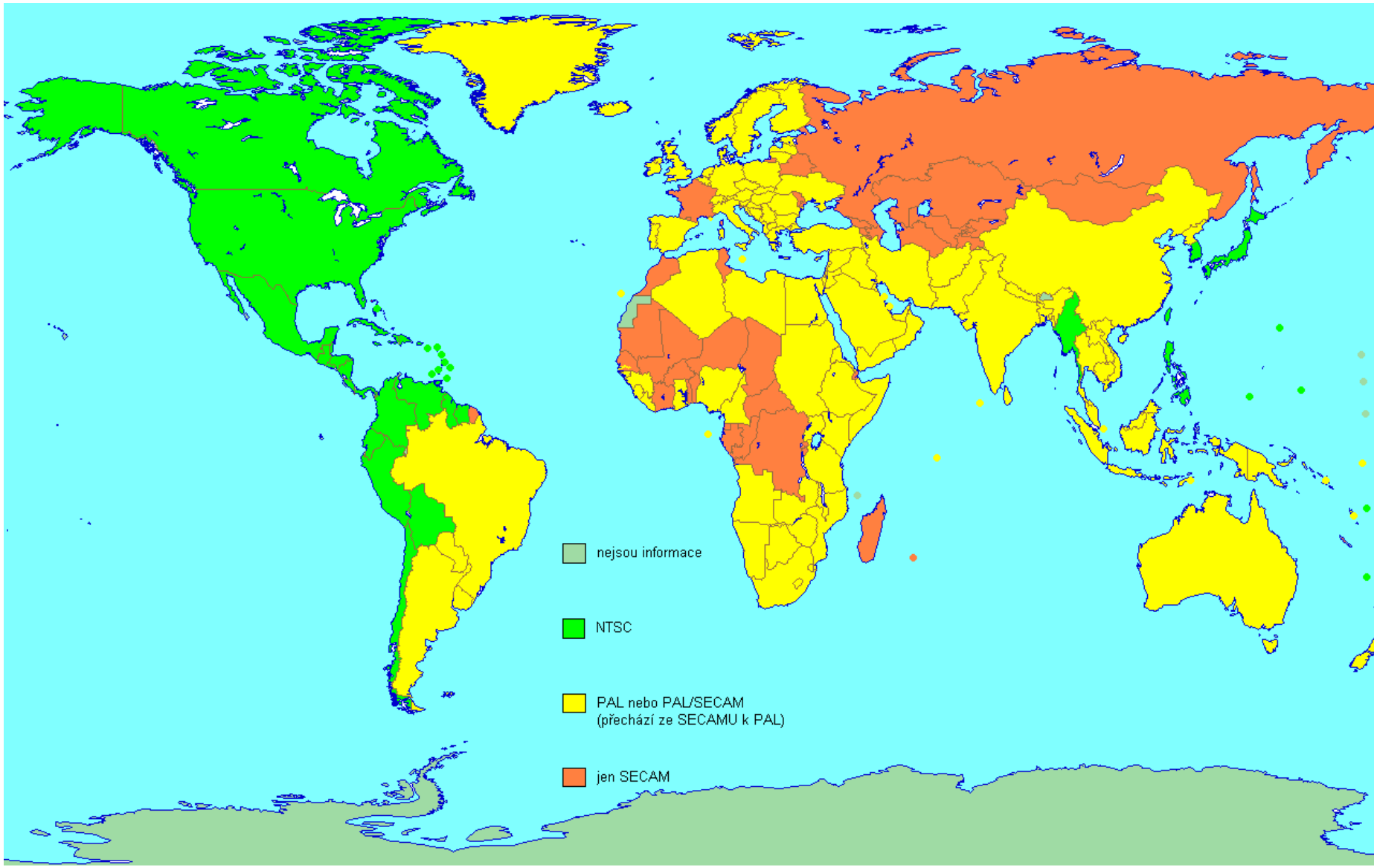
Kompozitní signál



RCA, Cinch

BNC

Color TV Standards of the World



Digitalizace videosignálu, digitální standardy

Digitaliazace videosignálu

Kompozitní (composite) videosignál: NTSC, PAL, SECAM, MAC
Složkové (component) videosignál: RGB, YUV

ITU-R BT 601 - Digitalizace složkového videosignálu YUV

Ortogonalní vzorkovací struktura

Jasový kanál - 13.5 MHz, Chrominanční kanál - 6.75 MHz,

aplikovaná na signál po korekci gama.

Linearní kvantizace PCM, 8 bitů (resp. 10 bitů)

Synchronizace - 0, 255 (1024)

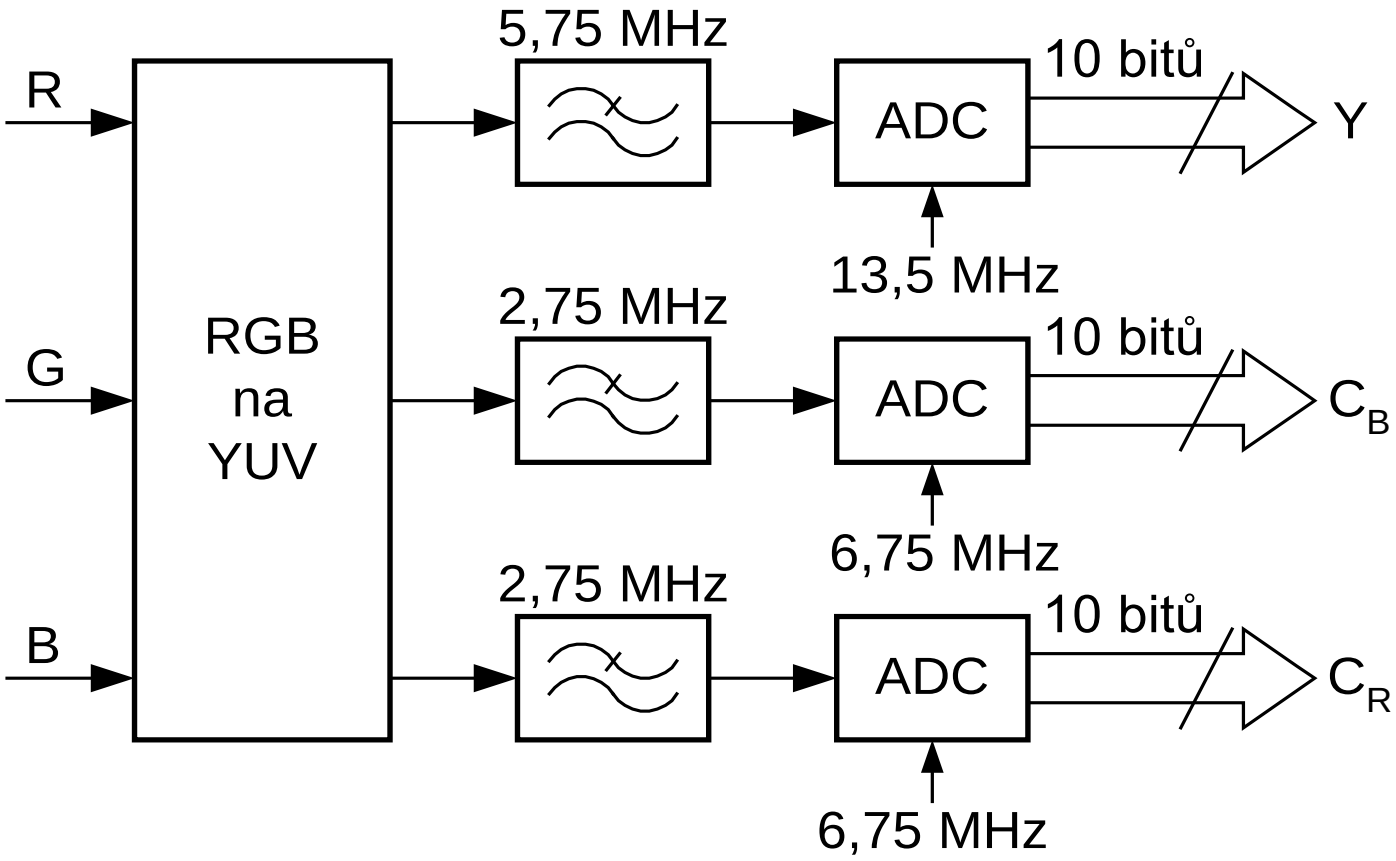
Počet jasových, resp. chrominančních vzorků v řádce - **720, 360**

Počet aktivních řádek - 576 (2 x 288)

Moiré, aliasing, stroboskopický efekt

https://www.youtube.com/watch?v=_0naTvrigBY

Digitalizace videosignálu (ITU-R 601, 4:2:2)

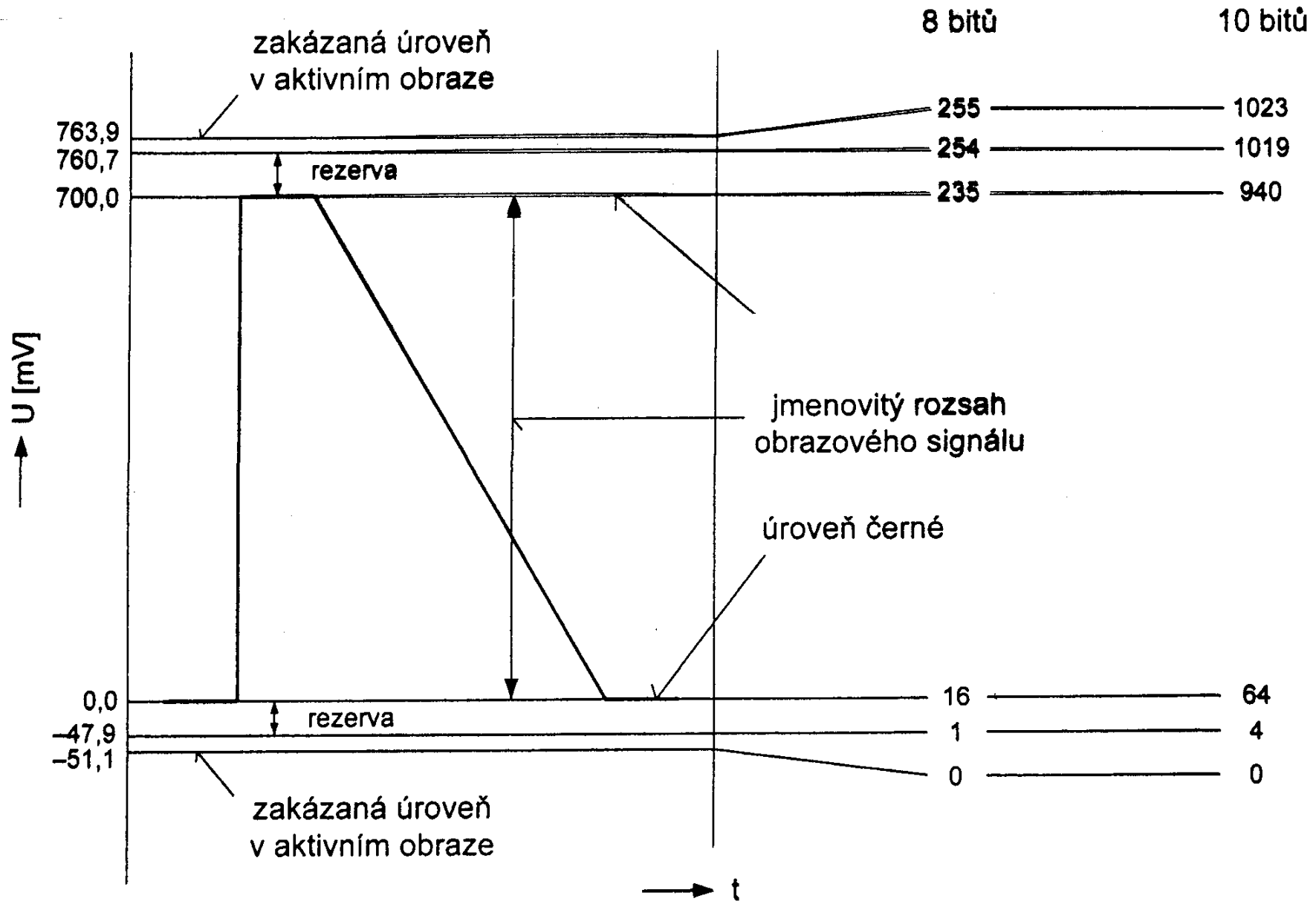


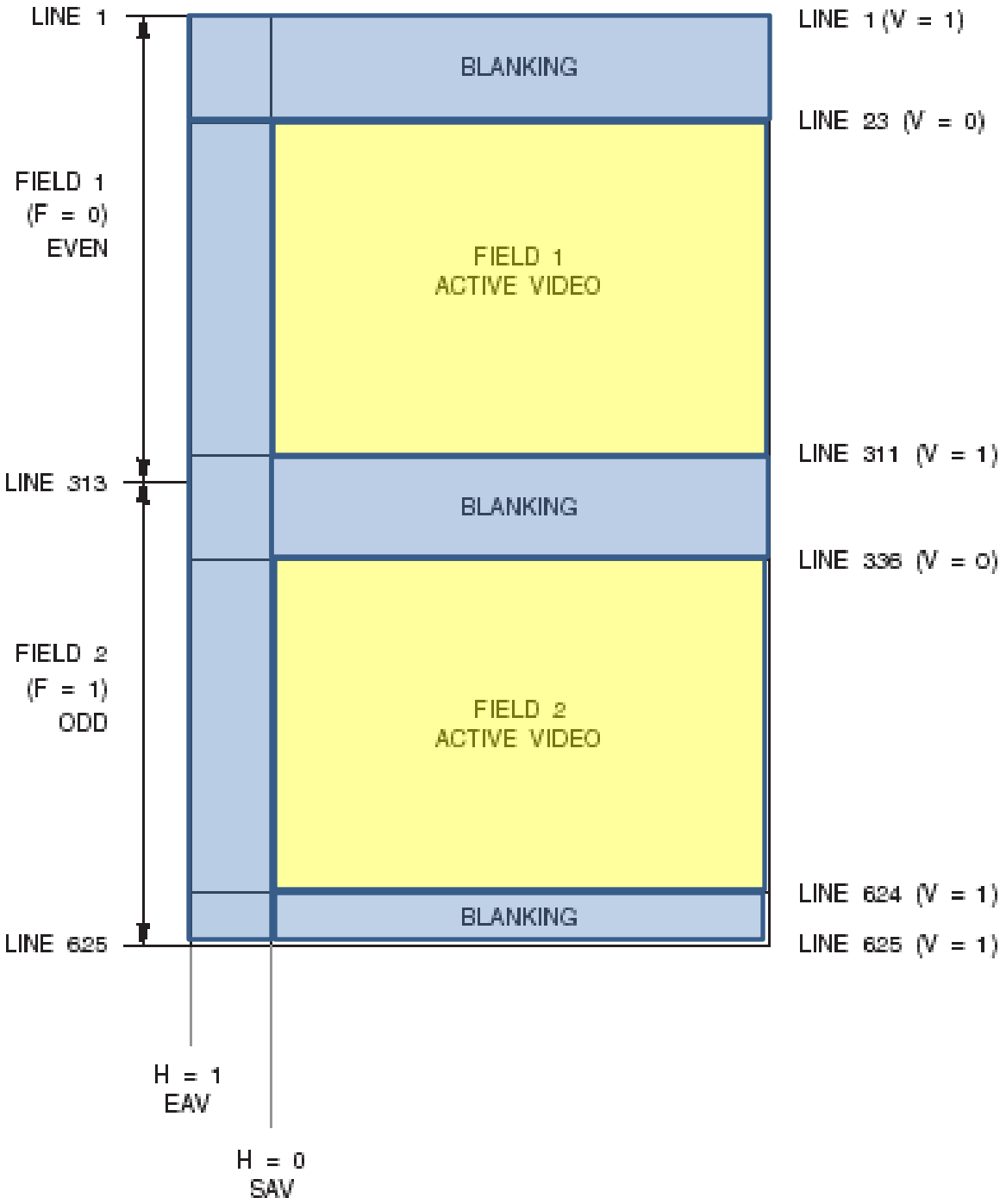
SD - fs = 25 Hz, fvz = 13,5 MHz, bitový tok 270 Mb/s

HD - fs = 25 Hz, fvz = 74,25 MHz, bit. tok 1 485 Mb/s

Full HD - fs = 50 Hz, fvz = 148,5 MHz, bit. tok 2 970 Mb/s

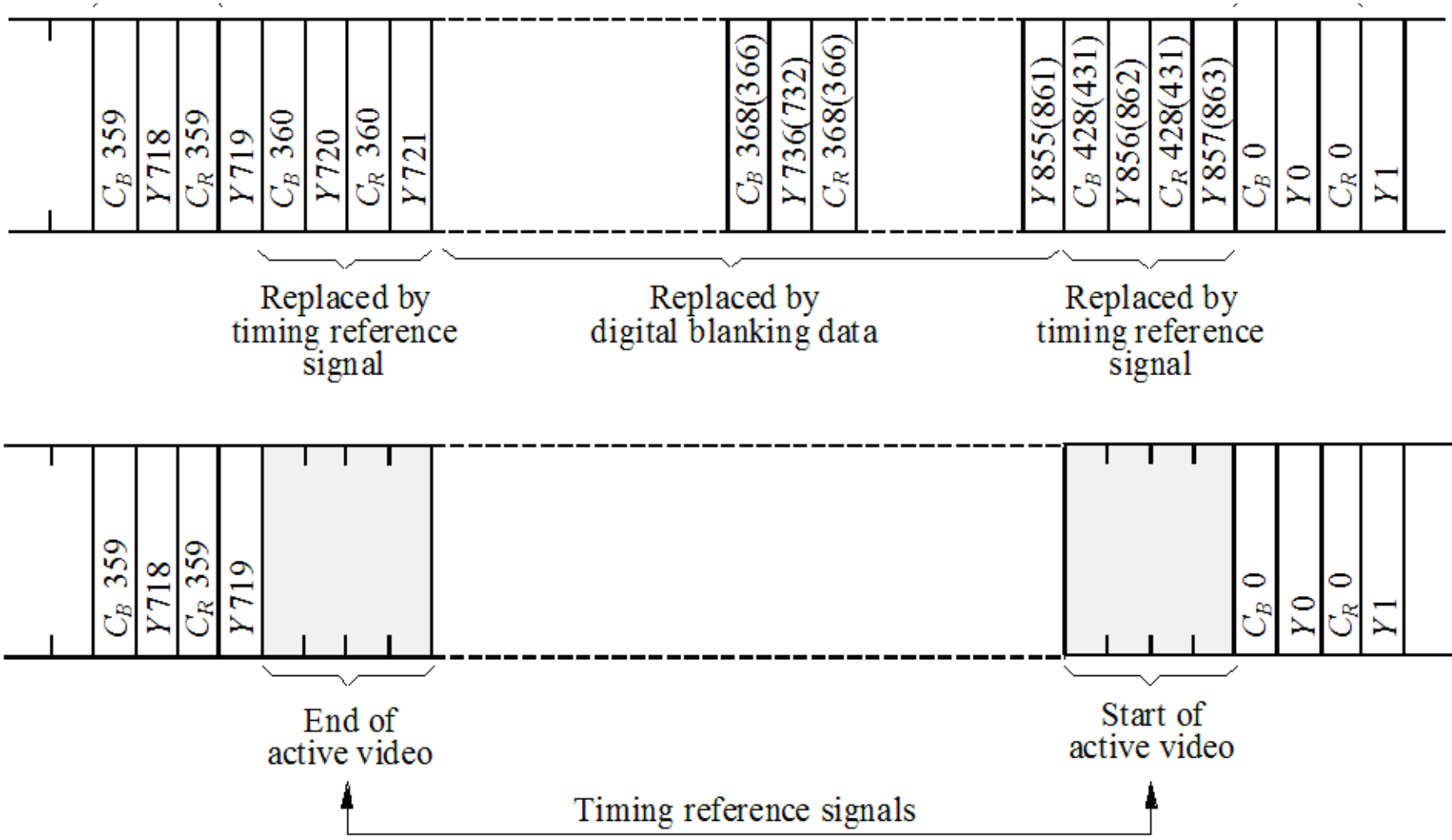
Jasový signál





LINE NUMBER	F	V
1–22	0	1
23–310	0	0
311–312	0	1
313–335	1	1
336–623	1	0
624–625	1	1

Synchronizace



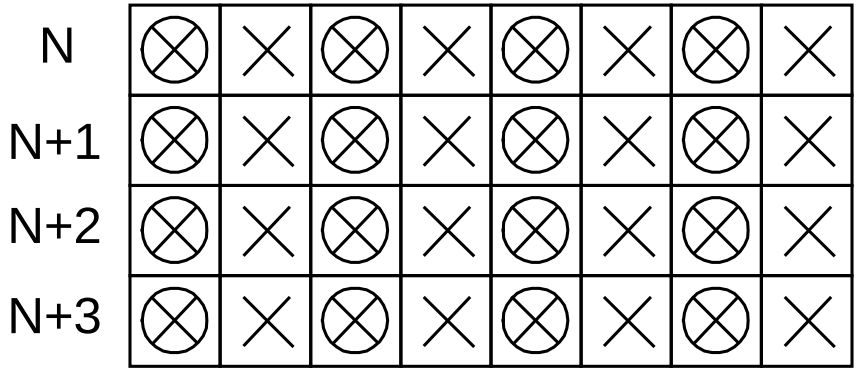
Popis SAV a EAV

	8-bit Data								10-bit Data	
	D9 (MSB)	D8	D7	D6	D5	D4	D3	D2	D1	D0
preamble	1	1	1	1	1	1	1	1	1	1
	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
status word	1	F	V	H	P3	P2	P1	P0	0	0

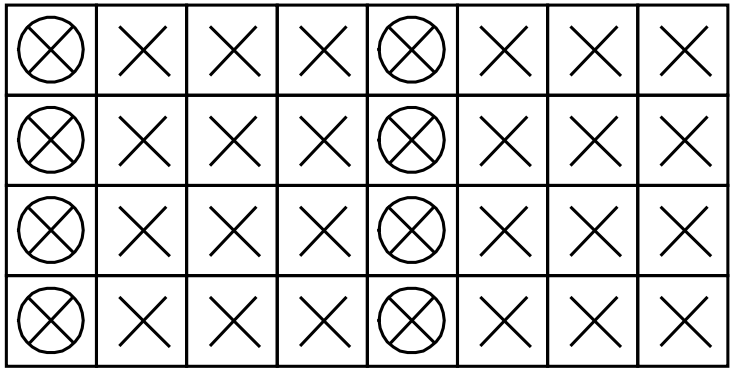
F = “0” for Field 1 F = “1” for Field 2
V = “1” during vertical blanking
H = “0” at SAV H = “1” at EAV
P3–P0 = protection bits

$P3 = V \oplus H$
$P2 = F \oplus H$
$P1 = F \oplus V$
$P0 = F \oplus V \oplus H$

Chrominanční formáty

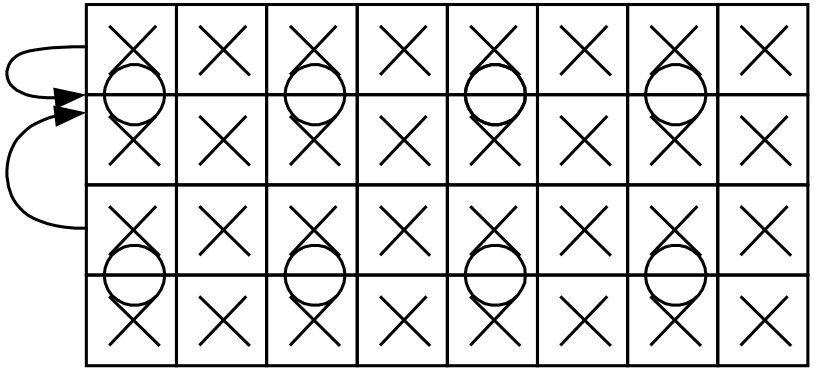


4:2:2 Rec 601



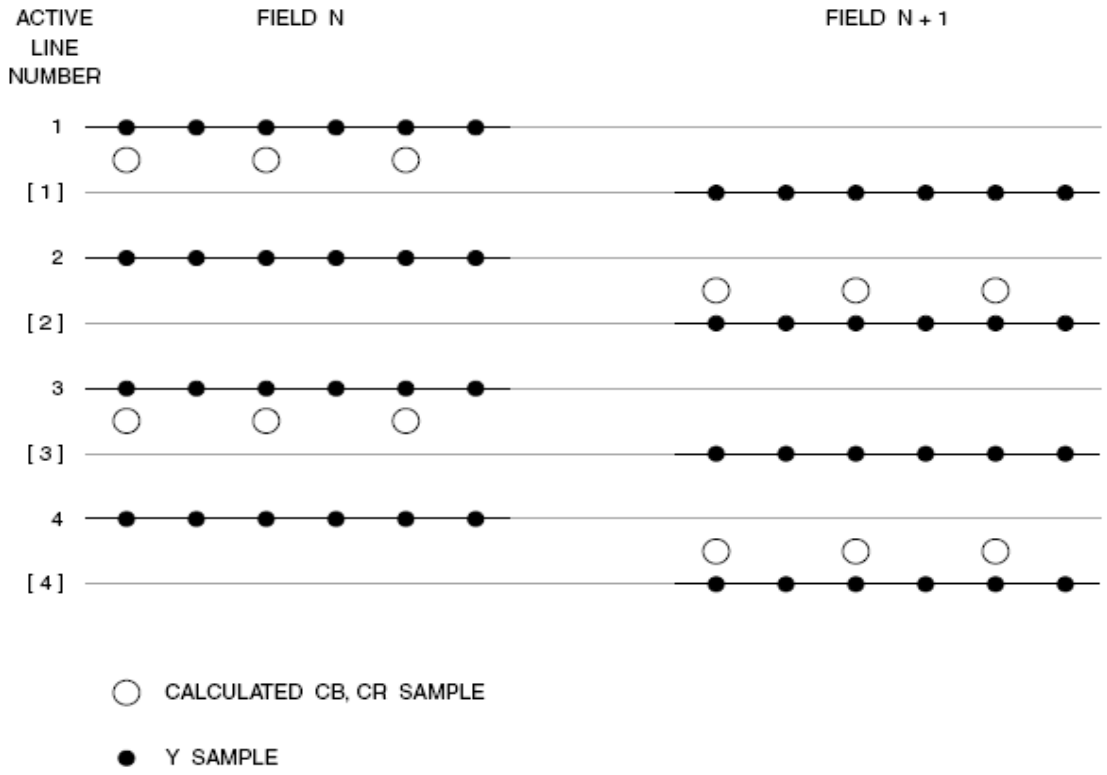
4:1:1

Složkový RGB 4:4:4



4:2:0

Chrominanční formát 4:2:0 (detaily)



SDTV, HDTV a UHD

480i/ 30	NTSC (celkem 525 řádek) 720 x 480 pixelů		4 : 3
576i /25	**PAL (cel. 625 řádek) 720 x 576 (768 x 575) 4 : 2 : 2 270 Mb/s**		**4 : 3**

720p/ 50	HDTV formát (1280 x 720)	1.5 Gb/s	16 : 9
1080i / 25	**HDTV formát (1920 x 1080)**	**1.5 Gb/s**	**16 : 9**
1080p/ 50	Full HDTV formát (1920 x 1080)	3 Gb/s	16 : 9

2160p/ 25 / 50	4k UHD formát, (3840 x 2160)	6 Gb/s 12 Gb/s	16 : 9
4320p/ 25 / 50	8k UHD formát, (7680 x 4320)	(24 Gb/s) (48 Gb/s)	16 : 9

UHD a HDTV: f_{frames}: 25, 29.97, 30,
resp. f_{fields} 50, 59.94, 60 f/s

SDI – Serial Digital Interface

Standard	Name	Introduced	Bitrates	Example video formats
SMPTE 259M	SD-SDI	1989	270 Mbit/s, 360 Mbit/s, 143 Mbit/s, and 177 Mbit/s	480i, 576i
SMPTE 344M	ED-SDI		540 Mbit/s	480p, 576p
SMPTE 292M	HD-SDI	1998	1.485 Gbit/s, and 1.485/1.001 Gbit/s	720p, 1080i
SMPTE 372M	Dual Link HD-SDI	2002	2.970 Gbit/s, and 2.970/1.001 Gbit/s	1080p60
SMPTE 424M	3G-SDI	2006	2.970 Gbit/s, and 2.970/1.001 Gbit/s	1080p60
SMPTE ST-2081	6G-SDI	2015	6 Gbit/s	1080p120, 2160p30
SMPTE ST-2082	12G-SDI	2015	12 Gbit/s	2160p60
SMPTE ST-2083	24G-SDI	In development	24 Gbit/s	2160p120, 4320p30

Embedded audio - SD (SMPTE 272) , HD (SMPTE 299M)

16 (D.L. 32) channels, 48 kHz, 24 (SD 20) bit/sample, PCM)

SDI - Electrical Interface and Data Format

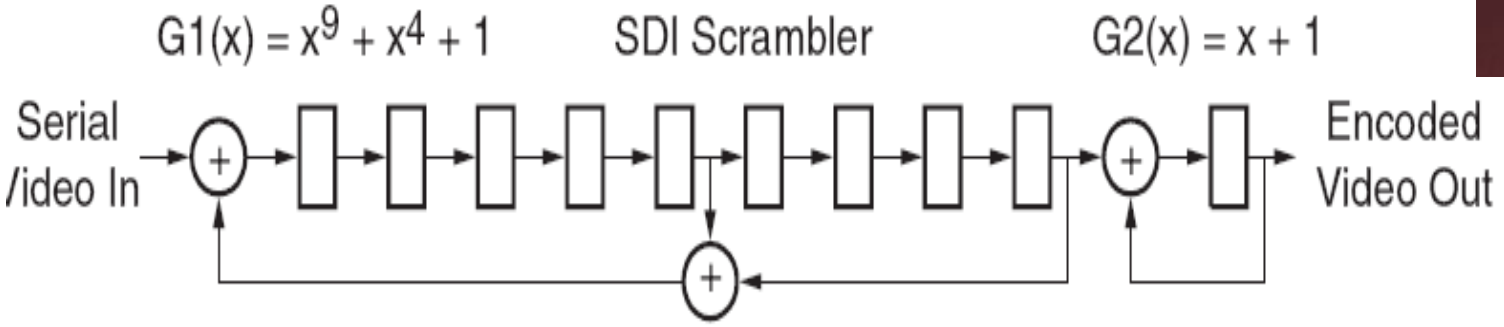
Coaxial cable (SD, HD), 75 Ohms, 800 – 30 mV, up to 300 m , BNC

Optical Cable (HD)

Uncompressed digital component signal

SD-SDI 4:2:2, 270 Mb/s (360 MB/s), Cb Y Cr Y Cb …,

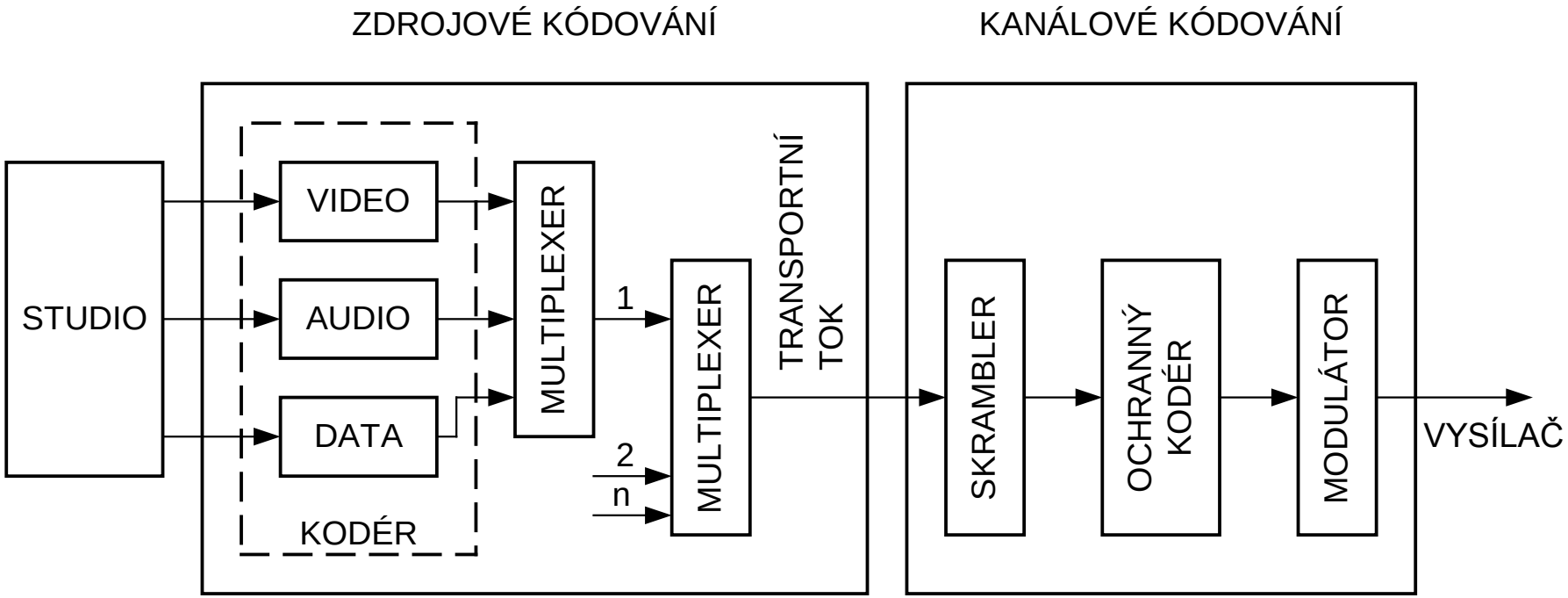
HD-SDI Dual Link: - Y,Y, … ; a C_b , C_r , C_b ..



Ancillary data: **Embedded audio** - přenos zvukového signálu,
EDH (Error Detection and Handling) - měření chyb přenosu,
VPID (Video Payload Identifier) - formátu videosignálu.

DVB – Digital Video Broadcasting

Projekt evropské digitální televize, od 1993



MPEG-2

H.264, **H.265**

DVB

DVB - S, T, C

DVB – S2,T2,C2

That´s all Folks.