ROHDE&SCHWARZ

BROADCASTING DIVISION

Application Note

The digital Video Standard according to ITU-R BT. 601/656

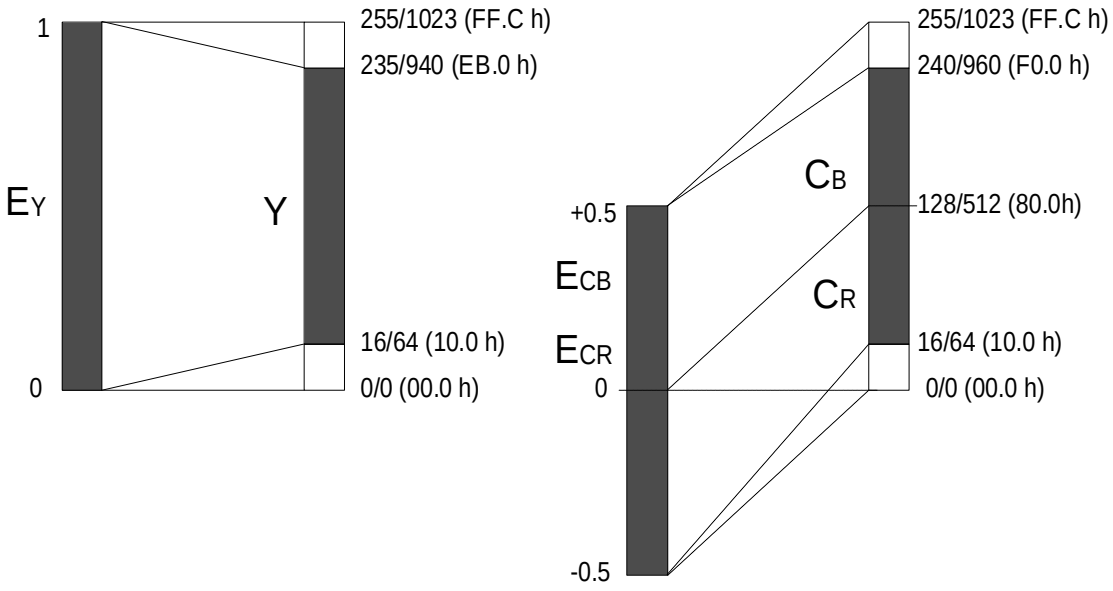
Products:

CCVS+COMPONENT GENERATOR	***SAF***
CCVS GENERATOR	***SFF***
DIGITAL VIDEO COMPONENT ANALYSER	***VCA***

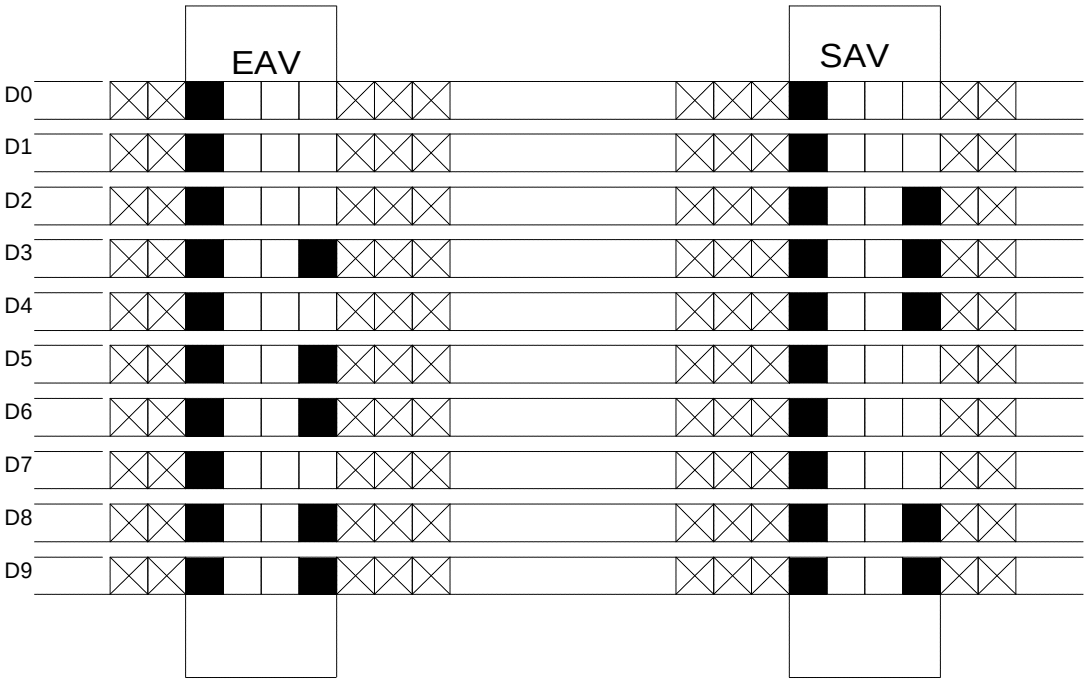
7BM19_0E

ITU-R BT. 601

Leveldiagram at the input of an A/D converter for the analogue component signals Y , C_B , C_R



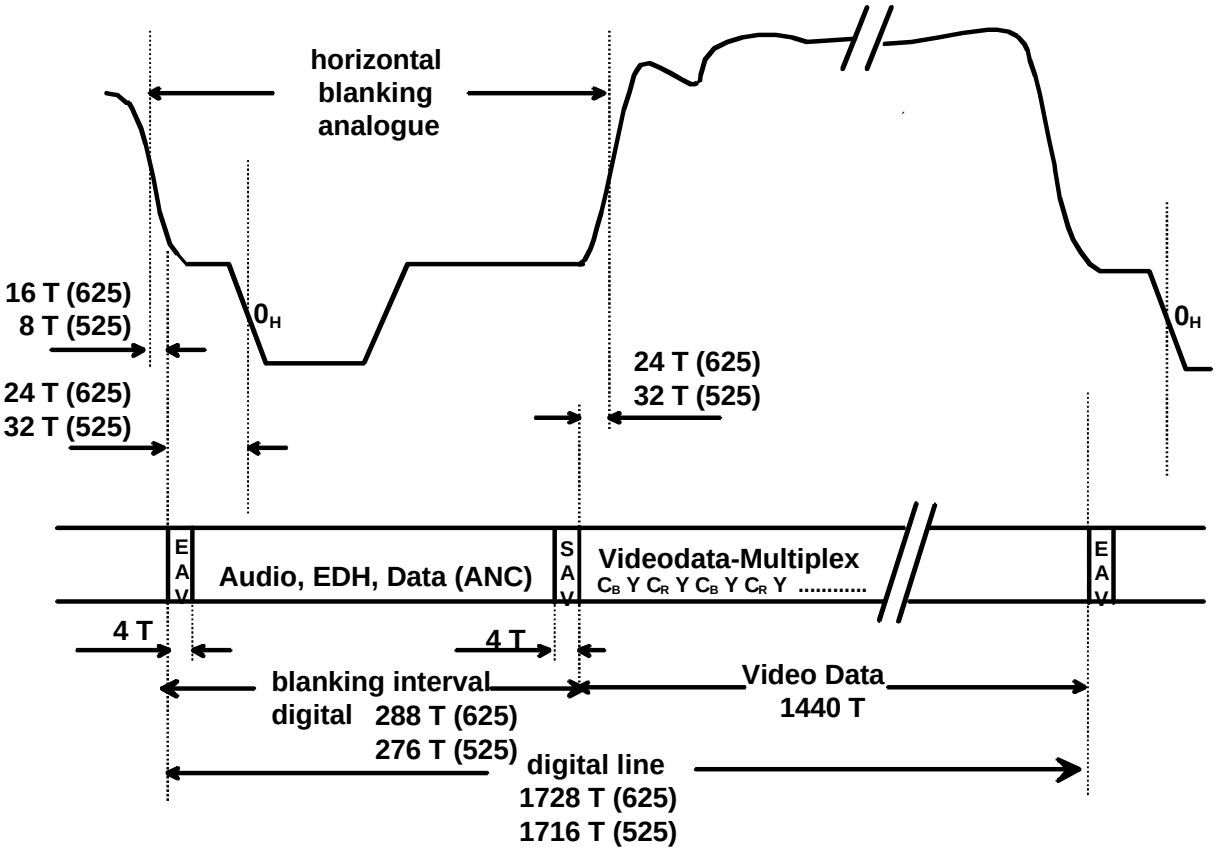
Example for digital synchronizing signals in the parallel interface (10 bit)



black points indicate the value 1 , white points 0
XY within EAV is DA.0 (11011010 00)
XY within SAV is C7.0 (1100011100) this significates
this line an active one in an even field

ITU-R BT. 601

Data format and timing relationship with the analogue video signal



ITU-R BT. 601

structure of digital synchronizing signals

code word		bit number 9	8	7	6	5	4	3	2	1	0
first word	(FF.C)	1	1	1	1	1	1	1	1	1	1
second word	(00.0)	0	0	0	0	0	0	0	0	0	0
third word	(00.0)	0	0	0	0	0	0	0	0	0	0
fourth word	(XY.0)	1	F	V	H	P3	P2	P1	P0	0	0

F = 0 first field
F = 1 second field
V = 0 or 1 (in VBI)
H = 0 in SAV
H = 1 in EAV
P0, P1, P2, P3 see table of control bits

Table of values for V, F in VBI

interval to be marked			line number	
			system 525/60	system 625/50
digital vertical blanking interval				
field 1	start	(V=1)	1	624
	end	(V=0)	10	23
field2	start	(V=1)	264	311
	end	(V=0)	273	336
digital field				
field 1	start	(F=0)	4	1
field 2	start	(F=1)	266	313

The values of V and F change within the transmission of the EAV signal at the start of each digital line.
The line numbers count according to ITU-R BT. 470; the number of the digital line changes at the reference point 0_H.

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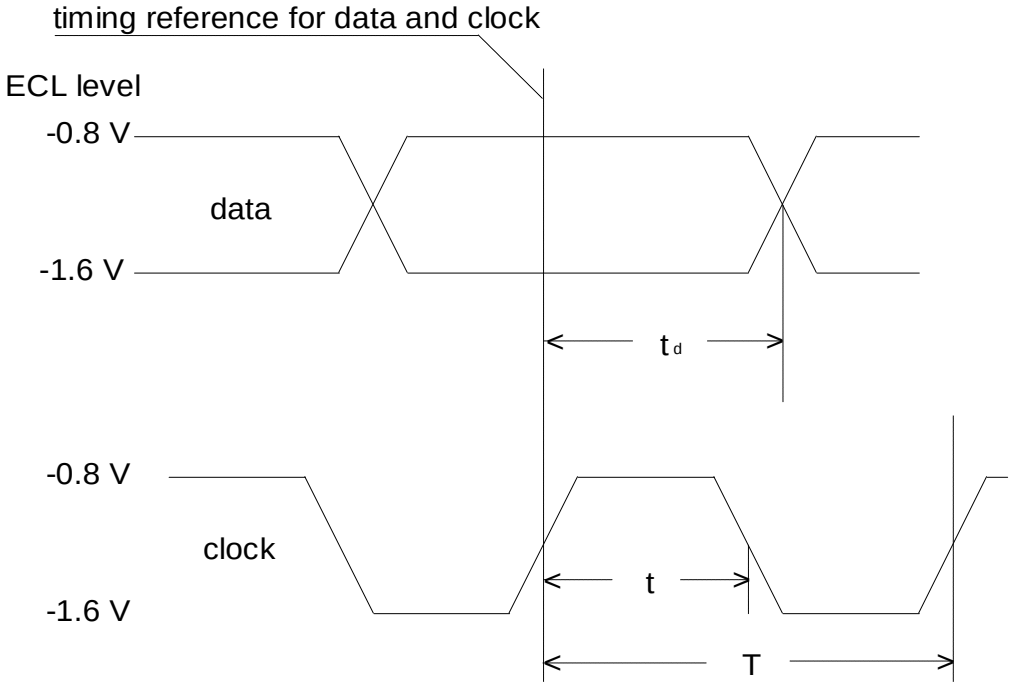
Table of controlbits

const.	F	V	H	P3	P2	P1	P0	const.	const.	XY.0	level dec.			
1	0	0	0	0	0	0	0	0	0	80.0	128.0	1st field	active picture	SAV
1	0	0	1	1	1	0	1	0	0	9D.0	151.0			EAV
1	0	1	0	1	0	1	1	0	0	AB.0	171.0		VBI	SAV
1	0	1	1	0	1	1	0	0	0	B6.0	182.0			EAV
1	1	0	0	0	1	1	1	0	0	C7.0	199.0	2nd field	active picture	SAV
1	1	0	1	1	0	1	0	0	0	DA.0	218.0			EAV
1	1	1	0	1	1	0	0	0	0	EC.0	236.0		VBI	SAV
1	1	1	1	0	0	0	1	0	0	F1. 0	241.0			EAV

Signal Timing and Levels (parallel interface)



Clock-to-data Timing (at source)

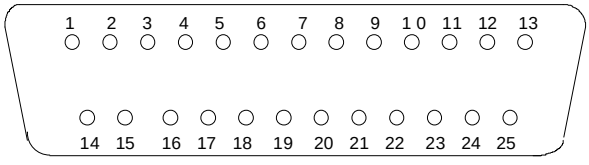
clock period (625): $T = 1/ (1728 \times f_H) = 37.037$ ns
clock period (525): $T = 1/ (1716 \times f_H) = 37.037$ ns
clock pulse width: $t = 18.52 \pm 3$ ns
data timing - sending end: $t_d = 18.5 \pm 3$ ns
f_H = line frequency

variation of data timing - sending end in SAF and SFF : 18.5 ± 10 ns

Connector contact assignments

The connector's contacts, numbered in the standard manner depicted below must be assigned in accordance with the following table

Contact	Assignment	Contact	Assignment
1	clock	14	clock return
2	system ground	15	system ground
3	data 9 (MSB)	16	data 9 return
4	data 8	17	data 8 return
5	data 7	18	data 7 return
6	data 6	19	data 6 return
7	data 5	20	data 5 return
8	data 4	21	data 4 return
9	data 3	22	data 3 return
10	data 2	23	data 2 return
11	data 1	24	data 1 return
12	data 0	25	data 0 return
13	chassis ground		



Connector containing male pins (plug)

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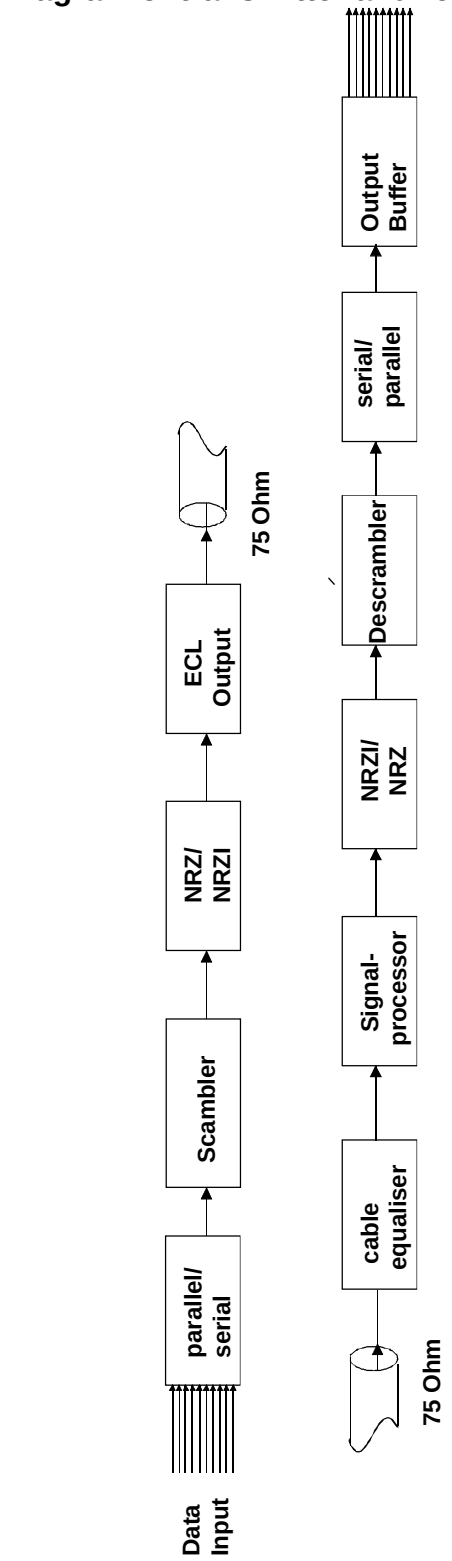
Serial System Parameters

ITEM	4 : 2 : 2 (D1)	4 x f_{SC} PAL (D2)	4 x f_{SC} NTSC (D2)
total bit rate Mb / s	270.0	177.3	143.2
resolution	10 (8) bit / word		
channel coding	scrambled NRZI by $G(x) = (x^9 + x^4 + 1) (x + 1)$		
serial sync word	3FF, 000, 000 hex (10 bit)		
order of transmission	LSB first		
nominal signal level	800 mV ± 10% (terminated)		
code limitation	000 through 003 and 3FC through 3FF shall not appear in any data words		

ITU-R BT. 601

serial 270 Mbit / sec

Diagram of transmitter and receiver line



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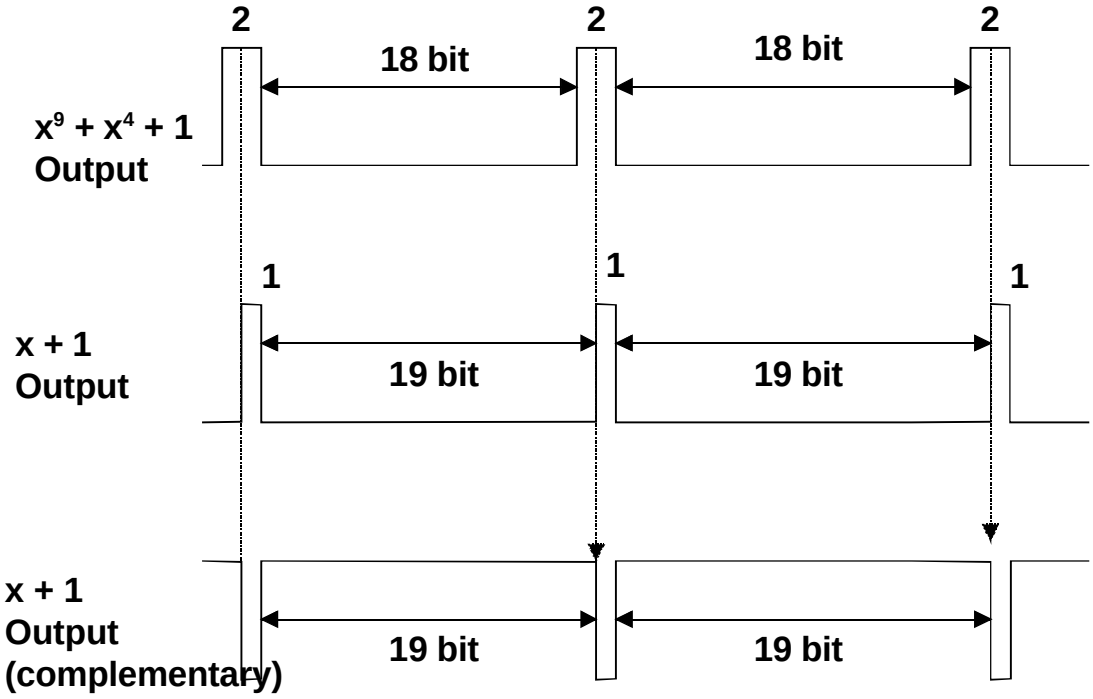
serial 270 Mbit / sec

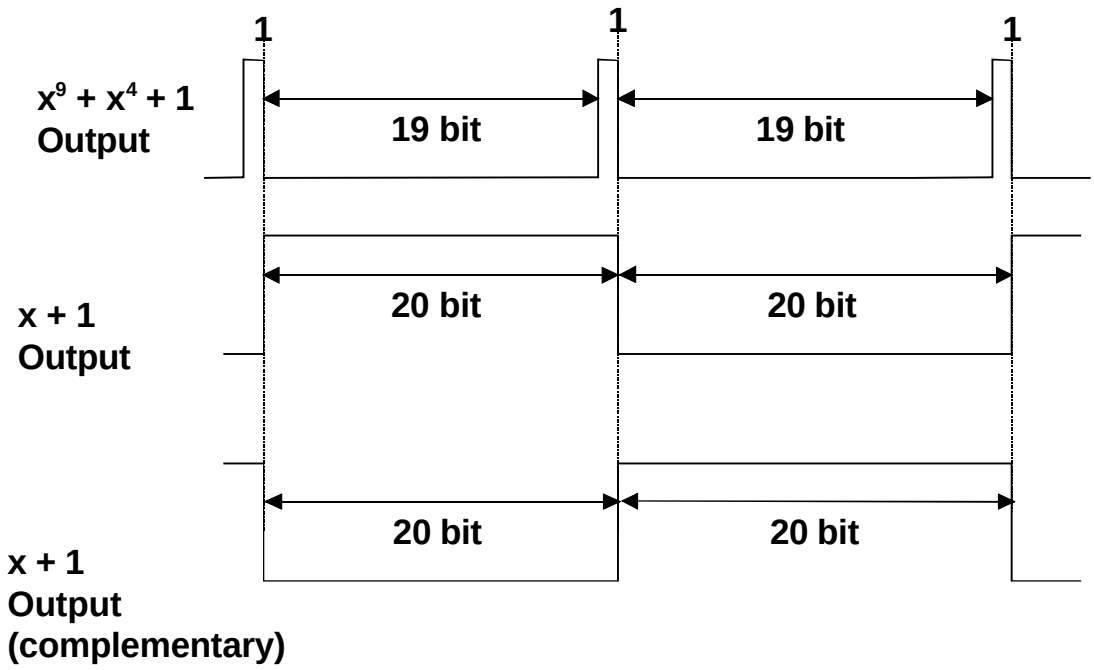
Pathological Signals for 10 bit Serial Interface



Signal for Testing the Cable Equaliser

serial 270 Mbit /sec

Pathological Signals for 10 bit Serial Interface



Signal for Testing the PLL in the Receiver

ITU-R BT. 601

SAF / SFF Signalgroup ITU-R BT. 601 (Option)

Signaloverview
according to ITU-R BT. 801

CCIR 601	
1 GREY LEVEL	21 PATHOL.SIGNAL Y=088h C=100h
2 ALTERNATING BLACK/WHITE	22 PATHOL.SIGNAL Y=044h C=080h
3 EOL PULSE	23 PATHOL.SIGNAL Y=022h C=040h
4 BLACK/WHITE	24 PATHOL.SIGNAL Y=011h C=020h
5 RAMP YELLOW/GREY	25 PATHOL.SIGNAL Y=008h C=210h
6 RAMP GREY BLUE	26 PATHOL.SIGNAL Y=198h C=108h
7 RAMP CYAN GREY	27 PATHOL.SIGNAL Y=004h C=300h
8 RAMP GREY RED	28 PATHOL.SIGNAL Y=0CCh C=180h
9 RAMP CB Y CR Y	29 PATHOL.SIGNAL Y=066h C=0C0h
10 EOL BAR WHITE	30 PATHOL.SIGNAL Y=033h C=060h
11 EOL BAR BLUE	31 PATHOL.SIGNAL Y=019h C=230h
12 EOL BAR RED	32 PATHOL.SIGNAL Y=00Ch C=318h
13 EOL BAR YELLOW	33 PATHOL.SIGNAL Y=006h C=18Ch
14 EOL BAR CYAN	34 DIG.COL.BARS 100/0/100/0
15 SEQUENCE 1010	35 DIG.COL.BARS 100/0/75/0
16 SEQUENCE 11001100	36 RAMP Y
17 SEQUENCE 111000111000	37 RAMP Y CB CR
18 SDI CHECK FIELD	38 RAMP CB

19 PATHOL.SIGNAL Y=198h C=300h	39 RAMP CR
20 PATHOL.SIGNAL Y=110h C=200h	

Pathological Signals

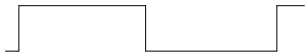
1. Pathological Signals for Cable Equalizers in the Serial Digital Interface

Possible word combinations to generate a stress pattern for cable equalization

. No.	Hex		Validity	
	chroma 1st sample	luminance 2nd sample	4 : 2 : 2 D1 10 bit	8 bit
1	200 h	331 h	yes	no
2	300 h	198 h	yes	yes
3	180 h	0CC h	yes	yes
4	0C0 h	066 h	yes	no
5	060 h	033 h	yes	no
6	230 h	019 h	yes	no
7	318 h	0CC h	yes	yes
8	18C h	006 h	yes	no

2. Pathological Signals for Genlock of PLL in the Serial Digital Interface

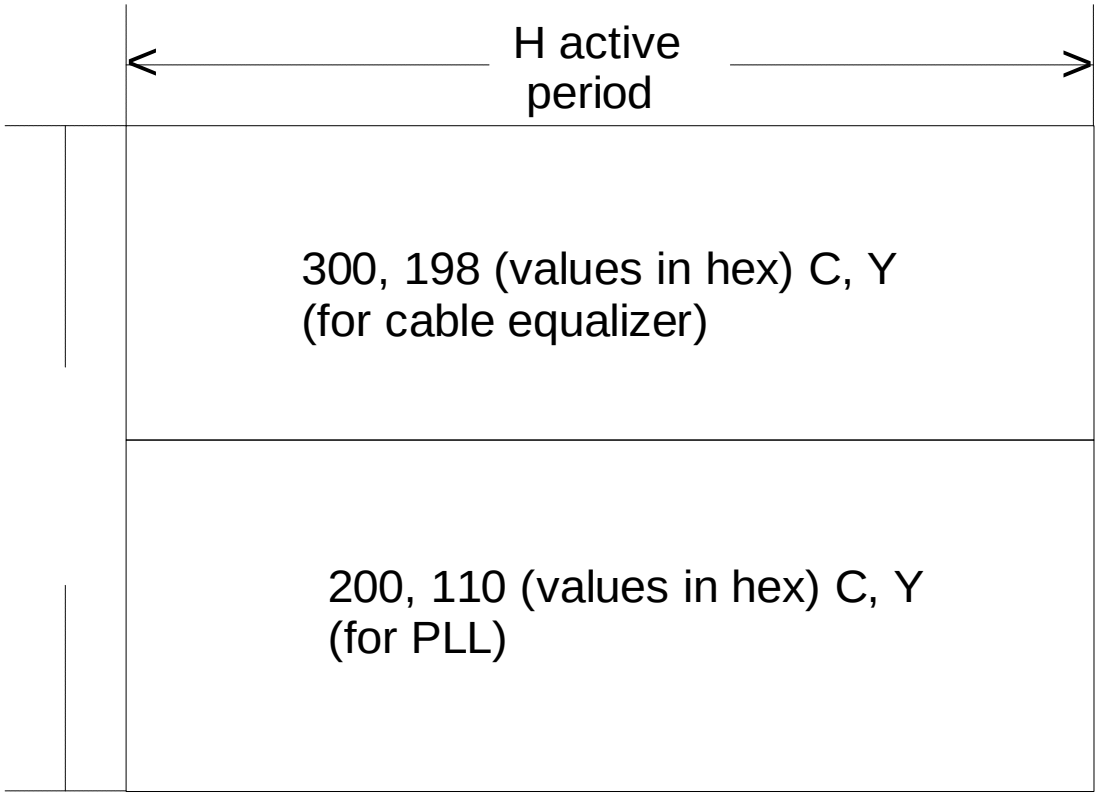
Possible word combinations to generate a stress pattern for genlock of PLL



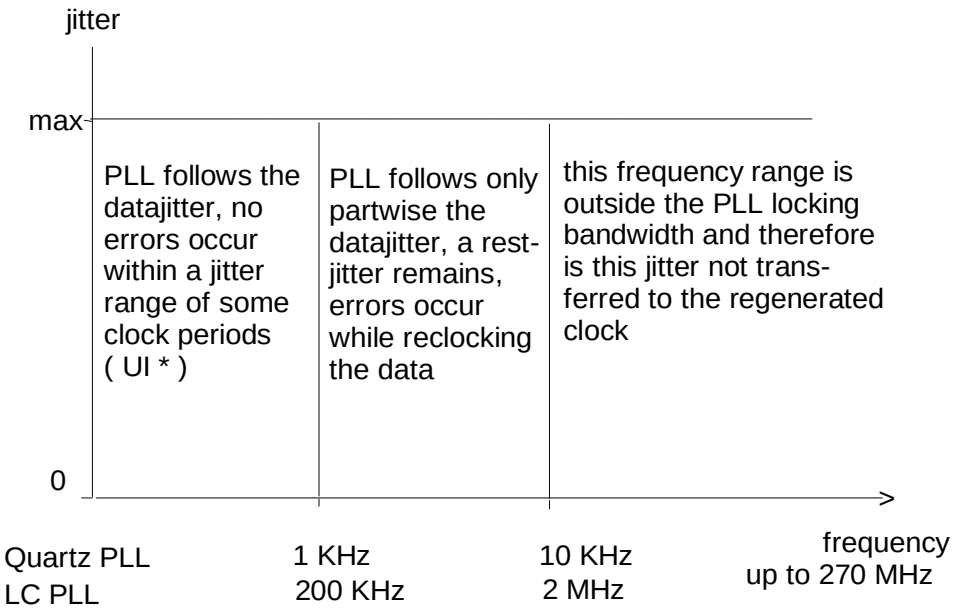
. No.	Hex		Validity	
	chroma 1st sample	luminance 2nd sample	4 : 2 : 2 D1 10 bit	8 bit
1	200 h	110 h	yes	yes
2	100 h	088 h	yes	yes
3	080 h	044 h	yes	yes
4	040 h	022 h	yes	no
5	020 h	011 h	yes	no
6	210 h	008 h	yes	yes
7	108 h	004 h	yes	yes

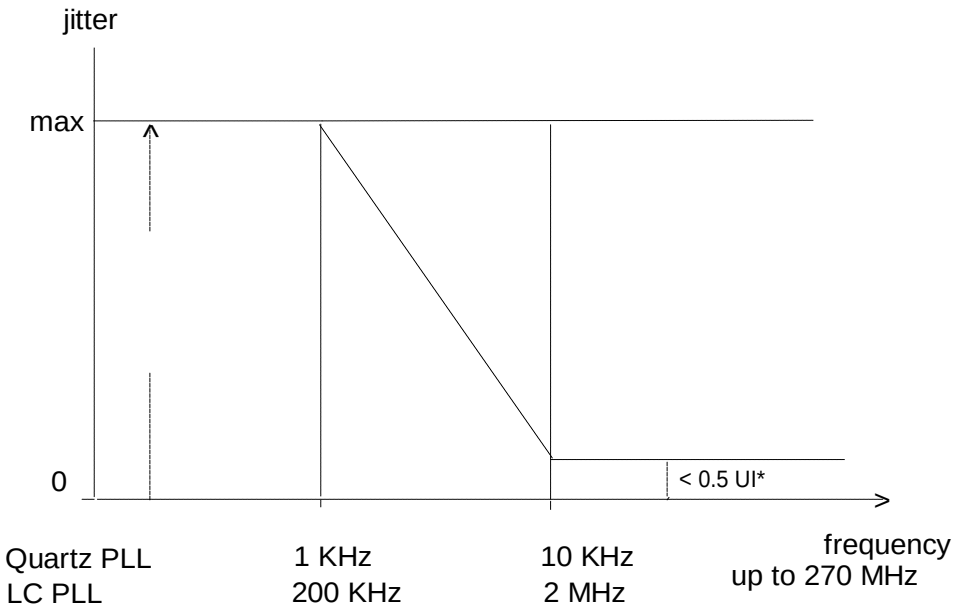
ITU-R BT. 601

SDI Check Pattern
(serial digital interface)



Jitter of a Serial Digital Interface Signal





* UI = Unit Interval (clock period), at 270 Mbit/s 1UI = 3.7 ns

ITU-R BT. 601

Technical Data for Option S.F - Z1

Standard	ITU-R BT. 601 / 656 (4:2:2) SMPTE 125M / 259 M
Systems	625 lines/50 Hz and 525 lines/60 Hz
Signals	according to ITU-R BT. 801 pathological signals for SDI all SAF/SFF signals
Parallel output	27 Msamples/sec
level	ECL level
rise/fall time (20/80%)	< 5 ns
clockpulse width	18.5 ns ± 3ns
delay clock/data	18.5 ns ± 3 ns
clock/data shifting	± 10 ns
connector	25 pin SUB D (ISO 2110 - 1980)
Serial output	270 Mbit / sec acc. D1 format
level	V_{PP} = 800 mV ± 10% @ 75 Ω
rise/fall time (20/80%)	0.75....1.5 ns
output impedance	75Ω
return loss	≥ 15 dB within 10... 270 MHz
connector	BNC

ITU-R BT. 601

The SAF/SFF option "CCIR 601" has advanced possibilities:

- parallel and two serial outputs
  with 8 / 10 bit resolution and
  27 Msamples / sec and 270 Mbit / sec

- the 10 th bit has additional funktion in all three components Y, Cb, Cr :

  - toggle bit for quantization noise measuring
  - settable to 0 or 1 for measuring the scaling factor mV / LSB

- adjustable rise / fall times of signaltransitions allow precise measurement of luma / chroma delay

- output and variation in amplitude, timing and phase of all SAF / SFF testsignals
  (testpatterns, ZONE PLATES, linearities...)
  including the self generated ones

- special ITU-R BT. 601 testsignals are

  - signals according to ITU-R BT. 801
  - all pathlogical signals

- no PC needed for changing the signals´

  - amplitude in Y, Cb, Cr independently from eachother
  - timing with the PHASE/TIME menu or using features of SIGNAL EDIT

  So you are able to test DSP machines (trick mixers, frame stores ...) also at the limits of the system.

- the amplitude limits are
  - max. 254 dec / FE hex for 8 bit
    1019 dec / 3FB hex for 10 bit
  - min. 1 dec / 01 hex for 8 bit
    4 dec / 04 hex for 10 bit

- editing the H frequency allows changing the number of auxilliary data between EAV and SAV to check the sychronizing digital equipment.

- the onscreen comparision of the digital signal and the composite or component signal shows immediately defects and differences of the DSP

- the vertical blanking interval (VBI) is not influenced by the coding according to ITU-R BT. 601; the inserted VITS are part of the digital data. This is most useful for testing the influence of DSP in digital machines in the VBI.