

## One-chip PAL decoder and RGB matrix

TDA8391

## FEATURES

- A black-current stabilizer which controls the black currents of the three electron guns
- Contrast and brightness control of inserted RGB signals
- Self aligned oscillator
- Capacitive coupling with black level clamping of the luminance, colour difference and RGB inputs
- Equal black levels for internal TV and external signals
- 12 MHz bandwidth
- Emitter follower outputs for driving the RGB output stages

## GENERAL DESCRIPTION

The TDA8391 is a one-chip PAL colour decoder which is designed to be used in combination with the P2CCD Delay Line (TDA8451A) and the Filter Combination (TDA8452A or TDA8453). The device combines the circuits that are required for the identification and demodulation of pulse signals, RGB matrixing and amplification. Inductive components are not required due to the integration of the filters and the delay lines. The TDA8391 provides a crystal-precise reference signal for the clock generator circuits in TDA8451A and TDA8452A/8453; therefore, no adjustments are required to the filters and delay times.

The TDA8391 is functionally identical to the TDA8390, it has the same pinning and its application is almost identical.

## QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_P$	positive supply voltage (pin 23)		10.8	12	13.2	V
$I_P$	positive supply current (pin 23)		55	70	100	mA
$V_{25(p-p)}$	luminance input voltage (peak-to-peak value)		–	0.45	–	V
$C_{CR}$	contrast control range (pin 7)		–	20	–	dB
$V_{30(p-p)}$	chrominance input voltage (peak-to-peak value)		–	465	–	mV
$V_{26(p-p)}$	demodulator output voltages (pins 26 and 27) (peak-to-peak value) –(R-Y) (peak-to-peak value)		0.55	0.65	0.77	V
$V_{27(p-p)}$	–(B-Y) (peak-to-peak value)		0.70	0.82	0.97	V
$S_{CR}$	saturation control range (pin 6)		50	–	–	dB
$V_{21(p-p)}$	colour difference input signals –(R-Y) (peak-to-peak value)		–	0.65	–	V
$V_{22(p-p)}$	–(B-Y) (peak-to-peak value)		–	0.82	–	V
$V_{14,16,18(p-p)}$	RGB input signal for an output signal of 4 V black-to-white at nominal contrast (peak-to-peak value)		–	0.7	0.8	V
$V_9$	video switching	external RGB	0.9	–	–	V
$V_{13,15,17(p-p)}$	RGB output voltage at nominal luminance input and nominal contrast; black-to-white (peak-to-peak value)		3.5	4.0	4.5	V
$B_{CR}$	brightness control range (pin 5)		–	±1.3	–	V

## ORDERING INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
TDA8391	32	DIL	plastic	SOT201

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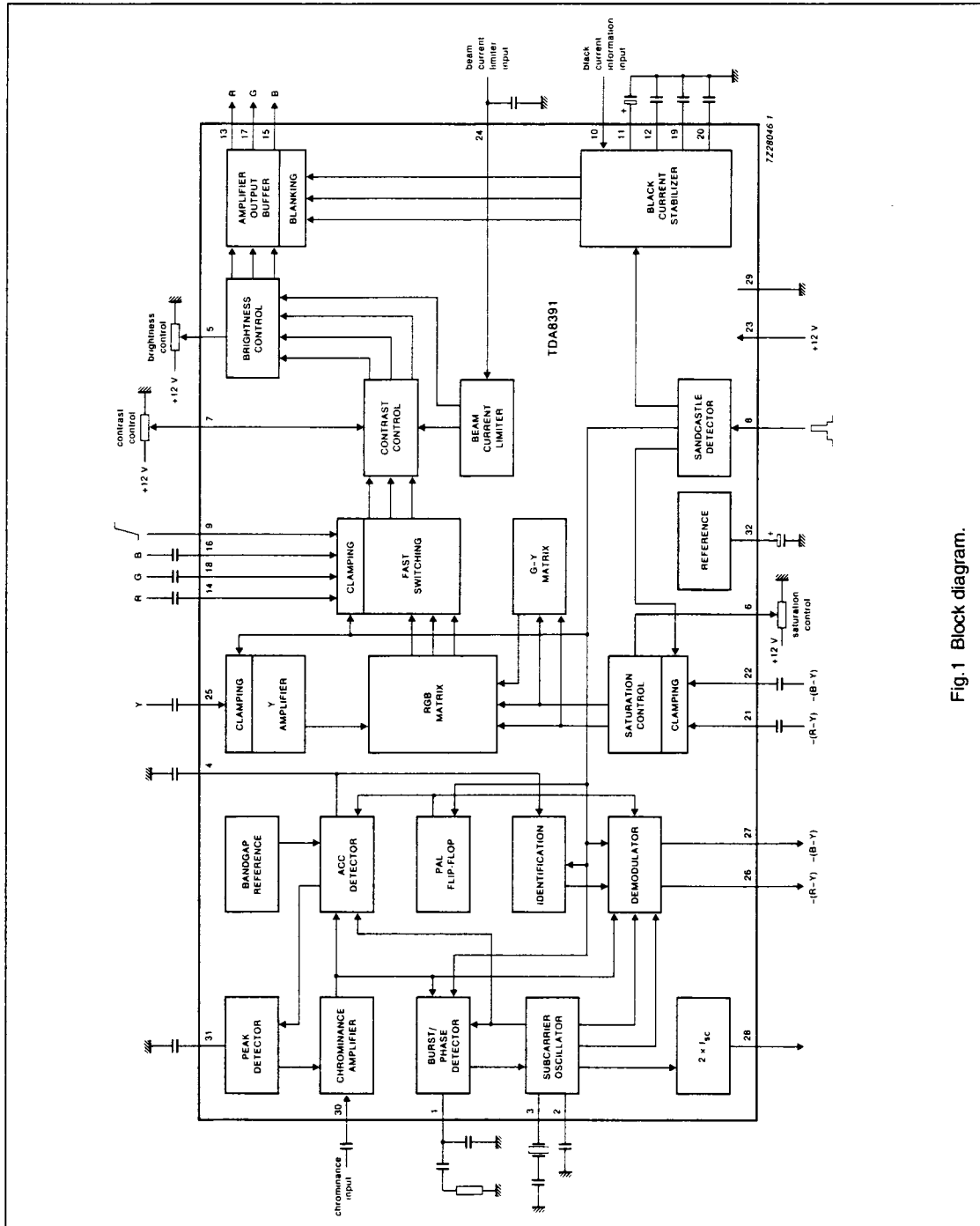
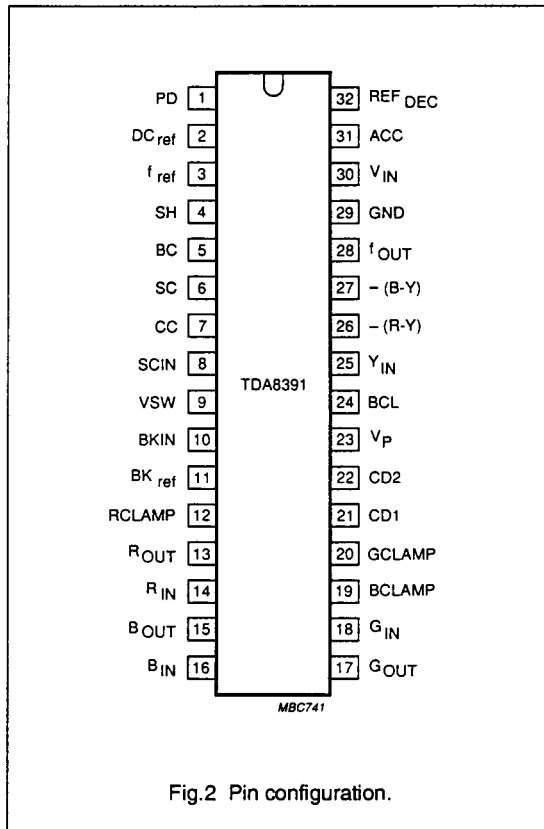


Fig. 1 Block diagram.

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## PINNING

SYMBOL	PIN	DESCRIPTION
PD	1	phase detector
DC <sub>ref</sub>	2	90° phase shift DC reference
f <sub>ref</sub>	3	4.43 MHz PAL reference frequency input
SH	4	sample-and-hold (PAL identification)
BC	5	brightness control
SC	6	saturation control
CC	7	contrast control
SCIN	8	sandcastle pulse input
VSW	9	video switch input
BKIN	10	black current input
BK <sub>ref</sub>	11	black current reference
RCLAMP	12	red clamping circuit
ROUT	13	red signal output
RIN	14	red insertion input
BOUT	15	blue signal output
BIN	16	blue insertion input
GOUT	17	green signal output
GIN	18	green insertion input
BCLAMP	19	blue clamping circuit
GCLAMP	20	green clamping circuit
CD1	21	-(R-Y) colour difference input
CD2	22	-(B-Y) colour difference input
V <sub>P</sub>	23	positive supply voltage
BCL	24	beam current limiter input
YIN	25	luminance input
-(R-Y)	26	-(R-Y) signal output
-(B-Y)	27	-(B-Y) signal output
f <sub>OUT</sub>	28	frequency doubler output
GND	29	ground
VIN	30	chrominance input
ACC	31	automatic colour control
REF <sub>DEC</sub>	32	reference decoupling

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## FUNCTIONAL DESCRIPTION

## Colour decoder

The input chrominance signal is amplified and applied to the burst phase detector (reference signal R-Y phase), the ACC and identification detector (reference signal  $\pm(R-Y)$  phase) and the two demodulators. The burst phase detector controls the oscillator which operates at a frequency of 4.43 MHz. By connecting pin 6 to 12 V, the free-running frequency of the oscillator can be adjusted (phase detector and colour killer switched off). The gain control stage of the oscillator is biased in such a way that sinewave signals are generated. The output from the oscillator is fed to a Miller integrator in order to obtain the required 90° phase shift. The reference signals obtained from the oscillator and 90° phase shift network are applied to the various demodulators.

The output signal from the ACC and identification detector is peak detected to generate the ACC voltage and detected in a sample and hold circuit to obtain the identification and killer information.

Because the P<sup>2</sup>CCD filter combination (TDA8452A/8453) requires a reference signal ( $2 \times f_{sc}$ ) the oscillator frequency is doubled, internally, and is made available at pin 28.

The demodulated signals, with the correct amplitude ratio, are applied to the TDA8451A. The TDA8391 can be combined with the SECAM decoder TDA8490 (Fig.4) by direct connection of their outputs. The output DC levels have been chosen so that the PAL decoder has priority (output level during PAL is higher than output level during SECAM).

## Control circuit

The luminance and colour difference signals together with the RGB inputs and fast switching pulse form the inputs to the control circuit. The required luminance input signal (from TDA8452A/8453) has a peak-to-peak value of 0.45 V (including sync). The colour difference input signals (from TDA8451A) have a negative phase with a 0.72 V  $-(R-Y)$  and 0.93 V  $-(B-Y)$  peak-to-peak value. After amplification, the luminance signal is applied to the RGB matrix.

The colour difference signals are fed to the saturation control circuit before being applied to the RGB matrix (the G-Y signal is generated after the saturation control circuit).

The normal matrix for PAL is:

$$(G-Y) = -0.51 -(R-Y) -0.19 -(B-Y).$$

The signals from the RGB matrix are applied to a fast switching circuit from where external RGB signals can be selected. The fast switching circuit is controlled by the video switching input. After amplification the RGB signals (internal or external video) are controlled on the contrast and brightness before being fed to the outputs. A typical output signal amplitude is 4 V black-to-white (nominal controls).

The black level of the RGB output signals is determined by the black current stabilization circuit. The information regarding the black current level of the picture tube is obtained in the same manner as the TDA3562A. The beam current limiter input is used to reduce the output signal amplitude via the contrast and brightness control circuits.

A block diagram is given in Fig.1. Figure 3 illustrates the PAL decoder configuration and Figure 4 the PAL-SECAM configuration. Figures 5, 6 and 7 illustrate the Saturation, Contrast and Brightness control curves respectively.

## LIMITING VALUES

In accordance with the Absolute Maximum System (IEC134)

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V <sub>23</sub>	positive supply voltage		-	13.2	V
P <sub>tot</sub>	total power dissipation		-	1.5	W
T <sub>amb</sub>	operating ambient temperature range		-25	+70	°C
T <sub>stg</sub>	storage temperature range		-25	+150	°C

## THERMAL RESISTANCE

SYMBOL	PARAMETER	THERMAL RESISTANCE
R <sub>th ja</sub>	from junction to ambient in free air	40 K/W

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**CHARACTERISTICS** $V_p = 12\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; all voltages are referenced to ground (pin 29) unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supply</b>						
$V_{23}$	positive supply voltage		10.8	12.0	13.2	V
$I_{23}$	supply current		55	70	100	mA
$P_{tot}$	total power dissipation		–	0.85	–	W
<b>DEMODULATOR PART</b>						
CHROMINANCE AMPLIFIER (PIN 30)						
$V_{30(p-p)}$	input signal amplitude (peak-to-peak value)	note 1	–	465	–	mV
$V_{30(p-p)}$	input signal amplitude before clipping occurs in the input stage (peak-to-peak value)		–	–	1100	mV
$V_{30(p-p)}$	minimum burst signal amplitude within the ACC control range (–1 dB) (peak-to-peak value)		30	–	–	mV
$R_{30}$	input resistance		9	12	15	k $\Omega$
$C_{30}$	input capacitance		–	–	4	pF
$CR_{ACC}$	ACC control range		30	–	–	dB
$\Delta V_o$	change in amplitude of the output signals (pins 26 and 27) over the ACC range		–	+1	$\pm 1.5$	dB
<b>REFERENCE PART</b>						
PHASE LOCKED LOOP						
$\Delta f$	catching range	note 2	$\pm 450$	–	–	Hz
$\Delta\Phi$	phase shift for $\pm 400\text{ Hz}$ deviation of the oscillator frequency	note 2	–	–	5	deg
OSCILLATOR (PIN 3)						
$TC_{osc}$	temperature coefficient of the oscillator frequency	note 2	–	–2	–	Hz/K
$\Delta f$	frequency deviation for a supply voltage change from 10 V to 13.2 V	note 2	–	40	–	Hz
$R_3$	input resistance (pin 3)		400	650	900	$\Omega$
$C_3$	input capacitance (pin 3)		–	–	6	pF

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## CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
ACC AND IDENTIFICATION DETECTORS (PINS 4 AND 31)						
$V_4$	voltage at the PAL identification output pin 4					
	nominal input signal for PAL without burst input		–	5.0	–	V
			–	2.9	–	V
$V_4$	colour OFF voltage		–	3.3	–	V
$V_4$	colour ON voltage		–	3.5	–	V
$V_{31}$	voltage at peak detector output (pin 31)					
	voltage at nominal input signal voltage without input signal		–	5.8	–	V
			–	2.7	–	V
DEMODULATORS (PINS 26 AND 27)						
$V_{26(p-p)}$	output signal amplitude $-(R-Y)$ output (peak-to-peak value) (pin 26)		0.54	0.65	0.76	V
$V_{27(p-p)}$	output signal amplitude $-(B-Y)$ output (peak-to-peak value) (pin 27)		0.68	0.82	0.97	V
$V_{26,27}$	ratio of amplification of both demodulators $G-(B-Y)/G-(R-Y)$		1.6	1.78	1.96	
$t_d$	internal delay between chrominance input and $-(R-Y)/-(B-Y)$ output		140	200	260	ns
f	frequency response between 0 and 1 MHz		–	–3	–	dB
$R_{26,27}$	output resistance (pins 26 and 27)		–	100	–	$\Omega$
$V_{26,27}$	output DC level when a PAL signal is identified		–	8.3	–	V
$V_{26,27}$	output level during killing		–	1.3	–	V
	unwanted signals at $-(R-Y)$ and $-(B-Y)$ outputs	note 3	–	–	–40	dB
$V_{26,27(p-p)}$	4.4 MHz residual carrier at the $-(R-Y)$ and $-(B-Y)$ outputs (peak-to-peak value)		–	–	10	mV
$V_{26,27(p-p)}$	8.8 MHz + harmonics residual carrier at the $-(R-Y)$ and $-(B-Y)$ outputs (peak-to-peak value)		–	–	20	mV
$V_{26(p-p)}$	H/2 ripple at $-(R-Y)$ output without input signal (peak-to-peak value)		–	–	50	mV

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$\Delta V/\Delta T$	change in amplitude $-(R-Y/B-Y)$ with temperature		-	-0.1	-	%/K
$\Delta V/\Delta V$	change in amplitude for a supply voltage change from 10.8 V to 13.2 V		-	-	$\pm 0.3$	dB
FREQUENCY DOUBLER OUTPUT (PIN 28)						
$V_{28(p-p)}$	output signal amplitude (peak-to-peak value)		200	300	-	mV
$R_{28}$	output resistance		-	50	-	$\Omega$
$V_{28}$	DC output level		-	4.5	-	V
REFERENCE DECOUPLING (PIN 32)						
$V_{32}$	DC level		-	9.0	-	V
CONTROL PART						
LUMINANCE INPUT (PIN 25)						
$V_{25(p-p)}$	input voltage (peak-to-peak value)	note 4	-	0.45	-	V
$V_{25(p-p)}$	input voltage before clipping occurs (peak-to-peak value)		-	-	0.8	V
$I_{25}$	input current		-	0.1	1	$\mu A$
f	frequency response of the total luminance and RGB amplifier circuits between 0 and 12 MHz		-	-3	-	dB
COLOUR DIFFERENCE INPUT SIGNALS (PINS 21 AND 22)						
$V_{21(p-p)}$	input signal amplitude $-(R-Y)$ (peak-to-peak value) (pin 21)		-	0.65	-	V
$V_{22(p-p)}$	input signal amplitude $-(B-Y)$ (peak-to-peak value) (pin 22)		-	0.82	-	V
$I_{21,22}$	input current (pins 21 and 22)		-	-	0.2	$\mu A$
RGB INPUTS (PINS 14, 16 AND 18) (NOTE 5)						
$V_{14,16,18(p-p)}$	input signal amplitude for an output signal of 4 V black-to-white at nominal contrast (peak-to-peak value)	notes 6 and 7	-	0.7	0.8	V
$\Delta V_{13,15,17}$	difference between the black level of the RGB signals and the black level of the inserted signals at the outputs		-	-	100	mV
f	frequency response of RGB amplifier between 0 and 12 MHz		-	-2	-	dB
$t_d$	delay difference for the three channels		-	0	-	ns

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
RGB INPUTS (PINS 14, 16 AND 18) (NOTE 5)						
$I_{14,16,18}$	input current		–	–	10	$\mu\text{A}$
VIDEO SWITCHING (PIN 9)						
$V_9$	input voltage	no insertion	–	–	0.3	V
		insertion of external RGB	0.9	–	4.0	V
$t_d$	switching delay		–	–	50	ns
$R_9$	input resistance		8	10	12	$\text{k}\Omega$
	suppression of the internal RGB signals with reference to 4 V(p-p) at the RGB outputs	$V_9 > 0.9 \text{ V}$ ; 0 to 5 MHz	46	50	–	dB
	suppression of the external RGB signals with reference to 4 V(p-p) at the RGB outputs	$V_9 < 0.3 \text{ V}$ ; 0 to 5 MHz	40	–	–	dB
SANDCASTLE INPUT (PIN 8)						
$V_8$	detection level for:					
	vertical blanking		1.0	1.5	2.0	V
	horizontal blanking		3.0	3.5	4.0	V
	upper part of pulse		6.5	7.0	7.5	V
$I_8$	input current	$V_1 = 0 \text{ to } 1.5 \text{ V}$	–	–0.4	–0.5	mA
		$V_1 = 1.5 \text{ to } 3.5 \text{ V}$	–	–13	–	$\mu\text{A}$
		$V_1 = 3.5 \text{ to } 7.0 \text{ V}$	–	–3.3	–	$\mu\text{A}$
		$V_1 = 7.0 \text{ to } 12 \text{ V}$	–	–0.1	–	$\mu\text{A}$
$t_d$	internal delay between black level clamping and burst gating pulse (leading edge)		1.5	2.0	2.5	$\mu\text{s}$
SATURATION CONTROL INPUT (PIN 6); (SEE FIG.5)						
SC	saturation control range		50	–	–	dB
$I_6$	input current saturation control	$V_6 < 4.5 \text{ V}$	–	–	10	$\mu\text{A}$
$R_6$	input resistance	$V_6 = 4.5 \text{ to } 6 \text{ V}$	–	10	–	$\text{k}\Omega$
		$V_6 = 6 \text{ to } 12 \text{ V}$	–	7	–	$\text{k}\Omega$
CONTRAST CONTROL INPUT (PIN 7); (SEE FIG.6)						
CC	contrast control range		–	20	–	dB
	tracking of contrast control between the three channels over a control range of 10 dB		–	0.3	1.0	dB
$I_7$	input current contrast control	$V_7 < 6 \text{ V}$	–	–	10	$\mu\text{A}$
$R_7$	input resistance	$V_7 > 6 \text{ V}$	–	10	–	$\text{k}\Omega$



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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
BRIGHTNESS CONTROL INPUT (PIN 5); (SEE FIG.7)						
$V_5$	brightness control voltage range	note 8	–	±1.3	–	V
$I_5$	input current brightness control		–	–	–50	µA
Colour difference matrices						
	G-Y/R-Y		–	–0.51	±10%	
	G-Y/B-Y		–	–0.19	±25%	
RGB amplifiers (pins 13 15 17)						
$V_{13,15,17(p-p)}$	output signal amplitude at nominal luminance input and nominal contrast; black-to-white (peak-to-peak value)	notes 1 and 6	3.5	4.0	4.5	V
$V_{15(p-p)}$	output signal amplitude for the blue channel at nominal contrast and saturation and no luminance signal at the input (pin 15) (peak-to-peak value)		4.3	5.4	6.5	V
$V_{max}$	maximum peak white level		10.0	10.5	11.0	V
$\Delta V_{13,15,17}$	difference in black level between the three outputs at nominal brightness	note 9	–	20	100	mV
	control range of black current stabilization at V black = 3 V and nominal brightness control		–	–	±2	V
$\Delta V$	black level shift with picture content		–	–	40	mV
$V_{13,15,17}$	output voltage during the 4L pulse after switch-ON		7.0	7.5	8.0	V
$\Delta V/\Delta T$	variation of black level with temperature		–	1.0	–	mV/K
$\Delta V$	variation of black level over contrast range at nominal saturation		–	–	100	mV
$\Delta V$	variation of black level over saturation range at nominal contrast		–	–	50	mV
	relative spread between the three output signals		–	–	10	%

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>RGB amplifiers (pins 13 15 17)</b>						
$V_b$	relative variation in black level between the three channels during variations of the following conditions: supply voltage $\pm 10\%$ at nominal controls contrast (20 dB) at nominal saturation saturation (50 dB) at nominal contrast brightness ( $\pm 1$ V) at nominal controls	note 8	–	–	100	mV
$\Delta V$	differential drift of the black level over a temperature range of 40 K	note 8	–	50	70	mV
$V_{bl}$	blanking level at the RGB outputs		–	1.0	–	V
$\Delta bl$	difference in blanking level of the three channels		–	0	10	mV
$\Delta V/\Delta T$	differential drift of the blanking levels over a temperature range of 40 K		–	0	10	mV
$(\Delta V_{bl} + V_{bl}) \times (V_p + \Delta V_p)$	tracking of the output black levels with supply voltage		0.9	1.0	1.1	
S/N	signal-to-noise ratio of output signals	note 3	–	60	–	dB
$R_{13,15,17}$	output resistance		–	150	–	$\Omega$
$I_{13,15,17}$	available output current		5	–	–	mA
$I_o$	current source at output stage		–	2.5	–	mA
<b>BLACK CURRENT STABILIZATION (PIN 10)</b>						
$V_{10}$	DC bias voltage		3.5	5.0	7.0	V
$\Delta V$	difference between input voltage for black current and leakage current		0.35	0.5	0.65	V
$I_{10}$	input current during black current		–	–	1	$\mu A$
$I_{10}$	input current during scan		–	–	10	mA
$V_{10}$	internal limiting level		8.5	9.0	9.5	V
$V_{10}$	switching threshold for black current control ON		7.6	8.0	8.4	V
$R_{10}$	input resistance during scan		1.0	1.5	2.0	k $\Omega$

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## CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
BLACK CURRENT STABILIZATION (PIN 10)						
$I_{12,19,20}$	DC input current during scan at pins 12, 19 and 20		–	–	50	nA
$I_{11,12,19,20}$	maximum charge/discharge current during measuring time of clamping pulse at pins 11, 12, 19 and 20		0.3	–	–	mA
BEAM CURRENT LIMITER (PIN 24)						
$V_{24}$	voltage when beam current limiter function is not active	note 9	5.0	6.0	–	V
$V_{24}$	trigger level for beam current limiter function		3.8	4.2	4.6	V

## Notes to the characteristics

1. The value indicated is a signal for a colour bar with 75% saturation (chrominance/burst ratio = 2.2 : 1).
2. All frequency variations are referred to 4.43 MHz carrier frequency and to the Philips 4.43 MHz crystal catalogue number 4322 143 04043. The specification is given for nominal crystal parameters. However, the load capacitance is fixed at a standard value of 18 pF for these crystal series.
3. The ratio between unwanted and wanted signals (e.g. crosstalk, phase errors and noise) is specified as the output signal amplitude (peak-to-peak value at nominal conditions) with respect to the RMS value of the unwanted signal.
4. Signal with negative going sync. Amplitude includes sync pulse amplitude.
5. When not used pins 14, 16 and 18 should be connected to ground via a 100 nF capacitor; pin 9 may be left open-circuit or connected to ground
6. Nominal contrast is specified as maximum contrast –3 dB. Nominal saturation as maximum saturation –6 dB.
7. Maximum input on pins 14, 16 and 18 is 1V(p-p).
8. With respect to the measuring pulse.
9. With respect to the measuring pulse. At nominal brightness the black level of an output is identical to the measuring level.
10. Pin 24 is connected internally to a high-resistance voltage divider (2 x 100 k $\Omega$ ).

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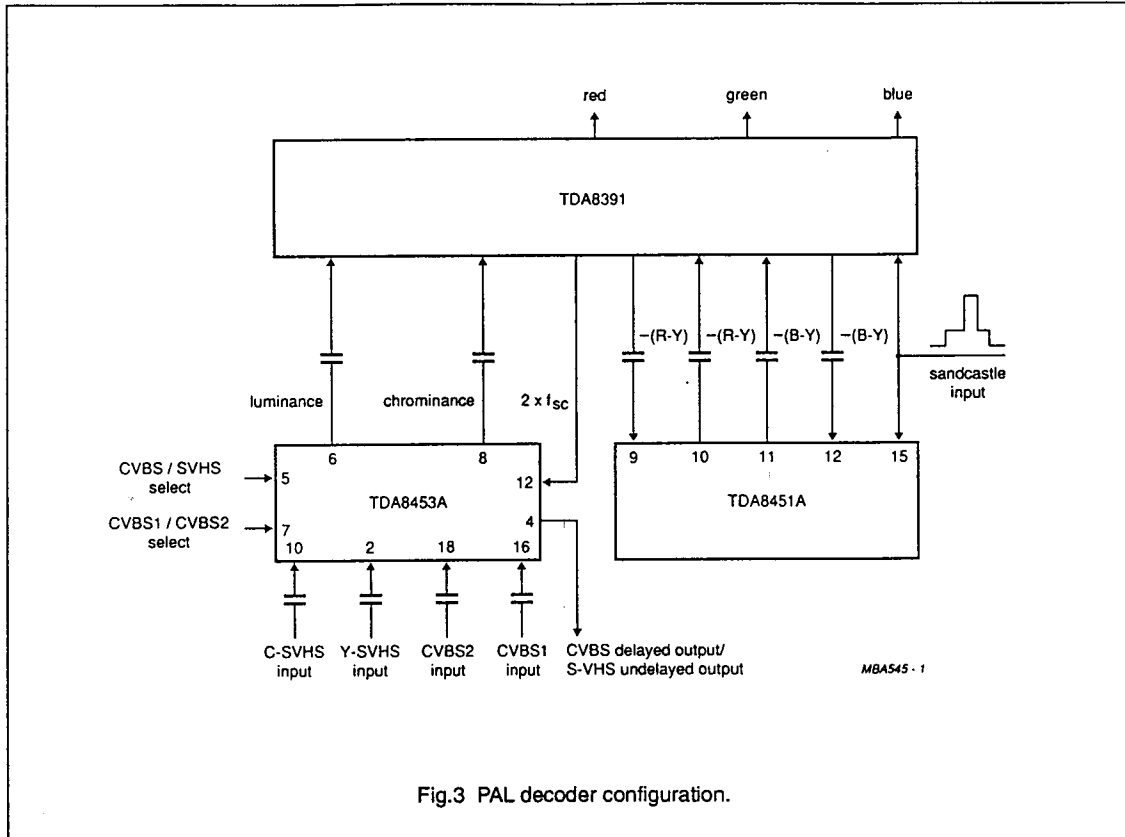


Fig.3 PAL decoder configuration.

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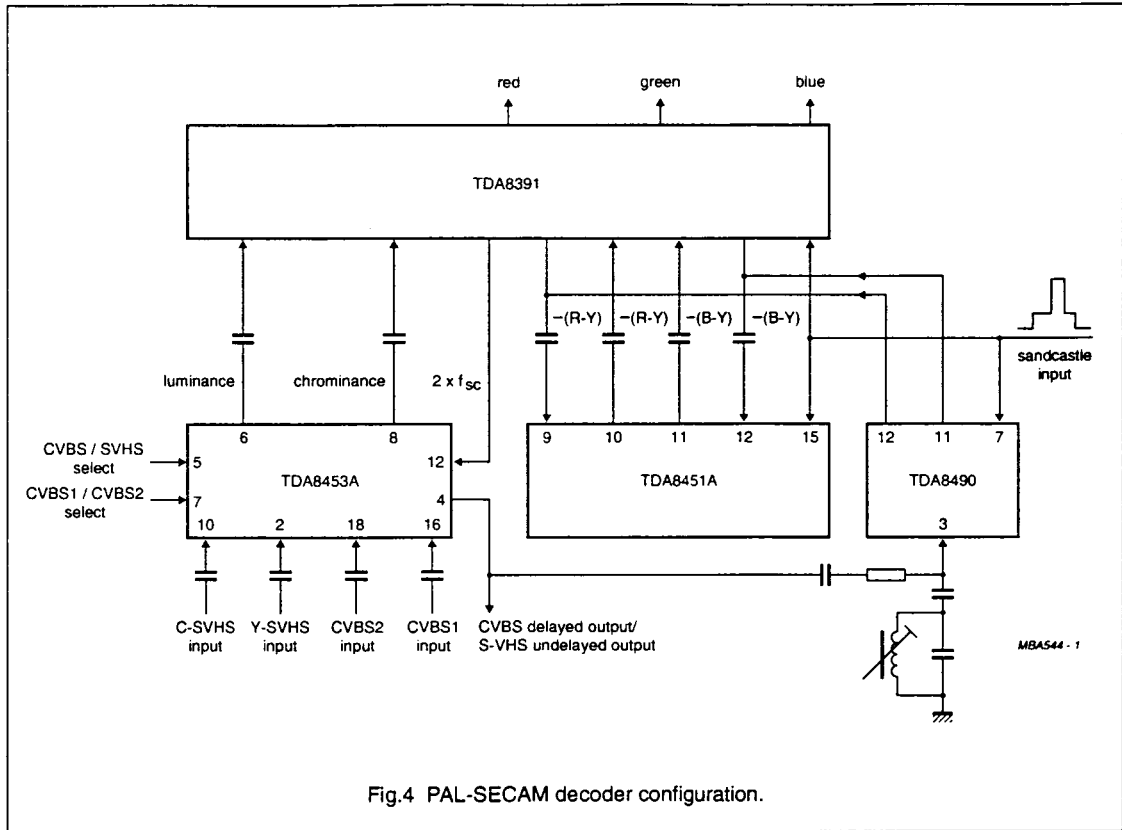


Fig.4 PAL-SECAM decoder configuration.

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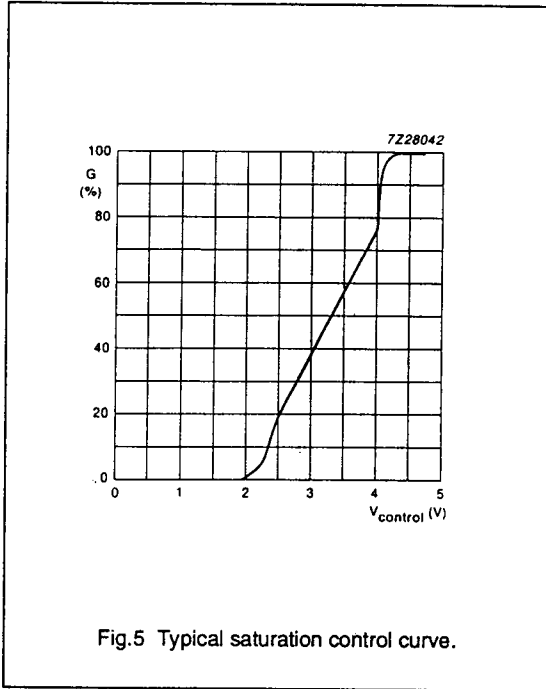


Fig.5 Typical saturation control curve.

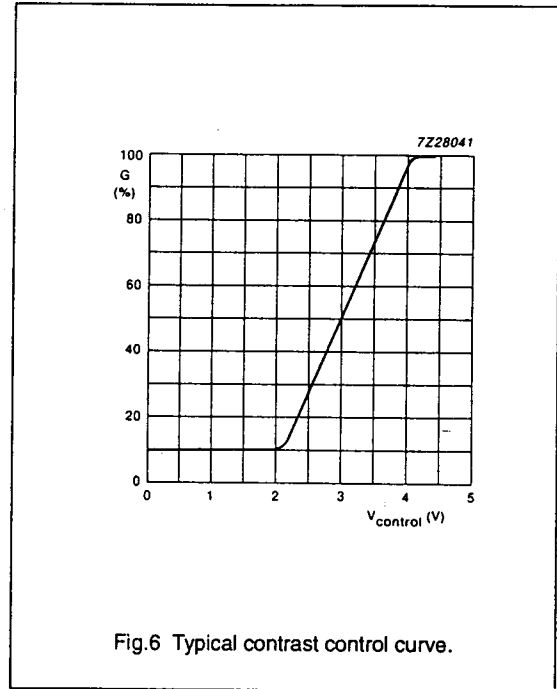
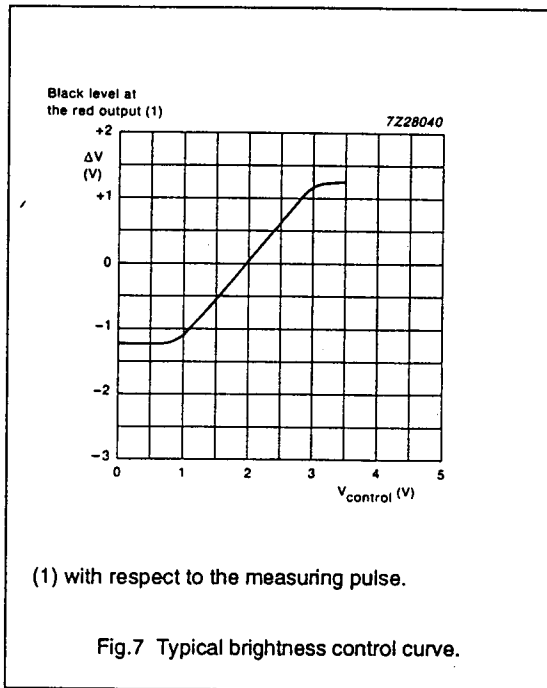


Fig.6 Typical contrast control curve.



(1) with respect to the measuring pulse.

Fig.7 Typical brightness control curve.

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APPLICATION INFORMATION

