

# DATA SHEET

## **TDA8771A**

Triple 8-bit video Digital-to-Analog  
Converter (DAC)

Product specification  
File under Integrated Circuits, IC02

1996 Jan 25

## Triple 8-bit video Digital-to-Analog Converter (DAC)

## TDA8771A

### FEATURES

- 8-bit resolution
- Sampling rate up to 35 MHz
- Internal reference voltage regulator
- No deglitching circuit required
- Large output voltage range
- 1 k $\Omega$  output load
- Power dissipation only 200 mW
- Single 5 V power supply
- 44-pin QFP package.

### GENERAL DESCRIPTION

The TDA8771A is a triple 8-bit video Digital-to-Analog Converter (DAC). It converts the digital input signals into analog voltage outputs at a maximum conversion rate of 35 MHz.

The DACs are based on resistor-string architecture with integrated output buffers. The output voltage range is determined by a built-in reference source.

The device is fabricated in a 5 V, CMOS process that ensures high functionality with low power dissipation.

### APPLICATIONS

- General purpose high-speed digital-to-analog conversion
- Digital TV
- Graphic display
- Desktop video processing.

### QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V <sub>DDA</sub>	analog supply voltage		4.5	5.0	5.5	V
V <sub>DDD</sub>	digital supply voltage		4.5	5.0	5.5	V
I <sub>DDA</sub>	analog supply current	R <sub>L</sub> = 1 k $\Omega$ ; note 1	10	33	45	mA
I <sub>DDD</sub>	digital supply current	f <sub>clk</sub> = 35 MHz	–	7	20	mA
INL	integral non-linearity	f <sub>clk</sub> = 35 MHz; ramp input	–	±0.5	±1	LSB
DNL	differential non-linearity	f <sub>clk</sub> = 35 MHz; ramp input	–	±0.25	±0.5	LSB
f <sub>clk(max)</sub>	maximum clock frequency		35	–	–	MHz
P <sub>tot</sub>	total power dissipation	R <sub>L</sub> = 1 k $\Omega$ ; f <sub>clk</sub> = 35 MHz; note 1	45	200	360	mW

### Note

1. Minimum and maximum data of current and power consumption are measured in worse case conditions: for minimum data, all digital inputs are at logic level 0 while for maximum data, all digital inputs are at logic level 1.

### ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA8771AH	QFP44	plastic quad flat package; 44 leads (lead length 1.3 mm); body 10 × 10 × 1.75 mm	SOT307-2

# Triple 8-bit video Digital-to-Analog Converter (DAC)

## TDA8771A

### BLOCK DIAGRAM

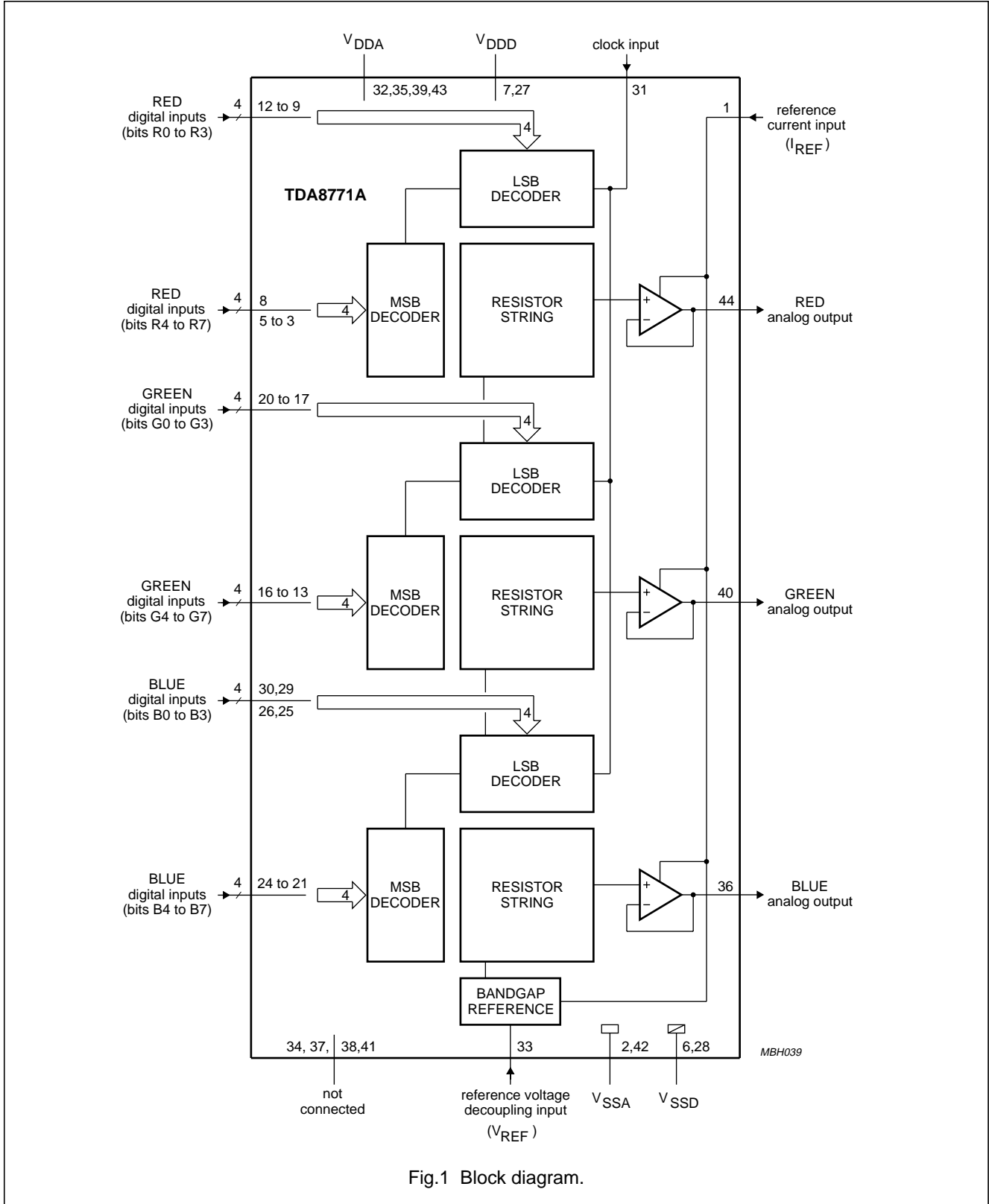


Fig.1 Block diagram.

# Triple 8-bit video Digital-to-Analog Converter (DAC)

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## PINNING

SYMBOL	PIN	DESCRIPTION
I <sub>REF</sub>	1	reference current input for output buffers
V <sub>SSA1</sub>	2	analog supply ground 1
R7	3	RED digital input data; bit 7 (MSB)
R6	4	RED digital input data; bit 6
R5	5	RED digital input data; bit 5
V <sub>SSD1</sub>	6	digital supply ground 1
V <sub>DDD1</sub>	7	digital supply voltage 1
R4	8	RED digital input data; bit 4
R3	9	RED digital input data; bit 3
R2	10	RED digital input data; bit 2
R1	11	RED digital input data; bit 1
R0	12	RED digital input data; bit 0 (LSB)
G7	13	GREEN digital input data; bit 7 (MSB)
G6	14	GREEN digital input data; bit 6
G5	15	GREEN digital input data; bit 5
G4	16	GREEN digital input data; bit 4
G3	17	GREEN digital input data; bit 3
G2	18	GREEN digital input data; bit 2
G1	19	GREEN digital input data; bit 1
G0	20	GREEN digital input data; bit 0 (LSB)
B7	21	BLUE digital input data; bit 7 (MSB)
B6	22	BLUE digital input data; bit 6
B5	23	BLUE digital input data; bit 5
B4	24	BLUE digital input data; bit 4
B3	25	BLUE digital input data; bit 3
B2	26	BLUE digital input data; bit 2
V <sub>DDD2</sub>	27	digital supply voltage 2
V <sub>SSD2</sub>	28	digital supply ground 2
B1	29	BLUE digital input data; bit 1
B0	30	BLUE digital input data; bit 0 (LSB)
CLK	31	clock input
V <sub>DDA1</sub>	32	analog supply voltage 1
V <sub>REF</sub>	33	decoupling input for reference voltage
n.c.	34	not connected
V <sub>DDA2</sub>	35	analog supply voltage 2
OUTB	36	BLUE analog output
n.c.	37	not connected
n.c.	38	not connected
V <sub>DDA3</sub>	39	analog supply voltage 3
OUTG	40	GREEN analog output

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SYMBOL	PIN	DESCRIPTION
n.c.	41	not connected
V <sub>SSA2</sub>	42	analog supply ground 2
V <sub>DDA4</sub>	43	analog supply voltage 4
OUTR	44	RED analog output

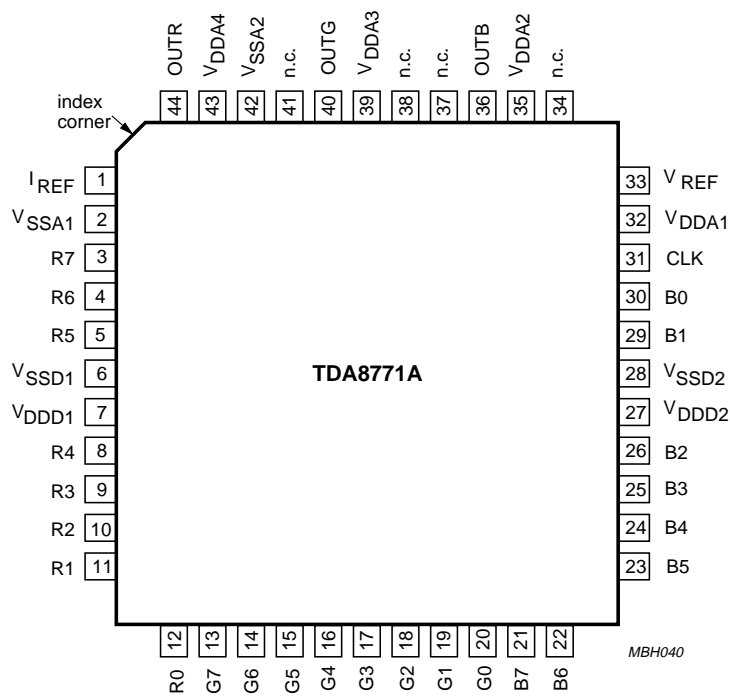


Fig.2 Pin configuration.

# Triple 8-bit video Digital-to-Analog Converter (DAC)

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## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC134).

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
$V_{DDA}$	analog supply voltage	-0.5	+6.5	V
$V_{DDD}$	digital supply voltage	-0.5	+6.5	V
$\Delta V_{DD}$	supply voltage difference between $V_{DDA}$ and $V_{DDD}$	-1.0	+1.0	V
$T_{stg}$	storage temperature	-55	+150	°C
$T_{amb}$	operating ambient temperature	0	+70	°C
$T_j$	junction temperature	-	+125	°C

## THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j-a}$	thermal resistance from junction to ambient in free air	75	K/W

## HANDLING

Inputs and outputs are protected against electrostatic discharges in normal handling. However, to be totally safe, it is desirable to take normal precautions appropriate to handling integrated circuits.

# Triple 8-bit video Digital-to-Analog Converter (DAC)

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## CHARACTERISTICS

$V_{DDA} = V_{DDD} = 4.5$  to  $5.5$  V;  $V_{SSA}$  and  $V_{SSD}$  shorted together;  $V_{DDA} - V_{DDD} = -0.5$  to  $+0.5$  V;  $T_{amb} = 0$  to  $70$  °C; typical values measured at  $V_{DDA} = V_{DDD} = 5$  V and  $T_{amb} = 25$  °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Supply</b>						
$V_{DDA}$	analog supply voltage		4.5	5.0	5.5	V
$V_{DDD}$	digital supply voltage		4.5	5.0	5.5	V
$I_{DDA}$	analog supply current	$R_L = 1$ k $\Omega$ ; note 1	10	33	45	mA
$I_{DDD}$	digital supply current	$f_{clk} = 35$ MHz	–	7	20	mA
<b>Inputs</b>						
CLOCK INPUT (PIN 31)						
$V_{IL}$	LOW level input voltage		0	–	1.2	V
$V_{IH}$	HIGH level input voltage		2.0	–	$V_{DDD}$	V
R, G, B DIGITAL INPUTS (PINS 12 TO 8, 5 TO 3, 20 TO 13, 30, 29 AND 26 TO 21)						
$V_{IL}$	LOW level input voltage		0	–	1.2	V
$V_{IH}$	HIGH level input voltage		2.0	–	$V_{DDD}$	V
$I_{REF}$ REFERENCE CURRENT INPUT FOR OUTPUT BUFFERS (PIN 1)						
$I_I$	input current		–	0.6	0.7	mA
<b>Timing; see Fig.3</b>						
$f_{clk(max)}$	maximum clock frequency		35	–	–	MHz
$t_{CPH}$	clock pulse width HIGH		8	–	–	ns
$t_{CPL}$	clock pulse width LOW		8	–	–	ns
$t_r$	clock rise time		–	–	5	ns
$t_f$	clock fall time		–	–	6	ns
$t_{SU;DAT}$	input data set-up time		4	–	–	ns
$t_{HD;DAT}$	input data hold time		4	–	–	ns
<b>Voltage reference (pin 33, referenced to <math>V_{SSA}</math>)</b>						
$V_{REF}$	output reference voltage		1.180	1.242	1.305	V
<b>Outputs</b>						
OUTB, OUTR, OUTG ANALOG OUTPUTS (PINS 36, 44 AND 40, REFERENCED TO $V_{SSA}$ ) FOR 1 k $\Omega$ LOAD; see Table 1						
FSR	full-scale output voltage range		2.80	2.95	3.10	V
$V_{os}$	offset of analog voltage output		–	0.25	–	V
$V_{Omax}$	maximum output voltage	data inputs = logic 1; note 2	2.95	3.20	3.45	V
$V_{Omin}$	minimum output voltage	data inputs = logic 0; note 2	0.05	0.25	0.45	V
THD	total harmonic distortion	$f_i = 4.43$ MHz; $f_{clk} = 35$ MHz	–	–44	–	dB
$Z_L$	output load impedance		0.9	1.0	1.1	k $\Omega$

# Triple 8-bit video Digital-to-Analog Converter (DAC)

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SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Transfer function (<math>f_{clk} = 35</math> MHz)</b>						
INL	integral non-linearity	ramp input	–	0.5	$\pm 1$	LSB
DNL	differential non-linearity	ramp input	–	0.25	$\pm 0.5$	LSB
$\alpha_{ct}$	crosstalk DAC to DAC		–50	–	–	dB
	DAC to DAC matching		–	1.0	2.0	%
<b>Switching characteristics (for 1 k<math>\Omega</math> output load); see Fig.4</b>						
$t_d$	input to 50% output delay time	full-scale change	–	12	–	ns
$t_{s1}$	settling time	10% to 90% of full-scale change	–	15	–	ns
$t_{s2}$	settling time	to $\pm 1$ LSB	–	50	–	ns
<b>Output transients (glitches)</b>						
$V_g$	area for 1 LSB change		–	1	–	LSB·ns

**Notes**

1. Minimum and maximum data of current and power consumption are measured in worse case conditions: for minimum data, all digital inputs are at logic level 0 while for maximum data, all digital inputs are at logic level 1.
2.  $V_O$  is directly proportional to  $V_{REF}$ .

**Table 1** Input coding and DAC output voltages (typical values)

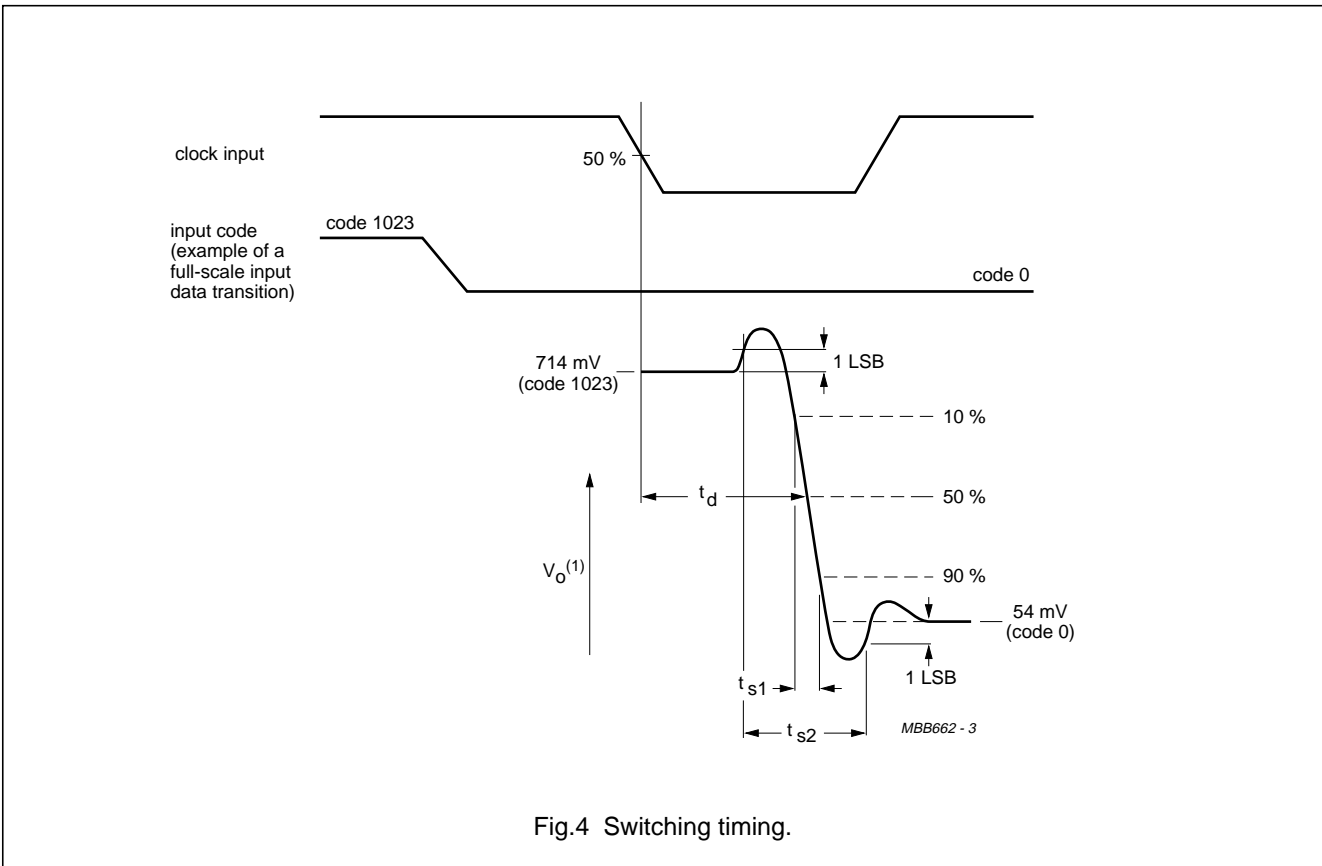
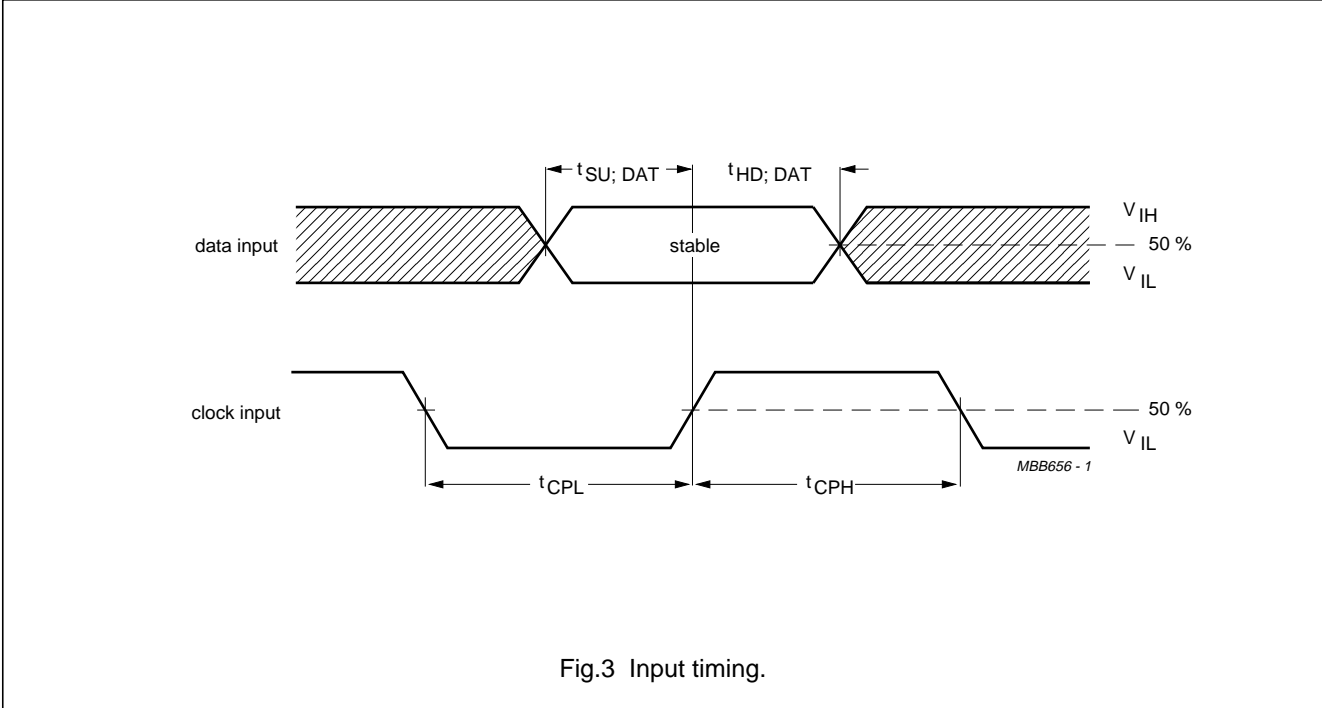
BINARY INPUT DATA (SYNC = BLANK = 0)	CODE	DAC OUTPUT VOLTAGES (V) OUTB, OUTR, OUTG $R_L = 1$ k $\Omega$
0000 0000	0	0.262
0000 0001	1	0.273
.... ....	.	.
1000 0000	128	1.731
.... ....	.	.
1111 1110	254	3.188
1111 1111	255	3.200



# Triple 8-bit video Digital-to-Analog Converter (DAC)

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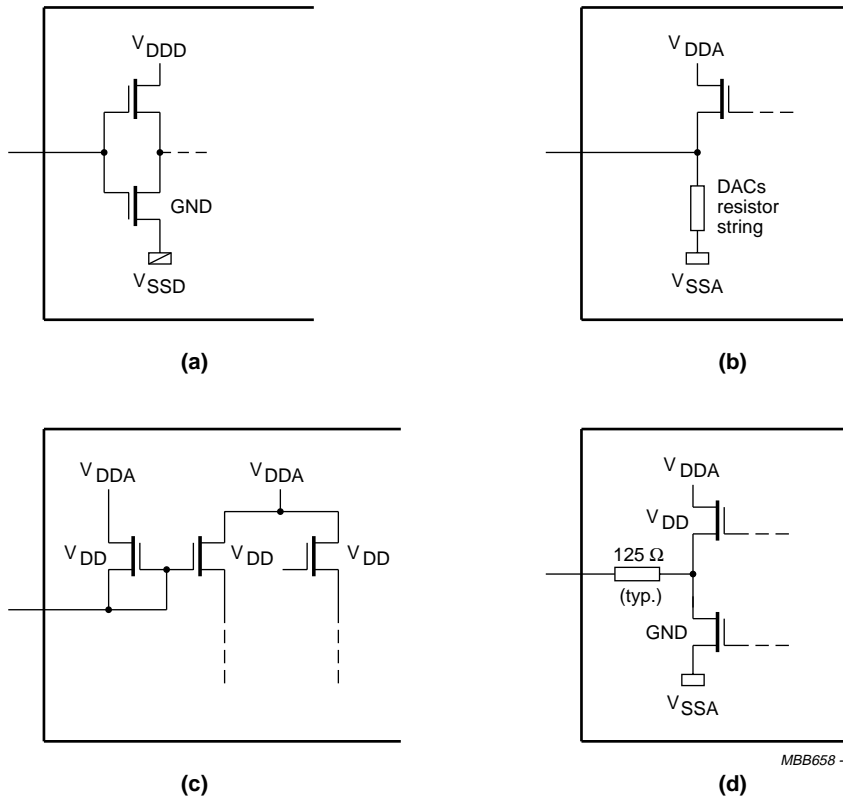
## TIMING



# Triple 8-bit video Digital-to-Analog Converter (DAC)

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## INTERNAL CIRCUITRY



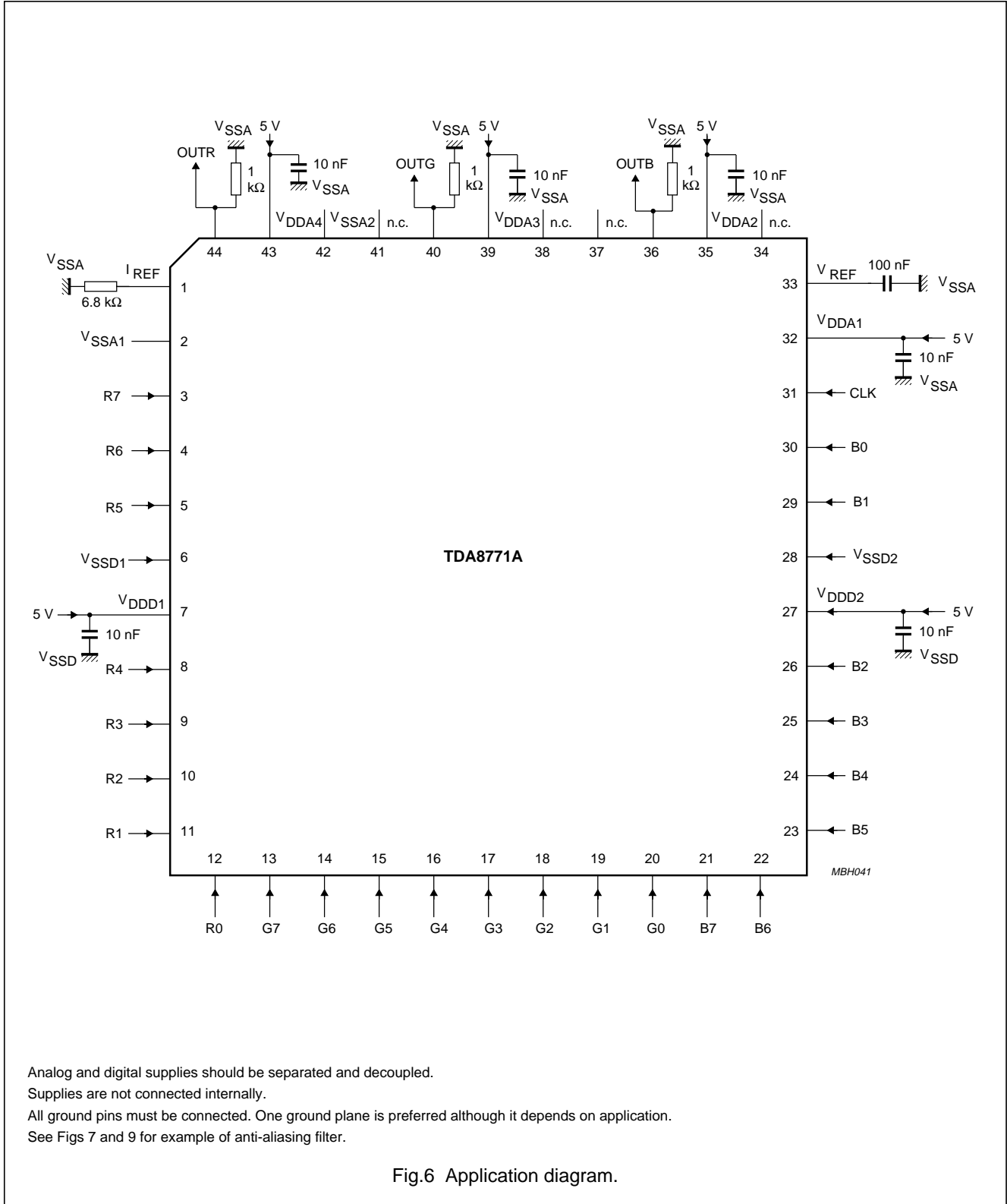
- (a) Digital inputs; pins 3 to 5, 8 to 26 and 29 to 31.
- (b)  $V_{REF}$ ; pin 33.
- (c)  $I_{REF}$ ; pin 1.
- (d) OUTR, G, B; pins 44, 40 and 36.

Fig.5 Internal circuitry.

# Triple 8-bit video Digital-to-Analog Converter (DAC)

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## APPLICATION INFORMATION



# Triple 8-bit video Digital-to-Analog Converter (DAC)

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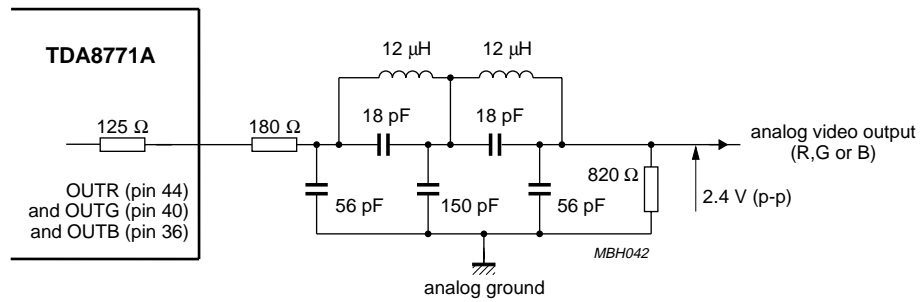


Fig.7 Example of anti-aliasing filter for 2.4 V output swing.

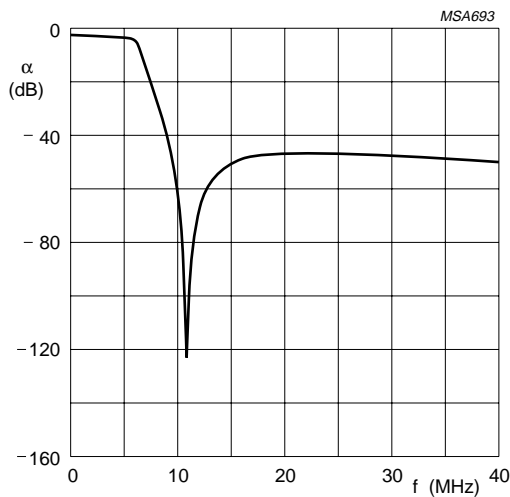


Fig.8 Frequency response for filter shown in Fig.7.

### Characteristics of Fig.8

- Order 5; adapted CHEBYSHEV
- Ripple  $\rho \geq 0.7$  dB
- $f$  at  $-3$  dB = 6.2 MHz
- $f_{\text{NOTCH}} = 10.8$  MHz.

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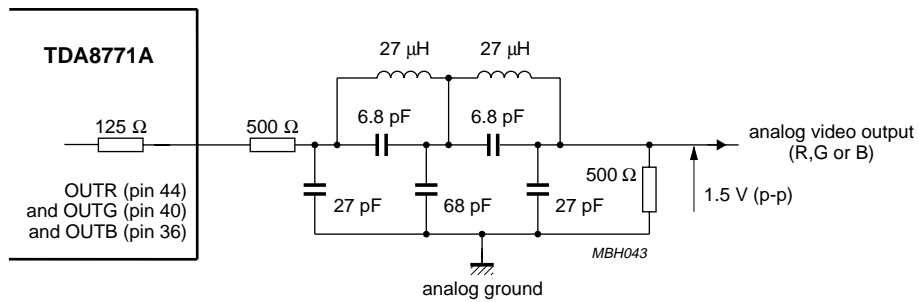


Fig.9 Example of anti-aliasing filter for 1.5 V output swing.

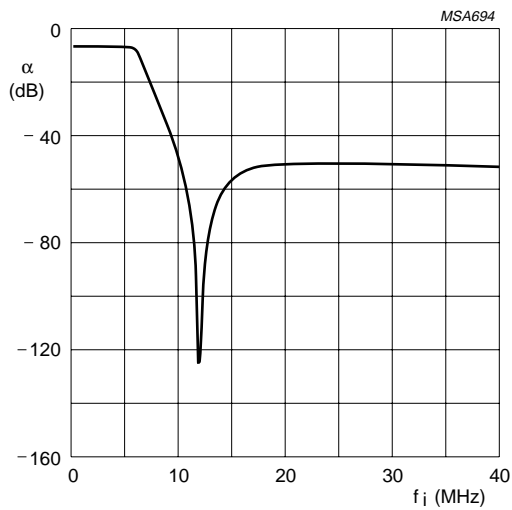


Fig.10 Frequency response for filter shown in Fig.9.

Characteristics of Fig.10

- Order 5; adapted CHEBYSHEV
- Ripple  $\rho \geq 0.25$  dB
- $f$  at  $-3$  dB = 5.6 MHz
- $f_{\text{NOTCH}} = 11.7$  MHz.

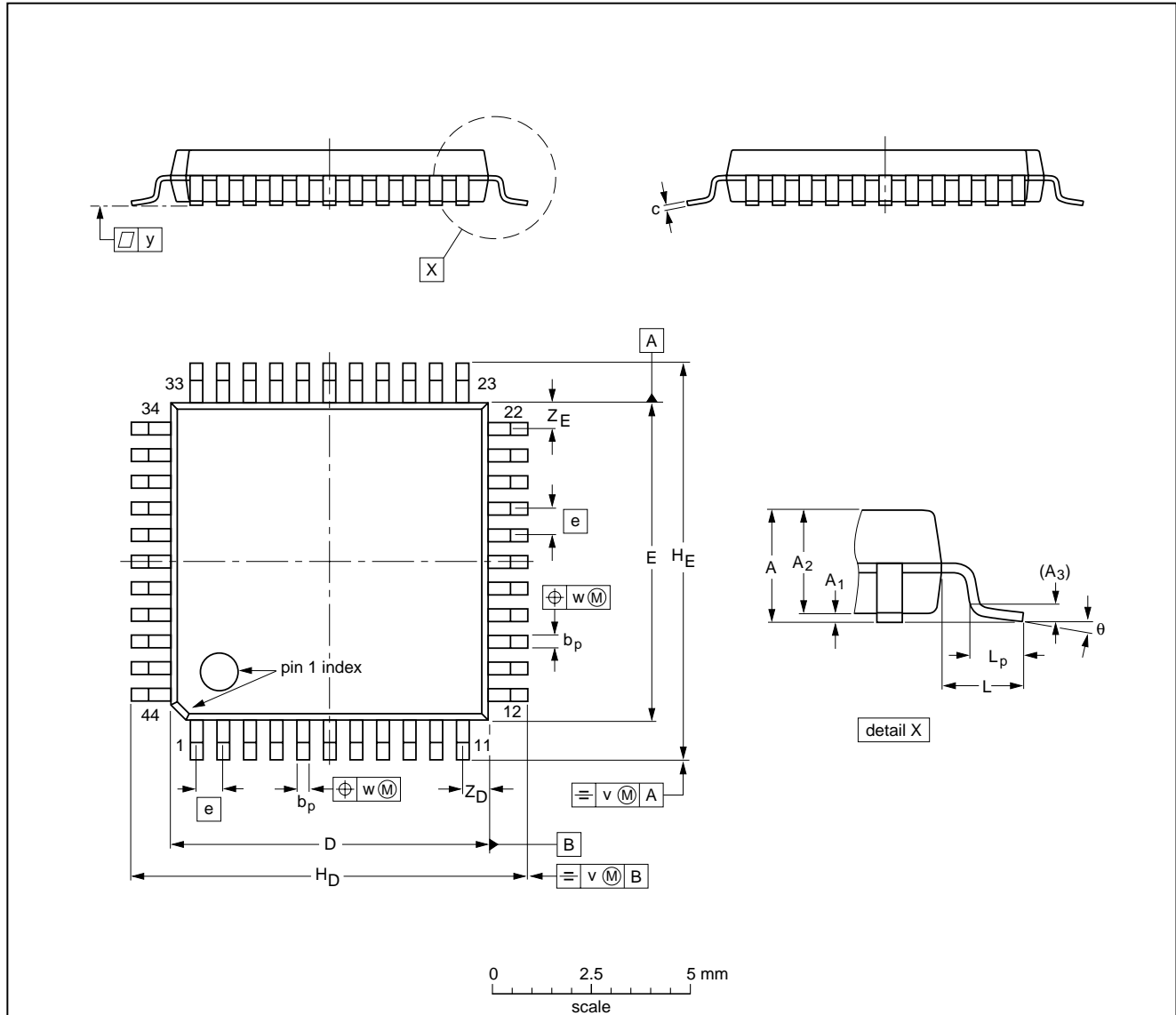
# Triple 8-bit video Digital-to-Analog Converter (DAC)

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## PACKAGE OUTLINE

QFP44: plastic quad flat package; 44 leads (lead length 1.3 mm); body 10 x 10 x 1.75 mm

SOT307-2



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>D</sub>	H <sub>E</sub>	L	L <sub>p</sub>	v	w	y	Z <sub>D</sub> <sup>(1)</sup>	Z <sub>E</sub> <sup>(1)</sup>	θ
mm	2.10	0.25 0.05	1.85 1.65	0.25	0.40 0.20	0.25 0.14	10.1 9.9	10.1 9.9	0.8	12.9 12.3	12.9 12.3	1.3	0.95 0.55	0.15	0.15	0.1	1.2 0.8	1.2 0.8	10° 0°

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT307-2						95-02-04 97-08-01

## Triple 8-bit video Digital-to-Analog Converter (DAC)

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### SOLDERING

#### Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "IC Package Databook" (order code 9398 652 90011).

#### Reflow soldering

Reflow soldering techniques are suitable for all QFP packages.

The choice of heating method may be influenced by larger plastic QFP packages (44 leads, or more). If infrared or vapour phase heating is used and the large packages are not absolutely dry (less than 0.1% moisture content by weight), vaporization of the small amount of moisture in them can cause cracking of the plastic body. For more information, refer to the Drypack chapter in our "Quality Reference Handbook" (order code 9397 750 00192).

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

#### Wave soldering

Wave soldering is **not** recommended for QFP packages. This is because of the likelihood of solder bridging due to closely-spaced leads and the possibility of incomplete solder penetration in multi-lead devices.

**If wave soldering cannot be avoided, the following conditions must be observed:**

- **A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.**
- **The footprint must be at an angle of 45° to the board direction and must incorporate solder thieves downstream and at the side corners.**

**Even with these conditions, do not consider wave soldering the following packages: QFP52 (SOT379-1), QFP100 (SOT317-1), QFP100 (SOT317-2), QFP100 (SOT382-1) or QFP160 (SOT322-1).**

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

#### Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

# Triple 8-bit video Digital-to-Analog Converter (DAC)

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## DEFINITIONS

<b>Data sheet status</b>	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
<b>Limiting values</b>	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
<b>Application information</b>	
Where application information is given, it is advisory and does not form part of the specification.	

## LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.



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Triple 8-bit video Digital-to-Analog  
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**NOTES**

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**NOTES**

## Philips Semiconductors – a worldwide company

**Argentina:** IEROD, Av. Juramento 1992 - 14.b, (1428)  
BUENOS AIRES, Tel. (541)786 7633, Fax. (541)786 9367

**Australia:** 34 Waterloo Road, NORTH RYDE, NSW 2113,  
Tel. (02)805 4455, Fax. (02)805 4466

**Austria:** Triester Str. 64, A-1101 WIEN, P.O. Box 213,  
Tel. (01)60 101-1236, Fax. (01)60 101-1211

**Belgium:** Postbus 90050, 5600 PB EINDHOVEN, The Netherlands,  
Tel. (31)40-2783749, Fax. (31)40-2788399

**Brazil:** Rua do Rocio 220 - 5<sup>th</sup> floor, Suite 51,  
CEP: 04552-903-SÃO PAULO-SP, Brazil,  
P.O. Box 7383 (01064-970),  
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Tel. (02)773 816, Fax. (02)777 6730

**China/Hong Kong:** 501 Hong Kong Industrial Technology Centre,  
72 Tat Chee Avenue, Kowloon Tong, HONG KONG,  
Tel. (852)2319 7888, Fax. (852)2319 7700

**Colombia:** IPRELENZO LTDA, Carrera 21 No. 56-17,  
77621 BOGOTA, Tel. (571)249 7624/(571)217 4609,  
Fax. (571)217 4549

**Denmark:** Prags Boulevard 80, PB 1919, DK-2300  
COPENHAGEN S, Tel. (45)32 88 26 36, Fax. (45)31 57 19 49

**Finland:** Sinikalliontie 3, FIN-02630 ESPOO,  
Tel. (358)0-615 800, Fax. (358)0-61580 920

**France:** 4 Rue du Port-aux-Vins, BP317,  
92156 SURESNES Cedex,  
Tel. (01)4099 6161, Fax. (01)4099 6427

**Germany:** P.O. Box 10 51 40, 20035 HAMBURG,  
Tel. (040)23 53 60, Fax. (040)23 53 63 00

**Greece:** No. 15, 25th March Street, GR 17778 TAVROS,  
Tel. (01)4894 339/4894 911, Fax. (01)4814 240

**India:** Philips INDIA Ltd, Shivsagar Estate, A Block,  
Dr. Annie Besant Rd. Worli, Bombay 400 018  
Tel. (022)4938 541, Fax. (022)4938 722

**Indonesia:** Philips House, Jalan H.R. Rasuna Said Kav. 3-4,  
P.O. Box 4252, JAKARTA 12950,  
Tel. (021)5201 122, Fax. (021)5205 189

**Ireland:** Newstead, Clonskeagh, DUBLIN 14,  
Tel. (01)7640 000, Fax. (01)7640 200

**Italy:** PHILIPS SEMICONDUCTORS S.r.l.,  
Piazza IV Novembre 3, 20124 MILANO,  
Tel. (0039)2 6752 2531, Fax. (0039)2 6752 2557

**Japan:** Philips Bldg 13-37, Kohnan2-chome, Minato-ku, TOKYO 108,  
Tel. (03)3740 5130, Fax. (03)3740 5077

**Korea:** Philips House, 260-199 Itaewon-dong,  
Yongsan-ku, SEOUL, Tel. (02)709-1412, Fax. (02)709-1415

**Malaysia:** No. 76 Jalan Universiti, 46200 PETALING JAYA,  
SELANGOR, Tel. (03)750 5214, Fax. (03)757 4880

**Mexico:** 5900 Gateway East, Suite 200, EL PASO, TX 79905,  
Tel. 9-5(800)234-7381, Fax. (708)296-8556

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Tel. (022)74 8000, Fax. (022)74 8341

**Pakistan:** Philips Electrical Industries of Pakistan Ltd.,  
Exchange Bldg. ST-2/A, Block 9, KDA Scheme 5, Clifton,  
KARACHI 75600, Tel. (021)587 4641-49,  
Fax. (021)577035/5874546

**Philippines:** PHILIPS SEMICONDUCTORS PHILIPPINES Inc.,  
106 Valero St. Salcedo Village, P.O. Box 2108 MCC, MAKATI,  
Metro MANILA, Tel. (63) 2 816 6380, Fax. (63) 2 817 3474

**Portugal:** PHILIPS PORTUGUESA, S.A.,  
Rua dr. António Loureiro Borges 5, Arquiparque - Miraflores,  
Apartado 300, 2795 LINDA-A-VELHA,  
Tel. (01)4163160/4163333, Fax. (01)4163174/4163366

**Singapore:** Lorong 1, Toa Payoh, SINGAPORE 1231,  
Tel. (65)350 2000, Fax. (65)251 6500

**South Africa:** S.A. PHILIPS Pty Ltd.,  
195-215 Main Road Martindale, 2092 JOHANNESBURG,  
P.O. Box 7430, Johannesburg 2000,  
Tel. (011)470-5911, Fax. (011)470-5494

**Spain:** Balmes 22, 08007 BARCELONA,  
Tel. (03)301 6312, Fax. (03)301 42 43

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