

DATA SHEET

TDA8784

**18 Msps, 10-bit analog-to-digital
interface for CCD cameras**

Product specification
Supersedes data of 1998 Aug 05
File under Integrated Circuits, IC02

1999 Sep 21

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

FEATURES

- Correlated Double Sampling (CDS), AGC, 10-bit ADC and reference regulator included, adjustable bandwidth (CDS and AGC)
- Fully programmable via a 3-wire serial interface
- Sampling frequency up to 18 MHz
- AGC gain from 4.5 to 34.5 dB (in 0.1 dB steps)
- CDS programmable bandwidth from 4 to 120 MHz
- AGC programmable bandwidth from 4 to 54 MHz
- Standby mode available for each block for power saving applications (20 mW typical)
- 6 dB fixed gain analog output for analog iris control
- 8-bit and 10-bit DAC included for analog settings
- Low power consumption of only 483 mW typical
- 5 V operation and 2.5 to 5.25 V operation for the digital outputs
- TTL compatible inputs, TTL and CMOS compatible outputs.

APPLICATIONS

- CCD camera systems.

GENERAL DESCRIPTION

The TDA8784 is a 10-bit analog-to-digital interface for CCD cameras. The device includes a correlated double sampling circuit, AGC and a low-power 10-bit Analog-to-Digital Converter (ADC) together with its reference voltage regulator.

The AGC and CDS have a bandwidth circuit controlled by on-chip DACs via a serial interface.

A 10-bit DAC controls the ADC input clamp level.

An additional 8-bit DAC is provided for additional system controls; its output voltage range is 1.4 V (p-p) which is available at pin OFDOUT.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA8784HL	LQFP48	plastic low profile quad flat package; 48 leads; body 7 × 7 × 1.4 mm	SOT313-2

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CCA}	analog supply voltage		4.75	5	5.25	V
V_{CCD}	digital supply voltage		4.75	5	5.25	V
V_{CCO}	digital outputs supply voltage		2.5	3	5.25	V
I_{CCA}	analog supply current		–	78	85	mA
I_{CCD}	digital supply current		–	18	20	mA
I_{CCO}	digital outputs supply current	$f_{CLK} = 18$ MHz; $C_L = 20$ pF; ramp input	–	1	–	mA
ADC_{res}	ADC resolution		–	10	–	bits
$V_{i(CDS)(p-p)}$	CDS input voltage (peak-to-peak value)		–	400	1200	mV
G_{CDS}	CDS output amplifier gain		–	6	–	dB
$f_{CLK(max)}$	maximum clock frequency	$f_{cut(CDS)} = 120$ MHz; $f_{cut(AGC)} = 54$ MHz	18	–	–	MHz
AGC_{dyn}	AGC dynamic range		–	30	–	dB
$N_{tot(rms)}$	total output noise from CDS input to ADC output (RMS value)	gain = 4.5 dB; $f_{cut(CDS)} = 120$ MHz; $f_{cut(AGC)} = 40$ MHz	–	0.125	–	LSB
$E_{in(rms)}$	equivalent input noise (RMS value)	gain = 34.5 dB	–	125	–	μ V
P_{tot}	total power consumption		–	483	550	mW

18 Mfps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

BLOCK DIAGRAM

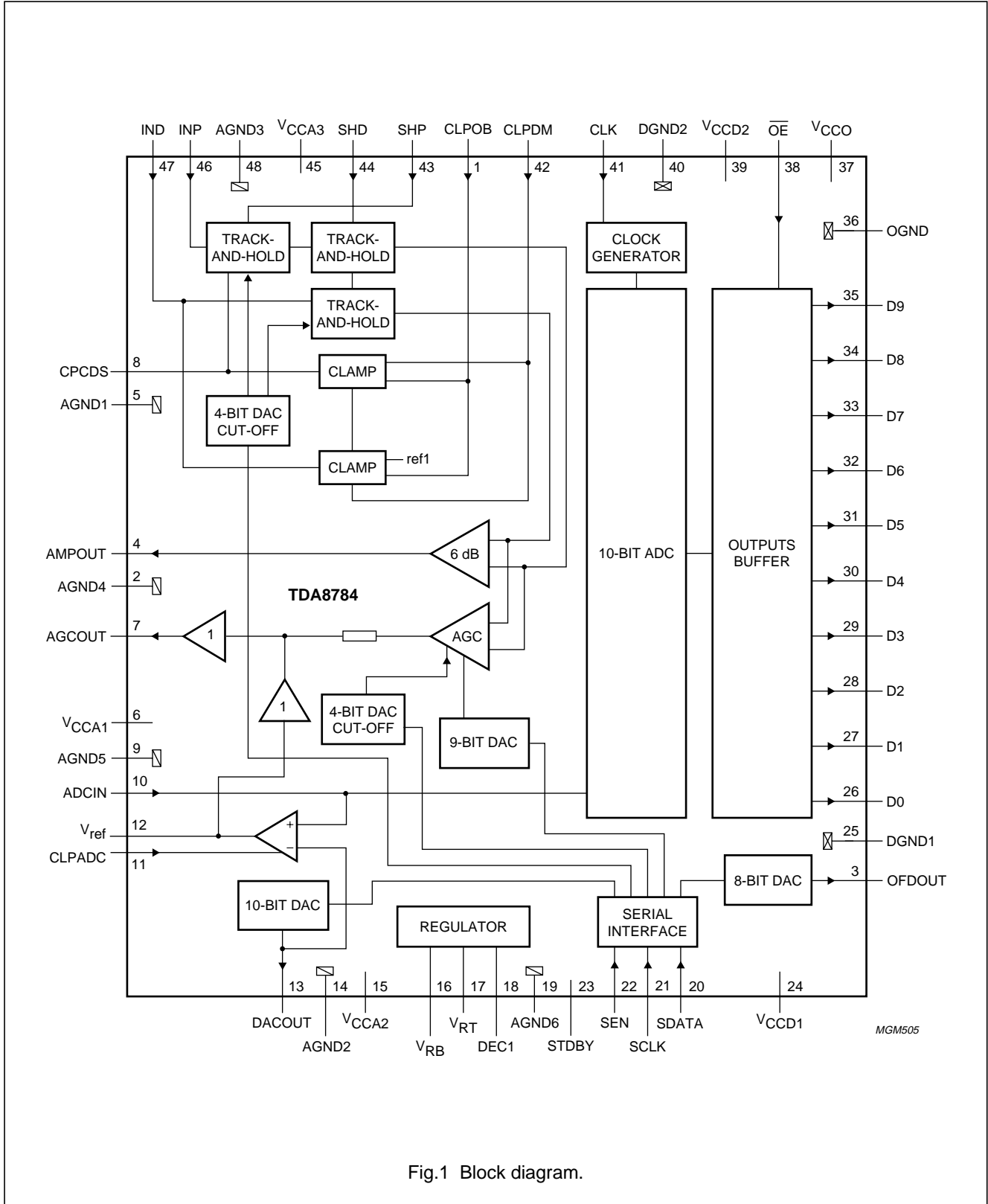


Fig.1 Block diagram.

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

PINNING

SYMBOL	PIN	DESCRIPTION
CLPOB	1	clamp pulse input at optical black
AGND4	2	analog ground 4
OFDOUT	3	analog output of the additional 8-bit control DAC (controlled via the serial interface)
AMPOUT	4	CDS amplifier output (fixed gain = 6 dB)
AGND1	5	analog ground 1
V _{CCA1}	6	analog supply voltage 1
AGCOUT	7	AGC amplifier signal output
CPCDS	8	clamp storage capacitor pin
AGND5	9	analog ground 5
ADCIN	10	ADC analog signal input from AGCOUT via a short circuit
CLPADC	11	clamp control input for ADC analog input signal clamp (used with a capacitor from V _{ref} to ground)
V _{ref}	12	ADC input clamp reference voltage (normally connected to pin V _{RB} or DACOUT, or shorted to ground via a capacitor)
DACOUT	13	DAC output for ADC clamp level
AGND2	14	analog ground 2
V _{CCA2}	15	analog supply voltage 2
V _{RB}	16	ADC reference voltage (BOTTOM) code 0
V _{RT}	17	ADC reference voltage (TOP) code 1023
DEC1	18	decoupling 1 (decoupled to ground via a capacitor)
AGND6	19	analog ground 6
SDATA	20	serial data input for the 4 control DACs (9-bit DAC for AGC gain, 8-bit DAC for frequency cut-off; additional 8-bit DAC for OFD output voltage; 10-bit DAC for ADC clamp level and the standby mode per block and edge pulse control); see Table 1
SCLK	21	serial clock input for the control DACs and their serial interface; see Table 1
SEN	22	enable input for the serial interface shift register (active when SEN = logic 0); see Table 1
STDBY	23	standby control pin (active HIGH); all the output bits are logic 0 when standby is enabled
V _{CCD1}	24	digital supply voltage 1
DGND1	25	digital ground 1
D0	26	ADC digital output 0 (LSB)
D1	27	ADC digital output 1
D2	28	ADC digital output 2
D3	29	ADC digital output 3
D4	30	ADC digital output 4
D5	31	ADC digital output 5
D6	32	ADC digital output 6
D7	33	ADC digital output 7
D8	34	ADC digital output 8
D9	35	ADC digital output 9 (MSB)
OGND	36	digital output ground
V _{CCO}	37	digital output supply voltage

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

SYMBOL	PIN	DESCRIPTION
OE	38	output enable (active LOW: digital outputs active; active HIGH: digital outputs high impedance)
V _{CCD2}	39	digital supply voltage 2
DGND2	40	digital ground 2
CLK	41	ADC clock input
CLPDM	42	clamp pulse input at dummy pixel
SHP	43	pre-set sample-and-hold pulse input
SHD	44	data sample-and-hold pulse input
V _{CCA3}	45	analog supply voltage 3
INP	46	pre-set input signal from CCD
IND	47	data input signal from CCD
AGND3	48	analog ground 3

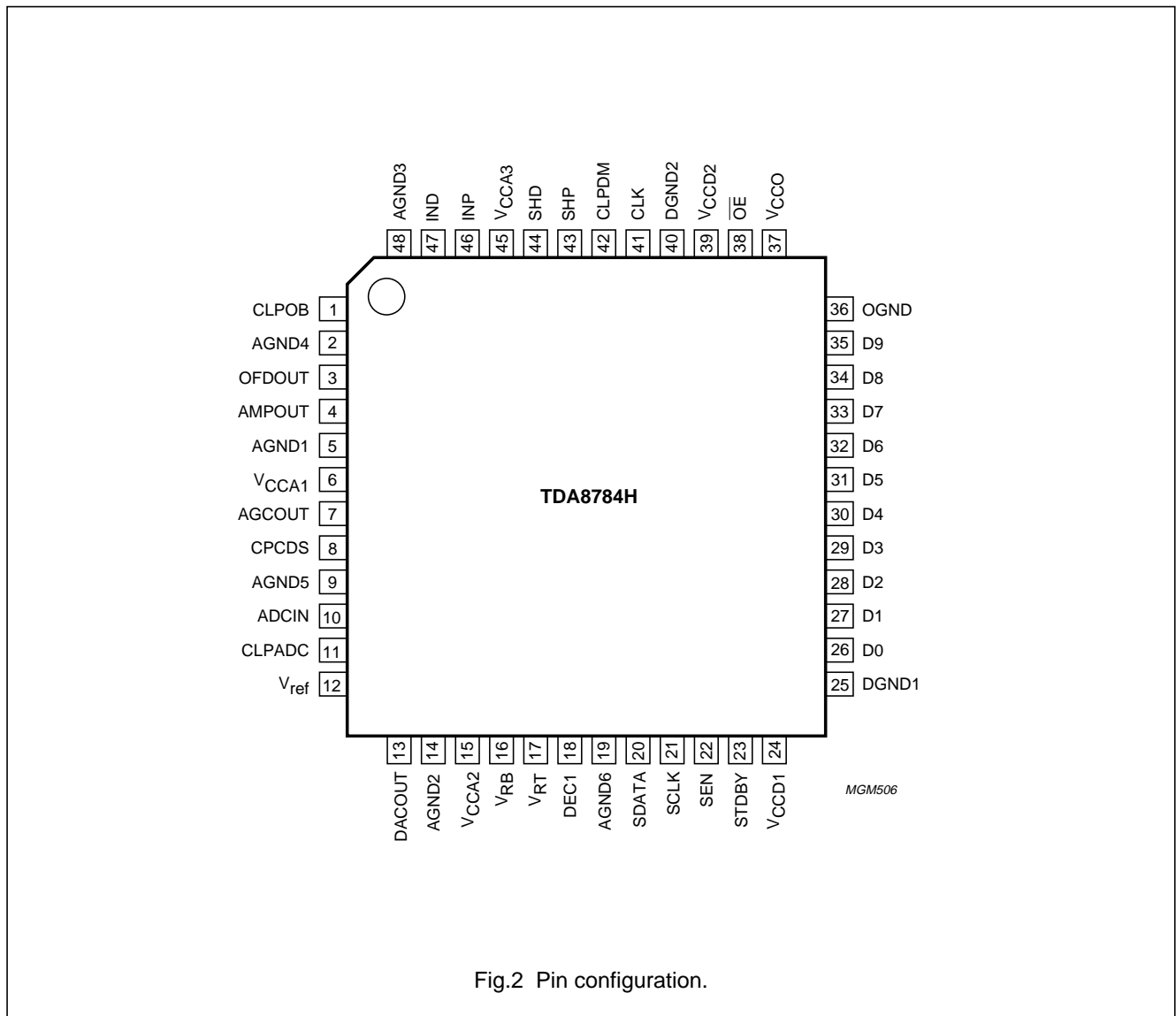


Fig.2 Pin configuration.

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CCA}	analog supply voltage	note 1	-0.3	+7.0	V
V_{CCD}	digital supply voltage	note 1	-0.3	+7.0	V
V_{CCO}	output stages supply voltage	note 1	-0.3	+7.0	V
ΔV_{CC}	supply voltage difference between V_{CCA} and V_{CCD}		-1.0	+1.0	V
	between V_{CCA} and V_{CCO}		-1.0	+4.0	V
	between V_{CCD} and V_{CCO}		-1.0	+4.0	V
V_i	input voltage	referenced to AGND	-0.3	+7.0	V
$V_{CLK(p-p)}$	AC input voltage for switching (peak-to-peak value)	referenced to DGND	-	V_{CCD}	V
I_o	output current		-	10	mA
T_{stg}	storage temperature		-55	+150	°C
T_{amb}	ambient temperature		-20	+75	°C
T_j	junction temperature		-	150	°C

Note

- The supply voltages V_{CCA} , V_{CCD} and V_{CCO} may have any value between -0.3 and +7.0 V provided that the supply voltage difference ΔV_{CC} remains as indicated.

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.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	76	K/W

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

CHARACTERISTICS

$V_{CCA} = V_{CCD} = 5\text{ V}$; $V_{CCO} = 3\text{ V}$; $f_{CLK} = 18\text{ MHz}$; $T_{amb} = 25\text{ °C}$; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies						
V_{CCA}	analog supply voltage		4.75	5	5.25	V
V_{CCD}	digital supply voltage		4.75	5	5.25	V
V_{CCO}	digital outputs supply voltage		2.5	3	5.25	V
I_{CCA}	analog supply current		–	78	85	mA
I_{CCD}	digital supply current		–	18	20	mA
I_{CCO}	digital outputs supply current	$C_L = 20\text{ pF}$ on all data outputs; ramp input	–	1	–	mA
Digital inputs						
CLOCK INPUT: CLK (REFERENCED TO DGND)						
V_{IL}	LOW-level input voltage		0	–	0.8	V
V_{IH}	HIGH-level input voltage		2.0	–	V_{CCD}	V
I_{IL}	LOW-level input current	$V_{CLK} = 0.8\text{ V}$	–1	–	+1	μA
I_{IH}	HIGH-level input current	$V_{CLK} = 2.0\text{ V}$	–	–	20	μA
Z_i	input impedance	$f_{CLK} = 18\text{ MHz}$	–	46	–	$\text{k}\Omega$
C_i	input capacitance	$f_{CLK} = 18\text{ MHz}$	–	1	–	pF
INPUTS: SHP AND SHD						
V_{IL}	LOW-level input voltage		0	–	0.8	V
V_{IH}	HIGH-level input voltage		2.0	–	V_{CCD}	V
I_{IL}	LOW-level input current	$V_{IL} = 0.6\text{ V}$	–	–6	–	μA
I_{IH}	HIGH-level input current	$V_{IH} = 2.2\text{ V}$	–	0	–	μA
INPUTS: SEN, SCLK, SDATA, \overline{OE} , STDBY, CLPDM, CLPOB AND CLPADC						
V_{IL}	LOW-level input voltage		0	–	0.8	V
V_{IH}	HIGH-level input voltage		2.0	–	V_{CCD}	V
I_i	input current		–2	–	+2	μA
Correlated Double Sampling (CDS)						
$V_{i(CDS)(p-p)}$	CDS input amplitude (peak-to-peak value)		–	400	1200	mV
$I_{CPCDS,INP,IND}$	input current pins 8, 46 and 47		–2	–	+2	μA
$t_{CDS(min)}$	CDS control pulses minimum active time	$f_{i(CDS1,2)} = f_{CLK(pix)}$; $V_{i(CDS)} = 1200\text{ mV (p-p)}$ black-to-white transition in 1 pixel ($\pm 1\text{ LSB typ.}$); $f_{cut(CDS)} = 40\text{ MHz}$; $f_{cut(AGC)} = 40\text{ MHz}$	12	–	–	ns
t_{hd1}	hold time INP compared to control pulse SHP	see Fig.5	–	1	–	ns

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
t_{hd2}	hold time of IND compared to control pulse SHD	see Fig.5	–	1	–	ns
$t_{set(CDS)}$	CDS settling time	see Fig.12; control DAC 4 bits input code; AGC gain = 0 dB; $f_{cut(AGC)} = 54$ MHz; $V_{i(CDS)} = 1200$ mV (p-p) black-to-white transition in 1 pixel (1 LSB typ.)				
		0000	–	12	–	ns
		0001	–	25	–	ns
		0010	–	45	–	ns
		0011	–	55	–	ns
		0100	–	105	–	ns
		0111	–	140	–	ns
		1000	–	270	–	ns
		1011	–	300	–	ns
		1111	–	365	–	ns
Amplifier outputs						
G_{AMPOUT}	output amplifier gain		–	6	–	dB
Z_{AMPOUT}	output amplifier impedance		–	300	–	Ω
$V_{AMPOUT(p-p)}$	output amplifier dynamic voltage (peak-to-peak value)		–	2.4	–	V
$V_{AMPOUT(bl)}$	output amplifier black level voltage		–	1.5	–	V
$V_{AGCOUT(p-p)}$	AGC output amplifier dynamic voltage level (peak-to-peak value)		–	2000	–	mV
V_{AGCOUT}	AGC output amplifier black level voltage	V_{ref} connected to DACOUT	–	V_{ref}	–	V
Z_{AGCOUT}	AGC output amplifier output impedance	at 10 kHz	–	5	–	Ω
I_{AGCOUT}	AGC output static drive current	static	–	–	1	mA
$G_{AGC(min)}$	minimum gain of AGC circuit	AGC DAC input code = 00 (9-bit control)	–	4.5	–	dB
$G_{AGC(max)}$	maximum gain of AGC circuit	AGC DAC input code ≥ 319 (9-bit control)	–	34.5	–	dB
$f_{cut(AGC)}$	cut-off frequency AGC	control DAC 4-bit input code = 00	–	54	–	MHz
		input code = 01	–	40	–	MHz
		input code = 15	–	4	–	MHz

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Clamps						
$g_{m(ADC)}$	ADC clamp transconductance	at clamp level	–	7	–	mS
$g_{m(CDS)}$	CDS clamp transconductance	at clamp level	–	1.5	–	mS
Analog-to-Digital Converter (ADC)						
$f_{CLK(max)}$	maximum clock frequency		18	–	–	MHz
t_{CPH}	clock pulse width HIGH		15	–	–	ns
t_{CPL}	clock pulse width LOW		15	–	–	ns
SR_{CLK}	clock input slew rate (rising and falling edge)	10% to 90%	0.5	–	–	V/ns
$V_{i(ADC)(p-p)}$	ADC input voltage level (peak-to-peak value)		–	2	–	V
V_{RB}	ADC reference voltage output code 0		–	1.5	–	V
V_{RT}	ADC reference voltage output code 1023		–	3.5	–	V
I_{ADCIN}	input current pin 10		–2	–	+120	μ A
INL	integral non-linearity	ramp input	–	± 0.6	± 1.5	LSB
DNL	differential non-linearity	ramp input	–	± 0.2	± 0.75	LSB
$t_{d(s)}$	sampling delay time		–	–	5	ns
Total chain characteristics (CDS + AGC + ADC)						
t_d	time delay between SHD and CLK	see Fig.5; 50% at rising edges CLK and SHP: transition full scale code 0 to 1023; $f_{cut(CDS)} = 40$ MHz; $f_{cut(AGC)} = 40$ MHz; $V_{i(CDS)} = 1200$ mV	–	40	–	ns
$N_{tot(rms)}$	total output noise (RMS value)	$f_{cut(CDS)} = 120$ MHz; $f_{cut(AGC)} = 40$ MHz; note 1 $G_{AGC} = 4.5$ dB $G_{AGC} = 34.5$ dB	–	0.125	–	LSB
			–	1.6	–	LSB
$V_{offset(fl-d)}$	maximum offset between CCD floating level and CCD dark pixel level		–200	–	+200	mV
$V_{n(i)(eq)(rms)}$	equivalent input noise voltage (RMS value)	AGC gain = 34.5 dB	–	125	–	μ V
		AGC gain = 4.5 dB	–	150	–	μ V
Digital-to-analog converter (OFDOUT)						
$V_{OFDOUT(p-p)}$	additional 8-bit control DAC (OFD) output voltage (peak-to-peak value)		–	1.4	–	V
$V_{OFDOUT(0)}$	DC output voltage for code 0		–	2.3	–	V
$V_{OFDOUT(255)}$	DC output voltage for code 255		–	3.7	–	V

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Z _{OFDOUT}	additional 8-bit control DAC (OFD) output impedance		–	2000	–	Ω
I _{OFDOUT}	OFD output current drive	static	–	–	50	μA
ADC clamp control DAC (see Fig.8)						
V _{DACOUT(p-p)}	ADC clamp 10-bit control DAC output voltage (peak-to-peak value)		–	1	–	V
V _{DACOUT}	DC output voltage	code 0	–	1.5	–	V
		code 1023	–	2.5	–	V
Z _{DACOUT}	ADC clamp control DAC output impedance		–	–	250	Ω
I _{DACOUT}	DAC output current drive	static	–	–	50	μA
OFE _{LOOP}	maximum offset error of DAC + ADC clamp loop	code 0	–	±5	–	LSB
		code 1023	–	±5	–	LSB
Digital outputs (f_{CLK} = 18 MHz; C_L = 20 pF)						
V _{OH}	HIGH-level output voltage	I _{OH} = –1 mA	V _{CCO} – 0.5	–	V _{CCO}	V
V _{OL}	LOW-level output voltage	I _{OL} = 1 mA	0	–	0.5	V
I _{OZ}	output current in 3-state mode	0 V < V _o < V _{CCO}	–20	–	+20	μA
t _{o(h)}	output hold time	see Fig.5	8	–	–	ns
t _{o(d)}	output delay time	C _i = 20 pF; V _{CCO} = 5 V	–	17	23	ns
		C _i = 10 pF	–	15	21	ns
		C _i = 20 pF; V _{CCO} = 3 V	–	20	29	ns
		C _i = 10 pF	–	17	25	ns
		C _i = 20 pF; V _{CCO} = 2.5 V	–	22	33	ns
		C _i = 10 pF	–	18	28	ns
Serial interface						
f _{SCLK(max)}	maximum frequency of serial interface		5	–	–	MHz

Note

- Noise measurement at ADC outputs: the coupling capacitor at the input is connected to ground, so that only the noise contribution of the front-end is evaluated. The front-end operates at 18 Mpix with a line of 1024 pixels. The first 40 are used to run CLPOB and the last 40 to run CLPDM. Data at the ADC outputs is measured during the other pixels. The differences between the types of codes statistic is then computed; the result is the noise. No quantization noise is taken into account as no signal is input.

18 Msp/s, 10-bit analog-to-digital interface for CCD cameras

TDA8784

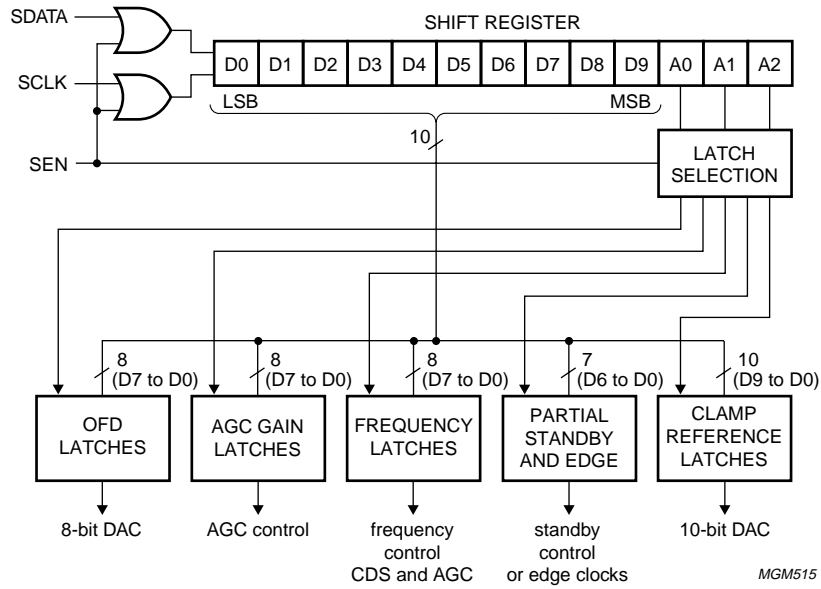
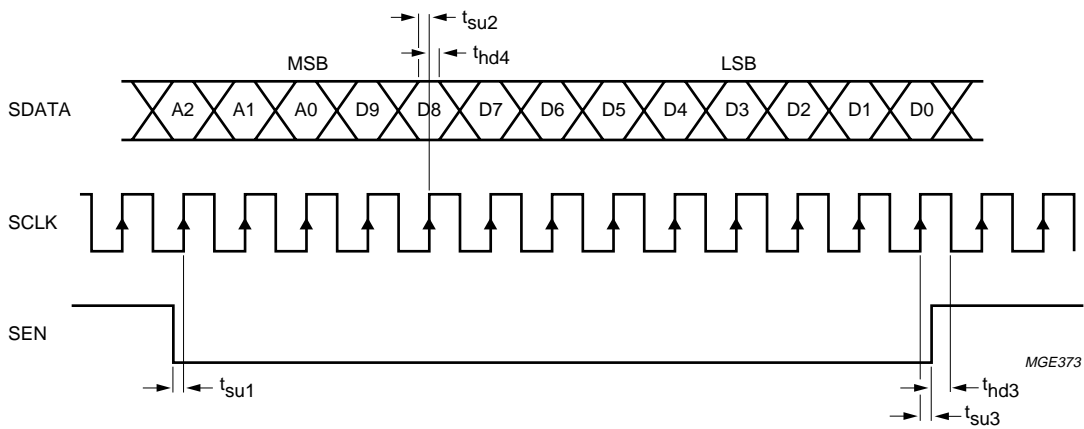


Fig.3 Serial interface block diagram.



$t_{su1} = t_{su2} = 4 \text{ ns (min.)}$; $t_{hd3} = t_{hd4} = 4 \text{ ns (min.)}$.

Fig.4 Loading sequence of control DACs input data via the serial interface.

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

Table 1 Serial interface programming

ADDRESS BITS			DATA BITS D9 to D0
A2	A1	A0	
0	0	0	OFD output control (D7 to D0).
0	0	1	Cut-off frequency of CDS and AGC. Only the 4 LSBs (D3 to D0) are used for CDS. D4 to D7 are used for AGC. D8 and D9 should be set to logic 0.
0	1	0	AGC gain control (D8 to D0).
0	1	1	Partial standby controls for power consumption optimization. Only the 4 LSBs (D3 to D0) are used. Edge control for pulses SHP, SHD, CLAMP and clock ADC: D0 = 1: CDS + AGC in standby; $I_{CCA} + I_{CCD} = 48 \text{ mA}$ D1 = 1: OFD DAC in standby; $I_{CCA} + I_{CCD} = 98 \text{ mA}$ D2 = 1: 6 dB amplifier (output on AMPOUT pin) in standby; $I_{CCA} + I_{CCD} = 98.5 \text{ mA}$ D3 = 1: SHP and SHD activated with falling edge (for positive pulse) D4 = 1: CLPDM, CLPOB and CLPADC activated on HIGH level; note 1 D5 = 0: CLKADC activated with falling edge D6 must be set to logic 0.
1	0	0	Clamp reference DAC (D9 to D0).

Note

1. When CLPADC is HIGH (D4 = 1: serial interface), the ADC input is clamped to voltage level V_{ref} . V_{ref} is connected to ground via a capacitance.

Table 2 Standby selection

STDBY	DATA BITS D9 to D0	$I_{CCA} + I_{CCD}$ (TYP.)
1	LOW	4 mA
0	active	99 mA

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

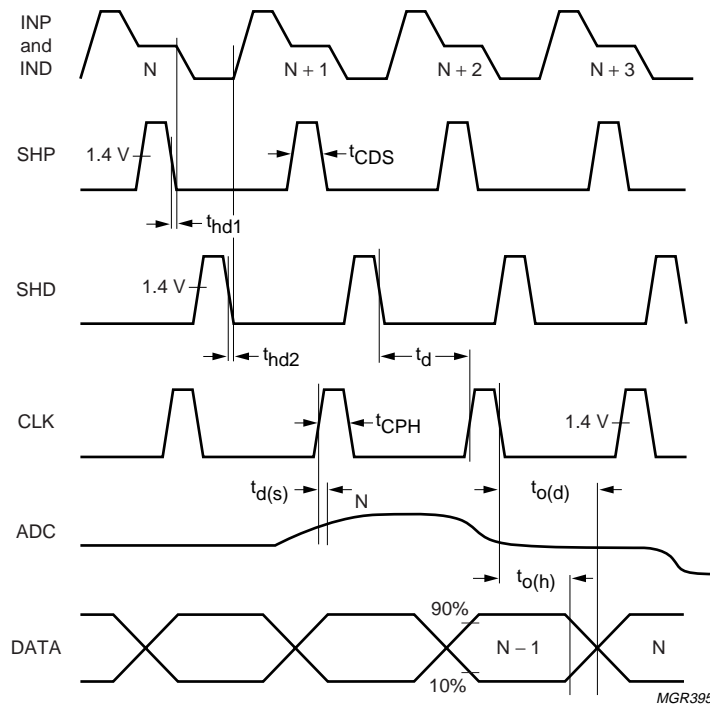
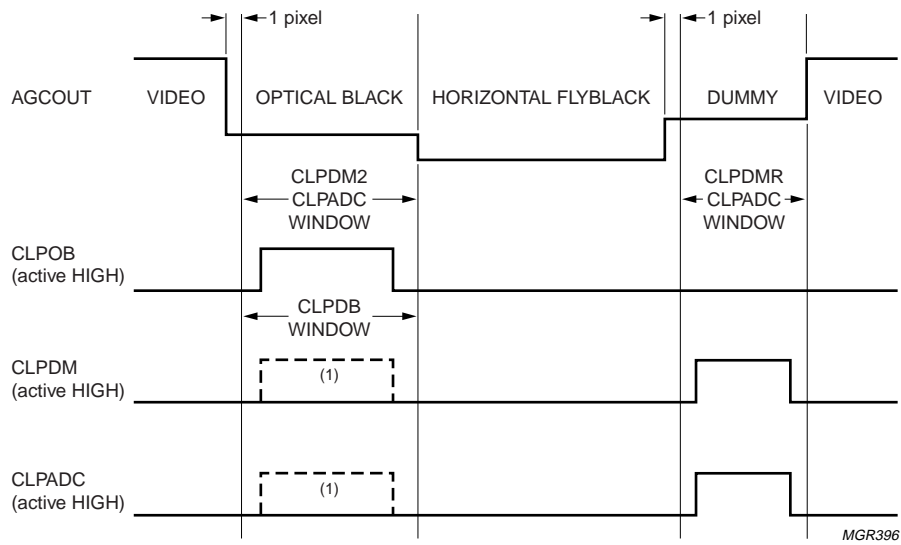


Fig.5 Pixel frequency timing diagram.

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784



(1) When dummy pixels are not available.

Fig.6 Line frequency timing diagram.

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

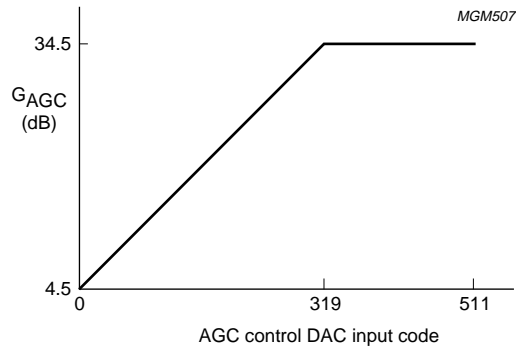


Fig.7 AGC gain as a function of DAC input code.

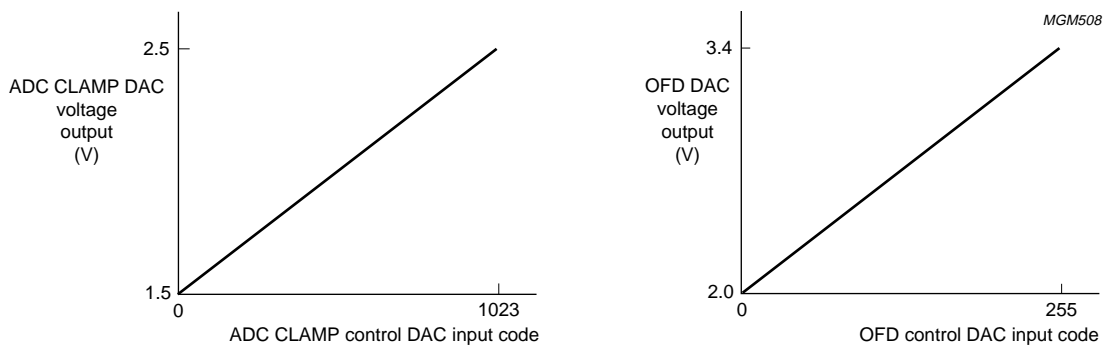


Fig.8 DAC voltage output as a function of DAC input code.

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

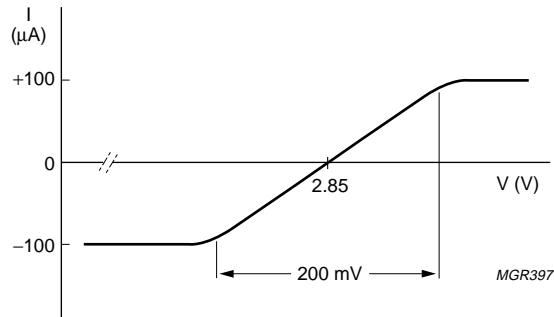


Fig.9 Typical clamp current for pin CPCDS.

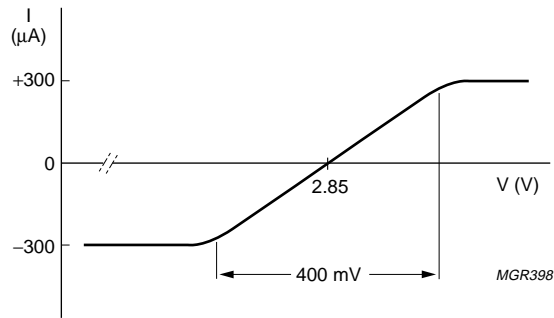


Fig.10 Typical clamp current for pins IND and INP.

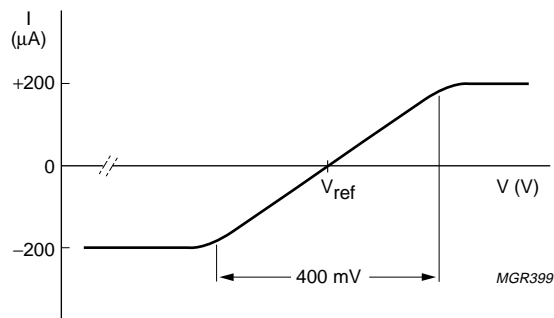
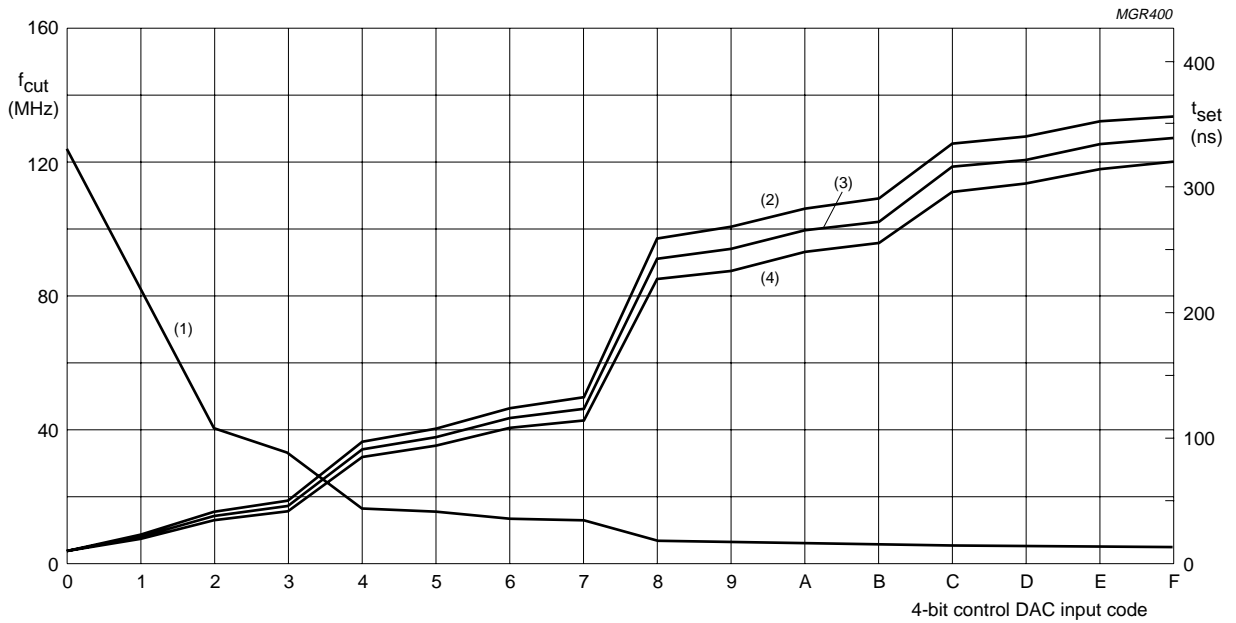


Fig.11 Typical clamp current for pin V_{ref} .

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

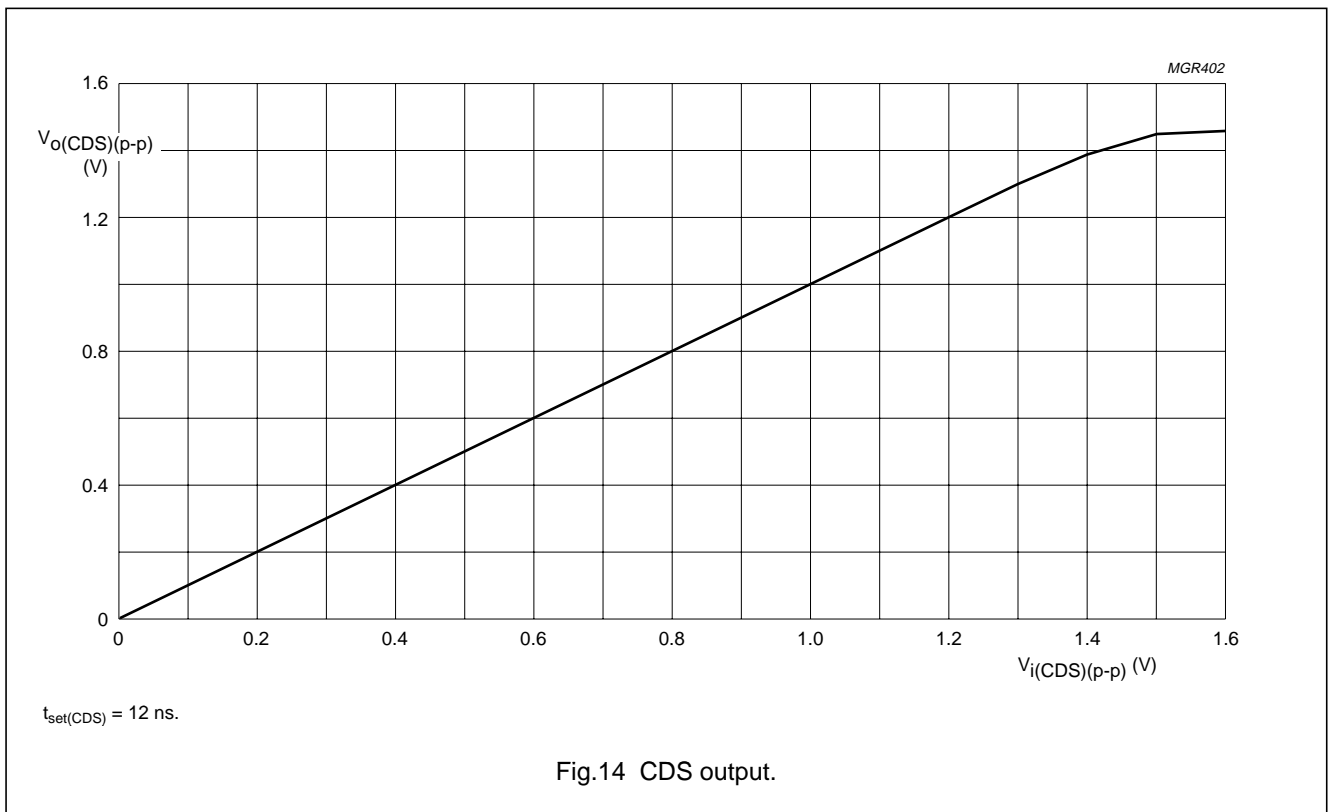
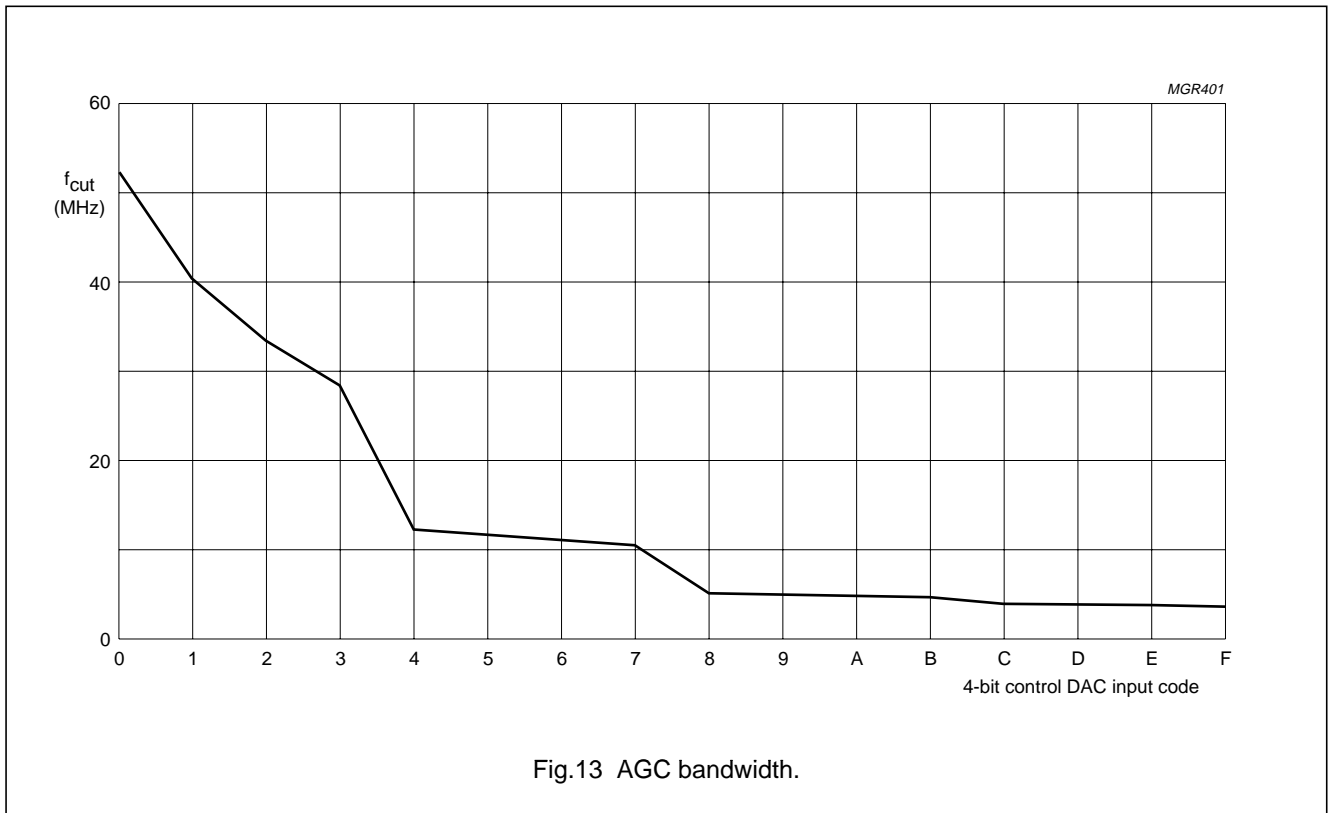


- (1) f_{cut} .
- (2) t_{set} (10b).
- (3) t_{set} (9b).
- (4) t_{set} (8b).

Fig.12 CDS settling time and bandwidth.

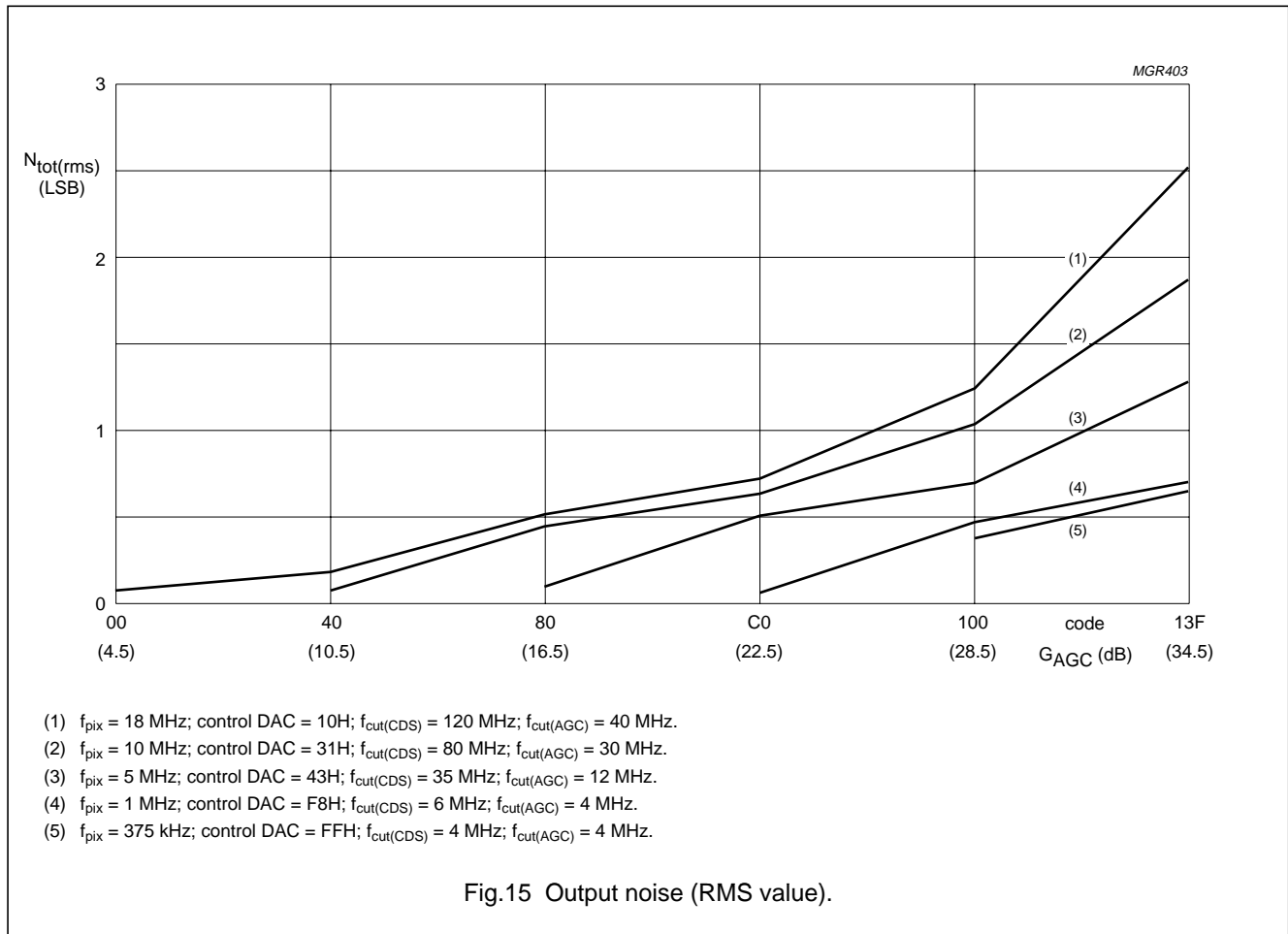
18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784



18 Msps, 10-bit analog-to-digital interface for CCD cameras

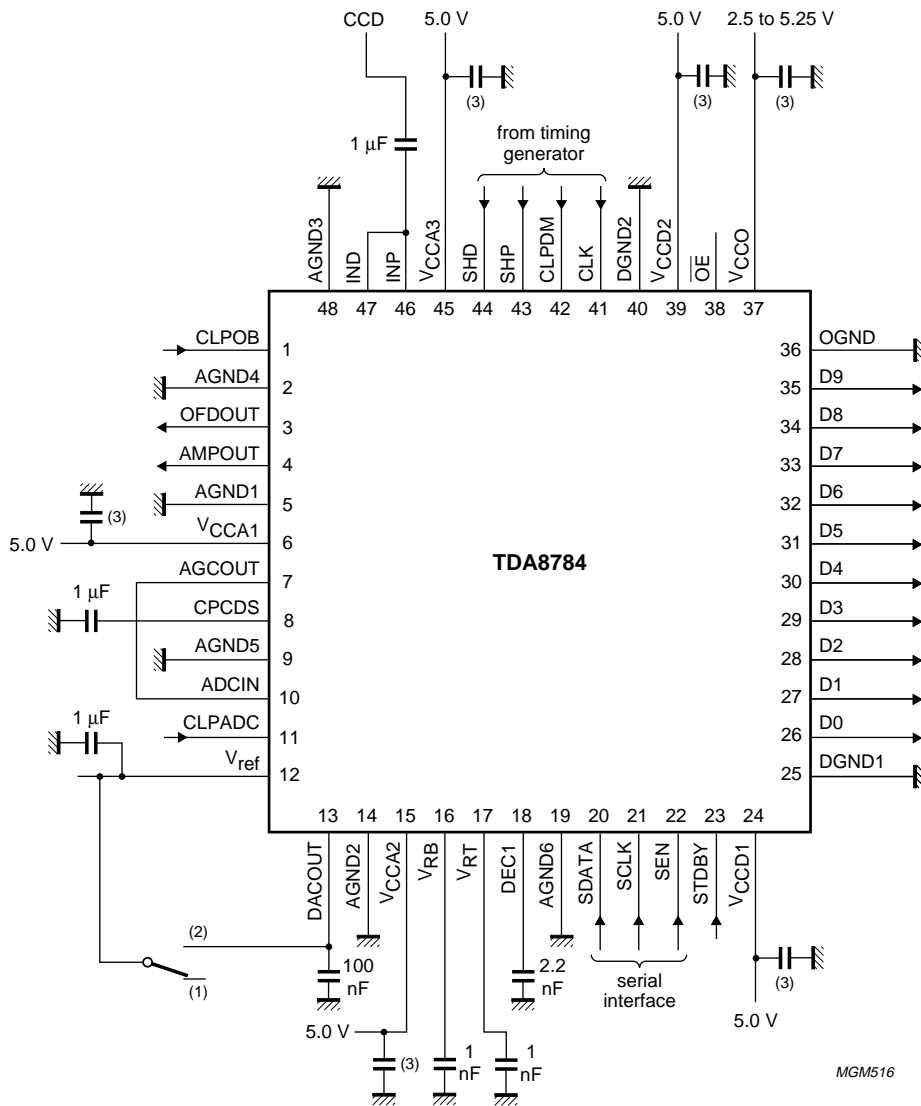
TDA8784



18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

APPLICATION INFORMATION



Depending on the application, the following connections must be made:

- (1) The clamp level of the signal input at ADCIN can be tuned from code 00 to code 511 in 0.5 LSB steps of ADC via the serial interface (clamp ADC activated).
- (2) Clamp ADC not activated, direct connection from DACOUT to V_{ref}.
- (3) All supply pins must be decoupled with 100 nF capacitors as close as possible to the device.

Fig.16 Application diagram.

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

Power and grounding recommendations

When designing a printed-circuit board for applications such as PC cameras, surveillance cameras, camcorders and digital still cameras, care should be taken to minimize the noise.

For the front-end integrated circuit, the basic rules of printed-circuit board design and implementation of analogue components (such as classical operational amplifiers) must be respected, particularly with respect to power and ground connections.

The following additional recommendation is given for the CDS input pin(s) which is/are internally connected to the programmable gain amplifier:

- The connections between CCD interface and CDS input should be as short as possible and a ground ring protection around these connections can be beneficial. Separate analogue and digital supplies provide the best solution. If it is not possible to do this on the board then the analogue supply pins must be decoupled effectively from the digital supply pins. If the same power supply and ground are used for all the pins then the decoupling capacitors must be placed as close as possible to the IC package.
- In a two-ground system, in order to minimize the noise through package and die parasitics, the following recommendations must be implemented:
 - All the analogue and digital supply pins must be decoupled to the analogue ground plane. Only the ground pin associated with the digital outputs must be connected to the digital ground plane. All the other ground pins should be connected to the analogue ground plane. The analogue and digital ground planes must be connected together at one point as close as possible to the ground pin associated with the digital outputs.
 - The digital output pins and their associated lines should be shielded by the digital ground plane which can be used then as return path for digital signals.

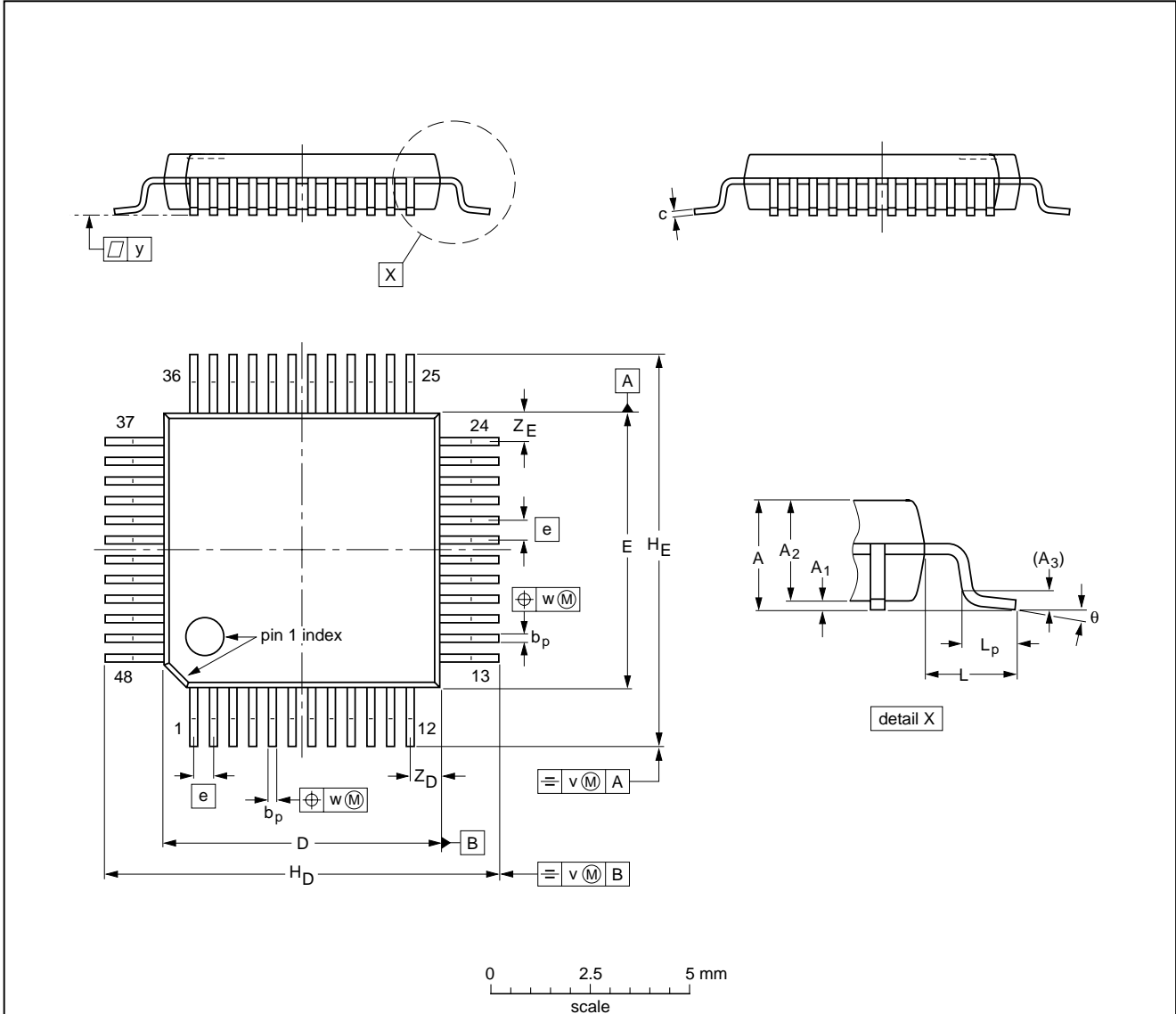
18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

PACKAGE OUTLINE

LQFP48: plastic low profile quad flat package; 48 leads; body 7 x 7 x 1.4 mm

SOT313-2



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _D	H _E	L	L _p	v	w	y	Z _D ⁽¹⁾	Z _E ⁽¹⁾	θ
mm	1.60	0.20 0.05	1.45 1.35	0.25	0.27 0.17	0.18 0.12	7.1 6.9	7.1 6.9	0.5	9.15 8.85	9.15 8.85	1.0	0.75 0.45	0.2	0.12	0.1	0.95 0.55	0.95 0.55	7° 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			
SOT313-2						94-12-19 97-08-01

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

SOLDERING

Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

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 methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
 - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
 - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

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.

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.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron 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.

18 Msps, 10-bit analog-to-digital interface for CCD cameras

TDA8784

Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW ⁽¹⁾
BGA, SQFP	not suitable	suitable
HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable ⁽²⁾	suitable
PLCC ⁽³⁾ , SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended ⁽³⁾⁽⁴⁾	suitable
SSOP, TSSOP, VSO	not recommended ⁽⁵⁾	suitable

Notes

- All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the "Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods".
- These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
- If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
- Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

DEFINITIONS

Data sheet status	
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.
Limiting values	
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.	
Application information	
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.

18 Msps, 10-bit analog-to-digital
interface for CCD cameras

TDA8784

NOTES

18 Msps, 10-bit analog-to-digital
interface for CCD cameras

TDA8784

NOTES

Philips Semiconductors – a worldwide company

Argentina: see South America

Australia: 3 Figtree Drive, HOMEBUSH, NSW 2140,
Tel. +61 2 9704 8141, Fax. +61 2 9704 8139

Austria: Computerstr. 6, A-1101 WIEN, P.O. Box 213,
Tel. +43 1 60 101 1248, Fax. +43 1 60 101 1210

Belarus: Hotel Minsk Business Center, Bld. 3, r. 1211, Volodarski Str. 6,
220050 MINSK, Tel. +375 172 20 0733, Fax. +375 172 20 0773

Belgium: see The Netherlands

Brazil: see South America

Bulgaria: Philips Bulgaria Ltd., Energoproject, 15th floor,
51 James Bourchier Blvd., 1407 SOFIA,
Tel. +359 2 68 9211, Fax. +359 2 68 9102

Canada: PHILIPS SEMICONDUCTORS/COMPONENTS,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

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: see South America

Czech Republic: see Austria

Denmark: Sydhavnsgade 23, 1780 COPENHAGEN V,
Tel. +45 33 29 3333, Fax. +45 33 29 3905

Finland: Sinikalliontie 3, FIN-02630 ESPOO,
Tel. +358 9 615 800, Fax. +358 9 6158 0920

France: 51 Rue Carnot, BP317, 92156 SURESNES Cedex,
Tel. +33 1 4099 6161, Fax. +33 1 4099 6427

Germany: Hammerbrookstraße 69, D-20097 HAMBURG,
Tel. +49 40 2353 60, Fax. +49 40 2353 6300

Hungary: see Austria

India: Philips INDIA Ltd, Band Box Building, 2nd floor,
254-D, Dr. Annie Besant Road, Worli, MUMBAI 400 025,
Tel. +91 22 493 8541, Fax. +91 22 493 0966

Indonesia: PT Philips Development Corporation, Semiconductors Division,
Gedung Philips, Jl. Buncit Raya Kav.99-100, JAKARTA 12510,
Tel. +62 21 794 0040 ext. 2501, Fax. +62 21 794 0080

Ireland: Newstead, Clonskeagh, DUBLIN 14,
Tel. +353 1 7640 000, Fax. +353 1 7640 200

Israel: RAPAC Electronics, 7 Kehilat Saloniki St, PO Box 18053,
TEL AVIV 61180, Tel. +972 3 645 0444, Fax. +972 3 649 1007

Italy: PHILIPS SEMICONDUCTORS, Via Casati, 23 - 20052 MONZA (MI),
Tel. +39 039 203 6838, Fax +39 039 203 6800

Japan: Philips Bldg 13-37, Kohnan 2-chome, Minato-ku,
TOKYO 108-8507, Tel. +81 3 3740 5130, Fax. +81 3 3740 5057

Korea: Philips House, 260-199 Itaewon-dong, Yongsan-ku, SEOUL,
Tel. +82 2 709 1412, Fax. +82 2 709 1415

Malaysia: No. 76 Jalan Universiti, 46200 PETALING JAYA, SELANGOR,
Tel. +60 3 750 5214, Fax. +60 3 757 4880

Mexico: 5900 Gateway East, Suite 200, EL PASO, TEXAS 79905,
Tel. +9-5 800 234 7381, Fax +9-5 800 943 0087

Middle East: see Italy

Netherlands: Postbus 90050, 5600 PB EINDHOVEN, Bldg. VB,
Tel. +31 40 27 82785, Fax. +31 40 27 88399

New Zealand: 2 Wagener Place, C.P.O. Box 1041, AUCKLAND,
Tel. +64 9 849 4160, Fax. +64 9 849 7811

Norway: Box 1, Manglerud 0612, OSLO,
Tel. +47 22 74 8000, Fax. +47 22 74 8341

Pakistan: see Singapore

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

Poland: Al.Jerozolimskie 195 B, 02-222 WARSAW,
Tel. +48 22 5710 000, Fax. +48 22 5710 001

Portugal: see Spain

Romania: see Italy

Russia: Philips Russia, Ul. Usatcheva 35A, 119048 MOSCOW,
Tel. +7 095 755 6918, Fax. +7 095 755 6919

Singapore: Lorong 1, Toa Payoh, SINGAPORE 319762,
Tel. +65 350 2538, Fax. +65 251 6500

Slovakia: see Austria

Slovenia: see Italy

South Africa: S.A. PHILIPS Pty Ltd., 195-215 Main Road Martindale,
2092 JOHANNESBURG, P.O. Box 58088 Newville 2114,
Tel. +27 11 471 5401, Fax. +27 11 471 5398

South America: Al. Vicente Pinzon, 173, 6th floor,
04547-130 SÃO PAULO, SP, Brazil,
Tel. +55 11 821 2333, Fax. +55 11 821 2382

Spain: Balmes 22, 08007 BARCELONA,
Tel. +34 93 301 6312, Fax. +34 93 301 4107

Sweden: Kottbygatan 7, Akalla, S-16485 STOCKHOLM,
Tel. +46 8 5985 2000, Fax. +46 8 5985 2745

Switzerland: Allmendstrasse 140, CH-8027 ZÜRICH,
Tel. +41 1 488 2741 Fax. +41 1 488 3263

Taiwan: Philips Semiconductors, 6F, No. 96, Chien Kuo N. Rd., Sec. 1,
TAIPEI, Taiwan Tel. +886 2 2134 2886, Fax. +886 2 2134 2874

Thailand: PHILIPS ELECTRONICS (THAILAND) Ltd.,
209/2 Sanpavuth-Bangna Road Prakanong, BANGKOK 10260,
Tel. +66 2 745 4090, Fax. +66 2 398 0793

Turkey: Yukari Dudullu, Org. San. Blg., 2.Cad. Nr. 28 81260 Umraniye,
ISTANBUL, Tel. +90 216 522 1500, Fax. +90 216 522 1813

Ukraine: PHILIPS UKRAINE, 4 Patrice Lumumba str., Building B, Floor 7,
252042 KIEV, Tel. +380 44 264 2776, Fax. +380 44 268 0461

United Kingdom: Philips Semiconductors Ltd., 276 Bath Road, Hayes,
MIDDLESEX UB3 5BX, Tel. +44 208 730 5000, Fax. +44 208 754 8421

United States: 811 East Arques Avenue, SUNNYVALE, CA 94088-3409,
Tel. +1 800 234 7381, Fax. +1 800 943 0087

Uruguay: see South America

Vietnam: see Singapore

Yugoslavia: PHILIPS, Trg N. Pasica 5/v, 11000 BEOGRAD,
Tel. +381 11 62 5344, Fax.+381 11 63 5777

For all other countries apply to: Philips Semiconductors,
International Marketing & Sales Communications, Building BE-p, P.O. Box 218,
5600 MD EINDHOVEN, The Netherlands, Fax. +31 40 27 24825

Internet: <http://www.semiconductors.philips.com>

© Philips Electronics N.V. 1999

SCA 68

All rights are reserved. Reproduction in whole or in part is prohibited without the prior written consent of the copyright owner.

The information presented in this document does not form part of any quotation or contract, is believed to be accurate and reliable and may be changed without notice. No liability will be accepted by the publisher for any consequence of its use. Publication thereof does not convey nor imply any license under patent- or other industrial or intellectual property rights.

Printed in The Netherlands

545004/25/02/pp28

Date of release: 1999 Sep 21

Document order number: 9397 750 06032

Let's make things better.

Philips
Semiconductors



PHILIPS