TDA9964

12-bit, 3.0 V, 30 Msps analog-to-digital interface for CCD cameras

Rev. 03 — 16 January 2001 **Objective specification**

1. Description

The TDA9964 is a 12-bit analog-to-digital interface for CCD cameras. The device includes a correlated double sampling circuit, PGA, clamp loops and a low-power 12-bit ADC together with its reference voltage regulator.

The PGA gain and the ADC input clamp level are controlled via the serial interface.

An additional DAC is provided for additional system controls; its output voltage range is 1.0 V p-p, which is available at pin OFDOUT.

2. Features

- Correlated Double Sampling (CDS), Programmable Gain Amplifier (PGA), 12-bit Analog-to-Digital Converter (ADC) and reference regulator included
- Fully programmable via a 3-wire serial interface
- Sampling frequency up to 30 MHz
- PGA gain range of 24 dB (in steps of 0.1 dB)
- Low power consumption of only 175 mW at 2.7 V
- Power consumption in standby mode of 4.5 mW (typ.)
- 3.0 V operation and 2.5 to 3.6 V operation for the digital outputs
- All digital inputs accept 5 V signals
- Active control pulses polarity selectable via serial interface
- 8-bit DAC included for analog settings
- TTL compatible inputs, CMOS compatible outputs.

3. Applications

- Low-power, low-voltage CCD camera systems.

PHILIPS

4. Quick reference data

Table 1: Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{CCA}	analog supply voltage		2.7	3.0	3.6	V
V_{CCD}	digital supply voltage		2.7	3.0	3.6	V
V_{CCO}	digital outputs supply voltage		2.5	2.7	3.6	V
I_{CCA}	analog supply current	all clamps active	–	60	–	mA
I_{CCD}	digital supply current		–	3	–	mA
I_{CCO}	digital outputs supply current	f_{pix} = 30 MHz; C_L = 10 pF; input ramp response time is 800 µs	–	1	–	mA
ADC_{res}	ADC resolution		–	12	–	bits
$V_{i(CDS)(p-p)}$	maximum CDS input voltage (peak-to-peak value)	V_{CC} = 2.85 V	650	–	–	mV
		$V_{CC} \geq$ 3.0 V	800	–	–	mV
$f_{pix(max)}$	maximum pixel frequency		30	–	–	MHz
$f_{pix(min)}$	minimum pixel frequency		tbf	–	–	MHz
DR_{PGA}	PGA dynamic range		–	24	–	dB
$N_{tot(rms)}$	total noise from CDS input to ADC output	PGA gain = 0 dB; see Figure 8	–	1.5	–	LSB
$E_{in(rms)}$	equivalent input noise (RMS value)	gain = 24 dB	–	70	–	µV
P_{tot}	total power consumption	$V_{CCA} = V_{CCD} = V_{CCO}$ = 3 V	–	195	–	mW
		$V_{CCA} = V_{CCD} = V_{CCO}$ = 2.7 V	–	175	–	mW

5. Ordering information

Table 2: Ordering information

Type number	Package		
	Name	Description	Version
TDA9964HL	LQFP48	plastic low profile quad flat package; 48 leads; body 7 × 7 × 1.4 mm	SOT313-2

6. Block diagram

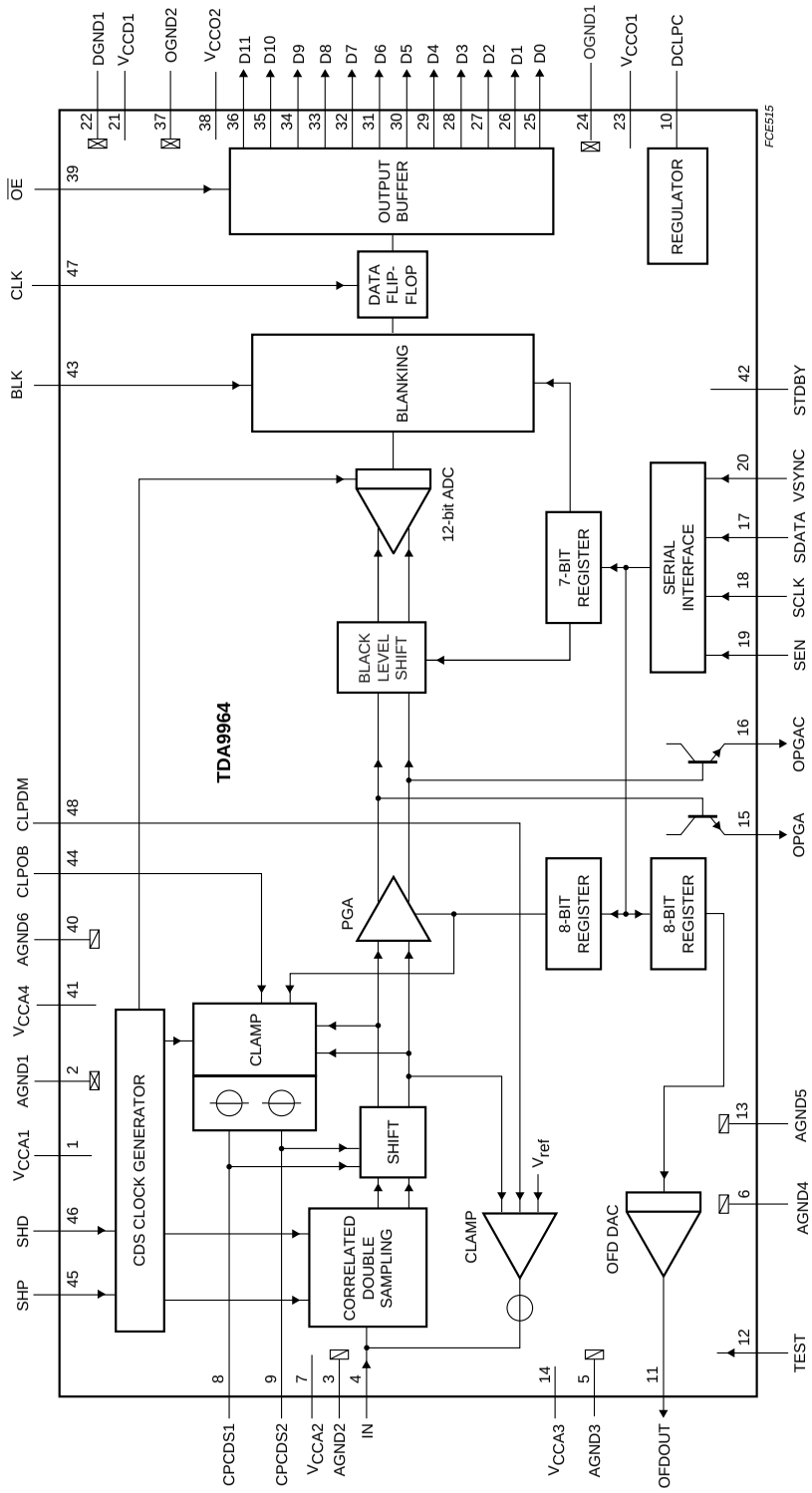


Fig 1. Block diagram.

7. Pinning information

7.1 Pinning

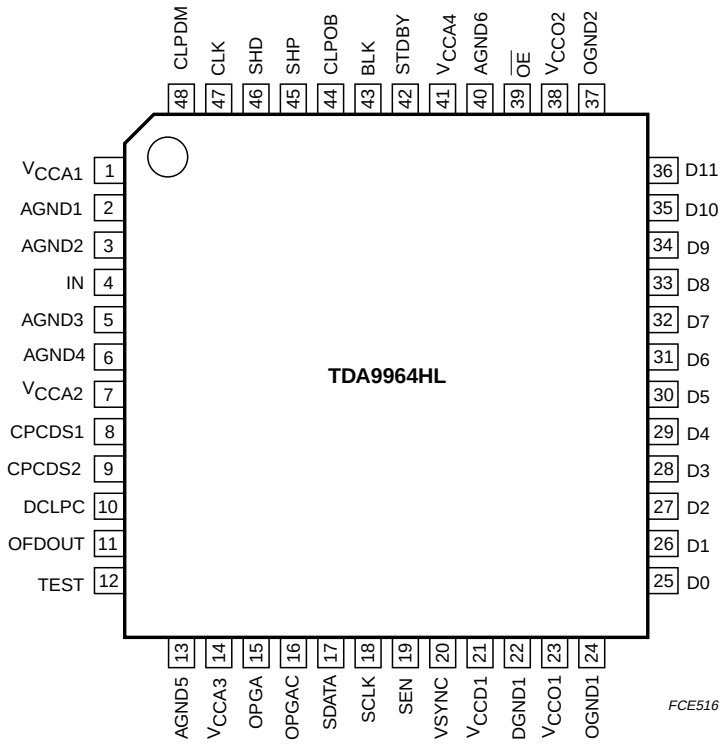


Fig 2. Pin configuration.

7.2 Pin description

Table 3: Pin description

Symbol	Pin	Description
V_{CCA1}	1	analog supply voltage 1
AGND1	2	analog ground 1
AGND2	3	analog ground 2
IN	4	input signal from CCD
AGND3	5	analog ground 3
AGND4	6	analog ground 4
V_{CCA2}	7	analog supply voltage 2
CPCDS1	8	clamp storage capacitor pin 1
CPCDS2	9	clamp storage capacitor pin 2
DCLPC	10	regulator decoupling pin
OFDOUT	11	analog output of the additional 8-bit control DAC
TEST	12	test mode input pin (should be connected to AGND5)
AGND5	13	analog ground 5
V_{CCA3}	14	analog supply 3

Table 3: Pin description *...continued*

Symbol	Pin	Description
OPGA	15	PGA output (test pin)
OPGAC	16	PGA complementary output (test pin)
SDATA	17	serial data input for serial interface control
SCLK	18	serial clock input for serial interface
SEN	19	strobe pin for serial interface
VSYNC	20	vertical sync pulse input
V_{CCD1}	21	digital supply voltage 1
DGND1	22	digital ground 1
V_{CCO1}	23	output supply voltage 1
OGND1	24	digital output ground 1
D0	25	ADC digital output 0 (LSB)
D1	26	ADC digital output 1
D2	27	ADC digital output 2
D3	28	ADC digital output 3
D4	29	ADC digital output 4
D5	30	ADC digital output 5
D6	31	ADC digital output 6
D7	32	ADC digital output 7
D8	33	ADC digital output 8
D9	34	ADC digital output 9
D10	35	ADC digital output 10
D11	36	ADC digital output 11 (MSB)
OGND2	37	output digital ground 2
V_{CCO2}	38	output supply voltage 2
$\overline{OE}$	39	output enable control input (LOW: outputs active; HIGH: outputs are high impedance)
AGND6	40	analog ground 6
V_{CCA4}	41	analog supply voltage 4
STDBY	42	standby mode control input (LOW: TDA9964 active; HIGH: TDA9964 standby)
BLK	43	blanking control input
CLPOB	44	clamp pulse input at optical black
SHP	45	preset sample-and-hold pulse input
SHD	46	data sample-and-hold pulse input
CLK	47	data clock input
CLPDM	48	clamp pulse input at dummy pixel

8. Limiting values

Table 4: Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CCA}	analog supply voltage		[1]	–0.3	+7.0	V
V_{CCD}	digital supply voltage		[1]	–0.3	+7.0	V
V_{CCO}	digital outputs supply voltage		[1]	–0.3	+7.0	V
ΔV_{CC}	supply voltage difference:					
	between V_{CCA} and V_{CCD}			–0.5	+0.5	V
	between V_{CCA} and V_{CCO}			–0.5	+1.2	V
	between V_{CCD} and V_{CCO}			–0.5	+1.2	V
V_i	input voltage	referenced to AGND		–0.3	+7.0	V
I_o	data output current			–	±10	mA
T_{stg}	storage temperature			–55	+150	°C
T_{amb}	ambient temperature			–20	+75	°C
T_j	junction temperature			–	150	°C

[1] 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.

9. Thermal characteristics

Table 5: Thermal characteristics

Symbol	Parameter	Conditions	Value	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	76	K/W

10. Characteristics

Table 6: Characteristics

V_{CCA} = V_{CCD} = 3.0 V; V_{CCO} = 2.7 V; f_{pix} = 30 MHz; T_{amb} = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supplies						
V_{CCA}	analog supply voltage		2.7	3.0	3.6	V
V_{CCD}	digital supply voltage		2.7	3.0	3.6	V
V_{CCO}	digital outputs supply voltage		2.5	2.7	3.6	V
I_{CCA}	analog supply current	all clamps active	–	60	–	mA
I_{CCD}	digital supply current		–	3	–	mA
I_{CCO}	digital outputs supply current	C_L = 10 pF on all data outputs; input ramp response time is 800 µs	–	1	–	mA

Table 6: Characteristics *...continued*

V_{CCA} = V_{CCD} = 3.0 V; V_{CCO} = 2.7 V; f_{pix} = 30 MHz; T_{amb} = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Digital inputs						
Pins: SHP, SHD and CLK (referenced to DGND)						
V_{IL}	LOW-level input voltage		0	–	0.6	V
V_{IH}	HIGH-level input voltage		2.2	–	5.5	V
I_i	input current	$0 \leq V_i \leq 5.5$ V	–3	–	+3	µA
Z_i	input impedance	f_{CLK} = 30 MHz	–	50	–	kΩ
C_i	input capacitance	f_{CLK} = 30 MHz	–	–	2	pF
Pins: CLPDM, CLPOB, SEN, SCLK, SDATA, STBY, $\overline{OE}$, BLK, VSYNC						
V_{IL}	LOW-level input voltage		0	–	0.6	V
V_{IH}	HIGH-level input voltage		2.2	–	5.5	V
I_i	input current	$0 \leq V_i \leq 5.5$ V	–2	–	+2	µA
Clamps						
Global characteristics of the clamp loops						
$t_{W(clamp)}$	clamp active pulse width in number of pixels	PGA code = 255 for maximum 4 LSB error	12	–	–	pixels
Input clamp (driven by CLPDM)						
$g_{m(CDS)}$	CDS input clamp transconductance		–	20	–	mS
Correlated Double Sampling (CDS)						
$V_{i(CDS)(p-p)}$	maximum peak-to-peak CDS input amplitude (video signal)	V_{CC} = 2.85 V	650	–	–	mV
		$V_{CC} \geq 3.0$ V	800	–	–	mV
$V_{reset(max)}$	maximum CDS input reset pulse amplitude		500	–	–	mV
$I_{i(IN)}$	input current into pin IN	at floating gate level	tbf	–	tbf	µA
C_i	input capacitance		–	2	–	pF
$t_{CDS(min)}$	CDS control pulses minimum active time	$V_{i(CDS)(p-p)}$ = 800 mV black to white transition in 1 pixel with 98.5% V_i recovery	8	–	–	ns
$t_{h(IN;SHP)}$	CDS input hold time (pin IN) compared to control pulse SHP	see Figure 3 and 4	4	–	–	ns
$t_{h(IN;SHD)}$	CDS input hold time (pin IN) compared to control pulse SHD	see Figure 3 and 4	4	–	–	ns
Amplifier						
DR_{PGA}	PGA dynamic range		–	24	–	dB
ΔG_{PGA}	PGA gain step		0.08	0.10	0.12	dB
Analog-to-Digital Converter (ADC)						
DNL	differential non linearity	f_{pix} = 30 MHz; ramp input	–	±0.5	±0.9	LSB
Total chain characteristics (CDS + PGA + ADC)						
$f_{pix(max)}$	maximum pixel frequency		30	–	–	MHz

Table 6: Characteristics *...continued*

V_{CCA} = V_{CCD} = 3.0 V; V_{CCO} = 2.7 V; f_{pix} = 30 MHz; T_{amb} = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$f_{pix(min)}$	minimum pixel frequency		tbf	–	–	MHz
t_{CLKH}	CLK pulse width HIGH		12	–	–	ns
t_{CLKL}	CLK pulse width LOW		12	–	–	ns
$t_{d(SHD;CLK)}$	time delay between SHD and CLK	see Figure 3 and 4	10	–	–	ns
$t_{su(BLK;SHD)}$	set-up time of BLK compared to SHD	see Figure 3 and 4	5	–	–	ns
$V_{i(IN)}$	video input dynamic signal for ADC full-scale output	PGA code = 00	800	–	–	mV
		PGA code = 255	50	–	–	mV
$N_{tot(rms)}$	total noise from CDS input to ADC output (RMS value)	see Figure 8				
		PGA gain = 0 dB	–	1.5	–	LSB
		PGA gain = 9 dB	–	2.2	–	LSB
$E_{in(rms)}$	equivalent input noise voltage (RMS value)	PGA gain = 24 dB	–	70	–	µV
		PGA gain = 9 dB	–	140	–	µV
$O_{CCD(max)}$	maximum offset between CCD floating level and CCD dark pixel level		–100	–	+100	mV
Digital-to-analog converter (OFDOUT DAC)						
$V_{OFDOUT(p-p)}$	additional 8-bit control DAC (OFD) output voltage (peak-to-peak value)	R_i = 1 MΩ	–	1.0	–	V
$V_{OFDOUT(0)}$	DC output voltage for code 0		–	AGND	–	V
$V_{OFDOUT(255)}$	DC output voltage for code 255		–	AGND + 1.0	–	V
TC_{DAC}	DAC output range temperature coefficient		–	250	–	ppm/°C
Z_{OFDOUT}	DAC output impedance		–	2000	–	Ω
I_{OFDOUT}	OFD output current drive	static	–	–	100	µA
Digital outputs (f_{pix} = 30 MHz; C_L = 10 pF); see Figure 3 and 4						
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	0.5 V < V_o < V_{CCO}	–20	–	+20	µA
$t_{h(o)}$	output hold time		5	–	–	ns
$t_{d(o)}$	output delay time	C_L = 10 pF; V_{CCO} = 3.0 V	–	12	tbf	ns
		C_L = 10 pF; V_{CCO} = 2.7 V	–	14	tbf	ns
C_L	output load capacitance		–	–	15	pF
Serial interface						
$f_{SCLK(max)}$	maximum frequency of serial interface		10	–	–	MHz

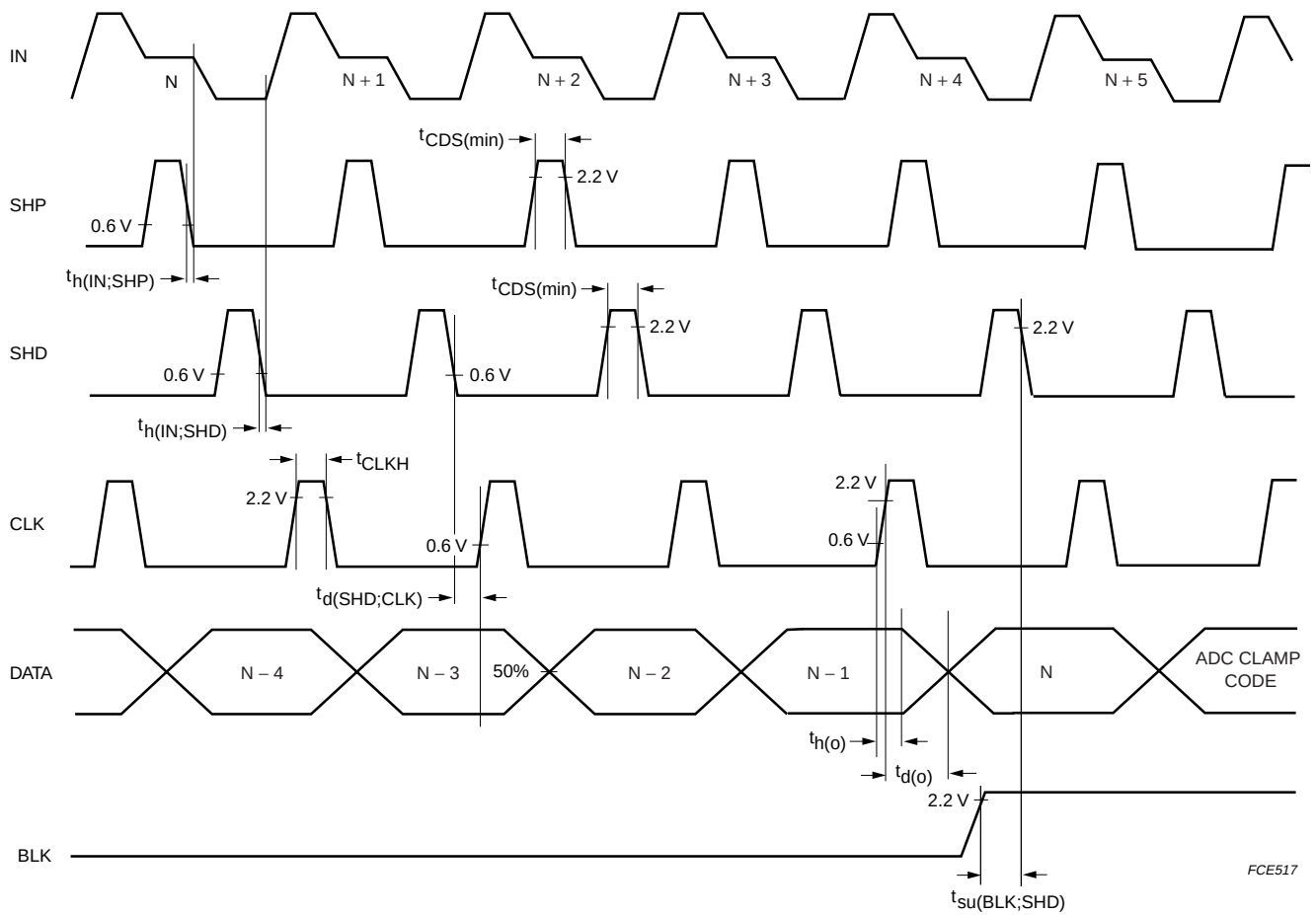


Fig 3. Pixel frequency timing diagram; all polarities active HIGH.

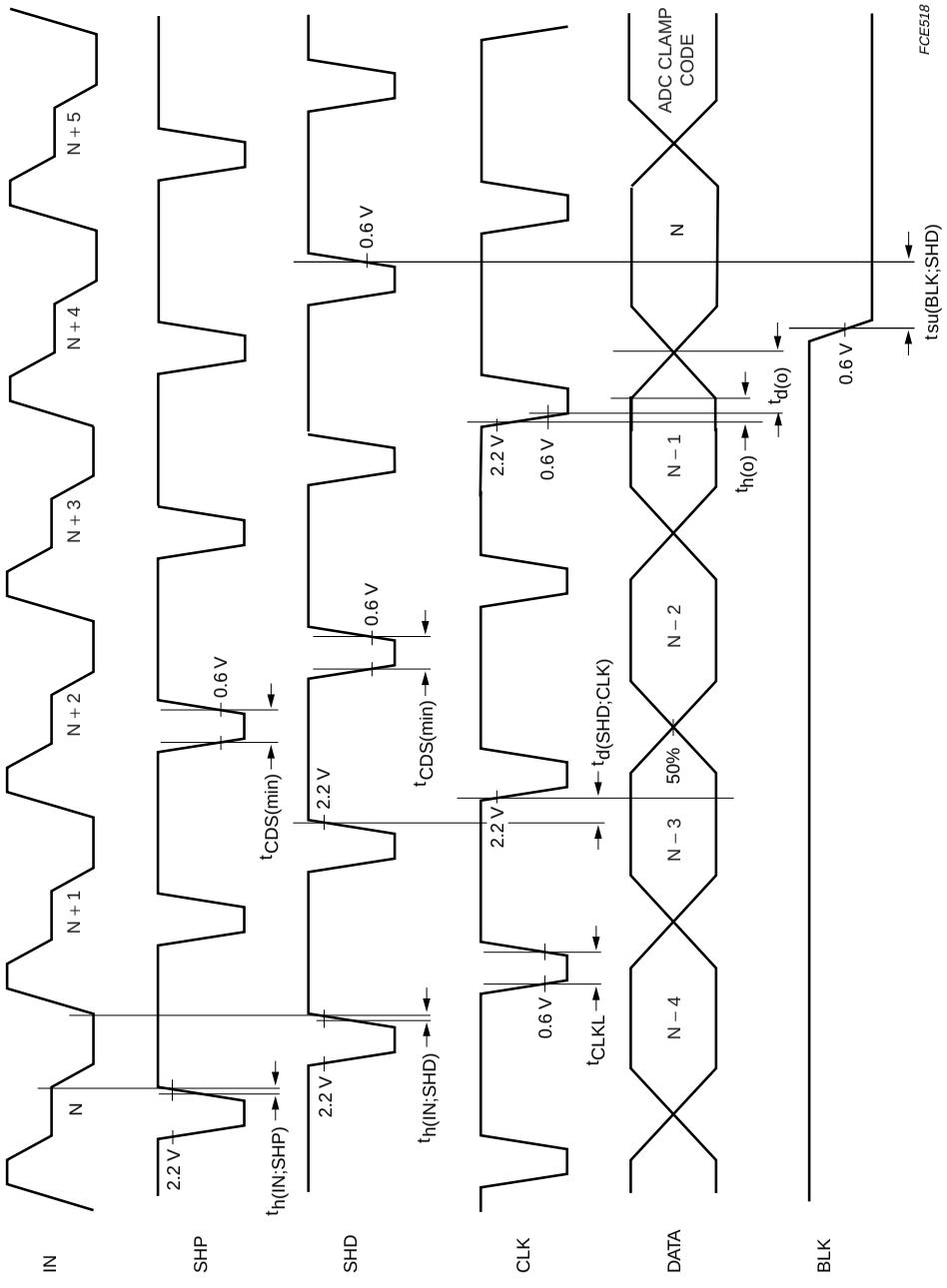


Fig 4. Pixel frequency timing diagram; all polarities active LOW.

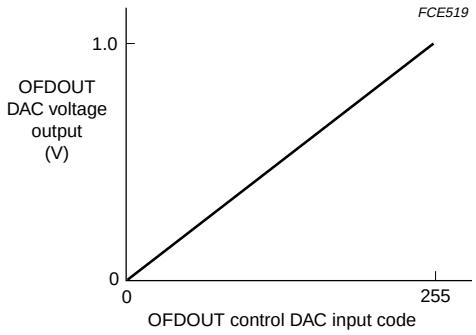


Fig 5. DAC voltage output as a function of DAC input code.

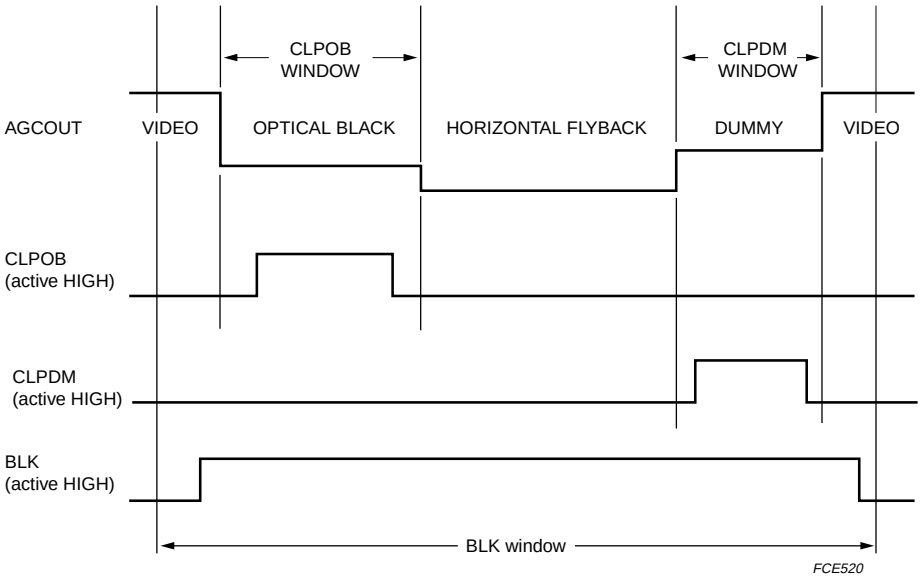


Fig 6. Line frequency timing diagram.

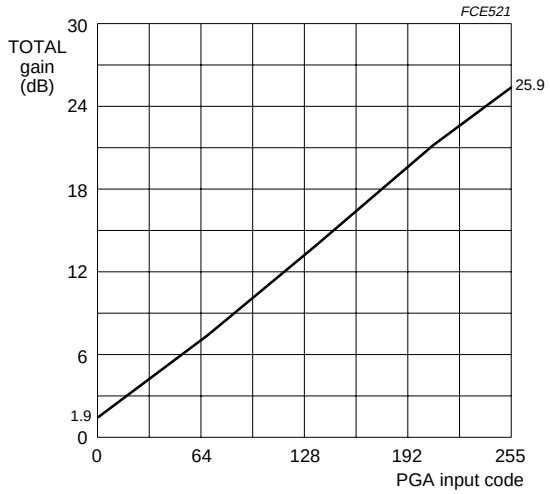
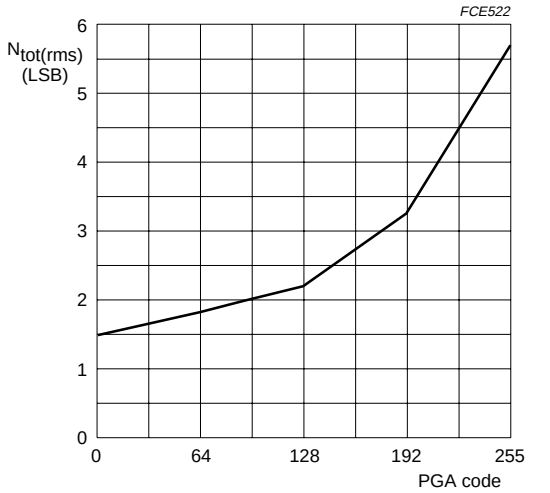


Fig 7. Total gain from CDS input to ADC input as a function of PGA input code.



Noise measurement at ADC outputs: Coupling capacitor at input is grounded, so only noise contribution of the front-end is evaluated. Front-end works at 30 Mpixels with line of 1024 pixels of which the first 40 lines are used to run CLPOB and the last 40 lines for CLPDM. Data at the ADC outputs is measured during the other pixels. As a result, the standard deviation of the codes statistic is computed, resulting in the noise. No quantization noise is taken into account as there is no input.

Fig 8. Typical total noise performance as a function of PGA gain.

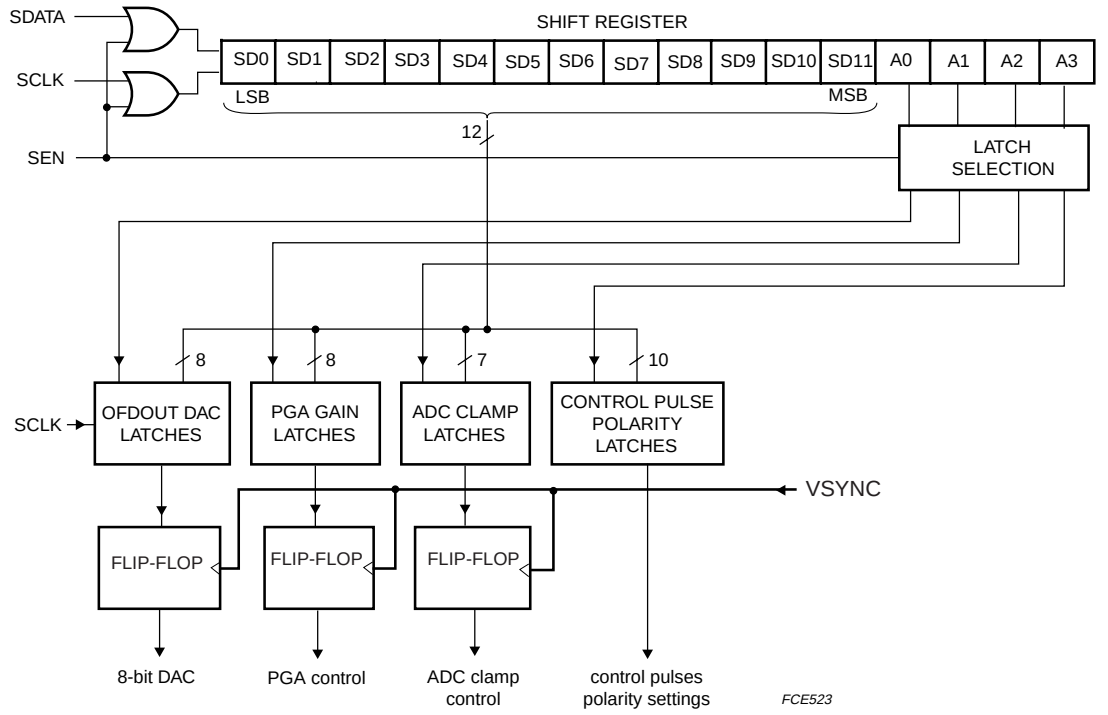
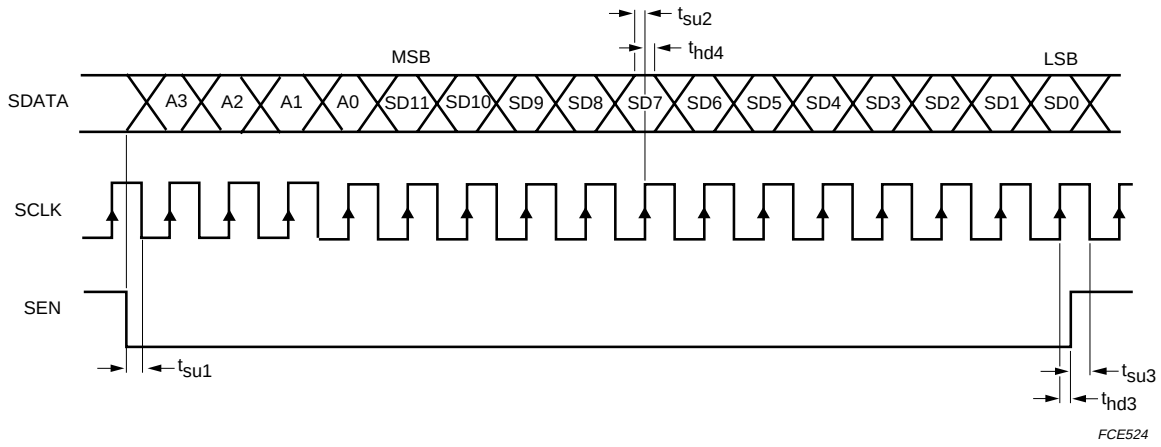


Fig 9. Serial interface block diagram.



$t_{su1} = t_{su2} = t_{su3} = 10$ ns (min.); $t_{hd3} = t_{hd4} = 10$ ns (min.)

Fig 10. Loading sequence of control input data via the serial interface.

Table 7: Serial interface programming

Address bits				Data bits D9 to D0
A3	A2	A1	A0	
0	0	0	0	PGA gain control (SD7 to SD0)
0	0	0	1	DAC OFDOUT output control (SD7 to SD0)
0	0	1	0	ADC clamp reference control (SD6 to SD0); from code 0 to 127
0	0	1	1	control pulses (pins SHP, SHD, CLPDM, CLPOB, BLK and CLK) polarity settings; SD2, SD6, SD7 and SD9 should be set to logic 1; for SD6 and SD7 see Table 9, 10, 11, and 12
0	1	0	0	SD7 = 0 by default; SD7 = 1 PGA gain up to 36 dB but noise and clamp behaviour are not guaranteed
1	1	1	1	initialization (SD11 to SD0 = 0)
other addresses				test modes

Table 8: Polarity settings

Symbol	Pin	Serial control bit	Active edge or level
SHP and SHD	45 and 46	SD4	1 = HIGH; 0 = LOW
CLK	47	SD5	1 = rising; 0 = falling
CLPDM	48	SD0	1 = HIGH; 0 = LOW
CLPOB	44	SD1	1 = HIGH; 0 = LOW
BLK	43	SD3	1 = HIGH; 0 = LOW
VSYNC	20	SD8	0 = rising; 1 = falling

Table 9: Standby control using pin STDBY

Bit SD7 of register 0011	STDBY	ADC digital outputs D11 to D0	$I_{CCA} + I_{CCO} + I_{CCD}$ (typ.)
1	1	last logic state	1.5 mA
	0	active	65 mA
0	1	active	65 mA
	0	test logic state	1.5 mA

Table 10: Output enable selection using output enable pin ($\overline{OE}$)

Bit SD6 of register 0011	$\overline{OE}$	ADC digital outputs D11 to D0
1	0	active, binary
	1	high impedance
0	0	high impedance
	1	active binary

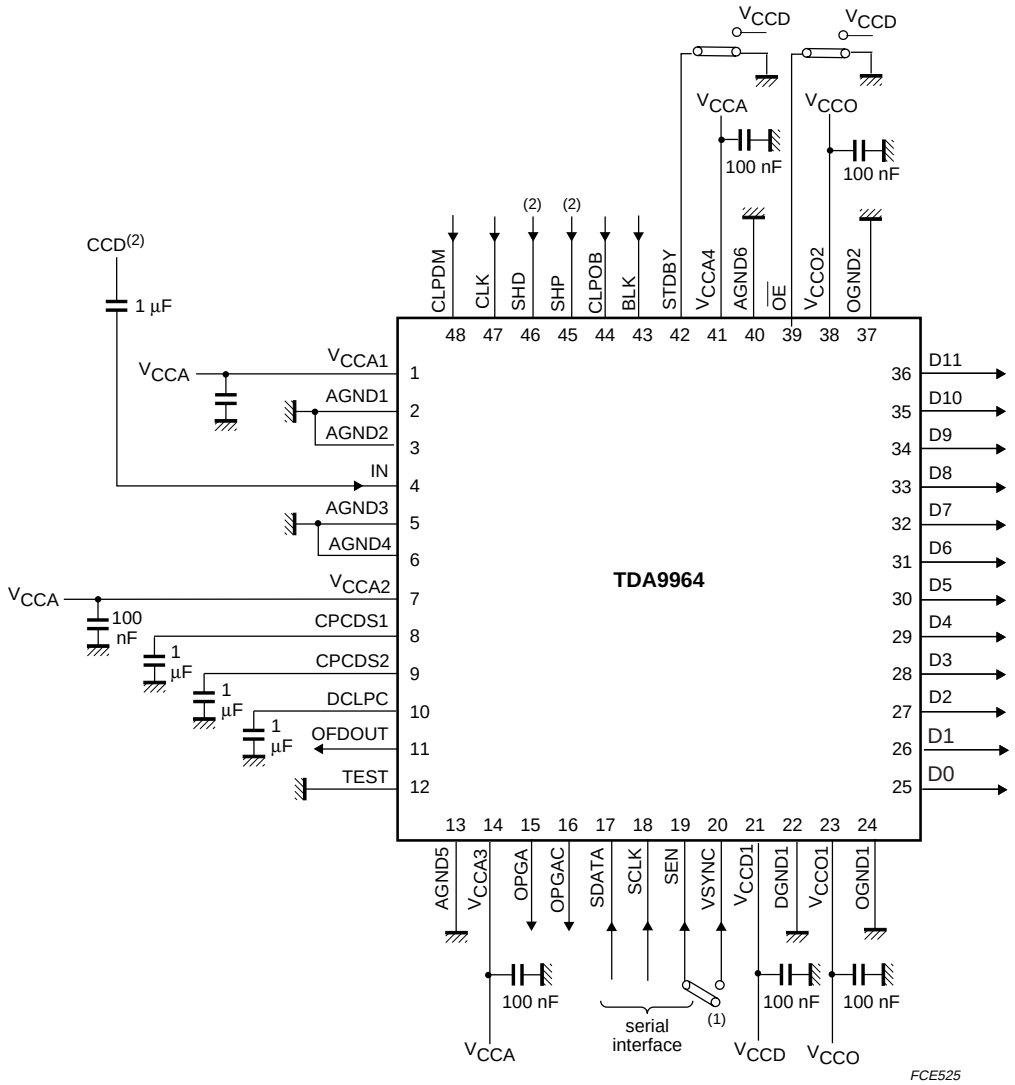
Table 11: Standby control by serial interface (register address A3 = 0, A2 = 0, A1 = 1 and A0 = 1); pin STDBY connected to ground

SD7	ADC digital outputs D11 to D0	$I_{CCA} + I_{CCO} + I_{CCD}$ (typ.)
0	last logic state	1.5 mA
1	active	65 mA

Table 12: Output enable control by serial interface (register address A3 = 0, A2 = 0, A1 = 1 and A0 = 1); output enable pin ($\overline{OE}$) connected to ground

SD6	ADC digital outputs D11 to D0
0	high impedance
1	active binary

11. Application information



(1) Pins SEN and VSYNC should be interconnected when the vertical sync signal is not available.

(2) Input signals IN, SHD and SHP must be adjusted to comply with timing signals $t_{h(IN;SHP)}$ and $t_{h(IN;SHD)}$ (see Section 10 "Characteristics").

Fig 11. Application diagram.

11.1 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 analog 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 analog and digital supplies provide the best solution. If it is not possible to do this on the board, the analog supply pins must be decoupled effectively from the digital supply pins. If the same power supply and ground are used for all the pins, the decoupling capacitors must be placed as closely as possible to the IC package.

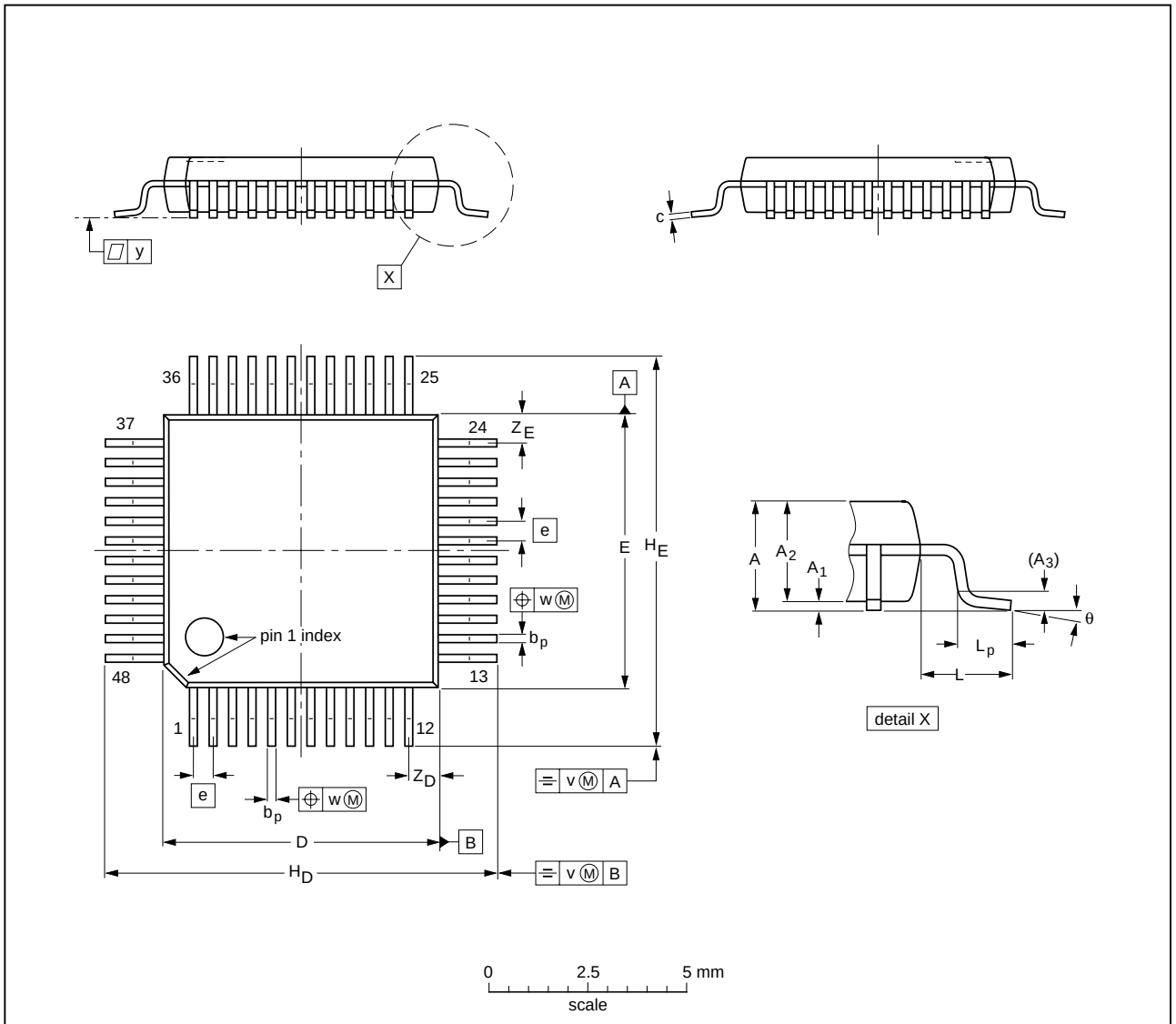
To minimize the noise caused by package and die parasitics in a two-ground system, the following recommendation must be implemented:

All analog and digital supply pins must be decoupled to the analog ground plane. Only the ground pin associated with the digital outputs must be connected to the digital ground plane. All other ground pins should be connected to the analog ground plane. The analog and digital ground planes must be connected together at one point as closely 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 then be used as return path for digital signals.

12. 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^o 0^o

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	136E05	MS-026				~~99-12-27~~ 00-01-19

Fig 12. SOT313-2.

13. Handling information

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

14. Soldering

14.1 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 can still be used for certain surface mount ICs, but it is not suitable for fine pitch SMDs. In these situations reflow soldering is recommended.

14.2 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, convection or convection/infrared 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 preferable be kept below 220 °C for thick/large packages, and below 235 °C small/thin packages.

14.3 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.

14.4 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.

14.5 Package related soldering information

Table 13: Suitability of surface mount IC packages for wave and reflow soldering methods

Package	Soldering method	
	Wave	Reflow [1]
BGA, HBGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, 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

[1] 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*.

[2] 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).

[3] 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.

[4] Wave soldering is only suitable for LQFP, QFP and TQFP 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.

[5] 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.

15. Revision history

Table 14: Revision history

Rev	Date	CPCN	Description
03	20010116	-	Objective specification; third version
02	20000801	-	Objective specification; second version
01	20000502	-	Objective specification; initial version

16. Data sheet status

Datasheet status	Product status	Definition [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

[1] Please consult the most recently issued data sheet before initiating or completing a design.

17. Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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.

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