

# DATA SHEET

## **TDA8787A**

10-bit, 3.0 V, up to 18 Msps  
analog-to-digital interface for  
CCD cameras

Product specification  
Supersedes data of 2000 Nov 14

2002 Oct 25

# 10-bit, 3.0 V, up to 18 Msps analog-to-digital interface for CCD cameras

## TDA8787A

### FEATURES

- Correlated Double Sampling (CDS), Programmable Gain Amplifier (PGA), 10-bit Analog-to-Digital Converter (ADC) and reference regulator included
- Fully programmable via a 3-wire serial interface
- Sampling frequency up to 18 MHz
- PGA gain range of 36 dB (in steps of 0.1 dB)
- Low power consumption of only 170 mW at 2.7 V
- Power consumption in standby mode of 4.5 mW (typical value)
- 3.0 V operation; 2.5 to 3.6 V operation for the digital outputs
- Active control pulses polarity selectable via serial interface
- 8-bit DAC included for analog settings
- TTL compatible inputs, CMOS compatible outputs.

### APPLICATIONS

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

### GENERAL DESCRIPTION

The TDA8787A is a 10-bit analog-to-digital interface for CCD cameras. The device includes a correlated double sampling circuit, a PGA, clamp loops and a low-power 10-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 peak-to-peak which is available at pin OFDOUT.

### ORDERING INFORMATION

| TYPE NUMBER | PACKAGE |                                                                      |          |
|-------------|---------|----------------------------------------------------------------------|----------|
|             | NAME    | DESCRIPTION                                                          | VERSION  |
| TDA8787AHL  | LQFP48  | plastic low profile quad flat package; 48 leads; body 7 × 7 × 1.4 mm | SOT313-2 |

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## 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 stages supply voltage                   |                                                                            | 2.5  | 2.6  | 3.6  | V       |
| $I_{CCA}$           | analog supply current                                   | all clamps active; $f_{pix} = 18$ MHz                                      | –    | 50   | 60   | mA      |
| $I_{CCD}$           | digital supply current                                  | $f_{pix} = 18$ MHz                                                         | –    | 13   | 17   | mA      |
| $I_{CCO}$           | digital outputs supply current                          | $f_{pix} = 18$ MHz; $C_L = 20$ pF; input ramp response time is 800 $\mu$ s | –    | 1    | 2    | mA      |
| $ADC_{res}$         | ADC resolution                                          |                                                                            | –    | 10   | –    | bits    |
| $V_{i(CDS)(p-p)}$   | CDS input amplitude (video signal) (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                                 |                                                                            | 18   | –    | –    | MHz     |
| $f_{pix(min)}$      | minimum pixel frequency                                 |                                                                            | 2    | –    | –    | MHz     |
| $DR_{PGA}$          | PGA dynamic range                                       |                                                                            | –    | 36   | –    | dB      |
| $N_{tot(rms)}$      | total noise (RMS value) at CDS input to ADC output      | PGA code = 0; see Fig.8                                                    | –    | 0.15 | –    | LSB     |
| $V_{n(i)(eq)(rms)}$ | equivalent input noise voltage (RMS value)              | PGA code = 383                                                             | –    | 70   | –    | $\mu$ V |
| $P_{tot}$           | total power consumption                                 | $V_{CCA} = V_{CCD} = V_{CCO} = 3$ V                                        | –    | 190  | –    | mW      |
|                     |                                                         | $V_{CCA} = V_{CCD} = V_{CCO} = 2.7$ V                                      | –    | 170  | –    | mW      |

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BLOCK DIAGRAM

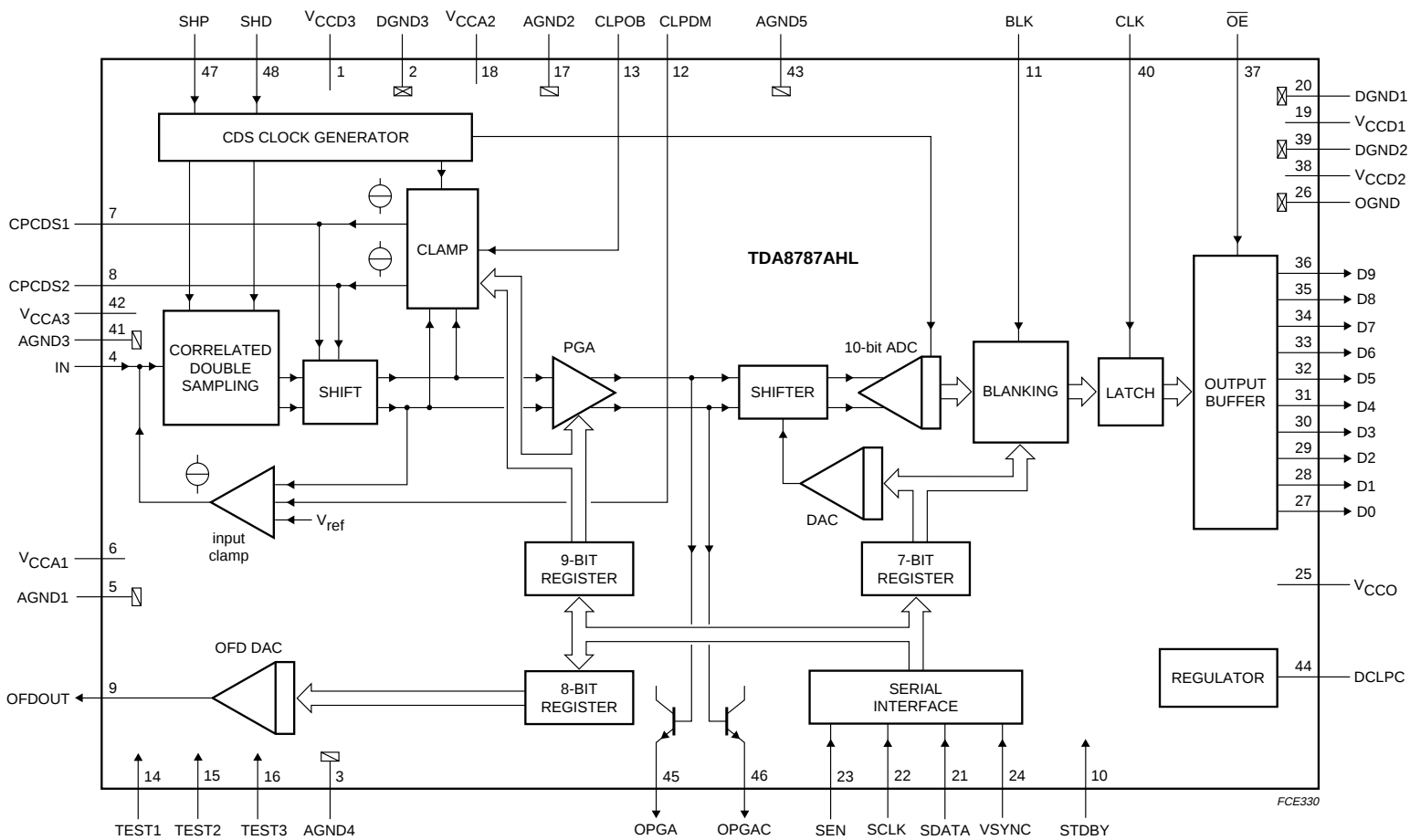


Fig.1 Block diagram.

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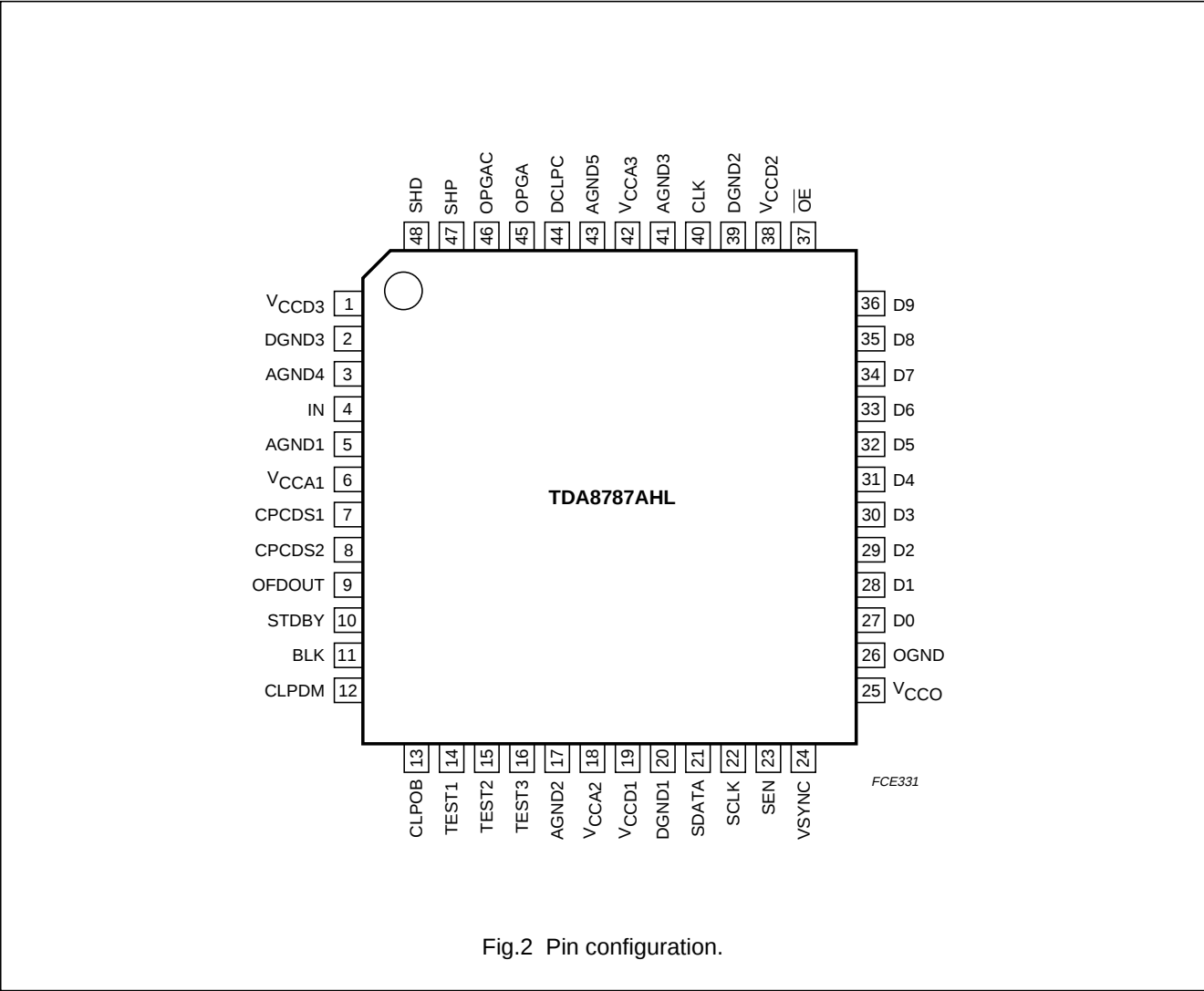
## PINNING

| SYMBOL            | PIN | DESCRIPTION                                                                        |
|-------------------|-----|------------------------------------------------------------------------------------|
| V <sub>CCD3</sub> | 1   | digital supply voltage 3                                                           |
| DGND3             | 2   | digital ground 3                                                                   |
| AGND4             | 3   | analog ground 4                                                                    |
| IN                | 4   | input signal from CCD                                                              |
| AGND1             | 5   | analog ground 1                                                                    |
| V <sub>CCA1</sub> | 6   | analog supply voltage 1                                                            |
| CPCDS1            | 7   | clamp storage capacitor 1                                                          |
| CPCDS2            | 8   | clamp storage capacitor 2                                                          |
| OFDOUT            | 9   | analog output of the additional 8-bit control DAC                                  |
| STDBY             | 10  | standby mode control input (LOW: TDA8787A active; HIGH: TDA8787A standby)          |
| BLK               | 11  | blanking control input                                                             |
| CLPDM             | 12  | clamp pulse input at dummy pixel (should be connected to ground)                   |
| CLPOB             | 13  | clamp pulse input for optical black                                                |
| TEST1             | 14  | test pin input 1 (should be connected to AGND2)                                    |
| TEST2             | 15  | test pin input 2 (should be connected to AGND2)                                    |
| TEST3             | 16  | test pin input 3 (should be connected to AGND2)                                    |
| AGND2             | 17  | analog ground 2                                                                    |
| V <sub>CCA2</sub> | 18  | analog supply voltage 2                                                            |
| V <sub>CCD1</sub> | 19  | digital supply voltage 1                                                           |
| DGND1             | 20  | digital ground 1                                                                   |
| SDATA             | 21  | serial data input for serial interface control                                     |
| SCLK              | 22  | serial clock input for serial interface control                                    |
| SEN               | 23  | strobe pin for serial interface control                                            |
| VSYNC             | 24  | vertical sync pulse input                                                          |
| V <sub>CCO</sub>  | 25  | output stages supply voltage                                                       |
| OGND              | 26  | digital output ground                                                              |
| D0                | 27  | ADC digital output 0 (LSB)                                                         |
| D1                | 28  | ADC digital output 1                                                               |
| D2                | 29  | ADC digital output 2                                                               |
| D3                | 30  | ADC digital output 3                                                               |
| D4                | 31  | ADC digital output 4                                                               |
| D5                | 32  | ADC digital output 5                                                               |
| D6                | 33  | ADC digital output 6                                                               |
| D7                | 34  | ADC digital output 7                                                               |
| D8                | 35  | ADC digital output 8                                                               |
| D9                | 36  | ADC digital output 9 (MSB)                                                         |
| OE                | 37  | output enable control input (LOW: outputs active; HIGH: outputs in high impedance) |
| V <sub>CCD2</sub> | 38  | digital supply 2                                                                   |
| DGND2             | 39  | digital ground 2                                                                   |
| CLK               | 40  | data clock input                                                                   |

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| SYMBOL | PIN | DESCRIPTION                         |
|--------|-----|-------------------------------------|
| AGND3  | 41  | analog ground 3                     |
| VCCA3  | 42  | analog supply 3                     |
| AGND5  | 43  | analog ground 5                     |
| DCLPC  | 44  | regulator decoupling pin            |
| OPGA   | 45  | PGA output (test pin)               |
| OPGAC  | 46  | PGA complementary output (test pin) |
| SHP    | 47  | preset sample-and-hold pulse input  |
| SHD    | 48  | data sample-and-hold pulse input    |



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## LIMITING VALUES

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

| SYMBOL          | PARAMETER                                                                                                                          | CONDITIONS         | MIN.                 | MAX.                 | UNIT        |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------|----------------------|----------------------|-------------|
| $V_{CCA}$       | analog supply voltage                                                                                                              | note 1             | -0.3                 | +5.0                 | V           |
| $V_{CCD}$       | digital supply voltage                                                                                                             | note 1             | -0.3                 | +5.0                 | V           |
| $V_{CCO}$       | output stages supply voltage                                                                                                       | note 1             | -0.3                 | +5.0                 | V           |
| $\Delta V_{CC}$ | supply voltage difference<br>between $V_{CCA}$ and $V_{CCD}$<br>between $V_{CCA}$ and $V_{CCO}$<br>between $V_{CCD}$ and $V_{CCO}$ |                    | -0.5<br>-0.5<br>-0.5 | +0.5<br>+1.2<br>+1.2 | V<br>V<br>V |
| $V_i$           | input voltage                                                                                                                      | referenced to AGND | -0.3                 | +5.0                 | V           |
| $I_o$           | data output current                                                                                                                |                    | -                    | $\pm 10$             | mA          |
| $T_{stg}$       | storage temperature                                                                                                                |                    | -55                  | +150                 | °C          |
| $T_{amb}$       | ambient temperature                                                                                                                |                    | -20                  | +75                  | °C          |
| $T_j$           | junction temperature                                                                                                               |                    | -                    | 150                  | °C          |

### Note

1. The supply voltages  $V_{CCA}$ ,  $V_{CCD}$  and  $V_{CCO}$  may have any value between -0.3 and +5.0 V provided that the supply voltage difference  $\Delta V_{CC}$  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  |

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## CHARACTERISTICS

$V_{CCA} = V_{CCD} = 3.0\text{ V}$ ;  $V_{CCO} = 2.6\text{ V}$ ;  $f_{\text{pix}} = 18\text{ MHz}$ ;  $T_{\text{amb}} = -20\text{ to }+75^{\circ}\text{C}$ ; unless otherwise specified.

| SYMBOL                                                                                          | PARAMETER                                          | CONDITIONS                                                                     | MIN. | TYP.  | MAX. | UNIT   |
|-------------------------------------------------------------------------------------------------|----------------------------------------------------|--------------------------------------------------------------------------------|------|-------|------|--------|
| Supplies                                                                                        |                                                    |                                                                                |      |       |      |        |
| V <sub>CCA</sub>                                                                                | analog supply voltage                              |                                                                                | 2.7  | 3.0   | 3.6  | V      |
| V <sub>CCD</sub>                                                                                | digital supply voltage                             |                                                                                | 2.7  | 3.0   | 3.6  | V      |
| V <sub>CCO</sub>                                                                                | digital outputs stages supply voltage              |                                                                                | 2.5  | 2.6   | 3.6  | V      |
| I <sub>CCA</sub>                                                                                | analog supply current                              | all clamps active                                                              | –    | 50    | 60   | mA     |
| I <sub>CCD</sub>                                                                                | digital supply current                             |                                                                                | –    | 13    | 17   | mA     |
| I <sub>CCO</sub>                                                                                | digital outputs supply current                     | C <sub>L</sub> = 20 pF on all data outputs; input ramp response time is 800 μs | –    | 1     | 2    | mA     |
| P <sub>tot</sub>                                                                                | total power consumption                            | V <sub>CCA</sub> = V <sub>CCD</sub> = V <sub>CCO</sub> = 3 V                   | –    | 190   | –    | mW     |
|                                                                                                 |                                                    | V <sub>CCA</sub> = V <sub>CCD</sub> = V <sub>CCO</sub> = 2.7 V                 | –    | 170   | –    | mW     |
| Digital inputs                                                                                  |                                                    |                                                                                |      |       |      |        |
| INPUTS: PINS STDBY, CLPDM, CLPOB, SCLK, SDATA, SEN, VSYNC, $\overline{\text{OE}}$ , CLK AND BLK |                                                    |                                                                                |      |       |      |        |
| V <sub>IL</sub>                                                                                 | LOW-level input voltage                            |                                                                                | 0    | –     | 0.6  | V      |
| V <sub>IH</sub>                                                                                 | HIGH-level input voltage                           |                                                                                | 2.2  | –     | 5.0  | V      |
| I <sub>i</sub>                                                                                  | input current                                      | 0 ≤ V <sub>i</sub> ≤ V <sub>CCD</sub>                                          | –2   | –     | +2   | μA     |
| INPUTS: PINS SHP AND SHD                                                                        |                                                    |                                                                                |      |       |      |        |
| V <sub>IL</sub>                                                                                 | LOW-level input voltage                            |                                                                                | 0    | –     | 0.6  | V      |
| V <sub>IH</sub>                                                                                 | HIGH-level input voltage                           |                                                                                | 2.2  | –     | 5.0  | V      |
| I <sub>i</sub>                                                                                  | input current                                      | 0 ≤ V <sub>i</sub> ≤ V <sub>CCD</sub>                                          | –10  | –     | +10  | μA     |
| Clamps                                                                                          |                                                    |                                                                                |      |       |      |        |
| GLOBAL CHARACTERISTICS OF THE CLAMP LOOPS                                                       |                                                    |                                                                                |      |       |      |        |
| t <sub>W(clamp)</sub>                                                                           | clamp active pulse width in numbers of pixels      | PGA input code = 255 for maximum 4 LSB error                                   | 12   | –     | –    | pixels |
| INPUT CLAMP: PIN CLPDM                                                                          |                                                    |                                                                                |      |       |      |        |
| g <sub>m(CDS)</sub>                                                                             | CDS input clamp transconductance                   |                                                                                | 1.5  | 2.7   | 3.5  | mS     |
| OPTICAL BLACK CLAMP: PIN CLPOB                                                                  |                                                    |                                                                                |      |       |      |        |
| G <sub>shift</sub>                                                                              | gain from CPCDS1 and 2 to PGA inputs               |                                                                                | –    | 0.27  | –    |        |
| I <sub>LSB(cp)</sub>                                                                            | charge pump current for ±1 LSB error at ADC output | PGA input code = 0                                                             | –    | ±20   | –    | μA     |
|                                                                                                 |                                                    | PGA input code = 383                                                           | –    | ±0.60 | –    | μA     |

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| SYMBOL                                                | PARAMETER                                                          | CONDITIONS                                                                                                                                            | MIN. | TYP.      | MAX.      | UNIT          |
|-------------------------------------------------------|--------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------|-----------|-----------|---------------|
| <b>Correlated Double Sampling (CDS): pin IN</b>       |                                                                    |                                                                                                                                                       |      |           |           |               |
| $V_{i(CDS)(p-p)}$                                     | CDS input amplitude (video signal) (peak-to-peak value)            | $V_{CC} = 2.85\text{ V}$                                                                                                                              | 650  | –         | –         | mV            |
|                                                       |                                                                    | $V_{CC} \geq 3.0\text{ V}$                                                                                                                            | 800  | –         | –         | mV            |
| $V_{i(rst)(max)}$                                     | maximum CDS input reset pulse amplitude                            |                                                                                                                                                       | 500  | –         | –         | mV            |
| $I_i$                                                 | input current                                                      | at floating gate level                                                                                                                                | –1   | –         | +1        | $\mu\text{A}$ |
| $C_i$                                                 | input capacitance                                                  |                                                                                                                                                       | –    | 2         | –         | pF            |
| $t_{CDS(min)}$                                        | CDS control pulses minimum active time                             | $V_{i(CDS)(p-p)} = 800\text{ mV}$ ; black-to-white transition in 1 pixel ( $\pm 2\text{ LSB}$ typical); $T_{amb} = 25\text{ }^\circ\text{C}$ ; note 1 | 11   | 15        | –         | ns            |
| $t_{h(IN-SHP)}$                                       | hold time SHP to IN                                                | $T_{amb} = 25\text{ }^\circ\text{C}$ ; see Figs 3 and 4                                                                                               | –    | 1         | 2         | ns            |
| $t_{h(IN-SHD)}$                                       | hold time SHD to IN                                                | $T_{amb} = 25\text{ }^\circ\text{C}$ ; see Figs 3 and 4                                                                                               | –    | 1         | 2         | ns            |
| <b>Amplifier</b>                                      |                                                                    |                                                                                                                                                       |      |           |           |               |
| $DR_{PGA}$                                            | PGA dynamic range                                                  |                                                                                                                                                       | –    | 36        | –         | dB            |
| $\Delta G_{PGA}$                                      | PGA gain step                                                      |                                                                                                                                                       | –0.3 | –         | +0.3      | dB            |
| <b>Analog-to-Digital Converter (ADC)</b>              |                                                                    |                                                                                                                                                       |      |           |           |               |
| $LE_{(l)}$                                            | integral non-linearity error                                       | $f_{pix} = 18\text{ MHz}$ ; ramp input                                                                                                                | –    | $\pm 1.3$ | $\pm 2.5$ | LSB           |
| $LE_{(d)}$                                            | differential non-linearity error                                   | $f_{pix} = 18\text{ MHz}$ ; ramp input                                                                                                                | –    | $\pm 0.5$ | $\pm 0.9$ | LSB           |
| <b>Total chain characteristics (CDS, PGA and ADC)</b> |                                                                    |                                                                                                                                                       |      |           |           |               |
| $f_{pix(max)}$                                        | maximum pixel frequency                                            |                                                                                                                                                       | 18   | –         | –         | MHz           |
| $f_{pix(min)}$                                        | minimum pixel frequency                                            |                                                                                                                                                       | 2    | –         | –         | MHz           |
| $t_{CLKH}$                                            | clock HIGH time                                                    |                                                                                                                                                       | 15   | –         | –         | ns            |
| $t_{CLKL}$                                            | clock LOW time                                                     |                                                                                                                                                       | 15   | –         | –         | ns            |
| $t_{d(SHD-CLK)}$                                      | time delay SHD to CLK                                              | see Fig.3                                                                                                                                             | 10   | –         | –         | ns            |
| $t_{su(BLK-CLK)}$                                     | set-up time of BLK compared to CLK                                 |                                                                                                                                                       | 10   | –         | –         | ns            |
| $V_{i(IN)}$                                           | video input dynamic signal for ADC full-scale output               | PGA input code = 0                                                                                                                                    | 800  | –         | –         | mV            |
|                                                       |                                                                    | PGA input code = 383                                                                                                                                  | 12.7 | –         | –         | mV            |
| $N_{tot(rms)}$                                        | total noise from CDS input to ADC output (RMS value)               | see Fig.8                                                                                                                                             |      |           |           |               |
|                                                       |                                                                    | PGA input code = 0                                                                                                                                    | –    | 0.15      | –         | LSB           |
|                                                       |                                                                    | PGA input code = 96                                                                                                                                   | –    | 0.8       | –         | LSB           |
| $V_{n(i)(eq)(rms)}$                                   | equivalent input noise voltage (RMS value)                         | PGA input code = 383                                                                                                                                  | –    | 70        | –         | $\mu\text{V}$ |
|                                                       |                                                                    | PGA input code = 0                                                                                                                                    | –    | 120       | –         | $\mu\text{V}$ |
| $O_{CCD(max)}$                                        | maximum offset between CCD floating level and CCD dark pixel level |                                                                                                                                                       | –80  | –         | +80       | mV            |

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| SYMBOL                                                                                                                    | PARAMETER                                                              | CONDITIONS                                       | MIN.                   | TYP.       | MAX.             | UNIT          |
|---------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------|------------------------|------------|------------------|---------------|
| <b>Digital-to-Analog Converter (OFDOUT DAC)</b>                                                                           |                                                                        |                                                  |                        |            |                  |               |
| $V_{\text{OFDOUT(p-p)}}$                                                                                                  | additional 8-bit control DAC (OFD) output voltage (peak-to-peak value) | $R_L = 1 \text{ M}\Omega$                        | –                      | 1.0        | –                | V             |
| $V_{\text{OFDOUT}}$                                                                                                       | DC output voltage                                                      | OFD input code 0                                 | –                      | AGND       | –                | V             |
|                                                                                                                           |                                                                        | OFD input code 255                               | –                      | AGND + 1.0 | –                | V             |
| $TC_{\text{OFD}}$                                                                                                         | OFD output range temperature coefficient                               |                                                  | –                      | 250        | –                | ppm/K         |
| $Z_{\text{OFDOUT}}$                                                                                                       | OFD output impedance                                                   |                                                  | –                      | 2000       | –                | $\Omega$      |
| $I_{\text{OFDOUT}}$                                                                                                       | OFD output drive current                                               | static                                           | –                      | –          | 100              | $\mu\text{A}$ |
| <b>Digital outputs (<math>f_{\text{pix}} = 18 \text{ MHz}</math>; <math>C_L = 10 \text{ pF}</math>); see Figs 3 and 4</b> |                                                                        |                                                  |                        |            |                  |               |
| $V_{\text{OH}}$                                                                                                           | HIGH-level output voltage                                              | $I_{\text{OH}} = -1 \text{ mA}$                  | $V_{\text{CCO}} - 0.5$ | –          | $V_{\text{CCO}}$ | V             |
| $V_{\text{OL}}$                                                                                                           | LOW-level output voltage                                               | $I_{\text{OL}} = 1 \text{ mA}$                   | 0                      | –          | 0.5              | V             |
| $I_{\text{OZ}}$                                                                                                           | OFF-state output current                                               | $0.5 \text{ V} < V_{\text{OZ}} < V_{\text{CCO}}$ | –20                    | –          | +20              | $\mu\text{A}$ |
| $t_{\text{h(o)}}$                                                                                                         | output hold time                                                       |                                                  | 9                      | –          | –                | ns            |
| $t_{\text{d(o)}}$                                                                                                         | output delay time                                                      | $V_{\text{CCO}} = 3.0 \text{ V}$                 | –                      | 17         | 23               | ns            |
|                                                                                                                           |                                                                        | $V_{\text{CCO}} = 2.7 \text{ V}$                 | –                      | 19         | 25               | ns            |
| $C_L$                                                                                                                     | load capacitance                                                       |                                                  | –                      | –          | 22               | pF            |
| <b>Serial interface</b>                                                                                                   |                                                                        |                                                  |                        |            |                  |               |
| $f_{\text{SCLK(max)}}$                                                                                                    | maximum frequency pin SCLK                                             |                                                  | 5                      | –          | –                | MHz           |

**Note**

1. Depending on application environments and especially in case of high gain operation and digital supply with jitter, it is preferable to apply 12 ns or higher CDS pulses.

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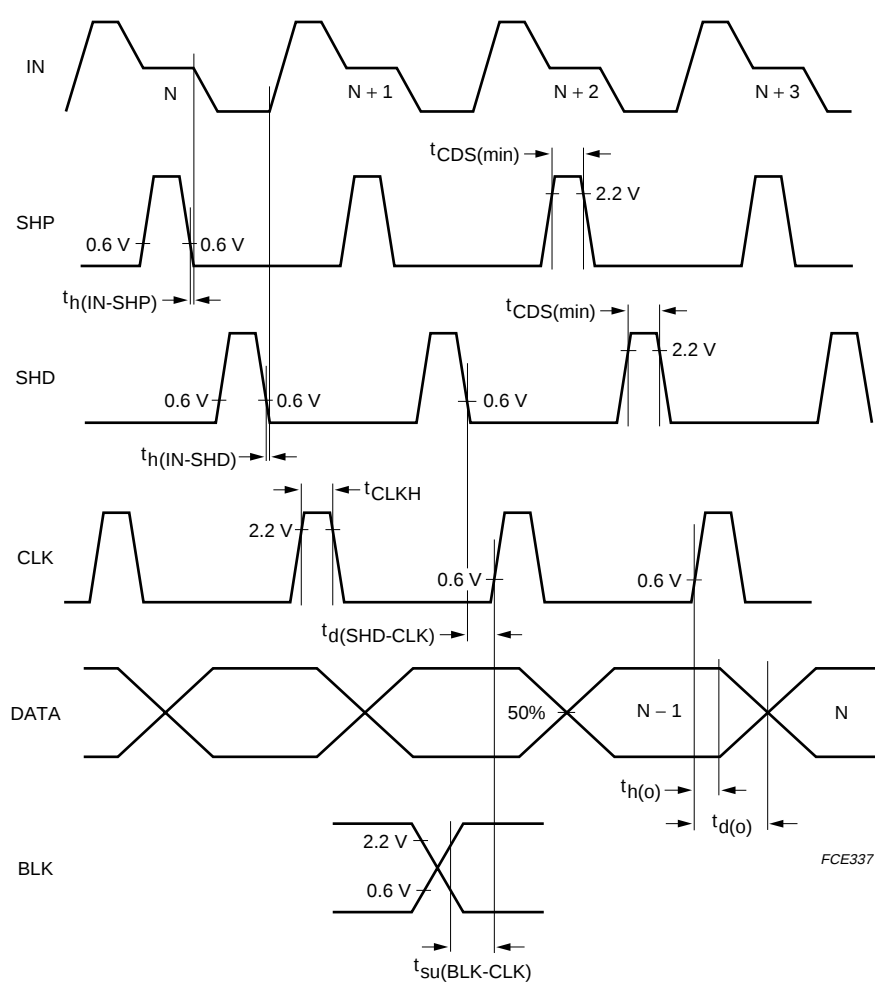


Fig.3 Pixel frequency timing diagram with active HIGH-level polarities.

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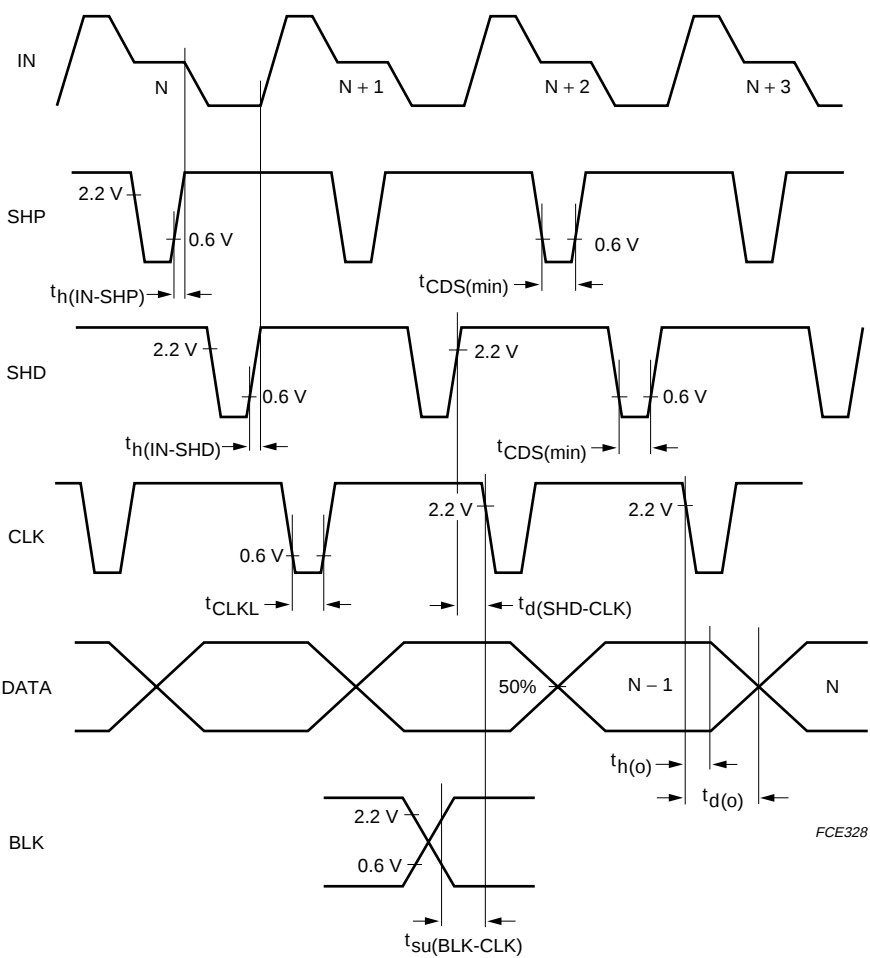


Fig.4 Pixel frequency timing diagram with active LOW-level polarities.

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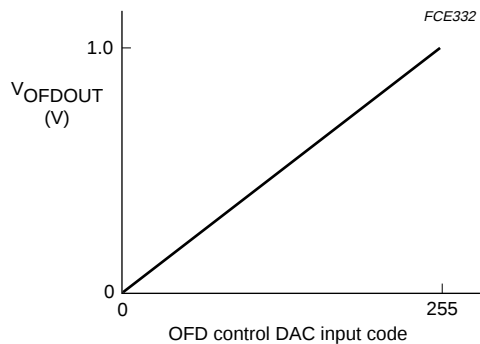
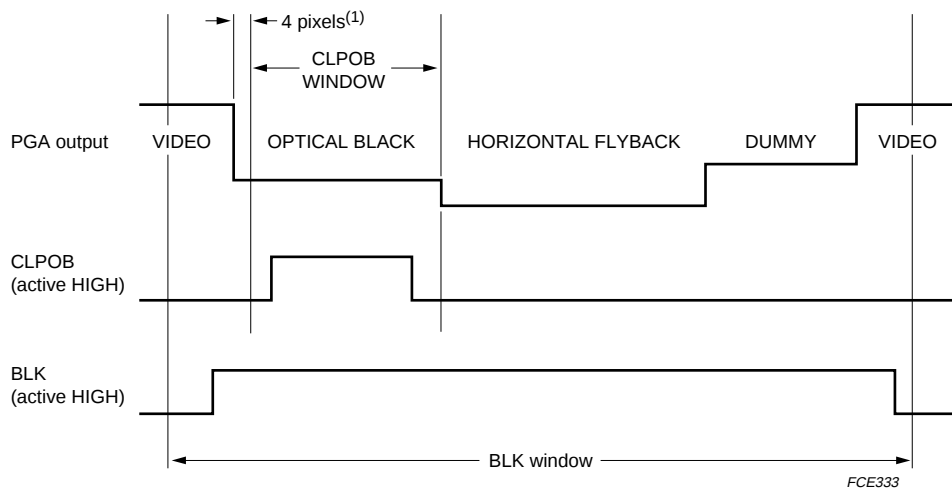


Fig.5 DAC output voltage output as a function of DAC input code.

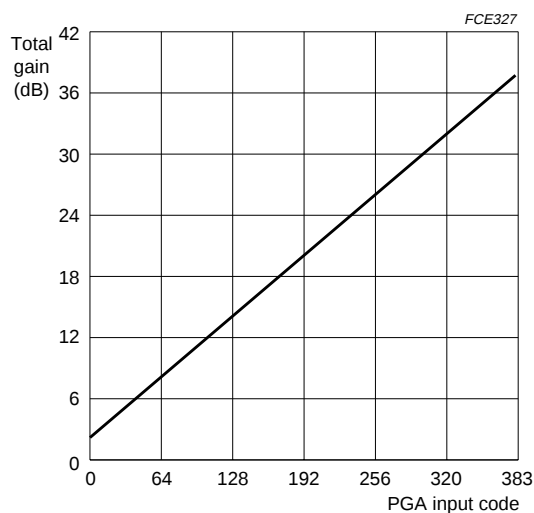


(1) In this case the number of clamp pixels is limited to  $18 \times (t_{w(clamp)})$ ; otherwise this timing interval can be

Fig.6 Line frequency timing diagram.

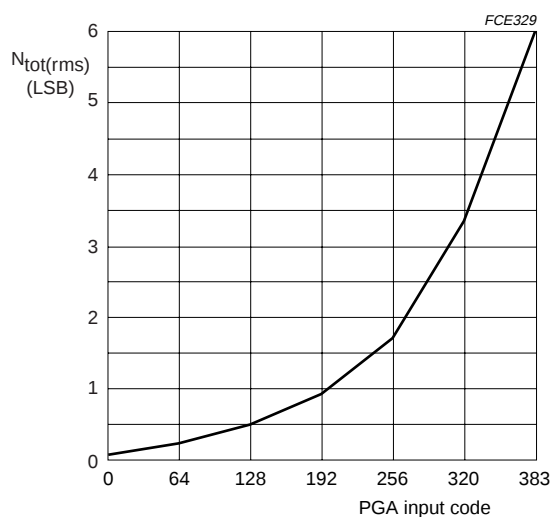
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ADC input range is 1 V<sub>pp</sub>.

Fig.7 Total gain as a function of PGA input code.

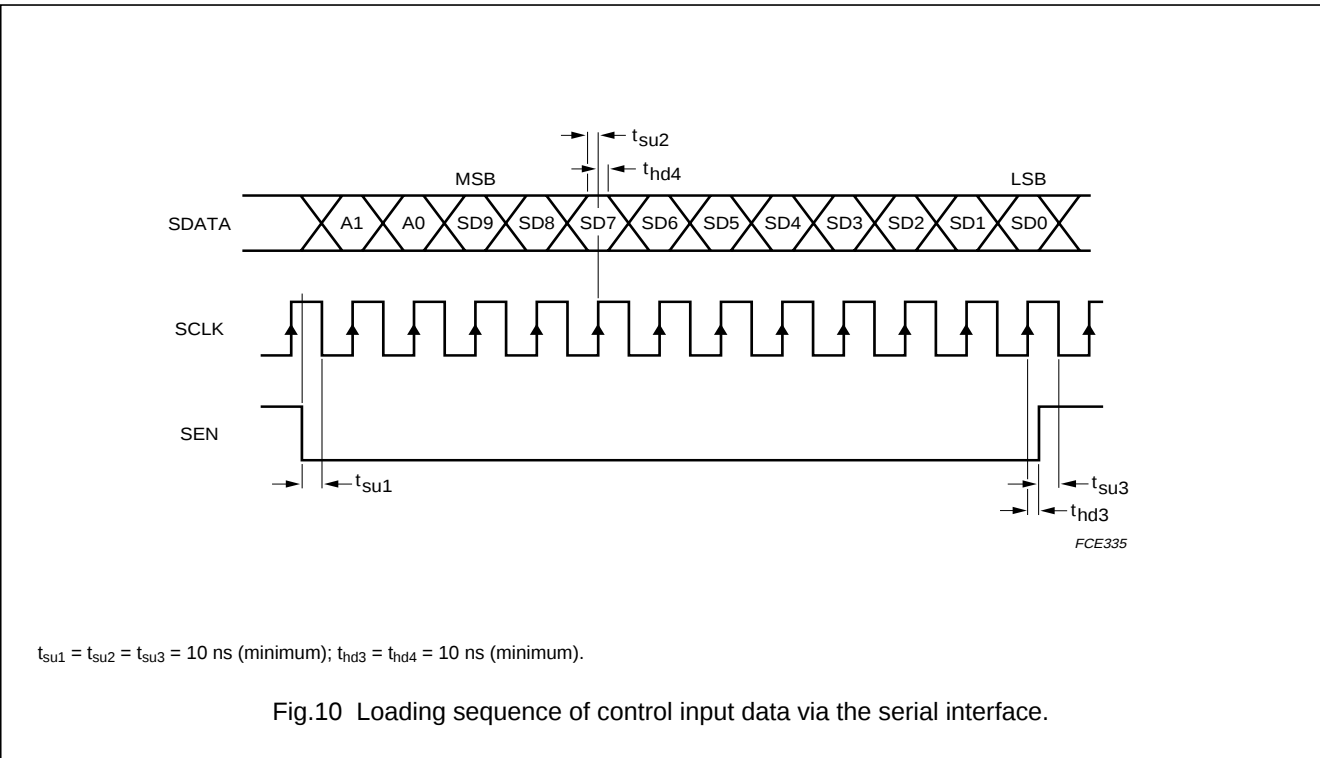
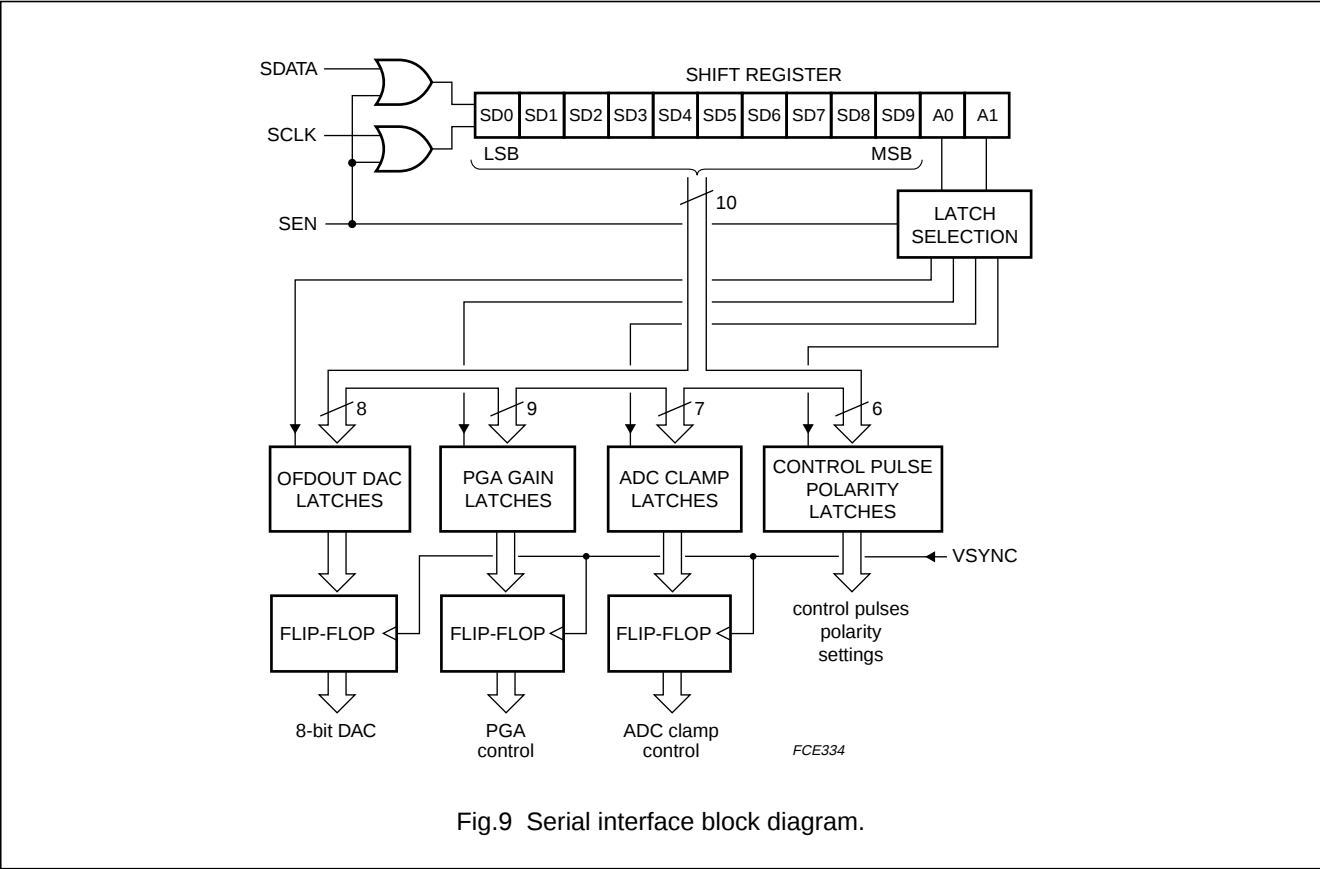


Noise measurement at ADC outputs; coupling capacitor at input is grounded, so only noise contribution of the front-end is evaluated. Front-end works at 18 Mpixels with line of 1024 pixels whose first 40 are used to run CLPOB and the last 40 for CLPDM. Data at the ADC outputs are measured during the other pixels. As a result of this, the standard deviation of the codes statistic is computed, resulting in the noise.

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

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**Table 1** Serial interface programming; see Figs 9 and 10

| ADDRESS BITS |    | DATA BITS SD9 TO SD0                                                                                         |
|--------------|----|--------------------------------------------------------------------------------------------------------------|
| A1           | A0 |                                                                                                              |
| 0            | 0  | PGA gain control (bits SD8 to SD0); bit SD9 should be set to logic 0                                         |
| 0            | 1  | DAC OFDOUT output control (bits SD7 to SD0); bits SD8 and SD9 should be set to logic 0                       |
| 1            | 0  | ADC clamp reference control (SD6 to SD0); from code 0 to 127; bits SD7, SD8 and SD9 should be set to logic 0 |
| 1            | 1  | control pulses polarity settings (pins SHP, SHD, CLPDM, CLPOB, BLK and CLK)                                  |

**Table 2** Polarity settings

| SYMBOL      | PIN                      | SERIAL CONTROL BIT <sup>(1)</sup> | ACTIVE EDGE OR LEVEL    |
|-------------|--------------------------|-----------------------------------|-------------------------|
| SHP and SHD | 47 and 48                | SD0                               | 1 = HIGH; 0 = LOW       |
| CLK         | 40                       | SD1                               | 1 = HIGH; 0 = LOW       |
| CLPDM       | 12 (connected to ground) | SD2                               | always 0 = LOW          |
| CLPOB       | 13                       | SD3                               | 1 = HIGH; 0 = LOW       |
| BLK         | 11                       | SD5                               | 1 = HIGH; 0 = LOW       |
| VSYNC       | 24                       | SD6                               | 0 = rising; 1 = falling |

**Note**

1. Bit SD4 is not used.

**Table 3** Standby mode selection; pin STDBY

| STDBY | ADC DIGITAL OUTPUTS; PINS D9 TO D0 | I <sub>CCA</sub> + I <sub>CCO</sub> + I <sub>CCD</sub> (typical) |
|-------|------------------------------------|------------------------------------------------------------------|
| 1     | logic state LOW                    | 1.5 mA                                                           |
| 0     | active                             | 64 mA                                                            |

**Table 4** Output enable ( $\overline{OE}$ ) pin 37

| $\overline{OE}$ | ADC DIGITAL OUTPUTS; PINS D9 TO D0 |
|-----------------|------------------------------------|
| 0               | active, binary                     |
| 1               | high impedance                     |

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### APPLICATION INFORMATION

#### 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 additional 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 the 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 this is not possible to do this on the board then 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 then the decoupling capacitors must be placed as close as possible to the IC package.

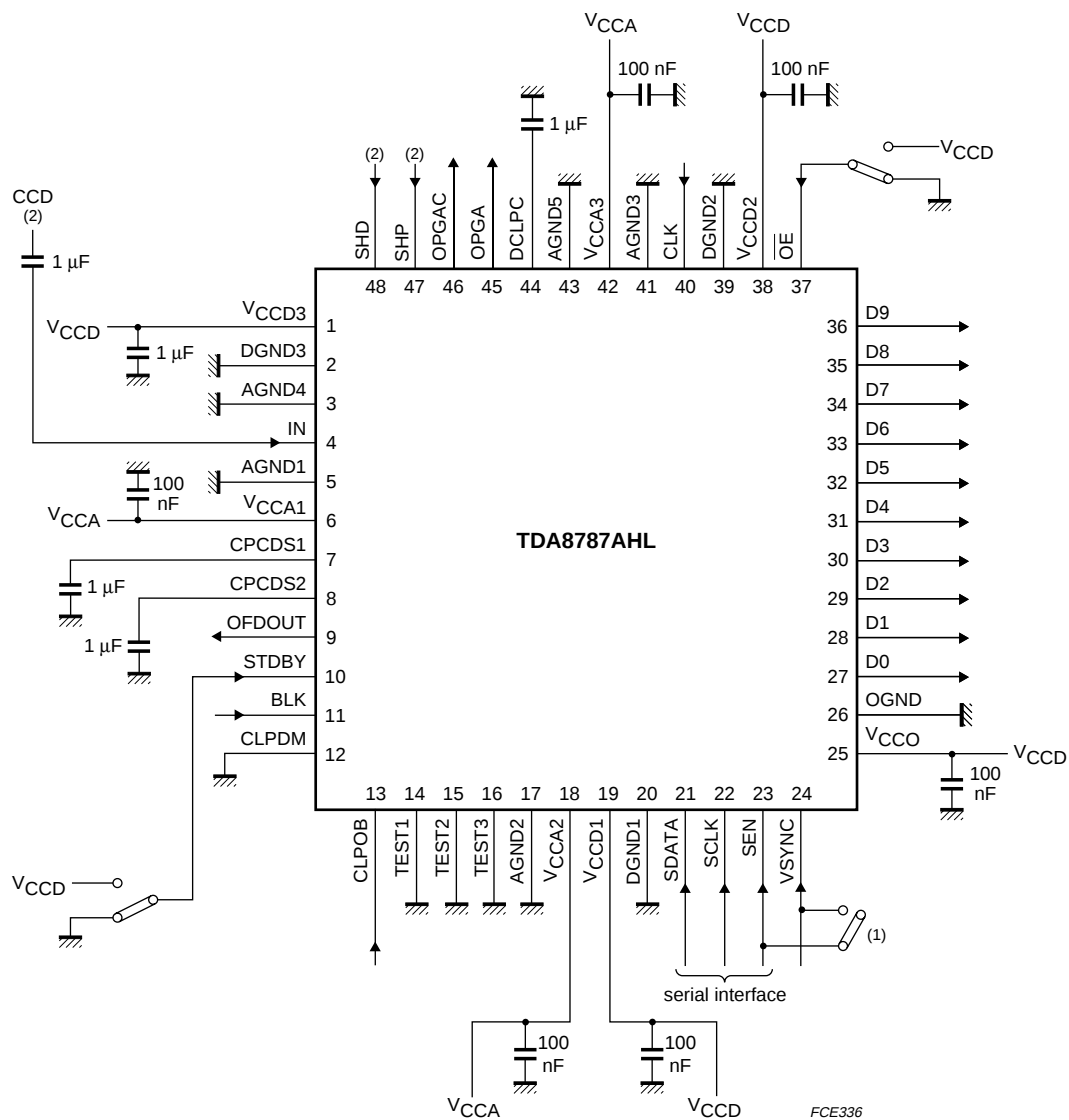
In order to minimize the noise due to package and die parasitics in a two-ground system, the following measures must be implemented:

- All the 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 the 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 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 then be used as a return path for digital signals.

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## Application diagram



- (1) Pins SEN and VSYNC should be interconnected when no vertical synchronization signal is available, while control pin VSYNC should be programmed by serial interface as LOW-level active.
- (2) The timing of the signals on pins IN, SHD and SHP has to comply with the hold times  $t_{h(IN-SHP)}$  and  $t_{h(IN-SHD)}$  (see Fig.3).

Fig.11 Application diagram.

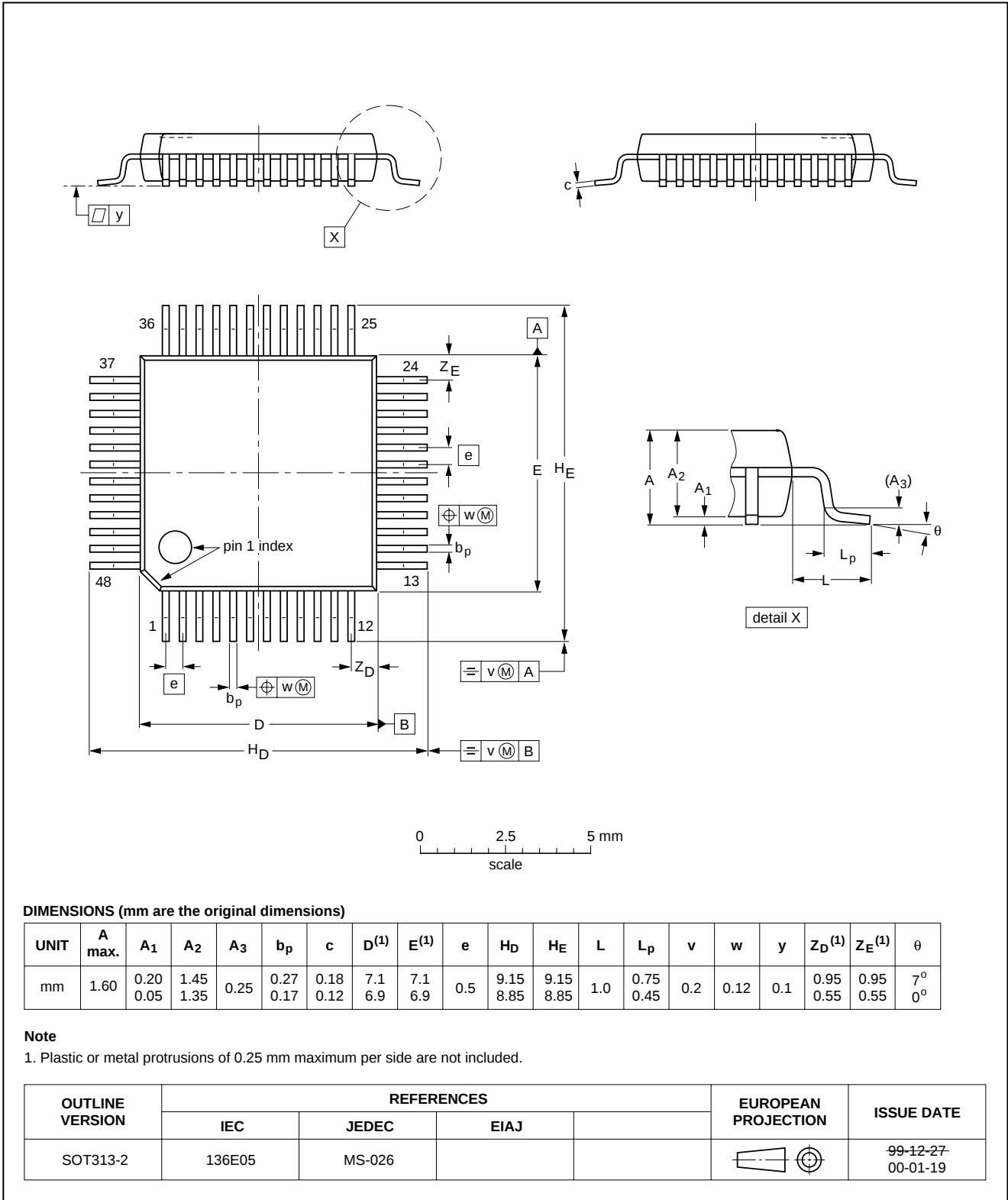
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PACKAGE OUTLINE

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

SOT313-2



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### 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 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.

#### 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 preferably be kept below 220 °C for thick/large packages, and below 235 °C for small/thin packages.

#### 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.

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

| PACKAGE <sup>(1)</sup>                                           | SOLDERING METHOD                  |                       |
|------------------------------------------------------------------|-----------------------------------|-----------------------|
|                                                                  | WAVE                              | REFLOW <sup>(2)</sup> |
| BGA, LBGA, LFBGA, SQFP, TFBGA, VFBGA                             | not suitable                      | suitable              |
| HBCC, HBGA, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, HVSON, SMS | not suitable <sup>(3)</sup>       | suitable              |
| PLCC <sup>(4)</sup> , SO, SOJ                                    | suitable                          | suitable              |
| LQFP, QFP, TQFP                                                  | not recommended <sup>(4)(5)</sup> | suitable              |
| SSOP, TSSOP, VSO                                                 | not recommended <sup>(6)</sup>    | suitable              |

### Notes

- For more detailed information on the BGA packages refer to the “(LF)BGA Application Note” (AN01026); order a copy from your Philips Semiconductors sales office.
- 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. On versions with the heatsink on the bottom side, the solder cannot penetrate between the printed-circuit board and the heatsink. On versions with the heatsink on the top side, the solder might be deposited on the heatsink surface.
- 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 suitable for LQFP, TQFP and QFP packages with a pitch (e) 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 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.

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## DATA SHEET STATUS

| LEVEL | DATA SHEET STATUS <sup>(1)</sup> | PRODUCT STATUS <sup>(2)(3)</sup> | DEFINITION                                                                                                                                                                                                                                                                                     |
|-------|----------------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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**NOTES**

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