

# ADC0808S125/250

Single 8-bit ADC, up to 125 MHz or 250 MHz

Rev. 04 — 2 July 2012

Product data sheet

## 1. General description

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The ADC0808S is a differential, high-speed, 8-bit Analog-to-Digital Converter (ADC) optimized for telecommunication transmission control systems and tape drive applications. It allows signal sampling frequencies up to 250 MHz.

The ADC0808S clock inputs are selectable between 1.8 V Complementary Metal Oxide Semiconductor (CMOS) or Low-Voltage Differential Signals (LVDS). The data output signal levels are 1.8 V CMOS.

All static digital inputs (CLKSEL, CCSSEL, CE\_N, OTC, DEL0 and DEL1) are 1.8 V CMOS compatible.

The ADC0808S offers the most flexible acquisition control system possible due to its programmable Complete Conversion Signal (CCS) which allows the delay time of the acquisition clock and acquisition clock frequency to be adjusted.

The ADC0808S is supplied in an HTQFP48 package.

## 2. Features

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- 8-bit resolution
- High-speed sampling rate up to 250 MHz
- Maximum analog input frequency up to 560 MHz
- Programmable acquisition output clock (complete conversion signal)
- Differential analog input
- Integrated voltage regulator or external control for analog input full-scale
- Integrated voltage regulator for input common-mode reference
- Selectable 1.8 V CMOS or LVDS clock input
- 1.8 V CMOS digital outputs
- 1.8 V CMOS compatible static digital inputs
- Binary or 2's complement CMOS outputs
- Only 2 clock cycles latency
- Industrial temperature range from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- HTQFP48 package

## 3. Applications

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- 2.5G and 3G cellular base infrastructure radio transceivers
- Wireless access systems
- Fixed telecommunications



- Optical networking
- Wireless Local Area Network (WLAN) infrastructure
- Tape drive applications

4. Ordering information

Table 1. Ordering information

| Type number      | Sampling frequency (MHz) | Package |                                                                                               |          |
|------------------|--------------------------|---------|-----------------------------------------------------------------------------------------------|----------|
|                  |                          | Name    | Description                                                                                   | Version  |
| ADC0808S125HW-C1 | 125                      | HTQFP48 | plastic thermal enhanced thin quad flat package; 48 leads; body 7 × 7 × 1 mm; exposed die pad | SOT545-2 |
| ADC0808S250HW-C1 | 250                      |         |                                                                                               |          |

5. Block diagram

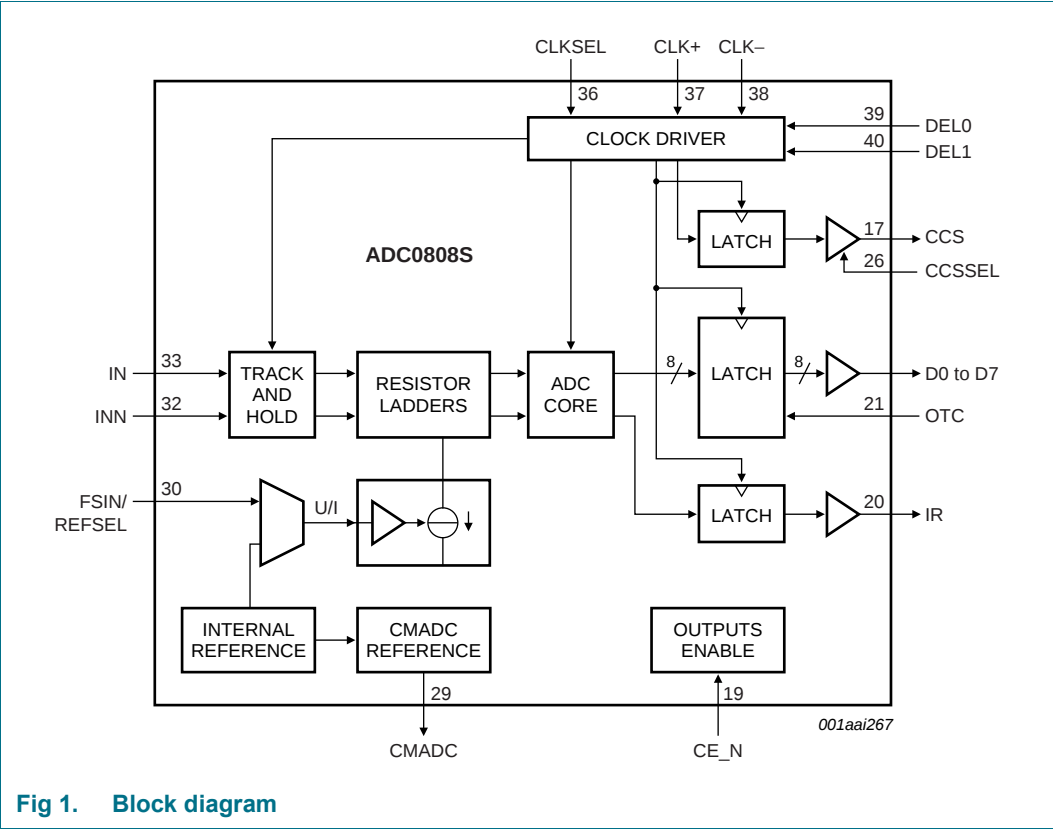
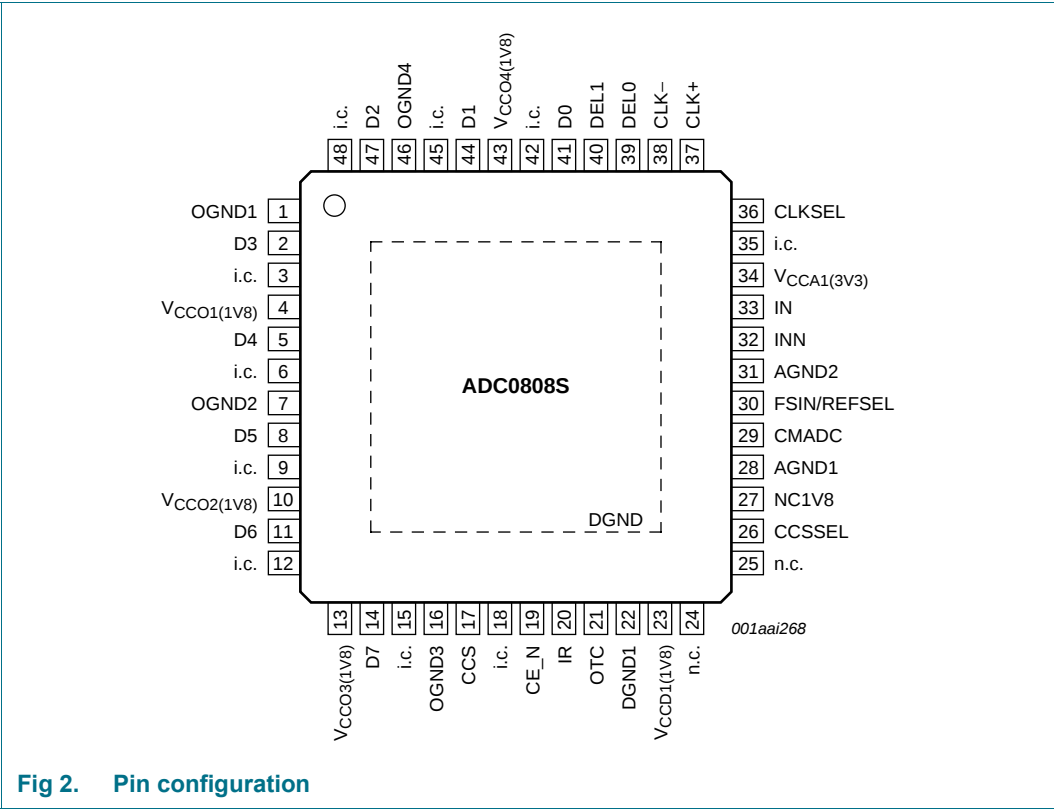


Fig 1. Block diagram

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 2. Pin description

| Symbol     | Pin | Type <sup>[1]</sup> | Description                          |
|------------|-----|---------------------|--------------------------------------|
| OGND1      | 1   | G                   | data output ground 1                 |
| D3         | 2   | O                   | data output bit 3                    |
| i.c.       | 3   | -                   | internally connected; leave open     |
| VCCO1(1V8) | 4   | P                   | data output supply voltage 1 (1.8 V) |
| D4         | 5   | O                   | data output bit 4                    |
| i.c.       | 6   | -                   | internally connected; leave open     |
| OGND2      | 7   | G                   | data output ground 2                 |
| D5         | 8   | O                   | data output bit 5                    |
| i.c.       | 9   | -                   | internally connected; leave open     |
| VCCO2(1V8) | 10  | P                   | data output supply voltage 2 (1.8 V) |
| D6         | 11  | O                   | data output bit 6                    |
| i.c.       | 12  | -                   | internally connected; leave open     |
| VCCO3(1V8) | 13  | P                   | data output supply voltage 3 (1.8 V) |
| D7         | 14  | O                   | data output bit 7                    |

Table 2. Pin description ...continued

| Symbol                 | Pin | Type <sup>[1]</sup> | Description                                                                 |
|------------------------|-----|---------------------|-----------------------------------------------------------------------------|
| i.c.                   | 15  | -                   | internally connected; leave open                                            |
| OGND3                  | 16  | G                   | data output ground 3                                                        |
| CCS                    | 17  | O                   | complete conversion signal output                                           |
| i.c.                   | 18  | -                   | internally connected; leave open                                            |
| CE_N                   | 19  | I(CMOS)             | chip enable input (active LOW)                                              |
| IR                     | 20  | O(CMOS)             | in-range output                                                             |
| OTC                    | 21  | I(CMOS)             | control input for 2's complement output                                     |
| DGND1                  | 22  | G                   | digital ground 1                                                            |
| V <sub>CCD1(1V8)</sub> | 23  | P                   | digital supply voltage 1 (1.8 V)                                            |
| n.c.                   | 24  | -                   | not connected                                                               |
| n.c.                   | 25  | -                   | not connected                                                               |
| CCSSEL                 | 26  | I(CMOS)             | control input for CCS frequency selection                                   |
| NC1V8                  | 27  | I                   | not connected or connected to V <sub>CCD1(1V8)</sub>                        |
| AGND1                  | 28  | G                   | analog ground 1                                                             |
| CMADC                  | 29  | O                   | regulator common-mode ADC output                                            |
| FSIN/REFSEL            | 30  | I                   | full-scale reference voltage input/internal or external reference selection |
| AGND2                  | 31  | G                   | analog ground 2                                                             |
| INN                    | 32  | I                   | complementary analog input                                                  |
| IN                     | 33  | I                   | analog input                                                                |
| V <sub>CCA1(3V3)</sub> | 34  | P                   | analog supply voltage 1 (3.3 V)                                             |
| i.c.                   | 35  | -                   | internally connected; leave open                                            |
| CLKSEL                 | 36  | I(CMOS)             | control input for clock input selection                                     |
| CLK+                   | 37  | I                   | clock input                                                                 |
| CLK-                   | 38  | I                   | complementary clock input                                                   |
| DEL0                   | 39  | I(CMOS)             | complete conversion signal delay input 0                                    |
| DEL1                   | 40  | I(CMOS)             | complete conversion signal delay input 1                                    |
| D0                     | 41  | O                   | data output bit 0                                                           |
| i.c.                   | 42  | -                   | internally connected; leave open                                            |
| V <sub>CCO4(1V8)</sub> | 43  | P                   | data output supply voltage 4 (1.8 V)                                        |
| D1                     | 44  | O                   | data output bit 1                                                           |
| i.c.                   | 45  | -                   | internally connected; leave open                                            |
| OGND4                  | 46  | G                   | data output ground 4                                                        |
| D2                     | 47  | O                   | data output bit 2                                                           |
| i.c.                   | 48  | -                   | internally connected; leave open                                            |
| DGND                   | -   | G                   | digital ground; exposed die pad                                             |

[1] See Table 3.

Table 3. Pin type description

| Type    | Description             |
|---------|-------------------------|
| I       | input                   |
| O       | output                  |
| I(CMOS) | 1.8 V CMOS level input  |
| O(CMOS) | 1.8 V CMOS level output |
| P       | power supply            |
| G       | ground                  |

## 7. Functional description

### 7.1 CMOS/LVDS clock input

The circuit has two clock inputs CLK+ and CLK–, with two modes of operation:

- LVDS mode: CLK+ and CLK– inputs are at differential LVDS levels. An external resistor of between 80  $\Omega$  and 120  $\Omega$  is required; see Figure 3.

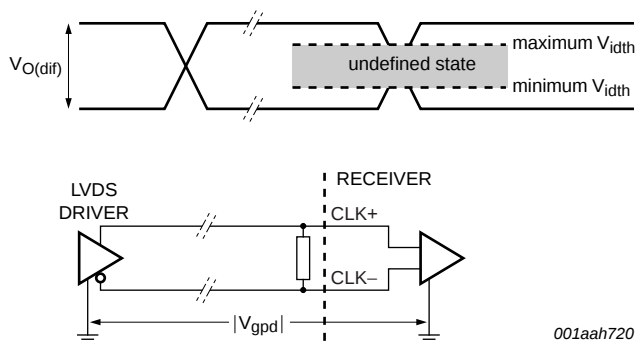


Fig 3. LVDS clock input

- 1.8 V CMOS mode: CLK+ input is at 1.8 V CMOS level and sampling is done on the rising edge of the clock input signal. In this case pin CLK– must be grounded; see Figure 4.

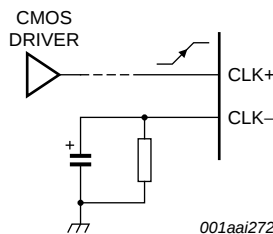


Fig 4. CMOS clock input

**Table 4. Clock input format selection**

| Pin CLKSEL            | Clock input signal |
|-----------------------|--------------------|
|                       | Pins CLK+ and CLK– |
| HIGH or not connected | LVDS               |
| LOW                   | 1.8 V CMOS         |

## 7.2 Digital output coding

The digital outputs are 1.8 V CMOS compatible.

The data output format can be either binary or 2's complement.

**Table 5. Output coding with differential inputs**

$V_{i(p-p)} = 2.0\text{ V}$ ;  $V_{ref(fs)} = 1.25\text{ V}$ ; typical values to AGND.

| Code      | Inputs (V)  |              | Output | Outputs D7 to D0 |                |
|-----------|-------------|--------------|--------|------------------|----------------|
|           | $V_{i(IN)}$ | $V_{i(INN)}$ | Pin IR | Binary           | 2's complement |
| Underflow | < 0.45      | > 1.45       | LOW    | 0000 0000        | 1000 0000      |
| 0         | 0.45        | 1.45         | HIGH   | 0000 0000        | 1000 0000      |
| 1         | -           | -            | HIGH   | 0000 0001        | 1000 0001      |
| :         | :           | :            | :      | :                | :              |
| 127       | 0.95        | 0.95         | HIGH   | 0111 1111        | 1111 1111      |
| :         | :           | :            | :      | :                | :              |
| 254       | -           | -            | HIGH   | 1111 1110        | 0111 1110      |
| 255       | 1.45        | 0.45         | HIGH   | 1111 1111        | 0111 1111      |
| Overflow  | > 1.45      | < 0.45       | LOW    | 1111 1111        | 0111 1111      |

The in-range CMOS output pin IR will be HIGH during normal operation. When the ADC input reaches either positive or negative full-scale, the IR output will be LOW.

Selection between output coding is controlled by pins OTC and CE\_N.

**Table 6. Output format selection**

| 2's complement outputs | Chip enable | Output data               |
|------------------------|-------------|---------------------------|
| Pin OTC                | Pin CE_N    | Pins D0 to D7, CCS and IR |
| LOW                    | LOW         | active; binary            |
| HIGH                   | LOW         | active; 2's complement    |
| X <sup>[1]</sup>       | HIGH        | high-impedance            |

[1] X = don't care.

7.3 Timing output

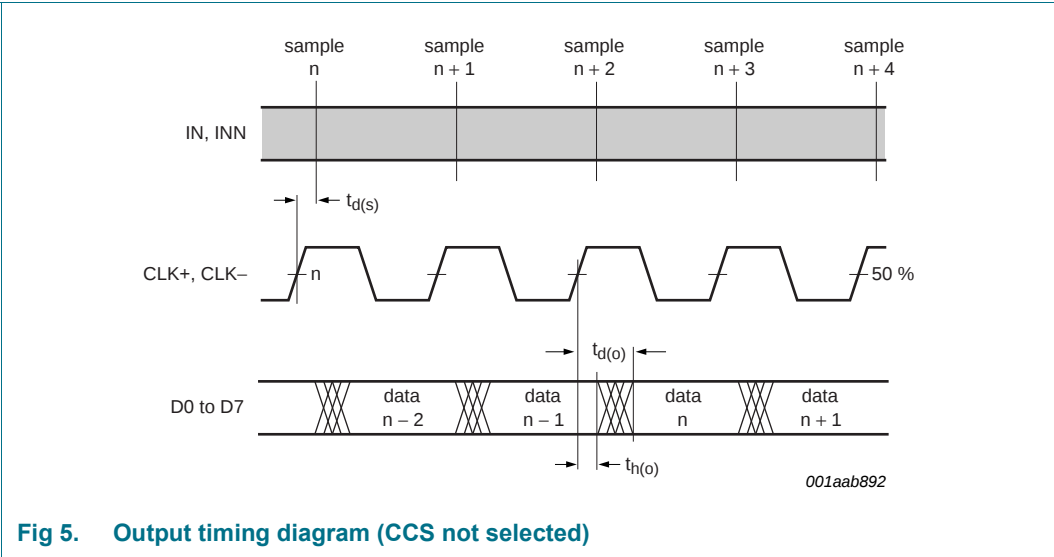


Fig 5. Output timing diagram (CCS not selected)

7.4 Timing complete conversion signal

The ADC0808S generates an adjustable clock output signal on pin CCS called Complete Conversion Signal, which can be used to control the acquisition of converted output data to the digital circuit connected to the ADC0808S output data bus.

Two logic input pins DEL0 and DEL1 control the delay of the edge of the CCS signal to achieve an optimal position in the stable, usable zone of the data as shown in Figure 6.

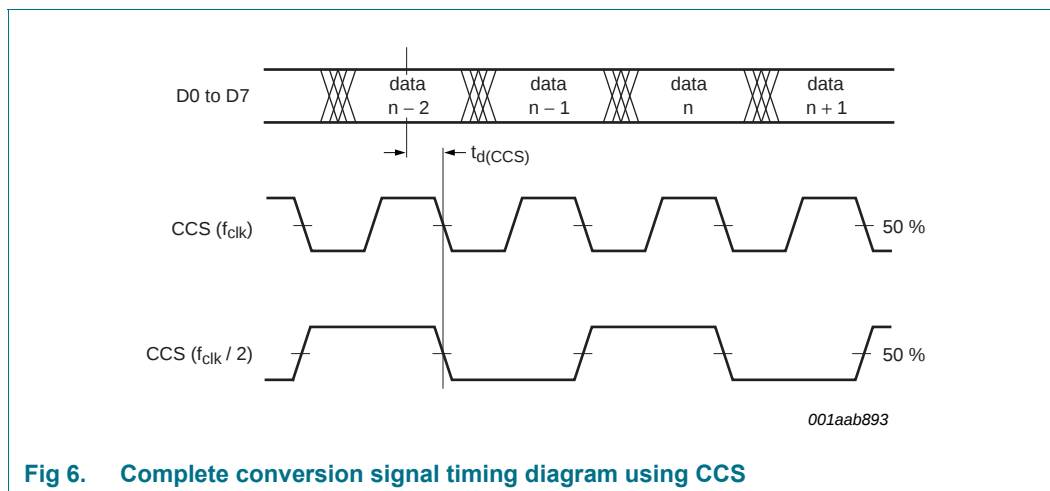
Table 7. Complete conversion signal selection

| Pin DEL0 | Pin DEL1 | Pin CCS              |
|----------|----------|----------------------|
| LOW      | LOW      | high-impedance       |
| HIGH     | LOW      | active; see Table 13 |
| LOW      | HIGH     |                      |
| HIGH     | HIGH     |                      |

Pin CCSSEL selects the CCS frequency; see Table 8.

Table 8. Complete conversion signal frequency selection

| Pin CCSSEL            | CCS frequency ( $f_{CCS}$ ) |
|-----------------------|-----------------------------|
| HIGH or not connected | $f_{clk}$                   |
| LOW                   | $f_{clk} / 2$               |



**Fig 6. Complete conversion signal timing diagram using CCS**

## 7.5 Full-scale input selection

The ADC0808S has an internal reference circuit which can be overruled by an external reference voltage. This can be done with the full-scale reference voltage ( $V_{\text{ref}(fs)}$ ) according to Table 9.

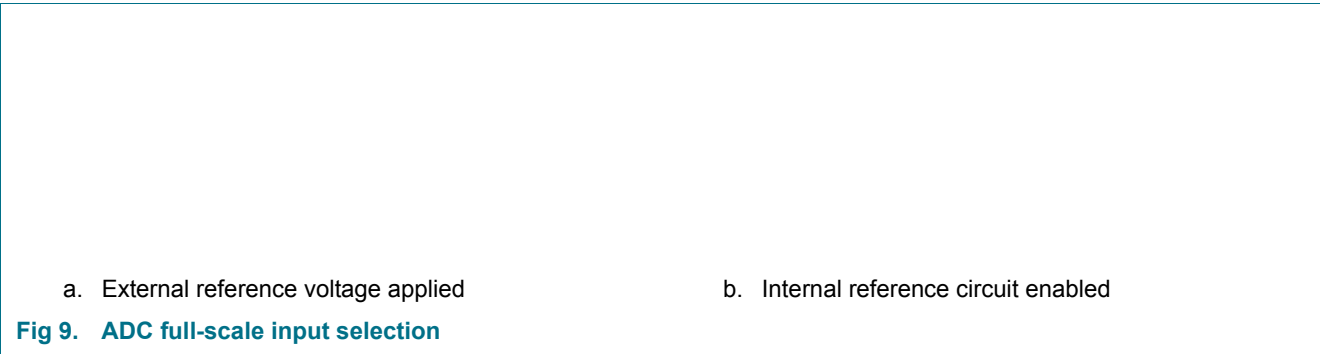
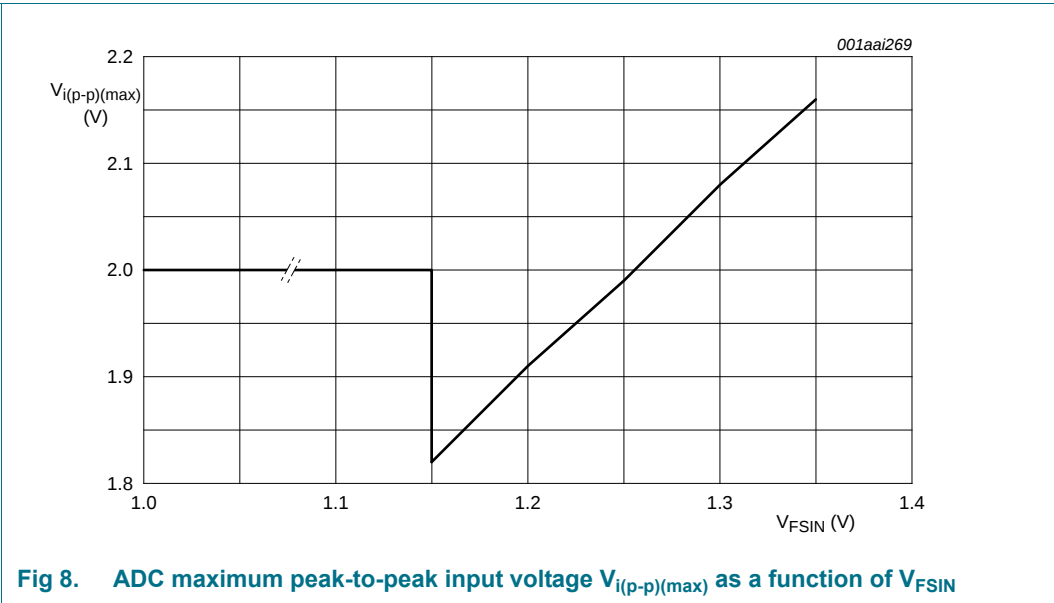
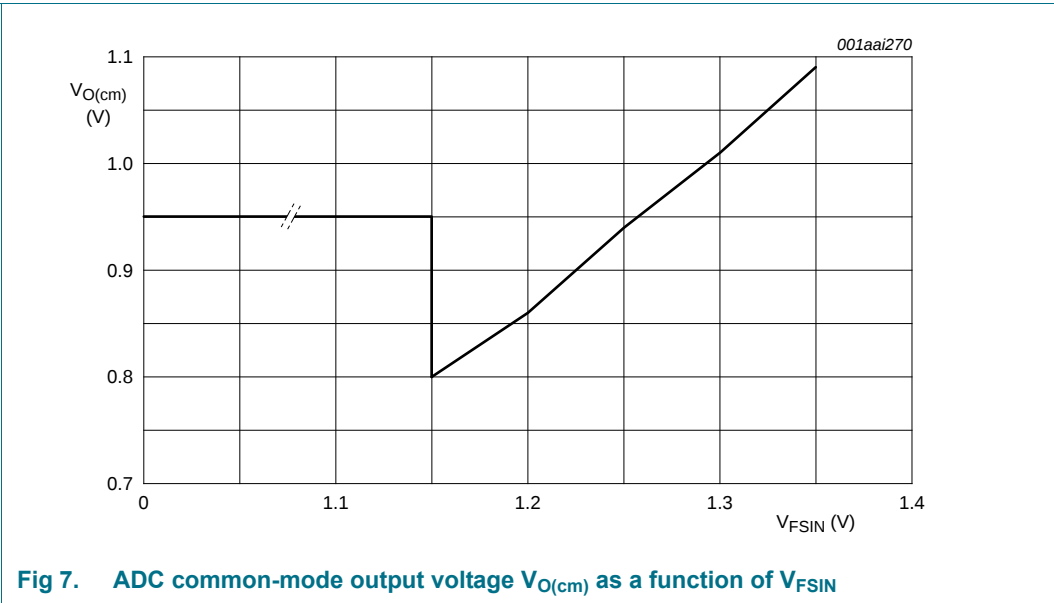
The ADC provides the required common-mode voltage on pin CMADC. In case of internal regulation, the regulator output voltage on pin CMADC is 0.95 V.

**Table 9. Full-scale input selection**

| Full-scale reference voltage<br>$V_{\text{ref}(fs)}$ | Common-mode output<br>voltage $V_{O(cm)}$ | Maximum peak-to-peak input<br>voltage $V_{i(p-p)(max)}$ |
|------------------------------------------------------|-------------------------------------------|---------------------------------------------------------|
| 1.15 V                                               | 0.8 V                                     | 1.825 V                                                 |
| 1.20 V                                               | 0.86 V                                    | 1.91 V                                                  |
| 1.25 V                                               | 0.94 V                                    | 1.99 V                                                  |
| 1.30 V                                               | 1.01 V                                    | 2.08 V                                                  |
| 1.35 V                                               | 1.09 V                                    | 2.16 V                                                  |

The internal reference circuit is enabled by connecting pin FSIN to ground. The common-mode output voltage  $V_{O(cm)}$  on pin CMADC will then be 0.95 V, and the maximum peak-to-peak input voltage  $V_{i(p-p)(max)}$  will be 2.0 V; see Figure 7 and Figure 8.

The ADC full-scale input selection principle is shown in Figure 9.



## 8. Limiting values

**Table 10. Limiting values**

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

| Symbol       | Parameter                | Conditions         | Min  | Max              | Unit |
|--------------|--------------------------|--------------------|------|------------------|------|
| $V_{CCA}$    | analog supply voltage    |                    | -0.5 | +4.6             | V    |
| $V_{CCD}$    | digital supply voltage   |                    | -0.5 | +2.5             | V    |
| $V_{CCO}$    | output supply voltage    |                    | -0.5 | +2.5             | V    |
| $V_{i(IN)}$  | input voltage on pin IN  | referenced to AGND | -0.5 | $V_{CCA} + 1$    | V    |
| $V_{i(INN)}$ | input voltage on pin INN | referenced to AGND | -0.5 | $V_{CCA} + 1$    | V    |
| $V_{i(CLK)}$ | input voltage on pin CLK | referenced to DGND | -0.5 | $V_{CCD} + 0.55$ | V    |
| $T_{stg}$    | storage temperature      |                    | -55  | +150             | °C   |
| $T_{amb}$    | ambient temperature      |                    | -40  | +85              | °C   |
| $T_j$        | junction temperature     |                    | -    | 150              | °C   |

## 9. Thermal characteristics

**Table 11. Thermal characteristics**

| Symbol        | Parameter                                   | Conditions | Typ  | Unit |
|---------------|---------------------------------------------|------------|------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | [1]        | 36.2 | K/W  |
| $R_{th(j-c)}$ | thermal resistance from junction to case    | [1]        | 14.3 | K/W  |

[1] In compliance with JEDEC test board, in free air.

## 10. Static characteristics

**Table 12. Static characteristics**

$V_{CCA} = 3.0\text{ V to }3.6\text{ V}$ ;  $V_{CCD} = 1.65\text{ V to }1.95\text{ V}$ ;  $V_{CCO} = 1.65\text{ V to }1.95\text{ V}$ ; pins AGND1, AGND2 and DGND1 shorted together;  $T_{amb} = -40\text{ °C to }+85\text{ °C}$ ;  $V_{i(IN)} - V_{i(INN)} = 2.0\text{ V} - 0.5\text{ dB}$ ;  $V_{i(cm)} = 0.95\text{ V}$ ;  $V_{FSIN} = 0\text{ V}$ ; typical values are measured at  $V_{CCA} = 3.3\text{ V}$ ,  $V_{CCD} = V_{CCO} = 1.8\text{ V}$ ,  $T_{amb} = 25\text{ °C}$  and  $C_L = 10\text{ pF}$ ; unless otherwise specified.

| Symbol                                  | Parameter               | Conditions                                               | Min     | Typ  | Max  | Unit |
|-----------------------------------------|-------------------------|----------------------------------------------------------|---------|------|------|------|
| <b>Supplies</b>                         |                         |                                                          |         |      |      |      |
| $V_{CCA}$                               | analog supply voltage   |                                                          | 3.0     | 3.3  | 3.6  | V    |
| $V_{CCD}$                               | digital supply voltage  |                                                          | 1.65    | 1.80 | 1.95 | V    |
| $V_{CCO}$                               | output supply voltage   |                                                          | 1.65    | 1.80 | 1.95 | V    |
| $I_{CCA}$                               | analog supply current   | $f_{clk} = 125\text{ MHz}$ ; $f_i = 1.25\text{ MHz}$     | -       | 60   | -    | mA   |
| $I_{CCD}$                               | digital supply current  | $f_{clk} = 125\text{ MHz}$ ; $f_i = 1.25\text{ MHz}$     | -       | 12   | -    | mA   |
| $I_{CCO}$                               | output supply current   | $f_{clk} = 125\text{ MHz}$ ; $f_i = 1.25\text{ MHz}$     | -       | 11   | -    | mA   |
| $P_{tot}$                               | total power dissipation | $f_{clk} = 125\text{ MHz}$ ; $f_i = 1.25\text{ MHz}$     | -       | 240  | -    | mW   |
| <b>Clock inputs: pins CLK+ and CLK-</b> |                         |                                                          |         |      |      |      |
| $R_i$                                   | input resistance        | [1]                                                      | -       | 10   | -    | kΩ   |
| $C_i$                                   | input capacitance       | [1]                                                      | -       | 1    | -    | pF   |
| <b>LVDS clock input; see Figure 3</b>   |                         |                                                          |         |      |      |      |
| $\Delta V_i$                            | input voltage range     | $V_i$ on pin CLK+ or CLK-;<br>$ V_{gpd}  < 50\text{ mV}$ | [2] 825 | -    | 1575 | mV   |

**Table 12. Static characteristics ...continued**

$V_{CCA} = 3.0\text{ V to }3.6\text{ V}$ ;  $V_{CCD} = 1.65\text{ V to }1.95\text{ V}$ ;  $V_{CCO} = 1.65\text{ V to }1.95\text{ V}$ ; pins AGND1, AGND2 and DGND1 shorted together;  $T_{amb} = -40\text{ °C to }+85\text{ °C}$ ;  $V_{I(IN)} - V_{I(INN)} = 2.0\text{ V} - 0.5\text{ dB}$ ;  $V_{I(cm)} = 0.95\text{ V}$ ;  $V_{FSIN} = 0\text{ V}$ ; typical values are measured at  $V_{CCA} = 3.3\text{ V}$ ,  $V_{CCD} = V_{CCO} = 1.8\text{ V}$ ,  $T_{amb} = 25\text{ °C}$  and  $C_L = 10\text{ pF}$ ; unless otherwise specified.

| Symbol                                                       | Parameter                            | Conditions                                                      | Min                    | Typ   | Max                 | Unit |
|--------------------------------------------------------------|--------------------------------------|-----------------------------------------------------------------|------------------------|-------|---------------------|------|
| V <sub>idth</sub>                                            | input differential threshold voltage | V <sub>gpd</sub>   < 50 mV                                      | [2] −100               | -     | +100                | mV   |
| I <sub>I</sub>                                               | input current                        | 825 mV < V <sub>I</sub> < 1575 mV                               | -                      | -     | 50                  | μA   |
| 1.8 V CMOS clock input; see Figure 4                         |                                      |                                                                 |                        |       |                     |      |
| V <sub>IL</sub>                                              | LOW-level input voltage              |                                                                 | DGND                   | -     | 0.2V <sub>CCD</sub> | V    |
| V <sub>IH</sub>                                              | HIGH-level input voltage             |                                                                 | 0.8V <sub>CCD</sub>    | -     | V <sub>CCD</sub>    | V    |
| I <sub>IL</sub>                                              | LOW-level input current              | V <sub>IL</sub> = 0.2V <sub>CCD</sub>                           | -                      | -     | 50                  | μA   |
| I <sub>IH</sub>                                              | HIGH-level input current             | V <sub>IH</sub> = 0.8V <sub>CCD</sub>                           | -                      | -     | 50                  | μA   |
| Analog inputs: pins IN and INN                               |                                      |                                                                 |                        |       |                     |      |
| R <sub>i</sub>                                               | input resistance                     |                                                                 | [1] -                  | 1.0   | -                   | MΩ   |
| C <sub>i</sub>                                               | input capacitance                    |                                                                 | [1] -                  | 1.0   | -                   | pF   |
| V <sub>I(cm)</sub>                                           | common-mode input voltage            | V <sub>i(IN)</sub> = V <sub>i(INN)</sub> ;<br>output code = 127 | 0.7                    | 0.95  | 1.0                 | V    |
| Digital input pins: OTC, CE_N, DEL0, DEL1, CLKSEL and CCSSEL |                                      |                                                                 |                        |       |                     |      |
| V <sub>IL</sub>                                              | LOW-level input voltage              |                                                                 | DGND                   | -     | 0.2V <sub>CCD</sub> | V    |
| V <sub>IH</sub>                                              | HIGH-level input voltage             |                                                                 | 0.8V <sub>CCD</sub>    | -     | V <sub>CCD</sub>    | V    |
| I <sub>IL</sub>                                              | LOW-level input current              | V <sub>IL</sub> = 0.3V <sub>CCD</sub>                           | -                      | -     | 50                  | μA   |
| I <sub>IH</sub>                                              | HIGH-level input current             | V <sub>IH</sub> = 0.7V <sub>CCD</sub>                           | -                      | -     | 50                  | μA   |
| Voltage controlled regulator output: pin CMADC               |                                      |                                                                 |                        |       |                     |      |
| V <sub>O(cm)</sub>                                           | common-mode output voltage           |                                                                 | 0.85                   | 0.95  | 1.1                 | V    |
| Reference voltage input: pin FSIN <sup>[3]</sup>             |                                      |                                                                 |                        |       |                     |      |
| V <sub>FSIN</sub>                                            | voltage on pin FSIN                  | internal reference                                              | -                      | 0     | 0.6                 | V    |
|                                                              |                                      | external reference                                              | 1.15                   | 1.25  | 1.35                | V    |
| I <sub>i(FSIN)</sub>                                         | input current on pin FSIN            |                                                                 | -                      | 12    | -                   | μA   |
| V <sub>i(p-p)(max)</sub>                                     | maximum peak-to-peak input voltage   | internal reference                                              | 1.92                   | 2     | 2.03                | V    |
|                                                              |                                      | external reference                                              |                        |       |                     |      |
|                                                              |                                      | V <sub>FSIN</sub> = 1.15 V                                      | 1.80                   | 1.825 | 1.85                | V    |
|                                                              |                                      | V <sub>FSIN</sub> = 1.25 V                                      | 1.98                   | 1.99  | 2.03                | V    |
|                                                              |                                      | V <sub>FSIN</sub> = 1.35 V                                      | 2.11                   | 2.16  | 2.18                | V    |
| Digital outputs: pins D0 to D7, CCS and IR                   |                                      |                                                                 |                        |       |                     |      |
| V <sub>OL</sub>                                              | LOW-level output voltage             |                                                                 | OGND                   | -     | 0.2                 | V    |
| V <sub>OH</sub>                                              | HIGH-level output voltage            |                                                                 | V <sub>CCO</sub> − 0.2 | -     | V <sub>CCO</sub>    | V    |

[1] Guaranteed by design.

[2]  $|V_{gpd}|$  is the voltage of ground potential difference across or between boards.

[3] The ADC input range can be adjusted with an external reference voltage applied to pin FSIN. This voltage must be referenced to AGND.

## 11. Dynamic characteristics

**Table 13. Dynamic characteristics**

$V_{CCA} = 3.0\text{ V to }3.6\text{ V}$ ;  $V_{CCD} = 1.65\text{ V to }1.95\text{ V}$ ;  $V_{CCO} = 1.65\text{ V to }1.95\text{ V}$ ; pins AGND1, AGND2 and DGND1 shorted together;  $T_{amb} = -40\text{ }^{\circ}\text{C to }+85\text{ }^{\circ}\text{C}$ ;  $V_{I(IN)} - V_{I(INN)} = 2.0\text{ V} - 0.5\text{ dB}$ ;  $V_{I(cm)} = 0.95\text{ V}$ ;  $V_{FSIN} = 0\text{ V}$ ; typical values are measured at  $V_{CCA} = 3.3\text{ V}$ ,  $V_{CCD} = V_{CCO} = 1.8\text{ V}$ ,  $T_{amb} = 25\text{ }^{\circ}\text{C}$  and  $C_L = 10\text{ pF}$ ; unless otherwise specified.

| Symbol                                                            | Parameter                       | Conditions                                                                                                 | Min | Typ   | Max | Unit |
|-------------------------------------------------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------|-----|-------|-----|------|
| Clock timing input: pins CLK+ and CLK−                            |                                 |                                                                                                            |     |       |     |      |
| f <sub>clk(min)</sub>                                             | minimum clock frequency         |                                                                                                            | -   | -     | 1   | MHz  |
| f <sub>clk(max)</sub>                                             | maximum clock frequency         |                                                                                                            | 250 | -     | -   | MHz  |
| t <sub>w(clk)</sub>                                               | clock pulse width               | f <sub>clk</sub> = 125 MHz                                                                                 | 1.8 | -     | -   | ns   |
| Timing output: pins D0 to D7 and IR <sup>[1]</sup> ; see Figure 5 |                                 |                                                                                                            |     |       |     |      |
| t <sub>d(s)</sub>                                                 | sampling delay time             | 1.8 V CMOS clock                                                                                           | -   | 1.3   | -   | ns   |
|                                                                   |                                 | LVDS clock                                                                                                 | -   | 1.65  | -   | ns   |
| t <sub>h(o)</sub>                                                 | output hold time                | 1.8 V CMOS clock                                                                                           | 3.3 | 4.4   | -   | ns   |
|                                                                   |                                 | LVDS clock                                                                                                 | 4.2 | 4.8   | -   | ns   |
| t <sub>d(o)</sub>                                                 | output delay time               | 1.8 V CMOS clock                                                                                           | -   | 5.4   | 6.9 | ns   |
|                                                                   |                                 | LVDS clock                                                                                                 | -   | 5.8   | 7.3 | ns   |
| Timing complete conversion signal: pin CCS; see Figure 6          |                                 |                                                                                                            |     |       |     |      |
| f <sub>CCS(max)</sub>                                             | maximum CCS frequency           |                                                                                                            | 125 | -     | -   | MHz  |
| t <sub>d(CCS)</sub>                                               | CCS delay time                  | DEL0 = HIGH; DEL1 = LOW                                                                                    | -   | 0.3   | -   | ns   |
|                                                                   |                                 | DEL0 = LOW; DEL1 = HIGH                                                                                    | -   | 0.8   | -   | ns   |
|                                                                   |                                 | DEL0 = HIGH; DEL1 = HIGH                                                                                   | -   | 1.9   | -   | ns   |
| 3-state output delay time: pins CCS, IR and D7 to D0              |                                 |                                                                                                            |     |       |     |      |
| t <sub>dZH</sub>                                                  | float to active HIGH delay time |                                                                                                            | -   | 2.1   | -   | ns   |
| t <sub>dZL</sub>                                                  | float to active LOW delay time  |                                                                                                            | -   | 2.2   | -   | ns   |
| t <sub>dHZ</sub>                                                  | active HIGH to float delay time |                                                                                                            | -   | 3.3   | -   | ns   |
| t <sub>dLZ</sub>                                                  | active LOW to float delay time  |                                                                                                            | -   | 2.9   | -   | ns   |
| Analog signal processing (50 % clock duty factor); see Section 12 |                                 |                                                                                                            |     |       |     |      |
| INL                                                               | integral non-linearity          | f <sub>clk</sub> = 20 MHz; f <sub>i</sub> = 21.4 MHz                                                       | -   | ±0.82 | -   | LSB  |
| DNL                                                               | differential non-linearity      | f <sub>clk</sub> = 20 MHz; f <sub>i</sub> = 21.4 MHz; no missing code guaranteed                           | -   | ±0.4  | -   | LSB  |
| E <sub>O</sub>                                                    | offset error                    | V <sub>CCA</sub> = 3.3 V; V <sub>CCD</sub> = 1.8 V; T <sub>amb</sub> = 25 °C; output code = 127            | -   | 2.5   | -   | mV   |
| E <sub>G</sub>                                                    | gain error                      | spread from device to device; V <sub>CCA</sub> = 3.3 V; V <sub>CCD</sub> = 1.8 V; T <sub>amb</sub> = 25 °C | -   | 1.85  | -   | %    |
| B                                                                 | bandwidth                       | f <sub>clk</sub> = 125 MHz; −3 dB; full-scale input <sup>[2]</sup>                                         | -   | 560   | -   | MHz  |
| THD                                                               | total harmonic distortion       | f <sub>clk</sub> = 125 MHz; f <sub>i</sub> = 78 MHz <sup>[3]</sup>                                         | -   | −53   | -   | dB   |
|                                                                   |                                 | f <sub>clk</sub> = 250 MHz; f <sub>i</sub> = 125 MHz                                                       | -   | −53   | -   | dB   |
| N <sub>th(RMS)</sub>                                              | RMS thermal noise               | shorted input; f <sub>clk</sub> = 125 MHz                                                                  | -   | 0.5   | -   | LSB  |
| S/N                                                               | signal-to-noise ratio           | f <sub>clk</sub> = 125 MHz; f <sub>i</sub> = 78 MHz <sup>[4]</sup>                                         | -   | 48    | -   | dBc  |
|                                                                   |                                 | f <sub>clk</sub> = 250 MHz; f <sub>i</sub> = 125 MHz                                                       | -   | 47    | -   | dBc  |

**Table 13. Dynamic characteristics ...continued**

$V_{CCA} = 3.0\text{ V to }3.6\text{ V}$ ;  $V_{CCD} = 1.65\text{ V to }1.95\text{ V}$ ;  $V_{CCO} = 1.65\text{ V to }1.95\text{ V}$ ; pins AGND1, AGND2 and DGND1 shorted together;  $T_{amb} = -40\text{ }^{\circ}\text{C to }+85\text{ }^{\circ}\text{C}$ ;  $V_{I(IN)} - V_{I(INN)} = 2.0\text{ V} - 0.5\text{ dB}$ ;  $V_{I(cm)} = 0.95\text{ V}$ ;  $V_{FSIN} = 0\text{ V}$ ; typical values are measured at  $V_{CCA} = 3.3\text{ V}$ ,  $V_{CCD} = V_{CCO} = 1.8\text{ V}$ ,  $T_{amb} = 25\text{ }^{\circ}\text{C}$  and  $C_L = 10\text{ pF}$ ; unless otherwise specified.

| Symbol | Parameter                               | Conditions                                                                   | Min   | Typ | Max | Unit |
|--------|-----------------------------------------|------------------------------------------------------------------------------|-------|-----|-----|------|
| SFDR   | spurious free dynamic range             | $f_{clk} = 125\text{ MHz}$ ; $f_i = 78\text{ MHz}$                           | -     | 55  | -   | dBc  |
|        |                                         | $f_{clk} = 250\text{ MHz}$ ; $f_i = 125\text{ MHz}$                          | -     | 55  | -   | dBc  |
| IMD2   | second-order intermodulation distortion | $f_1 = 124\text{ MHz}$ ; $f_2 = 126\text{ MHz}$ ; $f_{clk} = 250\text{ MHz}$ | [5] - | -55 | -   | dB   |
| IMD3   | third-order intermodulation distortion  | $f_1 = 124\text{ MHz}$ ; $f_2 = 126\text{ MHz}$ ; $f_{clk} = 250\text{ MHz}$ | [5] - | -60 | -   | dB   |

- [1] Output data acquisition: the output data is available after the maximum delay of  $t_{d(o)}$ .
- [2] The -3 dB analog bandwidth is determined by the 3 dB reduction in the reconstructed output, the input being a full-scale sine wave.
- [3] The total harmonic distortion is obtained with the addition of the first five harmonics.
- [4] The signal-to-noise ratio takes into account all harmonics above five and noise up to Nyquist frequency.
- [5] Intermodulation measured relative to either tone with analog input frequencies  $f_1$  and  $f_2$ . The two input signals have the same amplitude and the total amplitude of both signals provides full-scale to the converter (-6 dB below full-scale for each input signal). IMD3 is the ratio of the RMS value of either input tone to the RMS value of the worst case third-order intermodulation product.

## 12. Definitions

### 12.1 Static parameters

#### 12.1.1 Integral non-linearity

Integral non-linearity (INL) is defined as the deviation of the transfer function from a best-fit straight line (linear regression computation). The INL of the code is obtained from the equation:

$$INL(i) = \frac{V_{in}(i) - V_{in}(ideal)}{S} \quad (1)$$

where: S corresponds to the slope of the ideal straight line (code width), i corresponds to the code value,  $V_{in}$  is the input voltage.

#### 12.1.2 Differential non-linearity

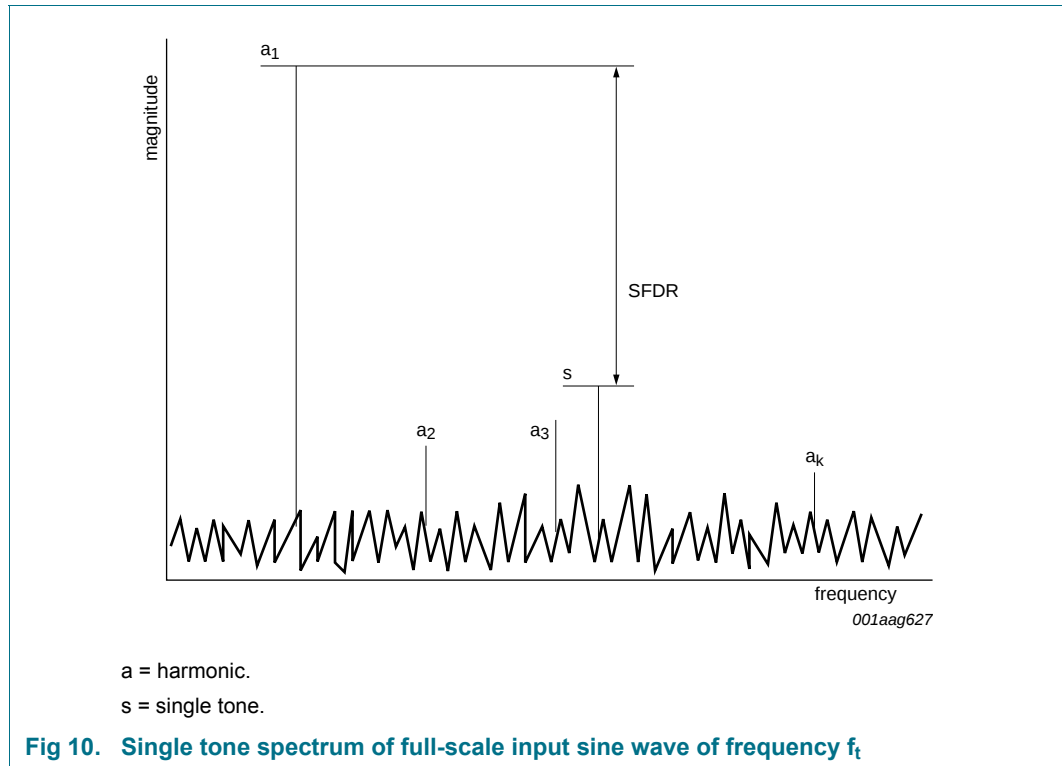
Differential non-linearity (DNL) is the deviation in code width from the value of 1 LSB.

$$DNL(i) = \frac{V_{in}(i+1) - V_{in}(i)}{S} \quad (2)$$

where:  $V_{in}$  is the input voltage; i is a code value from 0 to  $(2^n - 2)$ .

### 12.2 Dynamic parameters

Figure 10 shows the spectrum of a single tone full-scale input sine wave of frequency  $f_t$ , conforming to coherent sampling and which is digitized by the ADC under test. Coherent sampling: ( $f_t / f_s = M / N$ , where M = number of cycles and N = number of samples, M and N values being relatively prime).



**Remark:**  $P_{\text{noise}}$  in the equations in the following sections, is the sum of noise sources which include random noise, non-linearities, sampling time errors, and quantization noise.

### 12.2.1 Signal-to-Noise And Distortion (SINAD)

SINAD is the ratio of the output signal power to the noise plus distortion power for a given sample rate and input frequency, excluding the DC component:

$$SINAD[dB] = 10 \log_{10} \left( \frac{P_{\text{signal}}}{P_{\text{noise} + \text{distortion}}} \right) \quad (3)$$

### 12.2.2 Effective Number Of Bits (ENOB)

ENOB is derived from SINAD and gives the theoretical resolution required by an ideal ADC to obtain the same SINAD measured on the real ADC. A good approximation gives:

$$ENOB = \frac{SINAD - 1.76}{6.02} \quad (4)$$

### 12.2.3 Total Harmonic Distortion (THD)

THD is the ratio of the power of the harmonics to the power of the fundamental. For  $k - 1$  harmonics the THD is:

$$THD[dB] = 10 \log_{10} \left( \frac{P_{\text{harmonics}}}{P_{\text{signal}}} \right) \quad (5)$$

where:

$$P_{harmonics} = a_2^2 + a_3^2 + \dots + a_k^2 \quad (6)$$

$$P_{signal} = a_1^2 \quad (7)$$

The value of k is usually 6 (THD is calculated based on the first 5 harmonics).

#### 12.2.4 Signal-to-Noise ratio (S/N)

S/N is the ratio of the output signal power to the noise power, excluding the harmonics and the DC component:

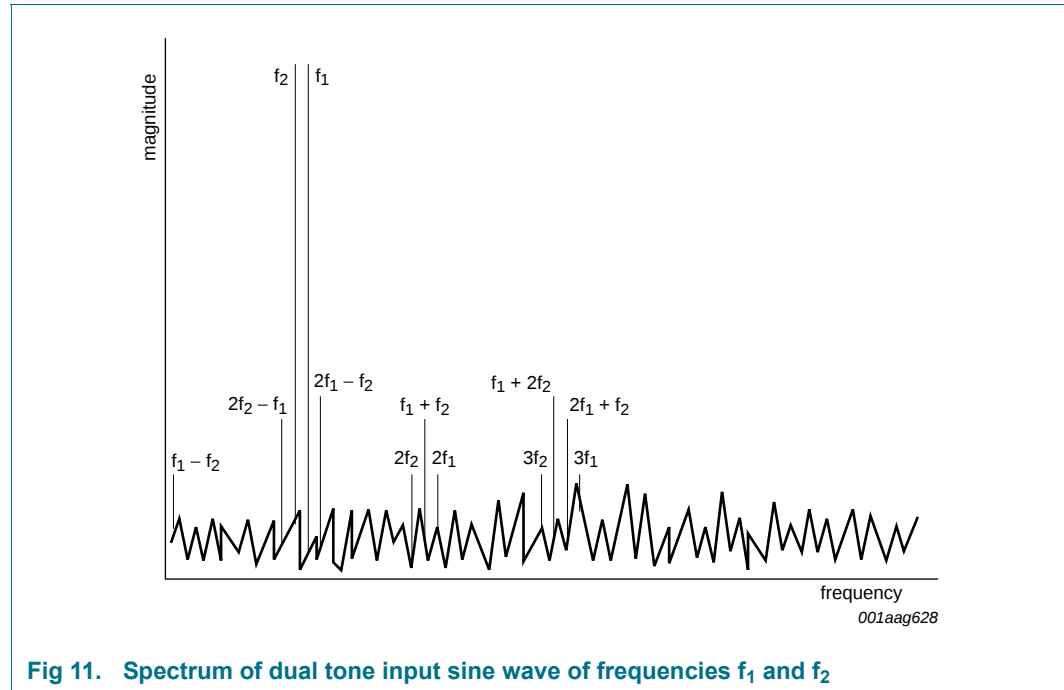
$$S/N = 10 \log_{10} \left( \frac{P_{signal}}{P_{noise}} \right) \quad (8)$$

#### 12.2.5 Spurious Free Dynamic Range (SFDR)

The SFDR value specifies the available signal range as the spectral distance between the amplitude of the fundamental ( $a_1$ ) and the amplitude of the largest spurious harmonic and non-harmonic ( $\max(s)$ ), excluding the DC component:

$$SFDR[dB] = 20 \log_{10} \left( \frac{a_1}{\max(s)} \right) \quad (9)$$

#### 12.2.6 InterModulation Distortion (IMD)



The second-order and third-order intermodulation distortion products IMD2 and IMD3 are defined using a dual tone input sinusoid, where  $f_1$  and  $f_2$  are chosen according to the coherence criterion.

IMD is the ratio of the RMS value of either tone to the RMS value of the worst, second or third-order intermodulation products.

The total intermodulation distortion is given by:

$$IMD[dB] = 10 \log_{10} \left( \frac{P_{intermod}}{P_{signal}} \right) \quad (10)$$

where:

$$P_{intermod} = a_{im(f_1-f_2)}^2 - a_{im(f_1+f_2)}^2 + a_{im(f_1-2f_2)}^2 + a_{im(f_1+2f_2)}^2 + \dots \quad (11)$$

$$\dots + a_{im(2f_1-f_2)}^2 + a_{im(2f_1+f_2)}^2$$

where  $a_{im(f_n)}^2$  is the power in the intermodulation component at  $f_n$ .

$$P_{signal} = a_{f_1}^2 + a_{f_2}^2 \quad (12)$$

13. Package outline

HTQFP48: plastic thermal enhanced thin quad flat package; 48 leads;  
body 7 x 7 x 1 mm; exposed die pad

SOT545-2

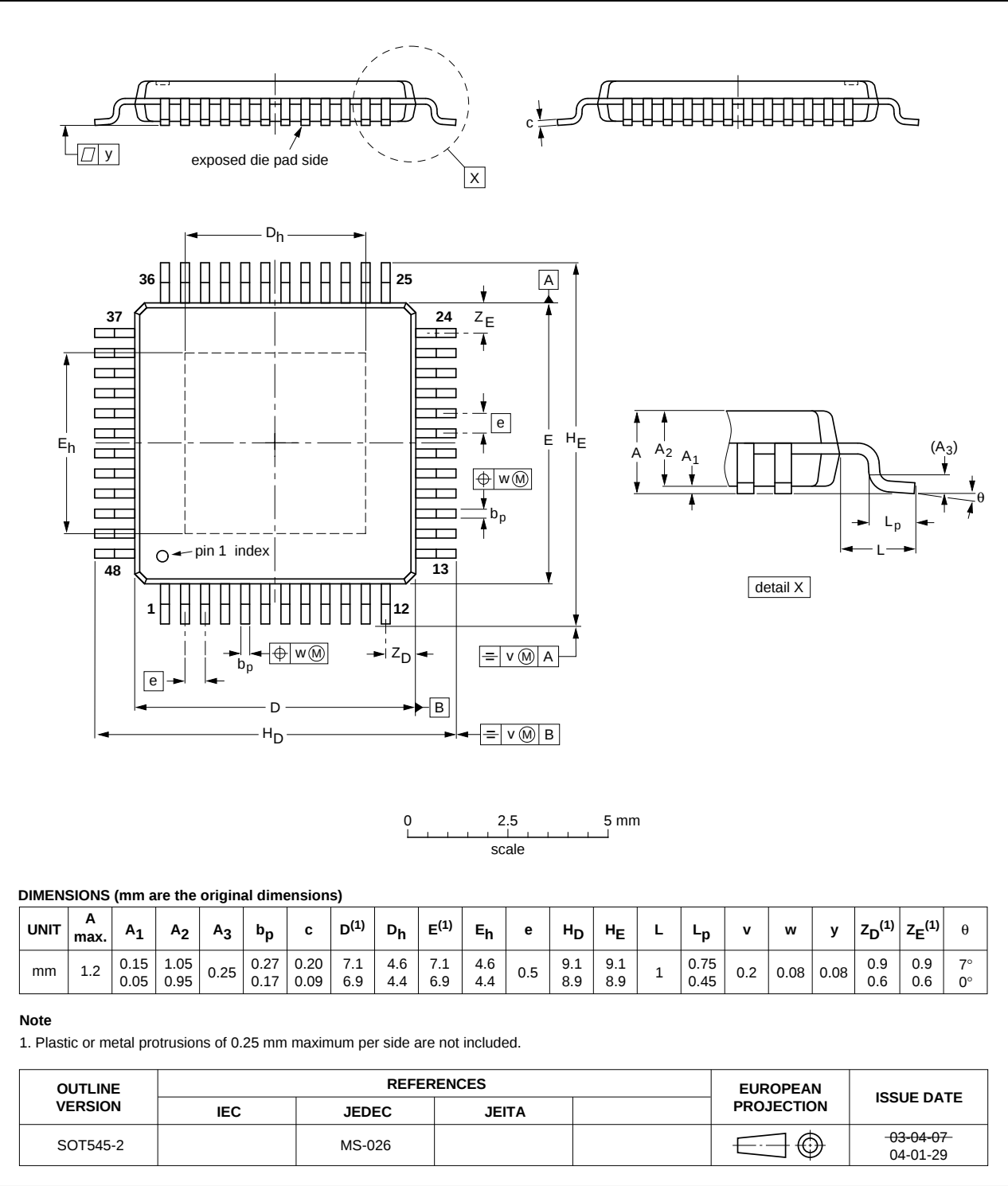


Fig 12. Package outline SOT545-2 (HTQFP48)

## 14. Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

### 14.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

### 14.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leadless or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leadless SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leadless packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

### 14.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

## 14.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see Figure 13) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with Table 14 and 15

**Table 14. SnPb eutectic process (from J-STD-020C)**

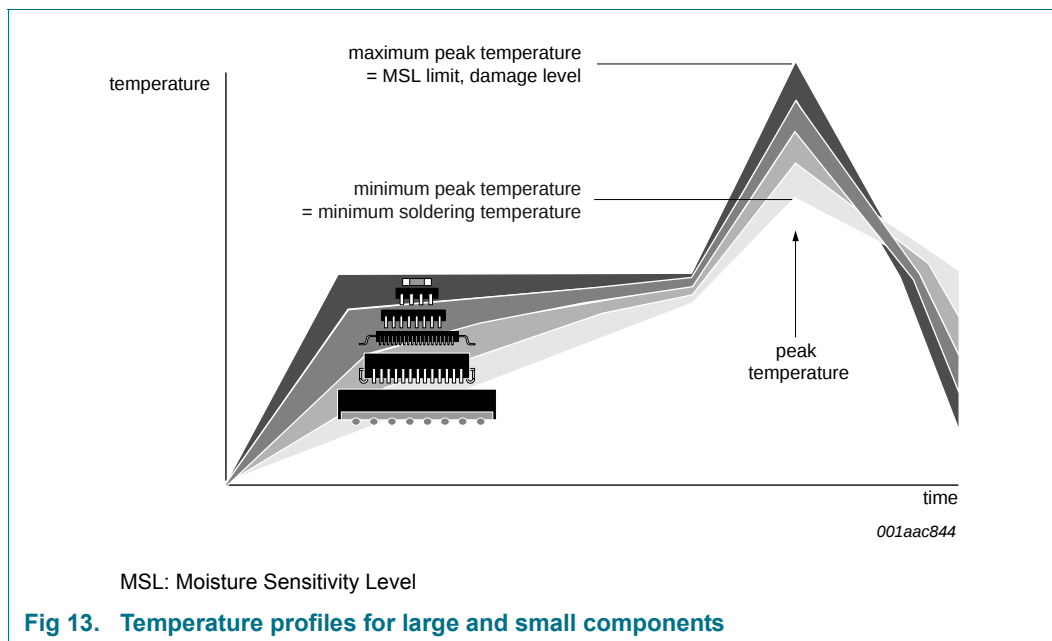
| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                  | 235                             | 220   |
| ≥ 2.5                  | 220                             | 220   |

**Table 15. Lead-free process (from J-STD-020C)**

| Package thickness (mm) | Package reflow temperature (°C) |             |        |
|------------------------|---------------------------------|-------------|--------|
|                        | Volume (mm <sup>3</sup> )       |             |        |
|                        | < 350                           | 350 to 2000 | > 2000 |
| < 1.6                  | 260                             | 260         | 260    |
| 1.6 to 2.5             | 260                             | 250         | 245    |
| > 2.5                  | 250                             | 245         | 245    |

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see Figure 13.



For further information on temperature profiles, refer to Application Note *AN10365* “Surface mount reflow soldering description”.

## 15. Revision history

**Table 16.** Revision history

| Document ID               | Release date        | Data sheet status    | Change notice | Supersedes                    |
|---------------------------|---------------------|----------------------|---------------|-------------------------------|
| ADC0808S125_ADC0808S250_4 | 20120702            | Product data sheet   | -             | ADC0808S125_A<br>DC0808S250_3 |
| ADC0808S125_ADC0808S250_3 | 20090224            | Product data sheet   | -             | ADC0808S125_A<br>DC0808S250_2 |
| Modifications:            | • Table 13 updated. |                      |               |                               |
| ADC0808S125_ADC0808S250_2 | 20081007            | Product data sheet   | -             | TDA9917_1                     |
| TDA9917_1                 | 20060609            | Objective data sheet | -             | -                             |

## 16. Contact information

For more information or sales office addresses, please visit: <http://www.idt.com>

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