

# ADC1005S060

Single 10 bits ADC, up to 60 MHz

Rev. 02 — 13 August 2008

Product data sheet

## 1. General description

The ADC1005S060 is a 10-bit high-speed low-power Analog-to-Digital Converter (ADC) for professional video and other applications. It converts the analog input signal into 10-bit binary or gray coded digital words at a maximum sampling rate of 60 MHz. All digital inputs and outputs are Transistor-Transistor Logic (TTL) and CMOS compatible, although a low-level sine wave clock input signal is allowed.

The device requires an external source to drive its reference ladder.

## 2. Features

- 10-bit resolution (binary or gray code)
- Sampling rate up to 60 MHz
- DC sampling allowed
- One clock cycle conversion only
- High signal-to-noise ratio over a large analog input frequency range (9.3 effective bits at 5 MHz full-scale input at  $f_{\text{clk}} = 60$  MHz)
- No missing codes guaranteed
- In-Range (IR) CMOS output
- TTL and CMOS levels compatible digital inputs
- 2.7 V to 3.6 V CMOS digital outputs
- Low-level AC clock input signal allowed
- External reference voltage regulator
- Power dissipation only 312 mW (typical)
- Low analog input capacitance, no buffer amplifier required
- No sample-and-hold circuit required

## 3. Applications

- Video data digitizing
- Radar
- Barcode scanners
- Digital instrumentation
- Transient signal analysis
- $\Sigma\Delta$  modulators
- Medical imaging

## 4. Quick reference data

**Table 1. Quick reference data**

$V_{CCA} = 4.75\text{ V to }5.25\text{ V}$ ;  $V_{CCD} = 4.75\text{ V to }5.25\text{ V}$ ; *AGND and DGND shorted together*;  
 $T_{amb} = 0\text{ }^{\circ}\text{C to }70\text{ }^{\circ}\text{C}$ ; *typical values measured at  $V_{CCA} = V_{CCD} = 5\text{ V}$ ;  $V_{CCO} = 3.3\text{ V}$ ;  $V_{RB} = 1.3\text{ V}$ ;  
 $V_{RT} = 3.7\text{ V}$ ;  $C_L = 10\text{ pF}$  and  $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.*

| Symbol         | Parameter                  | Conditions                                | Min  | Typ        | Max       | Unit |
|----------------|----------------------------|-------------------------------------------|------|------------|-----------|------|
| $V_{CCA}$      | analog supply voltage      |                                           | 4.75 | 5.0        | 5.25      | V    |
| $V_{CCD}$      | digital supply voltage     |                                           | 4.75 | 5.0        | 5.25      | V    |
| $V_{CCO}$      | output supply voltage      |                                           | 2.7  | 3.3        | 3.6       | V    |
| $I_{CCA}$      | analog supply current      |                                           | -    | 29         | 37        | mA   |
| $I_{CCD}$      | digital supply current     |                                           | -    | 33         | 40        | mA   |
| $I_{CCO}$      | output supply current      | $f_{clk} = 60\text{ MHz}$ ;<br>ramp input | -    | 0.5        | 2.0       | mA   |
| INL            | integral non-linearity     |                                           | -    | $\pm 0.8$  | $\pm 2.0$ | LSB  |
| DNL            | differential non-linearity |                                           | -    | $\pm 0.35$ | $\pm 0.9$ | LSB  |
| $f_{clk(max)}$ | maximum clock frequency    |                                           | 60   | -          | -         | MHz  |
| $P_{tot}$      | total power dissipation    | $f_{clk} = 60\text{ MHz}$ ;<br>ramp input | -    | 312        | 411       | mW   |

## 5. Ordering information

**Table 2. Ordering information**

| Type number   | Package |                                                                   | Version  |
|---------------|---------|-------------------------------------------------------------------|----------|
|               | Name    | Description                                                       |          |
| ADC1005S060TS | SSOP28  | plastic shrink small outline package; 28 leads; body width 5.3 mm | SOT341-1 |

## 6. Block diagram

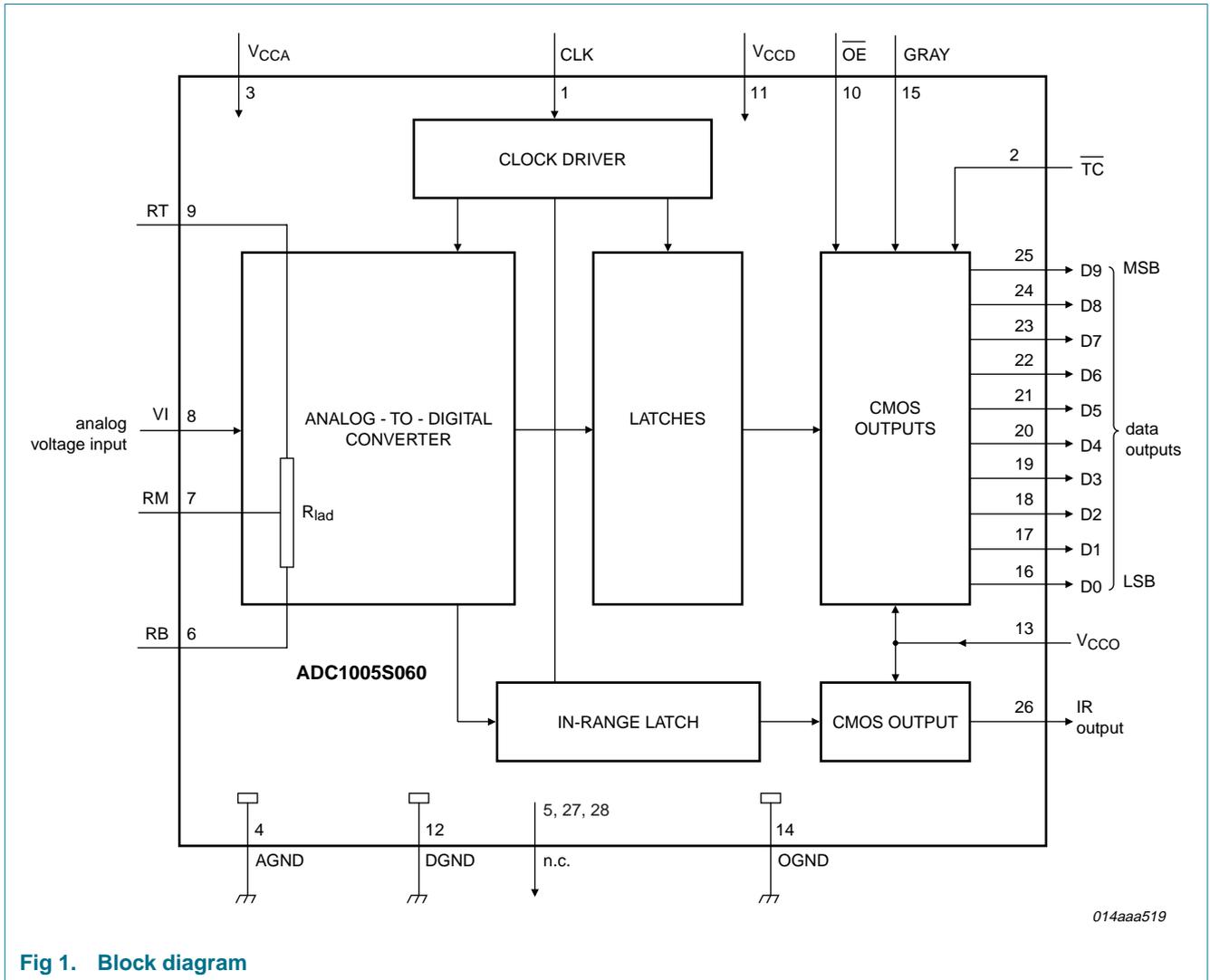
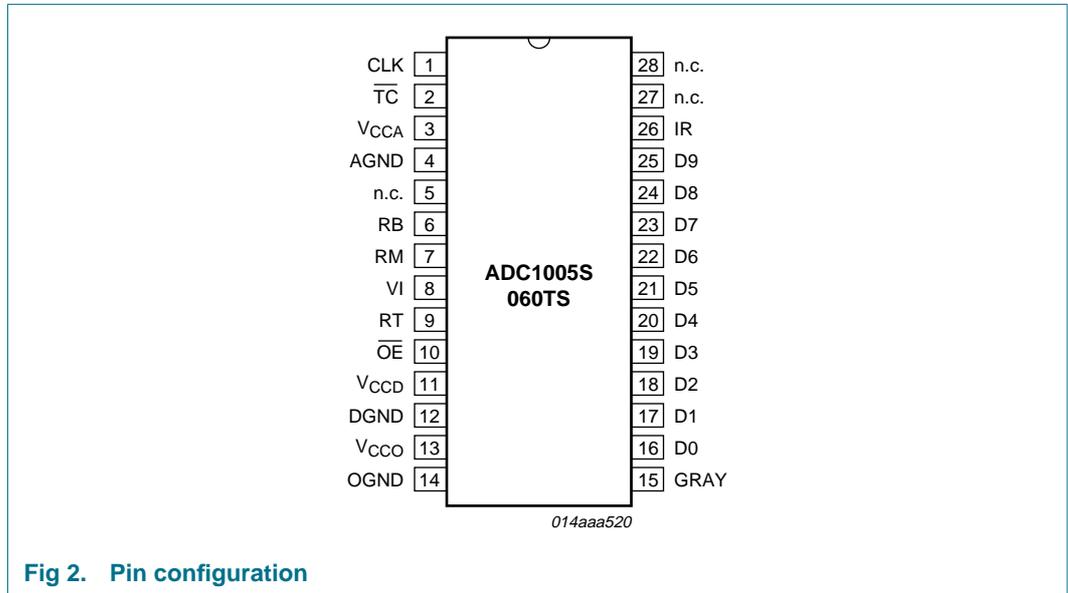


Fig 1. Block diagram

## 7. Pinning information

### 7.1 Pinning



### 7.2 Pin description

**Table 3. Pin description**

| Symbol          | Pin | Description                                       |
|-----------------|-----|---------------------------------------------------|
| CLK             | 1   | clock input                                       |
| $\overline{TC}$ | 2   | twos complement input (active LOW)                |
| $V_{CCA}$       | 3   | analog supply voltage (5 V)                       |
| AGND            | 4   | analog ground                                     |
| n.c.            | 5   | not connected                                     |
| RB              | 6   | reference voltage BOTTOM input                    |
| RM              | 7   | reference voltage MIDDLE input                    |
| VI              | 8   | analog voltage input                              |
| RT              | 9   | reference voltage TOP input                       |
| $\overline{OE}$ | 10  | output enable input (active LOW)                  |
| $V_{CCD}$       | 11  | digital supply voltage (2.7 V to 3.6 V)           |
| DGND            | 12  | digital ground                                    |
| $V_{CCO}$       | 13  | supply voltage for output stages (2.7 V to 3.6 V) |
| OGND            | 14  | output ground                                     |
| GRAY            | 15  | gray code input (active HIGH)                     |
| D0              | 16  | data output; bit 0 (Least Significant Bit (LSB))  |
| D1              | 17  | data output; bit 1                                |
| D2              | 18  | data output; bit 2                                |
| D3              | 19  | data output; bit 3                                |

**Table 3. Pin description ...continued**

| Symbol | Pin | Description                                     |
|--------|-----|-------------------------------------------------|
| D4     | 20  | data output; bit 4                              |
| D5     | 21  | data output; bit 5                              |
| D6     | 22  | data output; bit 6                              |
| D7     | 23  | data output; bit 7                              |
| D8     | 24  | data output; bit 8                              |
| D9     | 25  | data output; bit 9 (Most Significant Bit (MSB)) |
| IR     | 26  | in-range data output                            |
| n.c.   | 27  | not connected                                   |
| n.c.   | 28  | not connected                                   |

## 8. Limiting values

**Table 4. Limiting values**

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

| Symbol            | Parameter                        | Conditions                                  | Min      | Max       | Unit |
|-------------------|----------------------------------|---------------------------------------------|----------|-----------|------|
| $V_{CCA}$         | analog supply voltage            |                                             | [1] -0.3 | +7.0      | V    |
| $V_{CCD}$         | digital supply voltage           |                                             | [1] -0.3 | +7.0      | V    |
| $V_{CCO}$         | output supply voltage            |                                             | [1] -0.3 | +7.0      | V    |
| $\Delta V_{CC}$   | supply voltage difference        | $V_{CCA} - V_{CCD}$                         | -0.1     | +1.0      | V    |
|                   |                                  | $V_{CCD} - V_{CCO};$<br>$V_{CCA} - V_{CCO}$ | -0.1     | +4.0      | V    |
| $V_I$             | input voltage                    | referenced to AGND                          | -0.3     | +7.0      | V    |
| $V_{i(clk)(p-p)}$ | peak-to-peak clock input voltage | for switching; referenced to DGND           | -        | $V_{CCD}$ | V    |
| $I_O$             | output current                   |                                             | -        | 10        | mA   |
| $T_{stg}$         | storage temperature              |                                             | -55      | +150      | °C   |
| $T_{amb}$         | ambient temperature              |                                             | -40      | +85       | °C   |
| $T_j$             | junction temperature             |                                             | -        | 150       | °C   |

[1] The supply voltages  $V_{CCA}$ ,  $V_{CCD}$  and  $V_{CCO}$  may have any value between -0.3 V and +7.0 V provided that the supply voltage differences  $\Delta V_{CC}$  are respected.

## 9. Thermal characteristics

**Table 5. Thermal characteristics**

| Symbol        | Parameter                                   | Condition   | Value | Unit |
|---------------|---------------------------------------------|-------------|-------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | 110   | K/W  |

## 10. Characteristics

**Table 6. Characteristics**

$V_{CCA} = 4.75\text{ V to }5.25\text{ V}$ ;  $V_{CCD} = 4.75\text{ V to }5.25\text{ V}$ ; AGND and DGND shorted together;  $T_{amb} = 0\text{ }^{\circ}\text{C to }70\text{ }^{\circ}\text{C}$ ; typical values measured at  $V_{CCA} = V_{CCD} = 5\text{ V}$ ;  $V_{CCO} = 3.3\text{ V}$ ;  $V_{RB} = 1.3\text{ V}$ ;  $V_{RT} = 3.7\text{ V}$ ;  $C_L = 10\text{ pF}$  and  $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| Symbol                                                                                                  | Parameter                 | Conditions                                | Min  | Typ | Max       | Unit          |
|---------------------------------------------------------------------------------------------------------|---------------------------|-------------------------------------------|------|-----|-----------|---------------|
| <b>Supplies</b>                                                                                         |                           |                                           |      |     |           |               |
| $V_{CCA}$                                                                                               | analog supply voltage     |                                           | 4.75 | 5.0 | 5.25      | V             |
| $V_{CCD}$                                                                                               | digital supply voltage    |                                           | 4.75 | 5.0 | 5.25      | V             |
| $V_{CCO}$                                                                                               | output supply voltage     |                                           | 2.7  | 3.3 | 3.6       | V             |
| $\Delta V_{CC}$                                                                                         | supply voltage difference | $V_{CCA} - V_{CCD}$                       | -0.2 | -   | +0.2      | V             |
|                                                                                                         |                           | $V_{CCA} - V_{CCO}$ ; $V_{CCD} - V_{CCO}$ | -0.2 |     | +2.55     | V             |
| $I_{CCA}$                                                                                               | analog supply current     |                                           | -    | 29  | 37        | mA            |
| $I_{CCD}$                                                                                               | digital supply current    |                                           | -    | 33  | 40        | mA            |
| $I_{CCO}$                                                                                               | output supply current     | $f_{clk} = 60\text{ MHz}$ ; ramp input    | -    | 0.5 | 2.0       | mA            |
| $P_{tot}$                                                                                               | total power dissipation   | $f_{clk} = 60\text{ MHz}$ ; ramp input    | -    | 312 | 411       | mW            |
| <b>Inputs</b>                                                                                           |                           |                                           |      |     |           |               |
| Clock input CLK (Referenced to DGND) <sup>[1]</sup>                                                     |                           |                                           |      |     |           |               |
| $V_{IL}$                                                                                                | LOW-level input voltage   |                                           | 0    | -   | 0.8       | V             |
| $V_{IH}$                                                                                                | HIGH-level input voltage  |                                           | 2    | -   | $V_{CCD}$ | V             |
| $I_{IL}$                                                                                                | LOW-level input current   | $V_{clk} = 0.8\text{ V}$                  | -1   | 0   | +1        | $\mu\text{A}$ |
| $I_{IH}$                                                                                                | HIGH-level input current  | $V_{clk} = 2\text{ V}$                    | -    | 2   | 10        | $\mu\text{A}$ |
| $C_i$                                                                                                   | input capacitance         |                                           | -    | 2   | -         | pF            |
| Inputs $\overline{\text{OE}}$ , $\overline{\text{TC}}$ and GRAY (Referenced to DGND); see Table 3 and 4 |                           |                                           |      |     |           |               |
| $V_{IL}$                                                                                                | LOW-level input voltage   |                                           | 0    | -   | 0.8       | V             |
| $V_{IH}$                                                                                                | HIGH-level input voltage  |                                           | 2    | -   | $V_{CCD}$ | V             |
| $I_{IL}$                                                                                                | LOW-level input current   | $V_{IL} = 0.8\text{ V}$                   | -1   | -   | -         | $\mu\text{A}$ |
| $I_{IH}$                                                                                                | HIGH-level input current  | $V_{IH} = 2.0\text{ V}$                   | -    | -   | 1         | $\mu\text{A}$ |
| Analog input VI (Referenced to AGND)                                                                    |                           |                                           |      |     |           |               |
| $I_{IL}$                                                                                                | LOW-level input current   | $V_I = V_{RB} = 1.3\text{ V}$             | -    | 0   | -         | $\mu\text{A}$ |

**Table 6. Characteristics ...continued**

$V_{CCA} = 4.75\text{ V to }5.25\text{ V}$ ;  $V_{CCD} = 4.75\text{ V to }5.25\text{ V}$ ; AGND and DGND shorted together;  $T_{amb} = 0\text{ }^{\circ}\text{C to }70\text{ }^{\circ}\text{C}$ ; typical values measured at  $V_{CCA} = V_{CCD} = 5\text{ V}$ ;  $V_{CCO} = 3.3\text{ V}$ ;  $V_{RB} = 1.3\text{ V}$ ;  $V_{RT} = 3.7\text{ V}$ ;  $C_L = 10\text{ pF}$  and  $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| Symbol   | Parameter                | Conditions                    | Min | Typ | Max | Unit             |
|----------|--------------------------|-------------------------------|-----|-----|-----|------------------|
| $I_{IH}$ | HIGH-level input current | $V_I = V_{RT} = 3.7\text{ V}$ | -   | 55  | -   | $\mu\text{A}$    |
| $Y_i$    | input admittance         | $f_i = 5\text{ MHz}$          | [2] |     |     |                  |
|          |                          | $R_i$ , input resistance      | -   | 45  | -   | $\text{k}\Omega$ |
|          |                          | $C_i$ , input capacitance     | 3   | 5   | 7   | $\text{pF}$      |

**Reference voltages for the resistor ladder; see Table 7**

|                 |                                         |                               |     |      |                 |                           |             |
|-----------------|-----------------------------------------|-------------------------------|-----|------|-----------------|---------------------------|-------------|
| $V_{RB}$        | voltage on pin RB                       |                               | 1.2 | 1.3  | 2.2             | V                         |             |
| $V_{RT}$        | voltage on pin RT                       |                               | 3.4 | 3.7  | $V_{CCA} - 0.8$ | V                         |             |
| $V_{ref(dif)}$  | differential reference voltage          | $V_{RT} - V_{RB}$             | 2.2 | 2.4  | 3.2             | V                         |             |
| $I_{ref}$       | reference current                       | $V_{ref(dif)} = 2.4\text{ V}$ | -   | 17.6 | -               | $\text{mA}$               |             |
| $R_{lad}$       | ladder resistance                       |                               | -   | 136  | -               | $\Omega$                  |             |
| $TC_{Rlad}$     | ladder resistor temperature coefficient |                               | -   | 253  | -               | $\text{m}\Omega/\text{K}$ |             |
| $V_{offset}$    | offset voltage                          | $V_{ref(dif)} = 2.4\text{ V}$ |     |      |                 |                           |             |
|                 |                                         | BOTTOM                        | [3] | -    | 200             | -                         | $\text{mV}$ |
|                 |                                         | TOP                           | [3] | -    | 190             | -                         | $\text{mV}$ |
| $V_{i(a)(p-p)}$ | peak-to-peak analog input voltage       | $V_{ref(dif)} = 2.4\text{ V}$ | [4] | 1.95 | 2.01            | 2.10                      | V           |

**Outputs**

**Digital outputs D9 to D0 and IR (Referenced to OGND)**

|          |                           |                                |                 |   |           |               |
|----------|---------------------------|--------------------------------|-----------------|---|-----------|---------------|
| $V_{OL}$ | LOW-level output voltage  | $I_O = 1\text{ mA}$            | 0               | - | 0.5       | V             |
| $V_{OH}$ | HIGH-level output voltage | $I_O = -1\text{ mA}$           | $V_{CCO} - 0.5$ | - | $V_{CCO}$ | V             |
| $I_{OZ}$ | OFF-state output current  | $0.5\text{ V} < V_O < V_{CCO}$ | -20             | - | +20       | $\mu\text{A}$ |

**Switching characteristics; Clock input CLK; see Figure 4[1]**

|                |                         |                                        |     |   |   |              |
|----------------|-------------------------|----------------------------------------|-----|---|---|--------------|
| $f_{clk(max)}$ | maximum clock frequency |                                        | 60  | - | - | $\text{MHz}$ |
| $t_{w(clk)H}$  | HIGH clock pulse width  | $T_{amb} = 25\text{ }^{\circ}\text{C}$ | 7.0 | - | - | $\text{ns}$  |
| $t_{w(clk)L}$  | LOW clock pulse width   | $T_{amb} = 25\text{ }^{\circ}\text{C}$ | 3.5 | - | - | $\text{ns}$  |

**Analog signal processing;  $f_{clk} = 60\text{ MHz}$**

**Linearity**

|     |                            |            |   |            |           |     |
|-----|----------------------------|------------|---|------------|-----------|-----|
| INL | integral non-linearity     | ramp input | - | $\pm 0.8$  | $\pm 2.0$ | LSB |
| DNL | differential non-linearity | ramp input | - | $\pm 0.35$ | $\pm 0.9$ | LSB |

**Table 6. Characteristics ...continued**

$V_{CCA} = 4.75\text{ V to }5.25\text{ V}$ ;  $V_{CCD} = 4.75\text{ V to }5.25\text{ V}$ ; AGND and DGND shorted together;  $T_{amb} = 0\text{ }^{\circ}\text{C to }70\text{ }^{\circ}\text{C}$ ; typical values measured at  $V_{CCA} = V_{CCD} = 5\text{ V}$ ;  $V_{CCO} = 3.3\text{ V}$ ;  $V_{RB} = 1.3\text{ V}$ ;  $V_{RT} = 3.7\text{ V}$ ;  $C_L = 10\text{ pF}$  and  $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| Symbol                                                                                                                         | Parameter                   | Conditions                                                          | Min | Typ        | Max | Unit          |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------|---------------------------------------------------------------------|-----|------------|-----|---------------|
| $E_{\text{offset}}$                                                                                                            | offset error                | middle code                                                         | -   | $\pm 1$    | -   | LSB           |
| $E_G$                                                                                                                          | gain error                  | from device to device                                               | [5] | $\pm 0.5$  | -   | %             |
| <b>Bandwidth</b>                                                                                                               |                             |                                                                     |     |            |     |               |
| B                                                                                                                              | bandwidth                   | full-scale sine wave                                                | [6] | 30         | -   | MHz           |
|                                                                                                                                |                             | 75 % full-scale sine wave                                           | -   | 45         | -   | MHz           |
|                                                                                                                                |                             | small signal at mid-scale;<br>$V_I = \pm 10\text{ LSB}$ at code 512 | -   | 700        | -   | MHz           |
| $t_{s(\text{LH})}$                                                                                                             | LOW to HIGH settling time   | full-scale square wave;<br>see <a href="#">Figure 6</a>             | [7] | 5          | -   | ns            |
| $t_{s(\text{HL})}$                                                                                                             | HIGH to LOW settling time   | full-scale square wave;<br>see <a href="#">Figure 6</a>             | [7] | 5          | -   | ns            |
| <b>Harmonics</b>                                                                                                               |                             |                                                                     |     |            |     |               |
| $\alpha_{2\text{H}}$                                                                                                           | second harmonic level       | $f_i = 5\text{ MHz}$                                                | -   | -68        | -   | dB            |
| $\alpha_{3\text{H}}$                                                                                                           | third harmonic level        | $f_i = 5\text{ MHz}$                                                | -   | -67        | -   | dB            |
| THD                                                                                                                            | total harmonic distortion   | $f_i = 5\text{ MHz}$                                                | -   | -64        | -   | dB            |
|                                                                                                                                |                             | $f_i = 15\text{ MHz}$                                               | -   | -57        | -   | dB            |
| SFDR                                                                                                                           | spurious free dynamic range | $f_i = 5\text{ MHz}$                                                | -   | 72         | -   | dB            |
| <b>Signal-to-Noise ratio[8]</b>                                                                                                |                             |                                                                     |     |            |     |               |
| S/N                                                                                                                            | signal-to-noise ratio       | without harmonics;<br>$f_i = 5\text{ MHz}$                          | -   | 58         | -   | dB            |
|                                                                                                                                |                             | without harmonics;<br>$f_i = 15\text{ MHz}$                         | 53  | 57         | -   | dB            |
| <b>Effective bits[8]</b>                                                                                                       |                             |                                                                     |     |            |     |               |
| ENOB                                                                                                                           | effective number of bits    | $f_i = 5\text{ MHz}$                                                | -   | 9.3        | -   | bits          |
|                                                                                                                                |                             | $f_i = 10\text{ MHz}$                                               | -   | 8.9        | -   | bits          |
|                                                                                                                                |                             | $f_i = 15\text{ MHz}$                                               | -   | 8.8        | -   | bits          |
|                                                                                                                                |                             | $f_i = 20\text{ MHz}$                                               | -   | 8.6        | -   | bits          |
| <b>Two-tone intermodulation[9]</b>                                                                                             |                             |                                                                     |     |            |     |               |
| $\alpha_{\text{IM}}$                                                                                                           | intermodulation suppression | $f_{\text{clk}} = 60\text{ MHz}$                                    | -   | -67        | -   | dB            |
| <b>Bit error rate</b>                                                                                                          |                             |                                                                     |     |            |     |               |
| BER                                                                                                                            | bit error rate              | $f_i = 5\text{ MHz}$ ; $V_I = \pm 16\text{ LSB}$ at code 512        | -   | $10^{-13}$ | -   | times/samples |
| <b>Timing (<math>f_{\text{clk}} = 60\text{ MHz}</math>; <math>C_L = 10\text{ pF}</math>); see <a href="#">Figure 4</a>[10]</b> |                             |                                                                     |     |            |     |               |
| $t_{d(\text{s})}$                                                                                                              | sampling delay time         |                                                                     | -   | 0.7        | 2   | ns            |
| $t_{h(\text{o})}$                                                                                                              | output hold time            |                                                                     | 4   | -          | -   | ns            |
| $t_{d(\text{o})}$                                                                                                              | output delay time           | $V_{\text{CCO}} = 2.7\text{ V}$                                     | -   | 10         | 14  | ns            |
|                                                                                                                                |                             | $V_{\text{CCO}} = 3.3\text{ V}$                                     | -   | 9          | 13  | ns            |

**Table 6. Characteristics ...continued**

$V_{CCA} = 4.75\text{ V to }5.25\text{ V}$ ;  $V_{CCD} = 4.75\text{ V to }5.25\text{ V}$ ; AGND and DGND shorted together;  $T_{amb} = 0\text{ }^{\circ}\text{C to }70\text{ }^{\circ}\text{C}$ ; typical values measured at  $V_{CCA} = V_{CCD} = 5\text{ V}$ ;  $V_{CCO} = 3.3\text{ V}$ ;  $V_{RB} = 1.3\text{ V}$ ;  $V_{RT} = 3.7\text{ V}$ ;  $C_L = 10\text{ pF}$  and  $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

| Symbol                                                                                                                                      | Parameter                       | Conditions               | Min | Typ | Max | Unit |
|---------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|--------------------------|-----|-----|-----|------|
| $C_L$                                                                                                                                       | load capacitance                |                          | -   | -   | 10  | pF   |
| SR                                                                                                                                          | slew rate                       | $V_{CCO} = 2.7\text{ V}$ | 0.2 | 0.3 | -   | V/ns |
| <b>3-state output delay times (<math>f_{clk} = 60\text{ MHz}</math>; <math>V_{CCO} = 3.3\text{ V}</math>); see <a href="#">Figure 5</a></b> |                                 |                          |     |     |     |      |
| $t_{dZH}$                                                                                                                                   | float to active HIGH delay time |                          | -   | 16  | 20  | ns   |
| $t_{dZL}$                                                                                                                                   | float to active LOW delay time  |                          | -   | 30  | 34  | ns   |
| $t_{dHZ}$                                                                                                                                   | active HIGH to float delay time |                          | -   | 25  | 30  | ns   |
| $t_{dLZ}$                                                                                                                                   | active LOW to float delay time  |                          | -   | 23  | 27  | ns   |

[1] The rise and fall times of the clock signal must not be less than 0.5 ns.

[2] The input admittance is  $Y_i + \frac{I}{R_i} + j\omega C_i$

[3] Analog input voltages producing code 0 up to and including code 1023:

a)  $V_{\text{offset BOTTOM}}$  is the difference between the analog input which produces data equal to 00 and the reference voltage on pin RB ( $V_{RB}$ ) at  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

b)  $V_{\text{offset TOP}}$  is the difference between the reference voltage on pin RT ( $V_{RT}$ ) and the analog input which produces data outputs equal to code 1023 at  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

[4] To ensure the optimum linearity performance of such a converter architecture the lower and upper extremities of the converter reference resistor ladder are connected to pins RB and RT via offset resistors  $R_{OB}$  and  $R_{OT}$  as shown in [Figure 3](#).

a) The current flowing into the resistor ladder is  $I = \frac{V_{RT} - V_{RB}}{R_{OB} + R_L + R_{OT}}$  and the full-scale input range at the converter, to cover code 0

$$\text{to 1023 is } V_I = R_L \times I_L = \frac{R_L}{R_{OB} + R_L + R_{OT}} \times (V_{RT} + V_{RB}) = 0.8375 \times (V_{RT} - V_{RB})$$

b) Since  $R_L$ ,  $R_{OB}$  and  $R_{OT}$  have similar behavior with respect to process and temperature variation, the ratio  $\frac{R_L}{R_{OB} + R_L + R_{OT}}$

will be kept reasonably constant from device to device. Consequently, variation of the output codes at a given input voltage depends mainly on the difference  $V_{RT} - V_{RB}$  and its variation with temperature and supply voltage. When several ADCs are connected in parallel and fed with the same reference source, the matching between each of them is optimized.

$$[5] E_G = \frac{(V_{1023} - V_0) - V_{i(p-p)}}{V_{i(p-p)}} \times 100$$

[6] The analog bandwidth is defined as the maximum input sine wave frequency which can be applied to the device. No glitches greater than 2 LSB, neither any significant attenuation are observed in the reconstructed signal.

[7] The analog input settling time is the minimum time required for the input signal to be stabilized after a sharp full-scale input (square wave signal) in order to sample the signal and obtain correct output data.

[8] Effective bits are obtained via a Fast Fourier Transform (FFT) treatment taking 8000 acquisition points per equivalent fundamental period. The calculation takes into account all harmonics and noise up to half the clock frequency (Nyquist frequency). Conversion to signal-to-noise ratio:  $S/N = \text{ENOB} \times 6.02 + 1.76\text{ dB}$ .

[9] Intermodulation measured relative to either tone with analog input frequencies of 4.3 MHz and 4.5 MHz. The two input signals have the same amplitude and the total amplitude of both signals provides full-scale to the converter.

[10] Output data acquisition: the output data is available after the maximum delay time of  $t_{d(o)}$ . NXP recommends the lowest possible output load. These parameters are guaranteed by characterization and not by production test.

## 11. Additional information relating to Table 6

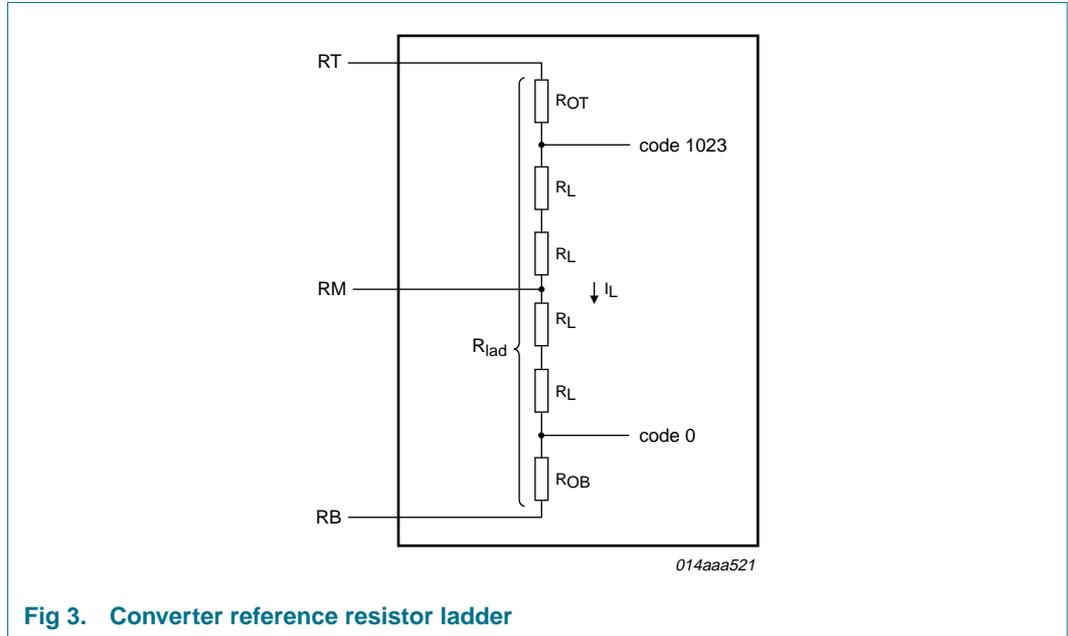


Fig 3. Converter reference resistor ladder

Table 7. Output coding and input voltage (typical values; referenced to AGND,  $V_{RB} = 1.3\text{ V}$ ,  $V_{RT} = 3.7\text{ V}$ ; binary/gray codes)

| Code      | $V_{i(a)(p-p)}$ (V) | IR | Binary outputs D9 to D0 | Gray outputs D9 to D0 |
|-----------|---------------------|----|-------------------------|-----------------------|
| Underflow | < 1.5               | 0  | 00 0000 0000            | 00 0000 0000          |
| 0         | 1.5                 | 1  | 00 0000 0000            | 00 0000 0000          |
| 1         | -                   | 1  | 00 0000 0001            | 00 0000 0001          |
| ↓         | -                   | ↓  | ↓                       | ↓                     |
| 1022      | -                   | 1  | 11 1111 1110            | 10 0000 0001          |
| 1023      | 3.51                | 1  | 11 1111 1111            | 10 0000 0000          |
| Overflow  | > 3.51              | 0  | 11 1111 1111            | 10 0000 0000          |

Table 8. Output coding and input voltage (typical values; referenced to AGND; binary/twos complement codes)

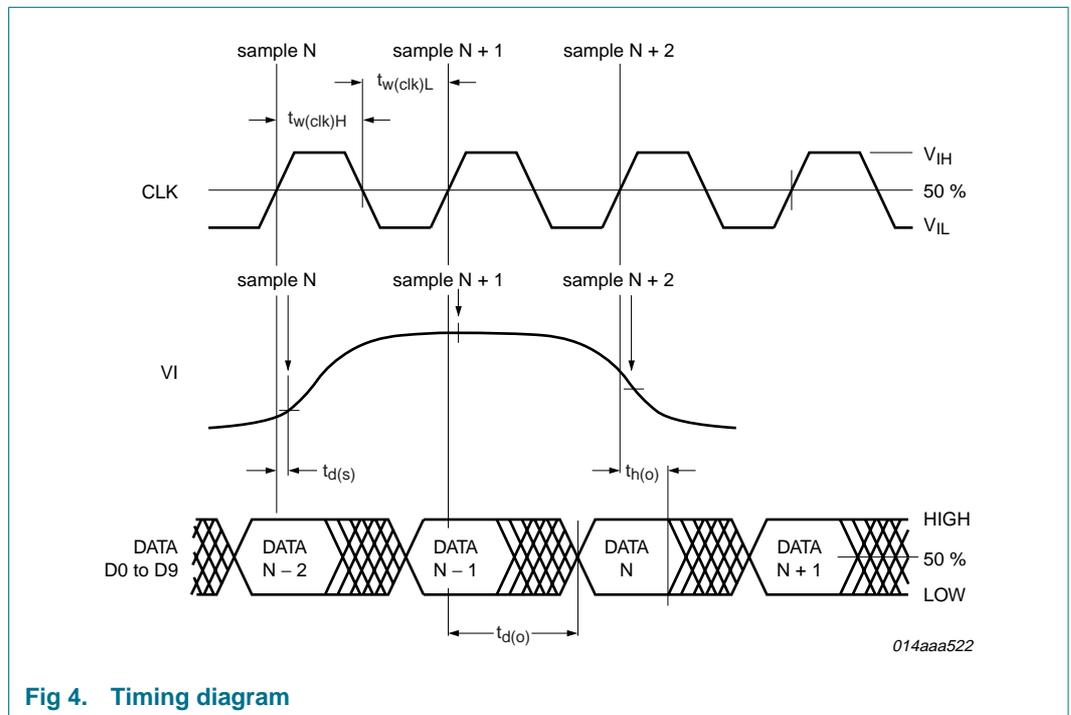
| Code      | $V_{i(a)(p-p)}$ (V) | IR | Binary outputs D9 to D0 | twos complement outputs D9 to D0 |
|-----------|---------------------|----|-------------------------|----------------------------------|
| Underflow | < 1.5               | 0  | 00 0000 0000            | 10 0000 0000                     |
| 0         | 1.5                 | 1  | 00 0000 0000            | 10 0000 0000                     |
| 1         | -                   | 1  | 00 0000 0001            | 10 0000 0001                     |
| ↓         | -                   | ↓  | ↓                       | ↓                                |
| 1022      | -                   | 1  | 11 1111 1110            | 01 1111 1110                     |
| 1023      | 3.51                | 1  | 11 1111 1111            | 01 1111 1111                     |
| Overflow  | > 3.51              | 0  | 11 1111 1111            | 01 1111 1111                     |

**Table 9. TC mode selection**

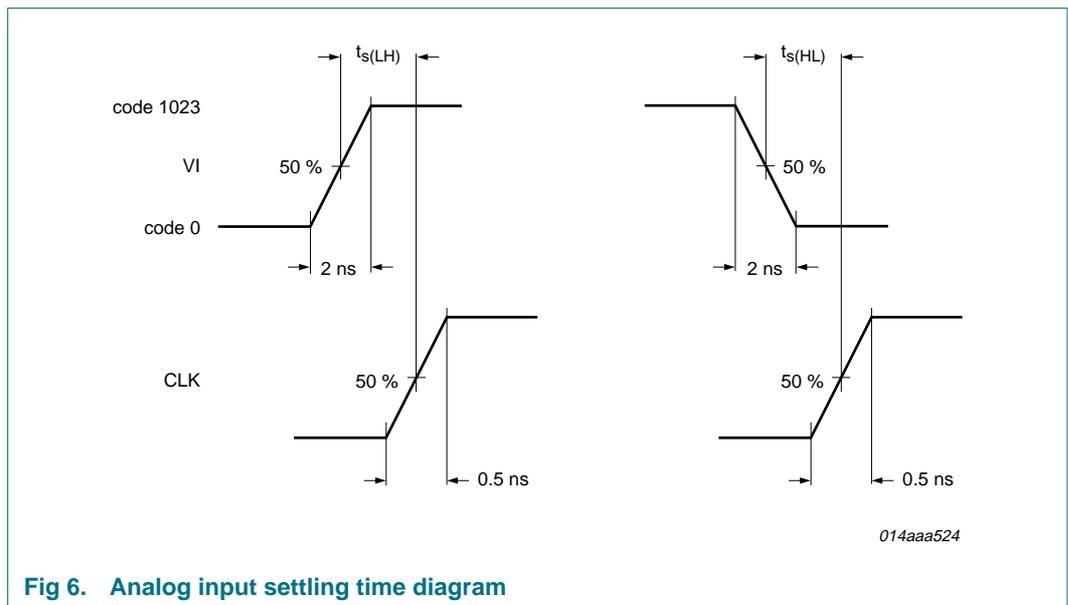
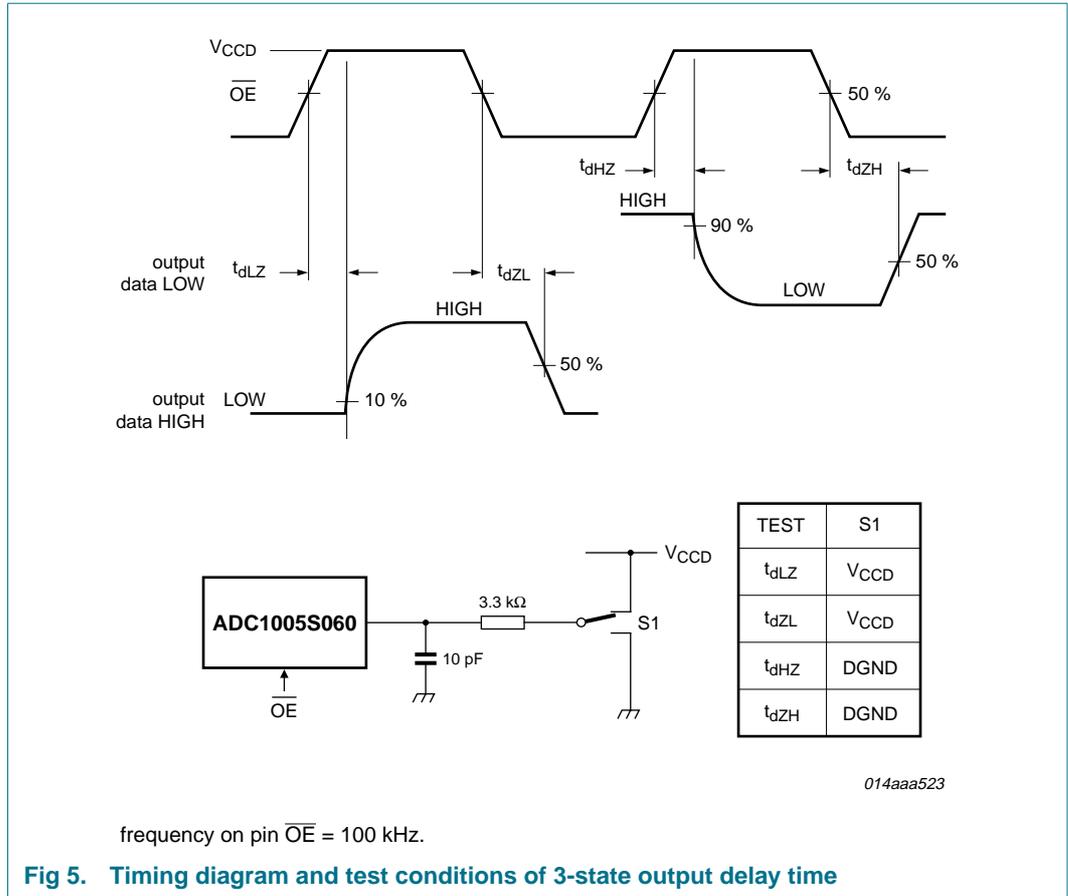
| TC | OE | D9 to D0                 | IR             |
|----|----|--------------------------|----------------|
| X  | 1  | high impedance           | high impedance |
| 0  | 0  | active; two's complement | active         |
| 1  | 0  | active; binary           | active         |

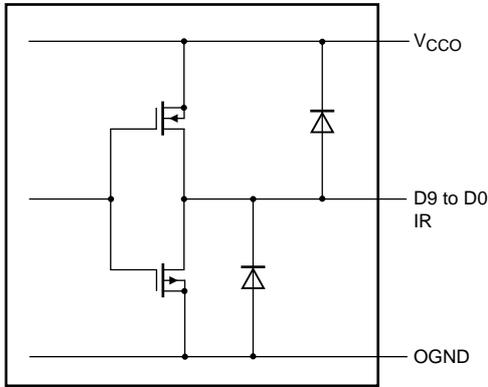
**Table 10. Gray mode selection**

| Gray | OE | D9 to D0       | IR             |
|------|----|----------------|----------------|
| X    | 1  | high impedance | high impedance |
| 0    | 0  | active; binary | active         |
| 1    | 0  | active; gray   | active         |



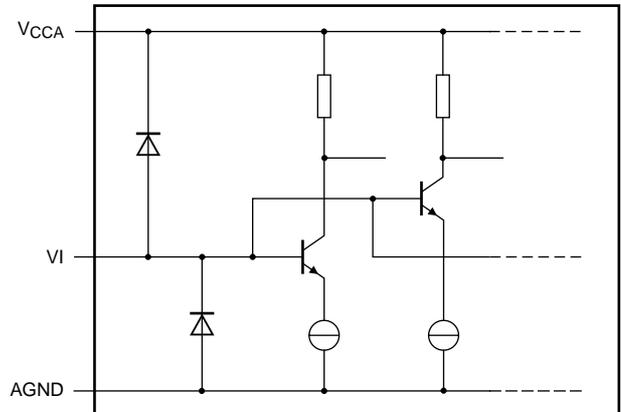
**Fig 4. Timing diagram**





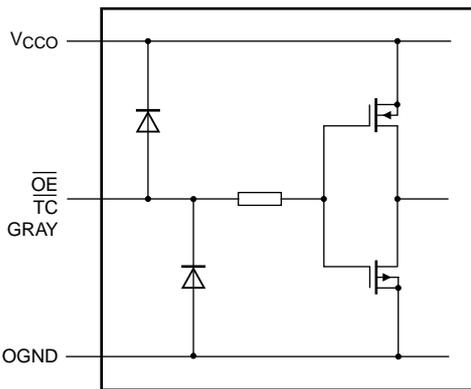
014aaa525

Fig 7. D9 to D0 and IR outputs



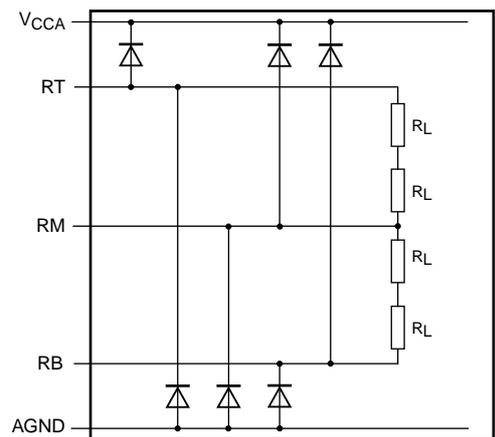
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Fig 8. VI analog input



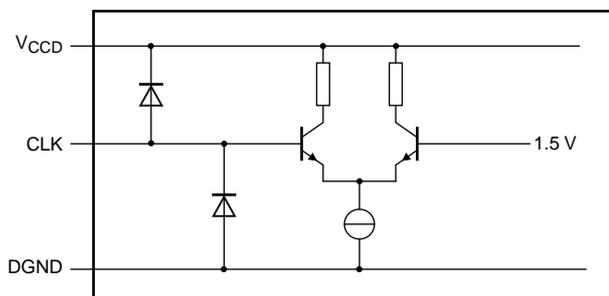
014aaa527

Fig 9. OE GRAY and TC inputs



014aaa528

Fig 10. RB, RM and RT inputs

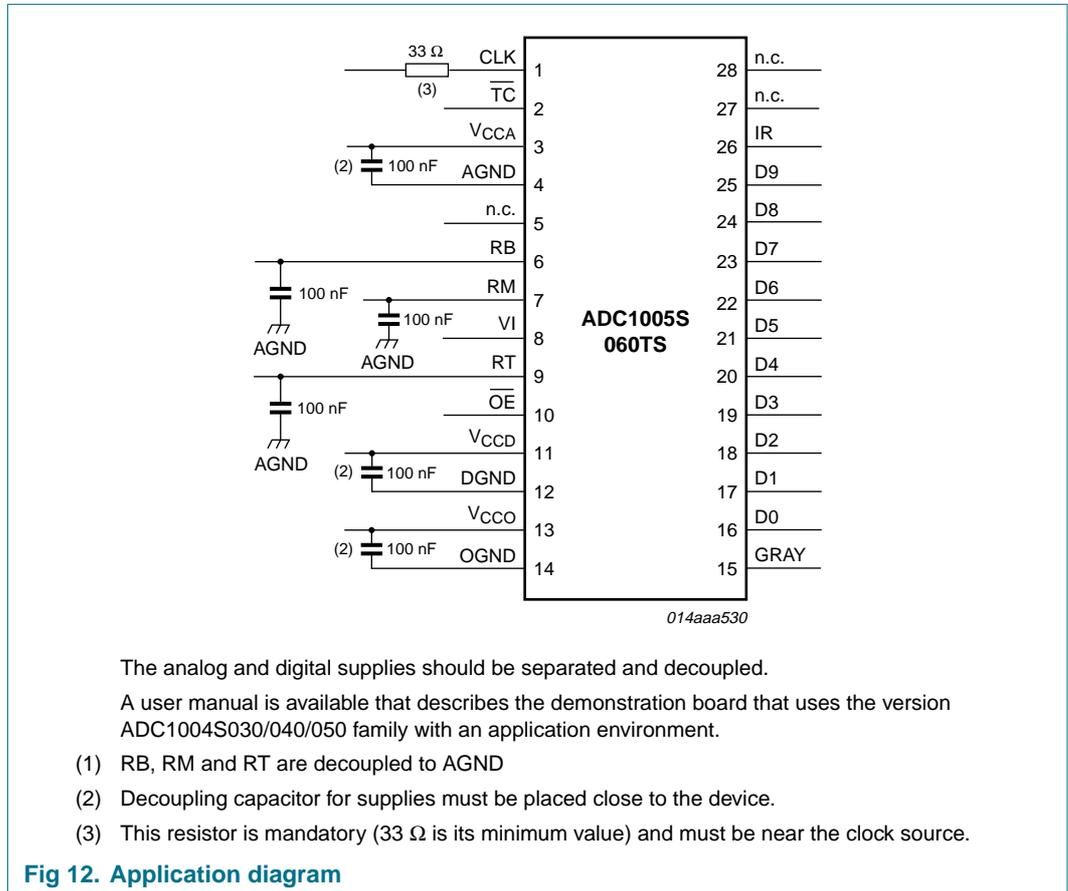


014aaa529

Fig 11. CLK input

## 12. Application information

### 12.1 Application diagrams



### 12.2 Alternative parts

The following alternative parts are also available:

**Table 11. Alternative parts**

| Type number | Description                                           |                     | Sampling frequency |
|-------------|-------------------------------------------------------|---------------------|--------------------|
| ADC0804S030 | Single 8 bits ADC                                     | <a href="#">[1]</a> | 30 MHz             |
| ADC0804S040 | Single 8 bits ADC                                     | <a href="#">[1]</a> | 40 MHz             |
| ADC0804S050 | Single 8 bits ADC                                     | <a href="#">[1]</a> | 50 MHz             |
| ADC1003S030 | Single 10 bits ADC, with internal reference regulator | <a href="#">[1]</a> | 30 MHz             |
| ADC1003S040 | Single 10 bits ADC, with internal reference regulator | <a href="#">[1]</a> | 40 MHz             |
| ADC1003S050 | Single 10 bits ADC, with internal reference regulator | <a href="#">[1]</a> | 50 MHz             |

**Table 11. Alternative parts**

| Type number | Description        |                     | Sampling frequency |
|-------------|--------------------|---------------------|--------------------|
| ADC1004S030 | Single 10 bits ADC | <a href="#">[1]</a> | 30 MHz             |
| ADC1004S040 | Single 10 bits ADC | <a href="#">[1]</a> | 40 MHz             |
| ADC1004S050 | Single 10 bits ADC | <a href="#">[1]</a> | 50 MHz             |

[1] Pin to pin compatible

## 13. Package outline

SSOP28: plastic shrink small outline package; 28 leads; body width 5.3 mm

SOT341-1

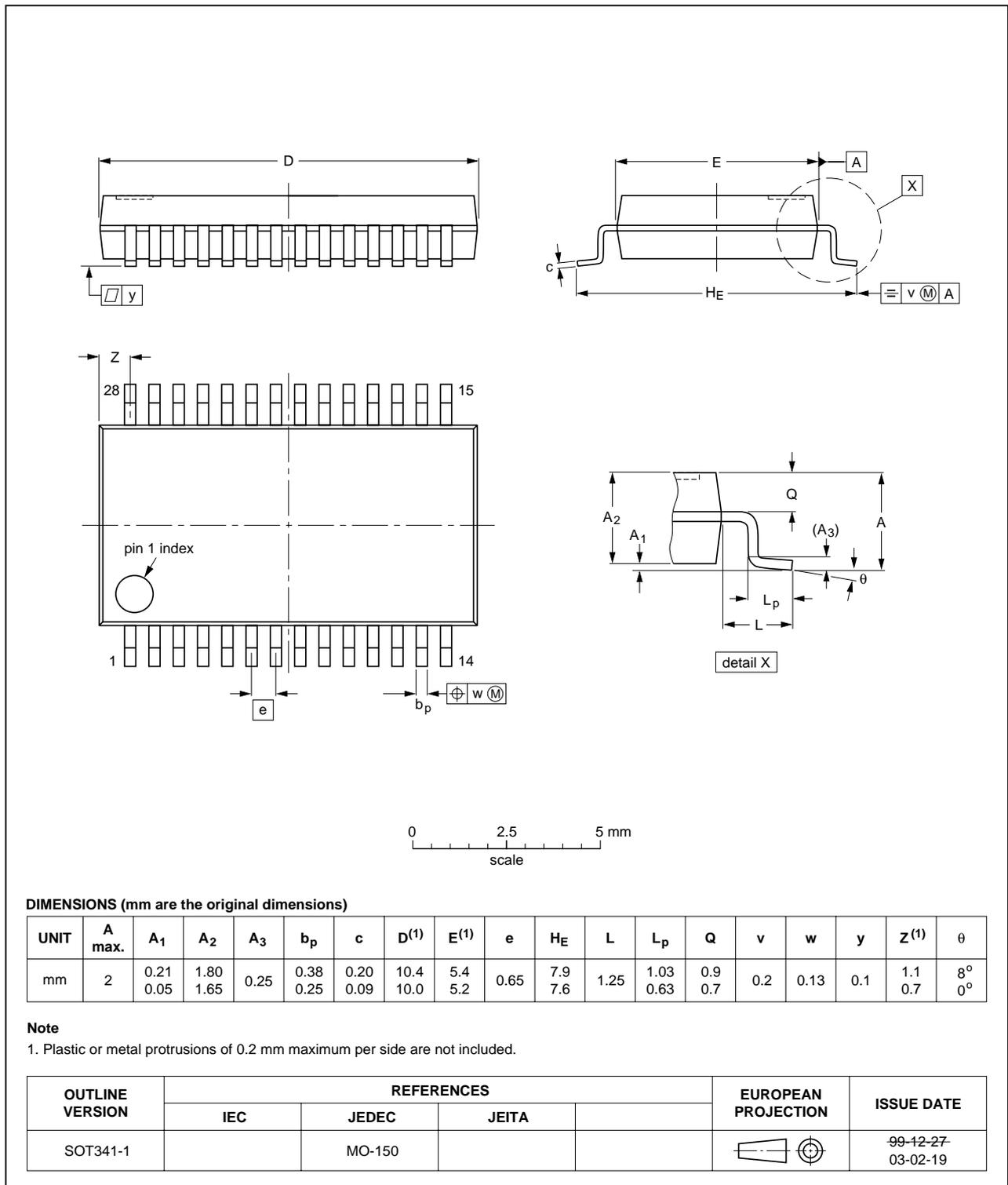


Fig 13. Package outline SOT341-1 (SSOP28)

## 14. Revision history

Table 12. Revision history

| Document ID    | Release date                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Data sheet status  | Change notice | Supersedes    |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------|---------------|
| ADC1005S060_2  | 20080813                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Product data sheet | -             | ADC1005S060_1 |
| Modifications: | <ul style="list-style-type: none"> <li>• Corrections made to INL and DNL conditions in <a href="#">Table 1</a>.</li> <li>• Corrections made to several entries and notes in <a href="#">Table 6</a>.</li> <li>• Correction made to table description in <a href="#">Table 7</a>.</li> <li>• Correction made to column D9 to D0 in <a href="#">Table 10</a>.</li> <li>• Correction made to <a href="#">Figure 8</a>.</li> <li>• Correction made to <a href="#">Figure 10</a>.</li> </ul> |                    |               |               |
| ADC1005S060_1  | 20080616                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Product data sheet | -             | -             |

## 15. Legal information

### 15.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition                                                                            |
|-----------------------------------|-------------------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

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

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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Date of release: 13 August 2008

Document identifier: ADC1005S060\_2