

# DATA SHEET

## **TDA8761A**

**9-bit analog-to-digital converter  
for digital video**

Preliminary specification  
File under Integrated Circuits, IC02

1996 Feb 13

## 9-bit analog-to-digital converter for digital video

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### FEATURES

- 9-bit resolution
- Sampling rate up to 40 MHz
- DC sampling allowed
- One clock cycle conversion only
- High signal-to-noise ratio over a large analog input frequency range (8.2 effective bits at 10 MHz full-scale input at  $f_{\text{clk}} = 30$  MHz)
- No missing codes guaranteed
- In range (IR) CMOS output
- CMOS compatible digital inputs
- 3 to 5 V CMOS digital outputs
- Low-level AC clock input signal allowed
- External reference voltage regulator
- Power dissipation only 165 mW (typical)
- Low analog input capacitance, no buffer amplifier required
- No sample-and-hold circuit required.

### APPLICATIONS

Analog-to-digital conversion for:

- Video data digitizing
- Digital Video Broadcasting (DVB)
- Cable TV.

### GENERAL DESCRIPTION

The TDA8761A is a 9-bit analog-to-digital converter (ADC) for professional video and digital video set box applications. It converts the analog input signal into 9-bit binary-coded digital words at a maximum sampling rate of 40 MHz. Its linearity performance ensures the required conversion accuracy in the event of 256QAM demodulator concept and for all symbol frequencies. All digital inputs and outputs are CMOS compatible, although a low-level sine wave clock input signal is allowed.

### QUICK REFERENCE DATA

| SYMBOL                | PARAMETER                     | CONDITIONS                             | MIN. | TYP.       | MAX.      | UNIT |
|-----------------------|-------------------------------|--|------|------------|-----------|------|
| $V_{\text{CCA}}$      | analog supply voltage         |  | 4.75 | 5.0        | 5.25      | V    |
| $V_{\text{CCD}}$      | digital supply voltage        |  | 4.75 | 5.0        | 5.25      | V    |
| $V_{\text{CCO}}$      | output stages supply voltage  |  | 3.0  | 3.3        | 5.25      | V    |
| $I_{\text{CCA}}$      | analog supply current         |  | –    | 18         | tbf       | mA   |
| $I_{\text{CCD}}$      | digital supply current        |  | –    | 13         | tbf       | mA   |
| $I_{\text{CCO}}$      | output stages supply current  | $f_{\text{clk}} = 30$ MHz; ramp input  | –    | 3          | tbf       | mA   |
| INL                   | integral non-linearity        | $f_{\text{clk}} = 30$ MHz; ramp input  | –    | $\pm 0.8$  | tbf       | LSB  |
| AINL                  | AC integral non-linearity     | full-scale input sine wave; note 1     | –    | $\pm 0.75$ | tbf       | LSB  |
|                       |                               | 50% full-scale input sine wave; note 1 | –    | $\pm 0.5$  | tbf       | LSB  |
| DNL                   | differential non-linearity    | $f_{\text{clk}} = 30$ MHz; ramp input  | –    | $\pm 0.3$  | $\pm 0.7$ | LSB  |
| ADNL                  | AC differential non-linearity | full-scale input sine wave; note 1     | –    | $\pm 0.5$  | tbf       | LSB  |
|                       |                               | 50% full-scale input sine wave; note 1 | –    | $\pm 0.3$  | tbf       | LSB  |
| $f_{\text{clk(max)}}$ | maximum clock frequency       |  | 40   | –          | –         | MHz  |
| $P_{\text{tot}}$      | total power dissipation       |  | –    | 165        | tbf       | mW   |

### Note

1.  $f_i = 10$  MHz and  $f_{\text{clk}} = 30$  MHz;  $f_i = 8$  MHz and  $f_{\text{clk}} = 20$  MHz.

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## ORDERING INFORMATION

| TYPE NUMBER | PACKAGE |   |          |
|-------------|---------|---|----------|
|             | NAME    | DESCRIPTION   | VERSION  |
| TDA8761AM   | SSOP28  | plastic shrink small outline package; 28 leads; body width 5.3 mm | SOT341-1 |

## BLOCK DIAGRAM

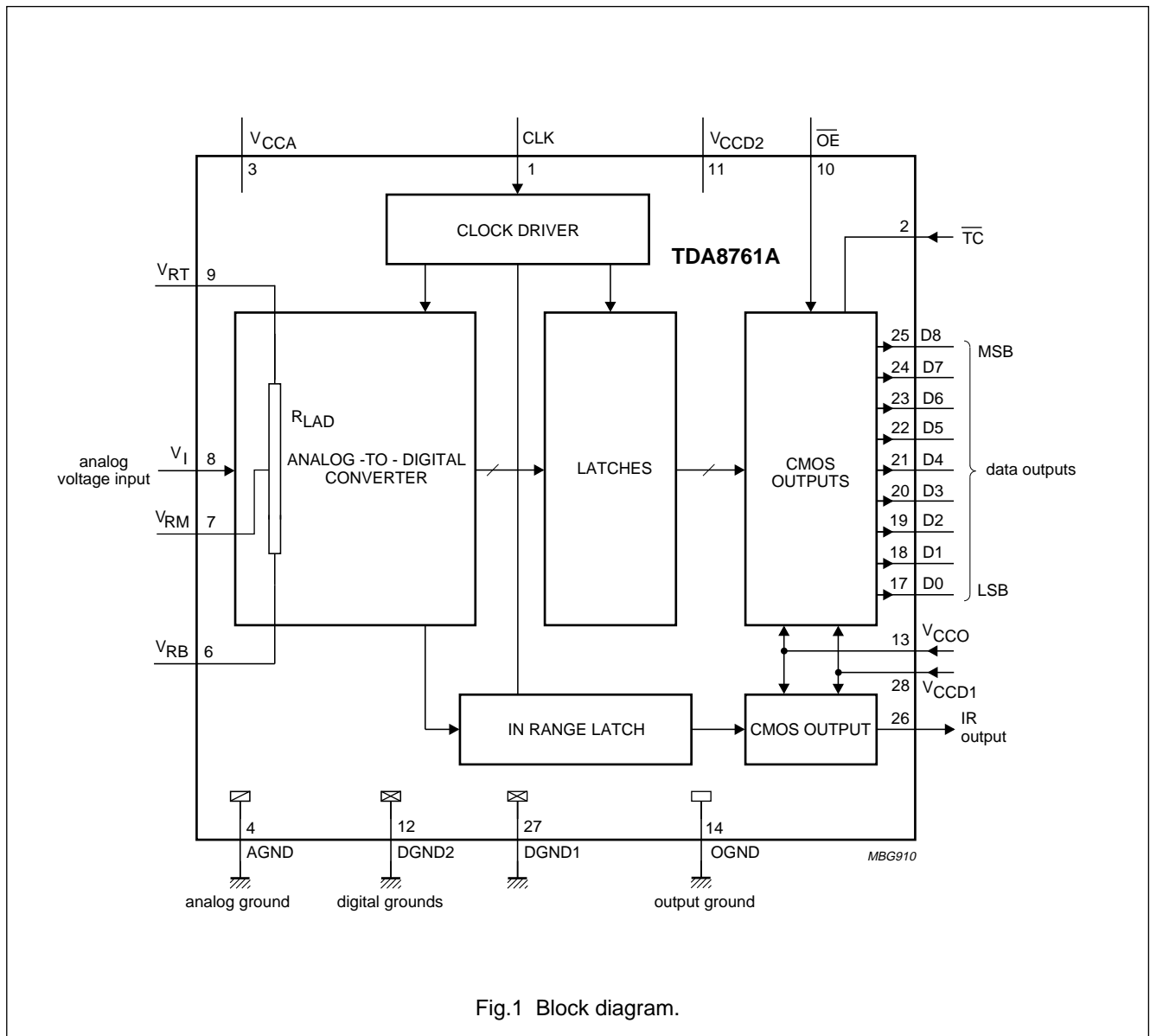


Fig.1 Block diagram.

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### PINNING

| SYMBOL            | PIN | DESCRIPTION  |
|-------------------|-----|--|
| CLK               | 1   | clock input  |
| $\overline{TC}$   | 2   | two's complement input (active LOW)                |
| V <sub>CCA</sub>  | 3   | analog supply voltage (+5 V)                       |
| AGND              | 4   | analog ground                                      |
| n.c.              | 5   | not connected                                      |
| V <sub>RB</sub>   | 6   | reference voltage BOTTOM input                     |
| V <sub>RM</sub>   | 7   | reference voltage MIDDLE                           |
| V <sub>I</sub>    | 8   | analog input voltage                               |
| V <sub>RT</sub>   | 9   | reference voltage TOP input                        |
| $\overline{OE}$   | 10  | output enable input (CMOS level input, active LOW) |
| V <sub>CCD2</sub> | 11  | digital supply voltage 2 (+5 V)                    |
| DGND2             | 12  | digital ground 2                                   |
| V <sub>CCO</sub>  | 13  | supply voltage for output stages (+3 to 5 V)       |
| OGND              | 14  | output ground                                      |
| n.c.              | 15  | not connected                                      |
| n.c.              | 16  | not connected                                      |
| D0                | 17  | data output; bit 0 (LSB)                           |
| D1                | 18  | data output; bit 1                                 |
| D2                | 19  | data output; bit 2                                 |
| D3                | 20  | data output; bit 3                                 |
| D4                | 21  | data output; bit 4                                 |
| D5                | 22  | data output; bit 5                                 |
| D6                | 23  | data output; bit 6                                 |
| D7                | 24  | data output; bit 7                                 |
| D8                | 25  | data output; bit 8 (MSB)                           |
| IR                | 26  | in range data output                               |
| DGND1             | 27  | digital ground 1                                   |
| V <sub>CCD1</sub> | 28  | digital supply voltage 1 (+5 V)                    |

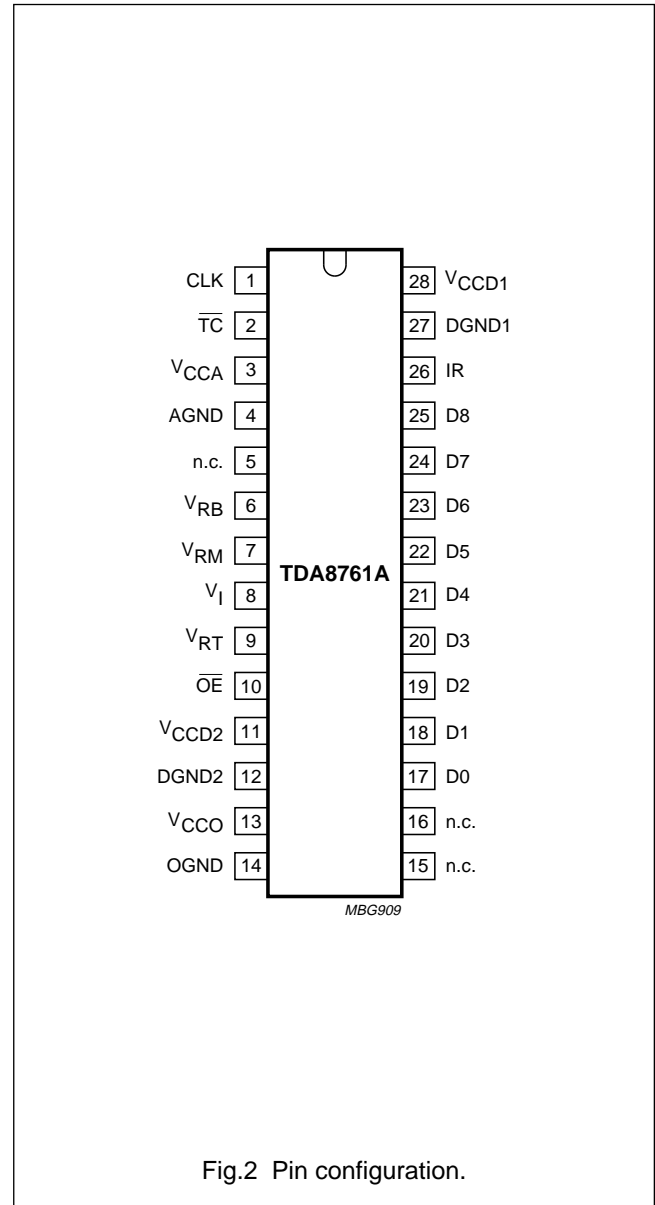


Fig.2 Pin configuration.

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### LIMITING VALUES

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

| SYMBOL          | PARAMETER   | CONDITIONS         | MIN. | MAX.      | UNIT |
|-----------------|---|--------------------|------|-----------|------|
| $V_{CCA}$       | analog supply voltage   | note 1             | -0.3 | +7.0      | V    |
| $V_{CCD}$       | digital supply voltage  | note 1             | -0.3 | +7.0      | V    |
| $V_{CCO}$       | output stages supply voltage                                  | note 1             | -0.3 | +7.0      | V    |
| $\Delta V_{CC}$ | supply voltage differences between<br>$V_{CCA}$ and $V_{CCD}$ |                    | -1.0 | +1.0      | V    |
|                 | $V_{CCD}$ and $V_{CCO}$                                       |                    | -1.0 | +4.0      | V    |
|                 | $V_{CCA}$ and $V_{CCO}$                                       |                    | -1.0 | +4.0      | V    |
| $V_I$           | input voltage   | referenced to AGND | -0.3 | +7.0      | V    |
| $V_{i(p-p)}$    | AC input voltage for switching<br>(peak-to-peak value)        | referenced to DGND | -    | $V_{CCD}$ | V    |
| $I_O$           | output current  |                    | -    | 10        | mA   |
| $T_{stg}$       | storage temperature   |                    | -55  | +150      | °C   |
| $T_{amb}$       | operating ambient temperature                                 |                    | 0    | +70       | °C   |
| $T_j$           | junction temperature  |                    | -    | +150      | °C   |

### Note

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

### HANDLING

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

### THERMAL CHARACTERISTICS

| SYMBOL        | PARAMETER   | VALUE | UNIT |
|---------------|---|-------|------|
| $R_{th\ j-a}$ | thermal resistance from junction to ambient in free air | 110   | K/W  |

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### CHARACTERISTICS

$V_{CCA} = V_3$  to  $V_4 = 4.75$  to  $5.25$  V;  $V_{CCD} = V_{11}$  to  $V_{12}$  and  $V_{28}$  to  $V_{27} = 4.75$  to  $5.25$  V;  $V_{CCO} = V_{13}$  to  $V_{14} = 3.0$  to  $5.25$  V; AGND and DGND shorted together;  $T_{amb} = 0$  to  $+70$  °C; typical values measured at  $V_{CCA} = V_{CCD} = 5$  V and  $V_{CCO} = 3.3$  V;  $V_{i(p-p)} = 1.8$  V;  $C_L = 15$  pF and  $T_{amb} = 25$  °C; unless otherwise specified.

| SYMBOL   | PARAMETER                          | CONDITIONS                     | MIN.         | TYP. | MAX.         | UNIT       |
|--|------------------------------------|--------------------------------|--------------|------|--------------|------------|
| <b>Supply</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 stages supply voltage       |                                | 3.0          | 3.3  | 5.25         | V          |
| $\Delta V_{CC}$  | supply voltage differences between |                                |              |      |              |            |
|  | $V_{CCA}$ and $V_{CCD}$            |                                | -0.2         | -    | +0.2         | V          |
|  | $V_{CCA}$ and $V_{CCO}$            |                                | -0.2         | -    | +2.25        | V          |
|  | $V_{CCD}$ and $V_{CCO}$            |                                | -0.2         | -    | +2.25        | V          |
| $I_{CCA}$  | analog supply current              |                                | -            | 18   | tbf          | mA         |
| $I_{CCD}$  | digital supply current             |                                | -            | 13   | tbf          | mA         |
| $I_{CCO}$  | output stages supply current       | $f_{clk} = 30$ MHz; ramp input | -            | 3    | tbf          | mA         |
| <b>Inputs</b>  |                                    |                                |              |      |              |            |
| CLOCK INPUT CLK (REFERENCED TO DGND); note 1                                 |                                    |                                |              |      |              |            |
| $V_{IL}$   | LOW level input voltage            |                                | 0            | -    | $0.3V_{CCD}$ | V          |
| $V_{IH}$   | HIGH level input voltage           |                                | $0.7V_{CCD}$ | -    | $V_{CCD}$    | V          |
| $I_{IL}$   | LOW level input current            | $V_{clk} = 0.3V_{CCD}$         | -1           | 0    | +1           | $\mu$ A    |
| $I_{IH}$   | HIGH level input current           | $V_{clk} = 0.7V_{CCD}$         | -            | 2    | 10           | $\mu$ A    |
| $Z_i$  | input impedance                    | $f_{clk} = 30$ MHz             | -            | 2    | -            | k $\Omega$ |
| $C_i$  | input capacitance                  | $f_{clk} = 30$ MHz             | -            | 2    | -            | pF         |
| INPUTS $\overline{OE}$ AND $\overline{TC}$ (REFERENCED TO DGND); see Table 2 |                                    |                                |              |      |              |            |
| $V_{IL}$   | LOW level input voltage            |                                | 0            | -    | $0.3V_{CCD}$ | V          |
| $V_{IH}$   | HIGH level input voltage           |                                | $0.7V_{CCD}$ | -    | $V_{CCD}$    | V          |
| $I_{IL}$   | LOW level input current            | $V_{IL} = 0.3V_{CCD}$          | -1           | -    | -            | $\mu$ A    |
| $I_{IH}$   | HIGH level input current           | $V_{IH} = 0.7V_{CCD}$          | -            | -    | 1            | $\mu$ A    |
| $V_i$ (ANALOG INPUT VOLTAGE REFERENCED TO AGND)                              |                                    |                                |              |      |              |            |
| $I_{IL}$   | LOW level input current            | $V_i = V_{RB} = 1.3$ V         | -            | 0    | -            | $\mu$ A    |
| $I_{IH}$   | HIGH level input current           | $V_i = V_{RT} = 3.43$ V        | -            | 35   | -            | $\mu$ A    |
| $Z_i$  | input impedance                    | $f_i = 10$ MHz                 | -            | 8    | -            | k $\Omega$ |
| $C_i$  | input capacitance                  | $f_i = 10$ MHz                 | -            | 5    | -            | pF         |

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| SYMBOL   | PARAMETER   | CONDITIONS   | MIN.            | TYP.       | MAX.              | UNIT          |
|--|---|--|-----------------|------------|-------------------|---------------|
| <b>Reference voltages for the resistor ladder; see Table 1</b> |   |  |                 |            |                   |               |
| $V_{RB}$   | reference voltage BOTTOM                            |  | 1.2             | 1.3        | 2.45              | V             |
| $V_{RT}$   | reference voltage TOP                               |  | 3.0             | 3.43       | $V_{CCA} - 0.8$ V | V             |
| $V_{diff}$   | differential reference voltage<br>$V_{RT} - V_{RB}$ |  | 1.8             | 2.13       | 3.0               | V             |
| $I_{ref}$  | reference current                                   | $V_{RT} - V_{RB} = 2.13$ V                             | –               | 8.7        | –                 | mA            |
| $R_{LAD}$  | resistor ladder                                     |  | –               | 245        | –                 | $\Omega$      |
| $TC_{RLAD}$  | temperature coefficient of the resistor ladder      |  | –               | 1860       | –                 | ppm           |
|  |   |  | –               | 456        | –                 | m $\Omega$ /K |
| $V_{osB}$  | offset voltage BOTTOM                               | note 2   | –               | 160        | –                 | mV            |
| $V_{osT}$  | offset voltage TOP                                  | note 2   | –               | 160        | –                 | mV            |
| $V_{i(p-p)}$   | analog input voltage<br>(peak-to-peak value)        | note 3   | 1.5             | 1.81       | 2.5               | V             |
| <b>Outputs</b>   |   |  |                 |            |                   |               |
| DIGITAL OUTPUTS D8 TO D0 AND IR (REFERENCED TO OGND)           |   |  |                 |            |                   |               |
| $V_{OL}$   | LOW level output voltage                            | $I_{OL} = 1$ mA  | 0               | –          | 0.5               | V             |
| $V_{OH}$   | HIGH level output voltage                           | $I_{OH} = -1$ mA                                       | $V_{CCO} - 0.5$ | –          | $V_{CCO}$         | V             |
| $I_{OZ}$   | output current in 3-state mode                      | $0.5$ V < $V_O$ < $V_{CCO}$                            | –20             | –          | +20               | $\mu$ A       |
| <b>Switching characteristics</b>                               |   |  |                 |            |                   |               |
| CLOCK INPUT CLK; see Fig.4; note 1                             |   |  |                 |            |                   |               |
| $f_{clk(max)}$   | maximum clock frequency                             |  | 40              | –          | –                 | MHz           |
| $t_{CPH}$  | clock pulse width HIGH                              |  | 10              | –          | –                 | ns            |
| $t_{CPL}$  | clock pulse width LOW                               |  | 10              | –          | –                 | ns            |
| <b>Analog signal processing</b>                                |   |  |                 |            |                   |               |
| LINEARITY  |   |  |                 |            |                   |               |
| INL  | integral non-linearity                              | $f_{clk} = 30$ MHz; ramp input                         | –               | $\pm 0.8$  | tbf               | LSB           |
| AINL   | AC integral non-linearity                           | full-scale input sine wave; note 5                     | –               | $\pm 0.75$ | tbf               | LSB           |
|  |   | 50% full-scale input sine wave; note 5                 | –               | $\pm 0.5$  | tbf               | LSB           |
| DNL  | differential non-linearity                          | $f_{clk} = 30$ MHz; ramp input                         | –               | $\pm 0.3$  | $\pm 0.7$         | LSB           |
| ADNL   | AC differential non-linearity                       | full-scale input sine wave; note 5                     | –               | $\pm 0.5$  | tbf               | LSB           |
|  |   | 50% full-scale input sine wave; note 5                 | –               | $\pm 0.3$  | tbf               | LSB           |
| OFER   | offset error  | middle code;<br>$V_{RB} = 1.3$ V;<br>$V_{RT} = 3.43$ V | –               | $\pm 1$    | –                 | LSB           |
| GER  | gain error (from device to device)                  | $V_{RB} = 1.3$ V;<br>$V_{RT} = 3.43$ V; note 4         | –               | $\pm 0.1$  | –                 | %             |

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| SYMBOL  | PARAMETER                                 | CONDITIONS   | MIN. | TYP.       | MAX. | UNIT             |
|---|---|--|------|------------|------|------------------|
| BANDWIDTH ( $f_{\text{clk}} = 30 \text{ MHz}$ )                   |   |  |      |            |      |                  |
| B   | analog bandwidth                          | full-scale sine wave;<br>note 6  | –    | 10         | –    | MHz              |
|   |   | 75% full-scale sine<br>wave; note 6  | –    | 14         | –    | MHz              |
|   |   | small signal at mid-scale;<br>$V_1 = \pm 10 \text{ LSB}$ at<br>code 256; note 6                              | –    | 350        | –    | MHz              |
| $t_{\text{STLH}}$   | analog input settling time<br>LOW-to-HIGH | full-scale square wave;<br>Fig.6; note 7   | –    | 2.0        | tbf  | ns               |
| $t_{\text{STHL}}$   | analog input settling time<br>HIGH-to-LOW | full-scale square wave;<br>Fig.6; note 7   | –    | 2.5        | tbf  | ns               |
| HARMONICS ( $f_{\text{clk}} = 30 \text{ MHz}$ ); see Figs 7 and 8 |   |  |      |            |      |                  |
| THD   | total harmonic distortion                 | $f_i = 10 \text{ MHz}$   | –    | –56        | –    | dB               |
| SIGNAL-TO-NOISE RATIO; see Figs 7 and 8; note 8                   |   |  |      |            |      |                  |
| S/N   | signal-to-noise ratio (full scale)        | without harmonics;<br>$f_{\text{clk}} = 30 \text{ MHz}$ ;<br>$f_i = 10 \text{ MHz}$                          | 51   | 53         | –    | dB               |
| EFFECTIVE BITS; see Figs 7 and 8; note 8                          |   |  |      |            |      |                  |
| EB  | effective bits                            | $f_{\text{clk}} = 30 \text{ MHz}$  |      |            |      |                  |
|   |   | $f_i = 4.43 \text{ MHz}$   | –    | 8.7        | –    | bits             |
|   |   | $f_i = 10 \text{ MHz}$   | –    | 8.2        | –    | bits             |
| TWO-TONE; note 9  |   |  |      |            |      |                  |
| TTIR  | two-tone intermodulation<br>rejection     | $f_{\text{clk}} = 30 \text{ MHz}$  | –    | –56        | –    | dB               |
| BIT ERROR RATE  |   |  |      |            |      |                  |
| BER   | bit error rate                            | $f_{\text{clk}} = 30 \text{ MHz}$ ;<br>$f_i = 10 \text{ MHz}$ ;<br>$V_1 = \pm 16 \text{ LSB}$ at<br>code 256 | –    | $10^{-13}$ | –    | times/<br>sample |
| DIFFERENTIAL GAIN; note 10  |   |  |      |            |      |                  |
| $G_{\text{diff}}$   | differential gain                         | $f_{\text{clk}} = 30 \text{ MHz}$ ;<br>PAL modulated ramp  | –    | 0.5        | –    | %                |
| DIFFERENTIAL PHASE; note 10                                       |   |  |      |            |      |                  |
| $\varphi_{\text{diff}}$   | differential phase                        | $f_{\text{clk}} = 30 \text{ MHz}$ ;<br>PAL modulated ramp  | –    | 0.3        | –    | deg              |



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| SYMBOL  | PARAMETER           | CONDITIONS                        | MIN. | TYP. | MAX. | UNIT |
|---|---------------------|-----------------------------------|------|------|------|------|
| <b>Timing</b> ( $f_{\text{clk}} = 30 \text{ MHz}$ ; $C_L = 15 \text{ pF}$ ); see Fig.4; note 11 |                     |                                   |      |      |      |      |
| $t_{\text{ds}}$   | sampling delay time |                                   | –    | –    | 2    | ns   |
| $t_{\text{h}}$  | output hold time    |                                   | 5    | –    | –    | ns   |
| $t_{\text{d}}$  | output delay time   | $V_{\text{CCO}} = 4.75 \text{ V}$ | –    | 13   | 16   | ns   |
|   |                     | $V_{\text{CCO}} = 3.15 \text{ V}$ | –    | 16   | 19   | ns   |
| $C_L$   | digital output load |                                   | –    | 15   | 40   | pF   |
| <b>3-state output delay times</b> ; see Fig.5   |                     |                                   |      |      |      |      |
| $t_{\text{dZH}}$  | enable HIGH         |                                   | –    | 14   | 18   | ns   |
| $t_{\text{dZL}}$  | enable LOW          |                                   | –    | 16   | 20   | ns   |
| $t_{\text{dHZ}}$  | disable HIGH        |                                   | –    | 16   | 20   | ns   |
| $t_{\text{dLZ}}$  | disable LOW         |                                   | –    | 14   | 18   | ns   |

**Notes**

- In addition to a good layout of the digital and analog ground, it is recommended that the rise and fall times of the clock must not be less than 0.5 ns.
- Analog input voltages producing code 0 up to and including code 511:
  - $V_{\text{osB}}$  (voltage offset BOTTOM) is the difference between the analog input which produces data equal to 00 and the reference voltage BOTTOM ( $V_{\text{RB}}$ ) at  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ .
  - $V_{\text{osT}}$  (voltage offset TOP) is the difference between  $V_{\text{RT}}$  (reference voltage TOP) and the analog input which produces data outputs equal to code 511 at  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ .
- In order to ensure the optimum linearity performance of such converter architecture the lower and upper extremities of the converter reference resistor ladder (corresponding to output codes 0 and 511 respectively) are connected to pins  $V_{\text{RB}}$  and  $V_{\text{RT}}$  via offset resistors  $R_{\text{OB}}$  and  $R_{\text{OT}}$  as shown in Fig.3.

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

to cover code 0 to code 511, is  $V_I = R_L \times I_L = \frac{R_L}{R_{\text{OB}} + R_L + R_{\text{OT}}} \times (V_{\text{RT}} - V_{\text{RB}}) = 0.852 \times (V_{\text{RT}} - V_{\text{RB}})$

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

$\frac{R_L}{R_{\text{OB}} + R_L + R_{\text{OT}}}$  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  $V_{\text{RT}} - V_{\text{RB}}$  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 then optimized.

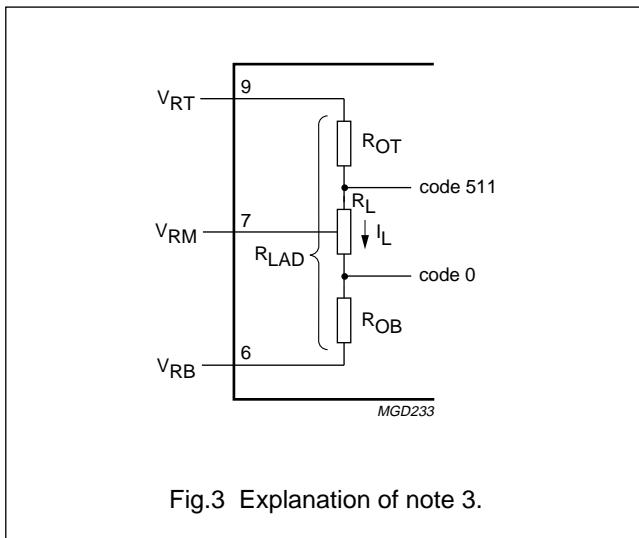
$$4. \text{ GER} = \frac{(V_{511} - V_0) - 1.8 \text{ V}}{1.8 \text{ V}} \times 100$$

- $f_i = 10 \text{ MHz}$  and  $f_{\text{clk}} = 30 \text{ MHz}$ ;  $f_i = 8 \text{ MHz}$  and  $f_{\text{clk}} = 20 \text{ MHz}$ .
- The analog bandwidth is defined as the maximum input sine wave frequency which can be applied to the device. No glitches greater than 2 LSBs, neither any significant attenuation are observed in the reconstructed signal.
- 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.

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8. Effective bits are obtained via a Fast Fourier Transform (FFT) treatment taking 8K acquisition points per equivalent fundamental period. The calculation takes into account all harmonics and noise up to half of the clock frequency (NYQUIST frequency). Conversion to signal-to-noise ratio:  $S/N = EB \times 6.02 + 1.76$  dB.
9. Intermodulation measured relative to either tone with analog input frequencies of 10.0 MHz and 10.10 MHz. The two input signals have the same amplitude and the total amplitude of both signals provides full-scale to the converter.
10. Measurement carried out using video analyser VM700A, where the video analog signal is reconstructed through a digital-to-analog converter.
11. Output data acquisition: the output data is available after the maximum delay time of  $t_d$ .



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**Table 1** Output coding and input voltage (typical values; referenced to AGND,  $V_{RB} = 1.3\text{ V}$ ,  $V_{RT} = 3.43\text{ V}$ )

| STEP | $V_{I(p-p)}$ | IR | BINARY OUTPUT BITS |    |    |    |    |    |    |    |    | TWO'S COMPLEMENT OUTPUT BITS |    |    |    |    |    |    |    |    |
|------|--------------|----|--------------------|----|----|----|----|----|----|----|----|------------------------------|----|----|----|----|----|----|----|----|
|      |              |    | D8                 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | D8                           | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
| U/F  | <1.46        | 0  | 0                  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0                            | 0  | 0  | 0  | 0  | 0  | 0  | 0  |    |
| 0    | 1.46         | 1  | 0                  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0                            | 0  | 0  | 0  | 0  | 0  | 0  | 0  |    |
| 1    | .            | 1  | 0                  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0                            | 0  | 0  | 0  | 0  | 0  | 0  | 1  |    |
| .    | .            | .  | .                  | .  | .  | .  | .  | .  | .  | .  | .  | .                            | .  | .  | .  | .  | .  | .  | .  |    |
| .    | .            | .  | .                  | .  | .  | .  | .  | .  | .  | .  | .  | .                            | .  | .  | .  | .  | .  | .  | .  |    |
| 510  | .            | 1  | 1                  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1                            | 1  | 1  | 1  | 1  | 1  | 1  | 0  |    |
| 511  | 3.27         | 1  | 1                  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1                            | 1  | 1  | 1  | 1  | 1  | 1  | 1  |    |
| O/F  | >3.27        | 0  | 1                  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1                            | 1  | 1  | 1  | 1  | 1  | 1  | 1  |    |

**Table 2** Mode selection

| $\overline{TC}$ | $\overline{OE}$ | D8 to D0                 | IR             |
|-----------------|-----------------|--------------------------|----------------|
| X               | 1               | high impedance           | high impedance |
| 0               | 0               | active; two's complement | active         |
| 1               | 0               | active; binary           | active         |

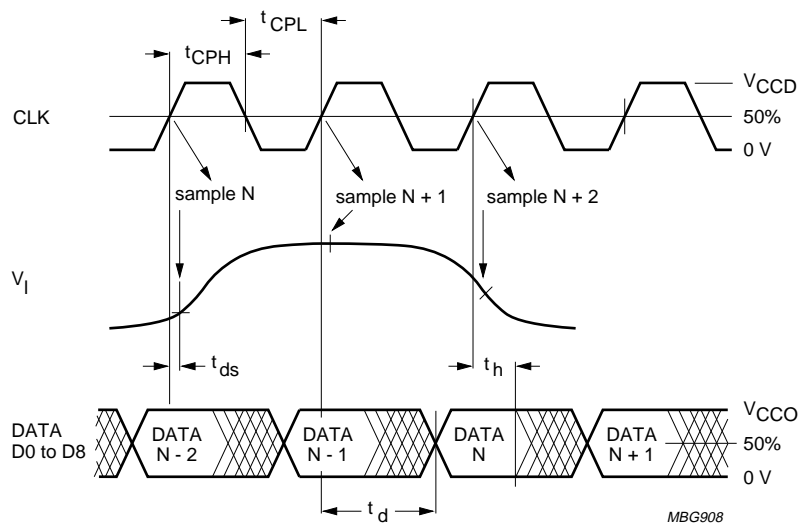


Fig.4 Timing diagram.

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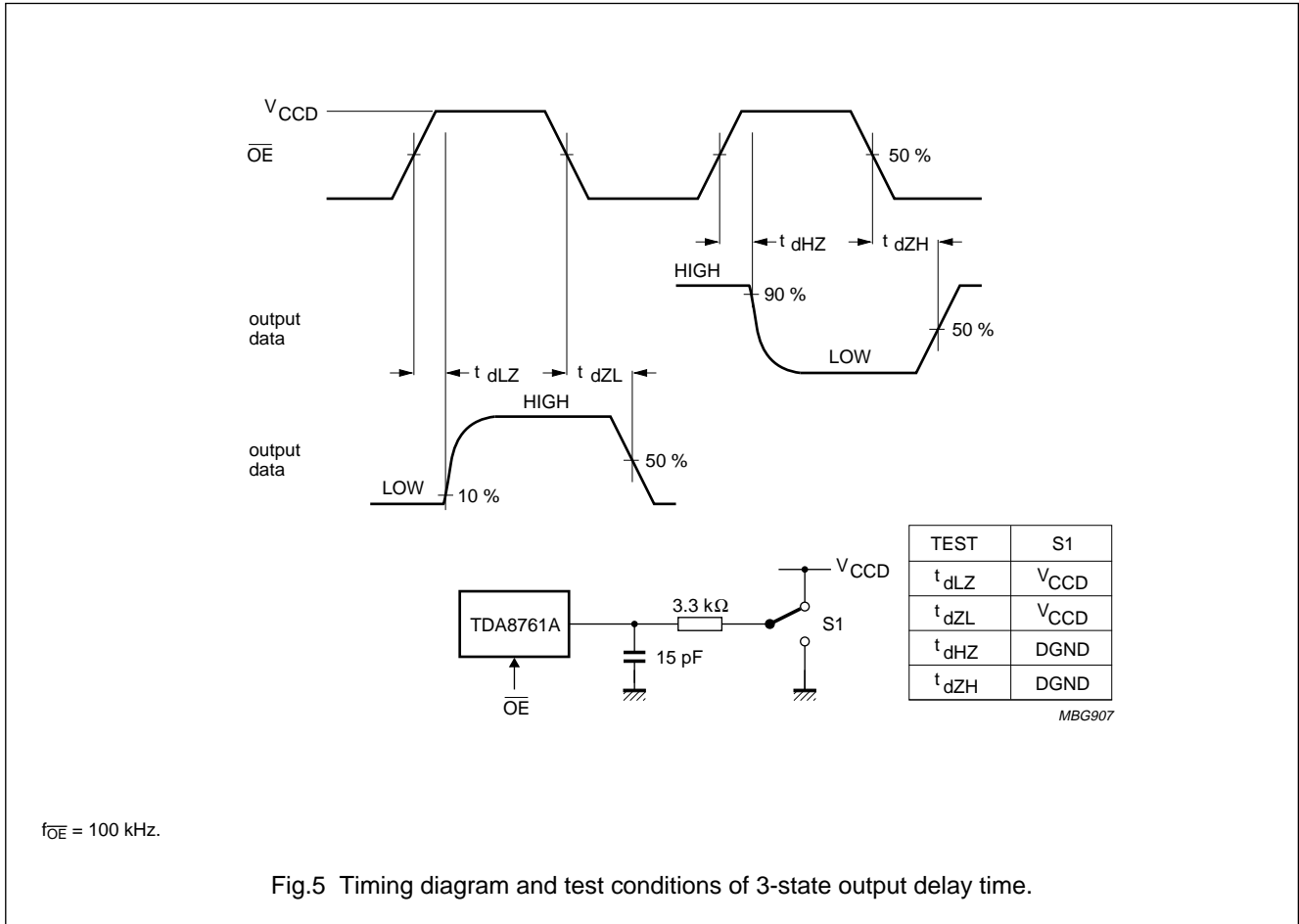


Fig.5 Timing diagram and test conditions of 3-state output delay time.

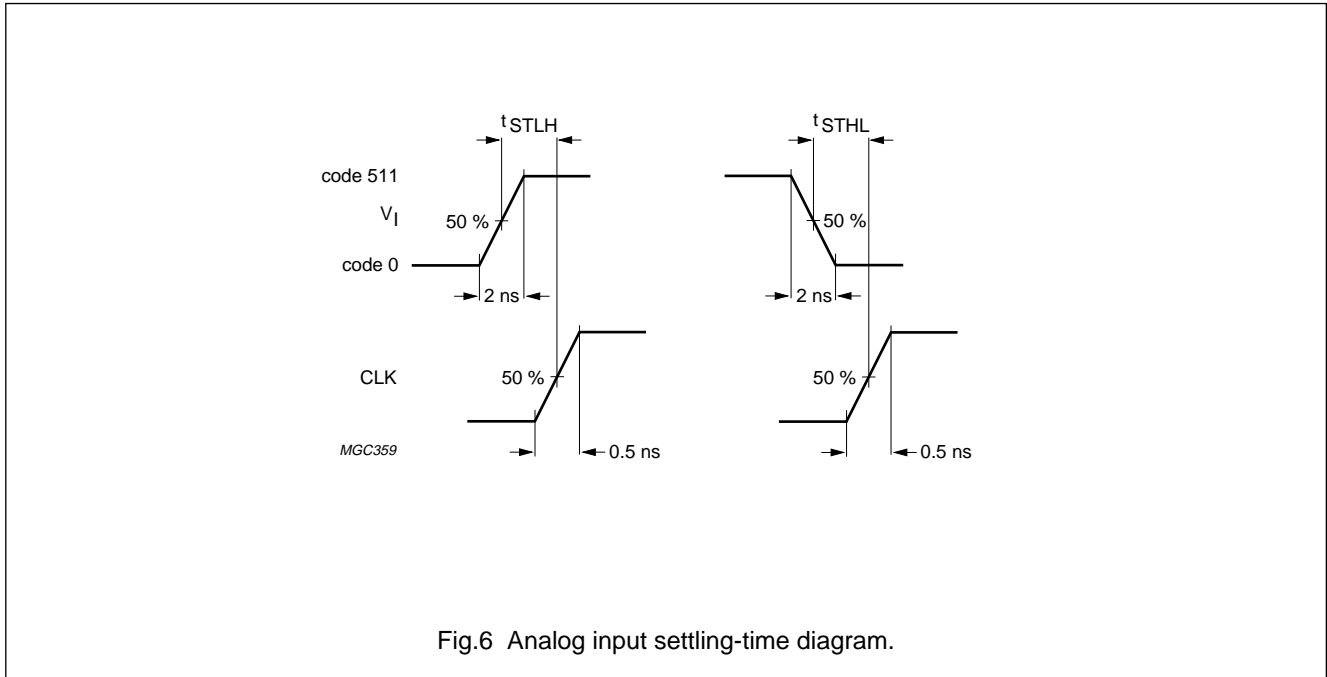
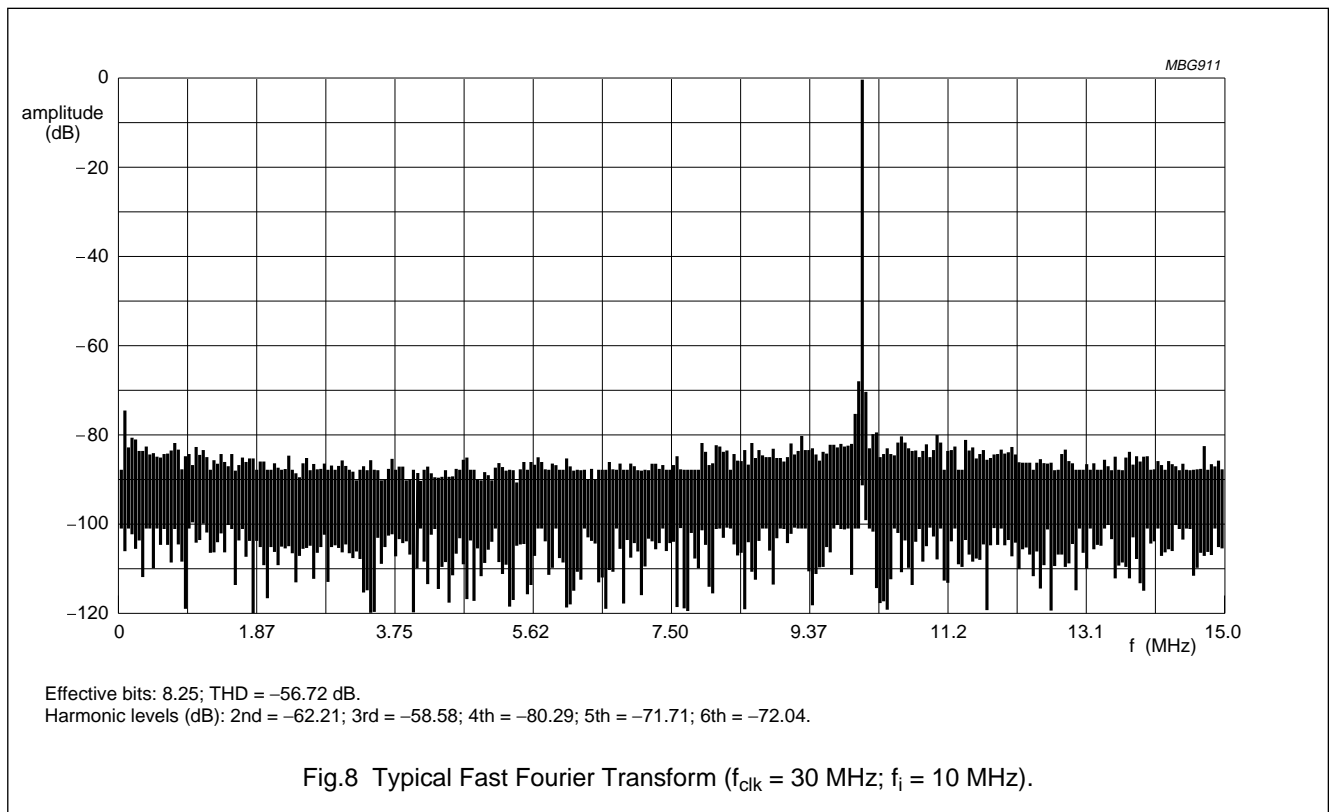
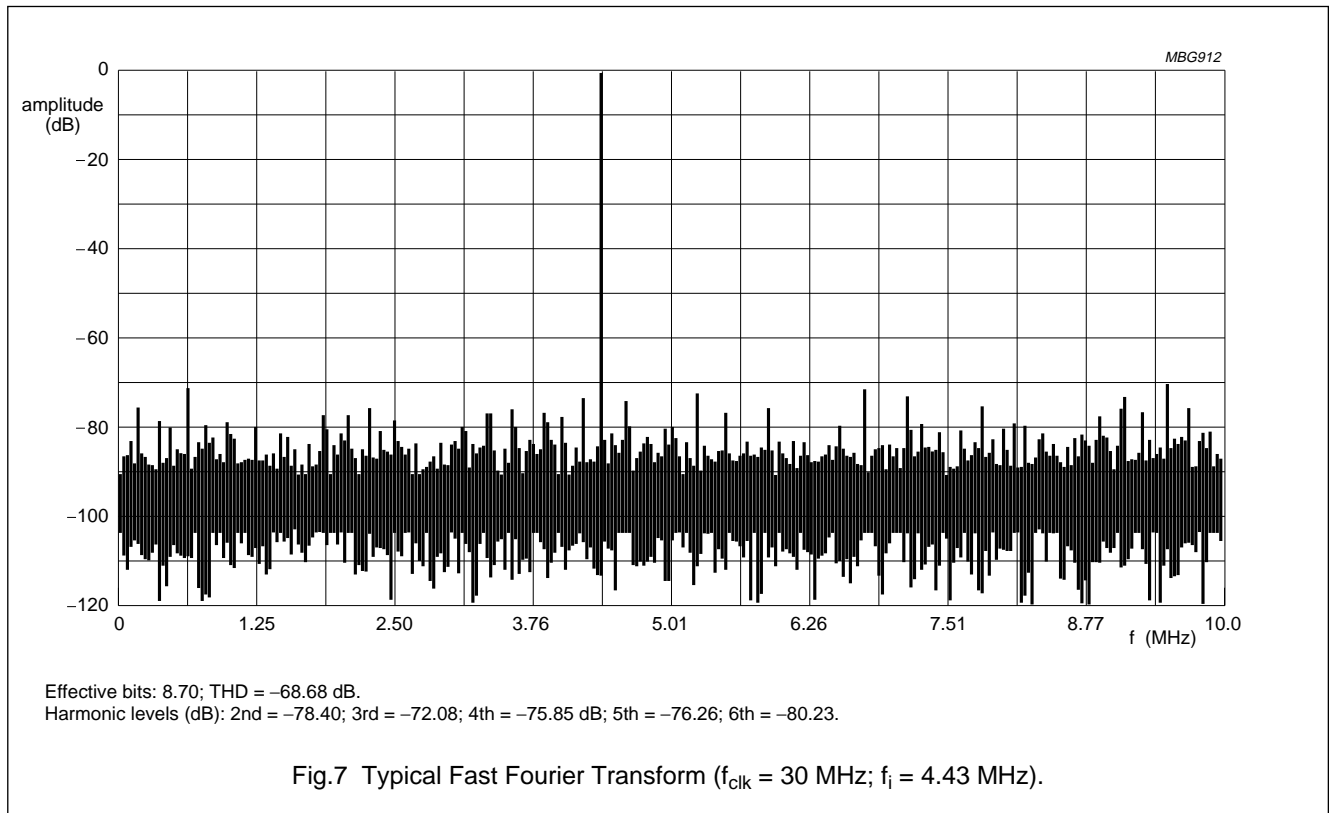


Fig.6 Analog input settling-time diagram.

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## INTERNAL PIN CONFIGURATIONS

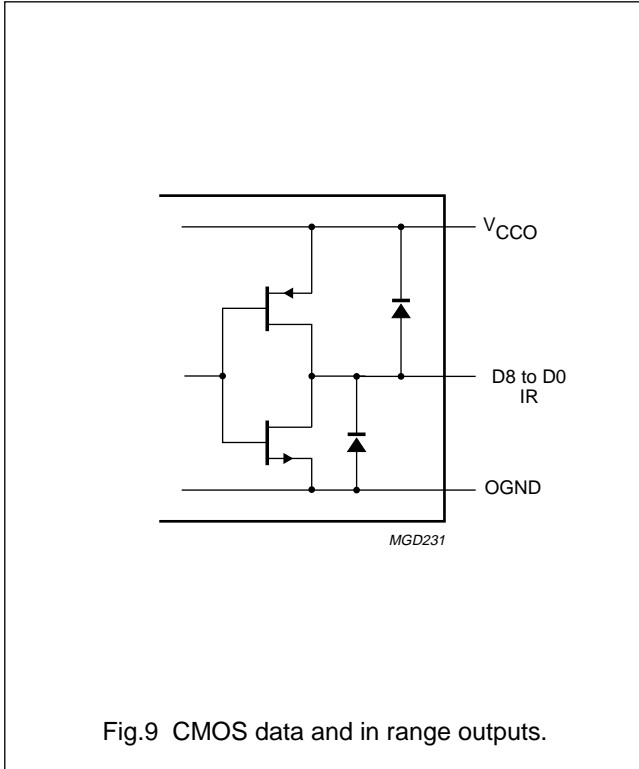


Fig.9 CMOS data and in range outputs.

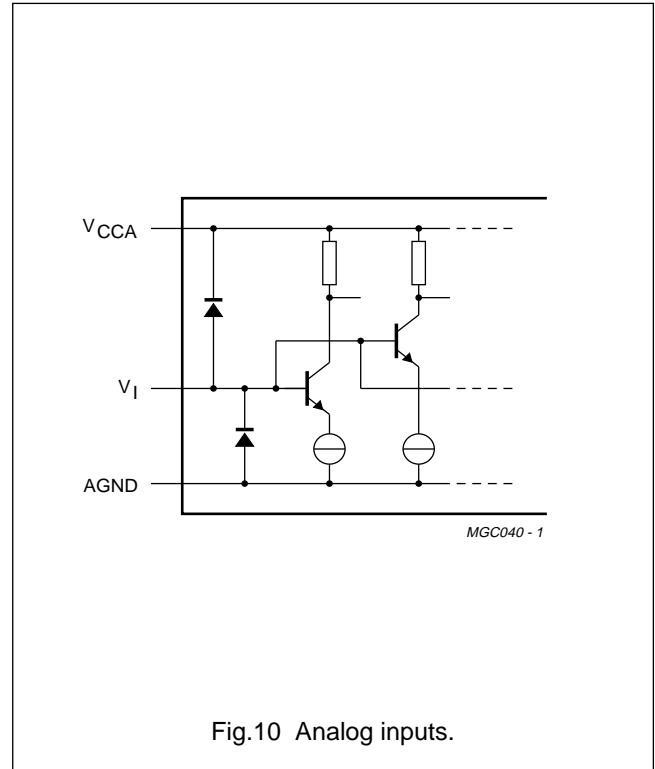


Fig.10 Analog inputs.

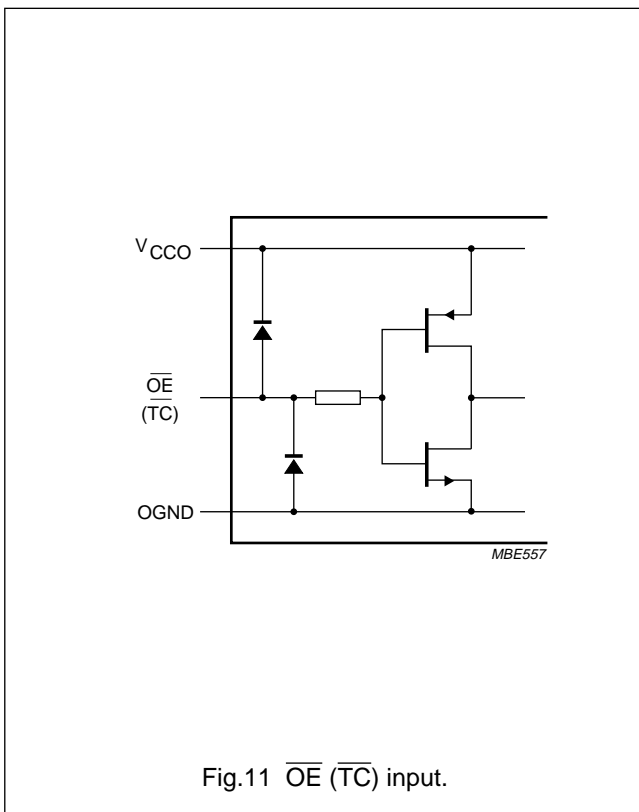


Fig.11  $\overline{OE}$  ( $\overline{TC}$ ) input.

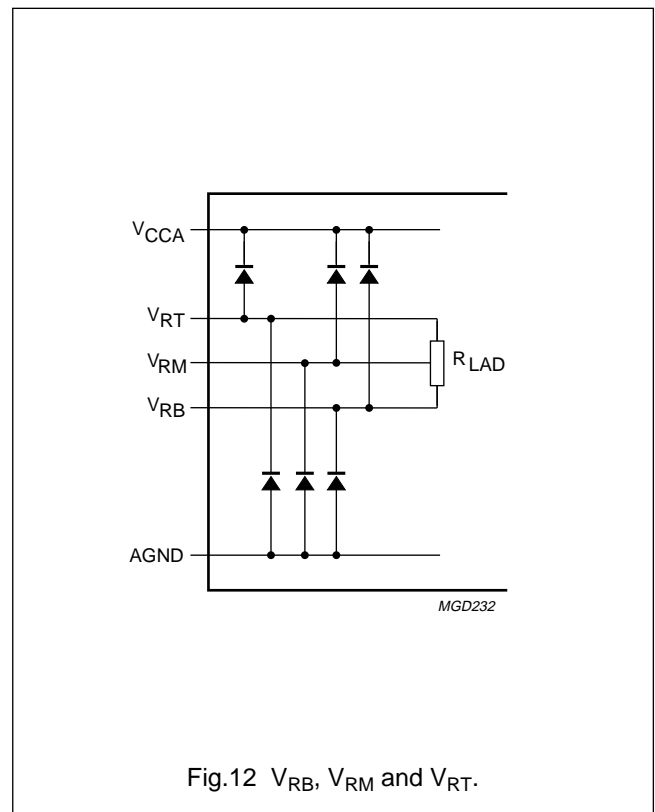


Fig.12  $V_{RB}$ ,  $V_{RM}$  and  $V_{RT}$ .

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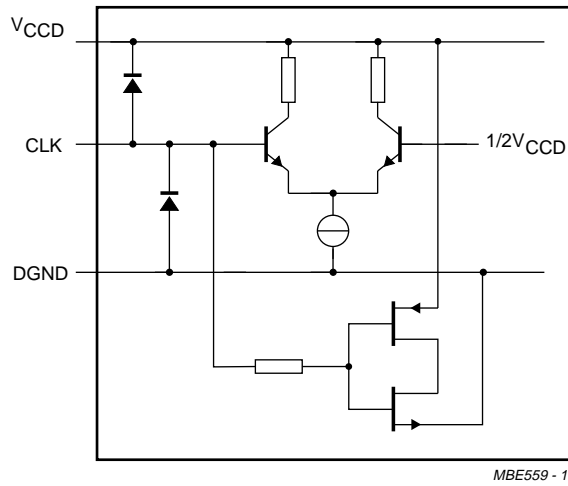
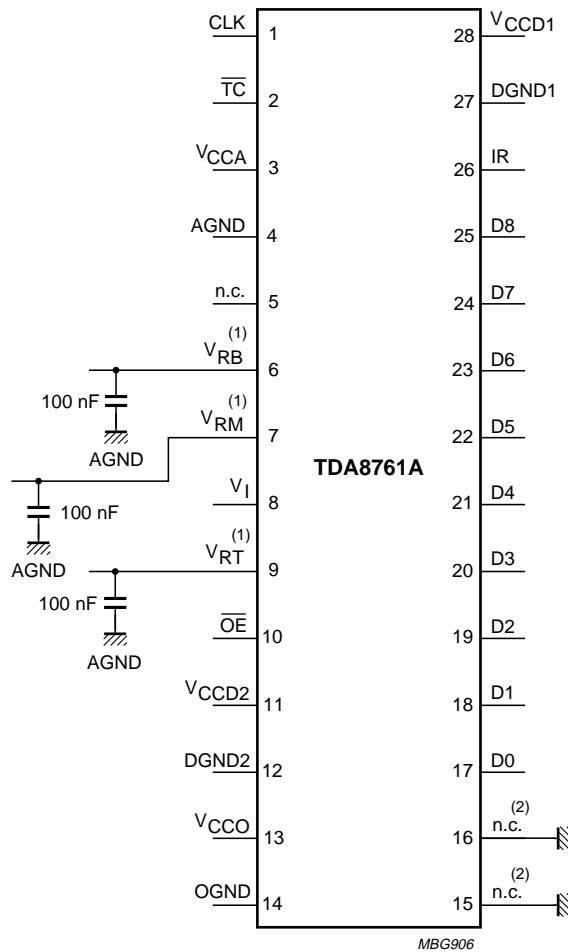


Fig.13 CLK input.

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## APPLICATION INFORMATION



The analog and digital supplies should be separated and decoupled.

The external voltage regulator must be built such that a good supply voltage ripple rejection is achieved with respect to the LSB value. Eventually, the reference ladder voltages can be derived from a well regulated  $V_{CCA}$  supply through a resistor bridge and a decoupled capacitor.

(1)  $V_{RB}$ ,  $V_{RM}$  and  $V_{RT}$  are decoupled to AGND.

(2) Pins 15 and 16 should be connected to DGND in order to prevent noise influence.

Fig.14 Application diagram.



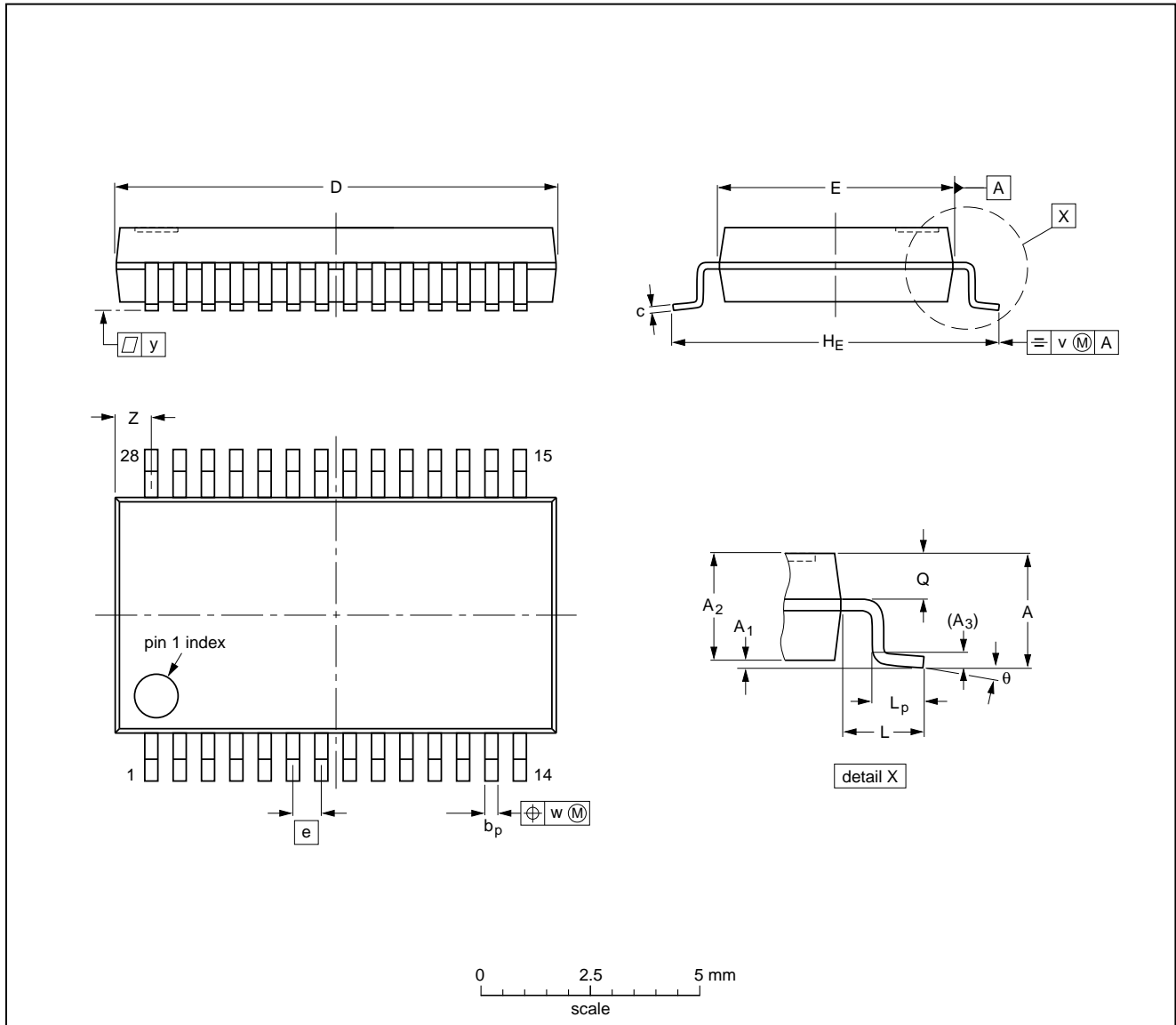
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## PACKAGE OUTLINE

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

SOT341-1



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | b <sub>p</sub> | c            | D <sup>(1)</sup> | E <sup>(1)</sup> | e    | H <sub>E</sub> | L    | L <sub>p</sub> | Q          | v   | w    | y   | Z <sup>(1)</sup> | $\theta$ |
|------|--------|----------------|----------------|----------------|----------------|--------------|------------------|------------------|------|----------------|------|----------------|------------|-----|------|-----|------------------|----------|
| mm   | 2.0    | 0.21<br>0.05   | 1.80<br>1.65   | 0.25           | 0.38<br>0.25   | 0.20<br>0.09 | 10.4<br>10.0     | 5.4<br>5.2       | 0.65 | 7.9<br>7.6     | 1.25 | 1.03<br>0.63   | 0.9<br>0.7 | 0.2 | 0.13 | 0.1 | 1.1<br>0.7       | 8°<br>0° |

**Note**

1. Plastic or metal protrusions of 0.20 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES |          |      |  | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|----------|------|--|---------------------|----------------------|
|                 | IEC        | JEDEC    | EIAJ |  |                     |                      |
| SOT341-1        |            | MO-150AH |      |  |                     | 93-09-08<br>95-02-04 |

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### SOLDERING

#### Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "IC Package Databook" (order code 9398 652 90011).

#### Reflow soldering

Reflow soldering techniques are suitable for all SSOP packages.

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

#### Wave soldering

Wave soldering is **not** recommended for SSOP packages. This is because of the likelihood of solder bridging due to closely-spaced leads and the possibility of incomplete solder penetration in multi-lead devices.

If wave soldering cannot be avoided, the following conditions must be observed:

- **A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.**
- **The longitudinal axis of the package footprint must be parallel to the solder flow and must incorporate solder thieves at the downstream end.**

**Even with these conditions, only consider wave soldering SSOP packages that have a body width of 4.4 mm, that is SSOP16 (SOT369-1) or SSOP20 (SOT266-1).**

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

#### Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C. When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

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### DEFINITIONS

|   |   |
|---|---|
| <b>Data sheet status</b>  |   |
| Objective specification   | This data sheet contains target or goal specifications for product development.       |
| Preliminary specification   | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification   | This data sheet contains final product specifications.                                |
| <b>Limiting values</b>  |   |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. |   |
| <b>Application information</b>  |   |
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Printed in The Netherlands

537021/1100/01/pp20  
Document order number:

Date of release: 1996 Feb 13  
9397 750 00636