

# DATA SHEET

**TDA8764A**

**10-bit high-speed low-power ADC**

Product specification  
File under Integrated Circuits, IC11

2000 Jul 03

## 10-bit high-speed low-power ADC

## TDA8764A

## 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 to 3.6 V CMOS digital outputs
- Low-level AC clock input signal allowed
- Power dissipation only 312 mW
- Low analog input capacitance, no buffer amplifier required
- No sample-and-hold circuit required.

## APPLICATIONS

High-speed analog-to-digital conversion for:

- Video data digitizing
- Radar pulse analysis
- High energy physics research
- Transient signal analysis
- $\Sigma\Delta$  modulators
- Medical imaging.

## GENERAL DESCRIPTION

The TDA8764A 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 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.

## ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TDA8764ATS/6	SSOP28	plastic shrink small outline package; 28 leads; body width 5.3 mm	SOT341-1
TDA8764AHL/6	LQFP32	plastic low profile quad flat package; 32 leads; body $5 \times 5 \times 1.4$ mm	SOT401-1

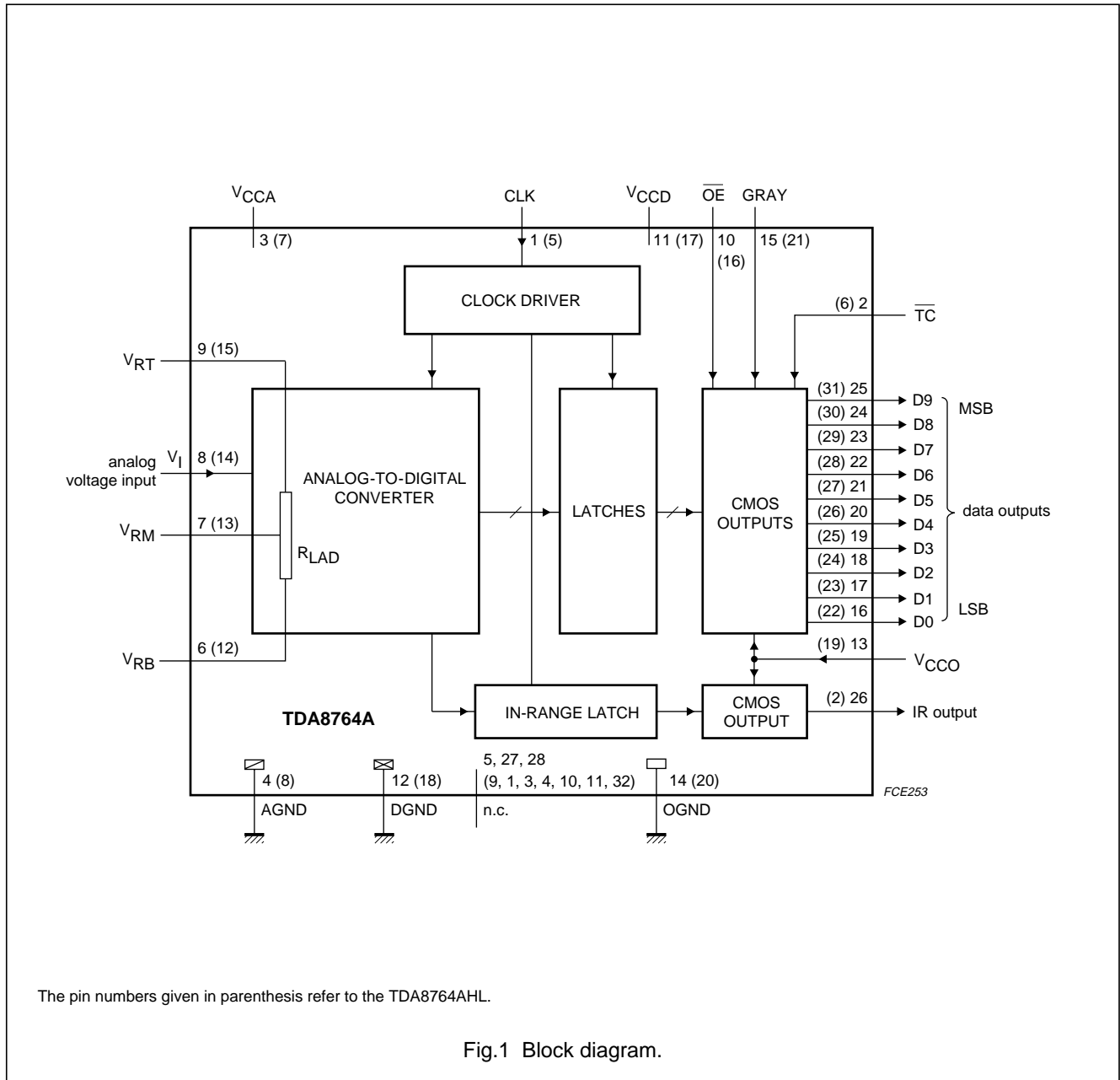
## QUICK REFERENCE DATA

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		2.7	3.3	3.6	V
$I_{\text{CCA}}$	analog supply current		–	29	37	mA
$I_{\text{CCD}}$	digital supply current		–	33	40	mA
$I_{\text{CCO}}$	output stages supply current	$f_{\text{clk}} = 60$ MHz; ramp input	–	0.5	2.0	mA
INL	integral non-linearity	$f_{\text{clk}} = 60$ MHz; ramp input	–	$\pm 0.8$	$\pm 2$	LSB
DNL	differential non-linearity	$f_{\text{clk}} = 60$ MHz; ramp input	–	$\pm 0.35$	$\pm 0.9$	LSB
$f_{\text{clk(max)}}$	maximum clock frequency	TDA8764ATS and TDA8764AHL	60	–	–	MHz
$P_{\text{tot}}$	total power dissipation	$f_{\text{clk}} = 60$ MHz; ramp input	–	312	411	mW

# 10-bit high-speed low-power ADC

# TDA8764A

## BLOCK DIAGRAM



The pin numbers given in parenthesis refer to the TDA8764AHL.

Fig.1 Block diagram.

## 10-bit high-speed low-power ADC

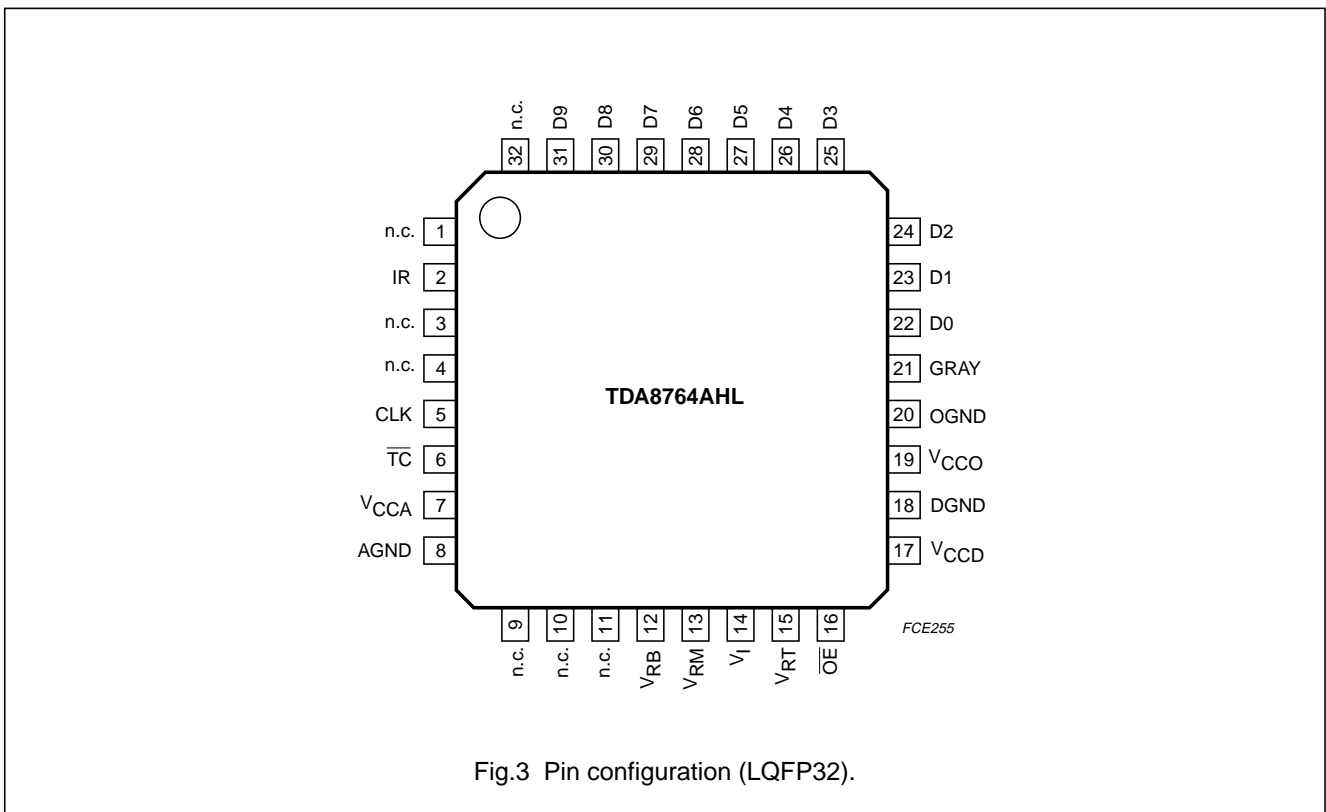
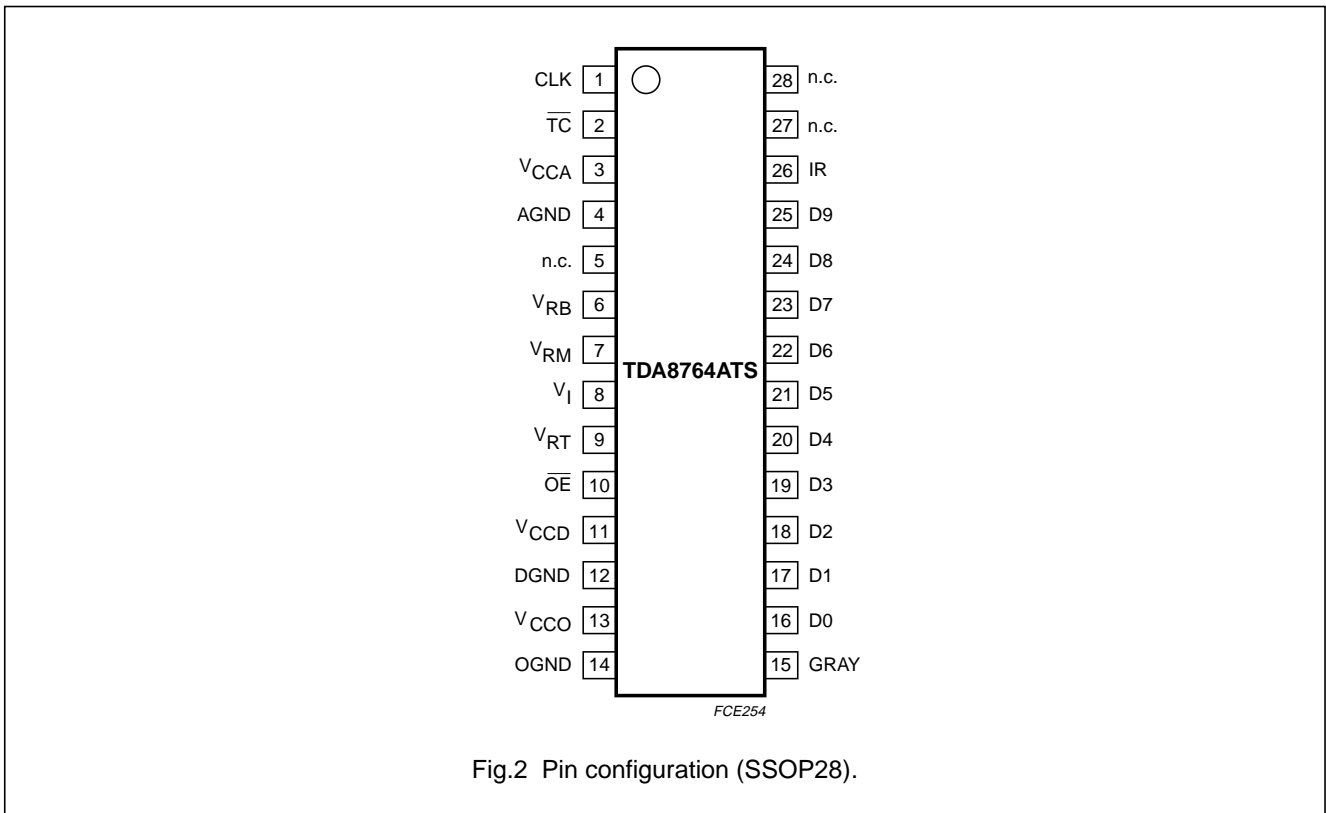
## TDA8764A

## PINNING

SYMBOL	PIN		DESCRIPTION
	TDA8764ATS	TDA8764AHL	
CLK	1	5	clock input
$\overline{TC}$	2	6	twos complement input (active LOW)
V <sub>CCA</sub>	3	7	analog supply voltage (5 V)
AGND	4	8	analog ground
n.c.	5	9	not connected
V <sub>RB</sub>	6	12	reference voltage BOTTOM input
V <sub>RM</sub>	7	13	reference voltage MIDDLE input
V <sub>I</sub>	8	14	analog input voltage
V <sub>RT</sub>	9	15	reference voltage TOP input
$\overline{OE}$	10	16	output enable input (active LOW)
V <sub>CCD</sub>	11	17	digital supply voltage (5 V)
DGND	12	18	digital ground
V <sub>CCO</sub>	13	19	supply voltage for output stages (2.7 to 3.6 V)
OGND	14	20	output ground
GRAY	15	21	gray code input (active HIGH)
D0	16	22	data output; bit 0 (LSB)
D1	17	23	data output; bit 1
D2	18	24	data output; bit 2
D3	19	25	data output; bit 3
D4	20	26	data output; bit 4
D5	21	27	data output; bit 5
D6	22	28	data output; bit 6
D7	23	29	data output; bit 7
D8	24	30	data output; bit 8
D9	25	31	data output; bit 9 (MSB)
IR	26	2	in range data output
n.c.	27	1	not connected
n.c.	28	3	not connected
n.c.	–	4	not connected
n.c.	–	10	not connected
n.c.	–	11	not connected
n.c.	–	32	not connected

10-bit high-speed low-power ADC

TDA8764A



## 10-bit high-speed low-power ADC

## TDA8764A

**LIMITING VALUES**

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{CCA}$	analog supply voltage	note 1	-0.3	+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 difference between $V_{CCA} - V_{CCD}$ $V_{CCA} - V_{CCO}$ $V_{CCD} - V_{CCO}$		-1.0 -1.0 -1.0	+1.0 +4.0 +4.0	V V V
$V_I$	input voltage	referenced to AGND	-0.3	+7.0	V
$V_{I(sw)(p-p)}$	AC input voltage for switching (peak-to-peak value)	referenced to DGND	-	$V_{CCD}$	V
$I_O$	output current		-	10	mA
$T_{stg}$	storage temperature		-55	+150	°C
$T_{amb}$	ambient temperature		-40	+85	°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	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient SSOP28 LQFP32	in free air	110 90	K/W K/W

## 10-bit high-speed low-power ADC

## TDA8764A

**CHARACTERISTICS**

$V_{CCA} = 4.75$  to  $5.25$  V;  $V_{CCD} = 4.75$  to  $5.25$  V;  $V_{CCO} = 2.7$  to  $3.6$  V; AGND and DGND shorted together;  
 $T_{amb} = 0$  to  $70$  °C; typical values measured at  $V_{CCA} = V_{CCD} = 5$  V;  $V_{CCO} = 3.3$  V;  $V_{RB} = 1.3$  V;  $V_{RT} = 3.7$  V;  $C_L = 10$  pF  
and  $T_{amb} = 25$  °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 stages supply voltage		2.7	3.3	3.6	V
$\Delta V_{CC}$	supply voltage difference between					
	$V_{CCA} - V_{CCD}$		-0.20	-	+0.20	V
	$V_{CCA} - V_{CCO}$		-0.20	-	+2.55	V
	$V_{CCD} - V_{CCO}$		-0.20	-	+2.55	V
$I_{CCA}$	analog supply current		-	29	37	mA
$I_{CCD}$	digital supply current		-	33	40	mA
$I_{CCO}$	output stages supply current	$f_{clk} = 60$ MHz; ramp input	-	0.5	2.0	mA
<b>Inputs</b>						
PIN CLK (REFERENCED TO DGND); note 1						
$V_{IL}$	LOW-level input voltage		0	-	0.8	V
$V_{IH}$	HIGH-level input voltage		2	-	$V_{CCD}$	V
$I_{IL}$	LOW-level input current	$V_{CLK} = 0.8$ V	-1	0	+1	$\mu$ A
$I_{IH}$	HIGH-level input current	$V_{CLK} = 2$ V	-	2	10	$\mu$ A
$C_i$	input capacitance		-	2	-	pF
PINS $\overline{OE}$ ; TC AND GRAY (REFERENCED TO DGND); see Tables 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	$V_{IL} = 0.8$ V	-1	-	-	$\mu$ A
$I_{IH}$	HIGH-level input current	$V_{IH} = 2$ V	-	-	1	$\mu$ A
PIN $V_i$ (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	$V_i = V_{RT} = 3.7$ V	-	55	-	$\mu$ A
$Y_i$	input admittance	$f_i = 5$ MHz; note 2				
	$R_i$ input resistance		-	45	-	k $\Omega$
	$C_i$ input capacitance		3	5	7	pF

## 10-bit high-speed low-power ADC

## TDA8764A

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	2.2	V
$V_{RT}$	reference voltage TOP		3.4	3.7	$V_{CCA} - 0.8$	V
$V_{diff(ref)}$	differential reference voltage $V_{RT} - V_{RB}$		2.2	2.4	3.2	V
$I_{ref}$	reference current	$V_{diff} = 2.4$ V	–	17.6	–	mA
$R_{LAD}$	resistor ladder		–	136	–	$\Omega$
$TC_{RLAD}$	temperature coefficient of the resistor ladder		–	1860	–	ppm
			–	253	–	m $\Omega$ /K
$V_{offset(B)}$	offset voltage BOTTOM	$V_{diff} = 2.4$ V; note 3	–	200	–	mV
$V_{offset(T)}$	offset voltage TOP	$V_{diff} = 2.4$ V; note 3	–	190	–	mV
$V_{I(p-p)}$	analog input voltage (peak-to-peak value)	$V_{diff} = 2.4$ V; note 4	1.95	2.01	2.10	V
<b>Outputs</b>						
PINS D9 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>						
PIN CLK; see Fig.5; note 1						
$f_{clk(max)}$	maximum clock frequency		60	–	–	MHz
$t_{CPH}$	clock pulse width HIGH	$T_{amb} = 25$ °C	7.0	–	–	ns
$t_{CPL}$	clock pulse width LOW	$T_{amb} = 25$ °C	3.5	–	–	ns
<b>Analog signal processing</b>						
LINEARITY						
INL	integral non-linearity	$f_{clk} = 60$ MHz; ramp input	–	$\pm 0.8$	$\pm 2$	LSB
DNL	differential non-linearity	$f_{clk} = 60$ MHz; ramp input; no missing code	–	$\pm 0.35$	$\pm 0.9$	LSB
$E_{offset}$	offset error	middle code	–	$\pm 1$	–	LSB
$E_G$	gain error (from device to device)	note 5	–	$\pm 0.5$	–	%



## 10-bit high-speed low-power ADC

## TDA8764A

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
BANDWIDTH ( $f_{CLK} = 60$ MHz)						
B	analog bandwidth	full-scale sine wave; note 6	–	30	–	MHz
		75% full-scale sine wave; note 6	–	45	–	MHz
		small signal at mid-scale; $V_I = \pm 10$ LSB at code 512; note 6	–	700	–	MHz
$t_{stLH}$	analog input settling time LOW-to-HIGH	full-scale square wave; see Fig.7; note 7	–	5	–	ns
$t_{stHL}$	analog input settling time HIGH-to-LOW	full-scale square wave; see Fig.7; note 7	–	5	–	ns
HARMONICS ( $f_{CLK} = 60$ MHz)						
$H_{all(FS)}$	harmonics (full-scale); all components second harmonic third harmonic	$f_i = 5$ MHz				
			–	–68	–	dB
			–	–67	–	dB
SFDR	spurious free dynamic range	$f_i = 5$ MHz	–	72	–	dB
THD	total harmonic distortion	$f_i = 5$ MHz	–	–64	–	dB
		$f_i = 15$ MHz	–	–57	–	dB
SIGNAL-TO-NOISE RATIO; note 8						
$SNR_{FS}$	signal-to-noise ratio (full-scale)	without harmonics; $f_{clk} = 60$ MHz; $f_i = 5$ MHz	–	58	–	dB
		without harmonics; $f_{clk} = 60$ MHz; $f_i = 15$ MHz	53	57	–	dB
EFFECTIVE BITS; note 8						
EB	effective bits	$f_{clk} = 60$ MHz				
		$f_i = 5$ MHz	–	9.3	–	bits
		$f_i = 10$ MHz	–	8.9	–	bits
		$f_i = 15$ MHz	–	8.8	–	bits
		$f_i = 20$ MHz	–	8.6	–	bits
TWO-TONE; note 9						
TTID	two-tone intermodulation distortion	$f_{clk} = 60$ MHz	–	–67	–	dB
BIT ERROR RATE						
BER	bit error rate	$f_{clk} = 60$ MHz; $f_i = 5$ MHz; $V_I = \pm 16$ LSB at code 512	–	$10^{-13}$	–	times/ sample

## 10-bit high-speed low-power ADC

## TDA8764A

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Timing (<math>f_{\text{clk}} = 60 \text{ MHz}</math>; <math>C_L = 10 \text{ pF}</math>); see Fig.5 and note 10</b>						
$t_{\text{ds}}$	sampling delay time		–	0.7	2	ns
$t_{\text{h}}$	output hold time		4	–	–	ns
$t_{\text{d}}$	output delay time TDA8764ATS	$V_{\text{CCO}} = 2.7 \text{ V}$	–	10	14	ns
		$V_{\text{CCO}} = 3.3 \text{ V}$	–	9	13	ns
$t_{\text{d}}$	output delay time TDA8764AHL	$V_{\text{CCO}} = 2.7 \text{ V}$	–	13	17	ns
		$V_{\text{CCO}} = 3.3 \text{ V}$	–	12	16	ns
$C_L$	digital output load capacitance		–	–	10	pF
SR	slew rate	$V_{\text{CCO}} = 2.7 \text{ V}$	0.2	0.3	–	V/ns
<b>3-state output delay times (<math>f_{\text{clk}} = 60 \text{ MHz}</math>); see Fig.6</b>						
$t_{\text{dZH}}$	enable HIGH	$V_{\text{CCO}} = 3.3 \text{ V}$	–	16	20	ns
$t_{\text{dZL}}$	enable LOW	$V_{\text{CCO}} = 3.3 \text{ V}$	–	30	34	ns
$t_{\text{dHZ}}$	disable HIGH	$V_{\text{CCO}} = 3.3 \text{ V}$	–	25	30	ns
$t_{\text{dLZ}}$	disable LOW	$V_{\text{CCO}} = 3.3 \text{ V}$	–	23	27	ns

**Notes**

- The rise and fall times of the clock signal must not be less than 0.5 ns.
- The input admittance is  $Y_i = \frac{1}{R_i} + j\omega C_i$
- Analog input voltages producing code 0 up to and including code 1023:
  - $V_{\text{offset(B)}}$  (offset voltage BOTTOM) is the difference between the analog input which produces data equal to 00 and the reference voltage BOTTOM ( $V_{\text{RB}}$ ) at  $T_{\text{amb}} = 25 \text{ }^\circ\text{C}$ .
  - $V_{\text{offset(T)}}$  (offset voltage TOP) is the difference between  $V_{\text{RT}}$  (reference voltage TOP) and the analog input which produces data outputs equal to code 1023 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 1023 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.4.

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

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.

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

- 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, nor any significant attenuation are observed in the reconstructed signal.

10-bit high-speed low-power ADC

TDA8764A

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 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 4.5 and 4.3 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  $t_d$ . It is recommended to have the lowest possible output load. These parameters are guaranteed by characterization and not by production test.

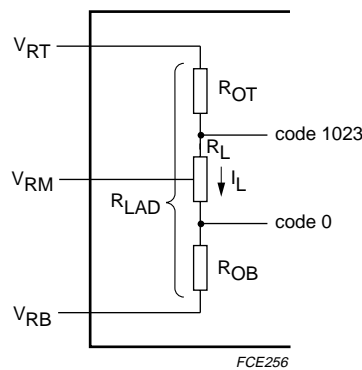


Fig.4 Explanation of note 4.

## 10-bit high-speed low-power ADC

## TDA8764A

**Table 1** Output coding and input voltage (typical values; referenced to AGND;  $V_{RB} = 1.3$  V;  $V_{RT} = 3.7$  V; binary/gray codes)

STEP	$V_I$	IR	BINARY OUTPUT BITS										GRAY OUTPUT BITS									
			D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
U/F	<1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	1.5	1	0	0	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	0	1	0	0	0	0	0	0	0	0	1	
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
1022	:	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	1		
1023	3.51	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0		
O/F	>3.51	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0		

**Table 2** Output coding and input voltage (typical values; referenced to AGND; binary/twos complement codes)

STEP	$V_I$	IR	BINARY OUTPUT BITS										TWS COMPLEMENT OUTPUT BITS									
			D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
U/F	<1.5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0		
0	1.5	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0		
1	:	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1		
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
1022	:	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0		
1023	3.51	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1		
O/F	>3.51	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1		

**Table 3**  $\overline{TC}$  mode selection

$\overline{TC}$	$\overline{OE}$	D9 to D0	IR
X	1	high-impedance	high-impedance
0	0	active; twos complement	active
1	0	active; binary	active

**Table 4** Gray mode selection

GRAY	$\overline{OE}$	D9 to D0	IR
X	1	high-impedance	high-impedance
0	0	active; binary	active
1	0	active; gray	active

10-bit high-speed low-power ADC

TDA8764A

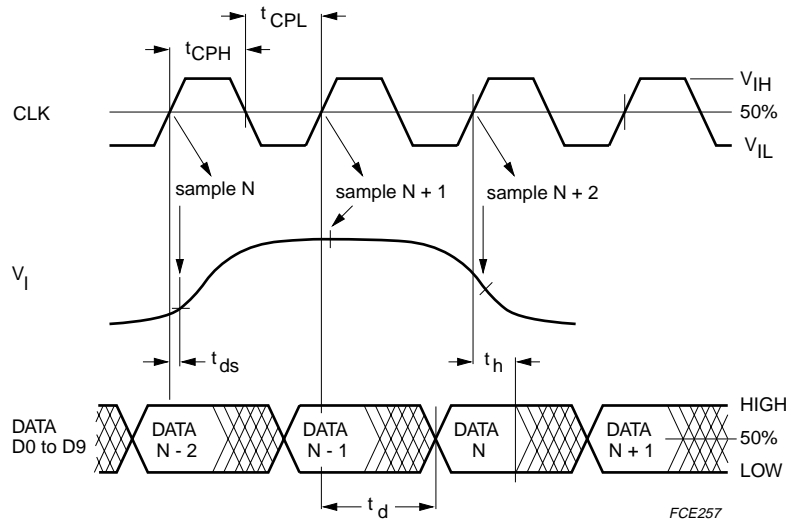
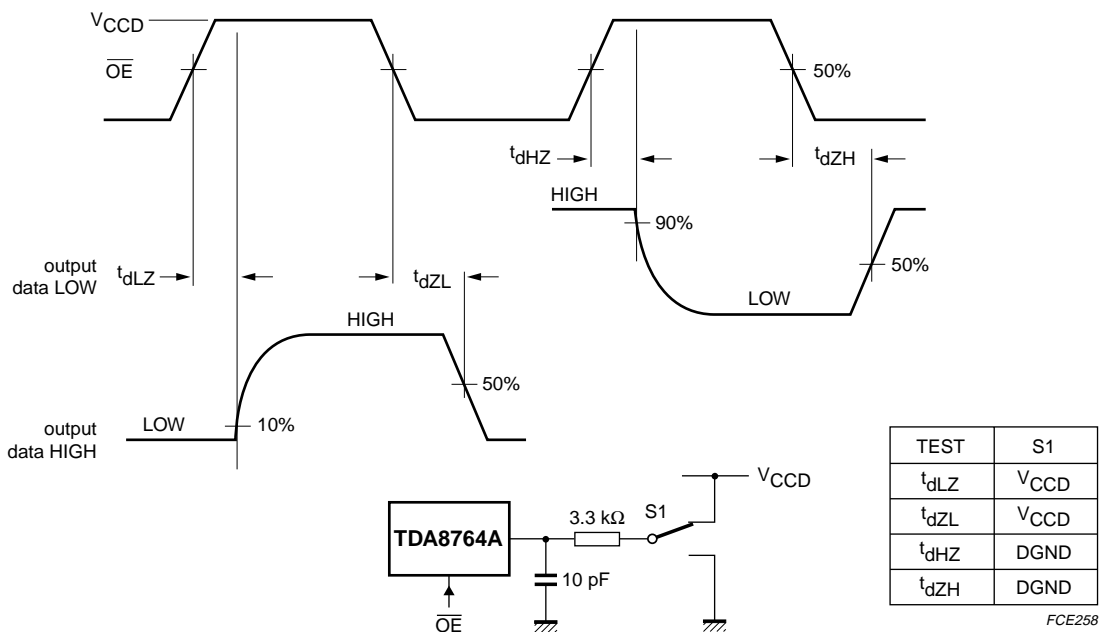


Fig.5 Timing diagram.



$f_{OE} = 100 \text{ kHz}$ .

Fig.6 Timing diagram and test conditions of 3-state output delay time.

10-bit high-speed low-power ADC

TDA8764A

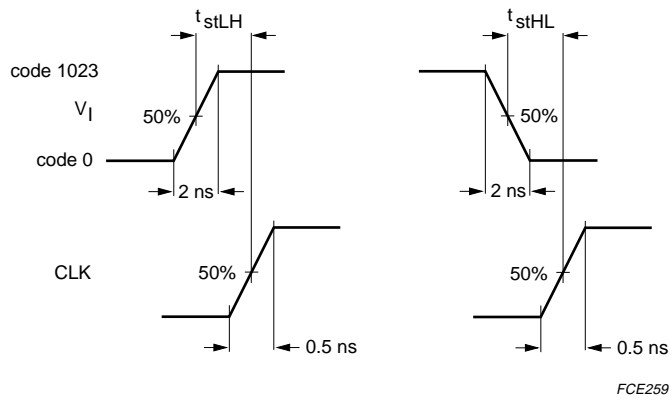


Fig.7 Analog input settling-time diagram.

10-bit high-speed low-power ADC

TDA8764A

INTERNAL PIN CONFIGURATIONS

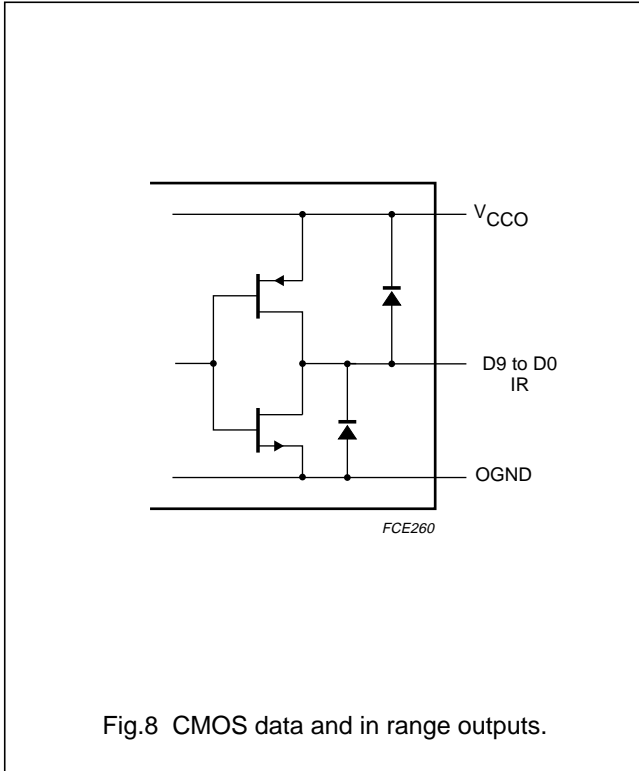


Fig.8 CMOS data and in range outputs.

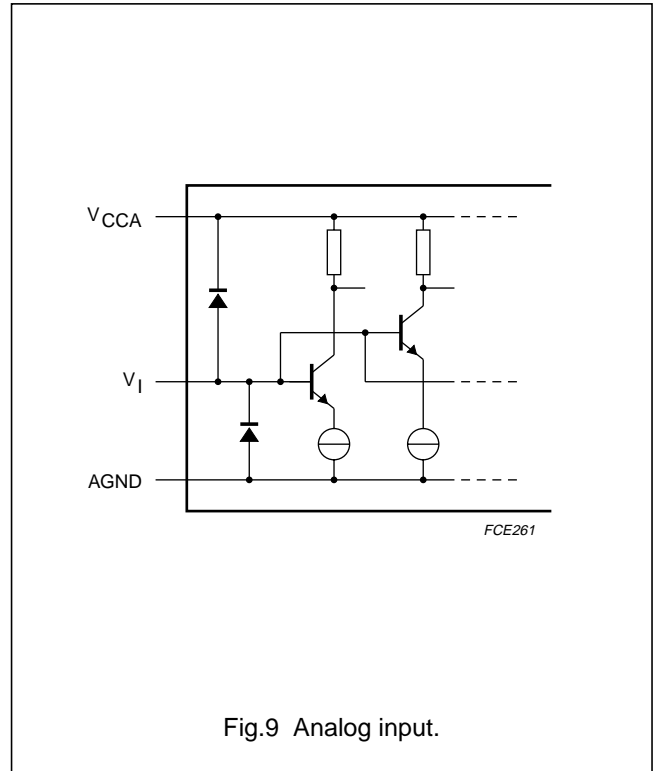


Fig.9 Analog input.

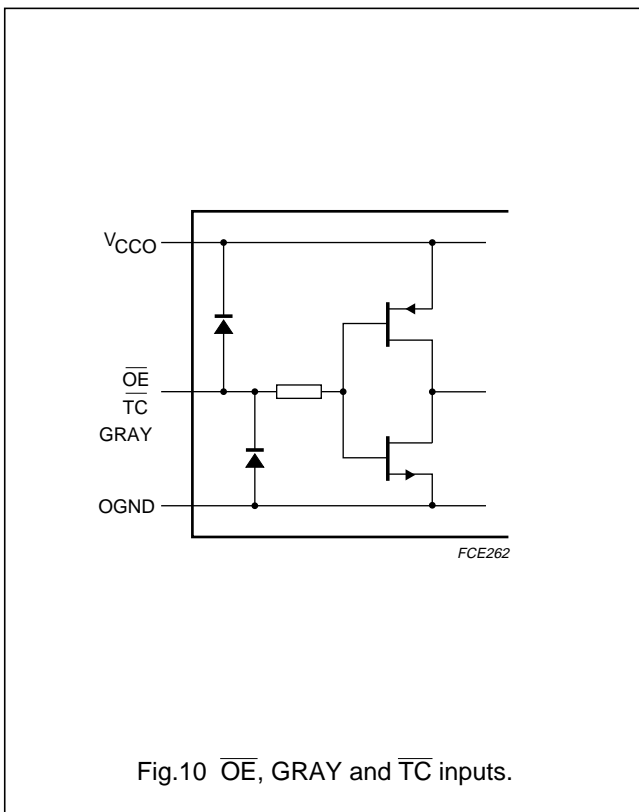


Fig.10  $\overline{OE}$ , GRAY and  $\overline{TC}$  inputs.

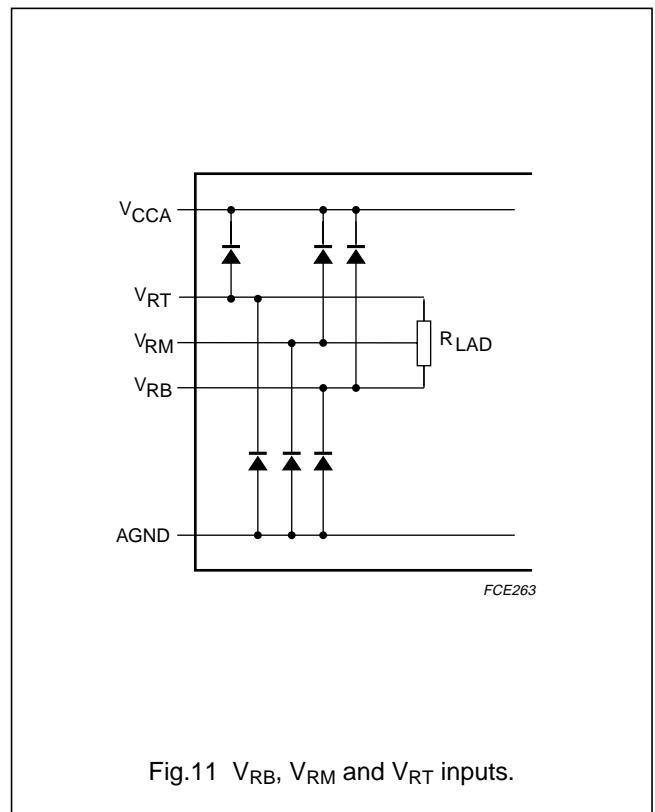


Fig.11  $V_{RB}$ ,  $V_{RM}$  and  $V_{RT}$  inputs.

10-bit high-speed low-power ADC

TDA8764A

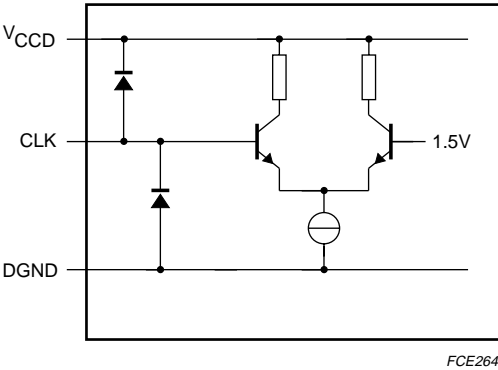


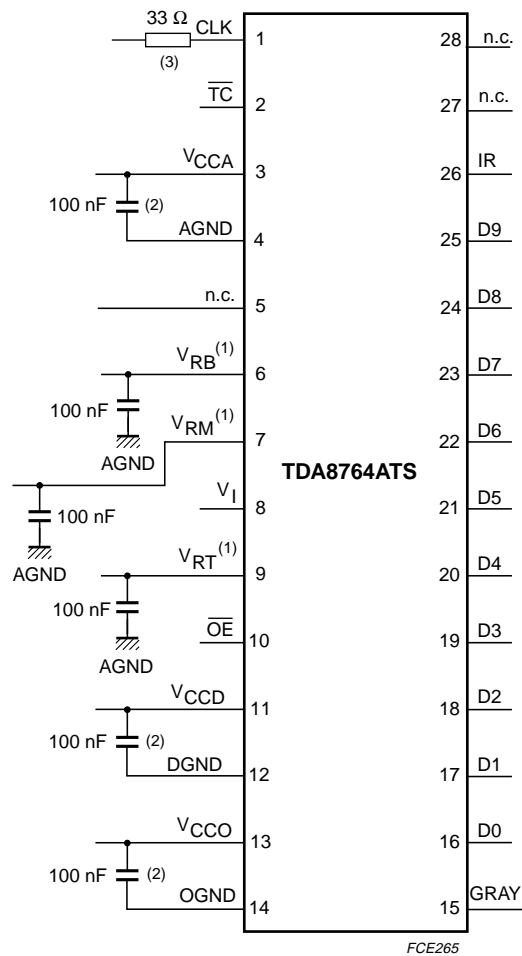
Fig.12 CLK input.



10-bit high-speed low-power ADC

TDA8764A

APPLICATION INFORMATION



The analog and digital supplies should be separated and well decoupled.

An application note is available and describes the design and the realization of a demoboard that uses TDA8764ATS with an application environment.

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

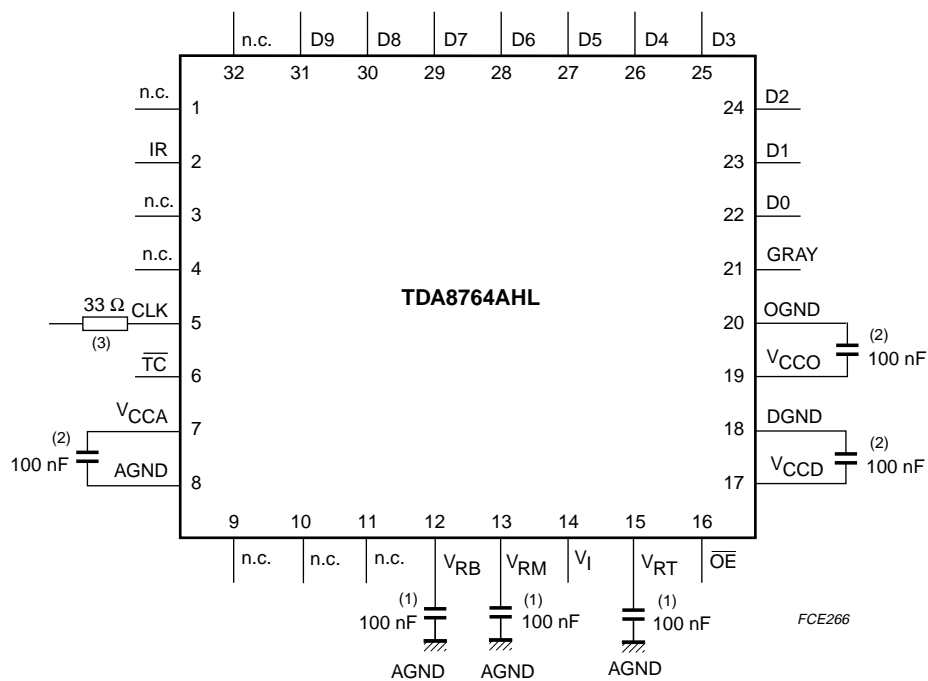
(2) Decoupling capacitor for supplies **must be placed close to the device**.

(3) This resistor is mandatory ( $33 \Omega$  is its minimum value) and must be near the clock source.

Fig.13 Application diagram (SSOP28).

10-bit high-speed low-power ADC

TDA8764A



The analog and digital supplies should be separated and well decoupled.

An application note is available and describes the design and the realization of a demoboard that uses TDA8764AHL with an application environment.

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

(2) Decoupling capacitor for supplies **must be placed close to the device**.

(3) This resistor is mandatory (33  $\Omega$  is its minimum value) and must be near the clock source.

Fig.14 Application diagram (LQFP32).

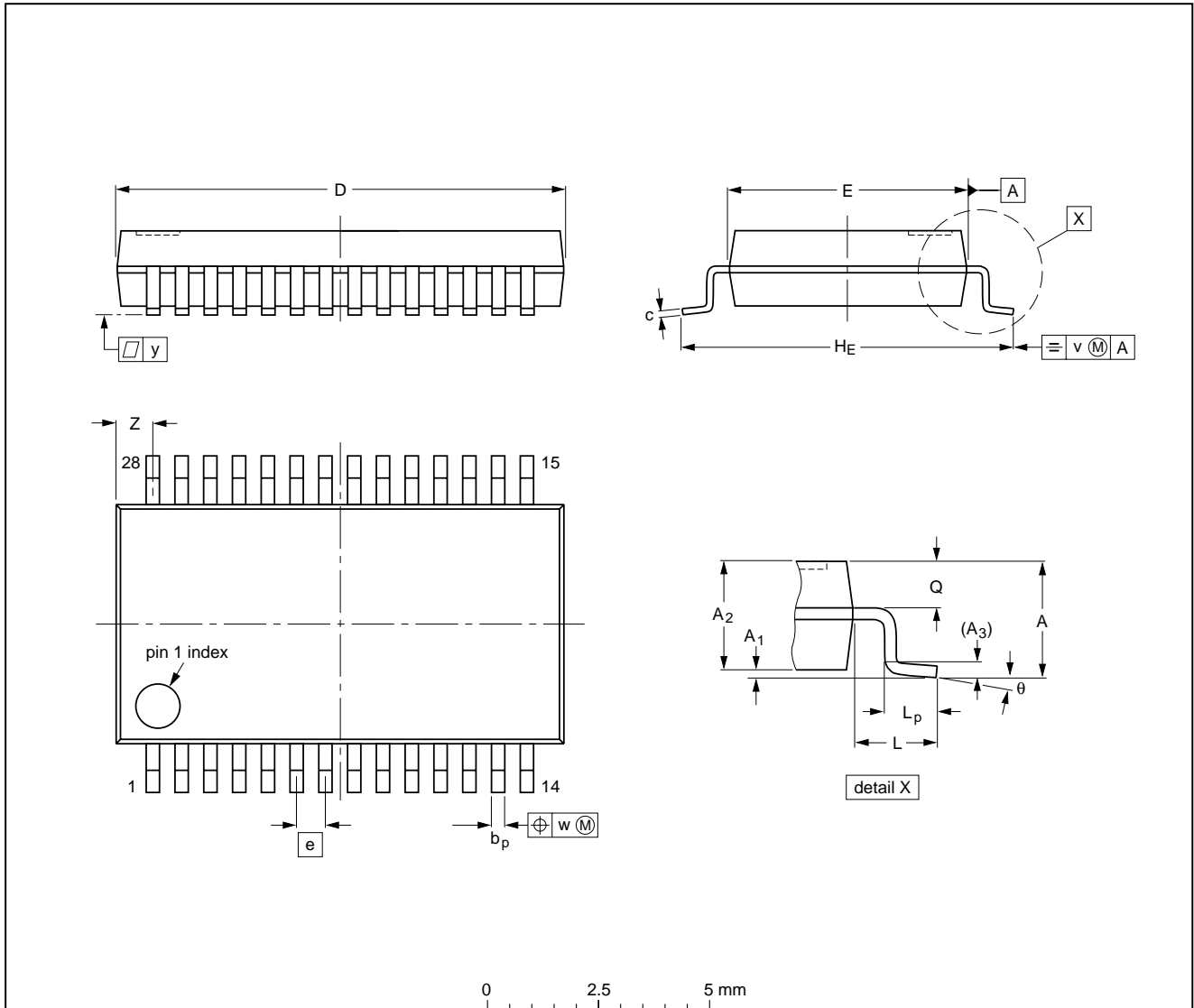
# 10-bit high-speed low-power ADC

# TDA8764A

## PACKAGE OUTLINES

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>	θ
mm	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	10.4 10.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.1 0.7	8° 0°

**Note**

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

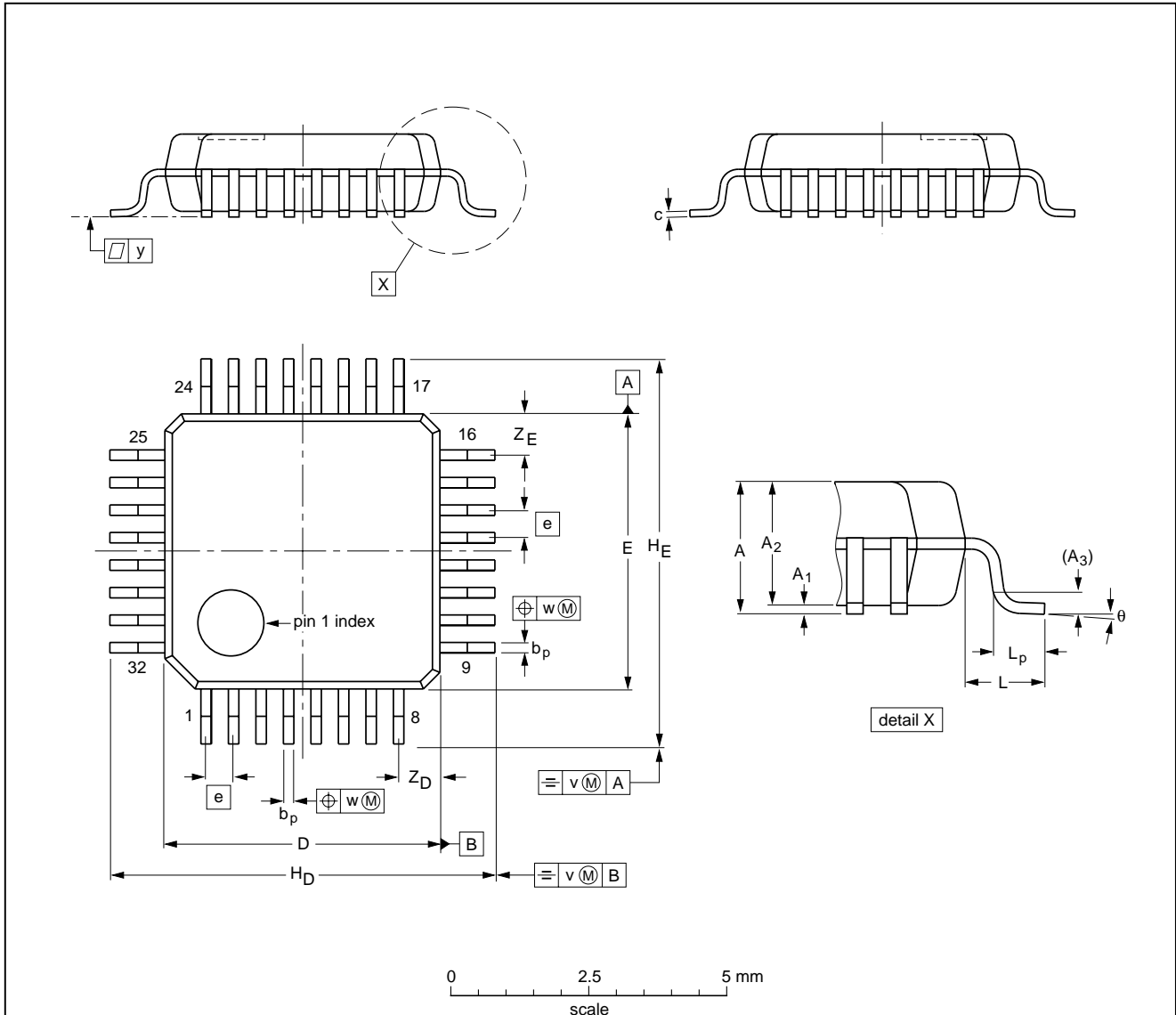
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT341-1		MO-150				95-02-04 99-12-27

10-bit high-speed low-power ADC

TDA8764A

LQFP32: plastic low profile quad flat package; 32 leads; body 5 x 5 x 1.4 mm

SOT401-1



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>D</sub>	H <sub>E</sub>	L	L <sub>p</sub>	v	w	y	Z <sub>D</sub> <sup>(1)</sup>	Z <sub>E</sub> <sup>(1)</sup>	θ
mm	1.60	0.15 0.05	1.5 1.3	0.25	0.27 0.17	0.18 0.12	5.1 4.9	5.1 4.9	0.5	7.15 6.85	7.15 6.85	1.0	0.75 0.45	0.2	0.12	0.1	0.95 0.55	0.95 0.55	7° 0°

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ		
SOT401-1	136E01	MS-026			99-12-27 00-01-19

## 10-bit high-speed low-power ADC

## TDA8764A

### SOLDERING

#### Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

#### Reflow soldering

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

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

#### Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

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

Typical dwell time is 4 seconds at 250 °C.

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

#### Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

## 10-bit high-speed low-power ADC

## TDA8764A

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

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

## Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

## 10-bit high-speed low-power ADC

## TDA8764A

## DATA SHEET STATUS

DATA SHEET STATUS	PRODUCT STATUS	DEFINITIONS <sup>(1)</sup>
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

## Note

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

## DEFINITIONS

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

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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