ADC0801S040

Single 8 bits ADC, up to 40 MHz

Rev. 02 — 18 August 2008 Product data sheet

1. General description

The ADC0801S040 is an 8-bit universal analog-to-digital converter (ADC) for video and general purpose applications. It converts the analog input signal from 2.7 V to 5.5 V into 8-bit binary-coded digital words at a maximum sampling rate of 40 MHz. All digital inputs and outputs are CMOS/Transistor-Transistor Logic (TTL) compatible. A sleep mode allows reduction of the device power consumption to 4 mW.

2. Features

- 8-bit resolution
- Operation between 2.7 V and 5.5 V
- Sampling rate up to 40 MHz
- DC sampling allowed
- High signal-to-noise ratio over a large analog input frequency range (7.3 effective bits at 4.43 MHz full-scale input at f_{clk} = 40 MHz)
- CMOS/TTL compatible digital inputs and outputs
- External reference voltage regulator
- Power dissipation only 30 mW (typical value)
- Low analog input capacitance, no buffer amplifier required
- Sleep mode (4 mW)
- No sample-and-hold circuit required

3. Applications

- Video data digitizing
- Camera
- Camcorder
- Radio communication
- Car alarm system

NXP founded by Philips

4. Quick reference data

Table 1. Quick reference data

V_{DDA} = V5 to V6 = 3.3 V; V_{DDD} = V3 to V4 = 3.3 V; V_{DDO} = V20 to V11 = 3.3 V; V_{SSA}, V_{SSD} and V_{SSO} shorted together; $V_{i(a)(p-p)}$ = 1.84 V; C_L = 20 pF; T_{amb} = 0 °C to 70 °C; typical values measured at T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DDA}	analog supply voltage		2.7	3.3	5.5	V
V_{DDD}	digital supply voltage		2.7	3.3	5.5	V
V_{DDO}	output supply voltage		2.5	3.3	5.5	V
ΔV_{DD}	supply voltage difference	$V_{DDA} - V_{DDD}$	–0.2	-	+0.2	V
		$V_{DDD} - V_{DDO}$	–0.2	-	+2.25	V
I_{DDA}	analog supply current		-	4	6	mA
I_{DDD}	digital supply current		-	5	8	mA
I_{DDO}	output supply current	f_{clk} = 40 MHz; ramp input; C_L = 20 pF	-	1	2	mA
INL	integral non-linearity	ramp input; see Figure 6	-	±0.5	±0.75	LSB
DNL	differential non-linearity	ramp input; see Figure 7	-	±0.25	±0.5	LSB
$f_{clk(max)}$	maximum clock frequency		40	-	-	MHz
P_{tot}	total power dissipation	$V_{DDA} = V_{DDD} = V_{DDO}$ = 3.3 V	-	30	53	mW

5. Ordering information

Table 2. Ordering information

Type number	Package		
	Name	Description	Version
ADC0801S040TS	SSOP20	plastic shrink small outline package; 20 leads; body width 4.4 mm	SOT266-1

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6. Block diagram

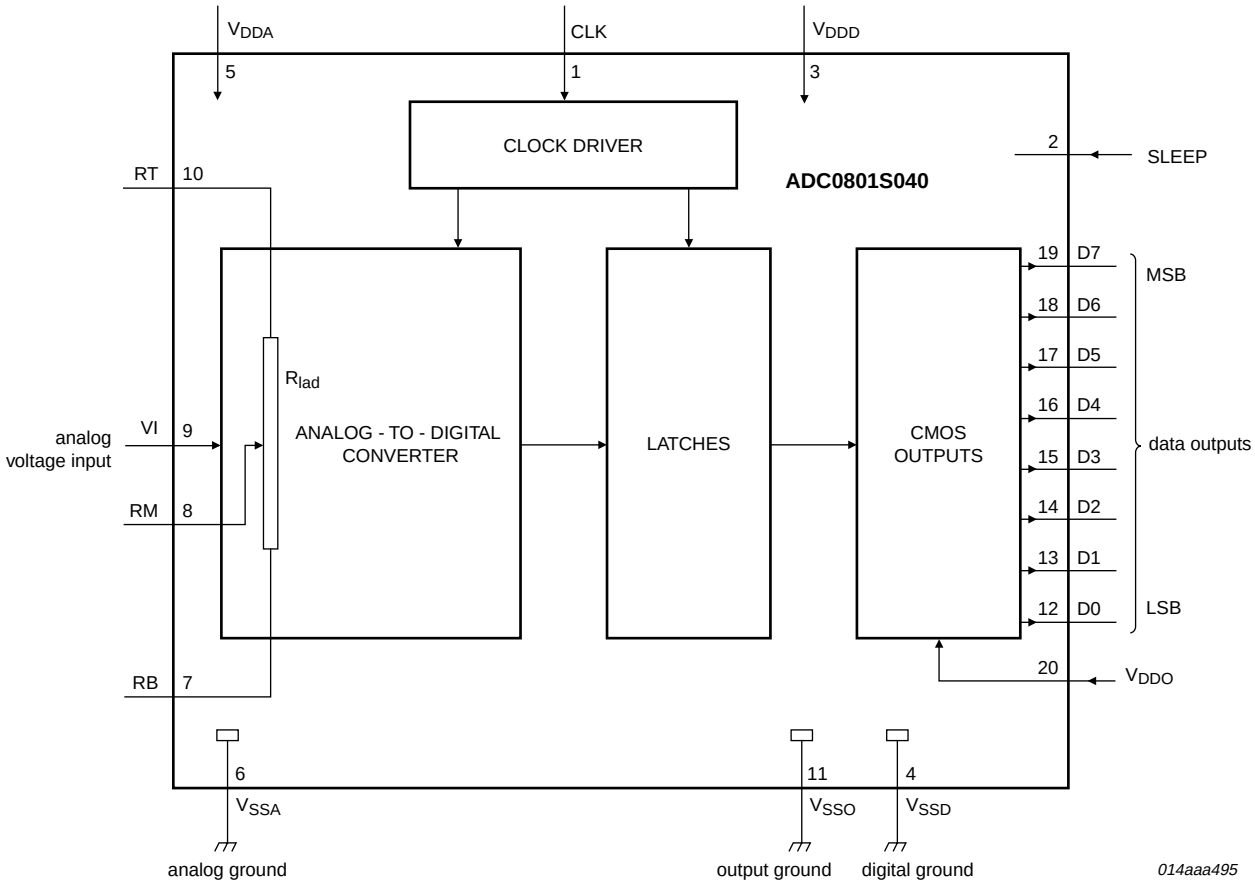

Fig 1. Block diagram

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7. Pinning information

7.1 Pinning

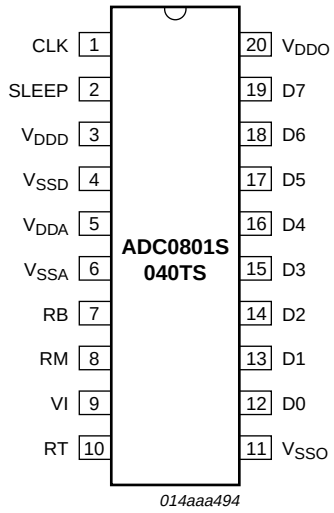

Fig 2. Pin configuration

7.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
CLK	1	clock input
SLEEP	2	sleep mode input
V_{DDD}	3	digital supply voltage (2.7 V to 5.5 V)
V_{SSD}	4	digital ground
V_{DDA}	5	analog supply voltage (2.7 V to 5.5 V)
V_{SSA}	6	analog ground
RB	7	reference voltage BOTTOM input
RM	8	reference voltage MIDDLE
VI	9	analog input voltage
RT	10	reference voltage TOP input
V_{SSO}	11	output stage ground
D0	12	data output; bit 0 (Least Significant Bit (LSB))
D1	13	data output; bit 1
D2	14	data output; bit 2
D3	15	data output; bit 3
D4	16	data output; bit 4
D5	17	data output; bit 5

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Table 3. Pin description *...continued*

Symbol	Pin	Description
D6	18	data output; bit 6
D7	19	data output; bit 7 (Most Significant Bit (MSB))
V_{DDO}	20	positive supply voltage for output stage (2.7 V to 5.5 V)

8. Limiting values

Table 4. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
V_{DDA}	analog supply voltage		[1]	–0.3	+7.0	V
V_{DDD}	digital supply voltage		[1]	–0.3	+7.0	V
V_{DDO}	output supply voltage		[1]	–0.3	+7.0	V
ΔV_{DD}	supply voltage difference	$V_{DDA} - V_{DDD}$; $V_{DDD} - V_{DDO}$; $V_{DDA} - V_{DDO}$		–0.1	+4.0	V
V_I	input voltage	referenced to V_{SSA}		–0.3	+7.0	V
$V_{i(clk)(p-p)}$	peak-to-peak clock input voltage	referenced to V_{SSD}		-	V_{DDD}	V
I_O	output current			-	10	mA
T_{stg}	storage temperature			–55	+150	°C
T_{amb}	ambient temperature			–20	+75	°C
T_j	junction temperature			-	150	°C

[1] The supply voltages V_{DDA}, V_{DDD} and V_{DDO} may have any value between –0.3 V and +7.0 V provided that the supply voltage ΔV_{DD} remains as indicated.

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	120	K/W

10. Characteristics

Table 6. Characteristics

V_{DDA} = V5 to V6 = 3.3 V; V_{DDD} = V3 to V4 = 3.3 V; V_{DDO} = V20 to V11 = 3.3 V; V_{SSA}, V_{SSD} and V_{SSO} shorted together; $V_{i(a)(p-p)}$ = 1.84 V; C_L = 20 pF; T_{amb} = 0 °C to 70 °C; typical values measured at T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supplies						
V_{DDA}	analog supply voltage		2.7	3.3	5.5	V
V_{DDD}	digital supply voltage		2.7	3.3	5.5	V
V_{DDO}	output supply voltage		2.5	3.3	5.5	

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Table 6. Characteristics *...continued*

V_{DDA} = V5 to V6 = 3.3 V; V_{DDD} = V3 to V4 = 3.3 V; V_{DDO} = V20 to V11 = 3.3 V; V_{SSA}, V_{SSD} and V_{SSO} shorted together; $V_{i(a)(p-p)}$ = 1.84 V; C_L = 20 pF; T_{amb} = 0 °C to 70 °C; typical values measured at T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
ΔV_{DD}	supply voltage difference	$V_{DDA} - V_{DDD}$		–0.2	-	+0.2	V
		$V_{DDD} - V_{DDO}$		–0.2	-	+2.25	V
I_{DDA}	analog supply current			-	4	6	mA
I_{DDD}	digital supply current			-	5	8	mA
I_{DDO}	output supply current	f_{clk} = 40 MHz; ramp input; C_L = 20 pF		-	1	2	mA
P_{tot}	total power dissipation	$V_{DDA} = V_{DDD} = V_{DDO}$ = 3.3 V		-	30	53	mW
Inputs							
Clock input CLK (Referenced to V_{SSD})[1]							
V_{IL}	LOW-level input voltage			0	-	0.3 V_{DDD}	V
V_{IH}	HIGH-level input voltage	$V_{DDD} \leq$ 3.6 V		0.6 V_{DDD}	-	V_{DDD}	V
		V_{DDD} > 3.6 V		0.7 V_{DDD}	-	V_{DDD}	V
I_{IL}	LOW-level input current	V_{clk} = 0.3 V_{DDD}		–1	0	+1	µA
I_{IH}	HIGH-level input current	V_{clk} = 0.7 V_{DDD}		-	-	5	µA
Z_i	input impedance	f_{clk} = 40 MHz		-	4	-	kΩ
C_i	input capacitance	f_{clk} = 40 MHz		-	3	-	pF
Input SLEEP (Referenced to V_{SSD}); see Table 8							
V_{IL}	LOW-level input voltage			0	-	0.3 V_{DDD}	V
V_{IH}	HIGH-level input voltage	$V_{DDD} \leq$ 3.6 V		0.6 V_{DDD}	-	V_{DDD}	V
		V_{DDD} > 3.6 V		0.7 V_{DDD}	-	V_{DDD}	V
I_{IL}	LOW-level input current	V_{IL} = 0.3 V_{DDD}		–1	-	-	µA
I_{IH}	HIGH-level input current	V_{IH} = 0.7 V_{DDD}		-	-	+1	µA
Analog input VI (Referenced to V_{SSA})							
I_{IL}	LOW-level input current	$V_I = V_{RB}$		-	0	-	µA
I_{IH}	HIGH-level input current	$V_I = V_{RT}$		-	9	-	µA
Z_i	input impedance	f_i = 1 MHz		-	20	-	kΩ
C_i	input capacitance	f_i = 1 MHz		-	2	-	pF
Reference voltages for the resistor ladder; see Table 7							
V_{RB}	voltage on pin RB			1.1	1.2	-	V
V_{RT}	voltage on pin RT	$V_{RT} \leq V_{DDA}$		2.7	3.3	V_{DDA}	V
$V_{ref(dif)}$	differential reference voltage	$V_{RT} - V_{RB}$		1.5	2.1	2.7	V
I_{ref}	reference current			-	0.95	-	mA
R_{lad}	ladder resistance			-	2.2	-	kΩ
TC_{Rlad}	ladder resistor temperature coefficient			-	4092	-	mΩ/K
V_{offset}	offset voltage	BOTTOM	[2]	-	170	-	mV
		TOP	[2]	-	170	-	mV
$V_{i(a)(p-p)}$	peak-to-peak analog input voltage		[3]	1.4	1.76	2.4	V

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Table 6. Characteristics *...continued*

V_{DDA} = V5 to V6 = 3.3 V; V_{DDD} = V3 to V4 = 3.3 V; V_{DDO} = V20 to V11 = 3.3 V; V_{SSA}, V_{SSD} and V_{SSO} shorted together; $V_{i(a)(p-p)}$ = 1.84 V; C_L = 20 pF; T_{amb} = 0 °C to 70 °C; typical values measured at T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Digital outputs D7 to D0 and IR (Referenced to V_{SSD})							
V_{OL}	LOW-level output voltage	I_O = 1 mA		0	-	0.5	V
V_{OH}	HIGH-level output voltage	I_O = –1 mA		V_{DDO} – 0.5	-	V_{DDO}	V
I_{OZ}	OFF-state output current	0.4 V < V_O < V_{DDO}		–20	-	+20	µA
Clock input CLK; see Figure 4[1]							
$f_{clk(max)}$	maximum clock frequency			40	-	-	MHz
$t_{w(clk)H}$	HIGH clock pulse width			9	-	-	ns
$t_{w(clk)L}$	LOW clock pulse width			9	-	-	ns
Analog signal processing (f_{clk} = 40 MHz)							
Linearity							
INL	integral non-linearity	ramp input; see Figure 6		-	±0.5	±0.75	LSB
DNL	differential non-linearity	ramp input; see Figure 7		-	±0.25	±0.5	LSB
Bandwidth							
B	bandwidth	full-scale sine wave	[4]	-	10		MHz
		75 % full-scale sine wave		-	13		MHz
		50 % full-scale sine wave		-	20		MHz
		small signal at mid scale; V_i = ±10 LSB at code 128		-	350		MHz
Input set response; see Figure 8[5]							
$t_{s(LH)}$	LOW to HIGH settling time	full-scale square wave		-	3	5	ns
$t_{s(HL)}$	HIGH to LOW settling time	full-scale square wave		-	3	5	ns
Harmonics; see Figure 9[6]							
THD	total harmonic distortion	f_i = 4.43 MHz		-	–50	-	dB
Signal-to-Noise ratio; see Figure 9[6]							
S/N	signal-to-noise ratio	without harmonics; f_i= 4.43 MHz		-	47	-	dB
Effective bits; see Figure 9[6]							
ENOB	effective number of bits	f_i = 300 MHz		-	7.8	-	bits
		f_i = 4.43 MHz		-	7.3	-	bits
Differential gain[7]							
G_{dif}	differential gain	PAL modulated ramp		-	1.5	-	%

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Table 6. Characteristics *...continued*

V_{DDA} = V5 to V6 = 3.3 V; V_{DDD} = V3 to V4 = 3.3 V; V_{DDO} = V20 to V11 = 3.3 V; V_{SSA}, V_{SSD} and V_{SSO} shorted together; $V_{i(a)(p-p)}$ = 1.84 V; C_L = 20 pF; T_{amb} = 0 °C to 70 °C; typical values measured at T_{amb} = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Differential phase[7]						
φ_{dif}	differential phase	PAL modulated ramp	-	0.25	-	deg
Timing (f_{clk} = 40 MHz; C_L = 20 pF); see Figure 4[8]						
$t_{d(s)}$	sampling delay time		-	-	5	ns
$t_{h(o)}$	output hold time		5	-	-	ns
$t_{d(o)}$	output delay time	V_{DDO} = 4.75 V	8	12	15	ns
		V_{DDO} = 3.15 V	8	17	20	ns
		V_{DDO} = 2.7 V	8	18	21	ns
3-state output delay times; see Figure 5						
t_{dHZ}	active HIGH to float delay time		-	14	18	ns
t_{dZL}	float to active LOW delay time		-	16	20	ns
t_{dZH}	float to active HIGH delay time		-	16	20	ns
t_{dLZ}	active LOW to float delay time		-	14	18	ns

[1] 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 1 ns.

[2] Analog input voltages producing code 0 up to and including code 255:

a) V_{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 °C.

b) V_{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 255 at T_{amb} = 25 °C.

[3] 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 to 255 is $V_I = R_L \times I_L = \frac{R_L}{R_{OB} + R_L + R_{OT}} \times (V_{RT} + V_{RB}) = 0.838 \times (V_{RT} - V_{RB})$

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.

[4] 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, nor any significant attenuation is observed in the reconstructed signal.

[5] 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.

[6] 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 of the clock frequency (Nyquist frequency). Conversion to signal-to-noise ratio: S/N = ENOB × 6.02 + 1.76 dB.

[7] Measurement carried out using video analyzer VM700A, where video analog signal is reconstructed through a DAC.

[8] Output data acquisition: the output data is available after the maximum delay time of $t_{d(o)}$.

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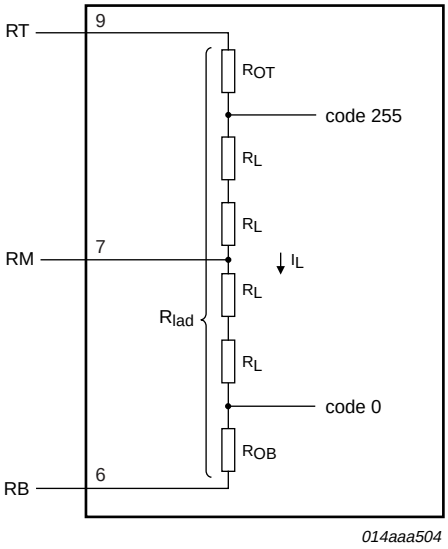

Fig 3. Explanation of Table 6 Table note 3

11. Additional information relating to Table 6

Table 7. Output coding and input voltage (typical values; referenced to V_{SSA})

Code	$V_{i(a)(p-p)}$ (V)	Binary outputs D7 to D0
Underflow	< 1.37	00 0000 00
0	1.37	00 0000 00
1	-	00 0000 01
↓	-	↓
254	-	11 11 11 10
255	3.13	11 11 11 11
Overflow	> 3.13	11 11 11 11

Table 8. Mode selection

SLEEP	D7 to D0	I_{DDA} + I_{DDD} (typ)
1	high impedance	1.2 mA
0	active	9 mA

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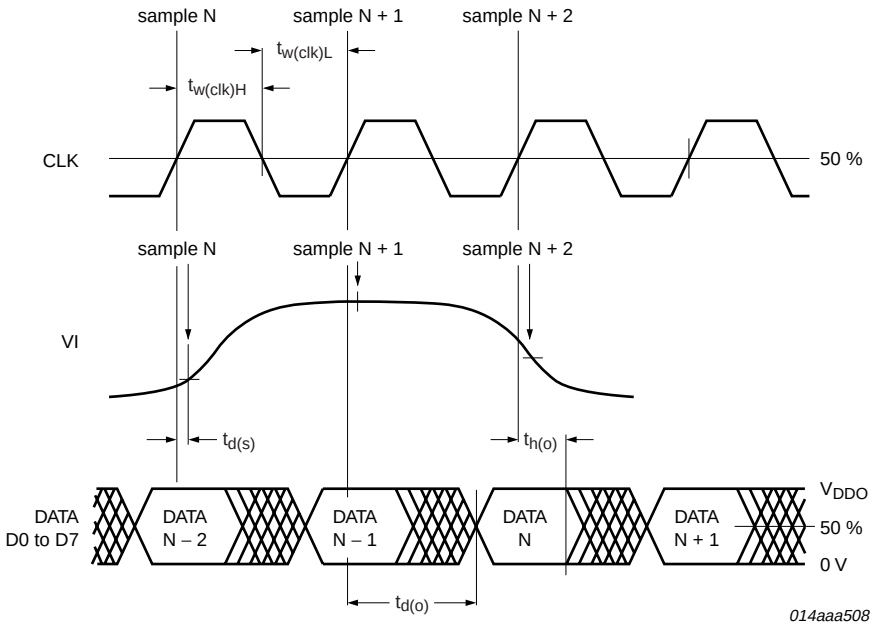

Fig 4. Timing diagram

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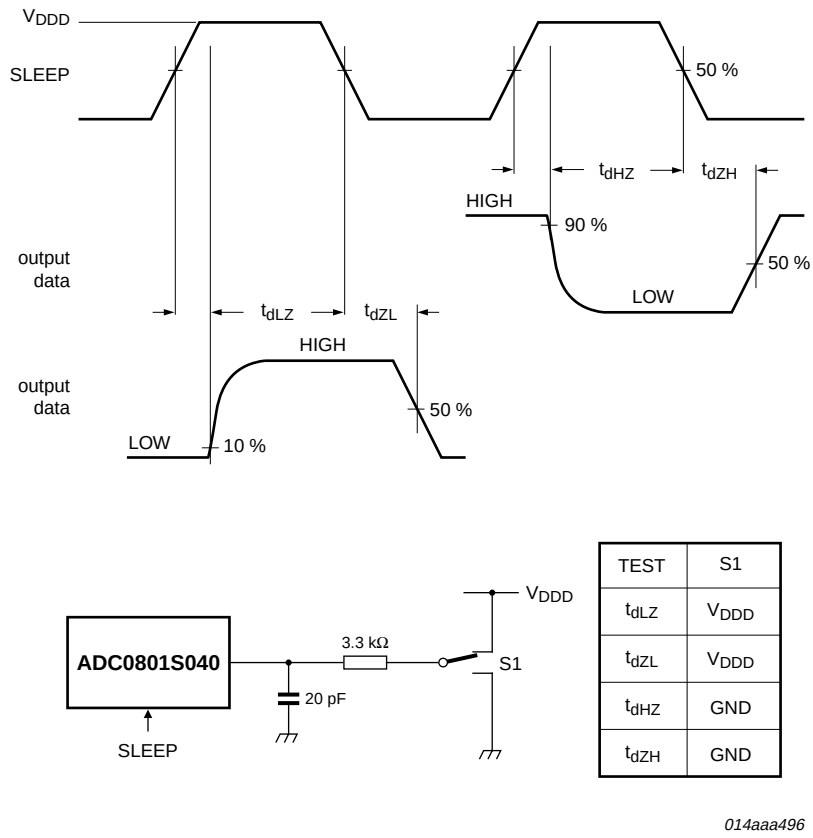

TEST	S1
t_{dLZ}	V_{DDD}
t_{dZL}	V_{DDD}
t_{dHZ}	GND
t_{dZH}	GND

frequency on pin SLEEP = 100 kHz.

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

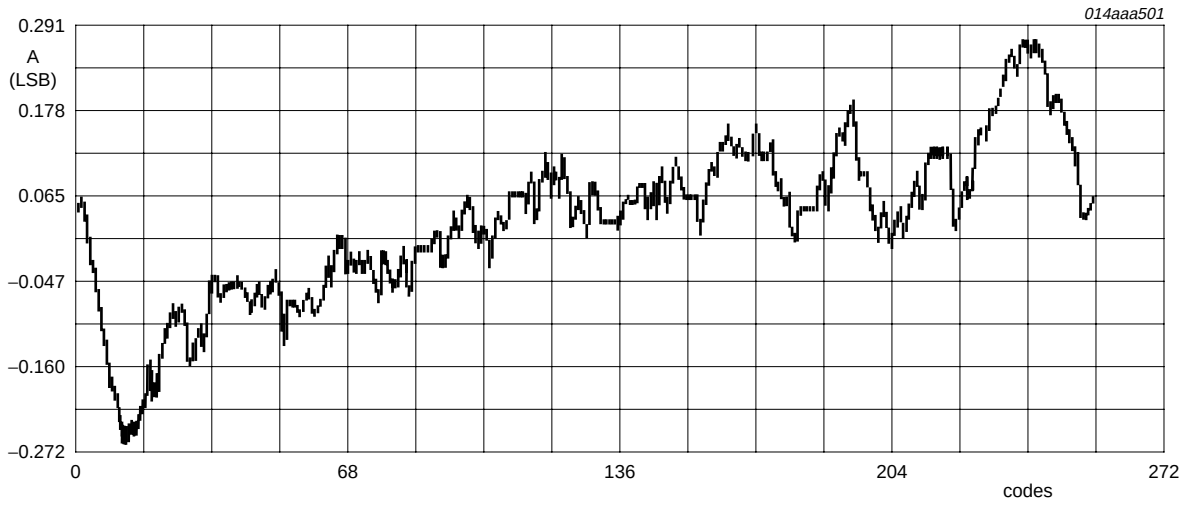

Fig 6. Typical Integral Non-Linearity (INL) performance

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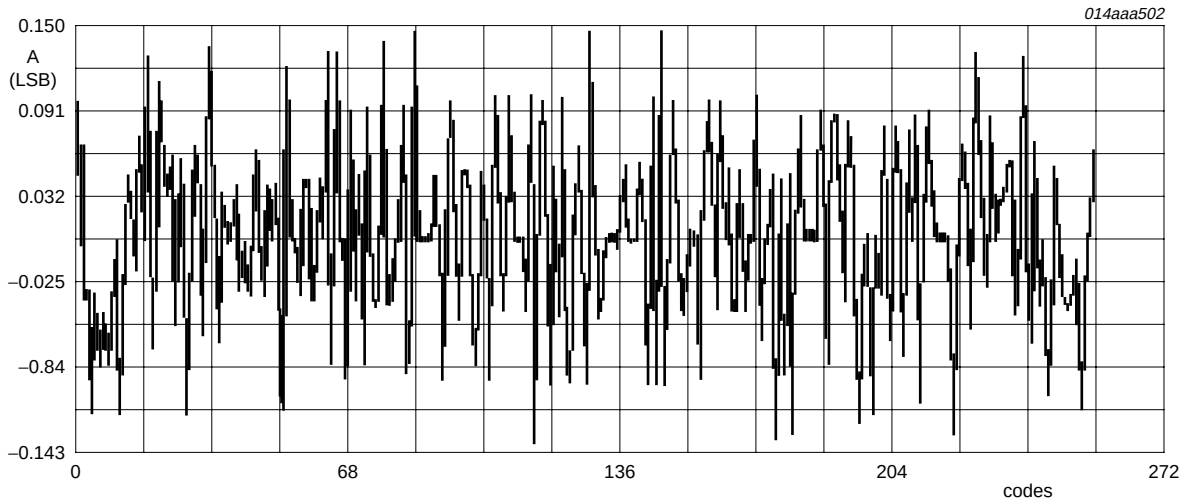

Fig 7. Typical Differential Non-Linearity (DNL) performance

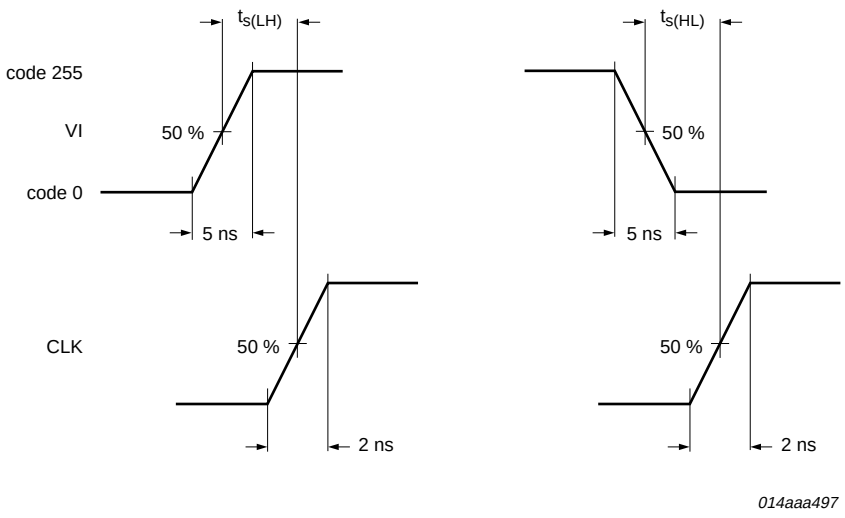

Fig 8. Analog input settling-time diagram

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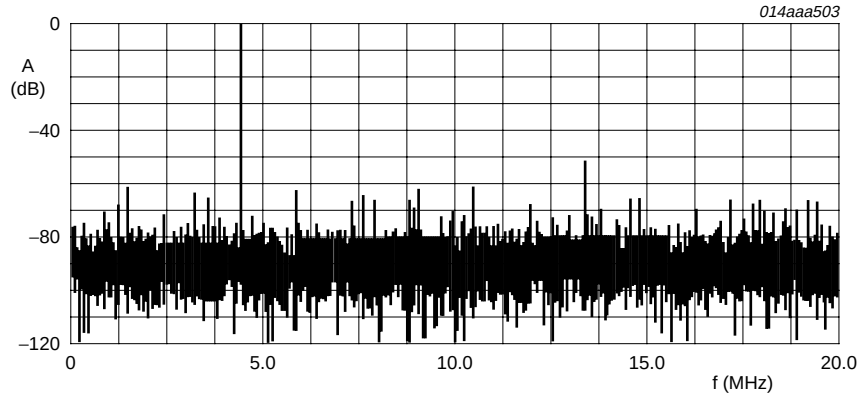

Effective bits: 7.32; THD = –51.08 dB.

Harmonic levels (dB): 2nd = –68.99; 3rd = –51.62; 4th = –66.05; 5th = –63.23; 6th = –72.79.

Fig 9. Typical fast Fourier transform (f_{clk} = 40 MHz; f_i = 4.43 MHz)

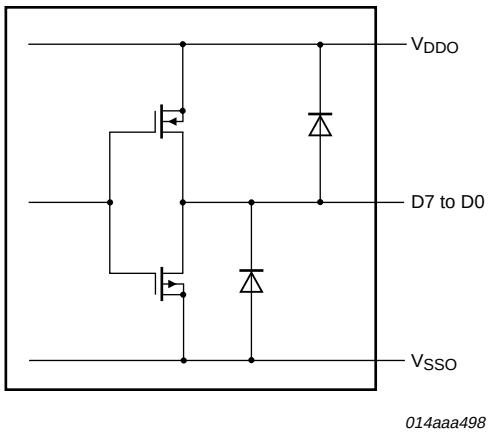

Fig 10. CMOS data outputs

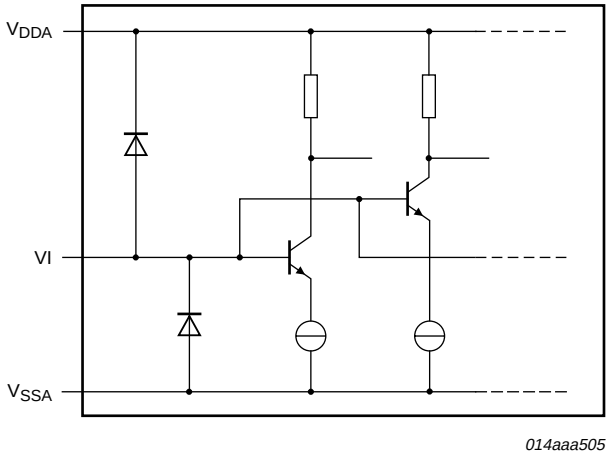

Fig 11. VI analog input

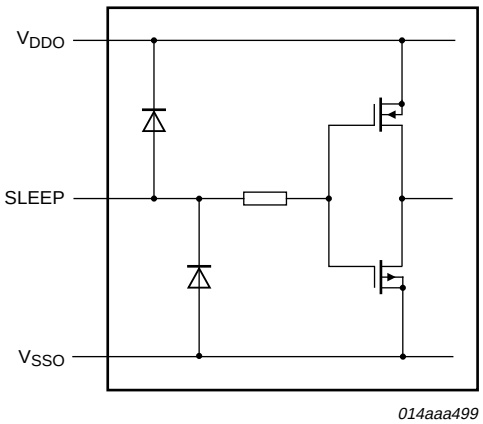

Fig 12. SLEEP 3-state input

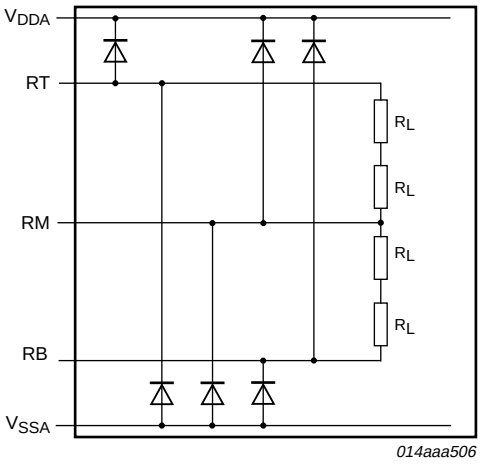

Fig 13. RB, RM and RT inputs

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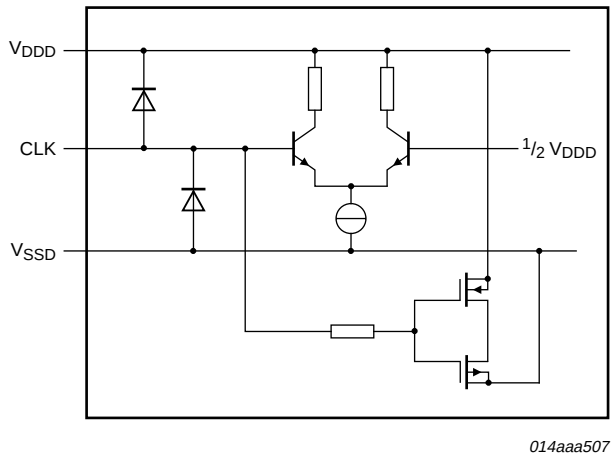

Fig 14. CLK input

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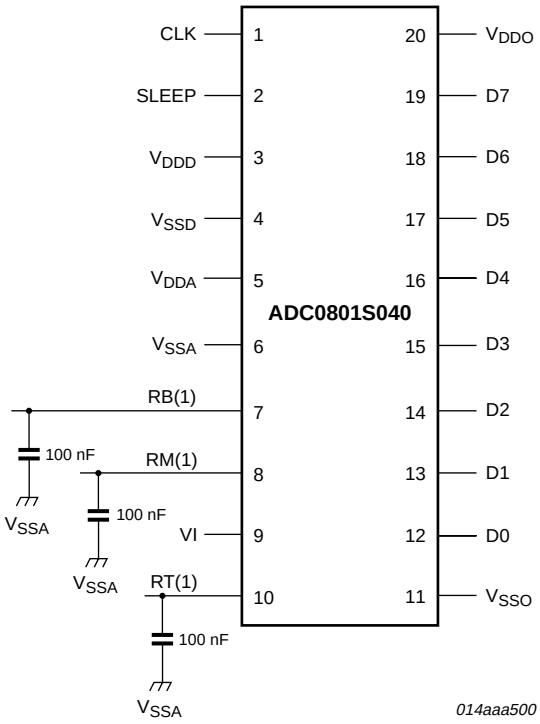
12. Application information

12.1 Application diagrams



The analog and digital supplies should be separated and decoupled.

The external voltage reference generator must be built in such a way 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_{DDA} supply through a resistor bridge and a decoupling capacitor.

(1) RB, RM, RT are decoupled to V_{SSA}.

Fig 15. Application diagram

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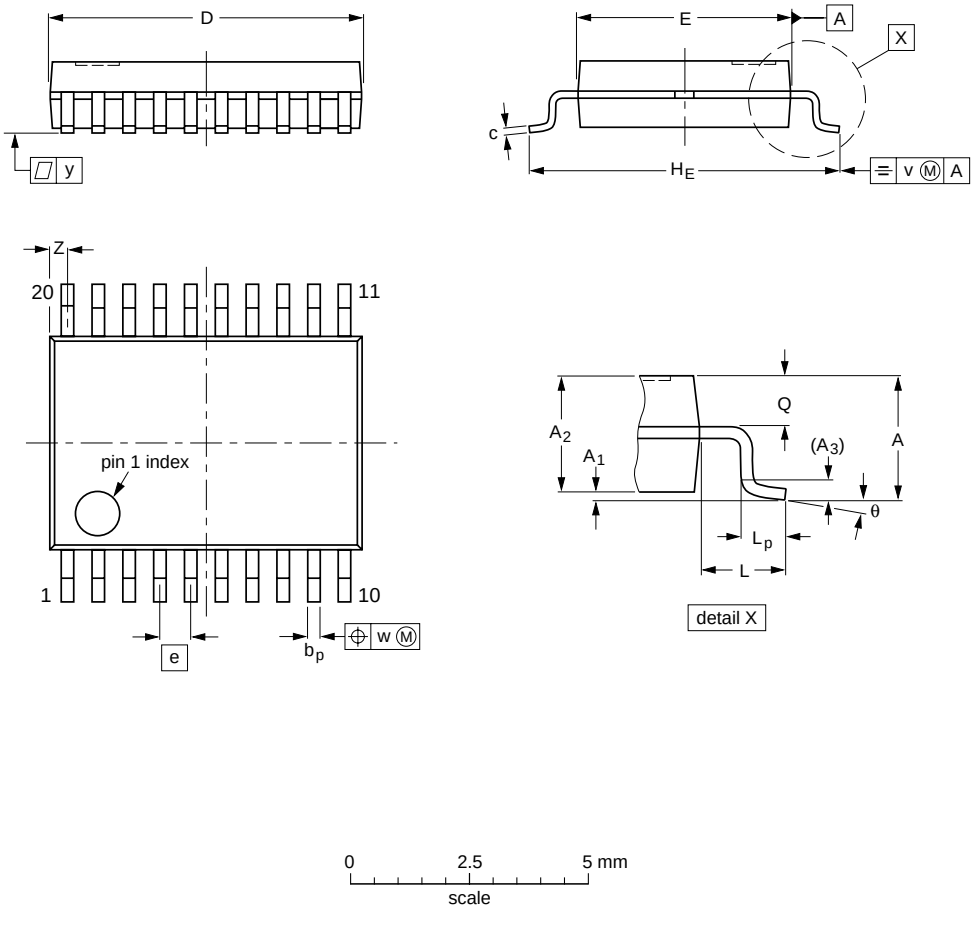
13. Package outline

SSOP20: plastic shrink small outline package; 20 leads; body width 4.4 mm **SOT266-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.5	0.15 0	1.4 1.2	0.25	0.32 0.20	0.20 0.13	6.6 6.4	4.5 4.3	0.65	6.6 6.2	1	0.75 0.45	0.65 0.45	0.2	0.13	0.1	0.48 0.18	10^o 0^o

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	JEITA			
SOT266-1		MO-152				~~99-12-27~~ 03-02-19

Fig 16. Package outline SOT266-1 (SSOP20)

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14. Revision history

Table 9. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
ADC0801S040_2	20080818	Product data sheet	-	ADC0801S040_1
Modifications:	• Corrections made to table notes in Figure 1. • Corrections made to Table 3. • Corrections made to symbol in Table 4. • Corrections made to Table 6. • Corrections made to Figure 13			
ADC0801S040_1	20080612	Product data sheet	-	-

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15.1 Data sheet status

Document status[1][2]	Product status[3]	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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17. Contents

1 General description 1
2 Features 1
3 Applications 1
4 Quick reference data 2
5 Ordering information 2
6 Block diagram 3
7 Pinning information 4
7.1 Pinning 4
7.2 Pin description 4
8 Limiting values 5
9 Thermal characteristics 5
10 Characteristics 5
11 Additional information relating to Table 6 9
12 Application information 15
12.1 Application diagrams 15
13 Package outline 16
14 Revision history 17
15 Legal information 18
15.1 Data sheet status 18
15.2 Definitions 18
15.3 Disclaimers 18
15.4 Trademarks 18
16 Contact information 18
17 Contents 19

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Date of release: 18 August 2008
Document identifier: ADC0801S040_2

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