

# ADC0801S040

Single 8 bits ADC, up to 40 MHz

Rev. 02 — 18 August 2008

Product data sheet

## 1. General description

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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

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- 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  $f_{\text{clk}} = 40$  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

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

**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.

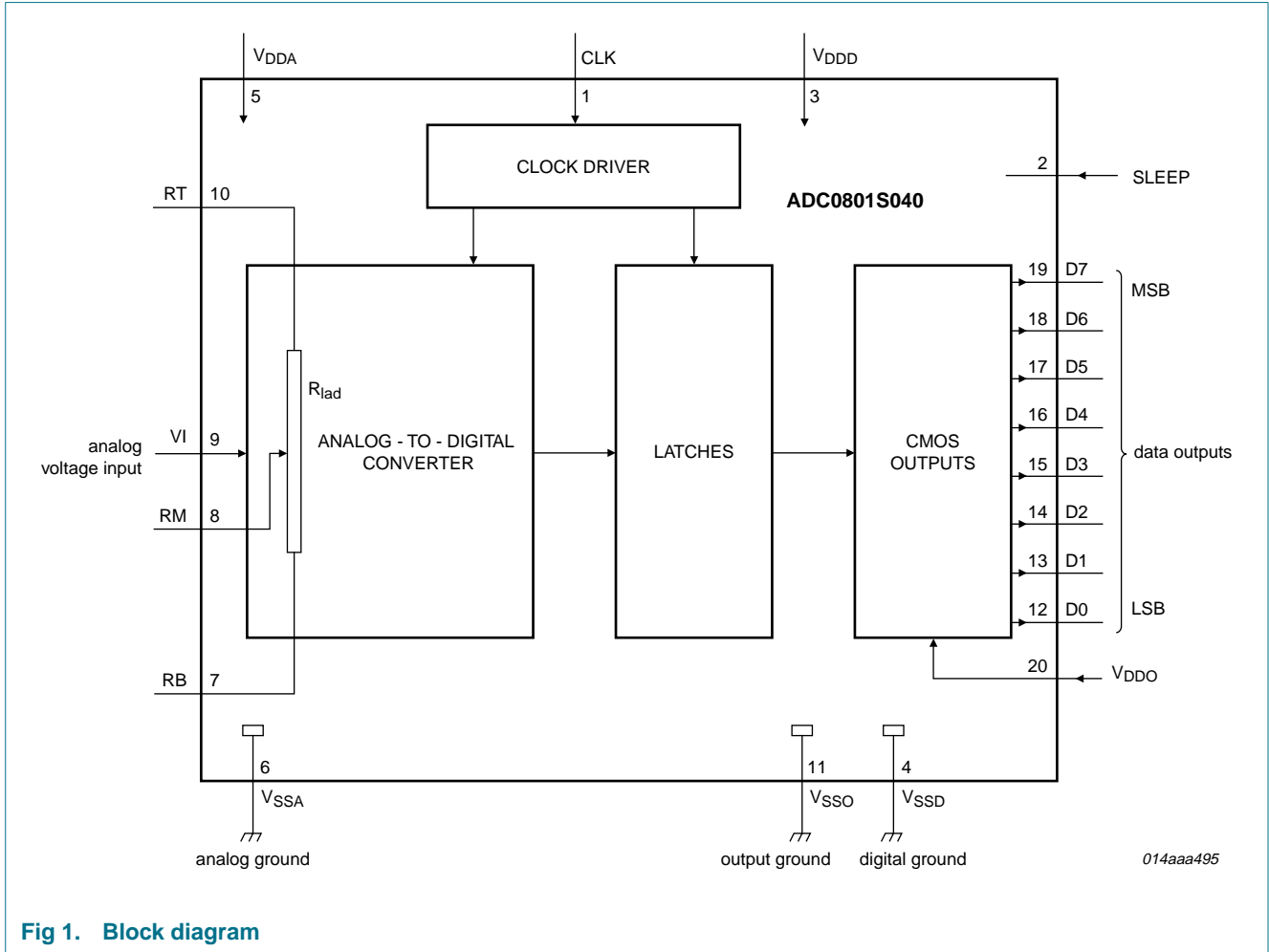
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DDA}$	analog supply voltage		2.7	3.3	5.5	V
$V_{DDD}$	digital supply voltage		2.7	3.3	5.5	V
$V_{DDO}$	output supply voltage		2.5	3.3	5.5	V
$\Delta V_{DD}$	supply voltage difference	$V_{DDA} - V_{DDD}$	-0.2	-	+0.2	V
		$V_{DDD} - V_{DDO}$	-0.2	-	+2.25	V
$I_{DDA}$	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 <a href="#">Figure 6</a>	-	$\pm 0.5$	$\pm 0.75$	LSB
DNL	differential non-linearity	ramp input; see <a href="#">Figure 7</a>	-	$\pm 0.25$	$\pm 0.5$	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		Version
	Name	Description	
ADC0801S040TS	SSOP20	plastic shrink small outline package; 20 leads; body width 4.4 mm	SOT266-1

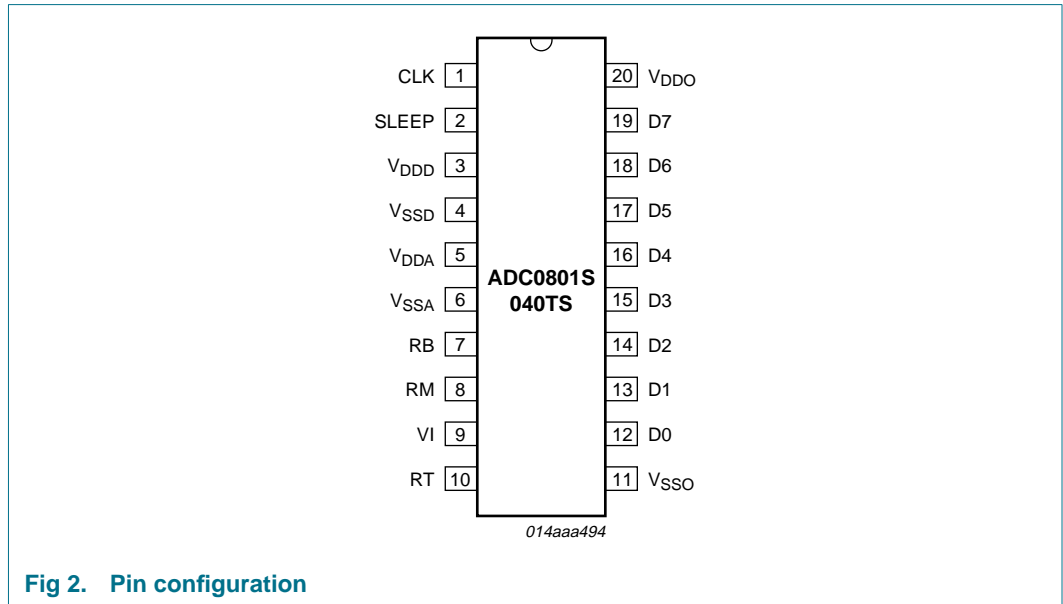
**6. Block diagram**



**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
SLEEP	2	sleep mode input
V <sub>DD</sub>	3	digital supply voltage (2.7 V to 5.5 V)
V <sub>SS</sub>	4	digital ground
V <sub>DDA</sub>	5	analog supply voltage (2.7 V to 5.5 V)
V <sub>SSA</sub>	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 <sub>SSO</sub>	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

**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 <sub>DDO</sub>	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 <sub>DDA</sub>	analog supply voltage		[1] -0.3	+7.0	V
V <sub>DDD</sub>	digital supply voltage		[1] -0.3	+7.0	V
V <sub>DDO</sub>	output supply voltage		[1] -0.3	+7.0	V
ΔV <sub>DD</sub>	supply voltage difference	V <sub>DDA</sub> - V <sub>DDD</sub> ; V <sub>DDD</sub> - V <sub>DDO</sub> ; V <sub>DDA</sub> - V <sub>DDO</sub>	-0.1	+4.0	V
V <sub>I</sub>	input voltage	referenced to V <sub>SSA</sub>	-0.3	+7.0	V
V <sub>i(clk)(p-p)</sub>	peak-to-peak clock input voltage	referenced to V <sub>SSD</sub>	-	V <sub>DDD</sub>	V
I <sub>O</sub>	output current		-	10	mA
T <sub>stg</sub>	storage temperature		-55	+150	°C
T <sub>amb</sub>	ambient temperature		-20	+75	°C
T <sub>j</sub>	junction temperature		-	150	°C

[1] The supply voltages V<sub>DDA</sub>, V<sub>DDD</sub> and V<sub>DDO</sub> may have any value between -0.3 V and +7.0 V provided that the supply voltage ΔV<sub>DD</sub> remains as indicated.

## 9. Thermal characteristics

**Table 5. Thermal characteristics**

Symbol	Parameter	Condition	Value	Unit
R <sub>th(j-a)</sub>	thermal resistance from junction to ambient	in free air	120	K/W

## 10. Characteristics

**Table 6. Characteristics**

V<sub>DDA</sub> = V5 to V6 = 3.3 V; V<sub>DDD</sub> = V3 to V4 = 3.3 V; V<sub>DDO</sub> = V20 to V11 = 3.3 V; V<sub>SSA</sub>, V<sub>SSD</sub> and V<sub>SSO</sub> shorted together; V<sub>i(a)(p-p)</sub> = 1.84 V; C<sub>L</sub> = 20 pF; T<sub>amb</sub> = 0 °C to 70 °C; typical values measured at T<sub>amb</sub> = 25 °C unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Supplies</b>						
V <sub>DDA</sub>	analog supply voltage		2.7	3.3	5.5	V
V <sub>DDD</sub>	digital supply voltage		2.7	3.3	5.5	V
V <sub>DDO</sub>	output supply voltage		2.5	3.3	5.5	V

**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
$\Delta V_{DD}$	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  $V_{SSD}$ )<sup>[1]</sup>**

$V_{IL}$	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	$\mu$ A
$I_{IH}$	HIGH-level input current	$V_{clk} = 0.7 V_{DDD}$	-	-	5	$\mu$ A
$Z_i$	input impedance	$f_{clk} = 40$ MHz	-	4	-	k $\Omega$
$C_i$	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	-	-	$\mu$ A
$I_{IH}$	HIGH-level input current	$V_{IH} = 0.7 V_{DDD}$	-	-	+1	$\mu$ A

**Analog input VI (Referenced to  $V_{SSA}$ )**

$I_{IL}$	LOW-level input current	$V_I = V_{RB}$	-	0	-	$\mu$ A
$I_{IH}$	HIGH-level input current	$V_I = V_{RT}$	-	9	-	$\mu$ A
$Z_i$	input impedance	$f_i = 1$ MHz	-	20	-	k $\Omega$
$C_i$	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	-	k $\Omega$
$TC_{Rlad}$	ladder resistor temperature coefficient		-	4092	-	m $\Omega$ /K
$V_{offset}$	offset voltage	BOTTOM	<sup>[2]</sup> -	170	-	mV
		TOP	<sup>[2]</sup> -	170	-	mV
$V_{i(a)(p-p)}$	peak-to-peak analog input voltage		<sup>[3]</sup> 1.4	1.76	2.4	V

**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;  $T_{amb} = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ; typical values measured at  $T_{amb} = 25^\circ\text{C}$  unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Digital outputs D7 to D0 and IR (Referenced to <math>V_{SSD}</math>)</b>						
$V_{OL}$	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	$\mu\text{A}$
<b>Clock input CLK; see Figure 4[1]</b>						
$f_{clk(max)}$	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
<b>Analog signal processing (<math>f_{clk} = 40</math> MHz)</b>						
<b>Linearity</b>						
INL	integral non-linearity	ramp input; see Figure 6	-	$\pm 0.5$	$\pm 0.75$	LSB
DNL	differential non-linearity	ramp input; see Figure 7	-	$\pm 0.25$	$\pm 0.5$	LSB
<b>Bandwidth</b>						
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; $V_i = \pm 10$ LSB at code 128	-	350	-	MHz
<b>Input set response; see Figure 8[5]</b>						
$t_{s(LH)}$	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
<b>Harmonics; see Figure 9[6]</b>						
THD	total harmonic distortion	$f_i = 4.43$ MHz	-	-50	-	dB
<b>Signal-to-Noise ratio; see Figure 9[6]</b>						
S/N	signal-to-noise ratio	without harmonics; $f_i = 4.43$ MHz	-	47	-	dB
<b>Effective bits; see Figure 9[6]</b>						
ENOB	effective number of bits	$f_i = 300$ MHz	-	7.8	-	bits
		$f_i = 4.43$ MHz	-	7.3	-	bits
<b>Differential gain[7]</b>						
$G_{dif}$	differential gain	PAL modulated ramp	-	1.5	-	%

**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
<b>Differential phase</b> <sup>[7]</sup>						
$\phi_{dif}$	differential phase	PAL modulated ramp	-	0.25	-	deg
<b>Timing (<math>f_{clk} = 40</math> MHz; <math>C_L = 20</math> pF); see Figure 4<sup>[8]</sup></b>						
$t_{d(s)}$	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
<b>3-state output delay times; see Figure 5</b>						
$t_{dHZ}$	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:  $S/N = ENOB \times 6.02 + 1.76$  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  $t_{d(o)}$ .



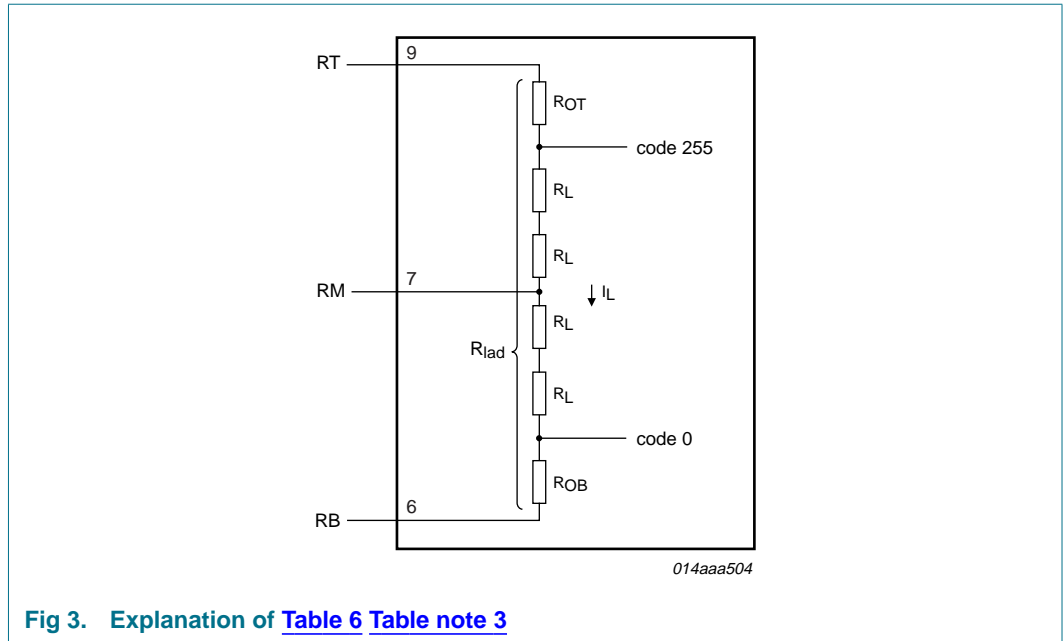


Fig 3. Explanation of [Table 6 Table note 3](#)

## 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

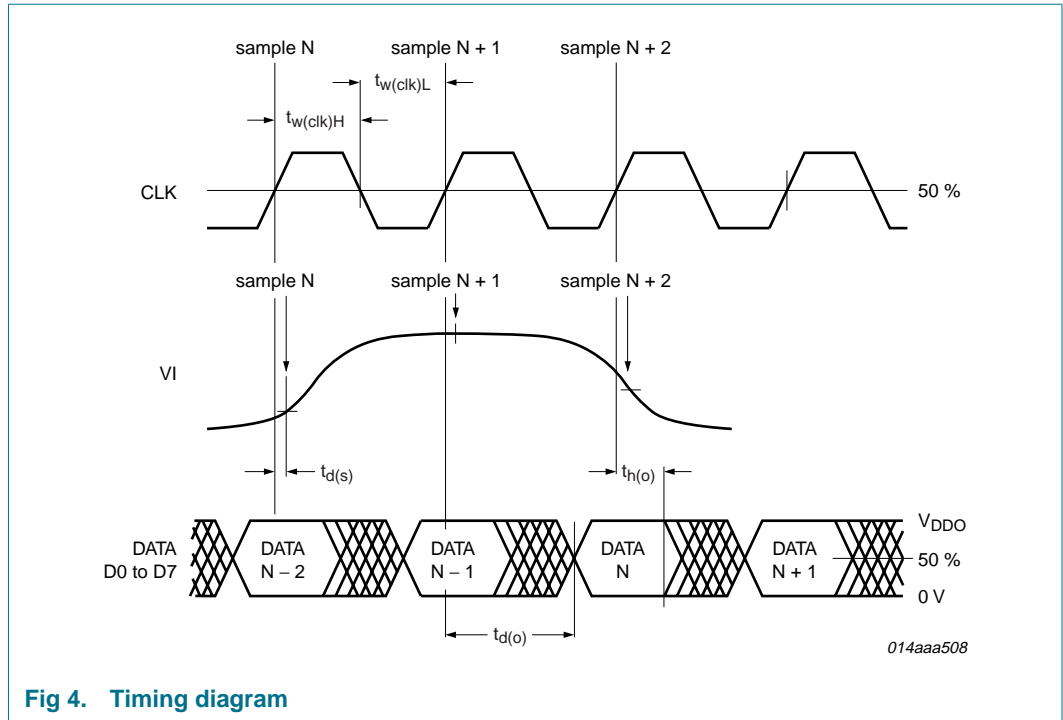
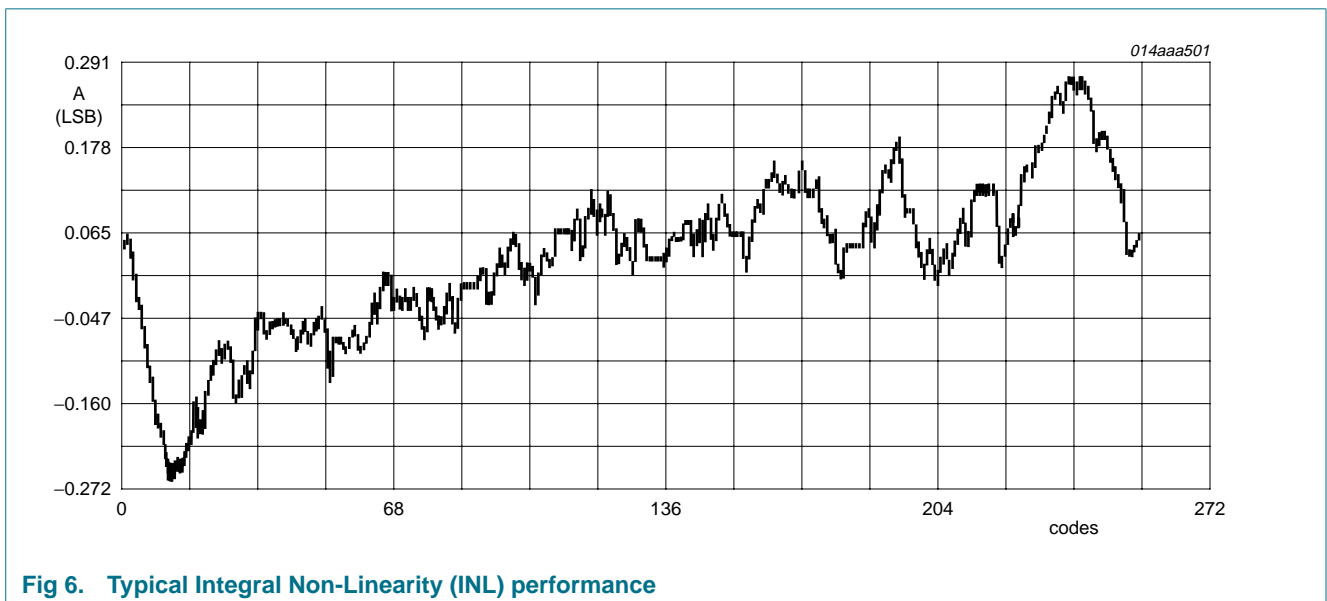
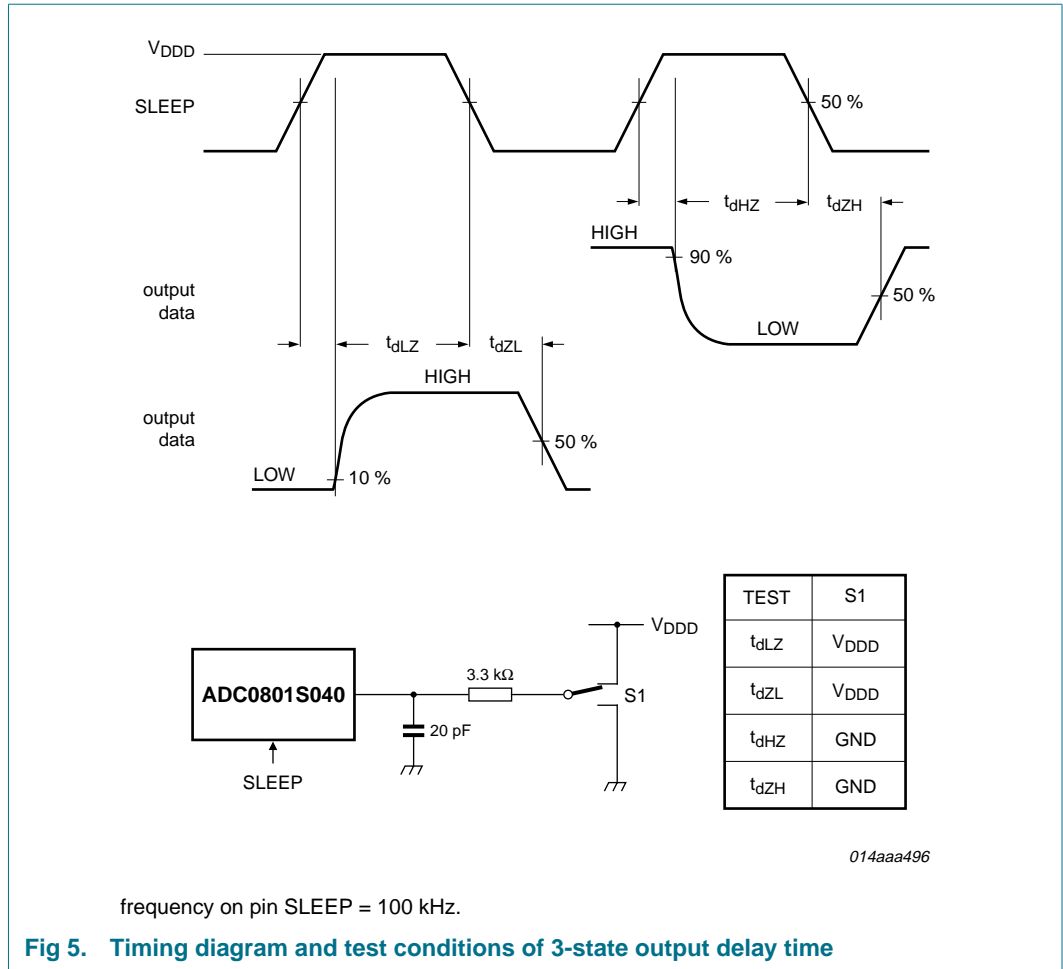


Fig 4. Timing diagram



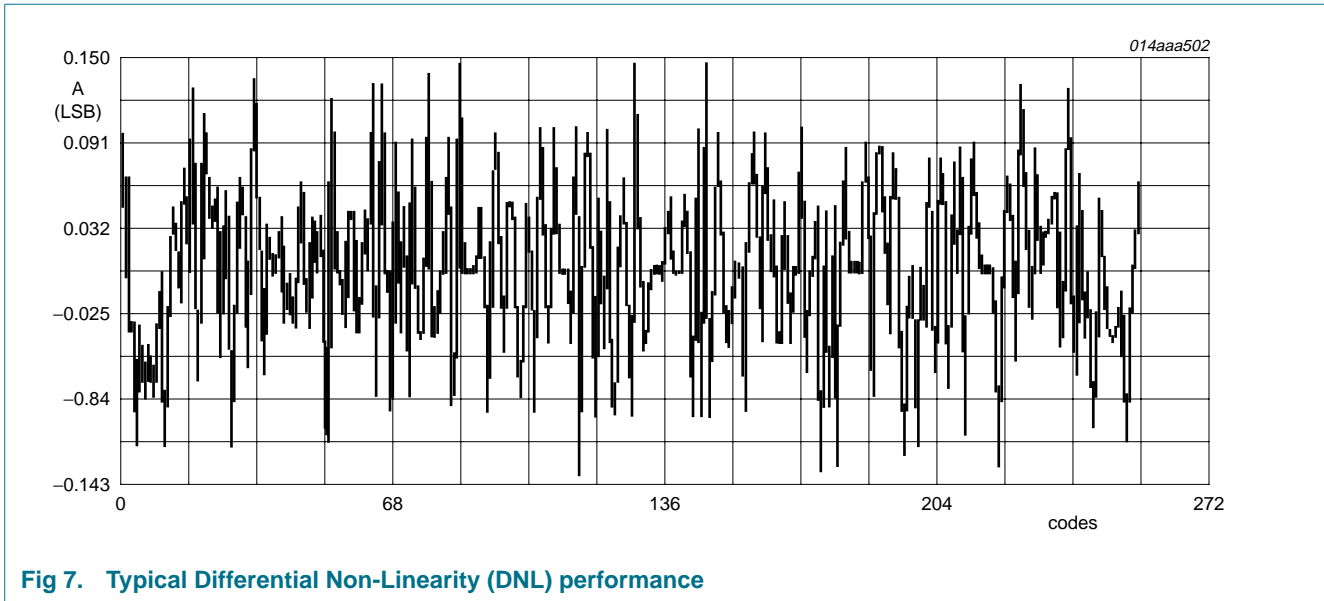


Fig 7. Typical Differential Non-Linearity (DNL) performance

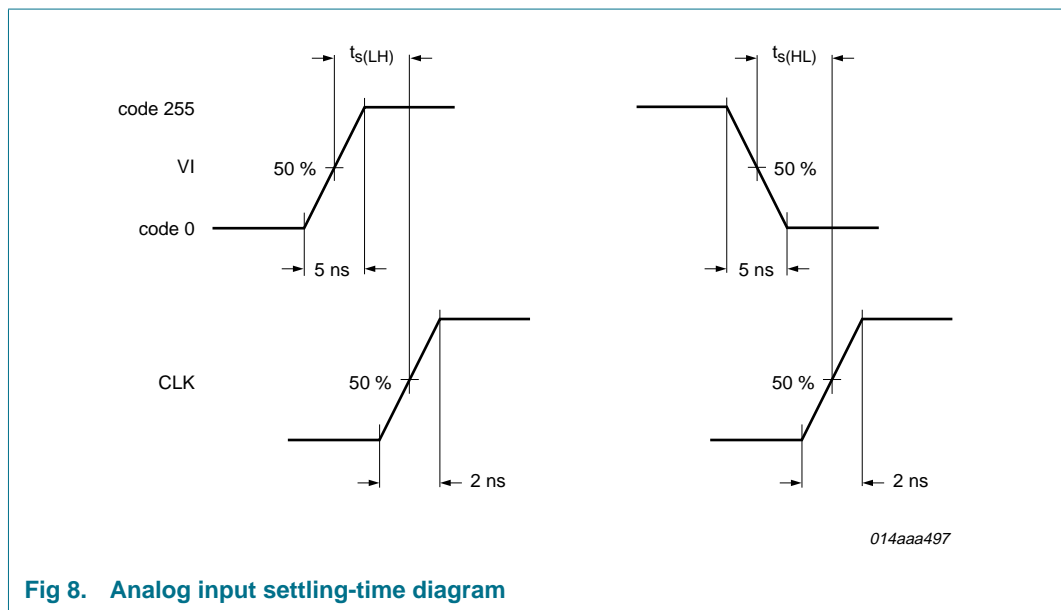
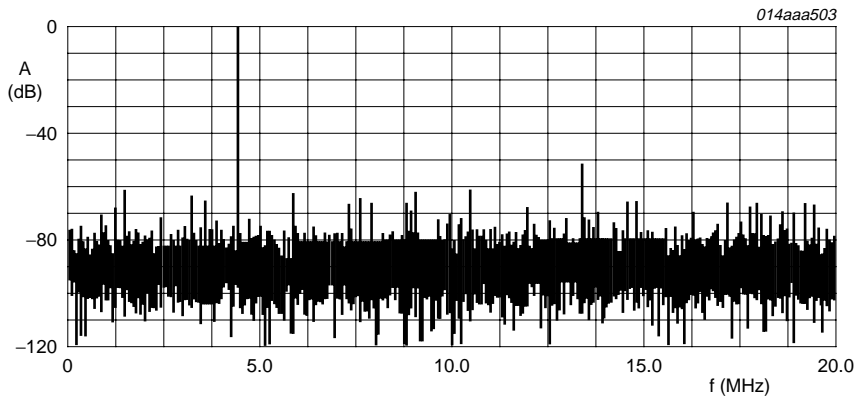


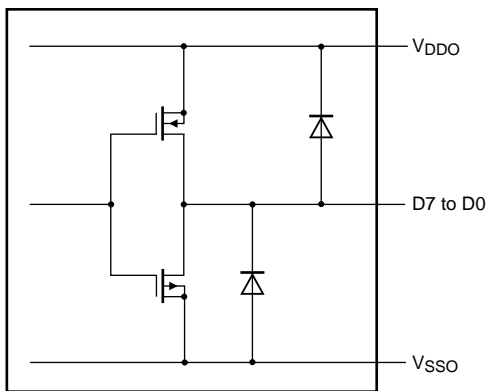
Fig 8. Analog input settling-time diagram



Effective bits: 7.32; THD = -51.08 dB.

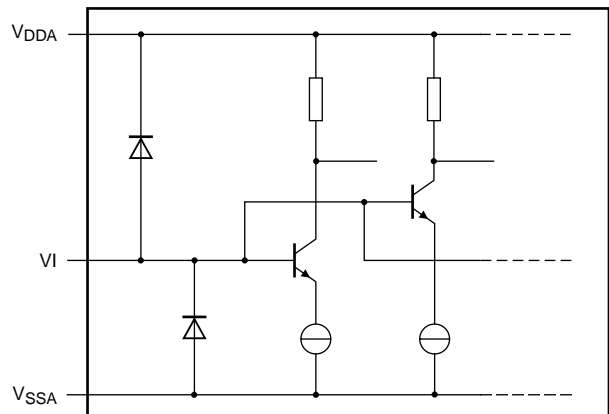
Harmonic levels (dB): 2nd = -68.99; 3rd = -51.62; 4th = -66.05; 5th = -63.23; 6th = -72.79.

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



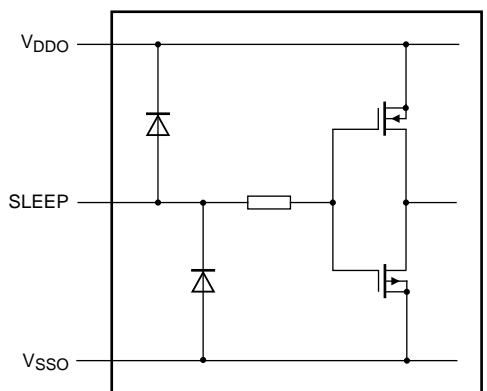
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Fig 10. CMOS data outputs



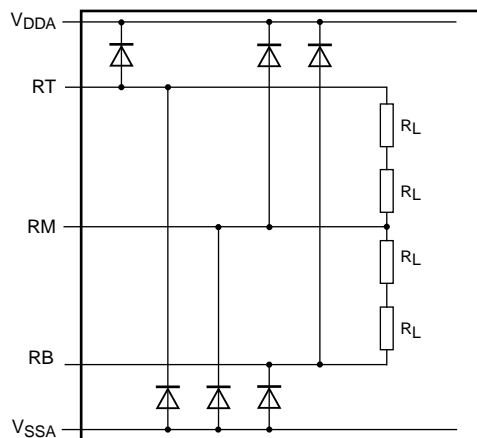
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Fig 11. VI analog input



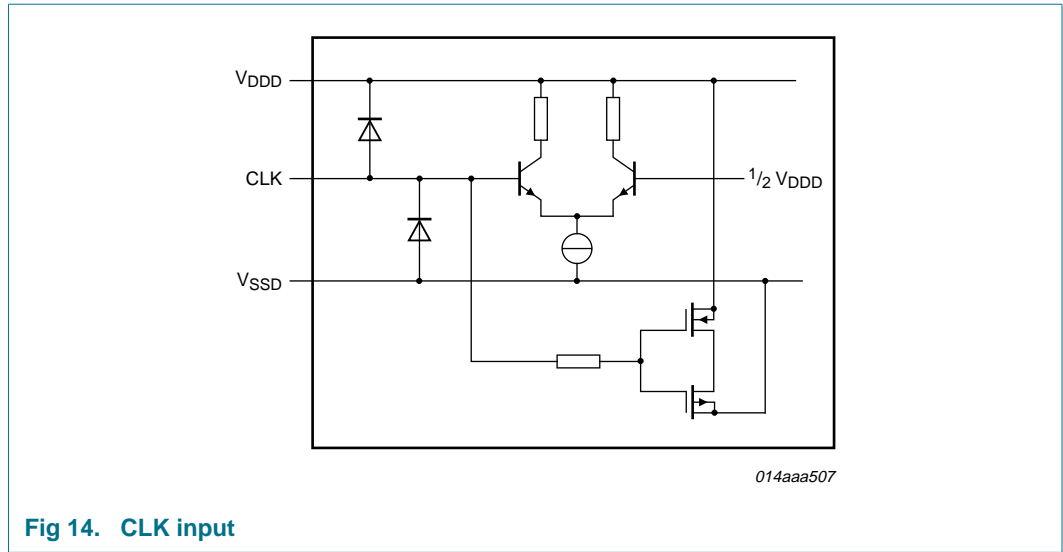
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Fig 12. SLEEP 3-state input



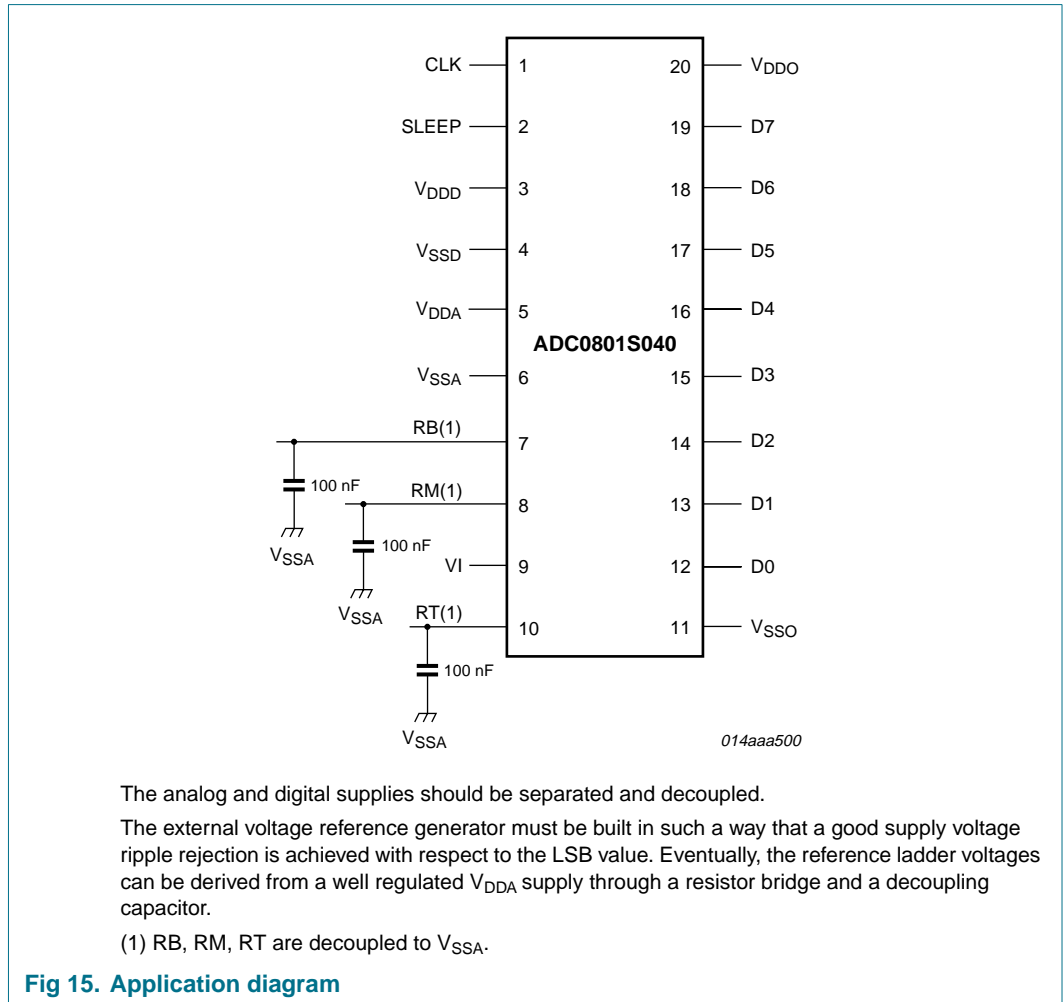
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Fig 13. RB, RM and RT inputs



**12. Application information**

**12.1 Application diagrams**



**Fig 15. Application diagram**

13. Package outline

SSOP20: plastic shrink small outline package; 20 leads; body width 4.4 mm

SOT266-1

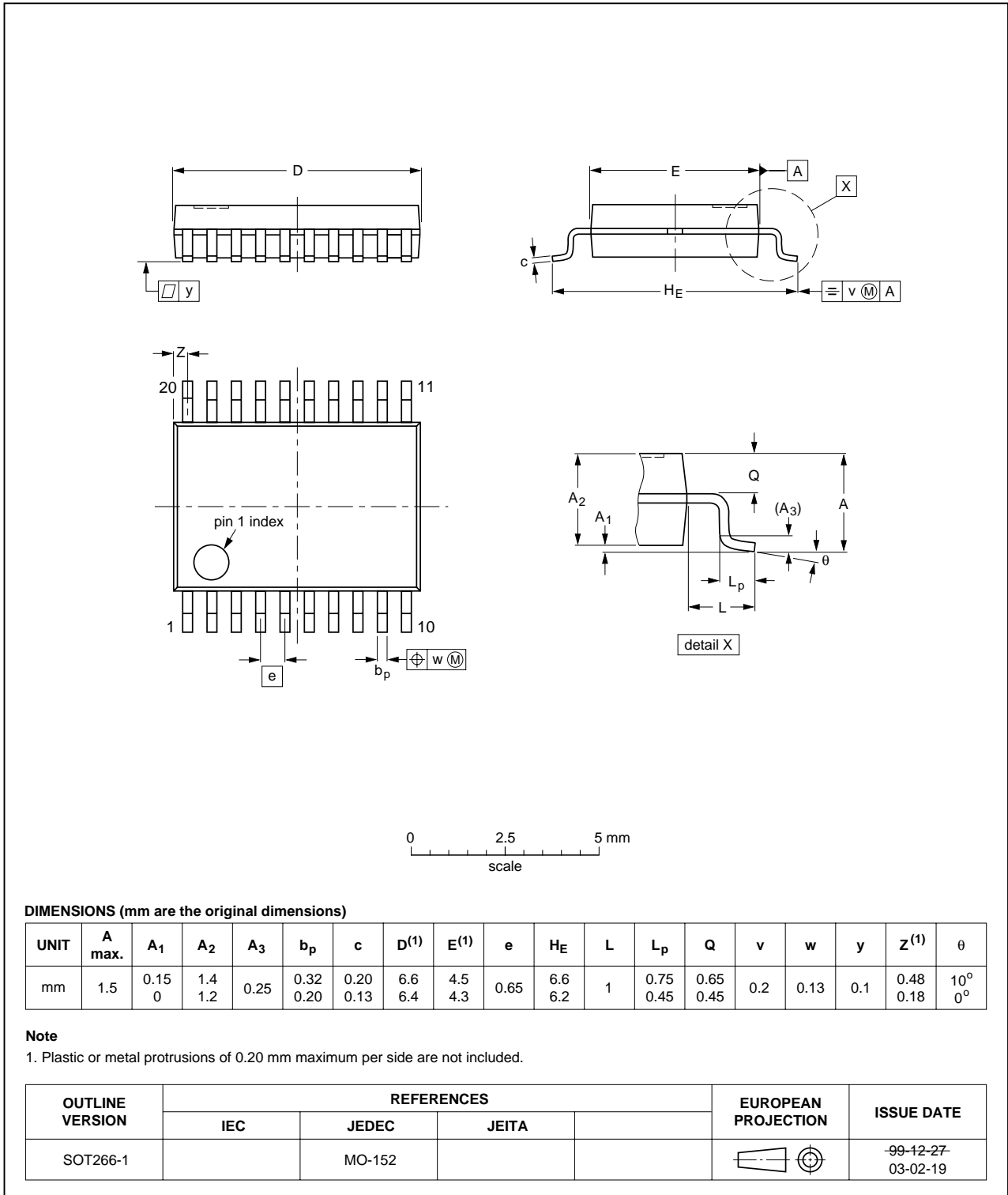


Fig 16. Package outline SOT266-1 (SSOP20)



## 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:		<ul style="list-style-type: none"><li>• Corrections made to table notes in <a href="#">Figure 1</a>.</li><li>• Corrections made to <a href="#">Table 3</a>.</li><li>• Corrections made to symbol in <a href="#">Table 4</a>.</li><li>• Corrections made to <a href="#">Table 6</a>.</li><li>• Corrections made to <a href="#">Figure 13</a></li></ul>		
ADC0801S040_1	20080612	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>.

### 15.2 Definitions

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