

# 74LVC86A

## Quad 2-input EXCLUSIVE-OR gate

Rev. 05.00 — 15 May 2006

Product data sheet

### 1. General description

The 74LVC86A provides four 2-input EXCLUSIVE-OR functions. It is a high-performance, low power, low-voltage, Si-gate CMOS device and superior to most advanced CMOS compatible TTL families.

Inputs can be driven from either 3.3 V or 5 V devices. This feature allows the use of these devices as translators in mixed 3.3 V and 5 V applications.

### 2. Features

- 5 V tolerant inputs for interlacing with 5 V logic
- Supply voltage range from 1.2 V to 3.6 V
- CMOS low power consumption
- Direct interface with TTL levels
- Complies with JEDEC standard JESD8-B / JESD36
- ESD protection:
  - ◆ HBM JESD22-A114-C exceeds 2000 V
  - ◆ CDM JESD22-C101-C exceeds 1000 V
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and  $-40\text{ }^{\circ}\text{C}$  to  $125\text{ }^{\circ}\text{C}$

### 3. Ordering information

Table 1: Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74LVC86AD	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74LVC86ADB	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SSOP14	plastic shrink small outline package; 14 leads; body width 5.3 mm	SOT337-1
74LVC86APW	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74LVC86ABQ	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	DHVQFN14	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body $2.5 \times 3 \times 0.85\text{ mm}$	SOT762-1

## 4. Functional diagram

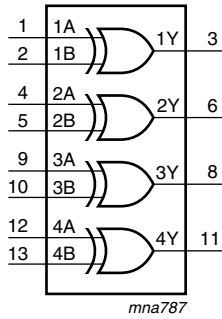


Fig 1. Logic diagram

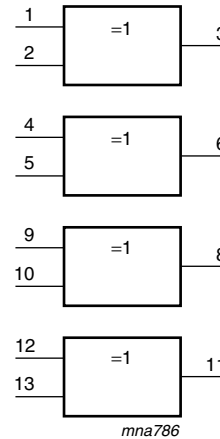


Fig 2. IEC logic symbol

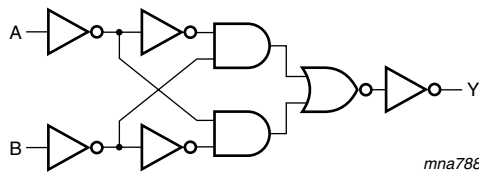


Fig 3. Logic diagram for one gate

## 5. Pinning information

### 5.1 Pinning

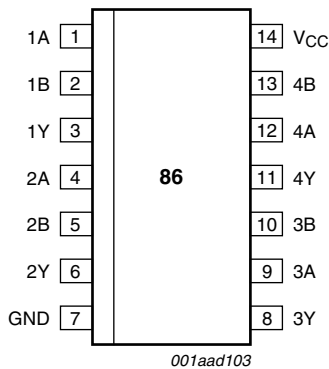
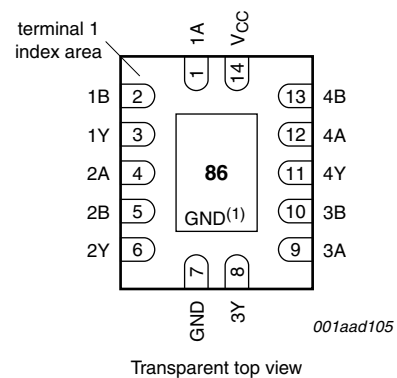


Fig 4. Pin configuration for SO14 and (T)SSOP14



- (1) The die substrate is attached to this pad using conductive die attach material. It can not be used as a supply pin or input.

Fig 5. Pin configuration for DHVQFN14

## 5.2 Pin description

**Table 2:** Pin description

Symbol	Pin	Description
1A	1	data input
1B	2	data input
1Y	3	data output
2A	4	data input
2B	5	data input
2Y	6	data output
GND	7	ground (0 V)
3Y	8	data output
3A	9	data input
3B	10	data input
4Y	11	data output
4A	12	data input
4B	13	data input
V <sub>CC</sub>	14	supply voltage

## 6. Functional description

**Table 3:** Functional table<sup>[1]</sup>

Input		Output
nA	nB	nY
L	L	L
L	H	H
H	L	H
H	H	L

[1] H = HIGH voltage level  
L = LOW voltage level.

## 7. Limiting values

**Table 4: Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC}$	supply voltage		-0.5	+6.5	V
$I_{IK}$	input clamping current	$V_I < 0$	-	-50	mA
$V_I$	input voltage		[1] -0.5	+6.5	V
$I_{OK}$	output clamping current	$V_O > V_{CC}$ or $V_O < 0$	-	$\pm 50$	mA
$V_O$	output voltage		[1] -0.5	$V_{CC} + 0.5$	V
$I_O$	output current	$V_O = 0$ to $V_{CC}$	-	$\pm 50$	mA
$I_{CC}$	supply current		-	+100	mA
$I_{GND}$	ground current		-	-100	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +125 °C	[2] -	500	mW

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] For SO14 packages: above 70 °C the value of  $P_{tot}$  derates linearly with 8 mW/K.

For (T)SSOP14 packages: above 60 °C the value of  $P_{tot}$  derates linearly with 5.5 mW/K.

For DHVQFN14 packages: above 60 °C the value of  $P_{tot}$  derates linearly with 4.5 mW/K.

## 8. Recommended operating conditions

**Table 5: Recommended operating conditions**

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage		1.2	-	3.6	V
$V_I$	input voltage		0	-	5.5	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature	in free air	-40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 1.65$ V to 2.7 V	0	-	20	ns/V
		$V_{CC} = 2.7$ V to 3.6 V	0	-	10	ns/V

## 9. Static characteristics

**Table 6: Static characteristics**

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Typ <sup>[1]</sup>	Max	Unit
<b><math>T_{amb} = -40\text{ °C to }+85\text{ °C}</math></b>						
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 1.2\text{ V}$	1.08	-	-	V
		$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	$0.65 \times V_{CC}$	-	-	V
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	1.7	-	-	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	2.0	-	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 1.2\text{ V}$	-	-	0.12	V
		$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	-	-	$0.35 \times V_{CC}$	V
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	-	-	0.7	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	-	0.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$				
		$I_O = -100\text{ }\mu\text{A}; V_{CC} = 1.65\text{ V to }3.6\text{ V}$	$V_{CC} - 0.2$	-	-	V
		$I_O = -4\text{ mA}; V_{CC} = 1.65\text{ V}$	$V_{CC} - 0.45$	-	-	V
		$I_O = -8\text{ mA}; V_{CC} = 2.3\text{ V}$	$V_{CC} - 0.5$	-	-	V
		$I_O = -12\text{ mA}; V_{CC} = 2.7\text{ V}$	$V_{CC} - 0.5$	-	-	V
		$I_O = -18\text{ mA}; V_{CC} = 3.0\text{ V}$	$V_{CC} - 0.6$	-	-	V
		$I_O = -24\text{ mA}; V_{CC} = 3.0\text{ V}$	$V_{CC} - 0.8$	-	-	V
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$				
		$I_O = 100\text{ }\mu\text{A}; V_{CC} = 1.65\text{ V to }3.6\text{ V}$	-	-	0.2	V
		$I_O = 4\text{ mA}; V_{CC} = 1.65\text{ V}$	-	-	0.45	V
		$I_O = 8\text{ mA}; V_{CC} = 2.3\text{ V}$	-	-	0.6	V
		$I_O = 12\text{ mA}; V_{CC} = 2.7\text{ V}$	-	-	0.4	V
		$I_O = 24\text{ mA}; V_{CC} = 3.0\text{ V}$	-	-	0.55	V
$I_I$	input leakage current	$V_{CC} = 3.6\text{ V}; V_I = 5.5\text{ V}$ or GND	-	$\pm 0.1$	$\pm 5$	$\mu\text{A}$
$I_{CC}$	supply current	$V_{CC} = 3.6\text{ V}; V_I = V_{CC}$ or GND; $I_O = 0$	-	0.1	10	$\mu\text{A}$
$\Delta I_{CC}$	additional supply current per input pin	$V_{CC} = 2.7\text{ V to }3.6\text{ V}; V_I = V_{CC} - 0.6\text{ V}; I_O = 0$	-	5	500	$\mu\text{A}$
$C_I$	input capacitance	$V_{CC} = 0\text{ V to }3.6\text{ V}; V_I = \text{GND to }V_{CC}$	-	5.0	-	pF
<b><math>T_{amb} = -40\text{ °C to }+125\text{ °C}</math></b>						
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 1.2\text{ V}$	1.08	-	-	V
		$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	$0.65 \times V_{CC}$	-	-	V
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	1.7	-	-	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	2.0	-	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 1.2\text{ V}$	-	-	0.12	V
		$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	-	-	$0.35 \times V_{CC}$	V
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	-	-	0.7	V
		$V_{CC} = 2.7\text{ V to }3.6\text{ V}$	-	-	0.8	V

**Table 6:** Static characteristics ...continued

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Typ <sup>[1]</sup>	Max	Unit
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = -100 μA; V <sub>CC</sub> = 1.65 V to 3.6 V	V <sub>CC</sub> - 0.3	-	-	V
		I <sub>O</sub> = -4 mA; V <sub>CC</sub> = 1.65 V	V <sub>CC</sub> - 0.6	-	-	V
		I <sub>O</sub> = -8 mA; V <sub>CC</sub> = 2.3 V	V <sub>CC</sub> - 0.65	-	-	V
		I <sub>O</sub> = -12 mA; V <sub>CC</sub> = 2.7 V	V <sub>CC</sub> - 0.65	-	-	V
		I <sub>O</sub> = -18 mA; V <sub>CC</sub> = 3.0 V	V <sub>CC</sub> - 0.75	-	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>				
		I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 1.65 V to 3.6 V	-	-	0.3	V
		I <sub>O</sub> = 4 mA; V <sub>CC</sub> = 1.65 V	-	-	0.65	V
		I <sub>O</sub> = 8 mA; V <sub>CC</sub> = 2.3 V	-	-	0.8	V
		I <sub>O</sub> = 12 mA; V <sub>CC</sub> = 2.7 V	-	-	0.6	V
I <sub>I</sub>	input leakage current	V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = 5.5 V or GND	-	-	±20	μA
		I <sub>O</sub> = 0	-	-	40	μA
I <sub>CC</sub>	supply current	V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0	-	-	40	μA
ΔI <sub>CC</sub>	additional supply current per input pin	V <sub>CC</sub> = 2.7 V to 3.6 V; V <sub>I</sub> = V <sub>CC</sub> - 0.6 V; I <sub>O</sub> = 0	-	-	5000	μA

[1] All typical values are measured at V<sub>CC</sub> = 3.3 V (unless stated otherwise) and T<sub>amb</sub> = 25 °C.

## 10. Dynamic characteristics

**Table 7:** Dynamic characteristicsVoltages are referenced to GND (ground = 0 V). For test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	Min	Typ <sup>[1]</sup>	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +85 °C</b>						
t <sub>PHL</sub> , t <sub>PLH</sub>	HIGH to LOW, LOW to HIGH propagation delay nA, nB to nY	see <a href="#">Figure 6</a>				
		V <sub>CC</sub> = 1.2 V	-	11.0	-	ns
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.5	4.1	9.0	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.9	2.4	5.1	ns
		V <sub>CC</sub> = 2.7 V	1.0	2.5	5.5	ns
t <sub>sk(o)</sub>	output skew time	V <sub>CC</sub> = 3.0 V to 3.6 V	<sup>[2]</sup> -	-	1.0	ns
<b>T<sub>amb</sub> = -40 °C to +125 °C</b>						
t <sub>PHL</sub> , t <sub>PLH</sub>	HIGH to LOW, LOW to HIGH propagation delay nA, nB to nY	see <a href="#">Figure 6</a>				
		V <sub>CC</sub> = 1.2 V	-	-	-	ns
		V <sub>CC</sub> = 1.65 V	0.5	-	11.5	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.9	-	6.5	ns
		V <sub>CC</sub> = 2.7 V	1.0	-	7.0	ns
t <sub>sk(o)</sub>	output skew time	V <sub>CC</sub> = 3.0 V to 3.6 V	<sup>[2]</sup> -	-	1.5	ns

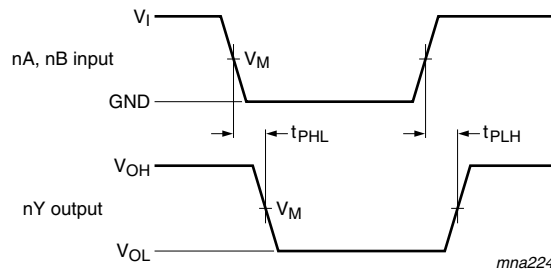
**Table 7: Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	Min	Typ <sup>[1]</sup>	Max	Unit
<b>T<sub>amb</sub> = 25 °C</b>						
C <sub>PD</sub>	power dissipation capacitance per gate.	V <sub>I</sub> = GND to V <sub>CC</sub>		<sup>[3]</sup>		
		V <sub>CC</sub> = 1.65 V to 1.95 V	-	13	-	pF
		V <sub>CC</sub> = 2.3 V to 2.7 V	-	16	-	pF
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	20	-	pF

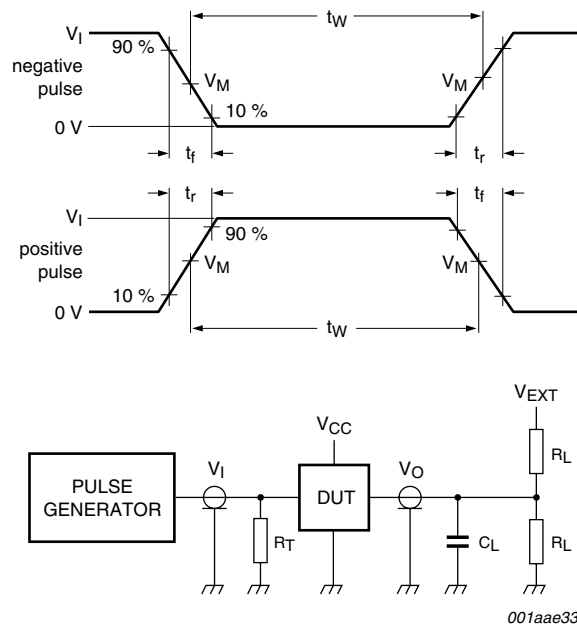
- [1] Typical values are measured at T<sub>amb</sub> = 25 °C and V<sub>CC</sub> = 1.8 V, 2.5 V, 2.7 V, and 3.3 V respectively.
- [2] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.
- [3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$  where:  
 f<sub>i</sub> = input frequency in MHz,  
 f<sub>o</sub> = output frequency in MHz,  
 C<sub>L</sub> = output load capacitance in pF,  
 V<sub>CC</sub> = supply voltage in Volts,  
 N = number of inputs switching,  
 Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of the outputs.

## 11. AC waveforms



V<sub>M</sub> = 1.5 V at V<sub>CC</sub> ≥ 2.7 V;  
 V<sub>M</sub> = 0.5 × V<sub>CC</sub> at V<sub>CC</sub> < 2.7 V;  
 V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage drops that occur with the output load.

**Fig 6. The inputs nA and nB to output nY propagation delay**



001aae331

Test data is given in [Table 8](#).

Definitions for test circuit:

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

$R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

$V_{EXT}$  = External voltage for measuring switching times.

**Fig 7. Load circuitry for switching times**

**Table 8: Test data**

Supply voltage	Input		Load		$V_{EXT}$		
	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PLH}, t_{PHL}$	$t_{PLZ}, t_{PZL}$	$t_{PHZ}, t_{PZH}$
1.65 V to 1.95 V	$V_{CC}$	$\leq 2$ ns	30 pF	1 k $\Omega$	open	$2 \times V_{CC}$	GND
2.3 V to 2.7 V	$V_{CC}$	$\leq 2$ ns	30 pF	500 $\Omega$	open	$2 \times V_{CC}$	GND
2.7 V	2.7 V	$\leq 2.5$ ns	50 pF	500 $\Omega$	open	6 V	GND
3.0 V to 3.6 V	2.7 V	$\leq 2.5$ ns	50 pF	500 $\Omega$	open	6 V	GND

12. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1

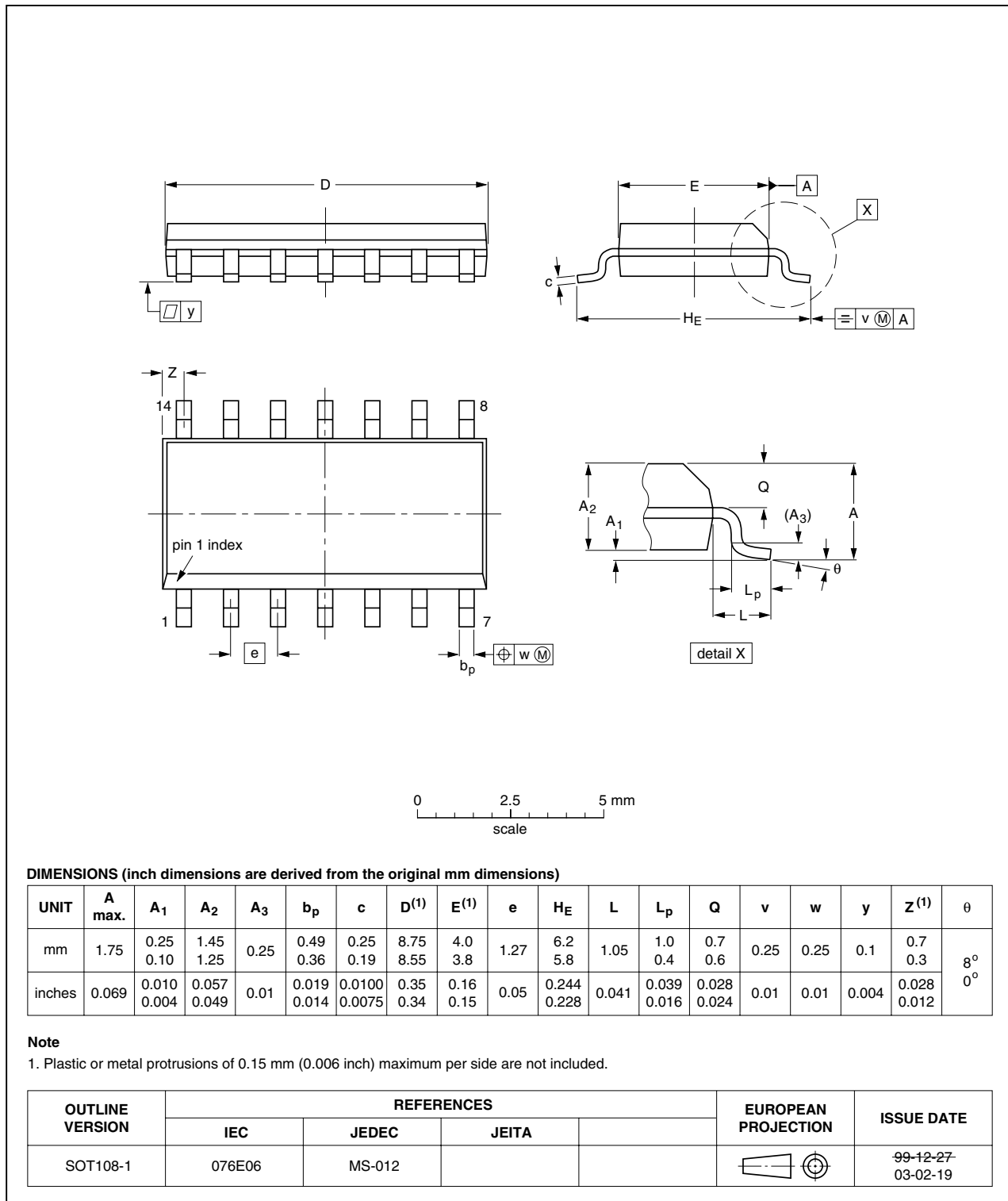


Fig 8. Package outline SOT108-1 (SO14)

SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm

SOT337-1

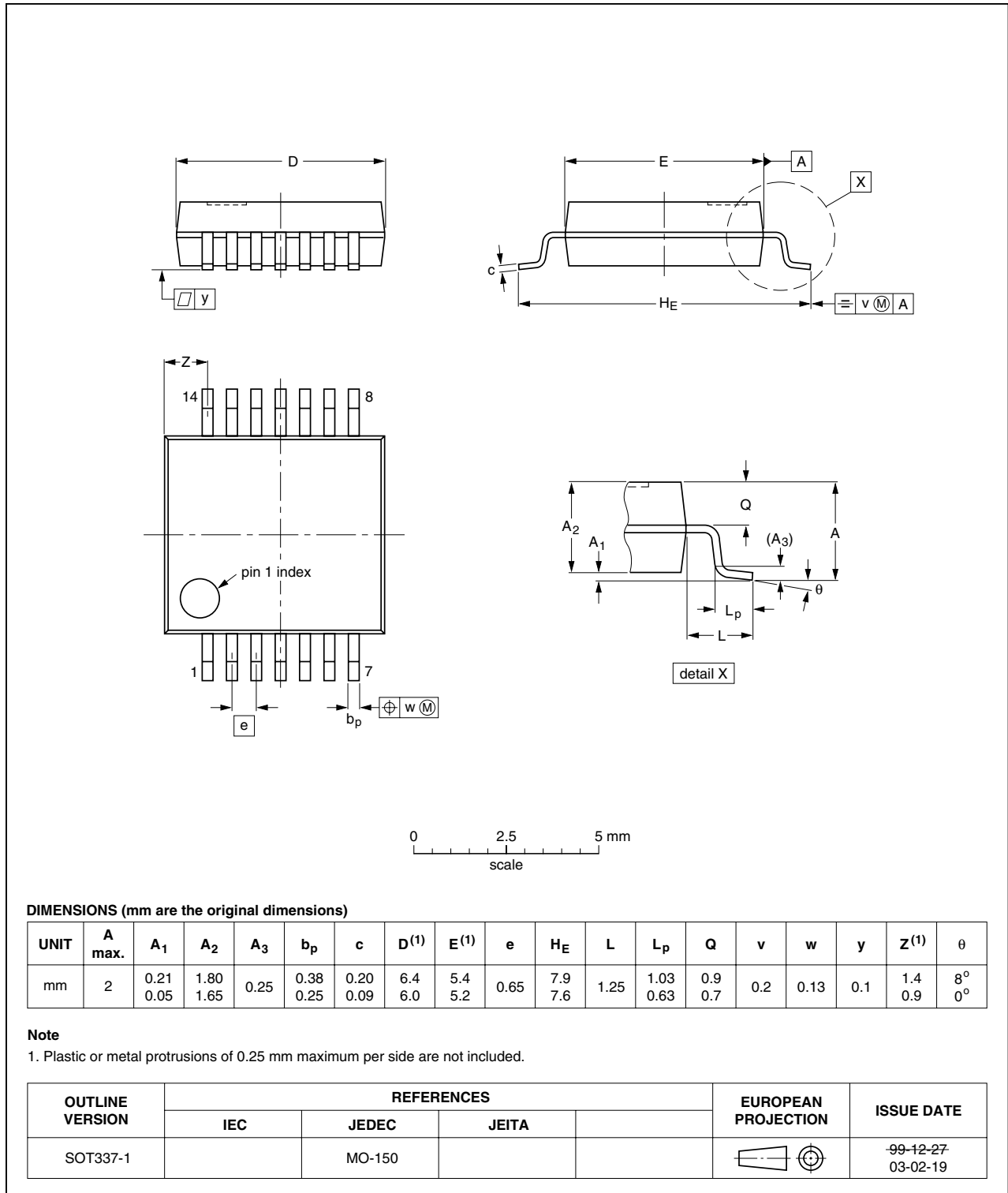


Fig 9. Package outline SOT337-1 (SSOP14)

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1

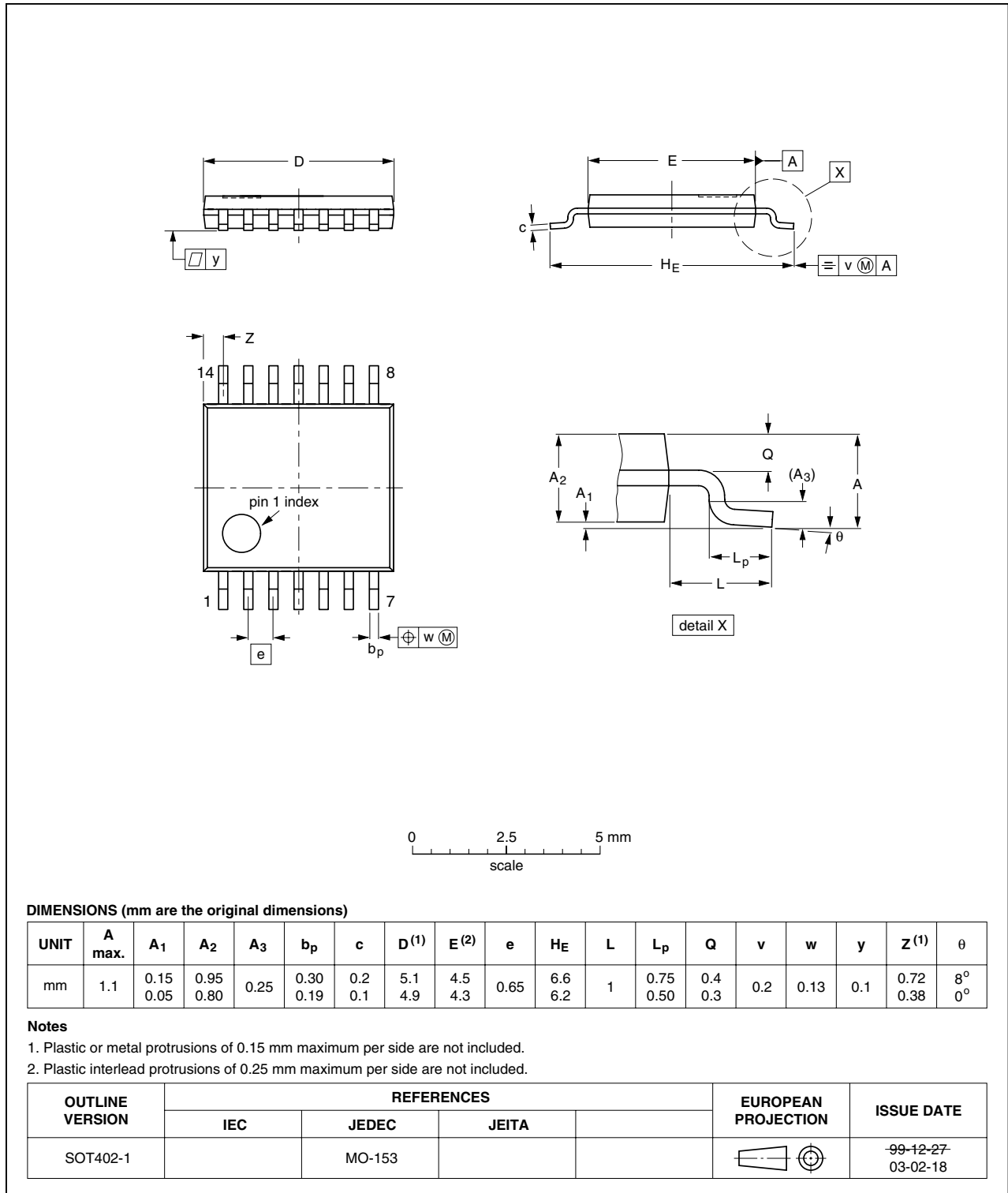


Fig 10. Package outline SOT402-1 (TSSOP14)

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1

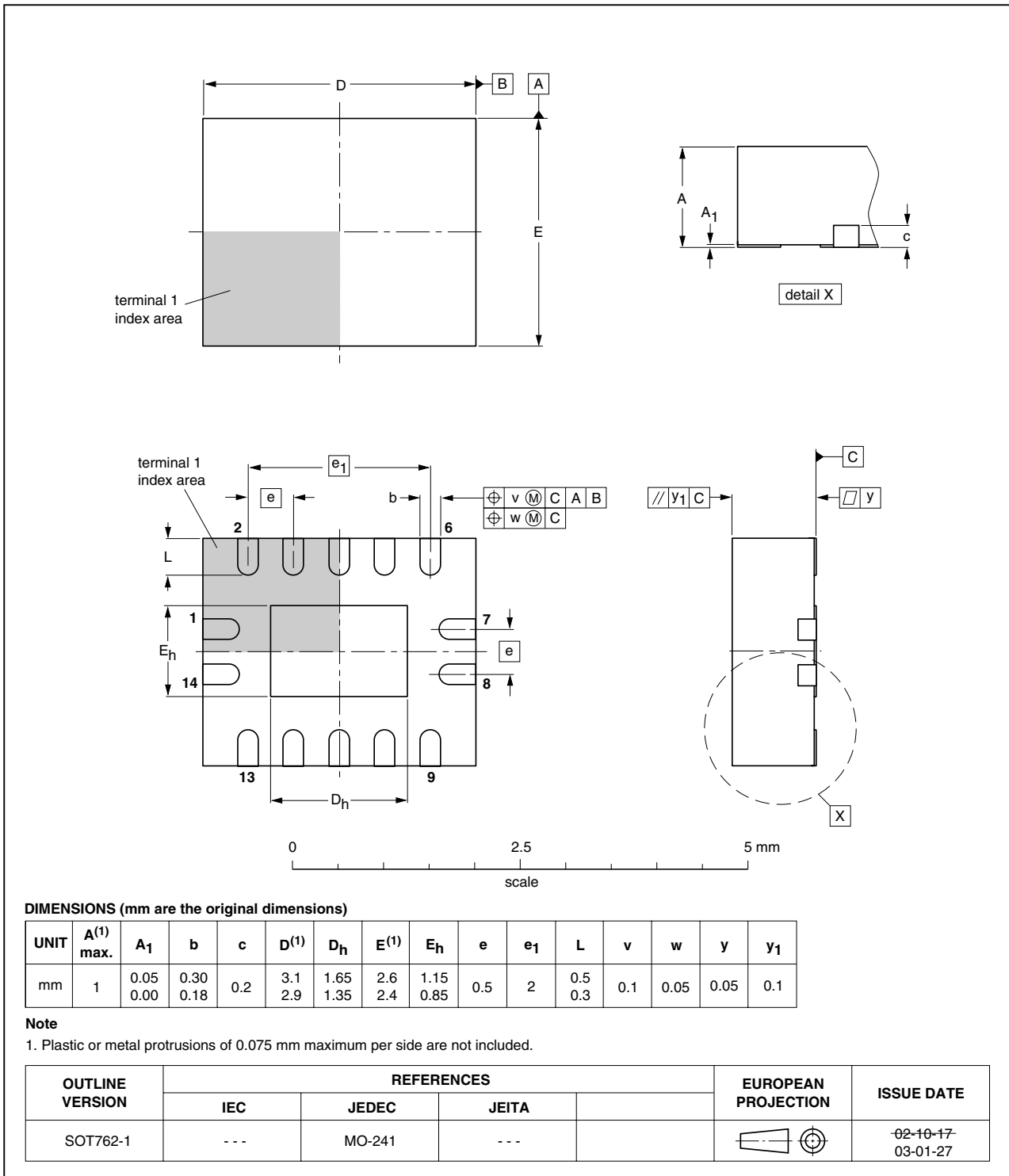


Fig 11. Package outline SOT762-1 (DHVQFN14)

## 13. Abbreviations

**Table 9. Abbreviations**

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
TTL	Transistor Transistor Logic

## 14. Revision history

**Table 10. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
74LVC86A_5	<tbd>	Product data sheet	-	74LVC86A_4
Modifications:	<ul style="list-style-type: none"> <li>The format of this data sheet is redesigned to comply with the current presentation and information standard of Philips Semiconductors.</li> <li><a href="#">Table 4</a>, <a href="#">Table 5</a>, <a href="#">Table 6</a>, <a href="#">Table 7</a> and <a href="#">Table 8</a>: values added for lower voltage ranges.</li> </ul>			
74LVC86A_4 (9397 750 129666)	20040304	Product specification	-	74LVC86A_3
74LVC86A_3 (9397 750 10503)	20031111	Product specification	-	74LVC86A_2
74LVC86A_2 (9397 750 04488)	19980428	Product specification	-	74LVC86A_1
74LVC86A_1	-	-	-	-

## 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.semiconductors.philips.com>.

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Date of release: 15 May 2006

Document identifier: 74LVC86A\_5