

# 74HC4049

Hex inverting HIGH-to-LOW level shifter

Rev. 6 — 8 January 2013

Product data sheet

## 1. General description

The 74HC4049 is a hex inverter with over-voltage tolerant inputs. Inputs are overvoltage tolerant to 15 V. This enables the device to be used in HIGH-to-LOW level shifting applications.

## 2. Features and benefits

- Low-power dissipation
- Complies with JEDEC standard no. 7A
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2 000 V
  - ◆ MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

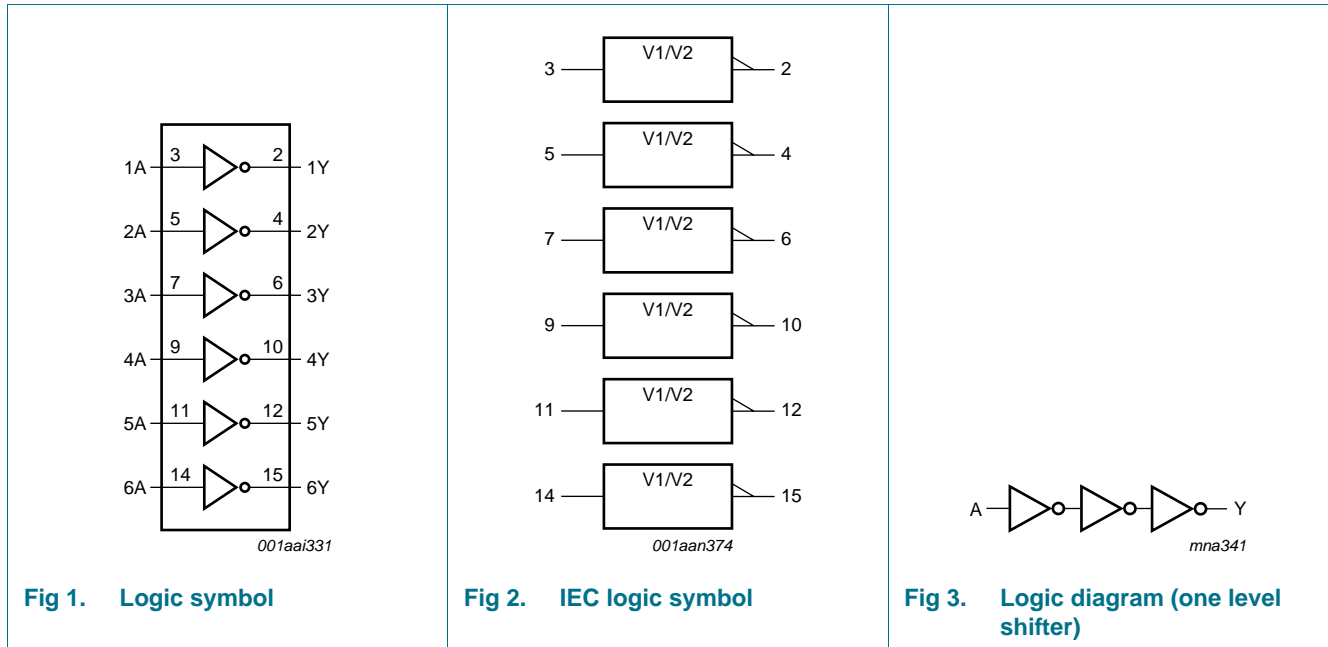
## 3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC4049N	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	DIP16	plastic dual in-line package; 16 leads (300 mil)	SOT38-4
74HC4049D	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC4049DB	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HC4049PW	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

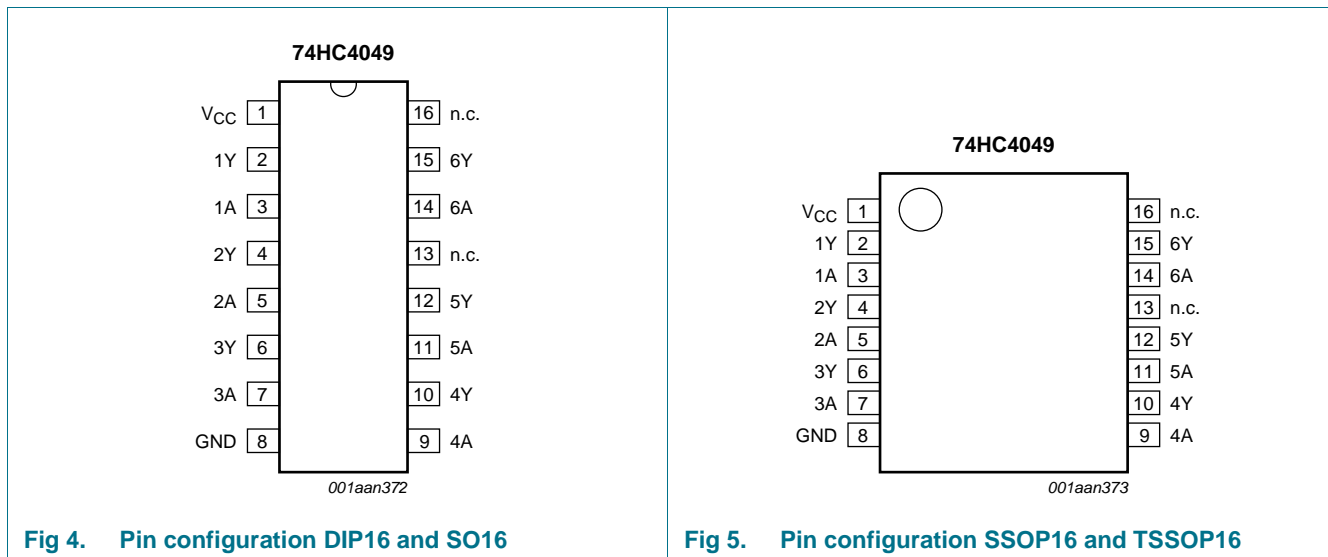


### 4. Functional diagram



### 5. Pinning information

#### 5.1 Pinning



## 5.2 Pin description

**Table 2.** Pin description

Symbol	Pin	Description
$V_{CC}$	1	supply voltage
1Y to 6Y	2, 4, 6, 10, 12, 15	output
1A to 6A	3, 5, 7, 9, 11, 14	input
GND	8	ground (0 V)
n.c.	13, 16	not connected

## 6. Functional description

**Table 3.** Function table [\[1\]](#)

Input	Output
nA	nY
L	H
H	L

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state.

## 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	+7	V
$V_{IK}$	input clamping voltage		-0.5	+16	V
$I_{IK}$	input clamping current	$V_I < -0.5$ V	-20	-	mA
$I_{OK}$	output clamping current	$V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V	-	$\pm 20$	mA
$I_O$	output current	$V_O = -0.5$ V to $(V_{CC} + 0.5)$ V	-	$\pm 25$	mA
$I_{CC}$	supply current		-	+50	mA
$I_{GND}$	ground current		-	-50	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	DIP16 package	<a href="#">[1]</a>	750	mW
		SO16, SSOP16 and TSSOP16 packages	<a href="#">[2]</a>	500	mW

[1] For DIP16 package:  $P_{tot}$  derates linearly with 12 mW/K above 70 °C.

[2] For SO16 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.

For SSOP16 and TSSOP16 packages:  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.

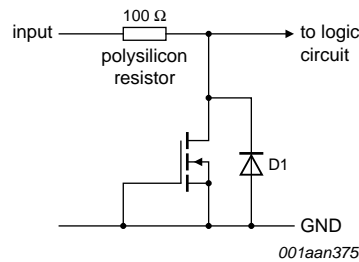


Fig 6. Input protection for the 74HC4049

## 8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage		2.0	5.0	6.0	V
$V_I$	input voltage		0	-	15	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 2.0\text{ V}; V_I = 2.0\text{ V}$	-	-	625	ns/V
		$V_{CC} = 4.5\text{ V}; V_I = 4.5\text{ V}$	-	1.67	139	ns/V
		$V_{CC} = 6.0\text{ V}; V_I = 6.0\text{ V}$	-	-	83	ns/V
		$V_{CC} = 6.0\text{ V}; V_I = 10.0\text{ V}$	-	-	81	ns/V
		$V_{CC} = 6.0\text{ V}; V_I = 15.0\text{ V}$	-	-	83	ns/V

## 9. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	$T_{amb} = 25\text{ °C}$			$T_{amb} = -40\text{ °C to } +85\text{ °C}$		$T_{amb} = -40\text{ °C to } +125\text{ °C}$		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 2.0\text{ V}$	1.5	1.3	-	1.5	-	1.5	-	V
		$V_{CC} = 4.5\text{ V}$	3.15	2.4	-	3.15	-	3.15	-	V
		$V_{CC} = 6.0\text{ V}$	4.2	3.1	-	4.2	-	4.2	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 2.0\text{ V}$	-	0.7	0.5	-	0.5	-	0.5	V
		$V_{CC} = 4.5\text{ V}$	-	1.8	1.35	-	1.35	-	1.35	V
		$V_{CC} = 6.0\text{ V}$	-	2.3	1.8	-	1.8	-	1.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$								
		$I_O = -20\text{ }\mu\text{A}; V_{CC} = 2.0\text{ V}$	1.9	2.0	-	1.9	-	1.9	-	V
		$I_O = -20\text{ }\mu\text{A}; V_{CC} = 4.5\text{ V}$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -20\text{ }\mu\text{A}; V_{CC} = 6.0\text{ V}$	5.9	6.0	-	5.9	-	5.9	-	V
		$I_O = -4.0\text{ mA}; V_{CC} = 4.5\text{ V}$	3.98	-	-	3.84	-	3.7	-	V
	$I_O = -5.2\text{ mA}; V_{CC} = 6.0\text{ V}$	5.48	-	-	5.34	-	5.2	-	V	

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

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

Symbol	Parameter	Conditions	T <sub>amb</sub> = 25 °C			T <sub>amb</sub> = -40 °C to +85 °C		T <sub>amb</sub> = -40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
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> = 20 μA; V <sub>CC</sub> = 2.0 V	-	-	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	-	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	-	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.26	-	0.33	-	0.4	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	-	0.26	-	0.33	-	0.4	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V	-	-	±0.1	-	±1.0	-	±1.0	μA
		V <sub>I</sub> = 15 V; V <sub>CC</sub> = 2.0 V to 6.0 V	-	-	±0.5	-	±5.0	-	±5.0	μA
I <sub>CC</sub>	supply current	V <sub>I</sub> = 15 V or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V	-	-	2.0	-	20	-	40	μA
C <sub>I</sub>	input capacitance		-	3.5	-	-	-	-	-	pF

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**Voltages are referenced to GND (ground = 0 V); C<sub>L</sub> = 50 pF unless otherwise specified; for test circuit see [Figure 8](#).

Symbol	Parameter	Conditions	T <sub>amb</sub> = 25 °C			T <sub>amb</sub> = -40 °C to +85 °C		T <sub>amb</sub> = -40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t <sub>pd</sub>	propagation delay	nA to nY; see <a href="#">Figure 7</a> <sup>[1]</sup>								
		V <sub>CC</sub> = 2.0 V	-	28	85	-	105	-	130	ns
		V <sub>CC</sub> = 4.5 V	-	10	17	-	21	-	26	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	8	-	-	-	-	-	ns
		V <sub>CC</sub> = 6.0 V	-	8	14	-	18	-	22	ns
t <sub>t</sub>	transition time	Yn; see <a href="#">Figure 7</a> <sup>[2]</sup>								
		V <sub>CC</sub> = 2.0 V	-	19	75	-	95	-	110	ns
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns
		V <sub>CC</sub> = 6.0 V	-	6	13	-	16	-	19	ns

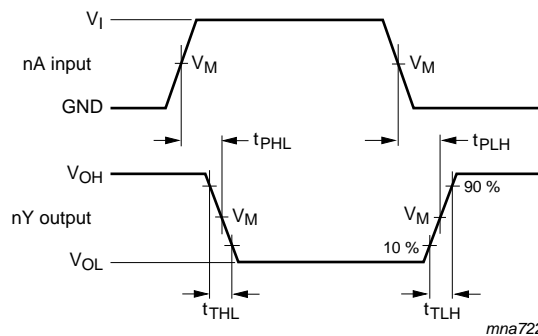
**Table 7. Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50 \text{ pF}$  unless otherwise specified; for test circuit see [Figure 8](#).

Symbol	Parameter	Conditions	$T_{\text{amb}} = 25 \text{ }^\circ\text{C}$			$T_{\text{amb}} = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$		$T_{\text{amb}} = -40 \text{ }^\circ\text{C}$ to $+125 \text{ }^\circ\text{C}$		Unit	
			Min	Typ	Max	Min	Max	Min	Max		
$C_{\text{PD}}$	power dissipation capacitance	$C_L = 50 \text{ pF}$ ; $f = 1 \text{ MHz}$ ; $V_I = \text{GND to } V_{\text{CC}}$	[3]	-	14	-	-	-	-	-	pF

- [1]  $t_{\text{pd}}$  is the same as  $t_{\text{PLH}}$  and  $t_{\text{PHL}}$ .
- [2]  $t_t$  is the same as  $t_{\text{THL}}$  and  $t_{\text{TLH}}$ .
- [3]  $C_{\text{PD}}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).  
 $P_D = C_{\text{PD}} \times V_{\text{CC}}^2 \times f_i \times N + \sum(C_L \times V_{\text{CC}}^2 \times f_o)$  where:  
 $f_i$  = input frequency in MHz;  
 $f_o$  = output frequency in MHz;  
 $C_L$  = output load capacitance in pF;  
 $V_{\text{CC}}$  = supply voltage in V;  
 $N$  = number of inputs switching;  
 $\sum(C_L \times V_{\text{CC}}^2 \times f_o)$  = sum of outputs.

## 11. Waveforms

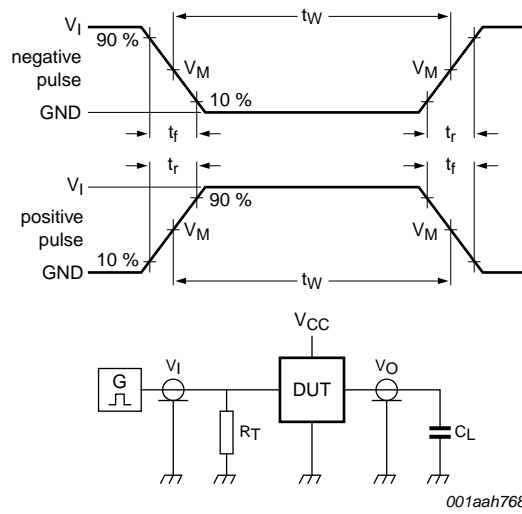


Measurement points are given in [Table 8](#).  
 $V_{\text{OL}}$  and  $V_{\text{OH}}$  are typical voltage output levels that occur with the output load.

**Fig 7. The input (nA) to output (nY) propagation delays**

**Table 8. Measurement points**

Type	Input	Output
	74HC4049	$V_M$ $0.5V_{\text{CC}}$



Test data is given in [Table 9](#).

Definitions test circuit:

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

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

$R_L$  = Load resistance.

S1 = Test selection switch.

**Fig 8. Test circuit for measuring switching times**

**Table 9. Test data**

Type	Input		Load	Test
	$V_I$	$t_r, t_f$	$C_L$	
74HC4049	$V_{CC}$	6.0 ns	15 pF, 50 pF	$t_{PLH}, t_{PHL}$

12. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil)

SOT38-4

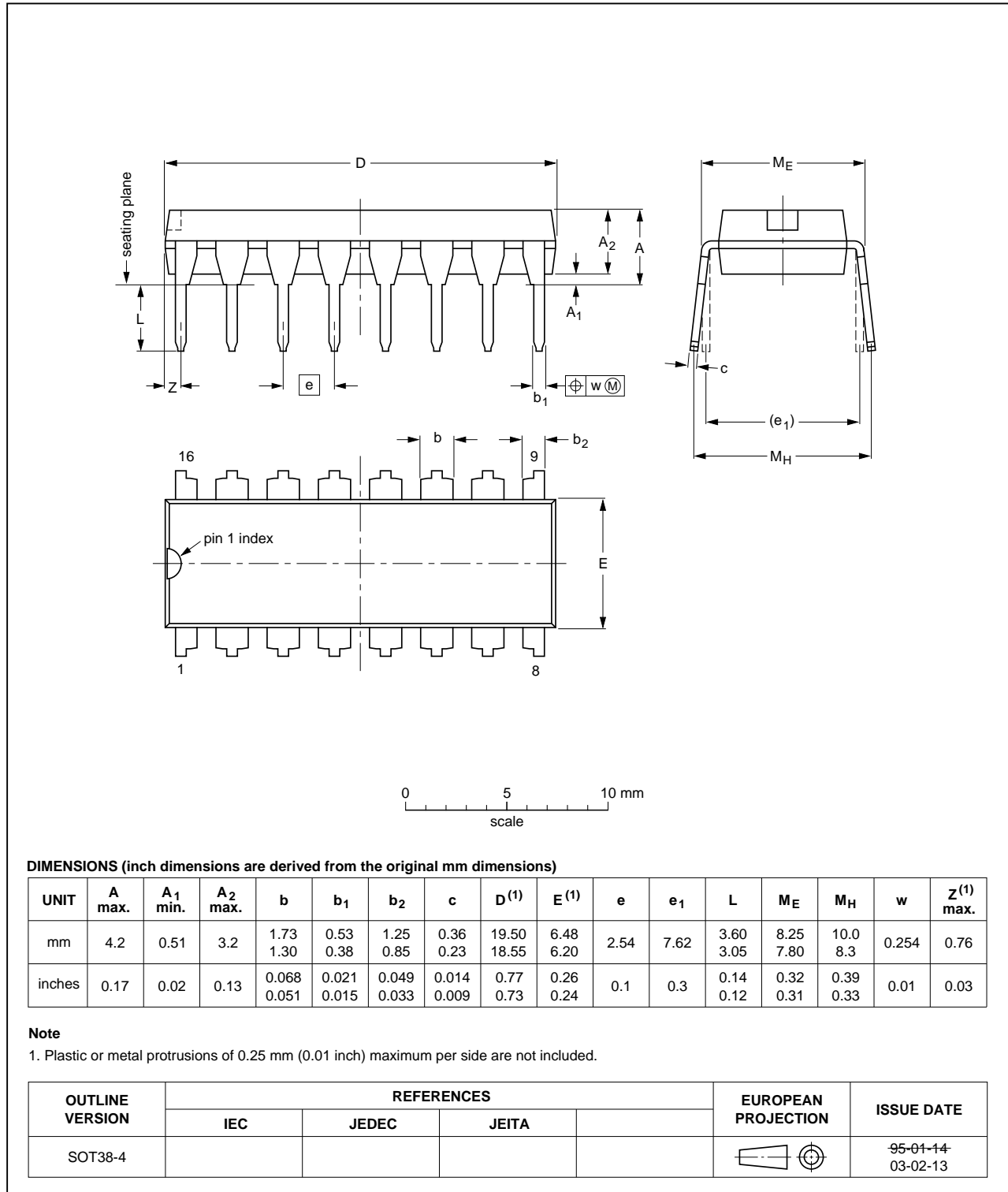


Fig 9. Package outline SOT38-4 (DIP16)



SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

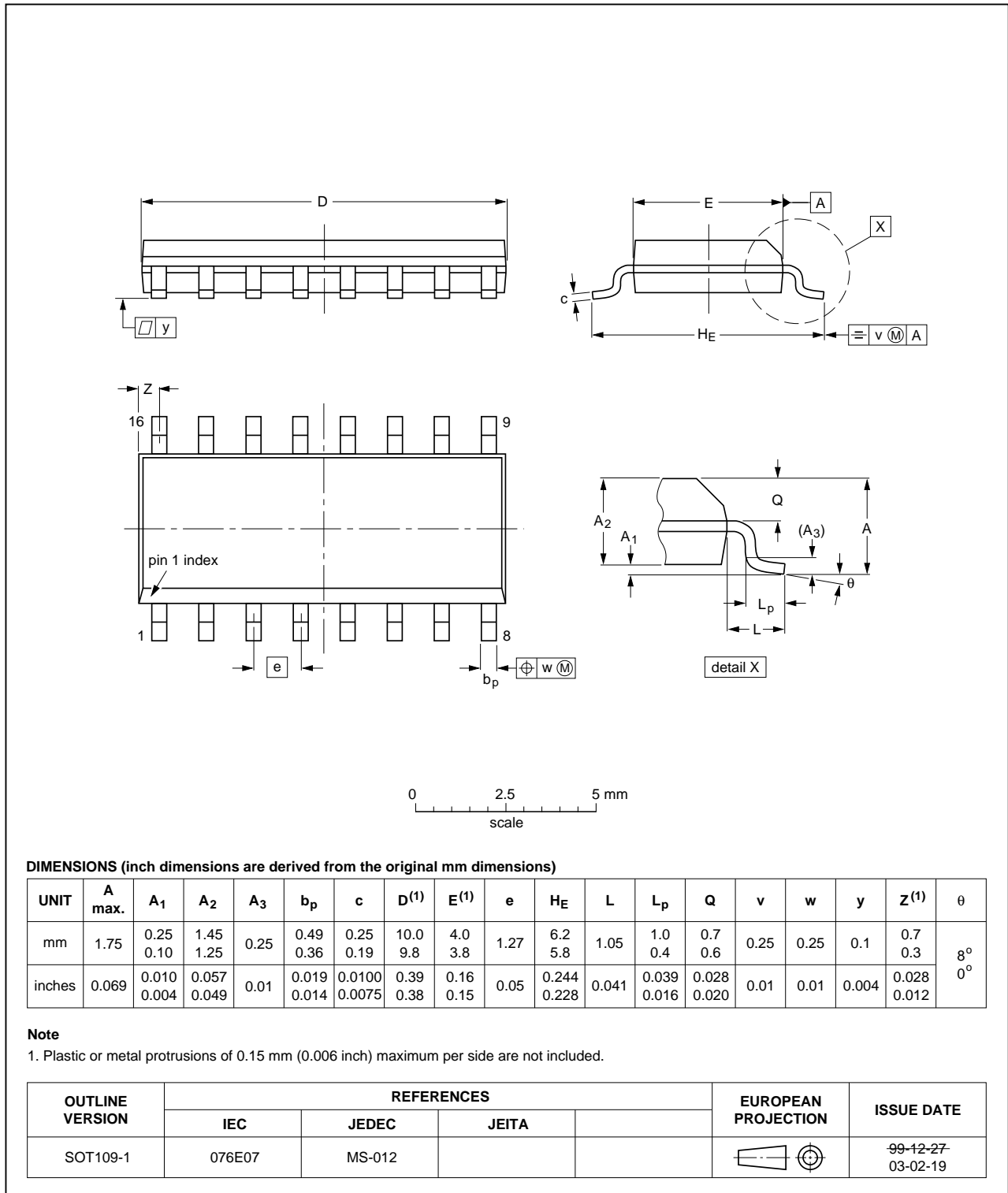


Fig 10. Package outline SOT109-1 (SO16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

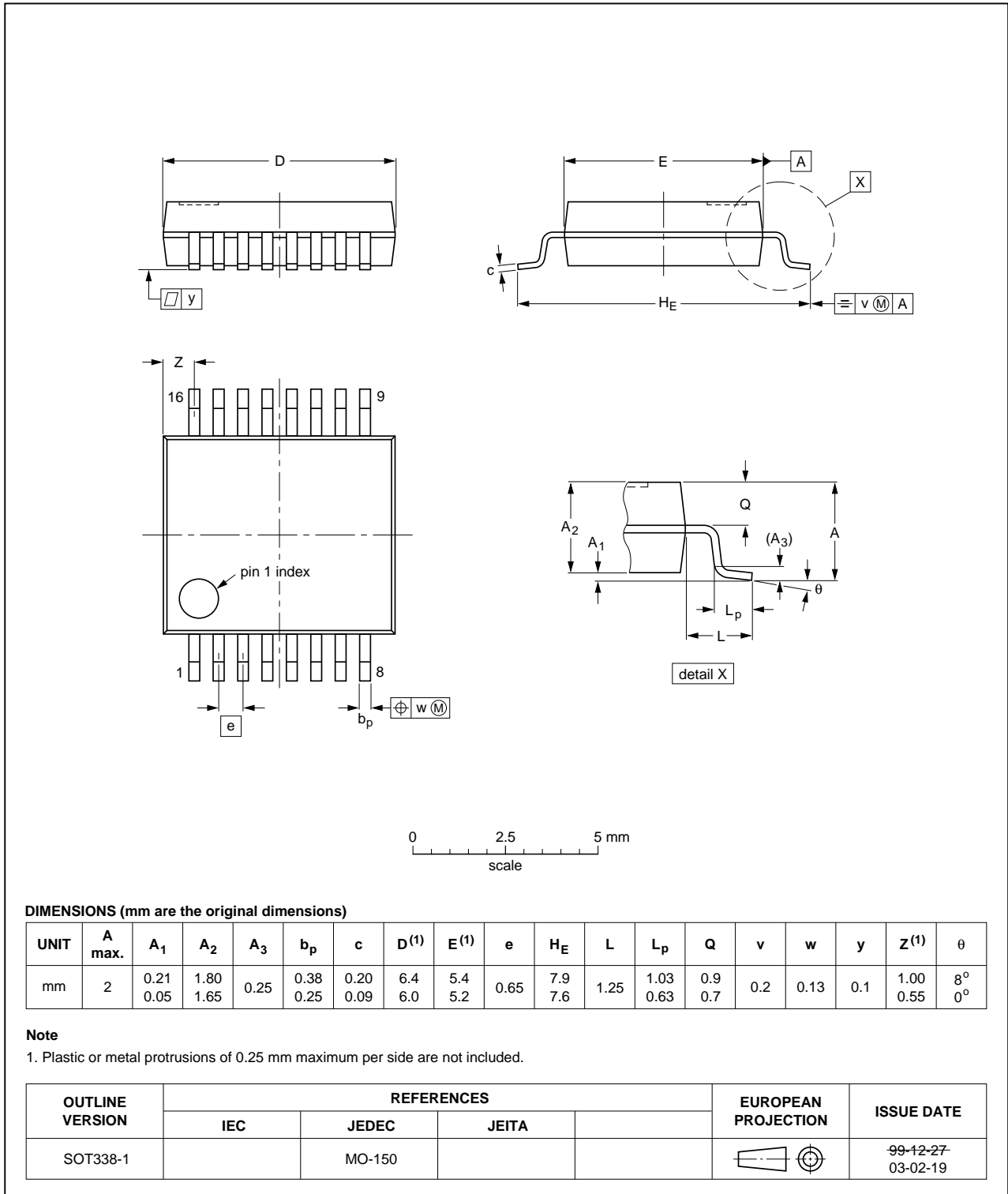


Fig 11. Package outline SOT338-1 (SSOP16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

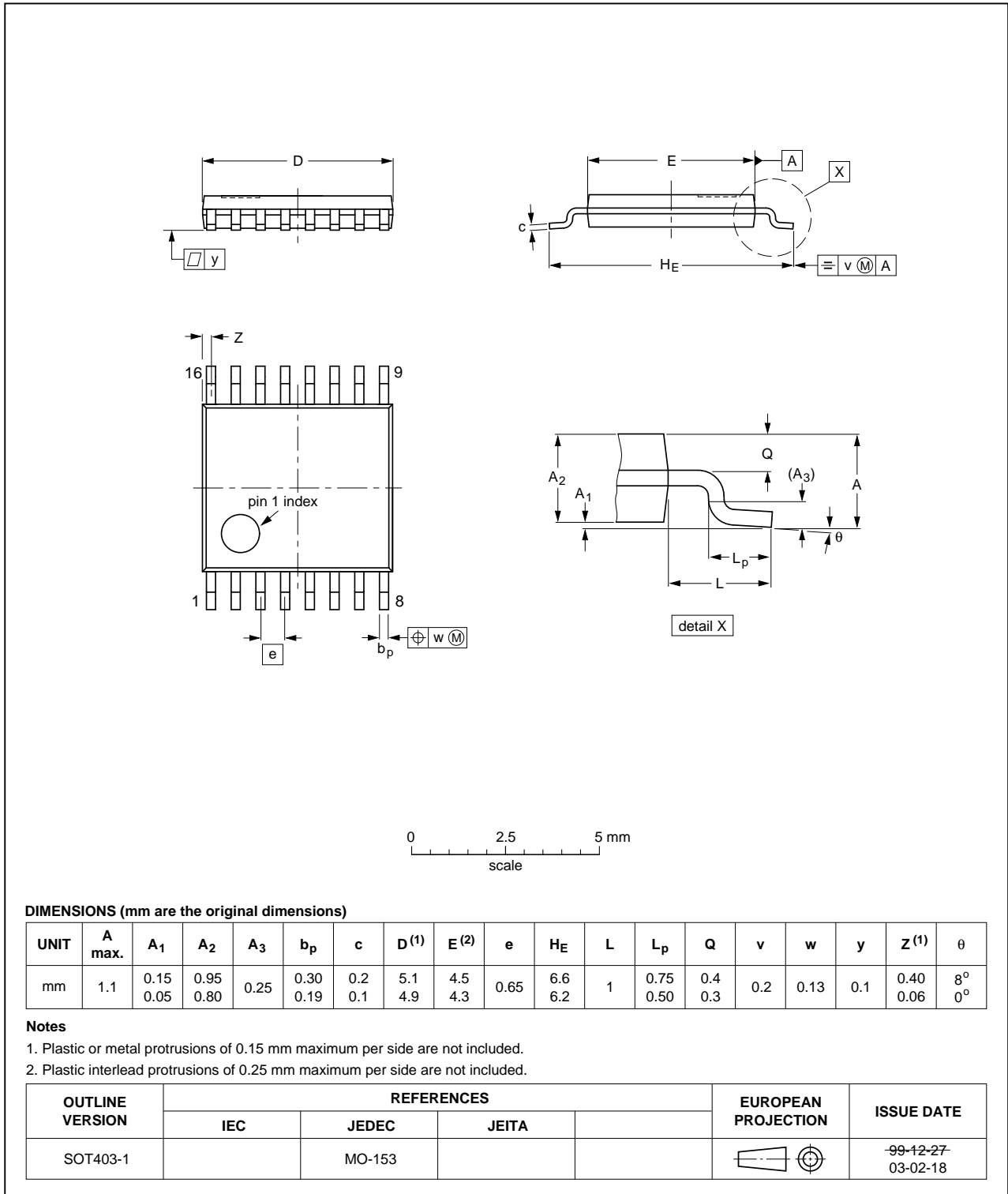


Fig 12. Package outline SOT403-1 (TSSOP16)

## 13. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

## 14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC4049 v.6	20130108	Product data sheet	-	74HC4049 v.5
Modifications:	<ul style="list-style-type: none"> <li>New general description.</li> </ul>			
74HC4049 v.5	20120803	Product data sheet	-	74HC4049 v.4
Modifications:	<ul style="list-style-type: none"> <li>Measurement points added to figure 7 (errata).</li> </ul>			
74HC4049 v.4	20111212	Product data sheet	-	74HC4049 v.3
74HC4049 v.3	20101230	Product data sheet	-	74HC4049_CNV v.2
74HC4049_CNV v.2	19970827	Product specification	-	-

## 15. Legal information

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Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
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Product [short] data sheet	Production	This document contains the product specification.

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[2] The term 'short data sheet' is explained in section "Definitions".

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