

# 74HC05

## Hex inverter with open-drain outputs

Rev. 02 — 18 June 2009

Product data sheet

### 1. General description

The 74HC05 is a high-speed Si-gate CMOS device that complies with JEDEC standard no. 7A.

The 74HC05 contains six inverters. The outputs of the 74HC05 are open-drain and can be connected to other open-drain outputs to implement active-LOW wired-OR or active-HIGH wired-AND functions. The open-drain outputs require pull-up resistors to perform correctly.

### 2. Features

- Wide operating voltage 2.0 V to 6.0 V
- Input levels:
  - ◆ For 74HC05: CMOS level
- Latch-up performance exceeds 100 mA per JESD 78 Class II level A
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ CDM JESD22-C101C exceeds 1000 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
74HC05D	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HC05PW	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HC05BQ	$-40\text{ }^{\circ}\text{C}$ 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

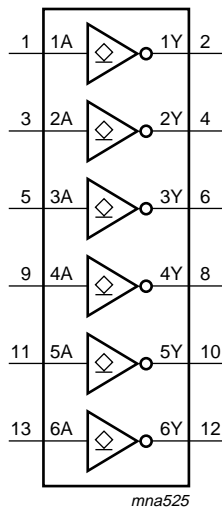


Fig 1. Logic symbol

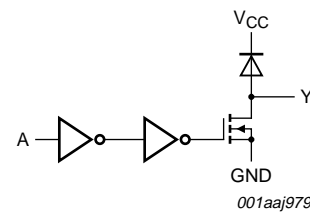


Fig 2. Logic diagram (one gate)

### 5. Pinning information

#### 5.1 Pinning

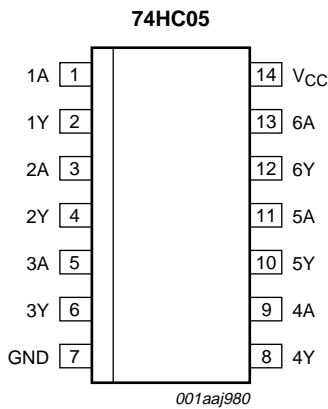
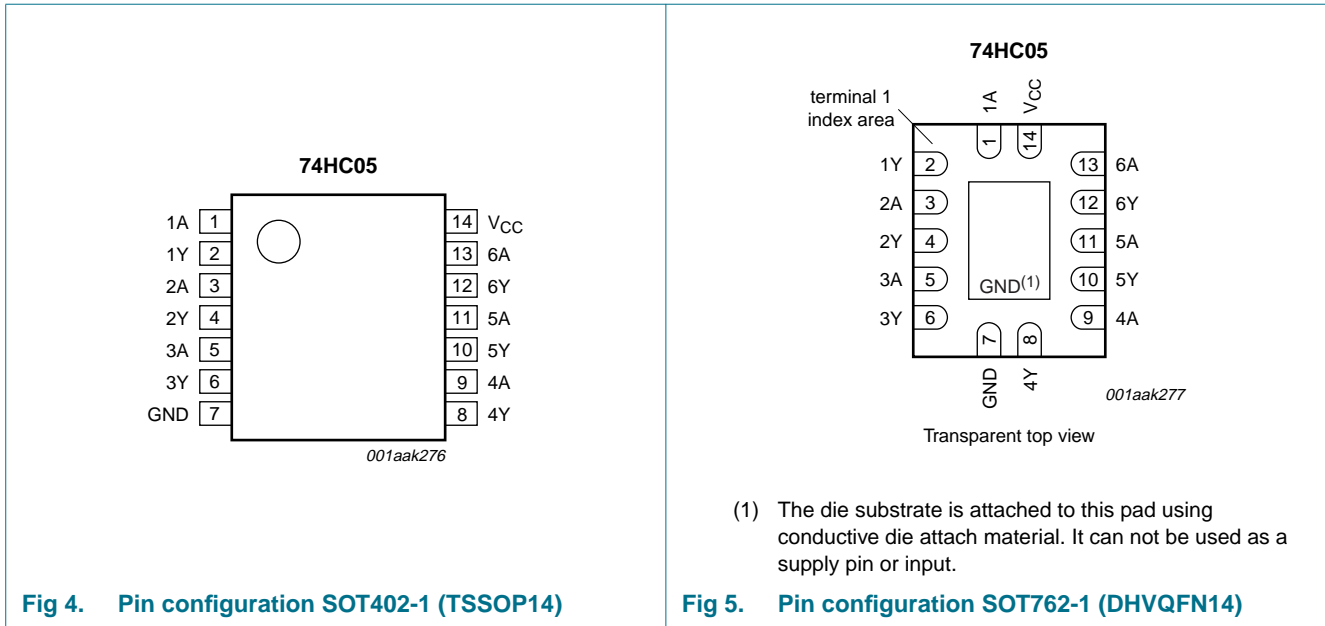


Fig 3. Pin configuration SOT108-1 (SO14)



5.2 Pin description

Table 2. Pin description

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

6. Functional description

Table 3. Function table<sup>[1]</sup>

Input	Output
nA	nY
L	Z
H	L

[1] H = HIGH voltage level; L = LOW voltage level; 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 <sub>CC</sub>	supply voltage		-0.5	+7	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V	[1] -	20	mA
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>CC</sub> + 0.5 V	[1] -	20	mA
V <sub>O</sub>	output voltage		[1] -0.5	V <sub>CC</sub> + 0.5 V	V

**Table 4. Limiting values ...continued**

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

Symbol	Parameter	Conditions	Min	Max	Unit
$I_O$	output current	$V_O < V_{CC} + 0.5\text{ V}$	-	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		[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 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.  
 For TSSOP14 packages:  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.  
 For DHVQFN14 packages:  $P_{tot}$  derates linearly with 4.5 mW/K above 60 °C.

## 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	-	$V_{CC}$	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 2.0\text{ V}$	-	-	625	ns/V
		$V_{CC} = 4.5\text{ V}$	-	1.67	139	ns/V
		$V_{CC} = 6.0\text{ V}$	-	-	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	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 2.0\text{ V}$	1.5	1.2	-	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	3.2	-	4.2	-	4.2	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 2.0\text{ V}$	-	0.8	0.5	-	0.5	-	0.5	V
		$V_{CC} = 4.5\text{ V}$	-	2.1	1.35	-	1.35	-	1.35	V
		$V_{CC} = 6.0\text{ V}$	-	2.8	1.8	-	1.8	-	1.8	V
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$								
		$I_O = 20\ \mu\text{A}; V_{CC} = 2.0\text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20\ \mu\text{A}; V_{CC} = 4.5\text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20\ \mu\text{A}; V_{CC} = 6.0\text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0\text{ mA}; V_{CC} = 4.5\text{ V}$	-	0.15	0.26	-	0.33	-	0.4	V
	$I_O = 5.2\text{ mA}; V_{CC} = 6.0\text{ V}$	-	0.16	0.26	-	0.33	-	0.4	V	

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

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

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
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	-	1	µA
I <sub>OZ</sub>	OFF-state output current	per input pin; V <sub>I</sub> = V <sub>IL</sub> ; V <sub>O</sub> = V <sub>CC</sub> or GND; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V; I <sub>O</sub> = 0 A	-	-	0.5	-	5.0	-	10	µA
I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> 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**

GND = 0 V; for test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +125 °C		Unit
			Min	Typ	Max	Max (85 °C)	Max (125 °C)	
t <sub>PLZ</sub>	LOW to OFF-state propagation delay	nA to nY; see <a href="#">Figure 6</a> V <sub>CC</sub> = 2.0 V	-	20	90	115	135	ns
		V <sub>CC</sub> = 4.5 V	-	11	18	23	27	ns
		V <sub>CC</sub> = 6.0 V	-	10	15	20	23	ns
t <sub>PZL</sub>	OFF-state to LOW propagation delay	nA to nY; see <a href="#">Figure 6</a> V <sub>CC</sub> = 2.0 V	-	22	90	115	135	ns
		V <sub>CC</sub> = 4.5 V	-	9	18	23	27	ns
		V <sub>CC</sub> = 6.0 V	-	8	15	20	23	ns
t <sub>THL</sub>	HIGH to LOW output transition time	see <a href="#">Figure 6</a> V <sub>CC</sub> = 2.0 V	-	18	75	95	110	ns
		V <sub>CC</sub> = 4.5 V	-	6	15	19	22	ns
		V <sub>CC</sub> = 6.0 V	-	5	13	16	19	ns
C <sub>PD</sub>	power dissipation capacitance	per inverter; V <sub>I</sub> = GND to V <sub>CC</sub> ; V <sub>CC</sub> = 5.0 V	[1]	-	4	-	-	pF

[1] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in µW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(0.5 \times C_L \times V_O^2 \times f_o) \text{ where:}$$

f<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

V<sub>O</sub> = output voltage in V (output HIGH);

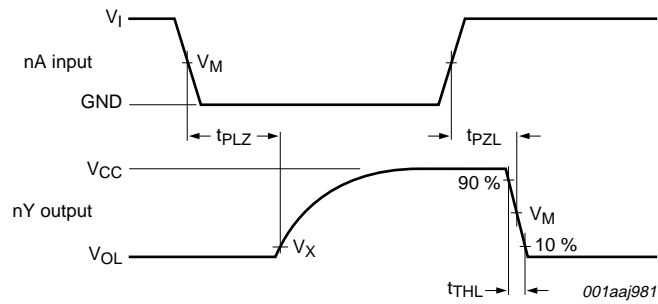
V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

R<sub>L</sub> = load resistance in MΩ;

C<sub>L</sub> = load capacitance in pF;

## 11. Waveforms



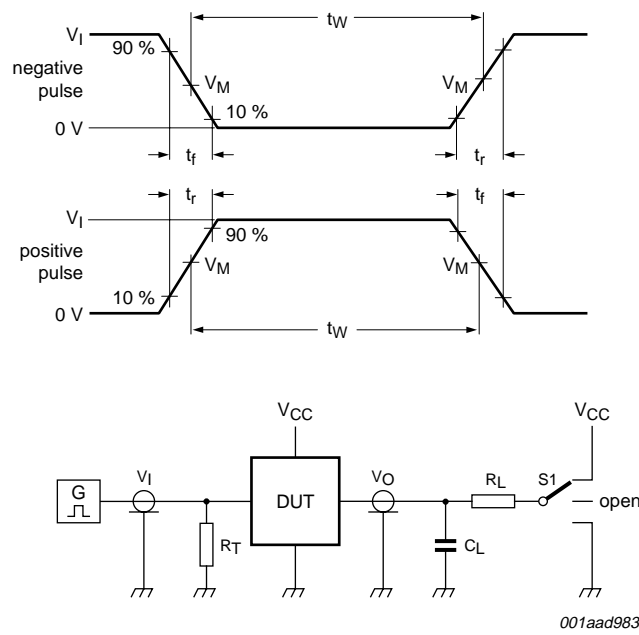
Measurement points are given in [Table 8](#).

$V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

**Fig 6. The input nA to output nY propagation delays and output transition times**

**Table 8. Measurement points**

Input	Output	
$V_M$	$V_M$	$V_X$
$0.5V_{CC}$	$0.5V_{CC}$	$0.1V_{CC}$



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.

**Fig 7. Test circuit for measuring switching times**

**Table 9. Test data**

Input		Load		S1 position
$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PZL}, t_{PLZ}$
$V_{CC}$	6 ns	50 pF	1 k $\Omega$	$V_{CC}$

12. Package outline

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

SOT108-1

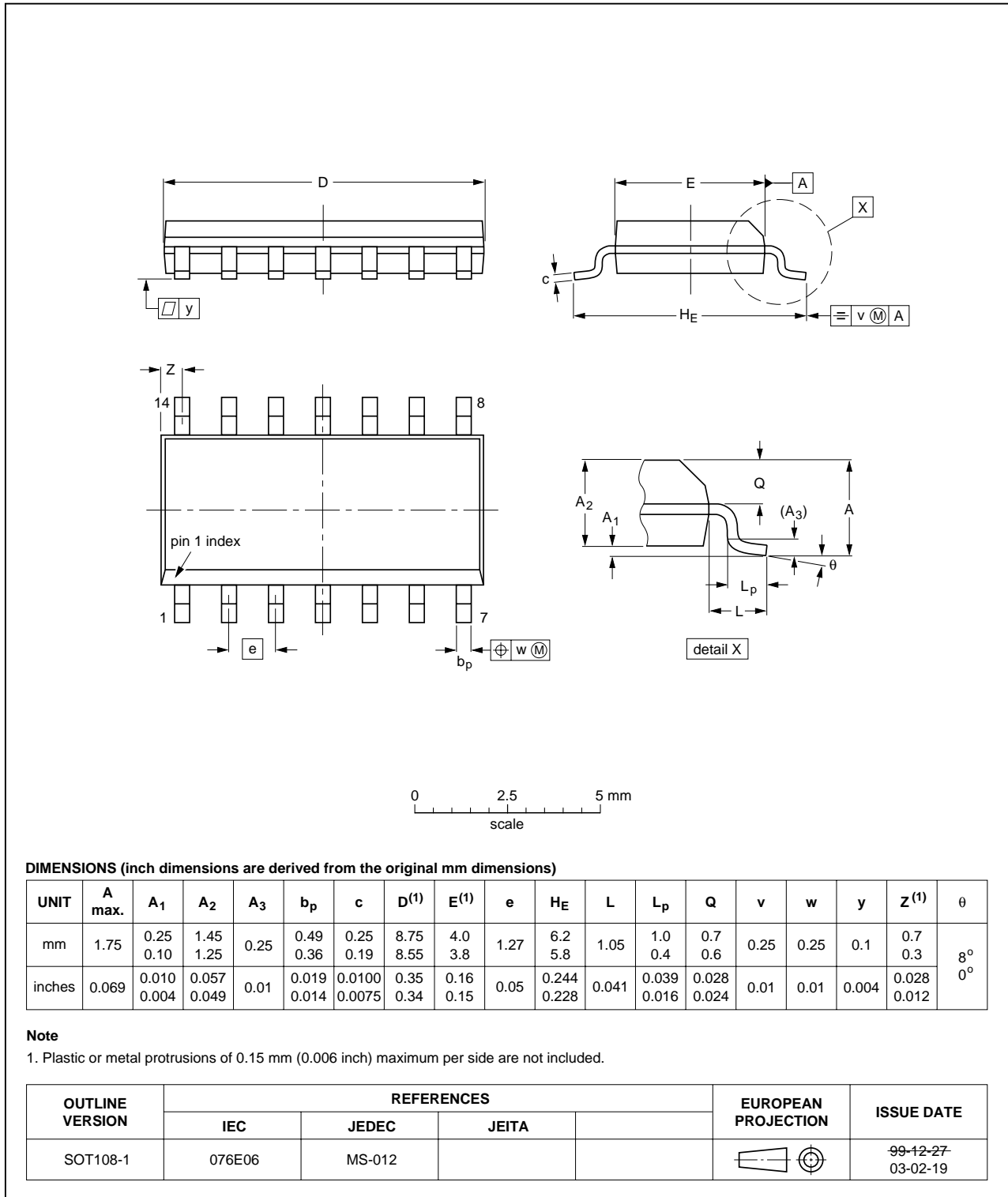


Fig 8. Package outline SOT108-1 (SO14)



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

SOT402-1

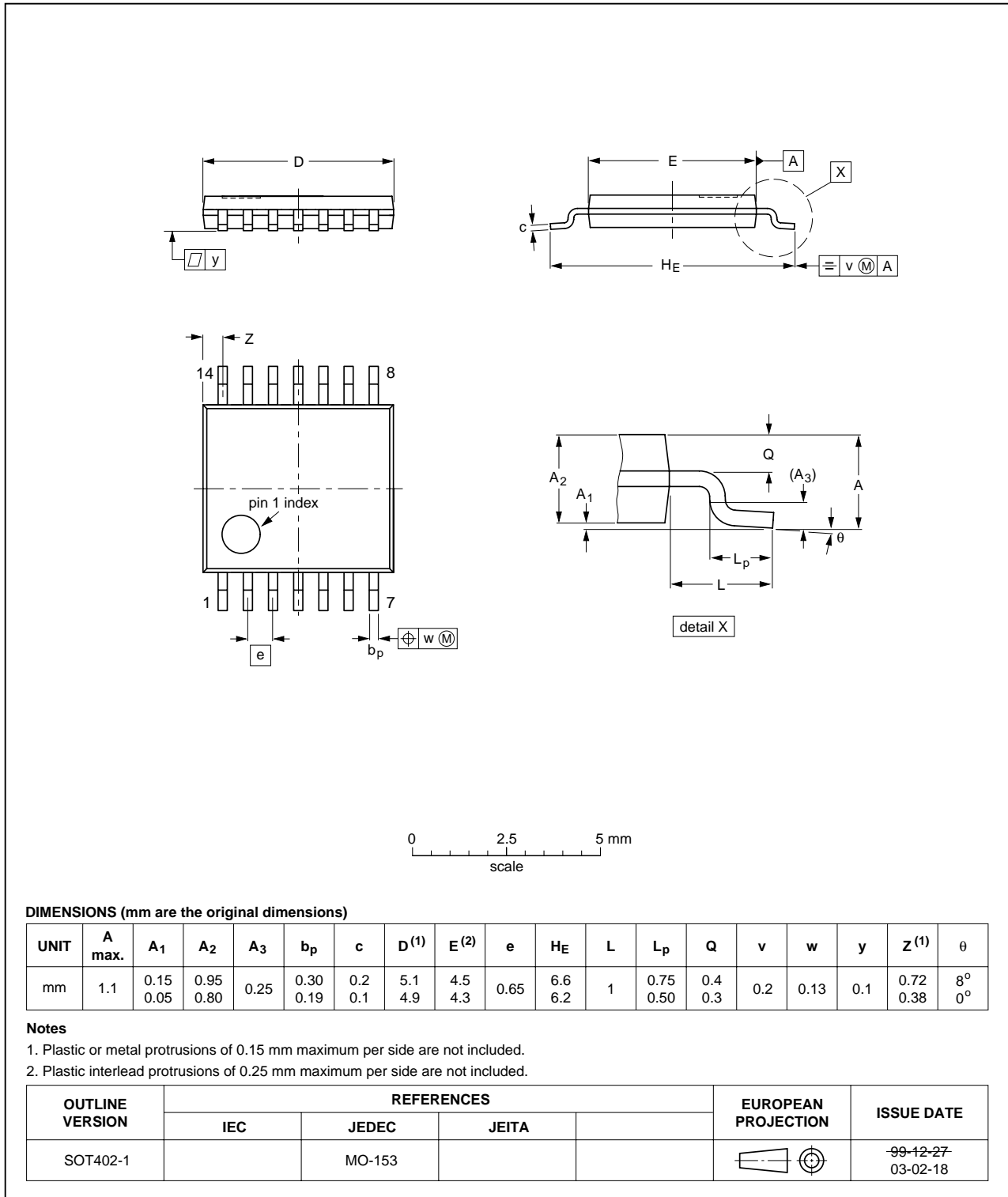


Fig 9. Package outline SOT402-1 (TSSOP14)

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

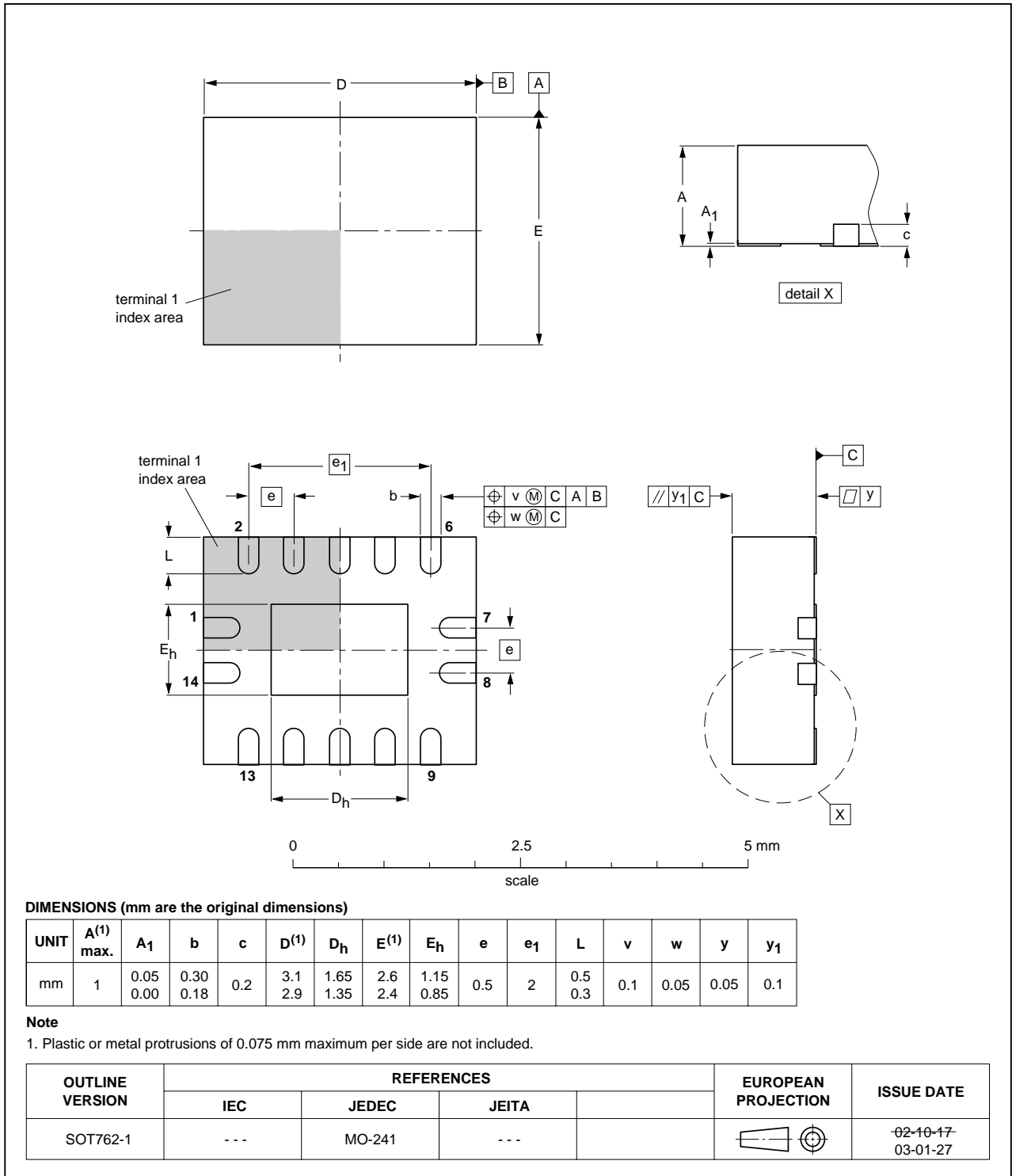


Fig 10. Package outline SOT762-1 (DHVQFN14)

## 13. Abbreviations

Table 10. Abbreviations

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

## 14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC05_2	20090618	Product data sheet	-	74HC05_1
Modifications:	• Added type numbers 74HC05PW (TSSOP14 package) and 74HC05BQ (DHVQFN14 package)			
74HC05_1	20090427	Product data sheet	-	-

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### 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.

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

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