74HC05

Hex inverter with open-drain outputs

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 °C to +85 °C and from −40 °C to +125 °C

3. Ordering information

Table 1.   Ordering information

| Type number	Package			
	Temperature range	Name	Description	Version
74HC05D	−40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HC05PW	−40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HC05BQ	−40 °C to +125 °C	DHVQFN14	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body $2.5 \times 3 \times 0.85$ mm	SOT762-1

nexperia

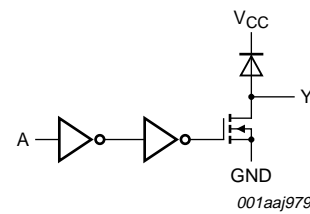## 4. Functional diagram
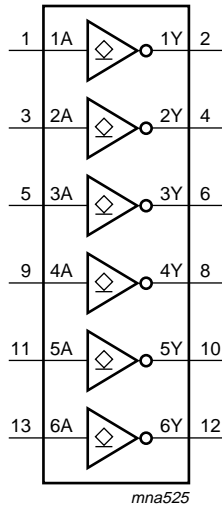
Fig 1.   Logic symbol

Fig 2.   Logic diagram (one gate)

5. Pinning information

5.1 Pinning
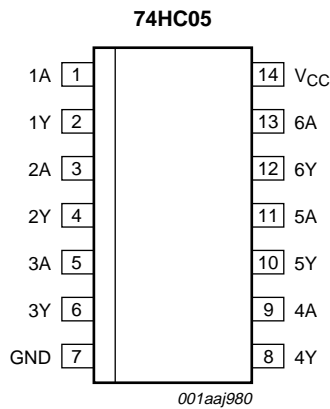
Fig 3.   Pin configuration SOT108-1 (SO14)

Fig 4. Pin configuration SOT402-1 (TSSOP14)

(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 SOT762-1 (DHVQFN14)
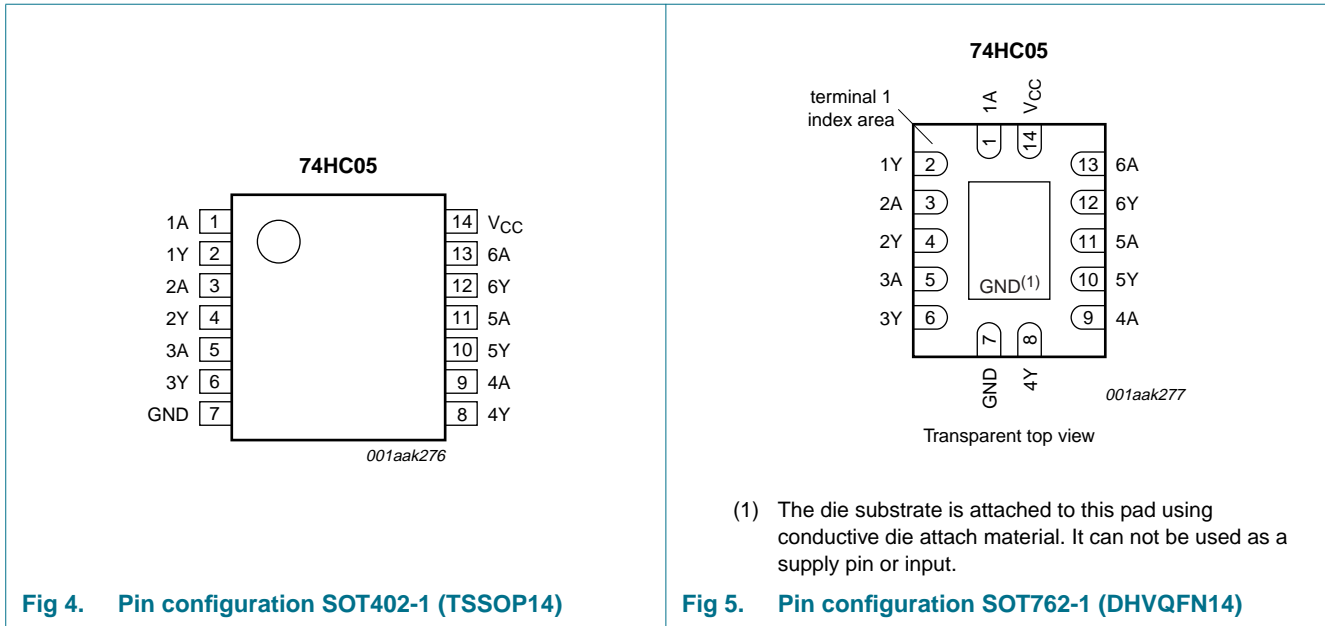
5.2 Pin description

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_{CC}	14	supply voltage

6. Functional description

Table 3. Function table[1]

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_{CC}	supply voltage			−0.5	+7	V
I_{IK}	input clamping current	$V_I < -0.5$ V or $V_I > V_{CC} + 0.5$ V	[1]	-	20	mA
I_{OK}	output clamping current	$V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V	[1]	-	20	mA
V_O	output voltage		[1]	−0.5	$V_{CC} + 0.5$ V	V

74HC05_2

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	$V_O < V_{CC} + 0.5$ 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	$V_{CC} = 2.0$ V	-	-	625	ns/V
		$V_{CC} = 4.5$ V	-	1.67	139	ns/V
		$V_{CC} = 6.0$ 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	$V_{CC} = 2.0$ V	1.5	1.2	-	1.5	-	1.5	-	V
		$V_{CC} = 4.5$ V	3.15	2.4	-	3.15	-	3.15	-	V
		$V_{CC} = 6.0$ V	4.2	3.2	-	4.2	-	4.2	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 2.0$ V	-	0.8	0.5	-	0.5	-	0.5	V
		$V_{CC} = 4.5$ V	-	2.1	1.35	-	1.35	-	1.35	V
		$V_{CC} = 6.0$ V	-	2.8	1.8	-	1.8	-	1.8	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}$ or V_{IL}								
		$I_O = 20$ µA; $V_{CC} = 2.0$ V	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20$ µA; $V_{CC} = 4.5$ V	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20$ µA; $V_{CC} = 6.0$ V	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0$ mA; $V_{CC} = 4.5$ V	-	0.15	0.26	-	0.33	-	0.4	V
		$I_O = 5.2$ mA; $V_{CC} = 6.0$ 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_I	input leakage current	$V_I = V_{CC}$ or GND; V_{CC} = 6.0 V	-	-	0.1	-	1	-	1	µA
I_{OZ}	OFF-state output current	per input pin; $V_I = V_{IL}$; $V_O = V_{CC}$ or GND; other inputs at V_{CC} or GND; V_{CC} = 6.0 V; I_O = 0 A	-	-	0.5	-	5.0	-	10	µA
I_{CC}	supply current	$V_I = V_{CC}$ or GND; I_O = 0 A; V_{CC} = 6.0 V	-	-	2.0	-	20	-	40	µA
C_I	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_{PLZ}	LOW to OFF-state propagation delay	nA to nY; see Figure 6						
		V_{CC} = 2.0 V	-	20	90	115	135	ns
		V_{CC} = 4.5 V	-	11	18	23	27	ns
		V_{CC} = 6.0 V	-	10	15	20	23	ns
t_{PZL}	OFF-state to LOW propagation delay	nA to nY; see Figure 6						
		V_{CC} = 2.0 V	-	22	90	115	135	ns
		V_{CC} = 4.5 V	-	9	18	23	27	ns
		V_{CC} = 6.0 V	-	8	15	20	23	ns
t_{THL}	HIGH to LOW output transition time	see Figure 6						
		V_{CC} = 2.0 V	-	18	75	95	110	ns
		V_{CC} = 4.5 V	-	6	15	19	22	ns
		V_{CC} = 6.0 V	-	5	13	16	19	ns
C_{PD}	power dissipation capacitance	per inverter; V_I = GND to V_{CC}; V_{CC} = 5.0 V [1]	-	4	-	-	-	pF

[1] C_{PD} is used to determine the dynamic power dissipation (P_D in µW).

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

V_O = output voltage in V (output HIGH);

V_{CC} = supply voltage in V;

N = number of inputs switching;

R_L = load resistance in MΩ;

C_L = load capacitance in pF;

11. Waveforms
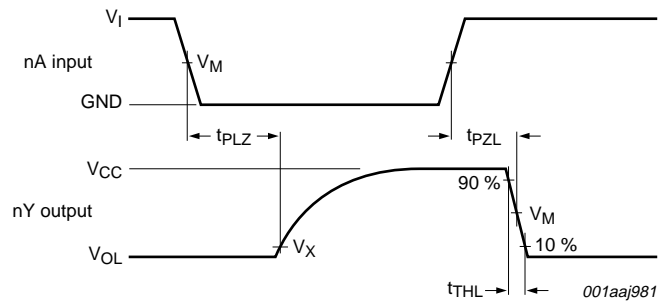
Measurement points are given in Table 8.

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**
$0.5V_{CC}$	$0.5V_{CC}$	$0.1V_{CC}$
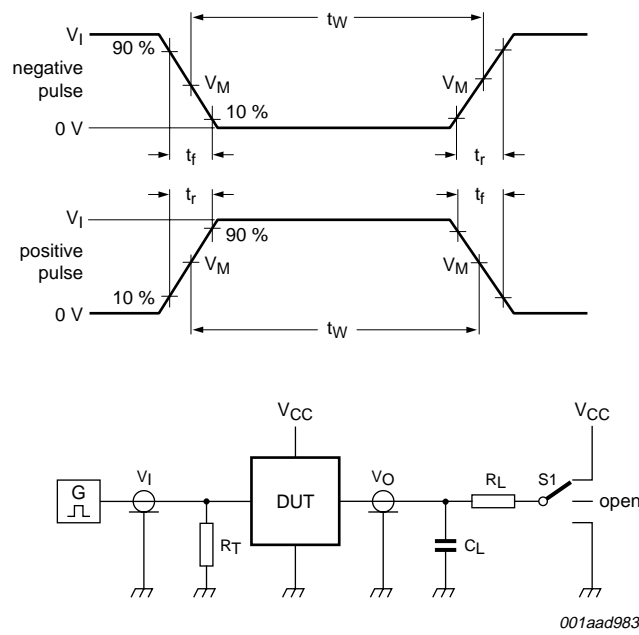
Test data is given in Table 9.

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 kΩ	V_{CC}

12. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm **SOT108-1**

DIMENSIONS (inch dimensions are derived from the original mm 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	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.35 0.34	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

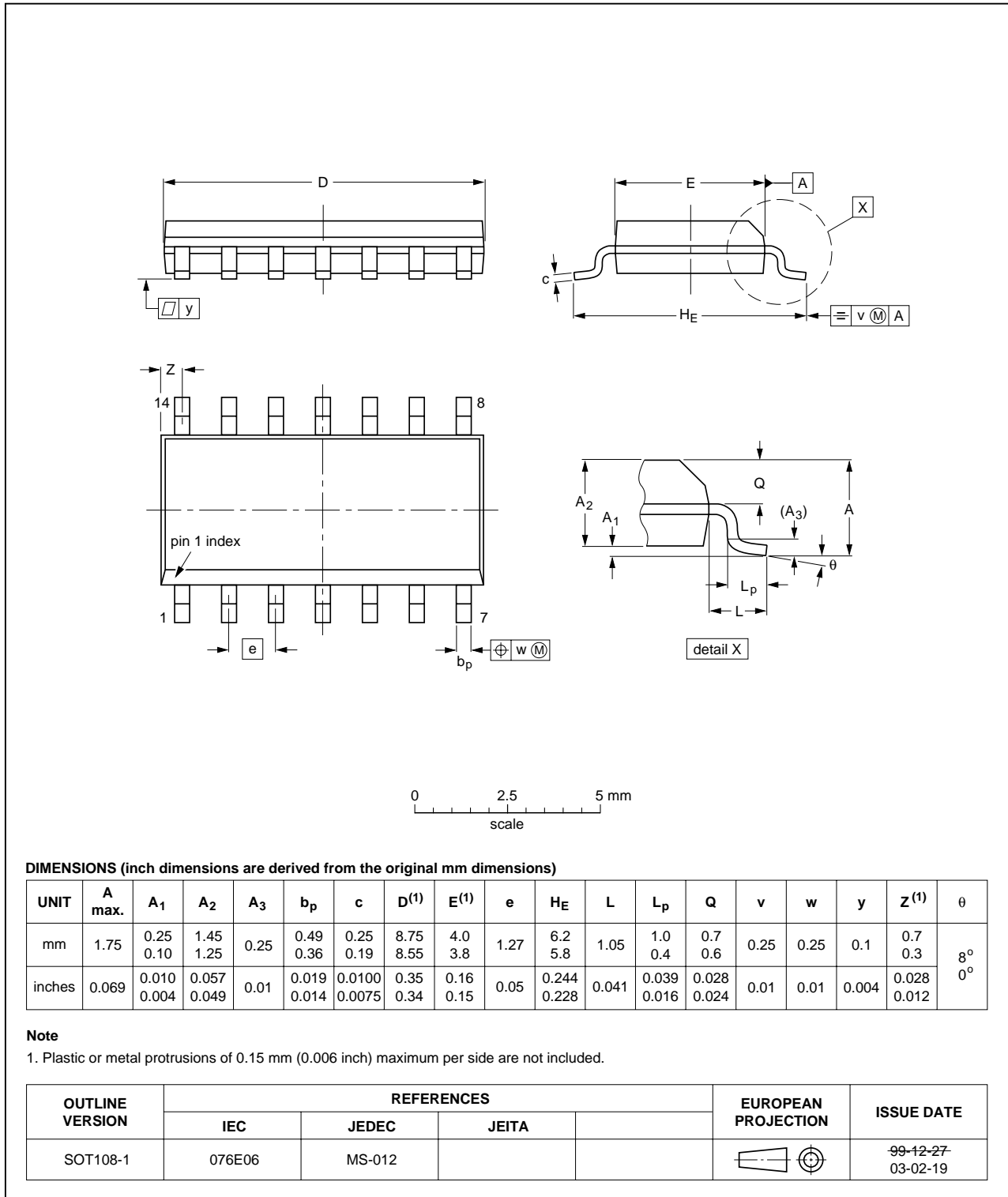| OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT108-1	076E06	MS-012				~~99-12-27~~ 03-02-19

Fig 8.   Package outline SOT108-1 (SO14)

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm SOT402-1

DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A₁	A₂	A₃	bp	c	D [1]	E [2]	e	HE	L	Lp	Q	v	w	y	Z [1]	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.72 0.38	8° 0°

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

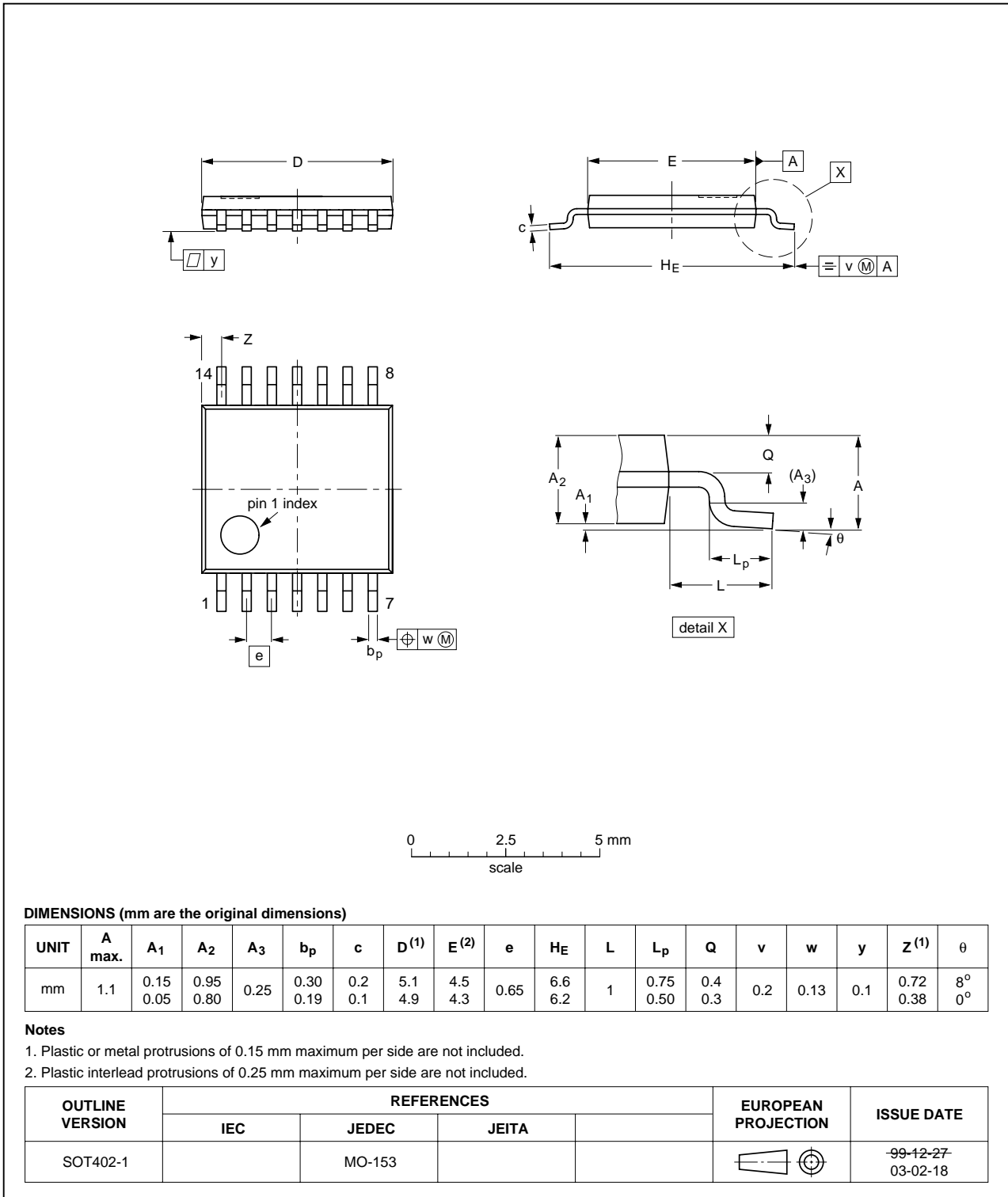| OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT402-1		MO-153				99-12-27 03-02-18

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
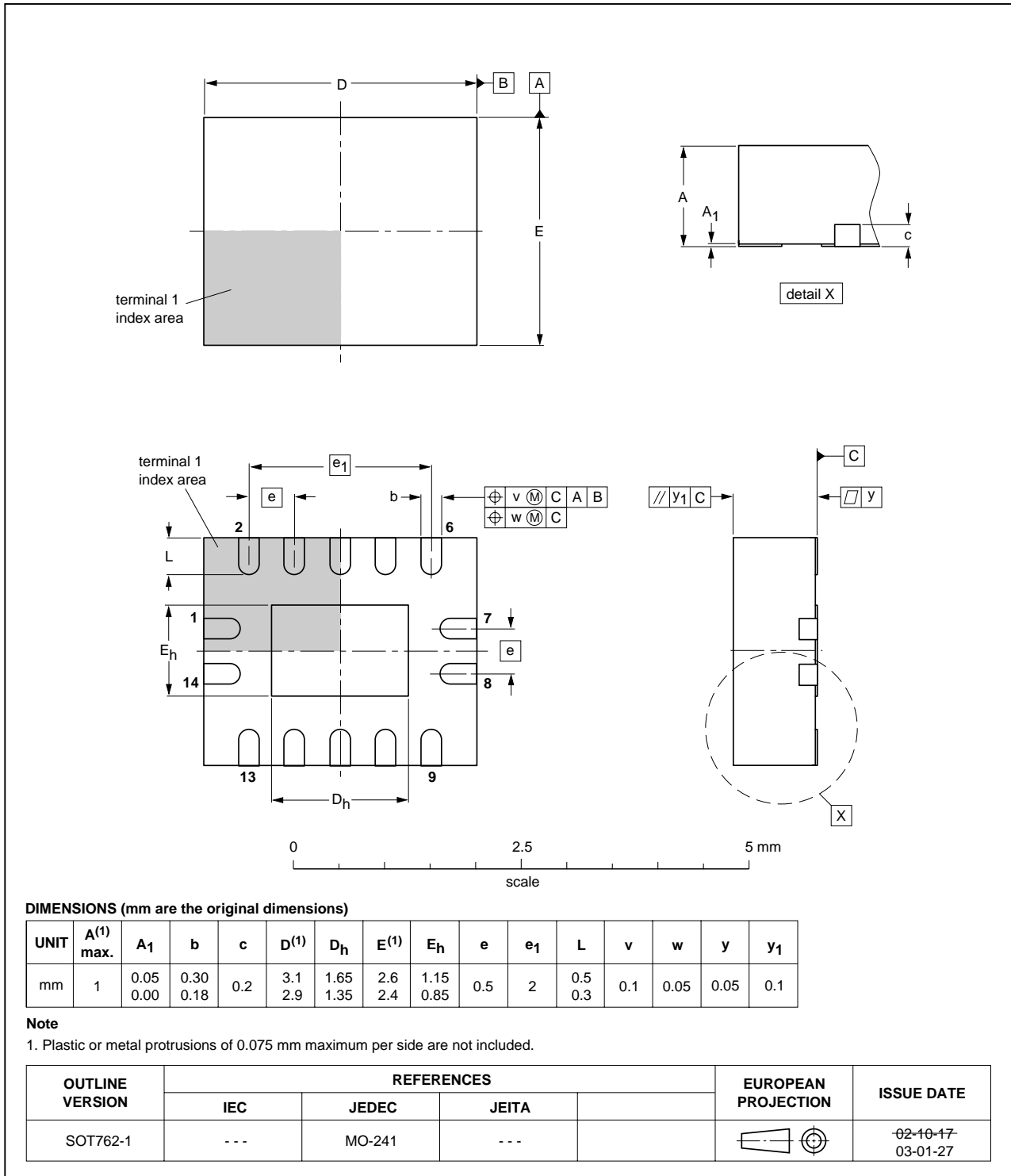
SOT762-1

DIMENSIONS (mm are the original dimensions)

UNIT	A(1) max.	A₁	b	c	D(1)	Dₕ	E(1)	Eₕ	e	e₁	L	v	w	y	y₁
mm	1	0.05 0.00	0.30 0.18	0.2	3.1 2.9	1.65 1.35	2.6 2.4	1.15 0.85	0.5	2	0.5 0.3	0.1	0.05	0.05	0.1

Note

1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT762-1	- - -	MO-241	- - -			~~02-10-17~~ 03-01-27

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	-	-

15. Legal information

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.nexperia.com.

15.2 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. Nexperia does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

Short data sheet — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local Nexperia sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

15.3 Disclaimers

General — Information in this document is believed to be accurate and reliable. However, Nexperia does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

Right to make changes — Nexperia reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use — Nexperia products are not designed, authorized or warranted to be suitable for use in medical, military, aircraft, space or life support equipment, nor in applications where failure or malfunction of a Nexperia product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Nexperia accepts no liability for inclusion and/or use of Nexperia products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. Nexperia makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Limiting values — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) may cause permanent damage to the device. Limiting values are stress ratings only and operation of the device at these or any other conditions above those given in the Characteristics sections of this document is not implied. Exposure to limiting values for extended periods may affect device reliability.

Terms and conditions of sale — Nexperia products are sold subject to the general terms and conditions of commercial sale, as published at http://www.nexperia.com/profile/terms, including those pertaining to warranty, intellectual property rights infringement and limitation of liability, unless explicitly otherwise agreed to in writing by Nexperia. In case of any inconsistency or conflict between information in this document and such terms and conditions, the latter will prevail.

No offer to sell or license — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

15.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

16. Contact information

For more information, please visit: **http://www.nexperia.com**

For sales office addresses, please send an email to: **salesaddresses@nexperia.com**

74HC05_2

Product data sheet **Rev. 02 — 18 June 2009** **12 of 13**

17. Contents