

# 74AHC1GU04-Q100

## Inverter

Rev. 1 — 21 November 2012

Product data sheet

## 1. General description

The 74AHC1GU04-Q100 is a high-speed Si-gate CMOS device. It provides an inverting single stage function.

The AHC device has CMOS input switching levels and supply voltage range 2 V to 5.5 V.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

## 2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - ◆ Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Symmetrical output impedance
- High noise immunity
- Low power dissipation
- Balanced propagation delays
- ESD protection:
  - ◆ MIL-STD-883, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V (C = 200 pF, R = 0  $\Omega$ )

## 3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74AHC1GU04GW-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP5	plastic thin shrink small outline package; 5 leads; body width 1.25 mm	SOT353-1
74AHC1GU04GV-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SC-74A	plastic surface-mounted package; 5 leads	SOT753

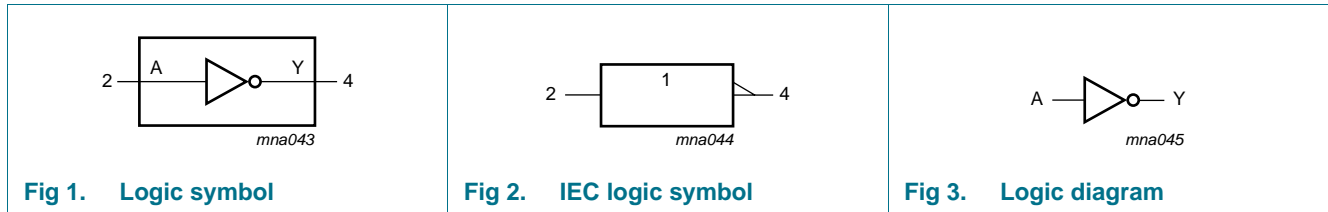
## 4. Marking

Table 2. Marking codes

Type number	Marking
74AHC1GU04GW-Q100	AD
74AHC1GU04GV-Q100	AU4

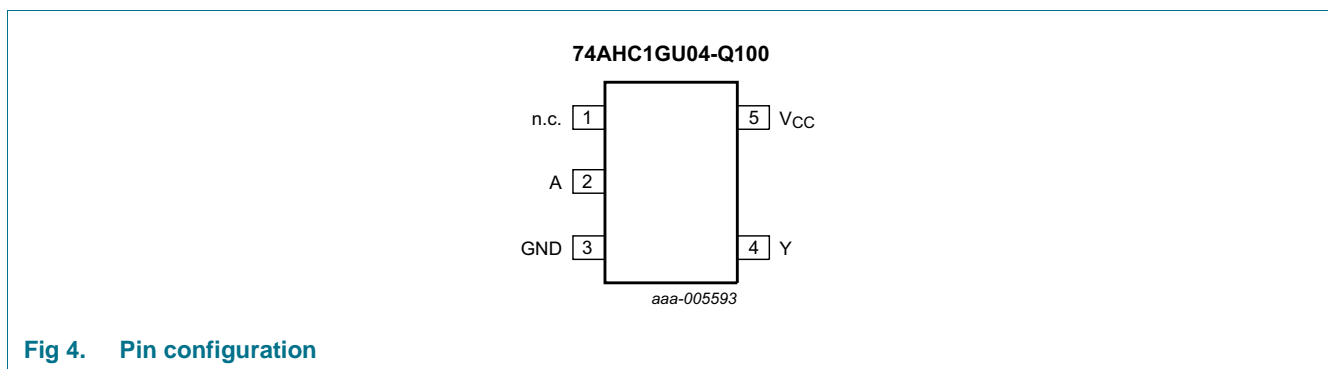


## 5. Functional diagram



## 6. Pinning information

### 6.1 Pinning



### 6.2 Pin description

**Table 3. Pin description**

Symbol	Pin	Description
n.c.	1	not connected
A	2	data input
GND	3	ground (0 V)
Y	4	data output
V <sub>CC</sub>	5	supply voltage

## 7. Functional description

**Table 4. Function table**

*H = HIGH voltage level; L = LOW voltage level*

Input	Output
A	Y
L	H
H	L

## 8. Limiting values

**Table 5. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC}$	supply voltage		-0.5	+7.0	V
$I_{IK}$	input clamping current	$V_I < -0.5$ V	-20	-	mA
$V_I$	input voltage		[1] -0.5	+7.0	V
$I_{OK}$	output clamping current	$V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V	-	$\pm 20$	mA
$I_O$	output current	$-0.5$ V $< V_O < V_{CC} + 0.5$ V	-	$\pm 25$	mA
$I_{CC}$	supply current		-	75	mA
$I_{GND}$	ground current		-75	-	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +125 °C	[2] -	250	mW

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

[2] For both TSSOP5 and SC-74A packages: above 87.5 °C the value of  $P_{tot}$  derates linearly with 4.0 mW/K.

## 9. Recommended operating conditions

**Table 6. 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	5.5	V
$V_I$	input voltage		0	-	5.5	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	$V_{CC} = 3.3$ V $\pm 0.3$ V	-	-	100	ns/V
		$V_{CC} = 5.0$ V $\pm 0.5$ V	-	-	20	ns/V

## 10. Static characteristics

**Table 7. Static characteristics**

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	1.7	-	-	1.7	-	1.7	-	V
		$V_{CC} = 3.0$ V	2.4	-	-	2.4	-	2.4	-	V
		$V_{CC} = 5.5$ V	4.4	-	-	4.4	-	4.4	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 2.0$ V	-	-	0.3	-	0.3	-	0.3	V
		$V_{CC} = 3.0$ V	-	-	0.6	-	0.6	-	0.6	V
		$V_{CC} = 5.5$ V	-	-	1.1	-	1.1	-	1.1	V

**Table 7. Static characteristics ...continued**  
 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 <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>								
		I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 3.0 V	2.9	3.0	-	2.9	-	2.9	-	V
		I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 3.0 V	2.58	-	-	2.48	-	2.40	-	V
		I <sub>O</sub> = -8.0 mA; V <sub>CC</sub> = 4.5 V	3.94	-	-	3.8	-	3.70	-	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> = 50 μA; V <sub>CC</sub> = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 50 μA; V <sub>CC</sub> = 3.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 50 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 3.0 V	-	-	0.36	-	0.44	-	0.55	V
		I <sub>O</sub> = 8.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.36	-	0.44	-	0.55	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; V <sub>CC</sub> = 0 V to 5.5 V	-	-	0.1	-	1.0	-	2.0	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> = 5.5 V	-	-	1.0	-	10	-	40	μA
C <sub>I</sub>	input capacitance		-	1.5	10	-	10	-	10	pF

## 11. Dynamic characteristics

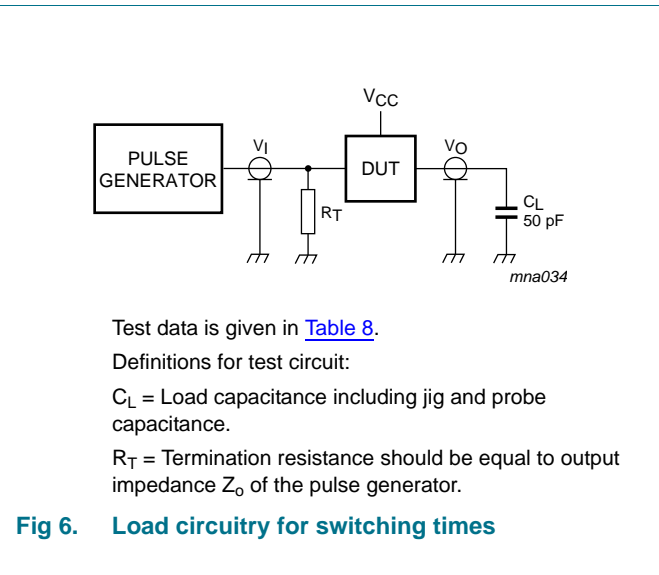
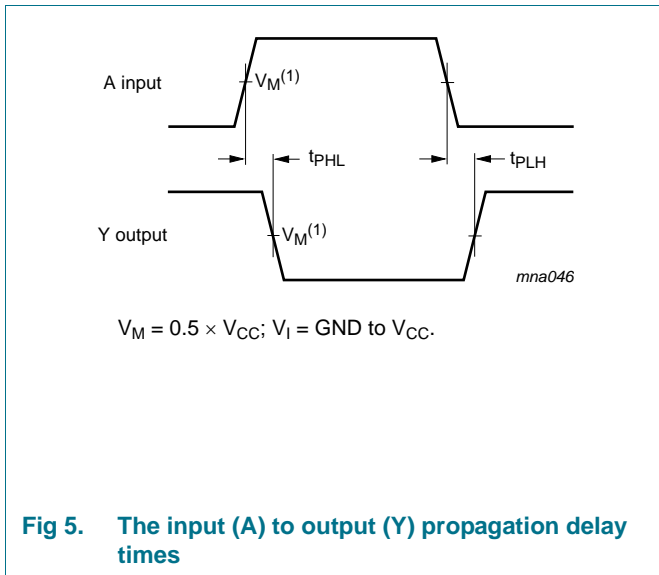
**Table 8. Dynamic characteristics**  
 GND = 0 V; t<sub>r</sub> = t<sub>f</sub> = ≤ 3.0 ns. For test circuit see [Figure 6](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit	
			Min	Typ	Max	Min	Max	Min	Max		
t <sub>pd</sub>	propagation delay	A to Y; see <a href="#">Figure 5</a> <a href="#">[1]</a>									
		V <sub>CC</sub> = 3.0 V to 3.6 V <a href="#">[2]</a>									
		C <sub>L</sub> = 15 pF	-	3.4	7.1	1.0	8.5	1.0	10.0	ns	
		C <sub>L</sub> = 50 pF	-	4.9	10.6	1.0	12.0	1.0	13.5	ns	
		V <sub>CC</sub> = 4.5 V to 5.5 V <a href="#">[3]</a>									
		C <sub>L</sub> = 15 pF	-	2.6	5.5	1.0	6.0	1.0	7.0	ns	
		C <sub>L</sub> = 50 pF	-	3.6	7.0	1.0	8.0	1.0	9.0	ns	
C <sub>PD</sub>	power dissipation capacitance	per buffer; V <sub>I</sub> = GND to V <sub>CC</sub> <a href="#">[4]</a>	-	14	-	-	-	-	-	pF	

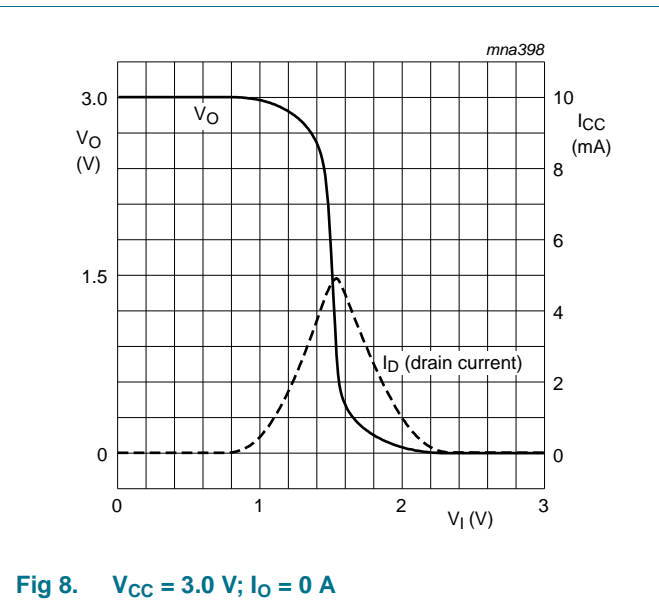
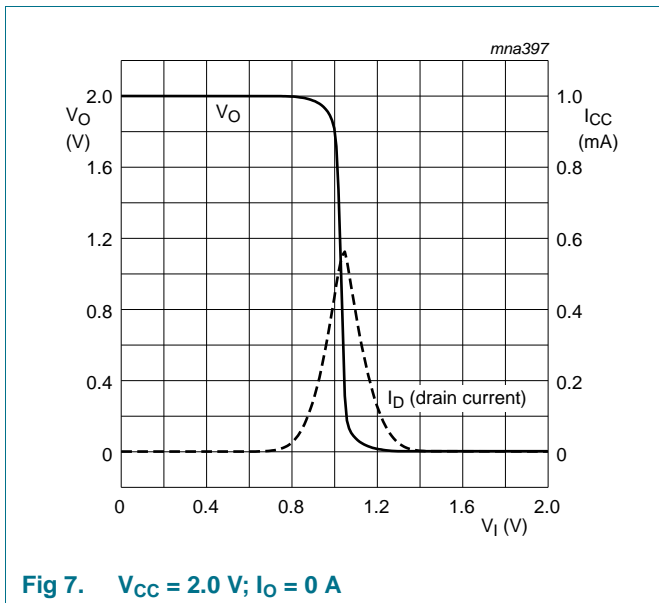
- [1] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.
- [2] Typical values are measured at V<sub>CC</sub> = 3.3 V.
- [3] Typical values are measured at V<sub>CC</sub> = 5.0 V.
- [4] C<sub>PD</sub> is used to determine the dynamic power dissipation P<sub>D</sub> (μW).  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$  where:  
 f<sub>i</sub> = input frequency in MHz;

$f_o$  = output frequency in MHz;  
 $C_L$  = output load capacitance in pF;  
 $V_{CC}$  = supply voltage in Volts.

### 12. Waveforms



### 13. Typical transfer characteristics



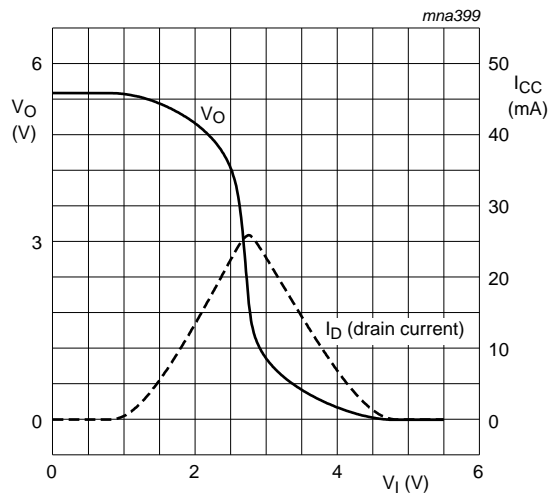


Fig 9.  $V_{CC} = 5.5\text{ V}; I_O = 0\text{ A}$

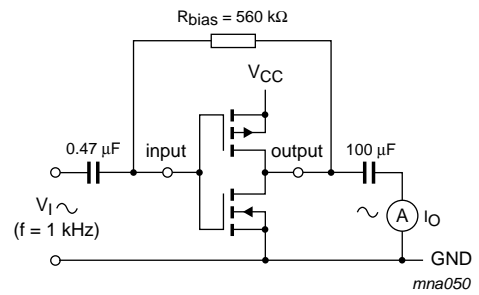


Fig 10. Test set-up for measuring forward transconductance  $g_{fs} = \Delta I_O / \Delta V_I$  at  $V_O$  is constant

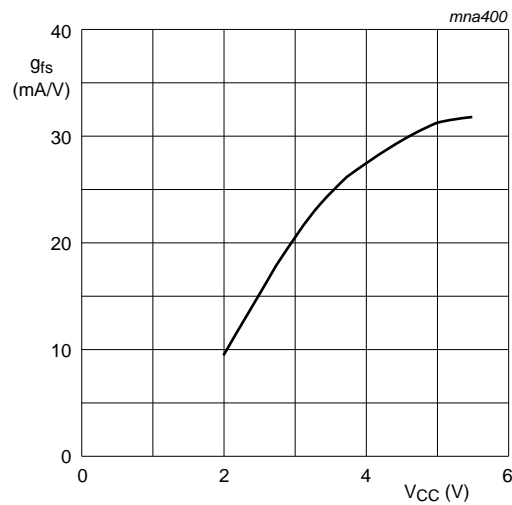


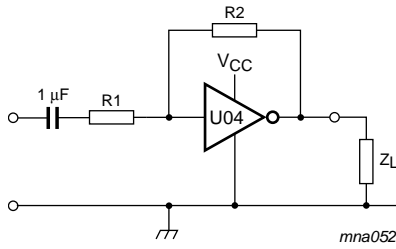
Fig 11. Typical forward transconductance  $g_{fs}$  as a function of the supply voltage at  $T_{amb} = 25\text{ }^\circ\text{C}$

## 14. Application information

Some applications are:

- Linear amplifier (see [Figure 12](#))
- In crystal oscillator design (see [Figure 13](#))

**Remark:** All values given are typical unless otherwise specified.



Maximum  $V_{o(p-p)} = V_{CC} - 1.5 \text{ V}$  centered at  $0.5 \times V_{CC}$ .

$$G_v = -\frac{G_{ol}}{1 + \frac{R1}{R2}(1 + G_{ol})}$$

$G_{ol}$  = open loop gain

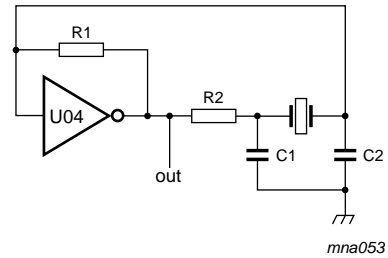
$G_v$  = voltage gain

$R1 \geq 3 \text{ k}\Omega$ ,  $R2 \leq 1 \text{ M}\Omega$

$Z_L > 10 \text{ k}\Omega$ ;  $G_{ol} = 20$  (typical)

Typical unity gain bandwidth product is 5 MHz.

Fig 12. Used as a linear amplifier



$C1 = 47 \text{ pF}$  (typical)

$C2 = 22 \text{ pF}$  (typical)

$R1 = 1 \text{ M}\Omega$  to  $10 \text{ M}\Omega$  (typical)

$R2$  optimum value depends on the frequency and required stability against changes in  $V_{CC}$  or average minimum  $I_{CC}$  ( $I_{CC}$  is typically 2 mA at  $V_{CC} = 3 \text{ V}$  and  $f = 1 \text{ MHz}$ ).

Fig 13. Crystal oscillator configuration

Table 9. External components for resonator ( $f < 1 \text{ MHz}$ )

All values given are typical and must be used as an initial set-up.

Frequency	R1	R2	C1	C2
10 kHz to 15.9 kHz	22 M $\Omega$	220 k $\Omega$	56 pF	20 pF
16 kHz to 24.9 kHz	22 M $\Omega$	220 k $\Omega$	56 pF	10 pF
25 kHz to 54.9 kHz	22 M $\Omega$	100 k $\Omega$	56 pF	10 pF
55 kHz to 129.9 kHz	22 M $\Omega$	100 k $\Omega$	47 pF	5 pF
130 kHz to 199.9 kHz	22 M $\Omega$	47 k $\Omega$	47 pF	5 pF
200 kHz to 349.9 kHz	22 M $\Omega$	47 k $\Omega$	47 pF	5 pF
350 kHz to 600 kHz	22 M $\Omega$	47 k $\Omega$	47 pF	5 pF

Table 10. Optimum value for R2

Frequency	R2	Optimum for
3 kHz	2.0 k $\Omega$	minimum required $I_{CC}$
	8.0 k $\Omega$	minimum influence due to change in $V_{CC}$
6 kHz	1.0 k $\Omega$	minimum required $I_{CC}$
	4.7 k $\Omega$	minimum influence by $V_{CC}$
10 kHz	0.5 k $\Omega$	minimum required $I_{CC}$
	2.0 k $\Omega$	minimum influence by $V_{CC}$
14 kHz	0.5 k $\Omega$	minimum required $I_{CC}$
	1.0 k $\Omega$	minimum influence by $V_{CC}$
>14 kHz	-	replace R2 by C3 with a typical value of 35 pF

15. Package outline

TSSOP5: plastic thin shrink small outline package; 5 leads; body width 1.25 mm

SOT353-1

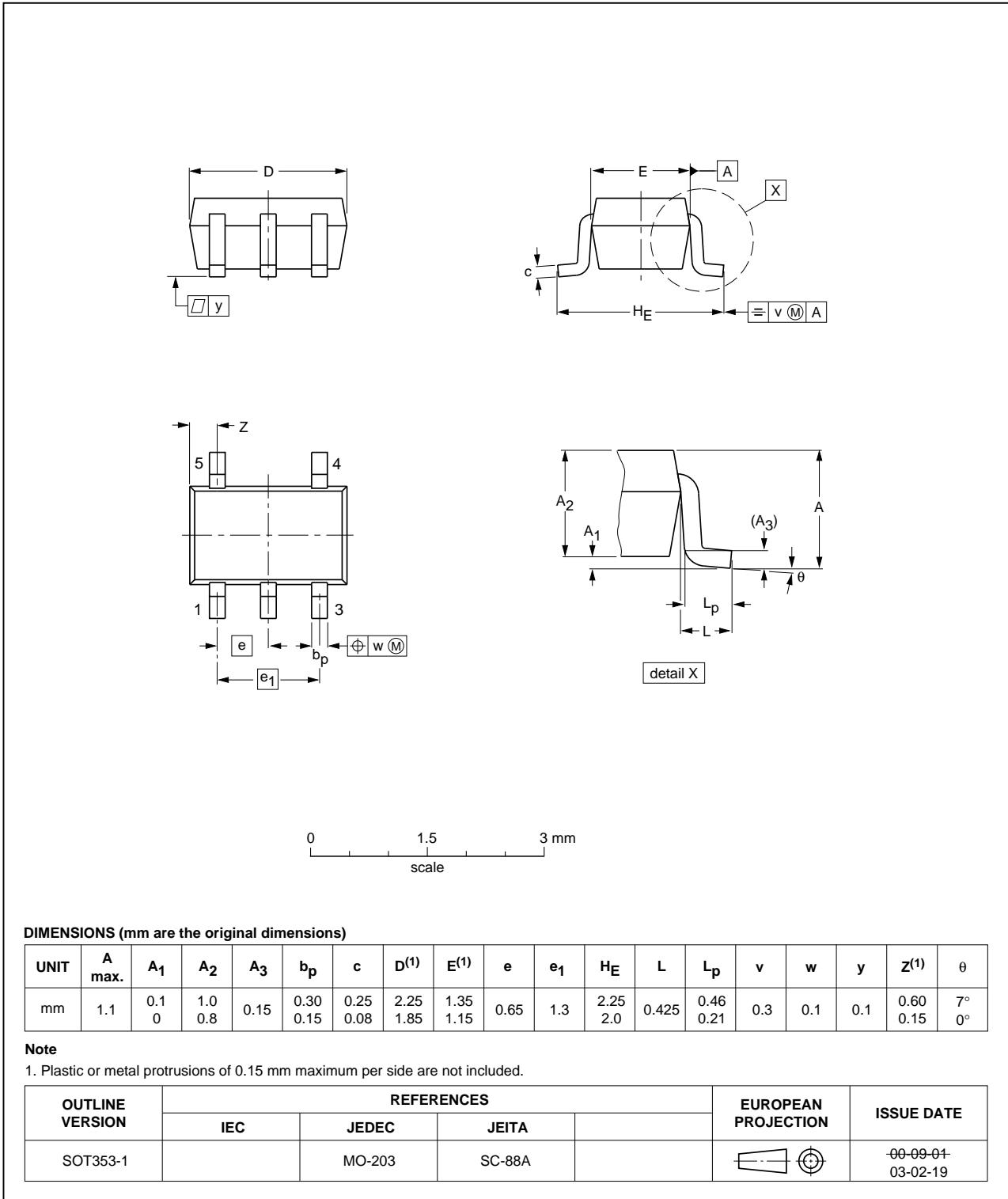


Fig 14. Package outline SOT353-1 (TSSOP5)



Plastic surface-mounted package; 5 leads

SOT753

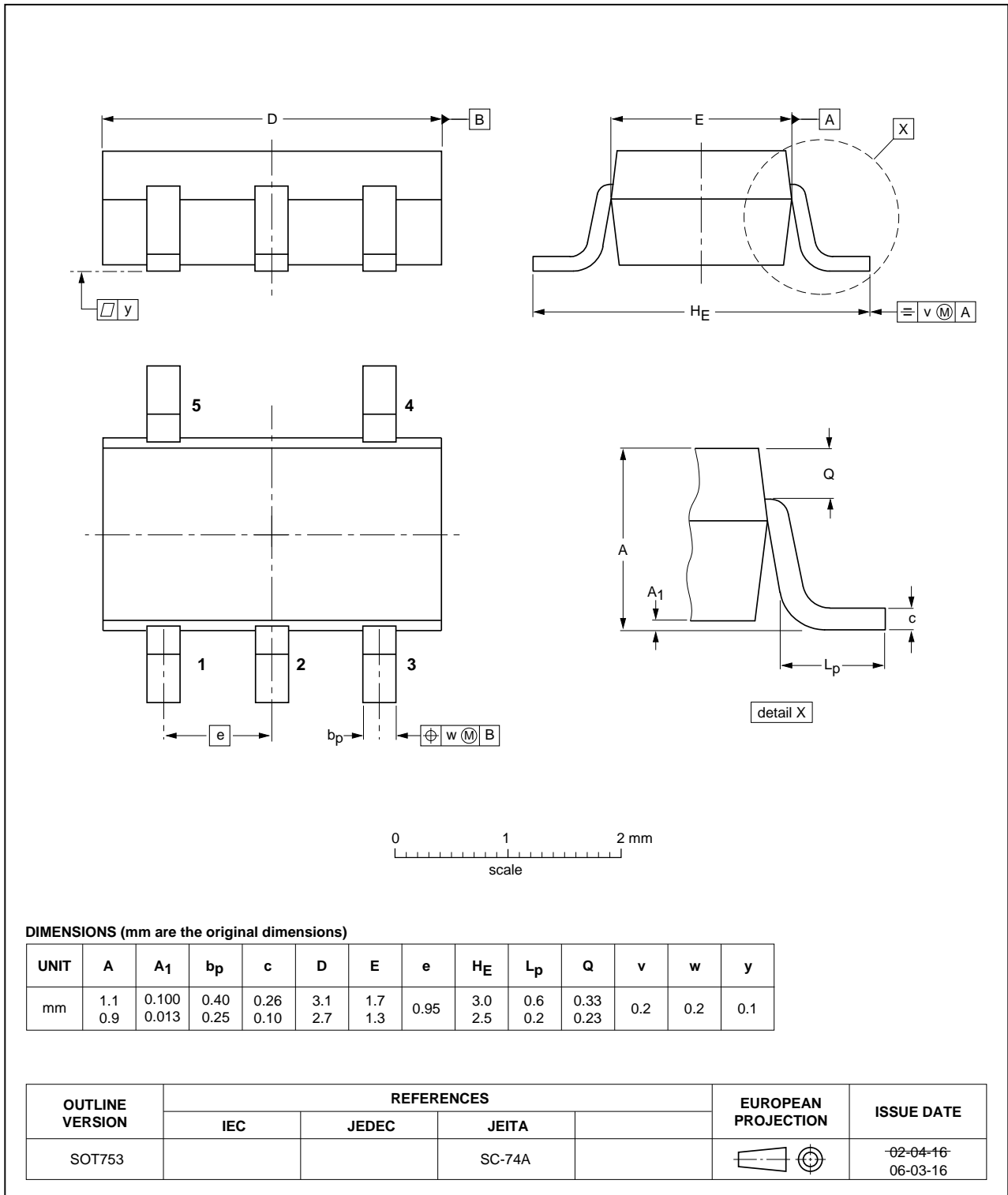


Fig 15. Package outline SOT753 (SC-74A)

## 16. Abbreviations

Table 11. Abbreviations

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

## 17. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74AHC1GU04_Q100 v.1	20121121	Product data sheet	-	-

## 18. Legal information

### 18.1 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>.

### 18.2 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. NXP Semiconductors 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 NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

**Product specification** — The information and data provided in a Product data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the Product data sheet.

### 18.3 Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors 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. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

**Right to make changes** — NXP Semiconductors 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 in automotive applications** — This NXP Semiconductors product has been qualified for use in automotive applications. Unless otherwise agreed in writing, the product is not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors 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. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Limiting values** — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

**Terms and conditions of commercial sale** — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

**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 competent authorities.

**Translations** — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

## 18.4 Trademarks

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

## 19. Contact information

---

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

## 20. Contents

1	<b>General description</b> .....	1
2	<b>Features and benefits</b> .....	1
3	<b>Ordering information</b> .....	1
4	<b>Marking</b> .....	1
5	<b>Functional diagram</b> .....	2
6	<b>Pinning information</b> .....	2
6.1	Pinning .....	2
6.2	Pin description .....	2
7	<b>Functional description</b> .....	2
8	<b>Limiting values</b> .....	3
9	<b>Recommended operating conditions</b> .....	3
10	<b>Static characteristics</b> .....	3
11	<b>Dynamic characteristics</b> .....	4
12	<b>Waveforms</b> .....	5
13	<b>Typical transfer characteristics</b> .....	5
14	<b>Application information</b> .....	6
15	<b>Package outline</b> .....	8
16	<b>Abbreviations</b> .....	10
17	<b>Revision history</b> .....	10
18	<b>Legal information</b> .....	11
18.1	Data sheet status .....	11
18.2	Definitions .....	11
18.3	Disclaimers .....	11
18.4	Trademarks .....	12
19	<b>Contact information</b> .....	12
20	<b>Contents</b> .....	13

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP B.V. 2012.

All rights reserved.

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

Date of release: 21 November 2012

Document identifier: 74AHC1GU04\_Q100