

# 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			Version
	Temperature range	Name	Description	
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

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## 5. Functional diagram

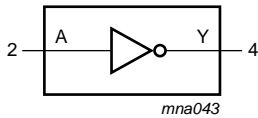


Fig 1. Logic symbol

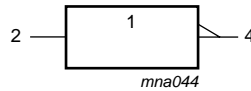


Fig 2. IEC logic symbol

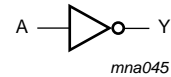


Fig 3. Logic diagram

## 6. Pinning information

### 6.1 Pinning

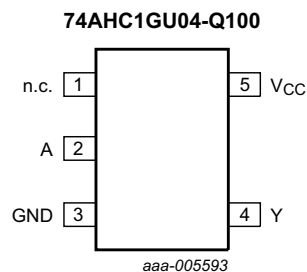


Fig 4. Pin configuration

### 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.

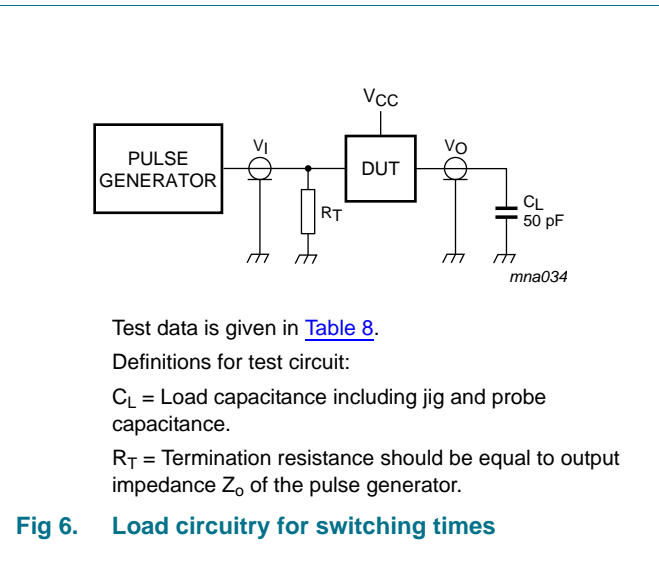
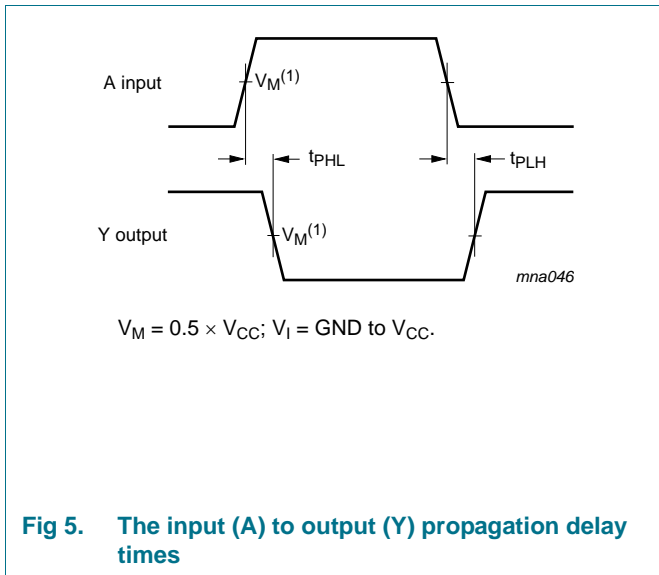
[4] C<sub>PD</sub> is used to determine the dynamic power dissipation P<sub>D</sub> (μW).

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

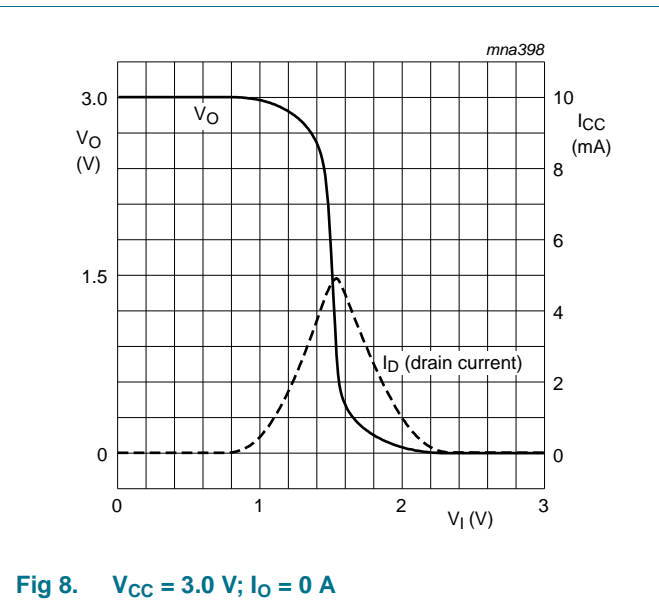
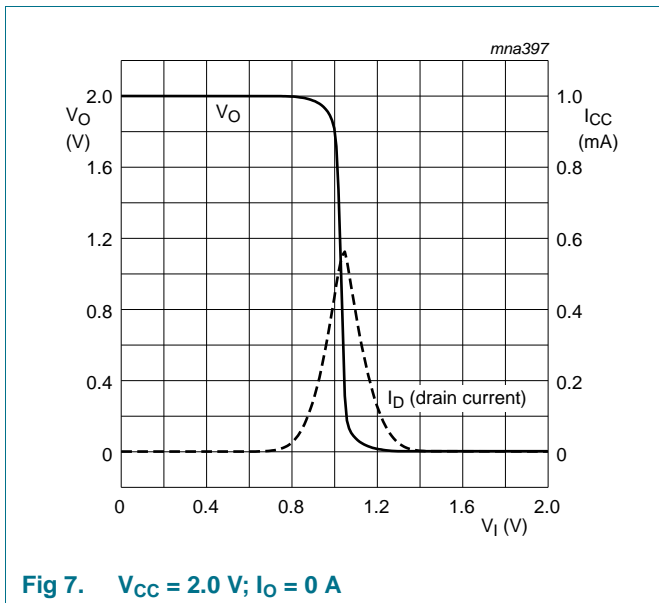
f<sub>i</sub> = input frequency in MHz;

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

## 12. Waveforms



## 13. Typical transfer characteristics



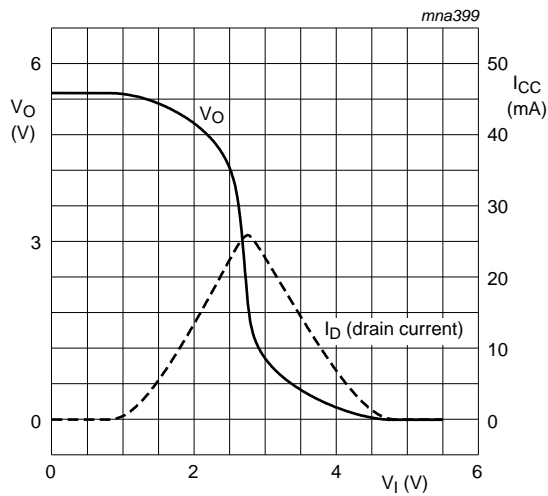


Fig 9.  $V_{CC} = 5.5 \text{ V}; I_O = 0 \text{ A}$

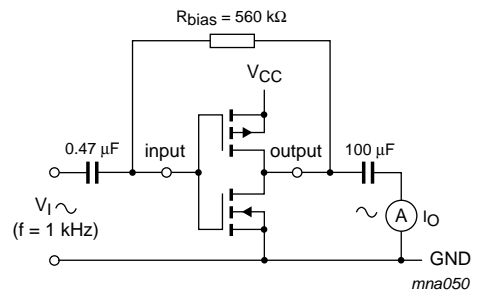


Fig 10. Test set-up for measuring forward transconductance  $g_{fs} = \Delta I_O / \Delta V_I$  at  $V_O$  is constant

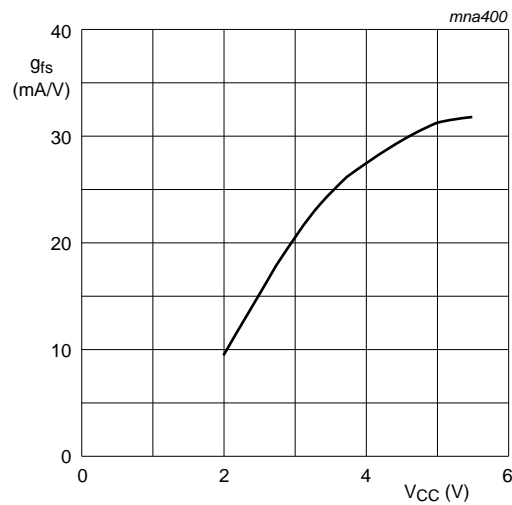


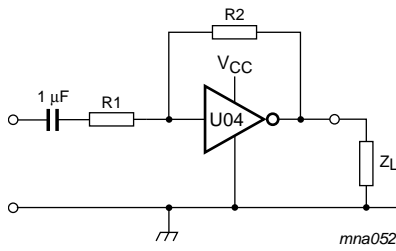
Fig 11. Typical forward transconductance  $g_{fs}$  as a function of the supply voltage at  $T_{amb} = 25 \text{ }^\circ\text{C}$

## 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

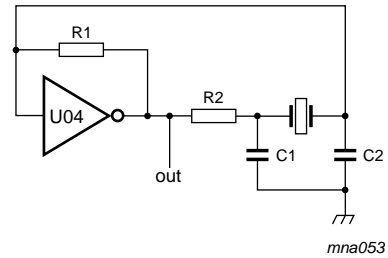
$G_v$  = voltage gain

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

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

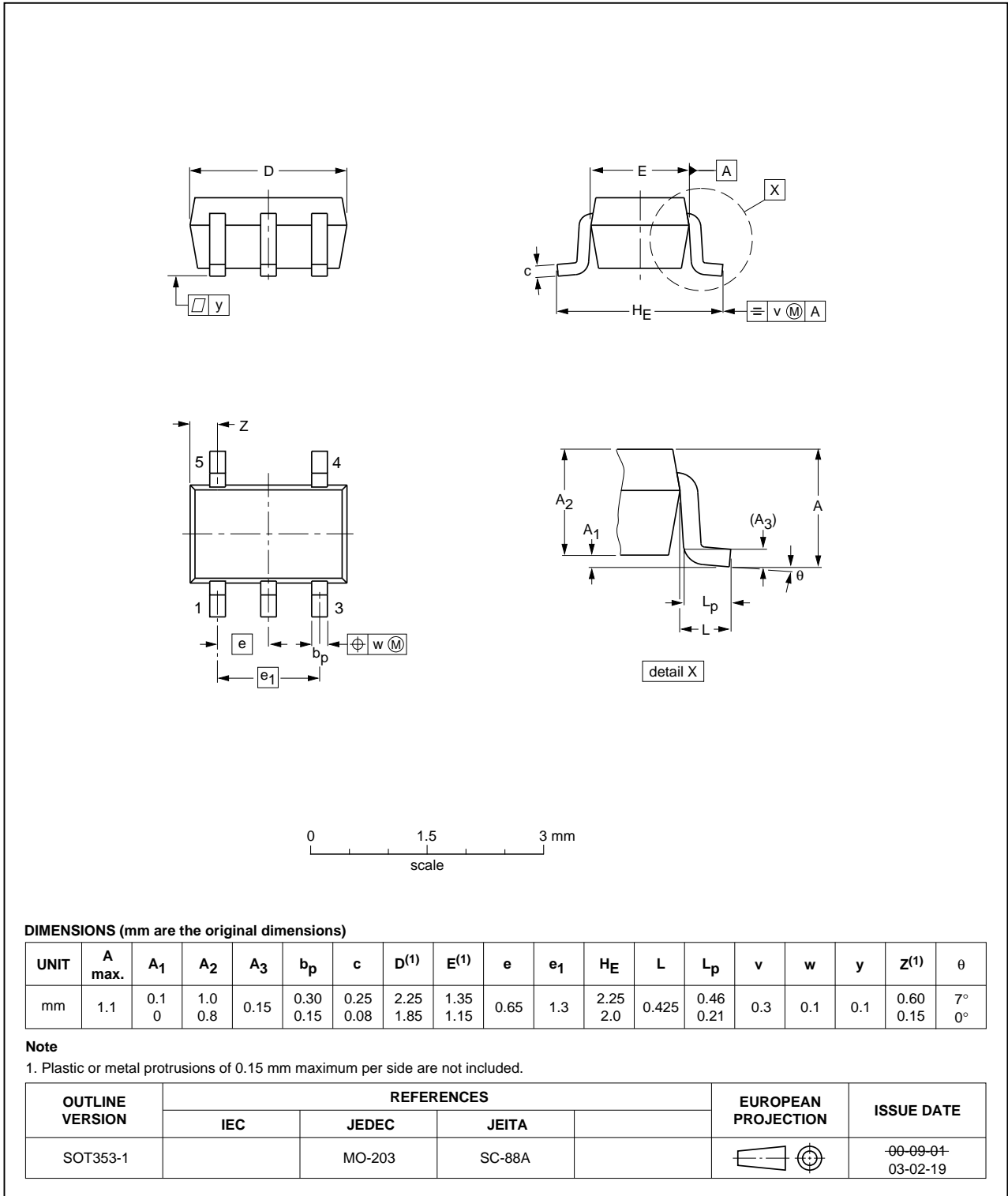


Fig 14. Package outline SOT353-1 (TSSOP5)



Plastic surface-mounted package; 5 leads

SOT753

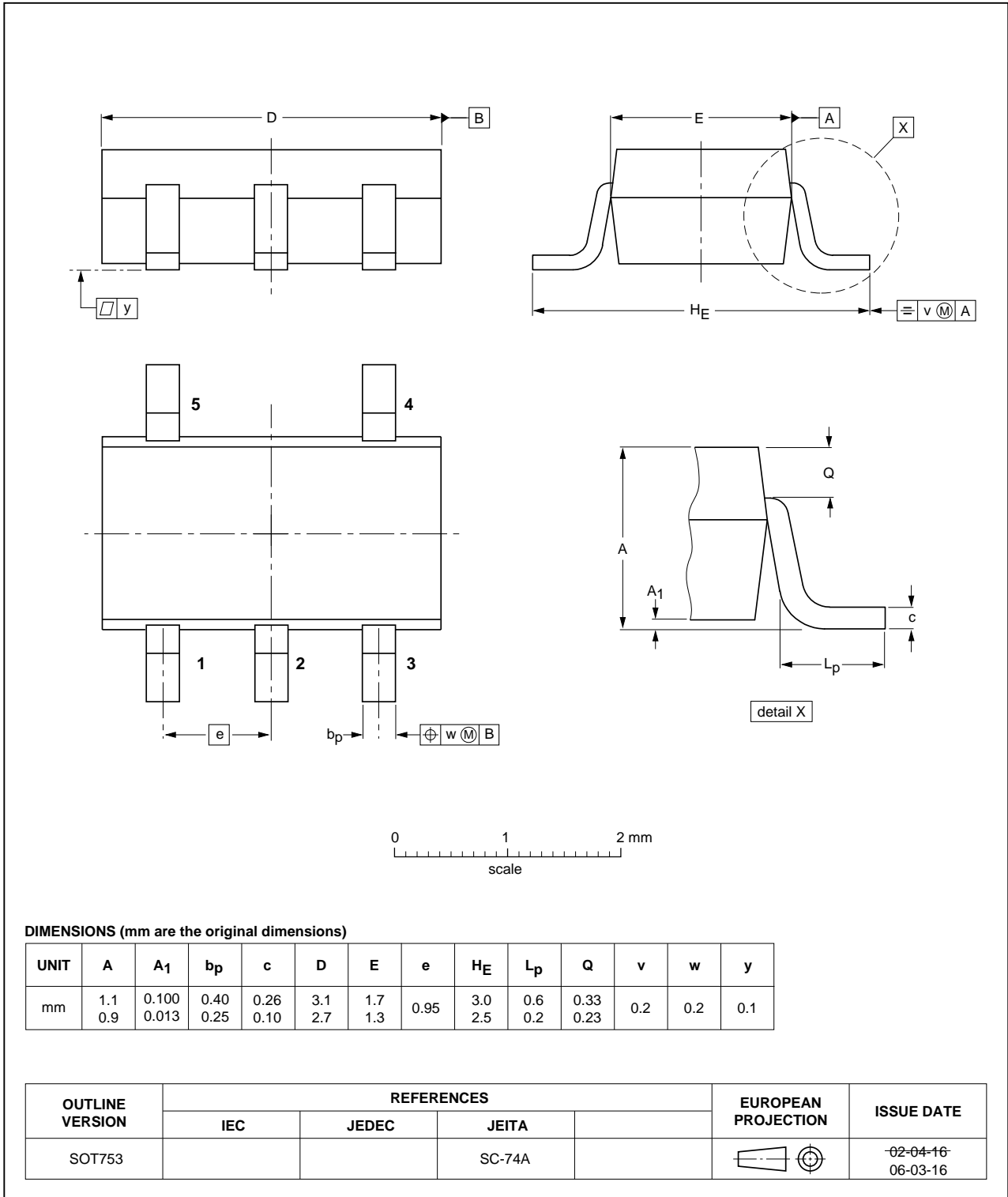


Fig 15. Package outline SOT753 (SC-74A)

## 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.
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