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Team Nexperia

74HC3GU04

Triple unbuffered inverter

Rev. 5 — 2 October 2013 Product data sheet

1. General description

The 74HC3GU04 is a triple unbuffered inverter. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC}.

2. Features and benefits

- Wide supply voltage range from 2.0 V to 6.0 V
- Symmetrical output impedance
- High noise immunity
- Low-power dissipation
- Balanced propagation delays
- Multiple package options
- ESD protection:
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
- Specified from −40 °C to +85 °C and −40 °C to +125 °C

3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC3GU04DP	−40 °C to +125 °C	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm	SOT505-2
74HC3GU04DC	−40 °C to +125 °C	VSSOP8	plastic very thin shrink small outline package; 8 leads; body width 2.3 mm	SOT765-1
74HC3GU04GD	−40 °C to +125 °C	XSON8	plastic extremely thin small outline package; no leads; 8 terminals; body 3 × 2 × 0.5 mm	SOT996-2

4. Marking

Table 2. Marking

Type number	Marking code[1]
74HC3GU04DP	HU4
74HC3GU04DC	HU4
74HC3GU04GD	HU4

[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

5. Functional diagram

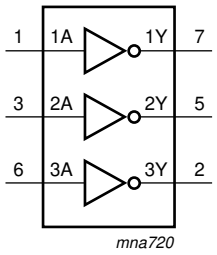


Fig 1. Logic symbol

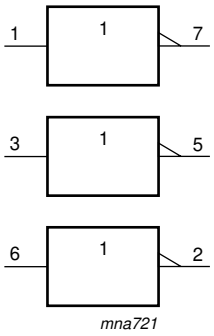


Fig 2. IEC logic symbol

6. Pinning information

6.1 Pinning

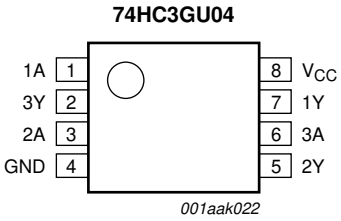
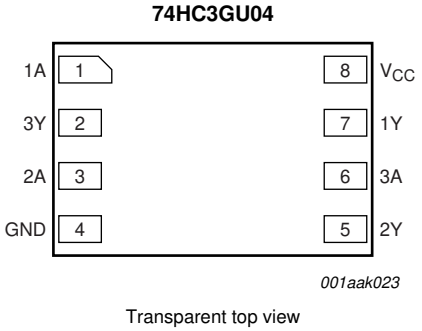


Fig 3. Pin configuration SOT505-2 (TSSOP8) and SOT765-1 (VSSOP8)



Transparent top view

Fig 4. Pin configuration SOT996-2 (XSON8)

6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
1A, 2A, 3A	1, 3, 6	data input
1Y, 2Y, 3Y	7, 5, 2	data output
GND	4	ground (0 V)
V_{CC}	8	supply voltage

7. Functional description

Table 4. Function table [1]

Input	Output
nA	**nY**
L	H
H	L

[1] H = HIGH voltage level; L = LOW voltage level.

8. Limiting values

Table 5. 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	+7.0	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
I_O	output current	$V_O = -0.5$ V to $(V_{CC} + 0.5$ V)	[1]	-	±25	mA
I_{CC}	quiescent supply current		[1]	-	50	mA
I_{GND}	ground current		[1]	−50	-	mA
T_{stg}	storage temperature			−65	+150	°C
P_{tot}	total power dissipation	$T_{amb} = -40$ °C to +125 °C	[2]	-	300	mW

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

[2] For TSSOP8 package: above 55 °C the value of P_{tot} derates linearly with 2.5 mW/K.
For VSSOP8 package: above 110 °C the value of P_{tot} derates linearly with 8 mW/K.
For XSON8 package: above 118 °C the value of P_{tot} derates linearly with 7.8 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	6.0	V
V_I	input voltage		0	-	V_{CC}	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	$V_{CC} = 2.0$ V	-	-	625	ns/V
		$V_{CC} = 4.5$ V	-	1.67	139	ns/V
		$V_{CC} = 6.0$ V	-	-	83	ns/V

10. Static characteristics

Table 7. Static characteristics

Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	–40 °C to +85 °C			–40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	
V_{IH}	HIGH-level input voltage	V_{CC} = 2.0 V	1.7	1.1	-	1.7	-	V
		V_{CC} = 4.5 V	3.6	2.4	-	3.6	-	V
		V_{CC} = 6.0 V	4.8	3.1	-	4.8	-	V
V_{IL}	LOW-level input voltage	V_{CC} = 2.0 V	-	0.9	0.3	-	0.3	V
		V_{CC} = 4.5 V	-	2.1	0.9	-	0.9	V
		V_{CC} = 6.0 V	-	2.9	1.2	-	1.2	V
V_{OH}	HIGH-level output voltage	V_I = V_{IH} or V_{IL}						
		I_O = –20 μA; V_{CC} = 2.0 V	1.9	2.0	-	1.9	-	V
		I_O = –20 μA; V_{CC} = 4.5 V	4.4	4.5	-	4.4	-	V
		I_O = –20 μA; V_{CC} = 6.0 V	5.9	6.0	-	5.9	-	V
		I_O = –4.0 mA; V_{CC} = 4.5 V	4.13	4.32	-	3.7	-	V
		I_O = –5.2 mA; V_{CC} = 6.0 V	5.63	5.81	-	5.2	-	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	V
		I_O = 20 μA; V_{CC} = 4.5 V	-	0	0.1	-	0.1	V
		I_O = 20 μA; V_{CC} = 6.0 V	-	0	0.1	-	0.1	V
		I_O = 4.0 mA; V_{CC} = 4.5 V	-	0.15	0.33	-	0.4	V
		I_O = 5.2 mA; V_{CC} = 6.0 V	-	0.16	0.33	-	0.4	V
I_I	input leakage current	V_I = V_{CC} or GND; V_{CC} = 6.0 V	-	-	±1.0	-	±1.0	μA
I_{CC}	supply current	per input pin; V_I = V_{CC} or GND; I_O = 0 A; V_{CC} = 6.0 V	-	-	10	-	20	μA
C_I	input capacitance		-	3.0	-	-	-	pF

[1] All typical values are measured at T_{amb} = 25 °C.

11. Dynamic characteristics

Table 8. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 6.

Symbol	Parameter	Conditions	–40 °C to +85 °C			–40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	
t_{pd}	propagation delay	nA to nY; see Figure 5 [2]						
		V_{CC} = 2.0 V	-	13	75	-	90	ns
		V_{CC} = 4.5 V	-	6	15	-	18	ns
		V_{CC} = 6.0 V	-	5	13	-	15	ns

Table 8. Dynamic characteristics *…continued*

Voltages are referenced to GND (ground = 0 V); for test circuit see Figure 6.

Symbol	Parameter	Conditions		–40 °C to +85 °C			–40 °C to +125 °C		Unit
				Min	Typ[1]	Max	Min	Max	
t_t	transition time	nY; see Figure 5	[3]						
		V_{CC} = 2.0 V		-	18	95	-	125	ns
		V_{CC} = 4.5 V		-	6	19	-	25	ns
		V_{CC} = 6.0 V		-	5	16	-	20	ns
C_{PD}	power dissipation capacitance	V_I = GND to V_{CC}	[4]	-	5	-	-	-	pF

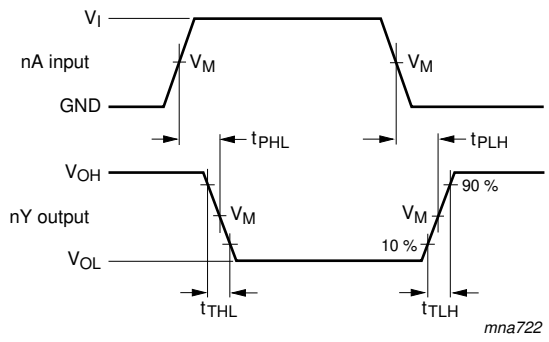
[1] All typical values are measured at T_{amb} = 25 °C.

[2] t_{pd} is the same as t_{PLH} and t_{PHL}.

[3] t_t is the same as t_{TLH} and t_{THL}.

[4] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ where:
f_i = input frequency in MHz;
f_o = output frequency in MHz;
C_L = output load capacitance in pF;
V_{CC} = supply voltage in V;
N = number of inputs switching;
$\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.

12. Waveforms

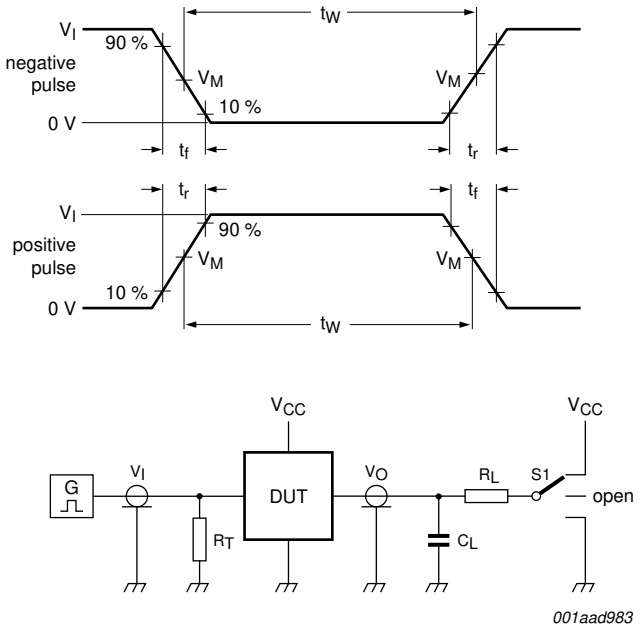


Measurement points are given in Table 9.

Fig 5. Propagation delay data input (nA) to data output (nY) and transition time output (nY)

Table 9. Measurement points

Type	Input	Output
	V_M	V_M
74HC3GU04	0.5 × V_{CC}	0.5 × V_{CC}



Test data is given in Table 10.

Definitions for 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.

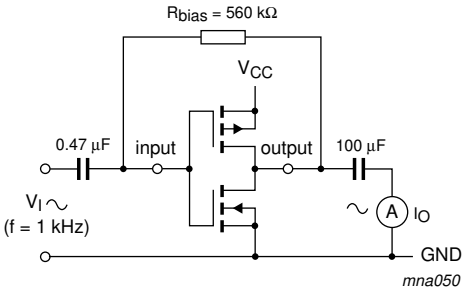
S1 = Test selection switch.

Fig 6. Test circuit for measuring switching times

Table 10. Test data

Type	Input		Load		S1 position
	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}
74HC3GU04	GND to V_{CC}	≤ 6 ns	50 pF	1 kΩ	open

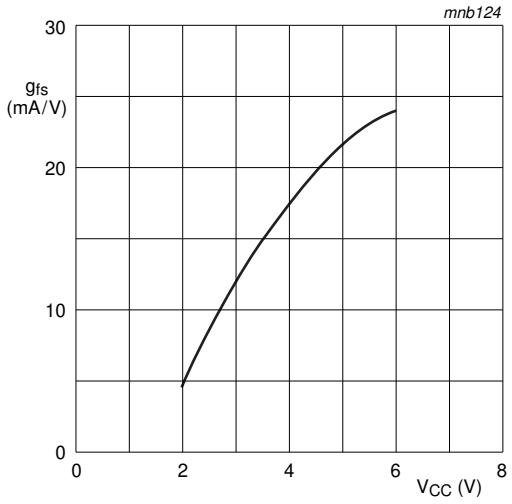
12.1 Additional characteristics



$$g_{fs} = \frac{\Delta I_O}{\Delta V_I}$$

V_O is constant.

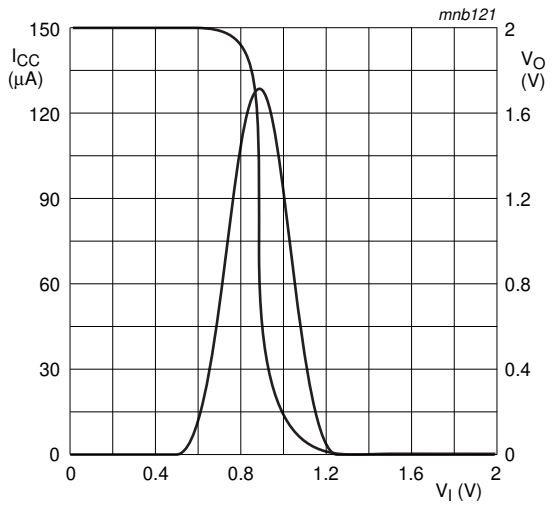
Fig 7. Test set-up for measuring forward transconductance



T_{amb} = 25 °C.

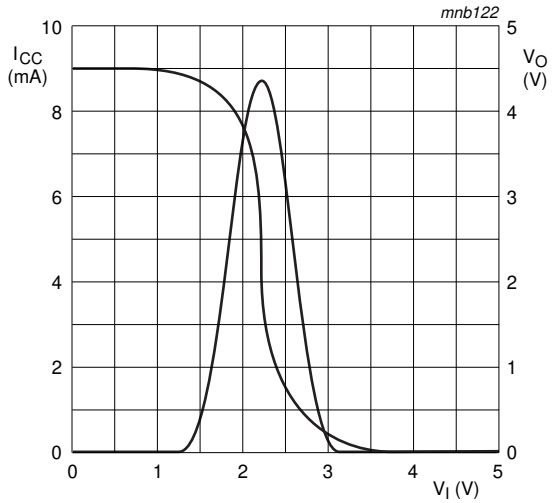
Fig 8. Typical forward transconductance as a function of supply voltage

13. Typical transfer characteristics



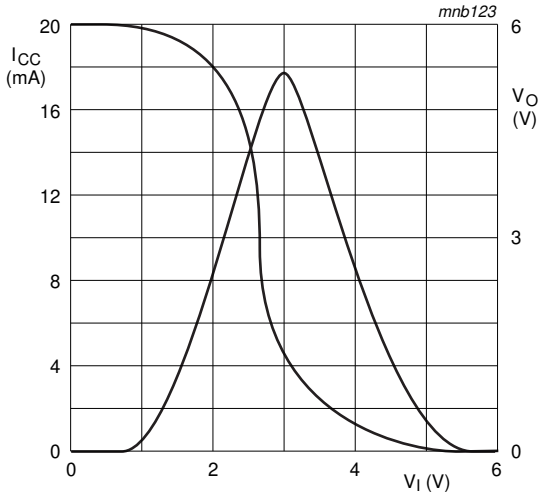
V_{CC} = 2.0 V; I_O = 0 A.

Fig 9. Typical transfer characteristics V_{CC} = 2.0 V



V_{CC} = 4.5 V; I_O = 0 A.

Fig 10. Typical transfer characteristics V_{CC} = 4.5 V



V_{CC} = 6.0 V; I_O = 0 A.

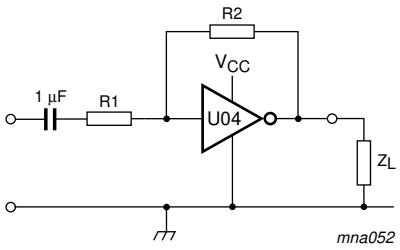
Fig 11. Typical transfer characteristics V_{CC} = 6.0 V

14. Application information

Some applications for the 74HC3GU04 are:

- Linear amplifier (see Figure 12)
- Crystal oscillator (see Figure 14).

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



Z_L > 10 kΩ.

R1 ≥ 3 kΩ.

R2 ≤ 1 MΩ.

Open loop amplification: A_{OL} = 20 (typical).

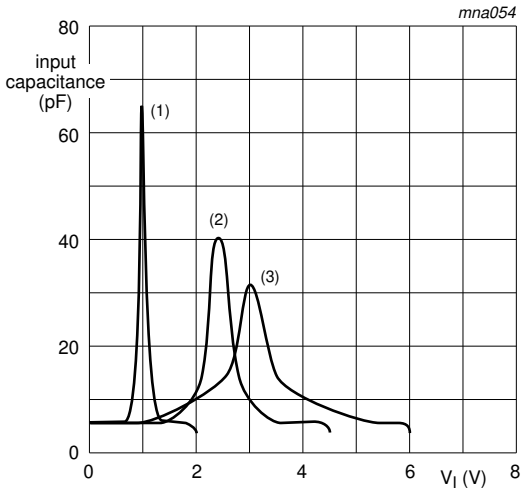
Voltage amplification: $A_V = -\dfrac{A_{OL}}{1 + \dfrac{R1}{R2}(1 + A_{OL})}$.

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

Unity gain bandwidth product is 5 MHz (typical).

Input capacitance see Figure 13.

Fig 12. Linear amplifier application

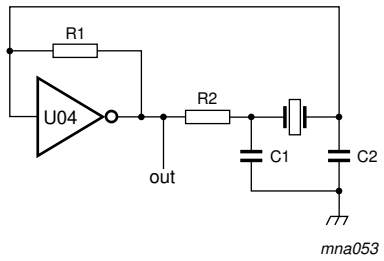


(1) V_{CC} = 2.0 V.

(2) V_{CC} = 4.5 V.

(3) V_{CC} = 6.0 V.

Fig 13. Typical input capacitance as a function of the input voltage



Test data is given in Table 11 and Table 12.

C1 = 47 pF (typical).

C2 = 22 pF (typical).

R1 = 1 MΩ to 10 MΩ (typical).

R2 optimum value depends on the frequency and required stability against changes in V_{CC} or average minimum I_{CC} (I_{CC} = 2 mA at V_{CC} = 3.0 V and f = 1 MHz)

Fig 14. Crystal oscillator application

Table 11. External components for resonator (f < 1 MHz)

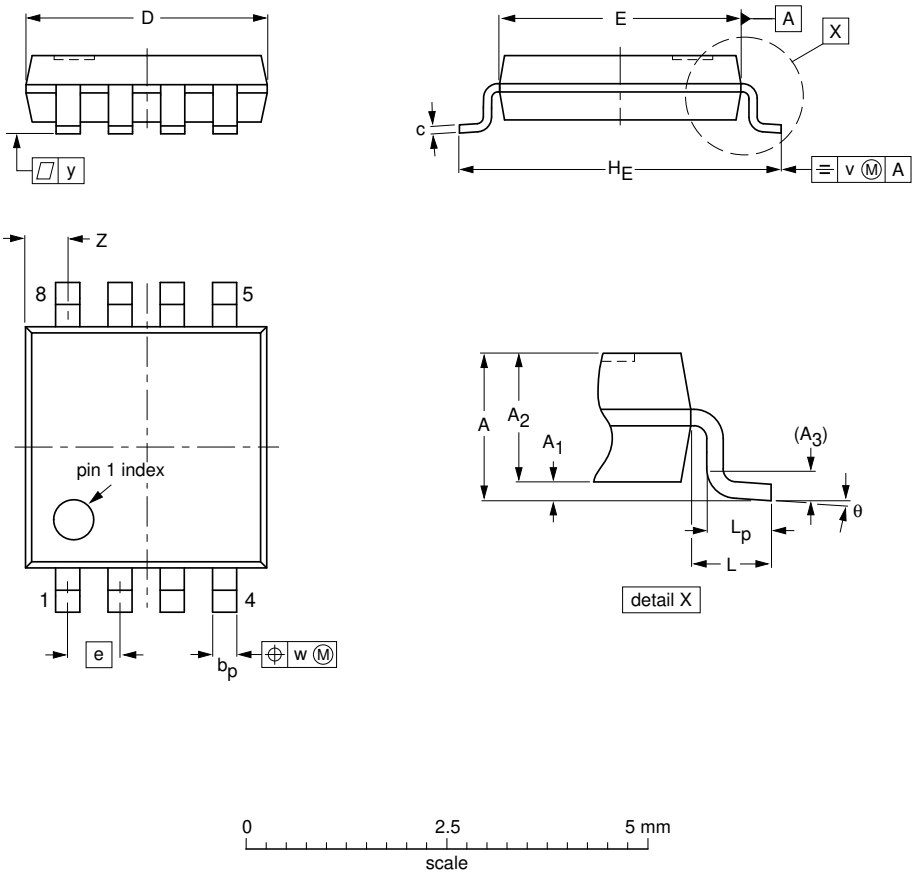
Frequency	R1	R2	C1	C2
10 kHz to 15.9 kHz	2.2 MΩ	220 kΩ	56 pF	20 pF
16 kHz to 24.9 kHz	2.2 MΩ	220 kΩ	56 pF	10 pF
25 kHz to 54.9 kHz	2.2 MΩ	100 kΩ	56 pF	10 pF
55 kHz to 129.9 kHz	2.2 MΩ	100 kΩ	47 pF	5 pF
130 kHz to 199.9 kHz	2.2 MΩ	47 kΩ	47 pF	5 pF
200 kHz to 349.9 kHz	2.2 MΩ	47 kΩ	47 pF	5 pF
350 kHz to 600 kHz	2.2 MΩ	47 kΩ	47 pF	5 pF

Table 12. Optimum value for R2

Frequency	R2	Optimum
3 kHz	2.0 kΩ	minimum required I_{CC}
	8.0 kΩ	minimum influence due to change in V_{CC}
6 kHz	1.0 kΩ	minimum required I_{CC}
	4.7 kΩ	minimum influence by V_{CC}
10 kHz	0.5 kΩ	minimum required I_{CC}
	2.0 kΩ	minimum influence by V_{CC}
14 kHz	0.5 kΩ	minimum required I_{CC}
	2.0 kΩ	minimum influence by V_{CC}
> 14 kHz	replace R2 by C3 = 35 pF (typical)	

15. Package outline

TSSOP8: plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm SOT505-2



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	v	w	y	$Z^{(1)}$	θ
mm	1.1	0.15 0.00	0.95 0.75	0.25	0.38 0.22	0.18 0.08	3.1 2.9	3.1 2.9	0.65	4.1 3.9	0.5	0.47 0.33	0.2	0.13	0.1	0.70 0.35	8° 0°

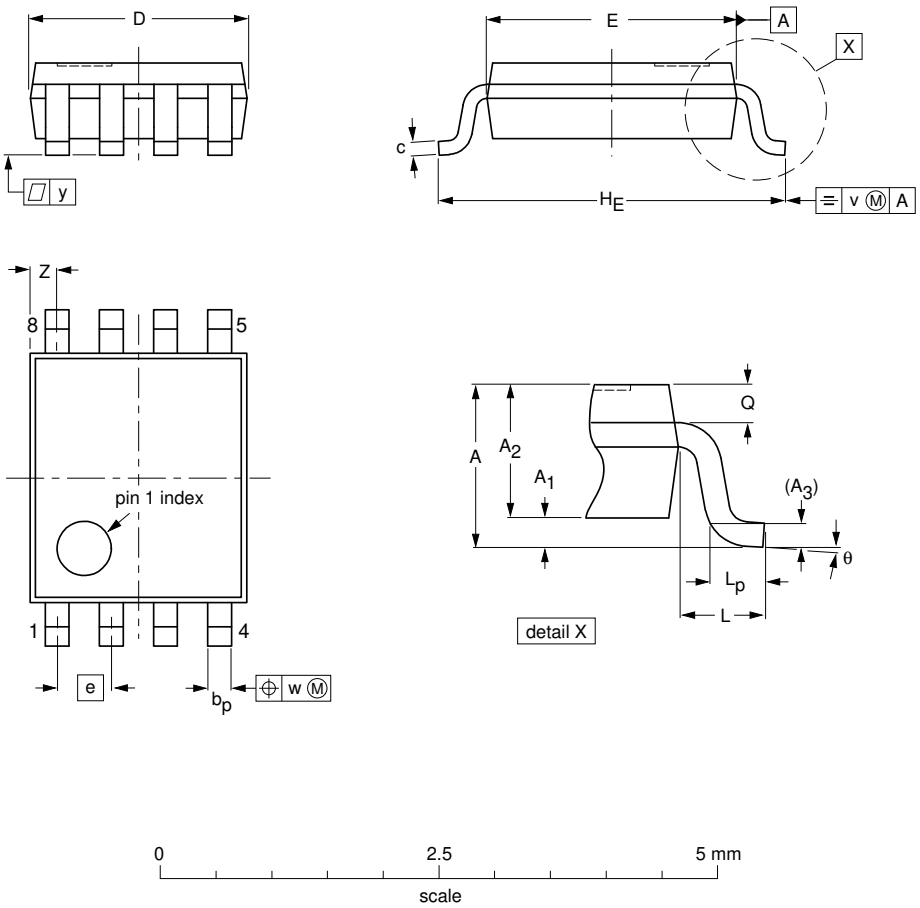
Note

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT505-2		- - -				02-01-16

Fig 15. Package outline SOT505-2 (TSSOP8)

VSSOP8: plastic very thin shrink small outline package; 8 leads; body width 2.3 mm **SOT765-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1	0.15 0.00	0.85 0.60	0.12	0.27 0.17	0.23 0.08	2.1 1.9	2.4 2.2	0.5	3.2 3.0	0.4	0.40 0.15	0.21 0.19	0.2	0.13	0.1	0.4 0.1	8° 0°

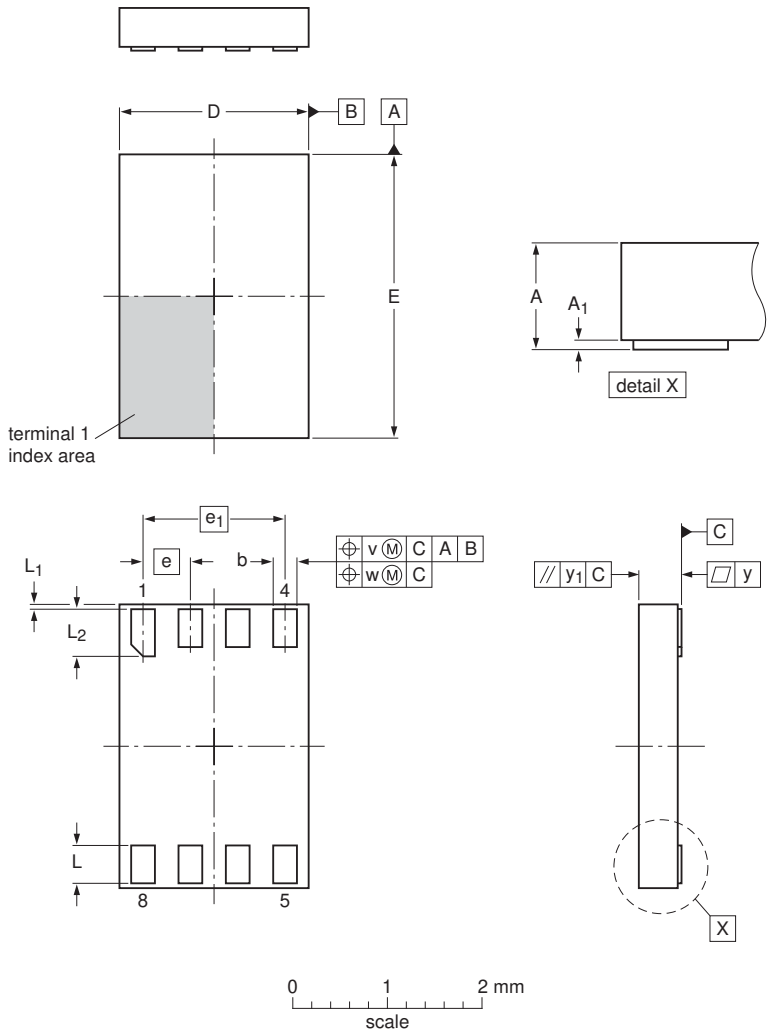
Notes

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT765-1		MO-187				02-06-07

Fig 16. Package outline SOT765-1 (VSSOP8)

XSON8: plastic extremely thin small outline package; no leads; 8 terminals; body 3 x 2 x 0.5 mm **SOT996-2**



Dimensions (mm are the original dimensions)

Unit[1]		A	A_1	b	D	E	e	e_1	L	L_1	L_2	v	w	y	y_1
mm	max	0.5	0.05	0.35	2.1	3.1	0.5	1.5	0.5	0.15	0.6	0.1	0.05	0.05	0.1
	nom														
	min		0.00	0.15	1.9	2.9			0.3	0.05	0.4				

sot996-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT996-2						~~07-12-21~~ 12-11-20

Fig 17. Package outline SOT996-2 (XSON8)

16. Abbreviations

Table 13. Abbreviations

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

17. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC3GU04 v.5	20131002	Product data sheet	-	74HC3GU04 v.4
Modifications:	• For type number 74HC3GU04GD XSON8U has changed to XSON8.			
74HC3GU04 v.4	20100111	Product data sheet	-	74HC3GU04 v.3
Modifications:	• Marking code for 74HC3GU04DP package changed from HU04 to HU4			
74HC3GU04 v.3	20090511	Product data sheet	-	74HC3GU04 v.2
74HC3GU04 v.2	20031126	Product specification	-	74HC3GU04 v.1
74HC3GU04 v.1	20030818	Product specification	-	-

18. Legal information

18.1 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.nxp.com.

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19. Contact information

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

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

20. Contents

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