74HC2GU04

Dual unbuffered inverter

Rev. 2 — 20 August 2014 | Product data sheet

1. General description

The 74HC2GU04 is a high-speed Si-gate CMOS device.

The 74HC2GU04 provides two unbuffered inverters.

2. Features and benefits

- Wide supply voltage range from 2.0 V to 6.0 V
- Complies with JEDEC standard no. 7A
- High noise immunity
- ESD protection:
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
- Low power dissipation
- Balanced propagation delays
- Multiple package options
- 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
74HC2GU04GW	–40 °C to +125 °C	SC-88	plastic surface-mounted package; 6 leads	SOT363
74HC2GU04GV	–40 °C to +125 °C	SC-74	plastic surface-mounted package (TSOP6); 6 leads	SOT457

4. Marking

Table 2. Marking

Type number	Marking code
74HC2GU04GW	PD
74HC2GU04GV	HU4

nexperia

5. Functional diagram

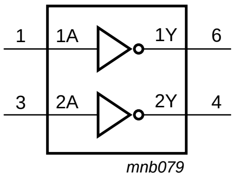


Fig 1. Logic symbol

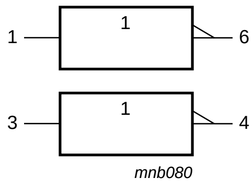


Fig 2. IEC logic symbol

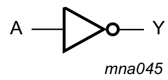


Fig 3. Logic diagram (one gate)

6. Pinning information

6.1 Pinning

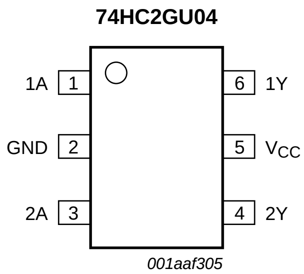


Fig 4. Pin configuration

6.2 Pin description

Table 3. Pin description

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

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}	supply current		[1]	-	+50	mA
I_{GND}	ground current		[1]	-	–50	mA
T_{stg}	storage temperature			–65	+150	°C
P_{tot}	total power dissipation		[2]	-	250	mW

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

[2] For SC-88 and SC-74 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

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
t_r	rise time	except for Schmitt trigger inputs				
		$V_{CC} = 2.0$ V	-	-	1000	ns
		$V_{CC} = 4.5$ V	-	-	500	ns
		$V_{CC} = 6.0$ V	-	-	400	ns
t_f	fall time	except for Schmitt trigger inputs				
		$V_{CC} = 2.0$ V	-	-	1000	ns
		$V_{CC} = 4.5$ V	-	-	500	ns
		$V_{CC} = 6.0$ V	-	-	400	ns

10. Static characteristics

Table 7. Static characteristics

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_{amb} = 25 °C						
V_{IH}	HIGH-level input voltage	V_{CC} = 2.0 V	1.7	1.1	-	V
		V_{CC} = 4.5 V	3.6	2.4	-	V
		V_{CC} = 6.0 V	4.8	3.1	-	V
V_{IL}	LOW-level input voltage	V_{CC} = 2.0 V	-	0.9	0.3	V
		V_{CC} = 4.5 V	-	2.1	0.9	V
		V_{CC} = 6.0 V	-	2.9	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	-	V
		I_O = –20 μA; V_{CC} = 4.5 V	4.4	4.5	-	V
		I_O = –20 μA; V_{CC} = 6.0 V	5.9	6.0	-	V
		I_O = –4.0 mA; V_{CC} = 4.5 V	4.13	4.32	-	V
		I_O = –5.2 mA; V_{CC} = 6.0 V	5.63	5.81	-	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	V
		I_O = 20 μA; V_{CC} = 4.5 V	-	0	0.1	V
		I_O = 20 μA; V_{CC} = 6.0 V	-	0	0.1	V
		I_O = 4.0 mA; V_{CC} = 4.5 V	-	0.15	0.26	V
		I_O = 5.2 mA; V_{CC} = 6.0 V	-	0.16	0.26	V
I_I	input leakage current	V_I = GND or V_{CC}; V_{CC} = 6.0 V	-	-	±0.1	μA
I_{CC}	supply current	V_I = GND or V_{CC}; I_O = 0 A; V_{CC} = 6.0 V	-	-	1.0	μA
C_I	input capacitance		-	3.0	-	pF
T_{amb} = –40 °C to +85 °C						
V_{IH}	HIGH-level input voltage	V_{CC} = 2.0 V	1.7	1.1	-	V
		V_{CC} = 4.5 V	3.6	2.4	-	V
		V_{CC} = 6.0 V	4.8	3.1	-	V
V_{IL}	LOW-level input voltage	V_{CC} = 2.0 V	-	0.9	0.3	V
		V_{CC} = 4.5 V	-	2.1	0.9	V
		V_{CC} = 6.0 V	-	2.9	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	-	V
		I_O = –20 μA; V_{CC} = 4.5 V	4.4	4.5	-	V
		I_O = –20 μA; V_{CC} = 6.0 V	5.9	6.0	-	V
		I_O = –4.0 mA; V_{CC} = 4.5 V	4.13	4.32	-	V
		I_O = –5.2 mA; V_{CC} = 6.0 V	5.63	5.81	-	V

Table 7. Static characteristics *…continued*
At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
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	V
		I_O = 20 μA; V_{CC} = 4.5 V	-	0	0.1	V
		I_O = 20 μA; V_{CC} = 6.0 V	-	0	0.1	V
		I_O = 4.0 mA; V_{CC} = 4.5 V	-	0.15	0.33	V
		I_O = 5.2 mA; V_{CC} = 6.0 V	-	0.16	0.33	V
I_I	input leakage current	V_I = GND or V_{CC}; V_{CC} = 6.0 V	-	-	±1.0	μA
I_{CC}	supply current	V_I = GND or V_{CC}; I_O = 0 A; V_{CC} = 6.0 V	-	-	10.0	μA
T_{amb} = –40 °C to +125 °C						
V_{IH}	HIGH-level input voltage	V_{CC} = 2.0 V	1.7	-	-	V
		V_{CC} = 4.5 V	3.6	-	-	V
		V_{CC} = 6.0 V	4.8	-	-	V
V_{IL}	LOW-level input voltage	V_{CC} = 2.0 V	-	-	0.3	V
		V_{CC} = 4.5 V	-	-	0.9	V
		V_{CC} = 6.0 V	-	-	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	-	-	V
		I_O = –20 μA; V_{CC} = 4.5 V	4.4	-	-	V
		I_O = –20 μA; V_{CC} = 6.0 V	5.9	-	-	V
		I_O = –4.0 mA; V_{CC} = 4.5 V	3.7	-	-	V
		I_O = –5.2 mA; V_{CC} = 6.0 V	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	-	-	0.1	V
		I_O = 20 μA; V_{CC} = 4.5 V	-	-	0.1	V
		I_O = 20 μA; V_{CC} = 6.0 V	-	-	0.1	V
		I_O = 4.0 mA; V_{CC} = 4.5 V	-	-	0.4	V
		I_O = 5.2 mA; V_{CC} = 6.0 V	-	-	0.4	V
I_I	input leakage current	V_I = GND or V_{CC}; V_{CC} = 6.0 V	-	-	±1.0	μA
I_{CC}	supply current	V_I = GND or V_{CC}; I_O = 0 A; V_{CC} = 6.0 V	-	-	20.0	μA

11. Dynamic characteristics

Table 8. Dynamic characteristics
Voltages are referenced to GND (ground = 0 V); for test circuit, see Figure 6.

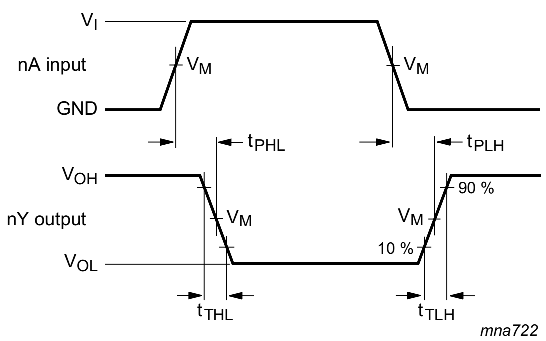
Symbol	Parameter	Conditions	25 °C			−40 °C to +125 °C			Unit
			Min	Typ	Max	Min	Max (85 °C)	Max (125 °C)	
t_{pd}	propagation delay	nA to nY; see Figure 5 [1]							
		V_{CC} = 2.0 V; C_L = 50 pF	-	13	60	-	75	90	ns
		V_{CC} = 4.5 V; C_L = 50 pF	-	6	12	-	15	18	ns
		V_{CC} = 6.0 V; C_L = 50 pF	-	5	10	-	13	15	ns
t_t	transition time	nY; see Figure 5 [2]							
		V_{CC} = 2.0 V; C_L = 50 pF	-	18	75	-	95	125	ns
		V_{CC} = 4.5 V; C_L = 50 pF	-	6	15	-	19	25	ns
		V_{CC} = 6.0 V; C_L = 50 pF	-	5	13	-	16	20	ns
C_{PD}	power dissipation capacitance	V_I = GND to V_{CC} [3]	-	5	-	-	-	-	pF

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

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

[3] 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 the outputs.

12. Waveforms



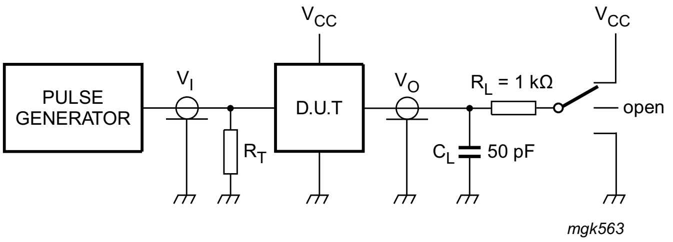
Measurement points are given in Table 9.

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

Fig 5. The data input (nA) to output (nY) propagation delays and output transition times

Table 9. Measurement points

Input			Output
V_M	V_I	$t_r = t_f$	V_M
$0.5V_{CC}$	GND to V_{CC}	6.0 ns	$0.5V_{CC}$



Test data is given in Table 10.

Definitions test circuit:

R_L = Load resistance.

C_L = Load capacitance including jig and probe capacitance.

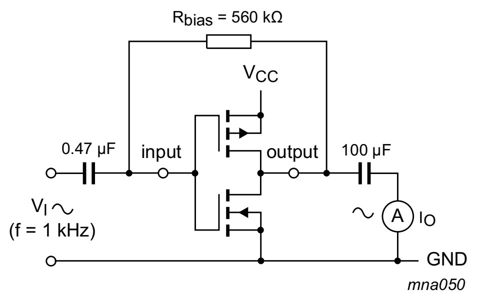
R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

Fig 6. Test circuit for measuring switching times

Table 10. Test data

Input		Test
V_I	t_r, t_f	t_{PHL}, t_{PLH}
GND to V_{CC}	6 ns	open

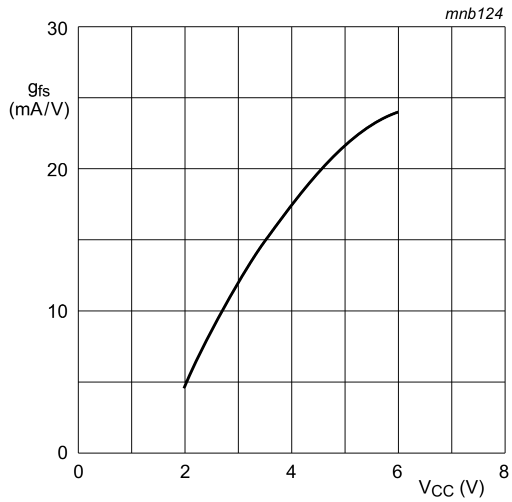
13. Additional characteristics



$$g_{fs} = \frac{\Delta I_o}{\Delta V_i}$$

V_O is constant.

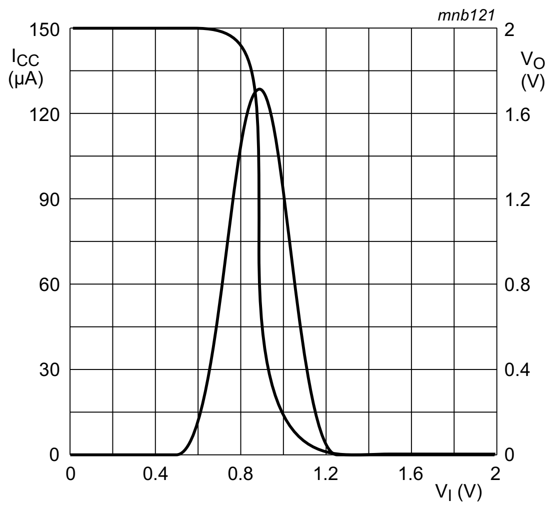
Fig 7. Test setup for measuring forward transconductance



T_{amb} = 25 °C.

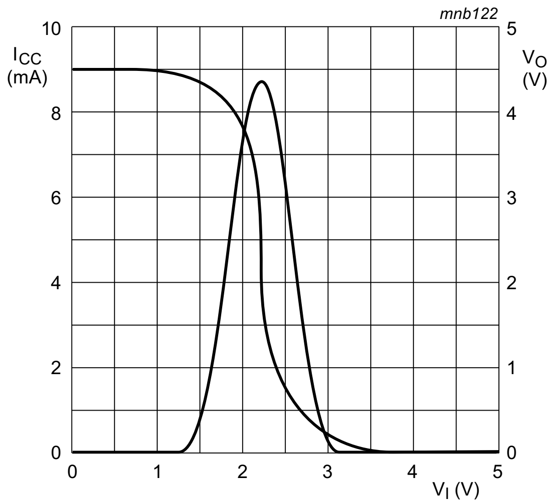
Fig 8. Typical forward transconductance as a function of supply voltage

14. Typical transfer characteristics



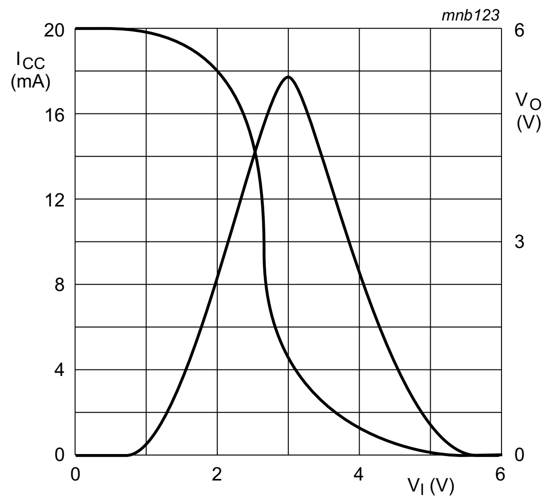
V_{CC} = 2.0 V; I_O = 0 A.

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.

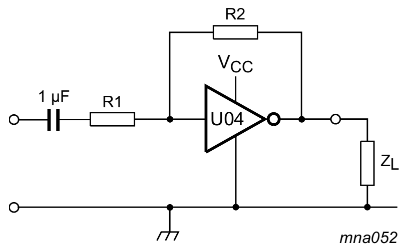
Fig 11. Typical transfer characteristics V_{CC} = 6.0 V

15. Application information

Some applications for the 74HC2GU04 are:

- Linear amplifier (see Figure 12)
- Crystal oscillator (see Figure 13)

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



Z_L > 10 kΩ.

R1 ≥ 3 kΩ.

R2 ≤ 1 MΩ.

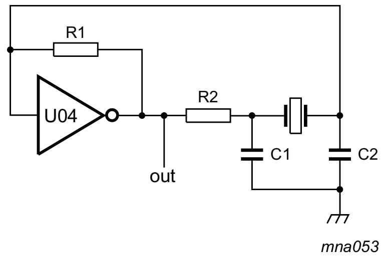
Open loop amplification: A_{OL} = 20.

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

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

Unity gain bandwidth product is 5 MHz.

Fig 12. Linear amplifier application



See Table 11 and Table 12.

C1 = 47 pF.

C2 = 22 pF.

R1 = 1 MΩ to 10 MΩ.

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 13. Crystal oscillator application

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

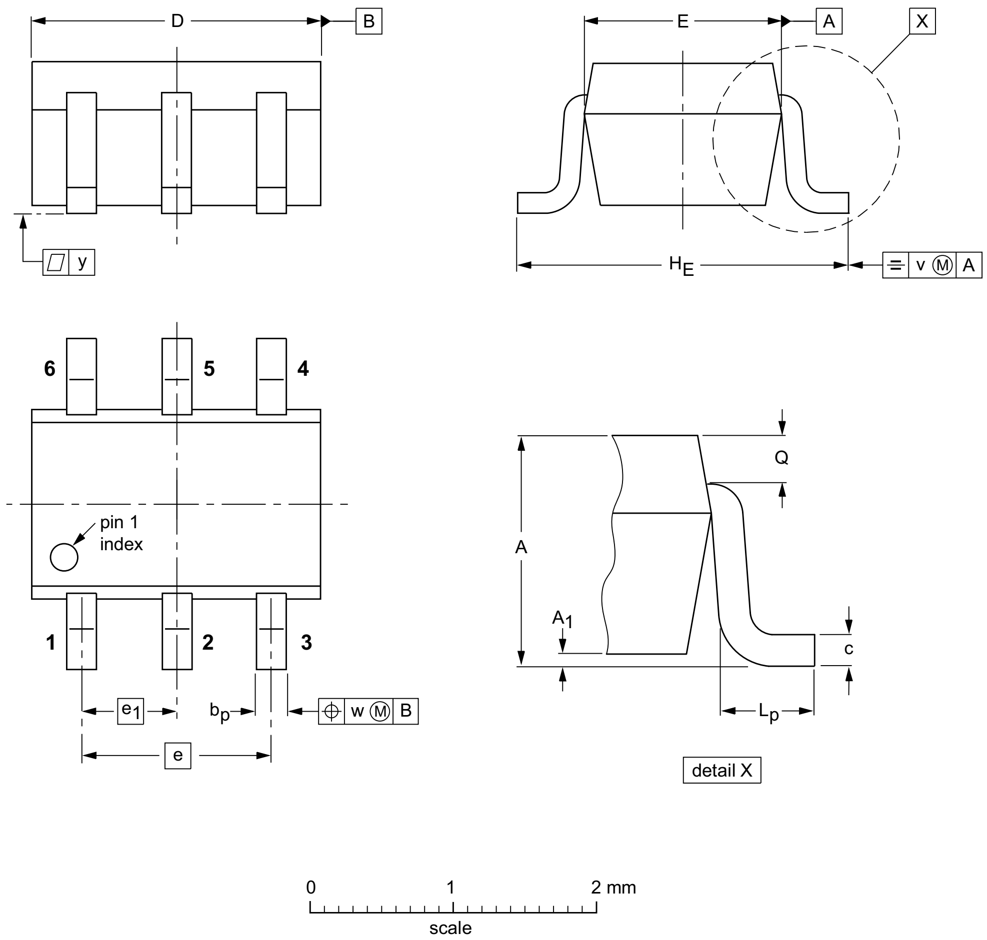
Frequency	R1	R2	C1	C2
10 kHz to 15.9 kHz	2.2 MΩ	220 kΩ	56 pF	20 pF
16 kHz to 24.9 kHz	2.2 MΩ	220 kΩ	56 pF	10 pF
25 kHz to 54.9 kHz	2.2 MΩ	100 kΩ	56 pF	10 pF
55 kHz to 129.9 kHz	2.2 MΩ	100 kΩ	47 pF	5 pF
130 kHz to 199.9 kHz	2.2 MΩ	47 kΩ	47 pF	5 pF
200 kHz to 349.9 kHz	2.2 MΩ	47 kΩ	47 pF	5 pF
350 kHz to 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	for minimum required I_{CC}
	8.0 kΩ	for minimum influence due to change in V_{CC}
6 kHz	1.0 kΩ	or minimum required I_{CC}
	4.7 kΩ	or minimum influence by V_{CC}
10 kHz	0.5 kΩ	or minimum required I_{CC}
	2.0 kΩ	or minimum influence by V_{CC}
14 kHz	0.5 kΩ	or minimum required I_{CC}
	2.0 kΩ	or minimum influence by V_{CC}
> 14 kHz	replace R2 by C3 = 35 pF (typical)	

16. Package outline

Plastic surface-mounted package; 6 leads **SOT363**



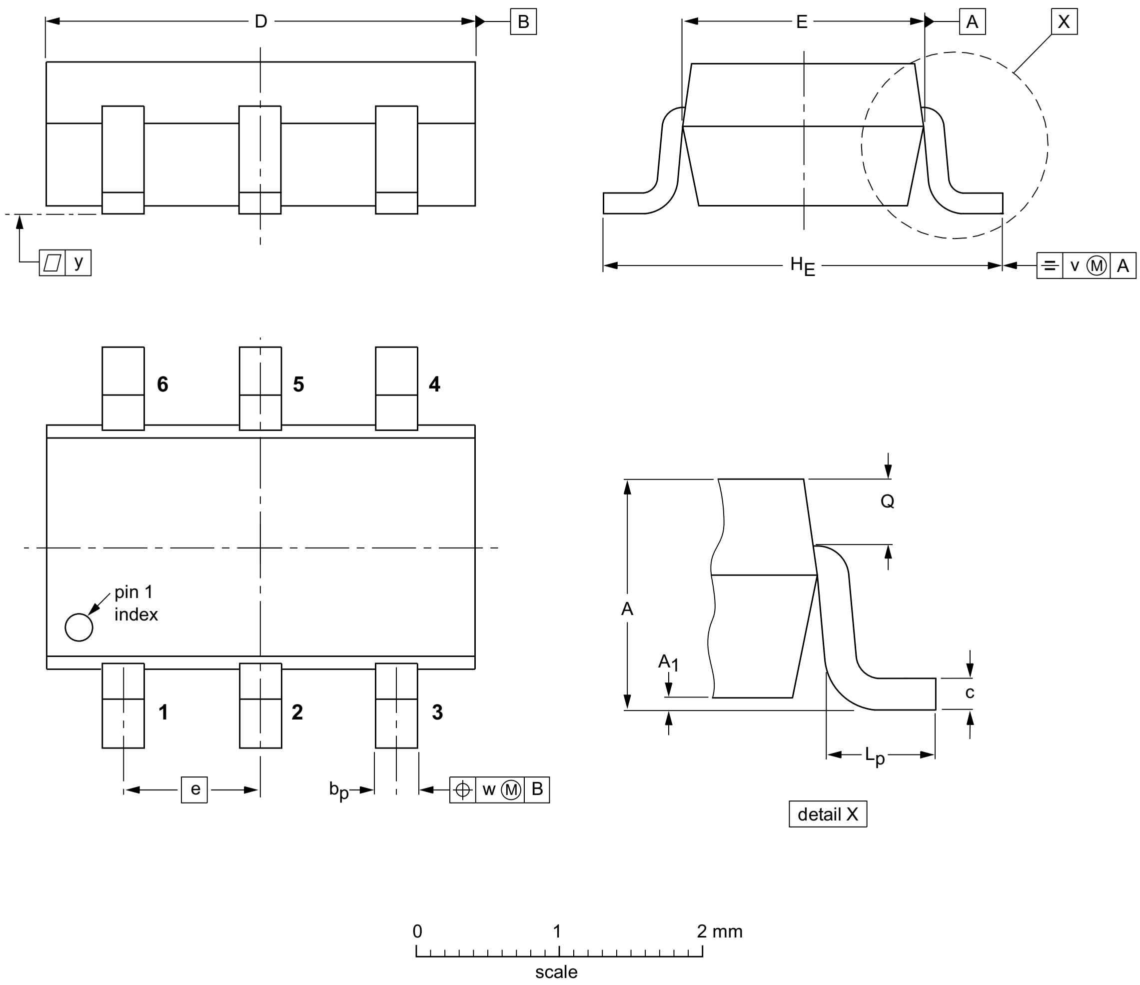
DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w	y
mm	1.1 0.8	0.1	0.30 0.20	0.25 0.10	2.2 1.8	1.35 1.15	1.3	0.65	2.2 2.0	0.45 0.15	0.25 0.15	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT363			SC-88			~~04-11-08~~ 06-03-16

Fig 14. Package outline SOT363 (SC-88)

Plastic surface-mounted package (TSOP6); 6 leads **SOT457**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b_p	c	D	E	e	H_E	L_p	Q	v	w	y
mm	1.1 0.9	0.1 0.013	0.40 0.25	0.26 0.10	3.1 2.7	1.7 1.3	0.95	3.0 2.5	0.6 0.2	0.33 0.23	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT457			SC-74			~~05-11-07~~ 06-03-16

Fig 15. Package outline SOT457 (SC-74)

17. 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

18. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC2GU04 v.2	20140820	Product data sheet	-	74HC2GU04 v.1
Modifications:	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate.			
74HC2GU04 v.1	20061006	Product data sheet	-	-

19. Legal information

19.1 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.

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20. Contact information

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

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

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