

# 74HC2GU04

Dual unbuffered inverter

Rev. 3 — 4 February 2022

Product data sheet

## 1. General description

The 74HC2GU04 is a dual 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
- CMOS low power dissipation
- High noise immunity
- Balanced propagation delays
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Complies with JEDEC standards
  - JESD8C (2.7 V to 3.6 V)
  - JESD7A (2.0 V to 6.0 V)
- 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
74HC2GU04GW	-40 °C to +125 °C	TSSOP6	plastic thin shrink small outline package; 6 leads; body width 1.25 mm	SOT363-2
74HC2GU04GV	-40 °C to +125 °C	SC-74; TSOP6	plastic surface-mounted package; 6 leads	SOT457

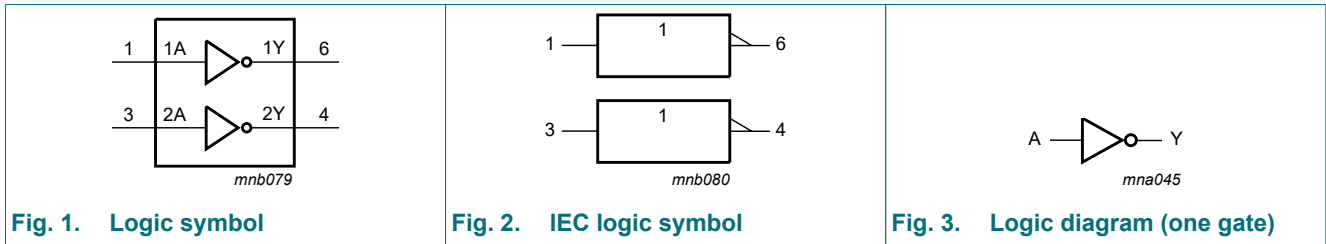
## 4. Marking

Table 2. Marking

Type number	Marking code [1]
74HC2GU04GW	PD
74HC2GU04GV	HU4

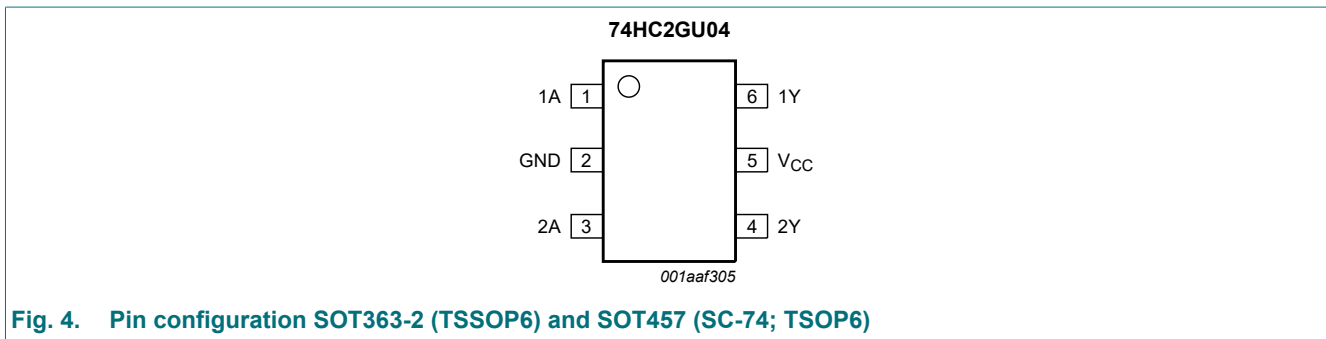
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

## 5. Functional diagram



## 6. Pinning information

### 6.1. Pinning



### 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 <sub>CC</sub>	5	supply voltage
1Y	6	data output

## 7. Functional description

Table 4. Function table

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

Input	Output
nA	nY
L	H
H	L

## 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	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ [1]	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ [1]	-	$\pm 20$	mA
$I_O$	output current	$V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$ [1]	-	$\pm 25$	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 SOT363-2 (TSSOP6) package:  $P_{tot}$  derates linearly with 3.7 mW/K above 83 °C.

For SOT457 (SC-74; TSOP6) package:  $P_{tot}$  derates linearly with 4.1 mW/K above 89 °C.

## 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				
		$V_{CC} = 2.0\text{ V}$	-	-	1000	ns
		$V_{CC} = 4.5\text{ V}$	-	-	500	ns
		$V_{CC} = 6.0\text{ V}$	-	-	400	ns
$t_f$	fall time	except for Schmitt trigger inputs				
		$V_{CC} = 2.0\text{ V}$	-	-	1000	ns
		$V_{CC} = 4.5\text{ V}$	-	-	500	ns
		$V_{CC} = 6.0\text{ V}$	-	-	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
<b>T<sub>amb</sub> = 25 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.7	1.1	-	V
		V <sub>CC</sub> = 4.5 V	3.6	2.4	-	V
		V <sub>CC</sub> = 6.0 V	4.8	3.1	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	0.9	0.3	V
		V <sub>CC</sub> = 4.5 V	-	2.1	0.9	V
		V <sub>CC</sub> = 6.0 V	-	2.9	1.2	V
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> = -20 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	4.13	4.32	-	V
		I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V	5.63	5.81	-	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> = 20 μA; V <sub>CC</sub> = 2.0 V	-	0	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	0	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.26	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	0.16	0.26	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = GND or V <sub>CC</sub> ; V <sub>CC</sub> = 6.0 V	-	-	±0.1	μA
I <sub>CC</sub>	supply current	V <sub>I</sub> = GND or V <sub>CC</sub> ; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V	-	-	1.0	μA
C <sub>I</sub>	input capacitance		-	3.0	-	pF

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +85 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.7	1.1	-	V
		V <sub>CC</sub> = 4.5 V	3.6	2.4	-	V
		V <sub>CC</sub> = 6.0 V	4.8	3.1	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	0.9	0.3	V
		V <sub>CC</sub> = 4.5 V	-	2.1	0.9	V
		V <sub>CC</sub> = 6.0 V	-	2.9	1.2	V
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> = -20 µA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	V
		I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	V
		I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	4.13	4.32	-	V
		I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V	5.63	5.81	-	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> = 20 µA; V <sub>CC</sub> = 2.0 V	-	0	0.1	V
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V	-	0	0.1	V
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 6.0 V	-	0	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.33	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	0.16	0.33	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = GND or V <sub>CC</sub> ; V <sub>CC</sub> = 6.0 V	-	-	±1.0	µA
I <sub>CC</sub>	supply current	V <sub>I</sub> = GND or V <sub>CC</sub> ; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V	-	-	10.0	µA
<b>T<sub>amb</sub> = -40 °C to +125 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.7	-	-	V
		V <sub>CC</sub> = 4.5 V	3.6	-	-	V
		V <sub>CC</sub> = 6.0 V	4.8	-	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	-	0.3	V
		V <sub>CC</sub> = 4.5 V	-	-	0.9	V
		V <sub>CC</sub> = 6.0 V	-	-	1.2	V
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> = -20 µA; V <sub>CC</sub> = 2.0 V	1.9	-	-	V
		I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 4.5 V	4.4	-	-	V
		I <sub>O</sub> = -20 µA; V <sub>CC</sub> = 6.0 V	5.9	-	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.7	-	-	V
		I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V	5.2	-	-	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> = 20 µA; V <sub>CC</sub> = 2.0 V	-	-	0.1	V
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V	-	-	0.1	V
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 6.0 V	-	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.4	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	-	0.4	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = GND or V <sub>CC</sub> ; V <sub>CC</sub> = 6.0 V	-	-	±1.0	µA
I <sub>CC</sub>	supply current	V <sub>I</sub> = GND or V <sub>CC</sub> ; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V	-	-	20.0	µA

## 11. Dynamic characteristics

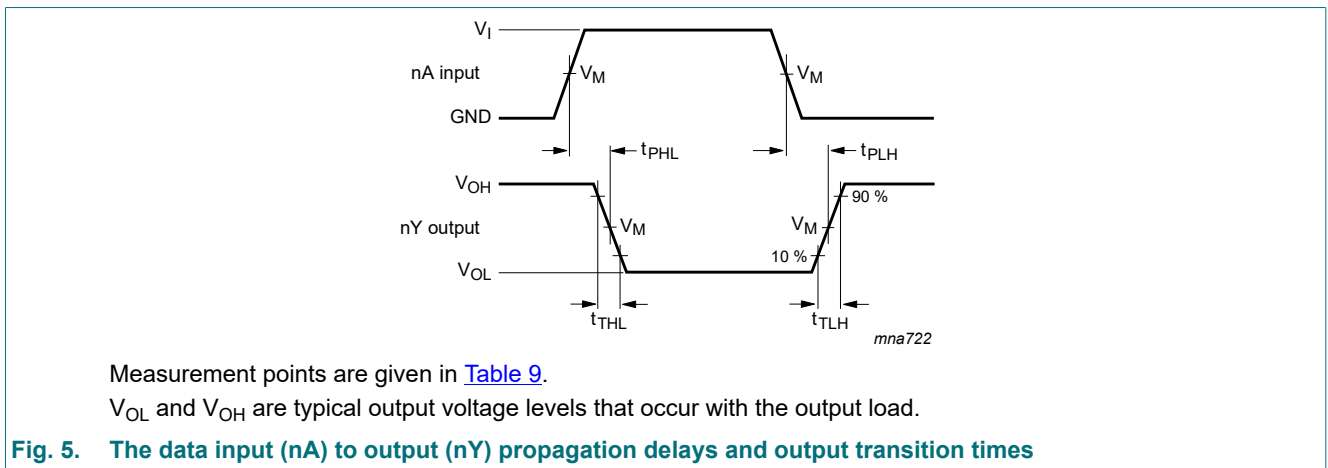
**Table 8. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit, see Fig. 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	nA to nY; see Fig. 5 [1]								
		V <sub>CC</sub> = 2.0 V; C <sub>L</sub> = 50 pF	-	13	60	-	75	-	90	ns
		V <sub>CC</sub> = 4.5 V; C <sub>L</sub> = 50 pF	-	6	12	-	15	-	18	ns
		V <sub>CC</sub> = 6.0 V; C <sub>L</sub> = 50 pF	-	5	10	-	13	-	15	ns
t <sub>t</sub>	transition time	nY; see Fig. 5 [2]								
		V <sub>CC</sub> = 2.0 V; C <sub>L</sub> = 50 pF	-	18	75	-	95	-	125	ns
		V <sub>CC</sub> = 4.5 V; C <sub>L</sub> = 50 pF	-	6	15	-	19	-	25	ns
		V <sub>CC</sub> = 6.0 V; C <sub>L</sub> = 50 pF	-	5	13	-	16	-	20	ns
C <sub>PD</sub>	power dissipation capacitance	V <sub>I</sub> = GND to V <sub>CC</sub> [3]	-	5	-	-	-	-	-	pF

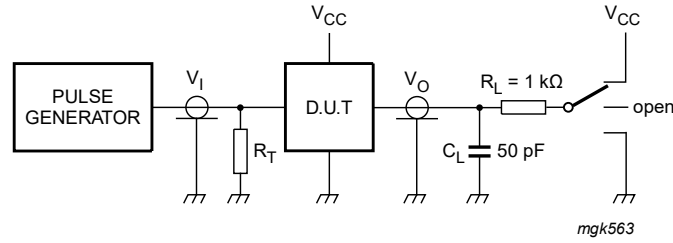
- [1] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.
- [2] t<sub>t</sub> is the same as t<sub>TLH</sub> and t<sub>THL</sub>.
- [3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$  where:  
 f<sub>i</sub> = input frequency in MHz;  
 f<sub>o</sub> = output frequency in MHz;  
 C<sub>L</sub> = output load capacitance in pF;  
 V<sub>CC</sub> = supply voltage in V;  
 N = number of inputs switching;  
 $\sum(C_L \times V_{CC}^2 \times f_o)$  = sum of the outputs.

### 11.1. Waveform and test circuit



**Table 9. Measurement points**

Input			Output
V <sub>M</sub>	V <sub>I</sub>	t <sub>r</sub> = t <sub>f</sub>	V <sub>M</sub>
0.5V <sub>CC</sub>	GND to V <sub>CC</sub>	6.0 ns	0.5V <sub>CC</sub>



Test data is given in [Table 10](#).

Definitions test circuit:

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

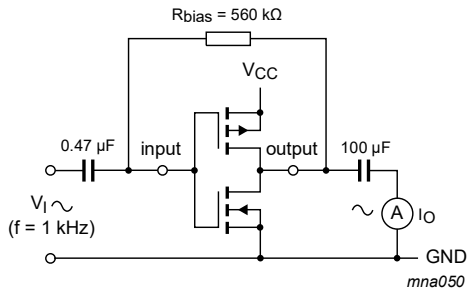
$R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

**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

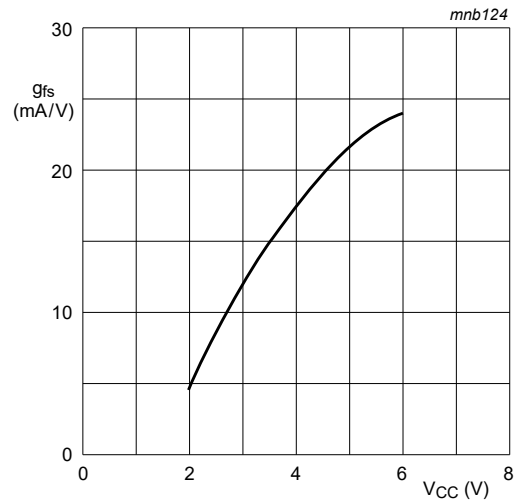
## 12. Additional characteristics



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

$V_O$  is constant.

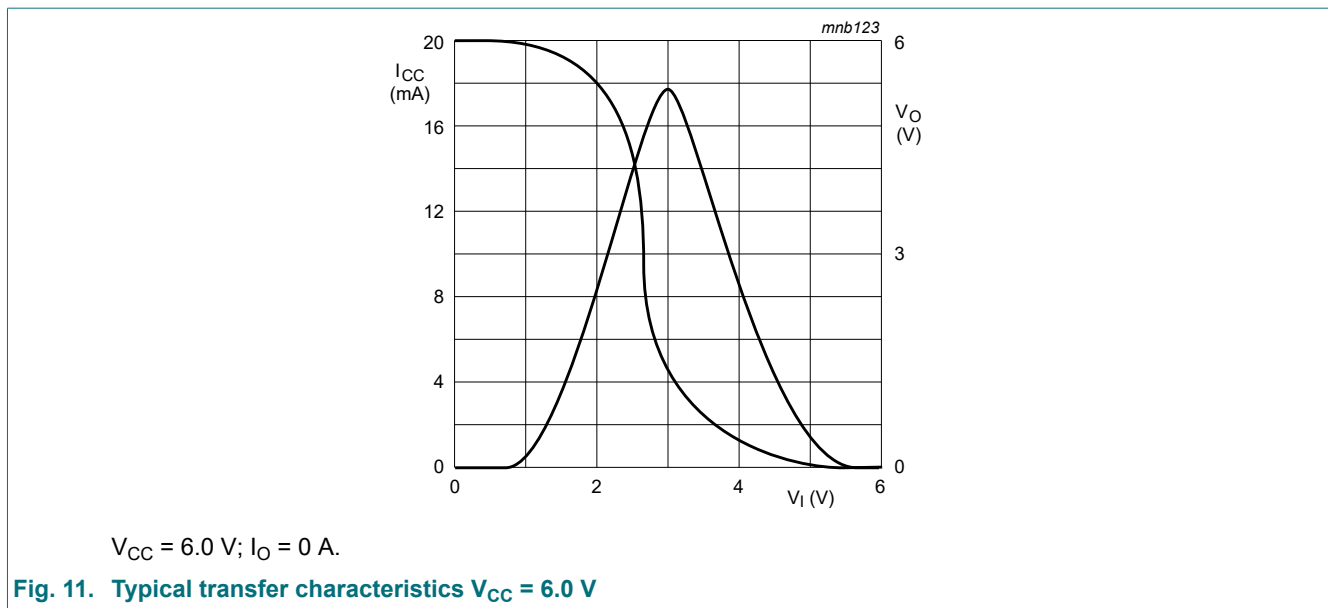
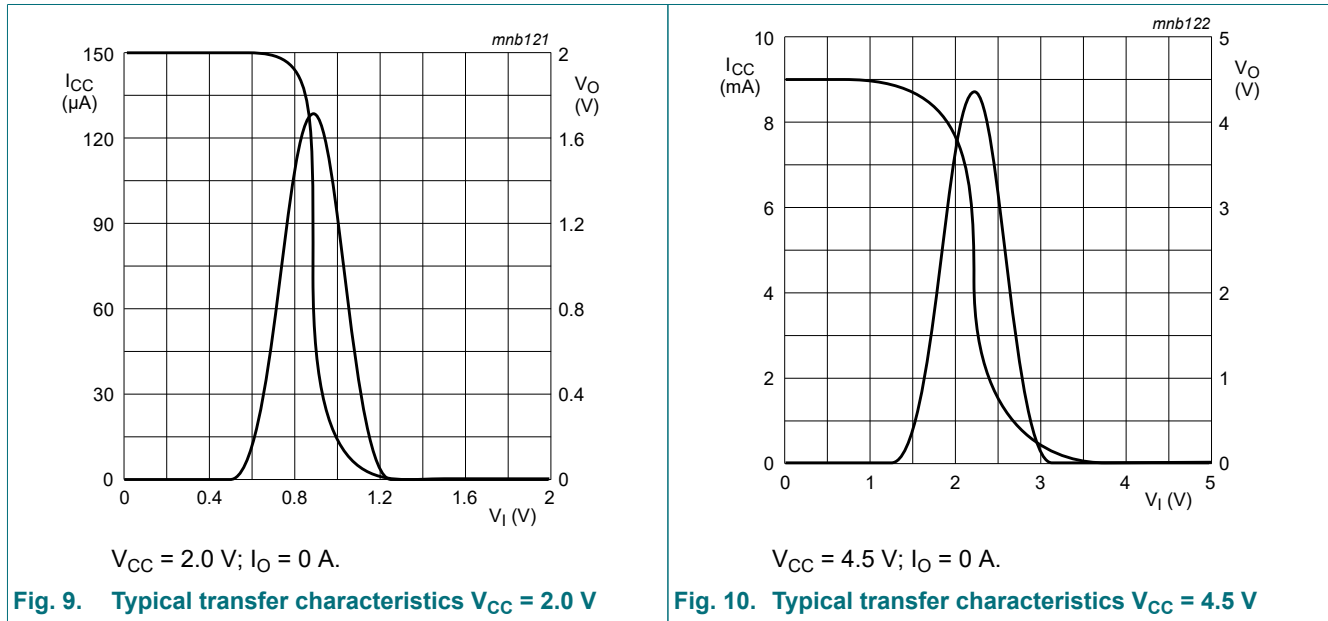
**Fig. 7. Test setup for measuring forward transconductance**



$T_{amb} = 25\text{ }^\circ\text{C}$ .

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

### 13. Typical transfer characteristics



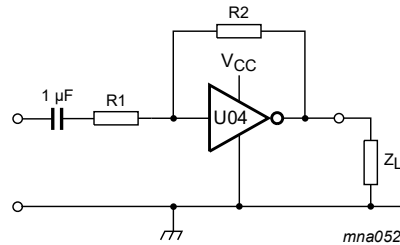


## 14. Application information

Some applications for the 74HC2GU04 are:

- Linear amplifier (see [Fig. 12](#))
- Crystal oscillator (see [Fig. 13](#))

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



$$Z_L > 10 \text{ k}\Omega.$$

$$R1 \geq 3 \text{ k}\Omega.$$

$$R2 \leq 1 \text{ M}\Omega.$$

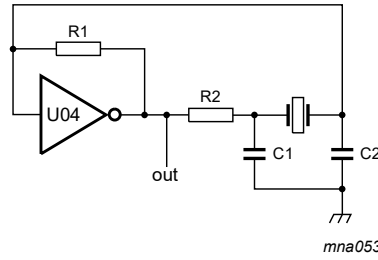
$$\text{Open loop amplification: } A_{OL} = 20.$$

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

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

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  $I_{CC}$

( $I_{CC} = 2 \text{ mA}$  at  $V_{CC} = 3.0 \text{ V}$  and  $f = 1 \text{ MHz}$ ).

**Fig. 13. Crystal oscillator application**

**Table 11. External components for resonator ( $f < 1 \text{ MHz}$ )**

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)	

### 15. Package outline

TSSOP6: plastic thin shrink small outline package; 6 leads; body width 1.25 mm

SOT363-2



Fig. 14. Package outline SOT363-2 (TSSOP6)

Plastic, surface-mounted package (SC-74; TSOP6); 6 leads

SOT457

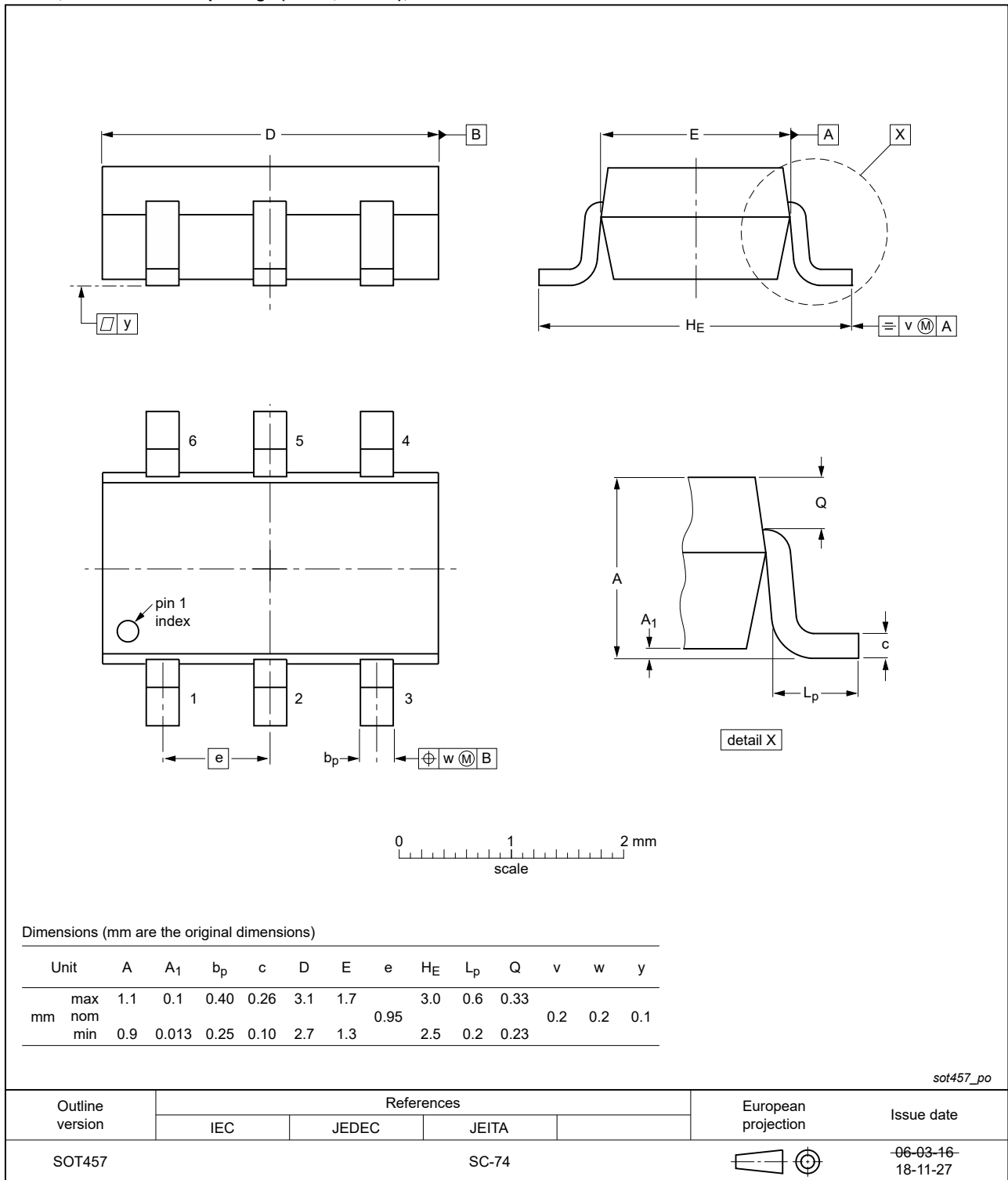


Fig. 15. Package outline SOT457 (SC-74; TSOP6)

## 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

## 17. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC2GU04 v.3	20220204	Product data sheet	-	74HC2GU04 v.2
Modifications:	<ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li>Package SOT363 (SC-88) changed to SOT363-2 (TSSOP6).</li> <li><a href="#">Section 1</a> and <a href="#">Section 2</a> updated.</li> <li><a href="#">Section 8</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li> <li><a href="#">Fig. 15</a>: Package outline drawing SOT457 (SC-74; TSOP6) updated.</li> </ul>			
74HC2GU04 v.2	20140820	Product data sheet	-	74HC2GU04 v.1
Modifications:	<ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> </ul>			
74HC2GU04 v.1	20061006	Product data sheet	-	-

## 18. Legal information

### 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 <https://www.nexperia.com>.

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