

74HC3GU04-Q100

Triple unbuffered inverter

Rev. 1 — 13 November 2013

Product data sheet

1. General description

The 74HC3GU04-Q100 is a triple unbuffered inverter. Inputs include clamp diodes that enable the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

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 $+125\text{ }^{\circ}\text{C}$
- 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:
 - ◆ MIL-STD-883, method 3015 exceeds 2000 V
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V ($C = 200\text{ pF}$, $R = 0\text{ }\Omega$)

3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC3GU04DP-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm	SOT505-2
74HC3GU04DC-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	VSSOP8	plastic very thin shrink small outline package; 8 leads; body width 2.3 mm	SOT765-1

4. Marking

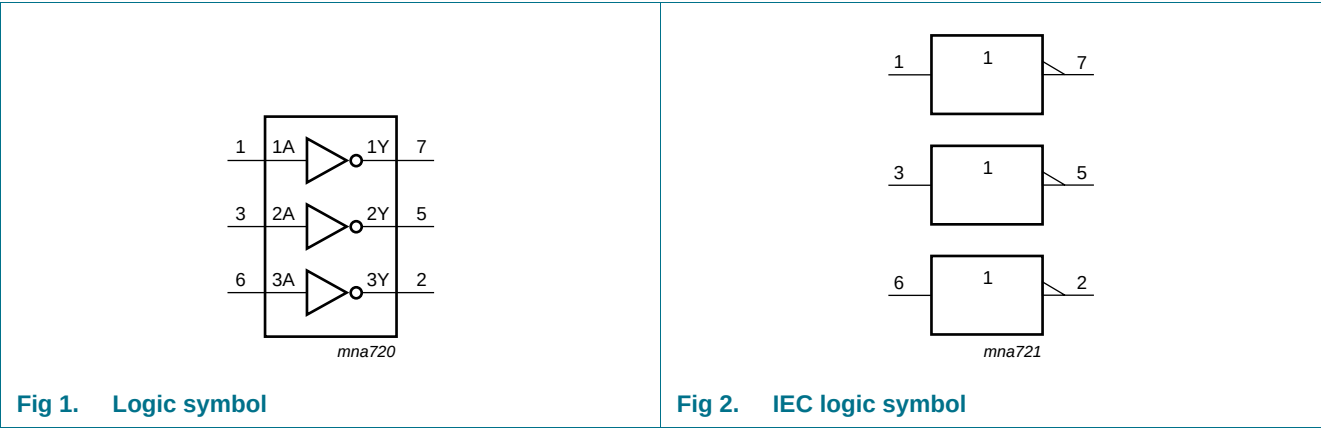
Table 2. Marking

Type number	Marking code ^[1]
74HC3GU04DP-Q100	HU4
74HC3GU04DC-Q100	HU4



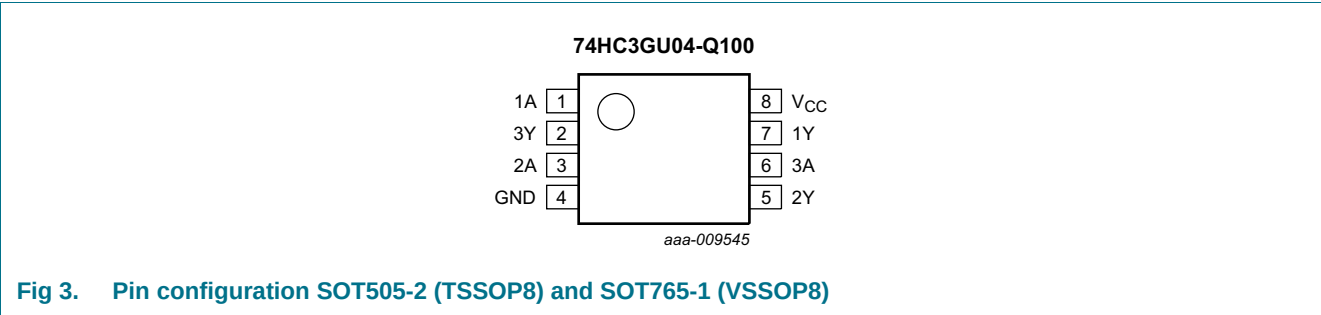
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

5. Functional diagram



6. Pinning information

6.1 Pinning



6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
1A, 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	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	[1] -	± 20	mA
I_{OK}	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	[1] -	± 20	mA
I_O	output current	$V_O = -0.5\text{ V}$ to $(V_{CC} + 0.5\text{ V})$	[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	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$	[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.

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	$V_{CC} = 2.0\text{ V}$	-	-	625	ns/V
		$V_{CC} = 4.5\text{ V}$	-	1.67	139	ns/V
		$V_{CC} = 6.0\text{ V}$	-	-	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
V _{OL}	LOW-level output voltage	I _O = –5.2 mA; V _{CC} = 6.0 V	5.63	5.81	-	5.2	-	V
		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 _I	input leakage current	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 _{CC}	supply 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;	-	-	10	-	20	µA
		I _O = 0 A; V _{CC} = 6.0 V						
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 5](#).

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 4 ^[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 5.

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 4						ns
		V _{CC} = 2.0 V	-	18	95	-	125	
		V _{CC} = 4.5 V	-	6	19	-	25	
		V _{CC} = 6.0 V	-	5	16	-	20	
C _{PD}	power dissipation capacitance	V _I = GND to V _{CC}	-	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} × V_{CC}² × f_i × N + Σ(C_L × V_{CC}² × 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;
Σ(C_L × V_{CC}² × f_o) = sum of outputs.

12. Waveforms

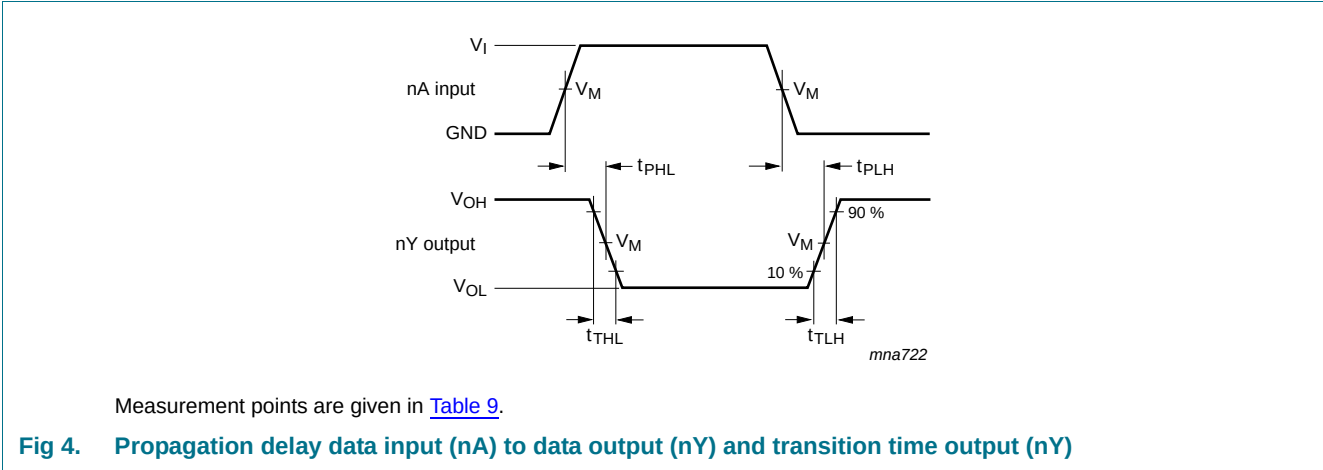


Table 9. Measurement points

Type	Input	Output
	V _M	V _M
74HC3GU04-Q100	0.5 × V _{CC}	0.5 × V _{CC}

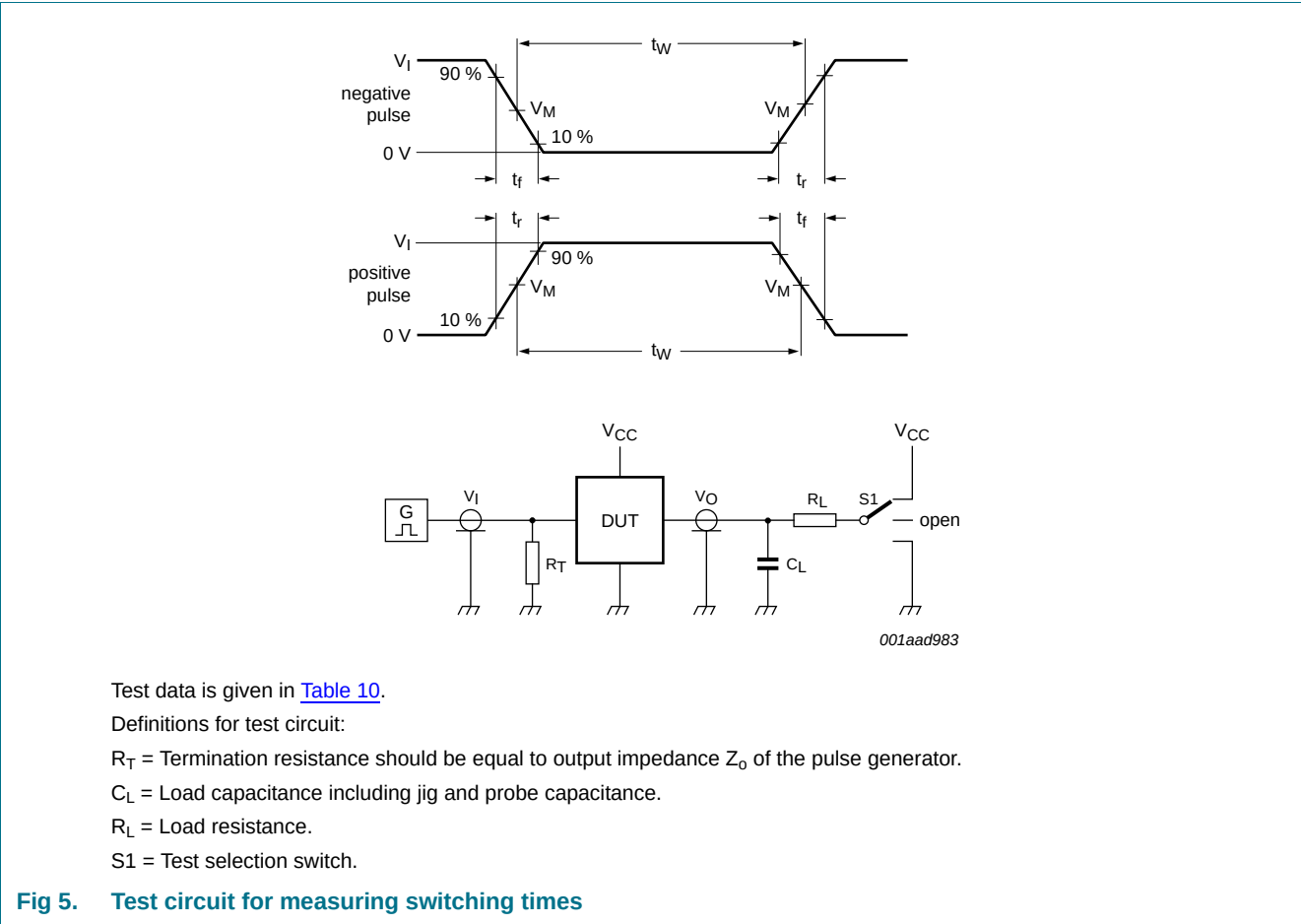
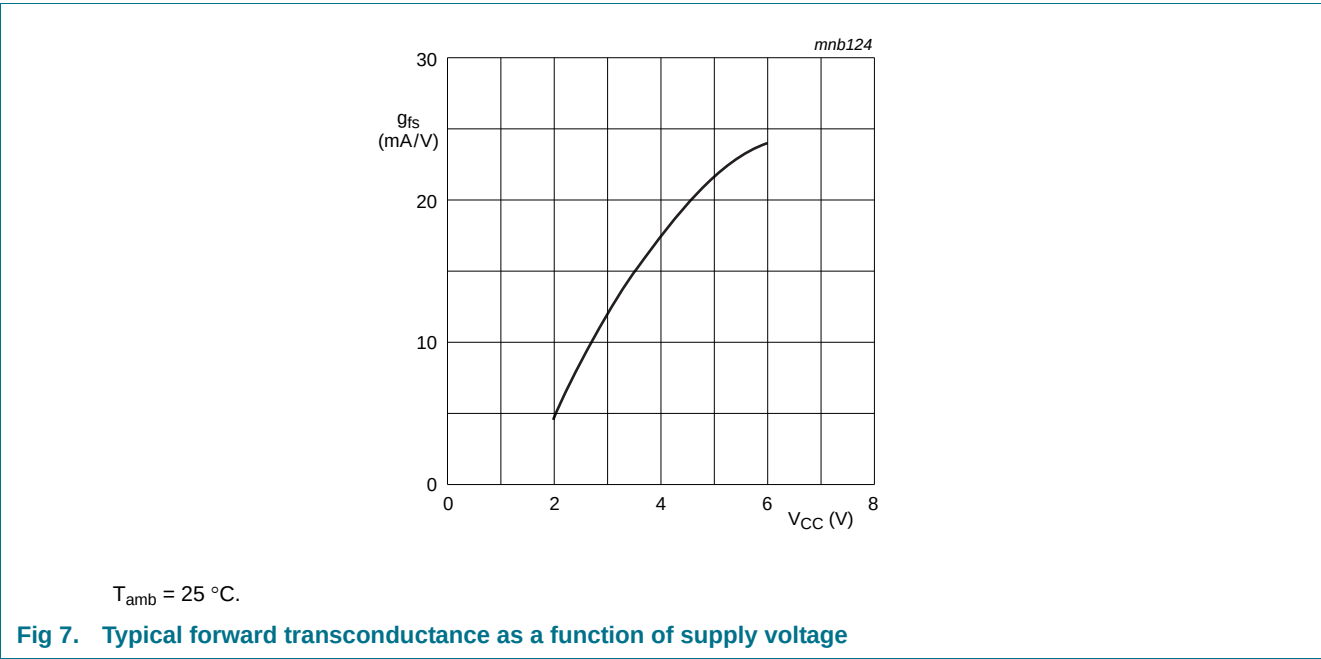
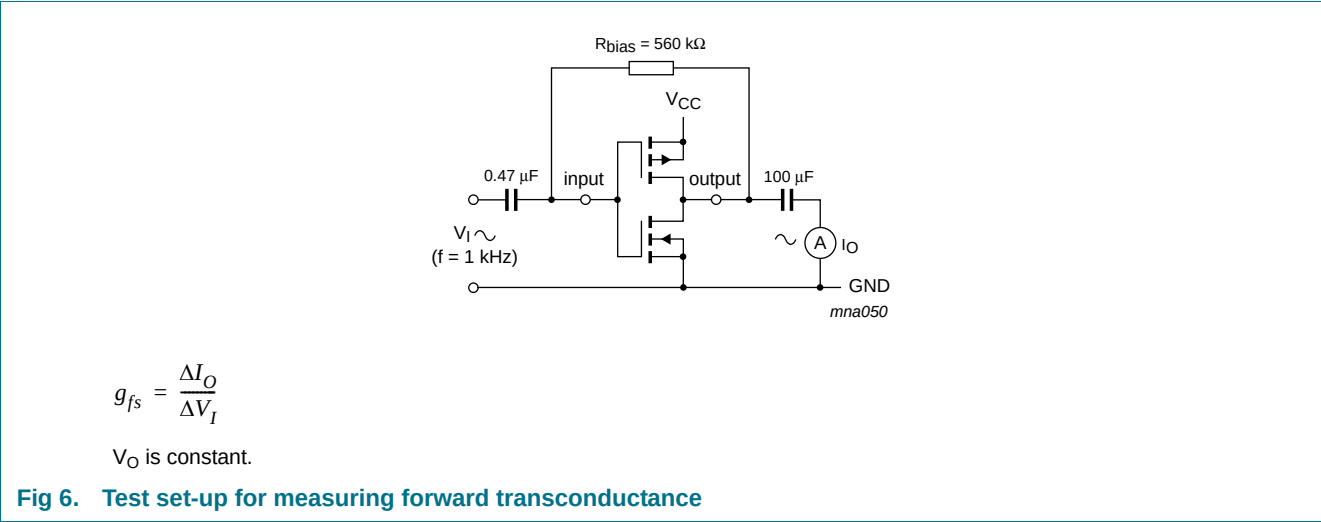


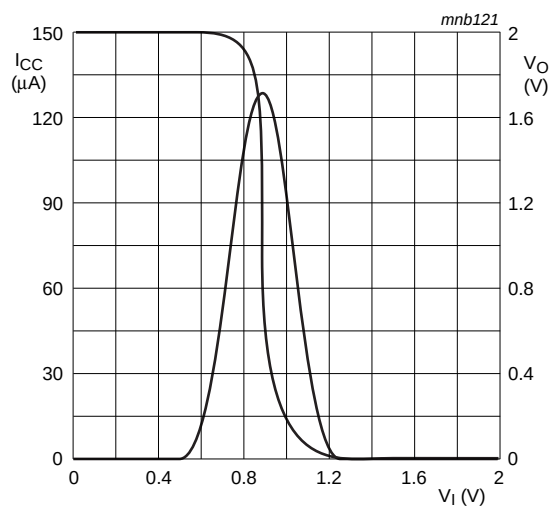
Table 10. Test data

Type	Input		Load		S1 position
	V_I	t_r, t_f	C_L	R_L	
74HC3GU04-Q100	GND to V_{CC}	≤ 6 ns	50 pF	1 k Ω	open

12.1 Additional characteristics

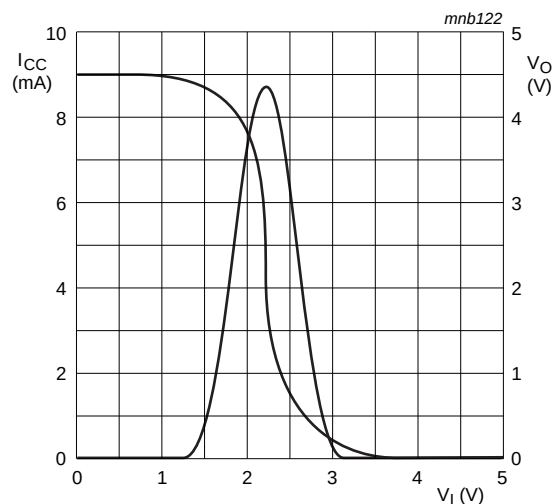


13. Typical transfer characteristics



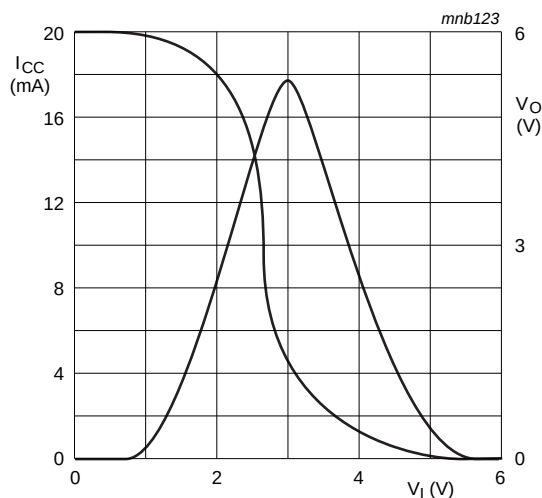
$V_{CC} = 2.0\text{ V}$; $I_O = 0\text{ A}$.

Fig 8. Typical transfer characteristics $V_{CC} = 2.0\text{ V}$



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

Fig 9. Typical transfer characteristics $V_{CC} = 4.5\text{ V}$



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

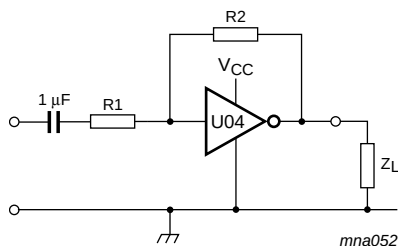
Fig 10. Typical transfer characteristics $V_{CC} = 6.0\text{ V}$

14. Application information

Some applications for the 74HC3GU04-Q100 are:

- Linear amplifier (see [Figure 11](#))
- Crystal oscillator (see [Figure 13](#)).

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



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

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

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

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

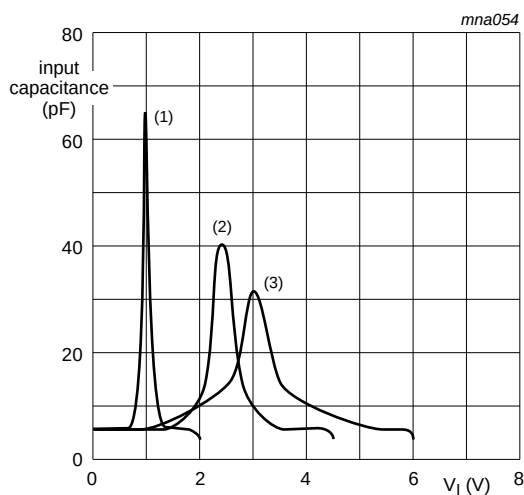
$$\text{Voltage amplification: } A_V = -\frac{A_{OL}}{1 + \frac{R1}{R2}(1 + A_{OL})}$$

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

Unity gain bandwidth product is 5 MHz (typical).

For input capacitance, see [Figure 12](#).

Fig 11. Linear amplifier application

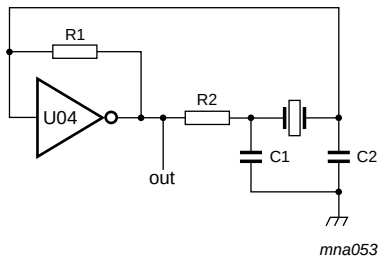


(1) $V_{CC} = 2.0 \text{ V}$.

(2) $V_{CC} = 4.5 \text{ V}$.

(3) $V_{CC} = 6.0 \text{ V}$.

Fig 12. 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 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	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 with 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

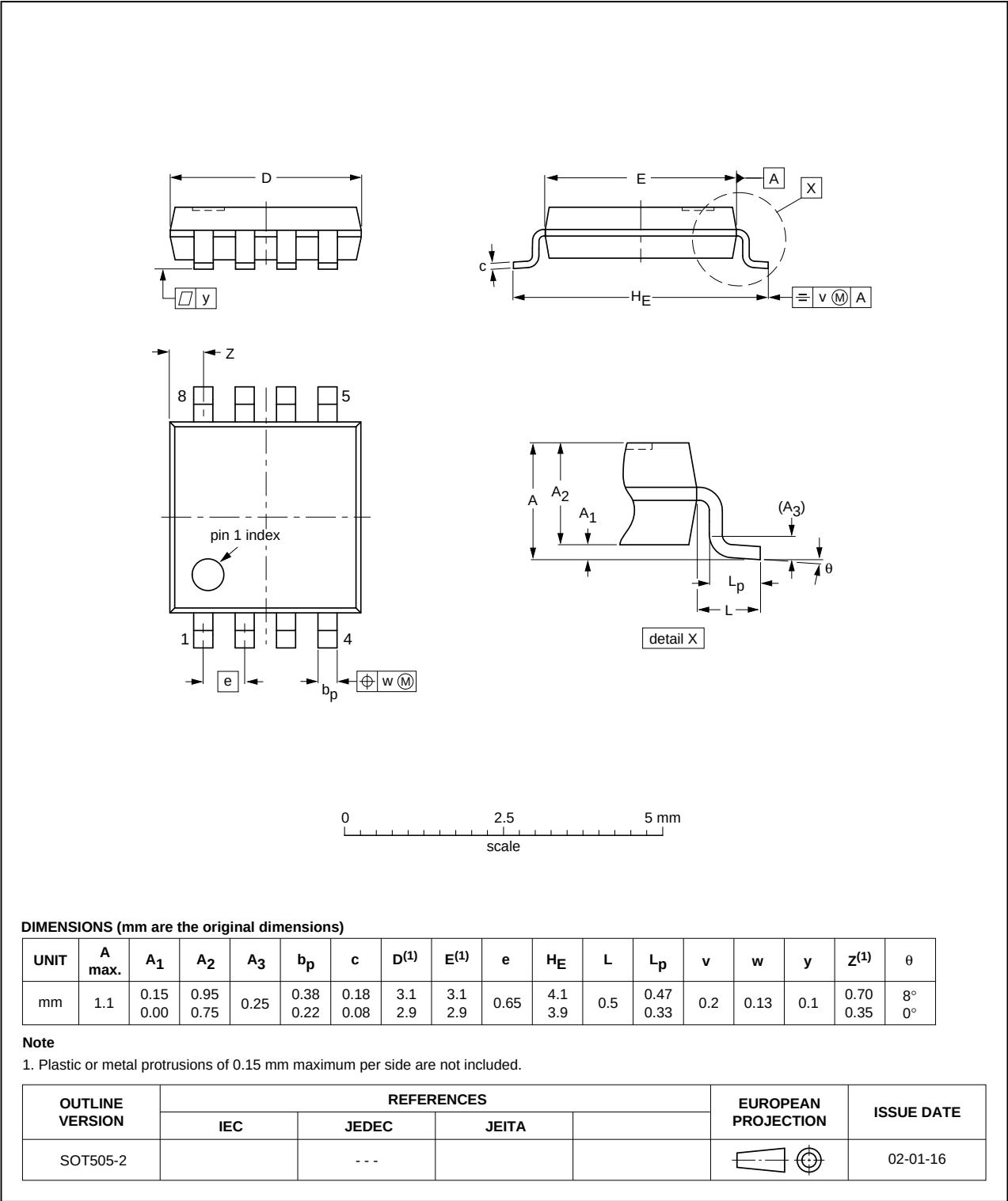


Fig 14. Package outline SOT505-2 (TSSOP8)

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

SOT765-1

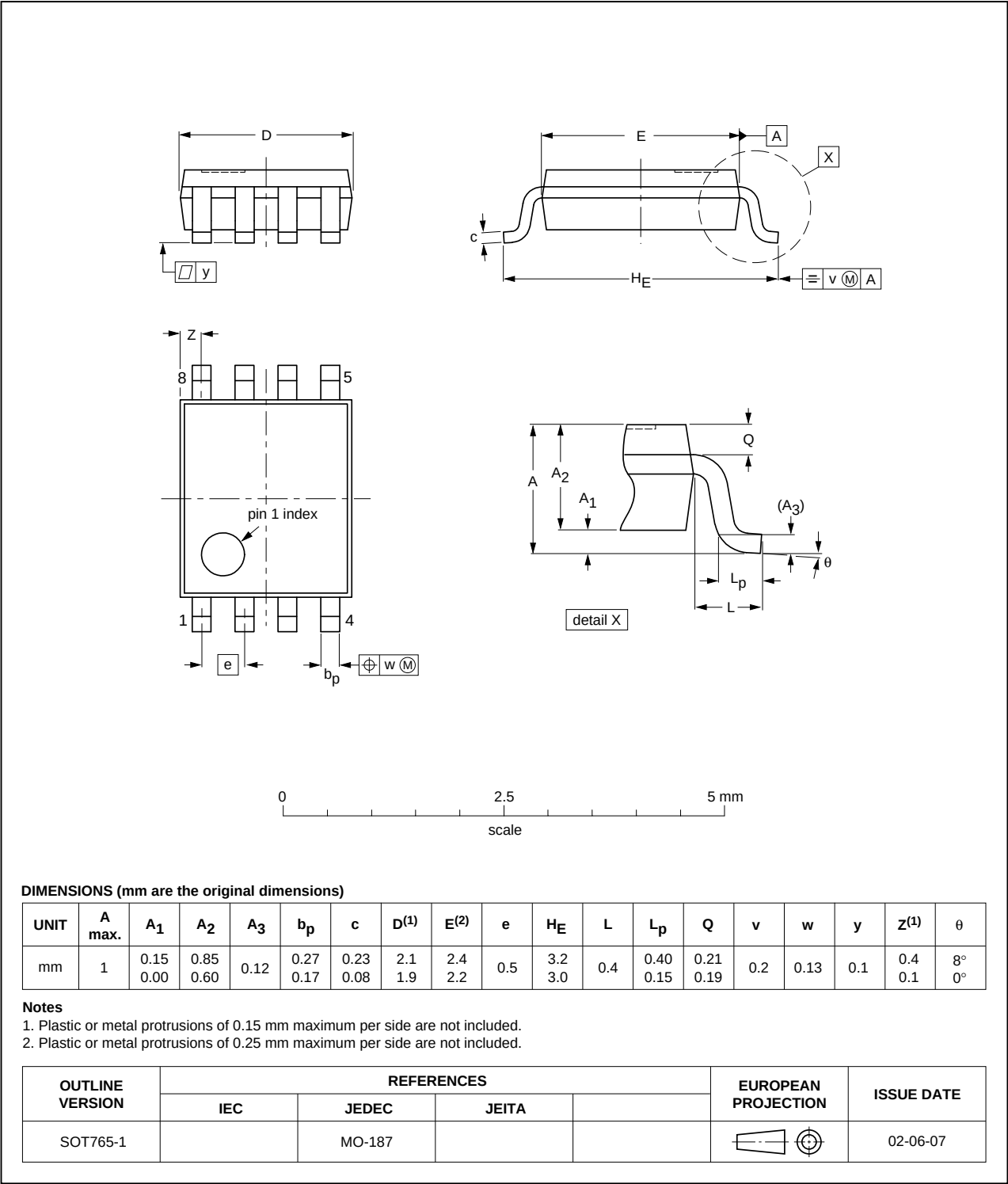


Fig 15. Package outline SOT765-1 (VSSOP8)

16. Abbreviations

Table 13. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
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_Q100 v.1	20131113	Product data sheet	-	-

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.
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