# 74HC20-Q100; 74HCT20-Q100

# **Dual 4-input NAND gate**

Rev. 2 — 27 March 2019

Product data sheet

## 1. General description

The 74HC20-Q100; 74HCT20-Q100 is a dual 4-input NAND gate. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{\rm CC}$ .

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 °C to +85 °C and from -40 °C to +125 °C
- · Complies with JEDEC standard JESD7A
- · Low-power dissipation
- Input levels:
  - For 74HC20-Q100: CMOS level
  - For 74HCT20-Q100: TTL level
- 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 Ω)
- Specified from -40 °C to +80 °C and from -40 °C to +125 °C.

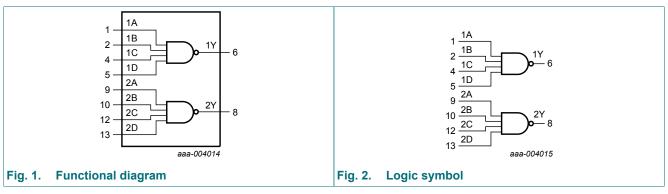
## 3. Ordering information

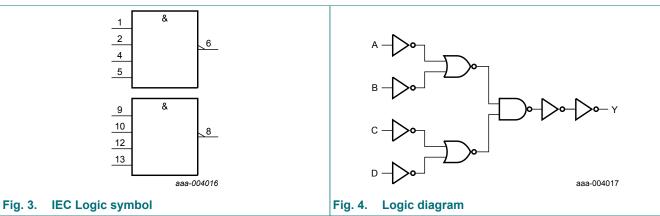
#### **Table 1. Ordering information**

Type number	Package			
	Temperature range	Name	Description	Version
74HC20D-Q100	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads;	SOT108-1
74HCT20D-Q100			body width 3.9 mm	
74HC20PW-Q100	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1



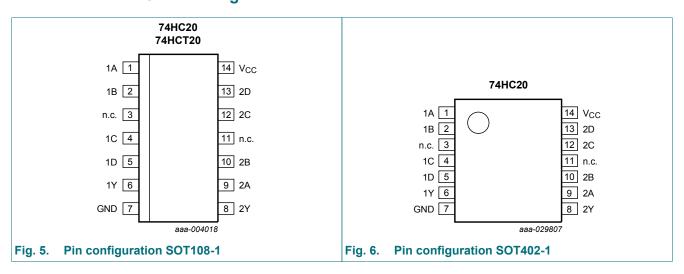
## 4. Functional diagram





## 5. Pinning information

## 5.1. Pinning



## 5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
1A, 1B, 1C, 1D	1, 2, 4, 5	data input
n.c.	3, 11	not connected
1Y	6	data output
GND	7	ground (0 V)
2Y	8	data output
2A, 2B, 2C, 2D	9, 10, 12, 13	data input
V <sub>CC</sub>	14	supply voltage

## 6. Functional description

#### Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; X = don't care.

Input				Output
nA	nB	nC	nD	nY
L	Х	Х	Х	Н
X	L	Х	Х	Н
X	X	L	Х	Н
X	X	Х	L	Н
Н	Н	Н	Н	L

## 7. Limiting values

#### **Table 4. 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 <sub>CC</sub>	supply voltage			-0.5	+7	V
I <sub>IK</sub>	input clamping current	$V_{I} < -0.5 \text{ V or } V_{I} > V_{CC} + 0.5 \text{ V}$	[1]	-	±20	mA
I <sub>OK</sub>	output clamping current	$V_{O}$ < -0.5 V or $V_{O}$ > $V_{CC}$ + 0.5 V	[1]	-	±20	mA
I <sub>O</sub>	output current	$-0.5 \text{ V} < \text{V}_{\text{O}} < \text{V}_{\text{CC}} + 0.5 \text{ V}$		-	±25	mA
I <sub>CC</sub>	supply current			-	50	mA
I <sub>GND</sub>	ground current			-50	-	mA
T <sub>stg</sub>	storage temperature			-65	+150	°C
P <sub>tot</sub>	total power dissipation	SO14, and TSSOP14 packages	[2]	-	500	mW

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

<sup>[2]</sup> For SO14 package: P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C. For TSSOP14 package: P<sub>tot</sub> derates linearly with 5.5 mW/K above 60 °C.

## 8. Recommended operating conditions

#### Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC20-Q100			74HCT20-Q100			Unit
			Min	Тур	Max	Min	Тур	Max	
V <sub>CC</sub>	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
VI	input voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V
Vo	output voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V
T <sub>amb</sub>	ambient temperature		-40	+25	+125	-40	+25	+125	°C
Δt/ΔV	input transition rise and fall rate	V <sub>CC</sub> = 2.0 V	-	-	625	-	-	-	ns/V
		V <sub>CC</sub> = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V <sub>CC</sub> = 6.0 V	-	-	83	-	-	-	ns/V

## 9. Static characteristics

#### **Table 6. Static characteristics**

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

Symbol	Parameter	Conditions		25 °C		-40 °C to	o +85 °C	-40 °C to	+125 °C	Unit
			Min	Тур	Max	Min	Max	Min	Max	
74HC20-	-Q100									
V <sub>IH</sub>	HIGH-level	V <sub>CC</sub> = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
	input voltage	V <sub>CC</sub> = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V <sub>CC</sub> = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V <sub>IL</sub>	LOW-level	V <sub>CC</sub> = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
	input voltage	V <sub>CC</sub> = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V <sub>CC</sub> = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	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	-	1.9	-	1.9	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		$I_{O}$ = -4.0 mA; $V_{CC}$ = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
		$I_{O}$ = -5.2 mA; $V_{CC}$ = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	V
$V_{OL}$	LOW-level	$V_I = V_{IH}$ or $V_{IL}$								
	output voltage	I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		$I_{O}$ = 20 $\mu$ A; $V_{CC}$ = 4.5 $V$	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		$I_{O}$ = 4.0 mA; $V_{CC}$ = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
		$I_{O}$ = 5.2 mA; $V_{CC}$ = 6.0 V	-	0.16	0.26	-	0.33	-	0.4	V
l <sub>l</sub>	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 6.0 \text{ V}$	-	-	±0.1	-	±1	-	±1	μΑ
I <sub>CC</sub>	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 6.0 \text{ V}$	-	-	2	-	20	-	40	μΑ
C <sub>I</sub>	input capacitance		-	3.5	-	-	-	-	-	pF

Symbol	Parameter	Conditions		25 °C		-40 °C to	+85 °C	-40 °C to	+125 °C	Unit
			Min	Тур	Max	Min	Max	Min	Max	
74HCT2	0-Q100	<u>'</u>								'
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
$V_{IL}$ LOW-level $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$ input voltage		-	1.2	0.8	-	0.8	-	0.8	V	
$V_{OH}$	HIGH-level	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5 \text{ V}$								
	output voltage	I <sub>O</sub> = -20 μA	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -4.0 mA	3.98	4.32	-	3.84	-	3.7	-	V
$V_{OL}$	LOW-level	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5 \text{ V}$								
	output voltage	I <sub>O</sub> = 20 μA	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 5.2 mA	-	0.15	0.26	-	0.33	-	0.4	V
l <sub>l</sub>	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5 \text{ V}$	-	-	±0.1	-	±1	-	±1	μΑ
I <sub>CC</sub>	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5 \text{ V}$	-	-	2	-	20	-	40	μΑ
ΔI <sub>CC</sub>	additional supply current	per input pin; $V_I = V_{CC} - 2.1 \text{ V}$ ; $I_O = 0 \text{ A}$ ; other inputs at $V_{CC}$ or GND; $V_{CC} = 4.5 \text{ V}$ to 5.5 V	-	30	108	-	135	-	147	μΑ
C <sub>I</sub>	input capacitance		-	3.5	-	-	-	-	-	pF

## 10. Dynamic characteristics

#### **Table 7. Dynamic characteristics**

GND = 0 V;  $C_L$  = 50 pF; for test circuit see Fig. 8.

Symbol	Parameter	Conditions			25 °C		-40 °C to	+125 °C	Unit
				Min	Тур	Max	Max (85 °C)	Max (125 °C)	
74HC20-	-Q100		·						
t <sub>pd</sub>	propagation delay	nA, nB, nC or nD to nY; see Fig. 7	[1]						
		V <sub>CC</sub> = 2.0 V		-	28	90	115	135	ns
		V <sub>CC</sub> = 4.5 V		-	10	18	23	27	ns
		V <sub>CC</sub> = 6.0 V		-	8	15	20	23	ns
		V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF		-	8	-	-	-	ns
t <sub>t</sub>	transition time	nY; see Fig. 7	[2]						
		V <sub>CC</sub> = 2.0 V		-	19	75	95	110	ns
		V <sub>CC</sub> = 4.5 V		-	7	15	19	22	ns
		V <sub>CC</sub> = 6.0 V		-	6	13	16	19	ns
C <sub>PD</sub>	power dissipation capacitance	per package; $V_I$ = GND to $V_{CC}$	[3]	-	22	-	-	-	pF

Symbol	Parameter	Conditions	25 °C			-40 °C to	+125 °C	Unit
			Min	Тур	Max	Max (85 °C)	Max (125 °C)	
<b>74HCT2</b>	0-Q100				'			
t <sub>pd</sub>	propagation delay	nA, nB, nC or nD to nY; see Fig. 7 [1]						
		V <sub>CC</sub> = 4.5 V	-	16	28	35	42	ns
		V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF	-	13	-	-	-	ns
t <sub>t</sub>	transition time	nY; $V_{CC} = 4.5 \text{ V}$ ; see <u>Fig. 7</u> [2]	-	7	15	19	22	ns
C <sub>PD</sub>	power dissipation capacitance	per package; $V_I$ = GND to $V_{CC}$ - 1.5 $V$ [3]	-	17	-	-	-	pF

- [1]  $t_{pd}$  is the same as  $t_{PHL}$  and  $t_{PLH}$ .
- [2]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .
- [3]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu W$ ):

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

 $f_i$  = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

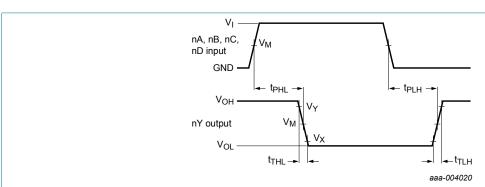
C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

 $\sum (C_L \times V_{CC}^2 \times f_0) = \text{sum of outputs.}$ 

### 10.1. Waveform and test circuit



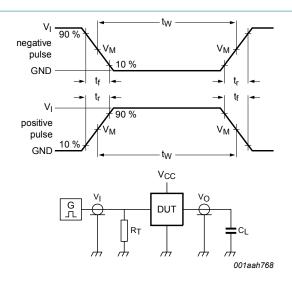
Measurement points are given in Table 8.

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

Fig. 7. Waveforms showing the input (nA, nB, nC, nD) to output (nY) propagation delays and the output transition times

**Table 8. Measurement points** 

Туре	Input	Output					
	V <sub>M</sub>	V <sub>M</sub>	V <sub>X</sub>	V <sub>Y</sub>			
74HC20-Q100	0.5V <sub>CC</sub>	0.5V <sub>CC</sub>	0.1V <sub>CC</sub>	0.9V <sub>CC</sub>			
74HCT20-Q100	1.3 V	1.3 V	0.1V <sub>CC</sub>	0.9V <sub>CC</sub>			



Test data is given in Table 9.

Definitions test circuit:

 $R_{T}$  = termination resistance should be equal to output impedance  $Z_{o}$  of the pulse generator.

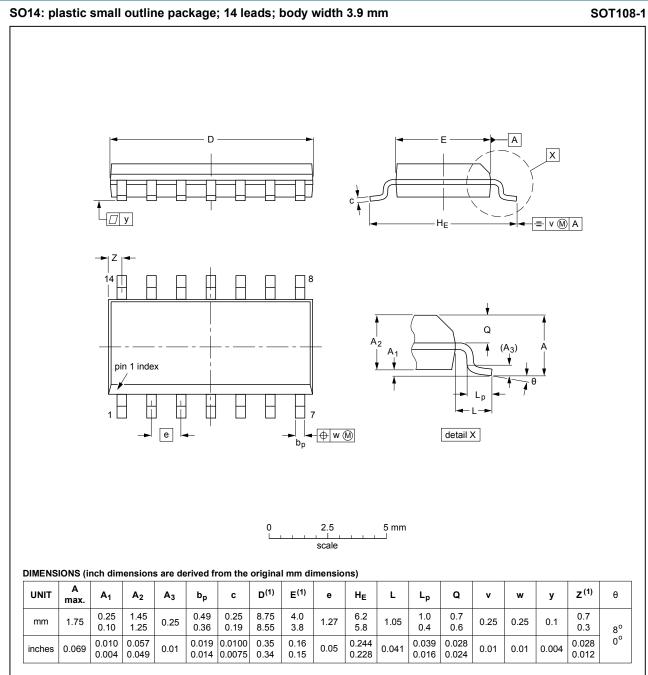
 $C_L$  = load capacitance including jig and probe capacitance.

### Fig. 8. Test circuit for measuring switching times

Table 9. Test data

Туре	Input L		Load	Test
	V <sub>I</sub>	t <sub>r</sub> , t <sub>f</sub>	CL	
74HC20-Q100	V <sub>CC</sub>	6.0 ns	15 pF, 50 pF	t <sub>PLH</sub> , t <sub>PHL</sub>
74HCT20-Q100	3.0 V	6.0 ns	15 pF, 50 pF	t <sub>PLH</sub> , t <sub>PHL</sub>

## 11. Package outline

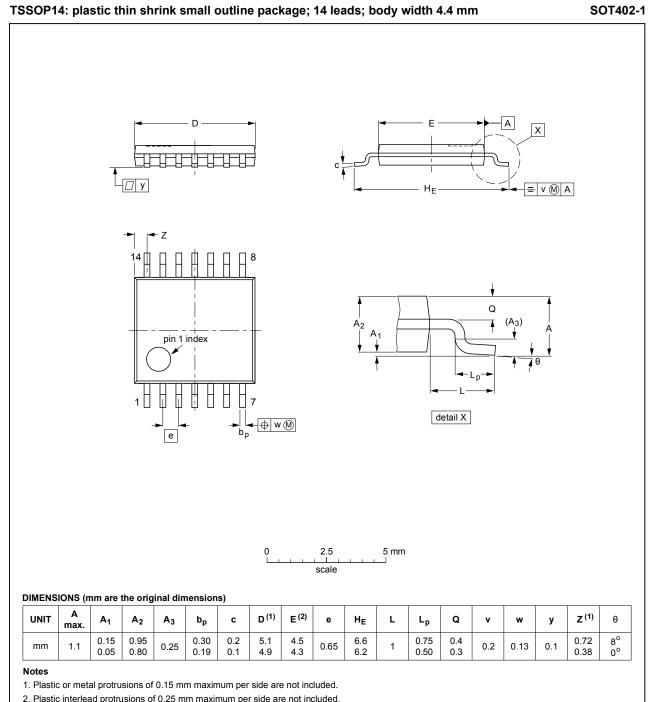


#### Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

	OUTLINE	REFERENCES				EUROPEAN	ISSUE DATE
	VERSION	IEC	JEDEC	JEITA		PROJECTION	ISSUE DATE
	SOT108-1	076E06	MS-012				<del>99-12-27</del> 03-02-19

Fig. 9. Package outline SOT108-1 (SO14)



2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE	REFERENCES				EUROPEAN	ISSUE DATE
VERSION	IEC	JEDEC	JEITA		PROJECTION	ISSUE DATE
SOT402-1		MO-153				<del>99-12-27</del> 03-02-18

Fig. 10. Package outline SOT402-1 (TSSOP14)

## 12. Abbreviations

#### **Table 10. 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

## 13. Revision history

#### **Table 11. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT20_Q100 v.2	20190327	Product data sheet	-	74HC_HCT20_Q100 v.1
Modifications:	<ul> <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> </ul>			
74HC_HCT20_Q100 v.1	20120717	Product data sheet	-	-

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#### **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.

- Please consult the most recently issued document before initiating or completing a design.
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74HC32S14-13 74LS133 74LVC1G86Z-7 74LVC2G08RA3-7 NLV74HC08ADTR2G NLV74HC14ADR2G NLV74HC20ADR2G
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