

# DATA SHEET

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## **74AHC86; 74AHCT86** Quad 2-input EXCLUSIVE-OR gate

Product specification  
File under Integrated Circuits, IC06

1999 Sep 17

## Quad 2-input EXCLUSIVE-OR gate

## 74AHC86; 74AHCT86

## FEATURES

- ESD protection:  
HBM EIA/JESD22-A114-A exceeds 2000 V  
MM EIA/JESD22-A115-A exceeds 200 V  
CDM EIA/JESD22-C101 exceeds 1000 V
- Inputs accepts voltages higher than  $V_{CC}$
- For AHC only:  
operates with CMOS input levels
- For AHCT only:  
operates with TTL input levels
- Specified from  $-40$  to  $+85$  °C and  $-40$  to  $+125$  °C.

## DESCRIPTION

The 74AHC/AHCT86 are high-speed Si-gate CMOS devices and are pin compatible with Low power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard no. 7A.

The 74AHC/AHCT86 provides the 2-input EXCLUSIVE-OR function.

## QUICK REFERENCE DATA

Ground = 0 V;  $T_{amb} = 25$  °C;  $t_r = t_f \leq 3.0$  ns.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			AHC	AHCT	
$t_{PHL}/t_{PLH}$	propagation delay nA, nB to nY	$C_L = 15$ pF; $V_{CC} = 5$ V	3.4	3.4	ns
$C_I$	input capacitance	$V_I = V_{CC}$ or GND	3.0	3.0	pF
$C_O$	output capacitance	$V_I = V_{CC}$ or GND	4.0	4.0	pF
$C_{PD}$	power dissipation capacitance	$C_L = 50$ pF; $f = 1$ MHz; notes 1 and 2	10	12	pF

## Notes

- $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu$ W).

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

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs;

$C_L$  = output load capacitance in pF;

$V_{CC}$  = supply voltage in Volts.

- The condition is  $V_I = \text{GND to } V_{CC}$ .

## FUNCTION TABLE

See note 1.

INPUT		OUTPUT
nA	nB	nY
L	L	L
L	H	H
H	L	H
H	H	L

## Note

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

## ORDERING INFORMATION

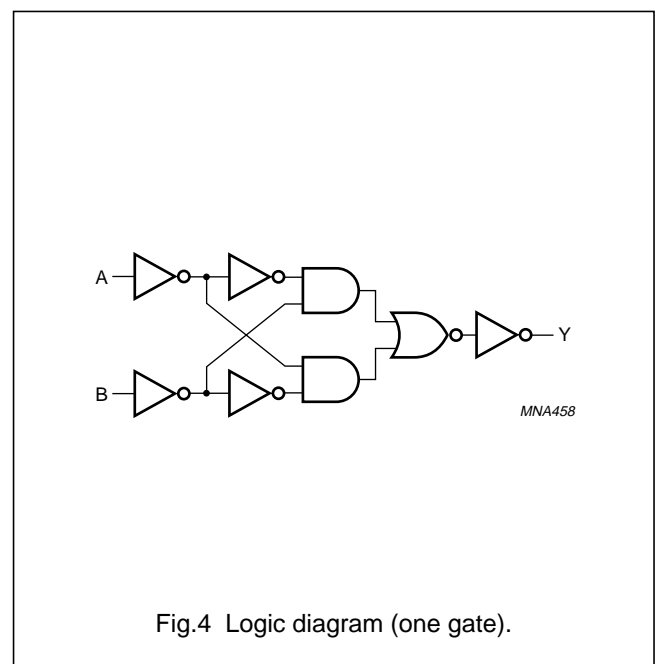
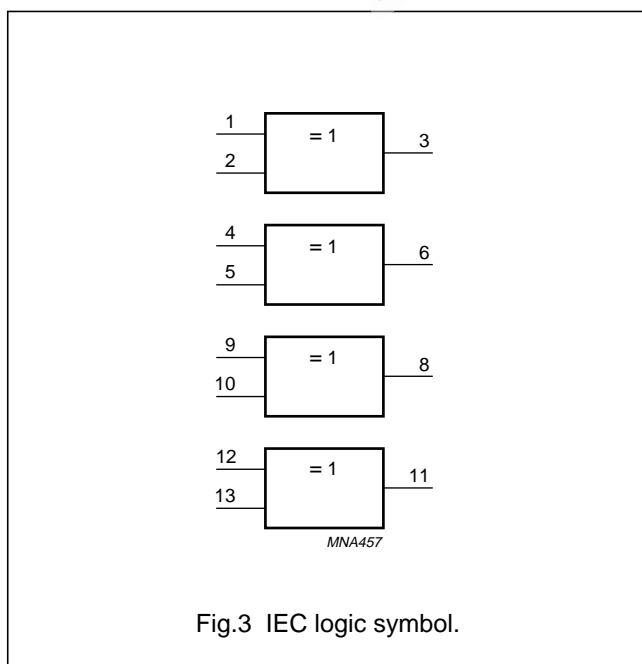
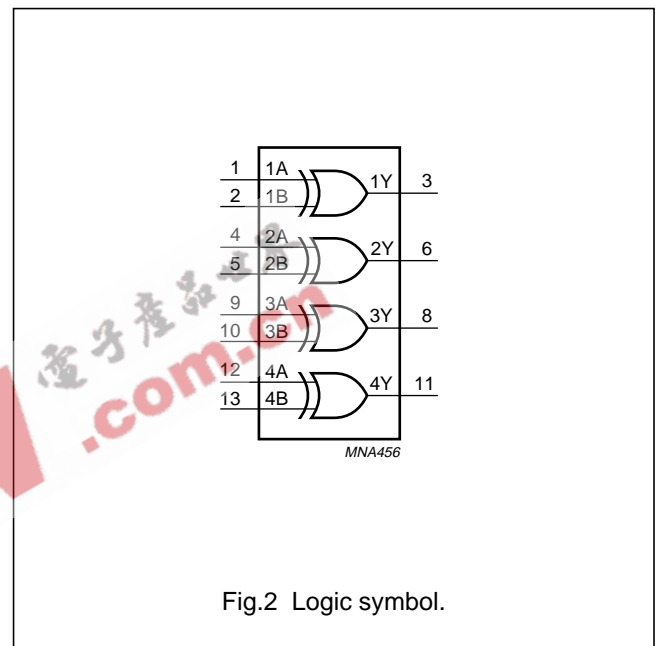
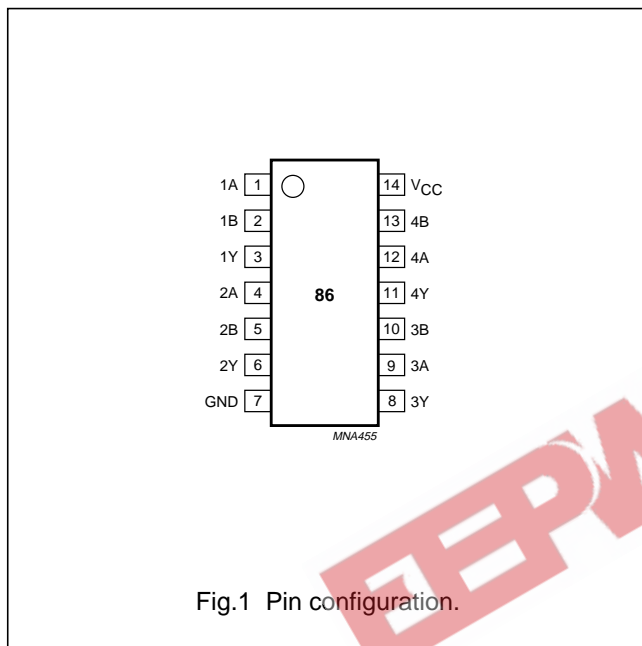
OUTSIDE NORTH AMERICA	NORTH AMERICA	PACKAGES			
		PINS	PACKAGE	MATERIAL	CODE
74AHC86D	74AHC86D	14	SO	plastic	SOT108-1
74AHC86PW	74AHC86PW DH	14	TSSOP	plastic	SOT402-1
74AHCT86D	74AHCT86D	14	SO	plastic	SOT108-1
74AHCT86PW	74AHCT86PW DH	14	TSSOP	plastic	SOT402-1

Quad 2-input EXCLUSIVE-OR gate

74AHC86; 74AHCT86

PINNING

PIN	SYMBOL	DESCRIPTION
1, 4, 9 and 12	1A to 4A	data inputs
2, 5, 10 and 13	1B to 4B	data inputs
3, 6, 8 and 11	1Y to 4Y	data outputs
7	GND	ground (0 V)
14	V <sub>CC</sub>	DC supply voltage



## Quad 2-input EXCLUSIVE-OR gate

## 74AHC86; 74AHCT86

## RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	74AHC			74AHCT			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
$V_{CC}$	DC supply voltage		2.0	5.0	5.5	4.5	5.0	5.5	V
$V_I$	input voltage		0	–	5.5	0	–	5.5	V
$V_O$	output voltage		0	–	$V_{CC}$	0	–	$V_{CC}$	V
$T_{amb}$	operating ambient temperature	see DC and AC characteristics per device	–40	+25	+85	–40	+25	+85	°C
			–40	+25	+125	–40	+25	+125	°C
$t_r, t_f (\Delta t/\Delta f)$	input rise and fall times except for Schmitt trigger inputs	$V_{CC} = 3.3 \pm 0.3 V$	–	–	100	–	–	–	ns/V
		$V_{CC} = 5 \pm 0.5 V$	–	–	20	–	–	20	

## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134); voltages are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{CC}$	DC supply voltage		–0.5	+7.0	V
$V_I$	input voltage		–0.5	+7.0	V
$I_{IK}$	DC input diode current	$V_I < -0.5 V$ ; note 1	–	–20	mA
$I_{OK}$	DC output diode current	$V_O < -0.5 V$ or $V_O > V_{CC} + 0.5 V$ ; note 1	–	$\pm 20$	mA
$I_O$	DC output source or sink current	$-0.5 V < V_O < V_{CC} + 0.5 V$	–	$\pm 25$	mA
$I_{CC}$	DC $V_{CC}$ or GND current		–	$\pm 75$	mA
$T_{stg}$	storage temperature		–65	+150	°C
$P_D$	power dissipation per package	for temperature range: –40 to +125 °C; note 2	–	500	mW

## Notes

- The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
- For SO package: above 70 °C the value of  $P_D$  derates linearly with 8 mW/K.  
For TSSOP package: above 60 °C the value of  $P_D$  derates linearly with 5.5 mW/K.

## Quad 2-input EXCLUSIVE-OR gate

## 74AHC86; 74AHCT86

## DC CHARACTERISTICS

## Family 74AHC

Over recommended operating conditions; voltage are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	TEST CONDITIONS		$T_{amb}$ (°C)						UNIT	
		OTHER	$V_{CC}$ (V)	25			-40 to +85		-40 to +125		
				MIN.	TYP.	MAX.	MIN.	MAX.	MIN.		MAX.
$V_{IH}$	HIGH-level input voltage		2.0	1.5	–	–	1.5	–	1.5	–	V
			3.0	2.1	–	–	2.1	–	2.1	–	
			5.5	3.85	–	–	3.85	–	3.85	–	
$V_{IL}$	LOW-level input voltage		2.0	–	–	0.5	–	0.5	–	0.5	V
			3.0	–	–	0.9	–	0.9	–	0.9	
			5.5	–	–	1.65	–	1.65	–	1.65	
$V_{OH}$	HIGH-level output voltage; all outputs	$V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -50 \mu A$	2.0	1.9	2.0	–	1.9	–	1.9	–	V
			3.0	2.9	3.0	–	2.9	–	2.9	–	
			4.5	4.4	4.5	–	4.4	–	4.4	–	
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$ ; $I_O = -4.0 \text{ mA}$	3.0	2.58	–	–	2.48	–	2.40	–	V
			4.5	3.94	–	–	3.8	–	3.70	–	
$V_{OL}$	LOW-level output voltage; all outputs	$V_I = V_{IH}$ or $V_{IL}$ ; $I_O = 50 \mu A$	2.0	–	0	0.1	–	0.1	–	0.1	V
			3.0	–	0	0.1	–	0.1	–	0.1	
			4.5	–	0	0.1	–	0.1	–	0.1	
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$ ; $I_O = 4.0 \text{ mA}$	3.0	–	–	0.36	–	0.44	–	0.55	V
			4.5	–	–	0.36	–	0.44	–	0.55	
$I_I$	input leakage current	$V_I = V_{CC}$ or GND	5.5	–	–	0.1	–	1.0	–	2.0	$\mu A$
$I_{OZ}$	3-state output OFF current	$V_I = V_{IH}$ or $V_{IL}$ ; $V_O = V_{CC}$ or GND	5.5	–	–	$\pm 0.25$	–	$\pm 2.5$	–	$\pm 10.0$	$\mu A$
$I_{CC}$	quiescent supply current	$V_I = V_{CC}$ or GND; $I_O = 0$	5.5	–	–	2.0	–	20	–	40	$\mu A$
$C_I$	input capacitance		–	–	3	10	–	10	–	10	pF

## Quad 2-input EXCLUSIVE-OR gate

## 74AHC86; 74AHCT86

## Family 74AHCT

Over recommended operating conditions; voltage are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	TEST CONDITIONS		T <sub>amb</sub> (°C)						UNIT	
		OTHER	V <sub>CC</sub> (V)	25			-40 to +85		-40 to +125		
				MIN.	TYP.	MAX.	MIN.	MAX.	MIN.		MAX.
V <sub>IH</sub>	HIGH-level input voltage		4.5 to 5.5	2.0	–	–	2.0	–	2.0	–	V
V <sub>IL</sub>	LOW-level input voltage		4.5 to 5.5	–	–	0.8	–	0.8	–	0.8	V
V <sub>OH</sub>	HIGH-level output voltage; all outputs	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = –50 µA	4.5	4.4	4.5	–	4.4	–	4.4	–	V
	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = –8.0 mA	4.5	3.94	–	–	3.8	–	3.70	–	V
V <sub>OL</sub>	LOW-level output voltage; all outputs	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 50 µA	4.5	–	0	0.1	–	0.1	–	0.1	V
	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 8.0 mA	4.5	–	–	0.36	–	0.44	–	0.55	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>	5.5	–	–	0.1	–	1.0	–	2.0	µA
I <sub>oz</sub>	3-state output OFF current	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = V <sub>CC</sub> or GND per input pin; other inputs at V <sub>CC</sub> or GND; I <sub>O</sub> = 0	5.5	–	–	±0.25	–	±2.5	–	±10.0	µA
I <sub>CC</sub>	quiescent supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0	5.5	–	–	2.0	–	20	–	40	µA
ΔI <sub>CC</sub>	additional quiescent supply current per input pin	V <sub>I</sub> = V <sub>CC</sub> – 2.1 V; other inputs at V <sub>CC</sub> or GND; I <sub>O</sub> = 0	4.5 to 5.5	–	–	1.35	–	1.5	–	1.5	mA
C <sub>I</sub>	input capacitance		–	–	3	10	–	10	–	10	pF

## Quad 2-input EXCLUSIVE-OR gate

## 74AHC86; 74AHCT86

## AC CHARACTERISTICS

## Type 74AHC86

Voltage are referenced to GND (ground = 0 V);  $t_r = t_f \leq 3.0$  ns.

SYMBOL	PARAMETER	TEST CONDITIONS		T <sub>amb</sub> (°C)						UNIT	
		WAVEFORMS	C <sub>L</sub>	25			-40 to +85		-40 to +125		
				MIN.	TYP.	MAX.	MIN.	MAX.	MIN.		MAX.
<b>V<sub>CC</sub> = 3.0 to 3.6 V; note 1</b>											
t <sub>PHL</sub> /t <sub>PLH</sub>	propagation delay nA, nB to nY	see Figs 5 and 6	15 pF	–	4.8	11.0	1.0	13.0	1.0	14.0	ns
			50 pF	–	6.8	14.5	1.0	16.5	1.0	18.5	ns
<b>V<sub>CC</sub> = 4.5 to 5.5 V; note 2</b>											
t <sub>PHL</sub> /t <sub>PLH</sub>	propagation delay nA, nB to nY	see Figs 5 and 6	15 pF	–	3.4	6.8	1.0	8.0	1.0	8.5	ns
			50 pF	–	4.8	8.8	1.0	10.0	1.0	11.0	ns

## Notes

1. Typical values at V<sub>CC</sub> = 3.3 V.
2. Typical values at V<sub>CC</sub> = 5.0 V.

## Type 74AHCT86

Ground = 0 V;  $t_r = t_f \leq 3.0$  ns.

SYMBOL	PARAMETER	TEST CONDITIONS		T <sub>amb</sub> (°C)						UNIT	
		WAVEFORMS	C <sub>L</sub>	25			-40 to +85		-40 to +125		
				MIN.	TYP.	MAX.	MIN.	MAX.	MIN.		MAX.
<b>V<sub>CC</sub> = 4.5 to 5.5 V; note 1</b>											
t <sub>PHL</sub> /t <sub>PLH</sub>	propagation delay nA, nB to nY	see Figs 5 and 6	15 pF	–	3.4	6.9	1.0	8.0	1.0	9.0	ns
			50 pF	–	4.9	8.8	1.0	10.0	1.0	11.0	ns

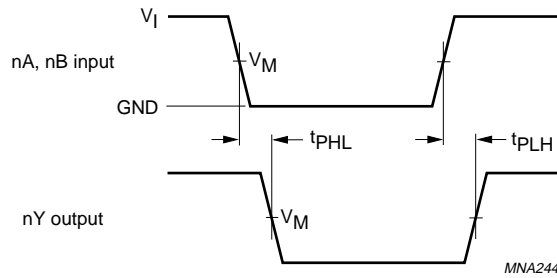
## Note

1. Typical values at V<sub>CC</sub> = 5.0 V.

Quad 2-input EXCLUSIVE-OR gate

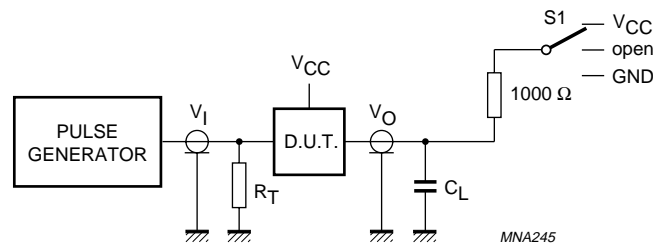
74AHC86; 74AHCT86

AC WAVEFORMS



FAMILY	V <sub>I</sub> INPUT REQUIREMENTS	V <sub>M</sub> INPUT	V <sub>M</sub> OUTPUT
AHC	GND to V <sub>CC</sub>	50% V <sub>CC</sub>	50% V <sub>CC</sub>
AHCT	GND to 3.0 V	1.5 V	50% V <sub>CC</sub>

Fig.5 The input (nA, nB) to output (nY) propagation delays.



TEST	S1
t <sub>PLH</sub> /t <sub>PHL</sub>	open
t <sub>PLZ</sub> /t <sub>PZL</sub>	V <sub>CC</sub>
t <sub>PHZ</sub> /t <sub>PZH</sub>	GND

Definitions for test circuit:  
 C<sub>L</sub> = load capacitance including jig and probe capacitance (see "AC characteristics" for values).  
 R<sub>T</sub> = termination resistance should be equal to the output impedance Z<sub>o</sub> of the pulse generator.

Fig.6 Load circuitry for switching times.



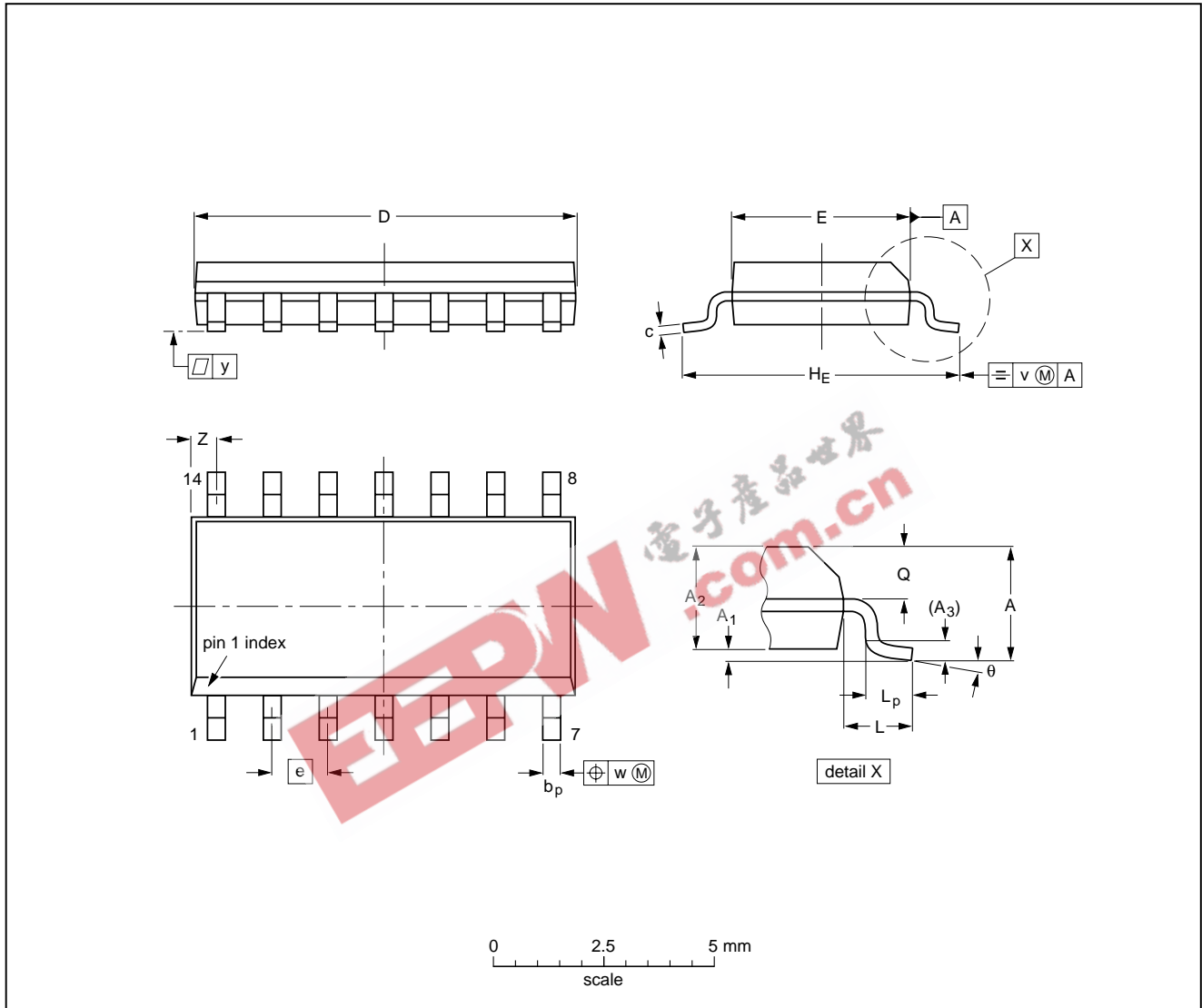
Quad 2-input EXCLUSIVE-OR gate

74AHC86; 74AHCT86

PACKAGE OUTLINES

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.35 0.34	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Note

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

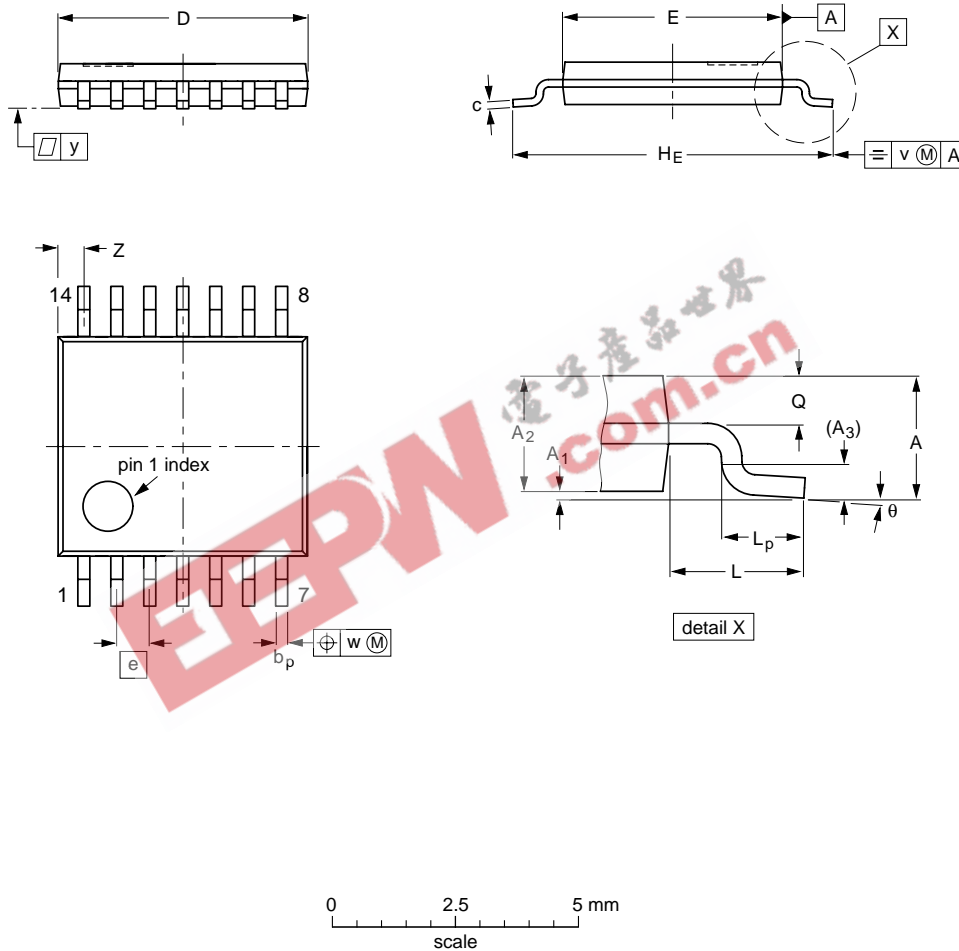
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	IEC	JEDEC	EIAJ			
SOT108-1	076E06S	MS-012AB				95-01-23 97-05-22

Quad 2-input EXCLUSIVE-OR gate

74AHC86; 74AHCT86

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	z <sup>(1)</sup>	θ
mm	1.10	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.72 0.38	8° 0°

Notes

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT402-1		MO-153				94-07-12 95-04-04

## Quad 2-input EXCLUSIVE-OR gate

## 74AHC86; 74AHCT86

**SOLDERING****Introduction to soldering surface mount packages**

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our "Data Handbook IC26; Integrated Circuit Packages" (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

**Reflow soldering**

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

**Wave soldering**

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

**Manual soldering**

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

## Quad 2-input EXCLUSIVE-OR gate

74AHC86; 74AHCT86

## Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW <sup>(1)</sup>
BGA, SQFP	not suitable	suitable
HLQFP, HSQFP, HSOP, SMS	not suitable <sup>(2)</sup>	suitable
PLCC <sup>(3)</sup> , SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended <sup>(3)(4)</sup>	suitable
SSOP, TSSOP, VSO	not recommended <sup>(5)</sup>	suitable

## Notes

- All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the "Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods".
- These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
- If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
- Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

## DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

## LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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Quad 2-input EXCLUSIVE-OR gate

74AHC86; 74AHCT86

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Quad 2-input EXCLUSIVE-OR gate

74AHC86; 74AHCT86

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Quad 2-input EXCLUSIVE-OR gate

74AHC86; 74AHCT86

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SCA 68

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