

SN74AHCT1G86 Single 2-Input Exclusive-OR Gate

1 Features

- Operating Range of 4.5 V to 5.5 V
- Max t_{pd} of 8 ns at 5 V
- Low Power Consumption, 10-A Maximum I_{CC}
- 8-mA Output Drive at 5 V
- Inputs Are TTL-Voltage Compatible
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
 - 2000-V Human Body Model (A114-A)
 - 1000-V Charged-Device Model (C101)

2 Applications

- Industrial PCs
- Stepper Motors
- AC Inverter Drives
- Notebook PCs
- Smart Meters: Data Concentrators
- Enterprise Servers

3 Description

The SN74AHCT1G86 is a single 2-input exclusive-OR gate. The device performs the Boolean function $Y = A \oplus B$ or $Y = \bar{A}B + A\bar{B}$ in positive logic.

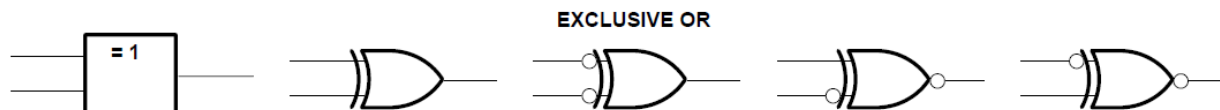
Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
SN74AHCT1G86	SOT-23 (5)	2.90 mm x 1.60 mm
		2.00 mm x 1.25 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

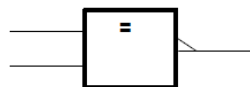
Exclusive-OR Logic

An exclusive-OR gate has many applications, some of which can be represented better by alternative logic symbols.



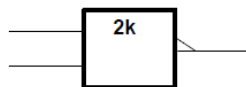
These five equivalent exclusive-OR symbols are valid for an SN74AHCT1G86 gate in positive logic; negation may be shown at any two ports.

LOGIC-IDENTITY ELEMENT



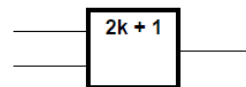
The output is active (low) if all inputs stand at the same logic level (i.e., $A = B$).

EVEN-PARITY ELEMENT



The output is active (low) if an even number of inputs (i.e., 0 or 2) are active.

ODD-PARITY ELEMENT



The output is active (high) if an odd number of inputs (i.e., only 1 of the 2) are active.



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4 Revision History

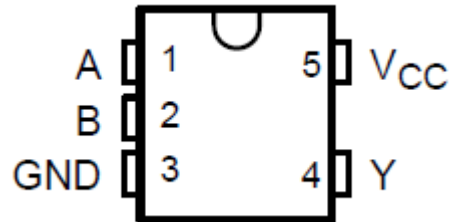
Changes from Revision L (January 2003) to Revision M

Page

- Added *Pin Configuration and Functions* section, *ESD Ratings* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section **1**

5 Pin Configuration and Functions

DBV or DCK Package
5-Pin SOT-23
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
1	A	I	A input
2	B	I	B input
3	GND	–	Ground pin
4	Y	O	Output
5	Vcc	–	Power pin

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) ⁽¹⁾

		MIN	MAX	UNIT
V _{CC}	Supply voltage	–0.5	7	V
V _I	Input voltage ⁽²⁾	–0.5	7	V
V _O	Output voltage ⁽²⁾	–0.5	V _{CC} + 0.5	V
I _{IK}	Input clamp current		–20	mA
I _{OK}	Output clamp current		20	mA
I _O	Continuous output current		25	mA
	Continuous current through V _{CC} or GND	–50	50	mA
T _{stg}	Storage temperature	–65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

6.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	2000	V
		1000	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage	4.5		5.5	V
V_{IH}	High-level input voltage	2			V
V_{IL}	Low-level input voltage			0.8	V
V_I	Input voltage	0		5.5	V
V_O	Output voltage	0		V_{CC}	V
I_{OH}	High-level output current			-8	mA
I_{OL}	Low-level output current			8	mA
t/v	Input transition rise or fall rate			20	ns/V
T_A	Operating free-air temperature	-40		125	°C

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		SN74AHCT1G86		UNIT
		DBV (SOT-23)	DCK (SC-70)	
		5 PINS	5 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	208.2	287.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	76.1	97.7	
$R_{\theta JB}$	Junction-to-board thermal resistance	52.5	65	
Ψ_{JT}	Junction-to-top characterization parameter	4	2	
Ψ_{JB}	Junction-to-board characterization parameter	51.8	64.2	

 (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report (SPRA953).

6.5 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	V_{CC}	$T_A = 25^\circ\text{C}$			$-40^\circ\text{C to } 85^\circ\text{C}$		$-40^\circ\text{C to } 125^\circ\text{C}$		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}	$I_{OH} = -50 \mu\text{A}$	4.5 V	4.4	4.5		4.4		4.4	V	
	$I_{OH} = -8 \text{ mA}$					3.8		3.8		
V_{OL}	$I_{OL} = 50 \mu\text{A}$	4.5 V			0.1		0.1	0.1	V	
	$I_{OL} = 8 \text{ mA}$				0.36		0.44	0.44		
I_I	$V_I = 5.5 \text{ V or GND}$	0 V to 5.5 V			± 0.1		± 1	± 1	μA	
I_{CC}	$V_I = V_{CC} \text{ or GND, } I_O = 0$	5.5 V			1		10	10	μA	
$\Delta I_{CC}^{(1)}$	One input at 3.4 V, Other inputs at V_{CC} or GND	5.5 V			1.35		1.5	1.5	mA	
C_i	$V_I = V_{CC} \text{ or GND}$	5 V		2	10		10	10	pF	

 (1) This is the increase in supply current for each input at one of the specified TTL voltage levels, rather than 0 V or V_{CC} .

6.6 Switching Characteristics

over recommended operating free-air temperature range, $V_{CC} = 5 V \pm 0.5 V$ (unless otherwise noted) (see)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	$T_A = 25^\circ C$		$-40^\circ C$ to $85^\circ C$		$-40^\circ C$ to $125^\circ C$		UNIT
				TYP	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A or B	Y	$C_L = 15 \text{ pF}$	5	6.2	1	8	1	9	ns
t_{PHL}				5	6.2	1	8	1	9	
t_{PLH}	A or B	Y	$C_L = 50 \text{ pF}$	5.5	7.9	1	9	1	10	ns
t_{PHL}				5.5	7.9	1	9	1	10	

6.7 Operating Characteristics

$V_{CC} = 5 V$, $T_A = 25^\circ C$

PARAMETER	TEST CONDITIONS	TYP	UNIT
C_{pd} Power dissipation capacitance	No load, $f = 1 \text{ MHz}$	18	pF

6.8 Typical Characteristics

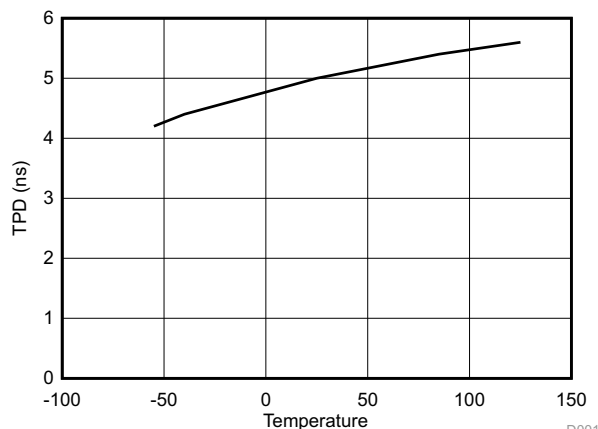
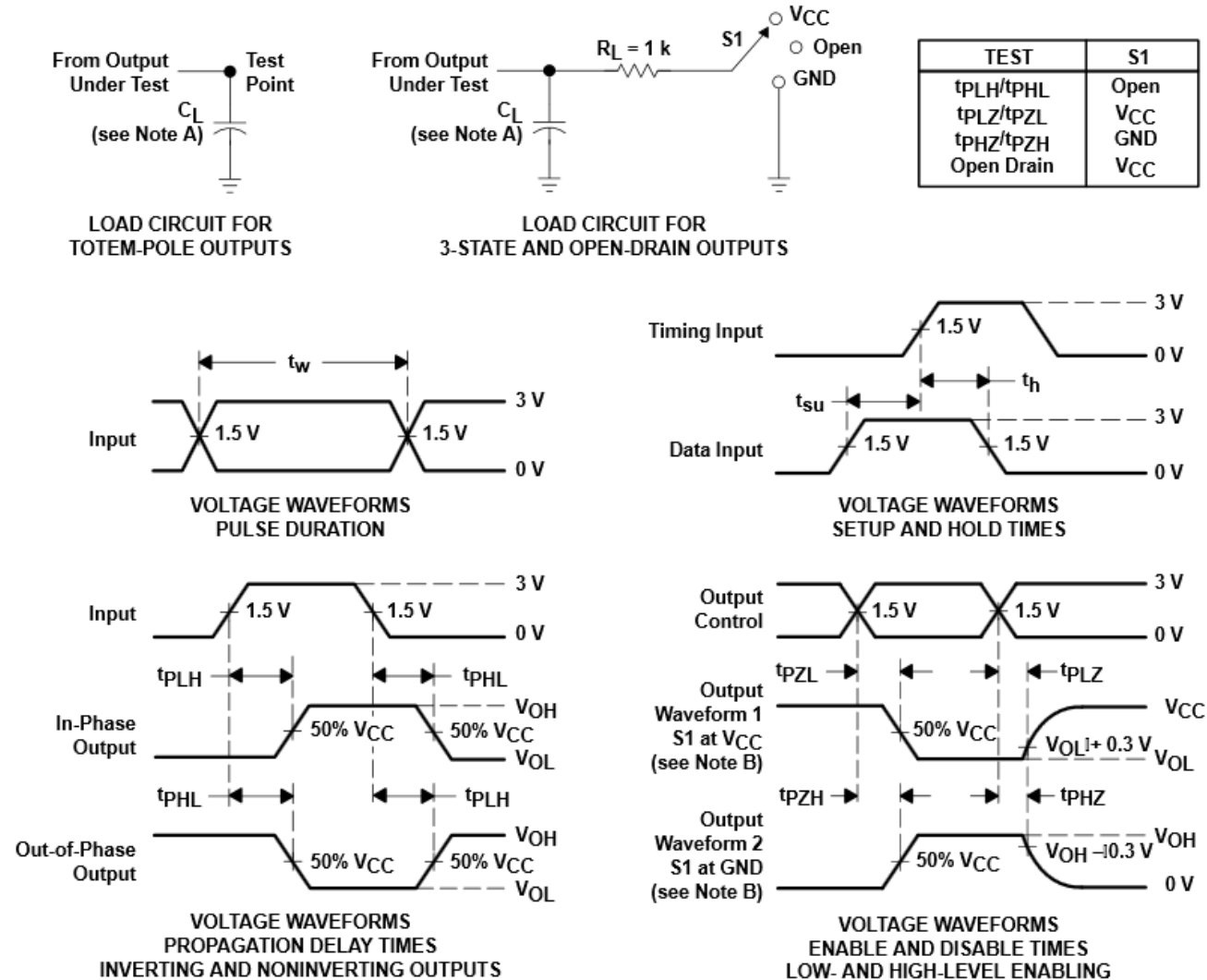


Figure 1. TPD vs. Temperature

7 Parameter Measurement Information



- NOTES: A. C_L includes probe and jig capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 C. All input pulses are supplied by generators having the following characteristics: PRR = 1 MHz, $Z_O = 50\ \Omega$, $t_r = 3\text{ ns}$, $t_f = 3\text{ ns}$.
 D. The outputs are measured one at a time with one input transition per measurement.
 E. All parameters and waveforms are not applicable to all devices.

Figure 2. Load Circuit and Voltage Waveforms

8 Detailed Description

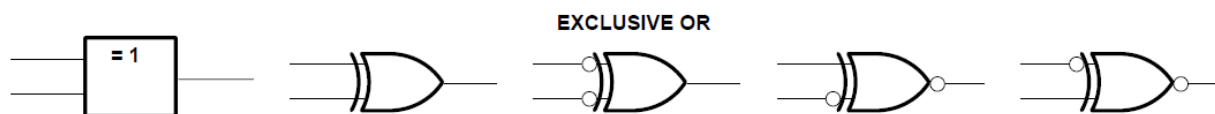
8.1 Overview

The SN74AHCT1G86 is a single 2-input exclusive-OR gate. The device performs the Boolean function $Y = A \oplus B$ or $Y = \overline{A}B + A\overline{B}$ in positive logic.

To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pull-down resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

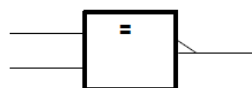
8.2 Functional Block Diagram

An exclusive-OR gate has many applications, some of which can be represented better by alternative logic symbols.



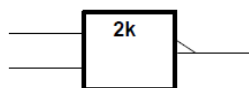
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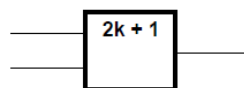
The output is active (low) if all inputs stand at the same logic level (i.e., $A = B$).

EVEN-PARITY ELEMENT



The output is active (low) if an even number of inputs (i.e., 0 or 2) are active.

ODD-PARITY ELEMENT



The output is active (high) if an odd number of inputs (i.e., only 1 of the 2) are active.

Figure 3. Exclusive-OR Logic

8.3 Feature Description

The device is ideal for operating in a 5-V logic system. The low propagation delay allows fast switching and higher speeds of operation. In addition, the low power consumption makes this device a good choice for portable and battery power-sensitive applications.

8.4 Device Functional Modes

Table 1. Function Table

INPUTS		OUTPUT
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	L

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The SN74AHCT1G86 is a Low drive CMOS device that can be used for a multitude of bus interface type applications where output ringing is a concern. The low drive and slow edge rates will minimize overshoot and undershoot on the outputs. The input switching levels have been lowered to accommodate TTL inputs of 0.8-V V_{IL} and 2-V V_{IH} . This feature makes it ideal for translating up from 3.3 V to 5 V.

9.2 Typical Application

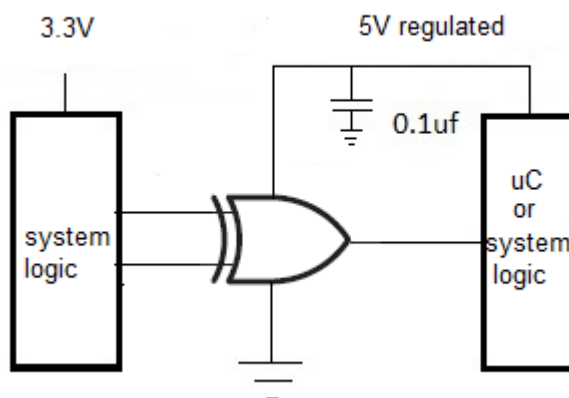


Figure 4. Typical Application Schematic

9.2.1 Design Requirements

This device uses CMOS technology and has balanced output drive. Take care to avoid bus contention because it can drive currents that would exceed maximum limits. The high drive will also create fast edges into light loads so consider routing and load conditions to prevent ringing.

9.2.2 Detailed Design Procedure

- Recommended input conditions:
 - Rise time and fall time specs. See $(\Delta t/\Delta V)$ in [Recommended Operating Conditions](#).
 - Specified high and low levels. See $(V_{IH}$ and $V_{IL})$ in [Recommended Operating Conditions](#).
- Recommended output conditions:
 - Load currents should not exceed 25 mA per output and 50 mA total for the part.
 - Outputs should not be pulled above V_{CC} .

Typical Application (continued)

9.2.3 Application Curves

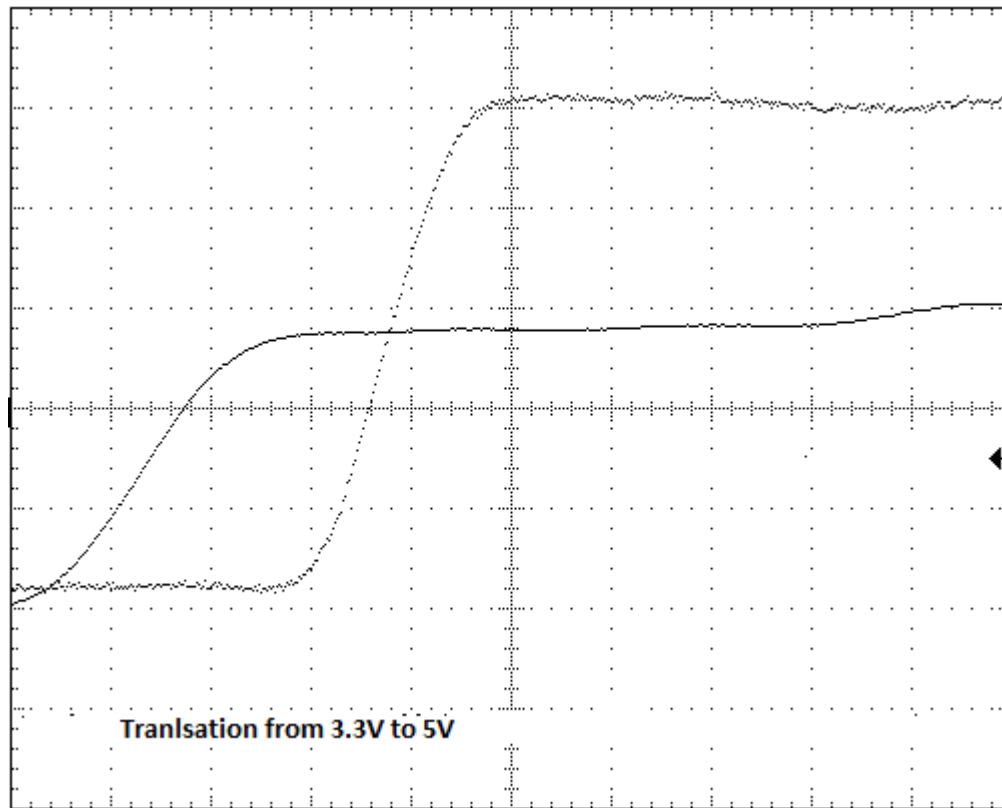


Figure 5. Translation From 3.3 V to 5.5 V

10 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the [Recommended Operating Conditions](#).

Each V_{CC} terminal should have a good bypass capacitor to prevent power disturbance. For devices with a single supply, TI recommends a 0.1- μF capacitor and if there are multiple V_{CC} terminals then TI recommends a 0.01- μF or 0.022- μF capacitor for each power terminal. Multiple bypass capacitors can be paralleled to reject different frequencies of noise. Frequencies of 0.1 μF and 1 μF are commonly used in parallel. The bypass capacitor should be installed as close as possible to the power terminal for best results.

11 Layout

11.1 Layout Guidelines

When using multiple bit logic devices inputs should not ever float.

In many cases, functions or parts of functions of digital logic devices are unused, for example, when only two inputs of a triple-input AND gate are used or only three of the four buffer gates are used. Such input pins should not be left unconnected because the undefined voltages at the outside connections result in undefined operational states. Specified below are the rules that must be observed under all circumstances. All unused inputs of digital logic devices must be connected to a high or low bias to prevent them from floating. The logic level that should be applied to any particular unused input depends on the function of the device. Generally they will be tied to GND or V_{CC} whichever make more sense or is more convenient. Floating outputs is generally acceptable, unless the part is a transceiver. If the transceiver has an output enable pin it will disable the outputs section of the part when asserted. This will not disable the input section of the I.O's so they also cannot float when disabled.

11.2 Layout Example

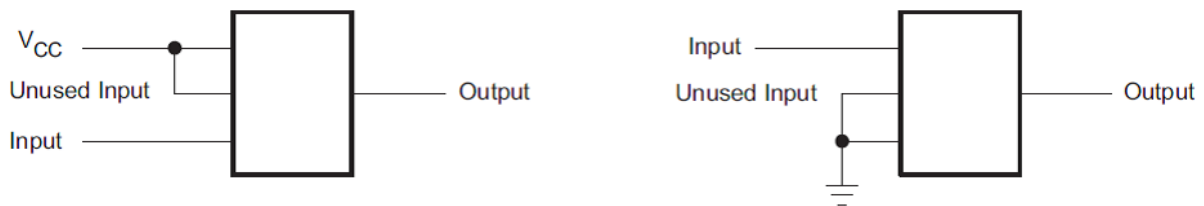


Figure 6. Layout Recommendation

12 Device and Documentation Support

12.1 Trademarks

All trademarks are the property of their respective owners.

12.2 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.3 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
74AHCT1G86DBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-40 to 125	B86G	Samples
74AHCT1G86DBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-40 to 125	B86G	Samples
SN74AHCT1G86DBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	(B863, B86G, B86J, B86S)	Samples
SN74AHCT1G86DBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	(B863, B86G, B86J, B86S)	Samples
SN74AHCT1G86DCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	(BH3, BHG, BHJ, BHL, BHS)	Samples
SN74AHCT1G86DCKT	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	(BH3, BHG, BHJ, BHL, BHS)	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

⁽⁶⁾ Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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OTHER QUALIFIED VERSIONS OF SN74AHCT1G86 :

- Automotive: [SN74AHCT1G86-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

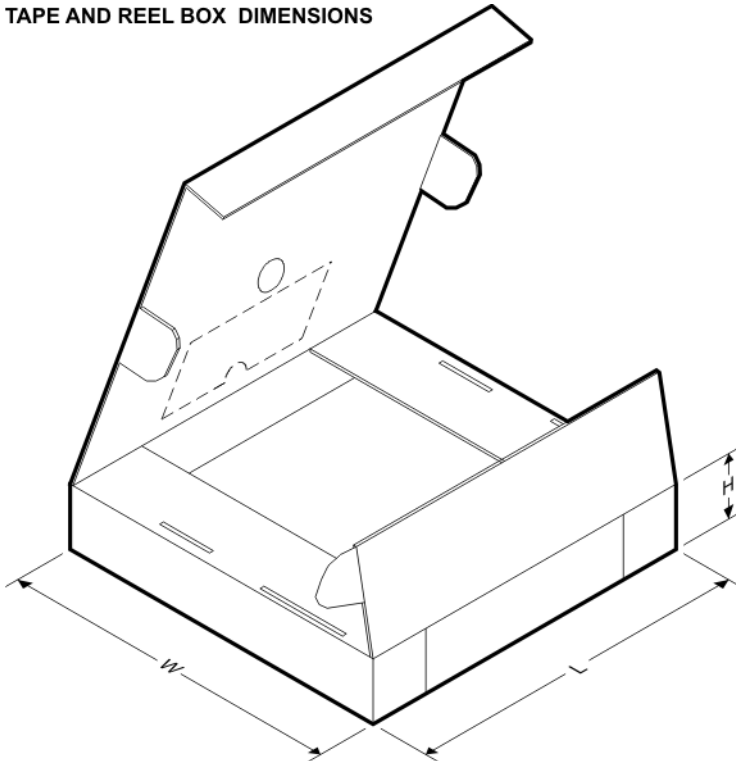


QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
74AHCT1G86DBVRG4	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
74AHCT1G86DBVTG4	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	178.0	9.2	3.3	3.23	1.55	4.0	8.0	Q3
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
SN74AHCT1G86DBVT	SOT-23	DBV	5	250	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
SN74AHCT1G86DBVT	SOT-23	DBV	5	250	178.0	9.2	3.3	3.23	1.55	4.0	8.0	Q3
SN74AHCT1G86DBVT	SOT-23	DBV	5	250	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3
SN74AHCT1G86DBVT	SOT-23	DBV	5	250	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
SN74AHCT1G86DCKR	SC70	DCK	5	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
SN74AHCT1G86DCKR	SC70	DCK	5	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
SN74AHCT1G86DCKR	SC70	DCK	5	3000	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
SN74AHCT1G86DCKR	SC70	DCK	5	3000	178.0	9.2	2.4	2.4	1.22	4.0	8.0	Q3
SN74AHCT1G86DCKT	SC70	DCK	5	250	178.0	9.2	2.4	2.4	1.22	4.0	8.0	Q3
SN74AHCT1G86DCKT	SC70	DCK	5	250	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
SN74AHCT1G86DCKT	SC70	DCK	5	250	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
74AHCT1G86DBVRG4	SOT-23	DBV	5	3000	180.0	180.0	18.0
74AHCT1G86DBVTG4	SOT-23	DBV	5	250	180.0	180.0	18.0
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	202.0	201.0	28.0
SN74AHCT1G86DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
SN74AHCT1G86DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
SN74AHCT1G86DBVT	SOT-23	DBV	5	250	202.0	201.0	28.0
SN74AHCT1G86DBVT	SOT-23	DBV	5	250	180.0	180.0	18.0
SN74AHCT1G86DCKR	SC70	DCK	5	3000	180.0	180.0	18.0
SN74AHCT1G86DCKR	SC70	DCK	5	3000	180.0	180.0	18.0
SN74AHCT1G86DCKR	SC70	DCK	5	3000	202.0	201.0	28.0
SN74AHCT1G86DCKR	SC70	DCK	5	3000	180.0	180.0	18.0
SN74AHCT1G86DCKT	SC70	DCK	5	250	180.0	180.0	18.0
SN74AHCT1G86DCKT	SC70	DCK	5	250	180.0	180.0	18.0
SN74AHCT1G86DCKT	SC70	DCK	5	250	180.0	180.0	18.0

DCK (R-PDSO-G5)

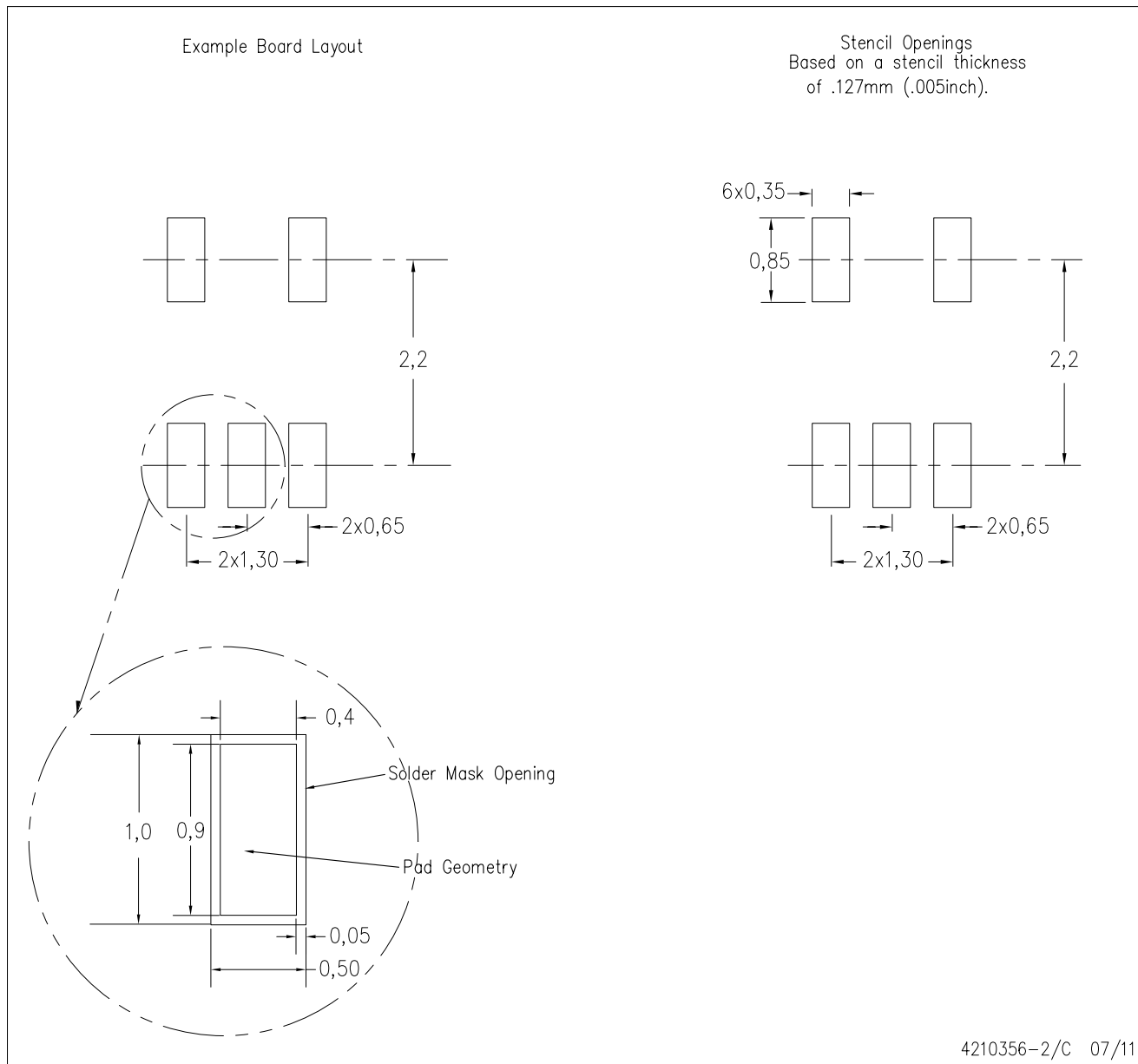
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
 - D. Falls within JEDEC MO-203 variation AA.

DCK (R-PDSO-G5)

PLASTIC SMALL OUTLINE



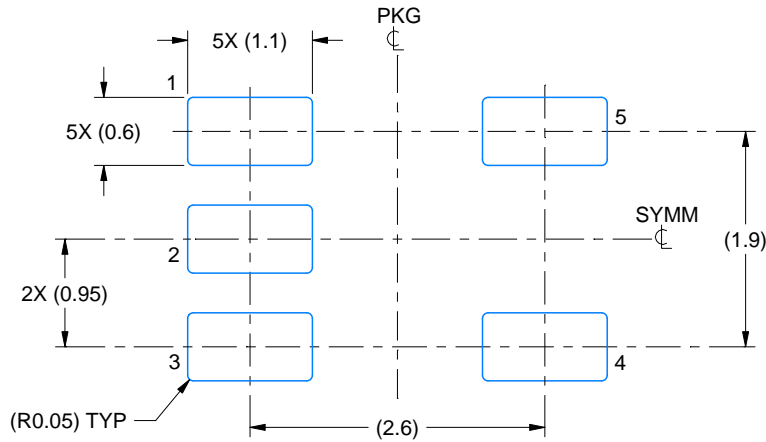
- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
 - Publication IPC-7351 is recommended for alternate designs.
 - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

EXAMPLE BOARD LAYOUT

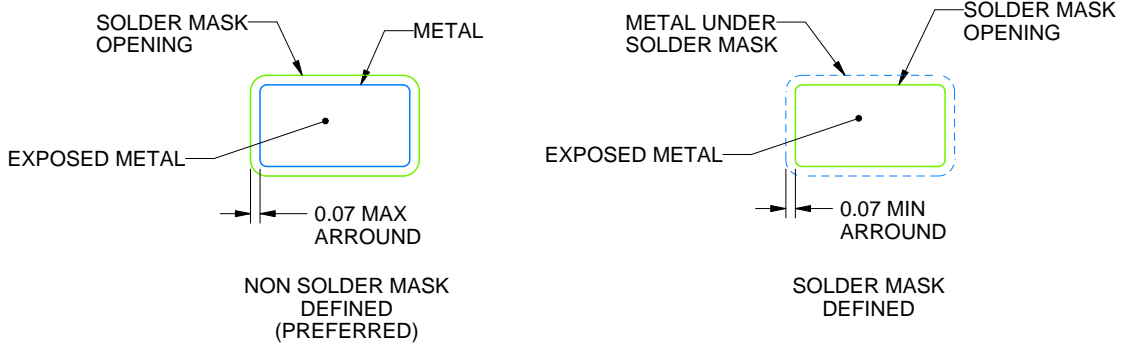
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

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NOTES: (continued)

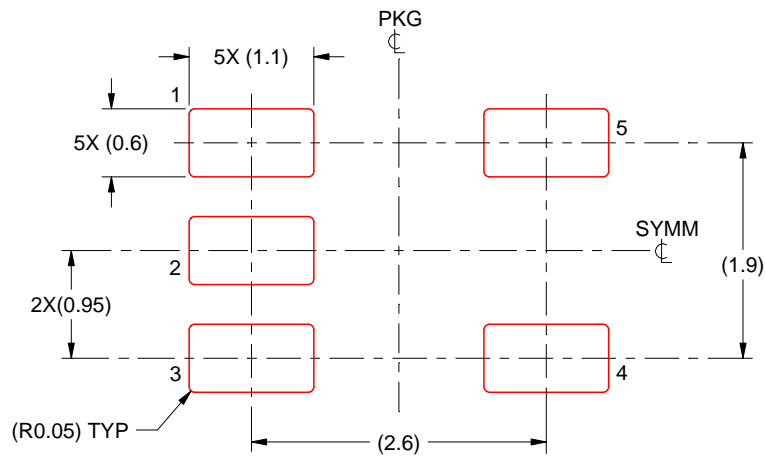
- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

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NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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