

SN74AHCT1G86 Single 2-Input Exclusive-OR Gate

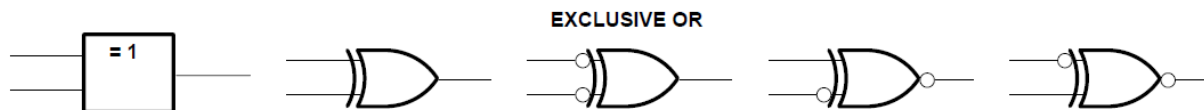
1 Features

- 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

2 Applications

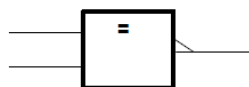
- Industrial PCs
- Stepper Motors
- AC Inverter Drives
- Notebook PCs
- Smart Meters: Data Concentrators
- Enterprise Servers

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



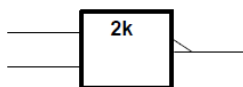
These five equivalent exclusive-OR symbols are valid for an SN74AHCT1G86 gate in positive logic; negation may be shown at any two ports.

LOGIC-IDENTITY ELEMENT



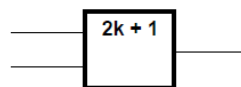
The output is active (low) if all inputs stand at the same logic level (i.e., $A = B$).

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.

Exclusive-OR Logic

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.

Package Information

PART NUMBER	PACKAGE ⁽¹⁾	PACKAGE SIZE ⁽²⁾
SN74AHCT1G86	DBV (SOT-23, 5)	2.90 mm × 2.8 mm
	DCK (SC-70, 5)	2.00 mm × 1.25 mm

- (1) For all available packages, see the orderable addendum at the end of the data sheet.
- (2) The package size (length × width) is a nominal value and includes pins, where applicable.



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4 Revision History

Changes from Revision N (August 2022) to Revision O (October 2023)	Page
<ul style="list-style-type: none"> Updated thermal values for DCK package from RθJA = 287.6 to 289.2, RθJC(top) = 97.7 to 205.8, RθJB = 65 to 176.2, ΨJT = 2 to 117.6, ΨJB = 64.2 to 175.1, RθJC(bot) = N/A, all values in °C/W 	5

Changes from Revision M (February 2015) to Revision N (August 2022)	Page
<ul style="list-style-type: none"> Updated the numbering format for tables, figures, and cross-references throughout the document..... 	1

5 Pin Configuration and Functions

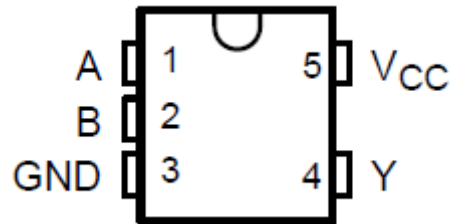


Figure 5-1. DBV or DCK Package 5-Pin SOT-23 Top View

PIN		TYPE ⁽¹⁾	DESCRIPTION
NO.	NAME		
1	A	I	A input
2	B	I	B input
3	GND	–	Ground pin
4	Y	O	Output
5	V _{CC}	–	Power pin

(1) Signal Types: I = Input, O = Output, I/O = Input or Output

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	V _I < 0		-20	mA	
I _{OK}	Output clamp current	V _O < 0 or V _O > V _{CC}		-20	20	mA
I _O	Continuous output current	V _O = 0 to V _{CC}		-25	25	mA
Continuous current through V _{CC} or GND		-50	50	mA		
T _{stg}	Storage temperature	-65	150	°C		
T _J	Junction Temperature		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	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±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 _{θJA}	Junction-to-ambient thermal resistance	208.2	289.2	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	76.1	205.8	
R _{θJB}	Junction-to-board thermal resistance	52.5	176.2	
ψ _{JT}	Junction-to-top characterization parameter	4	117.6	
ψ _{JB}	Junction-to-board characterization parameter	51.8	175.1	
R _{θJC(bot)}	Junction-to-case (bot) thermal resistance	N/A	N/A	

(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°C			–40°C to 85°C		–40°C to 125°C		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V _{OH}	High level output voltage I _{OH} = –50 μA I _{OH} = –8 mA	4.5 V	4.4	4.5		4.4		4.4		V
V _{OL}	Low level output voltage I _{OL} = 50 μA I _{OL} = 8 mA	4.5 V			0.1		0.1		0.1	V
I _I	Input leakage current V _I = 5.5 V or GND	0 V to 5.5 V			±0.1		±1		±1	μA
I _{CC}	Supply current V _I = V _{CC} or GND, I _O = 0	5.5 V			1		10		10	μA
ΔI _{CC} ⁽¹⁾	Supply-current change 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	Input capacitance V _I = V _{CC} 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 ± 0.5 V (unless otherwise noted) (see [Load Circuit and Voltage Waveforms](#))

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T _A = 25°C		–40°C to 85°C		–40°C to 125°C		UNIT
				TYP	MAX	MIN	MAX	MIN	MAX	
t _{PLH}	A or B	Y	C _L = 15 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 pF	5.5	7.9	1	9	1	10	ns
t _{PHL}				5.5	7.9	1	9	1	10	

6.7 Operating Characteristics

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

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

6.8 Typical Characteristics

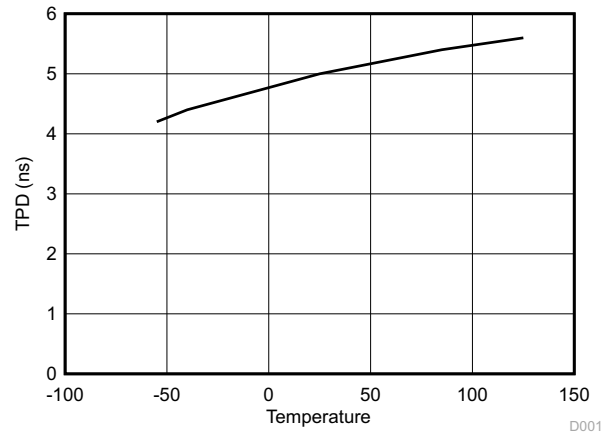
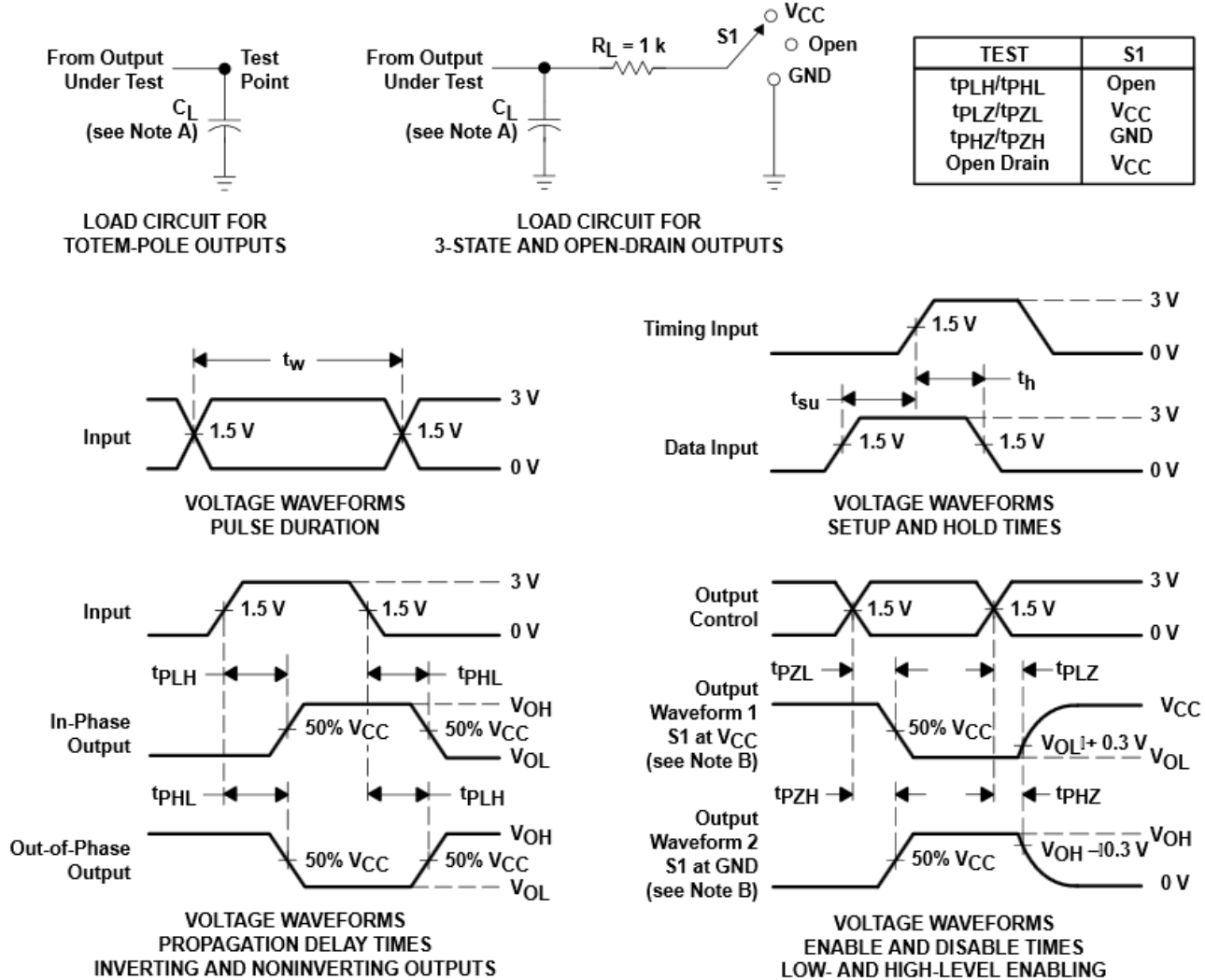


Figure 6-1. TPD vs. Temperature

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 7-1. Load Circuit and Voltage Waveforms

8 Detailed Description

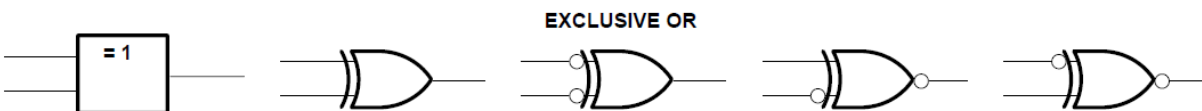
8.1 Overview

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

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

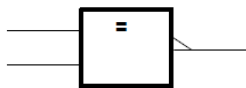
8.2 Functional Block Diagram

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



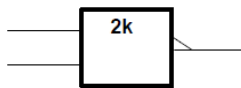
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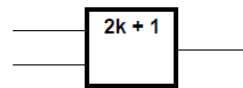
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EVEN-PARITY ELEMENT



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ODD-PARITY ELEMENT



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

Figure 8-1. 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 8-1. Function Table

INPUTS ⁽¹⁾		OUTPUT ⁽²⁾
A	B	Y
L	L	L
L	H	H
H	L	H
H	H	L

- (1) H = High Voltage Level, L = Low Voltage Level, X = Don't Care
 (2) H = Driving High, L = Driving Low, Z = High Impedance State

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, as well as validating and testing 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

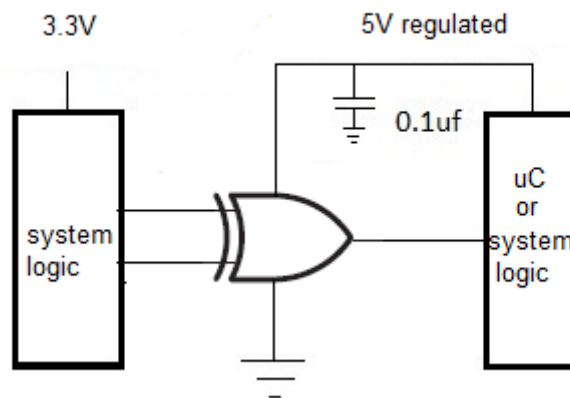


Figure 9-1. Typical Application Schematic

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 [Section 6.3](#).
 - Specified high and low levels. See $(V_{IH}$ and $V_{IL})$ in [Section 6.3](#).
- 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} .

9.2.3 Application Curves

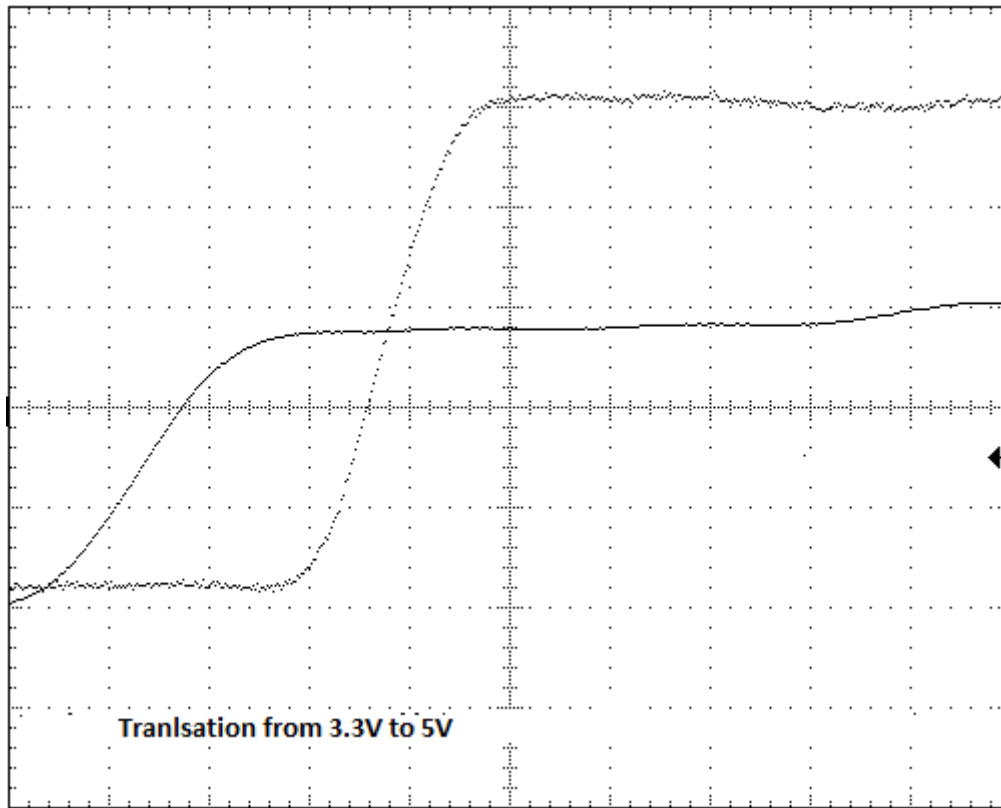


Figure 9-2. Translation From 3.3 V to 5.5 V

9.3 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the [Section 6.3](#).

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.

9.4 Layout

9.4.1 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.

9.4.2 Layout Example

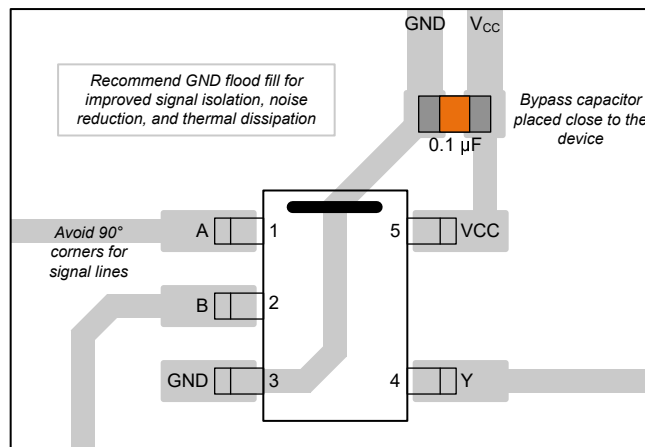


Figure 9-3. Layout Example for the SN74AHCT1G86

10 Device and Documentation Support

10.1 Documentation Support

10.1.1 Related Documentation

For related documentation, see the following:

- Texas Instruments, [CMOS Power Consumption and Cpd Calculation application note](#)
- Texas Instruments, [Designing With Logic application note](#)
- Texas Instruments, [Thermal Characteristics of Standard Linear and Logic \(SLL\) Packages and Devices application note](#)
- Texas Instruments, [Implications of Slow or Floating CMOS Inputs application note](#)

10.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](#). Click on [Subscribe to updates](#) to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

10.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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10.4 Trademarks

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10.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

10.6 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

11 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 finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
74AHCT1G86DBVRG4	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	B86G	Samples
74AHCT1G86DBVTG4	LIFEBUY	SOT-23	DBV	5	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	B86G	
SN74AHCT1G86DBVR	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	(B863, B86G, B86J, B86S)	Samples
SN74AHCT1G86DCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU SN	Level-1-260C-UNLIM	-40 to 125	(1QV, BH3, BHG, BH J, 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.

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

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continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

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	180.0	8.4	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
SN74AHCT1G86DCKR	SC70	DCK	5	3000	180.0	8.4	2.3	2.5	1.2	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
SN74AHCT1G86DCKR	SC70	DCK	5	3000	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	202.0	201.0	28.0
SN74AHCT1G86DBVR	SOT-23	DBV	5	3000	180.0	180.0	18.0
SN74AHCT1G86DCKR	SC70	DCK	5	3000	210.0	185.0	35.0
SN74AHCT1G86DCKR	SC70	DCK	5	3000	180.0	180.0	18.0
SN74AHCT1G86DCKR	SC70	DCK	5	3000	180.0	180.0	18.0

DBV0005A



PACKAGE OUTLINE

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



NOTES:

- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- Reference JEDEC MO-178.
- Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
- Support pin may differ or may not be present.

EXAMPLE BOARD LAYOUT

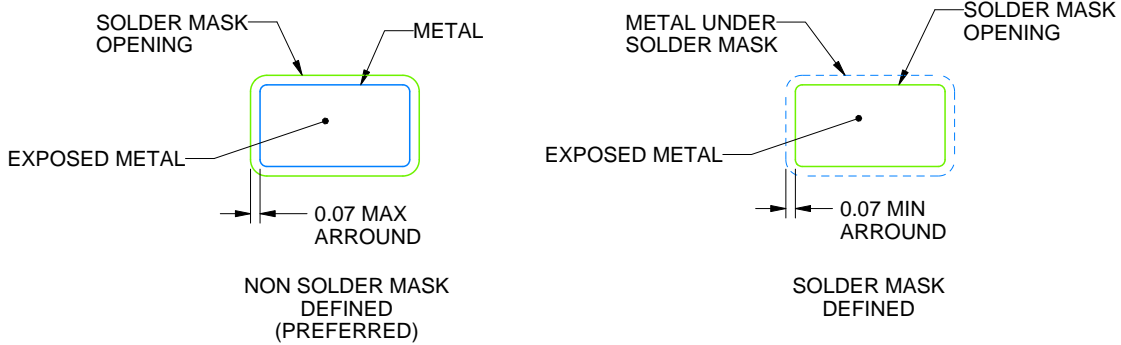
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

4214839/H 09/2023

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. 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

4214839/H 09/2023

NOTES: (continued)

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

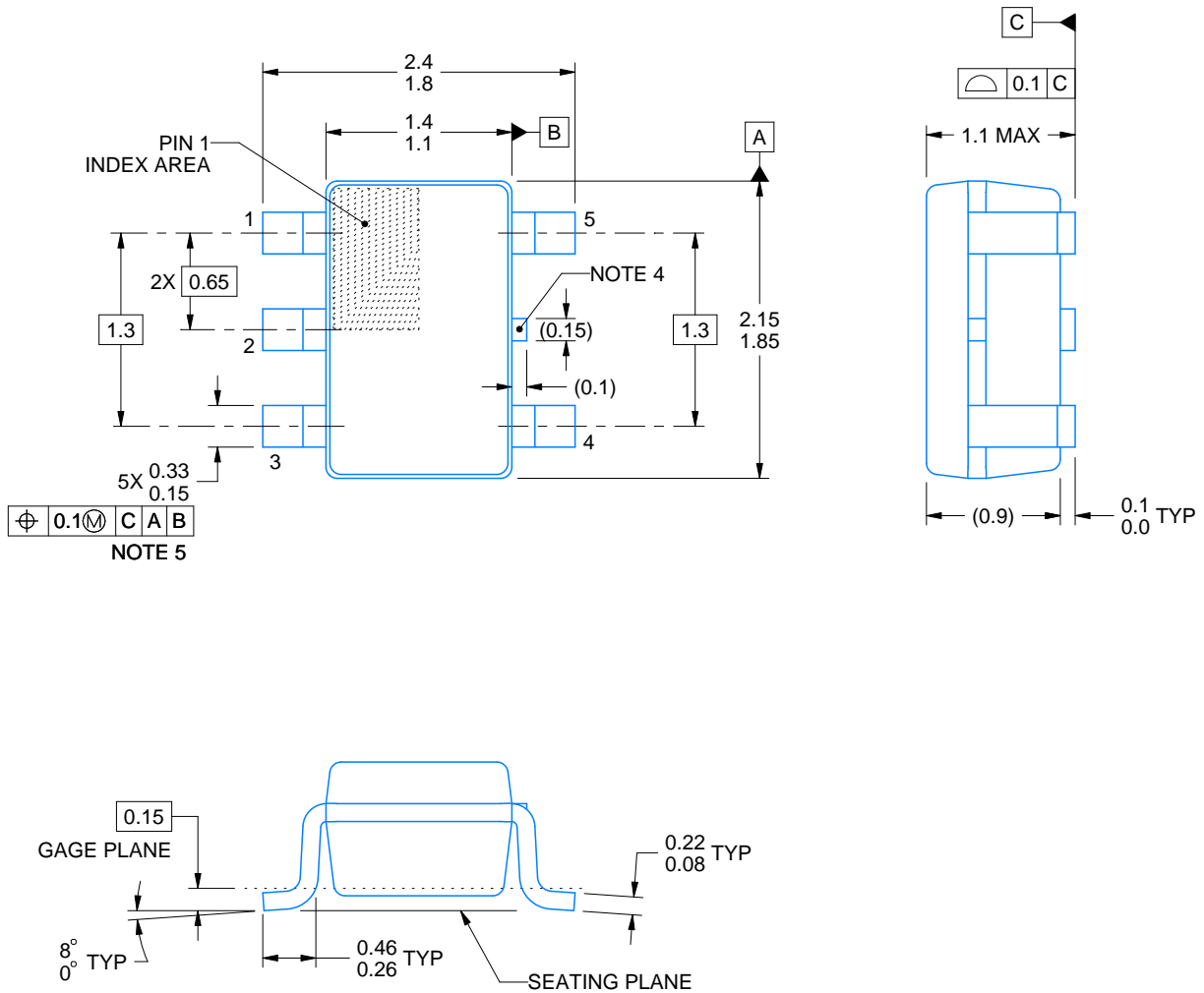
DCK0005A



PACKAGE OUTLINE

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



4214834/D 07/2023

NOTES:

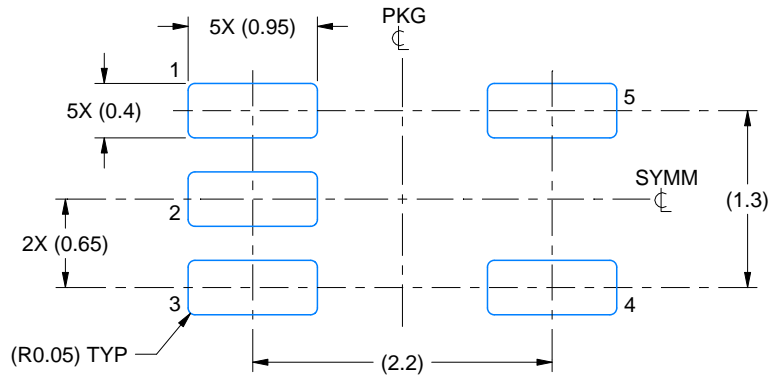
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-203.
4. Support pin may differ or may not be present.
5. Lead width does not comply with JEDEC.

EXAMPLE BOARD LAYOUT

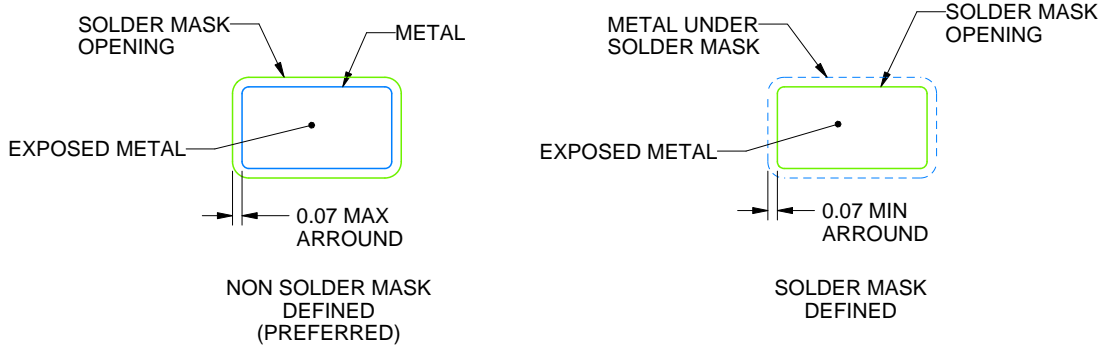
DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X



SOLDER MASK DETAILS

4214834/D 07/2023

NOTES: (continued)

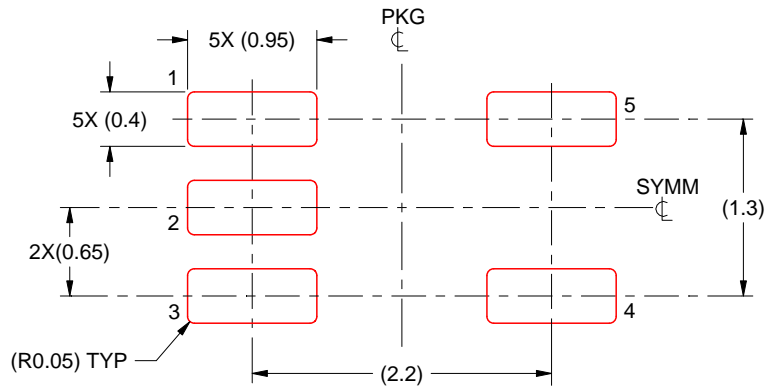
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:18X

4214834/D 07/2023

NOTES: (continued)

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

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